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Comparison of MACCS Users Calculations for the International Comparison Exercise on Probabilistic Accident Consequence Assessment Codes

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Prepared for
U.S. Nuclear Regulatory Commission

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ABSTRACT

Over the past several years (1990-1993), the OECD/NEA and CEC sponsored an international program intercomparing a group of six probabilistic consequence assessment (PCA) codes designed to simulate health and economic consequences of radioactive releases into the atmosphere following severe accidents at nuclear power plants (NPPs): ARANO (Finland), CONDOR (UK), COSYMA (CEC), LENA (Sweden), MACCS (USA), and OSCAAR (Japan). In parallel with this effort, two separate groups performed similar calculations using the MACCS and COSYMA codes. Results produced in the MACCS Users Group (Greece, Italy, Spain, and USA) calculations and their comparison are contained in the present report. Version 1.5.11.1 of the MACCS code was used for the calculations.

Good agreement between the results produced in the four participating calculations has been reached, with the exception of the results related to the ingestion pathway dose predictions. The main reason for the scatter in those particular results is attributed to the lack of a straightforward implementation of the specifications for agricultural production and countermeasures criteria provided for the exercise. A significantly smaller scatter in predictions of other consequences was successfully explained by some differences in meteorological data and weather sampling, by choices made by the participants in specifying the calculational grids, rain distance intervals, dispersion model options, as well as by differences in grid specification of population distribution.

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EXECUTIVE SUMMARY

Following the first comprehensive study of consequences of severe accidents at nuclear power plants, resulting in radioactive releases into the atmosphere, several countries initiated development of probabilistic consequence assessment (PCA) codes. The CRAC code developed in the early-seventies in the United States for predicting the health and economic consequences of radioactive releases was, to a large degree, a predecessor of those various codes. A later version of the CRAC code, CRAC2, eventually became the base for development of the US Nuclear Regulatory Comission code MACCS (MELCOR Accident Consequence Code System). The purpose of the MACCS code is to probabilistically simulate off-site health and economic consequences of radioactive releases following severe accidents at nuclear facilities. The code can be used for various applications including Probabilistic Risk Assessment (PRA) of nuclear power plants and other nuclear facilities, for sensitivity studies determining parameters important for PRA, and for cost-benefit analysis.

Over the past several years (1990-1993), the OECD/NEA and CEC co-sponsored an international program intercomparing six probabilistic consequence assessment codes. These codes are currently being used by different countries for predicting health and economic consequences of severe accidents at nuclear power plants that could result in releases of radioactive materials into the atmosphere. The six codes are: ARANO (Finland), CONDOR (UK), COSYMA (CEC), LENA (Sweden), MACCS (USA), and OSCAAR (Japan). In parallel with this inter-code comparison effort, two separate international groups performed similar calculations using the MACCS and COSYMA codes. These two codes were selected for this particular study because of their large users base in different countries. Results produced in the MACCS Users Group calculations and their comparison are contained in the present report. All calculations were performed using the MACCS 1.5.11.1 version of the code either on the IBM-PC or mainframe computers.

There were four countries in the MACCS Users Group participating in the MACCS inter-comparison exercise: Greece, Italy, Spain, and USA. The main tasks established for each team of participants were to: a) interpret the specifications developed for the exercise by the project management group, b) prepare the input data for MACCS and perform the requested calculations, c) analyze the results of comparison, and d) participate in preparation of the MACCS Users Group Summary Report.

Over the duration of the project, the MACCS Users Group had several meetings discussing specifications and their interpretation for adaptation into the MACCS input. In addition, the US team provided their MACCS input data files to the Group participants for reference purposes. However, the individual users were encouraged to follow their own approach in preparing the code's input.

The objectives established for the MACCS Users Group intercomparison effort were as follows:

- Provide quality assurance of the MACCS input data for the inter-code comparison calculations through comparison of four independently prepared MACCS input sets

- Provide a forum for discussion of users' experience with the MACCS code and its documentation

- Evaluate sensitivity of the code predictions to the different users' choices in input preparation from the same specification

- Analyze the results and explain the differences between the results, if any

- Confirm the adaptability of the MACCS code by implementing the inter-code comparison specification which was not specially designed for the MACCS code

- Recommend areas for code improvement

During the exercise, users from different countries successfully interpreted benchmarking specifications and used them to prepare the MACCS input data files, thus demonstrating the capability of MACCS to accept data which were not designed specifically for use in the MACCS code (the exception was the interpretation of the agricultural data). Yet, it was observed that the choices which the users make in the process of preparation of input data from the same specifications can result in noticeable differences between the predictions.

In general, good agreement between the results calculated by the four participants was reached with the exception of the results related to the ingestion pathway. The largest differences in the ingestion pathway results were found in the following related predictions: ingestion dose, crop disposal area, and cost of food banning. Relatively large variations in related consequence measures are due to different approaches in implementing the specification since the information provided in the specification could not be readily adopted by MACCS. Specifically, differences between the participants' modeling of the annual human food basket, criteria for crop disposal and farmland interdiction, mapping of agricultural production, as well as values for retention and transfer factors for different crop groups were the major cause of the observed variations. Differences in weather sampling, weather sequence categorization, dispersion model options, grid definition, and population distributions also contributed to the large variations in ingestion pathway consequence measures.

Among the users' recommendations for code improvements were the following: a) to provide a more flexible ingestion pathway model; b) to include into the MACCS code package a program for transforming data from geographical to a polar grid; c) to expand options available for modeling short and long-term counter-measure actions; d) to provide users with the predicted air and ground concentration of various radionuclides; and e) to improve the code's capability in modeling long-duration releases.

Interaction between the participants helped to quality assure the MACCS input data files used in the calculations, analyze results and provide explanations for differences between the four MACCS Users Group calculation results.

In order to provide MACCS users with a forum for discussing future MACCS improvements and for exchange of experiences in applying the code in various accident consequence evaluations, an International MACCS Users Group has been established.

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1 INTRODUCTION AND OBJECTIVES

The objective of this report is to complement two main reports – Overview Report [1] and Technical Report [2] – published jointly by OECD/NEA and CEC at the conclusion of an international program intercomparing a group of six probabilistic consequence assessment (PCA) codes. These codes are currently used by different countries for predicting health and economic consequences of severe accidents at nuclear power plants that could result in releases of radioactive materials into the atmosphere. The six codes are: ARANO (Finland), CONDOR (UK), COSYMA (CEC), LENA (Sweden), MACCS (USA), and OSCAAR (Japan). In parallel with this inter-code comparison effort, two separate international groups performed similar calculations using the MACCS and COSYMA codes. Results produced in the MACCS Users Group calculations and their comparison are contained in the present report. All calculations were performed using the MACCS 1.5.11.1 version of the code either on the IBM-PC or mainframe computers.

1.1 Background

Following the first comprehensive study of consequences of severe accidents at nuclear power plants resulting in releases into atmosphere of radioactive materials [3], several countries initiated development of PCA codes. The CRAC code [4] developed in the early-seventies in the United States for predicting the health and economic consequences of radioactive releases was, to a large degree, a predecessor of those various codes. A later version of the CRAC code, CRAC2 [5] eventually became the base for development of the U.S. NRC code MACCS (MELCOR Accident Consequence Code System) [6,7].

The purpose of the MACCS code is to probabilistically simulate offsite health and economic consequences of radioactive releases following severe accidents at nuclear power plants. The code can be used for various applications including Probabilistic Risk Assessment (PRA) of nuclear power plants and other nuclear facilities, for sensitivity studies determining parameters important for PRA, and for cost-benefit analyses.

There were four countries in the MACCS Users Group, participating in the MACCS code inter-comparison exercise:

GREECE:	Institute of Nuclear Technology and Radiation Protection, N.C.S.R. "Demokritos";
ITALY:	ENEL, ENEA/DISP, and ENEA/NUC-RIN;
SPAIN:	Universidad Politecnica de Madrid (UPM) and Consejo de Seguridad Nuclear;
USA:	Brookhaven National Laboratory, U.S. NRC, and U.S. DOE.

Each country's team produced one set of calculations used for comparisons. The four main tasks established for the participating teams were to:

- interpret the specifications developed for the exercise by the project management group,
- prepare the input data for MACCS and perform the requested calculations,
- analyze the results of comparison, and
- participate in preparation of the MACCS Users Group Summary Report.

Over the life of the project, the MACCS Users Group had several meetings discussing specifications and their interpretation for adaptation into the MACCS input. In addition, the U.S. team provided its MACCS input data files to the Group participants for reference purposes. However, the individual users were encouraged to follow their own approach in preparing the code's input. At a later stage, the differences in results were discussed and successfully explained in terms of the differences in the MACCS input used by the participants. In some cases, sensitivity calculations were performed to support the conclusions of comparisons.

Principal differences in the results within the group were attributed to differences in the specification data post-processed for use as input for MACCS, and particularly, the data for agricultural crop production and ingestion pathways as discussed in greater detail later in this report. One of the conclusions of the MACCS Users Group exercise was that the users can have a noticeable impact on PCA code results through specifications interpretation and thus, input preparation.

1.2 Objectives of MACCS Intercomparison

The objectives established for the MACCS Users Group inter-comparison effort included the following:

- Provide quality assurance of the MACCS input data for the inter-code comparison calculations through comparison of four independently prepared MACCS input data sets;
- Provide a forum for discussion of users' experience with the MACCS code and its documentation;
- Evaluate sensitivity of the code predictions to the different users' choices in input preparation from the same specification;
- Analyze the results and explain the differences between the results, if any;
- Confirm the adaptability of the MACCS code by implementing the inter-code comparison specification which was not specially designed for the MACCS code;
- Recommend areas for code improvement.

1.3 Report Organization

The report consists of five chapters and seven appendices. The Introductory Chapter is followed by Chapter 2 discussing the exercise specifications (various cases to be calculated and corresponding data) and their interpretation by different users. A table listing all major differences in the MACCS input is presented in Section 2.3.

A comparison of the results produced by different users is presented in Chapter 3. The results include the dose consequences, health effects, effects of counter-measures, and economic effects. Chapter 4 contains some users comments on possible MACCS improvements in the areas of the code's general features, models, and documentation. The report ends with Chapter 5 containing summary and conclusions which are followed by seven Appendices providing some additional information such as:

a) MACCS input data files,
b) sensitivity of results to the mapping of the agricultural production data,
c) predictions of integrated air concentration and ground surface contamination at specified locations (these results were produced by the Italian participants using a modified version of the MACCS code),
d) a list of consequence measures (from now on referred to as end-points) requested for comparison indicating those which are available from the MACCS's standard output,
e) table of results containing major end-points for all six calculations: 5th, 50th (median), 90th, and 95th percentiles, and the mean values,
f) the original specification paper distributed among the participants at the beginning of the exercise, and
g) details on the approach used to convert the data supplied on the rectangular geographical data to the polar grid.

2 INPUT DATA SPECIFICATIONS AND REQUESTED MEASURES

The participants of the exercise were provided with a comprehensive set of input specifications describing a fictitious site with the surrounding area extending to 2000 km from the point of release. The data base included such information as population distribution, land use, agricultural production and economic data on geographical grids of varying scales. Also provided was the hourly meteorological information for a period of one year [8,9]. In addition, values for external exposure shielding and shelter filtering parameters, dry deposition velocity, wash-out coefficient for wet deposition, surface roughness, and breathing rate were specified. There were five source terms given for the exercise varying in duration and energy of release, time before release, and fraction of the total inventory released to the environment for each isotope.

The specifications also included a set of counter-measures representing a largely over-simplified reality in order to minimize potential differences in results due to different approaches in modeling counter-measures by various codes. Finally, the series of cases to be calculated were provided. For details on specifications, the reader is referred to Appendix F.

2.1 Calculation Cases and Source Terms

Originally, there were ten cases (C1-C10) specified for calculations. However, in the course of the project, three of the cases were eliminated by the project management since the remaining cases would, to a large degree, serve the purpose of the codes inter-comparison. The last of the remaining seven cases was not calculated by MACCS since the code does not have the option for food disposal and farmland interdiction counter-measures based on the predicted crop contamination level (Bq/kg); instead, it interdicts farmland based on a projected dose from ingestion of food grown oncontaminated land. The final set of calculation cases is shown in Table 2.1. As it follows from the table, various combinations of scenarios and source terms (Table 2.2) cover a wide area of accident conditions and counter-measures thus providing an opportunity to exercise different features of the codes; objectives for each calculation can be found in Column 4 of Table 2.1.

2.2 Implementation and Interpretation of Specifications

This section discusses some difficulties the users experienced in interpreting and implementing the specifications for use in the MACCS calculations. Where possible, implications of various assumptions which had to be made and their significance in predicting the end-points of the calculations are also given. It is worth mentioning that the major difficulties with interpretation of specifications in the agriculture/economic area stem from the MACCS's general approach geared towards macro- as opposed to micro-modeling of the global economy and agriculture. Therefore, as it will appear from the discussion below, in preparation of the MACCS input files, approximations of the data provided in specifications were made.

Although all PCA codes participating in the exercise had many similarities in the approach to modeling of the major phases of consequence calculations (meteorological sampling, materials dispersion/deposition, dose/health effects predictions, and economic consequences), there were some differences in the input data requirements. It was recognized at the outset of the project that an attempt to satisfy all specific requirements of all codes would lead to a prohibitively large volume of input data and still would not eliminate all ambiguities in the input data interpretations due to the inherent difference in approaches adopted by the PCA codes. Therefore, the designers of the input specifications chose to use the "best possible" common set of input data, leaving its interpretation to the users of the participating codes.

Table 2.1 Matrix of Calculation Cases

Case*	Case Reference Name	Description	Objective
C1	Single-Phase	Source term ST2. Single-puff release. With economic predictions.	This is the base case with the counter-measures modeled. All materials are released in a single puff.
C2	Long Duration	Source term ST5: Same as ST2, but **a long duration (24 hours) release.** No economic predictions. The source term for this calculation is identical to the source term used in Case 1 except that the release duration is twenty four hours. In the BNL MACCS calculation, this release is sub-divided into four puffs of equal duration. According to the specifications of June 1992, all released materials are uniformly distributed among the puffs.	This case is designed to provide data on sensitivity of consequences to the duration of release.
C3	Single-Phase, No C/M	Source term ST2. Single-puff release. No counter-measures (no evacuation/relocation, no food disposal, and no farmland interdiction). No economic predictions.	This case predicts consequences of a release with no counter-measures. The results are very valuable for comparisons between different codes where implementation of the specified counter-measures could not be accomplished exactly.
C5	Two-Phase + Energy	Source term ST1. Two-puff release. Energy of release is greater than zero (plume lift-off). No economic predictions.	In this calculation the materials (same fraction of the total inventory as in the base case) are released in two puffs of different duration. Effect of the release energetics is investigated (plume lift-off).
C6	Low Magnitude	Source term ST3. Single-puff low magnitude release. Radius of Fixed (Evacuation) Area is 5 km (Note: In the base case scenario, the radius is 10 km). With economic predictions.	In this case the content of aerosols release is reduced by two orders of magnitude (fraction of released noble gases is reduced only by one order of magnitude). In addition, radius of the sheltering zone is reduced by a factor of two.
C7	Three-Phase	Source term ST4. Triple-puff release. No economic predictions.	In this case, the base case release is split into three identical puffs but with different release times.

*Note that the case numbers are not contiguous which reflects the evolution of the cases matrix over the duration of the project.

Table 2.2 Source Terms

Source Term	Warning Time* (h)	Release Time (h)	Duration of Release (h)	Energy of Release (W)	Xe/Kr	I	Cs	Te	Sr	Ru	La	Ce	Ba
ST1	1.0	2.0	1.0	2.0E+6	1.0	0.101	0.1	0.05	0.0	0.0	0.0	0.0	0.0
		3.0	5.0	2.0E+5	0.0	0.0	0.0	0.05	0.01	0.01	0.001	0.001	0.01
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BHADBCAADEA	0.36	1.03	0.5	1.9E+6	0.99	0.07	0.072	0.0094	0.0024	4.3E-4	1.2E-4	5.5E-4	0.0027
BHADBCAADDA		2.8	6.1	1.7E+5	0.01	0.047	0.0076	0.033	0.011	3.1E-4	0.0013	0.0014	0.0093
ST2	1.0	2.0	1.0	0	1.0	0.101	0.1	0.10	0.01	0.01	0.001	0.001	0.01
ST3	1.0	2.0	1.0	0	0.1	0.00101	0.001	0.001	1.E-4	1.E-4	1.E-5	1.E-5	1.E-4
ST4	1.0	2.0	1.0	0	1.0	0.03333	0.033	0.033	0.0033	0.0033	0.00033	0.00033	0.0033
		3.0	1.0	0	0.0	0.03333	0.033	0.033	0.0033	0.0033	0.00033	0.00033	0.0033
		5.0	1.0	0	0.0	0.03333	0.033	0.033	0.0033	0.0033	0.00033	0.00033	0.0033
ST5	1.0	2.0	24.0	0	1.0	0.101	0.1	0.10	0.01	0.01	0.001	0.001	0.01

*Time in the table is counted from the time of SCRAM according to the MACCS convention

**This is a two-puff release corresponding to the V-sequence (by-pass) in the NUREG-1150 Study (CR-4551) for the Surry-1 nuclear power plant (three-loop PWR). This accident sequence is initiated by a failure of the check valves separating the RCS and the Low Pressure Injection System (LPSI). A release into the environment through the auxiliary building develops following a subsequent failure of the LPSI piping. This source term with some modifications served as a prototype for this international intercomparison exercise

Below is an overview of the different MACCS users' assumptions used for interpreting the specifications in the course of preparing the MACCS input data. The exercise indicated that the most significant difficulty was experienced in the course of implementation of the specifications pertinent to the agricultural production /consumption. This directly affected calculations of the ingestion collective doses and health and economic effects as well as modeling the specified counter-measures based on contamination of the agricultural products and farmland. The comments below are arranged in the order of their importance in influencing the results of the calculations.

2.2.1 Interpretation of Agriculture and Economic Data

Most of the difficulties were encountered during preparation of the CHRONC input file containing the ingestion, economic, and long term counter-measures data. In general, all the codes participating in the exercise had rather different approaches in modeling the ingestion pathway. The differences in modeling, in turn, lead to differences in specification data required for creating appropriate code input data. Therefore, interpretation and implementation of specifications related to agricultural production and food consumption were more difficult to implement as compared to modeling of the other pathway exposures and consequences.

Some of the agriculture and economic data specifications could not be directly adapted into the MACCS input, forcing the users to introduce additional assumptions. This was the case for several issues including number of economic/agricultural regions specified for the calculations, humans annual food basket, animals feed basket, and various crops growing area distributions.

For example, the specifications provide partitioning of specific crops production in each grid cell on the map, while MACCS assigns identical partitioning of the crops on the entire map. In addition, the MACCS code limits the number of unique economic/agricultural regions to ninety nine (99). However, the calculational grid used for the exercise consisted of 29 x 16 = 464 rectangular cells. Although the production data were specified for seven regions on the map, the number of regions with unique production patterns was exceeding the limit. The large number of unique patterns was caused by the mixing of data from different regions on the boundaries between these seven regions when transforming from the rectangular grid to the polar grid. Therefore, a simplified approach using a homogenized production rate was employed for the MACCS calculations performed by the US team while a sensitivity calculation was performed in order to evaluate potential differences in the results due to this choice of mapping (see Appendix B for the results of the sensitivity studies).

An additional sensitivity calculation to the TCROOT parameters (transfer factor from soil to plants by root uptake) was performed by the Spanish participants. This set of parameters is important for the long term ingestion pathway dose calculations. The sensitivity calculations showed that the mean value of ingestion dose in Spanish calculations (Case 1) was about 1.6 times higher (1.02E4 P-Sv/6.21E3 P-Sv) than the corresponding value predicted in the US calculations. This indicates that differences in assumptions used for deriving TCROOT values resulted in significant differences in the dose predictions.

Different approaches chosen by the MACCS Users Group participants in modeling the agriculture and economic are presented in Section 2.3.

2.2.2 Counter-Measures Specifications

The original exercise specifications included some counter-measure scenarios which could not be implemented into the MACCS code, and all but e) were eventually replaced by other scenarios. Those included:

a) evacuation and sheltering from a 60-degree sector (eventually replaced by a full circle evacuation),
b) sheltering and evacuation conditional on a specified dose criterion (replaced by timed sheltering /evacuation),
c) request for sheltering with no evacuation (replaced with sheltering followed by instant evacuation),
d) separate projected exposure criteria for relocation and return of relocatees (replaced by a single criterion), and
e) crop bans/crop farmland interdiction based on the specific crop's contamination level.

After several discussions within the project management and Ad-Hoc groups, only the last set of specifications – crop bans/farmland interdiction criteria – was not modified since it could not be done in a way that it could become readily adaptable by all participating codes.

The crop bans (disposal)/farmland interdiction criteria in the exercise were specified individually for the following crops contributing to the human food basket: pasture for milk, pasture for meat, grain, vegetables, and roots and tubers. The specifications impose the following crop disposal criteria (in MACCS terminology, crop disposal refers to disposal during the growing period): eachparticular crop is banned if its consumption by an individual during one year leads to a projected ingestion dose of 5 mSv.

However, the MACCS crop disposal/farmland interdiction procedures are based on a food basket approach where all contents, i.e., all crops, of a food basket would be disposed of if the intake of the entire annual food basket was predicted to lead to a dose exceeding 5 mSv. In addition, in the MACCS code, the annual food basket is specified by a combination of farmland areas needed to produce specific amounts of various crops included into the food basket. The agricultural production data specified for the exercise, kg/yr/crop, was converted to the crop areas, m^2/person-yr/crop, by using the U. S. agricultural productivity data [7] (Appendix C, Addendum 1). The resulting annual production areas are given in Table 2.3. For comparison, areas used in the MACCS calculations by other countries' participants are also shown.

Note that these food basket crop areas do not explicitly appear in the MACCS input. Instead, they are used in an auxiliary program MAXGC which calculates maximum allowable ground contamination of the farmland such that the ingestion dose to an individual would not exceed a user-specified limit (5 mSv in this case) when consuming crops from the contaminated farmland during the growing season or in the succeeding years. To a certain degree, the difficulties in achieving consistency within the MACCS Users Group in modeling countermeasures related to the ingestion pathway were exacerbated by (a) some of the participants having only limited experience with the MAXGC code, and (b) the brevity of the MAXGC code description provided in the MACCS manual.

To illustrate the differences between MACCS and other codes participating in the main exercise in modeling the ingestion pathway counter-measures, COSYMA code [10] would be used as an example. In this code the crops and/or corresponding farmland are banned/interdicted one by one based on the ingestion dose received through consumption of each particular crop. Therefore, all foodstuffs exceeding the foodban

Table 2.3 MACCS Annual Food Basket Production Areas (m^2/Person-yr)

Foodstuff	USA	Greece	Italy	Spain
Grain-meat-man	418	418	1183	1183
Pasture-meat-man	140	140	403	157
Grain-man	272	272	272	272
Grain-milk-man	138	138	88	88
Pasture-milk-man	36	36	53	36
Vegetables-man	33	33	32	33
Roots-man	74	74	30	74
Stored-forage-milk-man	0	0	140	140
Stored-forage-meat-man	0	0	790	790
Legumes-milk-man	0	0	36	36
Legumes-meat-man	0	0	484	484
Legumes-man	0	0	128	0
Other	0	0	105	0
TOTAL	1111	1111	3744	3293

criterion are banned, while consumption of the remaining crops is allowed. Therefore, following from the above assumptions, the maximum combined dose from a five-crop food basket could be as high as 5 mSv * 5 = 25 mSv.

The choice of crop banning approach appears to constitute the main difference between the MACCS and COSYMA calculations. There does not appear to be an adequate way to reconcile the differences in approach between the two codes in the food banning area. Thus, it was suggested for the MACCS calculations that 5 mSv per year to be specified as the crop banning/farmland interdiction criterion for the entire basket (standard MACCS approach). Although being conservative, this limit is a) obtained from specifications, and b) used in the US Food and Drug Administration protective action recommendations [11].

In addition, 5 mSv was adopted as the maximum allowable annual food basket dose for implementing the farmland interdiction criterion in MACCS.

The fact that different MACCS users selected their own approaches in defining the counter-measures criteria, resulted in significant differences (see Section 3) in the predictions related to the ingestion pathway doses/consequences.

2.2.3 Population Distribution

Since the MACCS code requires the distribution of population to be supplied on a polar grid, a conversion of the population data specified on a geographical grid was required. Variations in population distributions produced by different programs developed for this particular application were insignificant.

Two programs were written [12,13] to convert the specified population distribution from a geographical grid to a polar grid used in MACCS. The programs were distributed to all the MACCS users participating in the exercise. A comparison with the population distributions produced by both programs showed a good agreement. The population map for the MACCS calculations in the codes intercomparison exercise was designed by using the approach outlined in Appendix G.

2.2.4 Source Terms

Implementation of the source term data specifications was straightforward, except for the long duration release (the 24 hr release had to be split into four 6 hr long puffs) and an imposed distinction between the organic and non-organic iodine. The latter has been taken into account only in terms of ascribing different dry deposition velocities for two particle sizes in the iodine nuclides group. However, the MACCS code does not make a distinction in washout between the organic and non-organic iodine as requested in the benchmark specifications (the washout coefficient for the organic iodine was specified to be two orders of magnitude lower that the one for the non-organic iodine) and the value assigned for the non-organic iodine was used in MACCS calculations. The resulting overprediction in the iodine washout during the rain weather sequences is not expected to be significant since the specified iodine release has only one percent of organic iodine.

2.3 Major Differences in MACCS Input Data and Their Implications

The differences in the input data used by the MACCS Users Group participants stemmed from some incompatibilities between the data specified and those needed for the MACCS input preparation. The major differences in input data used by the four participants are compiled in Table 2.4: nodalization, dispersion model options, rain distance intervals, mapping of agricultural production, and ingestion pathway modeling. These differences were largely responsible for the differences between the four predictions for each of the six cases. The last column of the table contains comments on implications of the input differences; in some cases, results of sensitivity calculations are also provided. The information contained in Table 2.4 is helpful in explaining the differences in predictions.

Table 2.4 Differences in Input and Their Implications

Parameter	Isotope	Greece	Italy	Spain	USA	Comments
Nodalization		30	29	31	29	
Boundary weather wind speed, m/s		4	3	5	5	A calculation for Case 3 (No C-Measures) with a boundary weather wind velocity of 4 m/s did not show any appreciable sensitivity to the decrease in the wind velocity from 5 m/s to 4 m/s (as in GREECE calculations). Italian sensitivity calculation showed that a decrease of the wind velocity from 5 m/s to 3 m/s increases the population receiving doses exceeding 0.001 Sv by approximately 2%.
Seasonal Elevations of Inversion Layer (m)		1054, 1890, 1924, 1412	547, 771, 977, 717	617, 780, 934, 771	547, 771, 977, 717	Italian sensitivity calculation showed that a two-fold increase in the inversion layer elevations leads to a lowering of the total EDEWBODY by approximately 10%.
Plume Transport Model Option (IPLUME)		Straight Line with Rotation (1)	Wind Shift with Rotation (2)	Straight Line with Rotation (1)	Wind Shift with Rotation (2)	The choice of the option is important for multi-phase source terms. For the threshold-based measures, the straight line model produces higher consequences. A sensitivity study for Case 7 (Three-Phase Release) showed a 38% increase in the number of Hypothyroidism Morbidities (threshold model); also note a decrease in the number of Latent Fatalities (linear model): Wind Shift / Straight Line Hypothyroidism Morbidities: 93 / 128 Latent Fatalities (Mean Values): 14400 / 13000

Table 2.4 (continued)

Parameter	Isotope	Greece	Italy	Spain	USA	Comments
Representative time point		0.0 Leading Edge of Cloud	0.5 Center of Cloud	0.5 Center of Cloud	0.5 Center of Cloud	For the emergency phase of the accident, the cloud leading edge option produces slightly higher consequences (higher deposition rate because of the lower sigma-z at the cloud's edge). A sensitivity study for Case 3 (no C-Measures) produced the following results (mean values): — Center of Cloud / Leading Edge of Cloud Early Fatalities: 40 / 44 Hypothyroidism Morbidities: 280 / 281 Latent Fatalities (Doses Received During Emergency Phase): 2770 / 2780
Rain distance intervals, km		Five: 10, 18, 28, 40, and 50	Five: 10, 20, 28, 40, and 50	Six: 5, 10, 16.5, 25, 35, and 50	Five: 10, 20, 28, 40, and 50	Sensitivity calculation showed that switching to the intervals used in the Spanish calculations increased the number of early fatalities by about 12%.
Annual food basket (see Table 2.3)		Adopted from BNL	Default food basket from the MACCS Users Manual	Combination of USA basket with MACCS Users Manual defaults. Total food basket area is 3293 m^2	Suggested in the December 1991 BNL Memo. Total food basket area is 1111 m^2	Increase in the annual food basket area (Spain) is supposed to lower the allowable farmland contamination limits used for the crop disposal (and land interdiction) calculations and thus lead to higher values of the crop disposal areas.
Mapping of farmland distribution (farmland area as fraction of total map area) and economic data		Same as USA	Same as USA	Seven regions: 0.105, 0.078, 0.015, 0.0784, 0.0366, 0.0275, 0.0132; Average fraction: 0.0365. Total farmland area is 4.91×10^5 km^2	0.05 Homogeneous Total farmland area is 6.26×10^5 km^2	Analysis of the specifications indicates that homogenization of agricultural production shifts production farther from the release site, and thus leads to prediction of lower ingestion doses and higher costs

Table 2.4 (continued)

Parameter	Isotope	Greece	Italy	Spain	USA	Comments
Ground concentration limits for calculating counter-measure farmland interdiction (GCMAX), Bq/m^2	Sr-89	Same as U.S.	1.80×10^{8}	3.67×10^{10}	3.60×10^{10}	Decrease in the GCMAX values translates into more stringent farmland interdiction criteria and thus leads to prediction of lower ingestion doses.
	Sr-90		5.90×10^{5}	1.25×10^{6}	1.25×10^{6}	
	Cs-134		9.20×10^{6}	5.83×10^{7}	5.86×10^{7}	
	Cs-137		7.40×10^{6}	4.60×10^{7}	4.63×10^{7}	
Ground concentration limits for calculating counter-measure crop disposal (PSCOTH /PSCMLK), Bq/m^2	Sr-89	Same as U.S.	2.20×10^{6}	2.04×10^{7}	1.96×10^{7}	Decrease in values of the permissible surface concentration (PSCOTH/PSCMLK) during the crops growing season should lead to a higher volume of crops disposal, and, therefore, to prediction of lower ingestion doses. In the Italian calculations, the values from the Users Manual divided by ten were used to approximate the specified crop disposal limit of 5 mSv.
	Sr-90		2.40×10^{4}	4.87×10^{4}	4.86×10^{4}	
	Cs-134		2.20×10^{4}	2.01×10^{4}	2.01×10^{4}	
	Cs-137		2.70×10^{4}	2.25×10^{4}	2.25×10^{4}	
	I-131		1.30×10^{5}	1.70×10^{7}	2.01×10^{7}	
Early Fatalities Model: EFFACA and EFFACB, Red Marrow (MACCS Users Guide, p.63 [6])		4.0 and 6.0	Same as US	Same as US	3.8 and 5.0	Note that larger values of the two coefficients in the Greece early fatalities model lead to lower number of early fatalities (another reason is a slightly smaller population in the vicinity of the plant used in the Greece site input data file).
Daily Cost of Evacuation/Relocation		Same as U.S.	5 ECUs/5 ECUs	Same as US	42 ECUs/42 ECUs	
Annual Depreciation Rate During Interdiction		Same as U.S.	10.0%	4.8%	5.0%	Based on the differences, the input from depreciation in Italy calculations would be a factor of two higher than in the other calculations. The fact that the Italy's predictions for Cost of Relocation, Appendix E, are not the highest indicates that the effect of this particular input is not of major importance.

3 COMPARISON OF MACCS CALCULATIONS

The comparison of results is presented in two formats:

a) case by case for a selected set of measures, and
b) measure by measure for all cases; this form of presentation also includes the CCDFs of each measure for two cases: Case 1 (Single-Phase) and Case 3 (Single-Phase, No C/M).

The first format provides the reader with an overview of results across all the important end-points starting from doses to health effects to results of counter-measures for each case separately. These results are shown in Figures 3.1 through 3.6. The second format (Figures 3.7 through 3.17) is advantageous in evaluation of the sensitivity of each particular measure to the calculation scenario and source term characteristics as well as for evaluating the scatter within each calculation using data for the 5th and 95th percentiles. The CCDFs for the major end-points are shown in Figures 3.18 through 3.28 for Case 1, and in Figures 3.29 through 3.35 for Case 3. Some of the measures will also be presented in table format. Review of the observed differences will be based on these data and it can be found in the following sections.

An examination of Figures 3.1 – 3.6 suggests that the predictions produced by the four participants compare well in all measures except for those end-points related to the ingestion pathway including doses, health, and economic consequences (see for example predictions of Total Dose, Ingestion Dose, and Latent Fatalities for Case 3 shown in Fig. 3.3). Note that the collective dose, person-Sv, is interchangeably denoted in plots as CEDEC (Collective Effective Dose Equivalent Commitment) or EDEWBODY (Effective Dose Equivalent for Whole Body, MACCS terminology).

3.1 Dose Consequences

3.1.1 Total Collective Effective Dose Equivalent Commitment – a(i), a(ii), a(xii), and a(xiii)[1]

The predictions of the mean collective dose accumulated over the long-term phase of the accident (following the emergency period of one week) for three different pathways are shown in Fig. 3.36 (Single-Phase (Case 1) and Single-Phase, No Counter-Measures (Case 3) results). The groundshine and inhalation doses show a good agreement between the four MACCS Users Group calculations. Note that the doses predicted in Case 3 calculations are higher than doses predicted in Case 1 calculations by approximately 10% for groundshine, and 20% for inhalation doses.

The predictions of total doses are very close for all the calculations with variations attributed to the differences in grids, population distribution, and meteorological data sampling. The major differences in the total societal doses are caused by the ingestion pathway dose predictions as follows from Figures 3.7 - 3.9 which show the doses predicted in all six cases. This conclusion is illustrated clearly by Fig. 3.8 displaying the total doses calculated without the ingestion dose pathway: agreement between the four calculation results is excellent. (Note that in some cases MACCS did not predict the 5th percentile data as seen in Figures 3.8 and 3.9.)

Note that in all cases the differences in the ingestion dose predictions did not significantly affect the total dose results. The exception is Case 3 where no counter-measures were modeled and the ingestion pathway was an important contributor to the total dose. The differences in the dose predictions are mainly due to differences in mapping of the agricultural production and in the dose criteria for crop disposal and farmland interdiction (see Appendix B for additional details). Other causes of differences between predictions are the variations in values of retention and transfer factors for different crops used by the participants.

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[1] See Table D.1 in Appendix D with a listing of all end points requested for the comparison

3.2 Health Effects

3.2.1 Early Effects: Fatalities and Hypothyroidism Morbidities – b(i), b(vi)

Differences in predictions of the number of early health effects—early fatalities and hypothyroidism morbidities - can be evaluated by reviewing the data presented in Figures 3.1 – 3.7 and 3.10 and 3.11. Some of the more important reasons for the differences are some variations in the meteorological input files and weather sampling, differences in grids and population distributions combined with the impact of the threshold-type models used for predicting the early health effects. For example, the lower values predicted in the Greece calculations can also be attributed to the specifics of the population distribution on the map that was lower than in the U.S. calculations in the vicinity of the plant site where the early effects are expected to be the largest. Note that the differences are greatest in the CCDF's higher percentile region (Figures 3.21, 3.22, 3.32, and 3.33); this is caused by an increased sensitivity of the results to variations in the weather sampling.

Additional calculations have been performed by the Spanish participants with the objective to evaluate the sensitivity of predictions of the early fatalities to the choice of the rain intervals (Table 3.1). The results indicated that significant spread only occurrs in the region of very high percentiles.

The maximum distance for the non-zero early fatalities risk is less than 10 km according to the calculations. Results should not be sensitive to the selection of the rain intervals in the regions beyond 10 km. Similar effects of grids, population distributions, meteorological data, and weather sampling are expected in predictions of the hypothyroidism morbidities.

3.2.2 Adult Individual Risk of Early Death as a Function of Distance - f(i)

The conditional individual risks of early fatalities for Cases 1 and 3 predicted in four MACCS Users Group calculations agree very well as can be seen from Figs. 3.10a and 3.10b (the value of risk is conditional on the probability of the corresponding source term). The spread between predictions increases slightly at farther distances from the release site where the effects of differences in meteorological data and weather sampling become more pronounced.

Table 3.1 Sensitivity of Number of Early Fatalities to Rain Intervals

Early Fatalities C1	U. S. Rain Intervals: 10, 20, 28, 40 and 50 km	Spain (Original) Rain Intervals: 5, 10, 16.5, 25, 35, 50 km	Spain (Modified) Rain Intervals: 10, 20, 25, 35 and 50 km
Probability of zero effects	0.7600	0.7605	0.7244
5 Percentile	0.0	0.0	0.0
MEAN	1.88	2.23	2.20
MEDIAN	0.0	0.0	0.0
90 Percentile	2.30	1.15	1.49
95 Percentile	20.4	5.7	6.5
99 Percentile	30.4	30.7	35.5
99.9 Percentile	37.9	213.0	158.0
Peak value (Probability)	157.0 (5.51×10^{-5})	3730.0 (2.24×10^{-4})	2180.0 (4.96×10^{-5})

3.2.3 Number of Fatal Cancers - b(ii) and b(vii)

The number of fatal cancers predicted without the ingestion pathway dose showed very small differences between the four MACCS Users Group results (Fig. 3.13) for all six cases. As expected, the differences in the total number of fatal cancers predicted by taking into account the ingestion pathway doses are the largest for Case 3 (no counter-measures) as shown in Fig. 3.12. This is an anticipated outcome resulting from the differences in the ingestion dose predictions.

3.2.4 Adult Individual Risk of Fatal Cancer as a Function of Distance - f(ii)

Similar to the early fatalities predictions, the predictions of conditional individual risk of latent fatalities for Cases 1 and 3 predicted in the MACCS User Group calculations also agree well as seen from Fig. 3.12a (the value of risk is conditional on the probability of the corresponding source term). The differences between results increase at farther distances from the plant site where the effects of differences in the weather sampling become more pronounced. Note that at those distances the values of conditional risk are very low (10^{-8}- 10^{-7}) which confirms the differences at large distances are due to weather sampling.

3.3 Effects of Counter-Measures

3.3.1 Total Number of People Relocated - c(iii)

The predictions of the total number of relocated people for five cases which modeled counter-measures are shown in Fig. 3.14. The 5th percentile values predicted for the low magnitude release (Case 6) indicate a significant number of weather sequences resulting no relocation (CCDFs show that the median value of number of relocatees is also zero). The differences between results are attributed to differences in the weather sampling, grids, and dispersion model options.

3.3.2 Area of Crop Growing Land from which Crops are Banned - d(iii)

The main factors responsible for differences between predictions of crop disposal area (Fig. 3.15) are differences in:

a) values of PSCOTH, surface contamination limits for crop disposal,
b) mapping of agricultural production, and
c) options selected for the dispersion model.

3.4 Economic Effects

3.4.1 Total Cost of Moving People - e(i)

The differences in predictions of total costs related to people relocation (Fig. 3.16) are, to a large extent a reflection of differences in predictions of number of people relocated (Fig. 3.14) since the variations in the unitary relocation costs used in the calculations are not significant. Note that these costs include the values of interdicted land and capital investment and constitute the bulk of population related costs; the daily evacuation costs which depend on the daily cost of evacuation/relocation (Table 2.4) are insignificant in comparison.

3.4.2 Total Cost of Food Bans - e(ii)

Differences in predictions of costs of crop disposal (Fig. 3.17) are mainly due to differences in the mapping of agricultural production (homogenized versus distributed) and in the crop banning criteria. Sensitivity calculations for Case 1 (Single-Phase) also showed an influence of secondary factors on the differences in predictions: meteorological data and weather sampling.

3.5 Summary of Comparison

In general, a good agreement between the results produced by the four MACCS Users Group participants has been reached, with the exception of the results related to the ingestion pathway dose predictions. The main reason for the differences in the latter results is attributed to variation in approaches to implementation of the specifications for the agricultural production and counter-measures criteria provided for the exercise. Significantly smaller differences between predictions of other consequences can be explained by differences in weather sampling, grids, rain distance intervals, dispersion model options, and population distributions.

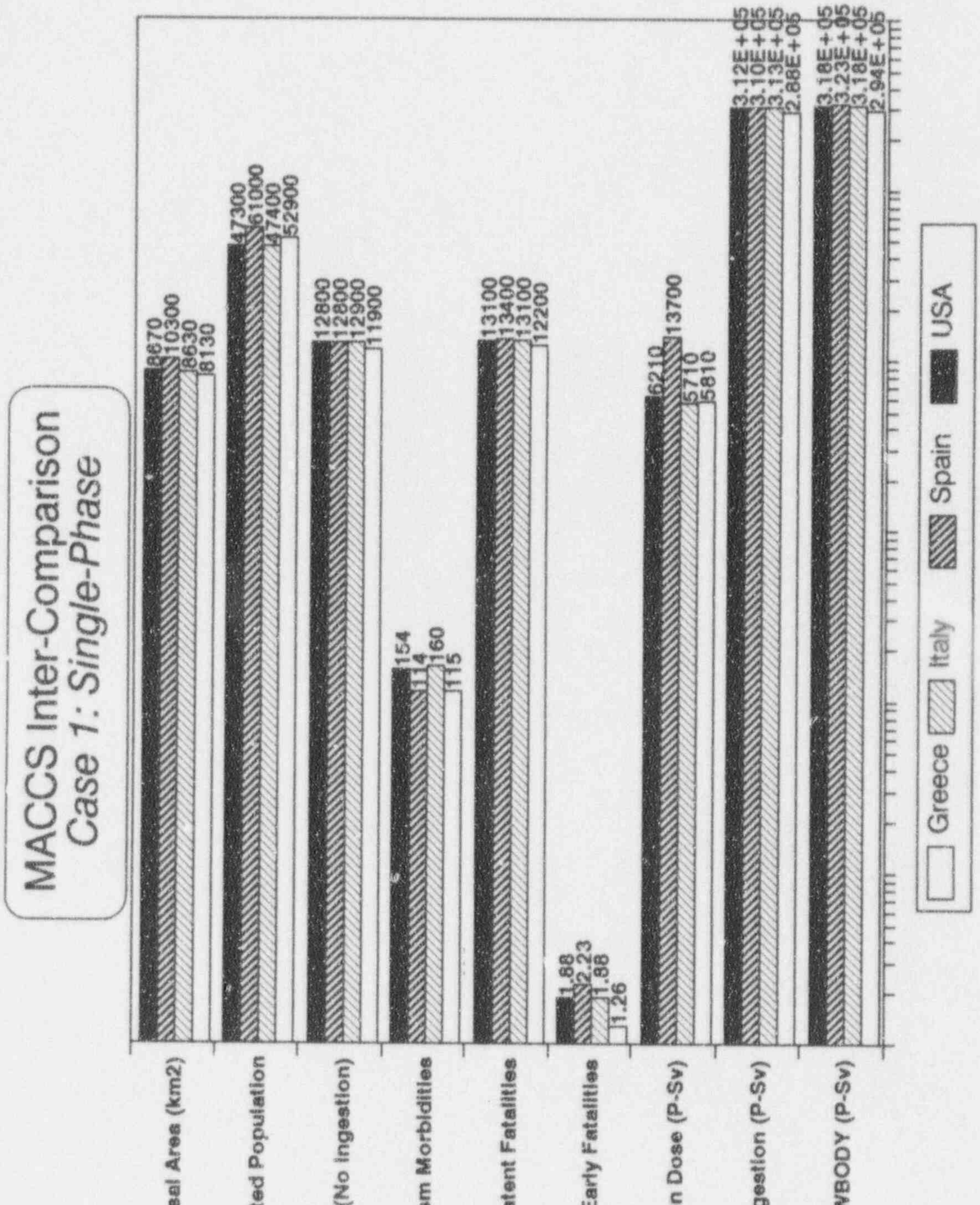

Figure 3.1 Single-Phase Prediction (Case 1): Mean Values Comparison

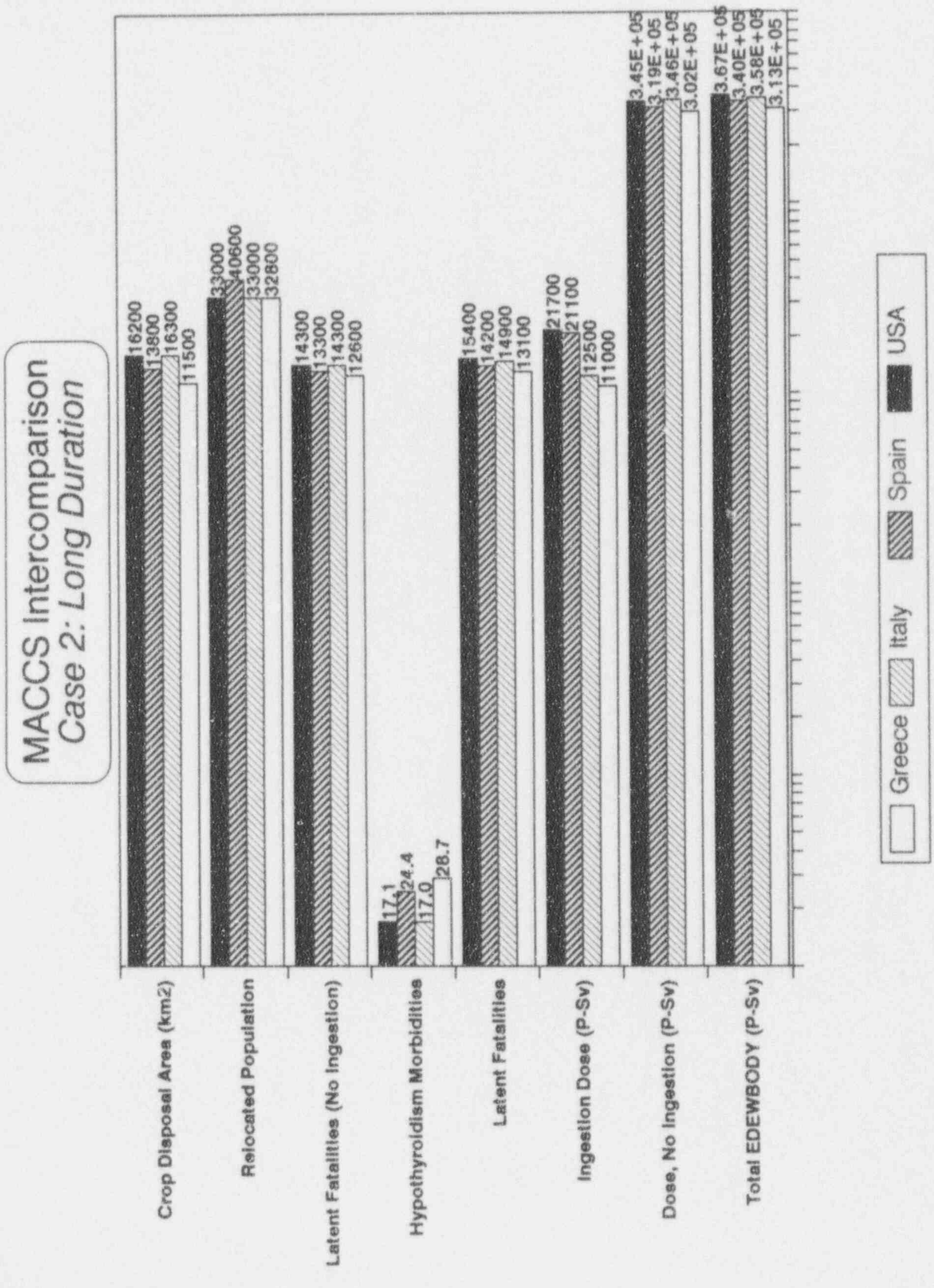

Figure 3.2 Long Duration Prediction (Case 2): Mean Values Comparison

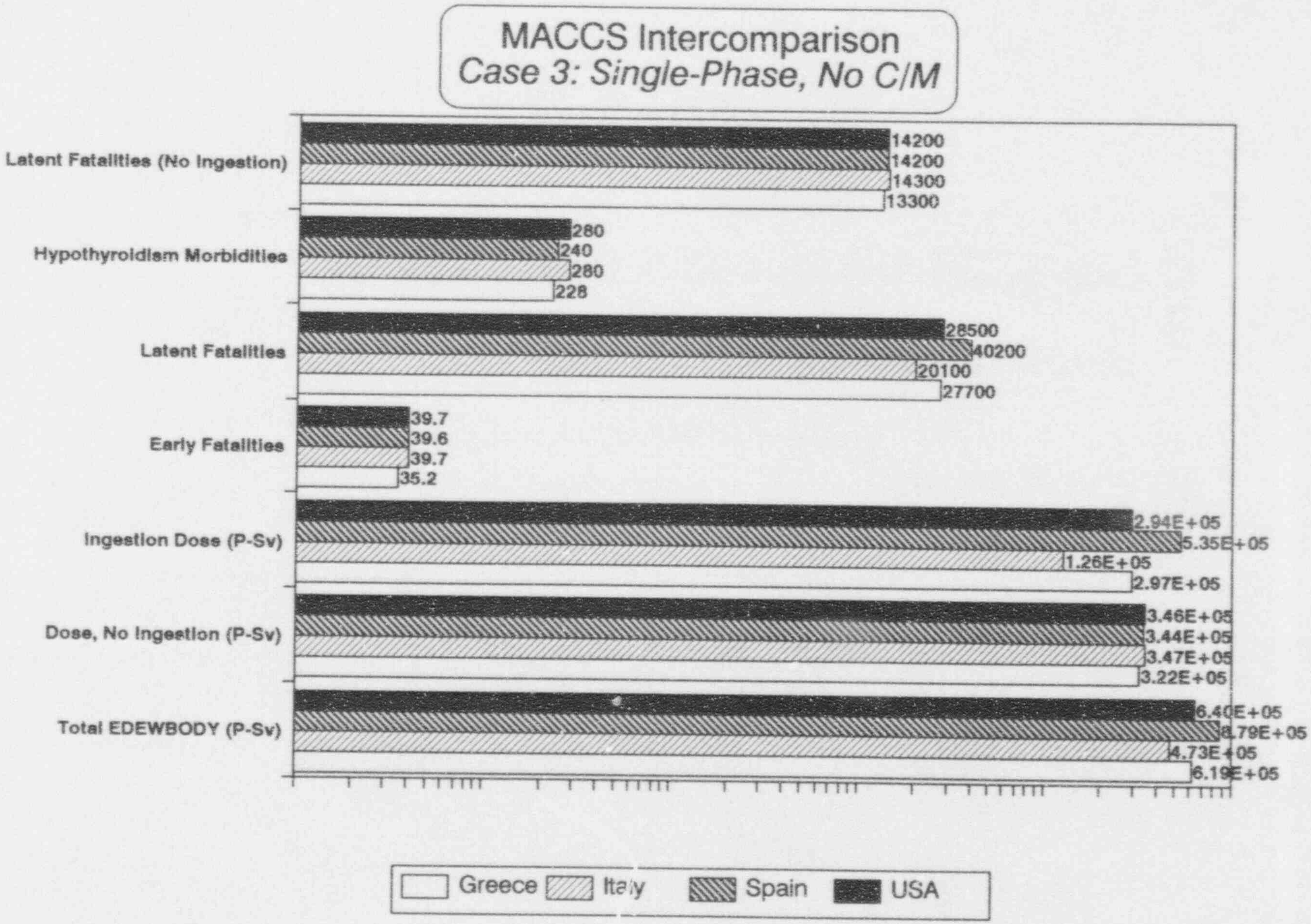

Figure 3.3 Single-Phase, No Counter Measures Prediction (Case 3): Mean Values Comparison

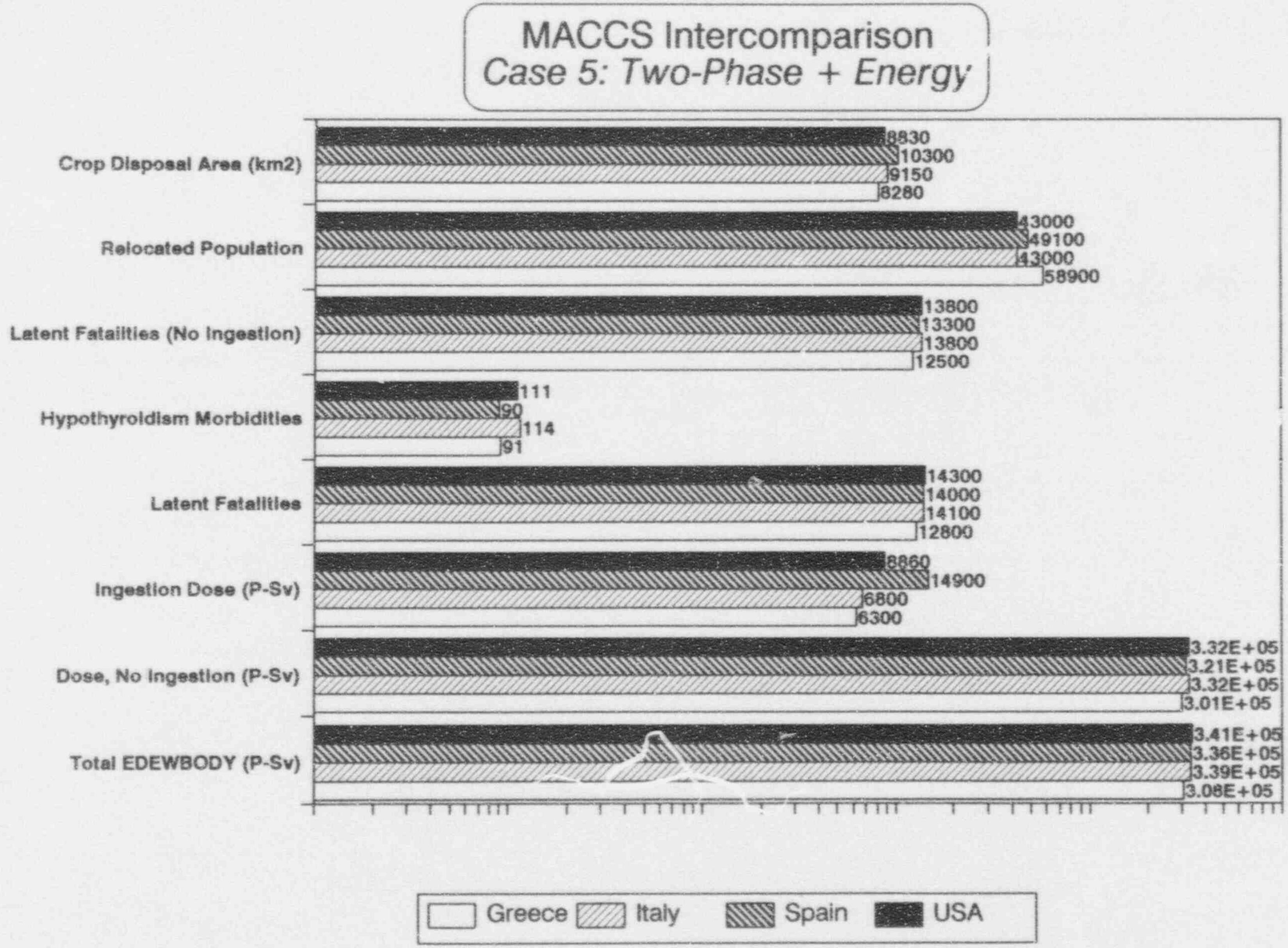

Figure 3.4 Two-Phase Release with Energy Prediction (Case 5): Mean Values Comparison

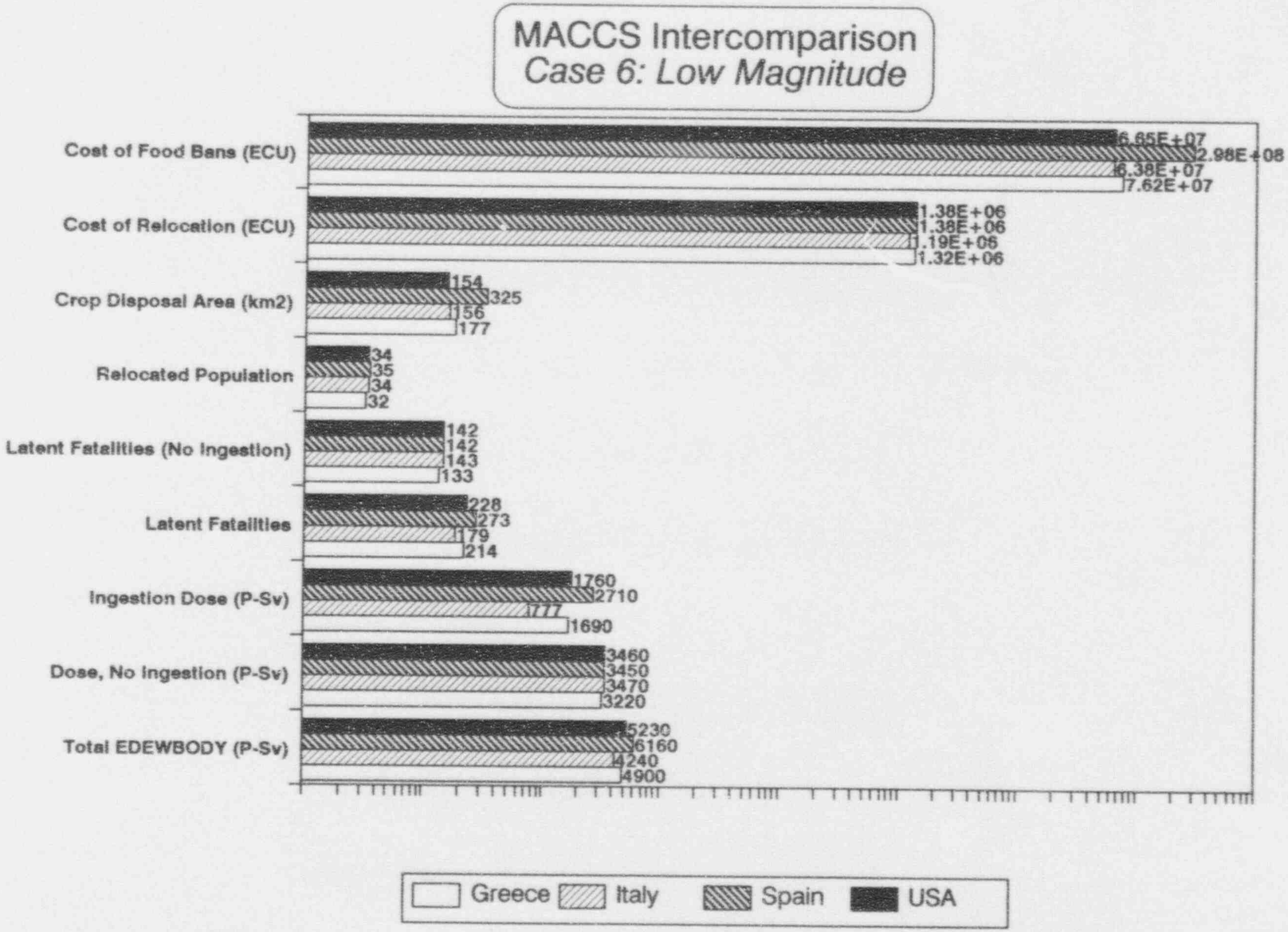

Figure 3.5 Low Magnitude Release Prediction (Case 6): Mean Values Comparison

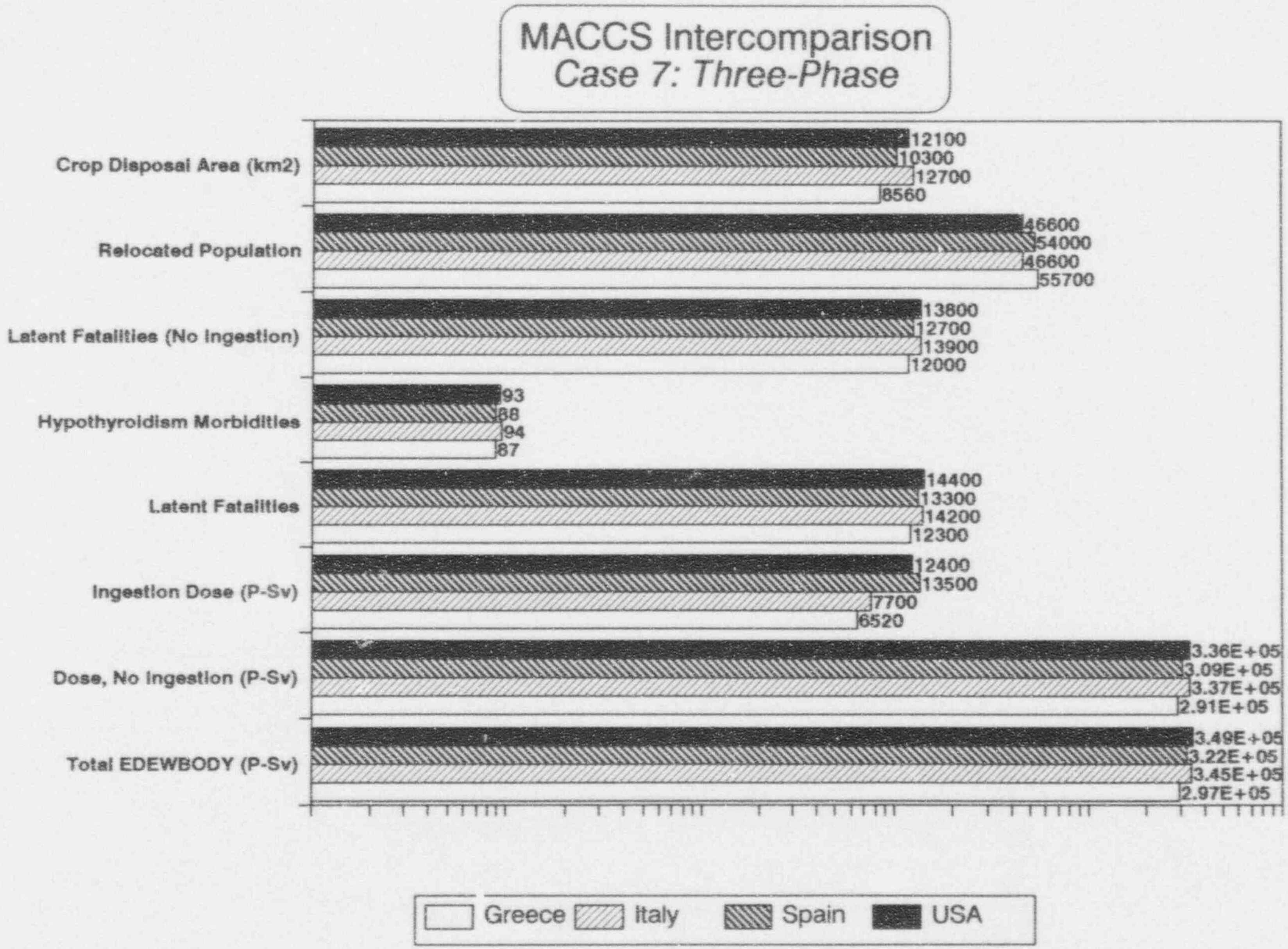

Figure 3.6 Three-Phase Prediction (Case 7): Mean Values Comparison

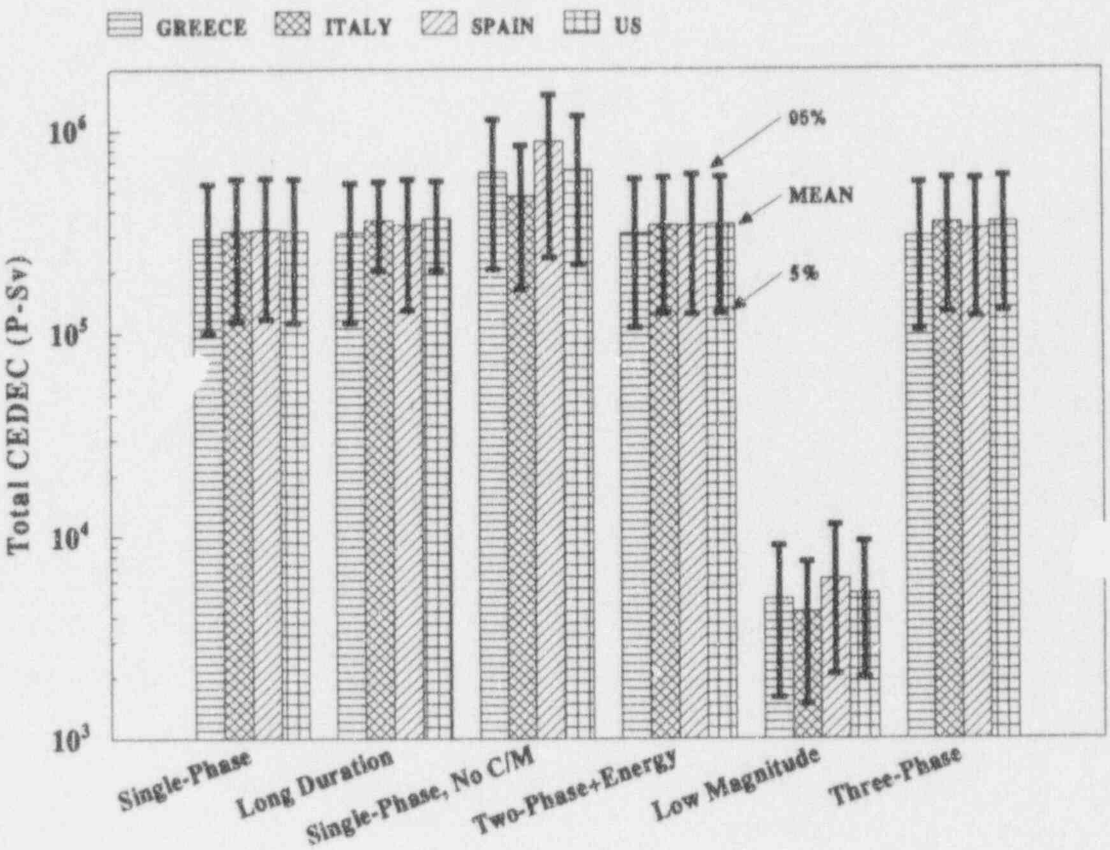

Figure 3.7 Total CEDEC Prediction: Mean, 5th, and 95th Percentiles Results Comparison

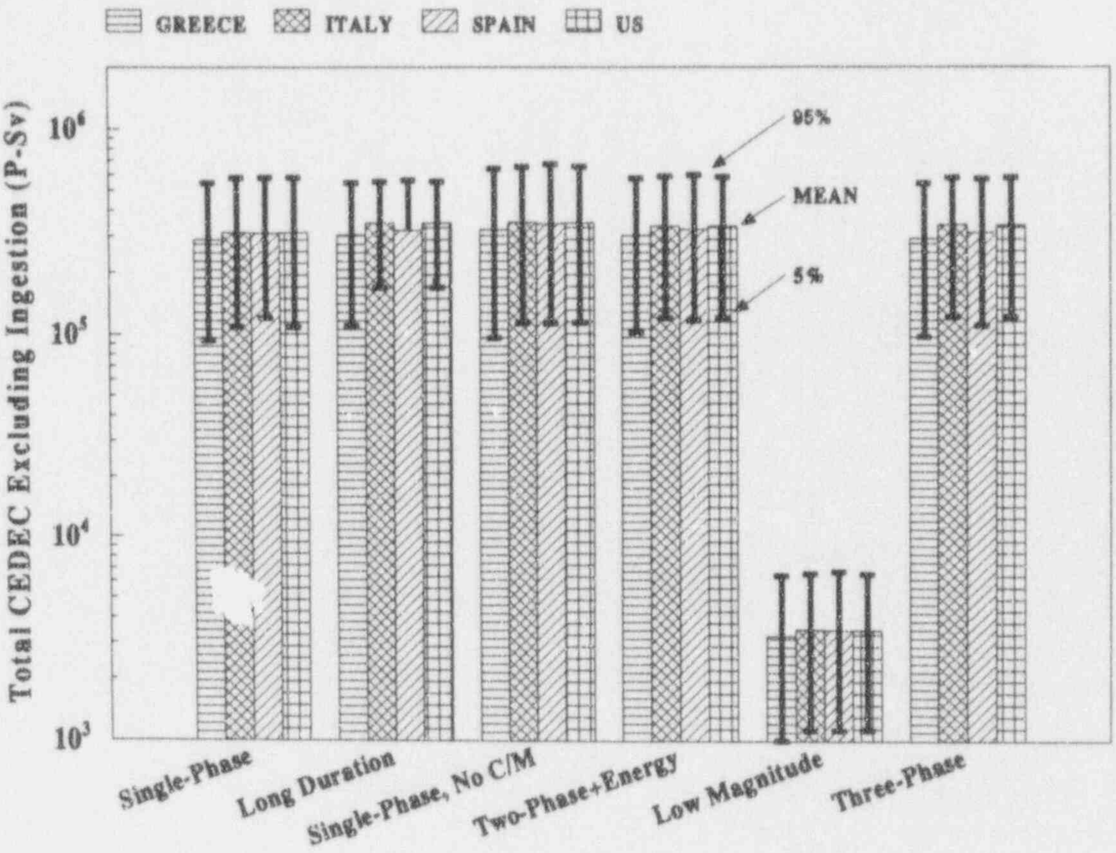

Figure 3.8 CEDEC Prediction Excluding Ingestion Pathway: Mean, 5th, and 95th Percentiles Results Comparison

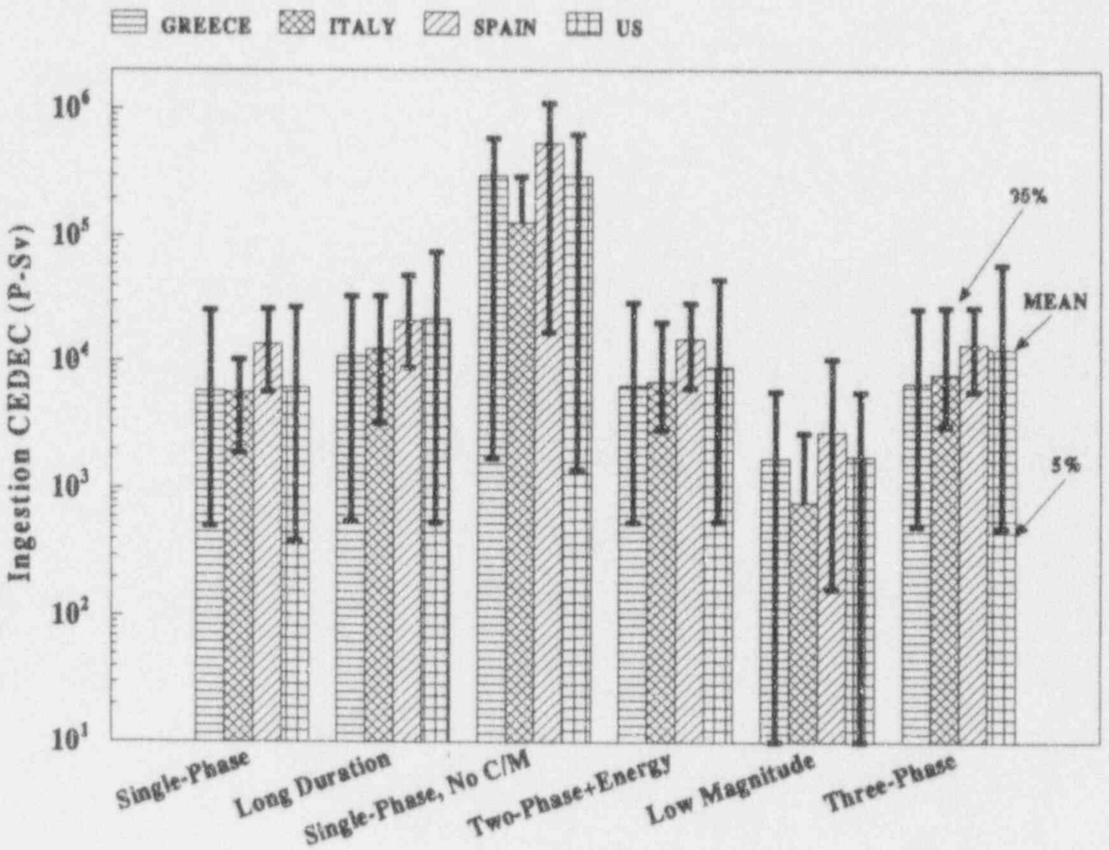

Figure 3.9 Ingestion Pathway CEDEC Prediction: Mean, 5th, and 95th Percentiles Results Comparison

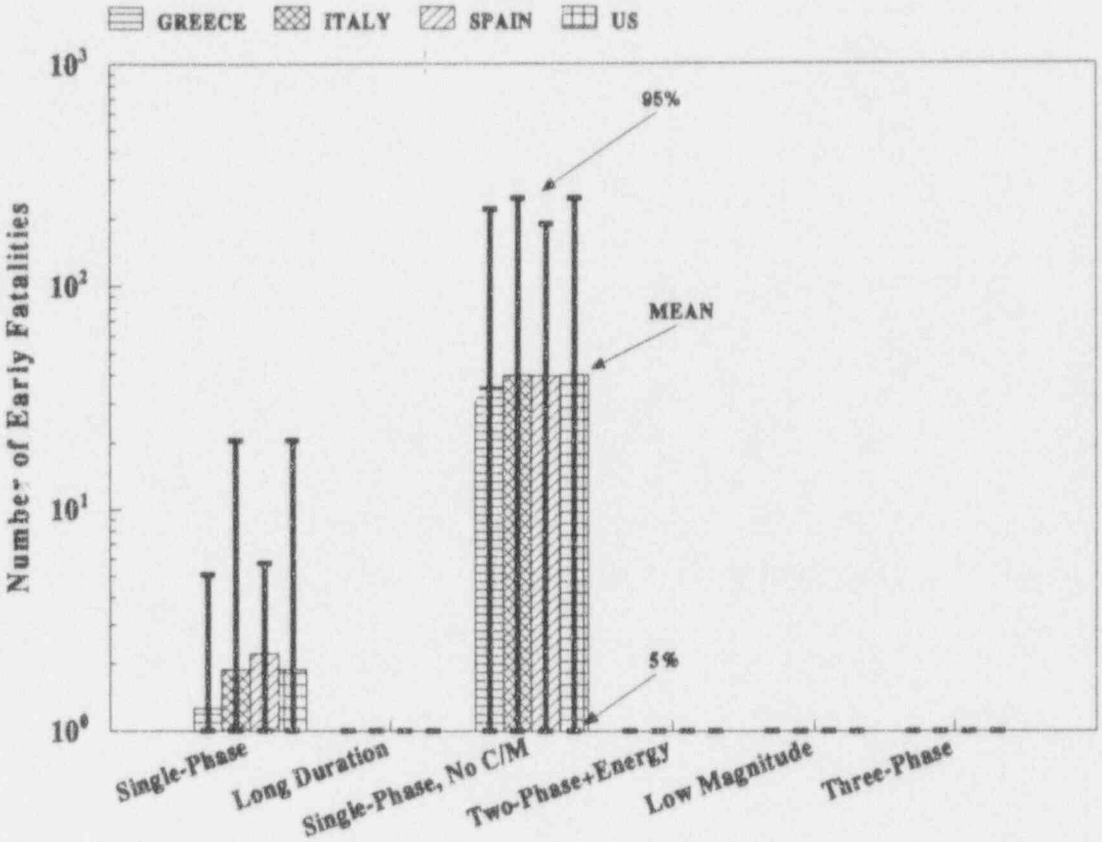

Figure 3.10 Number of Early Fatalities Prediction: Mean, 5th, and 95th Percentiles Results Comparison

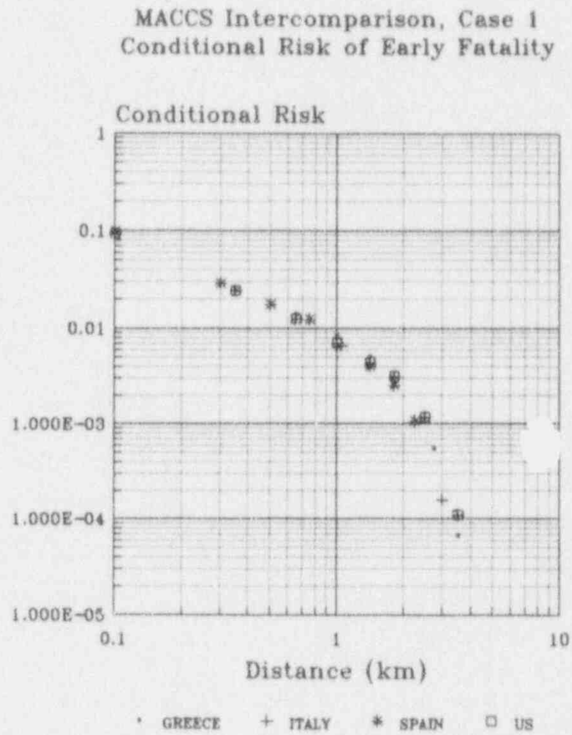

Figure 3.10a Conditional Risk of Early Fatality versus Distance Prediction (Case 1)

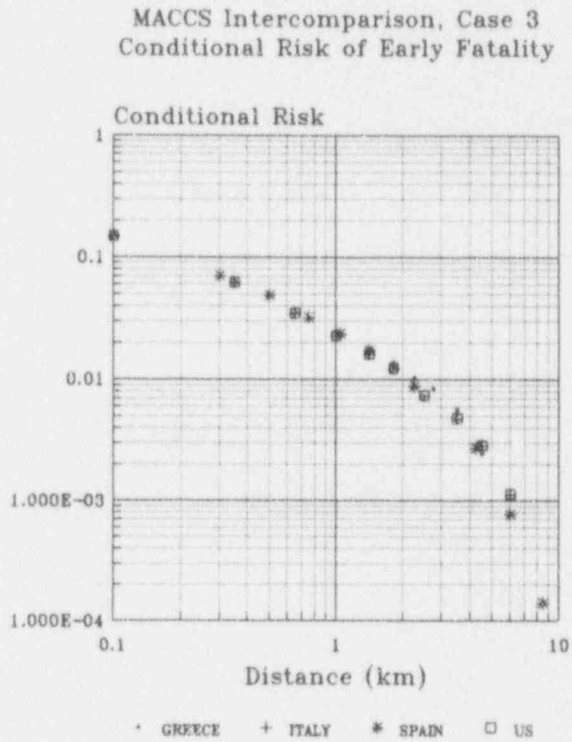

Figure 3.10b Conditional Risk of Early Fatality versus Distance Prediction (Case 3)

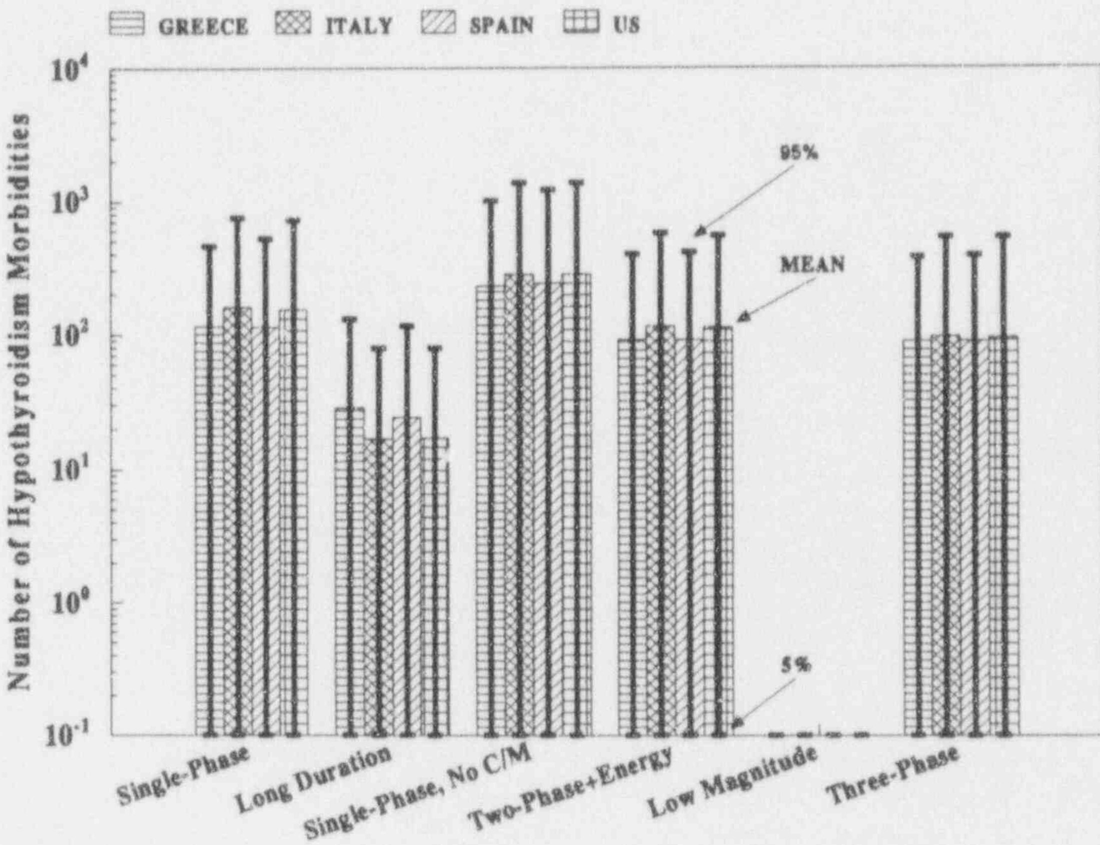

Figure 3.11 Number of Hypothyroidism Morbidities Prediction: Mean, 5th, and 95th Percentiles Results Comparison

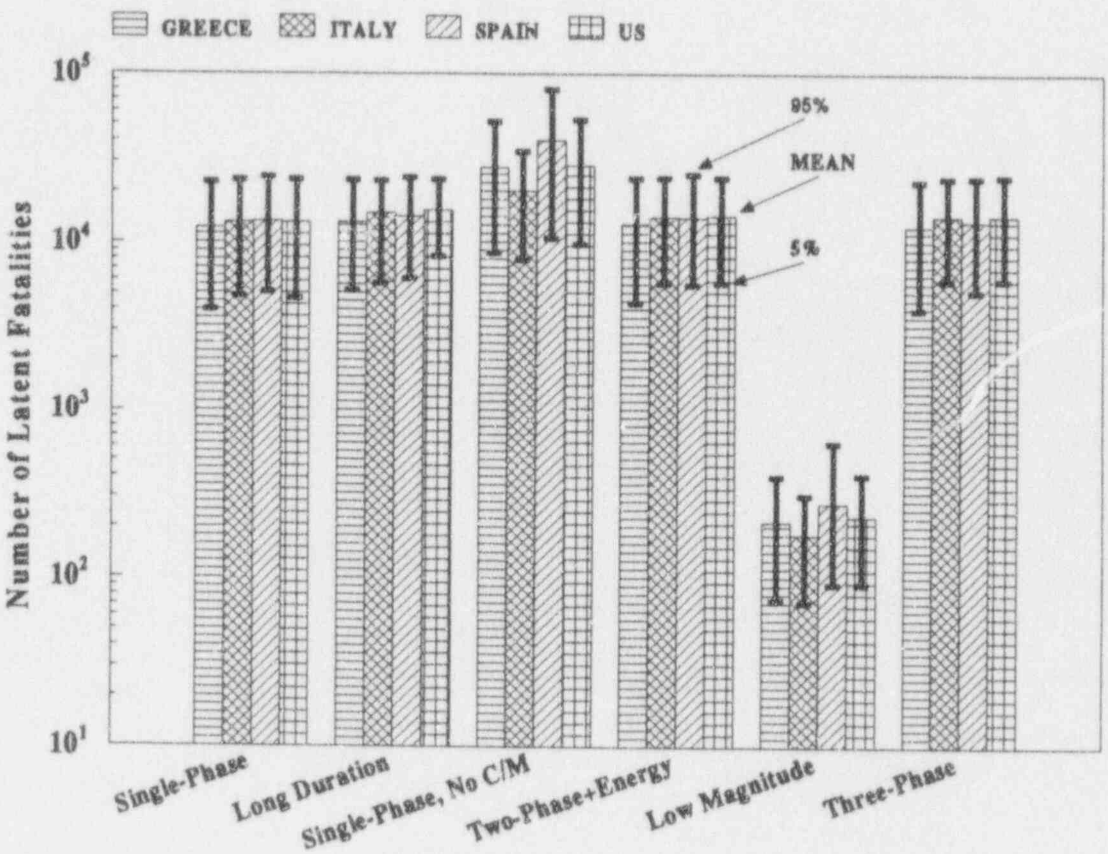

Figure 3.12 Number of Latent Fatalities Prediction: Mean, 5th, and 95th Percentiles Results Comparison

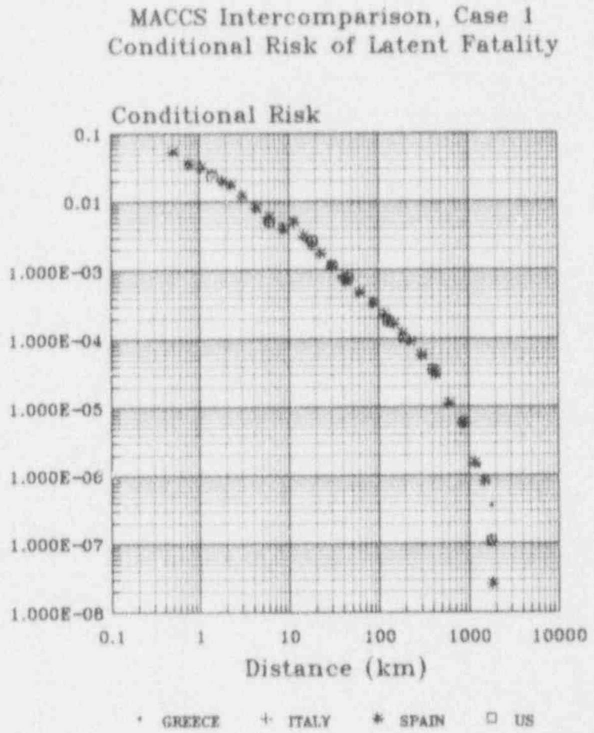

Figure 3.12a Conditional Risk of Latent Fatality versus Distance Prediction (Case 1)

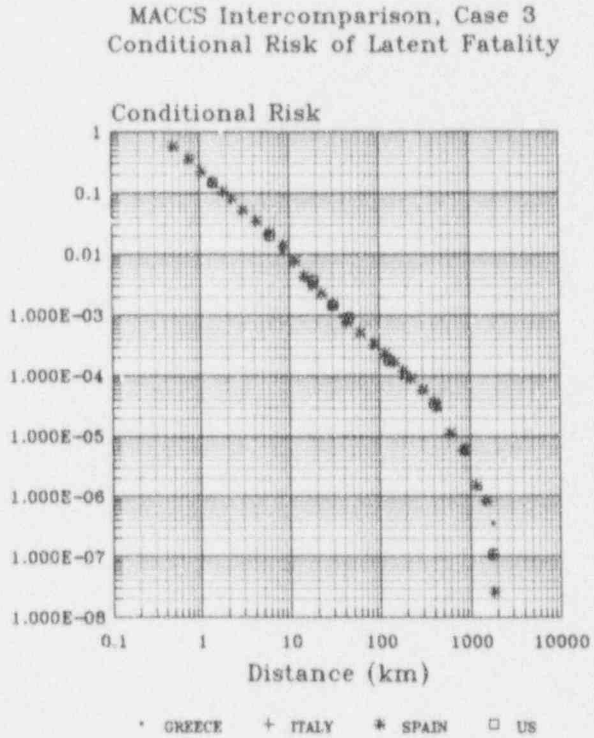

Figure 3.12b Conditional Risk of Latent Fatality versus Distance Prediction (Case 3)

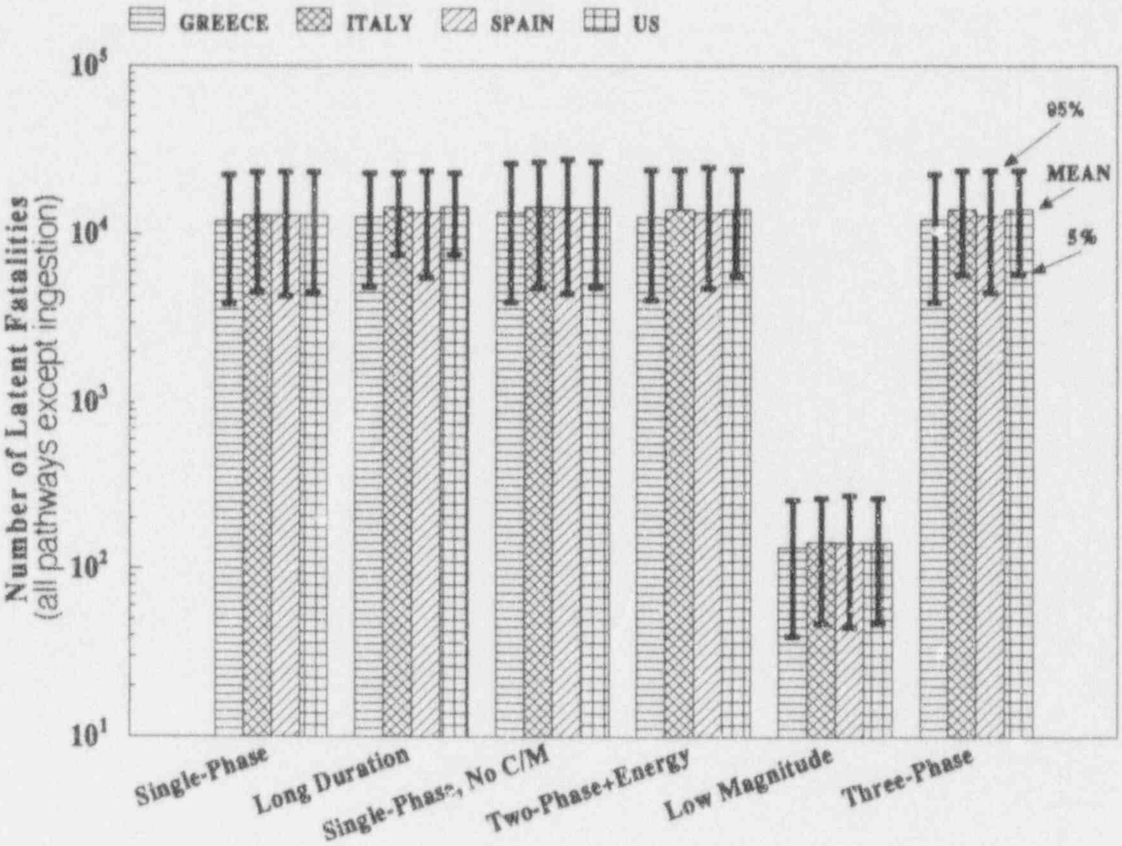

Figure 3.13 Number of Latent Fatalities (all pathways except ingestion) Prediction: Mean, 5th, and 95th Percentiles Results Comparison

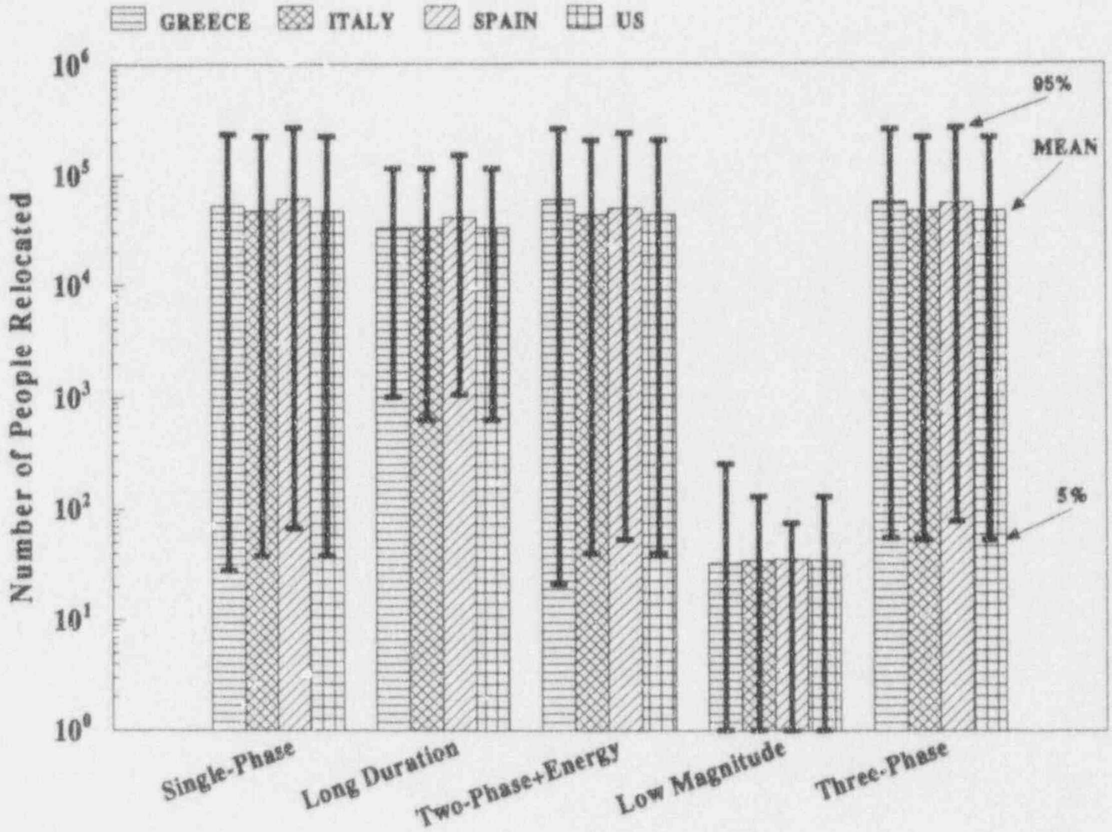

Figure 3.14 Relocated Population Prediction: Mean, 5th, and 95th Percentiles Results Comparison

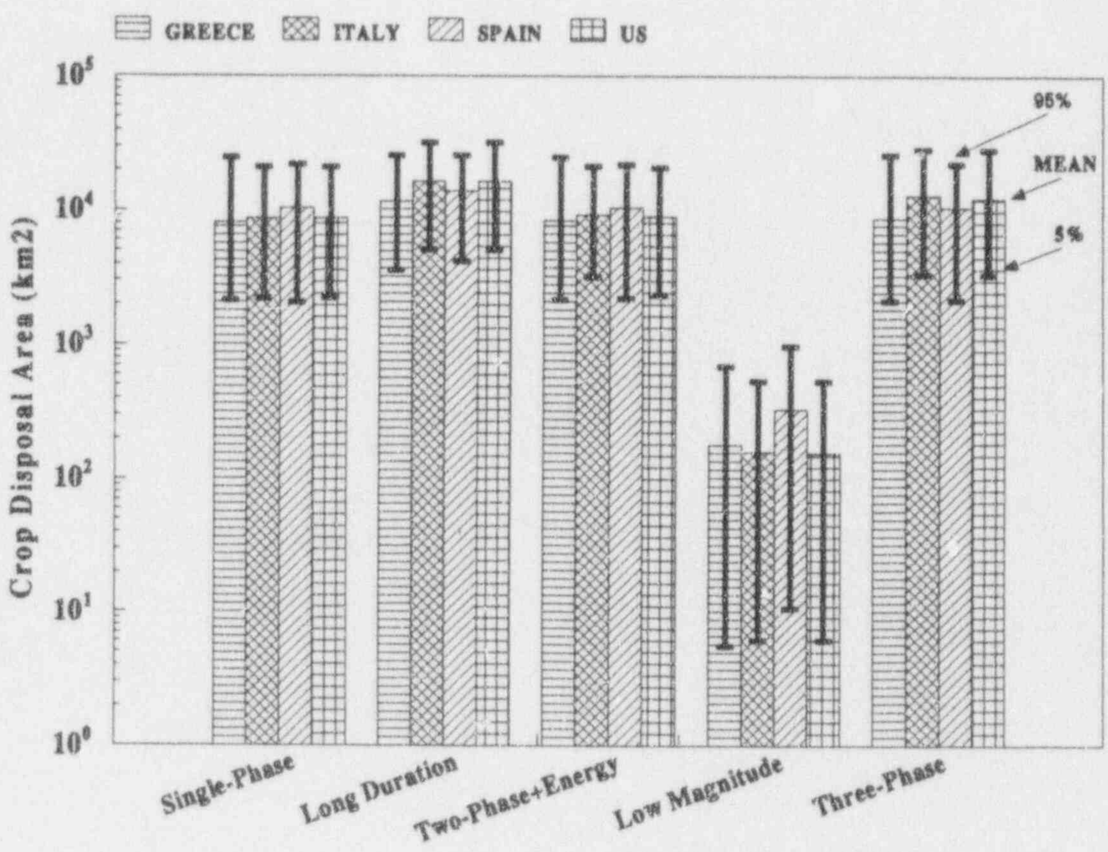

Figure 3.15 Crop Disposal Area Prediction: Mean, 5th, and 95th Percentiles Results Comparison

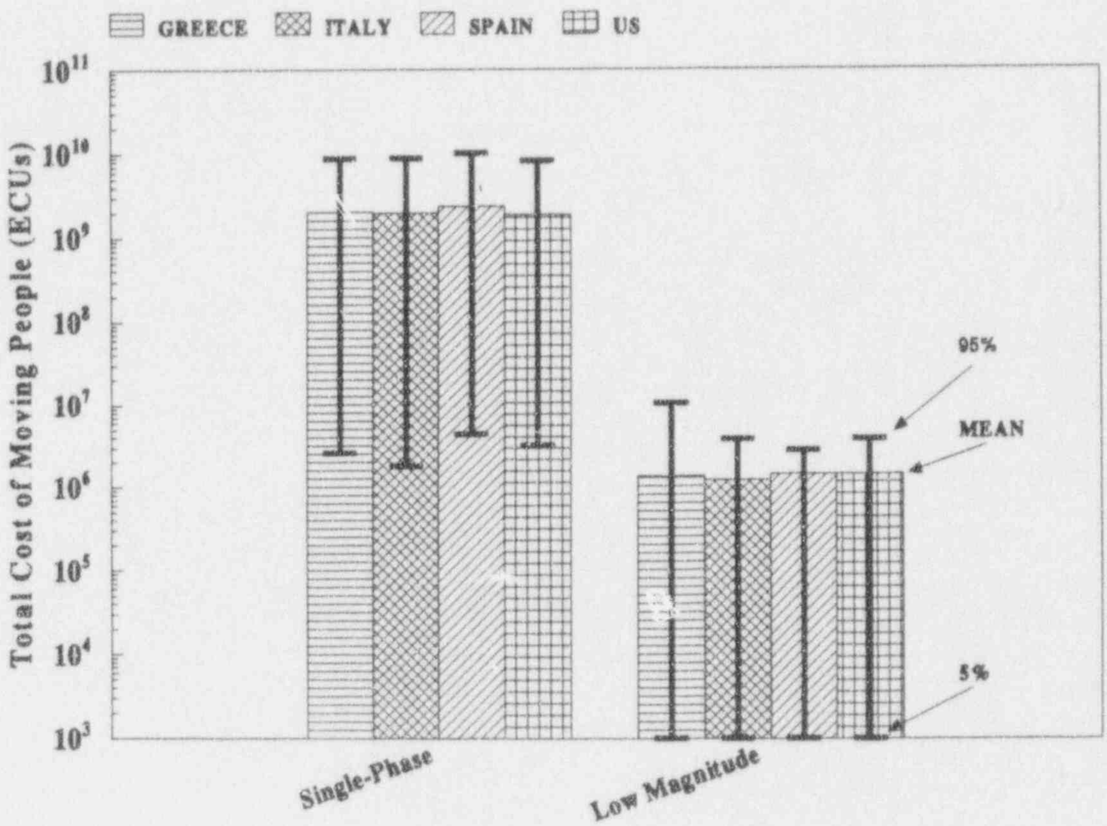

Figure 3.16 Cost of Relocation Prediction: Mean, 5th, and 95th Percentiles Results Comparison

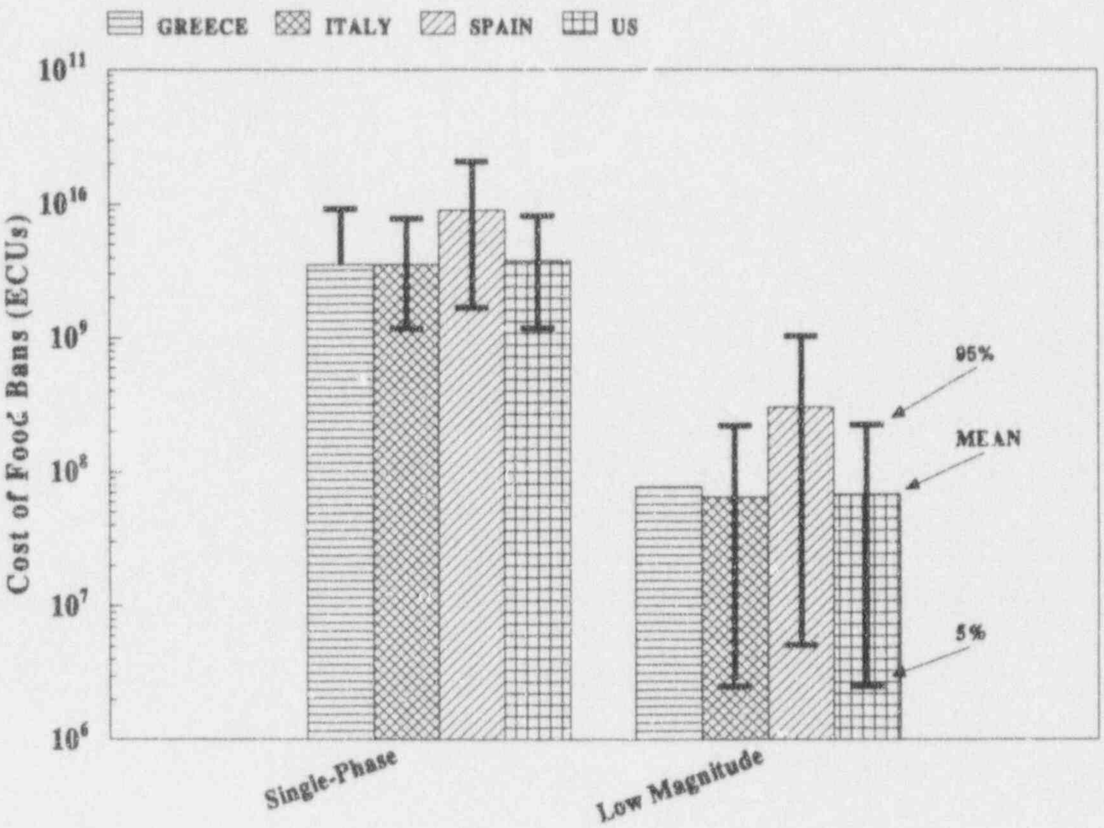

Figure 3.17 Cost of Food Bans Prediction: Mean, 5th, and 95th Percentiles Results Comparison

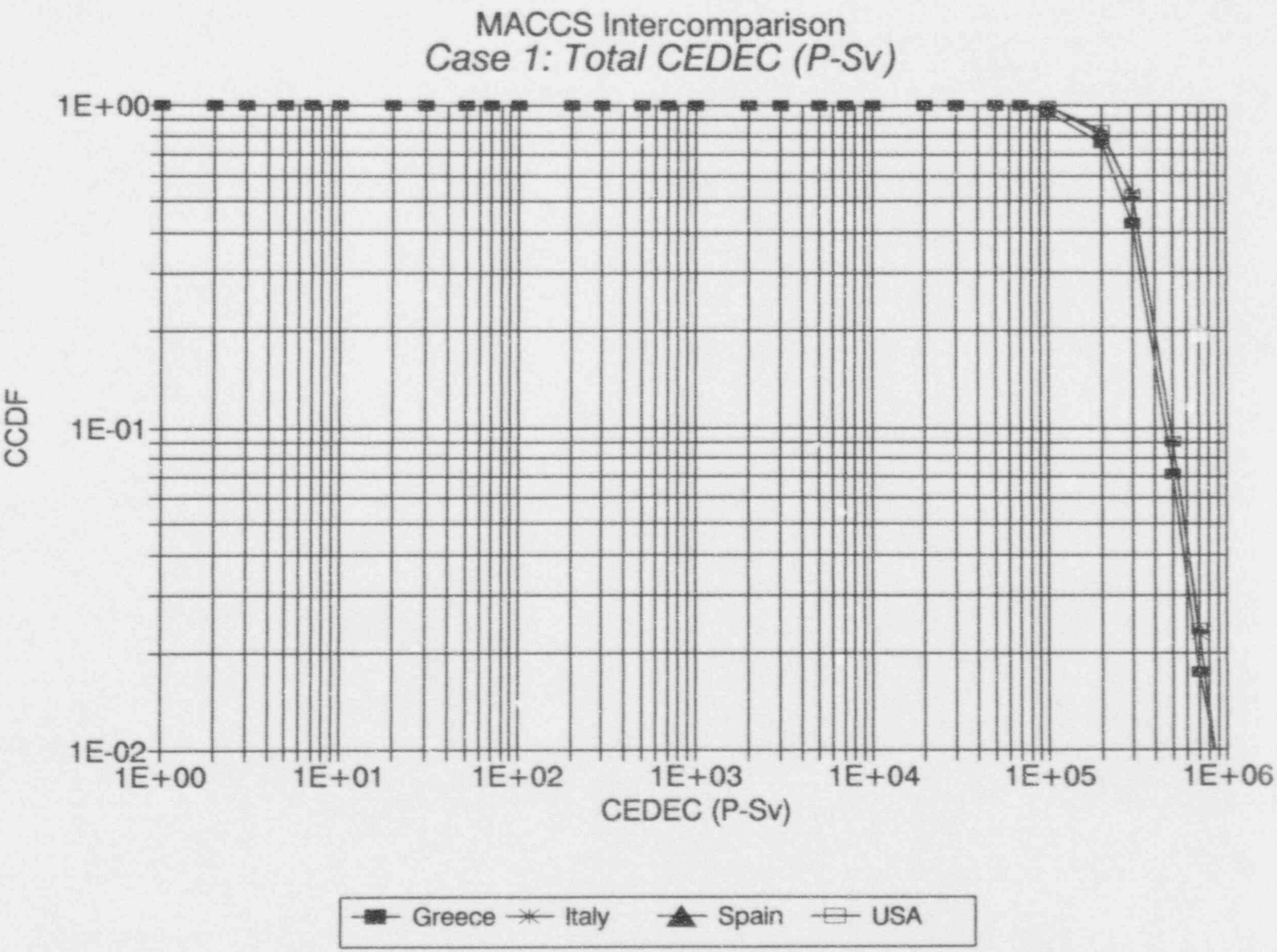

Figure 3.18 Total CEDEC Prediction: CCDF Results Comparison, Case 1

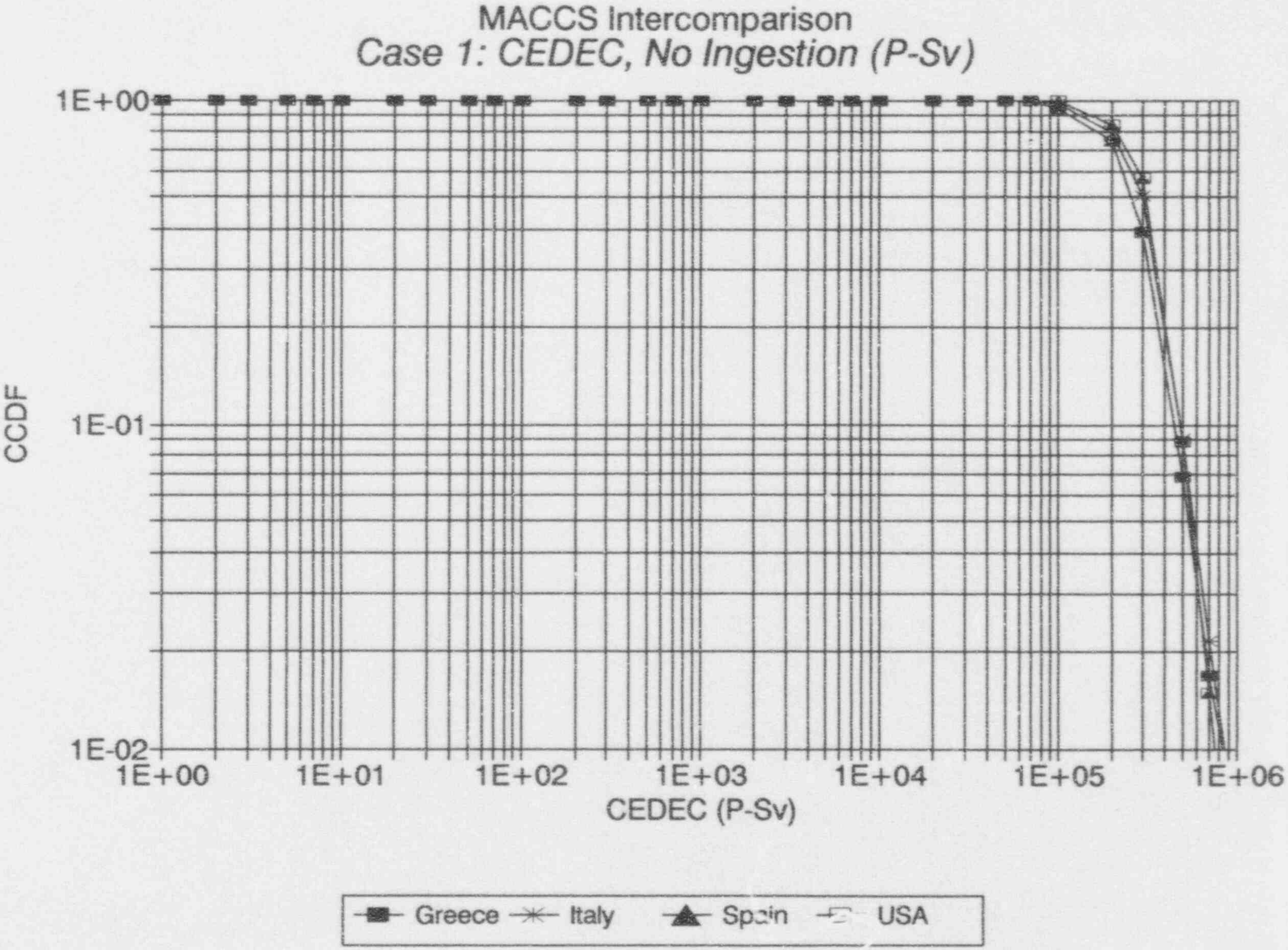

Figure 3.19 CEDEC Prediction (no ingestion pathway): CCDF Results Comparison, Case 1

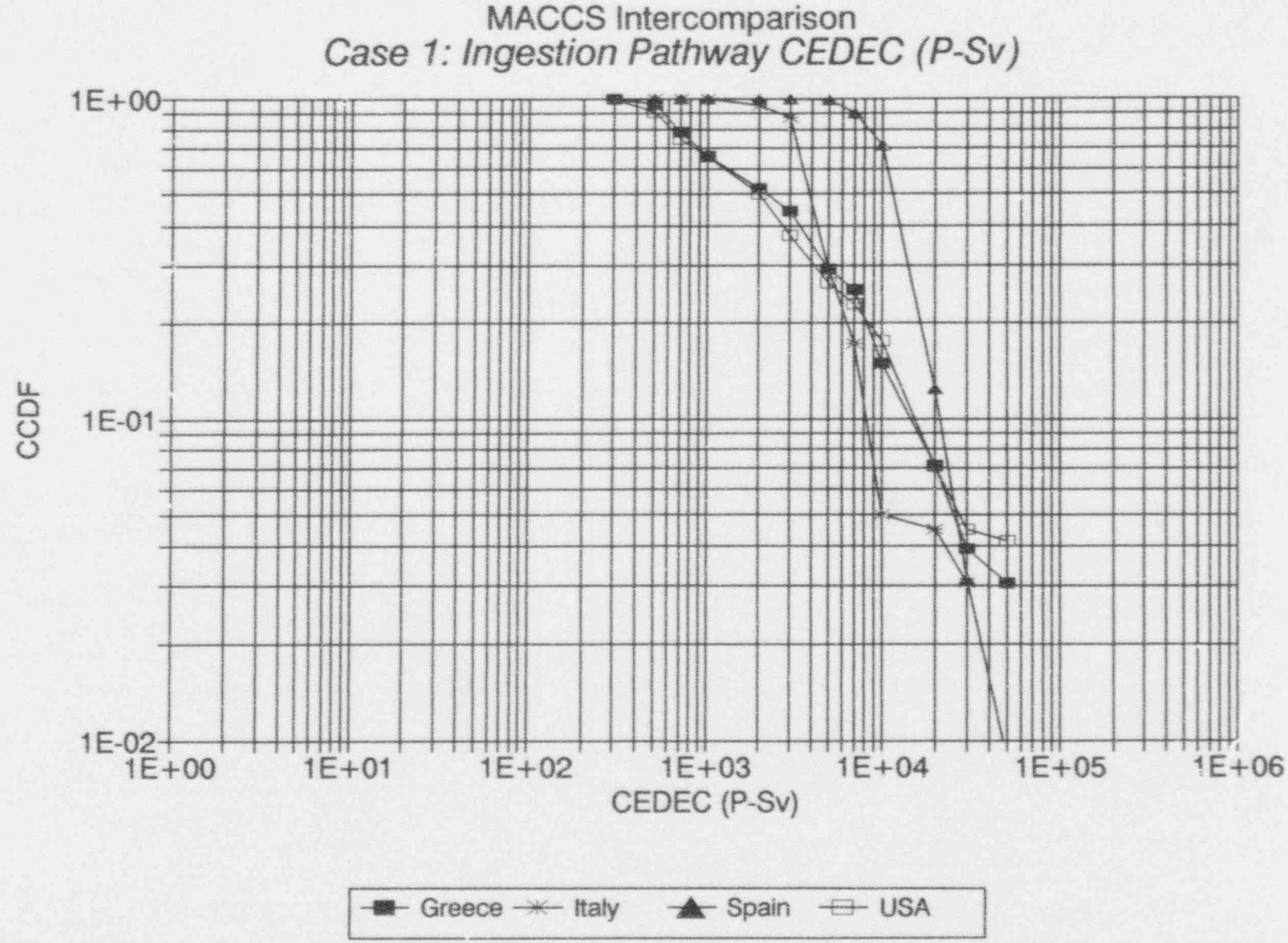

Figure 3.20 Ingestion Pathway CEDEC Prediction: CCDF Results Comparison, Case 1

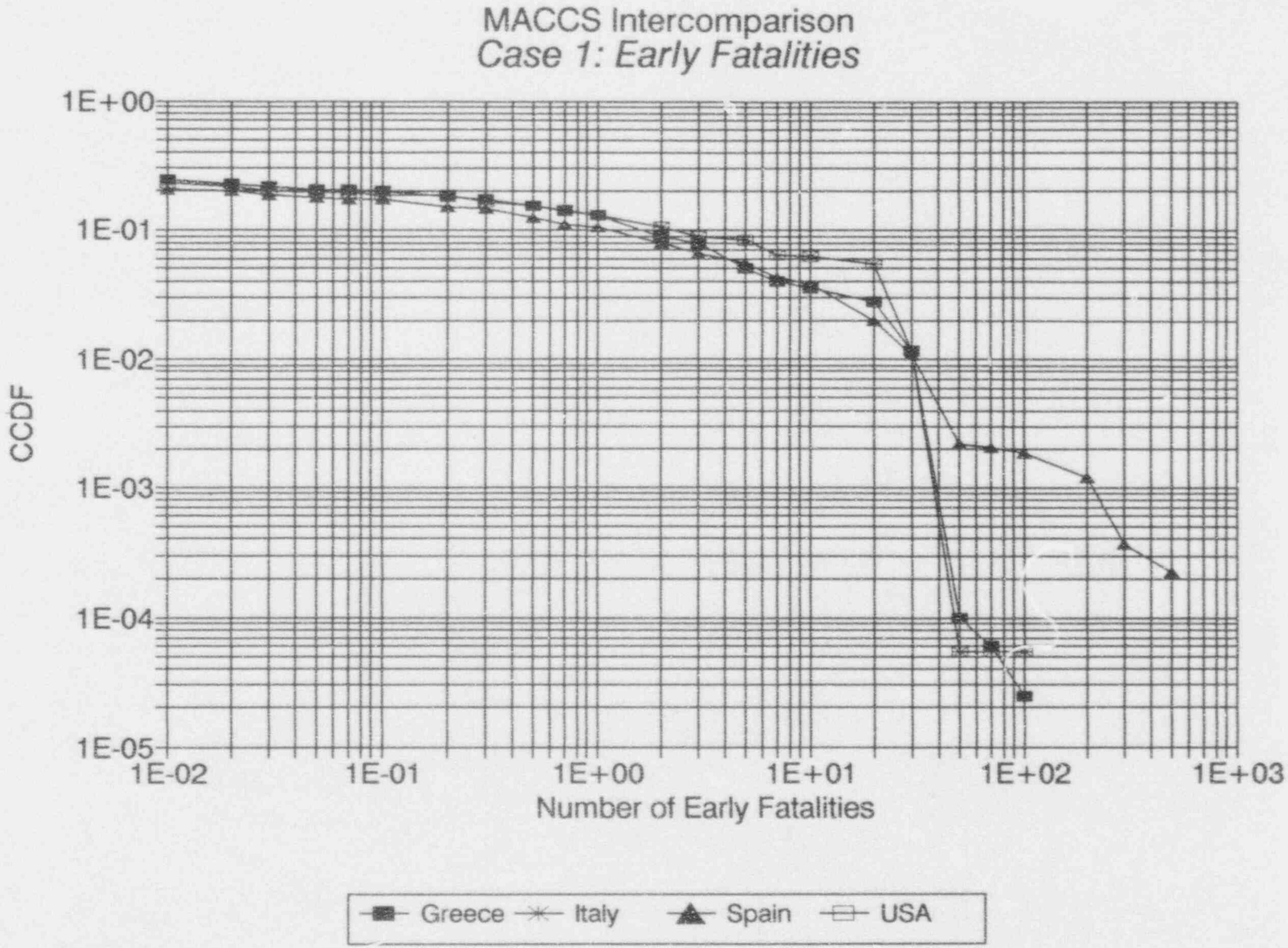

Figure 3.21 Early Fatalities Prediction: CCDF Results Comparison, Case 1

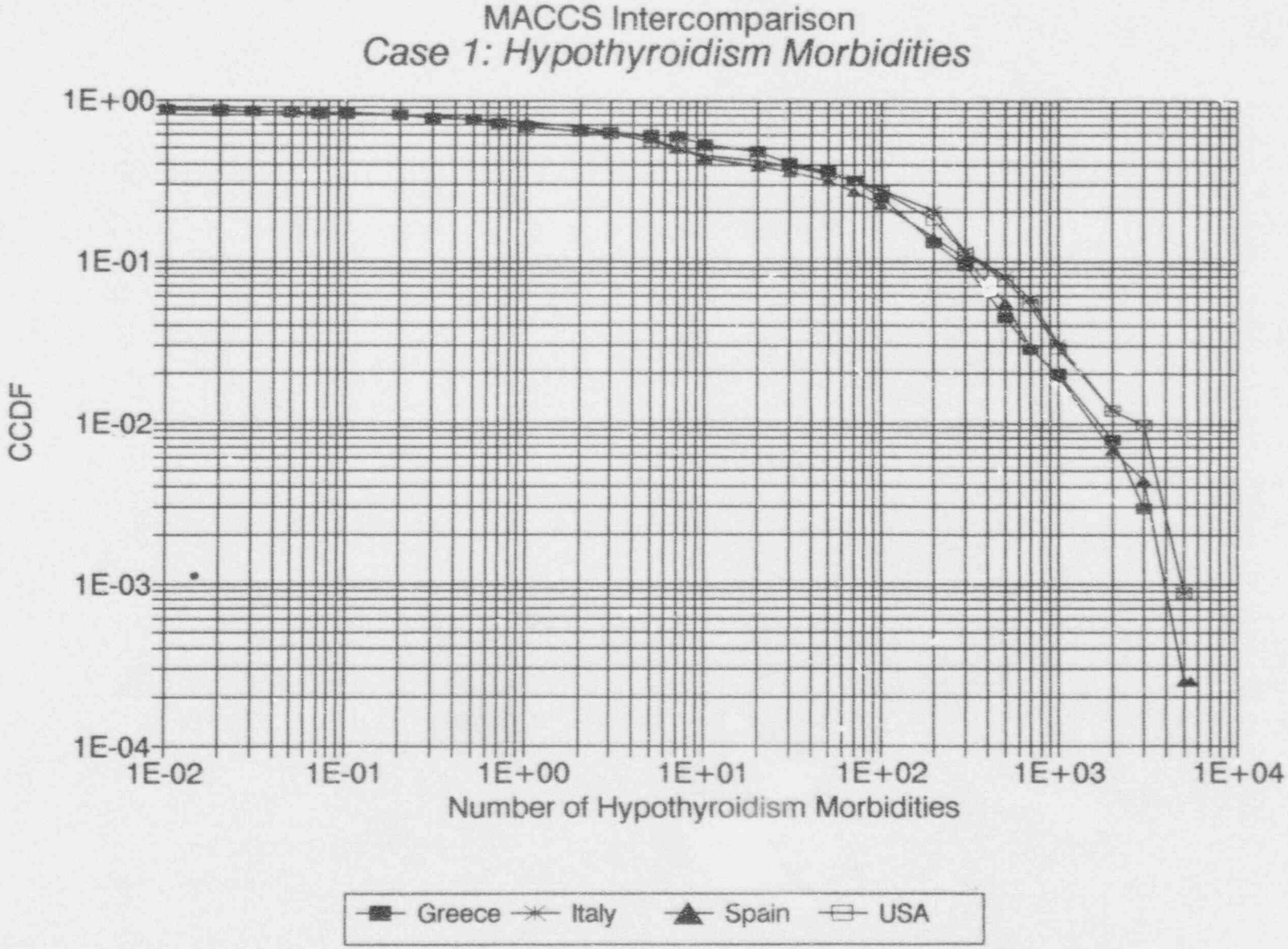

Figure 3.22 Hypothyroidism Morbidities Prediction: CCDF Results Comparison, Case 1

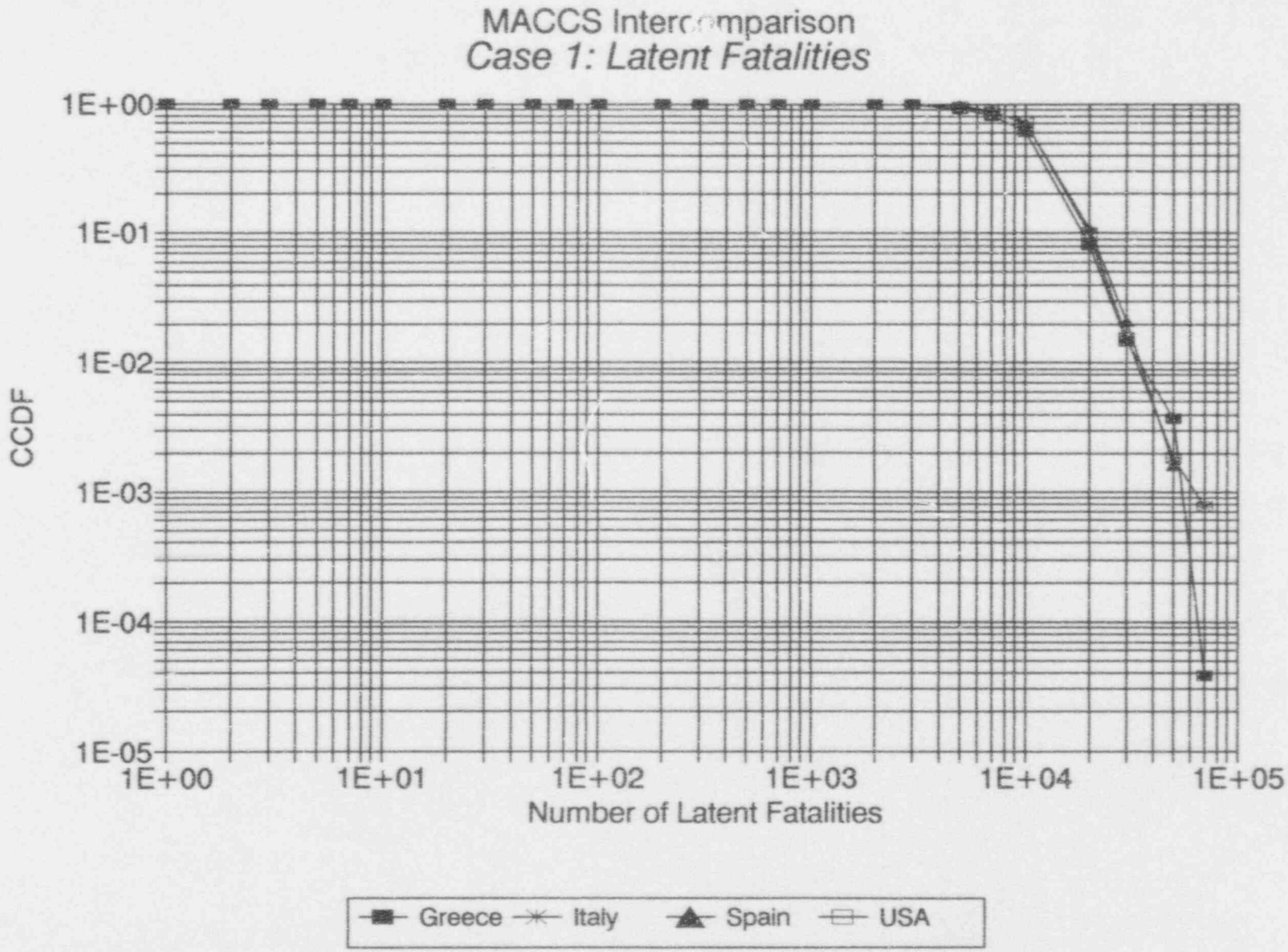

Figure 3.23 Latent Fatalities Prediction: CCDF Results Comparison, Case 1

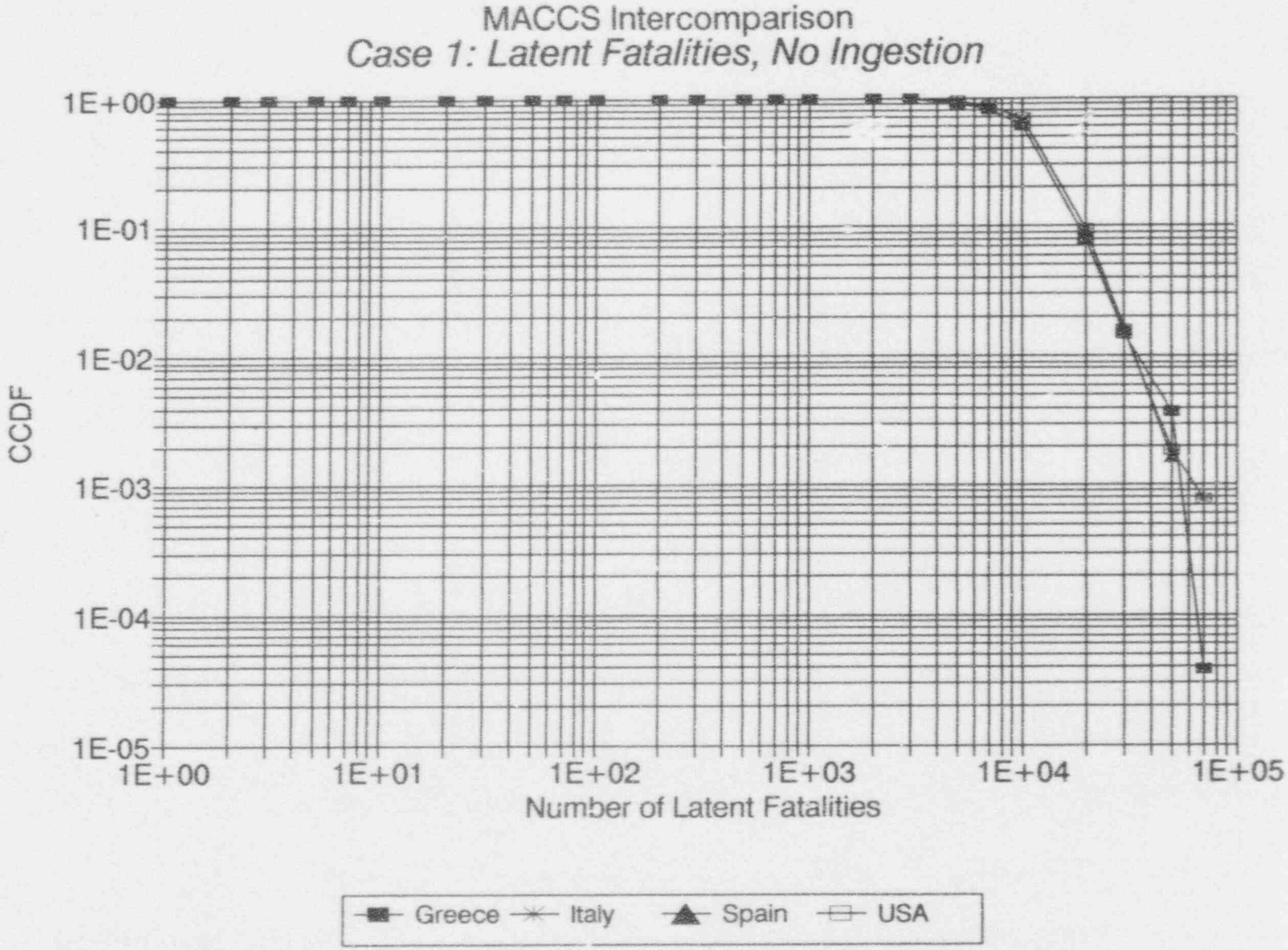

Figure 3.24 Latent Fatalities Prediction (no ingestion pathway): CCDF Results Comparison, Case 1

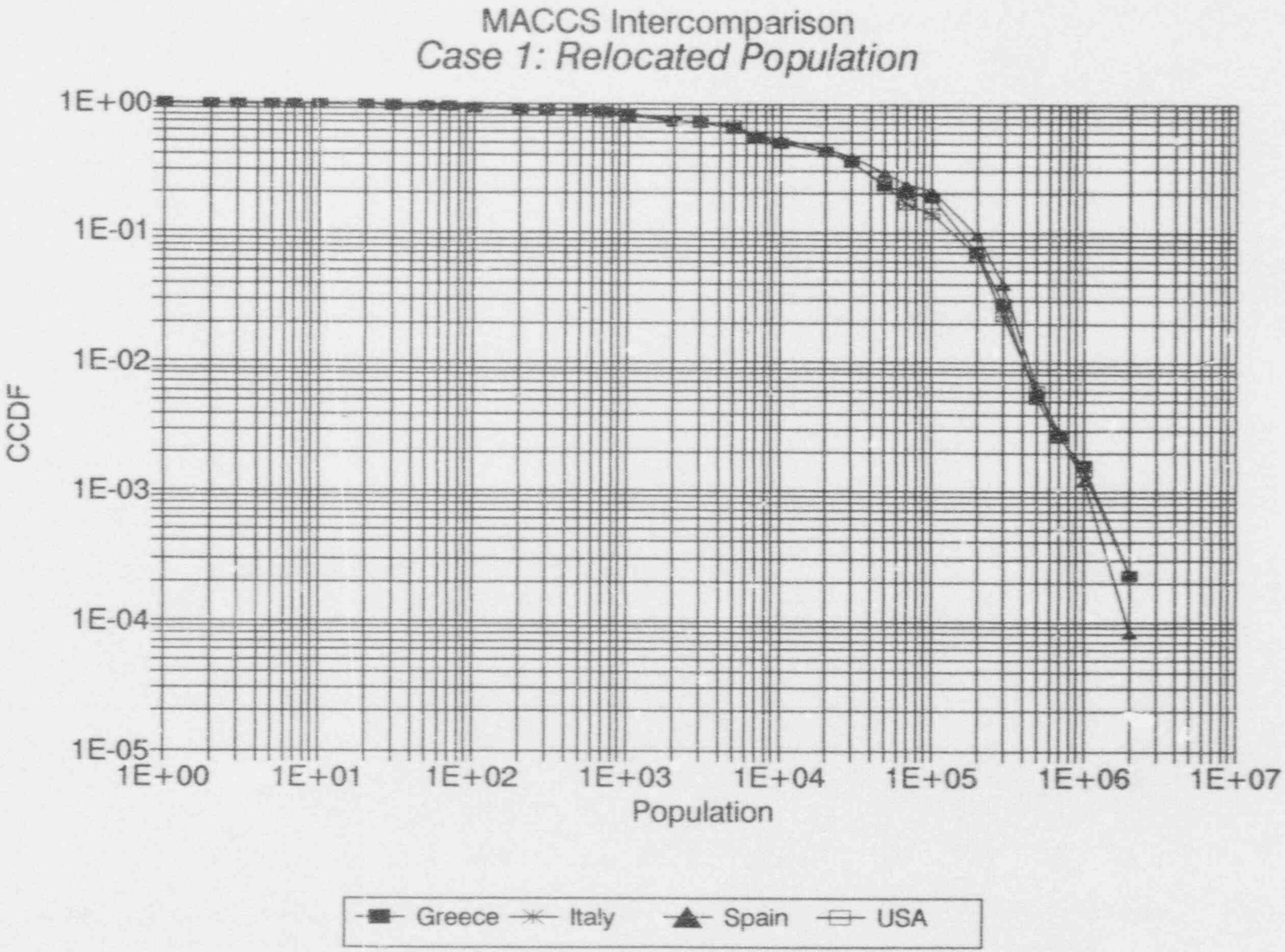

Figure 3.25 Relocated Population Prediction: CCDF Results Comparison, Case 1

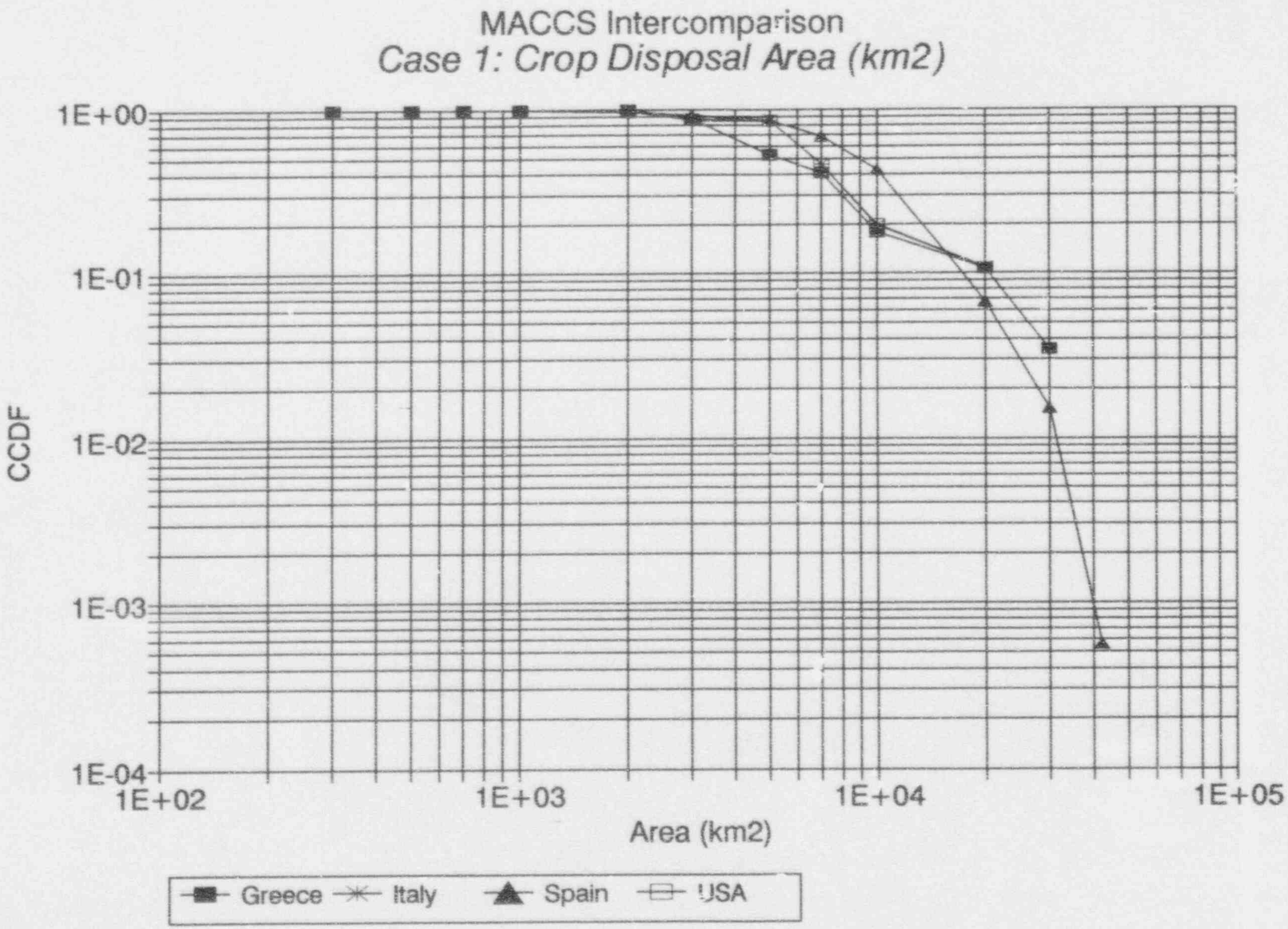

Figure 3.26 Crop Disposal Area Prediction: CCDF Results Comparison, Case 1

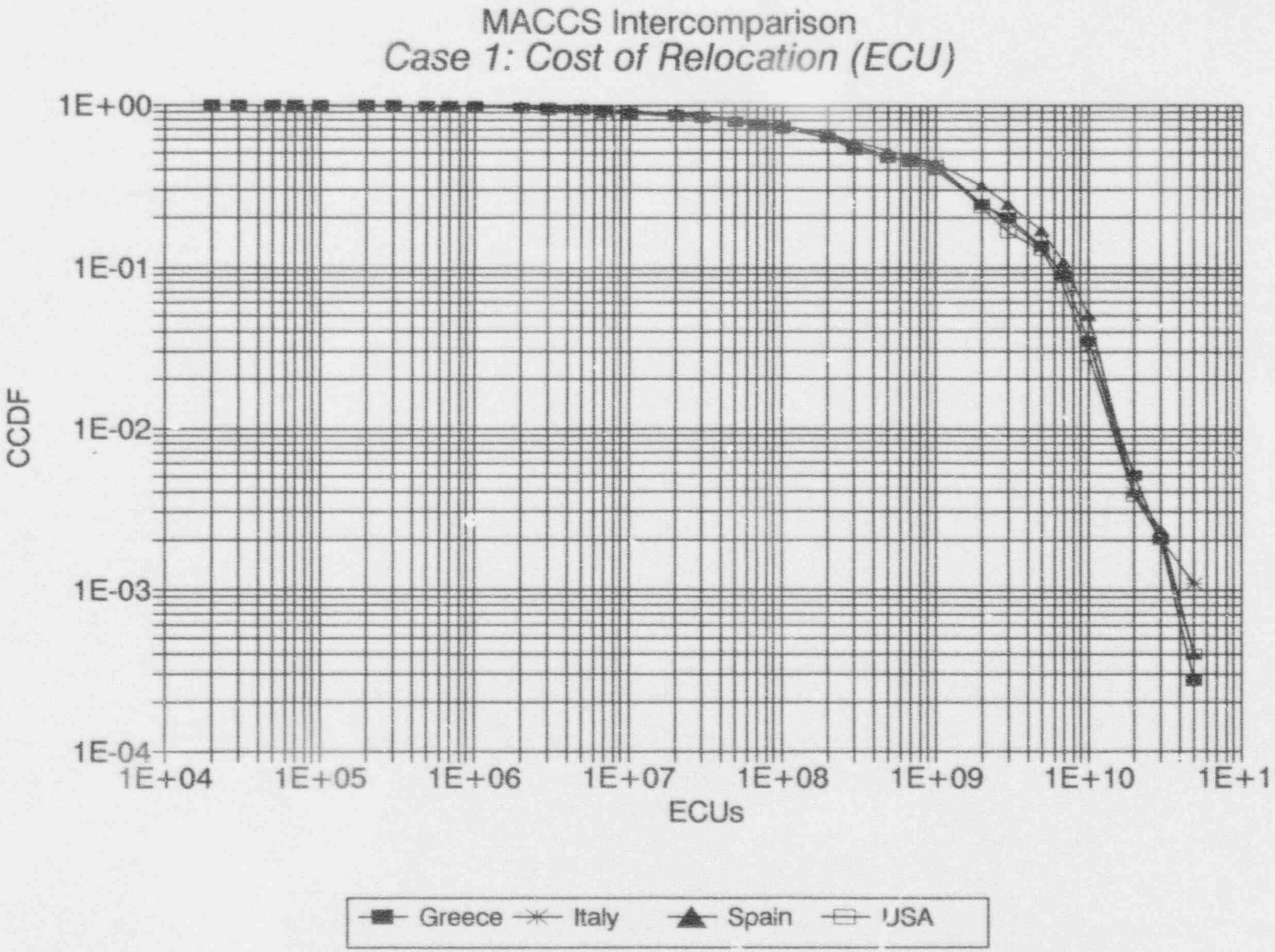

Figure 3.27 Cost of Relocation Prediction: CCDF Results Comparison, Case 1

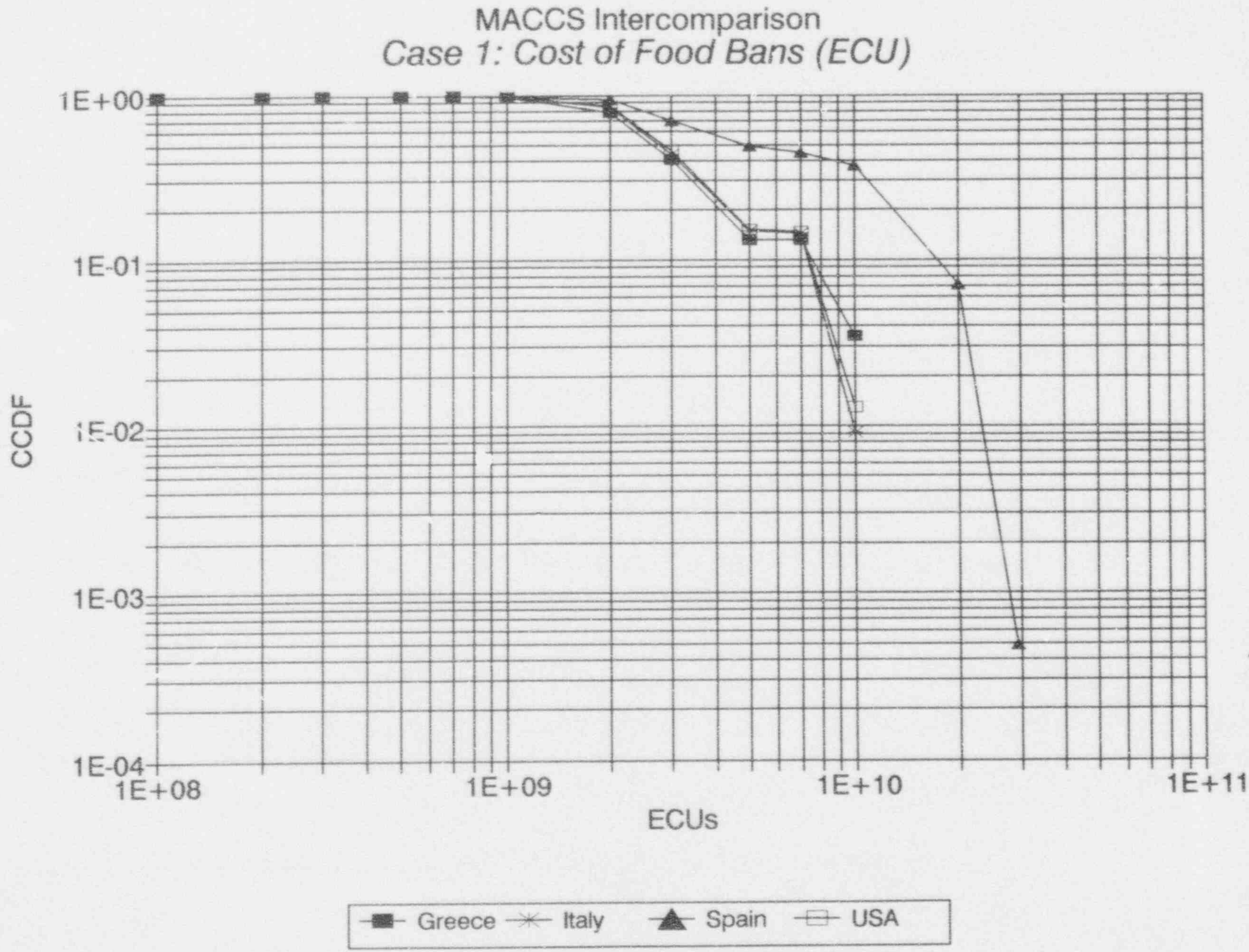

Figure 3.28 Cost of Food Bans Prediction: CCDF Results Comparison, Case 1

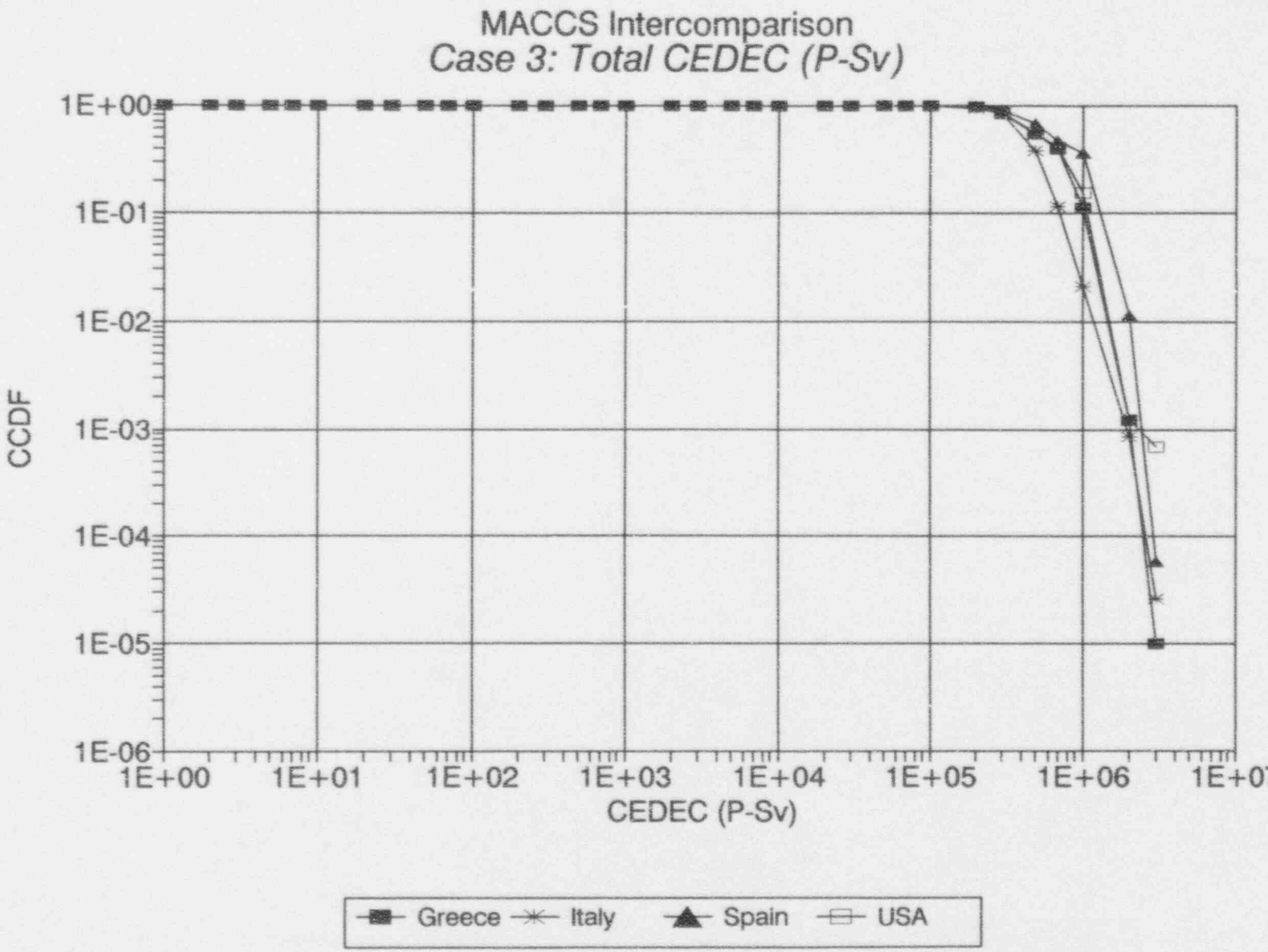

Figure 3.29 Total CEDEC Prediction: CCDF Results Comparison, Case 3

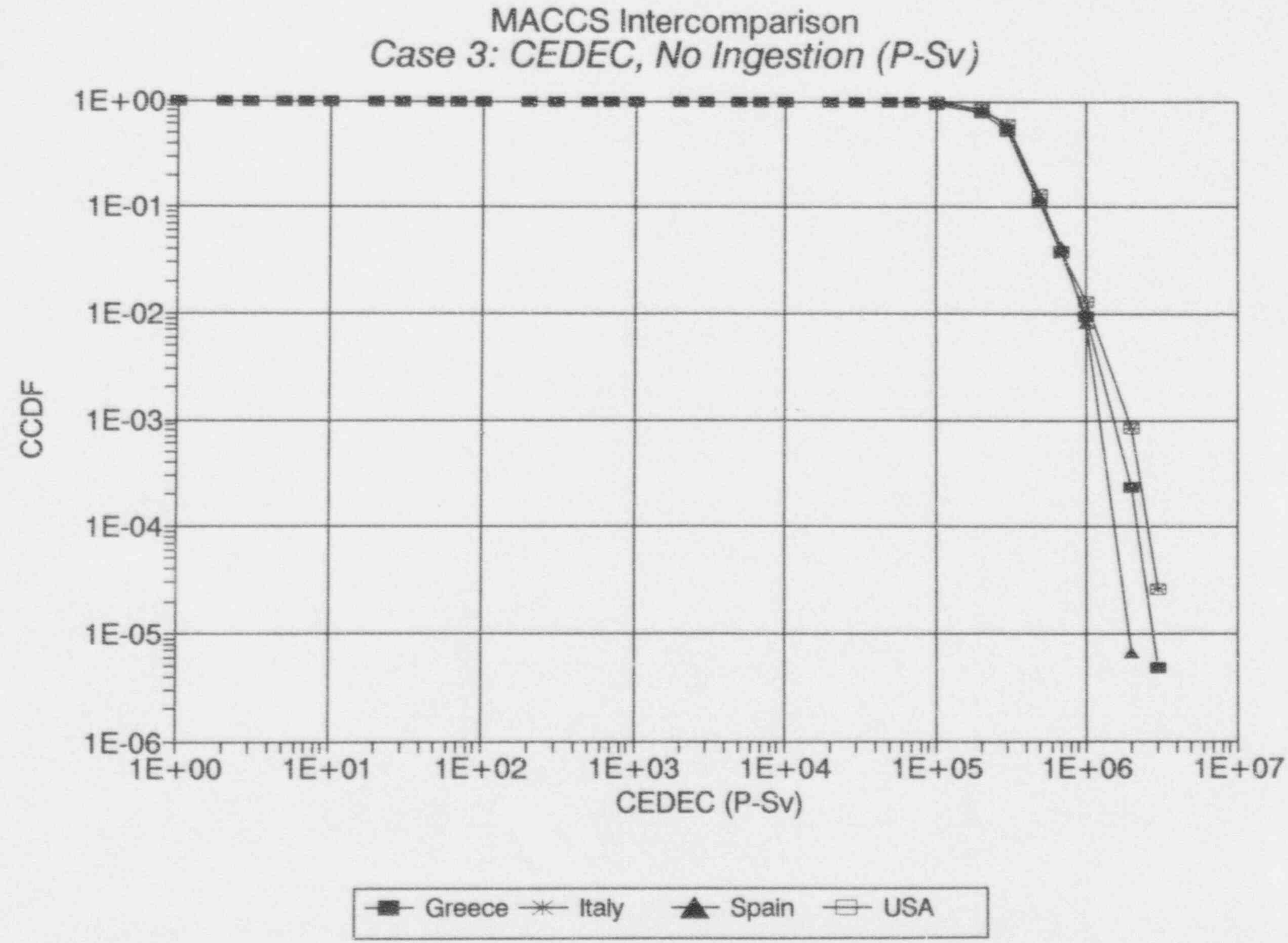

Figure 3.30 CEDEC Prediction (no ingestion pathway): CCDF Results Comparison, Case 3

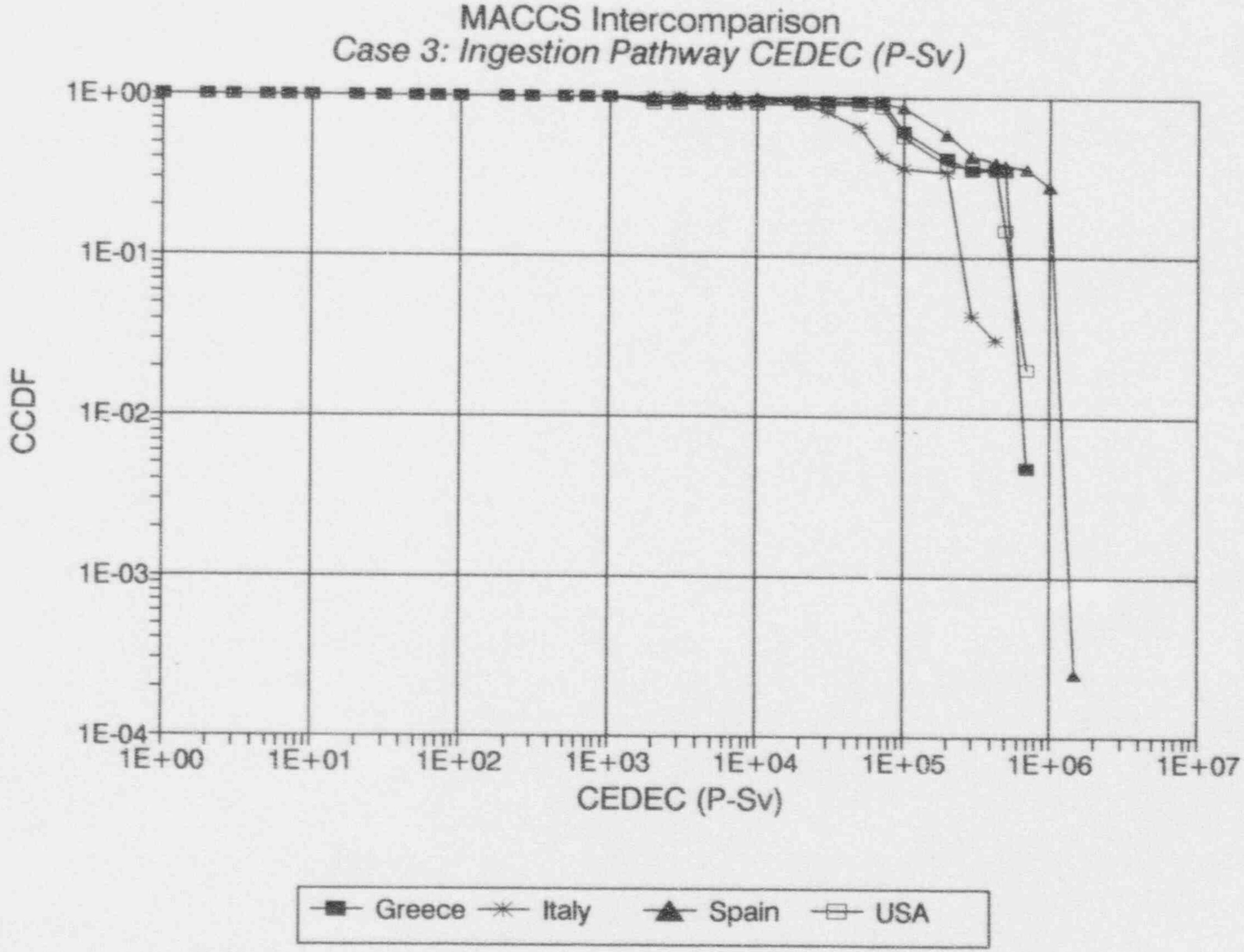

Figure 3.31 Ingestion Pathway CEDEC Prediction: CCDF Results Comparison, Case 3

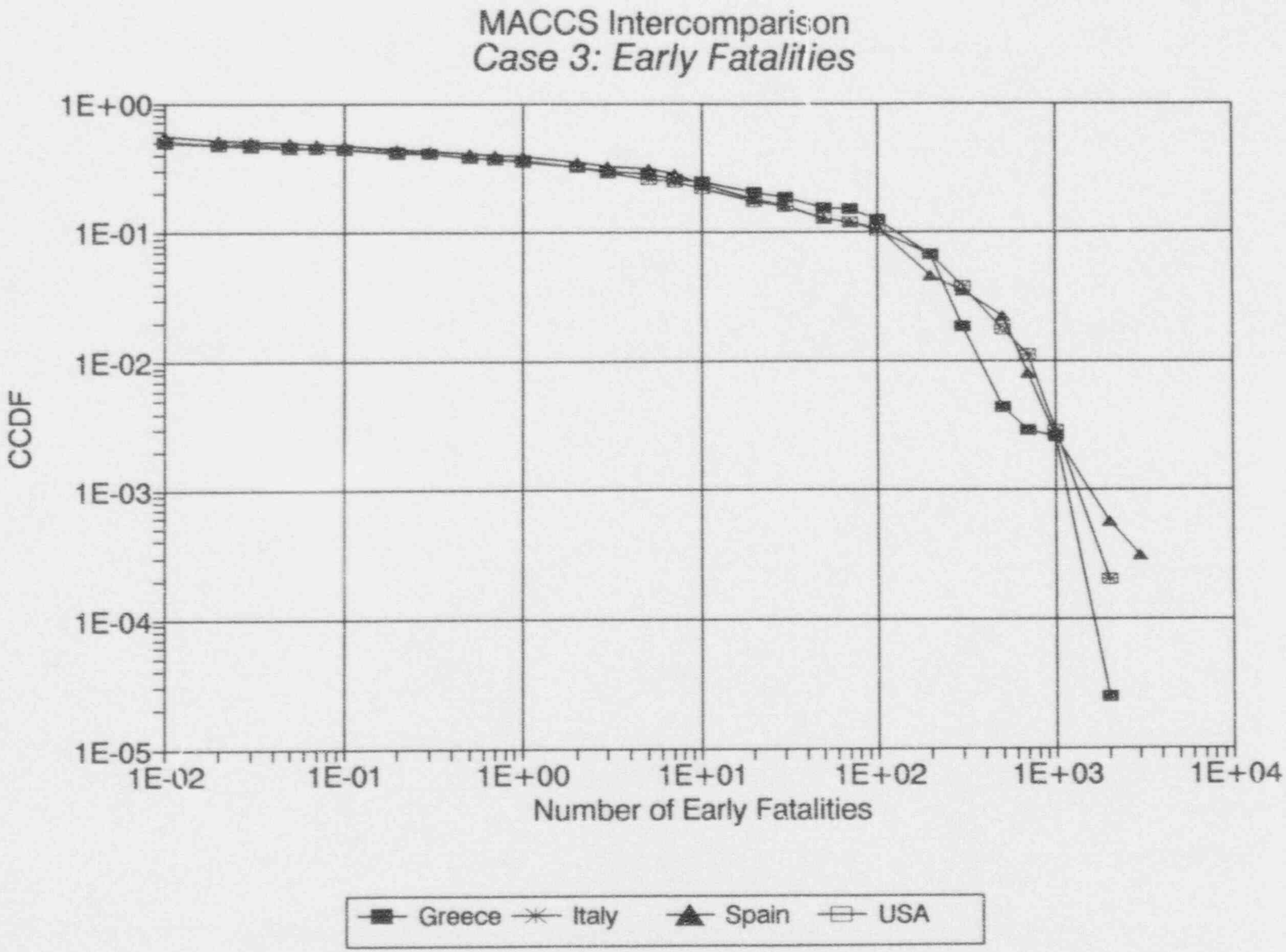

Figure 3.32 Early Fatalities Prediction: CCDF Results Comparison, Case 3

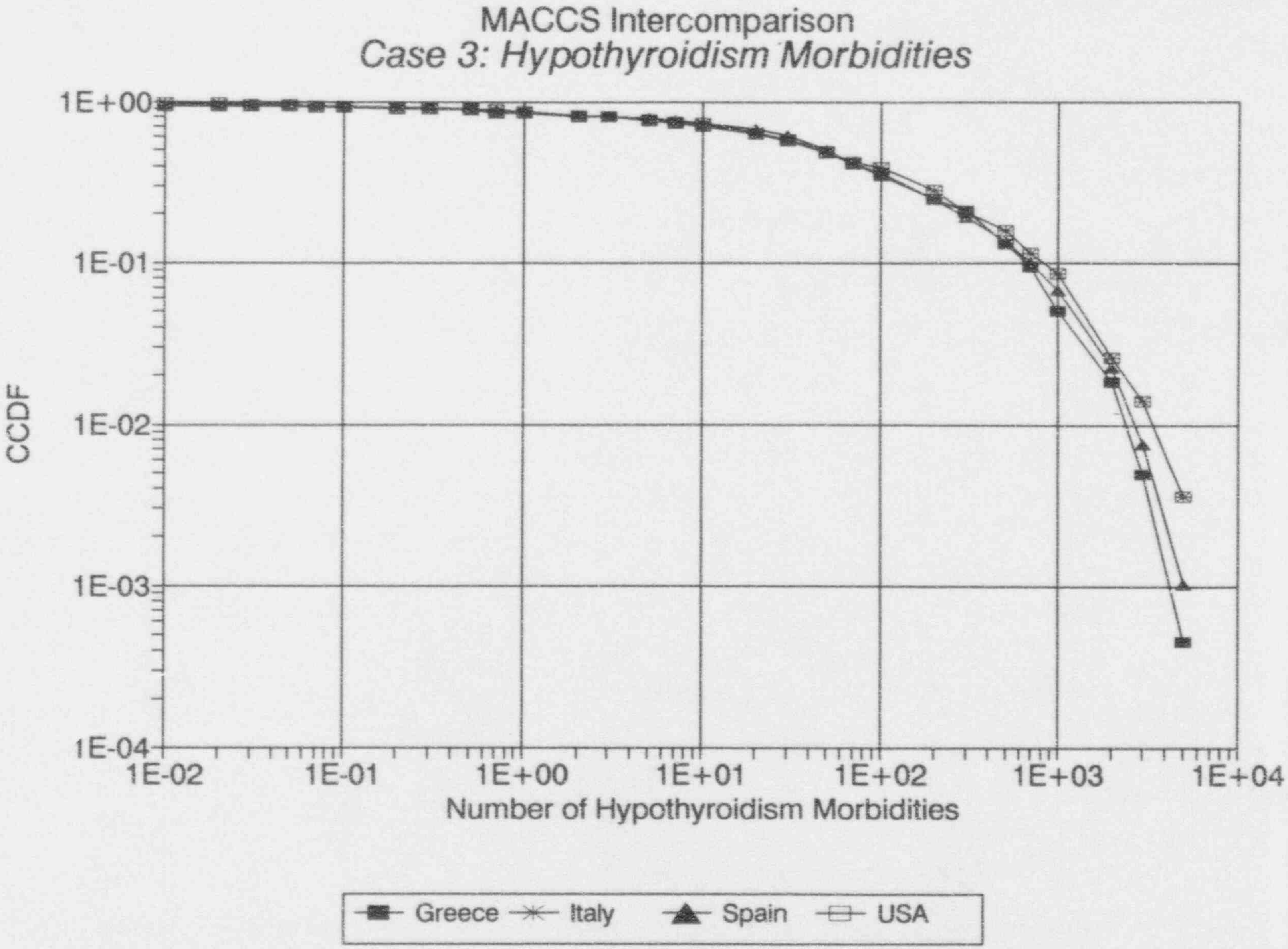

Figure 3.33 Hypothyroidism Morbidities Prediction: CCDF Results Comparison, Case 3

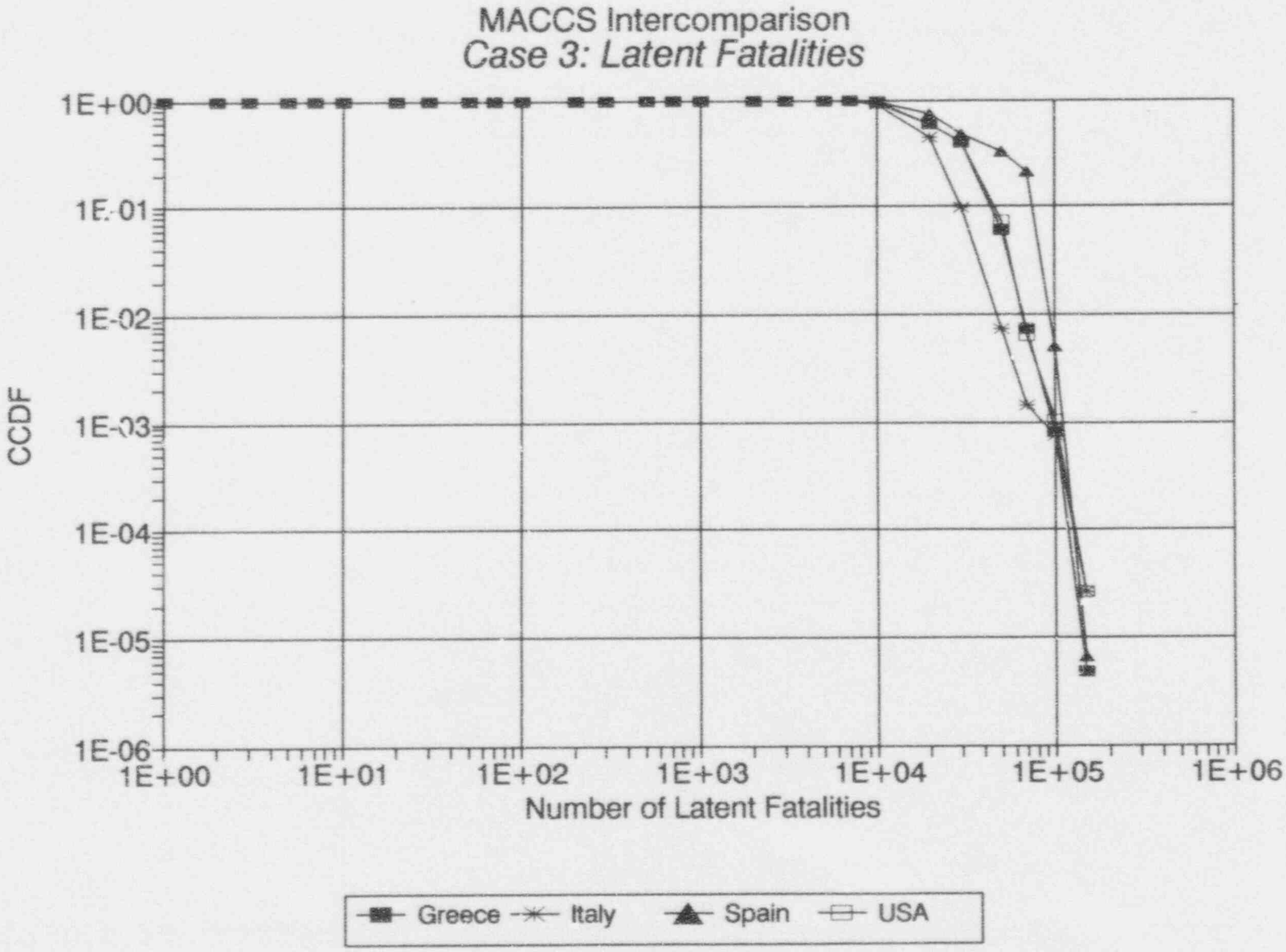

Figure 3.34 Latent Fatalities Prediction: CCDF Results Comparison, Case 3

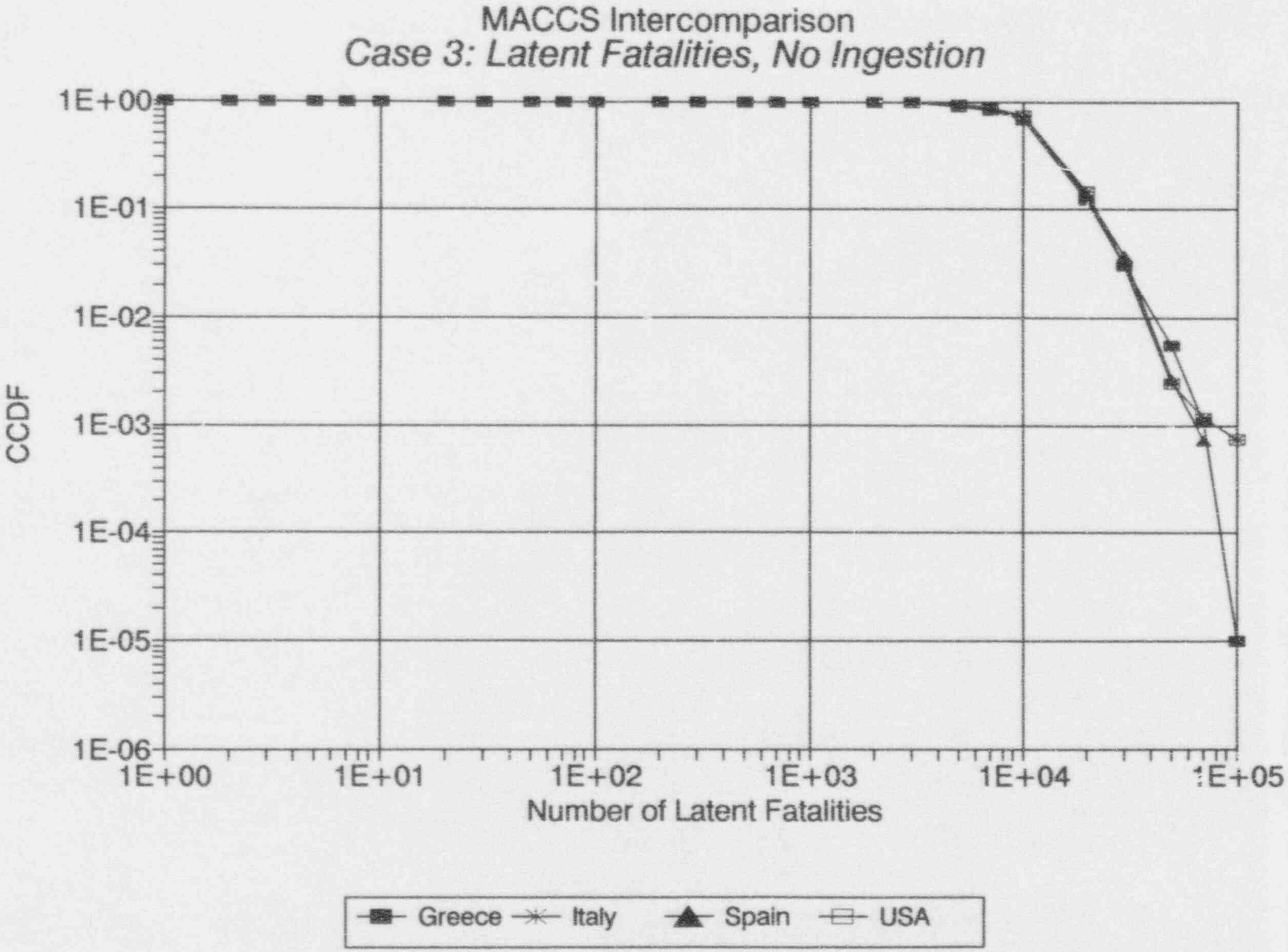

Figure 3.35 Latent Fatalities Prediction (no ingestion pathway): CCDF Results Comparison, Case 3

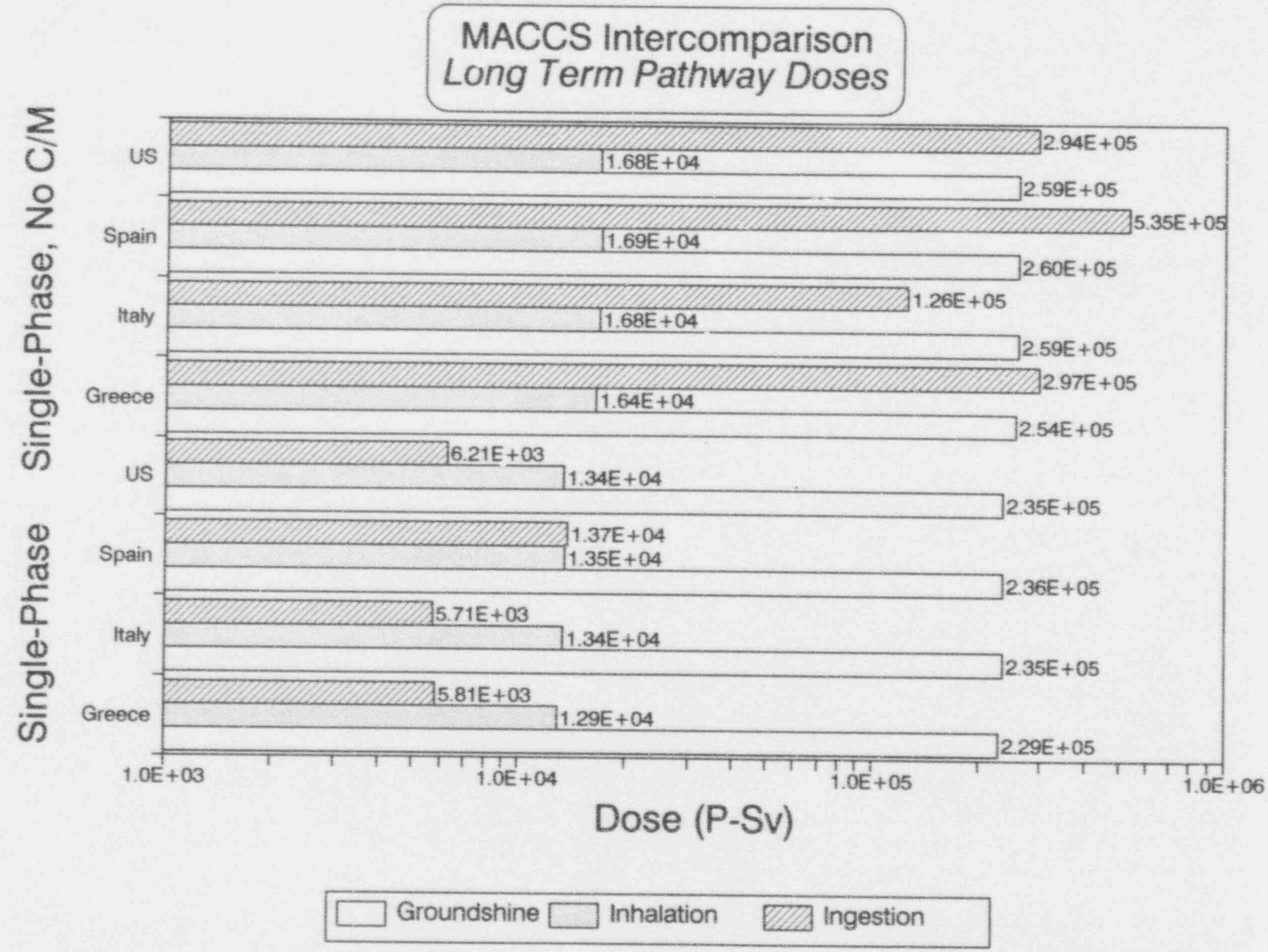

Figure 3.36 Long Term CEDEC Pathway Distribution Prediction, Mean Values (Single-Phase and No Counter-Measures Cases)

4 USERS RECOMMENDATIONS

This section contains some comments provided by the participants of the exercise. The comments point to the potential areas of improvements of the MACCS code such as input preparation, convenience of use, flexibility in modeling of counter-measures, providing sufficient data in the output, improvements in the phenomenological modeling, as well as in the code's documentation.

One of the most important observations refers to the difficulty with preparing the CHRONC input file. This input file contains the information needed for the long-term dose calculations including the ingestion pathway dose and counter-measures modeling. Specifically, a more detailed description of the MAXGC code would be helpful as a part of the users guide package. As mentioned previously, this code calculates the maximum allowed ground contamination of the farmland based on a user specified ingestion-related dose limit. It was suggested to quality assure and maintain this program as a pre-processor of data for the CHRONC input file.

It would be desirable to distribute an auxiliary program written specifically for this intercomparison exercise which transforms data from a geographical to a polar grid as part of the MACCS code package. One of such programs, CCPOPMAP [12], was prepared at BNL for the MACCS users in the course of the exercise, and it is described in Appendix G; GRISCTN [13] is another program written in Spain and used by the Spanish participants.

There were also several suggestions by the participants related to some aspects of the counter-measures modeling in the MACCS code. The major recommendations are:

a) allow for specification of sheltering and evacuation in a sector rather than within a circle (e.g., key-hole shaped evacuation zone);
b) allow for specification of evacuation and sheltering conditional on a dose criterion;
c) allow for specification of sheltering without subsequent evacuation during the emergency phase;
d) allow a greater flexibility in modeling of relocation and return of relocatees;
e) allow modeling of crop disposal and farmland interdiction based on a food contamination level (Bq/kg) since this is the preferred food interdiction criterion used worldwide.

It was also pointed out that a code option allowing calculations without considering the ingestion pathway would be useful for conducting sensitivity calculations. Currently, this can only be accomplished by modifying the input data.

In the process of implementing the specified source terms it became necessary to split a long duration release, ST 5, Table 2.2 (24 hr release) into four 6-hr long phases (maximum number of phases allowed by MACCS). However, this choice may not provide an adequate modeling of reality because of frequent changes in the wind direction such that probability for wind to blow in the same direction for six straight hours would be very low. To evaluate the wind direction history, the meteorological data used for the exercise were processed and presented as a contiguous wind direction distribution of weather samples (Fig. 4.1). It follows from this figure that only 244 6-hour or longer weather samples (about 6% of total) had wind blowing in the same direction. It is recognized that some code modifications may be required to provide MACCS with a capability to model the long duration releases.

In terms of the output data available from the MACCS code, it was suggested that a more detailed output package should include:

a) contributions from the different exposure pathways to the collective dose during the early (emergency) phase, and
b) data on the air and ground concentration versus distance predictions in a specified direction.

Addressing the latter concern, the Italian team developed modifications to the MACCS code [14] that allowed predictions of the weather-averaged radial distributions of air and ground concentration of specified radionuclides. Some results of the Italian predictions are provided in Appendix C.

Finally, it was pointed out that the MACCS Model Description, User Guide, and Programmer Reference Guide were valuable sources for learning, using and, if required, modifying the code. In terms of the clarity and completeness of the code's documentation, more detail descriptions of the output results, specifically in the part discussing the latent effects, and of the MAXGC program were recommended.

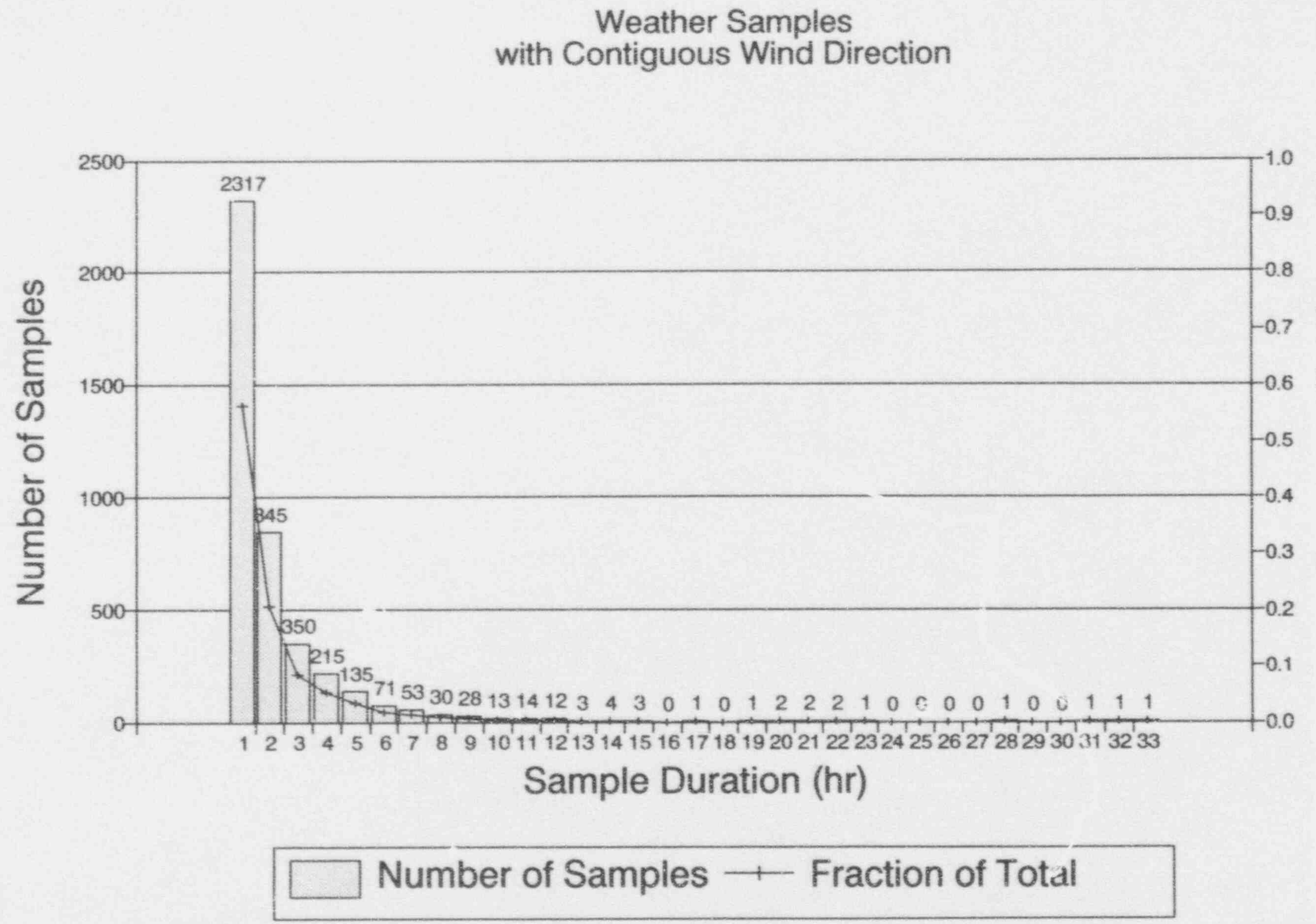

Figure 4.1 Meteorological Data: Distribution of Weather Samples with Contiguous Wind Direction

5 SUMMARY AND CONCLUSIONS

The following major conclusions were drawn from the experience gained by the MACCS Users Group:

The largest differences between predictions are found in the measures related to the ingestion pathway modeling. The measures with the largest spread were the ingestion dose, crop disposal area, and cost of food bans.

Reasons for the differences in the ingestion pathway predictions were identified to be (1) the differences in defining an annual human food basket which led to variations in criteria used for crop disposal and farmland interdiction, (2) the differences in mapping of agricultural production, and (3) variation in values of retention and transfer factors for different crops as well as in the crop root uptake coefficients (TCROOT).

Other factors contributing to the differences between results were the choice of the MACCS dispersion model options "straight line" or "wind shift", both with rotation, choice of rain distance intervals for weather data binning and meteorological sampling.

It was also observed that the choices which the users make in the process of preparation of input data from the same specifications can result in noticeable differences between the predictions.

In the course of the exercise, users from different countries successfully interpreted benchmarking specifications and used them to prepare the MACCS input data files thus demonstrating capability of MACCS to accept data which were not designed specifically for use in the MACCS code. The exception was the interpretation of the agricultural data.

Interaction between the participants helped to quality assure the MACCS input data files used in the calculations, analyze results and provide explanations for differences between the four MACCS Users Group calculation results.

An International MACCS Users Group has been established with the objective to provide the MACCS users with a forum for discussing future MACCS improvements and for exchange of experiences in applying the code in various accident consequence evaluations.

6 REFERENCES

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4. Wall, I.B., et al., Overview of the Reactor Safety Study Consequence Model, U. S. NRC, Washington, D.C., NUREG-0340, 1977.

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7. H-N Jow, et al., MELCOR Accident Consequence Code System (MACCS), Model Description, NUREG/CR-4691, Vol. 2, February 1990.

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9. CRPH, CSNI, Additional Data and Instructions for the Joint NEA/CEC Intercomparison Exercise on Probabilistic Accident Consequence Assessment Codes, NEA/PCA/DOC(91)5, CCP2, 1991.

10. COSYMA User Guide, Commission of European Communities, EUR 13045, KfK 4331 B, February 1991.

11. Accidental Radioactive Contamination of Human Food and Animal Feeds; Recommendations for State and Local Agencies, Federal Food and Drug Administration, Federal Register, Vol. 47, No. 205, pp. 47073-47083, October 22, 1982.

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13. Gallego E., "GRISCTN and ECOGRID: Two Programs for the Transformation of Data From the Geographical European Grid to Polar Grids". Report CTN-43/91 (ACA-04/91). Cátedra de Tecnología Nuclear, Polytechnical University of Madrid, Madrid, 1991.

14. Fanfarillo, A, Monti, S., Modification to the MACCS Code for Land Contaminations, ENEA QT-CHA-008, June 10, 1992.

Appendix A
Input Data for ATMOS, EARLY, and CHRONC Modules

A.1 ATMOS Input File for Case 1 (Single-Phase) Used in U. S. Calculations

```
* GENERAL DESCRIPTIVE TITLE DESCRIBING THIS "ATMOS" INPUT
*
RIATNAM1001  'International Comparison: ATMOS, CASES 1,3,4 (ST 2)'
**********************************************************************************
* GEOMETRY DATA BLOCK, LOADED BY INPGEO, STORED IN /GEOM/
*
* NUMBER OF RADIAL SPATIAL ELEMENTS
*                                                   changes made, alh 5-28-91
GENUMRAD001  29
*
*  INTERNATIONAL COMPARISON
*                                                    changes made, alh 5-28-91
GESPAEND001      0.2       0.5       0.8      1.2      1.6
GESPAEND002      2.        3.        4.       5.       7.
GESPAEND003     10.       13.       16.5     20.      24.
GESPAEND004     28.       32.       40.      50.      70.
GESPAEND005    100.      150.      200.     300.     500.
GESPAEND006    750.     1000.     1500.    2000.
**************************************************************************
* NUCLIDE DATA BLOCK, LOADED BY INPISO, STORED IN /ISOGRP/, /ISONAM/
*
* NUMBER OF NUCLIDES                                changes made, alh 5-17-91
*
ISNUMISO001 54
*
* NUMBER OF NUCLIDE GROUPS
*
ISMAXGRP001  9
*
* WET AND DRY DEPOSITION FLAGS FOR EACH NUCLIDE GROUP
*
*              WETDEP     DRYDEP
*
ISDEPFLA001    .FALSE.    .FALSE.
ISDEPFLA002    .TRUE.     .TRUE.
ISDEPFLA003    .TRUE.     .TRUE.
ISDEPFLA004    .TRUE.     .TRUE.
ISDEPFLA005    .TRUE.     .TRUE.
ISDEPFLA006    .TRUE.     .TRUE.
ISDEPFLA007    .TRUE.     .TRUE.
ISDEPFLA008    .TRUE.     .TRUE.
ISDEPFLA009    .TRUE.     .TRUE.
*
* NUCLIDE GROUP DATA FOR 9 NUCLIDE GROUPS
*
*              NUCNAM     PARENT   IGROUP        HAFLIF
*                                                 changes made, alh 5-17-91
ISOTPGRP001    CO-58       NONE       6       6.160E+06
ISOTPGRP002    CO-60       NONE       6       1.660E+08
ISOTPGRP003    KR-85       NONE       1       3.386E+08
ISOTPGRP004    KR-85M      NONE       1       1.613E+04
ISOTPGRP005    KR-87       NONE       1       4.560E+03
ISOTPGRP006    KR-88       NONE       1       1.008E+04
ISOTPGRP007    RB-86       NONE       3       1.611E+06
ISOTPGRP008    SR-89       NONE       5       4.493E+06
ISOTPGRP009    SR-90       NONE       5       8.865E+08
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ISOTPGRP011    Y-90       SR-90       7       2.307E+05
ISOTPGRP012    Y-91       SR-91       7       5.080E+06
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```

```
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ISOTPGRP021     RU-106       NONE      6       3.188E+07
ISOTPGRP022     SB-127       NONE      4       3.283E+05
ISOTPGRP023     SB-129       NONE      4       1.562E+04
ISOTPGRP024     TE-127      SB-127     4       3.366E+04
ISOTPGRP025     TE-127M      NONE      4       9.418E+06
ISOTPGRP026     TE-129      SB-129     4       4.200E+03
ISOTPGRP027     TE-129M      NONE      4       2.886E+06
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ISOTPGRP042     CE-141       NONE      8       2.811E+06  PARENT ADDED  LA-141
ISOTPGRP043     CE-143       NONE      8       1.188E+05
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ISOTPGRP050     PU-240      CM-244     8       2.133E+11
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ISOTPGRP052     AM-241      PU-241     7       1.366E+10
ISOTPGRP053     CM-242       NONE      7       1.408E+07
ISOTPGRP054     CM-244       NONE      7       5.712E+08
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* WET DEPOSITION DATA BLOCK, LOADED BY INFWET, STORED IN /WETCON/
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* WASHOUT COEFFICIENT NUMBER ONE, LINEAR FACTOR
*                                                   changes made, alh 5-17-91
WDCWASH1001  1.0E-4
*
* WASHOUT COEFFICIENT NUMBER TWO, EXPONENTIAL FACTOR
*
WDCWASH2001  0.8
*********************************************************************************
* ln 10.15.91: no elemental Iodine.
* Changing to two groups - organic Iodine and aerosol (CsI)
* DRY DEPOSITION DATA BLOCK, LOADED BY INPDRY, STORED IN /DRYCON/
*
* NUMBER OF PARTICLE SIZE GROUPS
*
DDNPSGRP001    2
*
* DEPOSITION VELOCITY OF EACH PARTICLE SIZE GROUP (M/S)
*              org I    others
DDVDEPOS001    0.0005   0.001
*
* PARTICLE SIZE DISTRIBUTION OF EACH NUCLIDE GROUP
* YOU MUST SPECIFY A COLUMN OF DATA FOR EACH OF THE PARTICLE SIZE GROUPS
*              organic I    others
RDPSDIST001     0.0          1.0
RDPSDIST002     0.01         0.99
RDPSDIST003     0.0          1.0
RDPSDIST004     0.0          1.0
RDPSDIST005     0.0          1.0
RDPSDIST006     0.0          1.0
RDPSDIST007     0.0          1.0
```

```
RDPSDIST008    0.0         1.0
RDPSDIST009    0.0         1.0
*******************************************************************************
* DISPERSION PARAMETER DATA BLOCK, LOADED BY INPDIS, STORED IN /DISPY/, /DISPZ/
*
* SIGMA = A X ** B  WHERE A AND B VALUES ARE FROM TADMOR AND GUR (1969)
*
* LINEAR TERM OF THE EXPRESSION FOR SIGMA-Y, 6 STABILITY CLASSES
*
* STABILITY CLASS: A        B        C        D        E        F
*
DPCYSIGA001   0.3658   0.2751   0.2089   0.1474   0.1046   0.0722
*
* EXPONENTIAL TERM OF THE EXPRESSION FOR SIGMA-Y, 6 STABILITY CLASSES
*
* STABILITY CLASS: A        B        C        D        E        F
*
DPCYSIGB001    .9031    .9031    .9031    .9031    .9031    .9031
*
* LINEAR TERM OF THE EXPRESSION FOR SIGMA-Z, 6 STABILITY CLASSES
*
* STABILITY CLASS: A        B        C        D        E        F
*
DPCZSIGA001   2.5E-4   1.9E-3     .2       .3       .4       .2
*
* EXPONENTIAL TERM OF THE EXPRESSION FOR SIGMA-Z, 6 STABILITY CLASSES
*
* STABILITY CLASS; A        B        C        D        E        F
*
DPCZSIGB001    2.125   1.6021    .8543    .6532    .6021    .6020
*
*  LINEAR SCALING FACTOR FOR SIGMA-Y FUNCTION, NORMALLY 1
*
DPYSCALE001    1.
*                                                   changes made alh 5-29-91
*  LINEAR SCALING FACTOR FOR SIGMA-Z FUNCTION,
*  NORMALLY USED FOR SURFACE ROUGHNESS LENGTH CORRECTION.
*  (Z1 / Z0) ** 0.2,    for IC project Z1 = 30 cm:
* (30 CM / 3 CM) ** 0.2 = 1.58
*
DPZSCALE001    1.58
******************************************************************************
* EXPANSION FACTOR DATA BLOCK, LOADED BY INPEXP, STORED IN /EXPAND/
*
* TIME BASE FOR EXPANSION FACTOR (SECONDS)
*
PMTIMBAS001    600.   (10 MINUTES)
*
* BREAK POINT FOR FORMULA CHANGE (SECONDS)
*
PMBRKPNT001   3600.   (1 HOUR)
*
* EXPONENTIAL EXPANSION FACTOR NUMBER 1
*
PMXPFAC1001       0.2
*
* EXPONENTIAL EXPANSION FACTOR NUMBER 2
*
PMXPFAC2001       0.25
*******************************************************************************
* PLUME RISE DATA BLOCK, LOADED BY INPLRS, STORED IN /PLUMRS/
*
* SCALING FACTOR FOR THE CRITICAL WIND SPEED FOR ENTRAINMENT OF A BUOYANT PLUME
* (USED BY FUNCTION CAUGHT)
*
PRSCLCRW001    1.
*
* SCALING FACTOR FOR THE A-D STABILITY PLUME RISE FORMULA
* (USED BY FUNCTION PLMRIS)
*
```

```
PRSCLADP001   1.
*
* SCALING FACTOR FOR THE E-F STABILITY PLUME RISE FORMULA
* (USED BY FUNCTION PLMRIS)
*
PRSCLEFP001   1.
*******************************************************************************
* WAKE EFFECTS DATA BLOCK, LOADED BY INPWAK, STORED IN /BILWAK/
*                                                      changes made alh 5-29-91
* BUILDING WIDTH (METERS)
*
WEBUILDW001   40.
*
* BUILDING HEIGHT (METERS)
*
WEBUILDH001   30.
*******************************************************************************
* RELEASE DATA BLOCK, LOADED BY INPREL, STORED IN /ATNAM2/, /MULREL/
*
RDATNAM2001 'International Comparison: ATMOS, Source Term 2'
*
* TIME AFTER ACCIDENT INITIATION WHEN THE ACCIDENT REACHES GENERAL EMERGENCY
* CONDITIONS (AS DEFINED IN NUREG-0654), OR WHEN PLANT PERSONNEL CAN RELIABLY
* PREDICT THAT GENERAL EMERGENCY CONDITIONS WILL BE ATTAINED
*
* ln: 12.11.91   = al - c, Table 4, Issue F
RDOALARM001        3600.0
*
* NUMBER OF PLUME SEGMENTS THAT ARE RELEASED
*
RDNUMREL001            1
*
* SELECTION OF RISK DOMINANT PLUME
*
RDMAXRIS001            1
*
* REFERENCE TIME FOR DISPERSION AND RADIOACTIVE DECAY
* mid-point
RDREFTIM001        0.5
*
* HEAT CONTENT OF THE RELEASE SEGMENTS (W)
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
*                                                      changes made, alh 5-17-91
* Source Term 2
RDPLHEAT001     0.0E06
* HEIGHT OF THE PLUME SEGMENTS AT RELEASE (M)
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
RDPLHITE001          10.0
*
* DURATION OF THE PLUME SEGMENTS (S)
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
* Source Term 2
RDPLUDUR001      3600.0  1 hour
*
* TIME OF RELEASE FOR EACH PLUME (S AFTER SCRAM)
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
* Source Term 2
RDPDELAY001      7200.0  2 hours
*
* CORE INVENTORY
*
*              NUCNAM        CORINV(BQ)
*                                                      changes made, alh 5-17-91
RDCORINV001    CO-58         3.08E+16
RDCORINV002    CO-60         1.14E+16
RDCORINV003    KR-85         2.17E+16
RDCORINV004    KR-85M        9.25E+17
RDCORINV005    KR-87         1.70E+18
RDCORINV006    KR-88         2.34E+18
RDCORINV007    RB-86         7.96E+15
```

```
RDCORINV008     SR-89          3.37E+18
RDCORINV009     SR-90          1.75E+17
RDCORINV010     SR-91          4.37E+18
RDCORINV011     Y-90           1.82E+17
RDCORINV012     Y-91           4.51E+18
RDCORINV013     ZR-95          5.88E+18
RDCORINV014     NB-95          5.81E+18
RDCORINV015     ZR-97          5.88E+18
RDCORINV016     MO-99          6.44E+18
RDCORINV017     TC-99M         5.55E+18
RDCORINV018     RU-103         5.25E+18
RDCORINV019     RU-105         3.51E+18
RDCORINV020     RH-105         3.18E+18
RDCORINV021     RU-106         1.30E+18
RDCORINV022     SB-127         2.93E+17
RDCORINV023     SB-129         9.95E+17
RDCORINV024     TE-127         2.85E+17
RDCORINV025     TE-127M        4.37E+16
RDCORINV026     TE-129         9.40E+17
RDCORINV027     TE-129M        1.67E+17
RDCORINV028     TE-131M        3.47E+17
RDCORINV029     TE-132         4.85E+18
RDCORINV030     I-131          3.39E+18
RDCORINV031     I-132          4.96E+18
RDCORINV032     I-133          [illegible]
RDCORINV033     I-1[illegible] 7.84E+18
RDCORINV034     I-135          6.40E+18
RDCORINV035     XE-133         6.85E+18
RDCORINV036     XE-135         1.67E+18
RDCORINV037     CS-134         3.85E+17
RDCORINV038     CS-136         1.33E+17
RDCORINV039     CS-137         2.29E+17
RDCORINV040     BA-140         6.14E+18
RDCORINV041     LA-140         6.32E+18
RDCORINV042     CE-141         5.92E+18
RDCORINV043     CE-143         5.44E+18
RDCORINV044     CE-144         3.59E+18
RDCORINV045     PR-143         5.40E+18
RDCORINV046     ND-147         2.36E+18
RDCORINV047     NP-239         7.32E+19
RDCORINV048     PU-238         3.17E+15
RDCORINV049     PU-239         1.11E+15
RDCORINV050     PU-240         1.06E+15
RDCORINV051     PU-241         3.21E+17
RDCORINV052     AM-241         2.06E+14
RDCORINV053     CM-242         6.62E+16
RDCORINV054     CM-244         2.75E+15
*
*  SCALING FACTOR TO ADJUST THE CORE INVENTORY FOR POWER LEVEL
*                                                 changes made, alh 5-17-91
RDCORSCA001    1.
*
* RELEASE FRACTIONS FOR ISOTOPE GROUPS IN RELEASE
*
*  ISOTOPE GROUPS:
* ln 10.24.91   La, Ce in specs === Group 7; Includes Pu
* ln 10.24.91   Ba, Sr, Ru === Group 6; separate in MACCS
*
* Source Term 2
*            XE/KR    I     CS     TE     SR     RU     LA      CE      BA
RDRELFRC001 1.0E+0  0.101  0.1    0.10   0.01   0.01   0.001   0.001   0.01
*******************************************************************************
* OUTPUT CONTROL DATA BLOCK, LOADED BY INPOPT, STORED IN /STOPME/, /ATMOPT/
*
* FLAG TO INDICATE THAT THIS IS THE LAST PROGRAM IN THE SERIES TO BE RUN
*
OCENDAT1001  .FALSE. (SET THIS VALUE TO .TRUE. TO SKIP EARLY AND CHRONC)
*
OCIDEBUG001  0
*
```

```
* NAME OF THE NUCLIDE TO BE LISTED ON THE DISPERSION LISTINGS
*
* OCNUCOUT001  CS-137
*******************************************************************************
* METEOROLOGICAL SAMPLING DATA BLOCK
*
* METEOROLOGICAL SAMPLING OPTION CODE:
*
* METCOD = 1, USER SPECIFIED DAY AND HOUR IN THE YEAR (FROM MET FILE),
*          2, WEATHER CATEGORY BIN SAMPLING,
*          3, 120 HOURS OF WEATHER SPECIFIED ON THE ATMOS USER INPUT FILE,
*          4, CONSTANT MET (BOUNDARY WEATHER USED FROM THE START),
*          5, STRATIFIED RANDOM SAMPLES FOR EACH DAY OF THE YEAR.
*
M1METCOD001  2
*
* LAST SPATIAL INTERVAL FOR MEASURED WEATHER
*
M2LIMSPA001  28
*
* BOUNDARY WEATHER MIXING LAYER HEIGHT
*
M2BNDMXH001  1000.  (METERS)
*
* BOUNDARY WEATHER STABILITY CLASS INDEX
*
M2IBDSTB001  4      (D-STABILITY)
*
* BOUNDARY WEATHER RAIN RATE
*
M2BNDRAN001  5.     (MM/HR)
*
* BOUNDARY WEATHER WIND SPEED
*
M2BNDWND001  5.     (M/S)
*
* NUMBER OF RAIN DISTANCE INTERVALS FOR BINNING
*
M4NRNINT001  5
*
* ENDPOINTS OF THE RAIN DISTANCE INTERVALS (KILOMETERS)
*
* NOTE: THESE MUST BE CHOSEN TO MATCH THE SPATIAL ENDPOINT DISTANCES
*       SPECIFIED FOR THE ARRAY SPAEND (10 % ERROR IS ALLOWED).
M4RNDSTS001  10.0  20.0  28.0  40.0  50.0
*
* NUMBER OF RAIN INTENSITY BREAKPOINTS
*                                                   changes made, alh 5-17-91
M4NRINTN001   2
*
* RAIN INTENSITY BREAKPOINTS FOR WEATHER BINNING (MILLIMETERS PER HOUR)
M4RNRATE001   0.5   3.0
*
* NUMBER OF SAMPLES PER BIN
M4NSMPLS001  4
*
* INITIAL SEED FOR RANDOM NUMBER GENERATOR
M4IRSEED001   79
```

A.2 EARLY Input File for Case 1 (Single-Phase) Used in U. S. Calculations

```
* GENERAL DESCRIPTIVE TITLE DESCRIBING THIS "EARLY" INPUT FILE
*
MIEANAM1001  'International Comparison: EARLY'
* According to Memo after July 15, 1991
* FLAG TO INDICATE THAT THIS IS THE LAST PROGRAM IN THE SERIES TO BE RUN
*
MIENDAT2001 .FALSE.   (.FALSE., SET THIS VALUE TO .TRUE. TO SKIP CHRONC)
*
* DISPERSION MODEL OPTION CODE:  1  *  STRAIGHT LINE
*                                2  *  WIND-SHIFT WITH ROTATION
*                                3  *  WIND-SHIFT WITHOUT ROTATION
*
MIIPLUME001  2
*
* NUMBER OF FINE GRID SUBDIVISIONS USED BY THE MODEL
*
MINUMFIN001  7    (3, 5 OR 7 ALLOWED)
*
* LEVEL OF DEBUG OUTPUT REQUIRED, NORMAL RUNS SHOULD SPECIFY ZERO
*
MIIPRINT001  0
*
* LOGICAL FLAG SIGNIFYING THAT THE BREAKDOWN OF RISK BY WEATHER CATEGORY
* BIN ARE TO BE PRESENTED TO SHOW THEIR RELATIVE CONTRIBUTION TO THE MEAN
*
*            RISBIN
*
MIRISCAT001   .FALSE.
*
* FLAG INDICATING IF WIND-ROSES FROM ATMOS ARE TO BE OVERRIDDEN
*
MIOVRRID001  .FALSE.  (USE THE WIND ROSE CALCULATED FOR EACH WEATHER BIN)
********************************************************************************
* POPULATION DISTRIBUTION DATA BLOCK, LOADED BY INPOPU, STORED IN /POPDAT/
*
*
PDPOPFLG001  FILE   - use site data file
* PDIBEGIN001  1   (SPATIAL INTERVAL AT WHICH POPULATION BEGINS)
* PDPOPDEN001  50. (POPULATION DENSITY (PEOPLE PER SQUARE KILOMETER))
* PDPOPFLG001  UNIFORM  - use uniform population distribution
********************************************************************************
* ORGAN DEFINITION DATA BLOCK, LOADED BY INORGA, STORED IN /EARDIM/ AND /ORGNAM/
*
* NUMBER OF ORGANS DEFINED FOR HEALTH EFFECTS
*
ODNUMORG001   10
*
* NAMES OF THE ORGANS DEFINED FOR HEALTH EFFECTS
*
ODORGNAM001 'SKIN', 'EDEWBODY', 'LUNGS', 'RED MARR', 'LOWER LI', 'STOMACH',
ODORGNAM002 'THYROIDH', 'BONE SUR', 'BREAST', 'BLAD WAL'
********************************************************************************
* SHIELDING AND EXPOSURE FACTORS, LOADED BY INDFAC, STORED IN /EADFAC/
*
* AT and LN 06.19.91
* NEA/CEC assumptions: 90% indoors 10% outdoors
*  indoor factor*90% + outdoor factor*10%
* ln 03.09.92  100% sheltering in the fixed zone: change in specs
*
*
* THREE VALUES OF EACH PROTECTION FACTOR ARE SUPPLIED,
* ONE FOR EACH TYPE OF ACTIVITY:
*
* ACTIVITY TYPE:
*     1 - EVACUEES WHILE MOVING
*     2 - NORMAL ACTIVITY IN SHELTERING AND EVACUATION ZONE
*     3 - SHELTERED ACTIVITY
*
```

```
* CLOUD SHIELDING FACTOR
*
*            EVACUEES       NORMAL              SHELTER
*                       0.1*0.9+1.0*0.1    0.05*0.9+1.0*0.1
* Final calculation: 100% sheltering:          0.05*100%
SECSFACT001      1.           0.19               0.05
*
* PROTECTION FACTOR FOR INHALATION
*
*            EVACUEES       NORMAL              SHELTER
*                       0.5*0.9+1.0*0.1     0.2*0.9+1.0*0.1
* Final calculation                             0.2*100%
SEPROTIN001       1.         0.55                0.2
*
* BREATHING RATE (CUBIC METERS PER SECOND)
*
SEBRRATE001  2.66E-4  2.66E-4  2.66E-4
*
* SKIN PROTECTION FACTOR
* 12.11.91 ln: see 3.2.5 and 3.2.7.a for skin shielding factors
*            EVACUEES            NORMAL              SHELTER
* STP calculation          0.5*0.9+1.0*0.1    0.2*0.9+1.0*0.1
* Final calculation:
* 03/09/92  Deposition on skin: 0.0001 m/s vs 0.01 m/s default
*                       0.005*90% + 0.01*10%
SESKPFAC001   0.01             0.0055              0.002
*
* GROUND SHIELDING FACTOR
*
* 07.30.91 ln: vehicles protection from ground radiation, NUREG-1150
* CEC do not provide the ground shielding factor for evacuees
* ln 12.11.91 Irrelevant: instant evacuation
*            EVACUEES         NORMAL              SHELTER
*                         0.1*0.9+1.0*0.1      0.05*0.9+1.0*0.1
* Final calculation:                              0.05*100%
SEGSHFAC001        0.5         0.19              0.05
*
* RESUSPENSION INHALATION MODEL CONCENTRATION COEFFICIENT (/METER)
*
*    RESCON = 1.E-4 IS APPROPRIATE FOR MECHANICAL RESUSPENSION BY VEHICLES.
*    RESHAF = 2.11 DAYS CAUSES 1.E-4 TO DECAY IN ONE WEEK TO 1.E-5, THE VALUE
*    OF RESCON USED IN THE FIRST TERM OF THE LONG-TERM RESUSPENSION EQUATION
*    USED IN CHRONC.
*
SERESCON001   1.E-4     (RESUSPENSION IS TURNED ON)
*
* RESUSPENSION CONCENTRATION COEFFICIENT HALF-LIFE (SEC)
*
SERESHAF001   1.82E5    (2.11 DAYS)
***********************************************************************************
* EVACUATION ZONE DATA BLOCK, LOADED BY EVNETW, STORED IN /NETWOR/, /EOPTIO/
*
* SPECIFIC DESCRIPTION OF THE EMERGENCY RESPONSE SCENARIO BEING USED
*
EZEANAM2001  '100% evacuation'
*
* THE TYPE OF WEIGHTING TO BE APPLIED TO THE EMERGENCY RESPONSE SCENARIOS
* YOU MUST SUPPLY A VALUE OF 'TIME' OR 'PEOPLE'
*
EZWTNAME001  'PEOPLE'
*
* WEIGHTING FRACTION APPLICABLE TO THIS SCENARIO
*
EZWTFRAC001  1.0   (100%)
*
* LAST RING IN THE MOVEMENT ZONE
* ln 10.15.91 no evacuation
EZLASMOV001    11
*
* FIRST SPATIAL INTERVAL IN THE EVACUATION ZONE
```

```
* Inner sheltering zone: to 10 kilometers
EZINIEVA001    11
*
* OUTER BOUNDS ON 3 EVACUATION ZONES (ZERO MEANS THE ZONE IS NOT DEFINED)
* ln 12.12.91 no evacuation: inner sheltering boundary coincides with
* outer boundary for evacuation
EZLASEVA001  0 0 11
*
* EVACUATION DELAY TIMES FOR THE 3 EVACUATION ZONES
* THIS IS THE DELAY TIME FROM OALARM (ATMOS) TO WHEN PEOPLE START MOVING
* ln 10.15.91 delay time is irrelevant
EZEDELAY001      0.0   0.0   0.0
*
* RADIAL EVACUATION SPEED (M/S)
* ln 10.15.91 speed is irrelevant
EZESPEED001   1.0E6
***************************************************************************
* SHELTER AND RELOCATION ZONE DATA BLOCK, LOADED BY INPEMR,
*                                      STORED IN /INPSRZ/, /RELOCA/
*
* TIME TO TAKE SHELTER IN THE INNER SHELTER ZONE (SECONDS FROM OALARM)
* ln 10.15.91: one hour
SRTTOSH1001     3600.0
*
* SHELTER DURATION IN THE INNER SHELTER ZONE (SECONDS FRL  TAKING SHELTER)
* ln 10.15.91: three hours
SRSHELT1001     10800.0
*
* LAST RING OF THE OUTER SHELTER ZONE
* ln 10.15.91: no outer sheltering zone, only relocation
SRLASHE2001       0
*
* TIME TO TAKE SHELTER IN THE OUTER SHELTER ZONE (SECONDS FROM OALARM)
*
SRTTOSH2001    0.0
*
* SHELTER DURATION IN THE OUTER SHELTER ZONE (SECONDS FROM TAKING SHELTER)
*
SRSHELT2001    0.0
*
* DURATION OF THE EMERGENCY PHASE (SECONDS FROM PLUME ARRIVAL)
*
SRENDEMP001  604800.   (ONE WEEK)
*
* CRITICAL ORGAN FOR RELOCATION DECISIONS
*
SRCRIORG001 'EDEWBODY'
* ln 12.11.91: no emergency phase relocation
* Dose-based relocation is modeled in the CHRONC's intermediate phase
* HOT SPOT RELOCATION TIME (SECONDS FROM PLUME ARRIVAL)
*  no relocation
SRTIMHOT001  604800.
*
* NORMAL RELOCATION TIME (SECONDS FROM PLUME ARRIVAL)
*
SRTIMNRM001  604800.0
*
* DOSE over 1 week to whole body that triggers relocation
*
* HOT SPOT RELOCATION DOSE CRITERION THRESHOLD (SIEVERTS)
SRDOSHOT001  100.0 Sv: no hot spot relocation
*
* NORMAL RELOCATION DOSE CRITERION THRESHOLD (SIEVERTS)
SRDOSNRM001  100.0 Sv: no normal relocation                              )
***************************************************************************
* EARLY FATALITY MODEL PARAMETERS, LOADED BY INEFAT, STORED IN /EFATAL/
*
* NUMBER OF EARLY FATALITY EFFECTS
* ln 6.24.92 version 11.1
EFNUMEFA001   3
```

```
*
*           ORGNAM       EFFACA   EFFACB   EFFTHR
*
EFATAGRP001 'RED MARR'      3.8      5.0     1.5
EFATAGRP002 'LUNGS'        10.0      7.0     5.0
EFATAGRP003 'LOWER LI'     15.0     10.0     8.0
******************************************************************************
* EARLY INJURY MODEL PARAMETERS, LOADED BY INEINJ, STORED IN /EINJUR/
*
* NUMBER OF EARLY INJURY EFFECTS
*
EINUMEIN001  7
*
*           EINAME           ORGNAM   EISUSC EITHRE EIFACA EIFACB
*
EINJUGRP001 'PRODROMAL VOMIT' 'STOMACH'  1.     .5      2.      3.
EINJUGRP002 'DIARRHEA'        'STOMACH'  1.     1.      3.      2.5
EINJUGRP003 'PNEUMONITIS'     'LUNGS'    1.     5.     10.      7.
EINJUGRP004 'SKIN ERYTHEMA'   'SKIN'     1.     3.      6.      5.
EINJUGRP005 'TRANSEPIDERMAL'  'SKIN'     1.    10.     20.      5.
EINJUGRP006 'THYROIDITIS'     'THYROIDH' 1.    40.    240.      2.
EINJUGRP007 'HYPOTHYROIDISM'  'THYROIDH' 1.     2.     60.      1.3
******************************************************************************
* ACUTE EXPOSURE CANCER PARAMETERS, LOADED BY INACAN STORED IN /ACANCR/.
*
* NUMBER OF ACUTE EXPOSURE CANCER EFFECTS
*
LCNUMACA001   7
*
* THRESHOLD DOSE FOR APPLYING THE DOSE DEPENDENT REDUCTION FACTOR
*
LCDDTHRE001   0.2  (LOWEST DOSE FOR WHICH DDREFA WILL BE APPLIED)
*
* DOSE THRESHOLD FOR LINEAR DOSE RESPONSE (SV)
*
LCACTHRE001   0.0  (LINEAR-QUADRATIC MODEL IS NOT BEING USED)
*
*           ACNAME     ORGNAM   ACSUSC DOSEFA DOSEFB CFRISK    CIRISK  DDREFA
LCANCERS001 'LEUKEMIA' 'RED MARR'  1.0   1.0   0.0   9.70E-3   9.70E-3  2.0
LCANCERS002 'BONE'     'BONE SUR'  1.0   1.0   0.0   9.00E-4   9.00E-4  2.0
LCANCERS003 'BREAST'   'BREAST'    1.0   1.0   0.0   5.40E-3   1.59E-2  1.0
LCANCERS004 'LUNG'     'LUNGS'     1.0   1.0   0.0   1.55E-2   1.73E-2  2.0
LCANCERS005 'THYROID'  'THYROIDH'  1.0   1.0   0.0   7.20E-4   7.20E-3  1.0
LCANCERS006 'GI'       'LOWER LI'  1.0   1.0   0.0   3.36E-2   5.75E-2  2.0
LCANCERS007 'OTHER'    'BLAD WAL'  1.0   1.0   0.0   2.76E-2   5.52E-2  2.0
******************************************************************************
* RESULT 1 OPTIONS BLOCK, LOADED BY INOUT1, STORED IN /INOUT1/
* TOTAL NUMBER OF A GIVEN EFFECT (LATENT CANCER, EARLY DEATH, EARLY INJURY)
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE1NUMBER    17
*
* ln, 08.02.91 Sheet 9: Total Cancer Fatalities
TYPE1OUT001     'CAN FAT/TOTAL'              1  29  CCDF (0-2000 km)
*
* ln, 08.02.91 Sheet 8: Early Fatalities Total
TYPE1OUT002     'ERL FAT/TOTAL'              1  29  CCDF (0-2000 km)
*
* Specific cancers:
* Sheet 10
TYPE1OUT003     'CAN FAT/LEUKEMIA'           1  29
* Sheet 11
TYPE1OUT004     'CAN FAT/LUNG'               1  29
TYPE1OUT005     'CAN FAT/BREAST'             1  29
TYPE1OUT006     'CAN FAT/GI'                 1  29
TYPE1OUT007     'CAN FAT/BONE'               1  29
TYPE1OUT008     'CAN FAT/OTHER'              1  29
TYPE1OUT009     'CAN INJ/THYROID'            1  29
TYPE1OUT010     'CAN INJ/BREAST'             1  29
```

```
TYPE1OUT011     'ERL INJ/PRODROMAL VOMIT'      1  29
TYPE1OUT012     'ERL INJ/DIARRHEA'             1  29
TYPE1OUT013     'ERL INJ/PNEUMONITIS'          1  29
TYPE1OUT014     'ERL INJ/THYROIDITIS'          1  29
TYPE1OUT015     'ERL INJ/HYPOTHYROIDISM'       1  29  CCDF
TYPE1OUT016     'ERL INJ/SKIN ERYTHEMA'        1  29
TYPE1OUT017     'ERL INJ/TRANSEPIDERMAL'       1  29
*
*******************************************************************************
* RESULT 2 OPTIONS BLOCK, LOADED BY INOUT2, STORED IN /INOUT2/
* FURTHEST DISTANCE AT WHICH A GIVEN RISK OF EARLY DEATH IS EXCEEDED.
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE2NUMBER  1
*
*           FATALITY RISK THRESHOLD
*
TYPE2OUT001  0.
*******************************************************************************
* RESULT 3 OPTIONS BLOCK, LOADED BY INOUT3, STORED IN /INOUT3/
* NUMBER OF PEOPLE WHOSE DOSE TO A GIVEN ORGAN EXCEEDS A GIVEN THRESHOLD.
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE3NUMBER  10
*
*               ORGAN NAME   DOSE THRESHOLD (SV)   DOSE FLAG
*
TYPE3OUT001     'EDEWBODY'        0.001              LIFETIME
TYPE3OUT002     'EDEWBODY'        0.004              LIFETIME
TYPE3OUT003     'EDEWBODY'        0.020              LIFETIME
TYPE3OUT004     'EDEWBODY'        0.040              LIFETIME
TYPE3OUT005     'EDEWBODY'        0.080              LIFETIME
TYPE3OUT006     'EDEWBODY'        0.120              LIFETIME
TYPE3OUT007     'EDEWBODY'        0.200              LIFETIME
TYPE3OUT008     'EDEWBODY'        0.500              LIFETIME
TYPE3OUT009     'EDEWBODY'        1.000              LIFETIME
TYPE3OUT010     'EDEWBODY'        2.000              LIFETIME
*
* TYPE3OUT001    'RED MARR'        1.5                  ACUTE
* TYPE3OUT002    'LUNGS'           5.0                  ACUTE
*******************************************************************************
* RESULT 4 OPTIONS BLOCK, LOADED BY INOUT4, STORED IN /INOUT4/
* 360 DEGREE AVERAGE RISK OF A GIVEN EFFECT AT A GIVEN DISTANCE.
*
* POSSIBLE TYPES OF EFFECTS ARE:
*   'ERL FAT/TOTAL'
*   'ERL INJ/INJURY NAME'
*   'CAN FAT/CANCER NAME'
*   'CAN FAT/TOTAL'
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE4NUMBER  19
*
*           RADIAL INDEX   TYPE OF EFFECT
*
* ln 08.02.91 Risk of early fatality
TYPE4OUT001        1          'ERL FAT/TOTAL'  (0.2 km)
TYPE4OUT002        2          'ERL FAT/TOTAL'  (0.5 km)
TYPE4OUT003        3          'ERL FAT/TOTAL'  (0.8 km)
TYPE4OUT004        4          'ERL FAT/TOTAL'  (1.2 km)
TYPE4OUT005        5          'ERL FAT/TOTAL'  (1.6 km)
TYPE4OUT006        6          'ERL FAT/TOTAL'  (2.0 km)
TYPE4OUT007        7          'ERL FAT/TOTAL'  (3.0 km)
TYPE4OUT008        8          'ERL FAT/TOTAL'  (4.0 km)
TYPE4OUT009        9          'ERL FAT/TOTAL'  (5.0 km)
TYPE4OUT010       10          'ERL FAT/TOTAL'  (7.0 km)
* ln 08.02.91 Risk of latent cancer fatality
```

```
TYPE4OUT011        5         'CAN FAT/TOTAL'   (1.6 km)
TYPE4OUT012       10         'CAN FAT/TOTAL'   (7.0 km)
TYPE4OUT013       14         'CAN FAT/TOTAL'   (20.0 km)
TYPE4OUT014       17         'CAN FAT/TOTAL'   (32.0 km)
TYPE4OUT015       19         'CAN FAT/TOTAL'   (50.0 km)
TYPE4OUT016       22         'CAN FAT/TOTAL'  (150.0 km)
TYPE4OUT017       25         'CAN FAT/TOTAL'  (500.0 km)
TYPE4OUT018       27         'CAN FAT/TOTAL' (1000.0 km)
TYPE4OUT019       29         'CAN FAT/TOTAL' (2000.0 km)
*****************************************************************************
* RESULT 5 OPTIONS BLOCK, LOADED BY INOUT5, STORED IN /INOUT5/
*
* TOTAL POPULATION DOSE TO A GIVEN ORGAN BETWEEN TWO DISTANCES.
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE5NUMBER     9
*
*              ORGAN      I1DIS5     I2DIS5
*
TYPE5OUT001 'EDEWBODY'      1          29      CCDF   (0-2000 km)
TYPE5OUT002 'SKIN'          1          29             (0-2000 km)
TYPE5OUT003 'LUNGS'         1          29             (0-2000 km)
TYPE5OUT004 'RED MARR'      1          29             (0-2000 km)
TYPE5OUT005 'LOWER LI'      1          29             (0-2000 km)
TYPE5OUT006 'STOMACH'       1          29             (0-2000 km)
TYPE5OUT007 '[illegible]OIDH'      1          29             (0-2000 km)
TYPE5OUT008 'B[illegible]SUR'      1          29             (0-2000 km)
TYPE5OUT009 'B[illegible]'         1          29             (0-2000 km)
*****************************************************************************
* RESULT 6 OPTIONS BLOCK, LOADED BY INOUT6, STORED IN /INOUT6/
*
* CENTERLINE DOSE TO AN ORGAN VS DIST BY PATHWAY, PATHWAY NAMES ARE AS FOLLOWS:
* straight line only
*  PATHWAY NAME:
*    'CLD'     - CLOUDSHINE
*    'GRD'     - GROUNDSHINE
*    'INH ACU' - "ACUTE DOSE EQUIVALENT" FROM DIRECT INHALATION OF THE CLOUD
*    'INH LIF' - "LIFETIME DOSE COMMITMENT" FROM DIRECT INHALATION OF THE CLOUD
*    'RES ACU' - "ACUTE DOSE EQUIVALENT" FROM RESUSPENSION INHALATION
*    'RES LIF' - "LIFETIME DOSE COMMITMENT" FROM RESUSPENSION INHALATION
*    'TOT ACU' - "ACUTE DOSE EQUIVALENT" FROM ALL PATHWAYS
*    'TOT LIF' - "LIFETIME DOSE COMMITMENT" FROM ALL PATHWAYS
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE6NUMBER     0
*****************************************************************************
* RESULT 7 OPTIONS BLOCK, LOADED BY INOUT7, STORED IN /INOUT7/
*
* CENTERLINE RISK OF A GIVEN EFFECT VS DISTANCE
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE7NUMBER   0
*****************************************************************************
* RESULT 8 OPTIONS BLOCK, LOADED BY INOUT8, STORED IN /INOUT8/
*
* POPULATION WEIGHTED FATALITY RISK BETWEEN 2 DISTANCES
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE8NUMBER   5
*                NAME        I1DIS8  I2DIS8
TYPE8OUT001 'ERL FAT/TOTAL'     1       9       (0-5 km: fixed zone)
TYPE8OUT002 'CAN FAT/LUNG'      1      29       (0-2000 km)
TYPE8OUT003 'CAN FAT/LEUKEMIA'  1      29       (0-2000 km)
TYPE8OUT004 'CAN FAT/BONE'      1      29       (0-2000 km)
TYPE8OUT005 'CAN FAT/TOTAL'     1      29       (0-2000 km)
```

A.3 CHRONC Input File for Case 1 (Single-Phase) Used in U. S. Calculations

```
* GENERAL DESCRIPTIVE TITLE DESCRIBING THIS "CHRONC" INPUT FILE
*
CHCHNAME001  'International Comparison: CHRONC'
********************************************************************************
* EMERGENCY RESPONSE COST DATA BLOCK
* DAILY COST FOR A PERSON WHO IS EVACUATED (DOLLARS/PERSON-DAY)
* evacuees and relocatees
* ln 08.06.91 Appendix 7: 5 ECUs/person-day+(3 ECU/7 days)+
* (1.32e4/365) = 41.6 ECU (Per diem, travel, lost income)
CHEVACST001  41.6
*
* DAILY COST FOR A PERSON WHO IS RELOCATED (DOLLARS/PERSON-DAY)
* ln 08.06.91: 19 March 1991, Appendix 7, (Per diem, travel, lost income)
CHRELCST001  41.6
********************************************************************************
* LONG TERM PROTECTIVE ACTION DATA BLOCK
*
* END OF THE INTERMEDIATE PHASE PERIOD
CHTMIPND001  604800. (no intermediate phase)
*
* DOSE CRITERION FOR INTERMEDIATE PHASE RELOCATION (SV)
*
CHDSCRTI001  0.100  Irrelevant...
*
* LONG-TERM PHASE DOSE PROJECTION PERIOD, THE DURATION OF THE EXPOSURE
* PERIOD OVER WHICH THE LONG-TERM DOSE CRITERION IS EVALUATED (SECONDS)
* LN 06.12.92: habitability limit for return of relocatees.
* Total dose of 100 mSv over 1 year starting at 7 days
CHTMPACT001   31536000.0   (1 year)
*
* DOSE CRITERION FOR LONG-TERM PHASE RELOCATION (SV)
* ln 06.12.92 100 mSv over 1 year
CHDSCRLT001    0.100 Sv
*
* CRITICAL ORGAN NAME FOR LONG-TERM ACTIONS
*
CHCRTOCR001 'EDEWBODY'
********************************************************************************
* DECONTAMINATION PLAN DATA BLOCK
* NUMBER OF LEVELS OF DECONTAMINATION
*
CHLVLDEC001  1
*
* DECONTAMINATION TIMES CORRESPONDING TO THE LVLDEC LEVELS OF DECONTAMINATION
*  (SECONDS)
*
CHTIMDEC001   1.E-5 (no decontamination is specified)
*
* DOSE REDUCTION FACTORS CORRESPONDING TO THE LVLDEC LEVELS OF DECONTAMINATION
*
CHDSRFCT001   1.0   (no decontamination, p.9, 19th March 1991)
*
* COST OF FARM DECONTAMINATION PER FARMLAND UNIT AREA (DOLLARS/HECTARE)
*  FOR THE VARIOUS LEVELS OF DECONTAMINATION
CHCDFRM0001   0.0       no decontamination costs
*
* COST OF NONFARM DECONTAMINATION PER RESIDENT PERSON (DOLLARS/PERSON)
*  FOR THE VARIOUS LEVELS OF DECONTAMINATION
CHCDNFRM001   0.0       no decontamination costs
*
* FRACTION OF FARMLAND DECONTAMINATION COST DUE TO LABOR
*  FOR THE VARIOUS DECONTAMINATION LEVELS
*
CHFRFDL0001  1.0
*
* FRACTION OF NON-FARM DECONTAMINATION COST DUE TO LABOR
*  FOR THE VARIOUS DECONTAMINATION LEVELS
*
```

```
CHFRNFDL001  1.0
*
* FRACTION OF TIME WORKERS IN FARM AREAS SPEND IN CONTAMINATED AREAS
*  FOR THE VARIOUS DECONTAMINATION LEVELS
*
CHTFWKF0001  1.0
*
* FRACTION OF TIME WORKERS IN NON-FARM AREAS SPEND IN CONTAMINATED AREAS
*  FOR THE VARIOUS DECONTAMINATION LEVELS
*
CHTFWKNF001  1.0
*
* AVERAGE COST OF DECONTAMINATION LABOR (DOLLARS/MAN-YEAR)
CHDLBCST001   1.0E-9  no decontamination costs
*******************************************************************************
* INTERDICTION COST DATA BLOCK
*
* DEPRECIATION (DETERIORATION) RATE DURING INTERDICTION PERIOD (PER YEAR)
* ln 12.11.91: non-farm non-resid.+housing+consumer durab.+urban land;
* Appendix 7, "GLOBAL ECONOMIC DATA..."
CHDPRATE001    0.056
*
* INVESTMENT INCOME RETURN (DISCOUNT RATE) DURING INTERDICTION PERIOD (PER YEAR)
* THIS VALUE SHOULD BE DERIVED AS A REAL RETURN RATE ADJUSTED FOR INFLATION
*
* ln 12.11.91 Appendix 7, "GLOBAL ECONOMIC DATA..."
CHDSRATE001    0.05
*
* POPULATION RELOCATION COST (DOLLARS/PERSON):
*  ALTERNATIVE HOUSING, MOVING COSTS, AND LOST INCOME FOR PEOPLE IN
*  AREAS WHICH REQUIRE DECONTAMINATION, INTERDICTION, OR CONDEMNATION
*
* ln 08.06.91: Appendix 7: 1.32e4 ECU*2yr+5.0 ECU*365*2yr+
* + 3.0 ECU = 30053 ECUs/person
CHPOPCST001   30053.
*******************************************************************************
* GROUNDSHINE WEATHERING DEFINITION DATA BLOCK
*
* NUMBER OF TERMS IN THE GROUNDSHINE WEATHERING RELATIONSHIP (EITHER 1 OR 2)
*
CHNGWTRM001   2
*
* GROUNDSHINE WEATHERING COEFFICIENTS
*
CHGWCOEF001   0.5    0.5           (JON HELTON)
*
* HALF LIVES CORRESPONDING TO THE GROUNDSHINE WEATHERING COEFFICIENTS (S)
*
CHTGWHLF001   1.6E7  2.8E9         (JON HELTON)
*******************************************************************************
* RESUSPENSION WEATHERING DEFINITION DATA BLOCK
*
* NUMBER OF TERMS IN THE RESUSPENSION WEATHERING RELATIONSHIP
*
CHNRWTRM001    3
*
* RESUSPENSION CONCENTRATION COEFFICIENTS   (/ METER)
*  RELATIONSHIP BETWEEN GROUND CONCENTRATION AND INSTANTANEOUS AIR CONC.
*
CHRWCOEF001  1.0E-5   1.0E-7   1.0E-9  (VALUES HERE SELECTED BY JON HELTON)
*
* HALF-LIVES CORRESPONDING TO THE RESUSPENSION CONCENTRATION COEFFICIENTS (S)
*
CHTRWHLF001  1.6E7    1.6E8    1.6E9   (6 MONTHS, 5 YEARS, 50 YEARS)
*******************************************************************************
* SITE REGION DESCRIPTION DATA BLOCK
*
* FRACTION OF AREA THAT IS LAND IN THE REGION
*
CHFRACLD001   0.95   (SITE FILE OVERRIDES THIS VALUE)
```

```
*
* FRACTION OF LAND DEVOTED TO FARMING IN THE REGION
*
CHFRCFRM001   0.3  (SITE FILE OVERRIDES THIS VALUE)
*
* AVERAGE VALUE OF ANNUAL FARM PRODUCTION IN THE REGION (DOLLARS/HECTARE)
*  (CASH RECEIPTS FROM FARMING PLUS VALUE OF HOME CONSUMPTION)/(LAND IN FARMS)
*
CHFRMPRD001   400.0  (SITE FILE OVERRIDES THIS VALUE)
*
* FRACTION OF FARM PRODUCTION RESULTING FROM DAIRY PRODUCTION IN THE REGION
* (VALUE OF MILK PRODUCED)/(CASH RECEIPTS FROM FARMING PLUS HOME CONSUMPTION)
*
CHDPFRCT001   0.2  (SITE FILE OVERRIDES THIS VALUE)
*
* VALUE OF FARM WEALTH (ECUs/ha)
* (AVERAGE VALUE PER HECTARE OF FARM LAND AND BUILDINGS)
* ln 12.23.91: from the SITE file
CHVALWF0001   12035.
*
* FRACTION OF FARM WEALTH IN IMPROVEMENTS FOR THE REGION
*
CHFRFIM0001   0.25
*
* NON-FARM WEALTH, PROPERTY AND IMPROVEMENTS FOR THE REGION (ECUs/PERSON)
* THE VALUE OF ALL RESIDENTIAL, BUSINESS, AND PUBLIC ASSETS WHICH WOULD BE
*  LOST IN THE EVENT OF PERMANENT INTERDICTION (CONDEMNATION) OF THE AREA
* including value of urban land
* ln 10.29.91: from the SITE file
CHVALWNF001    65059.
*
* FRACTION OF NON-FARM WEALTH IN IMPROVEMENTS FOR THE REGION
*
CHFRNFIM001   0.8
*******************************************************************************
* SPECIAL OPTIONS DATA BLOCK
*
* DETAILED PRINT OPTION CONTROL SWITCHES, LOOK AT THE CODE BEFORE TURNING ON!!
*         (KCEPNT, KDFPNT, KDTPNT, KGCPNT, KLTPNT, KWTPNT, KSWRSK, KSWDSC)
*
* Diagnostics: 1     2     3     4     5     6    7     8
*
CHKSWTCH001     0     0     0     0     0     0    0     0
*******************************************************************************
* NUMBER OF DEFINED CROPS IN THE CHRONC FOOD INGESTION MODEL
*                                                changes made alh 7-10-91
CHNFICRP001    4
*
* NOTE TO USER: THE CODE MAKES SPECIAL TREATMENT OF CROP NAMES BEGINNING
*  WITH 'PASTURE' DUE TO THE CONTINUOUS NATURE OF THE HARVESTING PROCESS.
*  IF THE USER WISHES TO DEFINE A NEW CROP CATEGORY FOR RANGELAND PASTURE,
*  IT SHOULD BE CALLED 'PASTURE-RANGE' OR 'PASTURE-DRY'.
*
*                              FRACTION OF CROP CONSUMED BY
*                                          DAIRY    MEAT
*           CROP NAME              MAN   ANIMALS  ANIMALS
*            NAMCRP              FRCTCH  FRCTCM   FRCTCB
* LN VN 11.18.91 BNL-3 basket
CHCRPTBL001 'PASTURE             ' 0.0    0.204   0.796
CHCRPTBL002 'GRAINS              ' 0.328  0.167   0.505
CHCRPTBL003 'GRN LEAFY VEGETABLES' 1.0    0.0     0.0
CHCRPTBL004 'ROOTS AND TUBERS    ' 1.0    0.0     0.0
*******************************************************************************

* WATER PATHWAY NUCLIDE DEFINITIONS FOR CHRONC
*
* NUMBER OF NUCLIDES IN THE WATER INGESTION PATHWAY MODEL
*
* ln 08.08.91
CHNUMWPI001    1
```

```
*
* TABLE OF NUCLIDE DEFINITIONS IN THE WATER INGESTION PATHWAY MODEL
*  WATER PATHWAY NUCLIDES MUST BE A SUBSFT OF THE INGESTION MODEL NUCLIDES
*
* IF A SITE DATA FILE IS DEFINED, THE DATA DEFINING THE WATERSHED INGESTION
*  FACTOR IS SUPERSEDED BY THE CORRESPONDING DATA IN THE SITE DATA FILE
*
*       WINGF VALUES BY DRAINAGE SYSTEM
*  NUCLIDE      SR-89   SR-90   CS-134  CS-137
*  RIVER        5.0E-6  5.0E-6  5.0E-6  5.0E-6
*  GREAT LAKE   2.0E-7  2.0E-7  2.0E-6  4.0E-6
*  OCEAN        0.0     0.0     0.0     0.0
*
*                       INITIAL     ANNUAL    INGESTION FACTOR
*            WATER      WASHOFF     WASHOFF    ((BQ INGESTED)/
*           NUCLIDE     FRACTION     RATE       (BQ IN WATER))
*
*            NAMWPI      WSHFRI      WSHRTA         WINGF
* ln 08.08.91
CHWTRISO001   SR-89        0.01        0.004          0.0E-6
*************************************************************************************
* FOOD PATHWAY DEFINITION DATA
* NUMBER OF NUCLIDES IN THE CHRONC FOOD INGESTION MODEL
*
CHNFIISO001  6  (UP TO 10 ALLOWED, BEWARE THAT DAUGHTER BUILDUP IS NOT TREATED)
*
* TABLE OF NUCLIDE DEFINITIONS IN THE CHRONC INGESTION PATHWAY MODEL
*
* NUCLIDES THAT WERE DEFINED IN THE WATER PATHWAY DATA ABOVE MUST BE
* A SUBSET OF THE CHRONC INGESTION FOOD PATHWAY NUCLIDES.  THE WATER
*  PATHWAY NUCLIDES MUST BE LISTED FIRST IN THIS DATA BLOCK AND IN THE
*  SAME ORDER AS THEY WERE LISTED IN THE WATER PATHWAY DATA BLOCK
*
*
*                                                  TRANSFER FACTORS
*                          RETENTION FACTORS     [(BQ TRANSFERRED)/
*          INGESTION  PROCESSING AND DECAY         (BQ INGESTED)]
*            NUCLIDE    MILK/MAN  MEAT/MAN         MILK     MEAT
* LN 11.18.91, TFBF modified
*             NAMIPI      DCYPMH     DCYPBH          TFMLK     TFBF
CHISODEF001  SR-89        0.82        0.70          0.022     0.000067
CHISODEF002  SR-90        1.0         1.0           0.022     0.000067
CHISODEF003  CS-134       0.99        0.97          0.11      0.00675
CHISODEF004  CS-137       1.0         1.0           0.11      0.00675
CHISODEF005  I-131        0.46        0.30          0.13      0.00161
CHISODEF006  I-133        0.1         0.00023       0.062     0.000740
*************************************************************************************
* TRANSFER FACTOR FROM SOIL TO PLANT BY ROOT-UPTAKE (AND BY SOIL INGESTION FOR
* GRAZING ON PASTURE) INTEGRATED OVER ALL TIME [(BQ TRANSFERRED)/(BQ DEPOSITED)]
*
* AT LN 08.08.91 Ulf Tveten July 17 1991 Memo
* ln 12.18.91 Should be different for JFLAG=5 in MAXGC;
*                                          GREEN    ROOTS
*                                          LEAFY    AND
*             NUCLIDE  PASTURE    GRAINS   VEG      TUBERS
*              NAMISO   TCROOT    TCROOT   TCROOT   TCROOT
*CHTCROOT001  SR-89     4.1E-4    4.3E-5   1.7E-4    1.1E-4
*CHTCROOT002  SR-90     2.6E-2    3.3E-3   1.3E-2    8.4E-3
*CHTCROOT003  CS-134    1.3E-3    3.5E-5   1.4E-5    5.6E-5
*CHTCROOT004  CS-137    6.9E-3    7.6E-5   3.0E-5    1.2E-4
*CHTCROOT005  I-131     1.6E-4      0.0      0.0       0.0
*CHTCROOT006  I-133     1.7E-6      0.0      0.0       0.0
*
* ln 12.18.91 TCROOT is calculated for the year 1 to year 2 root uptake
*                                              GREEN       ROOTS
*                                              LEAFY       AND
*           NUCLIDE     PASTURE     GRAINS     VEG         TUBERS
*            NAMISO      TCROOT     TCROOT     TCROOT      TCROOT
CHTCROOT001  SR-89     2.92E-06    3.17E-07   1.25E-06    8.14E-07
CHTCROOT002  SR-90     1.75E-03    1.91E-04   7.54E-04    4.91E-04
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CHTCROOT003  CS-134   2.84E-04   8.77E-06   3.46E-06   1.38E-05
CHTCROOT004  CS-137   4.53E-04   1.39E-05   5.51E-06   2.19E-05
CHTCROOT005  I-131    3.31E-19   0.00E+00   0.00E+00   0.00E+00
CHTCROOT006  I-133    0.00E+00   0.00E+00   0.00E+00   0.00E+00
*****************************************************************************
*  RADIOACTIVE DECAY RETENTION FACTORS (I.E., 1 - F WHERE F = FRACTION OF
*  RADIOACTIVITY LOST BY DECAY) FOR NUCLIDES IN CROPS FROM TIME OF HARVEST
*  TO TIME OF CONSUMPTION BY HUMANS (FRACTION RETAINED)
*                                                   changes made alh 7-10-91
*
* AT LN 08.08.91 Ulf Tveten July 17 1991 Memo
*                                         GREEN     ROOTS
*                                         LEAFY     AND
*          NUCLIDE  PASTURE     GRAINS    VEG       TUBERS
*
* ln 03.10.92 corrected DCYPCH for Cs-134 and Sr-89 (spain letter)
*            NAMISO    DCYPCH     DCYPCH  DCYPCH    DCYPCH
CHDCYPCH001  SR-89        0.0      0.06    0.75      0.30
CHDCYPCH002  SR-90        0.0      0.98    1.0       0.99
CHDCYPCH003  CS-134       0.0      0.78    0.97      0.92
CHDCYPCH004  CS-137       0.0      0.98    1.0       0.99
CHDCYPCH005  I-131        0.0      0.00003 0.45      0.0004
CHDCYPCH006  I-133        0.0      0.0     0.013     0.0
*****************************************************************************
*  RETENTION FACTORS FOR NUCLIDES IN CROPS FROM TIME OF HARVEST TO TIME OF
*  CONSUMPTION BY MILK-PRODUCING ANIMALS (FRACTION RETAINED).  FACTOR REFLECTS
*  LOSSES DUE TO RADIOACTIVE DECAY.
*                                                   changes made alh 7-10-91
*
* AT LN 08.08.91 Ulf Tveten July 17 1991 Memo
* LN 10.28.91 BNL food basket: added grain+legumes+stored.forage
* as "GRAIN" crop with all its characteristics; Ulf: DCYPCM for grain=0.
* Milk animals
*                                         GREEN     ROOTS
*                                         LEAFY     AND
*          NUCLIDE  PASTURE     CRAINS    VEG       TUBERS
*
*            NAMISO   DCYPCM     DCYPCM   DCYPCM    DCYPCM
CHDCYPCM001  SR-89      0.59      0.2      0.0       0.0
CHDCYPCM002  SR-90      1.0       0.99     0.0       0.0
CHDCYPCM003  CS-134     0.93      0.85     0.0       0.0
CHDCYPCM004  CS-137     1.0       0.99     0.0       0.0
CHDCYPCM005  I-131      0.54      0.032    0.0       0.0
CHDCYPCM006  I-133      0.54      0.0034   0.0       0.0
*****************************************************************************
*  RETENTION FACTORS FOR NUCLIDES IN CROPS FROM TIME OF HARVEST TO TIME OF
*  CONSUMPTION BY MEAT-PRODUCING ANIMALS (FRACTION RETAINED).  FACTOR REFLECTS
*  LOSSES DUE TO RADIOACTIVE DECAY.
*
* AT LN 08.08.91 Ulf Tveten July 17 1991 Memo
* LN 10.28.91 BNL food basket: added grain+legumes+stored.forage
* as "GRAIN" crop with all its characteristics; Ulf: DCYPCB for grain=0.
* Beef animals
*                                         GREEN     ROOTS
*                                         LEAFY     AND
*          NUCLIDE  PASTURE     GRAINS    VEG       TUBERS
*
*            NAMISO   DCYPCB     DCYPCB   DCYPCB     DCYPCB
CHDCYPCB001  SR-89      0.59      0.2      0.0        0.0
CHDCYPCB002  SR-90      1.0       0.99     0.0        0.0
CHDCYPCB003  CS-134     0.93      0.85     0.0        0.0
CHDCYPCB004  CS-137     1.0       0.99     0.0        0.0
CHDCYPCB005  I-131      0.54      0.032    0.0        0.0
CHDCYPCB006  I-133      0.54      0.0034   0.0        0.0
*****************************************************************************
*  CROP PROCESSING AND PREPARATION RETENTION FACTORS FOR NUCLIDES IN FOOD
*  CROPS CONSUMED BY HUMANS (FRACTION RETAINED).  FACTORS REFLECT LOSS OF
*  NUCLIDES FROM FOODS DUE TO PROCESSING (E.G., WASHING OF FRUIT, PEELING
*  OF POTATOES, LOSSES DURING CANNING) AND FOOD PREPARATION (COOKING) FROM
*  THE TIME OF PROCESSING OF THE HARVESTED CROP TO THE TIME OF CONSUMPTION
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*  BY HUMANS.  FACTORS DO NOT REFLECT LOSSES DUE TO RADIOACTIVE DECAY.
*
* AT LN 08.08.91 Ulf Tveten July 17 1991 Memo
* no retention during preparation and processing: specs
*                                                GREEN     ROOTS
*                                                LEAFY     AND
*           NUCLIDE  PASTURE    GRAINS  VEG        TUBERS
*
*            NAMISO   FPLSCH    FPLSCH  FPLSCH     FPLSCH
CHFPLSCH001  SR-89      0.0       1.0     1.0        1.0
CHFPLSCH002  SR-90      0.0       1.0     1.0        1.0
CHFPLSCH003  CS-134     0.0       1.0     1.0        1.0
CHFPLSCH004  CS-137     0.0       1.0     1.0        1.0
CHFPLSCH005  I-131      0.0       1.0     1.0        1.0
CHFPLSCH006  I-133      0.0       1.0     1.0        1.0
*****************************************************************************
* DEFINE THE DIRECT DEPOSITION TO CROPS TRANSFER FUNCTION
*
* NUMBER OF TERMS IN THE DIRECT DEPOSITION TO CROPS TRANSFER FUNCTION
*
CHNTRTRM001    2
*
* LOSSES DUE TO WEATHERING FROM PLANT SURFACES AND DURING TRANSLOCATION
* FROM PLANT SURFACES TO INTERIOR EDIBLE PORTIONS OF PLANTS ARE MODELLED
* USING THE FOLLOWING EQUATION:
*
* FRACTION RETAINED = CTCOEF1*EXP(-LN2/CTHALF1) + CTCOEF2*EXP(-LN2/CTHALF2)
*
* FOR PASTURE, STORED FORAGE, GREEN LEAFY VEGETABLES, AND OTHER FOOD CROPS,
* THIS EQUATION IS USED AS A TWO TERM WEATHERING EQUATION.  FOR GRAINS,
* LEGUMES AND SEEDS, AND ROOTS AND TUBERS WHERE RADIOACTIVITY IS CONSUMED
* ONLY IF TRANSLOCATED TO EDIBLE PORTIONS OF THE PLANT, THIS EQUATION IS
* REDUCED TO A TRANSLOCATION TRANSFER FACTOR BY SETTING CTCOEF2 TO ZERO,
* CTHALF2 TO ONE SECOND, AND CTHALF1 TO ABOUT ONE MILLION YEARS (1E13
* SECONDS).  WHEN USED TO MODEL TRANSLOCATION, THE VALUE OF THE TRANSLOCATION
* TRANSFER FACTOR IS DEVELOPED FROM FALLOUT DATA AND IS INPUT AS THE VALUE
* OF CTCOEF1.
*
* TWO TIME PERIODS ARE USED FOR WEATHERING, THE FIRST IS 14 DAYS LONG (1.21E6
* SECONDS) AND THE SECOND IS 50 DAYS LONG (4.32E6 SECONDS).
*
* DIRECT DEPOSITION TRANSFER COEFFICIENTS BY CHRONC INGESTION MODEL NUCLIDE
*  ((BQ TRANSFERRED)/(BQ DEPOSITED))
* AT LN 08.08.91 Ulf Tveten July 17 1991 Memo
*                                               GREEN    ROOTS
*                                               LEAFY    AND
*  TERM 1   NUCLIDE  PASTURE   GRAINS  VEG      TUBERS
CHCTCOEF101  SR-89      0.3      0.01   0.24    0.0006
CHCTCOEF102  SR-90      0.3      0.01   0.24    0.0006
CHCTCOEF103  CS-134     0.3      0.05   0.24    0.025
CHCTCOEF104  CS-137     0.3      0.05   0.24    0.025
CHCTCOEF105  I-131      0.3      0.0    0.24    0.0
CHCTCOEF106  I-133      0.3      0.0    0.24    0.0
*  TERM 2
CHCTCOEF201  SR-89      0.076     0.0    0.06   0.0
CHCTCOEF202  SR-90      0.076     0.0    0.06   0.0
CHCTCOEF203  CS-134     0.076     0.0    0.06   0.0
CHCTCOEF204  CS-137     0.076     0.0    0.06   0.0
CHCTCOEF205  I-131      0.076     0.0    0.06   0.0
CHCTCOEF206  I-133      0.076     0.0    0.06   0.0
*
* CROP TRANSFER HALF-LIVES BY CHRONC INGESTION MODEL NUCLIDE (SECONDS)
*
* AT LN 08.08.91 Ulf Tveten July 17 1991 Memo
*                                               GREEN      ROOTS
*                                               LEAFY      AND
*  TERM 1   NUCLIDE  PASTURE     GRAINS  VEG        TUBERS
CHCTHALF101  SR-89   1.21E6        1E13  1.21E6       1E13
CHCTHALF102  SR-90   1.21E6        1E13  1.21E6       1E13
CHCTHALF103  CS-134  1.21E6        1E13  1.21E6       1E13
```

```
CHCTHALF104  CS-137   1.21E6      1E13  1.21E6      1E13
CHCTHALF105  I-131    1.21E6       1.0  1.21E6       1.0
CHCTHALF106  I-133    1.21E6       1.0  1.21E6       1.0
*  TERM2
CHCTHALF201  SR-89    4.32E6       1.0  4.32E6       1.0
CHCTHALF202  SR-90    4.32E6       1.0  4.32E6       1.0
CHCTHALF203  CS-134   4.32E6       1.0  4.32E6       1.0
CHCTHALF204  CS-137   4.32E6       1.0  4.32E6       1.0
CHCTHALF205  I-131    4.32E6       1.0  4.32E6       1.0
CHCTHALF206  I-133    4.32E6       1.0  4.32E6       1.0
*******************************************************************************
* TABLE OF CROP DATA (GROWING SEASON AND FARMLAND SHARE) IN THE REGION.
*
* IF A SITE DATA FILE IS BEING USED (AS SPECIFIED ON THE EARLY USER INPUT FILE),
* THEN DATA FROM THE SITE FILE (AND NOT THE DATA BELOW) IS USED FOR THE
* CALCULATION OF DOSES AND COSTS FROM THE AGRICULTURE MODEL AND THE NUMBERS
* BELOW ARE NOT UTILIZED IN THE CALCULATIONS.
*
* IF A SITE DATA FILE IS NOT BEING USED, THE DATA BELOW IS USED IN ITS STEAD.
*
* IN ALL CASES, THE USER MUST SUPPLY VALID VALUES FOR THE PARAMETERS BELOW.
*
*                                   GROWING
*                                SEASON (DAYS) FARMLAND
*             CROP NAME          START  END    SHARE
* ln 10.29.91: obtained from global data, NOT from the specified "food basket.
* Food Basket fractions for pasture, grains, vegs, and roots are:
* 0.18 (0.169), 0.71 (0.73?), 0.034 (0.031), 0.076 (0.068)
*           NAMCRP              TGSBEG  TGSEND  FRCTFL
CHCRPRGN001 'PASTURE              '  105.   304.    0.169
CHCRPRGN002 'GRAINS               '  121.   243.    0.732
CHCRPRGN003 'GRN LEAFY VEGETABLES'     1.   365.    0.031
CHCRPRGN004 'ROOTS AND TUBERS     '   32.   304.    0.068
*******************************************************************************
* FLAG DETERMINING WHETHER OR NOT THE FOOD ACTIONS ARE COUPLED
* AT LN: 08.08.91: ulf's suggestion .FALSE.
CHCOUPLD001 .FALSE.  (GROWING-SEASON ACTIONS INDEPENDENT OF LONG-TERM ACTIONS)
*
* PROTECTIVE ACTION GUIDES FOR THE GROWING-SEASON PATHWAY FOR BOTH MILK
* AND NON-MILK CROPS, DEFINED SEPARATELY AS PSCMLK AND PSCOTH.
*
* ln NUREG-1150
* THESE VALUES ARE CALCULATED OUTSIDE OF THE CODE BY ASSUMING THAT THE
* ACCIDENT OCCURRED IN THE MIDDLE OF THE GROWING SEASON.  THESE VALUES
* ARE THE GROUND CONCENTRATION OF EACH NUCLIDE (ASSUMING A SINGLE NUCLIDE
* RELEASE) WHICH WOULD RESULT IN A MAXIMALLY EXPOSED INDIVIDUAL RECEIVING
* A DOSE NOT EXCEEDING 0.05 SIEVERT EFFECTIVE-WHOLE-BODY-DOSE-EQUIVALENT
* OR 0.15 SIEVERT TO THE THYROID. THE UNITS ARE (BECQUERELS / SQUARE-METER).
*
* LN 11.18.91 BNL-3 basket; 5 mSv (15 mSv thyroid)
*
*                           MILK AND    OTHER CROPS
*            NUCLIDE        PRODUCTS    AND PRODUCTS
*
*              NAMIPI        PSCMLK        PSCOTH         Values are
CHPAGMCP001   SR-89       1.9634E+07    1.9634E+07      based on 0.005 SV
CHPAGMCP002   SR-90       4.8629E+04    4.8629E+04      of EDEWBODY to
CHPAGMCP003   CS-134      2.0127E+04    2.0127E+04      a maximally exposed
CHPAGMCP004   CS-137      2.2549E+04    2.2549E+04      individual
CHPAGMCP005   I-131       2.0145E+07    2.0145E+07
CHPAGMCP006   I-133       6.6631E+09    6.6631E+09
*******************************************************************************
* PROTECTIVE ACTION GUIDES FOR LONG-TERM AGRICULTURAL PRODUCTION, GCMAXR, AND
* THE RATE AT WHICH EACH RADIONUCLIDE BECOMES UNAVAILABLE FOR UPTAKE, QROOT.
*                                                 changes made alh 7-10-91
* ln NUREG-1150:
* GCMAXR VALUES ARE CALCULATED OUTSIDE OF THE CODE BY ASSUMING THAT THE ACCIDENT
* IS EQUALLY LIKELY THROUGHOUT THE YEAR.  THESE VALUES ARE THE GROUND
* CONCENTRATION OF EACH NUCLIDE (ASSUMING A SINGLE NUCLIDE RELEASE) WHICH
* WOULD RESULT IN A MAXIMALLY EXPOSED INDIVIDUAL RECEIVING A DOSE COMMITMENT
```

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* NO GREATER THAN 0.005 SIEVERT EFFECTIVE-WHOLE-BODY-DOSE-EQUIVALENT OR
* 0.015 SIEVERT TO THE THYROID AS A RESULT OF AN EXPOSURE INTEGRATED
* FROM T=0 TO T=INFINITY.  THE DECISION TO CALCULATE GCMAXR VALUES
* BASED ON AN INFINITE EXPOSURE DURATION WAS MADE BY NRC STAFF.
* THE UNITS ARE (BQ/SQUARE-METER).
*
* QROOT VALUES ARE DERIVED TO TAKE ACCOUNT OF THE COMBINED EFFECT OF
* PERCOLATION, CHEMICAL BINDING AND RADIOACTIVE DECAY IN REDUCING THE AMOUNT
* OF MATERIAL AVAILABLE FOR LONG-TERM UPTAKE INTO FOOD IN UNITS OF (PER YEAR).
* ln 03.10.92 corrected DCYPCH for Cs-134 and Sr-89 (spain letter)
*              NAMIPI       GCMAXR        QROOT          Value for GCMAXR is
CHPAGLTS001    SR-89        3.5985E+10      4.9          based on 0.005 SV
CHPAGLTS002    SR-90        1.2504E+06      0.065        of EDEWBODY over
CHPAGLTS003    CS-134       5.8644E+07      0.59         1 year: end of
CHPAGLTS004    CS-137       4.6263E+07      0.28         year ONE to end
CHPAGLTS005    I-131        1.0000E+20     32.0          of year TWO,
CHPAGLTS006    I-133        1.0000E+20    290.0          JFLAG=5 in MAXGC
*******************************************************************************
* DEFINE THE TYPE 9 RESULTS
* LONG-TERM POPULATION DOSE IN A GIVEN REGION BROKEN DOWN BY THE 12 PATHWAYS
*
* NUMBER OF RESULTS OF THIS TYPE THAT ARE BEING REQUESTED
* FOR EACH RESULT YOU REQUEST, THE CODE WILL PRODUCE A SET OF 12
*
TYPE9NUMBER   1      (UP TO 10 ALLOWED)
*
*              ORGNAM        INNER      OUTER
*
TYPE9OUT001   'EDEWBODY'       1          29  CCDF  (0-2000 km)
*******************************************************************************
* ECONOMIC COST RESULTS IN A REGION BROKEN DOWN BY 12 TYPES OF COSTS
*
* NUMBER OF RESULTS OF THIS TYPE THAT ARE BEING REQUESTED
* FOR EACH RESULT YOU REQUEST, THE CODE WILL PRODUCE A SET OF 12
*
TYP10NUMBER   1      (UP TO 10 ALLOWED)
*
*              INNER      OUTER
*
TYP10OUT001      1          29  CCDF  (0-2000 km)
*******************************************************************************
* DEFINE A FLAG THAT CONTROLS THE PRODUCTION OF THE ACTION DISTANCE RESULTS
*
* SPECIFYING A VALUE OF .TRUE. TURNS ON ALL 8 OF THE ACTION DISTANCE RESULTS,
* A VALUE OF .FALSE. WILL ELIMINATE THE ACTION DISTANCE RESULTS FROM THE OUTPUT.
*
TYP11FLAG11  .TRUE.
*******************************************************************************
* IMPACTED AREA/POPULATION RESULTS IN A REGION BROKEN DOWN BY 6 TYPES OF IMPACTS
*
* NUMBER OF RESULTS OF THIS TYPE THAT ARE BEING REQUESTED
* FOR EACH RESULT YOU REQUEST, THE CODE WILL PRODUCE A SET OF 8
TYP12NUMBER   1      (UP TO 10 ALLOWED)
*              INNER      OUTER
TYP12OUT001      1          29  CCDF  (0-2000 km)
```

A.4 Input Data Comparison for Case 1 (Single-Phase) Used in All Calculations

In order to simplify comparison between the input data used by the four participants, the contents of the ATMOS, EARLY, and CHRONC files for Case 1 were collated together and are shown below. The first column is the Input Data ID and the second identifies the country-participant (due to obvious reasons, some of the column data are misaligned).

```
CHCDFRM0001 Greece   0.0        no decontamination costs
CHCDFRM0001 Italy    0.0
CHCDFRM0001 Spain    1.0E-30
CHCDFRM0001 USA      0.0
CHCDNFRM001 Greece   0.0        no decontamination costs
CHCDNFRM001 Italy    0.0
CHCDNFRM001 Spain    1.0E-30
CHCDNFRM001 USA      0.0
CHCOUPLD001 Greece .FALSE.  (GROWING-SEASON ACTIONS INDEPENDENT OF LONG-TERM ACTIONS)
CHCOUPLD001 Italy  .FALSE.
CHCOUPLD001 Spain  .FALSE.
CHCOUPLD001 USA    .FALSE.
CHCRPRGN001 Greece 'PASTURE                ' 105.    304.       0.169
CHCRPRGN001 Italy  'PASTURE                ' 105.    300.       0.169
CHCRPRGN001 Spain  'PASTURE                ' 105.    304.       0.169
CHCRPRGN001 USA    'PASTURE                ' 105.    304.       0.169
CHCRPRGN002 Greece 'GRAINS                 ' 121.    243.       0.732
CHCRPRGN002 Italy  'GRAINS                 ' 120.    240.       0.732
CHCRPRGN002 Spain  'GRAINS                 ' 121.    243.       0.732
CHCRPRGN002 USA    'GRAINS                 ' 121.    243.       0.732
CHCRPRGN003 Greece 'GRN LEAFY VEGETABLES'      1.    365.       0.031
CHCRPRGN003 Italy  'GRN LEAFY VEGETABLES'      1.    365.       0.031
CHCRPRGN003 Spain  'GRN LEAFY VEGETABLES'      1.    365.       0.031
CHCRPRGN003 USA    'GRN LEAFY VEGETABLES'      1.    365.       0.031
CHCRPRGN004 Greece 'ROOTS AND TUBERS       '  32.    304.       0.068
CHCRPRGN004 Italy  'ROOTS AND TUBERS       '  30.    240.       0.068
CHCRPRGN004 Spain  'ROOTS AND TUBERS       '  32.    304.       0.068
CHCRPRGN004 USA    'ROOTS AND TUBERS       '  32.    304.       0.068
CHCRPTBL001 Greece 'PASTURE                '   0.0     0.204    0.796
CHCRPTBL001 Italy  'PASTURE                '   0.0     0.1      0.9
CHCRPTBL001 Spain  'PASTURE                '   0.0     0.184    0.816
CHCRPTBL001 USA    'PASTURE                '   0.0     0.204    0.796
CHCRPTBL002 Greece 'GRAINS                 '   0.328   0.167    0.505
CHCRPTBL002 Italy  'GRAINS                 '   0.35    0.040    0.61
CHCRPTBL002 Spain  'GRAINS                 '   0.342   0.154    0.504
CHCRPTBL002 USA    'GRAINS                 '   0.328   0.167    0.505
CHCRPTBL003 Greece 'GRN LEAFY VEGETABLES'      1.0     0.0      0.0
CHCRPTBL003 Italy  'GRN LEAFY VEGETABLES'      1.0     0.0      0.0
CHCRPTBL003 Spain  'GRN LEAFY VEGETABLES'      1.0     0.0      0.0
CHCRPTBL003 USA    'GRN LEAFY VEGETABLES'      1.0     0.0      0.0
CHCRPTBL004 Greece 'ROOTS AND TUBERS       '   1.0     0.0      0.0
CHCRPTBL004 Italy  'ROOTS AND TUBERS       '   1.0     0.0      0.0
CHCRPTBL004 Spain  'ROOTS AND TUBERS       '   1.0     0.0      0.0
CHCRPTBL004 USA    'ROOTS AND TUBERS       '   1.0     0.0      0.0
CHCRTOCR001 Greece 'EDEWBODY'
CHCRTOCR001 Italy  'EDEWBODY'
CHCRTOCR001 Spain  'EDEWBODY'
CHCRTOCR001 USA    'EDEWBODY'
CHCTCOEF101 Greece  SR-89          0.3       0.01     0.24     0.0006
CHCTCOEF101 Italy   SR-89          0.3       0.01     0.24     0.0006
CHCTCOEF101 Spain   SR-89          0.3       0.01     0.24     0.0006
CHCTCOEF101 USA     SR-89          0.3       0.01     0.24     0.0006
CHCTCOEF102 Greece  SR-90          0.3       0.01     0.24     0.0006
CHCTCOEF102 Italy   SR-90          0.3       0.01     0.24     0.0006
CHCTCOEF102 Spain   SR-90          0.3       0.01     0.24     0.0006
CHCTCOEF102 USA     SR-90          0.3       0.01     0.24     0.0006
CHCTCOEF103 Greece  CS-134         0.3       0.05     0.24     0.025
CHCTCOEF103 Italy   CS-134         0.3       0.05     0.24     0.025
CHCTCOEF103 Spain   CS-134         0.3       0.05     0.24     0.025
CHCTCOEF103 USA     CS-134         0.3       0.05     0.24     0.025
CHCTCOEF104 Greece  CS-137         0.3       0.05     0.24     0.025
```

CHCTCOEF104	Italy	CS-137	0.3	0.05	0.24	0.025
CHCTCOEF104	Spain	CS-137	0.3	0.05	0.24	0.025
CHCTCOEF104	USA	CS-137	0.3	0.05	0.24	0.025
CHCTCOEF105	Greece	I-131	0.3	0.0	0.24	0.0
CHCTCOEF105	Italy	I-131	0.3	0.0	0.24	0.0
CHCTCOEF105	Spain	I-131	0.3	0.0	0.24	0.0
CHCTCOEF105	USA	I-131	0.3	0.0	0.24	0.0
CHCTCOEF106	Greece	I-133	0.3	0.0	0.24	0.0
CHCTCOEF106	Italy	I-133	0.3	0.0	0.24	0.0
CHCTCOEF106	Spain	I-133	0.3	0.0	0.24	0.0
CHCTCOEF106	USA	I-133	0.3	0.0	0.24	0.0
CHCTCOEF201	Greece	SR-89	0.076	0.0	0.06	0.0
CHCTCOEF201	Italy	SR-89	0.076	0.0	0.06	0.0
CHCTCOEF201	Spain	SR-89	0.076	0.0	0.06	0.0
CHCTCOEF201	USA	SR-89	0.076	0.0	0.06	0.0
CHCTCOEF202	Greece	SR-90	0.076	0.0	0.06	0.0
CHCTCOEF202	Italy	SR-90	0.076	0.0	0.06	0.0
CHCTCOEF202	Spain	SR-90	0.076	0.0	0.06	0.0
CHCTCOEF202	USA	SR-90	0.076	0.0	0.06	0.0
CHCTCOEF203	Greece	CS-134	0.076	0.0	0.06	0.0
CHCTCOEF203	Italy	CS-134	0.076	0.0	0.06	0.0
CHCTCOEF203	Spain	CS-134	0.076	0.0	0.06	0.0
CHCTCOEF203	USA	CS-134	0.076	0.0	0.06	0.0
CHCTCOEF204	Greece	CS-137	0.076	0.0	0.06	0.0
CHCTCOEF204	Italy	CS-137	0.076	0.0	0.06	0.0
CHCTCOEF204	Spain	CS-137	0.076	0.0	0.06	0.0
CHCTCOEF204	USA	CS-137	0.076	0.0	0.06	0.0
CHCTCOEF205	Greece	I-131	0.076	0.0	0.06	0.0
CHCTCOEF205	Italy	I-131	0.076	0.0	0.06	0.0
CHCTCOEF205	Spain	I-131	0.076	0.0	0.06	0.0
CHCTCOEF205	USA	I-131	0.076	0.0	0.06	0.0
CHCTCOEF206	Greece	I-133	0.076	0.0	0.06	0.0
CHCTCOEF206	Italy	I-133	0.076	0.0	0.06	0.0
CHCTCOEF206	Spain	I-133	0.076	0.0	0.06	0.0
CHCTCOEF206	USA	I-133	0.076	0.0	0.06	0.0
CHCTHALF101	Greece	SR-89	1.21E6	1E13	1.21E6	1E13
CHCTHALF101	Italy	SR-89	1.21E6	1E13	1.21E6	1E13
CHCTHALF101	Spain	SR-89	1.21E6	1E13	1.21E6	1E13
CHCTHALF101	USA	SR-89	1.21E6	1E13	1.21E6	1E13
CHCTHALF102	Greece	SR-90	1.21E6	1E13	1.21E6	1E13
CHCTHALF102	Italy	SR-90	1.21E6	1E13	1.21E6	1E13
CHCTHALF102	Spain	SR-90	1.21E6	1E13	1.21E6	1E13
CHCTHALF102	USA	SR-90	1.21E6	1E13	1.21E6	1E13
CHCTHALF103	Greece	CS-134	1.21E6	1E13	1.21E6	1E13
CHCTHALF103	Italy	CS-134	1.21E6	1E13	1.21E6	1E13
CHCTHALF103	Spain	CS-134	1.21E6	1E13	1.21E6	1E13
CHCTHALF103	USA	CS-134	1.21E6	1E13	1.21E6	1E13
CHCTHALF104	Greece	CS-137	1.21E6	1E13	1.21E6	1E13
CHCTHALF104	Italy	CS-137	1.21E6	1E13	1.21E6	1E13
CHCTHALF104	Spain	CS-137	1.21E6	1E13	1.21E6	1E13
CHCTHALF104	USA	CS-137	1.21E6	1E13	1.21E6	1E13
CHCTHALF105	Greece	I-131	1.21E6	1.0	1.21E6	1.0
CHCTHALF105	Italy	I-131	1.21E6	1.0	1.21E6	1.0
CHCTHALF105	Spain	I-131	1.21E6	1.0	1.21E6	1.0
CHCTHALF105	USA	I-131	1.21E6	1.0	1.21E6	1.0
CHCTHALF106	Greece	I-133	1.21E6	1.0	1.21E6	1.0
CHCTHALF106	Italy	I-133	1.21E6	1.0	1.21E6	1.0
CHCTHALF106	Spain	I-133	1.21E6	1.0	1.21E6	1.0
CHCTHALF106	USA	I-133	1.21E6	1.0	1.21E6	1.0
CHCTHALF201	Greece	SR-89	4.32E6	1.0	4.32E6	1.0
CHCTHALF201	Italy	SR-89	4.32E6	1.0	4.32E6	1.0
CHCTHALF201	Spain	SR-89	4.32E6	1.0	4.32E6	1.0
CHCTHALF201	USA	SR-89	4.32E6	1.0	4.32E6	1.0
CHCTHALF202	Greece	SR-90	4.32E6	1.0	4.32E6	1.0
CHCTHALF202	Italy	SR-90	4.32E6	1.0	4.32E6	1.0
CHCTHALF202	Spain	SR-90	4.32E6	1.0	4.32E6	1.0
CHCTHALF202	USA	SR-90	4.32E6	1.0	4.32E6	1.0
CHCTHALF203	Greece	CS-134	4.32E6	1.0	4.32E6	1.0
CHCTHALF203	Italy	CS-134	4.32E6	1.0	4.32E6	1.0
CHCTHALF203	Spain	CS-134	4.32E6	1.0	4.32E6	1.0

CHCTHALF203	USA	CS-134	4.32E6	1.0	4.32E6	1.0
CHCTHALF204	Greece	CS-137	4.32E6	1.0	4.32E6	1.0
CHCTHALF204	Italy	CS-137	4.32E6	1.0	4.32E6	1.0
CHCTHALF204	Spain	CS-137	4.32E6	1.0	4.32E6	1.0
CHCTHALF204	USA	CS-137	4.32E6	1.0	4.32E6	1.0
CHCTHALF205	Greece	I-131	4.32E6	1.0	4.32E6	1.0
CHCTHALF205	Italy	I-131	4.32E6	1.0	4.32E6	1.0
CHCTHALF205	Spain	I-131	4.32E6	1.0	4.32E6	1.0
CHCTHALF205	USA	I-131	4.32E6	1.0	4.32E6	1.0
CHCTHALF206	Greece	I-133	4.32E6	1.0	4.32E6	1.0
CHCTHALF206	Italy	I-133	4.32E6	1.0	4.32E6	1.0
CHCTHALF206	Spain	I-133	4.32E6	1.0	4.32E6	1.0
CHCTHALF206	USA	I-133	4.32E6	1.0	4.32E6	1.0
CHDCYPCB001	Greece	SR-89	0.59	0.2	0.0	0.0
CHDCYPCB001	Italy	SR-89	1.0	0.2	0.0	0.0
CHDCYPCB001	Spain	SR-89	0.5834	0.2	0.0	0.0
CHDCYPCB001	USA	SR-89	0.59	0.2	0.0	0.0
CHDCYPCB002	Greece	SR-90	1.0	0.99	0.0	0.0
CHDCYPCB002	Italy	SR-90	1.0	0.99	0.0	0.0
CHDCYPCB002	Spain	SR-90	0.9946	0.99	0.0	0.0
CHDCYPCB002	USA	SR-90	1.0	0.99	0.0	0.0
CHDCYPCB003	Greece	CS-134	0.93	0.85	0.0	0.0
CHDCYPCB003	Italy	CS-134	1.0	0.85	0.0	0.0
CHDCYPCB003	Spain	CS-134	0.9291	0.85	0.0	0.0
CHDCYPCB003	USA	CS-134	0.93	0.85	0.0	0.0
CHDCYPCB004	Greece	CS-137	1.0	0.99	0.0	0.0
CHDCYPCB004	Italy	CS-137	1.0	0.99	0.0	0.0
CHDCYPCB004	Spain	CS-137	0.9947	0.99	0.0	0.0
CHDCYPCB004	USA	CS-137	1.0	0.99	0.0	0.0
CHDCYPCB005	Greece	I-131	0.54	0.032	0.0	0.0
CHDCYPCB005	Italy	I-131	1.0	0.032	0.0	0.0
CHDCYPCB005	Spain	I-131	0.5400	0.032	0.0	0.0
CHDCYPCB005	USA	I-131	0.54	0.032	0.0	0.0
CHDCYPCB006	Greece	I-133	0.54	0.0034	0.0	0.0
CHDCYPCB006	Italy	I-133	1.0	0.0034	0.0	0.0
CHDCYPCB006	Spain	I-133	0.5400	0.0034	0.0	0.0
CHDCYPCB006	USA	I-133	0.54	0.0034	0.0	0.0
CHDCYPCH001	Greece	SR-89	0.0	0.06	0.75	0.30
CHDCYPCH001	Italy	SR-89	0.0	0.18	0.67	0.18
CHDCYPCH001	Spain	SR-89	0.0	0.0576	0.7408	0.2907
CHDCYPCH001	USA	SR-89	0.0	0.06	0.75	0.30
CHDCYPCH002	Greece	SR-90	0.0	0.98	1.0	0.99
CHDCYPCH002	Italy	SR-90	0.0	0.99	1.0	0.99
CHDCYPCH002	Spain	SR-90	0.0	0.9824	0.9980	0.9942
CHDCYPCH002	USA	SR-90	0.0	0.98	1.0	0.99
CHDCYPCH003	Greece	CS-134	0.0	0.78	0.97	0.92
CHDCYPCH003	Italy	CS-134	0.0	0.84	0.96	0.84
CHDCYPCH003	Spain	CS-134	0.0	0.7818	0.9729	0.9205
CHDCYPCH003	USA	CS-134	0.0	0.78	0.97	0.92
CHDCYPCH004	Greece	CS-137	0.0	0.98	1.0	0.99
CHDCYPCH004	Italy	CS-137	0.0	0.99	1.0	0.99
CHDCYPCH004	Spain	CS-137	0.0	0.9829	0.9981	0.9943
CHDCYPCH004	USA	CS-137	0.0	0.98	1.0	0.99
CHDCYPCH005	Greece	I-131	0.0	0.00003	0.45	0.0004
CHDCYPCH005	Italy	I-131	0.0	0.0099	0.7	0.0099
CHDCYPCH005	Spain	I-131	0.0	0.00003	0.4550	0.0004
CHDCYPCH005	USA	I-131	0.0	0.00003	0.45	0.0004
CHDCYPCH006	Greece	I-133	0.0	0.0	0.013	0.0
CHDCYPCH006	Italy	I-133	0.0	0.0	0.0	0.0
CHDCYPCH006	Spain	I-133	0.0	0.0	0.0128	0.0
CHDCYPCH006	USA	I-133	0.0	0.0	0.013	0.0
CHDCYPCM001	Greece	SR-89	0.59	0.2	0.0	0.0
CHDCYPCM001	Italy	SR-89	1.0	0.20	0.0	0.0
CHDCYPCM001	Spain	SR-89	0.5834	0.20	0.0	0.0
CHDCYPCM001	USA	SR-89	0.59	0.2	0.0	0.0
CHDCYPCM002	Greece	SR-90	1.0	0.99	0.0	0.0
CHDCYPCM002	Italy	SR-90	1.0	0.99	0.0	0.0
CHDCYPCM002	Spain	SR-90	0.9946	0.99	0.0	0.0
CHDCYPCM002	USA	SR-90	1.0	0.99	0.0	0.0
CHDCYPCM003	Greece	CS-134	0.93	0.85	0.0	0.0

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CHDCYPCM003 Italy   CS-134         1.0      0.85    0.0      0.0
CHDCYPCM003 Spain   CS-134         0.9291   0.85    0.0      0.0
CHDCYPCM003 USA     CS-134         0.93     0.85    0.0      0.0
CHDCYPCM004 Greece  CS-137         1.0      0.99    0.0      0.0
CHDCYPCM004 Italy   CS-137         1.0      0.99    0.0      0.0
CHDCYPCM004 Spain   CS-137         0.9947   0.99    0.0      0.0
CHDCYPCM004 USA     CS-137         1.0      0.99    0.0      0.0
CHDCYPCM005 Greece  I-131          0.54     0.032   0.0      0.0
CHDCYPCM005 Italy   I-131          1.0      0.032   0.0      0.0
CHDCYPCM005 Spain   I-131          0.5400   0.032   0.0      0.0
CHDCYPCM005 USA     I-131          0.54     0.032   0.0      0.0
CHDCYPCM006 Greece  I-133          0.54     0.0034  0.0      0.0
CHDCYPCM006 Italy   I-133          1.0      0.0034  0.0      0.0
CHDCYPCM006 Spain   I-133          0.5400   0.0034  0.0      0.0
CHDCYPCM006 USA     I-133          0.54     0.0034  0.0      0.0
CHDLBCST001 Greece   1.0E-9  no decontamination costs
CHDLBCST001 Italy    1.0E-35 (TO AVOID DIVIDE EXCEPTION)
CHDLBCST001 Spain    1.0E-30
CHDLBCST001 USA      1.0E-9  no decontamination costs
CHDPFRCT001 Greece   0.2     (SITE FILE OVERRIDES THIS VALUE)
CHDPFRCT001 Italy    0.198   (VIRGINIA STATE VALUE, SITE FILE OVERRIDES THIS VALUE)
CHDPFRCT001 Spain    0.190   (App. 7, CCP2, issue C overridden by site file)
CHDPFRCT001 USA      0.2     (SITE FILE OVERRIDES THIS VALUE)
CHDPRATE001 Greece   0.056
CHDPRATE001 Italy     .1
CHDPRATE001 Spain     .048
CHDPRATE001 USA      0.056
CHDSCRLT001 Greece   0.100 Sv
CHDSCRLT001 Italy    1.0E-1  (C1 PARIS)
CHDSCRLT001 Spain    0.100   (100 mSv, relocation and return criterion, June 92)
CHDSCRLT001 USA      0.100 Sv
CHDSCRTI001 Greece   0.100    Irrelevant...
CHDSCRTI001 Italy  100.
CHDSCRTI001 Spain    1.E+5
CHDSCRTI001 USA      0.100
CHDSRATE001 Greece   0.05
CHDSRATE001 Italy     .05
CHDSRATE001 Spain     .05    (Interest rate, APPENDIX 7, ISSUE C CCP2)
CHDSRATE001 USA      0.05
CHDSRFCT001 Greece   1.0     (no decontamination, p.9, 19th March 1991)
CHDSRFCT001 Italy    1.
CHDSRFCT001 Spain    1.0
CHDSRFCT001 USA      1.0     (no decontamination, p.9, 19th March 1991)
CHEVACST001 Greece  41.6
CHEVACST001 Italy    5.      (INCLUDES FOOD AND HOUSING COSTS BUT NOT LOST INCOME)
CHEVACST001 Spain   42.02
CHEVACST001 USA     41.6
CHFPLSCH001 Greece  SR-89       0.0     1.0       1.0      1.0
CHFPLSCH001 Italy   SR-89       0.0     0.25      0.5      0.8
CHFPLSCH001 Spain   SR-89       0.0     1.0       1.0      1.0
CHFPLSCH001 USA     SR-89       0.0     1.0       1.0      1.0
CHFPLSCH002 Greece  SR-90       0.0     1.0       1.0      1.0
CHFPLSCH002 Italy   SR-90       0.0     0.25      0.5      0.8
CHFPLSCH002 Spain   SR-90       0.0     1.0       1.0      1.0
CHFPLSCH002 USA     SR-90       0.0     1.0       1.0      1.0
CHFPLSCH003 Greece  CS-134      0.0     1.0       1.0      1.0
CHFPLSCH003 Italy   CS-134      0.0     0.25      0.5      0.8
CHFPLSCH003 Spain   CS-134      0.0     1.0       1.0      1.0
CHFPLSCH003 USA     CS-134      0.0     1.0       1.0      1.0
CHFPLSCH004 Greece  CS-137      0.0     1.0       1.0      1.0
CHFPLSCH004 Italy   CS-137      0.0     0.25      0.5      0.8
CHFPLSCH004 Spain   CS-137      0.0     1.0       1.0      1.0
CHFPLSCH004 USA     CS-137      0.0     1.0       1.0      1.0
CHFPLSCH005 Greece  I-131       0.0     1.0       1.0      1.0
CHFPLSCH005 Italy   I-131       0.0     0.33      0.5      0.8
CHFPLSCH005 Spain   I-131       0.0     1.0       1.0      1.0
CHFPLSCH005 USA     I-131       0.0     1.0       1.0      1.0
CHFPLSCH006 Greece  I-133       0.0     1.0       1.0      1.0
CHFPLSCH006 Italy   I-133       0.0     0.33      0.5      0.8
CHFPLSCH006 Spain   I-133       0.0     1.0       1.0      1.0
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CHFRLSCH006 USA     I-133       0.0     1.0      1.0      1.0
CHFRACLD001 Greece   0.95   (SITE FILE OVERRIDES THIS VALUE)
CHFRACLD001 Italy    0.95
CHFRACLD001 Spain    1.0
CHFRACLD001 USA      0.95
CHFRCFRM001 Greece   0.3    (SITE FILE OVERRIDES THIS VALUE)
CHFRCFRM001 Italy    0.382
CHFRCFRM001 Spain    0.0365
CHFRCFRM001 USA      0.3
CHFRFDL0001 Greece   1.0
CHFRFDL0001 Italy    0.0
CHFRFDL0001 Spain    0.0
CHFRFDL0001 USA      1.0
CHFRFIM0001 Greece   0.25    (MACCS user's guide. No value in the specification)
CHFRFIM0001 Italy    0.25
CHFRFIM0001 Spain    0.25
CHFRFIM0001 USA      0.25
CHFRMPRD001 Greece   400.0  (SITE FILE OVERRIDES THIS VALUE)
CHFRMPRD001 Italy    371.0
CHFRMPRD001 Spain   5026.
CHFRMPRD001 USA      400.0
CHFRNFDL001 Greece   1.0
CHFRNFDL001 Italy    0.0
CHFRNFDL001 Spain    0.0
CHFRNFDL001 USA      1.0
CHFRNFIM001 Greece   0.8
CHFRNFIM001 Italy    0.8
CHFRNFIM001 Spain    0.35     Weighted value for regions 1 and 2 only (covering the
CHFRNFIM001 USA      0.8
CHGWCOEF001 Greece   0.5    0.5    (User's Guide)
CHGWCOEF001 Italy    0.5    0.5
CHGWCOEF001 Spain    0.5    0.5
CHGWCOEF001 USA      0.5    0.5
CHISODEF001 Greece  SR-89       0.82     0.70          0.022     0.000067
CHISODEF001 Italy   SR-89       0.66     0.77          0.022     0.00022
CHISODEF001 Spain   SR-89       0.8461   0.6974        0.022     0.000067
CHISODEF001 USA     SR-89       0.82     0.70          0.022     0.000067
CHISODEF002 Greece  SR-90       1.0      1.0           0.022     0.000067
CHISODEF002 Italy   SR-90       1.0      1.0           0.022     0.00022
CHISODEF002 Spain   SR-90       0.9991   0.9978        0.022     0.000067
CHISODEF002 USA     SR-90       1.0      1.0           0.022     0.000067
CHISODEF003 Greece  CS-134      0.99     0.97          0.11      0.00675
CHISODEF003 Italy   CS-134      1.0      1.0           0.11      0.023
CHISODEF003 Spain   CS-134      0.9878   0.9697        0.11      0.00675
CHISODEF003 USA     CS-134      0.99     0.97          0.11      0.00675
CHISODEF004 Greece  CS-137      1.0      1.0           0.11      0.00675
CHISODEF004 Italy   CS-137      1.0      1.0           0.11      0.024
CHISODEF004 Spain   CS-137      0.9992   0.9979        0.11      0.00675
CHISODEF004 USA     CS-137      1.0      1.0           0.11      0.00675
CHISODEF005 Greece  I-131       0.46     0.30          0.13      0.00161
CHISODEF005 Italy   I-131       0.28     0.18          0.13      0.0024
CHISODEF005 Spain   I-131       0.5285   0.2957        0.13      0.00161
CHISODEF005 USA     I-131       0.46     0.30          0.13      0.00161
CHISODEF006 Greece  I-133       0.1      0.00023       0.062     0.000740
CHISODEF006 Italy   I-133       0.002    0.0           0.062     0.0011
CHISODEF006 Spain   I-133       0.1195   0.0002        0.062     0.000740
CHISODEF006 USA     I-133       0.1      0.00023       0.062     0.000740
CHKSWTCH001 Greece      0     0    0     0     0     0    0     0
CHKSWTCH001 Italy       0     0    0     0     0     0    0     0
CHKSWTCH001 Spain       0     0    0     0     0     0    0     0
CHKSWTCH001 USA         0     0    0     0     0     0    0     0
CHLVLDEC001 Greece  1
CHLVLDEC001 Italy   1
CHLVLDEC001 Spain   1
CHLVLDEC001 USA     1
CHNFICRP001 Greece  4    (UP TO 10 ALLOWED)
CHNFICRP001 Italy   4
CHNFICRP001 Spain   4
CHNFICRP001 USA     4
CHNFIISO001 Greece  6  (UP TO 10 ALLOWED, BEWARE THAT DAUGHTER BUILDUP IS NOT TREATED)
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CHNFIISO001	Italy	6			
CHNFIISO001	Spain	6			
CHNFIISO001	USA	6			
CHNGWTRM001	Greece	2			
CHNGWTRM001	Italy	2			
CHNGWTRM001	Spain	2			
CHNGWTRM001	USA	2			
CHNRWTRM001	Greece	3			
CHNRWTRM001	Italy	3			
CHNRWTRM001	Spain	3			
CHNRWTRM001	USA	3			
CHNTRTRM001	Greece	2			
CHNTRTRM001	Italy	2			
CHNTRTRM001	Spain	2			
CHNTRTRM001	USA	2			
CHNUMWPI001	Greece	1			
CHNUMWPI001	Italy	4			
CHNUMWPI001	Spain	1			
CHNUMWPI001	USA	1			
CHPAGLTS001	Greece	SR-89	3.5985E+10	4.9	based on 0.005 SV
CHPAGLTS001	Italy	SR-89	1.8E8	4.9	
CHPAGLTS001	Spain	SR-89	3.6745E+10	4.9	GCMAXR values obtained with
CHPAGLTS001	USA	SR-89	3.5985E+10	4.9	based on 0.005 SV
CHPAGLTS002	Greece	SR-90	1.2504E+06	0.065	of EDEWBODY over
CHPAGLTS002	Italy	SR-90	5.9E5	0.065	
CHPAGLTS002	Spain	SR-90	1.2500E+06	0.065	MAXGC program, using a
CHPAGLTS002	USA	SR-90	1.2504E+06	0.065	of EDEWBODY over
CHPAGLTS003	Greece	CS-134	5.8644E+07	0.59	1 year: end of
CHPAGLTS003	Italy	CS-134	9.2E6	0.59	
CHPAGLTS003	Spain	CS-134	5.8341E+07	0.59	food basket described in
CHPAGLTS003	USA	CS-134	5.8644E+07	0.59	1 year: end of
CHPAGLTS004	Greece	CS-137	4.6263E+07	0.28	year ONE to end
CHPAGLTS004	Italy	CS-137	7.4E6	0.28	
CHPAGLTS004	Spain	CS-137	4.6023E+07	0.28	note (January/22/93)
CHPAGLTS004	USA	CS-137	4.6263E+07	0.28	year ONE to end
CHPAGLTS005	Greece	I-131	1.0000E+20	32.0	of year TWO,
CHPAGLTS005	Italy	I-131	1.E20	32.0	
CHPAGLTS005	Spain	I-131	1.0E20	32.0	Dose criterion:
CHPAGLTS005	USA	I-131	1.0000E+20	32.0	of year TWO,
CHPAGLTS006	Greece	I-133	1.0000E+20	290.0	JFLAG=5 in MAXGC
CHPAGLTS006	Italy	I-133	1.E20	290.0	
CHPAGLTS006	Spain	I-133	1.0E20	290.0	0.005 Sv over 1 year.
CHPAGLTS006	USA	I-133	1.0000E+20	290.0	JFLAG=5 in MAXGC
CHPAGMCP001	Greece	SR-89	1.9634E+07	1.9634E+07	based on 0.005 SV
CHPAGMCP001	Italy	SR-89	2.2E06	2.2E06	
CHPAGMCP001	Spain	SR-89	2.0379E+07	2.0379E+07	Values obtained with MAXGC
CHPAGMCP001	USA	SR-89	1.9634E+07	1.9634E+07	based on 0.005 SV
CHPAGMCP002	Greece	SR-90	4.8629E+04	4.8629E+04	of EDEWBODY to
CHPAGMCP002	Italy	SR-90	2.4E04	2.4E04	
CHPAGMCP002	Spain	SR-90	4.8749E+04	4.8749E+04	using a food basket based
CHPAGMCP002	USA	SR-90	4.8629E+04	4.8629E+04	of EDEWBODY to
CHPAGMCP003	Greece	CS-134	2.0127E+04	2.0127E+04	a maximally exposed
CHPAGMCP003	Italy	CS-134	2.2E04	2.2E04	
CHPAGMCP003	Spain	CS-134	2.0126E+04	2.0126E+04	described in note(22/1/93)
CHPAGMCP003	USA	CS-134	2.0127E+04	2.0127E+04	a maximally exposed
CHPAGMCP004	Greece	CS-137	2.2549E+04	2.2549E+04	individual
CHPAGMCP004	Italy	CS-137	2.7E04	2.7E04	
CHPAGMCP004	Spain	CS-137	2.2519E+04	2.2519E+04	Dose limit 0.005 Sv of
CHPAGMCP004	USA	CS-137	2.2549E+04	2.2549E+04	individual
CHPAGMCP005	Greece	I-131	2.0145E+07	2.0145E+07	
CHPAGMCP005	Italy	I-131	1.3E05	8.0E05	
CHPAGMCP005	Spain	I-131	1.7626E+07	1.7626E+07	EDEWBODY to a maximally
CHPAGMCP005	USA	I-131	2.0145E+07	2.0145E+07	
CHPAGMCP006	Greece	I-133	6.6631E+09	6.6631E+09	
CHPAGMCP006	Italy	I-133	1.1E09	1.0E19	
CHPAGMCP006	Spain	I-133	5.5992E+09	5.5992E+09	exposed individual
CHPAGMCP006	USA	I-133	6.6631E+09	6.6631E+09	
CHPOPCST001	Greece	30053.	(ECUS/person)		
CHPOPCST001	Italy	30.05E+3			
CHPOPCST001	Spain	30053.			

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CHPOPCST001 USA      30053.
CHRELCST001 Greece   41.6
CHRELCST001 Italy    5.      (INCLUDES FOOD AND HOUSING COSTS BUT NOT LOST INCOME)
CHRELCST001 Spain   42.02
CHRELCST001 USA     41.6
CHRWCOEF001 Greece  1.0E-5   1.0E-7    1.0E-9  (VALUES HERE SELECTED BY JON HELTON)
CHRWCOEF001 Italy   1.0E-5   1.0E-7    1.0E-9  (VALUES HERE SELECTED BY JON HELTON)
CHRWCOEF001 Spain   1.0E-5   1.0E-7    1.0E-9  (User's Guide)
CHRWCOEF001 USA     1.0E-5   1.0E-7    1.0E-9  (VALUES HERE SELECTED BY JON HELTON)
CHTCROOT001 Greece  SR-89    2.92E-06  3.17E-07   1.25E-06   8.14E-07
CHTCROOT001 Italy   SR-89    4.1E-4    4.3E-5     1.7E-4     1.1E-4
CHTCROOT001 Spain   SR-89    4.1E-4    4.3E-5     1.7E-4     1.1E-4
CHTCROOT001 USA     SR-89    2.92E-06  3.17E-07   1.25E-06   8.14E-07
CHTCROOT002 Greece  SR-90    1.75E-03  1.91E-04   7.54E-04   4.91E-04
CHTCROOT002 Italy   SR-90    2.6E-2    3.3E-3     1.3E-2     8.4E-3
CHTCROOT002 Spain   SR-90    2.6E-2    3.3E-3     1.3E-2     8.4E-3
CHTCROOT002 USA     SR-90    1.75E-03  1.91E-04   7.54E-04   4.91E-04
CHTCROOT003 Greece  CS-134   2.84E-04  8.77E-06   3.46E-06   1.38E-05
CHTCROOT003 Italy   CS-134   1.3E-3    3.5E-5     1.4E-5     5.6E-5
CHTCROOT003 Spain   CS-134   1.3E-3    3.5E-5     1.4E-5     5.6E-5
CHTCROOT003 USA     CS-134   2.84E-04  8.77E-06   3.46E-06   1.38E-05
CHTCROOT004 Greece  CS-137   4.53E-04  1.39E-05   5.51E-06   2.19E-05
CHTCROOT004 Italy   CS-137   6.9E-3    7.6E-5     3.0E-5     1.2E-4
CHTCROOT004 Spain   CS-137   6.9E-3    7.6E-5     3.0E-5     1.2E-4
CHTCROOT004 USA     CS-137   4.53E-04  1.39E-05   5.51E-06   2.19E-05
CHTCROOT005 Greece  I-131    3.31E-19  0.00E+00   0.00E+00   0.00E+00
CHTCROOT005 Italy   I-131    1.6E-4    0.0        0.0        0.0
CHTCROOT005 Spain   I-131    1.6E-4    0.0        0.0        0.0
CHTCROOT005 USA     I-131    3.31E-19  0.00E+00   0.00E+00   0.00E+00
CHTCROOT006 Greece  I-133    0.00E+00  0.00E+00   0.00E+00   0.00E+00
CHTCROOT006 Italy   I-133    1.7E-6    0.0        0.0        0.0
CHTCROOT006 Spain   I-133    1.7E-6    0.0        0.0        0.0
CHTCROOT006 USA     I-133    0.00E+00  0.00E+00   0.00E+00   0.00E+00
CHTFWKF0001 Greece  1.0
CHTFWKF0001 Italy   0.0
CHTFWKF0001 Spain   0.0
CHTFWKF0001 USA     1.0
CHTFWKNF001 Greece  1.0
CHTFWKNF001 Italy   0.0
CHTFWKNF001 Spain   0.0
CHTFWKNF001 USA     1.0
CHTGWHLF001 Greece  1.6E7    2.8E9     (User's Guide)
CHTGWHLF001 Italy   1.6E7    2.8E9
CHTGWHLF001 Spain   1.6E7    2.8E9
CHTGWHLF001 USA     1.6E7    2.8E9
CHTIMDEC001 Greece  1.E-5   (no decontamination is specified)
CHTIMDEC001 Italy   1.E-35  (0 DAYS)
CHTIMDEC001 USA     1.E-5   (no decontamination is specified)
CHTMIPND001 Greece  604800.  (no intermediate phase)
CHTMIPND001 Italy   604800.  (1 WEEK)
CHTMIPND001 Spain   604800.  (ENDEMP, no intermediate phase is considered)
CHTMIPND001 USA     604800.  (no intermediate phase)
CHTMPACT001 Greece  31536000.0   (1 year)
CHTMPACT001 Italy   3.15E+7
CHTMPACT001 Spain   3.1536E+7
CHTMPACT001 USA     31536000.0
CHTRWHLF001 Greece  1.6E7    1.6E8    1.6E9   (6 MONTHS, 5 YEARS, 50 YEARS)
CHTRWHLF001 Italy   1.6E7    1.6E8    1.6E9
CHTRWHLF001 Spain   1.6E7    1.6E8    1.6E9
CHTRWHLF001 USA     1.6E7    1.6E8    1.6E9
CHVALWF0001 Greece  12035.
CHVALWF0001 Italy   12035.
CHVALWF0001 Spain   21275.  Weighted value taking into account the actual data,
CHVALWF0001 USA     12035.
CHVALWNF001 Greece  65059.
CHVALWNF001 Italy   65059.
CHVALWNF001 Spain   106479.  Weighted value for regions 1 and 2 only (covering the
CHVALWNF001 USA     65059.
CHWTRISO001 Greece   SR-89       0.01      0.004          0.0E-6
CHWTRISO001 Italy    SR-89       0.01      0.004          5.0E-6
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CHWTRISO001 Spain    SR-89        0.01       0.004           0.0
CHWTRISO001 USA      SR-89        0.01       0.004           0.0E-6
CHWTRISO002 Italy    SR-90        0.01       0.004           5.0E-6
CHWTRISO003 Italy    CS-134       0.005      0.001           5.0E-6
CHWTRISO004 Italy    CS-137       0.005      0.001           5.0E-6
DDNPSGRP001 Greece   2
DDNPSGRP001 Italy    3
DDNPSGRP001 Spain    2
DDNPSGRP001 USA      2
DDVDEPOS001 Greece   5.0E-04 1.0E-03
DDVDEPOS001 Italy    0.0       5.0E-4   1.0E-3
DDVDEPOS001 Spain    0.0005    0.001   (Page 6, CCP1, issue F)
DDVDEPOS001 USA      0.0005    0.001
DPCYSIGA001 Greece   0.3658    0.2751  0.2089    0.1474    0.1046    0.0722
DPCYSIGA001 Italy    0.3658    0.2751  0.2089    0.1474    0.1046    0.0722
DPCYSIGA001 Spain    0.3658    0.2751  0.2089    0.1474    0.1046    0.0722
DPCYSIGA001 USA      0.3658    0.2751  0.2089    0.1474    0.1046    0.0722
DPCYSIGB001 Greece    .9031     .9031   .9031     .9031     .9031     .9031
DPCYSIGB001 Italy     .9031     .9031   .9031     .9031     .9031     .9031
DPCYSIGB001 Spain    0.9031    0.9031  0.9031    0.9031    0.9031    0.9031
DPCYSIGB001 USA       .9031     .9031   .9031     .9031     .9031     .9031
DPCZSIGA001 Greece   2.5E-4    1.9E-3   .2        .3        .4        .2
DPCZSIGA001 Italy    2.5E-4    1.9E-3   .2        .3        .4        .2
DPCZSIGA001 Spain    2.5E-4    1.9E-3  0.2       0.3       0.4       0.2
DPCZSIGA001 USA      2.5E-4    1.9E-3   .2        .3        .4        .2
DPCZSIGB001 Greece   2.125     1.6021   .8543     .6532     .6021     .6020
DPCZSIGB001 Italy    2.125     1.6021   .8543     .6532     .6021     .6020
DPCZSIGB001 Spain    2.125     1.6021  0.8543    0.6532    0.6021    0.6020
DPCZSIGB001 USA      2.125     1.6021   .8543     .6532     .6021     .6020
DPYSCALE001 Greece     1.
DPYSCALE001 Italy      1.
DPYSCALE001 Spain      1.
DPYSCALE001 USA        1.
DPZSCALE001 Italy      1.58
DPZSCALE001 Spain      1.585    ((30/3)^0.2, 30 cm roughness, page 9 CCP1, issue F)
DPZSCALE001 USA        1.58
EFATAGRP001 Greece 'RED MARR'       4.0      6.0     1.5
EFATAGRP001 Italy  'RED MARR'       3.8      5.0     1.5
EFATAGRP001 Spain  'RED MARR'       3.8      5.0     1.5
EFATAGRP001 USA    'RED MARR'       3.8      5.0     1.5
EFATAGRP002 Greece 'LUNGS'         10.0      7.0     5.0
EFATAGRP002 Italy  'LUNGS'         10.0      7.0     5.0
EFATAGRP002 Spain  'LUNGS'         10.0      7.0     5.0
EFATAGRP002 USA    'LUNGS'         10.0      7.0     5.0
EFATAGRP003 Greece 'LOWER LI'      15.0     10.0     7.5
EFATAGRP003 Italy  'LOWER LI'      15.0     10.0     8.0
EFATAGRP003 Spain  'LOWER LI'      15.0     10.0     8.0
EFATAGRP003 USA    'LOWER LI'      15.0     10.0     8.0
EFNUMEFA001 Greece   3
EFNUMEFA001 Italy    3
EFNUMEFA001 Spain    3
EFNUMEFA001 USA      3
EINJUGRP001 Greece 'PRODROMAL VOMIT' 'STOMACH' 1.      .5      2.      3.
EINJUGRP001 Italy  'PRODROMAL VOMIT' 'STOMACH' 1.      .5      2.      3.
EINJUGRP001 Spain  'PRODROMAL VOMIT' 'STOMACH' 1.      .5      2.      3.
EINJUGRP001 USA    'PRODROMAL VOMIT' 'STOMACH' 1.      .5      2.      3.
EINJUGRP002 Greece 'DIARRHEA'       'STOMACH'  1.     1.       3.      2.5
EINJUGRP002 Italy  'DIARRHEA'       'STOMACH'  1.     1.       3.      2.5
EINJUGRP002 Spain  'DIARRHEA'       'STOMACH'  1.     1.       3.      2.5
EINJUGRP002 USA    'DIARRHEA'       'STOMACH'  1.     1.       3.      2.5
EINJUGRP003 Greece 'PNEUMONITIS'    'LUNGS'    1.     5.      10.      7.
EINJUGRP003 Italy  'PNEUMONITIS'    'LUNGS'    1.     5.      10.      7.
EINJUGRP003 Spain  'PNEUMONITIS'    'LUNGS'    1.     5.      10.      7.
EINJUGRP003 USA    'PNEUMONITIS'    'LUNGS'    1.     5.      10.      7.
EINJUGRP004 Greece 'SKIN ERYTHEMA'  'SKIN'     1.     3.       6.      5.
EINJUGRP004 Italy  'SKIN ERYTHEMA'  'SKIN'     1.     3.       6.      5.
EINJUGRP004 Spain  'SKIN ERYTHEMA'  'SKIN'     1.     3.       6.      5.
EINJUGRP004 USA    'SKIN ERYTHEMA'  'SKIN'     1.     3.       6.      5.
EINJUGRP005 Greece 'TRANSEPIDERMAL' 'SKIN'     1.    10.      20.      5.
EINJUGRP005 Italy  'TRANSEPIDERMAL' 'SKIN'     1.    10.      20.      5.
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EINJUGRP005 Spain  'TRANSEPIDERMAL' 'SKIN'     1.   10.    20.    5.
EINJUGRP005 USA    'TRANSEPIDERMAL' 'SKIN'     1.   10.    20.    5.
EINJUGRP006 Greece 'THYROIDITIS'    'THYROIDH' 1.   40.   240.    2.
EINJUGRP006 Italy  'THYROIDITIS'    'THYROIDH' 1.   40.   240.    2.
EINJUGRP006 Spain  'THYROIDITIS'    'THYROIDH' 1.   40.   240.    2.
EINJUGRP006 USA    'THYROIDITIS'    'THYROIDH' 1.   40.   240.    2.
EINJUGRP007 Greece 'HYPOTHYROIDISM' 'THYROIDH' 1.    2.    60.    1.3
EINJUGRP007 Italy  'HYPOTHYROIDISM' 'THYROIDH' 1.    2.    60.    1.3
EINJUGRP007 Spain  'HYPOTHYROIDISM' 'THYROIDH' 1.    2.    60.    1.3
EINJUGRP007 USA    'HYPOTHYROIDISM' 'THYROIDH' 1.    2.    60.    1.3
EINUMEIN001 Greece  7
EINUMEIN001 Italy   7
EINUMEIN001 Spain   7
EINUMEIN001 USA     7
EZEANAM2001 Greece  'INSTANTANEOUS EVACUATION WITHIN 10 KM, RELOCATION IN SAME AREA'
EZEANAM2001 Italy   'SHELTERING WITHIN 10 KM, RELOCATION MODELS APPLY ELSEWHERE'
EZEANAM2001 Spain   'BENCHMARK SCENARIO ADAPTED TO MACCS'
EZEANAM2001 USA     '100% evacuation'
EZEDELAY001 Greece   0.        0.      10800.   (0,0,3 HOURS)
EZEDELAY001 USA      0.0       0.0       0.0
EZESPEED001 Greece   1.0E6
EZESPEED001 USA      1.0E6
EZINIEVA001 Greece   12  (INNER SHELTERING ZONE: 10 KM - SAME WITH EVACUATION ZONE))
EZINIEVA001 USA      11
EZLASEVA001 Greece   0   0   12  (10 KM ZONE)
EZLASEVA001 USA      0   0   11
EZLASMOV001 Greece   12     (EVACUEES DISAPPEAR AFTER TRAVELING TO 10 KM)
EZLASMOV001 Italy     0     (NO EVACUATION)
EZLASMOV001 Spain     0     (No Evacuation Area, no further data in this section are
EZLASMOV001 USA      11
EZWTFRAC001 Greece   1.0
EZWTFRAC001 Italy    1.0
EZWTFRAC001 Spain    1.0
EZWTFRAC001 USA      1.0   (100%)
EZWTNAME001 Greece  'PEOPLE'
EZWTNAME001 Italy   'PEOPLE'
EZWTNAME001 Spain   'PEOPLE'
EZWTNAME001 USA     'PEOPLE'
GENUMRAD001 Greece  30
GENUMRAD001 Italy   29
GENUMRAD001 Spain   31
GENUMRAD001 USA     29
GESPAEND001 Greece     0.2       0.5      0.8       1.2       1.6
GESPAEND001 Italy      0.2       0.5      0.8       1.2       1.6
GESPAEND001 Spain      0.2       0.4      0.6       0.85      1.15
GESPAEND001 USA        0.2       0.5      0.8       1.2       1.6
GESPAEND002 Greece     2.0       2.5      3.0       4.0       5.0
GESPAEND002 Italy      2.0       3.0      4.0       5.0       7.0
GESPAEND002 Spain      1.55      2.00     2.50      3.50      5.00
GESPAEND002 USA        2.        3.       4.        5.        7.
GESPAEND003 Greece     7.0      10.0     14.0      18.0      23.0
GESPAEND003 Italy     10.0      13.0     16.5      20.0      24.0
GESPAEND003 Spain      7.00     10.00    13.00     16.50     20.00
GESPAEND003 USA        10.      13.      16.5      20.       24.
GESPAEND004 Greece    28.0      32.0     40.0      50.0      70.0
GESPAEND004 Italy     28.0      32.0     40.0      50.0      70.0
GESPAEND004 Spain     25.00     35.00    50.00     70.00    100.00
GESPAEND004 USA       28.       32.      40.       50.       70.
GESPAEND005 Greece   100.0     150.0    200.0     300.0     400.0
GESPAEND005 Italy    100.0     150.0    200.0     300.0     500.0
GESPAEND005 Spain    130.00    165.00   200.00    250.00    350.00
GESPAEND005 USA      100.      150.     200.      300.      500.
GESPAEND006 Greece   500.0     700.0   1000.0    1500.0    2000.0
GESPAEND006 Italy    750.0    1000.0   1500.0    2000.0
GESPAEND006 Spain    500.00    700.00  1000.00   1300.00   1650.00
GESPAEND006 USA      750.     1000.    1500.     2000.
GESPAEND007 Spain   2000.00
ISDEPFLA001 Greece    .FALSE.   .FALSE.
ISDEPFLA001 Italy     .FALSE.   .FALSE.
ISDEPFLA001 Spain     .FALSE.   .FALSE.
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ISDEPFLA001 USA       .FALSE.   .FALSE.
ISDEPFLA002 Greece    .TRUE.    .TRUE.
ISDEPFLA002 Italy     .TRUE.    .TRUE.
ISDEPFLA002 Spain     .TRUE.    .TRUE.
ISDEPFLA002 USA       .TRUE.    .TRUE.
ISDEPFLA003 Greece    .TRUE.    .TRUE.
ISDEPFLA003 Italy     .TRUE.    .TRUE.
ISDEPFLA003 Spain     .TRUE.    .TRUE.
ISDEPFLA003 USA       .TRUE.    .TRUE.
ISDEPFLA004 Greece    .TRUE.    .TRUE.
ISDEPFLA004 Italy     .TRUE.    .TRUE.
ISDEPFLA004 Spain     .TRUE.    .TRUE.
ISDEPFLA004 USA       .TRUE.    .TRUE.
ISDEPFLA005 Greece    .TRUE.    .TRUE.
ISDEPFLA005 Italy     .TRUE.    .TRUE.
ISDEPFLA005 Spain     .TRUE.    .TRUE.
ISDEPFLA005 USA       .TRUE.    .TRUE.
ISDEPFLA006 Greece    .TRUE.    .TRUE.
ISDEPFLA006 Italy     .TRUE.    .TRUE.
ISDEPFLA006 Spain     .TRUE.    .TRUE.
ISDEPFLA006 USA       .TRUE.    .TRUE.
ISDEPFLA007 Greece    .TRUE.    .TRUE.
ISDEPFLA007 Italy     .TRUE.    .TRUE.
ISDEPFLA007 USA       .TRUE.    .TRUE.
ISDEPFLA008 Greece    .TRUE.    .TRUE.
ISDEPFLA008 USA       .TRUE.    .TRUE.
ISDEPFLA009 USA       .TRUE.    .TRUE.
ISMAXGRP001 Greece  8
ISMAXGRP001 Italy   7
ISMAXGRP001 Spain   6
ISMAXGRP001 USA     9
ISNUMISO001 Greece 54
ISNUMISO001 Italy  54
ISNUMISO001 Spain  54
ISNUMISO001 USA    54
ISOTPGRP001 Greece    CO-58     NONE     6     6.160E+06
ISOTPGRP001 Italy     CO-58     NONE     6     6.160E+06
ISOTPGRP001 Spain     CO-58     NONE     5     6.117E+06
ISOTPGRP001 USA       CO-58     NONE     6     6.160E+06
ISOTPGRP002 Greece    CO-60     NONE     6     1.660E+08
ISOTPGRP002 Italy     CO-60     NONE     6     1.660E+08
ISOTPGRP002 Spain     CO-60     NONE     5     1.663E+08
ISOTPGRP002 USA       CO-60     NONE     6     1.660E+08
ISOTPGRP003 Greece    KR-85     NONE     1     3.386E+08
ISOTPGRP003 Italy     KR-85     NONE     1     3.386E+08
ISOTPGRP003 Spain     KR-85     NONE     1     3.383E+08
ISOTPGRP003 USA       KR-85     NONE     1     3.386E+08
ISOTPGRP004 Greece    KR-85M    NONE     1     1.613E+04
ISOTPGRP004 Italy     KR-85M    NONE     1     1.613E+04
ISOTPGRP004 Spain     KR-85M    NONE     1     1.613E+04
ISOTPGRP004 USA       KR-85M    NONE     1     1.613E+04
ISOTPGRP005 Greece    KR-87     NONE     1     4.560E+03
ISOTPGRP005 Italy     KR-87     NONE     1     4.560E+03
ISOTPGRP005 Spain     KR-87     NONE     1     4.578E+03
ISOTPGRP005 USA       KR-87     NONE     1     4.560E+03
ISOTPGRP006 Greece    KR-88     NONE     1     1.008E+04
ISOTPGRP006 Italy     KR-88     NONE     1     1.008E+04
ISOTPGRP006 Spain     KR-88     NONE     1     1.022E+04
ISOTPGRP006 USA       KR-88     NONE     1     1.008E+04
ISOTPGRP007 Greece    RB-86     NONE     3     1.611E+06
ISOTPGRP007 Italy     RB-86     NONE     3     1.611E+06
ISOTPGRP007 Spain     RB-86     NONE     3     1.612E+06
ISOTPGRP007 USA       RB-86     NONE     3     1.611E+06
ISOTPGRP008 Greece    SR-89     NONE     5     4.493E+06
ISOTPGRP008 Italy     SR-89     NONE     5     4.493E+06
ISOTPGRP008 Spain     SR-89     NONE     5     4.363E+06
ISOTPGRP008 USA       SR-89     NONE     5     4.493E+06
ISOTPGRP009 Greece    SR-90     NONE     5     8.865E+08
ISOTPGRP009 Italy     SR-90     NONE     5     8.865E+08
ISOTPGRP009 Spain     SR-90     NONE     5     9.189E+08
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ISOTPGRP009	USA	SR-90	NONE	5	8.865E+08
ISOTPGRP010	Greece	SR-91	NONE	5	3.413E+04
ISOTPGRP010	Italy	SR-91	NONE	5	3.413E+04
ISOTPGRP010	Spain	SR-91	NONE	5	3.420E+04
ISOTPGRP010	USA	SR-91	NONE	5	3.413E+04
ISOTPGRP011	Greece	Y-90	SR-90	7	2.307E+05
ISOTPGRP011	Italy	Y-90	SR-90	7	2.307E+05
ISOTPGRP011	Spain	Y-90	SR-90	6	2.304E+05
ISOTPGRP011	USA	Y-90	SR-90	7	2.307E+05
ISOTPGRP012	Greece	Y-91	SR-91	7	5.080E+06
ISOTPGRP012	Italy	Y-91	SR-91	7	5.080E+06
ISOTPGRP012	Spain	Y-91	SR-91	6	5.055E+06
ISOTPGRP012	USA	Y-91	SR-91	7	5.080E+06
ISOTPGRP013	Greece	ZR-95	NONE	7	5.659E+06
ISOTPGRP013	Italy	ZR-95	NONE	7	5.659E+06
ISOTPGRP013	Spain	ZR-95	NONE	6	5.528E+06
ISOTPGRP013	USA	ZR-95	NONE	7	5.659E+06
ISOTPGRP014	Greece	ZR-97	NONE	7	6.048E+04
ISOTPGRP014	Italy	ZR-97	NONE	7	6.048E+04
ISOTPGRP014	Spain	ZR-97	NONE	6	6.084E+04
ISOTPGRP014	USA	NB-95	ZR-95	7	3.033E+06
ISOTPGRP015	Greece	NB-95	ZR-95	7	3.033E+06
ISOTPGRP015	Italy	NB-95	ZR-95	7	3.033E+06
ISOTPGRP015	Spain	NB-95	ZR-95	6	3.037E+06
ISOTPGRP015	USA	ZR-97	NONE	7	6.048E+04
ISOTPGRP016	Greece	MO-99	NONE	6	2.377E+05
ISOTPGRP016	Italy	MO-99	NONE	6	2.377E+05
ISOTPGRP016	Spain	MO-99	NONE	5	2.376E+05
ISOTPGRP016	USA	MO-99	NONE	6	2.377E+05
ISOTPGRP017	Greece	TC-99M	MO-99	6	2.167E+04
ISOTPGRP017	Italy	TC-99M	MO-99	6	2.167E+04
ISOTPGRP017	Spain	TC-99M	MO-99	5	2.167E+04
ISOTPGRP017	USA	TC-99M	MO-99	6	2.167E+04
ISOTPGRP018	Greece	RU-103	NONE	6	3.421E+06
ISOTPGRP018	Italy	RU-103	NONE	6	3.421E+06
ISOTPGRP018	Spain	RU-103	NONE	5	3.394E+06
ISOTPGRP018	USA	RU-103	NONE	6	3.421E+06
ISOTPGRP019	Greece	RU-105	NONE	6	1.598E+04
ISOTPGRP019	Italy	RU-105	NONE	6	1.598E+04
ISOTPGRP019	Spain	RU-105	NONE	5	1.598E+04
ISOTPGRP019	USA	RU-105	NONE	6	1.598E+04
ISOTPGRP020	Greece	RU-106	NONE	6	3.188E+07
ISOTPGRP020	Italy	RU-106	NONE	6	3.188E+07
ISOTPGRP020	Spain	RU-106	NONE	5	3.187E+07
ISOTPGRP020	USA	RH-105	RU-105	6	1.278E+05
ISOTPGRP021	Greece	RH-105	RU-105	6	1.278E+05
ISOTPGRP021	Italy	RH-105	RU-105	6	1.278E+05
ISOTPGRP021	Spain	RH-105	RU-105	5	1.273E+05
ISOTPGRP021	USA	RU-106	NONE	6	3.188E+07
ISOTPGRP022	Greece	SB-127	NONE	4	3.283E+05
ISOTPGRP022	Italy	SB-127	NONE	4	3.283E+05
ISOTPGRP022	Spain	SB-127	NONE	4	3.326E+05
ISOTPGRP022	USA	SB-127	NONE	4	3.283E+05
ISOTPGRP023	Greece	SB-129	NONE	4	1.562E+04
ISOTPGRP023	Italy	SB-129	NONE	4	1.562E+04
ISOTPGRP023	Spain	SB-129	NONE	4	1.555E+04
ISOTPGRP023	USA	SB-129	NONE	4	1.562E+04
ISOTPGRP024	Greece	TE-127	SB-127	4	3.366E+04
ISOTPGRP024	Italy	TE-127	SB-127	4	3.366E+04
ISOTPGRP024	Spain	TE-127	SB-127	4	3.366E+04
ISOTPGRP024	USA	TE-127	SB-127	4	3.366E+04
ISOTPGRP025	Greece	TE-127M	NONE	4	9.418E+06
ISOTPGRP025	Italy	TE-127M	NONE	4	9.418E+06
ISOTPGRP025	Spain	TE-127M	NONE	4	9.418E+06
ISOTPGRP025	USA	TE-127M	NONE	4	9.418E+06
ISOTPGRP026	Greece	TE-129	SB-129	4	4.200E+03
ISOTPGRP026	Italy	TE-129	SB-129	4	4.200E+03
ISOTPGRP026	Spain	TE-129	SB-129	4	4.176E+03
ISOTPGRP026	USA	TE-129	SB-129	4	4.200E+03
ISOTPGRP027	Greece	TE-129M	NONE	4	2.886E+06

ISOTPGRP027	Italy	TE-129M	NONE	4	2.886E+06	
ISOTPGRP027	Spain	TE-129M	NONE	4	2.903E+06	
ISOTPGRP027	USA	TE-129M	NONE	4	2.886E+06	
ISOTPGRP028	Greece	TE-131M	NONE	4	1.080E+05	
ISOTPGRP028	Italy	TE-131M	NONE	4	1.080E+05	
ISOTPGRP028	Spain	TE-131M	NONE	4	1.080E+05	
ISOTPGRP028	USA	TE-131M	NONE	4	1.080E+05	
ISOTPGRP029	Greece	TE-132	NONE	4	2.808E+05	
ISOTPGRP029	Italy	TE-132	NONE	4	2.808E+05	
ISOTPGRP029	Spain	TE-132	NONE	4	2.815E+05	
ISOTPGRP029	USA	TE-132	NONE	4	2.808E+05	
ISOTPGRP030	Greece	I-131	TE-131M	2	6.947E+05	
ISOTPGRP030	Italy	I-131	TE-131M	2	6.947E+05	
ISOTPGRP030	Spain	I-131	TE-131M	2	6.947E+05	
ISOTPGRP030	USA	I-131	TE-131M	2	6.947E+05	
ISOTPGRP031	Greece	I-132	TE-132	2	8.226E+03	
ISOTPGRP031	Italy	I-132	TE-132	2	8.226E+03	
ISOTPGRP031	Spain	I-132	TE-132	2	8.280E+03	
ISOTPGRP031	USA	I-132	TE-132	2	8.226E+03	
ISOTPGRP032	Greece	I-133	NONE	2	7.488E+04	
ISOTPGRP032	Italy	I-133	NONE	2	7.488E+04	
ISOTPGRP032	Spain	I-133	NONE	2	7.488E+04	
ISOTPGRP032	USA	I-133	NONE	2	7.488E+04	
ISOTPGRP033	Greece	I-134	NONE	2	3.156E+03	
ISOTPGRP033	Italy	I-134	NONE	2	3.156E+03	
ISOTPGRP033	Spain	I-134	NONE	2	3.156E+03	
ISOTPGRP033	USA	I-134	NONE	2	3.156E+03	
ISOTPGRP034	Greece	I-135	NONE	2	2.371E+04	
ISOTPGRP034	Italy	I-135	NONE	2	2.371E+04	
ISOTPGRP034	Spain	I-135	NONE	2	2.380E+04	
ISOTPGRP034	USA	I-135	NONE	2	2.371E+04	
ISOTPGRP035	Greece	XE-133	I-133	1	4.571E+05	
ISOTPGRP035	Italy	XE-133	I-133	1	4.571E+05	
ISOTPGRP035	Spain	XE-133	I-133	1	4.532E+05	
ISOTPGRP035	USA	XE-133	I-133	1	4.571E+05	
ISOTPGRP036	Greece	XE-135	I-135	1	3.301E+04	
ISOTPGRP036	Italy	XE-135	I-135	1	3.301E+04	
ISOTPGRP036	Spain	XE-135	I-135	1	3.272E+04	
ISOTPGRP036	USA	XE-135	I-135	1	3.301E+04	
ISOTPGRP037	Greece	CS-134	NONE	3	6.501E+07	
ISOTPGRP037	Italy	CS-134	NONE	3	6.501E+07	
ISOTPGRP037	Spain	CS-134	NONE	3	6.507E+07	
ISOTPGRP037	USA	CS-134	NONE	3	6.501E+07	
ISOTPGRP038	Greece	CS-136	NONE	3	1.123E+06	
ISOTPGRP038	Italy	CS-136	NONE	3	1.123E+06	
ISOTPGRP038	Spain	CS-136	NONE	3	1.132E+06	
ISOTPGRP038	USA	CS-136	NONE	3	1.123E+06	
ISOTPGRP039	Greece	CS-137	NONE	3	9.495E+08	
ISOTPGRP039	Italy	CS-137	NONE	3	9.495E+08	
ISOTPGRP039	Spain	CS-137	NONE	3	9.467E+08	
ISOTPGRP039	USA	CS-137	NONE	3	9.495E+08	
ISOTPGRP040	Greece	BA-140	NONE	5	1.105E+06	
ISOTPGRP040	Italy	BA-140	NONE	5	1.105E+06	
ISOTPGRP040	Spain	BA-140	NONE	5	1.101E+06	
ISOTPGRP040	USA	BA-140	NONE	9	1.105E+06	
ISOTPGRP041	Greece	LA-140	BA-140	7	1.448E+05	
ISOTPGRP041	Italy	LA-140	BA-140	7	1.448E+05	
ISOTPGRP041	Spain	LA-140	BA-140	6	1.450E+05	
ISOTPGRP041	USA	LA-140	BA-140	7	1.448E+05	
ISOTPGRP042	Greece	CE-141	NONE	8	2.811E+06	
ISOTPGRP042	Italy	CE-141	NONE	7	2.811E+06	PARENT NOT ADDED
ISOTPGRP042	Spain	CE-141	NONE	6	2.808E+06	
ISOTPGRP042	USA	CE-141	NONE	8	2.811E+06	PARENT ADDED LA-141
ISOTPGRP043	Greece	CE-143	NONE	8	1.188E+05	
ISOTPGRP043	Italy	CE-143	NONE	7	1.188E+05	
ISOTPGRP043	Spain	CE-143	NONE	6	1.188E+05	
ISOTPGRP043	USA	CE-143	NONE	8	1.188E+05	
ISOTPGRP044	Greece	CE-144	NONE	8	2.457E+07	
ISOTPGRP044	Italy	CE-144	NONE	7	2.457E+07	
ISOTPGRP044	Spain	CE-144	NONE	6	2.456E+07	

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ISOTPGRP044 USA        CE-144       NONE        8        2.457E+07
ISOTPGRP045 Greece     PR-143      CE-143       7        1.173E+06
ISOTPGRP045 Italy      PR-143      CE-143       7        1.173E+06
ISOTPGRP045 Spain      PR-143      CE-143       6        1.172E+06
ISOTPGRP045 USA        PR-143      CE-143       7        1.173E+06
ISOTPGRP046 Greece     ND-147       NONE        7        9.495E+05
ISOTPGRP046 Italy      ND-147       NONE        7        9.495E+05
ISOTPGRP046 Spain      ND-147       NONE        6        9.487E+05
ISOTPGRP046 USA        ND-147       NONE        7        9.495E+05
ISOTPGRP047 Greece     NP-239       NONE        8        2.030E+05
ISOTPGRP047 Italy      NP-239       NONE        7        2.030E+05
ISOTPGRP047 Spain      NP-239       NONE        6        2.035E+05
ISOTPGRP047 USA        NP-239       NONE        8        2.030E+05
ISOTPGRP048 Greece     PU-238      CM-242       8        2.809E+09
ISOTPGRP048 Italy      PU-238      CM-242       7        2.809E+09
ISOTPGRP048 Spain      PU-238      CM-242       6        2.769E+09
ISOTPGRP048 USA        PU-238      CM-242       8        2.809E+09
ISOTPGRP049 Greece     PU-239      NP-239       8        7.700E+11
ISOTPGRP049 Italy      PU-239      NP-239       7        7.700E+11
ISOTPGRP049 Spain      PU-239      NP-239       6        7.594E+11
ISOTPGRP049 USA        PU-239      NP-239       8        7.700E+11
ISOTPGRP050 Greece     PU-240      CM-244       8        2.133E+11
ISOTPGRP050 Italy      PU-240      CM-244       7        2.133E+11
ISOTPGRP050 Spain      PU-240      CM-244       6        2.063E+11
ISOTPGRP050 USA        PU-240      CM-244       8        2.133E+11
ISOTPGRP051 Greece     PU-241       NONE        8        4.608E+08
ISOTPGRP051 Italy      PU-241       NONE        7        4.608E+08
ISOTPGRP051 Spain      PU-241       NONE        6        4.544E+08
ISOTPGRP051 USA        PU-241       NONE        8        4.608E+08
ISOTPGRP052 Greece     AM-241      PU-241       7        1.366E+10
ISOTPGRP052 Italy      AM-241      PU-241       7        1.366E+10
ISOTPGRP052 Spain      AM-241      PU-241       6        1.364E+10
ISOTPGRP052 USA        AM-241      PU-241       7        1.366E+10
ISOTPGRP053 Greece     CM-242       NONE        7        1.408E+07
ISOTPGRP053 Italy      CM-242       NONE        7        1.408E+07
ISOTPGRP053 Spain      CM-242       NONE        6        1.407E+07
ISOTPGRP053 USA        CM-242       NONE        7        1.408E+07
ISOTPGRP054 Greece     CM-244       NONE        7        5.712E+08
ISOTPGRP054 Italy      CM-244       NONE        7        5.712E+08
ISOTPGRP054 Spain      CM-244       NONE        6        5.715E+08
ISOTPGRP054 USA        CM-244       NONE        7        5.712E+08
LCACTHRE001 Greece    0.0  (LINEAR-QUADRATIC MODEL IS NOT BEING USED)
LCACTHRE001 Italy     0.0
LCACTHRE001 Spain     0.0
LCACTHRE001 USA       0.0
LCANCERS001 Greece 'LEUKEMIA' 'RED MARR' 1.0   1.0   0.0   9.70E-3   9.70E-3   2.0
LCANCERS001 Italy  'LEUKEMIA' 'RED MARR' 1.0   1.0   0.0   9.70E-3   9.70E-3   2.0
LCANCERS001 Spain  'LEUKEMIA' 'RED MARR' 1.0   1.0   0.0   9.70E-3   9.70E-3   2.0
LCANCERS001 USA    'LEUKEMIA' 'RED MARR' 1.0   1.0   0.0   9.70E-3   9.70E-3   2.0
LCANCERS002 Greece 'BONE'     'BONE SUR' 1.0   1.0   0.0   9.00E-4   9.00E-4   2.0
LCANCERS002 Italy  'BONE'     'BONE SUR' 1.0   1.0   0.0   9.00E-4   9.00E-4   2.0
LCANCERS002 Spain  'BONE'     'BONE SUR' 1.0   1.0   0.0   9.00E-4   9.00E-4   2.0
LCANCERS002 USA    'BONE'     'BONE SUR' 1.0   1.0   0.0   9.00E-4   9.00E-4   2.0
LCANCERS003 Greece 'BREAST'   'BREAST'   1.0   1.0   0.0   5.40E-3   1.59E-2   1.0
LCANCERS003 Italy  'BREAST'   'BREAST'   1.0   1.0   0.0   5.40E-3   1.59E-2   1.0
LCANCERS003 Spain  'BREAST'   'BREAST'   1.0   1.0   0.0   5.40E-3   1.59E-2   1.0
LCANCERS003 USA    'BREAST'   'BREAST'   1.0   1.0   0.0   5.40E-3   1.59E-2   1.0
LCANCERS004 Greece 'LUNG'     'LUNGS'    1.0   1.0   0.0   1.55E-2   1.73E-2   2.0
LCANCERS004 Italy  'LUNG'     'LUNGS'    1.0   1.0   0.0   1.55E-2   1.73E-2   2.0
LCANCERS004 Spain  'LUNG'     'LUNGS'    1.0   1.0   0.0   1.55E-2   1.73E-2   2.0
LCANCERS004 USA    'LUNG'     'LUNGS'    1.0   1.0   0.0   1.55E-2   1.73E-2   2.0
LCANCERS005 Greece 'THYROID'  'THYROIDH' 1.0   1.0   0.0   7.20E-4   7.20E-3   1.0
LCANCERS005 Italy  'THYROID'  'THYROIDH' 1.0   1.0   0.0   7.20E-4   7.20E-3   1.0
LCANCERS005 Spain  'THYROID'  'THYROIDH' 1.0   1.0   0.0   7.20E-4   7.20E-3   1.0
LCANCERS005 USA    'THYROID'  'THYROIDH' 1.0   1.0   0.0   7.20E-4   7.20E-3   1.0
LCANCERS006 Greece 'GI'       'LOWER LI' 1.0   1.0   0.0   3.36E-2   5.75E-2   2.0
LCANCERS006 Italy  'GI'       'LOWER LI' 1.0   1.0   0.0   3.36E-2   5.75E-2   2.0
LCANCERS006 Spain  'GI'       'LOWER LI' 1.0   1.0   0.0   3.36E-2   5.75E-2   2.0
LCANCERS006 USA    'GI'       'LOWER LI' 1.0   1.0   0.0   3.36E-2   5.75E-2   2.0
LCANCERS007 Greece 'OTHER'    'BLAD WAL' 1.0   1.0   0.0   2.76E-2   5.52E-2   2.0
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LCANCERS007 Italy  'OTHER'     'BLAD WAL' 1.0   1.0   0.0   2.76E-2   5.52E-2  2.0
LCANCERS007 Spain  'OTHER'     'BLAD WAL' 1.0   1.0   0.0   2.76E-2   5.52E-2  2.0
LCANCERS007 USA    'OTHER'     'BLAD WAL' 1.0   1.0   0.0   2.76E-2   5.52E-2  2.0
LCDDTHRE001 Greece   0.2  (LOWEST DOSE FOR WHICH DDREFA WILL BE APPLIED)
LCDDTHRE001 Italy    0.2
LCDDTHRE001 Spain    0.2
LCDDTHRE001 USA      0.2
LCNUMACA001 Greece   7
LCNUMACA001 Italy    7
LCNUMACA001 Spain    7
LCNUMACA001 USA      7
M1METCOD001 Greece  2
M1METCOD001 Italy   2
M1METCOD001 Spain   2
M1METCOD001 USA     2
M2BNDMXH001 Greece  1000.   (METERS)
M2BNDMXH001 Italy   1000.
M2BNDMXH001 Spain   1000.
M2BNDMXH001 USA     1000.
M2BNDRAN001 Greece  5.      (MM/HR)
M2BNDRAN001 Italy   5.
M2BNDRAN001 Spain   5.
M2BNDRAN001 USA     5.
M2BNDWND001 Greece  4.      (M/S)
M2BNDWND001 Italy   3.
M2BNDWND001 Spain   5.
M2BNDWND001 USA     5.
M2IBDSTB001 Greece  4       (D-STABILITY)
M2IBDSTB001 Italy   4
M2IBDSTB001 Spain   4
M2IBDSTB001 USA     4
M2LIMSPA001 Greece  30      (Last Interval)
M2LIMSPA001 Italy   29
M2LIMSPA001 Spain   31
M2LIMSPA001 USA     29
M4IRSEED001 Greece   79
M4IRSEED001 Italy    79
M4IRSEED001 Spain    79
M4IRSEED001 USA      79
M4NRINTN001 Greece   2
M4NRINTN001 Italy    2
M4NRINTN001 Spain    2
M4NRINTN001 USA      2
M4NRNINT001 Greece  5
M4NRNINT001 Italy   5
M4NRNINT001 Spain   6
M4NRNINT001 USA     5
M4NSMPLS001 Greece  4
M4NSMPLS001 Italy   4
M4NSMPLS001 Spain   4
M4NSMPLS001 USA     4
M4RNDSTS001 Greece      10.0   18.0  28.0   40.0   50.0
M4RNDSTS001 Italy       10.0   20.0  28.0   40.0   50.0
M4RNDSTS001 Spain        5.0   10.0  16.5   25.0   35.0  50.0
M4RNDSTS001 USA         10.0   20.0  28.0   40.0   50.0
M4RNRATE001 Greece   0.5    3.0
M4RNRATE001 Italy    0.5    3.0
M4RNRATE001 Spain    0.5    3.0
M4RNRATE001 USA      0.5    3.0
MIENDAT2001 Greece .FALSE.     (SET THIS VALUE TO .TRUE. TO SKIP CHRONC)
MIENDAT2001 Italy  .FALSE.
MIENDAT2001 Spain  .FALSE.
MIENDAT2001 USA    .FALSE.
MIIPLUME001 Greece  1    No shift
MIIPLUME001 Italy   2    With shift
MIIPLUME001 Spain   1    No shift
MIIPLUME001 USA     2    With shift
MIIPRINT001 Greece  0  (TURN OFF THE DEBUG PRINT)
MIIPRINT001 Italy   0
MIIPRINT001 Spain   0
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MIIPRINT001 USA     0
MINUMFIN001 Greece  7
MINUMFIN001 Italy   7
MINUMFIN001 Spain   7
MINUMFIN001 USA     7
MIOVRRID001 Greece  .FALSE.  (USE THE WIND ROSE CALCULATED FOR EACH WEATHER BIN)
MIOVRRID001 Italy   .FALSE.
MIOVRRID001 Spain   .FALSE.
MIOVRRID001 USA     .FALSE.
MIRISCAT001 Greece   .FALSE.
MIRISCAT001 Italy    .FALSE.
MIRISCAT001 Spain    .FALSE.
MIRISCAT001 USA      .FALSE.
OCENDAT1001 Greece  .FALSE. (SET THIS VALUE TO .TRUE. TO SKIP EARLY AND CHRONC)
OCENDAT1001 Italy   .FALSE.
OCENDAT1001 Spain   .FALSE.
OCENDAT1001 USA     .FALSE.
OCIDEBUG001 Greece  0  No debug
OCIDEBUG001 Italy   0
OCIDEBUG001 Spain   0
OCIDEBUG001 USA     0
ODNUMORG001 Greece   10
ODNUMORG001 Italy    10
ODNUMORG001 Spain    10
ODNUMORG001 USA      10
ODORGNAM001 Greece 'SKIN', 'EDEWBODY', 'LUNGS', 'RED MARR', 'LOWER LI', 'STOMACH',
ODORGNAM001 Italy  'SKIN', 'EDEWBODY', 'LUNGS', 'RED MARR', 'LOWER LI', 'STOMACH',
ODORGNAM001 Spain  'SKIN', 'EDEWBODY', 'LUNGS', 'RED MARR', 'LOWER LI', 'STOMACH',
ODORGNAM001 USA    'SKIN', 'EDEWBODY', 'LUNGS', 'RED MARR', 'LOWER LI', 'STOMACH',
ODORGNAM002 Greece 'THYROIDH', 'BONE SUR', 'BREAST', 'BLAD WAL'
ODORGNAM002 Italy  'THYROIDH', 'BONE SUR', 'BREAST', 'BLAD WAL'
ODORGNAM002 Spain  'THYROIDH', 'BONE SUR', 'BREAST', 'BLAD WAL'
ODORGNAM002 USA    'THYROIDH', 'BONE SUR', 'BREAST', 'BLAD WAL'
PDPOPFLG001 Greece  FILE    Use the Site Data File
PDPOPFLG001 Italy   FILE
PDPOPFLG001 Spain   FILE
PDPOPFLG001 USA     FILE
PMBRKPNT001 Greece   3600.   (1 HOUR, User's Guide)
PMBRKPNT001 Italy    3600.
PMBRKPNT001 Spain    3600.
PMBRKPNT001 USA      3600.
PMTIMBAS001 Greece    600.   (10 MINUTES, User's Guide)
PMTIMBAS001 Italy     600.
PMTIMBAS001 Spain     600.
PMTIMBAS001 USA       600.
PMXPFAC1001 Greece      0.2  (User's Guide)
PMXPFAC1001 Italy       0.2
PMXPFAC1001 Spain       0.2
PMXPFAC1001 USA         0.2
PMXPFAC2001 Greece      0.25 (User's Guide)
PMXPFAC2001 Italy       0.25
PMXPFAC2001 Spain       0.25
PMXPFAC2001 USA         0.25
PRSCLADP001 Greece   1.
PRSCLADP001 Italy    1.
PRSCLADP001 Spain    1.
PRSCLADP001 USA      1.
PRSCLCRW001 Greece   1.
PRSCLCRW001 Italy    1.
PRSCLCRW001 Spain    1.
PRSCLCRW001 USA      1.
PRSCLEFP001 Greece   1.
PRSCLEFP001 Italy    1.
PRSCLEFP001 Spain    1.
PRSCLEFP001 USA      1.
RDCORINV001 Greece     CO-58        3.080E+16
RDCORINV001 Italy      CO-58        3.080E+16
RDCORINV001 Spain      CO-58        3.08E+16
RDCORINV001 USA        CO-58        3.08E+16
RDCORINV002 Greece     CO-60        1.140E+16
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RDCORINV002	Italy	CO-60	1.140E+16
RDCORINV002	Spain	CO-60	1.14E+16
RDCORINV002	USA	CO-60	1.14E+16
RDCORINV003	Greece	KR-85	2.170E+16
RDCORINV003	Italy	KR-85	2.170E+16
RDCORINV003	Spain	KR-85	2.17E+16
RDCORINV003	USA	KR-85	2.17E+16
RDCORINV004	Greece	KR-85M	0.925E+18
RDCORINV004	Italy	KR-85M	9.250E+17
RDCORINV004	Spain	KR-85M	9.25E+17
RDCORINV004	USA	KR-85M	9.25E+17
RDCORINV005	Greece	KR-87	1.700E+18
RDCORINV005	Italy	KR-87	1.700E+18
RDCORINV005	Spain	KR-87	1.70E+18
RDCORINV005	USA	KR-87	1.70E+18
RDCORINV006	Greece	KR-88	2.340E+18
RDCORINV006	Italy	KR-88	2.340E+18
RDCORINV006	Spain	KR-88	2.34E+18
RDCORINV006	USA	KR-88	2.34E+18
RDCORINV007	Greece	RB-86	7.960E+15
RDCORINV007	Italy	RB-86	7.960E+15
RDCORINV007	Spain	RB-86	7.96E+15
RDCORINV007	USA	RB-86	7.96E+15
RDCORINV008	Greece	SR-89	3.370E+18
RDCORINV008	Italy	SR-89	3.370E+18
RDCORINV008	Spain	SR-89	3.37E+18
RDCORINV008	USA	SR-89	3.37E+18
RDCORINV009	Greece	SR-90	1.750E+17
RDCORINV009	Italy	SR-90	1.750E+17
RDCORINV009	Spain	SR-90	1.75E+17
RDCORINV009	USA	SR-90	1.75E+17
RDCORINV010	Greece	SR-91	4.370E+18
RDCORINV010	Italy	SR-91	4.370E+18
RDCORINV010	Spain	SR-91	4.37E+18
RDCORINV010	USA	SR-91	4.37E+18
RDCORINV011	Greece	Y-90	1.820E+17
RDCORINV011	Italy	Y-90	1.820E+17
RDCORINV011	Spain	Y-90	1.82E+17
RDCORINV011	USA	Y-90	1.82E+17
RDCORINV012	Greece	Y-91	4.510E+18
RDCORINV012	Italy	Y-91	4.510E+18
RDCORINV012	Spain	Y-91	4.51E+18
RDCORINV012	USA	Y-91	4.51E+18
RDCORINV013	Greece	ZR-95	5.880E+18
RDCORINV013	Italy	ZR-95	5.880E+18
RDCORINV013	Spain	ZR-95	5.88E+18
RDCORINV013	USA	ZR-95	5.88E+18
RDCORINV014	Greece	ZR-97	5.880E+18
RDCORINV014	Italy	ZR-97	5.880E+18
RDCORINV014	Spain	ZR-97	5.88E+18
RDCORINV014	USA	NB-95	5.81E+18
RDCORINV015	Greece	NB-95	5.810E+18
RDCORINV015	Italy	NB-95	5.810E+18
RDCORINV015	Spain	NB-95	5.81E+18
RDCORINV015	USA	ZR-97	5.88E+18
RDCORINV016	Greece	MO-99	6.440E+18
RDCORINV016	Italy	MO-99	6.440E+18
RDCORINV016	Spain	MO-99	6.44E+18
RDCORINV016	USA	MO-99	6.44E+18
RDCORINV017	Greece	TC-99M	5.550E+18
RDCORINV017	Italy	TC-99M	5.550E+18
RDCORINV017	Spain	TC-99M	5.55E+18
RDCORINV017	USA	TC-99M	5.55E+18
RDCORINV018	Greece	RU-103	5.250E+18
RDCORINV018	Italy	RU-103	5.250E+18
RDCORINV018	Spain	RU-103	5.25E+18
RDCORINV018	USA	RU-103	5.25E+18
RDCORINV019	Greece	RU-105	3.510E+18
RDCORINV019	Italy	RU-105	3.510E+18
RDCORINV019	Spain	RU-105	3.51E+18

RDCORINV019	USA	RU-105	3.51E+18
RDCORINV020	Greece	RU-106	1.300E+18
RDCORINV020	Italy	RU-106	1.300E+18
RDCORINV020	Spain	RU-106	1.30E+18
RDCORINV020	USA	RH-105	3.18E+18
RDCORINV021	Greece	RH-105	3.180E+18
RDCORINV021	Italy	RH-105	3.180E+18
RDCORINV021	Spain	RH-105	3.18E+18
RDCORINV021	USA	RU-106	1.30E+18
RDCORINV022	Greece	SB-127	2.930E+17
RDCORINV022	Italy	SB-127	2.930E+17
RDCORINV022	Spain	SB-127	2.93E+17
RDCORINV022	USA	SB-127	2.93E+17
RDCORINV023	Greece	SB-129	9.950E+17
RDCORINV023	Italy	SB-129	9.950E+17
RDCORINV023	Spain	SB-129	9.95E+17
RDCORINV023	USA	SB-129	9.95E+17
RDCORINV024	Greece	TE-127	2.850E+17
RDCORINV024	Italy	TE-127	2.850E+17
RDCORINV024	Spain	TE-127	2.85E+17
RDCORINV024	USA	TE-127	2.85E+17
RDCORINV025	Greece	TE-127M	4.370E+16
RDCORINV025	Italy	TE-127M	4.370E+16
RDCORINV025	Spain	TE-127M	4.37E+16
RDCORINV025	USA	TE-127M	4.37E+16
RDCORINV026	Greece	TE-129	9.400E+17
RDCORINV026	Italy	TE-129	9.400E+17
RDCORINV026	Spain	TE-129	9.40E+17
RDCORINV026	USA	TE-129	9.40E+17
RDCORINV027	Greece	TE-129M	1.670E+17
RDCORINV027	Italy	TE-129M	1.670E+17
RDCORINV027	Spain	TE-129M	1.67E+17
RDCORINV027	USA	TE-129M	1.67E+17
RDCORINV028	Greece	TE-131M	3.470E+17
RDCORINV028	Italy	TE-131M	3.470E+17
RDCORINV028	Spain	TE-131M	3.47E+17
RDCORINV028	USA	TE-131M	3.47E+17
RDCORINV029	Greece	TE-132	4.850E+18
RDCORINV029	Italy	TE-132	4.850E+18
RDCORINV029	Spain	TE-132	4.85E+18
RDCORINV029	USA	TE-132	4.85E+18
RDCORINV030	Greece	I-131	3.390E+18
RDCORINV030	Italy	I-131	3.390E+18
RDCORINV030	Spain	I-131	3.39E+18
RDCORINV030	USA	I-131	3.39E+18
RDCORINV031	Greece	I-132	4.960E+18
RDCORINV031	Italy	I-132	4.960E+18
RDCORINV031	Spain	I-132	4.96E+18
RDCORINV031	USA	I-132	4.96E+18
RDCORINV032	Greece	I-133	6.810E+18
RDCORINV032	Italy	I-133	6.810E+18
RDCORINV032	Spain	I-133	6.81E+18
RDCORINV032	USA	I-133	6.81E+18
RDCORINV033	Greece	I-134	7.840E+18
RDCORINV033	Italy	I-134	7.840E+18
RDCORINV033	Spain	I-134	7.84E+18
RDCORINV033	USA	I-134	7.84E+18
RDCORINV034	Greece	I-135	6.400E+18
RDCORINV034	Italy	I-135	6.400E+18
RDCORINV034	Spain	I-135	6.40E+18
RDCORINV034	USA	I-135	6.40E+18
RDCORINV035	Greece	XE-133	6.850E+18
RDCORINV035	Italy	XE-133	6.850E+18
RDCORINV035	Spain	XE-133	6.85E+18
RDCORINV035	USA	XE-133	6.85E+18
RDCORINV036	Greece	XE-135	1.670E+18
RDCORINV036	Italy	XE-135	1.670E+18
RDCORINV036	Spain	XE-135	1.67E+18
RDCORINV036	USA	XE-135	1.67E+18
RDCORINV037	Greece	CS-134	3.850E+17

RDCORINV037	Italy	CS-134	3.850E+17
RDCORINV037	Spain	CS-134	3.85E+17
RDCORINV037	USA	CS-134	3.85E+17
RDCORINV038	Greece	CS-136	1.330E+17
RDCORINV038	Italy	CS-136	1.330E+17
RDCORINV038	Spain	CS-136	1.33E+17
RDCORINV038	USA	CS-136	1.33E+17
RDCORINV039	Greece	CS-137	2.290E+17
RDCORINV039	Italy	CS-137	2.290E+17
RDCORINV039	Spain	CS-137	2.29E+17
RDCORINV039	USA	CS-137	2.29E+17
RDCORINV040	Greece	BA-140	6.140E+18
RDCORINV040	Italy	BA-140	6.140E+18
RDCORINV040	Spain	BA-140	6.14E+18
RDCORINV040	USA	BA-140	6.14E+18
RDCORINV041	Greece	LA-140	6.320E+18
RDCORINV041	Italy	LA-140	6.320E+18
RDCORINV041	Spain	LA-140	6.32E+18
RDCORINV041	USA	LA-140	6.32E+18
RDCORINV042	Greece	CE-141	5.920E+18
RDCORINV042	Italy	CE-141	5.920E+18
RDCORINV042	Spain	CE-141	5.92E+18
RDCORINV042	USA	CE-141	5.92E+18
RDCORINV043	Greece	CE-143	5.440E+18
RDCORINV043	Italy	CE-143	5.440E+18
RDCORINV043	Spain	CE-143	5.44E+18
RDCORINV043	USA	CE-143	5.44E+18
RDCORINV044	Greece	CE-144	3.590E+18
RDCORINV044	Italy	CE-144	3.590E+18
RDCORINV044	Spain	CE-144	3.59E+18
RDCORINV044	USA	CE-144	3.59E+18
RDCORINV045	Greece	PR-143	5.400E+18
RDCORINV045	Italy	PR-143	5.400E+18
RDCORINV045	Spain	PR-143	5.40E+18
RDCORINV045	USA	PR-143	5.40E+18
RDCORINV046	Greece	ND-147	2.360E+18
RDCORINV046	Italy	ND-147	2.360E+18
RDCORINV046	Spain	ND-147	2.36E+18
RDCORINV046	USA	ND-147	2.36E+18
RDCORINV047	Greece	NP-239	7.320E+19
RDCORINV047	Italy	NP-239	7.320E+19
RDCORINV047	Spain	NP-239	7.32E+19
RDCORINV047	USA	NP-239	7.32E+19
RDCORINV048	Greece	PU-238	3.170E+15
RDCORINV048	Italy	PU-238	3.170E+15
RDCORINV048	Spain	PU-238	3.17E+15
RDCORINV048	USA	PU-238	3.17E+15
RDCORINV049	Greece	PU-239	1.110E+15
RDCORINV049	Italy	PU-239	1.110E+15
RDCORINV049	Spain	PU-239	1.11E+15
RDCORINV049	USA	PU-239	1.11E+15
RDCORINV050	Greece	PU-240	1.060E+15
RDCORINV050	Italy	PU-240	1.060E+15
RDCORINV050	Spain	PU 240	1.06E+15
RDCORINV050	USA	PU-240	1.06E+15
RDCORINV051	Greece	PU-241	3.210E+17
RDCORINV051	Italy	PU-241	3.210E+17
RDCORINV051	Spain	PU-241	3.21E+17
RDCORINV051	USA	PU-241	3.21E+17
RDCORINV052	Greece	AM-241	2.060E+14
RDCORINV052	Italy	AM-241	2.060E+14
RDCORINV052	Spain	AM-241	2.06E+14
RDCORINV052	USA	AM-241	2.06E+14
RDCORINV053	Greece	CM-242	6.620E+16
RDCORINV053	Italy	CM-242	6.620E+16
RDCORINV053	Spain	CM-242	6.62E+16
RDCORINV053	USA	CM-242	6.62E+16
RDCORINV054	Greece	CM-244	2.750E+15
RDCORINV054	Italy	CM-244	2.750E+15
RDCORINV054	Spain	CM-244	2.75E+15

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RDCORINV054 USA        CM-244       2.75E+15
RDCORSCA001 Greece  1.0
RDCORSCA001 Italy   1.0
RDCORSCA001 Spain   1.0
RDCORSCA001 USA     1.0
RDMAXRIS001 Greece          1
RDMAXRIS001 Italy           1
RDMAXRIS001 Spain           1
RDMAXRIS001 USA             1
RDNUMREL001 Greece          1
RDNUMREL001 Italy           1
RDNUMREL001 Spain           1
RDNUMREL001 USA             1
RDOALARM001 Greece      3600.  (Table 4, CCP1, issue F, warning time)
RDOALARM001 Italy       3600.
RDOALARM001 Spain       3600.
RDOALARM001 USA         3600.
RDPDELAY001 Greece      7200.  (2 HOURS)
RDPDELAY001 Italy       7200.
RDPDELAY001 Spain       7200.
RDPDELAY001 USA         7200.
RDPLHEAT001 Greece         0.0
RDPLHEAT001 Italy          0.0
RDPLHEAT001 Spain          0.0
RDPLHEAT001 USA            0.0
RDPLHITE001 Greece        10.
RDPLHITE001 Italy         10.
RDPLHITE001 Spain         10.
RDPLHITE001 USA           10.
RDPLUDUR001 Greece      3600.
RDPLUDUR001 Italy       3600.
RDPLUDUR001 Spain       3600.
RDPLUDUR001 USA         3600.
RDPSDIST001 Greece     0.         1.
RDPSDIST001 Italy      1.0        0.0       0.0
RDPSDIST001 Spain      0.         1.
RDPSDIST001 USA        0.0        1.0
RDPSDIST002 Greece     0.01       0.99
RDPSDIST002 Italy      0.0        0.01      0.99
RDPSDIST002 Spain      0.01       0.99
RDPSDIST002 USA        0.01       0.99
RDPSDIST003 Greece     0.         1.
RDPSDIST003 Italy      0.0        0.0       1.0
RDPSDIST003 Spain      0.         1.
RDPSDIST003 USA        0.0        1.0
RDPSDIST004 Greece     0.         1.
RDPSDIST004 Italy      0.0        0.0       1.0
RDPSDIST004 Spain      0.         1.
RDPSDIST004 USA        0.0        1.0
RDPSDIST005 Greece     0.         1.
RDPSDIST005 Italy      0.0        0.0       1.0
RDPSDIST005 Spain      0.         1.
RDPSDIST005 USA        0.0        1.0
RDPSDIST006 Greece     0.         1.
RDPSDIST006 Italy      0.0        0.0       1.0
RDPSDIST006 Spain      0.         1.
RDPSDIST006 USA        0.0        1.0
RDPSDIST007 Greece     0.         1.
RDPSDIST007 Italy      0.0        0.0       1.0
RDPSDIST007 USA        0.0        1.0
RDPSDIST008 Greece     0.         1.
RDPSDIST008 USA        0.0        1.0
RDPSDIST009 USA        0.0        1.0
RDREFTIM001 Greece     0.0       (LEADING EDGE)
RDREFTIM001 Italy      0.5       (mid-point)
RDREFTIM001 Spain      0.5
RDREFTIM001 USA        0.5
RDRELFRC001 Greece     1.0E+C     0.101     1.0E-1     1.0E-1     1.0E-2     1.0E-2     1.0E-3     1.0E-3
RDRELFRC001 Italy      1.0E+0     1.01E-1   1.0E-1     1.0E-1     1.0E-2     1.0E-2     1.0E-3
RDRELFRC001 Spain      1.0        0.101     0.1        0.1        0.01       0.001
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RDRELFRC001 USA        1.0E+0     0.101     0.1       0.10      0.01      0.01      0.001     0.001     0.01
SEBRRATE001 Greece     2.66E-4    2.66E-4   2.66E-4
SEBRRATE001 Italy      2.66E-4    2.66E-4   2.66E-4
SEBRRATE001 Spain      2.66E-4    2.66E-4   2.66E-4   (PAG 9, CCP1 issue F)
SEBRRATE001 USA        2.66E-4    2.66E-4   2.66E-4
SECSFACT001 Greece     1.         0.19      0.05
SECSFACT001 Italy      1.00       0.19      0.05      (C1)  AFA
SECSFACT001 Spain      1.         0.19      0.05
SECSFACT001 USA        1.         0.19      0.05
SEGSHFAC001 Greece     0.5        0.19      0.05
SEGSHFAC001 Italy      1.00       0.19      0.05      (C1)
SEGSHFAC001 Spain      1.0        0.19      0.05
SEGSHFAC001 USA        0.5        0.19      0.05
SEPROTIN001 Greece     1.         0.55      0.20
SEPROTIN001 Italy      1.00       0.55      0.2       (C1)  AFA
SEPROTIN001 Spain      1.0        0.55      0.2
SEPROTIN001 USA        1.         0.55      0.2
SERESCON001 Greece   1.E-4     (RESUSPENSION IS TURNED ON)
SERESCON001 Italy    1.E-4
SERESCON001 Spain    1.E-4
SERESCON001 USA      1.E-4
SERESHAF001 Greece   1.82E5     (2.11 DAYS)
SERESHAF001 Italy    1.82E5
SERESHAF001 Spain    1.825E5
SERESHAF001 USA      1.82E5
SESKPFAC001 Greece   1.0         0.0055      0.0020
SESKPFAC001 Italy    0.01        5.5E-3      2.0E-3
SESKPFAC001 Spain    0.01        0.0055      0.002
SESKPFAC001 USA      0.01        0.0055      0.002
SRCRIORG001 Greece 'EDEWBODY'
SRCRIORG001 Italy  'EDEWBODY'
SRCRIORG001 Spain  'EDEWBODY'
SRCRIORG001 USA    'EDEWBODY'
SRDOSHOT001 Greece  100.       (NO HOT SPOT RELOCATION)
SRDOSHOT001 Italy   1.E+2
SRDOSHOT001 Spain   100000.0
SRDOSHOT001 USA     100.0
SRDOSNRM001 Greece  100.  no normal relocation
SRDOSNRM001 Italy   1.E+2
SRDOSNRM001 Spain   100000.0
SRDOSNRM001 USA     100.0
SRENDEMP001 Greece  604800.   (ONE WEEK)
SRENDEMP001 Italy   604800.
SRENDEMP001 Spain   604800.
SRENDEMP001 USA     604800.
SRLASHE2001 Greece      0      (NO OUTER SHELTER ZONE)
SRLASHE2001 Italy      11      (10 KM SHELTER ZONE)
SRLASHE2001 Spain      12      (Fixed area, 10 km. Page 6, CCP1, issue F)
SRLASHE2001 USA         0
SRSHELT1001 Greece      10800.    (3 HOURS)
SRSHELT1001 Italy       0.        (NO INNER SHELTER ZONE)
SRSHELT1001 Spain       0.        (THERE IS NO INNER SHELTER ZONE)
SRSHELT1001 USA         10800.0
SRSHELT2001 Greece      0.
SRSHELT2001 Italy       10800.    (3 HOURS)
SRSHELT2001 Spain       10800.0   (3 hours, until the instantaneous evacuation)
SRSHELT2001 USA         0.0
SRTIMHOT001 Greece      0.        (NO EMERGENCY PHASE RELOCATION)
SRTIMHOT001 Italy       604800.   (1 WEEK)
SRTIMHOT001 Spain       0.0       (No emergency relocation)
SRTIMHOT001 USA         604800.
SRTIMNRM001 Greece      0.        (NO EMERGENCY PHASE RELOCATION)
SRTIMNRM001 Italy       604800.   (1 WEEK)
SRTIMNRM001 Spain       0.0       (No emergency relocation)
SRTIMNRM001 USA         604800.0
SRTTOSH1001 Greece      3600.     (1 HOUR)
SRTTOSH1001 Italy       0.        (NO INNER SHELTER ZONE)
SRTTOSH1001 Spain       0.        (THERE IS NO INNER SHELTER ZONE)
SRTTOSH1001 USA     3600.0
SRTTOSH2001 Greece    0.
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SRTTOSH2001 Italy  3600.     (1 HOUR)
SRTTOSH2001 Spain  3600.0    (1 hour from the warning time)
SRTTOSH2001 USA       0.0
TYP10NUMBER Greece   1       (UP TO 10 ALLOWED)
TYP10NUMBER Italy    1       (UP TO 10 ALLOWED)
TYP10NUMBER Spain    1       (UP TO 10 ALLOWED)
TYP10NUMBER USA      1       (UP TO 10 ALLOWED)
TYP10OUT001 Greece       1       ,   30 CCDF  (0-2000 km)
TYP10OUT001 Italy        1          29  CCDF (0-2000 KM)
TYP10OUT001 Spain        1            31   'CCDF'    (0-2000 KM)
TYP10OUT001 USA          1            29 CCDF  (0-2000 km)
TYP11FLAG11 Greece  .TRUE.
TYP11FLAG11 Italy   .TRUE.
TYP11FLAG11 Spain   .TRUE.
TYP11FLAG11 USA     .TRUE.
TYP12NUMBER Greece   1       (UP TO 10 ALLOWED)
TYP12NUMBER Italy    1
TYP12NUMBER Spain    1
TYP12NUMBER USA      1
TYP12OUT001 Greece       1            30 CCDF  (0-2000 km)
TYP12OUT001 Italy        1            29 CCDF (0-2000 KM)
TYP12OUT001 Spain        1            31   'CCDF'     (0-2000 KM)
TYP12OUT001 USA          1            29 CCDF  (0-2000 km)
TYPE1NUMBER Greece     18
TYPE1NUMBER Italy      20
TYPE1NUMBER Spain      20
TYPE1NUMBER USA        17
TYPE1OUT001 Greece     'ERL FAT/TOTAL'                1  30   CCDF (0 TO 2000 KM)
TYPE1OUT001 Italy      'ERL FAT/TOTAL'                1  29   CCDF              )
TYPE1OUT001 Spain      'ERL FAT/TOTAL'                1  31   CCDF
TYPE1OUT001 USA        'CAN FAT/TOTAL'                1  29  CCDF (0-2000 km)
TYPE1OUT002 Greece     'ERL INJ/PRODROMAL VOMIT'      1  30
TYPE1OUT002 Italy      'ERL INJ/PRODROMAL VOMIT'      1  29
TYPE1OUT002 Spain      'ERL INJ/PRODROMAL VOMIT'      1  31
TYPE1OUT002 USA        'ERL FAT/TOTAL'                1  29  CCDF (0-2000 km)
TYPE1OUT003 Greece     'ERL INJ/DIARRHEA'             1  30
TYPE1OUT003 Italy      'ERL INJ/DIARRHEA'             1  29
TYPE1OUT003 Spain      'ERL INJ/PNEUMONITIS'          1  31
TYPE1OUT003 USA        'CAN FAT/LEUKEMIA'             1  29
TYPE1OUT004 Greece     'ERL INJ/PNEUMONITIS'          1  30
TYPE1OUT004 Italy      'ERL INJ/PNEUMONITIS'          1  29
TYPE1OUT004 Spain      'ERL INJ/SKIN ERYTHEMA'        1  31
TYPE1OUT004 USA        'CAN FAT/LUNG'                 1  29
TYPE1OUT005 Greece     'ERL INJ/THYROIDITIS'          1  30
TYPE1OUT005 Italy      'ERL INJ/THYROIDITIS'          1  29
TYPE1OUT005 Spain      'ERL INJ/TRANSEPIDERMAL'       1  31
TYPE1OUT005 USA        'CAN FAT/BREAST'               1  29
TYPE1OUT006 Greece     'ERL INJ/HYPOTHYROIDISM'       1  30   CCDF (0 TO 2000 KM)
TYPE1OUT006 Italy      'ERL INJ/HYPOTHYROIDISM'       1  29   CCDF
TYPE1OUT006 Spain      'ERL INJ/THYROIDITIS'          1  31
TYPE1OUT006 USA        'CAN FAT/GI'                   1  29
TYPE1OUT007 Greece     'ERL INJ/SKIN ERYTHEMA'        1  30
TYPE1OUT007 Italy      'ERL INJ/SKIN ERYTHEMA'        1  29
TYPE1OUT007 Spain      'ERL INJ/HYPOTHYROIDISM'       1  31   CCDF
TYPE1OUT007 USA        'CAN FAT/BONE'                 1  29
TYPE1OUT008 Greece     'ERL INJ/TRANSEPIDERMAL'       1  30
TYPE1OUT008 Italy      'ERL INJ/TRANSEPIDERMAL'       1  29
TYPE1OUT008 Spain      'CAN FAT/LEUKEMIA'             1  31
TYPE1OUT008 USA        'CAN FAT/OTHER'                1  29
TYPE1OUT009 Greece     'CAN FAT/TOTAL'                1  30   CCDF (0 TO 2000 KM)
TYPE1OUT009 Italy      'CAN FAT/TOTAL'                1  29   CCDF
TYPE1OUT009 Spain      'CAN FAT/BONE'                 1  31
TYPE1OUT009 USA        'CAN INJ/THYROID'              1  29
TYPE1OUT010 Greece     'CAN FAT/LUNG'                 1  30
TYPE1OUT010 Italy      'CAN INJ/TOTAL'                1  29
TYPE1OUT010 Spain      'CAN FAT/BREAST'               1  31
TYPE1OUT010 USA        'CAN INJ/BREAST'               1  29
TYPE1OUT011 Greece     'CAN FAT/THYROID'              1  30
TYPE1OUT011 Italy      'CAN FAT/LUNG'                 1  29
TYPE1OUT011 Spain      'CAN FAT/LUNG'                 1  31
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TYPE1OUT011 USA       'ERL INJ/PRODROMAL VOMIT'     1  29
TYPE1OUT012 Greece    'CAN FAT/BREAST'              1  30
TYPE1OUT012 Italy     'CAN FAT/THYROID'             1  29
TYPE1OUT012 Spain     'CAN FAT/THYROID'             1  31
TYPE1OUT012 USA       'ERL INJ/DIARRHEA'            1  29
TYPE1OUT013 Greece    'CAN FAT/GI'                  1  30
TYPE1OUT013 Italy     'CAN FAT/BREAST'              1  29
TYPE1OUT013 Spain     'CAN FAT/GI'                  1  31
TYPE1OUT013 USA       'ERL INJ/PNEUMONITIS'         1  29
TYPE1OUT014 Greece    'CAN FAT/LEUKEMIA'            1  30
TYPE1OUT014 Italy     'CAN FAT/GI'                  1  29
TYPE1OUT014 Spain     'CAN FAT/OTHER'               1  31
TYPE1OUT014 USA       'ERL INJ/THYROIDITIS'         1  29
TYPE1OUT015 Greece    'CAN FAT/BONE'                1  30
TYPE1OUT015 Italy     'CAN FAT/LEUKEMIA'            1  29
TYPE1OUT015 Spain     'CAN INJ/BREAST'              1  31
TYPE1OUT015 USA       'ERL INJ/HYPOTHYROIDISM'      1  29  CCDF
TYPE1OUT016 Greece    'CAN FAT/OTHER'               1  30
TYPE1OUT016 Italy     'CAN FAT/BONE'                1  29
TYPE1OUT016 Spain     'CAN INJ/LUNG'                1  31
TYPE1OUT016 USA       'ERL INJ/SKIN ERYTHEMA'       1  29
TYPE1OUT017 Greece    'CAN INJ/THYROID'             1  30
TYPE1OUT017 Italy     'CAN FAT/OTHER'               1  29
TYPE1OUT017 Spain     'CAN INJ/THYROID'             1  31
TYPE1OUT017 USA       'ERL INJ/TRANSEPIDERMAL'      1  29
TYPE1OUT018 Greece    'CAN INJ/BREAST'              1  30
TYPE1OUT018 Italy     'ERL FAT/TOTAL'               1  11   CCDF
TYPE1OUT018 Spain     'CAN INJ/GI'                  1  31
TYPE1OUT019 Italy     'CAN FAT/TOTAL'               1  11   CCDF
TYPE1OUT019 Spain     'CAN INJ/OTHER'               1  31
TYPE1OUT020 Italy     'CAN INJ/TOTAL'               1  11
TYPE1OUT020 Spain     'CAN FAT/TOTAL'               1  31   CCDF
TYPE2NUMBER Greece  1
TYPE2NUMBER Italy   1
TYPE2NUMBER Spain   1
TYPE2NUMBER USA     1
TYPE2OUT001 Italy   0.
TYPE2OUT001 Spain   0.
TYPE2OUT001 USA     0.
TYPE3NUMBER Greece 10
TYPE3NUMBER Italy   9
TYPE3NUMBER Spain  10
TYPE3NUMBER USA    10
TYPE3OUT001 Greece    'EDEWBODY'       0.001           LIFETIME
TYPE3OUT001 Italy     'EDEWBODY'       0.001           LIFETIME
TYPE3OUT001 Spain     'EDEWBODY'       0.001           LIFETIME
TYPE3OUT001 USA       'EDEWBODY'       0.001           LIFETIME
TYPE3OUT002 Greece    'EDEWBODY'       0.004           LIFETIME
TYPE3OUT002 Italy     'EDEWBODY'       0.004           LIFETIME
TYPE3OUT002 Spain     'EDEWBODY'       0.004           LIFETIME
TYPE3OUT002 USA       'EDEWBODY'       0.004           LIFETIME
TYPE3OUT003 Greece    'EDEWBODY'       0.020           LIFETIME
TYPE3OUT003 Italy     'EDEWBODY'       0.020           LIFETIME
TYPE3OUT003 Spain     'EDEWBODY'       0.020           LIFETIME
TYPE3OUT003 USA       'EDEWBODY'       0.020           LIFETIME
TYPE3OUT004 Greece    'EDEWBODY'       0.040           LIFETIME
TYPE3OUT004 Italy     'EDEWBODY'       0.040           LIFETIME
TYPE3OUT004 Spain     'EDEWBODY'       0.040           LIFETIME
TYPE3OUT004 USA       'EDEWBODY'       0.040           LIFETIME
TYPE3OUT005 Greece    'EDEWBODY'       0.080           LIFETIME
TYPE3OUT005 Italy     'EDEWBODY'       0.080           LIFETIME
TYPE3OUT005 Spain     'EDEWBODY'       0.080           LIFETIME
TYPE3OUT005 USA       'EDEWBODY'       0.080           LIFETIME
TYPE3OUT006 Greece    'EDEWBODY'       0.120           LIFETIME
TYPE3OUT006 Italy     'EDEWBODY'       0.120           LIFETIME
TYPE3OUT006 Spain     'EDEWBODY'       0.120           LIFETIME
TYPE3OUT006 USA       'EDEWBODY'       0.120           LIFETIME
TYPE3OUT007 Greece    'EDEWBODY'       0.200           LIFETIME
TYPE3OUT007 Italy     'EDEWBODY'       0.200           LIFETIME
TYPE3OUT007 Spain     'EDEWBODY'       0.200           LIFETIME
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TYPE3OUT007 USA       'EDEWBODY'       0.200           LIFETIME
TYPE3OUT008 Greece    'EDEWBODY'       0.500           LIFETIME
TYPE3OUT008 Italy     'EDEWBODY'       0.500           LIFETIME
TYPE3OUT008 Spain     'EDEWBODY'       0.500           LIFETIME
TYPE3OUT008 USA       'EDEWBODY'       0.500           LIFETIME
TYPE3OUT009 Greece    'EDEWBODY'       1.000           LIFETIME
TYPE3OUT009 Italy     'EDEWBODY'       1.000           LIFETIME
TYPE3OUT009 Spain     'EDEWBODY'       1.000           LIFETIME
TYPE3OUT009 USA       'EDEWBODY'       1.000           LIFETIME
TYPE3OUT010 Greece    'EDEWBODY'       2.000           LIFETIME
TYPE3OUT010 Spain     'EDEWBODY'       2.000           LIFETIME
TYPE3OUT010 USA       'EDEWBODY'       2.000           LIFETIME
TYPE4NUMBER Greece  20
TYPE4NUMBER Italy   19
TYPE4NUMBER Spain   20
TYPE4NUMBER USA     19
TYPE4OUT001 Greece      1         'ERL FAT/TOTAL'   (0.2 KM)
TYPE4OUT001 Italy       1         'ERL FAT/TOTAL'
TYPE4OUT001 Spain       1         'ERL FAT/TOTAL'
TYPE4OUT001 USA         1         'ERL FAT/TOTAL'   (0.2 km)
TYPE4OUT002 Greece      2         'ERL FAT/TOTAL'   (0.5 KM)
TYPE4OUT002 Italy       2         'ERL FAT/TOTAL'
TYPE4OUT002 Spain       2         'ERL FAT/TOTAL'
TYPE4OUT002 USA         2         'ERL FAT/TOTAL'   (0.5 km)
TYPE4OUT003 Greece      3         'ERL FAT/TOTAL'   (0.8 KM)
TYPE4OUT003 Italy       3         'ERL FAT/TOTAL'
TYPE4OUT003 Spain       3         'ERL FAT/TOTAL'
TYPE4OUT003 USA         3         'ERL FAT/TOTAL'   (0.8 km)
TYPE4OUT004 Greece      4         'ERL FAT/TOTAL'   (1.2 KM)
TYPE4OUT004 Italy       4         'ERL FAT/TOTAL'
TYPE4OUT004 Spain       4         'ERL FAT/TOTAL'
TYPE4OUT004 USA         4         'ERL FAT/TOTAL'   (1.2 km)
TYPE4OUT005 Greece      5         'ERL FAT/TOTAL'   (1.6 KM)
TYPE4OUT005 Italy       5         'ERL FAT/TOTAL'
TYPE4OUT005 Spain       5         'ERL FAT/TOTAL
TYPE4OUT005 USA         5         'ERL FAT/TOTAL'   (1.6 km)
TYPE4OUT006 Greece      6         'ERL FAT/TOTAL'   (2.0 KM)
TYPE4OUT006 Italy       6         'ERL FAT/TOTAL'
TYPE4OUT006 Spain       6         'ERL FAT/TOTAL'
TYPE4OUT006 USA         6         'ERL FAT/TOTAL'   (2.0 km)
TYPE4OUT007 Greece      7         'ERL FAT/TOTAL'   (2.5 KM)
TYPE4OUT007 Italy       7         'ERL FAT/TOTAL'
TYPE4OUT007 Spain       7         'ERL FAT/TOTAL'
TYPE4OUT007 USA         7         'ERL FAT/TOTAL'   (3.0 km)
TYPE4OUT008 Greece      8         'ERL FAT/TOTAL'   (3.0 KM)
TYPE4OUT008 Italy       8         'ERL FAT/TOTAL'
TYPE4OUT008 Spain       8         'ERL FAT/TOTAL'
TYPE4OUT008 USA         8         'ERL FAT/TOTAL'   (4.0 km)
TYPE4OUT009 Greece      9         'ERL FAT/TOTAL'   (4.0 KM)
TYPE4OUT009 Italy       9         'ERL FAT/TOTAL'
TYPE4OUT009 Spain       9         'ERL FAT/TOTAL'
TYPE4OUT009 USA         9         'ERL FAT/TOTAL'   (5.0 km)
TYPE4OUT010 Greece     10         'ERL FAT/TOTAL'   (5.0 KM)
TYPE4OUT010 Italy      10         'ERL FAT/TOTAL'
TYPE4OUT010 Spain      10         'ERL FAT/TOTAL'
TYPE4OUT010 USA        10         'ERL FAT/TOTAL'   (7.0 km)
TYPE4OUT011 Greece      4         'CAN FAT/TOTAL'   (1.2 KM)
TYPE4OUT011 Italy       5         'CAN FAT/TOTAL'
TYPE4OUT011 Spain      11         'ERL FAT/TOTAL'
TYPE4OUT011 USA         5         'CAN FAT/TOTAL'   (1.6 km)
TYPE4OUT012 Greece     12         'CAN FAT/TOTAL'   (10 KM)
TYPE4OUT012 Italy      10         'CAN FAT/TOTAL'
TYPE4OUT012 Spain      12         'ERL FAT/TOTAL'
TYPE4OUT012 USA        10         'CAN FAT/TOTAL'   (7.0 km)
TYPE4OUT013 Greece     14         'CAN FAT/TOTAL'   (18 KM)
TYPE4OUT013 Italy      14         'CAN FAT/TOTAL'
TYPE4OUT013 Spain      13         'ERL FAT/TOTAL'
TYPE4OUT013 USA        14         'CAN FAT/TOTAL'   (20.0 km)
TYPE4OUT014 Greece     18         'CAN FAT/TOTAL'   (40 KM)
TYPE4OUT014 Italy      17         'CAN FAT/TOTAL'
```

```
TYPE4OUT014 Spain       14          'ERL FAT/TOTAL'
TYPE4OUT014 USA         17          'CAN FAT/TOTAL'    (32.0 km)
TYPE4OUT015 Greece      21          'CAN FAT/TOTAL'    (100 KM)
TYPE4OUT015 Italy       19          'CAN FAT/TOTAL'
TYPE4OUT015 Spain       15          'ERL FAT/TOTAL'
TYPE4OUT015 USA         19          'CAN FAT/TOTAL'    (50.0 km)
TYPE4OUT016 Greece      23          'CAN FAT/TOTAL'    (200 KM)
TYPE4OUT016 Italy       22          'CAN FAT/TOTAL'
TYPE4OUT016 Spain       16          'ERL FAT/TOTAL'
TYPE4OUT016 USA         22          'CAN FAT/TOTAL'    (150.0 km)
TYPE4OUT017 Greece      26          'CAN FAT/TOTAL'    (500 KM)
TYPE4OUT017 Italy       25          'CAN FAT/TOTAL'
TYPE4OUT017 Spain       17          'ERL FAT/TOTAL'
TYPE4OUT017 USA         25          'CAN FAT/TOTAL'    (500.0 km)
TYPE4OUT018 Greece      28          'CAN FAT/TOTAL'    (1000 KM)
TYPE4OUT018 Italy       27          'CAN FAT/TOTAL'
TYPE4OUT018 Spain       18          'ERL FAT/TOTAL'
TYPE4OUT018 USA         27          'CAN FAT/TOTAL'    (1000.0 km)
TYPE4OUT019 Greece      29          'CAN FAT/TOTAL'    (1500 KM)
TYPE4OUT019 Italy       29          'CAN FAT/TOTAL'
TYPE4OUT019 Spain       19          'ERL FAT/TOTAL'
TYPE4OUT019 USA         29          'CAN FAT/TOTAL'   (2000.0 km)
TYPE4OUT020 Greece      30          'CAN FAT/TOTAL'   (2000 KM)
TYPE4OUT020 Spain       20          'ERL FAT/TOTAL'
TYPE5NUMBER Greece     9
TYPE5NUMBER Italy      3
TYPE5NUMBER Spain      9
TYPE5NUMBER USA        9
TYPE5OUT001 Greece 'EDEWBODY'       1         30    CCDF  (0-2000 KM)
TYPE5OUT001 Italy  'EDEWBODY'       1         11          (0-10 KM)
TYPE5OUT001 Spain  'EDEWBODY'       1         31    CCDF
TYPE5OUT001 USA    'EDEWBODY'       1         29    CCDF    (0-2000 km)
TYPE5OUT002 Greece 'SKIN'           1         30            (0-2000 KM)
TYPE5OUT002 Italy  'EDEWBODY'       1         17            (0-32 KM)
TYPE5OUT002 Spain  'SKIN'           1         31
TYPE5OUT002 USA    'SKIN'           1         29            (0-2000 km)
TYPE5OUT003 Greece 'LUNGS'          1         30            (0-2000 KM)
TYPE5OUT003 Italy  'EDEWBODY'       1         29    CCDF    (0-2000 KM)
TYPE5OUT003 Spain  'LUNGS'          1         31
TYPE5OUT003 USA    'LUNGS'          1         29            (0-2000 km)
TYPE5OUT004 Greece 'RED MARR'       1         30            (0-2000 KM)
TYPE5OUT004 Spain  'RED MARR'       1         31
TYPE5OUT004 USA    'RED MARR'       1         29            (0-2000 km)
TYPE5OUT005 Greece 'LOWER LI'       1         30            (0-2000 KM)
TYPE5OUT005 Spain  'LOWER LI'       1         31
TYPE5OUT005 USA    'LOWER LI'       1         29            (0-2000 km)
TYPE5OUT006 Greece 'STOMACH'        1         30            (0-2000 KM)
TYPE5OUT006 Spain  'STOMACH'        1         31
TYPE5OUT006 USA    'STOMACH'        1         29            (0-2000 km)
TYPE5OUT007 Greece 'THYROIDH'       1         30            (0-2000 KM)
TYPE5OUT007 Spain  'THYROIDH'       1         31
TYPE5OUT007 USA    'THYROIDH'       1         29            (0-2000 km)
TYPE5OUT008 Greece 'BONE SUR'       1         30            (0-2000 KM)
TYPE5OUT008 Spain  'BONE SUR'       1         31
TYPE5OUT008 USA    'BONE SUR'       1         29            (0-2000 km)
TYPE5OUT009 Greece 'BREAST'         1         30            (0-2000 KM)
TYPE5OUT009 Spain  'BREAST'         1         31
TYPE5OUT009 USA    'BREAST'         1         29            (0-2000 km)
TYPE6NUMBER Greece      10
TYPE6NUMBER Italy       0
TYPE6NUMBER Spain       0
TYPE6NUMBER USA         0
TYPE6OUT001 Greece   'EDEWBODY'    'TOT LIF'     4         4       CCDF  (0.8-1.2 KM)
TYPE6OUT002 Greece   'EDEWBODY'    'CLD'         4         4
TYPE6OUT003 Greece   'EDEWBODY'    'GRD'         4         4
TYPE6OUT004 Greece   'EDEWBODY'    'INH LIF'     4         4
TYPE6OUT005 Greece   'EDEWBODY'    'RES LIF'     4         4
TYPE6OUT006 Greece   'EDEWBODY'    'TOT LIF'    17        17       CCDF  (28-32 KM)
TYPE6OUT007 Greece   'EDEWBODY'    'CLD'        17        17
TYPE6OUT008 Greece   'EDEWBODY'    'GRD'        17        17
```

```
TYPE6OUT009 Greece  'EDEWBODY'     'INH LIF'    17        17
TYPE6OUT010 Greece  'EDEWBODY'     'RES LIF'    17        17
TYPE7NUMBER Greece   2
TYPE7NUMBER Italy    0
TYPE7NUMBER Spain    0
TYPE7NUMBER USA      0
TYPE7OUT001 Greece     'ERL FAT/TOTAL'       1              30
TYPE7OUT002 Greece     'CAN FAT/TOTAL'       1              30
TYPE8NUMBER Greece   5
TYPE8NUMBER Italy    2
TYPE8NUMBER Spain    6
TYPE8NUMBER USA      5
TYPE8OUT001 Greece 'ERL FAT/TOTAL'     1       10        (0-5 KM FIXED ZONE)
TYPE8OUT001 Italy  'ERL FAT/TOTAL'     1       11        CCDF  (0-10 KM)
TYPE8OUT001 Spain  'ERL FAT/TOTAL'     1       10        (5 km)
TYPE8OUT001 USA    'ERL FAT/TOTAL'     1        9        (0-5 km: fixed zone)
TYPE8OUT002 Greece 'CAN FAT/TOTAL'     1       30        (0-2000 KM)
TYPE8OUT002 Italy  'CAN FAT/TOTAL'     1       11        CCDF  (0-10 KM)
TYPE8OUT002 Spain  'CAN FAT/LUNG'      1       31
TYPE8OUT002 USA    'CAN FAT/LUNG'      1       29        (0-2000 km)
TYPE8OUT003 Greece 'CAN FAT/LUNG'      1       30        (0-2000 KM)
TYPE8OUT003 Spain  'CAN FAT/LEUKEMIA'  1       31
TYPE8OUT003 USA    'CAN FAT/LEUKEMIA'  1       29        (0-2000 km)
TYPE8OUT004 Greece 'CAN FAT/LEUKEMIA'  1       30        (0-2000 KM)
TYPE8OUT004 Spain  'CAN FAT/BONE'      1       31
TYPE8OUT004 USA    'CAN FAT/BONE'      1       29        (0-2000 km)
TYPE8OUT005 Greece 'CAN FAT/BONE'      1       30        (0-2000 KM)
TYPE8OUT005 Spain  'CAN FAT/TOTAL'     1       31
TYPE8OUT005 USA    'CAN FAT/TOTAL'     1       29        (0-2000 km)
TYPE8OUT006 Spain  'CAN INJ/TOTAL'     1       31
TYPE9NUMBER Greece   1       (UP TO 10 ALLOWED)
TYPE9NUMBER Italy    2       (UP TO 10 ALLOWED)
TYPE9NUMBER Spain    1       (UP TO 10 ALLOWED)
TYPE9NUMBER USA      1       (UP TO 10 ALLOWED)
TYPE9OUT001 Greece    'EDEWBODY'      1          30  CCDF  (0-2000 km)
TYPE9OUT001 Italy     'EDEWBODY'      1          29  CCDF  (0-2000 KM)
TYPE9OUT001 Spain     'EDEWBODY'      1          31 'CCDF' (0-2000 KM)
TYPE9OUT001 USA       'EDEWBODY'      1          29  CCDF  (0-2000 km)
TYPE9OUT002 Italy     'RED MARR'      1          29  CCDF  (0-2000 KM)
WDCWASH1001 Greece  1.0E-4   (Page 6 CCP1, issue F)
WDCWASH1001 Italy   1.0E-4
WDCWASH1001 Spain   1.0E-4
WDCWASH1001 USA     1.0E-4
WDCWASH2001 Greece  0.8       (Page 6 CCP1, issue F)
WDCWASH2001 Italy   0.8
WDCWASH2001 Spain   0.8
WDCWASH2001 USA     0.8
WEBUILDH001 Greece   30.
WEBUILDH001 Italy    30.
WEBUILDH001 Spain    30.       (Building Height (m), Page 9 CCP1, issue F)
WEBUILDH001 USA      30.
WEBUILDW001 Greece   40.
WEBUILDW001 Italy    40.
WEBUILDW001 Spain    40.       (Building Width (m), Page 9 CCP1, issue F)
WEBUILDW001 USA      40.
```

Appendix B
Implementation of Specifications on Agricultural Production and Foodbans

Introduction

Results produced in the inter-comparison calculations showed significant differences in predictions of the ingestion pathway doses and their consequences—health and economic effects. This Appendix contains some analysis of the differences in the ingestion pathway consequence predictions.

The two major differences in the implementation of specifications and modeling of the ingestion pathway by different MACCS users are:

a) mapping of the agricultural production on the calculation grid, and

b) procedures for deriving the food bans and farmland interdiction criteria.

Mapping of Agricultural Production

There were a number of causes preventing an exact implementation of the distribution of agricultural production on the map for MACCS as was specified in the exercise. Discussion of these cases follows.

Number of Economic/Agricultural Regions

The MACCS code (version 1.5.11.1) limits the number of unique economic/agricultural regions to 99. However, the calculational grid used for the exercise consisted of 29 × 16 = 464 rectangular cells. Although the production data were available for seven regions on the map, the number of regions with unique production patterns after transforming the specification data onto the polar grid exceeded the upper limit. The large number of unique patterns was caused by the mixing of data from different regions on the boundaries between these seven regions when transforming from the rectangular grid to the polar grid. Therefore, a simplified approach using a homogenized production rate was suggested and employed by the Greek, Italian, and U. S. participants while the Spanish participants used seven economic regions in their calculations.

The effect of the homogenization of agricultural production becomes more obvious when the agricultural land area is compared for the two cases of interest: homogenized and distributed production. Fig. B.1 shows the fraction of the agricultural area in a ring as a function of the ring's outer radius on the polar grid (29 rings). As this figure indicates, the fraction of agricultural land in the case of distributed mapping is consistently higher than in the case of homogenized mapping, except for the last ring whose area is the largest (1500 km to 2000 km). The discrepancy in distributions discussed above stems from the fact that the specifications assign a higher volume of agricultural production to the areas adjacent to the release location when compared to homogenized agricultural production distribution. Given that the total production specified for the whole grid was maintained, shifting the agricultural production farther from the site of release lowers the consequences due to depletion of the radioactive cloud by atmospheric dispersion and deposition of the contaminants leading to a reduction in the overall farmland contamination levels. Therefore, the ingestion pathway doses resulting from the radioactive fallout will be higher in the case of the non-uniform distributed (agricultural areas, not crops) production calculation (Spain, Table 2.4) when compared to the homogenized production calculation (U. S.). The results of sensitivity analysis performed by Spain confirmed this hypothesis.

Appendix B: Implementation of Specifications on Agricultural Production and Foodbans

There were some other areas in the specification which allowed additional degrees of freedom in its interpretation:

a) MACCS code requires specification of the pasture area in order to calculate the uptake of the radioactive materials into the foodchain by grazing animals. Since the exercise specifications did not include these data, the pasture area had to be back-calculated in US calculations from the available data on the annual gross milk production rate and the US data on milk productivity, pasture production rate, and cow feeding patterns. In addition, since no information was provided for the animals annual feed basket, a basket consisting of grain and pasture was designed for the MACCS calculations.

b) In the MACCS code, the base parameters for calculating the transfer of all specific deposited materials into various crops are the surface concentrations of deposited materials and the crops growing areas. The specific crop growing area in each of the 99 possible types of economic regions is defined by two sets of parameters: 1) fraction of the agricultural land in the region, and 2) partitioning of the agricultural land between different crops. Note that in MACCS this partitioning is identical for all regions of the grid. Invariability of Set 1 data over the entire grid prevents detailed mapping of the crops production distribution on the grid. The effects of uniform crop production are difficult to evaluate since the relative importance of each crop would have to be analyzed.

c) Since the specifications provide only the annual production (kg/yr) for various crops and the total crop growing area in a region, the crops unit area production rates have to be assumed for the MACCS input preparation in order to calculate the various crops growing areas in a map grid cell. The U. S. MACCS calculations were performed with the assumption that the unit area production rates are those typical for the US agriculture (note that the radionuclides transfer coefficients for different crops correspond to the US unit area production rates). The necessity for using information not given by the specifications introduces another degree of uncertainty in comparing the ingestion pathway predictions.

d) The crop disposal (banning) criteria in the exercise were specified individually for the following crops contributing to the human food basket: pasture for milk, pasture for meat, grain, vegetables, and roots and tubers. The specifications impose the following crop disposal criteria (in MACCS terminology, crop disposal refers to disposal of a crop during the corresponding crop's growing period): each particular crop is banned if its consumption by an individual during one year leads to a projected ingestion dose of 5 mSv. However, the MACCS crop disposal/farmland interdiction procedures are based on a food basket approach: all crops produced in any grid element are discarded if the intake of the entire annual food basket produced in this cell would lead to a projected dose exceeding 5 mSv. Since in the MACCS code, the annual food basket is specified by a combination of farmland areas required to produce the specific components of the basket, the agricultural production data specified for the exercise, kg/yr/crop, was modified so that the U. S. agricultural productivity data could be used [NUREG/CR-4691, SAND86-1562, Vol. 2, Appendix C, Addendum 1] to obtain the crop areas, m^2/yr-man/crop. A need for such an assumption resulted in the differences in the food baskets definitions used in the four participants calculations (see Table 2.3 of this report).

Sensitivity Analyses

In order to evaluate the changes in results to the mapping of the agricultural production (fraction of land which is devoted to farming), sensitivity analyses were performed for Case 3 (no counter-measures).

The original U. S. MACCS Case 3 calculations were performed with the homogenized agricultural production. Another set of calculations was done with a radially distributed agricultural production. In the second set of calculations, twenty nine economic regions were used for mapping the agricultural production. All of these economic regions corresponded to twenty nine rings of the polar grid used for the original calculations. The distribution of the fraction of agricultural area in each region is shown in Fig. B.2. The total agricultural area including pasture was 626,000 km^2, same as in the original set.

In the Case 3 scenario the population on the map was not evacuated/relocated, and no farmland interdiction/condemnation or crop disposal were exercised. This calculation should directly illustrate the sensitivity of results to homogenization of the agricultural production.

As anticipated, calculations performed with homogenization of the agricultural production showed a reduction in the expectation value of the ingestion dose by a factor of 2.8. The expectation values of the total collective and ingestion doses for the two cases are shown in Table B.1.

Table B.1 Total and Ingestion Pathway Dose Predictions; Expectation Values (Case 3)

Measure/Calculation	Homogenized	Distributed*
Total (P-Sv)	6.4E05	1.2E06
Ingestion (P-Sv)	2.9E05	8.2E05

*Radial production distribution on'

As mentioned earlier, the increase in dose for the distributed case is attributed to the fact that more crops are grown in a relatively close proximity to the release location--regions with a higher level of contamination.

The MACCS Case 3 calculation showed that practically the entire ingestion dose (2.93E05 P-Sv out of 2.94E05 P-Sv) was coming from ingestion of radionuclides directly deposited on the crops during the growing season. Therefore, the implementation of the criteria for the crop disposal is crucial for predicting the collective doses via ingestion pathway.

An additional set of calculations examining the effects of the TCROOT parameters (transfer factor from soil to plants by root uptake) was performed by the Spanish participants. This set of parameters is important for the long term ingestion pathway dose calculations. These calculations showed that the mean value of ingestion dose in Spanish calculations (Case 1) was about 1.6 times higher (1.02E4 P-Sv/6.21E3 P-Sv) than the corresponding value predicted in the U. S. calculations. This indicates that differences in assumptions used for deriving values for TCROOT resulted in noticeable differences in the dose predictions.

Conclusion

Appendix B: Implementation of Specifications on Agricultural Production and Foodbans

The differences in predictions of the ingestion pathway collective doses and corresponding health effects in the MACCS calculations can be attributed to interpretation and implementation of some basic food chain-related specifications provided for the exercise, such as mapping of agricultural production, ingestion pathway model parameters, and crop disposal criteria.

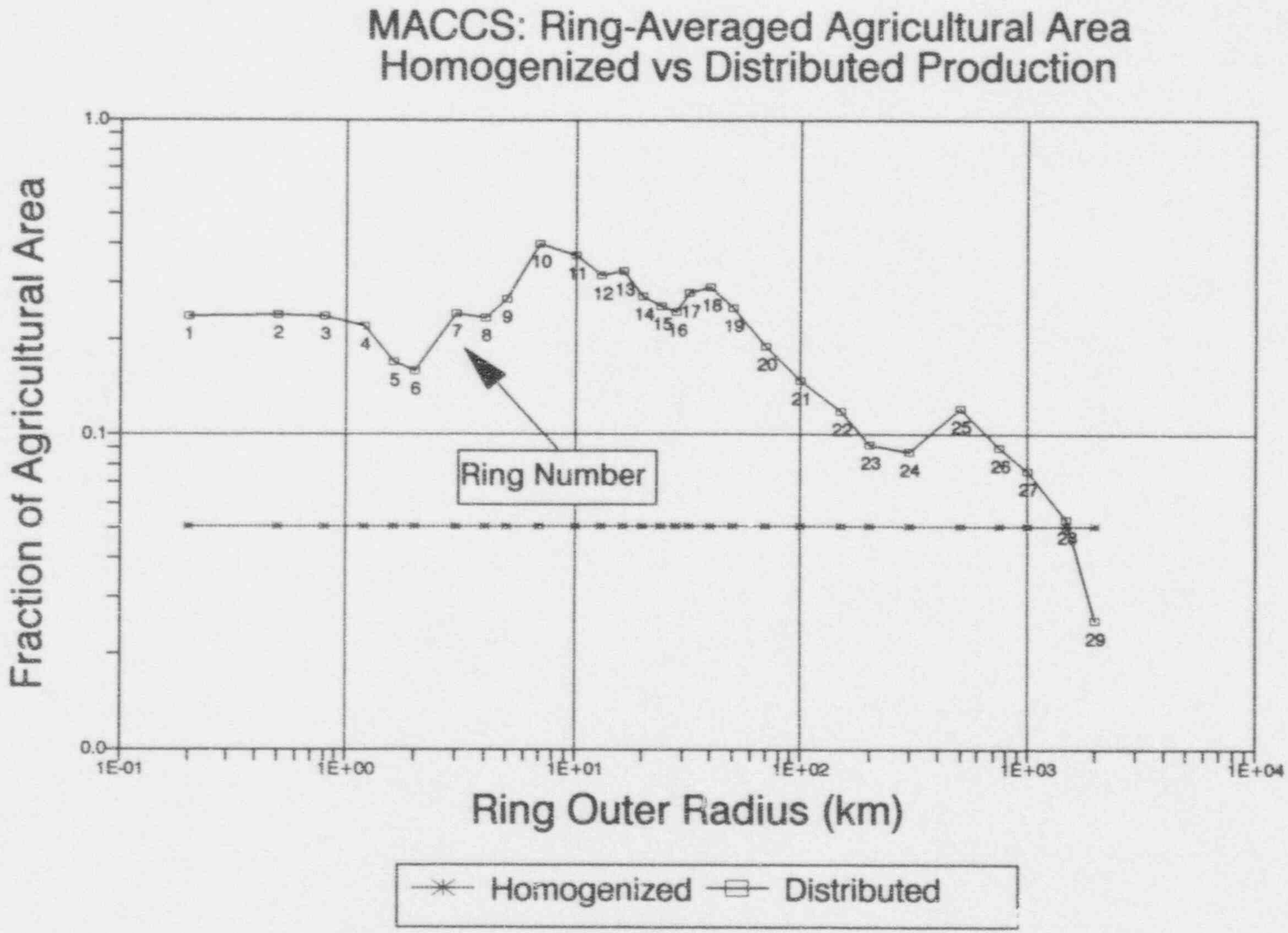

Figure B.1 Radial Ring-Averaged Distribution of Agricultural Area: Homogenized versus Distributed Production

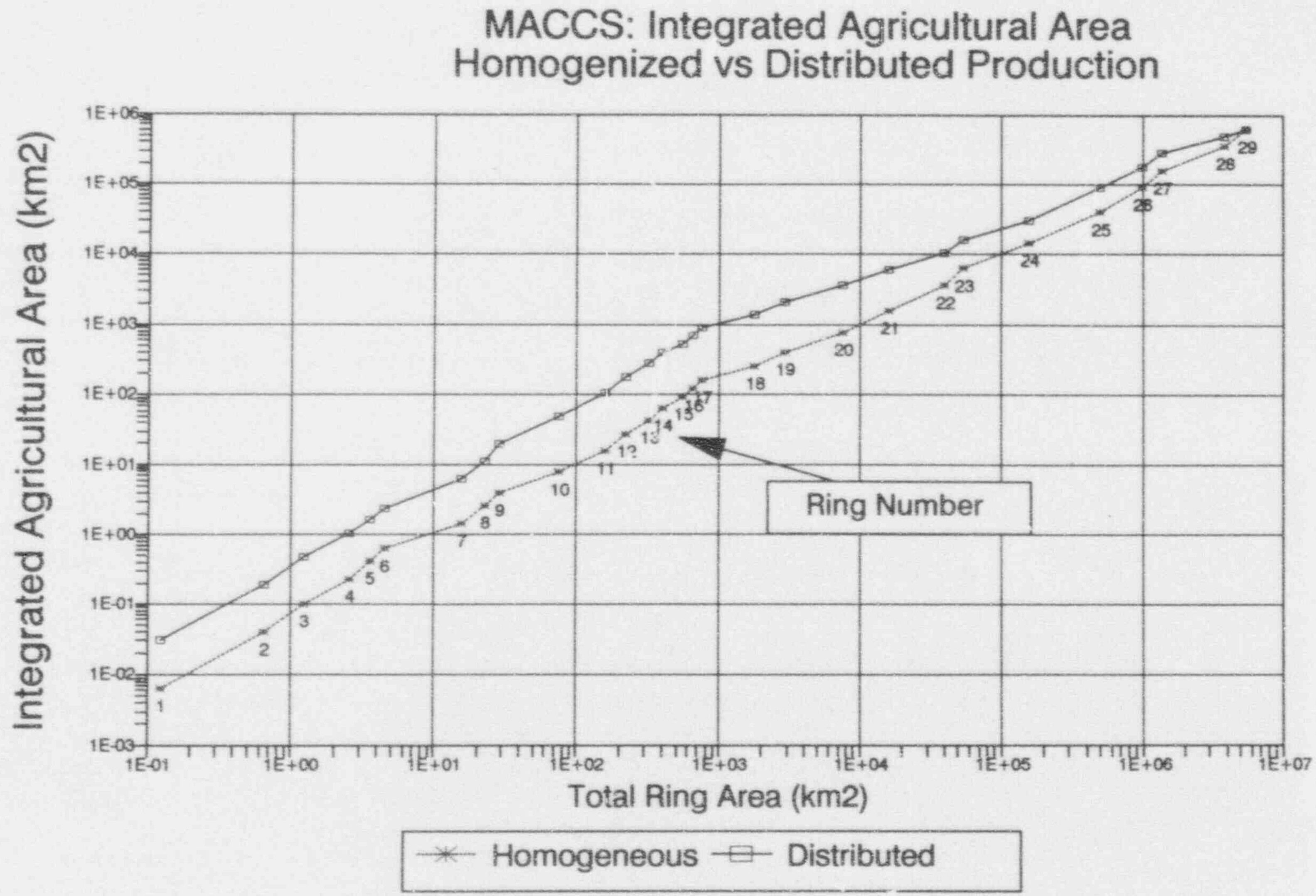

Figure B.2 Accumulative Agricultural Area: Homogenized versus Distributed Production

Appendix C: Modification of the MACCS Code for Ground and Ground-Level Air Contamination

Some design criteria for nuclear power plants of next generation in different countries address the issue of land contamination in case of severe accidents. This indicates a need for calculational tools capable of producing data required for evaluation of compliance with those criteria (information for this section has been provided by the Italian participants).

The current version of MACCS does not provide a user with this particular type of information in the code's output: it produces only the ground and air concentrations for single plume releases and single weather trials, without taking into account the statistics introduced by weather variations. Considering some of the benchmark requests related to air and ground contamination results, it was decided to introduce in MACCS the calculation of statistical data for the ground surface and ground-level air concentrations for any of the radioisotopes, averaged over the meteorological trials when multiple weather sequences are supplied a) by the user, b) directly (METCOD=3), or c) by means of a Meteorological Data File (METCOD=1, 2, or 5). These concentrations may be calculated at the centerline of each sector and thus represent the maximum value in a particular sector.

Reference [13] provides a full description of the modifications along with the instructions how to use the new option.

Tables C.1 and C.2 show a comparison of the centerline air and ground concentrations for the Single Phase scenario (Case 1) at 1 km and 30 km due North calculated by MACCS with the CONDOR and COSYMA predictions.

Table C.1 Time Integrated Air Concentration of Cs-137 at the Ground Level in Direction due North, Bq*s/m^3

Codes	1 km	30 km
MACCS	9.46E+10	2.63E+08
COSYMA	2.01E+10	3.55E+07
CONDOR	3.83E+10	8.61E+07

Table C.2 Ground Concentration of Cs-137 in Direction Due North, Bq/m^2

Codes	1 km	30 km
MACCS	1.05E+08	6.99E+05
COSYMA	2.09E+07	2.65E+05
CONDOR	4.39E+07	2.37E+05

Table C.3 MACCS Prediction of Mean Centerline and due North Air and Ground Concentrations (Case 1)

Results	Centerline Results		Frequency of Due North	Due North Results	
Concentrations	1 km	30 km		1 km	30 km
Air, Bq*s/m^3	1.75E12	4.79E09	0.055	9.46E10	2.63E08
Ground, Bq/m^2	1.90E09	1.27E07	0.055	1.05E08	6.99E05

Note that the results predicted for specific locations should be strongly influenced by differences in the weather sampling procedures and cloud dispersion calculations. The effects of weather sampling are most pronounced in the results produced by the codes using the trajectory cloud dispersion models (CONDOR and COSYMA).

MACCS data for concentrations due North in Tables C.1 and C.2 were derived from the centerline values multiplied by the probability for the wind to blow in the direction due North (see Table C.3), for all the meteorological bins identified by the MACCS weather binning procedure (value of 0.055 was taken from the Meteorological Summary Table produced by the MACCS's output module).

As it follows from Tables C.1 and C.2, the difference in mean values between different codes predictions can be significant, exceeding a factor of seven for the MACCS/COSYMA ratio for air concentration at 30 km.

Appendix D: Results Requested for Comparisons

This Appendix lists the end-points requested for comparisons (Table D.1); the table also indicates the results not available from the MACCS output. The unavailability of some results precludes inter-comparison with different codes in some areas (for example, air or land contamination or some health effect at a specific location).

As follows from Table D.1, the specifications requested approximately 43 endpoints for comparison with eighteen of these endpoints available from the MACCS standard output.

The measures requested but not available from the MACCS output were prioritized by the MACCS users in terms of those measures' worth for the purposes of codes intercomparison, and are listed below in two priority groups (see column with "Sheet No." in Table D.1):

Measures of first priority: 3, 4, 5, 6, 7, 8, 9, 10, 11, 21, 24, 25, 32, 36, 37, 38, and 39.

Measures of second priority: 15, 16, 17, 22, 23, 27, 28.

Note that the number of relocatees requested (Sheet No. 20) can only be approximated by the sum of the numbers of people from the interdicted and condemned areas, respectively, that are available in the MACCS output.

Table D.1 Calculation Results Requested for the Exercise

Sheet No.	Code	Description of Result	MACCS	Comment/Results
1		Assumptions		
		Dose Consequences		
2	**a.i**	**Total EDEWBODY**	**Yes**	
3	a.ii	Contribution to a.i from different pathways	No	Only groundshine, ingestion, and resuspension population exposure data (Person-Sv) are available for the long term phase (after seven days); *centerline doses vs distance* are available for the Emergency Phase only
3 Aux		**Contribution to a.i from different pathways**	**Yes**	**MACCS-specific: Only long-term data are available**
4	a.iii	Acute bone marrow dose integrated to 1 day at the location 1 km due north	No	
5	a.iv	Pathways contributions to a.iii	No	
6	a.v	Same as a.iii, at 30 km	No	
7	a.vi	Pathways contributions to a.v	No	
8	a.vii	Adult effective dose equivalent, integrated to 50 years at the location 1 km due north	No	
9	a.viii	Pathways contributions to a.vii	No	
10	a.ix	Same as a.vii, at 30 km	No	
11	a.x	Pathways contributions to a.ix	No	
12	**A.XI**	**DISTRIBUTION: NUMBER OF PEOPLE RECEIVING SPECIFIED DOSE (EDEWBODY) VS DOSE**	**YES**	

Table D.1 continued

Sheet No.	Code	Description of Result	MACCS	Comment/Results
12a	**a.xii**	**Total collective effective dose equivalent commitment (ie over all time) to the whole population from all pathways excluding food (person Sv)**	**Yes**	
12b	**a.xiii**	**Total collective effective dose equivalent commitment (ie over all time) to the whole population from the ingestion pathway only (man Sv)**	**Yes**	
		Health Effects		
13	**b.i**	**Number of early deaths (prompt fatalities)**	**Yes**	
14	**b.ii**	**Number of fatal cancers**	**Yes**	
15	b.iii	Contribution of bone marrow irradiation to b.i	No	
16	b.iv	Contribution of lung irradiation to b.i	No	
17	b.v	Contribution of skin irradiation to b.i	No	
17a	**b.vi**	**Number of early morbidities from hypothyroidism**	**Yes**	
17b	**b.vii**	**Number of fatal cancers for all pathways except ingestion**	**Yes**	
		Effect of Countermeasures on People		
18	**c.i**	**Total number of people evacuated**	**Yes**	**Number of people within 10 (or 5, Case 6) km zone**
19	**c.ii**	**Total area of land evacuated**	**Yes**	**Area of a 10 (or 5, Case 6) km zone**

Table D.1 continued

Sheet No.	Code	Description of Result	MACCS	Comment/Results
20	c.iii	**Total number of people relocated**	**Yes**	**Interdiction Population in the MACCS output**
21	c.iv	Total area of land relocated	No	
22	c.v	Time integral of people relocated	No	
23	c.vi	Time integral of land area relocated	No	
Effect of Countermeasures on Agriculture				
24	d.i	Mass of milk/products banned	No	
25	d.ii	Maximum daily yield of milk/products lost	No	-
26	d.iii	**Crop disposal area (km^2)**	**Yes**	
27	d.iv	Number of livestock affected	No	
28	d.v	Time integral of crop growing area with crops banned	No	
29	d.vi	Time integral of livestock affected	No	
Economic Effects				
30	e.i	**Total cost of moving people**	**Yes**	**Population Dependent Costs in the MACCS output. These values include ALL costs related to peoples' relocation, i.e., moving expenses, lost income, and cost of condemned property**
31	e.ii	**Total cost of food bans**	**Yes**	**Area Dependent Costs in the MACCS output (cost of farmland loss is included; see comment for e.i)**
32	e.iii	**Cost of health effects**	**No**	

Table D.1 continued

Sheet No.	Code	Description of Result	MACCS	Comment/Results
33	e.iv	**Sum of costs (e.i + e.ii + e.iii)**	**Yes**	**Total Economic Cost (costs of health effects are not included in CCDF - only in the *mean* value; see comment for e.i)**
		Individual Risk		
34	f.i	**Adult risk of early fatality vs distance**	**Yes**	**No distinction between child and adult fatalities is modeled**
35	f.ii	**Adult risk of fatal cancer vs distance**	**Yes**	**Same as above**
		Atmospheric Dispersion Consequences		
36	g.i	A CCDF of the time integrated air concentration of Cs-137 at ground level at 1 km due north	No	
37	g.ii	A CCDF of the deposited ground concentration of Cs-137 at ground level at 1 km due north	No	
38	g.iii	A CCDF of the time integrated air concentration of Cs-137 at ground level at 30 km due north	No	
39	g.iv	A CCDF of the deposited ground concentration of Cs-137 at ground level at 30 km due north	No	

Total number of requested results: 43
Available in the MACCS output: 18

Appendix E: MACCS Calculation Results

	GREECE	ITALY	SPAIN	U. S.
Single-Phase (Case 1)				
Total EDEWBODY (P-Sv)				
5 Percentile	1.00E+05	1.14E+05	1.17E+05	1.12E+05
MEDIAN	2.68E+05	3.05E+05	3.04E+05	3.05E+05
MEAN	2.94E+05	3.18E+05	3.23E+05	3.18E+05
90 Percentile	4.54E+05	4.86E+05	4.85E+05	4.89E+05
95 Percentile	5.45E+05	5.78E+05	5.80E+05	5.76E+05
Dose, No Ingestion (P-Sv)				
5 Percentile	9.27E+04	1.08E+05	1.20E+05	1.08E+05
MEDIAN	2.57E+05	3.01E+05	2.95E+05	3.00E+05
MEAN	2.88E+05	3.13E+05	3.10E+05	3.12E+05
90 Percentile	4.48E+05	4.85E+05	4.75E+05	4.84E+05
95 Percentile	5.39E+05	5.74E+05	5.72E+05	5.73E+05
Ingestion Dose (P-Sv)				
5 Percentile	5.05E+02	1.90E+03	5.68E+03	3.87E+02
MEDIAN	2.23E+03	3.89E+03	1.15E+04	2.00E+03
MEAN	5.81E+03	5.71E+03	1.37E+04	6.21E+03
90 Percentile	1.45E+04	8.18E+03	2.13E+04	1.53E+04
95 Percentile	2.55E+04	1.03E+04	2.62E+04	2.73E+04
Early Fatalities				
5 Percentile	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEDIAN	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEAN	1.26E+00	1.88E+00	2.23E+00	1.88E+00
90 Percentile	1.64E+00	2.30E+00	1.15E+00	2.30E+00
95 Percentile	5.08E+00	2.04E+01	5.72E+00	2.04E+01
Latent Fatalities				
5 Percentile	3.97E+03	4.76E+03	5.09E+03	4.65E+03
MEDIAN	1.08E+04	1.14E+04	1.14E+04	1.14E+04
MEAN	1.22E+04	1.31E+04	1.34E+04	1.31E+04
90 Percentile	1.87E+04	1.99E+04	2.03E+04	2.00E+04
95 Percentile	2.25E+04	2.32E+04	2.42E+04	2.33E+04
Hypothyroidism Morbidities				
5 Percentile	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEDIAN	1.49E+01	6.99E+00	7.02E+00	6.99E+00
MEAN	1.15E+02	1.60E+02	1.14E+02	1.54E+02
90 Percentile	2.76E+02	3.64E+02	3.05E+02	3.42E+02
95 Percentile	4.62E+02	7.57E+02	5.26E+02	7.24E+02
Latent Fatalities (No Ingestion)				
5 Percentile	3.84E+03	4.48E+03	4.27E+03	4.48E+03
MEDIAN	1.07E+04	1.12E+04	1.11E+04	1.12E+04
MEAN	1.19E+04	1.29E+04	1.28E+04	1.28E+04
90 Percentile	1.85E+04	1.96E+04	1.95E+04	1.96E+04
95 Percentile	2.24E+04	2.31E+04	2.31E+04	2.31E+04
Relocated Population				
5 Percentile	2.82E+01	3.78E+01	6.67E+01	3.78E+01
MEDIAN	9.78E+03	9.95E+03	1.30E+04	9.95E+03
MEAN	5.29E+04	4.74E+04	6.10E+04	4.73E+04
90 Percentile	1.57E+05	1.38E+05	1.92E+05	1.38E+05
95 Percentile	2.34E+05	2.23E+05	2.69E+05	2.23E+05
Crop Disposal Area (km2)				
5 Percentile	2.12E+03	2.20E+03	2.04E+03	2.21E+03
MEDIAN	5.42E+03	6.68E+03	8.88E+03	6.69E+03
MEAN	8.13E+03	8.63E+03	1.03E+04	8.67E+03
90 Percentile	2.03E+04	2.01E+04	1.73E+04	2.01E+04
95 Percentile	2.45E+04	2.07E+04	2.17E+04	2.07E+04

		Cost of Relocation (ECU)		
5 Percentile	2.60E+06	1.77E+06	4.32E+06	3.16E+06
MEDIAN	3.83E+08	4.44E+08	5.91E+08	4.30E+08
MEAN	2.01E+09	1.94E+09	2.33E+09	1.84E+09
90 Percentile	6.32E+09	6.26E+09	7.18E+09	5.84E+09
95 Percentile	8.70E+09	8.70E+09	1.00E+10	8.11E+09
		Cost of Food Bans (ECU)		
5 Percentile	1.05E+09	1.16E+09	1.66E+09	1.17E+09
MEDIAN	2.64E+09	2.77E+09	4.80E+09	2.84E+09
MEAN	3.51E+09	3.52E+09	8.98E+09	3.74E+09
90 Percentile	7.54E+09	7.52E+09	1.74E+10	7.36E+09
95 Percentile	9.08E+09	7.74E+09	2.06E+10	8.05E+09

Long Duration (Case 2)

		Total EDEWBODY (P-Sv)		
5 Percentile	1.12E+05	2.01E+05	1.29E+05	2.03E+05
MEDIAN	3.10E+05	3.29E+05	3.22E+05	3.34E+05
MEAN	3.13E+05	3.58E+05	3.40E+05	3.67E+05
90 Percentile	4.73E+05	5.10E+05	5.03E+05	5.13E+05
95 Percentile	5.47E+05	5.57E+05	5.73E+05	5.60E+05
		Dose, No Ingestion (P-Sv)		
5 Percentile	1.10E+05	1.68E+05	1.20E+05	1.68E+05
MEDIAN	3.00E+05	3.22E+05	3.12E+05	3.22E+05
MEAN	3.02E+05	3.46E+05	3.19E+05	3.45E+05
90 Percentile	4.60E+05	5.01E+05	4.83E+05	5.01E+05
95 Percentile	5.38E+05	5.49E+05	5.57E+05	5.49E+05
		Ingestion Dose (P-Sv)		
5 Percentile	5.52E+02	3.20E+03	8.84E+03	5.34E+02
MEDIAN	5.09E+03	7.99E+03	1.52E+04	9.01E+03
MEAN	1.10E+04	1.25E+04	2.11E+04	2.17E+04
90 Percentile	2.89E+04	2.64E+04	3.76E+04	5.54E+04
95 Percentile	3.30E+04	3.31E+04	4.80E+04	7.38E+04
		Early Fatalities		
5 Percentile	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEDIAN	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEAN	0.00E+00	0.00E+00	0.00E+00	0.00E+00
90 Percentile	0.00E+00	0.00E+00	0.00E+00	0.00E+00
95 Percentile	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		Latent Fatalities		
5 Percentile	5.20E+03	5.71E+03	6.06E+03	8.22E+03
MEDIAN	1.14E+04	1.23E+04	1.18E+04	1.26E+04
MEAN	1.31E+04	1.49E+04	1.42E+04	1.54E+04
90 Percentile	2.03E+04	2.08E+04	2.08E+04	2.13E+04
95 Percentile	2.31E+04	2.30E+04	2.40E+04	2.34E+04
		Hypothyroidism Morbidities		
5 Percentile	0.00E+00		0.00E+00	0.00E+00
MEDIAN	1.20E+00	9.26E-01	2.05E+00	9.31E-01
MEAN	2.87E+01	1.70E+01	2.44E+01	1.71E+01
90 Percentile	6.19E+01	3.44E+01	5.29E+01	3.49E+01
95 Percentile	1.30E+02	7.89E+01	1.15E+02	7.89E+01
		Latent Fatalities (No Ingestion)		
5 Percentile	4.81E+03	7.44E+03	5.47E+03	7.44E+03
MEDIAN	1.11E+04	1.20E+04	1.15E+04	1.20E+04
MEAN	1.26E+04	1.43E+04	1.33E+04	1.43E+04
90 Percentile	1.96E+04	2.06E+04	2.02E+04	2.06E+04
95 Percentile	2.28E+04	2.27E+04	2.33E+04	2.27E+04
		Relocated Population		
5 Percentile	1.00E+03	6.25E+02	1.05E+03	6.25E+02
MEDIAN	1.69E+04	1.49E+04	1.87E+04	1.49E+04
MEAN	3.28E+04	3.30E+04	4.06E+04	3.30E+04
90 Percentile	7.41E+04	8.55E+04	1.11E+05	8.55E+04
95 Percentile	1.14E+05	1.13E+05	1.49E+05	1.13E+05

		Crop Disposal Area (km2)		
5 Percentile	3.52E+03	5.03E+03	4.12E+03	4.95E+03
MEDIAN	9.77E+03	1.34E+04	1.17E+04	1.31E+04
MEAN	1.15E+04	1.63E+04	1.38E+04	1.62E+04
90 Percentile	2.24E+04	2.71E+04	2.17E+04	2.71E+04
95 Percentile	2.52E+04	3.17E+04	2.53E+04	3.17E+04

Single-Phase, No C/M (Case 3)

		Total EDEWBODY (P-Sv)		
5 Percentile	2.04E+05	1.63E+05	2.33E+05	2.14E+05
MEDIAN	5.45E+05	4.21E+05	6.56E+05	5.59E+05
MEAN	6.19E+05	4.73E+05	8.79E+05	6.40E+05
90 Percentile	1.02E+06	7.24E+05	1.30E+06	1.06E+06
95 Percentile	1.13E+06	8.35E+05	1.49E+06	1.17E+06
		Dose, No Ingestion (P-Sv)		
5 Percentile	9.53E+04	1.13E+05	1.12E+05	1.13E+05
MEDIAN	3.05E+05	3.19E+05	3.17E+05	3.19E+05
MEAN	3.22E+05	3.47E+05	3.44E+05	3.46E+05
90 Percentile	5.13E+05	5.39E+05	5.34E+05	5.39E+05
95 Percentile	6.36E+05	6.49E+05	6.66E+05	6.49E+05
		Ingestion Dose (P-Sv)		
5 Percentile	1.70E+03		1.67E+04	1.37E+03
MEDIAN	1.45E+05	6.19E+04	2.47E+05	1.25E+05
MEAN	2.97E+05	1.26E+05	5.35E+05	2.94E+05
90 Percentile	5.51E+05	2.54E+05	1.06E+06	5.78E+05
95 Percentile	5.81E+05	2.91E+05	1.10E+06	6.25E+05
		Early Fatalities		
5 Percentile	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEDIAN	8.95E-03	1.23E-02	4.29E-02	1.23E-02
MEAN	3.52E+01	3.97E+01	3.96E+01	3.97E+01
90 Percentile	1.28E+02	1.03E+02	1.07E+02	1.03E+02
95 Percentile	2.19E+02	2.46E+02	1.88E+02	2.46E+02
		Latent Fatalities		
5 Percentile	8.69E+03	7.87E+03	1.05E+04	9.74E+03
MEDIAN	2.36E+04	1.78E+04	2.86E+04	2.36E+04
MEAN	2.77E+04	2.01E+04	4.02E+04	2.85E+04
90 Percentile	4.36E+04	2.97E+04	7.51E+04	4.56E+04
95 Percentile	5.16E+04	3.42E+04	8.03E+04	5.27E+04
		Hypothyroidism Morbidities		
5 Percentile	5.00E-03	1.41E-02	0.00E+00	5.69E-02
MEDIAN	4.40E+01	4.82E+01	4.95E+01	4.82E+01
MEAN	2.28E+02	2.80E+02	2.40E+02	2.80E+02
90 Percentile	6.53E+02	8.19E+02	6.87E+02	8.19E+02
95 Percentile	1.00E+03	1.36E+03	1.21E+03	1.36E+03
		Latent Fatalities (No Ingestion)		
5 Percentile	3.90E+03	4.73E+03	4.38E+03	4.73E+03
MEDIAN	1.13E+04	1.19E+04	1.17E+04	1.19E+04
MEAN	1.33E+04	1.43E+04	1.42E+04	1.42E+04
90 Percentile	2.13E+04	2.21E+04	2.19E+04	2.21E+04
95 Percentile	2.59E+04	2.64E+04	2.73E+04	2.64E+04

Two-Phase+Energy (Case 5)

		Total EDEWBODY (P-Sv)		
5 Percentile	1.05E+05	1.23E+05	1.22E+05	1.23E+05
MEDIAN	2.90E+05	3.18E+05	3.12E+05	3.18E+05
MEAN	3.08E+05	3.39E+05	3.36E+05	3.41E+05
90 Percentile	4.94E+05	5.05E+05	5.10E+05	5.09E+05
95 Percentile	5.74E+05	5.81E+05	6.01E+05	5.84E+05
		Dose, No Ingestion (P-Sv)		
5 Percentile	1.01E+05	1.19E+05	1.15E+05	1.19E+05
MEDIAN	2.68E+05	3.14E+05	3.04E+05	3.13E+05
MEAN	3.01E+05	3.32E+05	3.21E+05	3.32E+05
90 Percentile	4.84E+05	5.04E+05	5.03E+05	4.99E+05
95 Percentile	5.70E+05	5.80E+05	5.89E+05	5.76E+05
		Ingestion Dose (P-Sv)		
5 Percentile	5.35E+02	2.82E+03	5.95E+03	5.46E+02
MEDIAN	2.80E+03	4.82E+03	1.23E+04	3.63E+03
MEAN	6.30E+03	6.80E+03	1.49E+04	8.86E+03
90 Percentile	1.48E+04	9.77E+03	2.34E+04	1.96E+04
95 Percentile	2.90E+04	2.03E+04	2.87E+04	4.46E+04
		Early Fatalities		
5 Percentile	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEDIAN	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEAN	6.98E-04	2.34E-05	4.00E-01	2.34E-05
90 Percentile	0.00E+00	0.00E+00	0.00E+00	0.00E+00
95 Percentile	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		Latent Fatalities		
5 Percentile	4.34E+03	5.71E+03	5.57E+03	5.73E+03
MEDIAN	1.12E+04	1.17E+04	1.17E+04	1.18E+04
MEAN	1.28E+04	1.41E+04	1.40E+04	1.43E+04
90 Percentile	2.04E+04	2.10E+04	2.11E+04	2.11E+04
95 Percentile	2.38E+04	2.41E+04	2.50E+04	2.41E+04
		Hypothyroidism Morbidities		
5 Percentile	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEDIAN	7.14E+00	4.69E+00	4.98E+00	4.66E+00
MEAN	9.06E+01	1.14E+02	8.98E+01	1.11E+02
90 Percentile	2.11E+02	2.66E+02	2.22E+02	2.44E+02
95 Percentile	3.94E+02	5.66E+02	4.06E+02	5.40E+02
		Latent Fatalities (No Ingestion)		
5 Percentile	4.02E+03		4.68E+03	5.49E+03
MEDIAN	1.10E+04	1.15E+04	1.15E+04	1.15E+04
MEAN	1.25E+04	1.38E+04	1.33E+04	1.38E+04
90 Percentile	2.03E+04	2.05E+04	2.07E+04	2.05E+04
95 Percentile	2.37E+04	2.37E+04	2.47E+04	2.37E+04
		Relocated Population		
5 Percentile	2.08E+01	3.95E+01	5.25E+01	3.95E+01
MEDIAN	1.14E+04	1.02E+04	1.00E+04	1.02E+04
MEAN	5.89E+04	4.30E+04	4.91E+04	4.30E+04
90 Percentile	1.75E+05	1.32E+05	1.45E+05	1.32E+05
95 Percentile	2.58E+05	2.04E+05	2.34E+05	2.04E+05
		Crop Disposal Area (km2)		
5 Percentile	2.12E+03	3.13E+03	2.16E+03	2.28E+03
MEDIAN	5.50E+03	7.33E+03	8.91E+03	6.70E+03
MEAN	8.28E+03	9.15E+03	1.03E+04	8.83E+03
90 Percentile	2.03E+04	2.01E+04	1.73E+04	2.00E+04
95 Percentile	2.45E+04	2.10E+04	2.17E+04	2.04E+04

Low Magnitude (Case 6)

	Total EDEWBODY (P-Sv)			
5 Percentile	1.59E+03	1.48E+03	2.08E+03	2.01E+03
MEDIAN	4.19E+03	3.71E+03	4.90E+03	4.56E+03
MEAN	4.90E+03	4.24E+03	6.16E+03	5.23E+03
90 Percentile	7.90E+03	6.30E+03	1.05E+04	8.30E+03
95 Percentile	8.95E+03	7.43E+03	1.13E+04	9.41E+03
	Dose, No Ingestion (P-Sv)			
5 Percentile	9.59E+02	1.13E+03	1.13E+03	1.13E+03
MEDIAN	3.05E+03	3.20E+03	3.17E+03	3.20E+03
MEAN	3.22E+03	3.47E+03	3.45E+03	3.46E+03
90 Percentile	5.15E+03	5.40E+03	5.35E+03	5.39E+03
95 Percentile	6.38E+03	6.49E+03	6.67E+03	6.47E+03
	Ingestion Dose (P-Sv)			
5 Percentile	9.38E+00		1.62E+02	9.01E+00
MEDIAN	8.26E+02	4.26E+02	1.10E+03	8.05E+02
MEAN	1.69E+03	7.77E+02	2.71E+03	1.76E+03
90 Percentile	5.11E+02	2.21E+03	8.17E+03	5.02E+03
95 Percentile	5.60E+03	2.64E+03	1.03E+04	5.53E+03
	Early Fatalities			
5 Percentile	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEDIAN	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEAN	0.00E+00	0.00E+00	0.00E+00	0.00E+00
95 Percentile	0.00E+00	0.00E+00	0.00E+00	0.00E+00
90 Percentile	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Latent Fatalities			
5 Percentile	7.45E+01	7.12E+01	9.08E+01	9.08E+01
MEDIAN	1.84E+02	1.48E+02	2.09E+02	1.92E+02
MEAN	2.14E+02	1.79E+02	2.73E+02	2.28E+02
90 Percentile	3.45E+02	2.60E+02	5.29E+02	3.54E+02
95 Percentile	3.91E+02	3.03E+02	6.20E+02	3.99E+02
	Hypothyroidism Morbidities			
5 Percentile	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEDIAN	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEAN	3.97E-03	2.65E-03	3.62E-03	2.65E-03
90 Percentile	0.00E+00	0.00E+00	0.00E+00	0.00E+00
95 Percentile	1.25E-02	7.76E-03	6.07E-03	7.76E-03
	Latent Fatalities (No Ingestion)			
5 Percentile	3.93E+01	4.69E+01	4.43E+01	4.69E+01
MEDIAN	1.13E+02	1.19E+02	1.17E+02	1.19E+02
MEAN	1.33E+02	1.43E+02	1.42E+02	1.42E+02
90 Percentile	2.12E+02	2.21E+02	2.19E+02	2.21E+02
95 Percentile	2.57E+02	2.65E+02	2.73E+02	2.65E+02
	Relocated Population			
5 Percentile	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEDIAN	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEAN	3.24E+01	3.42E+01	3.50E+01	3.42E+01
90 Percentile	7.18E+01	2.59E+01	5.28E+01	2.59E+01
95 Percentile	2.51E+02	1.26E+02	7.36E+01	1.26E+02
	Crop Disposal Area (km2)			
5 Percentile	5.49E+00	6.06E+00	1.05E+01	6.06E+00
MEDIAN	7.43E+01	7.55E+01	2.22E+02	7.21E+01
MEAN	1.77E+02	1.56E+02	3.25E+02	1.54E+02
90 Percentile	5.15E+02	4.42E+02	7.36E+02	4.41E+02
95 Percentile	6.78E+02	5.23E+02	9.52E+02	5.23E+02
	Cost of Relocation (ECU)			
5 Percentile	2.50E+02	0.00E+00	2.54E+02	2.53E+02
MEDIAN	3.90E+05	5.15E+04	3.25E+05	3.26E+05
MEAN	1.32E+06	1.19E+06	1.38E+06	1.38E+06
90 Percentile	2.60E+06	8.88E+05	1.67E+06	9.27E+05
95 Percentile	1.00E+07	3.66E+06	2.66E+06	3.66E+06

		Cost of Food Bans (ECU)		
5 Percentile	2.24E+06	2.52E+06	5.12E+06	2.52E+06
MEDIAN	3.25E+07	3.31E+07	1.58E+08	3.13E+07
MEAN	7.62E+07	6.38E+07	2.98E+08	6.65E+07
90 Percentile	2.33E+08	2.02E+08	7.82E+08	2.02E+08
95 Percentile	2.92E+08	2.15E+08	1.01E+09	2.19E+08

Three-Phase (Case 7)

		Total EDEWBODY (P-Sv)		
5 Percentile	1.01E+05	1.25E+05	1.18E+05	1.26E+05
MEDIAN	2.77E+05	3.20E+05	3.06E+05	3.22E+05
MEAN	2.97E+05	3.45E+05	3.22E+05	3.49E+05
90 Percentile	4.58E+05	5.05E+05	4.81E+05	5.19E+05
95 Percentile	5.47E+05	5.77E+05	5.74E+05	5.90E+05
		Dose, No Ingestion (P-Sv)		
5 Percentile	9.59E+04	1.20E+05	1.09E+05	1.20E+05
MEDIAN	2.60E+05	3.18E+05	2.98E+05	3.17E+05
MEAN	2.91E+05	3.37E+05	3.09E+05	3.36E+05
90 Percentile	4.43E+05	5.02E+05	4.65E+05	4.99E+05
95 Percentile	5.35E+05	5.74E+05	5.62E+05	5.73E+05
		Ingestion Dose (P-Sv)		
5 Percentile	5.02E+02	2.98E+03	5.60E+03	4.81E+02
MEDIAN	1.94E+03	4.70E+03	1.16E+04	5.07E+03
MEAN	6.52E+03	7.70E+03	1.35E+04	1.24E+04
90 Percentile	1.47E+04	1.67E+04	2.15E+04	2.72E+04
95 Percentile	2.58E+04	2.65E+04	2.65E+04	5.80E+04
		Early Fatalities		
5 Percentile	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEDIAN	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEAN	2.00E-01	5.96E-02	1.75E-01	5.96E-02
90 Percentile	1.21E-01	8.59E-03	3.55E-02	8.59E-03
95 Percentile	7.53E-01	8.77E-02	4.32E-01	1.03E-01
		Latent Fatalities		
5 Percentile	3.93E+03	5.88E+03	5.05E+03	5.93E+03
MEDIAN	1.09E+04	1.17E+04	1.14E+04	1.19E+04
MEAN	1.23E+04	1.42E+04	1.33E+04	1.44E+04
90 Percentile	1.88E+04	2.06E+04	1.96E+04	2.13E+04
95 Percentile	2.27E+04	2.37E+04	2.39E+04	2.44E+04
		Hypothyroidism Morbidities		
5 Percentile	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MEDIAN	4.17E+00	2.67E+00	3.19E+00	2.67E+00
MEAN	8.69E+01	9.37E+01	8.77E+01	9.27E+01
90 Percentile	2.10E+01	2.50E+02	2.16E+02	2.48E+02
95 Percentile	3.68E+02	5.26E+02	3.79E+02	5.24E+02
		Latent Fatalities (No Ingestion)		
5 Percentile	3.86E+03	5.68E+03	4.40E+03	5.68E+03
MEDIAN	1.07E+04	1.16E+04	1.11E+04	1.16E+04
MEAN	1.20E+04	1.39E+04	1.27E+04	1.38E+04
90 Percentile	1.83E+04	2.04E+04	1.93E+04	2.04E+04
95 Percentile	2.23E+04	2.36E+04	2.36E+04	2.35E+04
		Relocated Population		
5 Percentile	5.44E+01	5.19E+01	7.65E+01	5.19E+01
MEDIAN	1.10E+04	1.16E+04	1.08E+04	1.16E+04
MEAN	5.57E+04	4.66E+04	5.40E+04	4.66E+04
90 Percentile	1.73E+05	1.42E+05	1.78E+05	1.42E+05
95 Percentile	2.54E+05	2.14E+05	2.59E+05	2.14E+05
		Crop Disposal Area (km2)		
5 Percentile	2.07E+03	3.26E+03	2.10E+03	3.24E+03
MEDIAN	5.53E+03	9.37E+03	8.91E+03	9.21E+03
MEAN	8.56E+03	1.27E+04	1.03E+04	1.21E+04
90 Percentile	2.09E+04	2.35E+04	1.74E+04	2.28E+04
95 Percentile	2.57E+04	2.82E+04	2.20E+04	2.80E+04

MEAN VALUES

Case 1

Total EDEWBODY (P-Sv)	2.94E+05	3.18E+05	3.23E+05	3.18E+05
Dose, No Ingestion (P-Sv)	2.88E+05	3.13E+05	3.10E+05	3.12E+05
Ingestion Dose (P-Sv)	5810	5710	13700	6210
Early Fatalities	1.26	1.88	2.23	1.88
Latent Fatalities	12200	13100	13400	13100
Hypothyroidism Morbidities	115	160	114	154
Latent Fatalities (No Ingestion)	11900	12900	12800	12800
Relocated Population	52900	47400	61000	47300
Crop Disposal Area (km2)	8130	8630	10300	8670
Cost of Relocation (ECU)	2.01E+09	1.94E+09	2.33E+09	1.84E+09
Cost of Food Bans (ECU)	3.51E+09	3.52E+09	8.98E+09	3.74E+09

Case 2

Total EDEWBODY (P-Sv)	3.13E+05	3.58E+05	3.40E+05	3.67E+05
Dose, No Ingestion (P-Sv)	3.02E+05	3.46E+05	3.19E+05	3.45E+05
Ingestion Dose (P-Sv)	11000	12500	21100	21700
Early Fatalities	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Latent Fatalities	13100	14900	14200	15400
Hypothyroidism Morbidities	28.7	17.0	24.4	17.1
Latent Fatalities (No Ingestion)	12600	14300	13300	14300
Relocated Population	32800	33000	40600	33000
Crop Disposal Area (km2)	11500	16300	13800	16200

Case 3

Total EDEWBODY (P-Sv)	6.19E+05	4.73E+05	8.79E+05	6.40E+05
Dose, No Ingestion (P-Sv)	3.22E+05	3.47E+05	3.44E+05	3.46E+05
Ingestion Dose (P-Sv)	2.97E+05	1.26E+05	5.35E+05	2.94E+05
Early Fatalities	35.2	39.7	39.6	39.7
Latent Fatalities	27700	20100	40200	28500
Hypothyroidism Morbidities	228	280	240	280
Latent Fatalities (No Ingestion)	13300	14300	14200	14200

Case 5

Total EDEWBODY (P-Sv)	3.08E+05	3.39E+05	3.36E+05	3.41E+05
Dose, No Ingestion (P-Sv)	3.01E+05	3.32E+05	3.21E+05	3.32E+05
Ingestion Dose (P-Sv)	6300	6800	14900	8860
Early Fatalities	6.98E-04	2.39E-05	4.00E-01	2.34E-05
Latent Fatalities	12800	14100	14000	14300
Hypothyroidism Morbidities	91	114	90	111
Latent Fatalities (No Ingestion)	12500	13800	13300	13800
Relocated Population	58900	43000	49100	43000
Crop Disposal Area (km2)	8280	9150	10300	8830

Case 6

Total EDEWBODY (P-Sv)	4900	4240	6160	5230
Dose, No Ingestion (P-Sv)	3220	3470	3450	3460
Ingestion Dose (P-Sv)	1690	777	2710	1760
Early Fatalities	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hypothyroidism Morbidities	3.97E-03	2.65E-03	3.62E-03	2.65E-03
Latent Fatalities	214	179	273	228
Latent Fatalities (No Ingestion)	133	143	142	142
Relocated Population	32	34	35	34
Crop Disposal Area (km2)	177	156	325	154
Cost of Relocation (ECU)	1.32E+06	1.19E+06	1.38E+06	1.38E+06
Cost of Food Bans (ECU)	7.62E+07	6.38E+07	2.98E+08	6.65E+07

Case 7

Total EDEWBODY (P-Sv)	2.97E+05	3.45E+05	3.22E+05	3.49E+05
Dose, No Ingestion (P-Sv)	2.91E+05	3.37E+05	3.09E+05	3.36E+05
Ingestion Dose (P-Sv)	6520	7700	13500	12400
Early Fatalities	2.00E-01	5.96E-02	1.75E-01	5.96E-02
Hypothyroidism Morbidities	87	94	88	93
Latent Fatalities	12300	14200	13300	14400
Latent Fatalities (No Ingestion)	12000	13900	12700	13800
Relocated Population	55700	46600	54000	46600
Crop Disposal Area (km2)	8560	12700	10300	12100

Appendix F: Specification Paper

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1. INTRODUCTION

Probabilistic consequences assessment (PCA) models are an important element of nuclear safety evaluation and, correspondingly, a fairly large number have been developed throughout the world. Given the existence of these models, which are invariably embodied in computer codes, it is relevant to ask how the calculations of each compare: do the various methods invoke different assumptions and how significant are any differences in calculated risks, from the point of view of the decision-making/ regulatory process? To this situation must be added the role of quality assurance of risk assessment techniques. It is essential that assessment methods are able to demonstrate a level of quality in order to justify their use in the decision-making context. Given all of this, it is clear that an international comparison of PCA codes is of some considerable value. Such activities not only facilitate a comparison of assumptions and results, they can also be considered as contributing to quality assurance, in that a particular set of assumptions and models may be more clearly understood and, thereby, better defended; moreover, by participating in the exercise, residual software problems may be discovered. An additional advantage of such code comparisons is that they serve to enhance the understanding of PCA methods.

An international PCA code comparison exercise of the kind referred to above was performed under the auspices of the OECD/NEA/CSNI in the early 1980's (Ref 1). This proved to be very valuable, providing a good check on the quality of the codes in general use at that time and providing a benchmark against which subsequent developments could be judged. However since then, a significant number of new models and codes have been produced and it is now felt appropriate to initiate a further study. In addition to its quality assurance role, the new study will complement the earlier exercise. In contrast to the earlier work where much attention was focused on the output from the individual modelling components of a consequence analysis (eg atmospheric dispersion, dosimetry), the new work will have a greater focus on the modelling endpoints of more immediate relevance to risk assessments (eg doses, health effects, number of people affected by countermeasures). Moreover, whereas the earlier exercise was limited in the exposure pathways and consequences addressed, these being determined by the state of development of PCA codes at that time, the new exercise will be comprehensive. Finally, the new exercise is also intended to encourage the harmonization of PCA codes.

This paper presents a specification for the new exercise. It has been prepared by the project management group (the composition of which is given in Appendix E) taking account of the views expressed, on a preliminary specification, at the September 1989 meeting of the NEA Task Group on Environmental Consequences of Accidents.

This specification paper will be followed by a second document, which will accompany the data to be used by all participants and contain a detailed set of instructions on their use, etc.

2. OBJECTIVES

The study will have the following objectives:

a. To contribute to PCA code quality assurance programs.
b. To guide future developments in the PCA field by identifying the merits and appropriate use of different methods.
c. To enhance the general appreciation of the applicability of PCA codes by those who develop and use them, particularly in decision making and regulatory contexts.
d. To provide a forum for discussion on various international approaches to PCA model and code development, and to encourage harmonization of codes.
e. To produce a report on the exercise which will act as a basic PCA code comparison reference.

In addition to the above, it is also expected that the exercise will generally increase the understanding of uncertainties in PCA codes and thereby assist in the identification of priorities for future research.

3 SPECIFICATION

3.1 General Features

The aim of the current exercise is to compare the results of PCA codes mainly with respect to those consequences of direct relevance to risk assessments. Thus, attention will be focused on consequences such as, doses, health effects and numbers of people affected by countermeasures, where these are expressed in a probabilistic format. It is, however, recognized that it may be necessary to consider other types of output in order to help explain some of the observed differences between codes. This has been taken account of in determining the list of endpoints specified in Section 3.4 below. *(Authors note: all references to various sections in this appendix are limited to Appendix F only.)* It may be necessary, of course, to add to this list as the project proceeds; however, it is considered more efficient to do this as and when the need arises as opposed to specifying a much larger list at this stage. Having said this, though, participants should not artificially limit their codes to calculating the endpoints specified; i.e., any output not asked for but which is normally calculated should be retained for possible future reference.

An additional feature of the specification, aimed at helping to explain observed differences, is that calculations will be performed under a range of assumptions. For example, some situations will be simulated with and without countermeasures, and with and without consideration of exposure from the ingestion of foodstuffs.

The problems to be tackled by participants are specified in fairly general terms, allowing the whole consequence assessment procedure to be tested. For example, population and agricultural data for the site to be studied will be provided on grids with element areas of 1 km^2 out to 50 km, 10^2 km^2 out to 500 km, and 10^4 km^2 beyond. It is up to individual participants how they utilize this in devising input data for their code; e.g., population data is usually on a polar grid within a code and participants should construct their own polar grid data using the information provided. (Different codes will possibly use polar grids of different sizes). Thus, one of the basic ideas underlying the exercise is that each participating organization should view itself as being commissioned to perform a series of risk calculations (with pre-defined risk endpoints), using a set of source terms, a body of data which defines a site and other information such as, the local countermeasures strategy, etc.

The data specified for the exercise have been chosen solely to carry out the code comparison and they have no absolute significance. Indeed, in the interests of facilitating the code comparison, the data adopted may on occasion be either overly simplified or unrepresentative.

3.2 Data Specifications for Project

The following indicates the nature of the data to be presented to participants. That data which essentially specifies the release site and its surrounding characteristics (population, agriculture) has been chosen solely for this exercise, they cannot be associated with any particular site.

Some of the following sections specify actual data, whereas others simply state how data for the exercise will be presented. In general where the amount of data is very small (eg shielding and filtering factor data) it is given below;

where it is large (e.g., population data) only the general features are described. Fuller data will be supplied later either in a supplementary document or on computer tapes or disks.

3.2.1 Population Data

Out to 50 km population data will be provided on a grid with element areas of 1 km^2. Between 50 km and 500 km, information will be presented on a grid with element areas of 10^2 km^2. Beyond this, out to 2000 km, data will be specified on a grid with element areas of 10^4 km^2. The regions for which 1 km^2, 10^2 km^2 and 10^4 km^2 gridded data will be made available are shown in Figure F1. Although the data extends beyond 2,000 km in some directions, for this exercise, consequences are only to be calculated out to a distance of 2,000 km.

3.2.2 Agricultural Data

Agricultural information will be specified on the same grids as the population data. The following will be provided:

a. cows' milk (consumed as milk kg/yr)
b. cows' milk products (kgs of milk used in milk products kg/yr
c. green vegetables (kg/yr)
d. root vegetables (kg/yr)
e. cows' meat (kg/yr)
f. cows' liver (kg/yr)
g. sheep meat (kg/yr)
h. sheep liver (kg/yr)
i. grain (kg/yr)

The agricultural production data, listed above, will be the quantities produced for human consumption only. Further, it will be assumed that all of the food produced within the area out to 2000 km is consumed by the population within the region (ie no food is exported outside the area of study). This data is provided for the evaluation of ingestion doses.

Farming and marketing/consumption practices for the various foodstuffs are given in Table F1. This information has been included for those whose codes or data can incorporate such assumptions. Nevertheless, it is appreciated that not all codes may be able to take these practices fully into account. In any event, the aim is to use annual `average' data on activity and time-integrated activity concentrations in food (per unit air or ground concentration) to represent the effect of accidents occurring at any time of the year.

It is recognized that the various codes may treat foodchain calculations with differing levels of complexity. To allow the effects of this on the comparison process to be identified, participants are asked to perform calculations with and without the ingestion pathway (see Section 3.3).

A number of codes require additional agricultural data for use by their economic models. For these codes the following additional agricultural data is provided:

j. number of livestock (assumed to be sheep and cattle only) within grid element
k. area of land within grid element (km^2) on which crops are grown (for some grid elements only a fraction of the land will be devoted to agriculture).

The total area of crop producing land out to 2000 km is 1.0 x 10^6 km^2 (Ref. F2). This is the total area of land producing grain, green vegetables and root vegetables and includes the production of these crops for purposes other than human consumption.

3.2.3 Economic Data

Economic data for the hypothetical region will be supplied. This will include regional information on aspects such as the value of the land and its assets, and the contribution to the economy by a number of economic sectors. The information will be based on the contributions to Gross Domestic Product (GDP), and will be specified in terms of the European Currency Unit (ECU).

Full details of the economic data to be used in the exercise will be provided in the data specification document (Ref 2).

3.2.4 Meteorological Data

One years worth of hourly meteorological information, relevant to the release location and covering wind speed (ms^{-1}), wind direction, stability category (Pasquill), rainfall (mm) and mixing layer depth (m) will be provided. Additionally, for the year in question, information from the "MESOS" data base will be made available.

3.2.5 Shielding and Filtering Factors

For simplicity within the comparison exercise, it will be assumed that the buildings in the area of interest can be characterized by one set of shielding and filtering factors, defined as the ratio of the dose inside to that outside. The following factors are regarded as being typical of European houses and should be used by participants:

a. Shielding factor for cloud gamma dose = 0.1.
b. Shielding factor for deposited gamma dose = 0.1.
c. Filtering factor for inhaled dose = 0.5.
d. Filtering factor for inhaled dose from resuspension = 0.5.

During normal living conditions it should be assumed that individuals spend 90% of their time indoors (benefiting from the above dose reductions) and 10% outdoors. This implies that the following average shielding and filtering factors should be used by participants:

a. Shielding factor for cloud gamma dose = 0.19
b. Shielding factor for deposited gamma dose = 0.19
c. Filtering factor for inhaled dose = 0.55
d. Filtering factor for inhaled dose from resuspension = 0.55

These average shielding and filtering factors should be applied to individuals in all areas and at all times, with the exception of those individuals who shelter prior to evacuation (see Section 3.2.7). Participants should also assume that deposition on skin indoors is half of that outdoors.

3.2.6 Deposition Velocity and Washout Coefficient

In the first instance, participants should use the following deposition data:

Dry deposition velocity:	noble gases	$0\ ms^{-1}$
	organic iodine	$5 \times 10^{-4}\ ms^{-1}$
	others (as 1 micron AMAD in oxide form)	$1 \times 10^{-3}\ ms^{-1}$
Washout coefficient:	of the form AJ^B (except for noble gases when coefficient = 0) where J = rain rate in mm hr^{-1} $A = 1 \times 10^{-4} s^{-1}$ per mm hr^{-1} (except for organic iodine when $A = 1 \times 10^{-6}\ s^{-1}$ per mm hr^{-1}) B = 0.8	

Standardizing according to the above will eliminate a known potential difference between the various codes. However, at a later stage in the exercise, participants will be asked to repeat some calculations using the deposition data they would normally select themselves, given the physico-chemical form of the released material (see Section 3.3).

Deposition on skin (both dry and wet) should be taken to be 1/10th of that on the ground.

3.2.7 Countermeasures Information

It is recognized that assumptions concerning countermeasures can have a marked impact on estimated risks and that a number of different countermeasures models (and associated assumptions) exist. To minimize differences which arise simply from different assumptions, it is desirable to standardize the calculations as much as possible. In order to achieve this a highly simplified countermeasures strategy is specified in this section. Participants are requested to simulate the various actions as closely as possible. To provide insights into any residual differences, participants are also asked to perform certain calculations both with and without countermeasures (see Section 3.3).

It is acknowledged that the adopted countermeasures strategy is somewhat artificial. It contains elements of existing emergency response plans but has been simplified to facilitate the comparison process.

a. Sheltering

Sheltering is only implemented in a fixed area. The fixed area is defined by a circle of radius 10 km (except for source term ST3 where the radius is 5 km) centered on the release location. For those individuals within the fixed area, sheltering commences 1 hour after the start of the warning time. The warning time is the period of time available for the initiation of countermeasures before the release of activity to the environment; it is specified, for each source term, in Table F4. Sheltering ends when evacuation begins (see below).

It will be assumed that all people in the fixed area shelter. The following shielding and filtering factors should be applied to those sheltering.

a. Shielding factor for cloud gamma dose = 0.05.

b. Shielding factor for deposited gamma dose = 0.05.

c. Filtering factor for inhaled dose = 0.2.

d. Filtering factor for inhaled dose from resuspension = 0.2.

It is thus assumed that active sheltering provides greater shielding and filtering protection than that obtained by buildings during normal activity (compare with data presented in Section 3.2.5). Participants should also assume that deposition on skin indoors is 0.2 of that outdoors.

b. Evacuation

Evacuation is only implemented in a fixed area. The fixed area is the same as that defined above for sheltering. For all people within the fixed area evacuation commences 4 hours after the start of the warning time and is completed instantaneously. For the return of these people evacuated from the fixed area, participants should, with one exception, use their usual defaults. The exception is those people from the fixed area who would be classed as relocatees, see below; their return criterion is that for relocated individuals.

c. Relocation

Relocation refers to the long-term removal of people from a contaminated area to limit chronic exposure, as distinct from evacuation where the aim is to limit short-term doses. Individuals who are initially evacuated may ultimately be regarded as relocatees if they are not allowed to return beyond the short term.

For the present exercise, relocation of individuals will take place seven days after the start of the release, if the projected effective dose equivalent to an individual, exceeds 100 mSv. In this case the projected dose to use is that from the external exposure from deposited gamma and resuspension pathways, integrated over the year following the accident (defined to be from 7 days to 365 days). The exception here is, of course, evacuated individuals who have already moved and who do not return to their property if this threshold is exceeded. For the resuspension route, the relevant dose here is the committed effective dose equivalent from intakes during the year. It will be assumed that in calculating the projected doses that people behave normally (eg spend 90% of this time indoors) and that the shielding and filtering factors specified in Section 3.2.5 apply. Relocated individuals may return to the affected area when the projected annual dose level (as defined above) has fallen to 100 mSv.

For the purposes of this exercise the number of people relocated is thus the number of people who would receive a dose (as defined above) of more than 100 mSv.

d. Control of Foodstuffs

Two cases are specified here:

(i) Each particular food product will be banned from consumption if the individual committed effective dose equivalent to an adult member of a critical group, from the annual intake of the food, is greater than 5 mSv. The food consumption pattern of the critical group member is specified in Table F3.

(ii) Each foodstuff will be banned if the radionuclide concentrations (Bq/kg) exceed the levels presented in Table F2.

For most calculations to be performed, case (i) will apply. Case (ii) will be used for a separate study (see Section 3.3).

e. Decontamination

For simplicity it is assumed that there is no decontamination.

3.2.8 Source Terms

The source term specifies both the magnitude of the release and, by defining a number of release parameters (eg height, duration), the manner of the release. These release characteristics can vary over a wide range, and current PCA codes are designed to model this variability. Hence in order to adequately test the codes it is necessary to compare their predictions for a number of source terms with different release characteristics.

The source terms used for this study are based on those contained in NUREG-1150 (Ref. F3). They were chosen as follows. First a basic source term was adopted. The release magnitude and other parameters of this source term are taken from NUREG-1150. The other source terms used have all been derived from this basic source term by modifying particular release characteristics. The characteristics to be modified were selected to enable the influence of the following to be tested: release magnitude, long duration release, phased release, energy content and particle size distribution. A number of other release characteristics could, in principle, be accounted for in the specification of the project; eg release height, building dimensions. These other characteristics, however, were considered to be of lesser significance and were excluded from the study to keep the number of source terms down to a manageable level.

Although they are based on those contained in NUREG-1150, the source terms used and the risks calculated from them do not reflect conditions at any particular nuclear facility. Additionally, it is worth noting that releases of the general kind considered here are assessed to have an extremely small frequency of occurrence.

Altogether six source terms are specified for this exercise; they are detailed in Table F4. The source terms are labelled ST1 to ST6. The radionuclide inventory to which the release fractions apply is that of a large commercial thermal reactor system; it is specified in the Additional Data and Instructions Paper (Ref. F2). For all source terms, the release will be assumed to occur from a point 10 m above ground level, from a building of height 30 m and effective width 40 m.

ST1 is the basic source term, it is a two phased release with plume rise. ST2 has the same release fractions as ST1 but it is a single phase release without plume rise. ST3 is again a single phase release without plume rise; it, however, has smaller release fractions than ST1, allowing the effect of release magnitude to be investigated. ST4, 5 and 6 all have the same release fractions as ST1. ST4, however, is a three phase release, while ST5 has a long duration. Finally, for ST6 particle size distributions and associated dry deposition characteristics are specified in Table F5.

A uniform rate of release should be assumed for each phase of all releases; this includes releases with only one phase (ST2, ST3 and ST5) and those with more than one (ST1 and ST4).

3.2.9 Other Data Assumptions

Participants should assume that the site is in a middle latitude region which has a rainy climate and experiences mild winters, and should use, if possible, appropriate resuspension factors. Further they should assume that the region is characterized by a roughness length of 0.3 m. Finally, in their evaluation of inhaled dose, participants should use a breathing rate of 2.66×10^{-4} m^3 s^{-1}.

3.3 Calculations to be Performed

Some general features of the calculations need to be noted here. Firstly, participants should take account of all major radiation exposure pathways, including chronic exposure to deposited activity, both external and through foodchains (except where noted below); these pathways were not included in the initial comparison exercise (Ref. F1). Secondly, consequences are only to be calculated within a circle, centered on the release point, of radius 2,000 km. Finally, in utilizing the information presented to them, participants will have to make some assumptions; these must be carefully written down since they are likely to be an important source of information in the comparison process.

Given all of the information presented in Section 3.2 and the need to explain observed differences between the various codes, a number of different types of calculations need to be performed. Calculations need to be performed for the 6 above specified source terms. Additionally, the following calculations are required: with and without countermeasures (see Section 3.2.7); with and without foodchain pathways (Section 3.2.2); with the deposition characteristics specified in Section 3.2.6 and then with the deposition data participants would normally select themselves; with countermeasures on foodstuffs based on activity concentration and then based on dose thresholds (Section 3.2.7).

It is not possible to deal with all the possible permutations and combinations from the above. In order to keep the exercise within manageable proportions, ten Code Comparison Calculations (C1 to 10) are specified; they are detailed in Table F6. In view of the potential complexities associated with economic calculations, reflecting its relative immaturity in the consequence modelling field, participants are only asked (in the first instance) to evaluate economic consequences for C1 and C6. The timetable for performing the various calculations is discussed in Section 4.

3.4 Consequences to be Calculated

The following consequences should (if possible) be calculated. <u>For each consequence, unless stated otherwise (and marked with an *), the Complementary Cumulative Distribution Function (CCDF) along with its expectation value and 50th, 90th, 95th, 99th, and 99.9th percentiles are required. Additionally, the probability of zero effects is required.</u> Since no release probabilities have been specified, all results should be conditional on each release occurring.

a. <u>Dose Consequences</u>

(i) Total collective effective dose equivalent commitment (i.e., over all time) to the whole population from all pathways (person Sv).

(ii) Contribution to the <u>mean</u> value of the CCDF in (i) from each exposure pathway.*

(iii) Adult bone marrow dose, from all pathways excluding food, integrated to one day at the location 1 km from the release point in the direction due north (0°) (Gy).

(iv) Contribution to the <u>mean</u> value of the CCDF in (iii) from each exposure pathway.*

(v) as (iii) but at a distance of 30 km.

(vi) Contribution to the <u>mean</u> value of the CCDF in (v) from each exposure pathway.*

(vii) Adult effective dose equivalent, from all pathways excluding food, integrated to 50 years, at the location 1 km from the release point in the direction due north (0°) (Sv).

(viii) Contribution to the mean value of the CCDF in (vii) from each exposure pathway.*

(ix) As (vii) but at a distance of 30 km.

(x) Contribution to the mean value of the CCDF in (ix) from each exposure pathway.*

(xi) Mean number of people in bands of individual dose (Sv), where the dose is defined as follows: the entire cloudshine dose, plus the entire inhalation dose (effective dose equivalent integrated to 50 years), plus the groundshine dose from 0 to 7 days, plus the resuspension inhalation dose (effective dose equivalent integrated to 50 years) for intakes from 0 to 7 days.* (The dose bands to use are specified on Result Sheet 12 of Ref 2.)

(xii) Total collective effective dose equivalent commitment (ie over all time) to the whole population from all pathways excluding food (man Sv)

The following dose consequence should be calculated for code comparison calculation C3 only:

(xiii) Total collective effective dose equivalent commitment (ie over all time) to the whole population from the ingestion pathway only (man Sv).

b. Health Effects

(i) Number of early deaths.

(ii) Number of fatal cancers (summed over all types).

Where they can readily be extracted from the code the following should also be calculated:

(iii) Contribution that early deaths from bone marrow irradiation, make to the mean value of the CCDF for early deaths.*

(iv) Contribution that early deaths from lung irradiation make to the mean value of the CCDF for early deaths.*

(v) Contribution that early deaths from skin irradiation make to the mean value of the CCDF for early deaths.*

(vi) Number of early morbidities from hypothyroidism.

(vii) Number of fatal cancers from doses for all pathways except ingestion.

c. Effect of Countermeasures on People

The values calculated for the first two consequences under this heading should be constant, as the only evacuation considered is that from a fixed area. They are, however, included for checking purposes.

(i) Total number of people evacuated (mean value only required).*

(ii) Total area of land evacuated (km^2) (mean value only required).*

(iii) Total number of people relocated (including those who were initially evacuated and eventually classed as relocatees, see Section 3.2.7).

(iv) Total area of land relocated (km^2).

(v) Total time integral of the number of people relocated (including those initially evacuated and eventually classed as relocatees, see Section 3.2.7) (person-y).

(vi) Total time integral of the area of land relocated (including areas initially evacuated and eventually classed as relocated land) (km^2-y).

d. Effect of Countermeasures on Agriculture

(i) Mass of milk and milk products banned from consumption (kg).

(ii) Maximum daily yield of milk and milk products lost (l/day) (assume 1 kg milk $\equiv$ 1 liter milk).

(iii) Area of crop growing land from which crops are banned; since this will be a function of time after the accident, it is the maximum area of land affected at any one time which is required (km^2).

(iv) Number of livestock affected; as in (iii), it is the maximum number of livestock affected at any one time which is required.

(v) Total time integral of the crop growing area from which crops are banned (km^2-y).

(vi) Total time integral of the number of livestock affected (livestock-y).

e. Economic Effects

(i) The total cost of moving people (ie those evacuated and/or relocated) (ecu).

(ii) The total cost of food bans (ecu).

(iii) The cost of health effects (early deaths and injuries, fatal and non-fatal cancers) (ecu).

(iv) The sum of the costs (i) to (iii) above (ecu).

Note, in each of the above, the total costs should be obtained by summing over all of the relevant individual elements of cost accounted for in the participants economic model.

f. Individual Risk

In the following cases, participants are asked to calculate mean values, averaged over all weather sequences and wind directions, as a function of distance. The contribution from foodstuffs should be excluded.

(i) Adult individual risk of early death as a function of distance from the release point.*

(ii) Adult individual risk of fatal cancer as a function of distance from the release point.*

g. Atmospheric Dispersion Consequences

In addition to the above consequences, the following are to be calculated for code comparison calculation C1 only (see Table 6):

(i) A CCDF of the time integrated air concentration, at ground level, of Cs-137 at the location 1 km from the release point in the direction due North (0°) ($Bqsm^{-3}$).

(ii) A CCDF of the deposited ground concentration of Cs-137, at the location 1 km from the release point in the direction due North (0°) ($Bq\ m^{-2}$). It is the concentration of Cs-137 at the time at which deposition from the plume ceases (ie the initial deposit) which is required.

(iii) As (i) but at a distance of 30 km.

(iv) As (ii) but at a distance of 30 km.

4. TIME SCALES

With the completion of the pilot study the intention is to finalize this specification paper and also the Additional data and Instructions paper, and distribute them to participants by the end of November 1991. Participants are to complete calculations C1 to C4 of Table F6 by the end of February 1992. Papers containing the results of these calculations will be compiled and distributed to Participants by the end of April 1992. These results will be discussed at the meeting of the Ad-hoc group on the 4 and 5 June 1992. Depending on the outcome of this meeting, the remaining calculations C5 to C10, and any repeat calculations, are to be completed by the end of August 1992. Further papers containing the results of these calculations will be compiled and distributed to Participants by the end of October 1992. These results together with a first draft of the report on the exercise will be discussed at a meeting in December 1992. Lastly, a final meeting of the ad-hoc group to finalize the report on the exercise will be held in March or April 1993.

5. REFERENCES

F1. International comparison study on reactor accident consequences modelling, summary report to CSNI by an NEA group of experts, OECD, Paris, 1984.

F2. Additional Data and Instructions for the Joint NEA/CEC Intercomparison Exercise on Probabilistic Accident Consequence Assessment Codes, NEA/PCA/DOC(91)3 (CCP2 1991 issue C).

F3. U. S. Nuclear Regulatory Commission, Reactor Risk Reference Document, NUREG-1150, 1987.

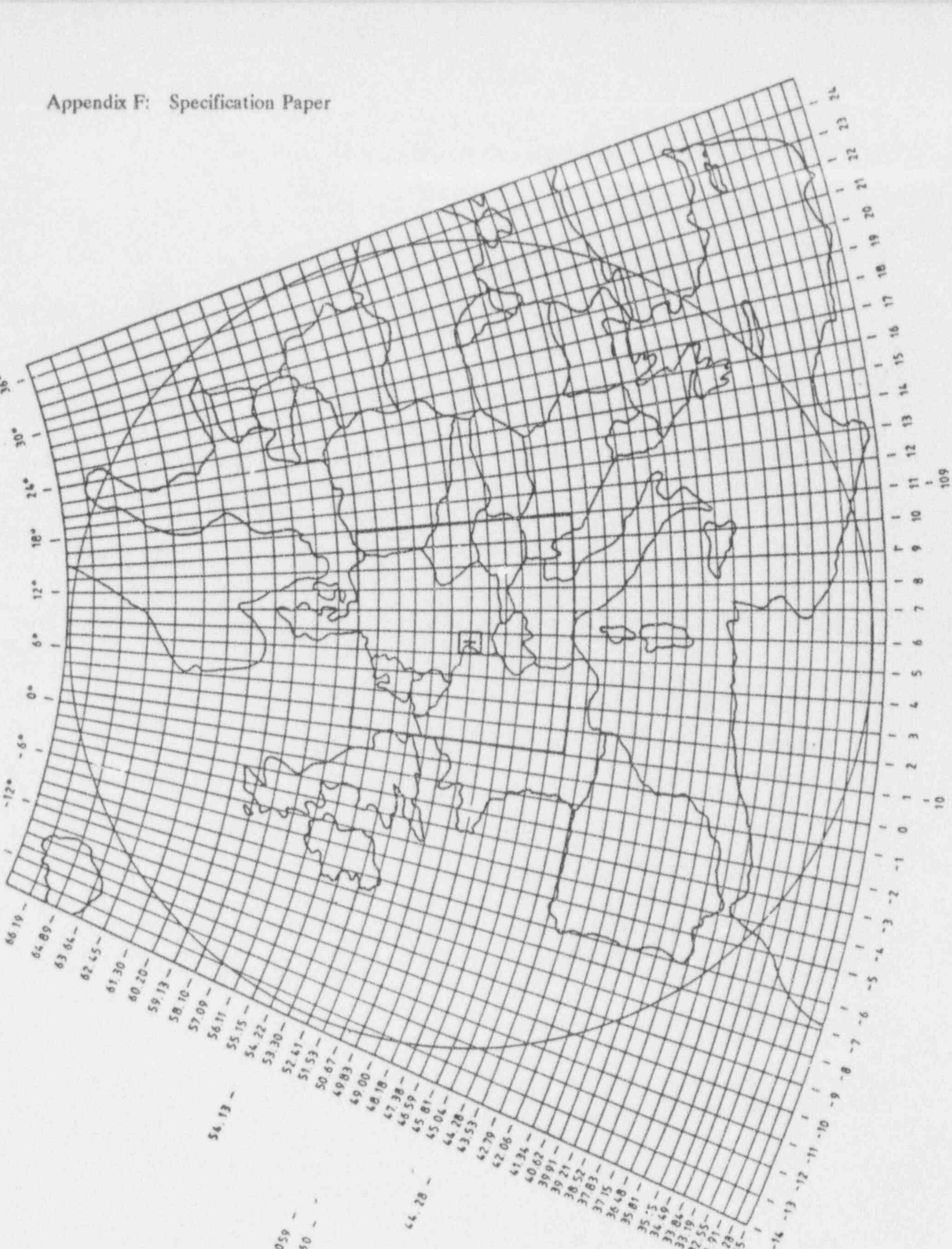

Figure F.1 Illustration of the Notation System for the Gridded Datasets

Table F.1 Farming Practices for Various Foodstuffs

Green Vegetables	Continuously harvested throughout the year
Cereals	Sown at the beginning of May and harvested at the start of September
Root Vegetables	Planted at beginning of February, including potatoes with cropping for consumption occurring from mid-June till the end of October
Cattle and Sheep	Pasture grazing from mid-April till the end of October. For remainder of year, feeding on locally grown silage or hay grown between the beginning of May and mid-September and stored until the start of November.

Mean delay time between harvest or collection of food and consumption:

Cows' Milk	2 days
Cows' Milk Products	30 days
Green Vegetables	5 days (fresh), 90 days (processed)
Root Vegetables	90 days (fresh and processed)
Meat and Liver	10 days (fresh), 90 days (processed)
Grain	The annual harvest of grain is consumed at a uniform rate between 3 and 15 months after harvest

Fraction of food production consumed fresh and processed:-

	Fresh	Processed
Green Vegetables	70%	30%
Root Vegetables	90%	10%
Meat and Liver	70%	30%

Table F.2 Banning Criteria for Foodbans Based on Radionuclide Concentration in Particular Foodstuffs

	Milk & Milk Products (Bq/kg)	Other Foodstuffs (Bq/kg)
Isotopes of strontium, notably Sr-90	125	750
Isotopes of iodine, notably I-131	500	2000
Alpha-emitting isotopes of plutonium and transplutonium element, notably Pu-239, Am-241	20	80
All other nuclides of half-life greater than 10 days, notably Cs-134, Cs-137	1000	1250

Note: Criteria apply to each foodstuff (see Section 3.2.2) separately.

(a) From the Official Journal of the European Committees No. L371/11.

Table F.3 Critical Group Food Consumption Pattern

Food	Adult Consumption Rate[a] (kg/y)
Cows' milk	180
Cows' milk products	130
Green vegetables	180
Root vegetables including potatoes	250
Cows' meat	71
Cows' liver	20
Sheep meat	13
Sheep liver	3.5
Grain	170

(a) Numbers are given to 2 significant figures

(b) From the CEC Program on Underlying Data for Derived Emergency Reference Levels, report in press and Morrey, et al. A preliminary assessment of the radiological impact of the Chernobyl reactor accident on the population of the European Community, EUR 11523, CEC 1988. (The consumption rates for cows' and sheep liver given above were estimated from the consumption rates for cows' and sheep offal quoted in these references.)

NOTE:
The numbers in this table define the diet to be used when calculating food bans. They are not average diet data appropriate for calculating doses to the population at large (ie they do not define a food basket).

Table F.4 Source Term Specification

Source Term	Time Before Release[1] (h)	Duration of Release (h)	Rate of Release (MW)	Release Height (m)	Warning Time[2] (h)	Release Fractions[3]						
						Xe-Kr	Org-I[4]	I	Cs-Rb	Te-Sb	Ba-Sr, Ru[5]	La[6]
ST1	2.0	1.0	2.0	10	1.0	1.0	0.001	0.1	0.1	0.05	0	0
	3.0	5.0	0.2	10	-	-	-	-	-	0.05	0.01	0.001
ST2	2.0	1.0	0	10	1.0	1.0	0.001	0.1	0.1	0.1	0.01	0.001
ST3[7]	2.0	1.0	0	10	1.0	0.01	0.00001	0.001	0.001	0.001	0.0001	0.00001
ST4	2.0	1.0	0	10	1.0	1.0	0.00033	0.033	0.033	0.033	0.0033	0.00033
	3.0	1.0	0	10	-	0	0.00033	0.033	0.033	0.033	0.0033	0.00033
	5.0	1.0	0	10	-	0	0.00033	0.033	0.033	0.033	0.0033	0.00033
ST5	2.0	24.0	0	10	1.0	1.0	0.001	0.1	0.1	0.1	0.01	0.001

STA6 same as for ST2 apart from particle size distribution, see Table 5

[1]Time between shutdown and beginning of release to the environment.
[2]Period of time available for the initiation of countermeasures before the release to the environment begins.
[3]All elements, apart from organic iodine and the noble gases, are assumed to be released in the oxide form and as an aerosol of size of 1 micron AMAD. The release fractions have been applied to the inventory of radionuclides in a 1250 MW(e) reactor [6].
[4]Organic Iodine.
[5]Includes Ru, Rh, Co, Mo. Tc.
[6]Includes Y, La, Zr, Nb, Ce, Pr, Nd, Np, Pu, Am, Cm.
[7]For source term ST3 the radius of the fixed area used for sheltering and evacuation is 5 km.

NOTE: Source term ST1 is based on a two-puff release corresponding to the V-sequence (by-pass) in the NUREG-1150 Study (CR-4551) for the Surry-1 NPP (three-loop PWR). This accident sequence is initiated by a failure of the check valves separating the RCS and the Low Pressure Injection System (LPSI). A release into the environment through the auxiliary building develops following a subsequent failure of the LPSI piping. This source term with some modifications has been used as a prototype for the international intercomparison exercise.

Table F.5 Source Term ST6

This source term is the same as ST2, except that the particulate material (all nuclides other than noble gases and iodine) has the following size distribution and associated dry deposition velocities.

Particle Size Group	Radius Range of Particles	Fraction of Total Mass	V_D (m/s)
1	0.0-0.1	0.093	9.3×10^{-4}
2	0.1-0.16	0.167	4.7×10^{-4}
3	0.16-0.25	0.240	5.6×10^{-4}
4	0.25-0.4	0.251	7.5×10^{-4}
5	0.4-0.64	0.161	1.4×10^{-3}
6	0.64-1.0	0.065	2.8×10^{-3}
7	1.0-1.6	0.019	5.6×10^{-3}
8	1.6-∞	0.004	9.3×10^{-3}

Note:

The above distribution has been devised specifically for the code comparison exercise and should not be used outside that context. It has been constructed (using a particle density of 4 gcm^{-3}) to have an AMAD of 1 μm; additionally the weighted average deposition velocity over the size distribution is 1.0×10^{-3}, ie the value specified in Section 3.2.6.

Table F.6 Code Comparison Calculations

C1	Source term ST2 with: countermeasures, deposition characteristics as specified in Section 3.2.6, ingestion pathways, countermeasures on food based on dose levels (see section 3.2.7)
C2	As C1 but with source term ST5
C3	As C1 but with no countermeasures
C4	As C1 but with no ingestion doses
C5 to C8	As C1 but with source terms ST1, ST3, ST4 and ST6, respectively
C9	As C1 but with participants own choice of deposition characteristics for the specified physico - chemical forms of the released material (see section 3.2.6).
C10	As C1 but with countermeasures on food based on activity levels (see Section 3.2.7)

Appendix G: Population Data Grid Conversion

The task at hand is to calculate the population distribution surrounding a given point on the earth's surface on a polar grid, assuming the population density to have been specified on a nested set of latitude-longitude grids surrounding the the point in question, the successive grids being coarser resolution but defined over a wider area.

The method to be used is as follows: Carry out steps 1–6 for each polar grid box in turn.

1. Select $nsamp^2$ points uniformly distributed in the grid box.

2. Compute the latitude and longitude corresponding to each of these points.

3. Find the finest resolution latitude-longitude grid box containing each interior point and assign the corresponding population density to the point.

4. Average the population density over all interior points.

5. Increase *nsamp* by a specified factor and repeat steps 1–4. If the result differs by more than an acceptable tolerance, repeat step 5.

6. Compute the area of the polar grid box and multiply by the computed density.

Assume a spherical earth, center C, with radius R. Let N be the North Pole, O be the point on the surface with latitude and longitude λ_O, ϕ_O, which is the origin of the polar grid. Let P be an arbitrary point on the surface, having polar grid coordinates (r, α) corresponding to latitude and longitude (λ, ϕ).

We adopt a basic rectangular Cartesian coordinate system with origin at C, such that the $z-$axis is directed towards N, and the $(\hat{x}, \hat{z})$plane contains the point O. At O we choose a rectangular system $(\hat{u}, \hat{v}, \hat{w})$, where the unit vector $\hat{u}$ points along the outward radial direction, so that $\hat{v}, \hat{w}$ lie in the tangent plane with $\hat{w}$ along its intersection with the $(\hat{x}, \hat{z})$ plane, i.e. pointing towards the projection of the point N onto the tangent plane.

These bases are related as follows:

$$\hat{u} \equiv [\cos\lambda_O, \quad 0, \quad \sin\lambda_O]$$
$$\hat{v} \equiv [0, \quad 1, \quad 0]$$
$$\hat{w} \equiv [-\sin\lambda_O, \quad 0, \quad \cos\lambda_O]$$

The polar grid is defined so that r is the distance from O to P along the surface, and α is the angle between the planes (C–O–N) and (C–O–P). If we project the polar grid from C onto the tangent plane at O, i.e. the plane $(\hat{v}, \hat{w})$, then P is projected into a point Q, with coordinates (ρ, α) in the projected grid. Let $\vec{O}$ be the vector from C to O, $\vec{P}$ the vector from C to P, and $\vec{Q}$ the vector from C to Q.

Then $\vec{O} = R\hat{u}$, and

$$\begin{aligned}\vec{Q} &= \vec{O} + \rho \sin\alpha \hat{v} + \rho\cos\alpha\hat{w} \\ &= [(R\cos\lambda_O - \rho\cos\alpha\sin\lambda_O), \quad \rho\sin\alpha, \quad (R\sin\lambda_O + \rho\cos\alpha\cos\lambda_O)]\end{aligned}$$

The vector $\vec{P}$ is given by:

$$\vec{P} = [R\cos\lambda\cos(\phi - \phi_O), \quad R\cos\lambda\sin(\phi-\phi_O), \quad R\sin\lambda]$$

But $\vec{P}$ and $\vec{Q}$ are related by a scale factor:

$$\vec{P} = \vec{Q}\cos(r/R),$$

and ρ and r are related by:

$$\rho = R\tan(r/R).$$

Using these relations and expressing the trigonometric functions in terms of $z = 1 - \cos(r/R)$, we finally obtain:

$$\begin{aligned}\sin\lambda &= (1-z)\sin\lambda_O + \sqrt{z(2-z)}\cos\alpha\sin\lambda_O \\ \phi &= \phi_O + \arctan\left[\frac{\sqrt{z(2-z)}\sin\alpha}{(1-z)\cos\lambda_O - \sqrt{z(2-z)}\cos\alpha\sin\lambda_O}\right]\end{aligned}$$

The surface area element associated with the coordinate system (r, α) is

$$\begin{aligned}dA &= dr \cdot R\sin(r/R)d\alpha \\ &= -R^2 d\cos(r/R)d\alpha \\ &= R^2 dz d\alpha\end{aligned}$$

The polar grid box bounded by $[r_1, r_2]$ and $[\alpha_1, \alpha_2]$ has area

$$A = R^2(z_1 - z_2)(\alpha_1 - \alpha_2)$$

For a given rectangular grid, we assume that we are given the starting latitude λ_0, the number of intervals $nlat$ and the final latitude λ_1. The latitude is divided into equal intervals in $\sin\lambda$, $\Delta_{\sin\lambda} = (\sin\lambda_1 - \sin\lambda_0)/nlat$.

The longitude array is specified by a starting longitude ϕ_0, a spacing Δ_ϕ and a maximum longitude ϕ_1.

A point with latitude and longitude λ, ϕ lies in the rectangular grid box $ilat, ilong$, where

$$ilat = \text{int}\left[\frac{(\sin\lambda - \sin\lambda_0)}{\Delta_{\sin\lambda}}\right]$$

$$ilong = \text{int}\left[\frac{\phi - \phi_0}{\Delta_\phi}\right]$$

To find the best point to use, we start with the smallest grid; if the point is within its data, use it, otherwise go to the next larger grid.

The actual Fortran code is listed below, typeset to make it more readable.

CCPOPMAP.FOR: Complete Fortran Listing.

```
common /latgrid/ sinlat0(3), sinlat1(3), nlat(3), dsinlat(3), glat0(3), glat1(3);
common /longgrid/ xlong0(3), xlong1(3), nlong(3), dlong(3);
common /dens/ d(150, 150, 3);
common /polgrid/ pop(30, 30), r(30), popr(30), popt(30), nr, nalpha, dalpha;
common /ref/ olat, olong, so, co, filnam(3);
common /const/ er, pi, tol, dtr, eps;
common /samp/ nsamp0, nsmax, zs(10000), alphas(10000);

character*12 filnam;
data er/6366.19/;
data glat0/0.0, 0.0, 0.0/glat1/0.0, 0.0, 0.0/eps/.0001/;

pi = 4.0*atan(1.0);
dtr = pi/180.0;

==================
The constants defined or read in here include the specification of the origin
λO, φO (olat, olong), the earths radius er, the limits on number of sample points
and required accuracy, a small value eps to avoid division by zero if one of the input
grid boxes is empty, and the conversion from degrees to radians, dtr.
==================

open(5, file = 'ccpopmap.inp', form = 'formatted', status = 'old') ;
read(5, 666) (filnam(nn), nn = 1, 3);
666: format(a12) ;

read(5, *) tol, nsamp0, nsmax, olat, olong, glat0(1), glat1(1), nalpha, nr, (r(kr),
    kr = 1, nr);

co = cos(olat*dtr);
so = sin(olat*dtr);

call gridin(1, .015, 0);
call gridin(2, .15, 1);
call gridin(3, 1.5, 1);
dalpha = 2*pi/nalpha;

popt(1) = 0.0;
do 10 i = 1, nr - 1;
```

```
popr(i) = 0.0;
do 11 j = 1, nalpha;
   den1 = 0.0;

   nsamp = nsamp0;
   r1 = r(i);
   r2 = r(i + 1);
   alpha1 = (j - 1.5)*dalpha;
   alpha2 = alpha1 + dalpha;
90: continue;
```

===================

In computing differences involving $z = 1 - \cos(r/R)$, which is a small number, it is better to use the relation

$z = 2\sin^2(r/2R) = 2y^2$

and express $z_1 - z_2$ as $2(y_1 - y_2)(y_1 + y_2)$.

===================

```
   y1 = sin(0.5*r1/er);
   y2 = sin(0.5*r2/er);
   z1 = 2*y1^2;
   z2 = 2*y2^2;
   area = 2*er^2*(y2 + y1)*(y2 - y1)*(alpha2 - alpha1);
   dz = 2*(y2 + y1)*(y2 - y1)/nsamp;
   dal = (alpha2 - alpha1)/nsamp;
   is = 1;
   do 20 n = 1, nsamp;
      do 20 m = 1, nsamp;
         zs(is) = z1 + (n - 0.5)*dz;
         alphas(is) = alpha1 + (m - 0.5)*dal;
20: is = is + 1;
   ismax = is - 1;

   tot = 0.;
   do 30 is = 1, ismax;
      sz = sqrt(zs(is)*(2 - zs(is)));
      ty = sz*sin(alphas(is));
      tx = (1 - zs(is))*co - sz*so*cos(alphas(is));
      xlong = olong + atan2(ty, tx)/dtr;
      sinlat = (1 - zs(is))*so + sz*co*cos(alphas(is));
      igrid = 0;
  40: igrid = igrid + 1;
      if (igrid > 3) then;
         ierror = 1;
         call err(ierror);
         go to 30;
      endif;
      ilat = (sinlat - sinlat0(igrid))/dsinlat(igrid) + 1;
      ilong = (xlong - xlong0(igrid))/dlong(igrid) + 1;
      if ((ilat < 1) ∨ (ilat > nlat(igrid))) goto 40;
      if ((ilong < 1) ∨ (ilong > nlong(igrid))) goto 40;
```

```
        den = d(ilat, ilong, igrid);

    30: tot = tot + den;
        den = tot/ismax;

        if (abs((den - den1)/(den + eps)) > tol ∧ nsamp < nsmax) then;
          nsamp = 2*nsamp;
          den1 = den;
          goto 90;
        endif;

        pop(i, j) = den*area;
   11: popr(i) = popr(i) + pop(i, j);
       if (i ≡ 1) popt(i) = popr(i);
       if (i > 1) popt(i) = popt(i - 1) + popr(i);

  10: continue;

      if (i > 1) popt(i) = popt(i - 1) + popr(i);
      open (31, file = 'ccpopmap.out', form = 'formatted', status = 'new') ;

      write(31,*) '               Ring Data:';
      write(31,*) ' inner and outer ring radii, ring and total population';
      do 60 ir = 1, nr - 1;
  60: write(31, 999) r(ir), r(ir + 1), popr(ir), popt(ir);
 999: format (4f12.1) ;

      write(31,*) 'MACCS Input (Sector Population):';
      do 70 ia = 1, nalpha;
  70: write(31, 112) (pop(ir, ia), ir = 1, nr - 1);
 112: format ((6(f12.0))) ;

      stop;
      end;

   subroutine gridin(igrid,dl,itype);

      ==================
      This routine has to allow for files in which the latitudes are specified by
      integers, itype = 0, or actual latitudes in degrees, itype = 1
      ==================

      common /latgrid/ sinlat0(3), sinlat1(3), nlat(3), dsinlat(3), glat0(3), glat1(3);
      common /longgrid/ xlong0(3), xlong1(3), nlong(3), dlong(3);
      common /dens/ d(150, 150, 3);
      common /polgrid/ pop(30, 30), r(30), popr(30), popt(30), nr, nalpha, dalpha;
      common /ref/ olat, olong, so, co, filnam(3);
      common /const/ er, pi, tol, dtr, eps;
      common /samp/ nsamp0, nsmax, zs(10000), alphas(10000);

      character*80 title;
      character*12 filnam;

      open (1, file = filnam(igrid), form = 'formatted', status = 'old') ;
      dlong(igrid) = dl;
      do 110 itit = 1, 3;
```

```
        read(1,901) title;
110: write(*,*) title;
     read(1,902) lonmin, lonmax;
     nlong(igrid) = lonmax - lonmin + 1;
     xlong0(igrid) = dl*lonmin;
     xlong1(igrid) = dl*(lonmax + 1);
     ilat = 1;
120: if (itype ≡ 0) then;
        read(1,903,end = 140) latnum;
     else;
        read(1,904,end = 140) xlat;
        sinlat1(igrid) = sin(xlat*dtr);
        if (ilat ≡ 1) sinlat0(igrid) = sinlat1(igrid);
     endif;
     nlongmax = nlong(igrid);
     read(1,905) (d(ilat, ilong, igrid), ilong = 1, nlongmax);
     do 130 ilong = 1, nlongmax;
130: d(ilat, ilong, igrid) = d(ilat, ilong, igrid)/(100^(igrid-1));
     ilat = ilat + 1;
     goto 120;
140: nlat(igrid) = ilat - 1;
     if (itype ≡ 0) then;
        sinlat0(igrid) = sin(glat0(igrid)*dtr);
        sinlat1(igrid) = sin(glat1(igrid)*dtr);
     endif;
     dsinlat(igrid) = (sinlat1(igrid) - sinlat0(igrid))/(nlat(igrid) - 1);
     write(*,*) igrid, nlat(igrid), nlong(igrid);
     return;
901: format(a) ;
902: format(2i4) ;
903: format(i4) ;
904: format(1p, e11.4) ;
905: format(8(1p, e10.3)) ;
     end;

   subroutine err(i);

     write(*,*) ' Point outside largest lat-long grid , i =', i;
     return;
     er·
```

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Probabilistic Risk Analysis Branch
Washington, DC 20555-0001

10. SUPPLEMENTARY NOTES

11. ABSTRACT (200 words or less)

Over the past several years, the OECD/NEA and CEC sponsored an international program intercomparing a group of six probabilistic consequence assessment (PCA) codes designed to simulate health and economic consequences of radioactive releases into atmosphere of radioactive materials following severe accidents at nuclear power plants (NPPs): ARANO (Finland), CONDOR (UK), COSYMA (CEC), LENA (Sweden), MACCS (USA), and OSCAAR (Japan). In parallel with this effort, two separate groups performed similar calculations using the MACCS and COSYMA codes. Results produced in the MACCS Users Group (Greece, Italy, Spain, and USA) calculations and their comparison are contained in the present report. Version 1.5.11.1 of the MACCS code was used for the calculations.

Good agreement between the results produced in the four participating calculations has been reached, with the exception of the results related to the ingestion pathway dose predictions. The main reason for the scatter in those particular results is attributed to the lack of a straightforward implementation of the specifications for agricultural production and counter-measures criteria provided for the exercise. A significantly smaller scatter in predictions of other consequences was successfully explained by differences in meteorological files and weather sampling, grids, rain distance intervals, dispersion model options, and population distributions.

12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.)

Radiation Hazards — Probabilistic Estimation, Coordinate Research Programs — International Cooperation, Maximum Credible Accident — Risk Assessment, Radiation Effects, Economic Impact — Computerized Simulation, Health Hazards — Computerized Simulation, Radioactive Effluents — Dispersions, Fallout, Radiation Dose Distributions, Computer Codes, M Codes

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