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November 9, 1984

Mr. Ralph Meyer
Fuel Behavior Branch
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Ralph:

Enclosed is our informal report on "Source Term Code Package Specifications". As you are aware, the first effort under our task on code package preparation was to review the various codes in detail, to evaluate possible approaches for simplifying the various codes so that they are less user dependent, and to specify a form for the code package that could be provided to interested users. The enclosed report is the result of these efforts.

It should be noted that because of the fairly tight schedule requested by the NRC, we had begun work on some of the code combinations noted in the specifications report. For example, the CORSOR code was being incorporated into the MARCH 2 code and this combination is essentially completed. It is important that some of these efforts be continued without excessive delay if the projected schedule is to be met for code package completion.

You may be interested to know that on several occasions I have informally outlined our plans for this task with various nuclear industry people and have found a great deal of interest. I believe there will be a significant demand for this source term code package when it is completed.

If you have questions or comments regarding this report, please let me know.

Sincerely,

Jim

James A. Gieseke
Physico-Chemical Systems Section

JAG:drr

Enc.

INFORMAL REPORT

on

SOURCE TERM CODE PACKAGE SPECIFICATIONS

to

U.S. NUCLEAR REGULATORY COMMISSION

November 9, 1984

by

J. A. Gieseke, P. Cybulskis, M. R. Kuhlman
and K. W. Lee

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by

J. A. Gieseke, P. Cybulskis, M. R. Kuhlman
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INTRODUCTION

The Nuclear Regulatory Commission (NRC) is in the process of reassessing the magnitude and characteristics of the release of radioactive material to the environment in severe reactor accidents. A major element in this reassessment of accident "source terms" is the series of calculations reported as BMI-2104 which utilizes a series of state of the art computer codes to predict fission product transport and deposition. The results of the BMI-2104 analyses demonstrate the viability of systematically and consistently applying state-of-the-art methodologies to accident source term assessment and demonstrate the expected dependence of source term predictions on the specifics of the accident sequences and reactor design being considered. The most important product of the accident source term assessment effort is a demonstrated methodology for accomplishing such analyses in specific situations of interest, rather than generically applicable numerical results.

Because of the difficulty in drawing generic conclusions from the results of a small number of specific sequences, there is a strong need to make this methodology available to others for responding to specific regulatory requirements. In order to assure technical soundness and maintain traceability, it is in the interest of the NRC to have a fixed, reviewed, and understandable system of codes employed for such purposes.

The suite of codes utilized for the BMI-2104 analyses consists of MARCH 2, MERGE, CORSOR, TRAPMELT, CORCON, VANESA, SPARC, and NAUA-4 (Modified). Because of numerous available code options, cumbersome interfacing procedures, and complicated problem setup/input preparation, the codes are not easily applied. Further, because of intentional

TRAPMELT 2.0 used in 2104. Mod 2.1 expanded species to cover WASH-1400 groups and trace H_2 as well as steam studies is what's being published. Mod 2.2 is to be developed.

flexibilities built into the codes for sensitivity and uncertainty studies, the results of code calculations can be influenced by the technical competence and experience of the user. To make the code package suitable for more routine use by less-experienced users with reasonable assurance that it will still give technically justifiable and traceable predictions, there is the need to eliminate options that are not needed, streamline the interfacing among the codes, and organize the input data selection. The source term code package being specified in this document is intended to satisfy this need and will result in a coherent calculational scheme for predicting source terms which can be made generally available. Preparation of the source term code package is based on using the available BMI-2104 suite of codes as a starting point.

GENERAL SPECIFICATIONS

ok to timber since basic science same and peer reviews will be obtained

The codes to be used in preparing the source term code package are the current versions of MARCH 2, MERGE, CORSORM, TRAPMELT 2.2, CORCON 2, VANESA, SPARC, and NAUA-4 (modified). As discussed later, several of these codes are being or will be combined to simplify interfacing. In addition, modifications are to be made for purposes of eliminating unnecessary options and a problem specification procedure is to be developed to make selection of input data more routine.

The code package should be transportable among various mainframe computer systems. To facilitate this, all programs will be prepared in FORTRAN 77. Because of differences among plotting routines and systems, no plotting package will be included; however, the output will be arranged in such a manner on output tapes so as to facilitate its use with various plotting packages. In addition, the output will be such that with preselected input control parameters, the output data to be printed can be specified by the user.

The general structure of the code package is defined in terms of the codes to be used in combined form. The details of these combinations and the reasons for combinations are discussed later in terms of code modifications. The separate codes are expected to be as follows:

(1) Input selection procedure
(2) MARCH/CORSOR
(3) TRAPMELT/MERGE
(4) CORCON/VANESA
(5) NAUA/SPARC
(6) NAUA/ICEDF
(7) NAUA.

The anticipated codes and their interfacing is illustrated in Figure 1. As noted, the individual combinations, the interfacing procedures, the option reductions, and input selection will be discussed in subsequent sections of this specifications report.

CODE COMBINATIONS AND INTERFACES

The process of transferring information from one code to the next is subject to errors and inconsistencies. One procedure for eliminating the possibility for such errors is to combine all codes such that data transfers occur automatically within the codes as they are run. However, a complete coupling of all codes eliminates the possibilities for or excessively complicates the process of running parametric analyses with selected codes or a portion of the package. There are also practical limitations to a totally coupled series of codes in terms of size relative to computer storage capabilities and in terms of ease in making future substitutions of codes within the package. Therefore, a few selected code couplings are planned for technical reasons, but otherwise the codes forming the package will be primarily of a stand-alone nature. With such codes, it is important that the data transfer among the codes be unambiguous and straightforward.

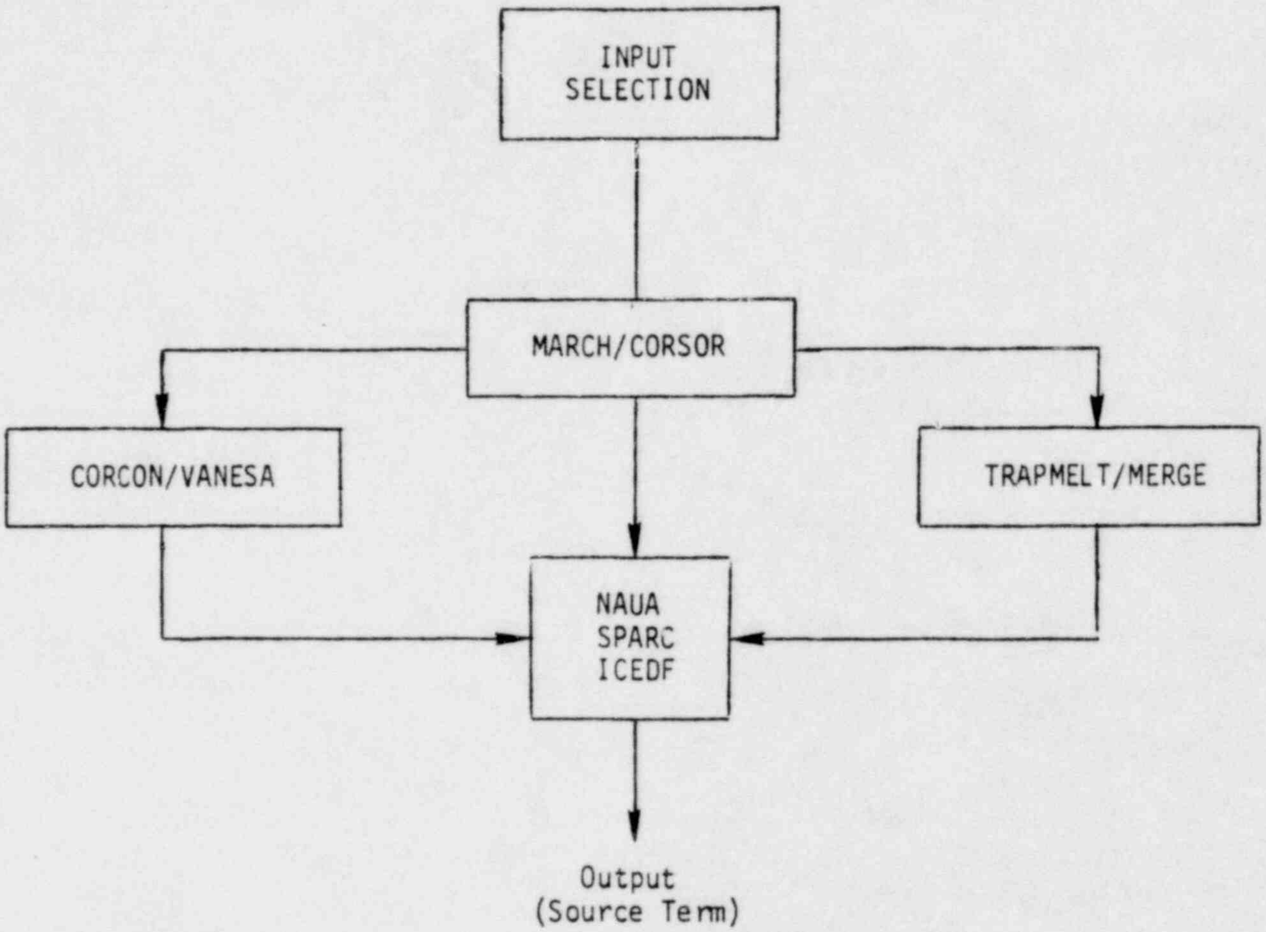


FIGURE 1. EXPECTED STRUCTURE OF SOURCE TERM CODE PACKAGE

Can you put CORCON into MARCH instead of INTER?

Code Combinations

MARCH-CORSOR

CORSOR will be incorporated into MARCH, where it will replace an existing subroutine for describing the loss of fission products from the fuel as the core overheats and melts. This will eliminate the need for a separate CORSOR run with its associated interfacing considerations and will make the overall analysis more self consistent.

The incorporation of CORSOR into MARCH will ensure that the same core nodalization and power distribution is utilized, eliminating several areas that can introduce inconsistencies.

TRAPMELT-MERGE

The MERGE and TRAPMELT codes will be combined so that the thermal hydraulic information provided by MERGE is directly available for the TRAPMELT fission product deposition calculations; the feedback between fission product heating of structures and their deposition and/or reevolution can be taken into account directly. Further, the combined code will be run by reading directly a data file written by MARCH, thus eliminating several interfacing manipulations.

Combining the MERGE and TRAPMELT codes will eliminate a number of potential problems in the setup of the analyses. In the combined version a single description of primary system nodalization will be used, as will be the case with structure description.

CORCON/VANESA

A combination of the CORCON and VANESA codes is currently under way at Sandia. If completed in a timely fashion, the codes will be utilized in a combined form. If not, the codes will be used separately.

...it BCL them together?

12/18/84 Yes. It's done.

What can be done about viscosity problem in CORCON Mod 1?

Lock Geo Greene, Dana Powers, and Dave Bradley in a room.

Code Interfaces

MARCH/CORSOR-SPARC

The conditions in the BWR suppression pool as well as the nature of the flows into the pool as calculated by MARCH have been used as input to SPARC for the evaluation of fission product scrubbing. The basic procedures used will be retained, with some changes to minimize interfacing problems. A number of the user-selected model options in SPARC will be fixed. The intent is to be able to run SPARC with thermal hydraulic data directly from the MARCH/CORSOR prepared data file.

MARCH/CORSOR-NAUA

The thermal hydraulic information regarding the containment atmosphere as predicted by MARCH is used as input for the NAUA fission product transport analyses. The interfacing of these two codes has been a particular source of difficulty in the past and has consumed substantial staff time. The past experience has pointed to a few variables, particularly the amount of water available for condensation on aerosol particles, as being the usual source of difficulty. This problem will be alleviated by calculating this factor directly within the MARCH/CORSOR code rather than inferring it from other quantities, as has been done in the past. Additional data will be saved at each MARCH/CORSOR calculational time step to ensure that all the needed information is available and to minimize the amount of external data manipulation that is required.

An area in the MARCH/CORSOR-NAUA interfacing that will be improved will be the physical description of the individual compartments that the containment system comprises. Currently the two codes each use individual inputs to provide this description; in the code package this will be changed so that the input used by MARCH/CORSOR is passed on to NAUA.

The fact that the NAUA code is a single compartment code has been a source of some difficulty during the BMI-2104 analyses, requiring

in some cases that it be run iteratively for multiple compartment problems. It is not, however, planned to reformulate NAUA into a multiple compartment code as part of this effort.

MARCH/CORSOR-CORCON/VANESA

In the BMI-2104 analyses the results of the MARCH and CORSOR calculations at the time of the start of the corium-concrete interaction were compiled into a hard copy for transmittal and use as input into the CORCON calculation; the results of the latter were then used as input into VANESA to calculate the fission product release during this phase of the accident. It is expected that this general data flow will be continued, unless a coupled version of MARCH and CORCON or a coupled version of CORCON-VANESA becomes generally available in the time frame of interest.

The information passed from MARCH/CORSOR to CORCON includes the composition and properties of the concrete, the effective radius of the reactor cavity, composition and temperature of the corium at the time of initiation of concrete attack, and the mass and temperature of the water in the reactor cavity during the corium-concrete interaction. VANESA will also need as input the masses of the various radionuclides remaining with the debris at the start of the corium-concrete interaction.

MARCH/CORSOR-TRAP/MERGE

During performance of the analyses reported in BMI-2104, most of the difficulties related to interfacing of MARCH output with MERGE and of CORSOR output with TRAPMELT were resolved through use of processing subroutines embedded in the codes. The mechanics of providing for the flow to TRAPMELT/MERGE of source material rates and gas composition, temperature, and flow rates from MARCH/CORSOR will involve mainly a combining of the processing which is already incorporated in these several codes.

TRAP/MERGE-NAUA

In the BMI-2104 study, the results of the TRAPMELT calculations supplied the input data set necessary for running the NAUA code. During the later stage of BMI-2104 analyses, significant work was done to automate the interface between the TRAPMELT and the NAUA codes. Thus, the specific input data which are currently mounted by the TRAP code onto a computer tape include the source rate, the particle size distribution, fraction of each species, and timing of each set of the source information. Therefore, a procedure closely similar to the current methodology will be applied to the future interface between the NAUA code and a new version of the TRAP-MERGE code.

TRAP/MERGE-SPARC

Some accident sequences in BWR analysis will require a direct interface between the TRAP-MERGE and the SPARC codes. Currently this interface is being performed manually. Consideration will be given to the possibility that the SPARC code be combined with the NAUA code. Use of the suppression pool in the NAUA code will then be an option and depending upon the option chosen, the source data put on a tape will be utilized appropriately by the revised NAUA code.

SPARC-NAUA

Depending upon the accident sequence of interest and the event in an accident sequence, the interface between the SPARC and NAUA codes can take place in both directions, i.e., NAUA-SPARC and SPARC-NAUA. Currently the interfacing of these two codes is performed manually primarily because of differences in timings used by the two codes and in the coding structures.

ELIMINATING OPTIONS AND REDUCING INPUT

A desirable feature of the source term code package is that results are to be traceable and not subject to unreasonable selections of input parameters or parameter combinations. Currently the codes selected for use in the code package are designed to encourage user selection of input for a very large number of code options and adjustable parameters. This structure was chosen to accommodate parametric studies or sensitivity/uncertainty analyses and to permit the codes to be updated easily. For example, new deposition rate coefficients, new judgments of agglomerate shape factors, or various opinions regarding containment failure modes could be easily accommodated. This type of flexibility in the codes is desirable from the research point of view, but may be unacceptable for regulatory applications. It is crucial that a firm best-estimate basis be kept throughout the codes and that this basis not be altered by the user. User departures from the recommended approach should be easily identified by the output listing. A more rigorous, less user-dependent code structure will allow comparisons among plants and sequences to be made on a consistent basis and will form an understandable basis for calculations made by numerous code package users.

To permit less user-dependent versions of the codes to be employed in the code package, it will be necessary to select specific models, to remove existing code options deemed unnecessary, and to "hard-wire" values for adjustable parameters. Of course it will be necessary to maintain enough flexibility that a variety of plant designs and accident sequences can be analyzed.

Model Specification

MARCH 2 Model Specification

MARCH 2 requires the user to specify a wide variety of options; some of these deal with the accident sequence description in a particular design, while others involve the choice of models for treating particular

phenomena. It is the latter group of options that will be minimized in the development of the code package. The choice of options will be minimized to the extent possible, while at the same time retaining sufficient flexibility to address a variety of plants and accident sequences.

The modeling options that will be fixed in the code package can be grouped in the following broad areas:

- Primary System: The primary system thermal hydraulic modeling options such as heat transfer to structures, steam generator performance, etc., will be defined to eliminate user choices.
- Core Degradation: Modeling choices dealing with the behavior of the overheated core, including metal-water reactions and core slumping, will be fixed in accordance with the options utilized in BMI-2104.
- In-Vessel Debris Behavior: The interaction of the core debris with water in the vessel bottom head will be treated with a particular debris bed model to be specified.
- Head Failure Modes: The modeling options for the failure of the vessel bottom head will be specified; it is expected that the failure mode assumed will be a function of the accident sequence. Sequences involving high pressure meltdown will imply a small opening in the vessel bottom head, while low pressure sequences will involve gross melting of the head for failure.
- Ex-Vessel Debris-Water Interactions: The interaction of core debris with water in the reactor cavity will be based on the particulate quench model with transfer to a debris bed when permitted by the levitation model. Prediction of an uncoolable debris bed will result in the start of corium-concrete interaction.
- Corium-Concrete Interactions: The input options to the INTER subroutine of MARCH will be fixed in accordance with the choices used in BMI-2104.
- Combustion Models: The specifications for the treatment of the burning of hydrogen and carbon monoxide will be based on the current

> default options in MARCH 2; however, separate choices will have to be provided for situations that include hydrogen igniters as well as those without them.

Further detail on the choice of modeling options to be fixed in the code package is given in Table 1.

CORSOR Model Specification

The CORSOR code (to be combined with MARCH 2) has options concerning the type of release rate model to be used and the nodalization of the core. Core nodalization will no longer be input directly but will be consistent with the MARCH representation. The release rate model to be retained will be the empirical rate option modeled after the correlation used in NUREG-0772. The "heat of vaporization" model, while more physically realistic, is less likely to be improved in the near future with most experimental data expected to be in a form most easily usable in upgrading the empirical representation. The initial fission product inventory previously input directly to CORSOR will come from the MARCH code after combination of the codes.

TRAPMELT Model Specification

The TRAPMELT portion of the TRAP-MERGE code has very few model selections to be made in the input. The only input selections currently possible are to include all or none of the deposition models in each control volume. Aerosol deposition will be hard-wired to operate in all control volumes and vapor deposition in all but the core regions (or possibly a surface temperature triggered vapor deposition switch added within the code). Current sensitivity multipliers for all rate coefficients will be removed or set internally to unity.

TABLE 1. MARCH MODEL SELECTION RECOMMENDATIONS

Function	Recommendation
PWR steam generator heat transfer	Enhanced steam generator performance
Heat transfer to structures above core	Use of detailed heat transfer correlations and best property correlations
Break and/or safety/relief valve elevation, break size. etc.	User specified
Core nodalization and power distribution	User specified
In-core heat transfer	Detailed convective heat transfer correlations, radiation within the core as well as to surrounding structures, no axial conduction
Metal-water reactions	State-of-the-art model using Urbanik-Heidrick rate constants, hydrogen blanketing, steam limitation, etc.
In-core channel blockage	Temperature for shutoff of metal-water reaction user specified
Meltdown model and core slumping	Model A with regionwise slumping
Core debris holdup on lower support structures	Debris interact with support structures, but effective mass of structures involved user specified
Metal-water reactions in vessel head	Calculated for homogeneous particles, particle size user specified
Debris-water interaction in bottom head	Debris bed model

TABLE 1. (Continued)

Function	Recommendation
Heat transfer between debris and vessel head	Experimentally based correlation
Head failure model	Gross failure for low pressure sequences, small opening for high pressure sequences
Debris-water interaction in reactor cavity	Particulate quench with transition to debris bed based on levitation model, particle size user specified. Uncoolable beds result in concrete attack.
Metal-water reactions in reactor cavity	Reactions of Zircaloy and steel included
Corium-concrete interactions	INTER heat transfer options fixed, geometrical factors user specified
Containment nodalization and flow connections	User specified
Containment failure level and mode	User specified
Engineered safety feature operation after containment failure	User specified in accident sequence definition
Combustible gas treatment	Values for flammability and flame propagation provided, ignition criteria dependent on design and accident sequence, several options suggested to treat situations with and without igniters
Calculation time step control	Recommended values included in the code
Frequency of printed output	User specified
Output files to tape	User specified

If an option remains that would permit deviation from B.III-2104, a print stmt should list the deviations.

CORCON/VANESA Model Specification

The model selection for these codes is not now known but will be determined after release of the code and consultation with Sandia.

SPARC Model Specification

There are no alternate models to be selected in the SPARC code. There are input parameters to be selected as will be discussed later.

NAUA Model Specification

The NAUA code has no alternate model selections to be made. There are possibilities for eliminating specific aerosol behavior mechanisms through input selection. These are described later.

Input Option/Parameter Selection

In the source term codes there are input data required which control selections of options within the codes, serve as constants within equations describing various mechanisms, and specify approaches to convergence. Many of these input data can be fixed to best-etimate values and "hard-wired" within the codes. The current plans for specification of input data are described for each of the codes where such an approach is appropriate.

MARCH 2 Input Specifications

NAMELIST NLMAR. This input provides the specification of MARCH control flags, computation and exit controls, and defines input and output files to be used. The required inputs are quite sequence dependent and cannot be prespecified; guidance will be provided to the user on how to select proper inputs.

NAMELIST NLINTL. This namelist provides for the input for a primary system blowdown table required for the analysis of large break loss of coolant accidents. Such blowdown tables are to be provided by the user. Typical sources of these blowdown tables would be detailed thermal hydraulic analyses of design basis accidents.

NAMELIST NLSLAB. The containment structural heat sinks are described by this input; these are highly plant dependent and should be provided by the user. The detailed description of how the structures are handled in MARCH is provided in the user's manual.

NAMELIST NLECC. The specification of upper head injection, accumulator, and refueling water (and/or condensate storage) tank water inventories are provided here. Also, the descriptions of the performance and failure characteristics of emergency core cooling system pumps are provided here. All these inputs are plant and sequence dependent and must be supplied by the user.

NAMELIST NLHX. The performance characteristics of emergency core cooling and containment spray heat exchangers, as well as the specifications of containment coolers are provided here.

NAMELIST NLMACE. NLMACE provides a wide variety of inputs regarding the description of the containment and associated systems in it. A series of containment flags are used to specify the type of containment, the relationship between the reactor cavity and the sumps, the location of the sumps, the locations of relief valve and break flows; these flags are typically associated with plant and sequence definition.

Pressure suppression data are required for BWR and ice condenser PWR containments. Several input parameters are provided to permit the stopping of engineered safety features, disposition of containment spray water, and disposition of emergency core coolant if its supply rate exceeds the capability of the primary system.

A series of burn flags tells the code whether burning is to be considered. If so, whether burning of carbon monoxide as well as hydrogen is to be treated, the criteria for burn propagation to be used, the presence of igniters, etc. Together with the burn flags is a set of default burn data; default values will be provided for the latter. However, the default data cannot be completely hard-wired since flexibility is needed to cover situations with and without igniters, inoperable igniters, spontaneous versus source ignition, etc.

Initial conditions in each of the containment compartments, including atmosphere composition must be provided. A transfer matrix which defines the flow paths between compartments must be provided. If the problem is to include consideration of combustion events, the transfer matrix is used to partially specify the criteria for burn propagation between compartments. A series of containment events can be specified by means of the event table; the types of events include the initiation of sprays, air return fans, and mass and energy inputs from external sources, containment failure events, etc.

<u>NAMELIST NLBOIL</u>. This namelist provides a variety of inputs dealing with the description of the reactor core and primary system, model selection for the behavior of the degraded core, debris water interactions in vessel, etc.

The physical description of the core, core power distribution, definition of the structures above and below the core, etc., are parameters that are very plant specific and must be provided by the user. Specific guidance on the meaning of each of these variables is provided in the user's manual.

A number of BOIL flags deals with the selection of model options such as in core heat transfer options, radiation models, core meltdown models, metal-water reaction options, etc. Default choices for most of these models will be provided as part of the code package specification. The choices specified will be largely those that were used in the BMI-2104 analyses. In addition to these flags, there are a number of specific parameters required to specify the criteria for the onset of

fuel movement out of the core, the collapse of the entire core into the bottom head, the treatment of metal-water reactions in the vessel head, etc.

For accident sequences initiated by small primary system breaks and transients, additional input requirements include specification of the break size and location, operating characteristics of the safety/relief valve, options to simulate operator intervention or failure of valves, etc. Additionally, the performance of the steam generators, including auxiliary feedwater system operation can be specified. All of these input parameters are part of the accident sequence definition.

There are also input specifications related to computational time step control; recommended options for these will be provided.

The frequency of the printed output for the primary system analyses is user controlled and must be specified in the input, including the core nodes whose temperatures are to be saved on the plot files.

NAMELIST NLHEAD. This namelist provides the specifications for the treatment of reactor vessel failure. It includes specification of the quantities of core materials that should be included in the core debris; these should basically be the total quantities of materials in the core. The model choices in NLHEAD allow the choice of the evaluation of the time to gross head overheating and failure, or the assessment of the time to reach local penetration of the bottom head. The former is more appropriate for sequences in which the primary system is at low pressure, the latter would be more appropriate for high pressure sequences.

NAMELIST NLHOT. This input namelist provides the specification for the treatment of debris-water interactions in the reactor cavity. A few of the inputs, such as the effective area of the reactor cavity and the heat capacity of structures outside the vessel to be included in the debris, are plant and sequence specific; the others are model options. Recommendations will be provided which assume that debris will undergo rapid quenching upon contact with water in the cavity until permitted to form a debris bed by the levitation model; if upon formation of the

debris bed is not coolable, onset of concrete attack will be assumed. The debris quenching analysis will include consideration of steel as well as Zircaloy reactions with steam. The choice of the particle size for the debris will be left to the user.

NAMELIST NLINTR. This namelist provides the input data and model selection for the corium-concrete interaction phase of severe accidents. The required input data deal with concrete composition, geometrical parameters, and initial conditions; these are all plant specific and are to be supplied by the user. Model parameters available include heat transfer coefficients between the debris and concrete, radiation modeling off the top of the debris, and treatment of concrete attack after debris solidification; these parameters will be fixed in the code package at recommended values. Some additional input parameters are available to control the frequency of printed output and the time to stop the calculation.

TRAP-MERGE Input Specifications

TRAP-MERGE input parameters are to be preselected or hardwired to the extent possible while still maintaining sufficient flexibility for a variety of plants and sequences. The input parameters serve a variety of functions and are identified in Table 2 along with the recommended form they will take in the code package.

NAUA Input Specification

Current NAUA input parameters are either to be fixed, moved to internal selection based on computed conditions, or maintained as user selectable for application flexibility. The recommended forms for the various input parameters are given in Table 3. ✗

TABLE 2. TRAP-MERGE INPUT/OPTION SPECIFICATION

Variable/ Option	Function	Recommendation
CPMAX	Maximum CP time	User selectable. The old style dump restart capability should be reinstated because the CHECKPOINT utility is too installation dependent.
DIV	Number of print steps	User selectable
KOMENT	Print input data comments	Hard-wire to Ø
KOMAD	Print ADHOC messages	Hard-wire to 1
NRES	Restart flag	User selectable
T	Problem start time	User selectable
TMAX	Problem stop time	User selectable
DELTM	Maximum time step	User selectable
REL	DVERK error criterion	Hard-wire to $1\text{-}x10^{-4}$
ETA1	Allowed source change	Hard-wire to 0.1
ETA2	Allowed matrix change	Hard-wire to 0.1
NK	Number of species	User selectable
NV	Number of volumes	User selectable
NS	Number of states	Hard-wire to 5
NDP	Number of particle parameters	Hard-wire to 2
SN	Species names	User selectable
NCC	Flow connect matrix	User selectable

TABLE 2. (Continued)

Variable/ Option	Function	Recommendation
NBET	Number of BETV flags	Hard-wire to 3
NB	BETV flags	Hard-wire appropriately
NHOC	Number of ADHOC flags	Hard-wire to 1
ND	ADHOC flags	Hard-wire
NOCOG	Coagulation control flags	Hard-wire
VPM, FRM, STM, SRM, THOM, TDM, VTM	Sensitivity multipliers	Hard-wire to 1.0
NTCOAG	Turbulent coagulation switch	Hard-wire
LENGTH DIAME AREA ASED HEIGHT	Effective compartment dimensions	User selectable
TFLOW, FLOW PRESS TEMP, DTEMP H2FRAK	Junction mass flow Thermal hydraulic condition	Supplied by MARCH
Initial mass	Initial mass	User selectable
Source mass		Supplied by CORSOR

TABLE 2. (Continued)

Variable/ Option	Function	Recommendation
PSET, PSE	Aerosol source parameters	Supplied by an earlier code prediction
PDEN	Particle density	User selectable or the code calculates

TABLE 3. NAUA INPUT/OPTION SPECIFICATION

Variable/ Option	Function	Recommendation
VOL	Volume	Read from MARCH
FSED	Floor area	Read from MARCH
FDIFF	Internal surface area	Read from MARCH
FORM	Dynamic shape factor	Fix at a value of 1
FORMKO	Condensation factor	Fix at a value of 1
DELD	Boundary layer thickness	Fix at 100 microns
RMIN	Minimum particle radius	Fix at 0.001 μm
RMAX	Maximum particle radius	Fix at 200 μm
KMAX	Number of size classes	Fix at 30
EPS	Accuracy parameter	Fix at 0.1
SZEIT	Starting time	Read from MARCH
TIME	Total problem time	Synchronize with timing of events
CPUZT	Cutoff value of particle mass in a size class	Set at 1×10^{-5} to 1×10^{-20} depending on sequence
D	Steam flow rate	Eliminate this input requirement and MARCH calculates supersaturation ratio
TL	Leak rate	Read from MARCH
D	Temeprature	Read from MARCH
RHO SRATE RG SIGL	Source	Read directly from TRAP-MERGE and VANESA

TABLE 3. (Continued)

Variable/ Option	Function	Recommendation
Restart capability		User selectable
Two compartments		User selectable
Coagulation		Use both mechanisms at all times, thus eliminate user's option; add turbulent coagulation
Condensation		Activate all the time, thus eliminate user's option
Leakage		Activate all the time, thus eliminate user's option

INPUT SELECTION PROCEDURE

The selection of input for the code package is concerned with setting up the problem of interest for a specified plant. It is envisioned that in addition to user's manuals for each of the codes forming the package an overall manual will be prepared for the package itself which describes input, output, interfacing procedures, and possibilities for plotting routines. A major portion of this document will be a description of the necessary input and how it can be derived. An extension of this user's manual is expected to be an interactive software package that leads the user through the input selection procedure and which may be used to prepare the input data set to be read by the code package on initiation of the calculation. In addition to the more detailed parameter selections associated with the individual code, two major topics in input selection are plant and sequence definition.

The physical description of the plant is obviously highly plant specific and cannot be supplied by other than the individual user of the code package. In addition to the code user's manuals for each of the codes that provide definitions of detailed input requirements, assistance will be provided to the potential users of the code package as an aid in input preparation. Similarly, the specification of the accident sequences to be considered is the province of the individual code user. Guidance will be provided in order to assist the user in the setup of particular types of accident sequences in specific plant designs. Guidance or assistance for both the plant description and accident specification, either in the form of partially complete default files or interactive software, will guide the user to the program flags that must be set and the types of specific input variables that must be provided. This guidance will deal with how the code models a variety of initiating events, safety feature operation, failure of operating safety features, operator intervention, etc. Also, directions on proper sequencing among the various transport codes will be specified.

TASK TITLE: SOURCE TERM CODE PACKAGE PREPARATION

TASK NUMBER: 9

NRC TASK LEADER(S): R. O. MEYER

BCD TASK LEADER(S): J. GIESEKE/P. CYBULSKIS

ACCOMPLISHMENTS AND CURRENT TASK STATUS: (November)

Several needed model changes were implemented into MARCH3. These changes included:

1. Ability to consider coolant layers above the corium debris in the reactor cavity for BWRs,
2. Treatment of suppression pool bypass, and
3. Correction of pathologies that were occasionally encountered in the MARCH-MARCON-CORCON interfaces.

The current reference version, designated as MARCH3, Version 182, was provided to Brookhaven National Labovatory for their quality assurance review.

The definition of the input variables was developed as part of the MARCH3 documentation.

PLANNED ACTIVIES: (December)

Efforts toward documentation of the STCP and preparation of a user's guide will be continued. The capability to plot CORCON results will be implemented as part of the STCP.

POTENTIAL PROBLEMS AND PROPOSED RESOLUTION:

Discussions with Sandia have indicated that a list of corrections to CORCON MOD2 is forthcoming; these will have to be factored into MARCH3 when they are received.

TASK TITLE: SOURCE TERM CODE PACKAGE PREPARATION

TASK NUMBER: 9

NRC TASK LEADER(S): R. O. MEYER

BCD TASK LEADER(S): J. GIESEKE/P. CYBULSKIS

ACCOMPLISHMENTS AND CURRENT TASK STATUS: (October)

As the Source Term Code Package has been utilized in the SARRP calculations, a number of limitations have been noted in the flexibility of the MARCH3 code. These limitations arise largely from conditions involving water layers within the reactor cavity. Some attention was given to modifying the code to accommodate these conditions. Other efforts have been concerned with preparing the documentation for the codes.

PLANNED ACTIVIES: (November)

Efforts will be directed toward documentation of the STCP and especially to preparation of a user's guide.

POTENTIAL PROBLEMS AND PROPOSED RESOLUTION:

Some anamalous results are being encountered in the MARCH-CORCON interface; these are being pursued, including consultation with Sandia and others.

TASK TITLE: SOURCE TERM CODE PACKAGE PREPARATION

TASK NUMBER: 9

NRC TASK LEADER(S): R. O. MEYER

BCL TASK LEADER(S): J. GIESEKE

ACCOMPLISHMENTS AND CURRENT TASK STATUS: (September)

Application of MARCH-3 to the analyses of the Peach Bottom sequences have highlighted a number of problems in the MARCH-CORCON interface that have required significant effort for their resolution. The first of these was related to the discrepancy in fission product decay heating as evaluated by CORCON and MARCH. For the Peach Bottom calculations, the problem was handled by adjusting the inputs to the simplified ANS decay heat standard as programmed in MARCH and normalizing the decay heat in CORCON to the MARCH-calculated values. For the subsequent plant analyses, the complete ANS standard will be programmed into MARCH. Another problem encountered dealt with the different fission product groupings required by the various portions of the Source Term Code Package, requiring a number of input and bookkeeping changes in MARCH-3.

Additional coding changes have been required to deal with the submerged reactor vessel bottom head in some of the Sequoyah analyses.

Review of the Peach Bottom results have raised a number of questions regarding the proper operation of MARCH-CORCON; extensive review of the results, including comparison of MARCH-CORCON calculations with the stand-alone CORCON-MOD2, indicates that the predicted results are consistent with what would be expected.

PLANNED ACTIVIES: (October)

The Grand Guld sequences to be analyzed will include flooded reactor cavity situations. MARCH-CORCON as received from Sandia will not take into account water in the reactor cavity for BWR's and coding upgrading will be required.

POTENTIAL PROBLEMS AND PROPOSED RESOLUTION:

The code effort to date has been devoted to making the Source Term Code Package operational and making it capable of handling a number of situations previously not encountered. To date, there has been little effort allotted to streamlining of the code and its documentation.

TASK TITLE: SOURCE TERM CODE PACKAGE PREPARATION

TASK NUMBER: 9

NRC TASK LEADER(S): R. O. MEYER

BCL TASK LEADER(S): J. GIESEKE

ACCOMPLISHMENTS AND CURRENT TASK STATUS: (August)

During August, final corrections were made to the MARCH-3 code, the NAUCAL code was integrated into the VANESA code to facilitate code interfacing, and several errors were located and corrected in the TRAP-MERGE code. Check-out of the interim version of the Source Term Code Package was successfully carried out as it was used to perform analyses for several Peach Bottom sequences. The task of preparing documentation for the code package was also begun.

PLANNED ACTIVIES: (September)

During September, efforts will be directed towards streamlining and simplifying the code package, and documentation will continue.

POTENTIAL PROBLEMS AND PROPOSED RESOLUTION:

None.

TASK TITLE: SOURCE TERM CODE PACKAGE PREPARATION

TASK NUMBER: 9

NRC TASK LEADER(S): R. O. MEYER

BCL TASK LEADER(S): J. GIESEKE

ACCOMPLISHMENTS AND CURRENT TASK STATUS: (July)

During July, the MARCH2, CORCON (Mod 2), and CORSOR codes were made operational in combined form as MARCH3. This code checked out successfully. The reference version of VANESA was received and made operational at BCL. Interfacing of VANESA to the NAUA code is being accomplished with a code called NAUCAL which is now being prepared. In future code package versions NAUCAL will be incorporated into VANESA. Interfacing between TRAP-MERGE and NAUA has been worked out successfully. A check-out of the entire Source Term Code Package is scheduled for early August using the Peach Bottom sequence TB.

PLANNED ACTIVIES: (August)

Following successful check-out of the code package in interim form, efforts will be initiated to streamline, simplify, and document the package.

POTENTIAL PROBLEMS AND PROPOSED RESOLUTION:

None.

TASK TITLE: SOURCE TERM CODE PACKAGE PREPARATION

TASK NUMBER: 9

NRC TASK LEADER(S): R. O. MEYER

BCL TASK LEADER(S): J. GIESEKE

ACCOMPLISHMENTS AND CURRENT TASK STATUS: (June)

The Sandia integrated version of MARCH-CORCON incorporating the interim version of CORCON was made operational in a overlayed version on the BCL computer system. The MARCH-CORCON code incorporating the reference version of CORCON-MOD2 was received from Sandia and its implementation was initiated. Code modifications for the interfacing between MARCH-CORCON and the VANESA code were initiated. The VANESA code (final version) has not yet been received from Sandia. Interfacing between MARCH-CORSOR and TRAP/MELT-MERGE was incorporated and automated during the month. Effort was devoted to the interfacing between MARCH and NAUA, particularly in the area of steam condensation on aerosol particles. Other activities were concerned with completing the interfacing between TRAP-MERGE and NAUA. Final completion and checkout of interfacing procedures should put the code package in the desired form for determining source term calculations.

PLANNED ACTIVITIES: (July)

Pending successful implementation of the reference version of MARCH-CORCON, the former will be integrated with MARCH-CORSOR. These activities will put the code package in the form required for the initial SARRP support calculations. Initial calculations with the integrated MARCH-CORSOR-CORCON will be performed. The outstanding questions affecting the completion of the interim version of the code package are the receipt of the reference version of VANESA, final selection of the designated fision product grouping, and checkout of code interfaces.

POTENTIAL PROBLEMS AND PROPOSED RESOLUTION:

Receipt of the latest version of the VANESA code is still being anticipated. The code package can not be completed to this first level until about two weeks after receipt of VANESA.

TASK TITLE: SOURCE TERM CODE PACKAGE PREPARATION

TASK NUMBER: 9

NRC TASK LEADER(S): R. O. MEYER

BCL TASK LEADER(S): J. GIESEKE

ACCOMPLISHMENTS AND CURRENT TASK STATUS: (May)

During May the major efforts under this task were concerned with obtaining a version of the MARCON and VANESA codes from Sandia and making them operational at BCL. The MARCON code received was not the latest version (containing latest CORCON Mod 2 version) but it was purported to be very close to the final version in form. Therefore, it was used in a first attempt to check on operation at BCL and to be ananlyzed for future inclusion of CORCON. The proper version of MARCON is promised to BCL as soon as some final debugging is completed. Since MARCH-CORCON exceeded the central memory available at BCL or INEL, the development of an overlayed version was initiated. Some difficulties are being encountered due to machine differences between the CRAY used at Sandia and the CYBER systems at BCL.

The VANESA code was received and was being made operational on BCL's computers. Because of the lack of VANESA documentation or comments within the listing, it has been a very slow process requiring assistance from both BNL and Sandia. However, progress was made and successful operation seem imminent.

PLANNED ACTIVIES: (June)

Completion of the MARCH3 package (MARCH/CORCON/CORSOR) is expected by mid-June subject to timely receipt of the latest MARCON version. Also, the VANESA code is expected to be operational, the interfacing (under way) between all codes completed and additional checkout runs of TRAP-MERGE completed in the latter part of June. The main impediment to completion of the code package to the level required for additional source term calculations is expected to be the receipt of the latest MARCON version.

POTENTIAL PROBLEMS AND PROPOSED RESOLUTION:

Receipt of the latest MARCON version will precede the completion of an operable code package by about 3 weeks. The schedule now seems dependent on receipt of this code.

TASK TITLE: SOURCE TERM CODE PACKAGE PREPARATION

TASK NUMBER: 9

NRC TASK LEADER(S): R. O. MEYER

BCL TASK LEADER(S): J. GIESEKE

ACCOMPLISHMENTS AND CURRENT TASK STATUS: (April)

A meeting was held with NRC staff and final agreement on the nature and specifications for the source term code package were agreed upon. The code package will be modified from previous specifications to incorporate both the CORCON-Mod 2 and CORSOR codes into the MARCH2 code. Further, it was agreed that an interim version of the package with important physical processes added and code integrations accomplished will be completed by about mid-June. This interim version will not include code streamlining or modifications to the NAUA-SPARC-ICEDF modules.

PLANNED ACTIVIES: (May)

During May, major efforts are to be directed toward preparation of the interim version of the code package.

POTENTIAL PROBLEMS AND PROPOSED RESOLUTION:

Receipt of a MARCH-CORCON combined code will be crucial to the timely completion of the interim code package.

TASK TITLE: SOURCE TERM CODE PACKAGE PREPARATION

TASK NUMBER: 9

NRC TASK LEADER(S): R. O. Meyer

BCL TASK LEADER(S): J. A. Gieseke

ACCOMPLISHMENTS AND CURRENT TASK STATUS: (March)

Activities on this task were minimal, but consisted of additional planning and source term code package specifications. The code package now seems to be fairly firmly defined and a meeting with NRC staff to discuss the status is being planned.

PLANNED ACTIVITIES: (April)

In early April, NRC approval for the code package specifications should be obtained after meeting to discuss details. It is then expected that efforts on preparation of the package will be accelerated greatly.

POTENTIAL PROBLEMS AND PROPOSED RESOLUTION:

None.

TASK TITLE: Source Term Code Package Preparation

TASK NUMBER: 9

NRC TASK LEADER(S): R. O. Meyer

BCL TASK LEADER(S): J. A. Gieseke

ACCOMPLISHMENTS AND CURRENT TASK STATUS: (February)

Activities to redefine the remaining efforts continued as information on the MARCON code was sought from Sandia. It was learned that this code should be available by about April for evaluation as part of the Source Term Code Package. Other efforts at redefinition were nearly completed and some efforts to improve the combined TRAP-MELT/MERGE code were continued.

PLANNED ACTIVITIES: (March)

The revised code package specifications should be completed and activities to prepare the code package should proceed.

POTENTIAL PROBLEMS AND PROPOSED RESOLUTION:

None

TASK TITLE: Source Term Code Package Preparation

TASK NUMBER: 9

NRC TASK LEADER(S): R. O. Meyer

BCL TASK LEADER(S): J. A. Gieseke

ACCOMPLISHMENTS AND CURRENT TASK STATUS: (January)

Major activities were delayed throughout January while definition of the remaining efforts and the associated costs were being reviewed. This was in response to BCL's receipt of NRC comments on the code specifications document. A major question being resolved concerns the status of the MARCON code and its availability from Sandia.

PLANNED ACTIVITIES: (February)

During February the remaining efforts, a proposed schedule, and associated costs will be estimated and transmitted to the NRC for discussion.

POTENTIAL PROBLEMS AND PROPOSED RESOLUTION:

Additional funding is required for this task to proceed as originally proposed. The current delay for detailing efforts will result in the proposed schedule being unattainable.

TASK TITLE: Source Term Code Package Preparation

TASK NUMBER: 9

NRC TASK LEADER(S): R. O. Meyer

BCL TASK LEADER(S): J. A. Gieseke

ACCOMPLISHMENTS AND CURRENT TASK STATUS: (December) 84

Nearly all activities on this task remained suspended during December. Of the few efforts pursued, the combined TRAP-MELT and MERGE computer codes were adjusted to make them more easily operated and various data file transfers were carried out in anticipation of renewed code package development work.

PLANNED ACTIVITIES: (January)

The NRC comments and suggestions regarding the code specifications should be received in early January and revised estimates of required efforts prepared by BCL in response to these suggestions. Work on code package preparation will begin with some of the more obvious code combinations being started.

POTENTIAL PROBLEMS AND PROPOSED RESOLUTION:

Additional funding must be received if this task is to proceed. Additional funds were committed by the NRC, but have not been allocated as yet.

TASK TITLE: Source Term Code PACKAGE Preparation

TASK NUMBER: 9

NRC TASK LEADER(S): R. O. Meyer

BCL TASK LEADER(S): J. A. Gieseke

ACCOMPLISHMENTS AND CURRENT TASK STATUS: (November)

The informal report on "Source Term Code Package Specification" was submitted to the NRC for review. Nearly all other activities on this task were suspended pending the NRC's review and comments on the specifications report.

PLANNED ACTIVITIES: (December)

It is expected that NRC comments and suggestions regarding the specifications report will be received and efforts on code package preparation can be resumed.

POTENTIAL PROBLEMS AND PROPOSED RESOLUTION:

None

TASK TITLE: Source Term Code Package Preparation

TASK NUMBER: 9

NRC TASK LEADER(S): R. Meyer

BCL TASK LEADER(S): J. Gieseke

ACCOMPLISHMENTS AND CURRENT TASK STATUS: (October)

Specifications for the source term code package were prepared in several areas. First, code combinations that would be straightforward and would reduce code interfacing problems were identified. Second, code options and input parameters were reviewed and those believed to be most suited for "hard-wiring" to best-estimate procedures or values were specified. Finally, some general guidelines to be followed in specifying input and to be used in problem specification were identified. These items were being described and discussed in an informal report on "Source Term Code Package Specification". This report was nearly completed and should be submitted for NRC review in early November.

In addition, efforts were directed toward implementing some of the obvious items called for in the specifications and which require a long lead time for completion. A major item of this type was the combination of the MARCH and CORSOR codes which is nearly complete. Additional effort was devoted to the interfacing of MARCH and NAUA in areas that have been troublesome and time consuming in the past.

PLANNED ACTIVITIES: (November)

In early November the informal report on "Source Term Code Package Specification" will be submitted to the NRC for review. In order to assure timely completion of the accident source term program package, it is necessary that a number of activities proceed while the NRC is reviewing the code package specifications.

POTENTIAL PROBLEMS AND PROPOSED RESOLUTION:

This task is scheduled for completion by May 15, 1985, but FY 85 funding has not been received as yet. Funds are requested by the end of November to insure no interruption and adherence to the scheduled completion date.

TASK TITLE: Source Term Code Package Preparation

TASK NUMBER: 9

NRC TASK LEADER(S): G. Marino

BCL TASK LEADER(S): J. A. Gieseke

ACCOMPLISHMENTS AND CURRENT TASK STATUS: (September)

Efforts were carried out to define code options and input constants that could be fixed in the code package and major code interfacing improvements identified. As an outcome of these efforts, a report was begun which will identify the nature of the code package.

PLANNED ACTIVITIES: (October)

During October, the expected nature of the code package will be defined further. These goals will be described in a report to the NRC staff. It is not expected that the report on code package definition and goals will be completed until early November.

POTENTIAL PROBLEMS AND PROPOSED RESOLUTION:

None at this time.

TASK TITLE: Source Term Code Package Preparation

TASK NUMBER: 9

NRC TASK LEADER(S): G. Marino

BCL TASK LEADER(S): J. A. Gieseke

ACCOMPLISHMENTS AND CURRENT TASK STATUS: (August) '84

Activities on this task were initiated in late August and consisted primarily of planning efforts. Listing of code options and input constants that could be fixed or "hard-wired" on the basics of technical judgment was begun.

PLANNED ACTIVITIES: (September)

The basic format and plans for the code package will be formulated for discussion with NRC staff.

POTENTIAL PROBLEMS AND PROPOSED RESOLUTION:

None at this time.

 1st Monthly for Task 9

TASK TITLE: Source Term Code Package Preparation

TASK NUMBER: 9

NRC TASK LEADER(S): G. Marino

BCL TASK LEADER(S): J. A. Gieseke

ACCOMPLISHMENTS AND CURRENT TASK STATUS:

This task will be initiated in August. Plans are being formulated.

PLANNED ACTIVITIES:

POTENTIAL PROBLEMS AND PROPOSED RESOLUTION:

VANESA - NAUA Interface

Converts VANESA release data into a file of source mass rates and nuclide release fractions required by NAUA. The VANESA particle size is converted to r_g. The Cs and I releases are checked against the melt inventory and reduced if the inventory is exceeded. A list of the amount of each species released is printed.

Activity — combine the interface code with VANESA. We need VANESA to accomplish this.

MARCH - CORSOR

Near Term:

1. Complete integration, update release coefficients, and verify operability
2. Benchmark thermal hydraulic (MARCH) and fission product release (CORSOR) predictions against earlier results

Longer Term:

1. Eliminate unusused options
2. Prepare user instructions and documentation

MARCH - NAUA

Near Term:

(1) Change treatment of steam condensation and droplet fallout in MARCH
(2) Coordinate with NAUA requirements
(3) Streamline data transfer
(4) Benchmark predictions of revised models

Long Term:

(1) Automate interface data transfer
(2) Prepare user instructions and documentation

MARCH - CORCON

Near Term:

① Test and verify operability of MARCH-CORCON integration received from Sandia

② Integrate CORCON with MARCH-CORSOR

③ Benchmark predictions of combined MARCH-CORSOR-CORCON

Long Term:

① Add as appropriate further developments, e.g., BWR version of MARCH-CORCON

② Integrate VANESA - if and when available

③ Prepare user instructions and documentation

MARCH INPUT PREPARATION

Near Term:

① Incorporate CORSOR and CORCON requirements

② Finalize model options to be utilized

Long Term:

① Eliminate unused options

② Prepare input preparation procedure

③ Documentation

COMPUTER REQUIREMENTS & RESTRICTIONS

Current version of MARCH-CONSOR requires all available central memory
Integration of CONCON may require segmenting, large core memory, or other approach.

Approach:

1. Initially do what we can, may have to rely on non-transportable approaches
2. Ultimately will streamline, segment, possibly use separate input preprocessor

DOCUMENTATION & SAMPLE PROBLEMS

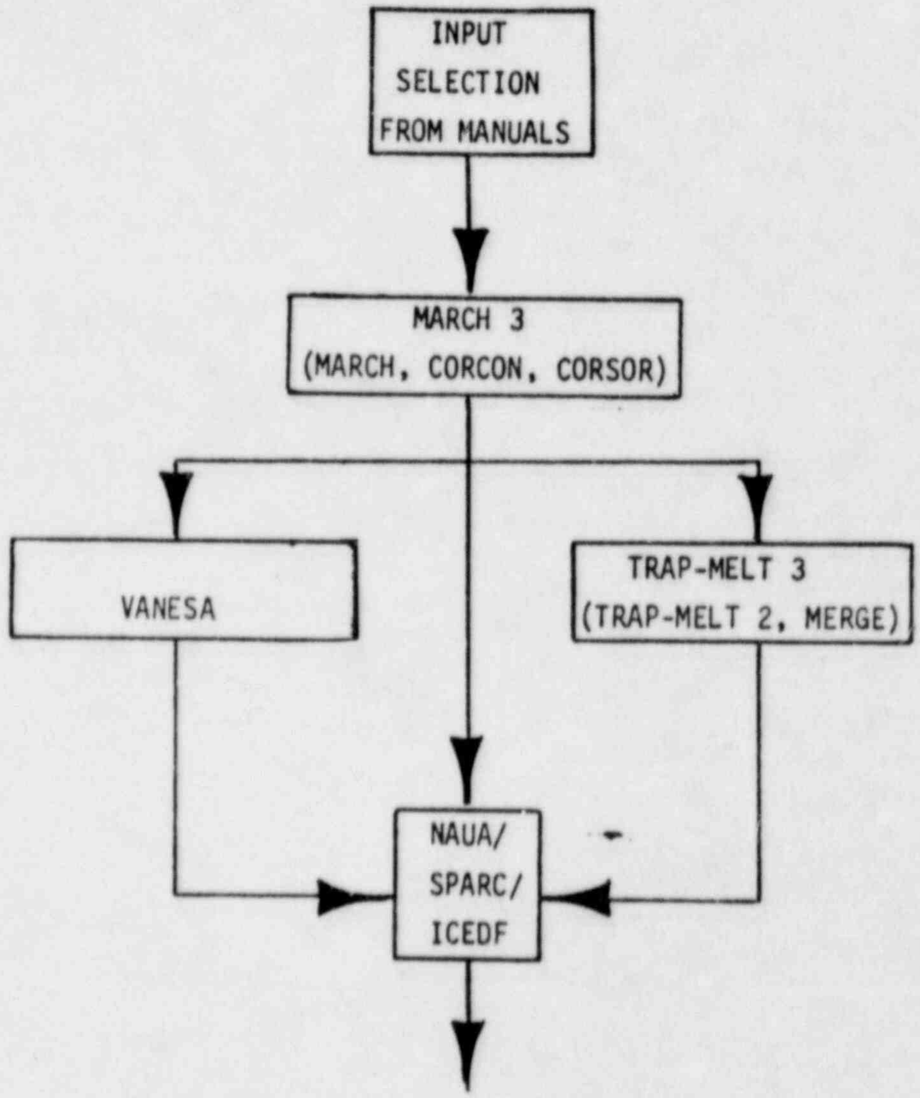
This is a longer term effort

Documentation will not repeat basic code descriptions available elsewhere

Documentation will emphasize differences between combined code package and individual codes

User instructions for combined code package will be featured

Complete set of sample problems including input, output and discussion of results



SOURCE TERM CODE PACKAGE

≡ TRAP-MERGE

TRAP-MELT3 Revisions for Code Package

TRAP-MELT presently interfaces with three other codes:

- CORSOR
- NAUA
- SPARC.

1. CORSOR Interface

Present: Tables of mass rates for each group (up to twenty entries) generated by CORSOR hand transported to TRAP-MELT.

Near Term: CORSOR tables written to separate tape which is read by TRAP-MELT.

Long Term: TRAP-MELT wil read the cumulative releases developed by CORSOR directly from separate tape and use these data to calculate the appropriate rates.

2. NAUA Interface

Present: TRAP-MELT generates tables of continuous mass release rates to containment (up to 100 entries) plus a "puff" release rate at head failure for each group. Also r_g, $\ln\sigma$, at these times.

Near Term: Check operability of this function in TRAP-MELT3, make corrections to pull release recently affected in TRAP-MELT2.

Long Term: Modify NAUA to accept histogram data directly.

3. SPARC Interface

Present: Same as NAUA interface. In addition, hand transfer of CsI and CsOH fraction (soluble fraction). SPARC is hand fed gas temp, flow, composition data from MARCH.

Near Term: No change.

Long Term: Same as for NAUA interface. Add soluble fraction calculation to TRAP-MELT3. Add write to tape of flow data to MERGE section of TRAP-MELT3.

In addition to the above interfacing modifications, some general modifications to TRAP-MELT3 are needed.

Near Term: Convert to MARCH time.

Reinstall dump restart capability.

Preset control parameters and sensitivity parameters.

Rearrange MERGE section input sequence.

Allow MERGE to continue past dryout with nominal flow.

Long Term: No change.

All changes will be checked by reference to a previous run, hand calculation, or by comparison runs old/new version on idealized data accessible to both versions. Continual documentation of changes with reference to most recent manuals.