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FORMULATION OF ADVANCED CONSUMABLES
MANAGEMENT MODELS

JANUARY 1979   CONTRACT NO. NAS9-14264

EXECUTIVE SUMMARY

Prepared by

J. K. Daly

J. G. Torian

Operational Systems Section

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CONTENTS

1.0 INTRODUCTION

Current consumables management techniques are supported by computer programs which provide consumables analysis in support of Space Transportation System (STS) preoperational flight programs. The techniques are also supported by operational period computer programs currently under development for space vehicles such as STS and other advanced spacecraft programs. These latter programs provide consumables management techniques which relieve skilled personnel from the routine processing associated with repetitive spacecraft mission planning and operational functions. This allows concentration on detailed trade studies and mission assessment in support of advanced missions and spacecraft. Current subsystem analysis tools used for trade studies and mission assessment are out of date with respect to computer application and flexibility to model the more advanced spacecraft subsystems. These reports present the results of a study to establish the requirements for advanced subsystem analytical tools and define the modifications and updating of current computer programs that will satisfy the requirements for future space programs.

The final report on the study to formulate advanced consumables management models is presented in two parts - an Executive Summary and a Final Technical Report.

This Executive Summary presents an overview of the study results.

The Final Technical Report presents the software design specifications for development of Environmental Control and Life Support System (ECLSS) and Electrical Power System (EPS) interactive computer programs.

2.0 FORMULATION OF INTERACTIVE SUBSYSTEM MODELS

Continued effective flight design support in the high frequency flight environment of Space Transportation System (STS) requires the updating of current analytical techniques. The objective of the improved techniques is to provide rapid model development, as well as performance analysis for a variety of subsystem configurations. The modeling and performance analysis of the ECLSS and EPS are required to assess both nominal and contingency flight plans. The development specifications for such models are presented in the Final Technical Report. An overview of these models and their characteristics follows.

2.1 ENVIRONMENTAL CONTROL AND LIFE SUPPORT ANALYSIS PROGRAM

The objectives of ECLSS performance evaluations are best satisfied by the application of an interactive computer program with which the user accesses a library of routines simulating the performance of various components and functions common to ECLSS. These routines are assembled with a driver routine (MAIN) to simulate the particular ECLSS under consideration. The assembled program is then loaded and executed to produce the transient performance parameters of the ECLSS under prescribed boundary conditions.

The assembly procedures for such a program are shown in Figure 1. The master library of routines is extracted from a secure file. The user has the option to enter a MAIN routine (as for initial development of an ECLSS model), or extract a particular MAIN from his individual library (as for update/edit and/or additional studies with a previously developed ECLSS model). The extracted MAIN may be altered as part of the update/edit process. The program is then MAP'ed and the MAIN may be stored in the user's file for future use. The particular ECLSS program is then ready for execution.

The execution procedure including a variety of input/output options is shown in Figure 2. The component characteristic data and initial conditions may be read in from restart data stored previously or entered directly. If
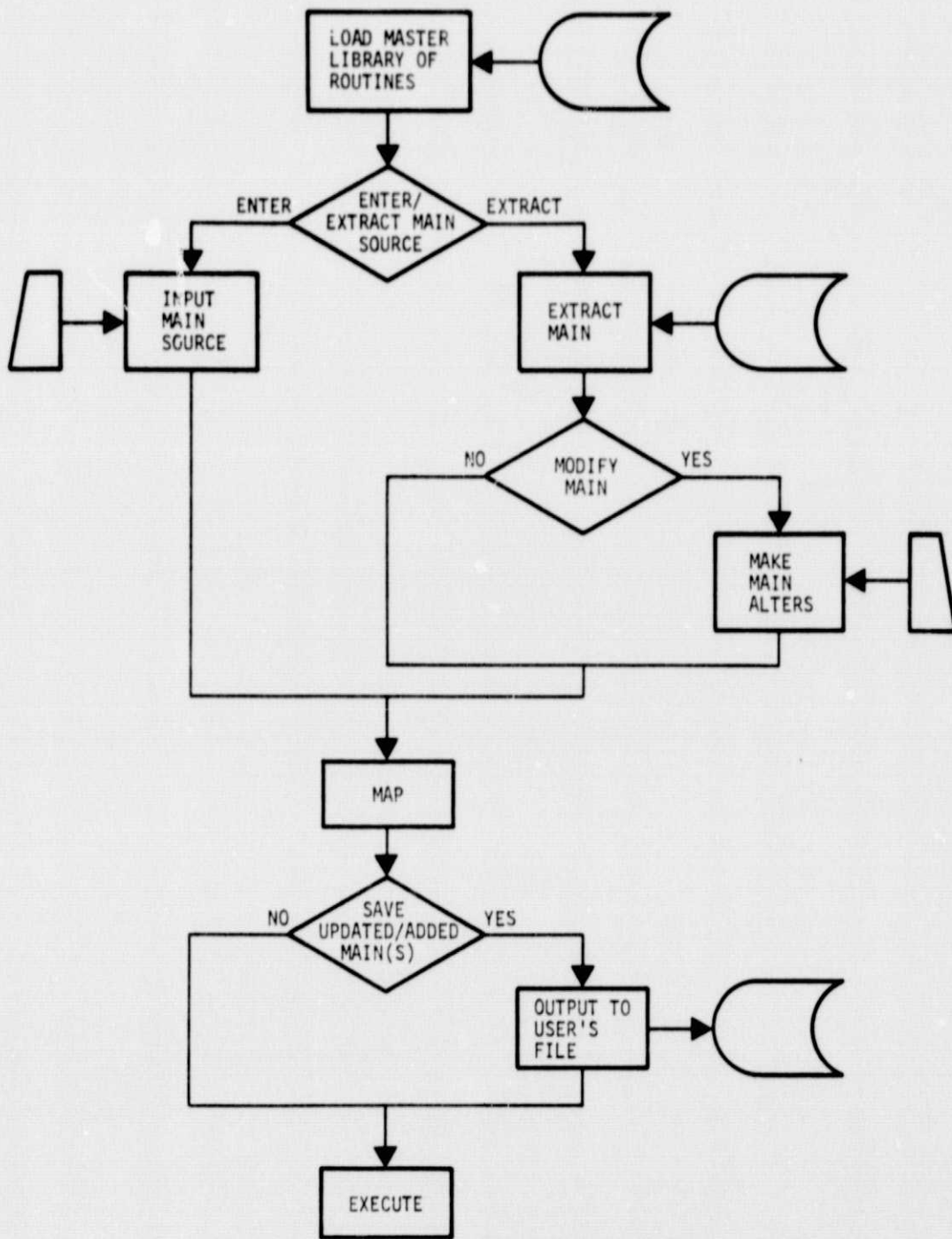
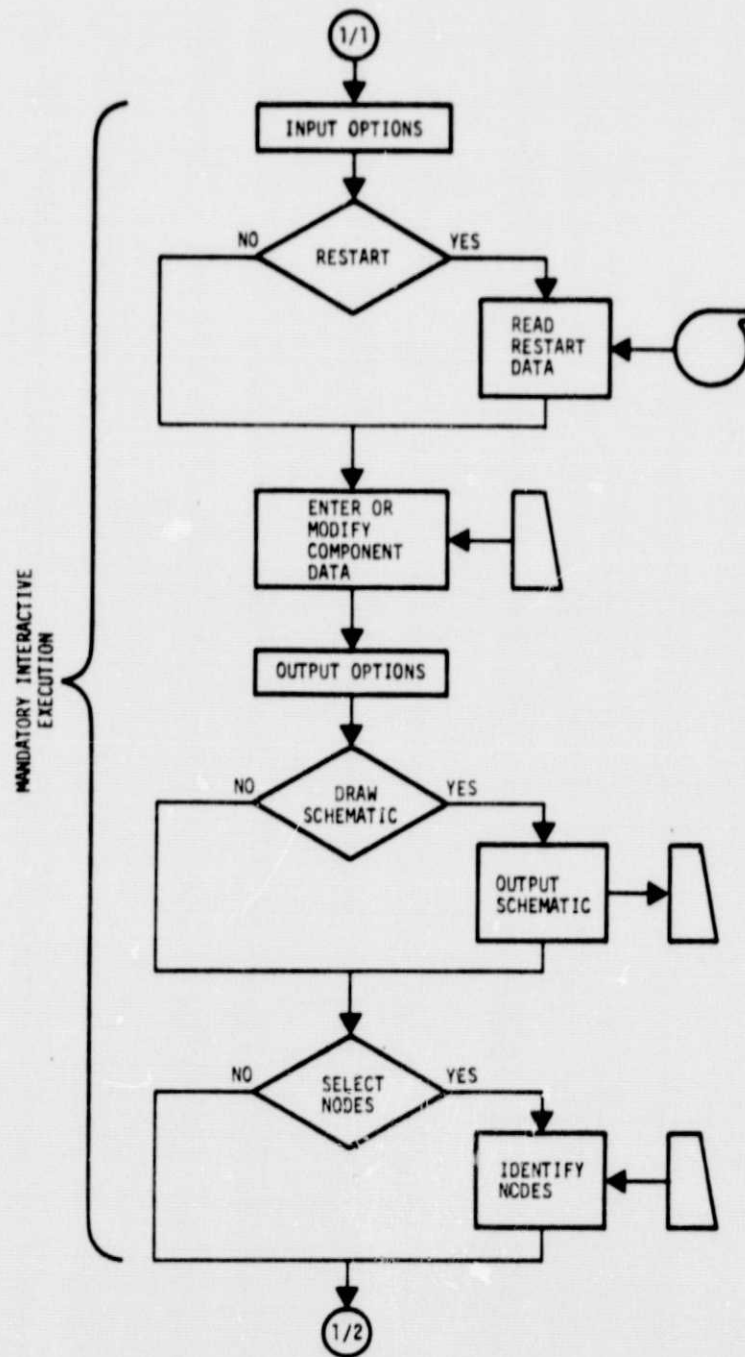Figure 1. ECLSS Program Assembly Procedures

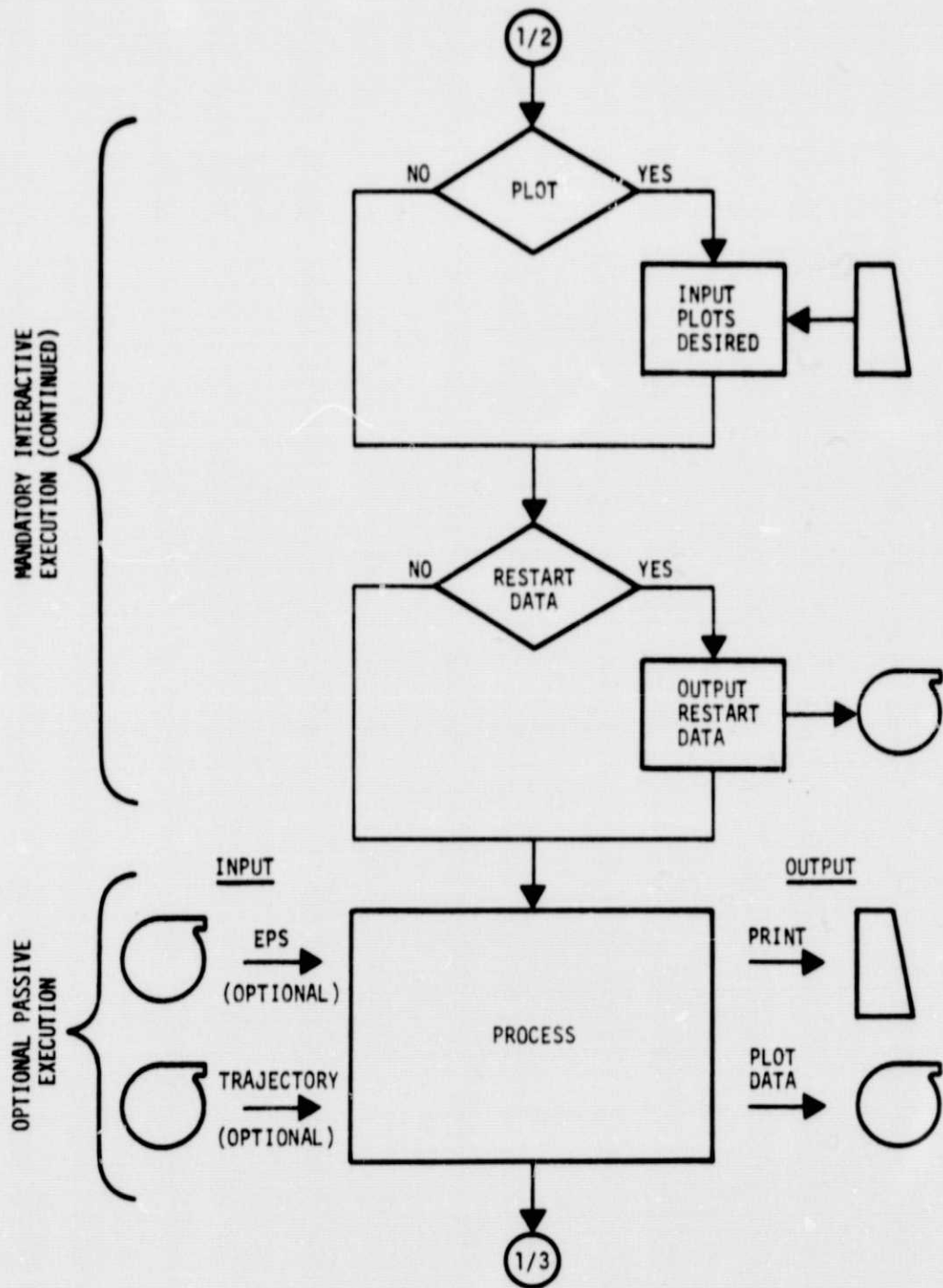Figure 2. ECLSS Program Execution Procedure

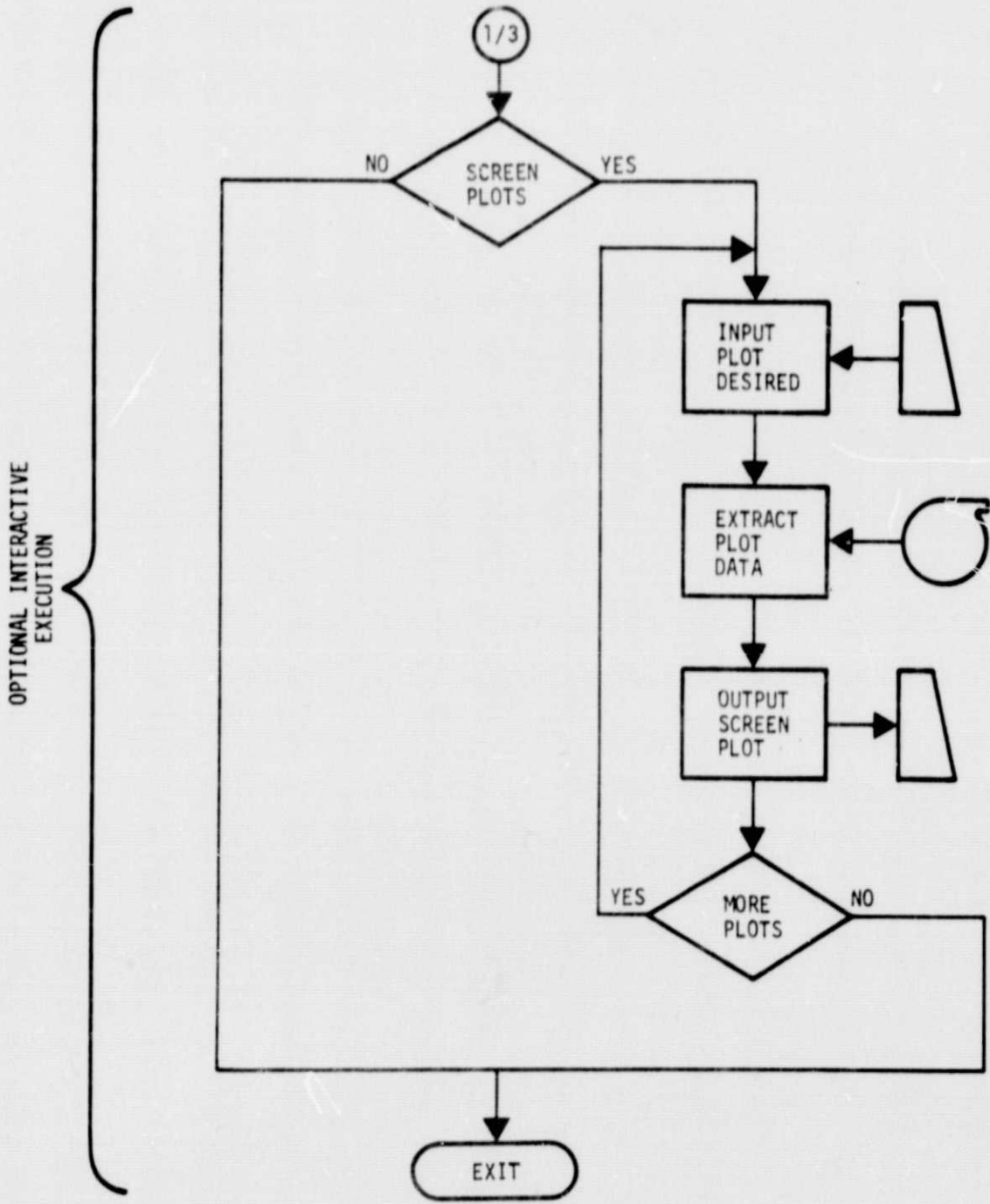Figure 2.   ECLSS Program Execution Procedure (Continued)

Figure 2. ECLSS Program Execution Procedure (Concluded)

the user desires, the system will output a schematic of the ECLSS modeled. The user has the option to select particular nodes (component locations) to be included in tabular output* or the system will default to include all output for tabular nodes defined in the model. If plots are desired, the user simply defines the particular parameters to be plotted. Restart data may be stored for future use. Up to this point the program is executed in an interactive mode which is mandatory as noted in Figure 2. The program then transfers to a second stage of execution.

The second stage of execution is passive in the sense the data are processed with no interaction on the part of the user. The processing accesses EPS data and/or trajectory data automatically, if required. The data can be accessed from tape, secure files, or interface to other programs resident in the system. This stage of execution produces the tabular and plot data. This stage is optional in that the user may execute and witness the tabular data as they are produced, or exit at this point. Exit may be desired in a case where the user desired only to update the model and review the schematic. Exit may also be desired so that this stage of execution can be performed off line in a batch-mode rather than interactively.

A second interactive execution is available which allows the user to extract the plot data just created or a previously created plot data for display on the terminal. The execution is interactive with the user simply specifying which plots are to be displayed.

Specifications for the ECLSS program have been developed at the detail design level with respect to modification of an existing batch mode program. The Fortran Environmental Analysis Routines (FEAR) of Reference 1 are the subject batch mode program. Development of this interactive program requires familiarity with ECLSS analysis, the FEAR program and Reference 1. However, an Appendix summarizing the characteristics of the FEAR program is included in the Final Technical Report. This Appendix is provided as a reference for the reader with a general interest in modifying batch mode programs to form interactive programs, rather than the specific modification of FEAR.

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*Tabular output may be stored for input to, or directly interfaced to other resident programs requiring these parameters.

A pilot model of the interactive model was developed and used as an aid in establishing these specifications. Illustrative interactive displays generated by the pilot model are used as examples throughout the specification text.

2.2 ELECTRICAL POWER SYSTEM PROGRAM

The objectives of EPS analysis are best satisfied by an interactive program similar in structure to the ECLSS program of the previous section. However, EPS models, in general, do not encompass as wide a variety of components and configurations as do ECLSS models. Accordingly, it is not necessary that the user be required to develop and supply the driver (MAIN). The EPS network description, component characteristic data, and boundary condition are entered interactively during execution.

The execution procedure for an interactive EPS program is shown in Figure 3.

The user interface with respect to network description, component characteristics definition and boundary condition data input, as well as internal processing of the program have been developed and included in the specification. The EPS program specifications are at the preliminary design level. The specifications in the Final Technical Report assume the reader is familiar with EPS analysis techniques. Emphasis is on top-down structuring in the development of an interactive program.
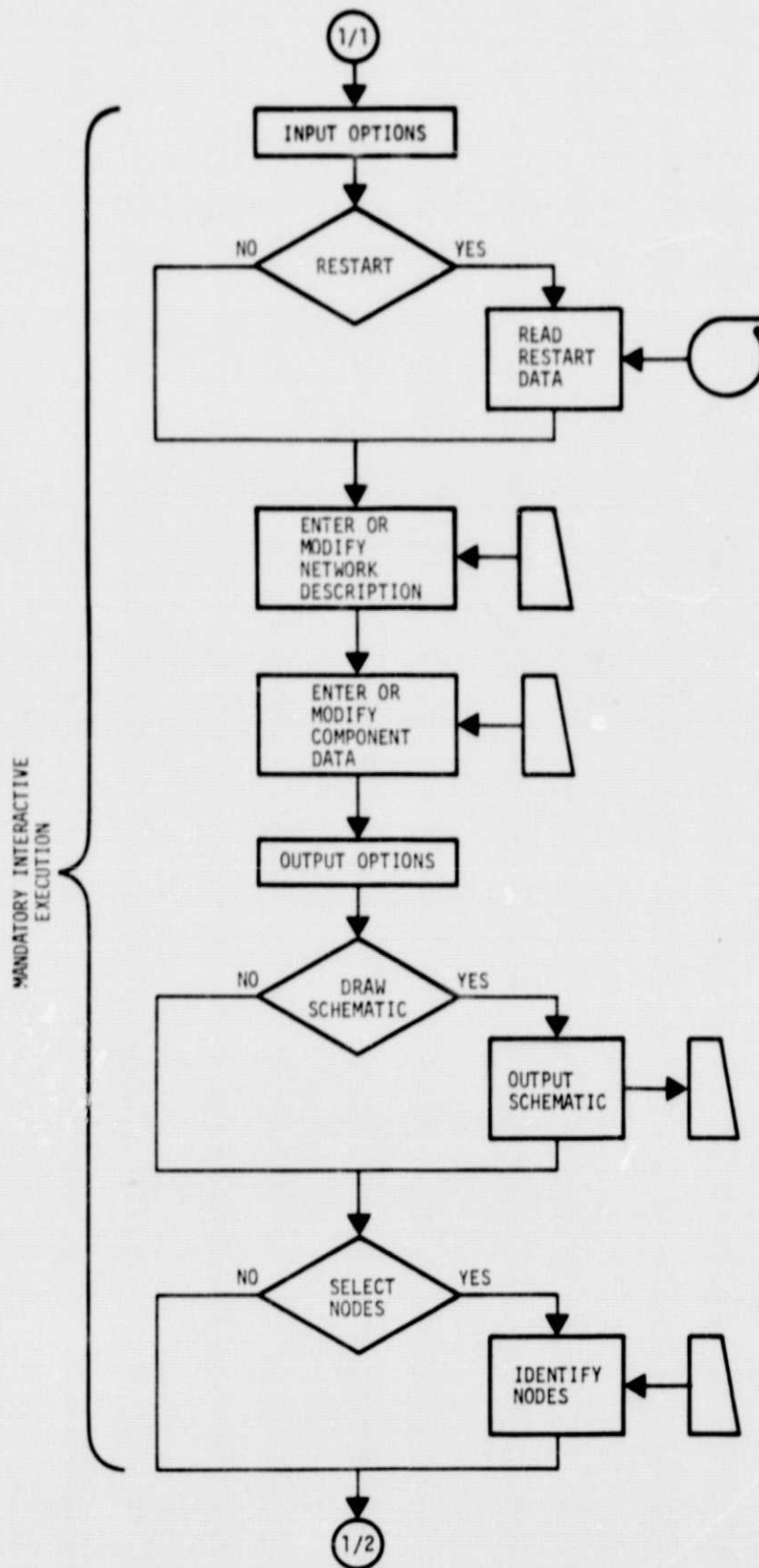
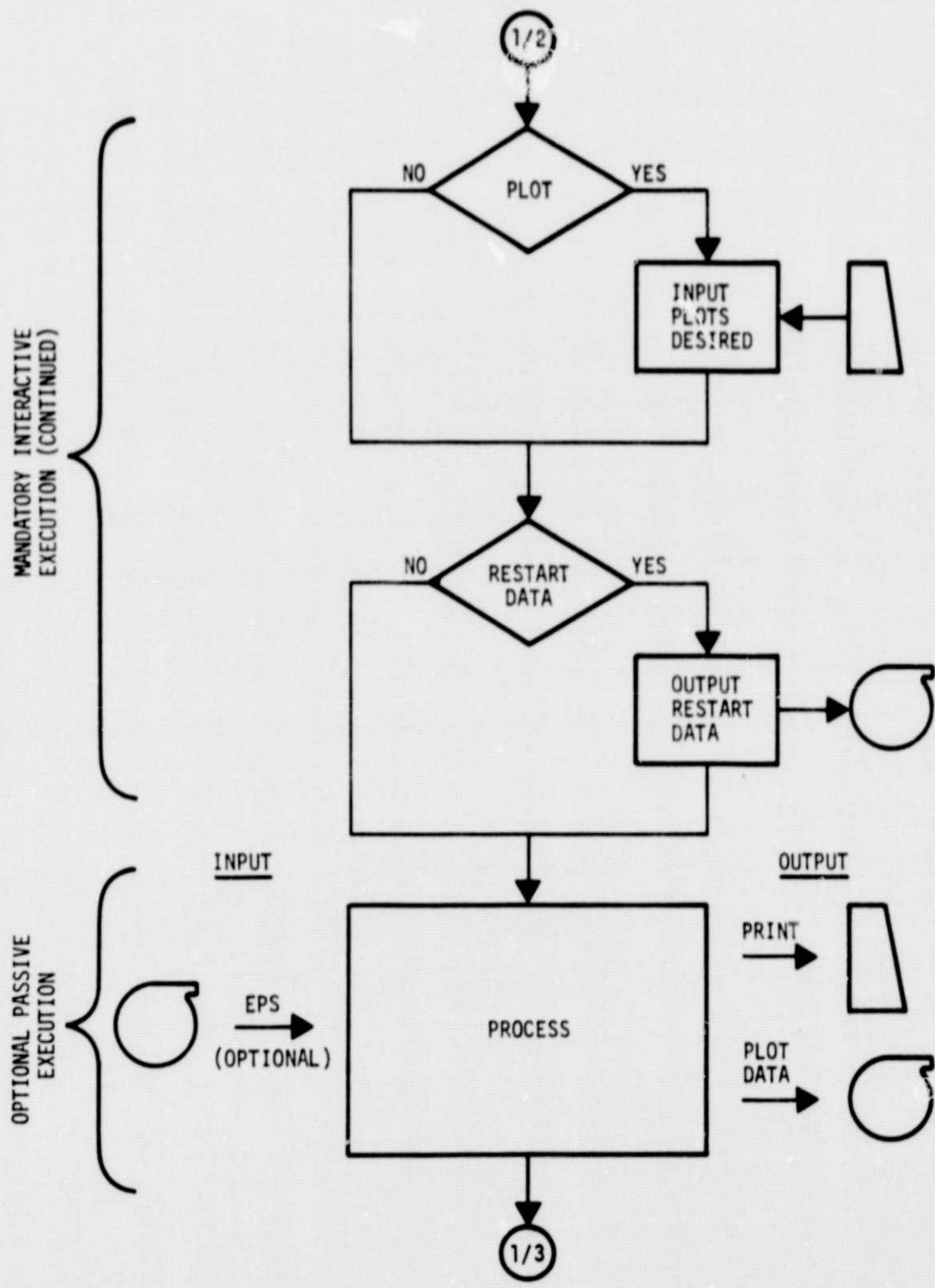Figure 3. EPS Program Execution Procedure
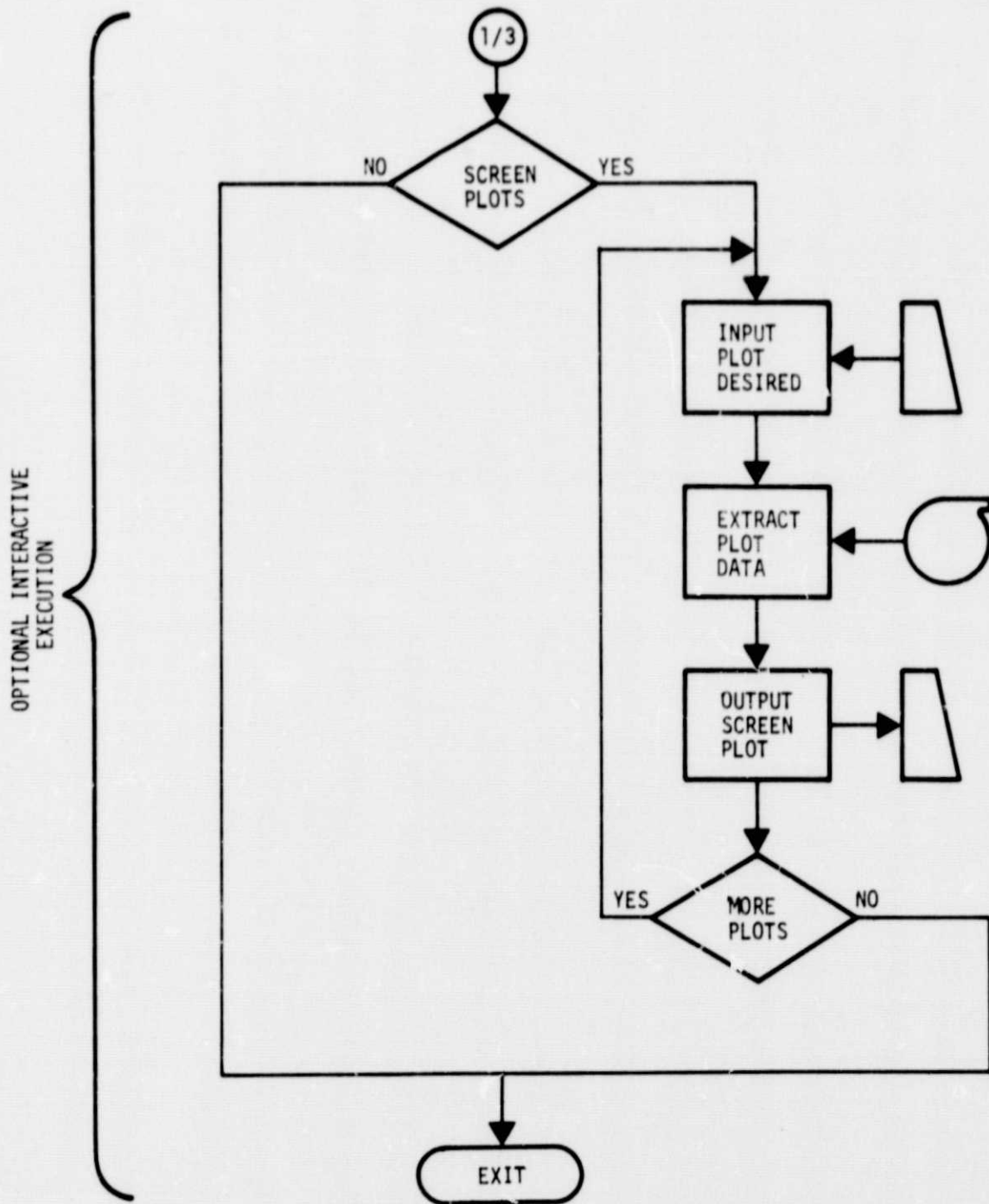
Figure 3. EPS Program Execution Procedure (Continued)

Figure 3. EPS Program Execution Procedure (Concluded)