I. INTRODUCTION

This document serves as a users' guide to the multilevel multichannel R-matrix code SAMMY. Beginning with Revision 6, the organization of this manual has been redesigned in an effort to make it more legible, logical, and useful. A summary of the structure of this document is given here.

Versions of this manual issued prior to Revision 6 included a guide to additions and modifications from previous versions; this information is now moved to the end of the manual, in Appendix A. An introduction specifically for release 7, describing recent modifications and additions to the code and the manual, is found immediately following this general introduction, in Section I.A. All SAMMY users are encouraged to read that section for an overview of recent developments.

Analysis of neutron cross-section data in the resolved resonance region (RRR) has three distinct aspects, each of which must be included in any analysis code: First, an appropriate formalism is needed for generating theoretical cross sections. Second, a plausible mathematical description must be provided for every experimental condition that affects the values of the quantities being measured. Third, a fitting procedure must be available to determine the parameter values which provide the "best" fit of theoretical to experimental numbers. These three aspects of the SAMMY code are described in Sections II, III, and IV of this manual, respectively.

Calculation of the cross sections in the RRR is described in Section II, with emphasis on the Reich-Moore approximation to R-matrix theory. Explicit equations are given for the various types of energy-differential cross sections (total, elastic, capture, fission, other reaction) and for the angle and energy-differential cross sections (elastic, reaction). Both Coulomb and non-Coulomb (neutron) formulae are shown.

Experimental modifications to the theoretical cross sections in the RRR are described in Section III. Included here are such effects as Doppler and resolution broadening, normalization and backgrounds, finite-size corrections, and treatment of more than one nuclide in the target sample.

SAMMY's fitting procedure is described in Section IV. Bayes' equations are derived from Bayes' theorem plus assumptions about normality and linearity. The relationship between Bayes' equations and the more familiar least squares equations is described. Emphasis is placed on methodologies for properly including all measurement uncertainty in the analysis process, including the many SAMMY options for inclusion of data covariance information.

Section V describes such topics as post-processor options (calculating multigroup cross sections or other averages) and other miscellaneous features.

The input to SAMMY is detailed in Section VI. Output is described in Section VII.

SAMMY's treatment of the unresolved resonance region (URR) is discussed in Section VIII. The theoretical treatment was borrowed directly from Fritz Fröhner's FITACS program;

subsequently, input/output and certain details of the calculation have been augmented to increase the utility of this code.

Section IX describes the relationship of SAMMY to the Evaluated Nuclear Data Files (ENDF). Certain types of ENDF files can be used to provide resonance parameters, parameter covariance matrices, or experimental data as input to SAMMY. Likewise, SAMMY can produce files containing resonance parameters, point-wise cross sections, or uncertainty information.

A number of auxiliary programs are available for use with SAMMY input or output. Section X contains a brief description of those for which this author has maintenance responsibility.

Advice for running SAMMY is presented in Section XI. Even experienced SAMMY users are encouraged to read this section, as it contains information about recent developments that may be unfamiliar (but potentially useful) to long-time users. Novices are likely to find valuable suggestions in this section. Anyone requesting the author's help is expected to have read and followed the procedures outlined in Section XI.B.

Sample runs are described in Section XII. These include (1) tutorial exercises (designed to familiarize a novice user with running the code), (2) test cases (designed for quality control, to ensure that the code gives consistent answers from one platform to another and from one version to another, but also useful as examples of input for specific features of the code), and (3) simulations (Monte Carlo simulations of multiple-scattering corrections, designed to test the accuracy of the SAMMY treatment for those corrections).

Section XIII provides an introduction to the computer code itself, for the benefit of the code managers at various sites. The casual user will probably not need the information from this section.