

# Development of an ICSBEP Benchmark Evaluation, Nearly 20 Years of Experience

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### INTRODUCTION

Detailed information on the International Criticality Safety Benchmark Evaluation Project (ICSBEP) is readily available in American Nuclear Society publications<sup>1</sup> and conference proceedings. The main product of the ICSBEP is the International Handbook of Evaluated Criticality Safety Benchmark Experiments<sup>2</sup> (ICSBEP Handbook). This handbook contains criticality safety benchmark specifications that have been derived from experiments performed at various nuclear critical facilities around the world. The benchmark specifications are intended for use by criticality safety engineers to validate calculational techniques used to establish minimum subcritical margins for operations with fissile material and to determine criticality alarm requirement and placement. Many of the specifications are also useful for nuclear data testing.

The community now has nearly 20 years of experience evaluating and documenting historical experiments performed at nuclear facilities throughout the world. The project has evolved considerably over those years. Today, details of experiments are documented more thoroughly, benchmark specifications are more completely described and considerable effort is required to quantify uncertainties. Development of an ICSBEP evaluation is discussed in detail in this paper with emphasis placed on evolutionary improvements and changes that have been made.

Usage of the ICSBEP Handbook has grown to phenomenal levels and covers a much broader spectrum of users than ever expected. The expanded usage of the Handbook has resulted in increased opportunity for error discovery and correction as users encounter and report specific problems. Error reporting is emphasized and the procedure for revising an evaluation detailed. Types of misuse of the data are also discussed.

Additional information on the ICSBEP may be found at <http://icsbep.inl.gov>.

### DEVELOPMENT OF AN ICSBEP EVALUATION

The basic structure of all ICSBEP benchmark evaluations is essentially the same and includes (1) a detailed description of the experiment; (2) an evaluation of the experiment, including an exhaustive effort to quantify the effects of uncertainties on measured quantities; (3) a concise presentation of benchmark-model

specifications; (4) sample calculation results; and (5) a summary of experimental references. Computer code input listings and other relevant information are generally preserved in appendixes.

A description of the experiment (Section 1) generally includes geometry, materials, and temperature. Other relevant information is sometimes available and is included with the description of the experiment.

Evaluation of the experiment (Section 2) includes an assessment of the quality and completeness of the data and a thorough quantification of uncertainties and the effects those uncertainties have on key measured parameters that are to be calculated by users. Both random and systematic uncertainties must be addressed. Individual contributions to uncertainties should be clearly summarized and overall effects of experimental uncertainties quantified.

Benchmark specifications (Section 3) include concisely stated geometry, material, and temperature specifications. Biases and associated uncertainty must be quantified and final benchmark values and uncertainties clearly summarized.

Results of sample calculations (Section 4) are provided so users can quickly compare their results with evaluator results as a means of identifying error. Misuse of results occurs when results are taken directly from the ICSBEP Handbook and used to support validation of safety analyses. Safety analysts should always perform their own validation calculations starting with the benchmark specifications given in Section 3.

Only publically available references that provide information directly related to the experiment are included in the reference section (Section 5) of an ICSBEP evaluation. Other relevant references such as handbooks, logbooks, code manuals, etc. are incorporated as footnotes to the citation in the text.

Typical computer code input listings are provided in Appendix A of an ICSBEP evaluation. Input listings are only provided as a means to document all details of the sample calculations, many of which are not explicitly described in Section 4. Input listing make it possible for users to troubleshoot their own calculations and determine if discrepant results are due to errors or code option differences in either their input or in the original evaluation. Misuse of input listing occurs when users simply use the input from the Handbook rather than creating their own. Additional appendixes, following Appendix A, can be included in the report as needed.

## PUBLICATION IN THE ICSBEP HANDBOOK

ICSBEP evaluations undergo three levels of peer review: internal review, independent review, and international technical group review. Internal reviewers are expected to verify that (1) the descriptive information given in the evaluation aligns with original documentation, published and unpublished; (2) the benchmark specification can be derived from the descriptive information given in the evaluation; (3) the benchmark specification is complete; (4) the results and conclusions are sound, and (5) the format is compliant with the publication style.

Independent peer reviewers are expected to perform the same level of review with the exception that comparison with original documentation is not always possible and is therefore not required. Finally, members of the international technical review group verify that benchmark specifications and conclusions are adequately supported.

## ERROR REPORTING

The rigorous review process followed by the ICSBEP was designed to minimize errors and omissions. However, the large user base is in an excellent position to discover errors. When errors are discovered and reported, the authors and reviewers are immediately contacted to verify and correct the errors. Once the evaluation has been revised, it is posted to the ICSBEP Internet Site (<http://icsbep.inl.gov>) until it is incorporated into the next publication of the Handbook and can be located by logging into the "Handbook", and selecting the "Newly Revised Evaluations" tab. Unfortunately, not all errors are reported. Users are encouraged to report errors immediately so they can be corrected by selecting the "Error Reporting" link in the upper left-hand corner of the ICSBEP Internet Site Home Page (<http://icsbep.inl.gov>), or by sending an e-mail directly to [icsbep@inl.gov](mailto:icsbep@inl.gov).

## CONCLUSIONS

The ICSBEP Handbook is a reference book, not a compilation of technical reports. The rigorous format is for the benefit of the expanded number of users. The information has been rigorously verified and the orderly layout in which the same type of information always appears in the same location is designed to assist the user.

ICSBEP evaluations require significant investment of time and resources by both authors and reviewers. However, resulting benchmark specifications will likely be of use for decades and significant savings will be realized.

## ACKNOWLEDGMENTS

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## REFERENCES

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