XA0200034 IAEA-SM-367/5/01

INTERNATIONAL TARGET VALUES 2000 FOR MEASUREMENT UNCERTAINTIES IN SAFEGUARDING NUCLEAR MATERIALS

H. AIGNER, R. BINNER, E. KUHN
International Atomic Energy Agency, Vienna, Austria

The IAEA has prepared a revised and updated version of International Target Values (ITVs) for uncertainty components in measurements of nuclear material. This represents the fifth revision of the original release of such tables issued in 1979 by the ESARDA/WGDA. The ITVs represent uncertainties to be considered in judging the reliability of analytical techniques applied to industrial nuclear and fissile material subject to safeguards verification. The tabulated values represent estimates of the "state of the practice" which ought to be achievable under routine conditions by adequately equipped, experienced laboratories. The most recent standard conventions in representing uncertainty and reliability data have been taken into account, while maintaining a format, which allows comparison to previous releases of ITVs. The ITVs 2000 are intended to be used by plant operators and safeguards organizations as a reference of the quality of measurements achievable in nuclear material accountancy, and for planning purposes. They may also be used for statistical inferences regarding the significance of operator-inspector differences whenever insufficient measurement data is available.

The IAEA prepared a draft of a technical report presenting the proposed ITVs 2000, and in April 2000 the chairmen or officers of the panels or organizations listed below were invited to co-author the report and to submit the draft to a discussion by their panels and organizations.

- Euratom Safeguards Inspectorate
- ESARDA Working Group on Destructive Analysis
- ESARDA Working Group on Non Destructive Analysis
- Institute of Nuclear Material Management
- Japanese Expert Group on ITV-2000
- ISO Working Group on Analyses in Spent Fuel Reprocessing
- ISO Working Group on Analyses in Uranium Fuel Fabrication
- ISO Working Group on Analyses in MOX Fuel Fabrication
- Agencia Brasileno-Argentina de Contabilidad y Control de Materiales Nucleares (ABACC)

Comments from the above groups were received and incorporated into the final version of the document, completed in April 2001[1]. The final report replaces the 1993 version of the Target Values, STR 294.

An effort was made to bring the nomenclature in line with the latest recommendations of ISO, EEC, BIPM, and EURACHEM. In particular, a clear distinction is made between the meaning of the term "error" and the term "uncertainty". The ITVs 2000 represent target standard uncertainties, expressing the precision achievable under stipulated conditions. These conditions typically fall in one of the two following categories: "repeatability conditions" normally encountered during the measurements done within one inspection period; or "reproducibility conditions" involving additional sources of measurement variability such as "between inspections" or "between laboratories" variations.

The presentation of the 1993 ITVs involved sixteen different tables, whereas the ITVs 2000 are presented in only six tables. Their format is designed to allow an easy comparison to previous releases.

- Five tables list the ITVs 2000 for bulk and density measurements, sampling, the determination of element concentration, of ^{235}U isotope abundance, and of plutonium isotope ratios, respectively.
- A sixth table gives the ITVs for the direct measurement of the total amount of fissile element or isotope by NDA techniques in a given item or batch.
- Each table identifies separate ITVs according to the type of material and measurement method, as appropriate.
- Additional materials and methods are being considered.
- Two parameters characterise the quality, which should be aimed for in a specific measurement of a given material using a specified method at a single laboratory:

  random uncertainty components, u(r), are due to errors varying in an unpredictable way among individual items or results. Counting statistics or the repeatability of measurements within a short period of time under constant conditions are typical examples for random uncertainty sources. Simply stated, the effects of random uncertainties can be reduced by repeated measurement, sampling and analysis, but it is not possible to correct for random errors.,

  uncertainty components of a systematic character, u(s), are due to errors affecting an entire group of items in the same way, like all measurement results interpreted with the same calibration curve, normalized with the same normalization experiments, or affected by the same background subtraction. But also uncertainties in the certified values of reference materials, nuclear data uncertainties or constant instrument or laboratory biases will appear to have a systematic character. The effects of uncertainties of a systematic character cannot be reduced by repetition under a fixed set of conditions encountered during a given inspection period. The cause of systematic errors may be known or unknown. If both the cause and the value of a systematic error are known, it can be corrected for, but there will still remain an uncertainty component of systematic character, which is associated with this correction.

As in earlier publications the values listed in the present document have been derived from an evaluation of actual measurement data. Four sources of information were considered. The most relevant and complete set of measurement data still comes from the information gathered by safeguards inspectorates during the statistical evaluation of the results of the measurements reported by the facility operators and the results of independent measurements performed on the same materials by the inspectors. This approach is referred to as the "top-down" approach. These data were complemented and confirmed by "bottom-up" assessments of measurement uncertainty components published by measurement specialists and derived according to the ISO, NIST and EURACHEM guides. In addition and whenever possible, it was verified that the proposed ITVs were consistent with the results of laboratory intercomparisons or measurement quality evaluation programmes. In cases where little or no statistical data was available (particularly for sampling uncertainties), some values were defined on the basis of expert opinion.

REFERENCES

[1] H. Aigner, et al. "International Target Values 2000 for Uncertainty Components in Safeguarding Nuclear Materials", Draft of Safeguards Technical Report, IAEA, Vienna, (April 2001)