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REGULATORY GUIDE

DIRECTORATE OF REGULATORY STANDARDS

REGULATORY GUIDE 5.22

ASSESSMENT OF THE ASSUMPTION OF NORMALITY (EMPLOYING INDIVIDUAL OBSERVED VALUES)

A. INTRODUCTION

Part 70 of Title 10 of the Code of Federal Regulations requires certain AEC special nuclear material (SNM) licensees to establish and maintain written material control and accounting procedures to enable the licensee to account for the special nuclear material in his possession. Part 70 also requires applicants for certain AEC licenses for SNM to submit to the Commission as part of the application a full description of such procedures, including statistical controls. The effectiveness of such controls depends greatly upon the validity of the statistical procedures applied. A key assumption often encountered in applications is that the measured value is a random variable that can be described by a normal or Gaussian distribution function. This guide identifies methods acceptable to the Regulatory staff for assessing the validity of such an assumption.

B. DISCUSSION

The general role of statistical methodology in SNM accountability is to serve as the basis for evaluations which objectively provide assurance that material in the possession of licensees is accounted for effectively and that losses are localized when they occur.

In maintaining material balances, it is usually impracticable to assay (observe) every item in a material process batch or lot (population). It would also be impossible, of course, to measure any material an infinite number of times. Accountability systems must therefore rely on observing a portion (sample) of the population being measured, from which general conclusions can be inferred about the population. Such statistically calculated inferences based on sample measurement data are basically predictions of what would be found if the sampled populations could be and were fully observed. The validity of inferences made on the basis of an assumed frequency function is dependent on the extent to which the assumed distribution describes the actual measurement process.

One of the most frequent assumptions made in developing and applying statistical procedures for treating measurement data is that observations comprising a sample were drawn from a population which can be described by a normal distribution. The examination of a typical set of measurements which adequately represent the distribution will show the individual measurement values clustering around the average, forming a symmetrical bell-shaped pattern. Two parameters, the mean and the variance, are sufficient to define a normal distribution of a particular set of data under examination.

Most statistical interval estimates and tests commonly used in practice are based on the assumption of normal distribution. Two features tend to promote the usage of the normal distribution, sometimes without sufficient investigation as to whether its assumption is justified. One is its usual applicability and the other is the fact that its mathematical operations are comparatively simple and well known. The basic procedural assumption that a measured random variable is normally distributed can often permit slight to moderate departures from normality without significantly affecting conclusions, depending on the statistical technique employed. However when decisions are based on the outcome of a statistical test, there is always a risk that a wrong conclusion has been reached, and any decision based on incomplete information runs the risk of either rejecting a true hypothesis or accepting a false one. The discernibility (power) of a statistical test will depend significantly upon the quantity and quality of data tested. A major departure from the normality assumption could result in misleading conclusions. For example, the level of control could be incorrectly determined and assessed if measurement errors are not

characterized properly in the calculation of limits of error. This could seriously affect the facility's ability to control quantities of material unaccounted for and to evaluate their significance. Therefore, the testing of the assumption of normality merits consideration as a control procedure.

Subcommittee N15-3 of the American National Standards Institute (ANSI) Standards Committee N15, Methods of Nuclear Materials Control, has developed a standard for assessing the assumption of normality (employing individual observed values). This standard has been designated ANSI N15.15-1973. [1]

[1] Copies may be obtained from the American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018.

C. REGULATORY POSITION

The statistical hypothesis testing techniques contained in the approved standard, ANSI N15.15-1973, "Assessment of the Assumption of Normality (Employing Individual Observed Values)," [1] are generally acceptable to the Regulatory staff for use in written procedures for the control of special nuclear material subject to the following. The interpretation of the significance of results from the application of the test of normality should consider the amount of data treated (sample size), in particular whether there are enough data available to reach a meaningful conclusion pertaining to the validity of the assumption for a given process.