Appendix D

Application of Decision Analysis Software, Expert Choice™, for Ranking Subjective Variables

D.1 Introduction to Expert Choice™

The well-recognized decision analysis software, "Expert Choice™" [D1], based on the analytic hierarchy process (AHP) formulated by Saaty [D2], is used to provide a method for ranking the relative likelihood of facility anomaly, according to the three types of states defined. The method consists of an inverted, tree-like structure, in the form of hierarchies (or levels) of main categories and sub-categories. Figure D1 indicates, on the left-hand side, the terminology used in the report and, on the right-hand side, the general terminology used in Expert Choice. The hierarchy structure is produced by relating a single top requirement, for example, the Likelihood of a Facility Anomaly (for a given type of facility), to lower levels of criteria/factors. The level of detail increases as the hierarchy level increases. The highest hierarchy level, physically the lowest on the diagrammatic structure, represents the three state types for which the relative anomaly likelihood comparison is required. Figure 1 provides the basic hierarchy used for the likelihood parameter assessment. This particular hierarchy is generic for all facilities in the undeclared category and is used as an example, assuming a high-speed gas centrifuge facility. At each hierarchy level, the grouped variables (connected by lines) are compared qualitatively in a pairwise way. This type of pairwise comparison forms the basis of the technique and enables weightings of the variables in the different hierarchy levels to be established.

The reason for grouping each hierarchy level into different categories and sub-categories is that comparing large number of items all at the same level would be cumbersome, because of the large number and also because of the potential lack of any form of commonality between every item. The pairwise comparison method is more efficient, requiring fewer judgments, when the items are grouped.

D.2 Advantages of Use

With respect to the rationale of the choice of method, a number of different decision making methods were reviewed that potentially could be used when subjective, uncertain and widely disparate parameters have to be compared and quantified. The conclusions are summarized below.

The often-used normalization type of method has fundamental analytical problems, discussed by Saaty [D3], and should be avoided. Because the scales of measurement of the different criteria are not the same, there is then no way to make the answer meaningful, unless somehow the scales can be interpreted in terms of a single scale so that they can be combined in a final meaningful way.

The Delphi-type decision-modeling approach of Saaty [D2, P.69], has each member of an expert group responding anonymously to a previously prepared questionnaire. It still has the technical limitations of a normalization method of comparing simultaneously all the various variables. This avoids strong personality domination, but appears to create quite large uncertainties compared to a collegiate consensus type system, such as the AHP, so a Delphi approach is not favoured.