# A SUGGESTED PROCEDURE FOR RESOLVING AN ANOMALY IN LEAST-SQUARES DATA ANALYSIS KNOWN AS "PEELLE'S PERTINENT PUZZLE" AND THE GENERAL IMPLICATIONS FOR NUCLEAR DATA EVALUATION*

by

Satoshi Chiba** and Donald L. Smith

Engineering Physics Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
U.S.A.

## ABSTRACT

Modern nuclear-data evaluation methodology is based largely on statistical inference, with the least-squares technique being chosen most often to generate best estimates for physical quantities and their uncertainties. It has been observed that those least-squares evaluations which employ covariance matrices based on absolute errors that are derived directly from the reported experimental data often tend to produce results which appear to be too low. This anomaly has come to be known as "Peelle's Pertinent Puzzle" (PPP) because the validity of certain evaluations afflicted in this manner has been called into question by R.V. Peelle. The anomaly, as originally posed by Peelle through a specific example, is discussed briefly in this report, and a procedure for resolving it is suggested. The method involves employing data uncertainties which are derived from errors expressed in percent. These percent errors are used, in conjunction with reasonable a priori estimates for the quantities to be evaluated (rather than the individual experimental values), to derive the covariance matrices which are required for applications of the least-squares procedure. This approach appears to lead to more rational weighting of the experimental data and, thus, to more realistic evaluated results than are obtained when the errors are

(continued on the following page)

---

* This work supported by the U.S. Department of Energy, Energy Research Programs, under contract W-31-109-Eng-38.

** Permanent address: Department of Physics, Japan Atomic Energy Research Institute, Tokai-mura, Naka-gun, Ibaraki-ken 319-11, Japan.

**ABSTRACT**

(continued from the preceding page)

based on the actual data. The procedure is very straightforward when only one parameter must be estimated. However, for those evaluation exercises involving more than one parameter, this technique demands that a priori estimates be provided at the outset for all of the parameters in question. Then, the least-squares method is applied iteratively to produce a sequence of sets of estimated values which are anticipated to convergence toward a particular set of parameters which one then designates as the "best" evaluated results from the exercise. It is found that convergence usually occurs very rapidly when the a priori estimates approximate the final solution reasonably well. In fact, the procedure is observed to be quite robust in that convergence is not too difficult to achieve even when the a priori estimates aren't very good. Some examples are given in this report to illustrate the problem and to demonstrate the approach suggested here for its resolution. Some general implications for the practice of nuclear data evaluation are also discussed.