Standardization of Analytical Methods

V. C. Mehlenbacher, Swift and Company, Chicago, Ill.

BEFORE we go into a technical discussion of method standardization, we had better define the subject. I am positive that if I asked a dozen of you what is meant by a "standard" method, there would be some astonishing variations in the replies. In my opinion a truly standardized method is one about which a) its accuracy has been determined by comparison with adequate primary standards, b) its precision under the conditions in which it will be used have been measured, c) all details have been adequately described so that there need be no variation in the manner in which it is carried out. Such a method is then ready to be accepted by the industry for use in all instances in which this particular determination or estimation is required.

Also, before we proceed any further to discuss this project of standardization, it's good business to know why we do it. That's what the people who control the purse strings usually want to know. Apropos of this, I'm going to read to you a paragraph from the Journal of Industrial Engineering Chemistry, Vol. 2, 1910, which I quote:

> It happens too often that every now and then the manufacturer dealing with chemists has returned to him results which lead him to lose faith in chemists and chemical processes. This usually happens when he sends out samples to different chemists and gets different results.

That statement was written nearly 50 years ago by W. D. Richardson, who preceded R. C. Newton as the chief administrator of the Swift and Company Research Laboratories. To the technical man concerned with buyers' and sellers' analyses, the paragraph I just quoted says a mouthful.

In addition to minimizing differences between buyer and seller, there are other incentives just as cogent to standardizing methods of analysis. These are the needs of research, and I'm sure you agree that these are most compelling. Analytical chemistry has been said to be the eyes through which research sees its way ahead. One can restate that sentence in many different ways, but it all adds up to the fact that normally research cannot be much better than the analysis which guides it.

The third important application of standardized methods is for purposes of production and product control. Of course, today control frequently involves something more than chemical analysis although control is usually thought of in relation to laboratories or test rooms or some similar facility. Control today is properly regarded as an industrial science in its own right, into which is coordinated the proper elements of analytical chemistry, biochemistry, physical chemistry, instrumentation, electronics, and, last but certainly not least, statistics. Control today is, or should be, a completely designed and standardized procedure with regard to size and number of samples, and schedule of sampling, and, to the extent that chemical methods or physical tests are applied, factual knowledge of their accuracy and precision is desirable.

THE NEED for the evaluation and standardization of methods stems from the fact that chemical methods yield variable results. The analytical chemist has been plagued with the problem of different answers at different times by different people and in different laboratories from the beginning. Such occurrences are troublesome, inefficient, and expensive. Fifty years ago, when analytical chemists began to do something about this, they set out to unify the methods to be used for commercial trading. The program of standardization which we have carried out during the last 20 years is a continuation and extension of the original business of unification. Some people choose to call the differences that I have just mentioned errors, but I have always preferred to refer to them as variations, and I think this is a more nearly correct term. In the first place, an error denotes a mistake, and these variations may be but are not necessarily mistakes. They are natural variations which occur for many reasons, several of which are many times out of the control of the analyst. Some of the more fundamental sources of variations in analytical results are presented below:

a) variations in the calibration of the glass apparatus employed;

b) variations in manipulation by people because of their natural responses, dexterity, etc. (There are certain subjective elements in almost any method of analysis.);

c) variations in the behavior of such instruments as are used;

d) variations in all of the other tools of the analyst including solutions;

e) variations in the reaction conditions;

f) variations in the sample (A very important variation is that of the sample, but this is another problem, almost as large and equally as important as the variation of analysis. I should like to emphasize in this connection that while I am not going to talk about sampling, in any investigation of a method it's important to distinguish between variations in sample and variations due to analysis.).

Many of these analytical variations may be minimized by maintaining good technique, by the use of other aids such as internal standards, within-laboratory knowns, primary standards, and check samples. But with all of the variations kept at a minimum, there still remain significant differences between people, between laboratories, and between companies. We face the effect of these variations in commercial trading, in guiding research, in writing or accepting product specifications. When you write specifications, do you take into consideration sample variation, analytical variation, product variation, plant variation, etc.? Likewise, when you accept customer specifications, do you set your manufacturing specifications to allow for a proper tolerance between laboratories? You probably don't. The standardization of methods involves, to my way of thinking, a determination of the magnitude of the several major sources of variation such as between days, between people, between plants, and between laboratories.

OF COURSE, one might ask what is the good of trying to classify these differences, why don't we just take a lump sum including all of them and let it go at that? The answer to this depends on how good we want to be, how accurately do we want to control? I suggest to you in this respect that such things as resampling, re-analysis, failure to comply with specifications and "give away" are expensive in today's market. By classifying variations and applying the appropriate limits for establishing workable and economical specifications, we can expect a maximum of economy with a minimum of trouble. As a couple of examples of the application of appropriate limits, we cite these. If we are establishing control for several plants, we are concerned with between-plant variations, possibly even to the extent of establishing different limits for different plants. When we are concerned with product that is going to be analyzed by a laboratory other than our own, for example, a buyer's, we most certainly should be worried about between-laboratory variations.

The economies involved are significant because the costs of analysis today for whatever purpose are soaring. It behooves us therefore to eliminate or at least minimize everything that contributes to unnecessary expense. When there is disagreement between buyer and seller and the analyses are repeated, the expense is doubled. It is so easy to say, "do it over," that we fail to consider how important this sort of thing may become.