MISCELLANEOUS

Explosion in an Autoclave caused by Cellulose Nitrate Tubes

The practice adopted in biological laboratories when disposing of contaminated material is to sterilize by steam in an autoclave, taking care to exclude anything known or suspected to lead to combustion. A latent danger exists if certain types of laboratory ware are treated in this way, without the research worker being aware that risk exists. An example of this occurred in this Establishment when a number of celluloid centrifuge tubes, potentially contaminated and intended for destruction, were sent for autoclaving. During the process spontaneous ignition of the tubes occurred, followed by explosive burning. The autoclave was wrecked and extensive superficial damage was done to the surrounding areas.

Although it can scarcely be regarded as good practice to autoclave material based on cellulose nitrate it is not patent that an explosion hazard exists. Information issued by the suppliers of the tubes in question includes reference to the inflammability of cellulose nitrate and the statement that they "cannot be autoclaved", but the statement doubtless means that the tubes are ruined by the treatment and gives no indication that the operation is potentially dangerous; it is possible that the chance of combustion is so small that there is no record of such an occurrence.

The circumstances in which the explosion occurred are both interesting and instructive. A number of unused celluloid tubes made for use with the ultracentrifuge were found to be unserviceable, having shrunk as a result of ageing for several years. The room in which they had been stored was used for work involving toxic materials, and it was decided to autoclave them as a safety precaution before discarding. The autoclaving procedure was a standard two-cycle operation, each cycle consisting of evacuation of the sterilizing chamber followed by admission of steam until a pressure of 20 lb./in.^{2} and a corresponding temperature of 125° was achieved and maintained for a prescribed period. The explosion occurred at the beginning of the second cycle at a point where the steam pressure was approaching the operating level of 20 lb./in.^{2}.

Examination of the recording instruments showed that no malfunctioning of the equipment had occurred. The probability that spontaneous ignition of the tubes was responsible for the accident led to tests being conducted at the Explosives Research and Development Establishment, Waltham Abbey. The tests demonstrated the thermal instability of some of the samples examined, and convincing proof of the cause of the explosion was obtained when an attempt to reproduce the explosion in simulated conditions was successful. From the various tests carried out at Waltham Abbey it was possible to attribute the cause of the accident to a combination of three factors; (1) age of the tubes; (2) temperature in the autoclave; (3) presence of water vapour.

The conditions needed to produce spontaneous combustion at such a low temperature are surprising to anyone who is not an explosives expert. In addition, the probability of the event and its severity are respectively dependent on the mass of material involved and the ratio of combustible mass to free volume of the chamber. In this explosion both the mass and the mass/volume ratio were high. Nevertheless, it is clear that material made from cellulose nitrate may present an explosion hazard when autoclaved and alternative methods of decontamination and destruction should be employed.

I thank colleagues at Waltham Abbey for verifying the cause of the accident.

I. H. Silver

Microbiological Research Establishment,
Porton Down, Salisbury, Wilts.

Life Tables

It is a pity that in reviewing the series of life tables recently compiled by Dr. R. A. M. Case *et al.*[1], Prof. L. Hogben has ignored the historical facts and thereby implied that actuaries have not only been unaware of the principles of cohort analysis in particular but also that their methods have also been of disservice to the public.

In point of fact the use of the life table (the adjective actuarial is redundant since all such tables are actuarial) was first introduced to research workers by William Farr about a hundred years before R. R. Kuczynski, and its use was re-inforced so far as the medical officers of health were concerned by George King in 1914 (ref. 2).

The limitations of life tables based on mortality rates experienced in a particular calendar year (or period of consecutive years) have long been appreciated by actuaries and the tables derived from the mortality of life office annuitants for 1900–20 (ref. 3), and also those derived from the mortality of Government annuitants for the same period[4], were both constructed on the principle of a cohort analysis of the recorded rates of mortality. In 1927 a paper was presented to the Institute of Actuaries by V. P. A. Derrick[5], which directed attention to the advantages gained from analysing mortality rates by generations rather than by calendar year, and similar thoughts were behind a paper presented to the Faculty of Actuaries by A. R. Davidson and A. R. Reid in the same year[6]. In 1936 the official journal of the Scandinavian actuarial societies published a paper by Cramér and Wold[7] in which a series of generation mortality curves were constructed from Swedish population data; while in 1953 the Institute and Faculty of Actuaries[8] published a volume of annuity tables which contained a series of hypothetical generation tables of mortality appropriate to annuitants. It is therefore inaccurate to imply that the method of cohort analysis is foreign to actuarial thought.

On the question of the use of actuarial expertize in the construction of English Life Tables it is important not to overlook that such tables have to serve many different purposes; in particular, the allegation of actuarial gamesmanship scarcely does justice to the painstaking efforts by the Registrar General to point out the limitations of a life table based on the combination of many generations. The construction of a life table must have some regard to the purposes for which it is intended to be used and the requirements for calculations appropriate for insurance company operations (where smoothness is important) will differ from those of the medical research worker.

The implied assumption that Greville's method is the only method of constructing abridged tables is also at variance with the facts. The supplement to the 75th Annual Report of the Registrar General (Cd. 7512, 1914) shows ample support of the use of abridged methods, and a comparison of seven different methods with the relative computation times has been available for some years[9]. It could also be argued that the method adopted by the Registrar General for constructing the abridged life table which appears annually in the September *Quarterly Return* has more common sense than Greville's method, the rationale of which involves assumptions regarding the analytical form of the rate of mortality.

R. E. Beard

252 High Holborn,
London, W.C.1.

[1] Hogben, L., *Nature*, **197**, 230 (1963).
[2] Supp. *Seventy-fifth Ann. Rep. Registrar General* (H.M.S.O.), Cd. 7512 (1914).
[3] *The Mortality of Annuitants 1900–1920* (Inst. Actuaries and Faculty of Actuaries, 1924).
[4] *Government Life Annuitants: Mortality Experience 1900–1920*, Rep. Gov. Actuary and the Actuary to the National Debt Commission (1924).
[5] Derrick, V. P. A., *J. Inst. Actuaries*, **58**, 117 (1927).
[6] Davidson, A. R., and Reid, A. R., *Trans. Fac. Act.*, **11**, 183 (1927).
[7] Cramér, H., and Wold, H., *Skandinavisk Aktuarietidskrift*, **18**, 161 (1935).
[8] *a* (55) *Table for Annuitants* (Camb. Univ. Press, 1953).
[9] Benjamin, B., *Elements of Vital Statistics*, 120 (George Allen and Unwin, Ltd., 1959).