The Evaluation of New Breath Alcohol Instruments for Police Use in Great Britain

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1. SUMMARY

Evidential breath alcohol testing was introduced into Great Britain in May 1983 and two instruments were approved for police use, namely the Lion Intoximeter 3000 and the Camic Breath Analyser. Recommendations were put forward in 1989 and 1990 by the Organisation Internationale de Metrologie Legale (OIML) for international control of new instruments but these have remained at the draft stage. A "Guide to Type Approval for Evidential Breath Alcohol Testing Instruments used for Road Traffic Law Enforcement in Great Britain" has been prepared and submitted to the European Commission for approval.

The "Guide to Type Approval" is based on the OIML Recommendations and the experience gained in Great Britain in the area of breath alcohol testing since 1983. It includes the general technical specification required for instrument performance and the main testing schemes which deal with instrument response to chemical and physical interference and to ethanol vapour samples. The ethanol vapour tests include assessment of accuracy, repeatability, drift and hysteresis. Also included are the effect of varying the delivered volume and duration of sample, and factors such as interruption of sample flow and mouth alcohol.

It is the intention to commence the evaluation of new evidential breath testing instruments in Great Britain at the beginning of 1993. This paper reviews the preparation and content of the "Guide to Type Approval" document in the light of the experience gained over the last nine years. The work involved and the problems encountered in producing a formal document are discussed.
2. INTRODUCTION

Drinking and driving still remains one of the major contributing factors to road accidents in Great Britain. In recent years the figures have shown a slight decrease but last year there were 4,568 fatal accidents of which 19% were alcohol related. Over the past 25 years a number of measures have been introduced into Great Britain in order to increase the effectiveness of the action taken by the police against drinking and driving. A major initiative was taken following the report of the Blennerhassett Committee in the late 1970's to introduce Electronic Roadside Screening Devices and Evidential Breath Alcohol Testing Instruments. The latter were introduced into Great Britain for the first time in May 1983 [1] and the two Home Office approved instruments which are currently in use are the Camic Breath Analyser and the Lion Intoximeter 3000.

The present legislation in Great Britain is the Road Traffic Act 1988 where the following levels are prescribed; blood 80mg/100ml, urine 107mg/100ml and breath 35yg/100 ml.

In 1984, a year after the introduction of the breath alcohol testing programme, the complete procedure was reviewed in a National Six Month Survey involving over 41,000 cases where comparisons were made with over 12,000 blood and urine samples. The findings were assessed by an independent observer Professor Sir William Paton who reported in June 1985 [2]. Arising from this report a research programme was initiated at the CRSE into the following areas; breath differences [3] failure to provide a satisfactory breath sample [4,5] and interfering substances [6,7,8]. This work has been previously reported, and has formed a major part of the discussions with instrument manufacturers for the production of the next generation of evidential breath alcohol testing instruments.

During this period a Working Group was formed in 1988 under the Organisation Internationale de Metrologie Legale (OIML) to consider drafting an international specification for new evidential breath testing instruments. The details of the membership of that Working Group are:

Member Countries of the Working Group (SP30-SR13)
France (secretariat) Austria, Belgium, Bulgaria, USA, Netherlands, Rumania, UK, USSR.

Observers
Germany, Australia, Canada, China, Cuba, Spain, Ireland, Norway, Poland, Sweden, Czechoslovakia, Yugoslavia
The Working Group produced a Second Draft in 1989 which was further modified at a meeting in Paris in 1990. There has been little progress since this date. In Great Britain it was necessary to proceed to evaluate new instrumentation so the "Guide to Type Approval Procedures for Evidential Breath Alcohol Testing Instruments used for Road Traffic Law Enforcement in Great Britain" was issued. It is based on the Second Draft OIML Recommendations and has been submitted for approval by the European Commission (EC) under the terms of the Directive dealing with Technical Barriers to Trade (83/189/EEC).

The breath testing procedure in Great Britain incorporates a 'Measuring Cycle' in which two breath samples from the subject are taken and the instrument is checked before and after these breath samples for accuracy by a ethanol vapour sample. At present a Liquid Simulator is used to produce the two check ethanol vapour samples but following successful research carried out under contract it is intended to replace the Liquid Simulator with a Gas Simulator.

3. RESEARCH AT THE CRSE

3.1 Breath Differences

The results from the Six Month Survey carried out in 1984 indicated that differences greater than 20% between two successive breath samples occurred in 1.6% of the cases. From the research carried out at the CRSE, which was reported at the T89 Conference in Chicago [3], differences up to 24% could be accounted for by breathing techniques which mainly involved the disruption of the equilibrium between the ethanol vapour in the breath sample and the mucous membrane of the Upper Respiratory Tract. It was concluded that differences greater than 24% were produced by some form of "mouth alcohol" which could be produced by regurgitation or eructation between breath samples or during the provision of a breath sample.

3.2 Failure to Provide a Satisfactory Breath Sample

This can present a serious problem for certain individuals in Great Britain because if they fail to provide an adequate breath sample for evidential breath testing purposes they may be charged with refusing to supply a sample which carries the same penalty as being in excess of the prescribed limit. The Six Month Survey in 1984 found that there were 3% of cases in this category.
A number of experiments have been carried out as part of a collaborative research project with Dr. Norman Johnson of the Middlesex Hospital in London [4,5]. The breathing characteristics of people with respiratory diseases and their ability to provide adequate breath samples were examined. In addition, earlier this year this series of experiments was completed by testing people of small stature who have small lung capacities. The results of this work will be published shortly [9].

In all these experiments the findings indicated that subjects with a Forced Vital Capacity (FVC) of less than 2.61 and a Forced Expired Volume in one second (FEV1) of less than 2.31 were generally unable to provide a satisfactory breath sample.

In discussion with instrument manufacturers it appeared that both these problems could be addressed by examining the way in which the instrument measured the ethanol concentration at the maximum value. A great deal of work has been carried out by several workers on breath profiles in relation to the breath sample volume and the ethanol concentration [10,11]. In combination they produce a typical breath alcohol profile. This profile will be fairly reproducible for genuine breath samples taken to the point of end expiration. It should be possible for a breath testing instrument to monitor this breath alcohol profile and take a reading at the point where the ethanol concentration is fairly constant, namely the ethanol concentration plateau and so produce an accurate result. Thus it would not be necessary to have a fixed discard volume of 1.51 in order to ensure that the breath sample approached an end-expiration sample as the instrument could deal with any genuine breath sample volume.

Should this breath alcohol plateau not be achieved as in the case of "mouth alcohol" which would produce a profile indicating a large increase in ethanol concentration followed by a rapid decrease then this breath sample would be rejected.

3.3 Possible Interfering Substances

From the research work carried out at the CRSE in conjunction with the Health and Safety Executive, which was published last year [6,7,8], it is clear that Infrared based instruments operating at a single wavelength could have problems in dealing
with all possible interfering substances. So new instrumentation should also address this problem by incorporating a multiple Infrared filter system or possibly two different detectors.

4. GUIDE TO TYPE APPROVAL PROCEDURES

When the OIML produced the Second Draft of the proposed Recommendations Relating to Evidential Breath Analysers in 1989 it was considered that the final draft would be agreed in 1990 and the international specification possibly available by 1991. During 1990 it appeared that the initial momentum of the OIML had significantly decreased so in 1991 it was decided to produce a "Guide To Type Approval Procedures" for use in Great Britain.

The requirements set out by the OIML have been closely followed bearing in mind that should the OIML document be ratified at a later date Great Britain would not wish to have a specification at variance with the international document. The structure of the OIML document was modified so that all the testing procedures are contained in three Annexes at the end. While carrying out this work the recommended tests were verified against the up to date EC recommendations and where necessary some of the specified requirements were changed. The Guide to Type Approval Procedures for Evidential Breath Alcohol Testing Instruments issued by the Home Office in Great Britain is set out in the following form:

(1) Introduction
(2) Type approval procedure
(3) General requirements
(4) Definitions
(5) General technical specification
(6) Metrological characteristics

Annexes. Test schemes for instrument response to:-

A. Chemical interference
B. Physical interference
C. Alcohol vapour samples.
The test schemes given in the Annexes cover the following areas.

4.1 Annex A (Chemical response)

The instrument under test will be subjected to 20 different substances in addition to a standard ethanol in air mixture at a concentration of 35µ/100ml. Substances will include water, carbon monoxide and dioxide, acetone, other alcohols, acetaldehyde, aliphatic and aromatic hydrocarbons, methyl ethyl ketone, diethyl ether and styrene. These are possible interfering substances suggested since the introduction of evidential breath testing in Great Britain.

4.2 Annex B (Physical response)

These, in the main, are standard physical interference tests that instruments must be able to deal with in order to function effectively. These include tests on supply voltage, physical disturbance of the supply voltage, vibration, mechanical shock, electrostatic discharge, electromagnetic field, and stability testing.

4.3 Annex C (Alcohol vapour response)

The recommendations set out in the OIML document have been closely followed. The tests will involve the measurement of instrument response for accuracy and repeatability over the full concentration range, hysteresis effect, the effect on sample volume and duration of sample, and a test to simulate alcohol in the Upper Respiratory Tract (mouth alcohol).

In order to carry out these tests and comparisons between wet gas and dry gas in a dynamic mode to simulate an actual breath sample the National Physical Laboratory (NPL) were contracted to design and build a Test Rig. The design conforms to the requirements given in the OIML document but uses more advanced technology. The Test Rig comprises a computer based data and instrument control system which will utilise a stored menu of breath flow and alcohol concentration profiles which cover the range of tests required. The gas sampling and mixing system employs a number of mass flow control valves which are computer controlled and the whole system is maintained at a constant temperature of 34°C ± 0.1°C.
5. GAS SIMULATOR

A decision was taken to replace the existing system of Liquid Simulators with Gas Simulators. In preparation for this a number of research contracts into Gas Simulator technology have been carried out by the NPL. The research included both ethanol/nitrogen and ethanol/air gas mixtures and it would appear that Gas Simulators will provide a viable alternative to Liquid Simulators.

The Gas Simulator will consist of an ethanol air mixture at a concentration of 35µg/100ml or 191.4ppm mole of ethanol per mole of air. The research carried out has confirmed that ethanol air mixtures can be produced to a tolerance of ± 1% relative to each batch and within ± 1% relative to the concentration of 35µg/100ml. This will give an accuracy of the complete process of better than ± 2% at a confidence level of 2 sigma. Trials with commercial gas suppliers in the UK have been conducted and appear to achieve the degree of accuracy required. This will allow the calibrated gas standard to be used without any adjustment of the evidential breath testing instrument. The gas manufacturers will be required to be accredited to the standards laid down by the National Measurement and Accreditation Service (NAMAS) or comparable organisation. This is the same as the present system for the accreditation of the accuracy of the ethanol solutions used in Liquid Simulators. A 10 litre cylinder at a pressure of 80 to 100 bar will be used. This will mean that at least 700 litres of useable gas will be available allowing for a safety margin of 100 litres or 10 bar. Up to 2 litres of gas are used for simulator checks per test resulting in 350 possible tests per gas cylinder. Possible change over valves have been evaluated so that two cylinders can be employed if necessary and the Instrument Servicing Organisation will be made responsible for changing cylinders so that there is no police officer involvement other than to reorder a replacement cylinder.

Operationally, the use of Gas Simulators to replace the Liquid Simulators, which require a weekly solution change, will be a major saving in police manpower and also in service costs, which have been found to be fairly high with the Liquid Simulator System.

6. CONCLUSIONS

Great Britain has produced a "Guide to Type Approval Procedures" which has been submitted for approval by the EC and is in agreement with the draft OIML document should that document be ratified at a later date.
The instruments which meet the requirements of the "Guide to Type Approval Procedures" will effectively deal with problems such as breath differences, failure to provide a satisfactory sample and possible interfering substances.

Great Britain is considering making the change from Liquid Simulators to Gas Simulators which it is anticipated will result in a major saving in police manpower.

Notification has been received from seven manufacturers that they will be submitting instruments for the evaluation in Great Britain which will begin early in 1993.

7. REFERENCES


9) Gomm PJ, Broster CG, McI Johnson N and Hammond K (1992). Study into the ability of healthy people of small stature to satisfy the sampling requirements of breath alcohol testing instruments. (In press)
