New evidential breath alcohol testing instruments. 
Testing and use.

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SUMMARY

Evidential Breath Alcohol Testing was started in Great Britain in May 1983 with the intention that breath would be the sample of choice for testing in Drink - Driving cases. Two instruments were approved for police use at that time, the Lion Intoximeter 3000 and the Camic Breath Analyser. These instruments have worked well in the years since their introduction but are now in need of replacement with more up to date models. This paper outlines the testing procedures followed during testing of Breath Alcohol Testing Instruments prior to submission to the Home Office for consideration of Type Approval for Police use in Great Britain and indicates the way that the necessary standards will be maintained.

INTRODUCTION

In 1991 the Home Office asked the Breath Alcohol Unit of the Forensic Science Service Central Research and Support Establishment to prepare a specification for a new series of Breath Alcohol Testing Instruments. The document which was prepared is based on the Recommendations of the Organisation International de Metrologie Legale (OIML) a second draft of which had been issued in 1988. In 1989 and 1990 the Breath Alcohol Unit proposed several modifications to this document and this combined information was used to prepare the specification requested by the Home Office. The document was produced in consultation with instrument manufacturers and the National Physical Laboratory to ensure that the demands made would be scientifically sound as well as achievable in practice. The requirements of the European Commission Directive on Electromagnetic Compatibility (EMC directive 89/336/EEC) were also incorporated in the document before it was presented to the European Commission for approval as were the changes contained in the third draft of the OIML
Recommendations for Breath Testers. Commission approval was received early in 1993 and the document entitled "A Guide to Type Approval Procedures for Evidential Breath Alcohol Testing Instruments used for Road Traffic Law Enforcement in Great Britain" was published in October 1994. (The Guide)  

TESTING ROUTINES

The test schedules set out in the Guide are arranged in three sections to cover Interfering Substances, Environmental Conditions, and Response to Alcohol Vapour Samples. The Guide also sets out the basic metrological requirements for instrument operation and specifies the units of measurement and accuracy demands as well as defining the steps in the measurement cycle for a breath test.

RESPONSE TO ALCOHOL VAPOURS

Since the 1983 instruments were tested, changes have taken place in the way Simulated Breath test samples are produced and calibration checking is carried out. The means of obtaining a sample to check the calibration of an instrument under the new scheme will be a gas cylinder containing 35μg/100ml Ethanol in Air Using this system a container of checking vapour is expected to last approximately 6 months rather than one week for the liquid simulator as at present. This will result in considerable savings in police time as they will not be involved in changing simulators other than changing from one cylinder to another by operating a switching valve, with consequent savings in cost.

Simulated Breath test samples are now designed to mimic the flow and alcohol concentration profiles of a human breath to give a more realistic test of the instrument performance. The alcohol concentration profile of a breath sample is known to rise to a plateau as the sample progresses and a sample taken on this plateau will more closely reflect the alcohol content of end expiratory air than a sample taken at a preset volume. A further benefit of taking samples at the alcohol plateau is that there is greater likelihood that subjects will be capable of supplying satisfactory samples no matter what their lung capacity.
To enable testing to be carried out using this type of sample the Breath Alcohol Unit set up a contract with the National Physical Laboratory to produce a Dynamic Breath Simulator (Test Rig) capable of producing samples of the types listed in the Guide. This device utilises computer controlled Mass Flow Controllers which control the mixing of gases to achieve the required variations in flow during presentation of the various samples so as to mimic a human breath. All active parts of the Rig are temperature controlled so that the samples are presented to the instrument under test at the prescribed temperature.

The samples produced by the Test Rig are those set out in the recommendations of the OIML. A 'standard' sample of 3 litres of vapour delivered in 5 seconds, with the last 3 seconds being an alcohol concentration plateau, is used to generate a series of samples at pre-set ethanol concentrations in air to test the accuracy and reproducibility of the instrument. A 'slow delivery' sample of 3 litres of vapour delivered in 15 seconds, with the last 6 seconds being an alcohol concentration plateau, is used to check the response of the instrument to a sample produced over a long period of time. The Test Rig also produces samples of different volumes (1.5 and 4.5 litres) to establish that the instrument is able to respond correctly to those samples which may be produced by people who for several reasons are only capable of supplying small volumes of breath as well as those who can provide much larger volumes. An intermediate type of sample which has a volume of 3 litres but a plateau of only 1.5 seconds is also catered for.

The most difficult sample to reproduce is that which contains extra ethanol over and above the alveolar concentration due to 'mouth alcohol'. This addition can take several forms which range from a high concentration of short duration with fast decay to a smaller increase in concentration which appears as a stable addition to the normal sample. This latter type of mouth alcohol is likely to produce a pair of samples which exhibit a large enough difference in the two results for this to be detected by the instrument software as a breath difference. The former type of sample is characterised by having a negative slope to the ethanol concentration, and it is this type which is set up in the controlling programme of the Test Rig. By using this type of sample we can establish that all instruments will respond correctly to a standard and reproducibly produced type of mouth alcohol sample.
Standard and long samples which are interrupted at pre-set points are also produced on the Test Rig. These can be used to establish that the instrument will respond to an interruption in sampling by rejecting such a sample as well as establishing that the instrument is correctly detecting an ethanol concentration plateau since the Test Rig is programmed to interrupt the sample at such a point that the ethanol concentration is still increasing when the interruption occurs. Other types of sample routines can be programmed into the test rig so enabling tests such as Detector Drift, Detector Hysteresis and High (10%) Carbon Dioxide Content of the sample vapour to be performed by selecting pre-determined sequences of samples.

These vapour samples are produced by mixing accurately known concentrations of Ethanol in Air with Balance Air, both containing 5% Carbon Dioxide to give the required profile and final Ethanol concentration. They are obtained from cylinders of compressed gas and are thus dry samples. Human breath is of course a moist sample, and to establish that the instrument under test is capable of responding correctly to moist samples as well as dry, the Accuracy and Reproducibility tests are repeated using vapour samples from liquid simulators maintained at a temperature of 34±0.2°C which contain solutions of Ethanol in Water with accurately known concentrations.

**EFFECT OF INTERFERING SUBSTANCES AND ENVIRONMENTAL DISTURBANCES**

Facilities for testing instrumental reaction to the range of interfering substances required in the Guide and environmental disturbances are not available within the Forensic Science Service. Consequently this testing has been undertaken by outside agencies approved by the Forensic Science Service and receipt of their reports is a condition for proceeding with Alcohol Response Testing. It is a feature of the requirements stated in the Guide that test results obtained at a testing establishment in another country which has reciprocal agreements with NAMAS will also be accepted. Testing of an instrument's response to interfering substances has been carried out where required by the National Physical Laboratory's Department of Quantum Metrology, and testing of response to environmental disturbances by a NAMAS Accredited commercial testing establishment.
INSTRUMENT FUNCTIONS

The latest instruments have facilities to enable improvements to be made in the test protocol. It is now possible for messages indicating deviations from the normal test results to be displayed on the instrument's screen and incorporated into the printed report of the test. These messages comprise Incomplete Specimens, Mouth Alcohol, Interfering Substances, Breath Difference, Out of Range of Instrument, and Simulator Check Failure. The inclusion of these messages is designed to inform the police that there has been some failure in the breath sample, so that they can take appropriate action to obtain an alternative sample for testing, and changes have been incorporated in British Law to provide legal backing for this action. Testing of these facilities along with the required metrological features is carried out under the general heading of Instrument Functions. This part of the testing routine is designed to check that the instruments function in the manner stated by the manufacturer as well as conforming to the requirements set out in the Guide.

POLICE TESTING

Further to laboratory testing of the instrument under test, an arrangement is made with the Association of Chief Police Officers (ACPO) through the National Police Liaison Officer for instruments to be installed in selected police stations. This gives police officers the opportunity to use the proposed new instruments in a normal police working environment with subjects drawn from motorists who have been detained under drink - drive legislation. Due to the fact that these instruments are not yet approved for police use, the subjects asked to take part in the testing are those who have already recorded an alcohol level below the legal limit and so are not liable to be prosecuted. The observations of police officers involved in the use of the new instruments are collated by the National Police Liaison Officer and a report is prepared for inclusion in the documentation submitted to the Home Office.

QUALITY ASSURANCE

It has been a feature of British Breath Alcohol Testing since the original introduction that production and servicing of instruments have been subject to control by the National Measurement and Accreditation Service (NAMAS). [Now known as the United Kingdom
Accreditation Service (UKAS)]. With the introduction of new instruments the opportunity has been taken to bring these requirements into line with current practices, for example, as well as testing the correct operation of the measuring cycle, the instrument's response to interfering substances is checked so as to ensure that production instruments perform to the same standards as the test instruments.

CONCLUSION

Examples of currently available Breath Alcohol Testing Instruments have been tested according to a published Guide and are about to enter service with the British police. The test procedures have been written in line with international recommendations (OIML) and have been approved by the European Commission.

References