THE FORENSIC SCIENCE SERVICE

EMC Immunity
Test Procedures for
Breath Alcohol Measuring Devices

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A RECOMMENDED TEST PROCEDURE

A.1 General Requirements

The equipment shall be capable of operating without indicating an erroneous reading when:

a. in fields of at least 10V/m from 80 to 2000 MHz.

b. in the presence of common mode currents from 27MHz-100MHz to Level 2 of EN 61000-4-6 (where applicable, not normally applicable for battery powered hand screeners).

c. the equipment is designed for attended actively operated or automatic supervised use, and when the simulated TETRA fields defined in Section A.4 at levels as defined in Table A-1 of Section A.4.3 are applied.

For a. and c. the basic test procedure defined in EN 61000-4-3 shall be used. For b. the basic common mode injection test procedure defined in EN 61000-4-6 shall be used. Specific additional TLED test requirements are detailed in the following Sections of this Annex.

Some of the requirements may have been met by complying with the provisions of Directive 89/336/EEC (Electromagnetic compatibility). Under these circumstances equipment complying with the Directive and which has already been granted the certificates of conformity provided for therein shall be exempt from the parts of the type approval procedure covered by the Directive.

A.2 Test Arrangement

A.2.1 General Arrangements

The TLED test arrangement is applicable to the radiated test. The conducted test arrangement is to be in accordance with EN61000-4-6.

The object of the tests is to confirm that the breath alcohol TLED is capable of operating in the presence of electromagnetic fields without recording an erroneous reading.

The layout of the breath alcohol TLED shall be representative of the normal operating conditions, in so far as this will permit a repeatable measurement. The measurement shall be carried out in screened test facilities described in EN 61000-4-3 with the equipment set up as intended for use. The field uniformity criteria of EN61000-4-3 apply for the radiated immunity test.

The TLED to be tested is placed centrally in the calibrated test area. For hand screeners, the device is held by a non-conducting stand 0.8m above the ground plane.

EBTIs must be tested whilst installed in their consoles. The EBTI main console is mounted 0.1m above the floor on non-conducting stands. Any separate keyboard should be attached and mounted 0.8m above the ground plane on a non-conducting bench (Figure 1).

It is recommended that any associated cable bundles/wiring are arranged in general accordance with EN61000-4-3:

- At least 1m cabling from the TLED to the test facilities power supplies must run in the calibrated area and thus be exposed to the RF fields.
- Any interconnecting cabling, such as to the keyboard will be treated as follows:
    - The manufacturer’s specified cable types and connectors shall be used,

- If the manufacturer's specification requires a wiring length of less than 3m, then the specified length shall be used. The wiring shall be bundled low-inductively to 1m length.
- If the specified length is greater than 3m or not specified then the illuminated length shall be a minimum of 1m. The remainder is run outside of the calibrated area on the floor de-coupled at the 1m point by the use of lossy tubes.

- In at least one orientation of the TLED the wiring shall be arranged parallel to the calibrated uniform area of the field.
- The exposed wiring is run in a configuration which simulates as closely as possible the manner it is run in operation.
- All wiring running on the floor in the calibrated test area shall be spaced 0.1m from the floor by means of low dielectric spacers.

The testing laboratory shall record any changes found necessary in layout.

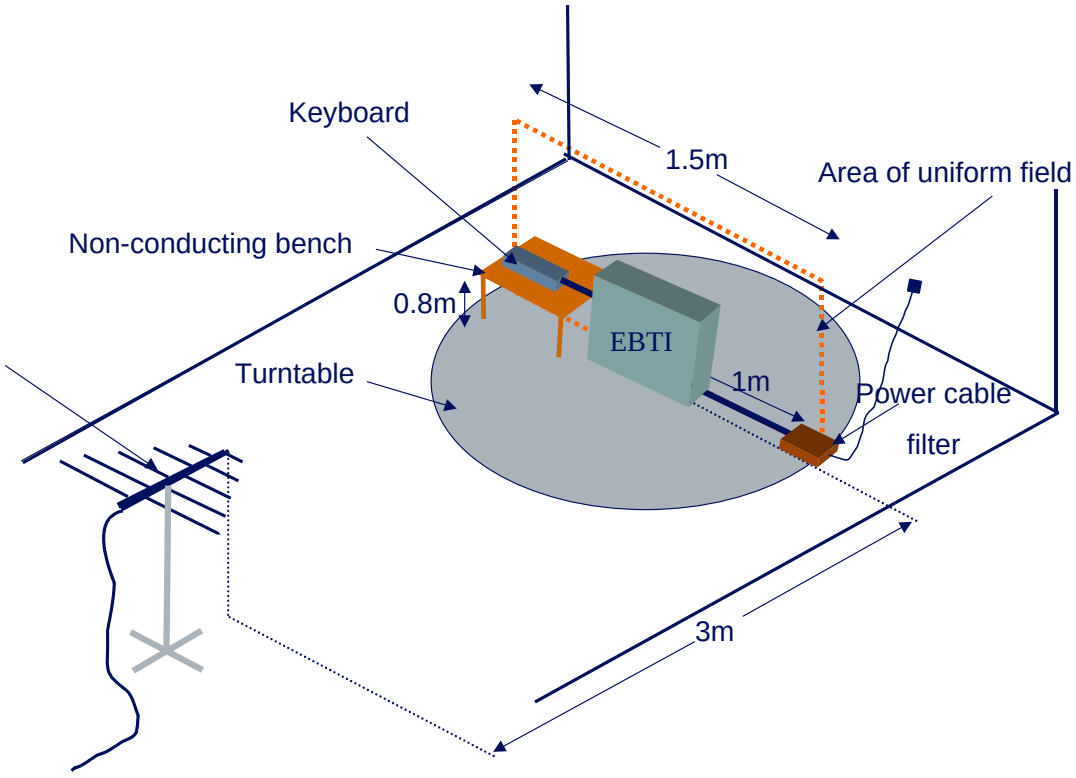

Figure 1: Test layout for EBTI with separate keyboard and power supply cable

The TLED under test is irradiated by both horizontal and vertically polarised fields from 4 orthogonal illumination angles. Figure 2 shows a plan view of a typical test arrangement. It is recommended that the TLED and any associated stimulators are mounted on a turntable. This reduces the complexity of the field calibration and improves test repeatability.

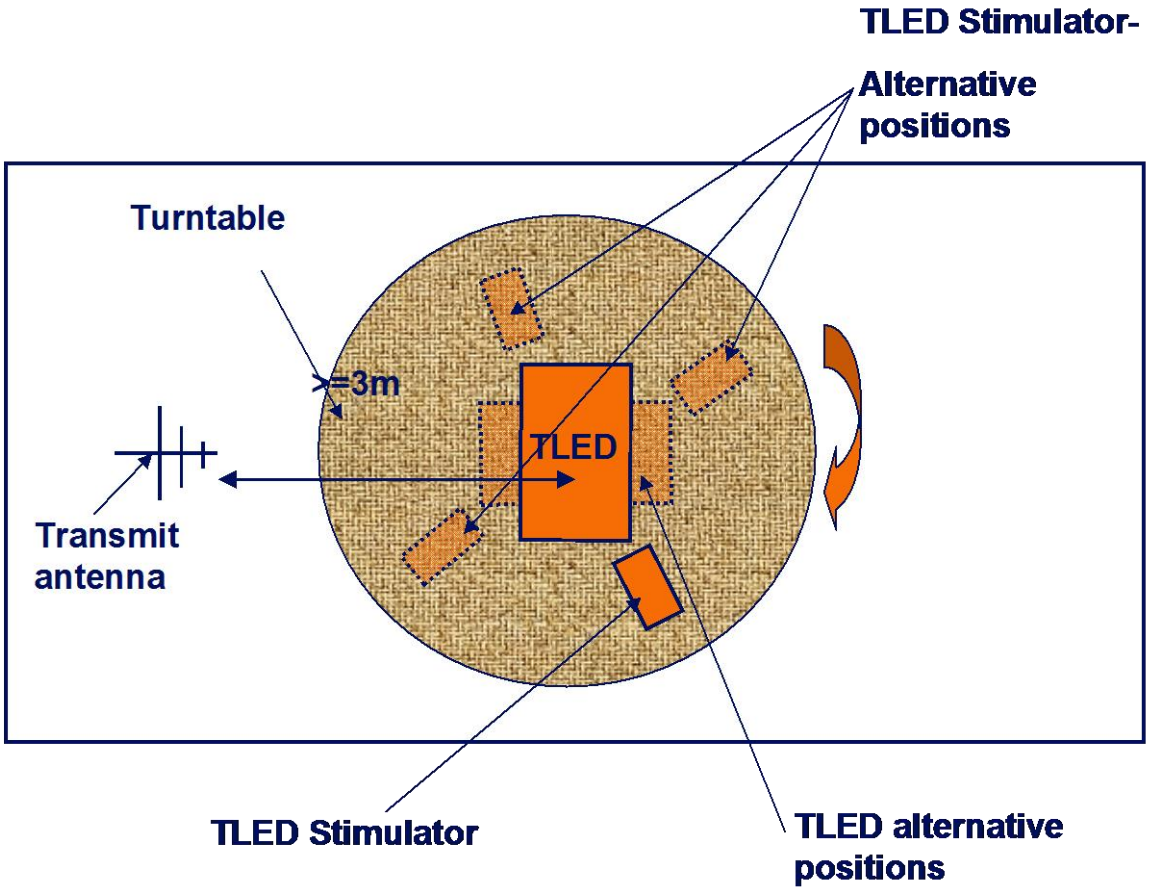

Figure 2: Plan view of a typical test layout in an anechoic/semi anechoic chamber.

A.2.2 Device Specific Test Arrangement Aspects

A.2.2.1 Roadside Screeners

Where available, the numerical display and indicators must be enabled during the test. The device must be in auto sample mode.

A.2.2.2 EBTIs

The device must be tested whilst installed in its cabinet, as the cabinet may contain additional wiring/electronics and thus may affect the EMC performance of the equipment.

A.2.3 Breath Alcohol Simulators Test Arrangement and Set-up

Care shall be taken to ensure that the connection of the simulator to the device does not degrade the immunity of the equipment under test.

Any remotely operated actuators required to operate the device must use non-conductive couplings and tubes so as not to modify the impinging field.

A.3 Standard Test Procedure

A.3.1 Test Procedure – General

The detailed test procedures defining the operation of the TLEDs is defined in Section A.5 for Roadside Screeners and Section A6 for EBTIs. In both cases references to increasing the applied test levels are to be ignored as the signal is applied at the appropriate test limit for these tests.

A.3.2 Conducted Immunity Test

The test is conducted in accordance with EN61000-4-6.

The modulation and limits are as defined in Sections A.3.4 & A.3.5.

A.3.3 Radiated Immunity Test

The test is conducted in basic accordance with EN61000-4-3 using the additional test requirements of this Annex. The TLED under test is irradiated by both horizontal and vertically polarised fields from 4 orthogonal illumination angles.

The modulation and limits are as defined in Sections A.3.4 & A.3.5.

A.3.4 Modulation

All test signals shall be 90% amplitude modulated with a 1kHz sine wave.

A.3.5 Test Limits and frequencies

The test limit is in terms of the CW value of the signal; the modulation being applied on top giving peak readings 90% higher than the CW limit.

- For the conducted immunity test, the limit to be used is Level 2 of Table 1 in EN61000-4-6.
- For the radiated immunity test, the limit to be used is 10V/m from 80MHz to 2GHz.

The applied RF signal is applied at each test frequency at the test limit for a time long enough to fully operate the TLED. The frequencies are stepped across incrementally with the step size not exceeding 1% of the previous frequency:

new frequency = old frequency * 1.01

A.4 Simulated TETRA Immunity Test

A.4.1 Test procedure - General

This document is intended as a reference source only, and an understanding of the operation of these devices is required before commencing work.

The detailed test procedures defining the operation of the TLEDs is defined in Section A.5 for Roadside Screeners and Section A6 for EBTIs.

The TLED under test is irradiated by both horizontally and vertically polarised fields from 4 orthogonal illumination angles in turn.

The TLED is tested at the 8 test frequencies by increasing the field, at each test frequency, from a minimum level of 12dB down from the appropriate test limit in steps of 3dB until the test level is achieved. The level at which the threshold of any effect is observed is logged and recorded in the test report.

The test limits to be used are to be selected from Table A-1, Section A.4.3 depending on the proposed usage of the TLED. The modulation to be applied is defined in Section A.4.4.

A.4.2 Test Frequencies

The test frequencies to be used for this test are:

- 380, 385, 390, 395, 400, 405, 410, 415 and 420MHz.

The tolerance on these frequencies is ± 0.1MHz.

A.4.3 Test Limits

The test limit is in terms of the peak value of the modulated signal as measured using a peak detector calibrated in terms of the equivalent rms sinewave value that would give the same reading. This is the standard calibration for all peak detector functions on EMC receivers or spectrum analysers.

The limits are defined in terms of various TLED categories:

Table A-1: Test Limits for Various Equipment Categories

Category	Application	Field Strength – V/m
A	Roadside screening devices not operated within vehicles	65
B	Evidential Breath Test Instruments used in a building location.	20

A.4.4 Modulation

For the test for immunity to TETRA signals:

The modulation to be applied shall be:

- An 18kHz square wave modulation with a depth >98% additionally gated on and off at 17Hz. The duty cycle shall be 50%.

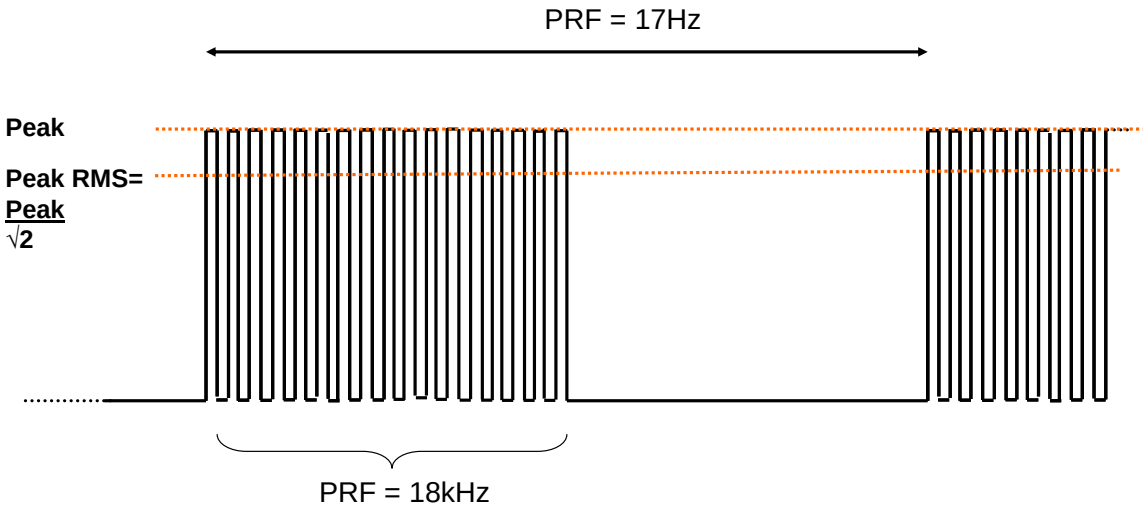

Figure 3: Proposed dual modulation envelope

The test limits are in terms of the peak value of the signal when measured using the peak detector function of the measuring receiver/spectrum analyser. This is calibrated in terms of the equivalent rms value of a sine wave as defined by:

> *When measuring a modulated signal, the bandwidth of the measuring receiver should be set wide enough to capture the total energy of the signal. The amplitude reading as measured by the peak detector function is noted. The unknown signal is disconnected and a sine wave signal at the same frequency fed in. Its amplitude is adjusted until the same reading is produced on the measuring receiver. This amplitude is expressed in terms of the rms value of the sine wave e.g. a 1 volt rms sinewave input will give an indicated measurement of 1 volt. This will not change if the signal is switched on and off, the peak reading will still be 1 volt hence the term peak rms. Figure 3 shows the relationship between peak and peak rms.*

The characteristics of the equipment to be used to measure the amplitude of the applied susceptibility test are:

- The amplitudes associated with the test limits are based on the peak of the rms envelope over the complete modulation period.
- Amplitude measurements shall be made in a manner which clearly establishes the peak amplitude of the modulated waveform.
- The measuring instrument must have a fast enough time response to respond to signal amplitude variations. A spectrum analyser may be used.
- The detection, resolution and video bandwidths of the measuring instrument must be wider than the modulating frequency.

- The measurement bandwidth shall be increased until the amplitude of the measured signal does not change by more than 1dB for a factor of three change in bandwidth. This bandwidth setting shall then be used for the test. At the proper setting the individual modulation sidebands will not be resolved.

It is important to meet these requirements especially when measuring modulated signals. The use of a spectrum analyser for signal measurement during susceptibility testing does provide advantages over power meters or receivers as it allows a more direct visual check on the quality of the applied signal during the testing. It provides direct indication if the signal source is becoming non-linear, or generating spurious signals. Sometimes, when mismatched, TWT amplifiers have been found to produce parasitic high power oscillations even with no input drive at a frequency which may be well removed from the required test frequency. Regular checks should be made on the quality of the test signal, and presence of spurious signals.

A.5 Test Procedure – Detailed for Roadside Screeners

An understanding of the operation of the Roadside Screeners or Electronic Screening Device, ESD, under test is required before commencing work.

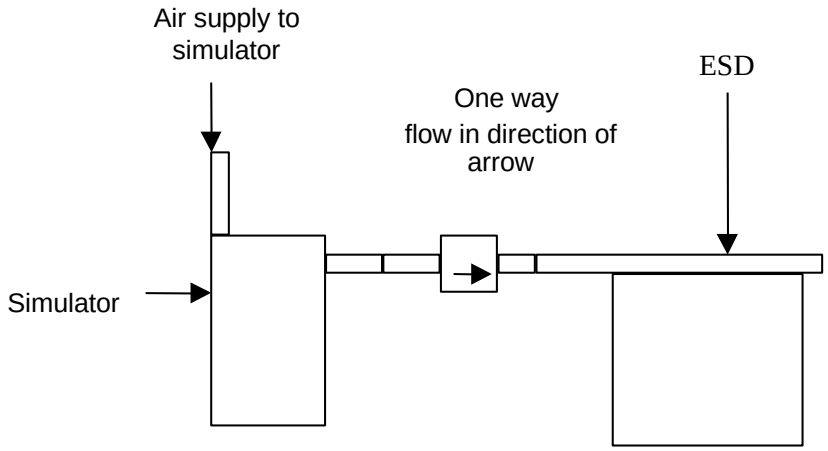

Figure 4 Test set up for ESD

The generic set-up for the test procedure is shown in Figure 4.

1. Divide the units supplied into pairs and designate one of each pair as the “test” unit, and the other as the “control” unit. Ideally one pair of devices should be supplied for each frequency test.

   Note: - The control units should not be subjected to RF at any time.

2. Pour approximately 500mL of a 40 μg/100mL simulator solution into each of the two wet simulator baths, using the same batch of solution for each. Allow 1 hour for the ESD to reach the working temperature of 34.0° C ± 0.2° C.
3. Set up one “test" unit in the shielded chamber/GTEM
4. Set up the other unit from that pair as a “control” outside the shielded chamber/GTEM.
5. Before applying any RF, carry out a first background check on both units using the simulator solutions. Record the following the parameters and confirm they are within the defined limits.

a. The time taken to analyse a sample (these values are used as the baseline to derive the analyse time limit for the test and therefore are not compared with any limit).
b. The reading displayed on the numerical display (Readings should be between 36 and 44 μg/100mL).
c. The result band displayed FAIL (if applicable).
d. The Blow time (the time taken for a sample to be delivered) is less than 3 seconds.

Note: - The flow rate should be set to the minimum at which the unit will accept a sample.

6. Set-up the necessary equipment required to generate the threat waveform.
7. Set-up the equipment required to monitor forward power.
8. Apply RF; start level defined in A.3.5
9. Blow a sample through the simulator solution into the unit in the shielded chamber whilst it is being irradiated.
10. Record the resulting forward power together with the data described in steps 5 a to d. Also record any comments on the susceptibility of the unit, on the log sheet. The Blow time is only required to be recorded if it is less than 3 seconds.
11. The susceptibility limits are:
    a. The change in the analyse time when compared with that from the background check (Step 5a) shall not be greater than ±25%.
    b. Any numerical result of the breath sample, which is outside the range of 36 to 44 μg/100mL inclusive.
    c. Any result indicted other than “FAIL” (if applicable).
    d. Blow time of less than 3 seconds
    e. Any effect that does not allow a valid sample to be taken or analysed by the unit.
12. Blow a sample through the simulator solution into the unit outside of the shielded chamber/GTEM. Record the same data as in steps 5 a to d. The Blow time is only required to be recorded if it is less than 3 seconds.
13. Turn off the RF and wait until the device indicates it is ready to take a new sample.
14. Increase the RF power by 3dB.
15. Repeat steps 8 to 13 until the maximum field strength is reached (defined in A.3.5).
16. Carry out a background check on both devices using the simulator solutions. The nominal Blow time for each unit should be 3 to 10 seconds. Record the following parameters and confirm that they are within the defined limits.
    a. The time taken to analyse a sample. The change in the analyse time when compared with that from the first background check (Step 5a) shall not be greater than ±25%.
    b. The reading displayed on the numerical display (Readings should be between 36 and 44 μg/100mL).
    c. The result band displayed “FAIL” (if applicable).
    d. The Blow time is less than 3 seconds.
17. If any of these parameters are out of limits repeat the test with a new pair of devices. If the second pair of devices also fail, contact the manufacturer for advice.

18. When the maximum power has been reached repeat all steps from step 8 for all the required test conditions, (threat frequencies) using a new pair of devices for each test.

A.6 Test Procedure – Detailed for EBTIs

Note: -The unit must be installed in the screened room twenty-four hour prior to commencing any test.

1. Pour approximately 500mL of a nominal 35 μg/100mL simulator solution into a wet simulator bath, and allow 1 hour to reach the working temperature of 34.0° C ± 0.5° C.
2. Pour approximately 500mL of a nominal 140 μg/100mL simulator solution into a wet simulator bath, and allow 1 hour to reach the working temperature of 34.0° C ± 0.5° C.

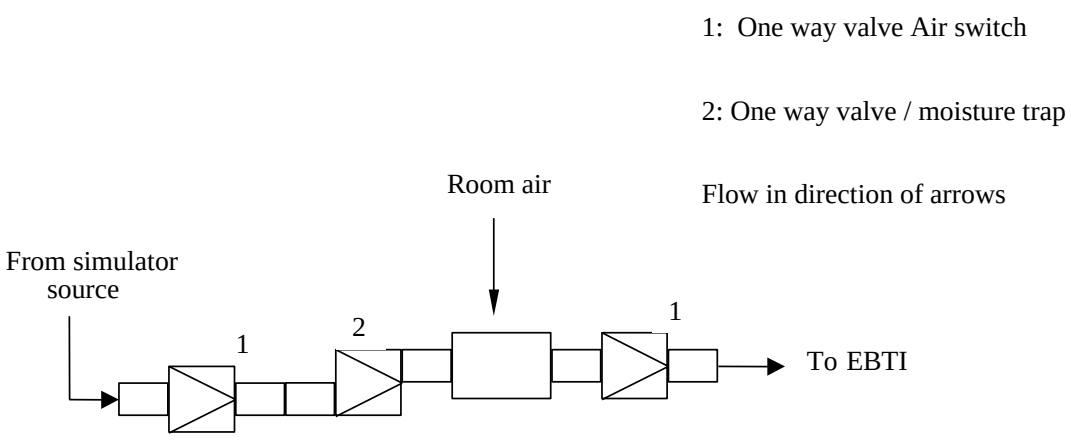

Figure 5: Coupling assembly

Note: - The flow rate should be set to the minimum at which the unit will accept a sample.

3. Connect the nominal 35μg/100mL simulator solution to the mouthpiece assembly of the device as shown in Figure 5.
4. Start the test sequence and blow samples through the solution into the instrument when requested.
5. Record the values on the printout from the device the baseline for the 35μg/100mL solution.
6. The baseline limits for the nominal 35μg/100mL solution are 32 to 38μg/100mL, if outside of these limits then replace the solution.
7. Connect the nominal 140μg/100mL simulator solution to the mouthpiece assembly of the device as shown in Figure 5.
8. Start the test sequence and blow samples through the solution into the instrument when requested.

9. Record the values on the printout from the device the baseline for the 140μg/100mL solution.
10. The baseline limits for the nominal 140μg/100mL solution are 126 to 154μg/100mL, if outside of these limits then replace the solution.

Note:- if any of the replacement solutions are outside of above limits contact the FSS for advice.

11. During RF testing the device is deemed to be susceptible if one or both of the following occurs:
    a. The numerical results of the breath samples differ by more than ± 10 % of the baseline tests.
    b. Any effect that does not allow a valid sample to be taken or analysed by the unit.
12. Set-up the necessary equipment required to generate the threat waveform.
13. Set-up the equipment required to monitor forward power.
14. Connect the nominal 35μg/100mL simulator solution to the mouthpiece assembly of the device as shown in figure 2.
15. Apply RF at the appropriate level.
16. Start the test sequence and blow samples through the simulator solution into the instrument when requested.
17. Record the resulting forward and reflected transmitter powers together with data described in steps 11 a and b (if appropriate), and any comments on the susceptibility of the unit, on the log sheet .
18. Record the appropriate parameters on the printed output from the EBTI.
19. Increase the RF power by 3dB.
20. Repeat steps 15 to 19 until the maximum power is reached. (see table for start level)
21. Repeat steps 15 to 20 for the 140μg/100mL