

# The 'monica<sup>®</sup>' mk6 benign case entry system

**This paper describes how mmic eod limited have developed a new and unique set of tools for the collection of samples for analysis without exposing the contents of the object to the environment and the chemical render-safe of conventional and improvised CBW and Toxic Industrial Chemicals (TIC).**

The initial requirement was for remote insertion of a sealed probe into large fuzed air dropped bombs containing chemical agent. In addition, the following was also required:

- Equipment, including power sources, to be man-portable, by a two man team.
- Equipment to be agent-hardened.
- No external electromagnetic signature.
- Any part of the equipment liable to contamination to be in materials had to be chemically hardened.

These interesting requirements lead to a series of interlocking problems which had to be processed in parallel. Lightweight power and lack of electromagnetic suggested compressed air as the power source.

Agent hardness is a complex subject. Firstly the materials used in construction should not be attacked or degraded by exposure to chemical agents (or the 'decon mix'). Secondly neither the materials themselves nor the methods of construction should allow chemical agent to be either absorbed or adsorbed.

As a structural material 316L stainless steel, although difficult to machine, has ideal chemical resistance and is practically non-magnetic with good mechanical properties.

The remaining problems of how to safely attach the equipment to the item and how to gain access to the contents without exposing the contents to the environment proved more intransigent. Careful analysis of these problems resulted with the following:

- An instantaneous non-magnetic attachment system that would not require surface preparation and would attach reliably to rusty, pitted, irregular surfaces of varying diameter. The attachment integrity should be capable of monitoring before and during the drilling operation to ensure there is an adequate safety margin.
- The drill/seal process should not involve drill withdrawal.

These two principles interact, since the method of attachment is defined by the downforce required to drill and the type of drill employed is determined by the amount of attachment force available.

It fairly quickly became evident that using an annular (hollow) drill in place of the normal twist drill had several advantages. This type of drill has a number of cutting teeth each ground to a precise configuration. This results in greatly improved cutting efficiency compared with a twist drill which dissipates a lot of energy in friction at the point.

Secondly an annular drill does not remove all the material so less energy is required to make the hole. Additionally much less swarf is produced because less material is removed.

Finally, and most significantly in this application, the drill has a hole down the middle! This means the drill can remain in place to provide a conduit to the target interior.

The tube which will eventually be used to access the target interior (known as the 'dipleg') needs an outer diameter (OD) of about 10 mm to provide reasonable flow rates for the viscous agents likely to be encountered. Blanket gas pressure may be required to displace the contents and this can be supplied via an annular gap around the dipleg. The combined drill and seal, or 'probe' has an inside diameter (ID) of 11 mm providing this capability.

A practical annular drill having an 11 mm ID has an OD of 18 mm and requires a downforce of about 50Kg to drill an average grade of structural steel. On breakthrough the probe will be subject to a blow out force resulting from internal pressure, if any, in the contents. Simple calculations show that this will be much less than 50 Kg for any known agent. Thus a hold-on force of 150 Kg would always provide a three-fold safety factor for the drilling operation.

The materials handling industry makes extensive use of vacuum operated suckers for moving everything from eggs to aircraft wings. A 'perfect' vacuum is 30" Hg, at which the weight of the Earth's atmosphere at sea level exerts a force of about 1 Kg/sq. cm. Practical vacuum generators for this type of application work in the 20" Hg area so, to provide the required 150 Kg hold on force, an evacuated area of about 300 sq. cm is needed; smaller than a sheet of A4 paper.

Vacuum has many advantages – it is easily generated by compact venturi-effect compressed air devices with no moving parts. The hold on force produced operates in all directions and is directly proportional to the vacuum level obtained which is simple to measure and monitor before and during the drilling operation. The vacuum foot is forced onto the workpiece by external pressure. The condition of the surface (provided it permits a vacuum to be established) is irrelevant.

At this stage of development it became clear that it would be possible to provide a piece of equipment capable of dealing with a very wide range of target diameters (including flat plate) and that such a device would have more general utility than one dedicated to a particular target diameter and wall thickness.

It will be appreciated that even highly skilled EOD technicians are under great stress when dealing with CBW and, of course, the consequences of a malfunction are likely to be much more serious than



Figure 1 Placing the equipment

with a conventional high explosive (HE) munition. The less the operative needs to concern himself with fine detail the more time he can devote to important safety concerns. It was decided that the operator should not need to know the exact target exact diameter or thickness. Instead the machine should adapt itself to the target without requiring setting up.

Eventually a solution for the holding vacuum 'feet' was produced providing stable reliable attachment of the equipment to practically any likely target and this has proved to be both extremely secure and operator friendly.

Achieving a gas-tight seal automatically regardless of case thickness also proved a challenge. The method eventually adopted uses a synthetic seal threaded onto the annular drill to form a 'probe assembly'.



Figure 2  
Probe assembly

From the illustration it will be seen that the seal has a parallel and a hexagonal portion. On breakthrough the drilling downforce forces the parallel part of the seal into the clean, accurately dimensioned hole made by the cutter until the hexagonal part impacts on the outer casing.

The rapid displacement on breakthrough is detected by the equipment, which is also continuously monitoring vacuum level and 'pecking' the drill (automatically withdrawing the drill at intervals during the process to reduce swarf).

When breakthrough is detected the drilling motor is automatically reversed. The hexagonal part of the probe has passed into a mechanical lock so, on motor reverse, the drill is drawn back into the seal expanding the seal until the expanded portion contacts the inside of the target casing. Motor reverse torque is preset to a level that will reliably pull the seal up to gas tight, whereupon the motor stalls and the drill/seal process is completed.

All that is required of the operator is to place the equipment on the target, retire to safety distance and initiate drilling with the squeeze grip controller.

Figure 1 shows the placement process and shows the compact nature of the equipment. The black 'umbilical' seen going out of the picture at bottom left is a 5M long agent-hardened bundle of pneumatic tubes linking motor, downforce rams, vacuum generator and sensors to the microprocessor control unit which is out of the picture. The control unit is linked to the remote operator handset.



Figure 3 Installed probe

Once the probe is installed and the vacuum generator turned off the drilling head may be lifted off the probe which remains sealed by an internal obturator. The probe provides fully sealed access for sampling and/or empty/render safe of contents. No non-invasive technique is capable of reliable identification of material inside a sealed container. This applies to chemical agents and TIC and even more so to biological agents. mmic eod supply a range of sampling

syringes for persistent and non-persistent agents. These samplers attach via a zero-drip self-sealing coupler to a short sampling dipleg which seals into the installed probe. The sampling dipleg may be left in place indefinitely to check for deterioration of contents or to detect accidental or deliberate change of contents in bulk storage containers. Apart from applications in CBW and TIC identification the technique also finds use in areas such as decommissioning nuclear and chemical plant where liquids of unknown nature may be left in 'traps' in pipeline runs.

They also supply sealed 'thief' type samplers for powders, granules or slurries, analysis kits, IATA approved sample transport containers and complete systems for transfer or in-situ neutralisation of contents. Suitable seals and other components are available for removing fuel and oxidizer from IRFNA oxidiser rockets.

## Testing and fielding

The equipment had been extensively tested during its development and subsequently at the UK MoD prior to its introduction there for demil operations. The testing procedures showed the system to be extremely reliable and failsafe. The probe installs against high internal pressures and is undetectably leak free when tested with simulants, live agents or helium.

Testing was completed and the system was ready to be deployed during the preamble to the second Iraq war and the war itself. It served a vital role in establishing the content and veracity of the existing 'declared' WMD there. The equipment is now field proven in Iraq and elsewhere with persistent and non-persistent agents of various types as well as powders and slurries. It has been adopted as a benign case entry system by the US DoD and UK MoD (where it is in regular use for demil ops) and other authorities.

As supplied the system comprises:

- Drilling head
- Umbilical attaching to
- Main control unit (MCU)
- Cable reel(s) connecting MCU to
- Remote Control Handset with drilling status indicators
- SCBA cylinders and connections
- Compressor for refilling cylinders
- Consumables and samplers

Plus (if required)

- Wireless CCTV
- Agent transfer system
- IATA approved toxic sample transport container
- Analysis system

All of this equipment can be carried in one small 4WD cross country vehicle.

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