Environment Agency

Evidence

Sharing resources with the Fire and Rescue Services during major air quality incidents

Report – SC160022

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Evidence at the Environment Agency

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Professor Doug Wilson
Director, Research, Analysis and Evaluation

Executive summary

This project reviews the capabilities of the Fire and Rescue Service (FRS) to monitor air quality at major incidents. It then considers how those capabilities might be used in conjunction with the air quality monitoring service operated by the Environment Agency on behalf of the multi-agency Air Quality Cell (AQC) to provide a more efficient and streamlined service for both.

The information detailed in the report is compiled from:

- survey questionnaires sent to all FRS with detection, identification and monitoring (DIM) capability and selected non-DIM FRS
- telephone interviews, presentations and meetings with senior FRS staff

It is recognised by both the FRS and the Environment Agency that there would be benefits from improved sharing of data and communication at major incidents affecting air quality. A structure to enable this already exists in part through a Memorandum of Understanding (MOU) between the FRS and the Environment Agency focused on the protection of water.

It is accepted by both the FRS and the Environment Agency that:

- there are mutual and complementary benefits in a shared approach to air quality monitoring
- a workable interoperability solution could be achieved through a combination of revision of the MOU, revised response practices and the availability of Environment Agency AQC equipment to DIM teams attending major air quality incidents

In terms of the existing equipment capabilities of the FRS and DIM teams to provide near field and hot zone data, the initial assessment is that there is limited opportunity for data sharing at present based on current working practices.

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1 Background

1.1 Overview

This report provides a detailed review of the air quality monitoring capabilities of the UK Fire and Rescue Service (FRS) and the Environment Agency in response to major air quality incidents, highlighting fire-related air quality incidents.

The aim of the review was to explore and describe possibilities for the mutual sharing of air quality data to ensure the safety of both the public and responders when dealing with major incidents affecting air quality. Particular emphasis was given during the review to circumstances where there is a degree of uncertainty over air contaminants.

The perceived benefits of FRS air quality data sharing for the Environment Agency's Air Quality in Major Incidents Service are seen as:

- ability to alert the AQC of the nature of the incident, detailing source materials and the potential for toxic air pollutants, which the AQC may not be aware of, that would assist with initial assessment and monitoring strategy
- ability to make available inner cordon (near field) measurements of chemical substances and particles for comparison with AQC measurements in the far field in order to assist with calibration and improve predictive modelling in real time
- ability to identify toxic substances being released that the AQC may not be looking for and which could lead to revision and future improvement in monitoring capability
- gain additional confidence in far-field measurements using portable equipment interpreting low ambient air concentrations of dangerous pollutants

For the FRS, the benefits of access to data from outside the inner cordon (mid- and far-field) are to provide:

- real time data to assist with firefighting decisions during incidents and to address concerns about the types and volume of emissions and potential impacts arising from control measures applied
- post-event data that can assist in reviewing firefighting decisions, the profile of emissions from a fire based on control measures employed, and their potential impact on response teams and public health

1.2 Report objectives

The main objectives of this report are to:

- determine the motivations and objectives of the FRS in conducting air quality monitoring at major incidents and to compare them with those of the Environment Agency

- identify the level of resource available within the FRS to monitor air quality in terms of available equipment, suitability and trained personnel
- identify any variation in resources between regional FRS
- compare the resources available to the FRS and the Environment Agency
- assess the capability and appetite for FRS involvement in the work of the AQC
- determine the mechanisms of data capture used by the FRS, the form of data retained and utilised, and the compatibility of data generated with that of the Environment Agency's air quality monitoring teams
- identify potential synergies
- analyse potential barriers (recognised or anticipated) that could inhibit cross-institutional collaboration
- recommend how actual or potential synergies might be developed and exploited for mutual benefit
- recommend actions to facilitate beneficial collaboration

2 Organisational response to an air quality incident

This section outlines the roles and objectives of the AQC and the FRS when dealing with air quality incidents.

2.1 AQC and the Environment Agency's monitoring service

The AQC is convened for major fire and chemical release incidents, but not for biological, radioactive or nuclear incidents. Its primary role is to:

- assess emissions to the air from major incidents
- provide public health advice to Tactical and Strategic Co-ordination Groups (TCGs and SCGs)

The 2 primary requirements for the AQC to be activated are that:

- the current or potential emissions from the incident pose a significant potential risk to the health of the public or the environment
- a multi-agency co-ordination group (that is, a TCG or a SCG) has been or is likely to be activated

The Environment Agency provides a monitoring service available 24/7 to the multi-agency AQC to obtain data to help inform the AQC's public health risk assessment and advice. If the monitoring service is required, the AQC will ask for it to be deployed. There are 4 response teams and 2 mobile laboratories. Mobilisation, travel and set-up times mean that the monitoring service is worth mobilising only for air quality incidents whose major emission phase is expected to last more than 8 hours.

2.2 FRS

According to the 'Fire and Rescue Service: Operation Guidance Involving Hazardous Materials' (DCLG and CFRA 2012), the most important roles of the FRS when attending hazardous materials incidents are to:

- save life and carry out rescues
- fight and prevent fires
- manage hazardous materials and protect the environment
- mitigate the effects of the incident
- ensure the health and safety of staff, responders and the public
- undertake safety management within the inner cordon

The FRS also has strategic multi-agency responsibilities. These are additional and in the main complementary to the specific fire and rescue functions that the FRS performs at the scene. The strategic objective is to co-ordinate multi-agency activity, including to:

- mitigate and minimise the impact of an incident
- inform the public and maintain public confidence
- assist in an early return to normality

Other important common strategic objectives for the FRS flowing from these responsibilities are to:

- participate in judicial, public, technical or other enquiries
- evaluate the response and identify lessons to be learnt
- participate in the restoration and recovery phases of a major incident

3 Survey methodology

The main source of information obtained from the FRS across the UK was a questionnaire specifically designed to address the project objectives. The questionnaire was distributed to representatives of the 19 brigades that have detection, identification and monitoring (DIM) capability. It was also distributed to 7 non-DIM brigades.

The question set was shared with the Environment Agency to confirm that all relevant information was being sought. The format of the document contained a mixture of 'yes'/'no' questions designed to capture commonality between brigades in a quantifiable way, and more open-ended questions to allow anecdotal commentary to be captured.

The questions posed to the FRS were as follows.

- What resource does your FRS have to monitor air quality at a (major) incident?
- What liaison is there between your FRS and the Environment Agency?
- What communication is there between the Environment Agency and FRS during an air quality incident?
- What air quality monitoring equipment is available to the FRS and how is it deployed?
- At an incident what species are routinely assessed?
- What are your air quality monitoring objectives?
- Where is air sampling directed?
- What operational standards are used for reporting air quality?
- Who would analyse and make decisions from the data produced?
- How are the data recorded for review?
- Are reports of air quality monitoring data completed by the FRS?
- For air quality monitoring reports that are completed, how are they stored?
- For air quality monitoring reports that are completed, how are they circulated?

In addition, further interviews and consultations with contributors were made through structured telephone interviews, presentations and face-to-face meetings. Comments from meetings and individual discussion from officers have been incorporated into this report.

4 Questionnaire results

Of the 26 questionnaires that were distributed, 15 (58%) were returned completed and follow-up calls made. Although a follow-up call was made, one further brigade stated that it would not be able to participate at this time. It was not possible to make contact with the remaining brigades.

The following information, which is drawn from questionnaire responses, reflects the views and local situation of respondents.

4.1 FRS air quality capability assessment

4.1.1 Organisation

In terms of response to an air quality incident, the following organisational structure is defined:

- **Incident Commander**. This nominated competent officer has overall responsibility for dictating tactics and resource management, and providing the link with the Environment Agency during major fire incidents.
- **Hazardous Materials and Environmental Protection Officer (HMEPO)/ Hazardous Materials Advisor (HMA**). The role of the HMEPO (formerly HAZMAT) is to provide advice to the incident commander on the hazardous properties and impacts of potential incident contaminants. Subsequently they may advise on tactics and other issues in relation to environmental protection.
- **Detection Identification and Monitoring (DIM) Officer.** This role is as a primary responder to chemical, biological, radiological or nuclear explosive [CBRN(e)] events. The chemical analysis responsibility is primarily concerned with National Resilience response. Under the existing organisational structures, a DIM officer is unlikely to be called to a major fire or subsequent air quality incident.

National Operation Guidance details an operational HMEPO/HMA response to generic hazards and controls when dealing with hazardous material incidents. This requires the drawing up of a risk management plan that details public exposure which includes working with ‘people and agencies that may provide additional advice or assistance’ (DCLG and CFRA 2012).

From discussions with officers, the main role of the HMEPO during a fire event is limited primarily to water risk assessment and how this may be affected by different firefighting approaches (for example, rapid knock down versus controlled burn). It is apparent that any operational decision on controlled burn or put out would not primarily be decided on the basis of air quality.

The initial objectives of the FRS in attendance are the determination of the cordon position, size and shape together with selection of personal protective equipment (PPE) for the fire crew.

It was noted that FRS first-on-scene crews primarily rely on support data (as detailed in Operational Guidance) to provide a preliminary assessment as to whether a supporting HMEPO/HMA team should be mobilised.

Information tools available to the FRS include:

- mobile data terminal based systems – Chemdata®,[1] WISER,[2] CIRUS[3]
- chemical meteorology (CHEMET)
- scientific advisors (on scene and remote services)
- site emergency plans

Air quality monitoring by the FRS is primarily carried out to:

- determine cordon position, often with the intention of being able to move the cordon inwards
- determine the potential environmental risk of the incident (for example, the presence of hazardous materials)

The initial motivation for this is to determine the safety for the team on the ground at the fire. However, further analysis can be carried out to assess the risk to the public and if required by another agency – though for air quality monitoring this may be referred to the AQC. Air quality monitoring is used less for PPE selection as the fire crews will tend to wear breathing apparatus or gas tight suits as standard at any incident where there is uncertainty as to risk.

UK fire services in the main use:

- Health and Safety Executive (HSE) EH40 guidance on workplace exposure limits[4]
- Immediately Dangerous to Life or Health (IDLH)[5] values/Acute Exposure Guideline Levels (AEGL)[6]

The standards used may depend on where the information on standards has come from, for example, whether using Chemdata or WISER. One fire service said it would tend to know the time weighted average (TWAs) limits for the common gases (for example, hydrogen sulphide and carbon monoxide). Another said that limits would form part of the DIM risk assessment.

4.1.2 Deployment

In terms of FRS resources, 11 out of the 15 contributors stated that they had HMEPOs who would be the first port of call when a potential environmental risk is identified.

The majority of HMEPOs are also trained as DIM officers; 9 out of the 15 contributors stated that they had DIM-trained HMEPOs. These brigades will therefore have additional capability when it comes to operation of the equipment on the DIM vehicle (and interpretation of the results) should this be mobilised.

During the questionnaire follow-up calls, all 15 contributors commented that the attendance of the HMEPO and subsequently the DIM team would depend on local judgement around the particulars of the incident rather than any specific triggers. Typical reasons why a HMEPO would be in attendance included:

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[1] https://the-ncec.com/en/resources/chemdata
[2] https://webwiser.nlm.nih.gov
[3] London Fire Brigade's Chemical Information Retrieval and Update System
[4] http://www.hse.gov.uk/pubns/books/eh40.htm
[5] https://www.cdc.gov/niosh/idlh/intridl4.html
[6] https://www.epa.gov/aegl

- if the presence of a hazardous chemical or gas was reported (for example, carbon monoxide, methane, asbestos or acetylene)
- if it was a large incident (for example, >6 pumps)
- if there was a potential environmental issue (for example, smoke or water run-off)

Once at these incidents, the HMEPO would decide what type of air quality monitoring to conduct and complete an environmental risk assessment. The HMEPO or a senior officer may request the attendance of the DIM team in relation to air quality; this is limited to small number of events per year in response to hazardous unknowns. Regular firefighters cannot mobilise a DIM team.

The decision to deploy DIM officers to an incident is based on a METHANE risk assessment methodology – primarily a CBRN(e) response – but air quality applicable for DIM response to be activated:. METHANE stands for:

M – Major event declared

E – Exact location

T – Type of incident

H – Hazards present, potential or suspected

A – Access, safe routes

N – Number, type and severity of casualties

E – Emergency services now present and those required

Information gathered by individual agencies is disseminated to all first responders and controllers.

Typical reasons why a DIM team would be requested to attend included:

- if further analysis was needed (for example, a multi-chemical or inconclusive incident)
- if there would be legal implications from the incident (for example, a crime scene, dumped chemicals or an illicit drugs lab)

In these cases, the DIM analysis would also be used to assist police and to classify and detail potential chemical hazards at the scene for evidence gathering purposes.

4.1.3 External third party attendance

In terms of further air quality monitoring, all contributors stated that they had an external party as a resource for air quality monitoring if needed. This included scientific support from bodies such as Bureau Veritas, West Midlands FRS Scientific Advisory Group, Glasgow Scientific Services (in Scotland) and the Institute of Naval Medicine.

Regarding other agencies, 3 brigades said that they could contact the Environment Agency for further support primarily relating to pollution and flood response.

In particular, outside England and Wales, the FRS in Scotland and Northern Ireland are understood to have a closer working relationship with their respective environment agencies – Scottish Environment Protection Agency (SEPA) and the Northern Ireland Environment Agency (NIEA). At the time of writing, no memorandum of understanding (MOU) or equivalent document was available from either of the FRS involved; this is worth additional investigation as a potential model for future liaison between the FRS and the Environment Agency in England and National Resources Wales in Wales. In Scotland, for example, the contributor mentioned that SEPA would be the lead agency for airborne pollutant monitoring and had emergency response capability to deploy for this.

A cited example involving use of a third party agency was that of a protracted incident on a ship, where air quality monitoring and plume modelling was by the attending FRS. This type of air quality monitoring was motivated by concerns about high levels of carbon monoxide due to the material that was combusting. Although this incident was ongoing over a number of days, its contained nature meant that it was not thought by Public Health England to pose a risk to the wider public due to the wind direction and containment; the National Air Quality Technical Advisor (NAQTA) was informed but the AQC was not activated.

4.1.4 Ambulance Service HART (Hazardous Area Response) team

The Incident Response Unit (IRU:HAZMAT) within the HART team has the capability to provide paramedic standard care within the inner cordon (hot zone) of incidents involving hazardous materials, usually within an industrial setting.

Specific use of handheld monitoring equipment was noted as being used by the Ambulance Service HART when deployed at the Drummonds Mill fire in Bradford in January 2016. Handheld monitors carried by the team triggered alarms and indicated toxic levels of carbon monoxide concentration close to the fire, resulting in a coordinated evacuation with West Yorkshire FRS/Police of around 100 homes in the immediate surrounding area. No formal information has been made available on the incident

4.2 Liaison between the Environment Agency and FRS

Commenting on liaison between the Environment Agency and FRS, all brigades said that they had a good working relationship with the Environment Agency. The majority (11 out of the 15) of the brigades said that there was a local resilience forum which they attended. At these forums, it was possible to update on recent incidents and the actions taken. Meetings tended to be quarterly.

Some brigades said that the Environment Agency was often invited to FRS training exercises if they felt that it would be relevant or useful to the Environment Agency.

In terms of equipment, many brigades were aware of the equipment supplied by the Environment Agency such as grab bags, pods containing things like drain blockers, and spill mats. It was mentioned by one brigade that the Environment Agency also supplied equipment for the recovery phase (for example, diggers).

The liaison that was mentioned related to strategies for flood and water quality mitigation. When air quality was mentioned, all 15 brigades said that they were unaware of having any Environment Agency equipment intended for air quality monitoring. HMEPO/HMA officers were generally aware of the service, but had limited or no knowledge of the capabilities regarding service provision.

There is a different approach for the standalone units in Northern Ireland and Scotland, where the 2 FRS appear to have stronger links with their respective environment agencies. While it was not possible to gather further details, the Northern Ireland FRS said that it is in the process of forming stronger, more formalised links with NIEA in terms of incident response, but no details were available at the time of writing.

Regarding air quality monitoring in Northern Ireland, the Northern Ireland FRS stated that:

- it did not provide air quality monitoring
- NIEA did not facilitate this either but could support the function by other means if required

4.3 FRS air quality equipment and shared air quality monitoring capabilities

4.3.1 Detection capability for target air quality species

The aim of this section of the questionnaire was to ascertain whether specific target species are monitored routinely as part of the initial risk assessment on attending the scene of a fire. It became apparent during follow-up conversations that, for the most part, the question had been interpreted differently.

We found that respondents tended to answer by detailing the capability that they could call on for monitoring these species, rather than what they actually monitor as part of an initial risk assessment. In practice, the DIM vehicle or the HMEPO would not be in attendance when the FRS first attends a scene and so the initial risk assessment would be carried out by the incident commander.

This initial risk assessment would be generated based on knowledge of the site, whether as a result of pre-inspection of the site – for example, for a Control of Major Accident Hazards (COMAH) site – or through conversation with an on-site employee on arrival at the incident. As the FRS tends to wear full fire kit and breathing apparatus as standard at an incident, monitoring of the atmosphere would not necessarily be a first priority. If it was felt that the nature of the incident was unclear (for example, there was uncertainty as to what was burning, such as might be the case for a waste fire), the attendance of the HMEPO might be requested at this point.

Figure 4.1 details the affirmative responses that the respondents gave regarding the monitoring capability they have for their specific species. The species are categorised by the locations where the instruments would be, that is, HMEPOs would have gas detectors supplied by GfG (http://www.gfg-inc.com/englisch/start.html) while the DIM team would have additional monitoring capabilities.

The majority of the instruments available to the FRS are point monitors and so tend to be used to monitor substances in the immediate area where it will be operating. There is currently no formal process for capturing air quality monitoring data. However, the data logged by the instruments are accessible within the FRS after the event, usually captured anecdotally on the respective fire control log.

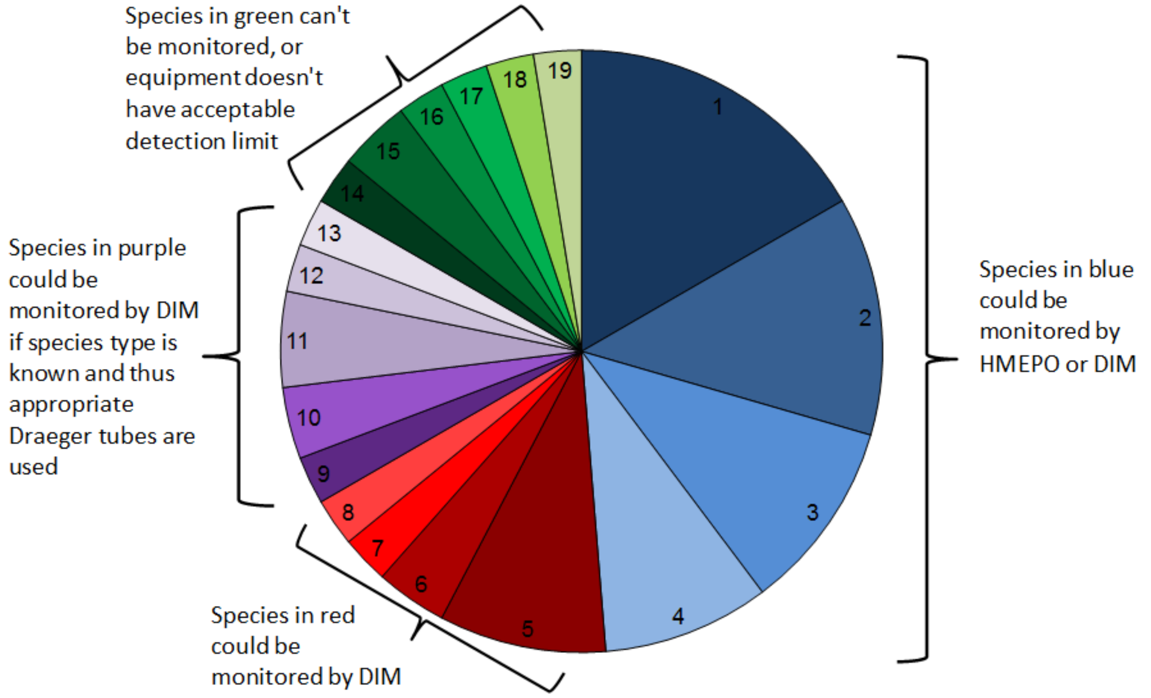

Figure 4.1 Detection capability for specific target species

Key:

1. Carbon monoxide CO
2. Hydrogen cyanide HCN
3. Ammonia NH_3
4. Chlorine Cl_2
5. Carbon dioxide CO_2
6. Sulphur dioxide SO_2
7. Acrolein (2-propenal)
8. Formaldehyde
9. Nitrogen oxides NOx
10. Phosgene $COCl_2$
11. Hydrogen chloride HCl
12. Hydrogen bromide HBr
13. Hydrogen fluoride HF
14. Phosphorous pentoxide P_2O_5
15. Particulate matter $PM_{2.5}/PM_{10}$
16. Polycyclic aromatic hydrocarbons PAHs
17. Dioxins and dibenzofurans
18. Isocyanates
19. Perfluoroisobutylene

4.4 FRS equipment assessment

This section describes some of the equipment available to the DIM teams that could be used on behalf of the Environment Agency to generate air quality data.

4.4.1 Gas sensors and photoionisation detectors (first responders/HMEPO/HMA/DIM teams)

Gas sensors and photoionisation detectors are predominantly utilised by 47% of first responders operating in the hot zone for initial screening of hazardous materials (as detailed in the questionnaire responses) and subsequent decisions on deployment of PPE to FRS responders. There is a facility to log data on both types of instruments, but this is not implemented as part of a standard deployment and the logging modes may currently be locked out for operational use.

4.4.2 HAPSITE® Smart Plus (DIM team)

The HAPSITE® Smart Plus is a chemical identification system based on a portable gas chromatograph/mass spectrometer (GC/MS) and is principally a qualitative device for detection of volatile organic compounds (VOCs) in real time. It can deliver a tentative identification (survey mode).

The device is designed to be used for organic molecules with an atomic mass unit (amu) of between 45 and 300. The manufacturer recognises that there are notable limitations on detection capabilities for identification of compounds at and below 70 amu. This would therefore exclude reliable detection of 1,3-butadiene, acrolein (2-propenal), methyl isocyanate, phosphine (hydrogen phosphide) and carbon monoxide, and limitations due to interference from atmospheric carbon dioxide.

In discussion with both scientific advisors and DIM officers it is accepted that, because of the specific operating window of the device, data generated from the HAPSITE Smart Plus would be extremely limited for detection of hazardous combustion and thermal decomposition products within the hot zone. Operationally in its standard mode of operation, the device has a limit of detection of several parts per million (ppm), which may be insufficient to detect substances of concern. In addition it not set up to undertake quantitative analysis unless a specific calibration gas is also used.

It is understood that the manufacturers, Inficon, will withdraw support for the HAPSITE Smart Plus in around 3 years' time as replacement, updated units are introduced. It is not currently clear how the Home Office, advised by DIM team representatives, will respond.

4.4.3 Draeger tubes (Simultest Kit) (HazMat/DIM)

The Draeger Simultest Kit allows for 5 species to be determined qualitatively at one time. In HazMat configuration, it is primarily used to determine the presence of nitrogen oxides, phosphine, acrolein (2-propenal) and formaldehyde. It is a piece of equipment that can be adapted easily to measure other analytes of concern to the AQC.

The data taken are predominantly limited to on-site use; there is no facility to log data automatically. However, the data are logged by each FRS internally and so are accessible after the event in the respective fire control log.

4.4.4 Particulate analysis (DIM team Scotland)

In general, there is no facility to measure airborne particulates. There is, however, anecdotal evidence that one FRS does have access to – and occasionally employs – a Microdust handheld dust measuring device for assessing the concentration of suspended matter (mg/m^3).

The Scottish DIM units carry SEPA Osiris particulate monitoring equipment with remote transmission capability. This type of equipment is not present as standard on English or Welsh DIM vehicles

4.4.5 Summary of potential for shared technical capability

The potential for shared capabilities between the FRS and the Environment Agency is limited to benzene, toluene, ethyl benzene, xylene (BTEX), carbon monoxide, chlorine, hydrogen sulphide and to, a limited extent, particulates (Table 4.1).

It is recognised that the HAPSITE Smart Plus equipment has the capabilities for providing an indication of BTEX levels in the air, but these are limited in survey mode. The equipment would not be primarily used in this type of application.

Initial incident responders are able to provide information on carbon monoxide, chlorine and hydrogen sulphide levels in the ambient air as part of their standard equipment issue.

Table 4.1 Potential for shared technical capability

Environment Agency air quality equipment	FRS equipment	Shared species capability
GASMET DX4030	HAPSITE Smart Plus (limited capability in survey mode)	BTEX Formaldehyde Phosgene (carbonyl dichloride)
QRAE Plus	GfG 460/Micro 5	Carbon monoxide Chlorine
Jerome 631-X Draeger tubes	Draeger Simultest Kit	Hydrogen sulphide
Osiris	Osiris (limited use of equipment, not standard issue in England and Wales)	Particulates (PM_{10}, $PM_{2.5}$)

4.5 FRS decisions on air quality monitoring strategy

In the case of smaller incidents, the responses in the completed questionnaires would suggest that the FRS tend to rely on initial analysis by their HMEPO or DIM-trained officers (without a DIM vehicle) within the hot zone. These officers make a decision on what air monitoring to conduct, often depending on the size/scale of the incident and possible pollutant release.

The decision to request further support is made based on the experience of the attending HMEPO/DIM officer. If they feel that further analysis is required, they usually contact their designated scientific support, so that additional air quality monitoring can be carried out to determine the wider impact of the incident within the FRS domain.

In the case of a larger incident, a multi-agency TCG or SCG may be established (for example, if requested by the HMEPO or DIM officer), chaired by the police or FRS. This is one of the triggers for activation of the AQC, which may in turn mobilise its monitoring resources if other triggers are met.

At the tactical level, if the AQC is formed it will discuss and analyse air quality data and information, reporting directly to the TCG. The AQC chair has responsibility for contacting the local authority and handing over to them responsibility for ongoing arrangements for air quality monitoring beyond the acute phase of an incident.

The AQC provides TCGs and the Scientific and Technical Advice Cells (STACs) of SCGs with regular AQC situation reports (AQC SITREPs), which summarise the ongoing public health assessment and provide relevant advice. The Public Health England representative on TCGs and SCGs acts as the spokesperson for the AQC and any AQC SITREPs provided.

4.6 Activation of the AQC

Nine of the 15 contributors said that they had no experience or knowledge of the AQC having been activated. Expanding on this, 2–3 of the contributors commented that they tended not to consider activation of the AQC. Some mentioned that this was mainly because the activation criteria were too stringent and so could not be met (for example, an incident lasting >6 hours). However, there appeared to be some confusion between the criteria for activating the AQC and the AQC's subsequent criteria for activating monitoring.

Other contributors said that there was no need to activate the AQC as they had their own scientific support. The underlying theme was that the AQC resources could not offer any additional information that would be of immediate assistance in terms of the immediate cordon. This highlights the disconnect between the needs of the FRS and its scientific supporters (funded by the FRS) and the Environment Agency/Public Health England.

For the 5 contributors that did recall incidents where AQC was requested, all these related to waste fires. In one scenario, the AQC was requested but, as a major incident was not declared, the AQC was not activated, highlighting the confusion surrounding the deployment of the AQC to an event. In another case, the AQC was requested but was described as being unavailable as 'it was attending another incident'.

Two or three DIM officers commented that waste fires in particular were of concern to the FRS due to the unknown nature of the combustibles, and so air quality monitoring would be considered as more of a priority at these incidents. There were no formal contacts between the NAQTA and the FRS in these cases, the supposition being that the AQC is a deployment service rather than one giving advice.

4.7 Communication with the Environment Agency during an air quality incident

During an incident with the potential to have an impact on air quality, the survey responses indicated the Environment Agency tended to be contacted either through a hotline[7] or via a single point of contact (Figure 4.2). In the majority of cases, contact with the Environment Agency tended to be requested by the attending HMEPO, PHE or

[7] It is unclear if this was the Incident Communication Service (ICS) for members of the public or the ICS for professional partners.

DIM officer. This was done through via Fire Control (that is, the officers radioed in to the fire control centre and contact was established by them).

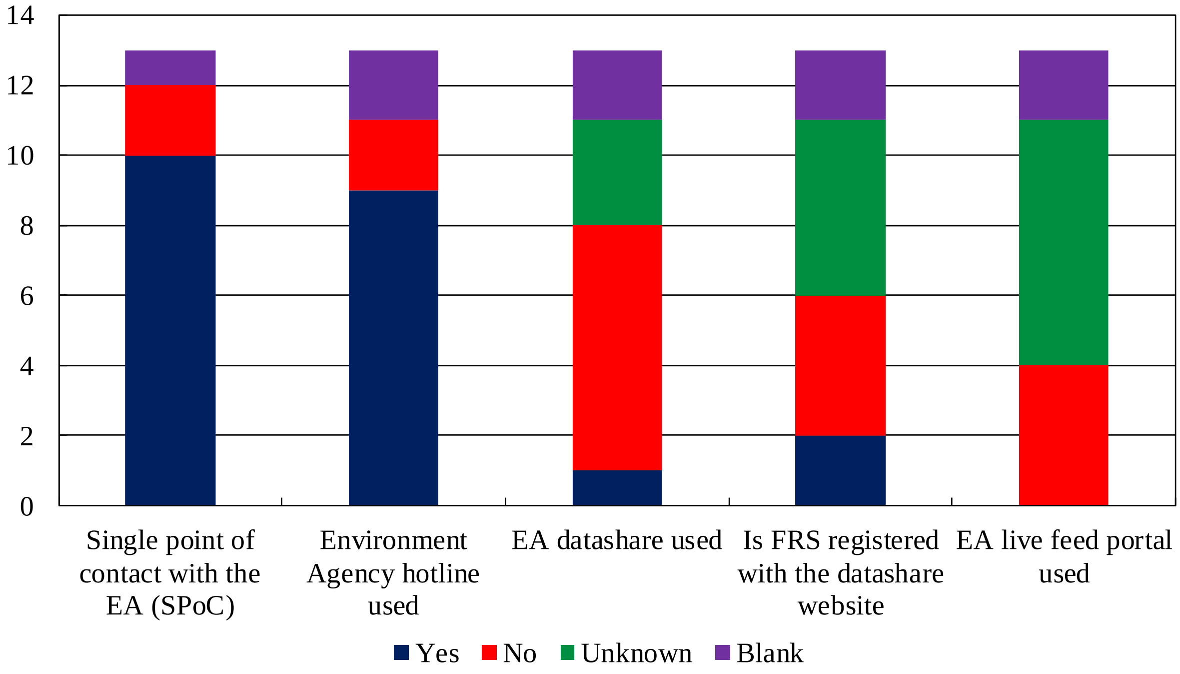

Figure 4.2 Methods of communication with the Environment Agency during an air quality incident

None of the contributors said that they used the Environment Agency live feed portal, and in fact most were unaware of this data platform. Indeed, the author of this report found no links to the portal or any information to describe in more detail the functionality of the live feed. This is an area that needs additional flagging and education with responders.

One contributor commented that if they thought an incident may become protracted before all of the activation criteria for the AQC are met, the FRS will notify the Environment Agency sooner, and ideally the Environment Agency duty officer will come out to assess the situation. The same contributor said that they would also contact Public Health England directly to see what it would recommend in terms of a public health response.

Methods for sharing data included:

- Resilience Direct (Cabinet Office multi-agency tool)
- through the command unit if a web-based feed was available
- through their specific fire control
- verbally from the HMEPO to the Incident Commander

Three contributors commented that there are specific action plans with mobilisation procedures, and it will be the HMEPO who decides whether to contact Environment Agency or not. This route needs further evaluation as a potential data sharing resource.

4.8 Examples of air quality measurements during FRS response

4.8.1 Fire at a waste transfer site

This incident concerned a major fire involving a waste transfer site storing waste plastic materials with local businesses located adjacent to the site.

During the initial response phase, air quality monitoring was conducted by Cheshire FRS to help in the positioning of vehicles and equipment, and to inform the choice of PPE for operational staff. ‘Stay indoors’ advice was given – it is understood by the local authority – to members of the public and adjacent sites were closed.

After the initial fire had been brought under control, a significant issue of smoke from smouldering materials was evident. It was determined that the fire response techniques available would result in a likely timescale of several weeks for the fire to be fully extinguished, during which continuing air quality issues would occur. Note that this incident did **not** result in the activation of an AQC or air quality incident monitoring teams.

A third party contractor (Bureau Veritas) was asked to make air quality measurements on behalf of the FRS, activated by the HMEPO in attendance. Measurements for a range of air quality parameters including particulates, acid gases, irritant gases and carbon monoxide were made at locations around the site perimeter, in the FRS operational areas and at industrial businesses immediately adjacent to the site. These data were used to inform the FRS PPE decision process and to provide advice on cordon location. This monitoring was carried out on a regular basis over the following 4 weeks of the incident.

During this period, additional air quality monitoring was carried out by Bureau Veritas on behalf of the local authority including measurements at residential areas, a nearby shopping centre and to the site of other local businesses to provide data to help the local authority assist with the provision of advice to relevant affected parties.

Monitoring data were shared with the FRS and the local authority, but it is not clear to Bureau Veritas to what extent the data were also shared with the Environment Agency. Bureau Veritas did attend formal meetings with the FRS, local authority, Environment Agency and HPA approximately one week after the event to discuss the most appropriate course of action relating to balancing environmental concerns against public health interests.

The main parameter measured that was found to be elevated was particulate matter, at locations adjacent to the incident location and at distances up to 2km from the fire location.

4.8.2 Fire at a stockpile of waste fridges and freezers

This incident involved a fire in a very large stockpile of fridges and freezers being stored on waste ground. Residential areas were located very close to the site.

A large plume of smoke was being released and the attending FRS had concerns about the composition of the smoke and its potential impact on the nearby residential area; this prompted the activation of the DIM team. It is not known if NAQTA/AQC notification was considered.

A sample of the smoke plume was collected from a location close to the source of the fire by the FRS using suitable PPE. The sample was contained in a gas bag and was tested using a HAPSITE Smart Plus instrument, producing a significant peak in the gas chromatogram identified as styrene.

A semi-quantitative analysis was performed. The identification and estimated concentration were used to inform the local authority decision-making process regarding advice and operational actions to protect nearby residents.

5 Conclusions

The role of the FRS is principally to save life and carry out rescues. It is supported by teams of HMEPOs and DIM officers, whose aims are to offer primary health and safety, environmental and National Resilience information. The AQC's primary role is to assess emissions to the air from major incidents and to provide public health advice to co-ordination groups (TCGs and SCGs), with monitoring resources available for incidents meeting trigger criteria.

This project aimed to review these objectives and the capabilities – in terms of resources, equipment and capacity available to deliver them – with a view to identifying areas where collaboration might lead to more efficient or comprehensive delivery of any or all of them.

Table 5.1 lists those areas currently seen as suitable for immediate collaboration.

Table 5.1 Possible areas for immediate collaboration

Objective	Owner of objective	Resource available to help address that objective	
		FRS/third party	**AQC**
Gather more evidence for possible legal proceedings following an incident	Environment Agency/FRS	Resources to monitor air quality close to source (inner cordon)	Resources to monitor air quality data beyond the cordon
Better inform firefighting decision-making process during and after the event	FRS	Range of portable monitoring equipment and expertise	Able to provide public health impact data downwind of the incident, and some information on emissions from various incident types
Improved efficiency for the AQC in gathering information on air quality during incidents to inform Public Health England's health risk assessment	Environment Agency	Equipment to provide early air quality hazard information on first attendance	Resources to monitor air quality data beyond the cordon

Air quality monitoring equipment is not normally carried on FRS pump appliances. It was felt by the brigades interviewed that the cost of having such equipment on the appliance outweighed any benefit, due to the need for regular calibration and maintenance checks, as well as having to train the crews on how to operate the equipment. Furthermore, there could be potential for misinterpretation of the data by non-specialist users.

More equipment becomes available as HMEPOs and then DIM resources are activated and, under some circumstances, through AQC activation, use of contractors and local authority follow-up. Clarifying the differing/shared objectives of the FRS and the AQC is an important prerequisite to identifying opportunities for collaborative working.

In terms of motivation, there was general agreement by both the FRS and Environment Agency representatives consulted that greater collaboration could be beneficial in enhancing the services offered to support:

- FRS operational decisions within the hot and near hot zone
- the AQC from a public health perspective beyond the cordon

This view is supported in an MOU and operational annexes (CFOA and Environment Agency 2015), a 2-part document which details how greater collaboration might be achieved in specific cases. Part 1 describes the principles under which the Chief Fire Officers' Association (CFOA) and the Environment Agency will work together. In Part 2, both parties commit to working together to agree and maintain the content of the operational annexes which set out guidance as to how the Environment Agency and individual brigades should operate together. These operational annexes cover:

- pollution prevention and mitigation
- preventing waste and industry site fires
- cooperation for flood response
- communication and management of the partnership

The MOU does not refer to air quality and it would appear from the questionnaire responses that clarification is needed for the various brigades on the role and triggers for activation of the AQC, and how these are distinct from the triggers for mobilising the Environment Agency monitoring service. The MOU in terms of structure and how it is being implemented across the FRS in England and Wales would appear to be a ready-made platform for closer working air quality relationships between the AQC and FRS.

5.1 Personnel resources

Discussions with a number of participants from the Environment Agency suggest that the role of the DIM officer appears to be largely misunderstood and can be confused with the role of scientific advisor.

To clarify, the DIM officer is part of the National Resilience capability and as such trained to support a CBRN(e) response. As a result, a DIM officer will not be deployed automatically at a major fire or air quality related incident unless there is a specific reason for attendance. The DIM capability is financed via the Home Office and operates within fixed operational criteria and financial resources.

Similarly, the constraints placed on the AQC require that a number of incident conditions must be met before deployment of monitoring can be initiated (see Section 3).

This review indicates that DIM officers are best placed to provide support to the AQC, being able to provide near-scene analytical data that may be of use to the AQC in assessing the likely public and environmental health implications of an incident. Similarly, the AQC offers capabilities that would help to meet FRS objectives

To enable each to give such support during incidents to which they would not normally be called out would require changes in organisational structure, and consideration of financial implications. Collaboration might be more straightforward to achieve where objectives and/or triggers for call-out coincide, but would require establishment of clear lines of communication.

From follow-up conversations with FRS representatives, it was apparent that there is an interest in future collaboration and in facilitating further monitoring if this would benefit the AQC. If there were a request for air sampling from a smoke plume or for monitoring of additional species that requires instruments not currently available to DIM teams, however, further consideration would be required regarding training, time allocation and so on such that the FRS's operational activity during incident attendance would not be compromised.

5.2 Equipment resources

Many (but not all) first-on-scene FRS teams have the capability to measure air quality within the hot zone using handheld gas monitoring and photoionisation detection equipment.

The first priority is providing data to protect the health and safety of firefighters on scene and to guide deployment of the correct equipment. By its nature, the information generated by the handheld equipment consists of spot analysis at accessible locations representing conditions in the hot zone. Data are generally not logged and would be of limited use to the AQC (other than, perhaps, acting as an early flag if the fire was outside the standard dataset). Away from the hot zone, initial responders would have limited capability or capacity for assessing air quality.

With the involvement of the DIM team, additional resources become available (that is, HAPSITE Smart Plus and the Draeger Simultest Kit).

HAPSITE Smart Plus was identified as having significant drawbacks when used for initial identification of combustion products (that is, around limitations on the species it would be able to identify). Its limited capability in this scenario offers little or nothing that meets the AQC objectives; the instrument is bespoke designed for CBRN(e) response

The Draeger Simultest Kit in HazMat configuration can be used for a rapid hot zone air analysis. It could provide early information on the presence and concentration of up to 5 of the most important constituents for AQC monitoring of toxic pollutants downwind of a plume.

Away from the hot zone, the FRS has limited capability for assessing species that would present public health issues.

A solution considered by a number of brigades would be to issue gas and particulate matter monitors (such as the Osiris equipment currently used by the Environment Agency monitoring service for the AQC) to the DIM teams on behalf of the AQC. Such monitors would provide near-scene measurements and air monitoring information, which would be of use to both the FRS and the AQC.

In terms of public health, airborne particulate monitoring is highly significant and, given limited resources, the focus might be best directed towards provision and training on the use and placement of Osiris or other particulate monitoring equipment for near-scene measurement. The information generated would also be relevant to the health and safety of staff within the cordon.

5.3 Operational constraints

All DIM team members consulted during the survey were concerned about transporting more equipment on the DIM vehicles, since these are already close to their weight limit. A GASMET or Osiris unit with a remote housing is a significantly heavy piece of equipment and, according to many DIM teams, could not be carried as standard support equipment. Smaller, indicative, particle concentration monitors (such as handheld optical scattering instruments) might not present the same logistical challenge.

6 Recommendations

It is recognised at a senior level in the FRS and in the organisations involved in the AQC that co-ordination of the AQC and FRS air quality measurement capabilities would deliver the public health and incident health and safety objectives of both groups more effectively and efficiently. Cross-organisational consultation is required to develop a workable operational structure and financial mechanism.

Prerequisites to joint working include the following.

- Further clarification of AQC and FRS objectives and consideration of how these might be achieved collaboratively, minimising staff and equipment costs overall.
- Reviewing the current MOU between the Environment Agency and the FRS (CFOA and Environment Agency 2015). The current document details principles on which a shared air quality platform might be developed (Operational Annex II – Preventing Industry and Industry Site Fires). Revision of the MOU, which at present is heavily focused on environmental issues (chiefly protecting watercourses) would clarify how the AQC and FRS might work together as currently happens with water-related issues.
- Development of pre-agreed arrangements to co-ordinate environmental sampling with health and safety monitoring. The current absence of such arrangements was highlighted in a number of telephone and face-to-face discussions with FRS personnel during this project.
- Recognition of the limitations on frontline appliances (first-on-scene) being able to provide any air quality data given the primacy of their duty to save lives and carry out rescues.
- Understanding where data sharing might be beneficial and considering means for sharing data where appropriate. For example:
    - How might spot measurements from within the cordon be of use to, and if so be communicated to, the AQC?
    - How might far-field measurements taken by the AQC or local authority be stored and used as evidence in subsequent legal cases?
- Development of a more ‘flexible’ approach to air quality monitoring by the AQC and the FRS. Currently both organisations operate to their own tightly defined operational criteria, which are not conducive to joint working.
- Investigating the options and benefits of additional equipment provision and/or training support. For example, additional air quality equipment supplied by the Environment Agency could be located with a single FRS in each region allowing a reasonable selection of equipment to be supplied while minimising capital costs and FRS training requirements rather than supplying kit to all brigades.
- Providing staff time and finance to support a collaboration project from within the FRS and the AQC partners.

The initial aim of a collaborative project would be to explore how the points above might be addressed. Subsequent work would then test the practicality of the options generated.

For example, one option might be to conduct pilot studies with DIM and non-DIM FRS to assess different models for the delivery of improved air quality data acquisition and its sharing between the AQC and the FRS. The main problem with such a pilot study is that relevant incidents may not occur often enough to guarantee that the trial procedures would be used during the pilot study period.

One possible solution to this this could be to undertake pilot exercises based on a variety of scenarios and delivery options. Exercises could:

- be desk-based with data injections
- be performed on suitable training sites, with controlled burns allowing actual deployment of FRS staff and equipment, and measurements to be taken
- involve deployment to normally sub-trigger threshold events

The results from this project indicate that the extra capability that might produce the most useful additional air quality measurements would be the addition of particulate monitoring to FRS response capabilities. This would allow local particle measurements and spot tests at other locations.

Another procedural change that may produce a quick and easy improvement would be to assess the extent that the FRS DIM (and other air quality) equipment can be configured for data logging and data download.

Further work on this project should also involve discussions with local authorities. They may have access to air quality equipment that could be deployed. They may also be interested in the results and have a legal duty regarding air quality in their area.

References

CFOA AND ENVIRONMENT AGENCY, 2015. *Memorandum of Understanding and Operational Annexes between the Chief Fire Officers' Association and the Environment Agency with effect from September 2015*. Tamworth, Staffordshire: Chief Fire Officers' Association. Available from: http://www.cfoa.org.uk/download/61162 [Accessed 28 September 2017].

DCLG AND CFRA, 2012. *Fire and Rescue Service operational guidance: incidents involving hazardous materials.* London: The Stationery Office. Available from: https://www.gov.uk/government/publications/hazardous-materials-operational-guidance-for-the-fire-and-rescue-service [Accessed 28 September 2017].

Bibliography

BLLRF, 2013. *Wood recycling emergency plan*. Luton: Bedfordshire and Luton Local Resilience Forum.

BRUNT, H. AND RUSSELL, D., 2012. Public health risk assessment and air quality cell for a tyre fire, Fforestfach, Swansea. In *Chemical Hazards and Poisons Report Issue 21*, pp. 7-12. Chilton, Didcot, Oxfordshire: Centre for Radiation, Chemical and Environmental Hazards, Health Protection Agency. Available from: https://www.gov.uk/government/publications/chemical-hazards-and-poisons-report-issue-21 [Accessed 28 September 2017].

JESIP, 2016. *Joint Doctrine: The interoperability framework*, 2nd edition. London: Joint Emergency Services Interoperability Programme. Available from: http://www.jesip.org.uk/what-is-the-joint-doctrine [Accessed 28 September 2017].

NATIONAL OPERATIONAL GUIDANCE PROGRAMME, 2015. *Initial operational response to a chemical, biological, radiological or nuclear explosive* [online]. London: UK Fire and Rescue Service. Available from: https://www.ukfrs.com/guidance/initial-operational-response-chemical-biological-radiological-or-nuclear-explosive [Accessed 28 September 2017].

NATIONAL OPERATIONAL GUIDANCE PROGRAMME, 2015. *Environmental Protection Handbook for the Fire and Rescue Service*. London: UK Fire and Rescue Service. Available from: https://www.ukfrs.com/sites/default/files/2017-09/Environment%20Agency%20and%20DCLG%20environmental%20handbook.pdf [Accessed 28 September 2017].

List of abbreviations

AEGL	Acute Exposure Guideline Levels
amu	atomic mass unit
AQC	Air Quality Cell
BTEX	benzene, toluene, ethyl benzene, xylene
CBRN(e)	chemical, biological, radiological or nuclear explosive
CFOA	Chief Fire Officers' Association
CRCE	Centre for Radiological, Chemical and Environmental Hazards [Public Health England]
CFRA	Chief Fire & Rescue Advisor
DIM	detection, identification and monitoring
FRS	Fire and Rescue Service
FTIR	Fourier transform infrared
GC/MS	gas chromatography/mass spectrometry
HART	Hazardous Area Response Team
HMA	Hazardous Materials Advisor
HMEPO	Hazardous Materials and Environmental Protection Officer
ICS	Incident Communication Service [Environment Agency]
LEL	lower explosive limit
MOU	memorandum of understanding
NAQTA	National Air Quality Technical Advisor
NIEA	Northern Ireland Environment Agency
PM	particulate matter
PPE	personal protective equipment
SCG	Strategic Co-ordination Group
SEPA	Scottish Environment Protection Agency
SITREP	situation report
TCG	Tactical Co-ordination Group
VOC	volatile organic compound

Appendix A: Capabilities

Environment Agency AQC equipment capabilities

Model	Description	Pollutants	Comment
Handheld analysers			
GasMet DX4030	Fourier transform infrared (FTIR) spectrometer	1,3-Butadiene Acrolein Ammonia Arsine Benzene Carbon monoxide Ethylbenzene Formaldehyde Hydrogen bromide Hydrogen chloride Hydrogen cyanide Hydrogen fluoride Methyl isocyanate Nitrogen dioxide Phosgene Phosphine Sulphur dioxide Toluene Xylene	Data logging
QRAE Plus	Gas sensor	Carbon monoxide Chlorine	Data logging
Jerome 631-X replaced by Draeger tubes	Gold film sensor/ sample tubes	Hydrogen sulphide	No data logging capability
Turnkey Osaris	Nephelometer	Particulate matter (total suspended particulate, PM_{10}, $PM_{2.5}$, $PM_{1.0}$)	Data logging
Portable sampling equipment			
TCR Tecora Echo	Particulate matter sampler	Filter sampling (PM_{10})	Data logging
TCR Tecora Echo	Particulate matter sampler	Filter sampling ($PM_{2.5}$)	Data logging
TCR Tecora Delta	Sample pump 0.2–30 litres per minute	Thermal desorption tubes	Data logging
TCR Tecora Delta	Sample pump 0.2–30 litres per minute	Liquid impinger solutions	Data logging

FRS DIM equipment capabilities (England)

Model	Description	Pollutants	Comment
Handheld analysers			
GfG G460 multi-gas detection meter/ Micro 5	Gas sensor	Flammable gases (% lower explosive limit, LEL) Oxygen Carbon monoxide Carbon dioxide Hydrogen sulphide Ammonia Hydrogen cyanide Chlorine	No data logging capability
ppbRAE 3000	Photoionisation detector	VOCs (calibrated with isobutylene) Determine if suitable for further analysis using the HAPSITE (see below)	No data logging capability
HAPSITE SMART Plus	GC/MS	Presence of any VOCs in real time along with a tentative identification (survey mode) Identifies VOCs in the atmosphere	Data logging (mass range 45–300 amu)
HazMatID 360	FTIR spectrometer	Identifies unknown solids and liquids (not vapours or gases)	Data logging capability
First Defender	Raman spectrophotometer	Identifies unknown solids and liquids (not vapours or gases)	Data logging capability
Draeger Simultest Kit gas detection tubes	Suite of sample tubes	Unknown gases or vapours (confirming the concentration of a toxic gas/results from other DIM equipment)	No data logging capability

Appendix B: Questionnaires

Questionnaire statistics

Questionnaires issued	
Number of questionnaires issued to FRS (England/Scotland/Northern Ireland)	29
Number of questionnaires completed and returned	15
Number of DIM FRS completed	11
Number of non-DIM FRS completed	4
Number not completed/no return	14

FRS questionnaire responses

The questions posed are highlighted in red in the summaries of responses given below.

What resources does your FRS have to monitor air quality at a (major) incident?					
	Yes	**No**	**Not known**	**Left blank**	**Number of returns**
Trained fire staff (HazMat)	6	4	2	3	15
HMPEO	13	1	0	1	15
DIM officer	10	3	0	2	15
External third party scientific advisor	14	0	0	1	15

Liaison between the FRS and the Environment Agency					
	Yes	**No**	**Not known**	**Left blank**	**Number of returns**
Identification of high risk sites?	11	0	3	1	15
Any data sharing agreements with the Environment Agency?	6	1	7	1	15
Is there a local Environment Agency/FRS liaison group?	4	8	2	1	15
Is there a local resilience forum?	13	0	0	2	15
Are there any local training programmes Environment Agency/FRS in place?	7	6	1	1	15
Any arrangements for equipment sharing?	8	3	3	1	15
Any formal communication between the Environment Agency/FRS?	0	0	0	15	15

Communication between the Environment Agency and FRS during an air quality incident					
	Yes	**No**	**Not known**	**Left blank**	**Number of returns**
Single point of contact with the Environment Agency	11	3	0	1	15
Environment Agency hotline used	11	2	0	2	15
Environment Agency DataShare (data download) used	1	7	4	3	15
Is the FRS registered with the DataShare website	2	5	5	3	15
Environment Agency live feed portal used	1	4	7	3	15

What air quality monitoring equipment is available to the FRS and how is it deployed					
First-on-scene (HAZMAT/HMEPO)	**Yes**	**No**	**Not known**	**Left blank**	**Number of returns**
Weather station anemometer (local wind speed/direction) Kestrel handheld weather device	1	11	0	3	15
Gas sensor (GfG G460, Scott Protege)	6	8	0	1	15
Photoionisation detector (ppbRAE 3000)	2	11	0	2	15
GC/MS (HAPSITE SMART Plus)	1	11	0	3	15
Draeger gas detection tubes (Simultest Kit HazMat/DIM)	2	10	0	3	15
Particulate monitoring equipment	0	12	3	0	15
DIM (on request)	**Yes**	**No**	**Not known**	**Left blank**	**Number of returns**
Weather station anemometer (local wind speed/direction) Kestrel handheld weather device	3	5	2	5	15
Gas sensor (GfG G460, Scott Protege)	11	0	1	3	15
Photoionisation detector (ppbRAE 3000)	10	0	2	3	15
GC/MS (HAPSITE SMART Plus)	11	0	1	3	15
Draeger gas detection tubes (Simultest Kit HazMat/DIM)	11	0	1	3	15
Particulate monitoring equipment	2	6	2	5	15

At an incident, which species are routinely assessed?					
Asphyxiant gases	**Yes**	**No**	**Not known**	**Left Blank**	**Number of returns**
Carbon monoxide	13	1	0	1	15
Carbon dioxide	7	6	0	2	15
Hydrogen cyanide	10	3	0	2	15
Irritant gases – acid gases	**Yes**	**No**	**Not known**	**Left blank**	**Number of returns**
Hydrogen chloride	4	8	0	3	15
Hydrogen bromide	2	10	0	3	15
Hydrogen fluoride	2	10	0	3	15
Hydrogen sulphide	13	1	0	1	15
Sulphur dioxide	3	9	0	3	15
Nitrogen oxides (NOx)	2	8	1	4	15
Irritant gases – organic irritants	**Yes**	**No**	**Not known**	**left blank**	**Number of returns**
Acrolein	2	8	0	5	15
Formaldehyde	2	8	0	5	15
Irritant gases – other	**Yes**	**No**	**Not known**	**Left blank**	**Number of returns**
Ammonia	8	4	1	2	15
Chlorine	7	5	0	3	15
Phosgene	3	7	1	4	15
Complex molecules	**Yes**	**No**	**Not known**	**Left blank**	**Number of returns**
VOCs	2	9	1	3	15
Particulates	**Yes**	**No**	**Not known**	**Left blank**	**Number of returns**
Particulate matter ($PM_{2.5}$/PM_{10})	2	8	0	5	15

Air quality monitoring objectives					
	Yes	**No**	**Not known**	**Left blank**	**Number of returns**
Cordon position determination	15	0	0	0	15
PPE selection for the fire crew	10	4	0	1	15
For advice to other agencies (that is, Environment Agency)	13	0	0	2	15
To assess risk to the public via the local authority	11	1	1	2	15
To provide initial data to for AQC activation	8	2	2	3	15

Where is air sampling directed?					
	Yes	**No**	**Not known**	**Left blank**	**Number of returns**
Sampling zone 1 – Nearest the incident (hot zone)	12	0	0	3	15
Sampling zone 2 – Outside the cordon	10	1	0	4	15
Sampling zone 3 – Surrounding locality	7	3	0	5	15

What operational risk standards are used for reporting air quality?					
	Yes	**No**	**Not known**	**Left blank**	**Number of returns**
Workplace exposure limits (EH40)	14	0	0	3	15
AEGL	11	2	0	2	15
World Health Organization monitoring guidelines	3	5	4	3	15

Who would analyse and make decisions from the data produced?					
	Yes	**No**	**Not known**	**Left blank**	**Number of returns**
Trained fire staff (HazMat)	8	2	0	5	15
HMEPO	15	0	0	0	15
DIM officer	13	0	0	2	15
External third party scientific advisor	13	0	0	2	15
Other agency (Environment Agency/ local authority)	6	1	0	8	15

How are the data recorded for review?					
	Yes	**No**	**Not known**	**Left blank**	**Number of returns**
All data are downloaded after every deployment	3	9	0	3	15
On dedicated FRS network	6	3	1	5	15
Laptop computer/ memory device	4	1	1	9	15
Normally not downloaded	0	0	15	0	15

Are air quality monitoring reports completed by the FRS?					
	Yes	**No**	**Not known**	**Left blank**	**Number of returns**
A post incident report is completed	13	2	0	0	15
After every deployment	6	4	0	5	15
On request only	1	6	0	8	15
Not reported	0	5	1	9	15

Air quality monitoring reports that are completed, how are stored?					
	Yes	**No**	**Not known**	**Left blank**	**Number of returns**
Formal written report (archived)	7	4	0	4	15
DIM DCLG reporting system	10	1	0	4	15
Laptop report stored on a local basis	5	4	0	6	15
Verbally (verbal debrief only)	2	5	0	8	15

Air quality monitoring reports that are completed, how are they circulated?					
	Yes	**No**	**Not known**	**Left blank**	**Number of returns**
FRS only	12	1	0	2	15
Other attending emergency services	8	2	0	5	15
Environment Agency	6	1	1	7	15
Other agencies (local authority)	6	1	0	8	15
Public (Freedom of Information requests)	4	0	1	10	15

Appendix C: DIM equipment description

Instrument type	Description
GfG G460 gas detector (electrochemical, infrared) 	Typical species: • Flammable gases (% LEL) • Oxygen • Carbon monoxide • Hydrogen sulphide • Ammonia • Hydrogen cyanide • Chlorine Features: • Real time monitoring • 55 hours of data logging (feature needs activating) • Handheld or clipped onto user • Detection limits of tens of parts per million Potential limitations: • Point source monitor, so does not have probe to present to smoke plume • Not waterproof
ppbRAE 3000 detector (photoionisation) 	Typical species: • VOCs Features: • 3 second response time • Wireless capability • Detection limit of parts per billion • Capable of gathering air sample into Tedlar bag for further analysis • Waterproof • Rugged (so could be introduced to the plume) Potential limitations • Point source monitor • Cannot identify specific VOC (for example, if there is a mixture of VOCs)
HAPSITE SMART plus (GC/MS) 	Typical species: • VOCs Features: • Portable • Wireless connectivity • Can separate and identify species in a mixture of VOCs, including sample collected into Tedlar bag • Detection limits of parts per billion (and sometimes parts per trillion) Potential limitations: • More technically demanding (requires DIM-trained officer) • Not waterproof • Cannot test non-volatile species such as liquids

Instrument type	**Description**
HazMatID 360 (Fourier transform infrared spectrometer) 	Typical species: • Analysis of white powder, solid and liquid substances Features: • Portable • Large library of species to access (>32,000 species) • Wireless connectivity • Can use similarity values to confirm confidence Potential limitations: • Cannot identify elemental substances or ionic salts, or gases • Water can interfere with results • Cannot identify minor components of mixture
Draeger Simultest Kit gas detection tubes 	Typical species: • Inorganic fumes including acid and basic gases • Organic vapours including alcohols, aliphatic hydrocarbons, aromatics, chlorinated hydrocarbons, ketones Features: • Quick and simple to use • Gives good estimate of concentration of gas • Can monitor concentration changes over time (using multiple tubes) • Can take samples for further laboratory analysis Potential limitations: • Need to have an idea of what species you are monitoring to select appropriate tube

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