LANDING SYSTEMS

COMAH PROCEDURE NUMBER: C13 - MAJOR ACCIDENT PREVENTION PLAN

Control of Major Accident Hazards Regulations 2015
SLSS.C13.MAPP.09.2025

MAJOR ACCIDENT PREVENTION POLICY (Lower Tier Site)

SAFRAN Landing Systems Services (UK) Ltd

Meteor Business Park
Cheltenham Road
Gloucester

GL2 9QL

ISSUE No.	EFFECTIVE DATE OF ISSUE	SECTION REF.	AMENDMENT DETAILS
2	4/1/14	All	Updated to new format and annual review.
3	01/12/15	All	New managing Director – Mr Darren Burge.
4	01/07/16	All	Reviewed in line with new COMAH Regulation – 2015
5	01/09/17	All	Annual Review
6	09/09/18	All	Annual Review
7	09/09/19	All	Annual Review
8	22/11/2020	All	Annual Review
9	21/10/2021	All	Annual Review
10	23/11/2022	All	Annual Review
11	23/09/2024	All	Regular Review
12	20/06/2025	All	Review

Contents

1.0 Purpose

MAJOR ACCIDENT PREVENTION POLICY

1.1 SAFRAN Landing Systems Services UK Limited, Cheltenham Road, Gloucester. GL2 9QL, is committed to complying fully with its duties under the Control of Major Accident Hazards Regulations 2015. This major accident prevention policy outlines the measures in place to effectively minimise the risk of a major accident and to mitigate the consequences should one occur.

2.0 Scope

The policy **shall** address the following probable risks:

- **On-site risks:** to employees, visitors, contractors, service contractors etc.;
- **Offsite risks:** to neighbouring persons and premises; and
- **Environmental risks:** principally from air and water pollution.

The policy addresses the following areas of the site where significant major hazards and incident potential has been identified:

- **Metal Finishes Facility:** Risk of toxic chemical spillages and the possibility of toxic gas release;
- **Zinc Nickel plating facility:** Risk of toxic chemical spillages
- **Materials Processing**: fire/explosion risk and chemical spillages;
- **Effluent Treatment Plant**: spillage of toxic/corrosive chemicals;
- **Chemical Store**: toxic chemicals;
- **Flammable Store** fire/explosion risk;
- **Waste Storage:** spillage of toxic/corrosive chemicals.

For each of the above areas, the MAPP shall address the following issues:

- **Organisation:** management structure and lines of responsibility;
- **Hazards**: identification of significant hazards for each area;
- **Precautions:** procedures and systems of work in place to control the resultant risks;
- **Emergency planning:** measures to mitigate the consequences of any potential incident;
- **Monitoring:** arrangements for monitoring performance of the preventive measures; and
- **Audit and review** procedures.

The MAPP does not in itself contain all of the hazard control procedures but it refers to the relevant COMAH Operational Procedures, works Procedures, Fire and Evacuation Procedures, Quality Procedures and Training Modules.

The MAPP also documents some of the control procedures in place to ensure that chemical inventory and effluents are controlled to ensure that the site remains within the lower tier threshold limits at all times.

Responsibility for implementation of this policy lies with the line managers of the various departments affected, as detailed within the document itself. The Company undertakes to ensure that adequate resources are provided for the implementation of the policy, together with resources for the necessary training, monitoring and audits needed to maintain it.

Signed: Kevin Mills **Signature:**……K Mills………………………..

Position: Business Support Manager **Date:**……………06/25……………………..

Signed: Arren Kinder **Signature:**…..…A Kinder……………………..

Position: Managing Director **Date:**..…………06/.25………………………....

On behalf of SAFRAN Landing Systems Services UK Limited

3.0 Introduction

This major accident prevention policy is submitted in order to comply with the Control of Major Accident Hazard Regulations 2015 as specified within schedule 1 of the regulations due to the amount of substances present at or above the qualifying quantity.

SAFRAN Landing Systems Services UK Ltd is part of the SAFRAN Group and currently qualifies for Lower Tier Status (LTS) due to the aggregation of hazardous chemicals and associated quantity thresholds listed in Schedule 1.

SAFRAN Landing Systems Services UK Ltd maintains repairs and overhauls aircraft landing gears/equipment.

4.0 Site Contact Details

Operator:	**SAFRAN Landing Systems Services UK Limited**
Address:	Meteor Business Park, Cheltenham Road, Gloucester GL2 9QL
Contact:	Kevin Mills
Telephone:	01452 716673
Fax:	01452 711600
E-mail:	kevin.mills@safrangroup.com

5.0 Site – General

5.1 The SAFRAN Landing Systems Services UK Limited site is located in a mixed industrial and agricultural setting between Cheltenham and Gloucester at grid reference SO 388330 222010 (see Figure 1). The main maintenance, repair and overhaul area is situated on the south side of the Cheltenham Road South (B4063), on the side of the road on the boundary of Gloucestershire Airport.

Figure 1.

Situated to the north of the site is our sister company Safran Landing Systems Ltd. which is also register as a Lower Tier COMAH site, manufacturing aircraft landing gear. To the west of the site there is a small industrial development with a variety of commercial and light industrial units. To the South and East of the site is Staverton Airport.

Aircraft landing gear(s) are repaired and overhauled on the site and has been under various company names since 1968. There are 3 buildings (Connected by annexes) which date from the late 1946 and the site currently covers some 4,000m². 281 people are currently employed at this location.

5.2 Surrounding Occupation

To the north is predominantly agricultural land with some residential housing and a nursing home within three quarters of a kilometre. Down Hatherley village is approximately 2.0 kilometres from the north perimeter fence. North West of the site there are sports fields and our sister Company SAFRAN Landing Systems.

To the South there are more industrial units and Gloucestershire Airport. Adjacent to the South perimeter is Severn Trent and a small industrial development with light industrial units. To the East is the perimeter of Staverton Airport.

5.3 Site – Processes

The site repairs and overhauls aircraft landing gear and landing gear hydraulic units for a range of military and civil aircraft including BAE, Airbus, Boeing, Piaggio, and MOD.

Machining

Including: Turning, grinding, sawing, milling and boring of landing gear components.

Materials Processing

Stress relieving and De-embrittlement

Surface Treatments

Shot peen, grit blasting and paint blasting (nut media).

Non-destructive Testing

Ultrasonic, magnaflux, dye penetrant inspection and acid etch inspection.

Electroplating

The electroplating (Metal Finishing Facility) uses various chemical compounds and or combinations of chemistry. Primarily the chemical processes can be split into

- Cadmium Plating
- Chromium Plating
- Nickel Plating
- Zinc Nickel

The chemicals used include cadmium cyanide, chromic acid, hydrofluoric acid, sulphuric acid. This is the principal area where hazardous chemicals are used subject to the COMAH Regulations and the remainder of the report will focus on this area.

Painting

Paint spraying uses a variety of designated paints including Epoxy two pack and Isocyanate coatings. Prior to paint a vapour degreasing process is carried out including the use of Volatile Organic Compounds (VOC's), these products are currently governed under the Environmental Permitting (England and Wales) Regulations SI 2010/675

- Our Site IPC Part B Authorization Permit Number: **TBC/PH/71/08/200004337915**
- Our Site IPPC Permit Number: **BL0138IP**

5.4 Quantities of Hazardous Materials on Site

Methodology of COMAH Calculation and Verification

As prescribed within Schedule 1 Part 3 of the COMAH Regulations to ascertain whether the regulations apply to the site the chemistry present shall be either equal or exceed the quantities given in Columns 2 or 3 for the substance or category.

If the quantity present or likely to be present is less than the qualifying quantity or threshold in column 2 the regulations do not apply. However, if it equals or exceeds the qualifying thresholds in column 3 the regulations apply in full i.e. Top Tier.

If quantity of chemistry exceeds only the qualifying quantity in column 2 regulations 7-14 do not apply, this is known as Lower Tier.

There are five factors that can be taken into account when calculating the quantities on site:

- **Aggregation**
- **2% Rule**
- **Substances generated in a major accident**
- **Non Classified substances**
- **Classification**
- **Mixtures and Preparations**

Note:

Only quantities of substances with similar hazards are added together to calculate the overall score.

Certain substances found on site are classified under the Regulations as:.

- **Categories H1 & H2 Acute Toxic**
- **Category H3 STOT Specific Target Organ Toxicity;**
- **Categories E1 and E2 Hazardous to the Aquatic Environment**
- **Category P5b Flammable Liquids**

All maximum values have been calculated and determined on the COMAH Excel spreadsheet. The total is made up of:

Tank/Vat Quantity

The quantity of substances held in department vats/tanks, as categorised under COMAH have been calculated using the Metal Finishes Facility (MFF) Shop tank make-up database.

This value is stable except any change in processes which causes a change in tank volume this needs to be highlighted prior to change. This is to determine the effect on the COMAH Calculation.

Stores Quantity

The quantity of chemicals held within the stores, which are categorised under COMAH is controlled by the Company Environmental Chemist, the Procurement Manager and team shall purchase all chemicals form the suppliers in line with the SAFRAN Approved Materials Database.

A computer spreadsheet (COMAH Excel spreadsheet) has itemised the maximum stocks available to be stored as raw material.

Any product which is reclassified or new product purchased which is categorised under COMAH needs to be included in the list and calculations. The database shall be reviewed by the Health Safety and Environmental Business Partner or Company Environmental Chemist any changes in the overall score shall be reported to the Business Support Manager for appropriate action.

Shop Stock Figures

These are the quantities of chemical which are stored on site but do not appear on the Stores stock levels. These quantities are relatively stable and have been set at maximum levels. Any change in the storage arrangements or quantities needs to be agreed the HS&E Department to ensure they do not affect the COMAH maximum calculation.

Waste Quantity

The quantity of waste builds up over a period and once there is a sufficient quantity a waste contractor is contacted to arrange for disposal. A procedure is in place within the MFF to ensure none of the concentrate waste stored within the holding tanks is of sufficient concentration to be classified under COMAH.

There are, on occasions, small quantities of waste chemicals classified under COMAH, which require disposal, the maximum foreseeable quantity levels shall be included within the COMAH Calculation and are available on the COMAH Excel spreadsheet.

5.5 Dangerous Substances – Information

Metal Cyanides

Solid cyanide salts are used for making up plating bath solutions. The plating bath solutions consist of a mixture of metal cyanide salts and complexes with other hazard constituents.

This section considers the properties of these salts as if they were sodium cyanide. The toxicity of all cyanide salts and their behavior on contact with acids are similar so this is considered to be a valid assumption in the context of the COMAH requirements.

Storage

All cyanide salts are purchased and stored as solids of about 99% purity. The solids contain low concentrations of impurities such as hydroxide, carbonate and formate which do not give rise to a significant hazard. The maximum quantity of solid cyanide salts stored is governed by the amounts stated on the COMAH Excel spreadsheet. All solid salts are kept in the secure Alkali store within the MFF department.

Physical and Chemical Behaviour

Solids

Melting point:	560^0C
Density:	1.6 – 1.62
Solubility in water:	34% at 15^0C

Moisture and carbon dioxide in the air shall evolve hydrogen cyanide very slowly.
Contact with acid liberates hydrogen cyanide gas.

Cyanides shall react violently with oxidising agents.
Plating Solutions

Complex metal cyanide solutions in water.

Boiling point:	about 105^{0}C
Freezing point:	about 1^{0}C
Specific gravity:	1.25

Contact with acids shall liberate hydrogen cyanide gas, but the solutions contain at least 20 g/l OH^- and at least 80 g/l CO_3^{2-} so there needs to be a significant ratio of acid to plating solution before HCN is evolved.

Hazards to Health

The routes of entry are ingestion, absorption through the skin and inhalation of HCN. In the strongly alkaline solutions used by SAFRAN Landing Systems Services UK Ltd, the vapour pressure shall be low, so inhalation risk shall be negligible unless the solutions were acidified.

Environmental Hazards

Toxicity is similar to that of HCN (see below).It is substantially biodegradable in water. In 14 days 99.8% of CN ions at a level of 35mg/l will be degraded and 60% at 180 mg/l. The no effect level for biological treatment processes is 10mg/l.

Hydrogen Cyanide

HCN is normally only present in very low quantities in the liquid or gas phase. It may be evolved accidentally by the mixing of cyanide solutions with acids.

Environmental Health Monitoring

All staff working on or around the plating facility are tested annually or after and changes to process or procedure, testing is via urine sampling with results monitored and staff notified. Adverse results are subject to investigation and resultant activity.

Storage

No HCN is stored on site.

Physical and Chemical Behaviour

Pure HCN is a liquid with the following properties:

Boiling point:	26^{0}C
Freezing point:	-14^{0}C
Specific gravity:	0.688

Detection

A twin HCN gas detector(s) has been fitted under the floor within MFF, this detector is calibrated every 12 months to ensure accuracy of levels and confidence. A traffic light warning system has been fixed to the main entrance doors giving clear visibility on the current state of gas emissions.
(C5 – Toxic Gas Emissions Evacuation)

Hazards to Health

Total CN in body (mg)	Effect
10-30	Rapid pulse, breathing difficulties, dizziness and weakness in the legs
20-60	Collapse leading to unconsciousness
50-90	Collapse, slow gasping breaths, death if untreated

It is stated that an average person can detoxify 30mg CN/hour.

The main route of entry is inhalation of HCN.

MEL: 10ppm

Figure 2 shows the time taken to achieve a given effect at various concentrations.

Environmental Hazards

Whilst its acute toxicity effects are well known, HCN is not believed to have any chronic effects on humans or other animal species. The enzyme Rhodenase enables detoxification to harmful substances. HCN is also not known to have any detrimental effect on vegetation.

Environmental considerations are therefore only based on the consideration of exposure of animal life to concentrations likely to cause acute toxicity effects.

Atmospheric

HCN vapour is lighter than air and its diffusion characteristics are such that it is dispersed easily. This means that it would be unlikely that ground contamination would occur in concentrations large enough to cause acute toxicity.

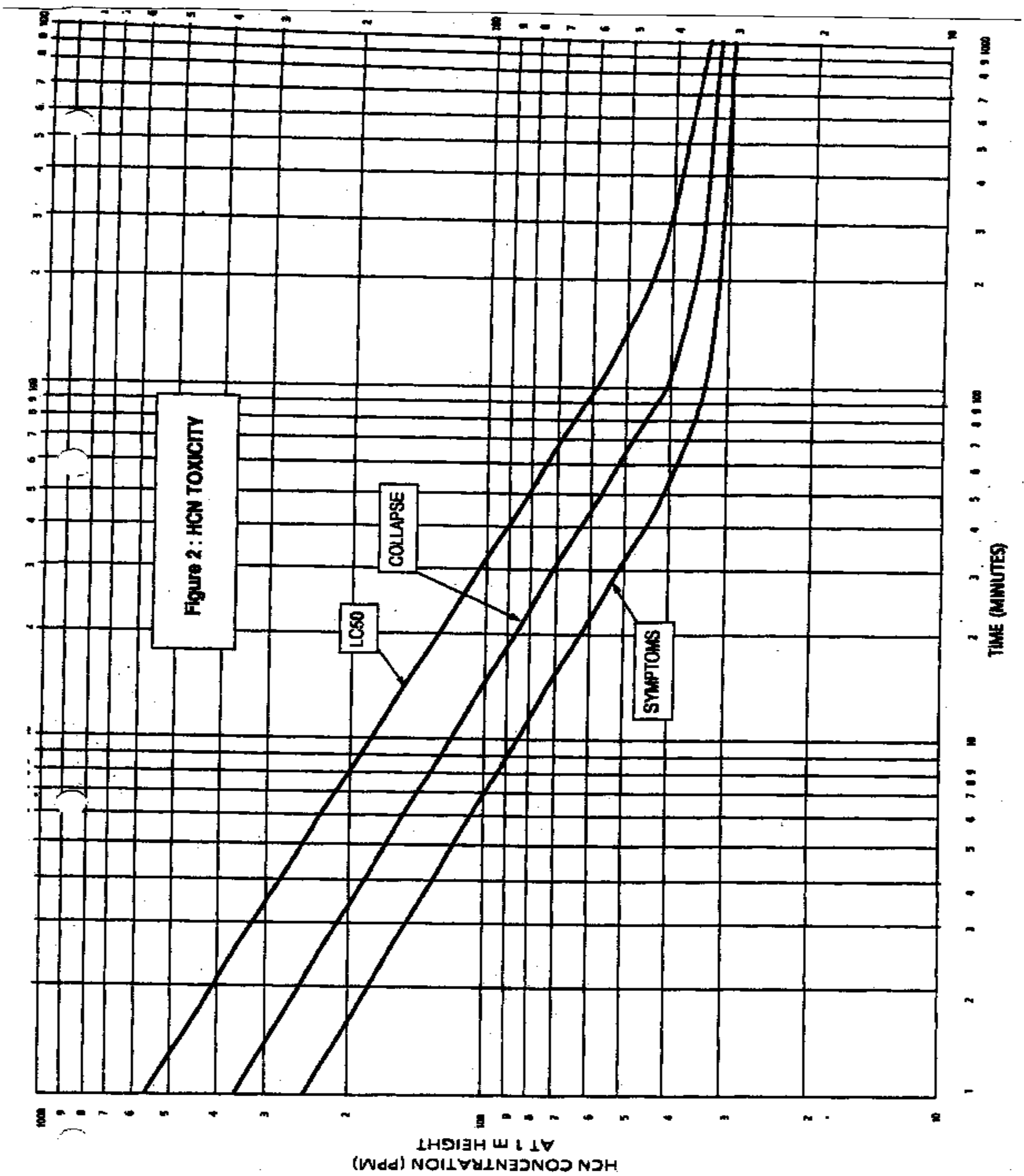
Residual HCN is washed out of atmosphere and rendered non-toxic by microbial activity or water hydrolysis.

Aquatic

HCN is completely miscible in water and its release into a water course could cause the death of aquatic species including fish before significant dilution takes place. The LC50 for *Daphnia magna* (48 hours) is 1.8mg/l, implying that HCN is toxic to invertebrates. The LC50 for rainbow trout (96 hours) is 57mg/l, implying that HCN is very toxic to fish.

HCN is not persistent and does not accumulate in the aquatic environment and degradation rates are similar to those for NaCN given above.

Figure 2 - HCN Toxicity



5.6 Geology and Hydrology

Geology

Based on the British Geological Survey 1:50,000 solid and drift maps (sheet 216) and the Policy and Practice for Protection of Groundwater the site appears to comprise:

- Made ground with associated underground services and foundations.
- Alluvial deposits associated with Hatherley Brook and Normans Brook.
- Bedrock comprising limestone of the Blue Lias (Lower Lias), Jurassic period. The thickness of the Lower Lias is about 50m and the bedrock dips toward the east.
- The Lower Lias is underlain by the Mercia Mudstone Group (MMG) of the Triassic period. Rocks from the MMG are exposed to the north-west of the site.

5.7 Hydrogeology

The alluvial deposits are classified as minor aquifer, generally only able to support locally important abstractions, and are likely to be in hydraulic continuity with local surface water courses.

The Lower Lias is classified as minor aquifer, being of varied permeability and is considered to be a limited groundwater resource. Flow mechanism is by fracture flow in permeable horizons.

The underlying MMG is a non-aquifer.

Shallow groundwater below the site may be expected to occur as perched water, possibly discontinuous within the granular made ground and alluvial deposits.

Deeper groundwater is anticipated in the Lower Lias, which is largely unconfined.

The flow of perched groundwater is believed to be in a north/north-westerly direction towards Normans Brook. The flow direction of deeper groundwater is likely to be towards the south-east and the direction of the dip of the bedrock.

5.8 Potential Contaminant Pathways and Receptors

The main potential receptor of contamination arising from a loss of containment on site is Normans Brook. The key potential pathways are:

- Volatization of potential contaminants in the made ground and alluvial deposits.
- Rapid surface water run-off of free phase or dissolved phase contaminants into Normans Brook.
- Migration of contaminants through the made ground to perched groundwater.
- Migration of dissolved phase contaminants within the perched water table down a hydraulic gradient providing base flow into Normans Brook.
- Migration of dissolved phase contaminants through preferential flow pathways in the made ground and alluvial deposits to permeable horizons in the Blue Lias.

The environmental sensitivity of the site's environmental setting is considered to be high with regard to surface waters, but low to moderate with regard to groundwater.

5.9 Hydrology

The site is relatively level and is at an elevation of about 20m. The nearest surface water features to the site are Hatherley Brook and Normans Brook located 50metres to the north and 700 metres to the south west of the site respectively. There is also a drainage channel surrounding the industrial site on which the subject site is located.

From the search of the relevant database no licenced water abstraction sites within 1000metres, however Hatherley Brook is a classified waterway which has been classified as Quality C.

5.10 Meteorology

Prevailing Wind

Wind direction is predominantly south-easterly, in the direction of Staverton village, 2 km from the site boundary.

5.11 Flooding

Flooding from Hatherley Brook

The year 2007 saw major flooding in the Gloucestershire area, no flood waters affected the SAFRAN Landing Systems Services UK Ltd site, There has also been an increased levels of localised flooding during 2023 and 2024 but this has not impacted activity on site. Annual reviews are carried out to assess any change to this risk.

5.12 Seismic Events

Earthquake

Earthquakes are not seen as a significant risk. Since the original site development there is no record of any significant impact from earthquakes.

In addition the British Geological Survey hazard map places the Gloucestershire area in an area defined as 5.0-6.0 on the European Macroseismic Scale (EMS 98). The intensity definitions from that scale are as follows:

EMS 5 - Felt by most indoors, small objects fall over.
EMS 6 - People run out in alarm, slight damage to buildings (plaster cracks).

The plant buildings are steel framed structures with inherent flexibility. They are not expected to suffer any damage from a level 5.0 – 6.0 intensity event. Likewise it is not anticipated that an event of this magnitude would cause any plant structural failure.

5.13 External Activities

Major Hazard Installations

No major hazard installations are known within the vicinity of the site.

Pipelines

There are no known pipelines carrying hazardous materials across the site.

Theft, Arson and Terrorism

The site is subject to 24-hour security patrols and has a secure perimeter fence.

Overhead Power Lines

No overhead power lines cross the site.

Aircraft Crash

The site is adjacent to Gloucestershire Airport (Staverton). The airport is used by light aircraft predominantly which do overfly the site. A possible aircraft crash would be dealt with by following the usual site emergency evacuation and response (Company Procedure Instruction).

At the time of writing consultation is underway with the airport authority to ensure that SAFRAN Landing Systems Services are aware of and can co-operate with the airport emergency plans.

6.0 Possible Major Accident Scenarios

6.1 Introduction

Hazard Identification

Potential major accident hazards were identified by way of a team based approach. The following members were involved in brainstorming type sessions at various times during the development of the MAPP.

Kevin Mills	Business Support Manager	SAFRAN Landing Systems Services UK Ltd
Steve Scullion	Environmental Chemist	Envsafe Ltd
Bryan Taylor	HSE & Laboratory Supervisor	SAFRAN Landing Systems Services UK Ltd
Joshua Lee	Laboratory Lead	SAFRAN Landing Systems Services UK Ltd

This approach is an ongoing activity and reviews are held annually to assess current best practice and reduction of stock levels.

The major accident hazards were identified as being in the following key areas:

- Raw materials unloading, transport, storage and vat refills.
- Process areas and basement in the MFF.
- Effluent treatment plant.
- Materials Processing oven operation.

6.2 Hazard Identification and Analysis

Sections 6.2.1 – 6.2.3 show the analysis of the identified hazards. See following pages:

6.2.1 Raw materials Unloading, Transport and Storage and vat refills.

No	Event description	Cause	Prevention and control measures	Mitigation measures	Consequences	Likelihood and risk acceptability
1	Spillage of solid sodium cyanide. **CAS No 143-33-9**	Pallet dropped on unloading in external areas of site. **Max storage Qty 50Kgs**	Training of FLT drivers. Packaging designed to CHIP standards. Trained Spill teams on site with chemical spill kits placed around site at chemical storage facilities	Immediate identification of spill by teams unloading, Spillage to be dealt with immediately and shovelled into empty drum. In wet conditions spillage containment kits (available at key points around site) would be used by trained spill teams. Business Support Manager informed immediately to complete post incident actions.	In dry weather spill can be controlled within area of spill using spill kits. In wet weather a small amount (<1kg) could go to drain. This could produce a significant contamination into sewer/controlled water source *POTENTIAL- MAJOR ENVIRONMENTAL ACCIDENT RISK*	Likelihood - Remote Packing robust and designed to CHIP Regs. Forklift carries product at no more than 1.5m above ground level. Packaging used is UN Group 1 approved, drop test at 1.8m considered satisfactory Orientation of product must be flat stacked and transported on portable bunds. ***MITIGATED RISK ACCEPTABLE***
2	Spillage of solid sodium cyanide. **CAS No 143-33-9**	Spillage within MFF Alkali store Spillage at weighing out station	Only closed containers handled. Alkali stores access restricted. All storage on bunding to contain any possible leakage contained Weighing system bunded Only authorised personnel allowed to use raw material	Spillage seen immediately and appropriate spill containment action taken. Localised effect. Product is solid so any leaks would not be susceptible to transfer elsewhere Business Support Manager informed immediately to complete post incident actions.	Spillage contained within store. Minimal chance of NaCN entering drainage. Or other chemical systems *POTENTIAL- NOT A MAJOR ACCIDENT RISK*	Likelihood – Very Remote ***MITIGATED RISK ACCEPTABLE***

No	Event description	Cause	Prevention and control measures	Mitigation measures	Consequences	Likelihood and risk acceptability
3	Spillage of liquid waste.	Tanker transfer pipe blowing off	No Very Toxic or Toxic substances stored as waste All liquid waste diluted to <1% very toxic and <7% toxic prior to storage. All tanker filling operations are supervised by MFF Chemist and Sub contract Chemist/Technician Clay matting/drain cover placed on outside drains in case of incident. Pollution control valves should off before transfer Trained Spill teams on site with chemical spill kits placed around site at chemical storage facilities.	Spillage seen immediately and tanker loading stopped. No chemistry to enter drainage as pollution control valves and drainage covers fitted before transfer. Trained Spill teams on site with chemical spill kits placed around site at chemical storage facilities. Only licensed and trained companies used. All containment procedures are checked before any waste is transferred. Two man operation. Driver to be stationed at Vacuum end in case of emergency Area coned off for access	Spillage only of dilute waste containing a small amount of Heavy metals. Local pollution but no drainage inside can be dealt with easily. No cross contamination with any other process *POTENTIAL -NOT A MAJOR ACCIDENT RISK*	Likelihood - Remote ***MITIGATED RISK ACCEPTABLE***
4	Fire	Fire in flammable store	No smoking area Small quantities of solvent stored for local usage Store is to correct BS specification.	Fire detection fitted across site Firefighting equipment such as extinguishers located across site. Good housekeeping.	Fire within Flammable stores unlikely to spread to other areas. Cyanides not flammable HCN would only be formed if water present HCN would be burnt in fire Small particles of cyanide may be entrained and dispersed but this would be small amounts and would have no significant effect off site *POTENTIAL -NOT A MAJOR ACCIDENT RISK*	Likelihood - Remote ***MITIGATED RISK ACCEPTABLE***

6.2.2 Metal Finishing Facility (MFF)

No.	Event description	Cause	Prevention and control measures	Mitigation measures	Consequences	Likelihood and risk acceptability
5	Leakage of plating solutions from tank	Corrosion/damage	Plating tanks in bunded basement area to prevent escape. Bunds separated to prevent mixing of reactive chemicals All tanks are covered by a written process specification PPM on tanks to identify corrosion.	Bunds inspected regularly Basement spillage procedure in place to deal with spillage to basement bunds	Spillage contained in basement bund Basement spillage procedure enacted to deal with spillage to basement bunds. *POTENTIAL -NOT A MAJOR ACCIDENT RISK*	Likelihood - Remote ***MITIGATED RISK ACCEPTABLE***
6	Overflow of plating solution tank	Operator error	Plating tanks in bunded basement area to prevent escape. Bunds separated to prevent mixing of reactive chemicals All tanks are covered by a written process specification Fill levels are controlled by timers on the water pumps and all chemical additions are controlled and authorised by the materials laboratory Tank contents are analysed every two weeks and tank level is checked	Bunds inspected regularly Basement spillage procedure in place to deal with spillage to basement bunds	Spillage contained in basement bund Basement spillage procedure enacted to deal with spillage to basement bunds. *POTENTIAL -NOT A MAJOR ACCIDENT RISK*	Likelihood - Remote ***MITIGATED RISK ACCEPTABLE***

6.2.3 Effluent Treatment

No.	Event description	Cause	Prevention and control measures	Mitigation measures	Consequences	Likelihood and risk acceptability
7	HCN generation	Mixing of acid and cyanide plating solutions in bund due to simultaneous tank rupture and separated bund failure	Bunds separated to prevent mixing of reactive chemicals – for incident to occur it would require the rupture of two tanks and the bunding. Bunds inspected regularly All staff involved in chemical additions and transport are trained regarding compatibility of chemicals and correct additions for each tank All tanks are clearly marked with details of their hazardous components	The solutions containing cyanide are highly alkaline with (OH^- and CO_3^{2-}) which would result in the slow evolution of HCN gas and thus a slowly rising concentration in air allowing plenty of time to evacuate on activation of the cyanide alarms Access to the basement bund area below the cyanide solution tanks is not allowed while production is in progress - permit to work system is in place to control entry. Gas detection systems are provided in the Surface Finishes Shop and bund areas linked to a cyanide gas alarm system.	The dispersion model in Appendix 1 identifies 3 dispersal scenarios with WEL rated against these 3 variations – total extraction from MFF, partial extraction and total capture of cyanide gases within the building. The worst case scenario for environmental impact is for total extraction where exposure at ground level on site and in the adjacent areas to site is above WELs. The scenario where total capture is within the building represents the lowest environmental impact with WELs below recommended levels in areas outside the building and adjacent areas.	The likelihood of the event is very low – it would require the rupture of *two* tanks *and* failure of the separated bunding Slow evolution of HCN and detection and alarm system would allow escape of shop personnel Off site risk low (see dispersion calculations ***MITIGATED RISK ACCEPTABLE***
8	Explosion	Sit based Activity resulting in explosion which may cause addition mechanical damage by explosion pressure or flying projectiles. This may cause injury or plant or asset damage which may lead to further emergency situations.	DSEAR Assessments completed Regularly and equipment ATEX	The activity on site such as Paint shops and dust extraction systems are reviewed and Safe systems of work put in place to prevent explosive incidents occurring	Explosion on site resulting in damage to the surrounding area and potential escape to the environment of Chemistry or fumes.	All DSEAR Areas assessed and equipped with ATEX equipment to prevent risk of explosion ***MITIGATED RISK ACCEPTABLE***

7.0 Management of Hazards

7.1 Inventory Control

Strict inventory control is required to ensure that the site remains within the COMAH lower tier inventory limits

Organisation

HSE & Laboratory Supervisor
Bryan Taylor $\xrightarrow{\text{deputy}}$ Laboratory Lead
Joshua LEE

Procedures

All chemical stocks within the scope of COMAH are subject to the Order Quantity Control Procedure. The procurement personnel are responsible for authorising all chemical orders against the maximum stockholdings.

All "safe" orders are based on the worst case scenario – i.e. the COMAH calculation accounts for our safety stock level PLUS stock in use PLUS the order quantity. Orders shall not be authorised when site stock is above the safety stock level.

Records

Records are held with the procurement department. The Company Environmental Chemist and SAFRAN Group Purchasing or nominated Deputy is responsible for maintaining and updating the stock and order quantities as in procedure C4 Substance control

Monitoring

Shop stock levels (including chemicals in use in solutions) shall be monitored every month by the Company Environmental Chemist & MFF Projects Team Leader or nominated deputy according to the Shop Substance Control Procedure (COMAH Operational Procedure C4)

Stores stock shall be monitored monthly by the Metal Finishing Facility Team Leader.

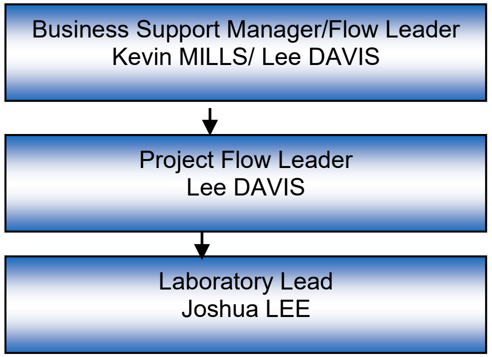
The Environmental Chemist shall check these figures monthly against the maximum stockholdings set out in (COMAH Operational Procedure C4)

Audit

Periodic audits shall be carried out by the health, safety and environment department In accordance with ISO 45001:2018 and BS EN ISO 14001:2015

7.2 Effluent Dilution Procedure

Organization



Carried out routinely by the Laboratory Team. Management responsibility lies with the Business Support Manager and Project Flow Leader.

Procedure

Spent plating solutions are transferred to a dedicated holding tank within the MFF. These tanks have been designated:

- Alkali
- Acid
- Effluent

All waste placed in these tanks is carried out by authorized personnel only according to the Shop Tank Dilution Procedure (COMAH Operational Procedure C.6)

All waste from these tanks is disposed under the Hazardous Waste Regulations 2005 by a Licensed Waste Carrier to a Licensed Waste Site.

Records

Records are kept of all Hazardous waste disposed of from the Metal Finishing Facility by the Business Support Manager for PIR Annual Reporting/CSR Reporting (SAFRAN Corporate Social Responsibility Reporting).

Monitoring

The contents of the process tanks are analyzed periodically to ensure that toxic chemicals are within the required specification.

Audit

Periodic checks on the procedure and records shall be carried out by the Company Environmental Chemist and the system shall be audited at least annually by the Health, Safety and Environmental In accordance with BS OHSAS 18001:2007 and BS EN ISO 14001:2015.

8.0 Change Management

Organization

Responsibility for maintenance of lower tier status and approval of all process changes affecting this lies with the Business Support Manager, HSE & Laboratory Supervisor, Team Leaders, Salvage Program Managers, and subcontract consultancy companies (if required)

Procedure

Refer to COMAH Lower Tier Control Procedure C2.

Audit

Periodic checks on the procedure and records shall be carried out by the Company Laboratory Team and the system shall be audited at least annually by the HSE & Laboratory Supervisor In accordance with ISO 45001:2018 and BS EN ISO 14001:2015

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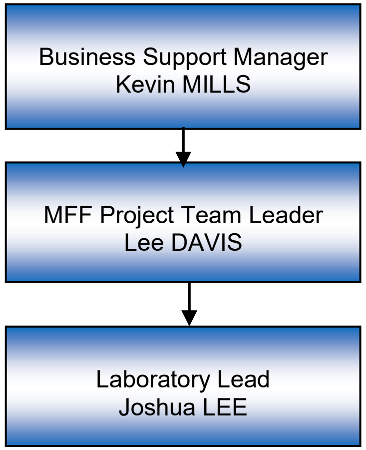
9.0 Chemical Store (Acid, Alkali, Flammable)

Organization



Significant Hazards and Precautions

Hazardous situation

- Spillage due to chemical container rupture.

Precautions:

- Toxic chemicals are stored in solid form.
- The small amounts of liquids stored are positioned on portable bunds.
- Access by authorised persons only (store locked).

Overall Risk: ***Low***

Emergency Planning

- Spillage containment kits available around the site.
- Small spillage kit held in store.
- Staff trained in emergency spillage procedures for the store.
- Risk cards for significant areas of the factory will be held at security for emergency services attending an incident at site.

Monitoring

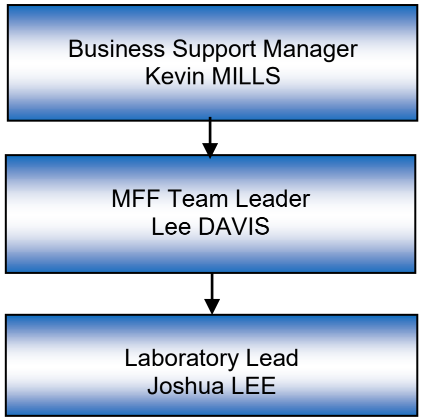
Spillage kits checked monthly and recorded.

Audit

- Operating procedures are audited every 12 months or in rthe event of major change.
- Visits to the store are carried out by BSI for ISO 14001:2015 Procedure compliance.
- Internal audit by HSE Team annually.

10.0 Flammable Store

Organization



Significant Hazards and Precautions

Hazardous situation:

- Fire/explosion due to ignition of flammable and highly flammable liquids.

Precautions:

- All electrical fittings are suitable for flammable atmospheres.
- Store is bunded.
- Access by authorised persons only (store locked).
- No electrical equipment (including mobile telephones) allowed in the store.

Overall Risk: ***Low***

Emergency Planning

- Spillage containment kits available around the site.
- Emergency response co-ordinated through security lodge (24 hour cover).
- Store staff trained in emergency spillage procedures for this area.
- Risk cards for all areas of the factory will be held at the security hut for emergency services attending an incident at site.

Monitoring

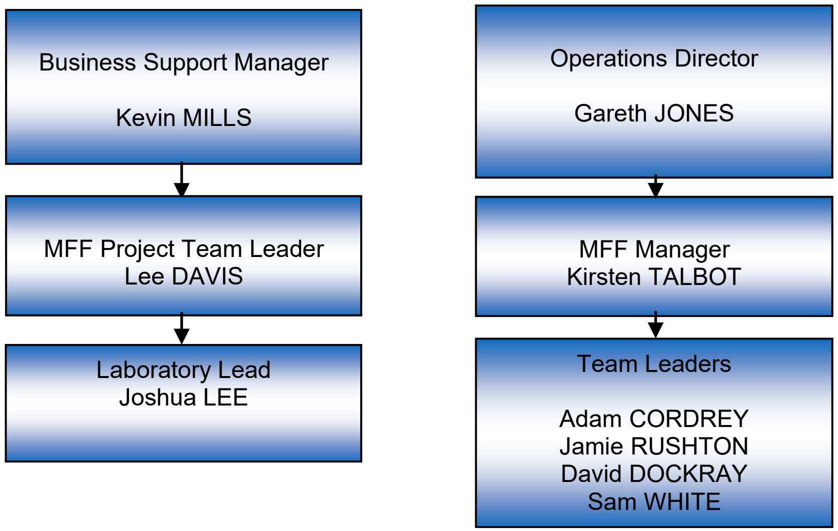
- Trading Standards Office carry out inspections following any agreed changes to store following submission of plans. Fire and Rescue Watches visit as part of inspection and familiarisation visits and produce a tactical plan.

Audit

- An Internal Audit is completed by the HSE Department
- dependent audit by BSI annually.

11.0 Metal Finishing

Organization



Significant Hazards and Precautions

Hazardous situation:

- Inadvertent mixing of incompatible plating solutions on rupture of plating tanks.
- Incorrect chemical additions at plating tanks.

Hazards:

- Exposure of personnel to toxic HCN gas in the MFF.
- Exposure of personnel in basement bund area to HCN gas.
- Exposure of persons outside the building to HCN gas.

Risk Discussion:

- *The likelihood of this event is very low – tanks are separately bunded so for mixing to occur it would require the rupture of two tanks* and *the bunding.*

  The solutions containing cyanide are highly alkaline with (OH^- and CO_3^{2-}) which would result in the slow *evolution of HCN gas and thus a slowly rising concentration in air allowing plenty of time to evacuate on activation of the cyanide alarms.*

Overall Risk: *Unforeseeable*

Precautions:

- All plating tanks containing cyanide-based solutions are separately bunded, so that in the highly unlikely event of two tanks failing there would be no mixing of incompatible plating solutions below the tanks.
- All staff involved in chemical additions and transport are trained regarding compatibility of chemicals and correct additions for each tank. Training records are held in Surface Finishes Shop.
- All tanks are clearly marked with details of their hazardous components.
- Access to the basement bund area below the cyanide solution tanks is not allowed while production is in progress. A permit system is in place to control entry.
- Exposure of persons outside in the event of an emergency is considered an insignificant risk due to the small quantities of gas likely to be involved and the dilution effect when exhausted through the LEV system.

Hazardous situation:

- Release of plating solutions on rupture of plating tanks.
- Spillage of chemicals during transport or additions to plating tanks.
- Rupture of concentrated waste tanks or spillage during tanker loading from concentrated waste tanks.

Risks:

- Environmental risk – harmful chemical spillages entering the environment.

Risk Discussion:

- All process tanks and waste tanks are bunded so the risk of liquid spillage from process or storage is low.
- All site drainage leaves site via interceptors allowing more time to take remedial action in the event of a spillage.
- Most chemicals are purchased and handled in solid form this makes it easier to contain and clean up in the event of an emergency.

Overall Risk: ***Low but significant***

Precautions:

- All plating tanks are bunded, draining into the MFF Shop sump.
- Procedure in place for dealing with chemical spillage into the basement sump (EMS Emergency Response Procedure 4.4.7.4).
- All chemical additions are in solid form aiding clean up in the event of a spillage
- Concentrate waste tanks are bunded
- A member of the Metal Finishing Facility staff supervises all tanker-loading operations so that emergency action can be taken quickly in the event of an accident.
- Chemical storage and transport precautions are contained in COMAH Procedures C10.

Emergency Planning:

- HCN Gas detection systems are installed in the MFF basement and are linked to a cyanide gas alarm system.
- A cyanide alarm evacuation procedure is in place and all plating shop staff have been trained in its operation. Records are held in MFF
- A risk card for this area of the factory is held at security for emergency services attending an incident at site.

- A written procedure is in place for evacuation of the MFF and for dealing with an emergency in this area.
- Spillage containment kits available around the site
- Emergency response co-ordinated through security lodge (24 hour cover).
- All staff trained in emergency spillage procedures in the HSE training matrix
- Risk cards for significant risk areas of the factory will be held at security for emergency services attending an incident at site.

Monitoring

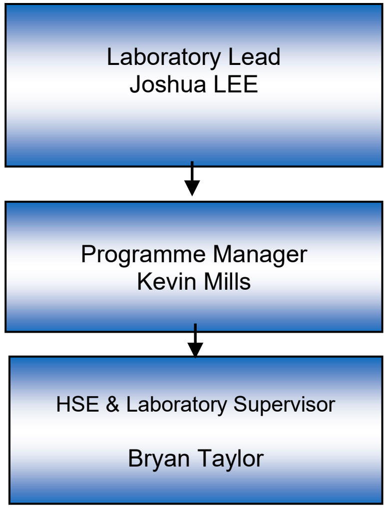
- Chrome mist testing is carried out every two weeks.
- A full evacuation drill is held annually.(Records are kept in the Facilities Department).
- Personal Monitoring is carried out annually. (Records are kept in the Facilities Department).
- Bunding in the basement area is inspected for integrity weekly – GPI and Monthly under external contract
- LEV is bi annually; records are kept by the Facilities/HSE Department.
- Spillage kits are checked monthly and following use by a sub-contractor – Process Operatives

Audit

- All reported significant spillages shall be reported to the Manager Facilities/HS&E, HS&E Advisor or the Company Chemist to advice on effective controls and remedial action necessary.
- The MFF is visited by Environmental Agency Officers as part of IPPC permit authorisation site visits.
- Procedures are audited at least annually by HSE and Facilities team.

12.0 Effluent Treatment Tank

Organization



Significant Hazards and Precautions

Hazardous situation:

- Spillage due to treatment tank rupture.
- Spillage due to treatment chemical tank rupture
- Spillage during tanker unloading/loading.

Precautions:

- Treatment plant floor bunded and fitted with impermeable membrane.
- Membrane proving pipes fitted to show if membrane leaks.

- Treatment tanks fitted with high-level alarms.
- Treatment chemical tanks are bunded.
- All tanker-loading operations are supervised by a member of Metal Finishing Facility Staff, so that emergency action can be taken quickly in the event of an accident/incident.

Emergency Planning

- Spillage containment kit and inert chemical treatments are available with MFF treatment chemical area
- Emergency response co-ordinated through security lodge (24 hour cover)
- All staff trained in emergency spillage procedures in the EMS training package
- Risk cards for significant areas of the factory will be held at the security for emergency services attending an incident at site.

Monitoring

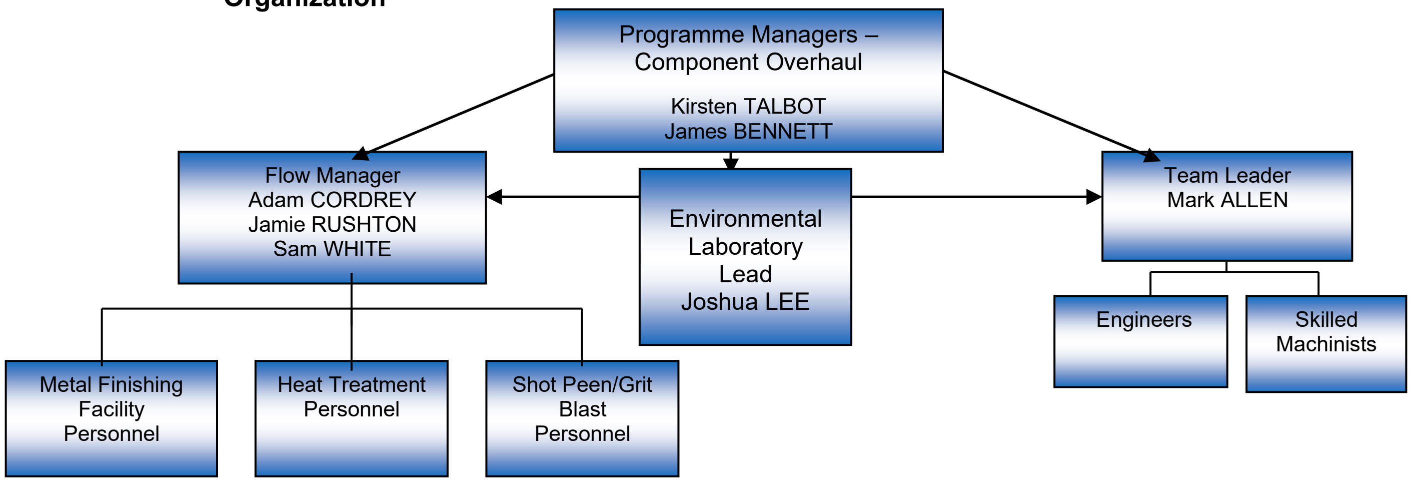
- The operators of the plant monitor the treatment of solutions process.
- In addition monitoring equipment such as high level alarms are fitted to treatment chemical holding tanks.

Audit

- The procedures are reviewed and audited within the department as circumstances require.
- Visits by Environmental Agency Officers are carried out as part of IPC Permit authorisation visits.
- Independent audit by Envsafe Limited annually

13.0 Material Processing

Organization



Significant Hazards and Precautions

Hazardous situation:

- Flammable atmospheres escaping from heat treatment ovens

Risk Discussion:

See site fire risk assessments.

Precautions:

- Sprinkler system.
- Access from oven doors opening entrances.

Emergency Planning

- Evacuation procedure in place (procedures are contained in the fire and emergency procedures.
- Fire / Emergency Evacuations are logged in Security Control and Safety and Environmental Office (drills and auto fire alarms).
- Emergency response co-ordinated through the security lodge (24 hour cover)
- Information for emergency services held at security lodge (including instructions not to use water within the surface finishing facility).

Monitoring

- Evacuation drills carried out for each building at least annually.

Audit

- The Site Fire and Emergency procedure is independently reviewed by the Works Engineer and Company Safety Representative
- Procedures are audited at least annually by HSE Department.

Appendix 1 – Air Quality impact Assessment of an abnormal release of hydrogen Cyanide

Safran Landing Systems Services (UK) Limited

Air quality impact assessment of an abnormal release of hydrogen cyanide

Meteor Business Park, Gloucester

Report	170337
Date	22 June 2017
Revision	0

AIR QUALITY IMPACT ASSESSMENT OF AN ABNORMAL RELEASE OF HYDROGEN CYANIDE

METEOR BUSINESS PARK, GLOUCESTER

Report prepared for

Safran Landing Systems Services (UK) Limited
Meteor Business Park
Cheltenham Road
Gloucester
GL2 9QL

Report prepared by

Environmental Scientifics Group Limited
Unit D
Bankside Trade Park
2 Wilkinson Road
Cirencester
Gloucestershire
GL7 1YT

Author Dr N Ford N Ford

22 June 2017

ISSUE HISTORY

Revision	Date	Approved	
170337,0	22 June 2017	N Ford	N Ford
First issue			

CONTENTS

0 SUMMARY

Safran Landing Systems GLS placed a contract with Environmental Scientifics Group Limited (ESG) to undertake an assessment of the impact on local air quality of an abnormal release of hydrogen cyanide from the metal finishing operations at its Meteor Business Park site. Two hydrogen cyanide generation scenarios (A & B) and three release scenarios (1, 2 and 3) were considered.

The absolute worst case hydrogen cyanide generation scenario (A) was considered where a failure of all vats and bund containments resulted in the mixing of the total vat inventory of sodium cyanide and sulphuric acid associated with chromium and cadmium plating with total reaction to produce hydrogen cyanide limited only by the presence of sodium hydroxide and sodium carbonate. A more realistic worst case (B) involving a limited failure of vats and bunds was also considered.

Assuming that the Metal Finishing Facility is evacuated and the air within extracted to atmosphere via the existing ventilation systems serving the vats, the resulting dispersion of hydrogen cyanide releases is predicted to have maximum impact beyond the site boundary, but within the Meteor Business Park. A maximum concentration of 8 times the workplace exposure limit is expected to occur on site. Beyond the site boundary process contributions exceed the Environmental Assessment Level for human health for hydrogen cyanide at all neighbouring commercial premises and residential locations within 1 km.

For the scenario where the release was confined within the Hangar 4 building and the extraction system shutdown with only fugitive releases to atmosphere, concentrations within the site boundary were predicted to be reduced to below the WEL at all ground level locations and to drop considerably at locations beyond the site boundary. This appears to be a somewhat more effective control measure for the protection of site workers following a release than the continued use of the extraction systems.

In the case of a complete failure of the containment of the Hangar 4 building the highest on site concentrations are experienced with the main affect being around the immediate vicinity of Hangar 4. Resulting concentrations beyond the site boundary are above the EAL at neighbouring commercial premises and residential locations, although at lower concentrations that for an extractive release.

The hydrogen cyanide generation scenario A reflects the maximum possible release and is considered highly unlikely. Scenario B is the more likely worst case scenario involving limited vat mixing which has been considered in previous assessments at Safran. For all release scenarios this provides a much lower ambient hydrogen cyanide impact than the corresponding scenario A with most concentrations being within the WEL on site and within the EAL at nearby residential locations. Although the concentrations at the nearest commercial neighbours exceed the EAL for exposure over an hour, this is much reduced and manageable with appropriate evacuation or containment procedures.

The assessment indicates that containment of the release within the Hangar 4 building and subsequent gradual release by fugitive means is likely to provide the least ambient impact and will generally ensure concentrations remain within the WEL and EAL for the most likely scenarios. The use of the existing extraction system to remove any hydrogen cyanide generated will result in higher concentrations beyond the site boundary. A full failure of containment is the worst case release scenario and tends to result in very high concentrations of hydrogen cyanide local to the release point.

In the event of a release from the Metals Finishes Facility it would be most appropriate to muster and evacuate towards the east of the site and to avoid the immediate areas around Hangar 4 and the main gate.

It is considered that the more probable worst case generation scenario with limited vat mixing is unlikely to cause environmental benchmark exceedence either on site or on nearby commercial or residential locations, if suitable precautions are taken. Remaining within premises with doors and window closed will allow time for external concentrations to drop to a safe level by dispersion. Alternatively evacuation will reduce the time exposed to the release with exposure unlikely to be in excess of the 15 minute workplace exposure level.

Necessary assumptions made to undertake the modelling are considered to have the effect of overestimating the process contribution to ambient concentrations of hydrogen cyanide. It is therefore considered that the predicted process impact on ambient concentrations reported herein is a conservative assessment and the conclusions reached therefore incorporate a reasonable margin of comfort in spite of the inevitable uncertainty of such modelling studies.

1 INTRODUCTION

Safran Landing Systems (UK) Limited (Safran) placed a contract with Environmental Scientifics Group Limited (ESG) to undertake an assessment of the impact on local air quality of an abnormal release of hydrogen cyanide from the metal finishing operations at its Meteor Business Park site.

1.1 Scope of study

Safran Landing Systems' metal finishing operations at its Meteor Business Park site employ a range of materials which could theoretically combine to cause a release of hydrogen cyanide. The potential for releases of hydrogen cyanide and the subsequent impact has been assessed using atmospheric dispersion modelling within the site's Major Accident Prevention Policy (MAPP). Safran Landing Systems consider that the assessment, undertaken in 2001, needs to be reviewed.

Within the metal finishing operations the principal route to production of hydrogen cyanide is the combination of sodium cyanide, used in cadmium plating, with sulphuric acid employed in chromium plating. The purpose of this study is to examine the potential release of hydrogen cyanide, its dispersion and the subsequent impact on ambient air quality both within the Safran site and further afield in the vicinity of the site. The significance of the resulting ambient air quality impact is assessed in the context of applicable workplace and ambient air quality guidelines.

1.2 General approach

The approach taken in this assessment comprised the following main stages:

- Determine a suitable modelling tool for the assessment.
- Collect appropriate representative process operational data for input to the model.
- Establish the location of the release relative to existing buildings (including nearby public and commercial buildings and residential properties).
- Obtain information on local background concentrations of hydrogen cyanide.
- Obtain 5 years' recent meteorological data from a measurement station appropriate to the location.
- Model the dispersion of potential releases of hydrogen cyanide from the Metal Finishing Facility to determine the process contribution to ambient concentrations of hydrogen cyanide over the Safran site and the neighbouring area with particular attention to locations of human exposure.
- Assess the predicted process contributions and established background concentrations with reference to applicable workplace and air quality standards to determine compliance.

Further details of the approach taken and model input information are provided in the following sections.

1.3 Structure of the report

This report provides an assessment of the impact of releases of hydrogen cyanide from abnormal operations on air quality within and in the vicinity of Safran's Meteor Business Park site. The approach to the assessment has been described above. The following sections provide a detailed commentary on the assessment and conclusions:

Section 2	Air quality standards and assessment criteria
Section 3	The model methodology employed and important input data
Section 4	The results of the assessment including sensitivity analysis
Section 5	Conclusions of the assessment

2 POLICY CONTEXT AND ASSESSMENT CRITERIA

Safran's metal finishing operations at their Meteor Business Park site employ materials which if combined have the potential to release hydrogen cyanide gas to the atmosphere. As part of the review of the Major Accident Prevention Policy, Safran have identified the need to update their assessment of the impact of abnormal operating scenarios which may result in the release of hydrogen cyanide.

2.1 Context of assessment

Many people are exposed to a variety of substances at work which can, under some circumstances, have a harmful effect on their health. Hydrogen cyanide is recognised as a hazardous substance in this regard with a specified workplace exposure limit (WEL) set in order to help protect the health of workers. Substances that have been assigned a WEL are subject to the requirements of Control of Substances Hazardous to Health (COSHH) regulations which require employers to prevent or control exposure to hazardous substances

The Environment Agency play an important role in relation to local air quality management by ensuring that processes under their regulatory control do not contribute significantly to any threat to the attainment of air quality standards. It is in this context that, as part of the environmental permitting process operated by the Environment Agency, it is necessary to demonstrate the impact of site operations on local air quality in the context of the Environment Agency's published guidance[1].

It is necessary to examine the impact of potential hydrogen cyanide releases both within the general workplace, as regulated under COSHH, and in the wider area beyond the site boundary where environmental standards relevant to human health apply.

2.2 Hydrogen cyanide releases from metal finishing operations

The metal finishing operations at Safran's Meteor Business Park site include both chromium plating using sulphuric acid and cadmium plating employing sodium cyanide. While stringent measures are in place to prevent the combination of these materials, there are abnormal circumstances where accidental mixing could occur.

On mixing the following reaction can occur:

$2NaCN$	+	H_2SO_4	→	$2HCN$	+	Na_2SO_4
Sodium cyanide		Sulphuric acid		Hydrogen cyanide		Sodium sulphate

2.3 Environmental Standards

The UK's air quality strategy is based on meeting obligations within the European Union (EU) Ambient Air Quality Directive (2008/50/EC, 21 May 2008)[2] and the Fourth Daughter Directive (relating to metals and hydrocarbons)[3]. These Directives specify legally binding limit values and target values. Limit values are set for individual pollutants and are made up of a concentration value, an averaging time over which it is to be measured, the number of exceedences allowed per year, if any, and a date by which it must be achieved. Some pollutants have more than one limit value covering different endpoints or averaging times. Target values and are set out in the same way as limit values and are to be attained where possible by taking all necessary measures not entailing disproportionate costs.

The Air Quality (Standards) Regulations 2010[4] transpose into English law the requirements of Directives 2008/50/EC and 2004/107/EC on ambient air quality. Equivalent regulations have been made by the devolved administrations in Scotland, Wales and Northern Ireland. Schedules 2 and 3 of the Regulations specify limit and target values respectively.

There are no air quality standards which are specific to the ambient concentration of hydrogen cyanide, however for the purposes of assessing the significance of pollutants in the ambient atmosphere the Environment Agency publish Environmental Assessment Levels (EALs) for the protection of human health[1]. The EAL relevant to this study is summarised in Table 2.1.

Table 2.1 Environmental Assessment Level

Pollutant	Basis	Concentration
Hydrogen cyanide	hourly mean	220 µg/m^3

The Air Quality Standards Regulations 2010[4] define ambient air as;

"...outdoor air in the troposphere, excluding workplaces where members of the public do not have regular access."

Compliance with limit values for the protection of human health does not need to be assessed (Schedule 1, Part 1) at the following locations:

a) any location situated within areas where members of the public do not have access and there is no fixed habitation;
b) on factory premises or at industrial locations to which all relevant provisions concerning health and safety at work apply;
c) on the carriageway of roads and on the central reservation of roads except where there is normally pedestrian access to the central reservation."

In this case it is considered that beyond the site boundary the EAL is likely to be applicable in areas where there is human exposure of an hour or more on a regular basis (e.g. commercial and residential premises). Within the site boundary it would be expected that regulations specific to the workplace would be applicable.

Hydrogen cyanide has a specified workplace exposure limit as summarised in Table 2.2[5].

Table 2.2 Workplace Exposure Limit

Pollutant	Basis	Concentration
Hydrogen cyanide	15 minute reference period	11000 µg/m^3

The WEL is on a short term basis which is generally set to help prevent effects such as eye irritation, which may occur following exposure for a few minutes. Hydrogen cyanide is noted as a substance which can be absorbed through the skin.

2.4 Background hydrogen cyanide concentrations

In considering the overall impact of a process release, such as this herein, on local air quality and compliance with environmental benchmarks, it is necessary not only to consider the contribution from the source but also the existing level of the substance of interest. There are no readily available data on ambient concentrations of hydrogen cyanide in the vicinity of the Safran site.

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General assessments indicate a concentration in the non-urban troposphere of around 180-190 ng/m^3 (c. 0.2 µg/m^3)[6]. This is equivalent to around 0.1% of the EAL and 0.002% of the WEL. In the context of the current study it is considered that the background level of hydrogen cyanide is unlikely to have any influence on attainment of environmental or workplace standards.

2.5 Assessment criteria

The Environment Agency[1] provides a methodology for assessing the impact and determining the acceptability of emissions to atmosphere on ambient air quality for human health

The contribution of the process (PC) to the ambient concentration of a given pollutant is considered insignificant, and requiring no further assessment, if both of the following conditions are met:

- the long term PC is less than 1% of the long term environmental standard
- the short term PC is less than 10% of the short term environmental standard

If these conditions are not met then the corresponding predicted environmental concentration ((PEC) i.e. PC + background concentration) should be assessed. The process contribution is considered insignificant and requiring no further assessment, if both of the following conditions are met:

- the short-term PC is less than 20% of the short term standard minus twice the long term background concentration
- the long-term PEC is less than 70% of the long-term environmental standard

3 MODELLING METHODOLOGY

The process contributions to ambient concentrations of hydrogen cyanide from the abnormal operating scenarios considered have been modelled using the Atmospheric Dispersion Modelling System (ADMS) version 5.2. The use of this modelling tool is widely accepted by UK Local Authorities and the Environment Agency.

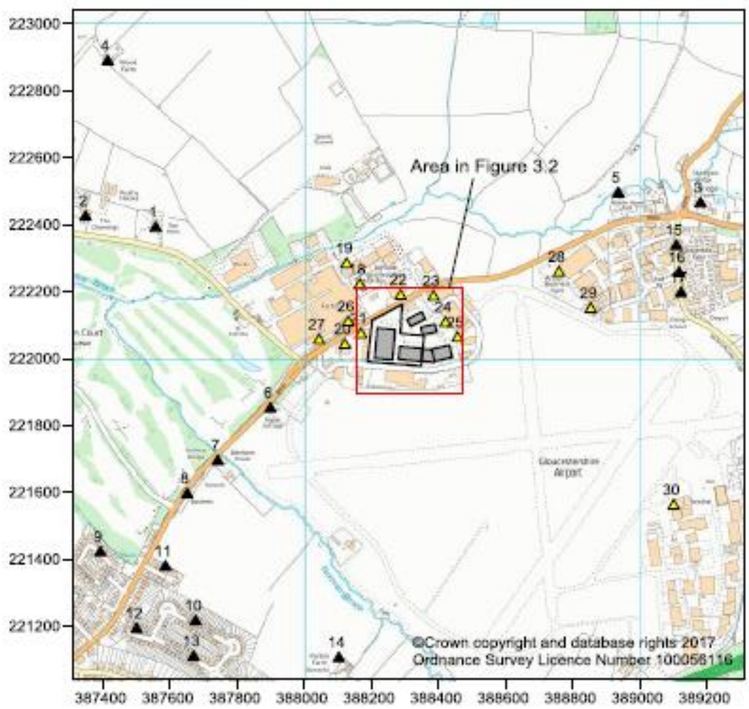
ADMS and the United States Environmental Protection Agency's (US EPA) AERMOD modelling systems are the two most widely used air dispersion models for regulatory purposes worldwide. Both are based on broadly similar principles. In this case ADMS 5.2 has been employed for the assessment

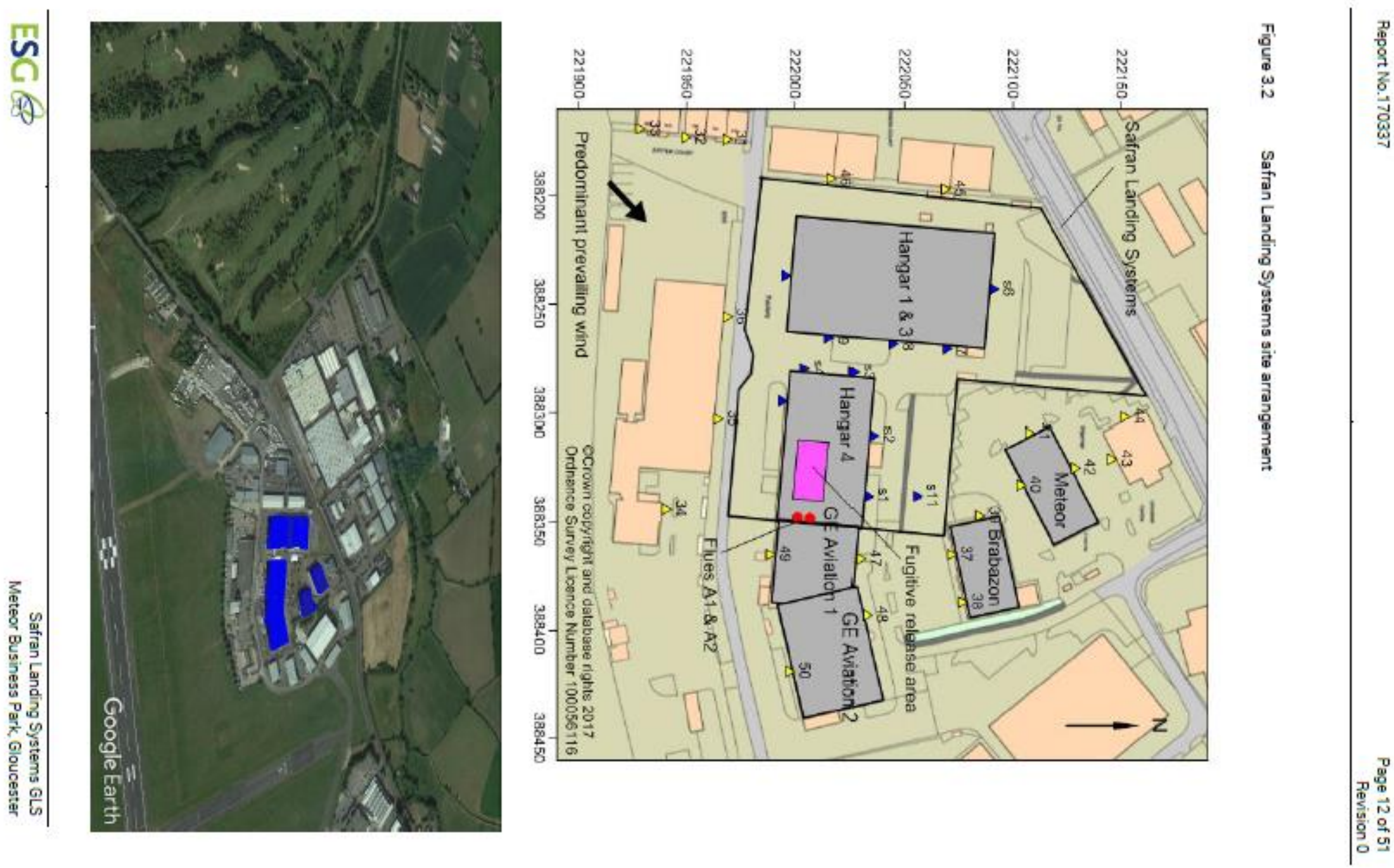
ADMS 5.2 requires a range of information in order to perform the modelling. The primary information required is discussed below.

3.1 Assessment area

Two assessment areas were considered, each with the Metal Finishing Facility (MFF) located approximately at the centre. Figure 3.1 illustrates the location of the site within the local area, while Figure 3.2 details the Safran site arrangement and neighbouring commericial premises on the Meteor Business Park.

Figure 3.1 Location of the Safran Landing Systems site




Report No.170337
Figure 3.2 Safran Landing Systems site arrangement
Safran Landing Systems
Hangar 1 & 3
Hangar 4
GE Aviation 1
GE Aviation 2
Meteor
Brabazon
Fugitive release area
Flues A1 & A2
Predominant prevailing wind
N
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Ordnance Survey Licence Number 100056116
Google Earth
Safran Landing Systems GLS
Meteor Business Park, Gloucester
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A general grid (300 m x 300 m) with receptors spaced at 3 m intervals (i.e. 10201 points for a 101 x 101 grid) was used to assess the process contribution to ground level concentrations over the area in Figure 3.2, which primarily encompassed the Safran site where the WEL might be expected to apply and also near commercial neighbours on the Meteor Business Park, who are more likely to be subject to the EAL.

The wider dispersion pattern, covering other commercial operations beyond the Cheltenham Road and the nearest residential locations was also considered over the larger 2 km x 2 km area shown in Figure 3.1 (10201 points at 20 m intervals). These locations are more likely to be subject to the EAL.

Both grids were considered at an elevation of 1.5 m above local ground level which is considered to be appropriate to an average height of human exposure.

In addition to the receptor grid, 11 receptors (S1 to S11 in Figure 3.2 (blue)) were located around the main site buildings and areas of frequent use on the Safran Landing Systems site and were at a level appropriate to the ground floor and first floor window heights as described in Table 3.1.

Table 3.1 Locations of receptors on the Safran Landing Systems' site

Receptor (see Figure 3.2)		Height m	Easting	Northing
S1	Hangar 4 North face	1.5 & 9.0	388338.1	222033.7
S2	Hangar 4 North face	1.5 & 9.0	388310.2	222036.0
S3	Hangar 4 West face	1.5 & 9.0	388281.5	222027.1
S4	Hangar 4 West face	1.5 & 9.0	388279.9	222004.6
S5	Hangar 4 South face	1.5 & 9.0	388294.7	221994.5
S6	Hangar 1 North face	1.5 & 9.0	388243.1	222091.5
S7	Hangar 1 East face	1.5 & 9.0	388270.6	222069.8
S8	Annex East face	1.5	388268.3	222045.0
S9	Hangar 3 East face	1.5 & 9.0	388265.6	222015.9
S10	Hangar 3 South face	1.5 & 9.0	388236.9	221996.1
S11	Reception	1.5	388338.1	222056.2

17 receptors (1 to 17 in Figure 3.1 (black)) were placed around the residential locations within about 1 km of the MFF and are summarised in Table 3.2. A further 20 receptors (31 to 50 in Figure 3.2 (yellow)) were placed around the commercial and industrial locations, generally within the Meteor Business Park, neighbouring Safran's site. In addition, 13 receptors (18 to 30 in Figure 3.1 (yellow)) were positioned at other commercial locations, generally outside of the Meteor Business Park, beyond 100 m of the MFF. These are described in Table 3.3. All residential and commercial receptors considered receptors were at an elevation of 1.5 m above local ground level.

It is also necessary to consider the impact of releases on any local statutory designated sites. In this case no local sites met the Environment Agency criteria for assessment and as such impact at nature conservation sites is not included in this assessment.

Table 3.2 Locations of residential receptors

Receptor (see Figure 3.1)	Position[a]	Easting	Northing
1 Terncourt	884 m NW	387557	222395
2 The Channings	1087 m NW	387348	222428
3 Bridge Farm	955 m NE	389181	222468
4 Wood Farm	1292 m NW	387414	222893
5 Mobile Home Park	770 m NE	388936	222498
6 Poplar Cottage	472 m W	387899	221855
7 Blenheim House	678 m SW	387742	221698
8 Boxtrees	805 m SW	387651	221599
9 Snowdon Gardens	1116 m SW	387392	221425
10 Orchard Way	1031 m SW	387676	221219
11 Westover Court	982 m SW	387586	221382
12 Field End	1169 m SW	387500	221196
13 Holtham Avenue	1117 m SW	387670	221113
14 Parton Farm	925 m S	388103	221109
15 Bamfurlong Lane 1	833 m NE	389109	222341
16 Bamfurlong Lane 2	811 m E	389117	222260
17 Bamfurlong Lane 3	800 m E	389123	222200

a. Location of the receptor relative to the A2 flue.

Table 3.3 Locations of commercial receptors

Receptor (see Figures 3.1 & 3.2)	Position[a]	Easting	Northing
18 Ambulance station	288 m NW	388165	222224
19 Ashville Business Park	362 m NW	388126	222287
20 Mitsubishi	231 m W	388121	222045
21 Completely Motoring	194 m NW	388169	222077
22 Mercedes Benz	201 m N	388287	222192
23 Actemium	192 m N	388385	222189
24 Safran 1 (other division)	132 m NE	388421	222111
25 Clarkson Evans	127 m NE	388457	222066
26 Safran 2 (other division)	244 m NW	388131	222113
27 Safran 2 (other division)	309 m W	388044	222059
28 Anson Business Park 1	486 m NE	388759	222261
29 Anson Business park 2	528 m E	388854	222153
30 Airport terminal	870 m SE	389101	221565
31 710-720 Jupiter Court	177 m W	388174	221969
32 730-810 Jupiter Court	182 m W	388173	221950
33 820 Jupiter Court	193 m W	388169	221929
34 Severn Trent Water 1	60 m S	388344	221941
35 Severn Trent Water 2	58 m SW	388303	221965
36 Severn Trent Water 3	97 m W	388256	221969
37 Brabazon 1	73 m N	388365	222072
38 Brabazon 2	85 m NE	388387	222077
39 Brabazon 3	84 m N	388347	222085
40 Harrier 1	104 m N	388333	222104

Table 3.3 (continued)

Receptor (see Figures 3.1 & 3.2)		Position[a]	Easting	Northing
41	Harrier 2	114 m N	388309	222108
42	Harrier 3	130 m N	388325	222129
43	Lancaster Centre 1	147 m N	388321	222146
44	Lancaster Centre 2	110 m SE	388441	221942
45	Vernon Court 1	166 m NW	388197	222069
46	Vernon Court 2	157 m W	388192	222017
47	GE Aviation 1	35 m NE	388367	222030
48	GE Aviation 2	55 m NE	388393	222033
49	GE Aviation 3	21 m SE	388365	221989
50	GE Aviation 4	71 m E	388419	221998

a. Location of the receptor relative to the A2 flue.

3.2 Buildings

The presence of buildings close to discharge flues can influence the dispersion of releases. The most significant impact can be the downwash of a plume around a building causing increased concentrations in the immediate area around the building. Buildings can also disturb the wind flow causing a turbulent wake downwind which can also affect dispersion. It is normally considered that buildings within 5 times the height of release should be considered in any modelling.

It is normally considered that buildings within 5 times the height of release should be considered in any modelling. In this case the adjacent Hangar 4 building and Hangars 1 and 3 on the site were considered. Beyond the site it was also necessary to consider the GE Aviation building adjacent to Hangar 4 and the Brabazon and Harrier office blocks. ADMS 5.2 models buildings as either rectangular or circular structures. As shown in Figure 3.2 all buildings were estimated as rectangular blocks. Based on the drawings provided by Safran [7] the defining parameters for these buildings, as summarised in Table 3.4, were estimated and used within the modelling.

Table 3.4 Building parameters

Building (see Figure 3.2)	Building centre grid reference		Height (m)		Length (m)	Width (m)
	Easting	Northing	Eaves	Ridge		
Hangar 4	388317	222014	9.4	10.4	69.0	38.5
Hangars 1 and 3	388240	222044	9.4	10.4	53.3	91.0
GE Aviation 1	388369	222009	9.4	10.4	38.5	36.4
GE Aviation 2	388410	222016	9.4	10.4	53.7	37.0
Harrier	388333	222118	10.4		49.3	23.0
Brabazon	388371	222087	10.4		43.1	23.2

The heights of buildings in Table 3.4 are referenced to the base of the north west corner of Hangar 4.

The sensitivity of predicted HCN concentrations at the location of maximum and at the commercial receptors on the Meteor Business Park (31 to 50 in Table 3.3) to selection of the main building was examined as below.

Main building	Change (%) in predicted concentration from base case with GE Aviation 1 as main building			
	At location of maximum		Mean over receptors 31 to 50	
	15 min mean	1 hour mean	15 min mean	1 hour mean
Hangar 4	-4.6	-4.7	-5.3	-5.3
Hangars 1 and 3	-4.6	-4.7	0	0
GE Aviation 1	0	0	0	0
GE Aviation 2	0	0	-0.1	-0.1

GE Aviation 1 was selected as the main building having the most influence on dispersion of releases based on this sensitivity analysis.

In this case it is assumed that the ambient atmosphere from within the Metal Finishing Facility, and in particular around the cadmium and chromium plating operation, is vented to atmosphere via the local exhaust ventilation systems exhaust to flues A1 and A2 (see Figure 3.2). Table 3.5 summarises the main characteristics of these flues.

Table 3.5 Exhaust flue characteristics

Flue	Height (m)	Internal diameter at exit (m)	Easting	Northing
A1	10.9	0.85	388347.9	222001.3
A2	14.4	1.50	388348.3	222006.9

3.3 Meteorology

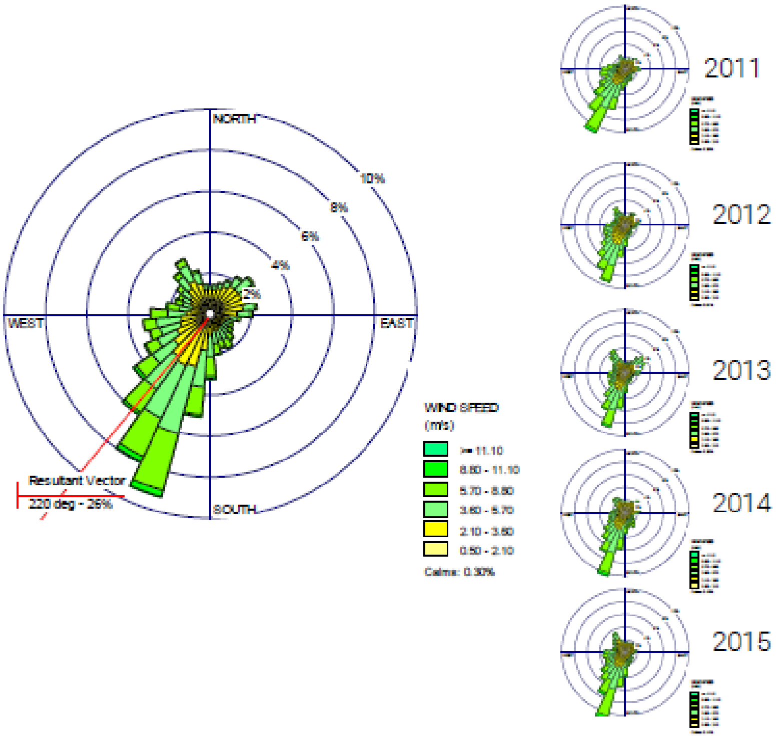
For this modelling assessment hourly sequential meteorological data from the nearest suitable meteorological station to the area was obtained. The data, provided by the UK Met Office, was from the Pershore station and covered the 5-year period 2011 to 2015. The Pershore station is around 23 km north east of the Safran site at an elevation of 35 m, compared with the site elevation of around 22 m. There are three other stations in the area which were also considered as possible sources of meteorological data:

Winchcombe (Sudeley Castle)	15 km E, elevation 112 m (incomplete data set)
Pershore College	22 km NE, elevation 22 m (incomplete data set)
Little Rissington	30 km E, elevation 210 m (complete data set)

On the basis of the general location and surface characteristics, the Pershore station was considered to provide measurements most representative of the conditions around the Safran Landing Systems site area.

The data included, among other parameters, hourly measurements of wind speed and direction. Figure 3.3 illustrates a composite wind rose for the Pershore station for the period considered within this modelling (2011 to 2015). It may be seen that the wind is predominantly from the south west.

Figure 3.3 Composite windrose for the Pershore station (2011 to 2015)



3.4 Surface characteristics

The characteristics of the surrounding surfaces and the land use within the assessment area have an important influence in determining turbulent fluxes and hence the stability of the boundary layer and atmospheric dispersion. In ADMS it is necessary to consider the following parameters which describe land use and surface properties:

Surface roughness
Surface aldebo
Minimum Monin Obukhov length
Priestley Taylor parameter

3.4.1 Surface roughness

The roughness length represents the aerodynamic effects of surface friction and is physically defined as the height at which the extrapolated surface layer wind profile tends to zero. This value is an important parameter used by meteorological pre-processors to interpret the vertical profile of wind speed and estimate friction velocities which are, in turn, used to define heat and momentum fluxes and, consequently, the degree of turbulent mixing.

The surface roughness length is related to the height of surface elements. Typically, the surface roughness length is approximately 10% of the height of the main surface features. Surface roughness is higher in built up areas than in rural locations.

A range of typical roughness values for common land use types are provided within ADMS:

Land use	Surface roughness (m)
Ice	0.00001
Snow	0.00005
Sea	0.0001
Short grass	0.005
Open grassland	0.02
Root crops	0.1
Agricultural areas	0.2-0.3
Parkland, open suburbia	0.5
Cities, woodland	1.0
Large urban areas	1.5

The site is located in a rural/small industrial area with warehousing and light industrial units in the immediate vicinity and with open fields beyond. The nearest medium density housing is around 1 km to the south west, although there are individual residential properties within 500 m. The general area is considered to fall into the category of cities and woodland reflecting the density of buildings in the area surrounding the Metals Finishing Facility. The sensitivity of predicted ambient HCN concentrations to surface roughness at the location of maximum and at the commercial receptors on the Meteor Business Park (31 to 50 in Table 3.3) was examined as below.

Surface roughness (m)	Change (%) in predicted concentration from base case with surface roughness of 1.0 m			
	At location of maximum		Mean over receptors 31 to 50	
	15 min mean	1 hour mean	15 min mean	1 hour mean
0.5	-13.5	-13.6	+2.2	-1.9
1.0	0	0	0	0
1.5	+13.5	+13.8	+6.7	+6.3

Variations in surface roughness of between 0.5 and 1.5 m resulted in a relatively small change in the predicted ambient HCN concentration which is not considered significant in the context of the conclusions reached in section 4.

3.4.2 Surface aldebo

The surface aldebo is the ratio of reflected to incident shortwave solar radiation at the surface of the earth and lies in the range 0 to 1. This parameter is dependent upon surface characteristics and varies throughout the year. Surface aldebo is higher (higher proportion of reflected radiation) when the ground is snow covered. Based on the recommendations of Oke (1987), ADMS provides default values of 0.6 for snow-covered ground and 0.23 for non-snow covered ground, respectively.

In this case a value for surface aldebo of 0.23 has been employed.

3.4.3 Monin Obukhov length

The Monin Obukhov length provides a measure of the stability of the atmosphere and allows for the effect of heat production in cities which may not be represented by the meteorological data. In urban areas heat generated from buildings and traffic warms the air above which has the effect of preventing the atmosphere from becoming very stable. Generally the larger the area the greater the effect. In stable conditions the Monin Obukhov length will not fall below a minimum value with the value becoming larger depending on the size of the city. The minimum value of the Monin Obukhov length generally lies between 1 and 200 m with 1 corresponding to a rural area. ADMS provides the following guidance on minimum Obukhov length:

Population size	Minimum Obukhov length (m)
Large conurbations (>1 million)	100
Cities and large towns	30
Mixed urban/industrial	30
Small towns	10
Rural area	1

In this case the area is considered to be typical of a mixed urban and industrial area and a minimum Monin Obukhov length of 30 has been employed. The sensitivity of predicted ambient HCN concentrations to minimum Monin Obukhov length at the location of maximum and at the commercial receptors on the Meteor Business Park (31 to 50 in Table 3.3) was examined as below.

Minimum Monin Obukhov Length (m)	Change (%) in predicted concentration from base case with Minimum Monin Obukhov Length of 30 m			
	At location of maximum		Mean over receptors 31 to 50	
	15 min mean	1 hour mean	15 min mean	1 hour mean
10	0	0	+0.6	0
30	0	0	0	0
100	0	0	-0.2	+0.4

Variations in the minimum Monin Obukhov Length of between 10 and 100 resulted in negligible changes in the predicted ambient HCN concentration. This is not considered significant in the context of the conclusions reached in section 4.

3.4.4 Priestley Taylor parameter

The Priestly Taylor parameter represents the surface moisture available for evaporation. Areas where moisture availability is greater will experience a greater proportion of incoming solar radiation released back to atmosphere in the form of latent heat, leaving less available in the form of sensible heat and, thus, decreasing convective turbulence. The Priestley Taylor parameter lies between 0 and 3. Based on suggestions by Holstag and van Ulden, ADMS provides default values of:

Land type	Priestley Taylor parameter
Dry bare earth	0
Dry grassland	0.45
Moist grassland	1

In this case the area is considered to be representative of moist grassland and a value of 1.0 for the Priestley Taylor parameter has been employed. The sensitivity of predicted ambient HCN concentrations to the Priestley Taylor parameter at the location of maximum and at the commercial receptors on the Meteor Business Park (31 to 50 in Table 3.3) was examined as below.

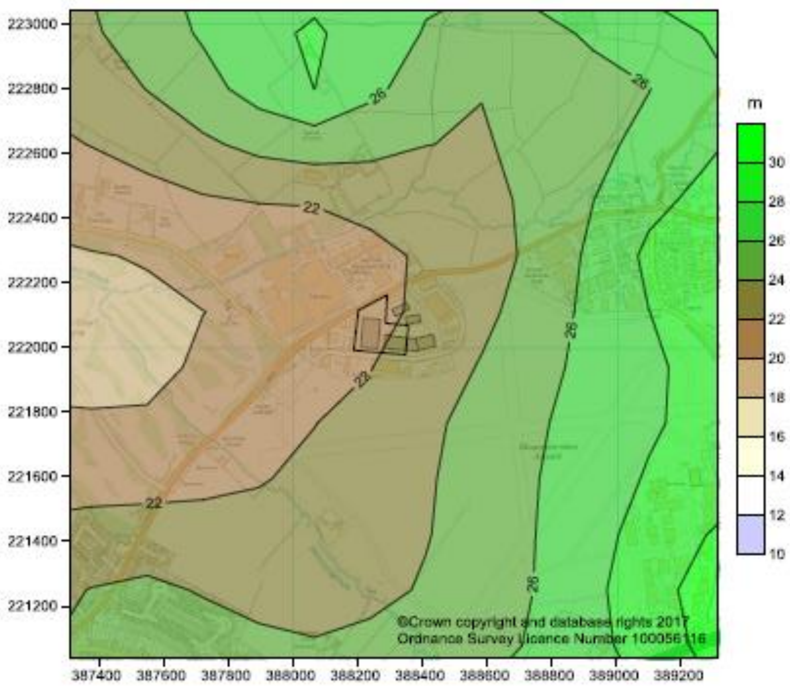
Priestley Taylor parameter	Change (%) in predicted concentration from base case with Priestley Taylor parameter of 1.0			
	At location of maximum		Mean over receptors 31 to 50	
	15 min mean	1 hour mean	15 min mean	1 hour mean
0	+44.3	+46.7	+10.0	+11.0
0.5	+21.1	+22.2	+9.7	+8.6
1.0	0	0	0	0

Variations in the Priestley Taylor parameter of between 0 and 1 resulted in substantial changes in the predicted ambient HCN concentration, although the value selected is considered to be most appropriate for this environment. Although the potential variations are substantial these are unlikely to impact on the conclusions reached in section 4.

3.4.5 Terrain

Terrain data was obtained for the assessment area from the Ordnance Survey Land-form Panorama DTM data base. There is little change in ground elevation across the large assessment area (Figure 3.1). The site lies in a relatively flat area with the ground slightly rising to the east (rising 5 m over a distance of around 2 km) as shown in Figure 3.4.

Figure 3.4 Ground elevation within assessment area



Sensitivity analyses indicated that consideration of ground elevation had the following influence on predicted ambient HCN concentrations.

Terrain	Change (%) in predicted concentration from base case with Terrain considered			
	At location of maximum		Mean over receptors 31 to 50	
	15 min mean	1 hour mean	15 min mean	1 hour mean
Yes	0	0	0	0
No	-21.1	-21.8	-8.4	-8.7

For avoidance of doubt, terrain has been considered in the current assessment.

3.5 Releases of hydrogen cyanide

The generation of hydrogen cyanide is considered to arise from the combination of sulphuric acid and sodium cyanide in the various parts of the plating process in the Metal Finishes Facility.

3.5.1 Material inventories

Based on the information provided by Safran[7] the following inventories of sodium cyanide and sulphuric acid have been determined.

Table 3.6 Inventory of vats containing sulphuric acid

Vat		1	3	4	12	55
		Chromium plating	Chromium plating	Chromium plating	Sulphuric acid etch	Cadmium passivation
Working volume	l	8483	8483	8483	4746	4746
Sulphuric acid	g/l	2.25-2.75	2.25-2.75	2.25-2.75	375-525	3-7
	kg	21.2	21.2	21.2	2136	23.7
	kgmol	0.22	0.22	0.22	21.80	0.24

a.It is assumed that sulphuric acid is present at the middle of its control range.

Table 3.7 Inventory of vats containing sodium cyanide

Vat		45	57	BC3
		Cadmium plating	Reactivation	Bronze plating
Working volume	l	6954	4746	612
Sodium cyanide	g/l	90-120	30-37	20-25
	kg	661	159	14
	kgmol	13.49	3.24	0.29
Sodium hydroxide	g/l	7.5-24	8-15	8-12
	kg	110	55	6
	kgmol	2.75	1.38	0.15
Sodium carbonate	g/l	50	-	-
	kg	348	-	-
	kgmol	3.28	-	-

a.It is assumed that substances are present at the middle of their control range.

Table 3.8 summarises the total sodium cyanide and sulphuric acid present:

Table 3.8 Summary of sulphuric acid and sodium cyanide inventories

Vat	Sulphuric acid		Sodium cyanide	
	kg	kg mol	kg	kgmol
1	21.2	0.22		
3	21.2	0.22		
4	21.2	0.22		
12	2136	21.80		
55	23.7	0.24		
45			661	13.49
57			159	3.24
BC3			14	0.29
Total	2223.3	22.70	834	17.02

3.5.2 Generation of hydrogen cyanide

The reaction between sulphuric acid and sodium hydroxide to produce hydrogen cyanide is:

$2NaCN$	+	H_2SO_4	→	$2HCN$	+	Na_2SO_4
Sodium cyanide		Sulphuric acid		Hydrogen cyanide		Sodium sulphate
(2 x 49 = 98 kg/mol)		98 kg/mol		(2 x 27 = 54 kg/mol)		142 kg/mol

2 moles of sodium cyanide reacts with 1 mole of sulphuric acid to produce 2 moles of hydrogen cyanide.

The presence of sodium hydroxide and sodium carbonate in the vats 45, 57 and BC3 will utilise some of the sulphuric acid present according to the following reactions:

$2NaOH$	+	H_2SO_4	→	$2H_2O$	+	Na_2SO_4
Sodium hydroxide		Sulphuric acid		Water		Sodium sulphate
(2 x 40 = 80 kg/mol)		98 kg/mol		(2 x 18 = 36 kg/mol)		142 kg/mol

Na_2CO_3	+	H_2SO_4	→	H_2O	+	CO_2	+	Na_2SO_4
Sodium carbonate		Sulphuric acid		Water		Carbon dioxide		Sodium sulphate
106 kg/mol		98 kg/mol		18 kg/mol		44 kg/mol		142 kg/mol

Two potential generation scenarios are considered:

Scenario A The total inventory of sodium cyanide and sulphuric acid mix and react

Scenario A	kg	kg mol
H_2SO_4 in vats 1, 3, 4, 12 & 55	2223	22.70
NaCN in vats 45, 57 & BC3	834	17.02
Theoretical HCN produced	460	17.02
H_2SO_4 utilised in reaction	834	8.51
NaOH present in vats 45, 57 & BC3	171	4.28
Na_2CO_3 present in vats 45, 57 & BC3	348	3.28
H_2SO_4 utilised in neutralisation reactions	531	5.42

Sulphuric acid is in excess and the amount of hydrogen cyanide generated is limited by the amount of sodium cyanide present. From the above inventory 17.02 kg mol of sodium cyanide requires 8.51 kg mol (834 kg) of sulphuric acid to produce 17.02 kg mol (460 kg) of hydrogen cyanide.

	$2NaCN$	+	H_2SO_4	→	$2HCN$	+	Na_2SO_4
kg mol	17.02		8.51		17.02		8.51
kg	834		834		460		1208

4.28 kg mol of sodium hydroxide utilises 2.14 kg mol of sulphuric acid and 3.28 kg mol sodium carbonate utilises 3.28 kg mol sulphuric acid. The total sulphuric acid utilised by the presence of sodium carbonate and sodium hydroxide is 5.42 kg mol equivalent to 531 kg.

	$2NaOH$	+	H_2SO_4	→	$2H_2O$	+	Na_2SO_4
kg mol	4.28		2.14		4.28		2.14
kg	171		210		77		304

	Na_2CO_3	+	H_2SO_4	→	H_2O	+	CO_2	+	Na_2SO_4
kg mol	3.28		3.28		3.28		3.28		3.28
kg	348		321		59		144		466

The total sulphuric acid utilised in the reactions is 1365 kg, which can be compared with an original inventory of 2223 kg.

Scenario B Vats 1, 3 and 4 react with the contents of vat 45

Scenario B	kg	kg mol
H_2SO_4 in vats 1, 3 & 4	63.6	0.66
NaCN in vat 45	661	13.49
Theoretical HCN produced	35.1	1.30
H_2SO_4 utilised in reaction	63.6	0.66
NaOH present in vat 45	110	2.75
Na_2CO_3 present in vat 45	348	3.28
H_2SO_4 utilised in neutralisation reactions	456	4.66

The reaction is limited by the amount of sulphuric acid present. 0.65 kg mol of sulphuric acid will react with 1.30 kg mol of sodium cyanide to produce 1.30 kg mol (35.1 kg) of hydrogen cyanide.

	$2NaCN$	+	H_2SO_4	→	$2HCN$	+	Na_2SO_4
kg mol	1.30		0.65		1.30		0.65
kg	63.6		63.6		35.1		92.1

If the reaction was governed by the amount of sodium cyanide present, the demand for sulphuric acid would be 6.55 kg mol (661 kg).

	$2NaCN$	+	H_2SO_4	→	$2HCN$	+	Na_2SO_4
kg mol	13.49		6.75		13.49		6.75
kg	661		661		364		958

There is also the potential for some sulphuric acid to react with any sodium hydroxide or sodium carbonate present. In this case 2.75 kg mol of sodium hydroxide utilises1.38 kg mol of sulphuric acid and 3.28 kg mol sodium carbonate utilises 3.28 kg mol sulphuric acid.

	$2NaOH$	+	H_2SO_4	→	$2H_2O$	+	Na_2SO_4
kg mol	2.75		1.38		2.75		1.38
kg	110		135		50		195

	Na_2CO_3	+	H_2SO_4	→	H_2O	+	CO_2	+	Na_2SO_4
kg mol	3.28		3.28		3.28		3.28		3.28
kg	348		321		59		144		466

The total sulphuric acid demand for these neutralisation reactions is therefore 456 kg.

The overall potential utilisation of sulphuric acid is 1117 kg. If it is assumed that the reactions proceed in proportion to their respective demand for sulphuric acid, then the generation of hydrogen cyanide will be 59% complete (661/1117) with 0.38 kg mol sulphuric acid reacting with 0.76 kg mol sodium cyanide to produce 0.76 kg mol (20.5 kg) hydrogen cyanide.

	$2NaCN$	+	H_2SO_4	→	$2HCN$	+	Na_2SO_4
kg mol	0.76		0.38		0.76		0.38
kg	37.2		37.2		20.5		53.9

3.5.3 Concentration of hydrogen cyanide in the workplace

Three scenarios are assumed for the dispersion of any hydrogen cyanide generated within Metal Finishes Facility:

1. The building remains intact and the spillages are confined to the bunded area beneath the plating area and the hydrogen cyanide generated is removed by the local extraction system without spreading throughout the entire building.

2. The building remains intact and the plating area is sealed and the extraction system shutdown so that the hydrogen cyanide generated fills the entire plating area building.

3. The building is severely damaged and unable to confine the hydrogen cyanide generated.

The dimensions and volumes associated with above scenarios are determined in Table 3.9.

Table 3.9 Dimensions of release areas

Scenario		1	2	3
Area	m^2	334	392	392
Volume	m^3	1470	3802	not applicable

a.Based on drawings provided by Safran[7]. Height of extraction hoods is 4.4 m. Height of the building is 8.5 m at the eaves and 10.9 m at the ridge.

For the release and dispersion scenarios the workplace concentrations in Table 3,10 estimated.

Table 3.10 Workplace concentrations

Release scenario		A	B
Mass of HCN released	kg	460	20.5
HCN concentration in scenario A	mg/m^3	312925	13946
HCN concentration in scenario B	mg/m^3	120989	5392
HCN concentration in scenario C	mg/m^3	not applicable	

The above concentrations assume that the total release is dispersed into the air volume before any extraction or fugitive losses. This will therefore be a maximum concentration as the reaction will proceed concurrently with any extraction or losses. For scenario C it is assumed that the entire mass generated will be released over the benchmark averaging period.

3.5.4 Ventilation extraction rates

The plating area has three extraction systems which exhaust to atmosphere through two flues. Two of the individual systems serving the cadmium and nickel plating operations combine to exhaust through one flue (A2) with the remaining flue (A1) serving the chromium plating extraction system. Periodic measurements are made in the roof level flues. The extraction rates determined from these measurements over the past 18 months are summarised in Table 3.11.

Table 3.11 Measured extraction rates

Flue		A1	A2
Diameter at release point	m	0.86	1.50
Area at release point	m^2	0.58	1.77
Height	m	10.9	14.4
Easting	m	388347.9	388348.3
Northing	m	222001.3	222006.9

Test date and report	Temperature °C	Volume flow rate actual m^3/h	Volume flow rate actual m^3/s	Velocity at flue exit m/s
A1 – Chromium plating extraction				
30.6.16 (LSO 160632, 27.7.16)	20	17881	4.97	8.6
6.12.16 (LSO161212, 8.1.17)	13	16199	4.50	7.8
9.3.16 (LSO170324, 24.3.17)	12	15974	4.44	7.7
Mean	15	16685	4.63	8.0
A2 – Cadmium and nickel plating extraction				
30.6.16 (LSO 160632, 27.7.16)	23	88206	24.50	13.8
6.12.16 (LSO161212, 8.1.17)	20	101516	28.20	15.9
9.3.16 (LSO170324, 24.3.17)	5	99582	27.66	15.6
Mean	16	96435	26.79	15.1

The total air extraction from the plating shop based on the measured volume flow rates is 31.42 m^3/s. This is equivalent to the extraction of all air within the bunded area (scenario 1) in 47 seconds. The release rates of hydrogen cyanide on this basis for scenarios 1A and 1B are 9787 g/s and 449 g/s respectively.

3.5.5 Fugitive releases

For Scenario 2 it is assumed that the prior to any leakage to atmosphere the total release occupies and is confined to the volume of the Plating area (3802 m^3) and then leaks to atmosphere over an area equivalent to the roof area (392 m^2) at the height of the eaves (8.5 m). It is also assumed that the building leaks at a rate equivalent to a complete air change in 2 hours (i.e. 1901 m^3/h or 0.5 m^3/s) which equates to release of 63.9 g/s and 2.9 g/s for Scenarios 2A and 2B respectively.

For Scenario 3 it is assumed that the entire mass of hydrogen cyanide generated is released to air at a height of 1 m over the area of the equivalent to the roof area (392 m^2). As this release is unconfined, it is further that assumed that the mass of hydrogen cyanide generated in Scenarios A and B is released to atmosphere entirely over the averaging period of the benchmark of interest.

3.5.6 HCN release rates

Based on the above assumptions the following release rates are expected.

Table 3.12 Extractive release rates (Scenarios 1A and 1B)

Extraction flue		A1	A2	A1	A2
Scenario		1A		1B	
Total HCN release	kg	460		20.5	
Volume occupied	m^3	1470		1470	
Concentration before extraction	mg/m^3	312925		13946	
Air extraction rate	m^3/s	4.63	26.79	4.63	26.79
Extraction time	s	47		47	
Total release rate	g/s	9787		436	
Release rate per flue[a]	g/s	1442	8345	64	372
	g/s (15 min mean)	75	436	3.3	19.4
	g/s (1 h mean)	18.8	109	0.8	4.9

a. In order to assess the release on the basis of the 15 minute and one hour means required by environmental benchmarks the average release, based on total extraction over these periods is considered.

Table 3.13 Fugitive release rates (Scenarios 2A, 2B, 3A and 3B)

Scenario		2A	2B	3A	3B
Total HCN release	kg	460	20.5	460	20.5
Volume occupied	m^3	3802	3802	not applicable	
Concentration before extraction	mg/m^3	120989	5392	not applicable	
Fugitive leak rate	m^3/s	0.5	0.5	not applicable	
Time for building air change	s	7200	7200	not applicable	
Area of release	m^2	392	392	392	392
HCN release rate[a]	g/s (15 min mean)	63.9	2.85	511	22.8
	g/s (1 h mean)	63.9	2.85	128	5.69
	g/s/m^2 (15 min mean)	0.163	0.0073	1.304	0.058
	g/s/m^2 (1 h mean)	0.163	0.0073	0.326	0.015

a. The total fugitive release time in Scenario 2 exceeds 1 hour and as such the actual fugitive release is consistent with determining compliance with both the 15 minute and 1 hour benchmarks.

3.6 Modelling scenarios

ADMS 5.2 has been employed to estimate process contributions to ambient concentrations of hydrogen cyanide based on the six release scenarios specified above. For the assessment the model has been run using meteorological data for each of five years (2011 to 2015).

4 MODELLING RESULTS

ADMS 5.2 has been used to model the release scenarios described in Section 3. The results of the modelling are discussed below. In this section results are presented in tabular form, whilst in Annex A contour plots are provided which illustrate the estimated process contribution to ambient concentrations of hydrogen cyanide over the assessment areas.

It is considered that over the area of the Safran site workplace exposure limits will be applicable, while beyond the site boundary it is more likely that Environmental Assessment Levels relevant to human health will need to be considered.

The hydrogen cyanide generation scenarios A and B vary only in their overall release of hydrogen cyanide. In the current MAPP scenario B is considered as an unlikely but practical worst case incident. Scenario A considered herein is the absolute worst case situation where all available sulphuric acid mixes and reacts with all available sodium cyanide. This is considered highly improbable even in the case of a catastrophic incident such as a light aircraft impact.

For release scenario 1, the releases are vented to atmosphere via the extraction system which operates at fixed conditions. The dispersion pattern is the same for 1A and 1B with only the magnitude of the impact varying. For scenarios 2 and 3 the discharges are fugitive and the dispersion pattern is somewhat different to scenario 1 with a more localised impact.

At each location considered the maximum hydrogen cyanide concentration resulting from the releases considered is determined based on a 15 minute or 1 hour averaging period. The maximum concentrations represent the maximum determined for the averaging period over the five meteorological years considered.

Figures A.1 to A.12 provide detailed dispersion contour plots of the impact of all six scenarios.

4.1 Impact of releases within the site boundary

As shown in Figure 4.1 (expressed as a multiple of the exceedence of the WEL) the location of maximum process contribution to ambient hydrogen cyanide concentrations for release scenario A, where the release is passed through the ventilation system, is beyond the site boundary, although largely within the Meteor Business Park, in an arc from the south to north east. The fugitive release scenarios in 2 and 3 have a release with little momentum and as such the higher concentrations tend to occur closer to the release point and generally around the immediate area of Hangar 4 and mostly within the site boundary.

At the locations considered in Figure 3.2 the maximum hydrogen cyanide concentrations determined are summarised in Table 4.1 in terms of the workplace exposure limit.

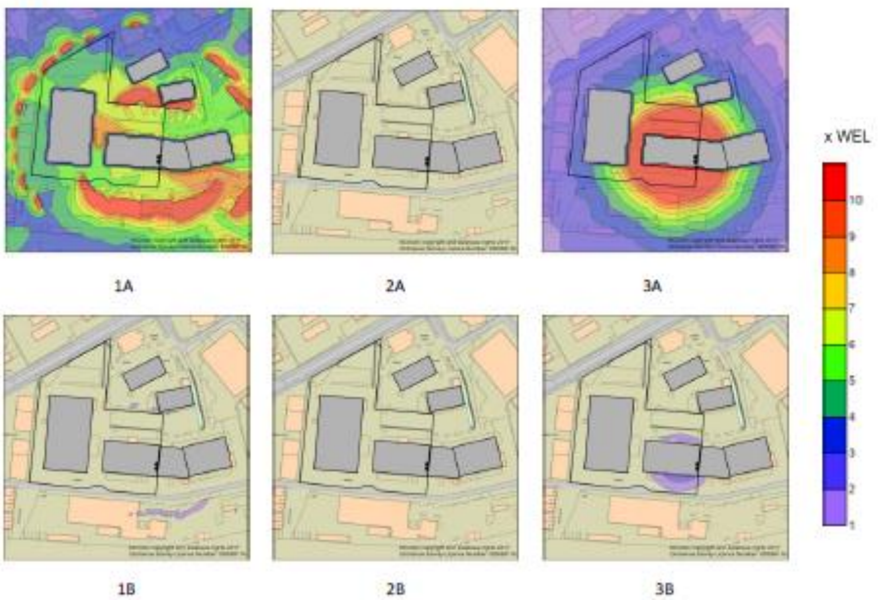
For scenario A, which is considered a highly improbable worse case condition, the maximum concentration at ground level within the site boundary occurs when the release is not confined (3A) and is equivalent to around 6300% of the WEL and while concentrations are highest around the Hangar 4 building the WEL across all of the site is exceeded. Lower concentrations are found where the release is confined and the extraction system is employed (1A), although concentrations across the entire site still exceed the WEL. The most effective means of limiting ambient exposure is to confine the release and allow a gradual fugitive release to atmosphere (2A). In this case there is some exceedence of the WEL around first floor window level of Hangar 4, but concentrations around the remainder of the site are within the WEL.

Table 4.1 Process contributions of hydrogen cyanide at on site locations

Location (see Figure 3.2)	Maximum process contribution of hydrogen cyanide (% WEL[a])					
	1A	2A	3A	1B	2B	3B
Maximum (ground level)	887	52	6300	39	2	290
s1	679	27	3162	30	1	148
s2	814	38	2660	36	2	125
s3	887	51	1532	39	2	72
s4	534	49	1562	24	2	73
s5	642	38	2656	28	2	125
s6	423	32	340	19	1	16
s7	671	45	596	30	2	28
s8	887	49	838	39	2	39
s9	534	49	931	24	2	44
s10	531	39	515	24	2	24
s11	679	49	1296	30	2	61
1s1	679	209	3246	30	10	152
1s2	814	195	2840	36	9	133
1s3	887	113	1578	39	5	74
1s4	534	131	1641	24	6	77
1s5	642	199	3025	28	9	142
1s6	423	35	336	19	2	16
1s7	671	56	590	30	3	28
1s9	534	84	995	24	4	47
1s10	531	50	548	24	2	26

a. The short term WEL for hydrogen cyanide is 11000 µg/m^3 averaged over a 15 minute period.
b. s and 1s indicates ground floor (1.5 m) and high level window (9.0 m) levels.

Figure 4.1 Dispersion pattern of releases over the site



For scenario B which is considered a more likely worst case, only the unconfined release scenario (3B) results in an exceedence of the WEL on site and then just in the immediate surroundings of Hangar 4. For release scenarios 1 and 2 there is compliance with the WEL within the site boundary.

In the event of a release from the Metals Finishes Facility it would be most appropriate to muster and evacuate towards the east and to avoid the immediate areas around Hangar 4 and the main gate

4.2 Impact of releases beyond the site boundary

The pattern of dispersion of release beyond the site boundary (expressed as a multiple of the EAL) is shown in Figure 4.2 for all scenarios. As might be expected the higher releases associated with HCN generation scenario A result in significantly higher concentrations than the corresponding scenario B, where releases are much lower. The predicted process contribution of HCN at the selected near commercial and residential receptors (see Tables 3.2 and 3.3) are summarised in Table 4.2.

Residential properties to the north east of the site around Bamfurlong Lane and nearby properties to the south west along the B4063 are the generally the most affected residential locations beyond the site boundary regardless of the release scenario. For generation scenario A there is exceedance of the EAL at all residential locations whether the release is by extractive or fugitive means. Process contributions tend to be higher when the release is extracted through flues A1 and A2 (scenario 1) as the release has more momentum and travels further. Process contributions are lower with the fugitive release mechanisms (2 and 3) as the release has less momentum and concentrates close to the point of release.

Figure 4.2 Dispersion pattern of releases beyond the site boundary

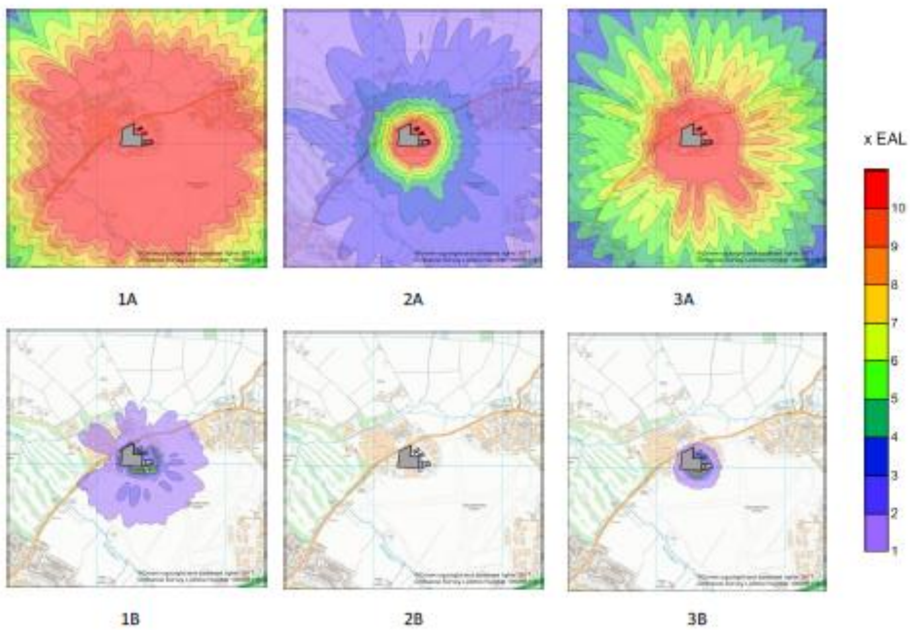


Table 4.2 Process contributions of hydrogen cyanide at off site locations

Location (see Figure 3.1)		Maximum process contribution of hydrogen cyanide (% EAL[a])					
		1A	2A	3A	1B	2B	3B
1	Terncourt	1070	216	478	48	10	22
2	The Channings	810	193	458	36	9	22
3	Bridge Farm	912	290	577	41	13	27
4	Wood Farm	483	150	291	22	7	14
5	Mobile Home Park	1305	313	627	58	14	29
6	Poplar Cottage	2729	340	776	122	16	36
7	Blenheim House	1478	253	766	66	12	36
8	Boxtrees	1192	263	648	53	12	30
9	Snowdon Gardens	705	201	433	31	9	20
10	Orchard Way	835	258	517	37	12	24
11	Westover Court	898	253	508	40	12	24
12	Field End	586	173	400	26	8	19
13	Holtham Avenue	661	245	490	29	11	23
14	Parton Farm	902	254	570	40	12	27
15	Bamfurlong Lane 1	1174	318	629	52	15	30
16	Bamfurlong Lane 2	1072	248	594	48	11	28
17	Bamfurlong Lane 3	1118	278	655	50	13	31
18	Ambulance station	2818	634	1374	125	29	64
19	Ashville Business Park	2471	449	1033	110	21	48
20	Mitsubishi	4588	775	1866	202	36	88
21	Completely Motoring	6268	947	2387	280	44	112
22	Mercedes Benz	3676	966	2190	163	45	103
23	Actemium	3579	872	2075	157	40	97
24	Safran 1 (other division)	5918	1251	3129	263	58	147
25	Clarkson Evans	28789	1180	2905	1278	55	136
26	Safran 2 (other division)	3805	724	1745	169	33	82
27	Safran 2 (other division)	4997	534	1195	222	25	56
28	Anson Business Park 1	2668	374	768	119	17	36
29	Anson Business park 2	1963	289	856	88	13	40
30	Airport terminal	1027	261	575	46	12	27
31	710-720 Jupiter Court	7115	1081	2728	317	50	128
32	730-810 Jupiter Court	4083	1070	2679	182	49	126
33	820 Jupiter Court	3655	957	2334	162	44	110
34	Severn Trent Water 1	15053	2167	8531	660	100	400
35	Severn Trent Water 2	7869	2186	15680	348	101	736
36	Severn Trent Water 3	12233	2065	7327	542	95	344
37	Brabazon 1	24379	2171	8435	1074	100	396
38	Brabazon 2	11023	1843	6047	485	85	284
39	Brabazon 3	11637	2114	7519	515	98	353
40	Harrier 1	7097	1865	5664	315	86	266
41	Harrier 2	5851	1760	4991	260	81	234

Table 4.2 (continued)

Location (see Figure 3.1)		Maximum process contribution of hydrogen cyanide (% EAL[a])					
		1A	2A	3A	1B	2B	3B
42	Harrier 3	4343	1509	3851	192	70	181
43	Lancaster Centre 1	4343	1286	3188	192	59	150
44	Lancaster Centre 2	23228	1323	3306	1029	61	155
45	Vernon Court 1	4915	1199	3036	217	55	142
46	Vernon Court 2	5012	1254	3313	222	58	155
47	GE Aviation 1	7146	2367	18732	316	109	879
48	GE Aviation 2	7146	2207	9180	316	102	431
49	GE Aviation 3	10248	2427	21395	453	112	1004
50	GE Aviation 4	6367	1819	5950	282	84	279

a. The short term EAL for hydrogen cyanide is 220 μg/m^3 averaged over a one hour period.

For generation scenario B the EAL is met comfortably at most residential locations with the confined fugitive release mechanism (2B) providing the lowest process contributions.

Commercial locations neighbouring the Safran site on the Meteor Business Park are more greatly affected than residential locations. Large exceedances of the EAL are predicted for release scenarios 1A to 3A with the Severn Trent site to the south and the Lancaster Centre to the north being particularly affected. Exceedences are greatest with Scenario A, although there is general exceedance of EAL with all scenarios considered. Scenario 2B provides the lowest impact, again demonstrating the effectiveness of confining the HCN generated and allowing a gradual release.

On the basis of Environmental Agency assessment criteria the process contribution of hydrogen cyanide would be considered significant at all residential and commercial locations considered in all scenarios. It is considered that the more probable worst case generation scenario (B) is unlikely to have significant impacts on either nearby commercial or residential locations, if suitable precautions are taken. Remaining within premises with doors and window closed will allow time for external concentrations to drop to a safe level by dispersion. Alternatively evacuation will reduce exposure times and, as shown in Figure 4.1, concentrations beyond the site boundary are generally less than the 15 minute WEL.

4.3 Influence of meteorological conditions

Table 4.3 summarises the influence of meteorological conditions on maximum process contributions at all residential receptors for the six scenarios considered.

The annual variations in meteorological conditions did not have a significant influence on maximum process contributions in most cases. As such it would not be expected that the conclusions of this assessment would be significantly changed by normal variations in meteorological conditions. It should be noted that this assessment is based on the maximum process contribution at each receptor for each 15 minute and hour period in each of the five years considered and as such will be an over estimate for the vast majority of the time.

Table 4.3 Influence of meteorological conditions on maximum process contribution of hydrogen cyanide

Location (see Figure 3.1)		Process contribution of hydrogen cyanide ratio of maximum to minimum (2011 to 2015) 15 minutes averaging (WEL)					
		1A	1B	2A	2B	3A	3B
1	Terncourt	1.4	1.4	1.4	1.4	1.6	1.6
2	The Channings	1.3	1.3	1.4	1.4	1.3	1.3
3	Bridge Farm	1.2	1.2	1.9	1.9	1.6	1.6
4	Wood Farm	1.1	1.1	1.8	1.8	1.6	1.6
5	Mobile Home Park	1.2	1.2	1.4	1.4	1.1	1.1
6	Poplar Cottage	1.8	1.8	1.1	1.1	1.1	1.1
7	Blenheim House	1.2	1.2	1.3	1.3	1.3	1.3
8	Boxtrees	1.2	1.2	1.2	1.2	1.1	1.1
9	Snowdon Gardens	1.1	1.1	1.1	1.1	1.1	1.1
10	Orchard Way	1.1	1.1	1.6	1.6	1.2	1.2
11	Westover Court	1.2	1.2	1.4	1.4	1.1	1.1
12	Field End	1.1	1.1	1.1	1.1	1.0	1.0
13	Holtham Avenue	1.1	1.1	1.7	1.7	1.4	1.4
14	Parton Farm	1.2	1.2	1.5	1.5	1.2	1.2
15	Bamfurlong Lane 1	1.2	1.2	1.3	1.3	1.1	1.1
16	Bamfurlong Lane 2	1.1	1.1	1.2	1.2	1.1	1.1
17	Bamfurlong Lane 3	1.2	1.2	1.1	1.1	1.0	1.0

4.4 Modelling uncertainty

The use of models to predict the dispersion of releases has associated uncertainties. The main uncertainties in this assessment result from:

- The dispersion of hydrogen cyanide within the Metal Finishing Facility is assumed to be confined to the cadmium and chromium plating area served by the ventilation systems exhausting to A1 and A2. Further dispersion throughout the building and release via other systems present, including by fugitive means, would lead to a different dispersion pattern and an extended extraction period. This is judged to have a beneficial effect on maximum process contributions.

- The hydrogen cyanide release determined for each scenario is based on all sulphuric acid available reacting with sodium cyanide and only limited by the presence of sodium hydroxide and sodium carbonate. This assumes all vats to be operating at capacity at the middle point of the chemical control range. In practice it is unlikely that all vats will be in this condition.

- In Scenario 2A and 2B a fugitive release rate equivalent to an air change every 2 hours has been assumed. This is considered to be reasonable for the building, although if the building were better sealed resulting in discharges over a longer period, then ambient impact would be reduced in proportion to the ventilation rate.

- The meteorological conditions upon which the assessment was based vary from hour to hour and year to year and influence ambient impact. A sensitivity analysis has shown the differences expected due to changes in meteorological conditions for a five year period. This assessment is based on the 15 minute or one hour period during each of the five years considered providing the maximum impact and as such is likely to be an overestimate for the vast majority of the time.

- The necessary assumptions made regarding surface characteristics (section 3.4) can have either a negative or positive impact on modelling outcomes. Sensitivity analyses indicates that a precautionary approach has generally been adopted in the assumptions made which tends towards an over estimate of ambient impact in most cases. The likely effects of modelling assumptions are not considered significant in terms of the conclusions of the assessment.

There are inherent uncertainties associated with the use of air dispersion models to predict the ambient impact of releases. With this in mind the assessment herein has been undertaken using conservative assumptions which tend towards an over estimation of the ambient impact. It is therefore considered that the assessment has taken a conservative approach and the conclusions reached therefore incorporate a reasonable margin of comfort in spite of the inevitable uncertainty of such modelling studies.

5 CONCLUSIONS

Safran Landing Systems GLS placed a contract with Environmental Scientifics Group Limited (ESG) to undertake an assessment of the impact on local air quality of an abnormal release of hydrogen cyanide from the metal finishing operations at its Meteor Business Park site. Two hydrogen cyanide generation scenarios (A & B) and three release scenarios (1, 2 and 3) were considered.

The absolute worst case hydrogen cyanide generation scenario (A) was considered where a failure of all vats and bund containments resulted in the mixing of the total vat inventory of sodium cyanide and sulphuric acid associated with chromium and cadmium plating with total reaction to produce hydrogen cyanide limited only by the presence of sodium hydroxide and sodium carbonate. A more realistic worst case (B) involving a limited failure of vats and bunds was also considered.

Assuming that the Metal Finishing Facility is evacuated and the air within extracted to atmosphere via the existing ventilation systems serving the vats, the resulting dispersion of hydrogen cyanide releases is predicted to have maximum impact beyond the site boundary, but within the Meteor Business Park. A maximum concentration of 8 times the workplace exposure limit is expected to occur on site. Beyond the site boundary process contributions exceed the Environmental Assessment Level for human health for hydrogen cyanide at all neighbouring commercial premises and residential locations within 1 km.

For the scenario where the release was confined within the Hangar 4 building and the extraction system shutdown with only fugitive releases to atmosphere, concentrations within the site boundary were predicted to be reduced to below the WEL at all ground level locations and to drop considerably at locations beyond the site boundary. This appears to be a somewhat more effective control measure for the protection of site workers following a release than the continued use of the extraction systems.

In the case of a complete failure of the containment of the Hangar 4 building the highest on site concentrations are experienced with the main affect being around the immediate vicinity of Hangar 4. Resulting concentrations beyond the site boundary are above the EAL at neighbouring commercial premises and residential locations, although at lower concentrations that for an extractive release.

The hydrogen cyanide generation scenario A reflects the maximum possible release and is considered highly unlikely. Scenario B is the more likely worst case scenario involving limited vat mixing which has been considered in previous assessments at Safran. For all release scenarios this provides a much lower ambient hydrogen cyanide impact than the corresponding scenario A with most concentrations being within the WEL on site and within the EAL at nearby residential locations. Although the concentrations at the nearest commercial neighbours exceed the EAL for exposure over an hour, this is much reduced and manageable with appropriate evacuation or containment procedures.

The assessment indicates that containment of the release within the Hangar 4 building and subsequent gradual release by fugitive means is likely to provide the least ambient impact and will generally ensure concentrations remain within the WEL and EAL for the most likely scenarios. The use of the existing extraction system to remove any hydrogen cyanide generated will result in higher concentrations beyond the site boundary. A full failure of containment is the worst case release scenario and tends to result in very high concentrations of hydrogen cyanide local to the release point.

In the event of a release from the Metals Finishes Facility it would be most appropriate to muster and evacuate towards the east of the site and to avoid the immediate areas around Hangar 4 and the main gate.

It is considered that the more probable worst case generation scenario with limited vat mixing is unlikely to cause environmental benchmark exceedence either on site or on nearby commercial or residential locations, if suitable precautions are taken. Remaining within premises with doors and window closed will allow time for external concentrations to drop to a safe level by dispersion. Alternatively evacuation will reduce the time exposed to the release with exposure unlikely to be in excess of the 15 minute workplace exposure level.

Necessary assumptions made to undertake the modelling are considered to have the effect of overestimating the process contribution to ambient concentrations of hydrogen cyanide. It is therefore considered that the predicted process impact on ambient concentrations reported herein is a conservative assessment and the conclusions reached therefore incorporate a reasonable margin of comfort in spite of the inevitable uncertainty of such modelling studies.

6 REFERENCES

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4. SI 2010:1001, Environmental Protection, The Air Quality Standards Regulations 2010.

5. Health and Safety Executive, EH240/2005 Workplace exposure limits, March 2013.

6. Hydrogen cyanide and Cyanides: human health aspects, Concise International Chemical Assessment, WHO, 2004.

7. Personal communication, email, G Brain (Safran Landing Systems GLS) to N Ford, 29 March 2017.

Annex A Dispersion modelling contour plots

The results of the modelling of the impact of hydrogen cyanide releases on ambient ground level concentrations are presented in tabular form in Section 4. In Annex A the results are presented as contour plots of the process contribution to ambient concentrations. All results are presented as the maximum contribution of the process (excluding existing background concentrations), expressed as a multiple of the applicable environmental benchmark. All plots are based on the maximum ambient concentration over the receptor grid for the five years (2011 to 2015) considered in the assessment.

The plots are considered over an area of 300 m x 300 m (see Figure 3.2) which essentially covers the immediate site where the workplace exposure limit (WEL) for hydrogen cyanide is considered to apply. Plots are also provided for a wider area (2 km x 2 km, see Figure 3.1) which covers the area in the immediate vicinity of the site and includes the closest commercial/industrial neighbours on the Meteor Business Park and residential locations. In this area, excluding the Safran site, the Environmental Assessment Level (EAL) for human health is considered to apply.

Contour plots are scaled between 1 and 10 times the environmental benchmark. An area with no colouring indicates a concentration below the applicable environmental benchmark. An area in red indicates a concentration equivalent to 10 or more times the environmental benchmark.

The figures presented consider both generation scenarios A and B.

The following figures are presented:

Figure 10	Scenario 2B - Predicted concentrations of hydrogen cyanide (maximum 1 hour mean - EAL) at 1.5 m
Figure 11	Scenario 3B - Predicted concentrations of hydrogen cyanide (maximum 15 minutes mean - WEL) at 1.5 m
Figure 12	Scenario 3B - Predicted concentrations of hydrogen cyanide (maximum 1 hour mean - EAL) at 1.5 m

Generation Scenario A

Maximum possible generation of hydrogen cyanide by combination of all vat inventories

Release scenario 1

Extraction by ventilation systems through flues A1 and A2

Figure A.1 Scenario 1A - Predicted concentrations of hydrogen cyanide (maximum 15 minutes mean - WEL) at 1.5 m

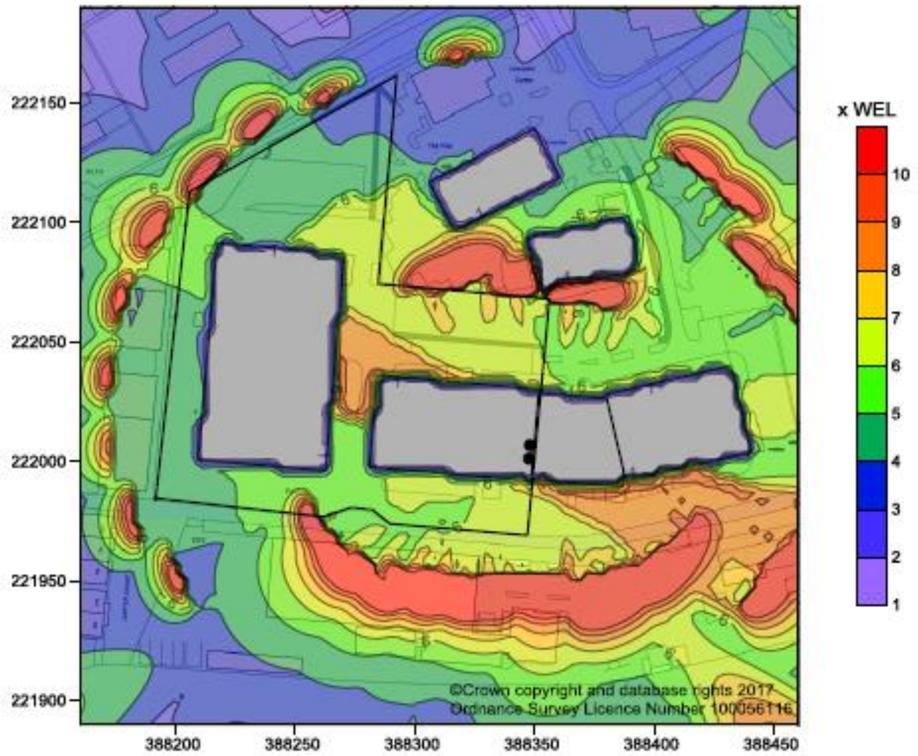
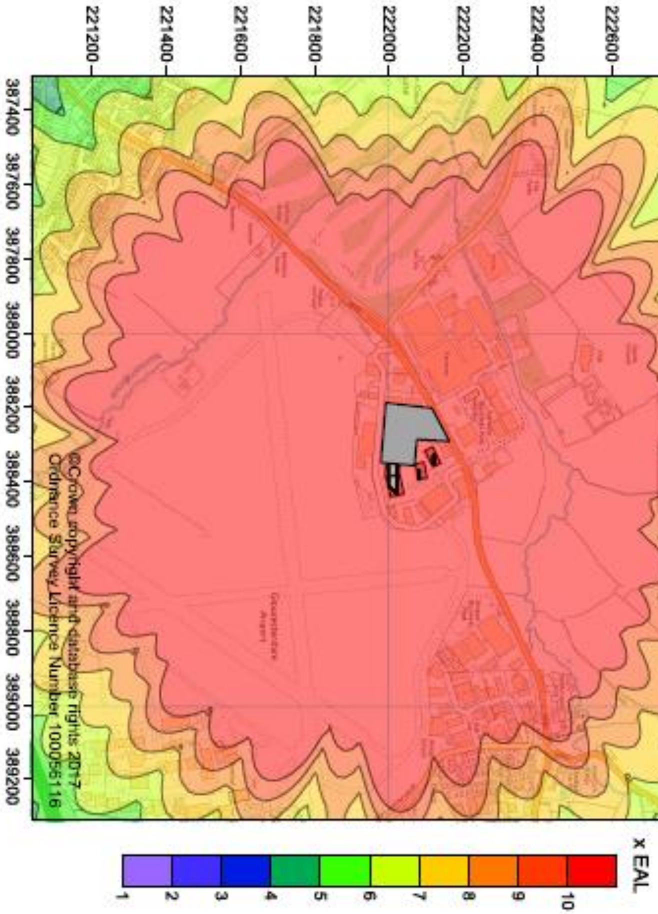


Figure A.2 Scenario 1A - Predicted concentrations of hydrogen cyanide (maximum 1 hour mean - EAL) at 1.5 m



Release scenario 2

Hangar 4 building sealed and release by fugitive leakage only

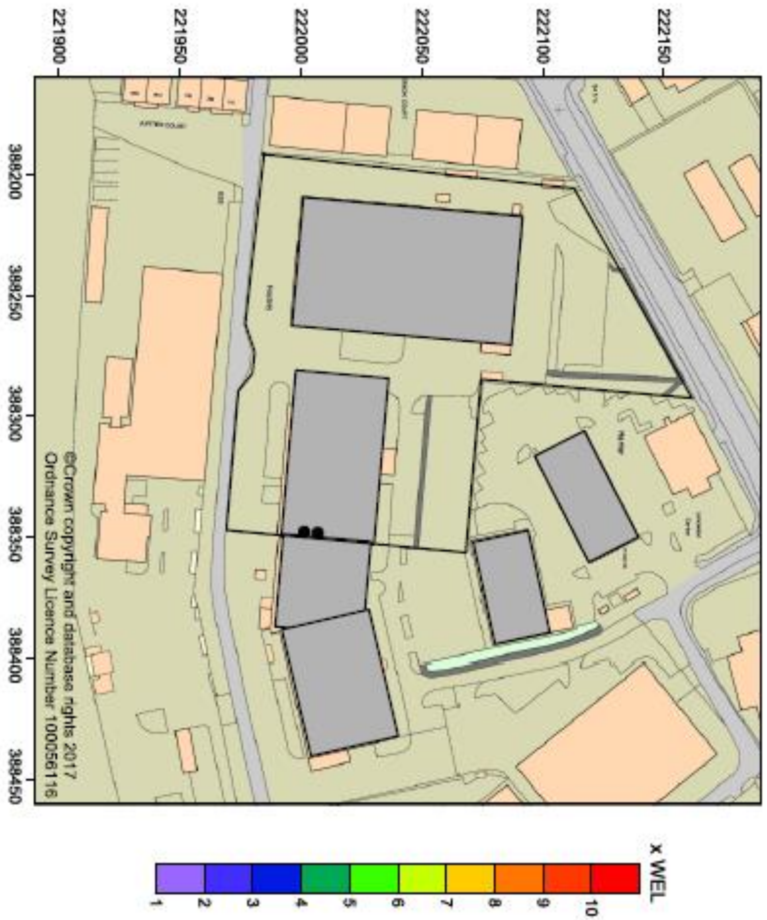
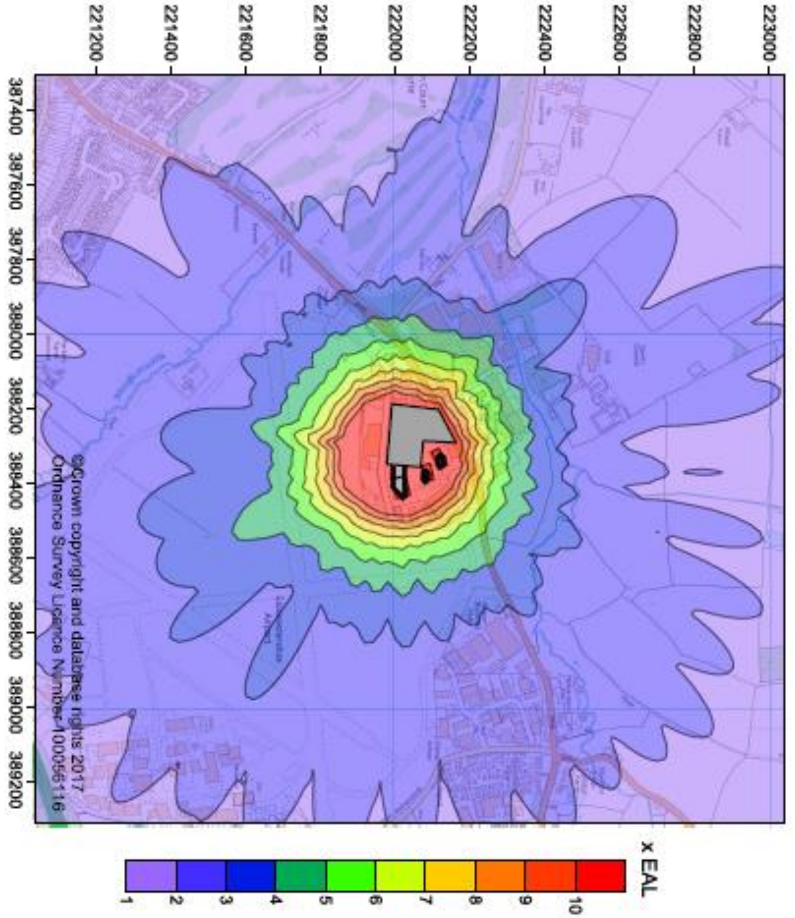


Figure A.3 Scenario 2A - Predicted concentrations of hydrogen cyanide (maximum 15 minutes mean - WEL) at 1.5 m

Figure A.4 Scenario 2A - Predicted concentrations of hydrogen cyanide (maximum 1 hour mean - EAL) at 1.5 m



Release scenario 3

Hangar 4 building containment breached with unconfined release

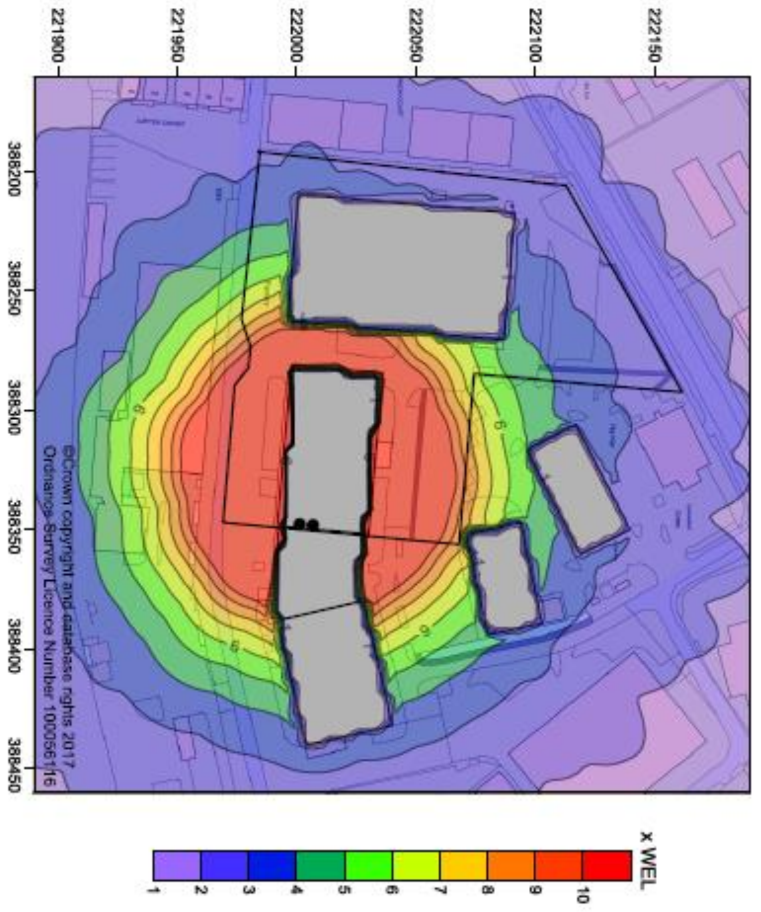
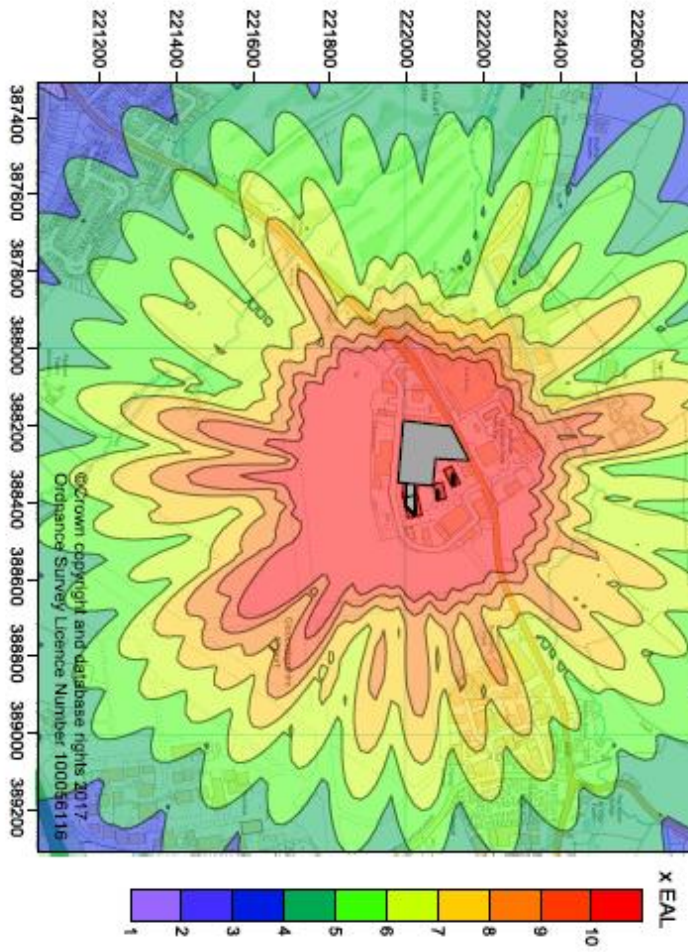


Figure A.5 Scenario 3A - Predicted concentrations of hydrogen cyanide (maximum 15 minutes mean - WEL) at 1.5 m

Figure A.6 Scenario 3A - Predicted concentrations of hydrogen cyanide (maximum 1 hour mean - EAL) at 1.5 m



ESG

Safran Landing Systems GLS
Meteor Business Park, Gloucester

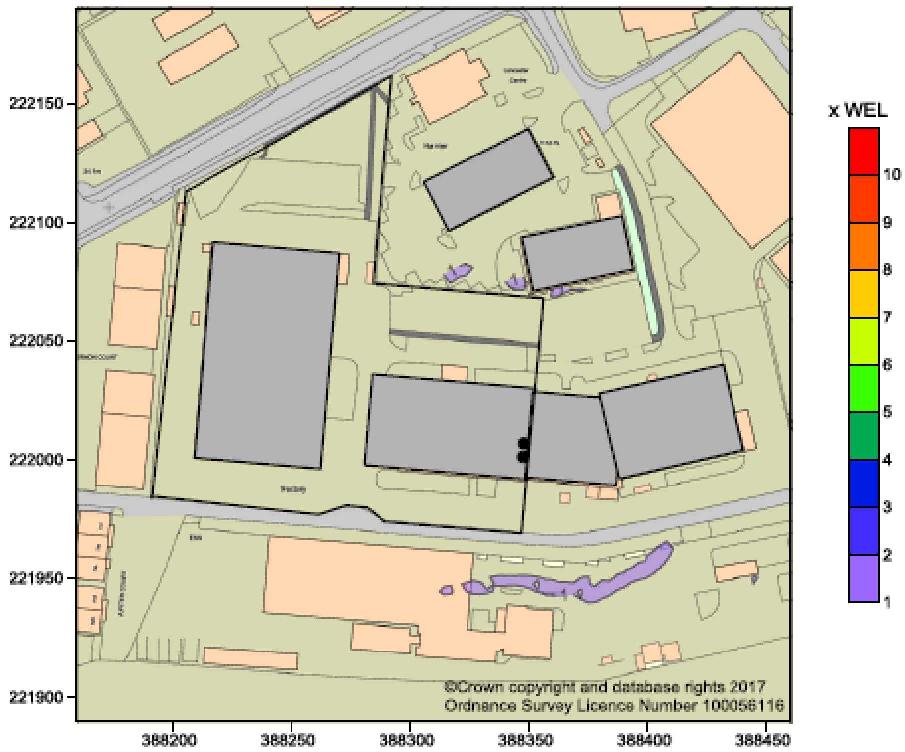
Generation Scenario B

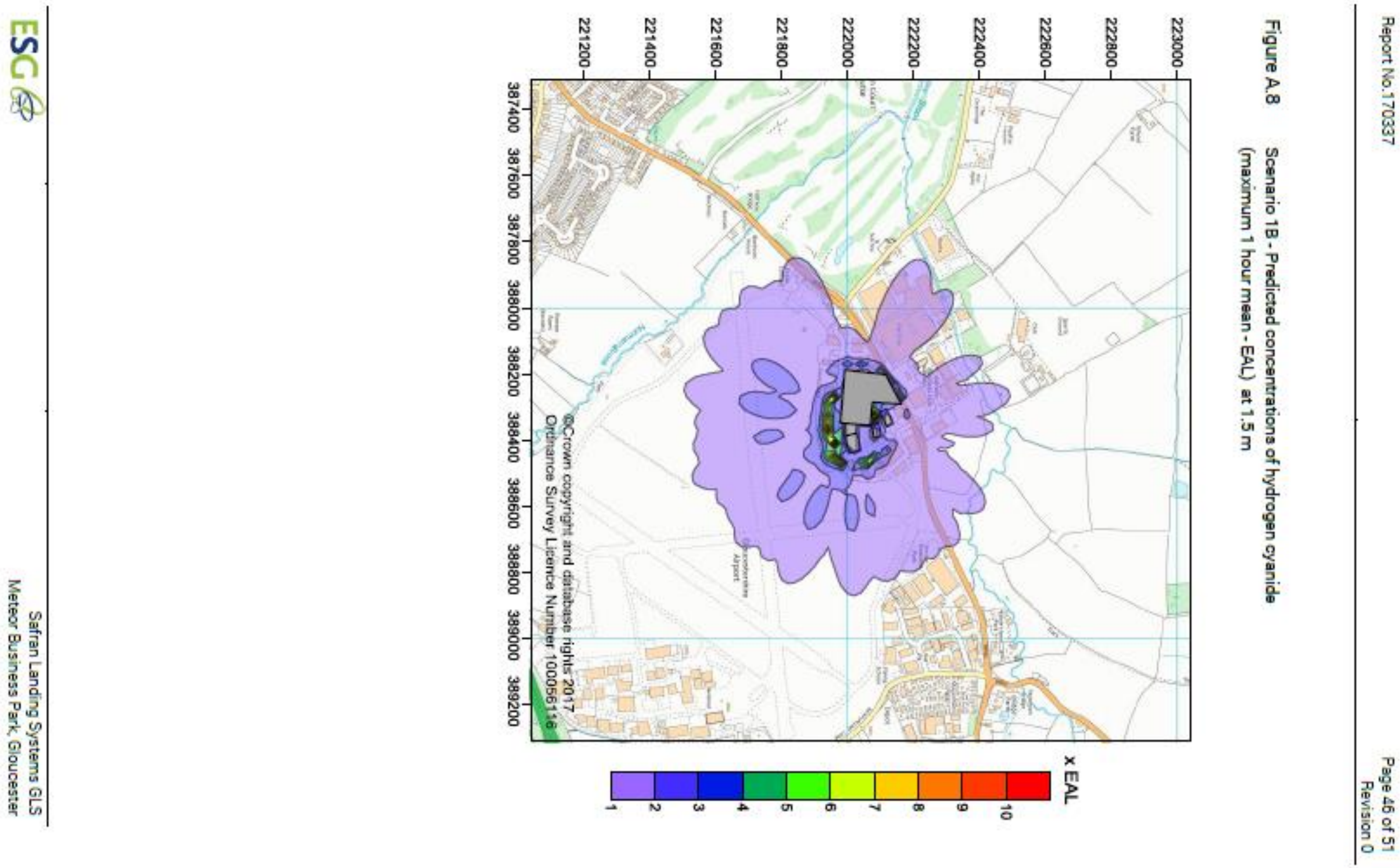
Hydrogen cyanide produced from mixing of Vats 1, 3 and 4 react with the contents of vat 45

Release scenario 1

Extraction by ventilation systems through flues A1 and A2

Figure A.7 Scenario 1B - Predicted concentrations of hydrogen cyanide (maximum 15 minutes mean - WEL) at 1.5 m




Report No.170337
Figure A.8 Scenario 1B - Predicted concentrations of hydrogen cyanide (maximum 1 hour mean - EAL) at 1.5 m
221200
221400
221600
221800
222000
222200
222400
222600
222800
223000
387400
387600
387800
388000
388200
388400
388600
388800
389000
389200
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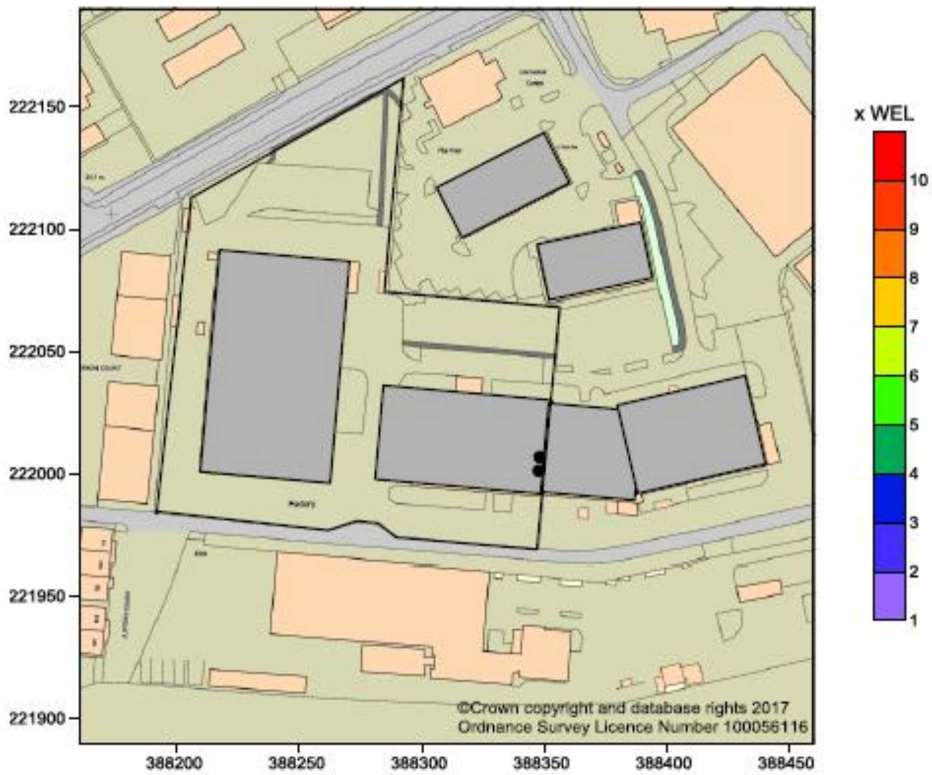
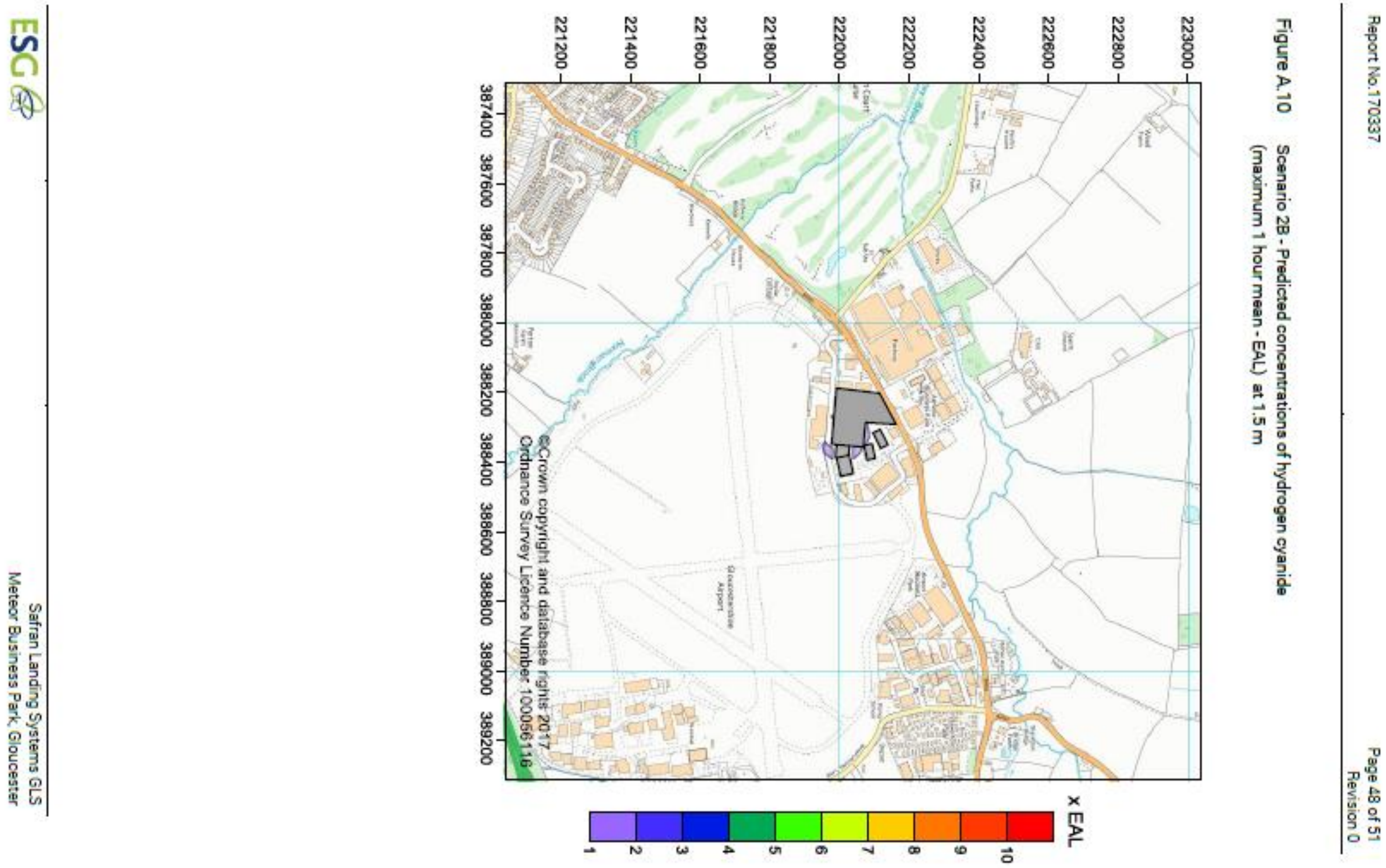
Release scenario 2

Hangar 4 building sealed and release by fugitive leakage only

Figure A.9 Scenario 2B - Predicted concentrations of hydrogen cyanide (maximum 15 minutes mean - WEL) at 1.5 m




Report No.170337
Figure A.10
Scenario 2B - Predicted concentrations of hydrogen cyanide
(maximum 1 hour mean - EAL) at 1.5 m
223000
222800
222600
222400
222200
222000
221800
221600
221400
221200
387400 387600 387800 388000 388200 388400 388600 388800 389000 389200
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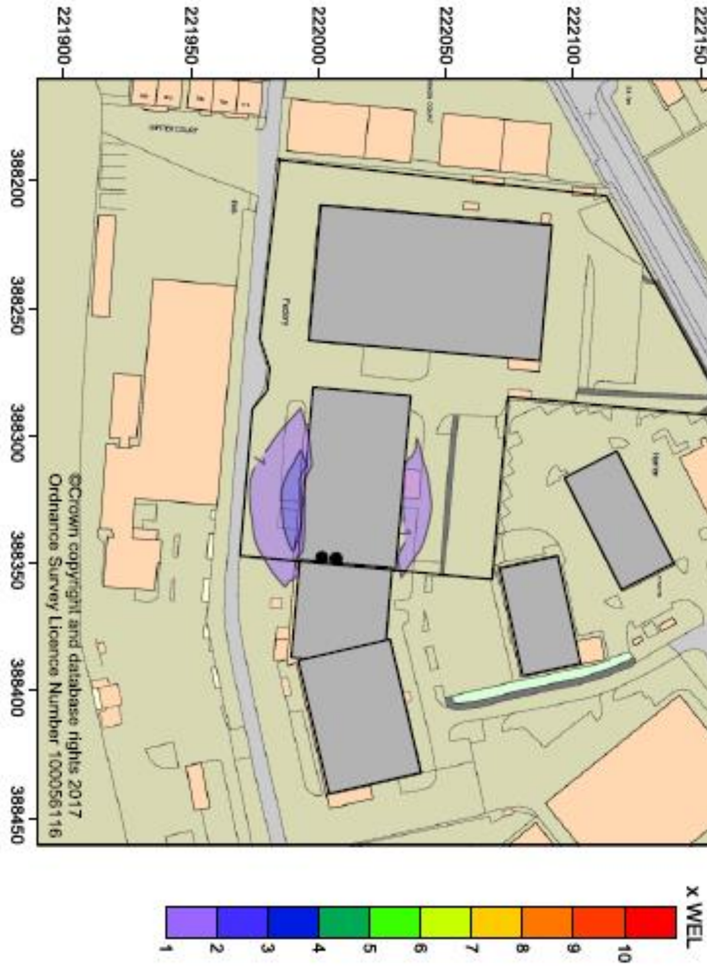
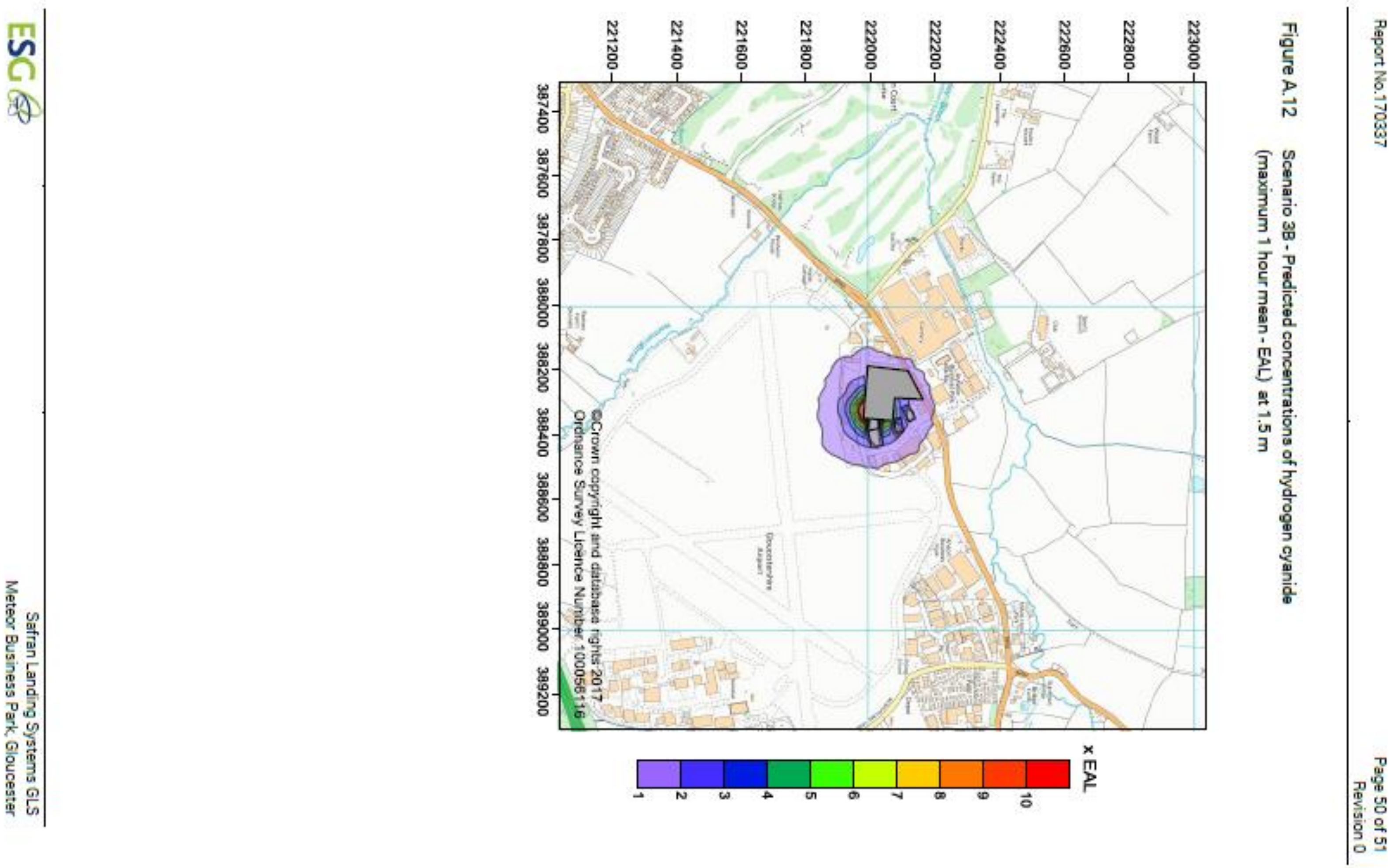
Release scenario 3

Hangar 4 building containment breeched with unconfined release

Figure A.11 Scenario 3B - Predicted concentrations of hydrogen cyanide (maximum 15 minutes mean - WEL) at 1.5 m




Report No.170337
Figure A.12 Scenario 3B - Predicted concentrations of hydrogen cyanide (maximum 1 hour mean - EAL) at 1.5 m
221200
221400
221600
221800
222000
222200
222400
222600
222800
223000
387400
387600
387800
388000
388200
388400
388600
388800
389000
389200
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Ordnance Survey Licence Number 100056116
x EAL
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ANNEX B Model input data

The input data used in the current assessment have been provided under separate cover. Electronic files containing the input data used in the modelling of the maximum process contributions have been provided as detailed below:

Scenarios 1A and 1 B

Hydrogen cyanide (1 hour)	SAF 1A S 2014.APL
Hydrogen cyanide (15 minutes)	SAF 1A L 2014.APL

Scenarios 2A & 2B

Hydrogen cyanide (1 hour)	SAF 1A S 2015.APL
Hydrogen cyanide (15 minutes)	SAF 1A L 2015.APL

Scenarios 3A & 3B

Hydrogen cyanide (1 hour)	SAF 1A S 2013.APL
Hydrogen cyanide (15 minutes)	SAF 1A L 2013.APL

END OF REPORT

Department: **MFF**

TANK INTEGRITY TEST RECORD

TABLE FOR SECTION C.7 & C.10 TANK INTEGRITY, TESTING AND RECORDING

TANK REF	LOCATION & METHOD:	DUE DATE	ACTUAL DATE	RESULT	ACTIONS REQUIRED	Corrective Action due date	Completed and signed off as fit for purpose