RESTRICTED (when complete) until prosecution concluded or 'no prosecution' recommendation is approved
Version 5 (09 Feb 2016 10:01)

Investigation Report with Recommendations

NB - The author experienced issues with formatting (i.e. font / italics / numbering / spacing / etc.) during the drafting of this report. This version is the best that was achieved.

Name of Dutyholder	**Rhodia UK Ltd**
Address of Dutyholder	PO Box 80, Trinity Street, Oldbury, West Midlands, B69 4LN.
Role of Dutyholder	HSWA 1974 – Employer COMAH 1999 (as amended) – Operator EPR 2007 – Operator
Address/location of incident	Trinity Street, Oldbury, West Midlands, B69 4LN. (i.e. Top Tier COMAH Establishment)
Date(s) of investigation	05 Jan 2009 – 23 Oct 2013 (i.e. see Section B1 for details).

Contents

Appendices *(Please tick (✓) when documents included in report)*

1.	EMM1	✓
2.	Draft information(s)	
3.	Summonses)	✓
4.	Witnesses and others interviewed	✓
5.	Exhibits	✓
6.	PACE records	✓
7.	FOCUS/COIN etc. inspection records	
8.	Evidence matrix	✓
9.	CPIA schedules	
10.	Costs schedule	✓
11.	Company search	

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12(5)(a)

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		Company Search

Part A – INVESTIGATION DETAILS

A1 - COIN Case Number:

4147755

A2 - Matter under investigation:

The uncontrolled release of approximately: (i) [redacted] of Phosphine (F^+ / T^+ / C / N); and (ii) [redacted] of Phosphorus vapour (F / T^+ / C / N).

12(5)(a)

A3 - Date of incident:

02 January 2009

A4 - Name of duty holder:

Rhodia UK Ltd

A5 - Role of duty holder:

Health and Safety at Work etc. Act 1974	– Employer
Control of Major Accident Hazards Regulations 1999 (as amended)	– Operator
Environmental Permitting (England and Wales) Regulations 2007	– Operator

A6 - Address of duty holder:

Address of duty holder:	PO Box 80, Trinity Street, Oldbury, West Midlands, B69 4LN.
Registered Office Address:	Oak House, Reeds Crescent, Watford, Hertfordshire, WD24 4QP.
Companies House Reg. No:	00036833

A7 - Location details:

COIN Company: 1014786	Rhodia UK Ltd
COIN Location: 4086707	PO Box 80, Trinity Street, Oldbury, West Midlands, B69 4LN.

A8 - Names and addresses of IPs:

[redacted]

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A9 - Name and full office address of lead HSE investigator:

[redacted]

HM Inspector (Regulatory), HID CEMHD 2C,
Health and Safety Executive,
Haswell House,
St Nicholas St,
Worcester,
WR1 1UW.

Tel: [redacted]1
[redacted]@hse.gsi.gov.uk

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A10 - Names of other HSE investigators:

[redacted]	HM Specialist Inspector	Mechanical Engineering	HID CEMHD 1H
[redacted]	HM Specialist Inspector	Process Safety	HID CEMHD 6B
[redacted]	HM Specialist Inspector	Process Safety	HID CEMHD 6B
[redacted]	HM Specialist Inspector	Predictive	HID CEMHD 5H

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A11 - Name and contact details for non-HSE investigators:

[redacted]

PPC Compliance Officer, Central Area (South), Midlands Region,
Environment Agency
9 Wellington Crescent
Fradley Park
Lichfield
Staffordshire
WS13 8RR

Tel: [redacted]
[redacted]@environment-agency.gov.uk

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A12 - Date investigation commenced:

05 Jan 2009	The Operator's RIDDOR notification (F2508) was received by the ICC on Fri 02 Jan 2009 at 14:47hrs (Ref: 02393090). HSE's local office, however, was unaware of the incident until it was brought to their attention on Mon 05 Jan 2009 and confirmed via a news website. The RIDDOR notification was 'accepted' by HID on 06 Jan 2009 – see Annexe 1.

A13 - Criminal Procedure and Investigations Act 1996:

Investigator	[redacted]	**Officer in charge of Inv (SIO)**	[redacted]
Disclosure Officer	N/A	**Prosecutor**	[redacted]

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A14 - Brief Executive Summary:

1. There was an uncontrolled release at around 12:06hrs on 02 January 2009 at the premises of Rhodia UK Ltd ('Rhodia'), Trinity Street, Oldbury, West Midlands (i.e. Top Tier COMAH site) of approximately:
   (i) [redacted] of Phosphine (i.e. COMAH named dangerous substance); and 12(5)(a)
   (ii) [redacted] of Phosphorus vapour (i.e. COMAH dangerous substance). 12(5)(a)
2. Upon contact with air these substances spontaneously ignited to produce approximately:
   [redacted] of Phosphorus pentoxide (i.e. COSHH substance hazardous to health). 12(5)(a)
3. This would then react with water vapour in the air to produce approximately:
   [redacted] of 100% Phosphoric acid (i.e. COSHH substance hazardous to health). 12(5)(a)
4. This was produced as a mist which would attract more water and be further diluted, but it is not known what dilution would be reached.
5. The mist travelled across the site and went off-site to the surrounding area of mixed residential, industrial, retail, hospitality, school, care, office, etc. premises; although the incident occurred on Friday 02 January 2009 which means that some of these premises may not have been occupied or fully occupied at the time.
6. The incident occurred during routine operation of the [redacted] when a welded steel bar ('rodder'), provided to prevent build-up of product in the [redacted] between the plant's [redacted] and [redacted] failed at the weld and broke in two. One piece of the rodder fell back into the vessels blocking the isolation valve in the [redacted] whilst the other piece pulled clear of the vessels to leave a ~30mm diameter orifice in the [redacted] nozzle's [redacted] through which the dangerous substances escaped. 12(5)(a)
7. Other than the immediate vicinity of the plant no part of the site was evacuated. On-site fire fighters and West Midlands Fire Service (WMFS) attended the scene and a water-curtain was set up over the building to knock down the mist. West Midlands Police set up road blocks in the vicinity of the site to restrict public access to the area and advised local residents to stay indoors, and the Highways Agency directed traffic on the nearby M5.

8. The on-site 'all-clear' was given at around 14:15hrs when the orifice was plugged. The off-site 'all-clear' was given by WMFS at around 15:15hrs. The Police completed their patrols of the affected area at around 22:46hrs.

9. Whilst no one on-site was reported as requiring first-aid or medical treatment, and there were no associated cases of ill-health or injury reported to the Health and Safety Executive (HSE) under RIDDOR, two Highways Agency Traffic Officers and one member of the public reported suffering ill-health effects as a consequence of the incident.

10. The incident was a 'Major Accident' as defined because:

    (i) It resulted from uncontrolled developments at a COMAH site;

    (ii) It led to serious danger* to people on- and off-site; and

    (iii) It involved one or more COMAH dangerous substances.

    *L111 – A Guide to the COMAH Regulations, as amended – page 13, paragraph 61 – *'Serious danger to people means a risk of death, physical injury or harm to health.'*

11. The incident satisfied the criteria for notification (i.e. COMAH Schedule 7*) and was thus reported to the European Commission.

    *L111 – A Guide to the COMAH Regulations, as amended, page 116, paragraph 1(a) – with regard to a consequence of the incident being *'accidental discharge of a dangerous substance involving a quantity of at least 5% of the qualifying quantity laid down in column 3 of Parts 2 or 3 of Schedule 1'* – the estimated quantity of phosphine released was [redacted] and that of phosphorus vapour was [redacted] which would mean that the incident was not reportable to the EC under this criterion. 12(5)(a)

    However – page 116, paragraph 1(b)(v) – with regard to a consequence of the incident being *'the evacuation or confinement of persons for more than two hours (person x hours): the value is at least 500'* – West Midlands Police estimated that the number of persons 'confined' during the 2 to 3 hours of the incident was 4,514 (so person x hours = 9,028 to 13,542).

    Either way – page 117, paragraph 2 states that if the incident was regarded by Member States as being *'of particular technical interest for preventing major accidents and limiting their consequences',* then it should be reported to the EC.

12. Subsequent findings led to the Competent Authority (CA) serving two HSWA Enforcement Notices on 15 May 2009, prohibiting the use of the [redacted] and [redacted] and [redacted] until Rhodia had: 12(5)(a)

    (i) Assessed the thermal expansion of the [redacted] and the [redacted] and 12(5)(a)

    (ii) Realigned the rodder systems to take account of thermal expansion; and

    (iii) Inspected relevant nozzles on the [redacted] and the [redacted] for fatigue cracking; and 12(5)(a)

    (iv) Taken the remedial measures identified as being necessary; or

    (v) Taken any other equally effective measures.

13. The Prohibition Notices were deferred for 48 hours to allow Rhodia to take [redacted] and [redacted] to a safe state (i.e. shut-down the plant safely). 12(5)(a)

14. The CA's records were updated on 01 July 2009 when the status of the Prohibition Notices was marked as 'Complete, remedial action taken'.

15. During their investigation into the incident, the CA required Rhodia to carry out a review/revision of certain aspects of the design, manufacture, installation, inspection, maintenance, use, isolation (and mitigation in the event of an emergency) of the plant. The CA continues to monitor Rhodia's progress with this work via the Intervention Plan.

A15 - Legal duties:

The Health and Safety at Work etc. Act 1974

Section 2(1): It shall be the duty of every employer to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all his employees.

Section 2(2): Without prejudice to the generality of an employer's duty under the preceding subsection, the matters to which that duty extends include in particular –

a. the provision and maintenance of plant and systems of work that are, so far as is reasonably practicable, safe and without risks to health;

b. ...

c. the provision of such information, instruction, training and supervision as is necessary to ensure, so far as is reasonably practicable, the health and safety at work of his employees; etc.

Section 3(1): It shall be the duty of every employer to conduct his undertaking in such a way as to ensure, so far as is reasonably practicable, that persons not in his employment who may be affected thereby are not thereby exposed to risks to their health or safety.

The Control of Major Accident Hazards Regulations 1999 (COMAH) as amended by the Control of Major Accident Hazards (Amendment) Regulations 2005

Regulation 4 – General duty: Every operator shall take all measures necessary to prevent major accidents and limit their consequences to persons and the environment.

Regulation 9(1) – On-site emergency plan: Every operator of an establishment shall prepare an emergency plan (in these Regulations referred to as an "on-site emergency plan") which shall be adequate for securing the objectives specified in Part 1 of Schedule 5 and shall contain the information specified in Part 2 of that Schedule.

Regulation 10(1) – Off-site emergency plan: The local authority, in whose area there is an establishment, shall prepare an emergency plan (in these Regulations referred to as an "off-site emergency plan") in respect of that establishment, and such a plan shall be adequate for securing the objectives specified in Part 1 of Schedule 5 and shall contain the information specified in Part 3 of that Schedule.

Regulation 10(3) – Off-site emergency plan: An operator shall supply to the local authority in whose area the establishment is situated the information necessary for the purpose of enabling the authority to prepare the off-site emergency plan.

Regulation 12 – Implementing emergency plans: A person who has prepared an emergency plan pursuant to a duty imposed on him by these Regulations shall take reasonable steps to put it into effect without delay when –

(i) A major accident occurs; or

(ii) An uncontrolled event occurs which could reasonably be expected to lead to a major accident.

The Environmental Permitting (England and Wales) Regulations 2007

Regulation 38(2): It is an offence for a person to fail to comply with or to contravene an environmental permit condition.

Part B – FACTUAL REPORT

NOTE:

This report is drafted using evidence gathered by the CA, including:

(i) That already in the possession of the CA at the time of the incident (e.g. Rhodia's COMAH Safety Report 2007);

(ii) That volunteered by Rhodia, or taken into possession by the CA, or recorded in the CA Inspectors' Notebooks as contemporaneous notes during the investigation; and

(iii) That recorded by the CA in CJA s9 Voluntary and/or PACE Witness Statements (and relevant supporting documentation) during the investigation.

B1 - Description of the facts and circumstances leading to the accident/event

Dates of Investigation:

05 Jan 2009 – CA site visit;
06 Jan 2009 – CA site visit;
08 Jan 2009 – CA site visit;
14 Jan 2009 – CA site visit;
16 Jan 2009 – HSL site visit (to take items into possession);
21 Jan 2009 – CA meeting;
23 Jan 2009 – CA site visit;
11 Feb 2009 – CA meeting with HSL;
27 Feb 2009 – CA site visit;
16 Mar 2009 – CA visit to Highways Agency and Asda Supermarket);
19 Mar 2009 – CA meeting with HSL;
01 Apr 2009 – CA meeting with HSL;
15 Apr 2009 – CA site visit;
16 Apr 2009 – CA site visit;
21 Apr 2009 – CA site visit;
05 May 2009 – CA meeting with HSL;
14 May 2009 – CA meeting;
15 May 2009 – CA site visit;
21 May 2009 – CA site visit;
08 Jun 2009 – CA site visit;
23 Jul 2009 – CA site visit;
05 Oct 2010 – CA meeting with Solicitor Agent;
20 Oct 2009 – CA site visit;
20 Jul 2010 – PACE Interview of Rhodia UK Ltd;
19 Jan 2011 – CA meeting with Solicitor Agent;
03 Mar 2011 – CA site visit;
14 Mar 2011 – CA site visit;
30 Mar 2011 – CA meeting with Solicitor Agent;
25 Jul 2011 – CA meeting with Solicitor Agent;
21 Sep 2011 – CA meeting;
27 Sep 2011 – CA meeting;
11 Oct 2011 – CA meeting;
14 Nov 2011 – CA site visit;
26 Mar 2012 – CA site visit *(PS inspection of plant – incorrect date on PS report i.e. 26 Mar 2010);*
24 May 2012 – CA meeting with Solicitor Agent; and
02 Aug 2012 – CA meeting with HSL.

Persons involved in the Investigation:

The following persons were all involved in the investigation on one or more of the above dates:

The CA:-

HSE	HM Principal Inspector, Regulatory
HSE	HM Inspector, Regulatory
HSE	HM Inspector, Regulatory
HSE	HM Principal Specialist Inspector, Mechanical Engineering
HSE	HM Specialist Inspector, Mechanical Engineering
HSE	HM Specialist Inspector, Mechanical Engineering / Trainee)
HSE	HM Specialist Inspector, Mechanical Engineering / Trainee)
HSE	HM Specialist Inspector, Process Safety
HSE	HM Specialist Inspector, Process Safety
HSL	Higher Scientist, Metallurgical
HSL	Higher Scientist, Mechanical
HSL	Principal Engineer
HSL	Principal Engineer
HSL	Engineering and Personal Safety Unit
HSL	Engineering and Personal Safety Unit
EA	Compliance Officer (PPC), Environment Agency
EA	Compliance Officer (PPC), Environment Agency
Frisby	Solicitor Agent (Frisby and Co Solicitors)
Frisby	Solicitor Agent (Frisby and Co Solicitors)

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The Operator:-

Rhodia	
Rhodia	
Rhodia	
Rhodia	
Rhodia	
Rhodia	
Rhodia	Lobby Commissionaire
Rhodia	Electrician / Fire Officer
Rhodia	PAF Plant Team Leader / Casualty Officer
Rhodia	
Rhodia	Welder
Rhodia	Team Leader / Operative
Rhodia	
Rhodia	
Rhodia	
Rhodia	QA Shift Manager / Works Incident Controller (WIC)
Rhodia	QA and Development Manager
Rhodia	Welder
Rhodia	Process Shift Manager / Technical Incident Controller (TIC)
Rhodia	Deputy Team Leader / Operative
Rhodia	
Rhodia	
Rhodia	
Rhodia	
Rhodia	
Rhodia	

[redacted]	Rhodia	Maintenance Fitter
	Rhodia	[redacted]
	Rhodia	Maintenance Fitter
	Rhodia	Maintenance Fitter
	Rhodia	Maintenance Fitter
	Rhodia	Maintenance Fitter
	Rhodia	Maintenance Fitter
	Rhodia	Rigger / Craftsperson
	Rhodia	Maintenance Fitter
	Rhodia	Deputy Team Leader
	Rhodia	[redacted]
	Rhodia	[redacted]
	Rhodia	Senior Process Engineer
	Rhodia	[redacted]
[redacted]	RCA	[redacted] (RCA Laboratories Ltd)
[redacted]	AVT	[redacted] (AV Technology Ltd)
[redacted]	DLA	Solicitor (DLA Piper UK LLP)
	DLA	Solicitor (DLA Piper UK LLP)

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Others:-

[redacted]	Asda	[redacted]
	Asda	[redacted]
	HA	Traffic Officer Manager (Highways Agency)
	HA	Traffic Officer (Highways Agency)
	HA	Traffic Officer (Highways Agency)

** These persons all provided a CJA s9 Voluntary Statement.*

Rhodia provided:

a. *A written statement in advance of the PACE interview:*
b. *A PACE Statement; and*
c. *Two written responses to written questions (i.e. whilst still under caution).*

INITIAL FINDINGS AND ACTION TAKEN:

The Operator

1. Rhodia (member of the Solvay Group) is a speciality chemical company which (according to their website) employs around 14,250 people worldwide and generated sales of €6.17 billion in 2011.

2. Rhodia UK Ltd employs around [redacted] people at their Oldbury site which occupies approximately 60 acres of land close to Junction 2 of the M5 motorway near Birmingham. See Annexe 2 – Map of Local Area.

12(5)(a)

3. The site houses [redacted] and produces phosphorus-based intermediates which are used in the manufacture of a wide range of products including pharmaceuticals, paints, detergents, water treatment chemicals and flame retardants. The Oldbury site is part of the global Rhodia Novecare business. See Annexe 3 – Map of Site.

12(5)(a)

The Substances and their CHIP Classifications

Phosphine:

PH_3 – COMAH named dangerous substance

F^+ – Extremely flammable (i.e. catches fire in contact with air)
R12 – Extremely flammable
R17 – Spontaneously flammable in air

T^+ – Very toxic (i.e. at very low levels causes damage to health)
R26 – Very toxic by inhalation

C – Corrosive (i.e. may destroy living tissue on contact)
R34 – Causes burns

N – Dangerous for the environment
R50 – Very toxic to aquatic organisms

Phosphorus (white/yellow):

P_4 – COMAH dangerous substance

F – Highly flammable (i.e. may catch fire in contact with air, etc.)
R17 – Spontaneously flammable in air

T^+ – Very toxic (i.e. at very low levels causes damage to health)
R26/28 – Very toxic by inhalation and if swallowed

C – Corrosive (i.e. may destroy living tissue on contact)
R35 – Causes severe burns

N – Dangerous for the environment
R50 – Very toxic to aquatic organisms

Phosphorus pentoxide:

P_2O_5 – COSHH substance hazardous to health

C – Corrosive (i.e. may destroy living tissue on contact)
R35 – Causes severe burns

Phosphoric acid (ortho-):

H_3PO_4 – COSHH substance hazardous to health

Hazard is dependent upon concentration, i.e.

Conc >= 25%:
C – Corrosive (i.e. may destroy living tissue on contact)
R34 – Causes burns

Conc >= 10% and < 25%:
Xi – Irritant (i.e. may cause inflammation to the skin or other mucous membranes)
R36/38 – Irritating to eyes and skin

The Plant and Process

Overview

1. Chemicals (mainly phosphorus-based) have been manufactured at the site since 1851.

2. Rhodia UK Ltd took over ownership and operation of the site in March 2000 as part of their acquisition of Albright and Wilson Ltd (A&W). It is understood that the majority (if not all) of A&W's employees at the site (including management) were retained by Rhodia following the acquisition.

3. Rhodia use phosphine as an intermediate in their manufacture of [redacted] and [redacted] collectively known as [redacted]. 12(5)(a)

4. There are two plants at the Oldbury site used for the manufacture of phosphine:

   (i) [redacted] – designed, installed and commissioned in 1981 by A&W; and 12(5)(a)

   (ii) [redacted] – designed, installed and commissioned mid-1990s by A&W. 12(5)(a)

   See Annexe 4 – Map of Plant.

5. [redacted] 12(5)(a)

6. [redacted] and [redacted] manufacture phosphine via the same two-stage process involving the controlled reaction of [redacted] 12(5)(a)

   (i) [redacted] 12(5)(a)

   (ii) [redacted] 12(5)(a)

7. Rhodia report that the advantage of this process is that the yields of [redacted] are high and there are limited by-products of [redacted] and [redacted] Alternative processes include the [redacted] but Rhodia report that with that process the [redacted] production is lower as it is not the main product and it also generates a significant quantity of [redacted] 12(5)(a)

8. On both [redacted] and [redacted] the [redacted] through which the [redacted] flows through gravity. This [redacted] is provided with a rodding device ('rodder') which is used to clear any build-up of [redacted] within the line. 12(5)(a)

9. The rodder is constructed of two-pieces [redacted] It was this rodder on [redacted] that failed (i.e. broke in two at the welded joint) on 02 Jan 2009, permitting the loss of containment of COMAH dangerous substances through the resultant ~ [redacted] 12(5)(a)

The [redacted] and the [redacted] 12(5)(a)

10. See Annexe 5 – Block Diagram of Process.

11. See Annexe 6 – Schematics of [redacted] and [redacted] Plants. 12(5)(a)

12. See Annexe 7 – Schematic of Rodder, [redacted] and [redacted] 12(5)(a)

13. [redacted] 12(5)(a)

14. [redacted] 12(5)(a)

15. [redacted] 12(5)(a)

16. [redacted] 12(5)(a)

17. [redacted] 12(5)(a)

[redacted]

18. [redacted] 12(5)(a)

19. [redacted] 12(5)(a)

[redacted]

20. [redacted] 12(5)(a)

21. [redacted] 12(5)(a)

22. [redacted] 12(5)(a)

23. [redacted] 12(5)(a)

24. [redacted] 12(5)(a)

25. [redacted] 12(5)(a)

26. [redacted] 12(5)(a)

27. [redacted] 12(5)(a)

28. [redacted] 12(5)(a)

The Rodder and Rodder Assembly

29. [redacted] 12(5)(a)

30. [redacted] 12(5)(a)

31. [redacted] 12(5)(a)

32. [redacted] 12(5)(a)

33. [redacted] 12(5)(a)

34. [redacted] 12(5)(a)

35. [redacted] 12(5)(a)

36. Rhodia state, however, that in 1989, following what they believe to have been concerns regarding the risk of an employee falling down the stairs whilst using the rodder, A&W automated (i.e. motorised) the rodding system. The [redacted] however, states that a rodder broke in the early 1980s when the process was manual and that it was this that prompted A&W to automate the process (and also to use a larger diameter bar than they'd used before – which may explain the apparent error in Rhodia's Voluntary Statement of 20 Jul 2010 where the diameter of the rodder is given as [redacted] rather than the [redacted] that it was at the time of the incident). 12(3) 12(5)(a)

37. Whatever the reason, A&W apparently designed and built the new system themselves and later provided the same system on [redacted] when that was built. Drawing 4341 (dated 13/04/89) – see Annexe 10 – does not show a handle but has a bearing bracket that is referenced to Drawing 4366 (dated 19/05/89) – see Annexe 11. This remains the same for later versions of Drawing 4341, and the CA were shown Drawing 4341 Revision C (dated 03/07/89) – see Annexe 12, and were advised by Rhodia's [redacted] that this was the design of the rodder at the time of the incident. 12(5)(a) 12(3)

38. [redacted] 12(5)(a)

39. The [redacted] was also originally designed for the rodder to be manufactured from a single piece of stainless steel bar. Rhodia state, however, that at some time during A&W's ownership of the site a two-piece rodder was designed following what they believe to have been difficulty in sourcing a single length of bar meeting the required straightness tolerance. A&W apparently designed and built the new two-piece rodder themselves and later provided the same type two-piece rodder on [redacted] 12(5)(a)

40. Further changes to the original manual design include: the paddle, which is now [redacted] long (apart from occasional variation in the width of the paddles, the rodders on [redacted] and [redacted] are identical in terms of design, installation and use); and the fact that there is no collar to limit insertion of the rodder which is now held in position by the drive mechanism (Drawing 4341C does not show how far into the [redacted] the rodder is expected to travel). 12(5)(a) 12(5)(a)

41. According to Drawing 4341C the [redacted] rodder is [redacted] long. 12(5)(a)

42. Rhodia's [redacted] 12(3) reported that the bar is only available in [redacted] 12(5)(a) lengths and that the weld is always made towards the motor-end of the rodder.

43. Rhodia state that at the time of the incident, and to the best of their knowledge, two-piece rodders had been in use on the plant for at least twenty years (i.e. since 1989 – as per the automated rodder) without incident or rodder-failure. Drawing 4341C (which, according to Rhodia's UK SHE Director – see above – was the design of the rodder at the time of the incident) does not, however, show the welded joint. Furthermore, on 08 Jan 2009, Rhodia showed the CA a used rodder. They were unsure of its age or origin (i.e. [redacted] or [redacted] but it was subsequently found to be a single-piece rodder (i.e. not a welded two-piece). Bearing in mind that Rhodia's [redacted] had also reported that rodders were manufactured only as and when they were required and that used rodders were not retained, it is not clear why this one-piece rodder had been retained, apparently for at least twenty years. 12(5)(a) 12(3)

Manufacture

44. The rodders on [redacted] and [redacted] are changed every two years. They are manufactured by Rhodia's own craftsmen and are made only as and when they are required. 12(5)(a)

45. In brief, the male and female connections are made by the [redacted] who then screws together the two pieces of bar and passes the rodder to the Welder. The Welder applies two runs of circumferential weld around the joint to prevent the two parts of the rodder from unscrewing during use. He then passes the rodder back to the [redacted] who removes the weld cap. The rodder is checked for straightness by the [redacted] before use. 12(3) 12(3) 12(3)

46. In detail, first the [redacted] orders the raw material on the advice of the Plant Engineer. He does not know who checks the raw material to a relevant standard. 12(3)

47. Upon receiving the raw material from the [redacted] the [redacted] makes [redacted]e male and female connections by drilling a hole in the end of one bar to a depth of approx [redacted] (controlled by either the gauge on the tail stock or by rule and marking on the drill bit). The tolerance on the hole diameter depen[redacted]s upon the drill size, and this is chosen by reference to a table. The threaded hole is roughly [redacted] deep. 12(3) 12(5)(a) 12(5)(a)

48. The external threaded bar is [redacted] in diameter and the thread pitch is controlled by the die or a die nut. The external screw thread shape and dimensions are controlled by the die then checked by the [redacted] using thread gauges. 12(5)(a) 12(3)

49. The [redacted] then checks the hole depth and male part with a rule to ensure that all threads engage and that the male part does not bottom-out. The bore is drilled and not machined so that the hole is not rough or marked. On the male section there is no deliberate radius, it is whatever the radius on the tool bit is. The radius is not controlled because where it is going into there is a chamfer edge on the bore. The radius is not inspected. The thread size, shape and dimensions are controlled by the tap and die used. 12(3)

50. After cutting the threads, the [redacted] hand-screws the two pieces of the bar together then gives them a $^1/_2$ turn with Stilsons. There is no control over the torque when tightening. The screw threads engage well but sometimes they can be a little tight and bind. 12(3)

51. To check that the rodder is straight the [redacted] rotates it in a lathe and checks it by eye. The [redacted] then checks the straightness using a dial test indicator (DTI). There is no other inspection. The [redacted] sprays the joint with anti-grease agent to ensure that it is clean and then passes the rodder to the Welder. 12(3) 12(3) 12(3)

52. Neither of the two [redacted] are aware of any post-machining/pre-welding inspection carried out on the rodder. Upon receiving it from the [redacted] they check the rodder for straightness using a spirit level and by eye. [redacted] have welded approximately two rodders in their time, neither of which were rejected for not being straight. 12(3) 12(3) 12(3)

53. The Welder cleans the site to be welded by means of emery cloth and a stainless steel wire brush. Without restraining the rodder he makes the weld with 5-7 l/min Argon; two runs (root and cap); 1.6mm filler; ~75-80 Amps; rotating the rodder by hand on rollers or v-blocks. The welding rod (TIG) is stamped '316L' to match the rod material and they use 316L rods (TIG wire) at 1.6mm diameter and Tungsten Inert Gas Welding where Argon is the inert gas. The Welder applies four tack welds at 90 degree intervals and then applies the root weld. He cleans the weld with a stainless steel brush but does not inspect it before applying the cap weld to be over-sized so that it can be machined back. It is believed that at this point the paddle is welded on, and always to the end of the long section of the rodder.

54. After welding, the rodder is left to cool for no given time (i.e. it depends upon work load and is checked by touch). The rodder is then checked by eye for cracks and by spirit level for straightness (i.e. to ensure that it's straight enough to prevent it catching when spinning during use). There is no post-weld heat-treatment of the rodder and the [redacted] are not aware of any non-destructive testing (NDT) carried out on the weld. 12(3)

55. The [redacted] states that he is not qualified to inspect welds and that there is no Weld Inspector on site. He states that for certain welds (e.g. on pipe work) there are Condition Monitors on site who carry out dye penetrant work. However, the weld on the rodder is not considered to be safety critical so there is no NDT carried out on it. 12(3)

56. The rodder is then returned to the [redacted] and is checked for straightness as before, by both the [redacted] and the [redacted] If the rodder is found to not be straight the [redacted] adjusts it using a hide hammer and whatever force is necessary. The rodder is then machined just enough to remove the top of the weld (i.e. there can be a lip on one side and a ridge on the other). After machining, the rodder is checked for straightness as before by the [redacted] 12(3)

57. The [redacted] decides whether a new rodder is fit for use based upon his experience and the competence of the [redacted] and the Welder. Whilst he has, in the past, rejected the raw material (i.e. unwelded bar) due to it being bent, a rodder has never been rejected because it was not straight enough. No parts of an old rodder are used to make a new one and no rodder has ever been tested to destruction. 12(3)

58. Rhodia state that two-piece rodders have been manufactured in this way for at least twenty years without any issues arising and with no failure of a rodder. However, as described above:

    (i) Rhodia's [redacted] reported that Drawing 4341C was the design of the rodder at the time of the incident, but this drawing does not show the welded joint; and 12(3)

    (ii) Whilst Rhodia reported that rodders are only made as and when required, and that used rodders are not retained, on 08 Jan 2009 Rhodia showed the CA a used rodder (of uncertain origin) which was subsequently found to be a single-piece rodder – apparently retained (for whatever reason) for at least twenty years.

59. Rhodia also state that the same staff have been making rodders using the same procedure every year for over twenty years, and that these staff are well aware of the procedure and relevant specifications and are competent craftsmen operating in accordance with good engineering practice. However:

    (i) The [redacted] has been on-site for around 36 years and in post for around 9 years and has overseen the manufacture of around 9 rodders, including that which failed on 02 Jan 2009; 12(3)

    (ii) The [redacted] has been on site for around 12 years and has been the [redacted] on-site for the past 5 years. He was trained how to machine the rodder by the [redacted] and states that he has machined approximately 15-20 rodders, including that which failed; 12(3)

(iii) Four Welders left Rhodia in the 3-4 years prior to the incident and there were (at the time of the incident) just [redacted] remaining; only two of whom are [redacted] Rhodia permits only [redacted] to weld rodders and neither of the [redacted] is certain as to which of them welded the rodder that failed; 12(3)

(iv) One of the Coded Welders has been on-site and in post for around 31 years. He states that he knows how to make the weld simply from his experience as a welder and that he has welded only a 'couple' of rodders; and

(v) The [redacted] has been on-site and in post for only 2 years. He states that he was trained by the [redacted] and the [redacted] and that that he also has welded only two rodders. The [redacted] believes it to be [redacted] who welded rodder that failed. 12(3)

60. Furthermore, the procedures used for the manufacture of the rodders were undocumented i.e. Rhodia hold no pre-incident documented procedures or specifications for either:

(i) Constructing the screw joint of the two piece rodder; or

(ii) Constructing, inspecting or testing the weld on the two-piece rodder; or

(iii) Adjusting the rodder to ensure the necessary level of straightness before it is used.

Installation

61. [redacted] 12(5)(a)

62. [redacted] 12(5)(a)

63. [redacted] 12(5)(a)

64. [redacted] 12(5)(a)

65. [redacted] 12(5)(a)

66. [redacted] 12(5)(a)

67. [redacted] 12(5)(a)

68. Since 2007-08, the above has been carried out every 6 months (i.e. when the rodder is inspected for corrosion and when it is replaced). Prior to this the procedure was carried out only when the rodder was replaced (i.e. every 2 years). Rhodia's [redacted] has set up the rodder in this way for the past 17 years. 12(3)

69. However, the procedures used for installing the rodder were undocumented, i.e. Rhodia hold no pre-incident documented procedures or specifications for either:

    (i) Setting up the rodder assembly; or

    (ii) Setting up the rodder; or

    (iii) Aligning the rodder with the [redacted] 12(5)(a)

70. The [redacted] states that no adjustments are made at any time to the rodding system or plant to take account of thermal expansion and that this has always been the case. 12(3)

71. Rhodia state that no realignment is required to take into account thermal expansion.

Planned Preventative Maintenance

72. The rodder is replaced every two years due to corrosion of the paddle.

73. The rodder assembly is inspected daily by Plant Operatives, six-monthly by the Maintenance Team, and annually by the Plant Engineering Team. However, Rhodia's [redacted] 12(3) reports that records are not kept of the findings of either the six-monthly or the annual inspections, and that these inspections are mainly for the purpose of assessing the level of corrosion of the rodder and do not include a check of e.g. the clearance of the bush in the [redacted] 12(5)(a)

74. According to Rhodia, the rodder that failed had seen approximately 15 months service and its last annual inspection (which was visual with no NDT) had been in September 2008 after 12 months service when it was deemed to be in a serviceable condition and was replaced without repair. This is confirmed by the [redacted] who states that the failed rodder was installed in September 2007. (The [redacted] does, however, later state that the failed rodder was new when installed in September 2008, but this contradicts not only his previous statement, but also that of Rhodia, plus Rhodia's Work Order and Permit to Work records. It is thus assumed that when providing his later statement he confused the [redacted] rodder with that in [redacted] which was indeed installed new in September 2008). 12(3) 12(5)(a) 12(5)(a)

Use

75. [redacted] 12(5)(a)

76. [redacted] 12(5)(a)

77. [redacted] 12(5)(a)

78. [redacted] 12(5)(a)

79. [redacted] 12(5)(a)

80. [redacted] 12(5)(a)

[redacted] 12(5)(a)

[redacted] 12(5)(a)

[redacted] 12(5)(a)

[redacted] 12(5)(a)

81. Rhodia produced a copy of instructions dated May 2007 regarding the operation of the rodder (see Annexe 13 – Instructions for Rodder Operation). However, these simply state the mechanics of the operation (i.e. [redacted] and [redacted] etc.) and do not specify the frequency of rodding. Furthermore, the two Plant Operatives interviewed (i.e. the [redacted] and [redacted]) were not aware of these instructions. 12(5)(a) 12(3) 12(3)

Reactive Maintenance

82. The [redacted] and the Operatives state that they have never noticed any vibration, juddering or banging during operation of the rodder. 12(3)

83. Rhodia state that they have no record of any such vibration and that the Operative cannot remember having experienced this on [redacted] and ask whether the HSE has become confused with [redacted]? – which would seem to imply that [redacted] was known to vibrate. 12(5)(a)

84. Rhodia state that the [redacted] and [redacted] Plants have been operated for over 20 yrs and there has never previously been a failure of a rodder or any indications to suggest that such a failure could occur. 12(5)(a)

85. However:

(i) As previously described, the [redacted] states that a one-piece rodder broke in the early 1980s; 12(3)

(ii) During operation product is sometimes seen on the retracting rodder and this fumes and sparks;

(iii) One of the Operatives states that he recalls a time or two when the rodder became completely jammed and they thought it had caught on the side of the [redacted] but that this happened very infrequently; 12(5)(a)

(iv) Rhodia state that sometimes the rodders become 'sticky' due to the build-up of [redacted] within the [redacted] Operatives report that when this happens both the rotating and reciprocating motions can seize; 12(5)(a)

(v) One of the Operatives states that the rodder on [redacted] hardly ever gets stuck, but the rodder on [redacted] tends to stick more often, i.e. '– it just jams'; 12(5)(a)

(vi) The other Operative describes the rodders as sticking 'fairly infrequently – maybe once a week at most';

(vii) There is apparently no pattern to when a rodder sticks i.e. it does not stick more or less often if they rod more frequently; and

(viii) When a rodder sticks the Operatives tap it with a metal bar or hammer by the [redacted] However, if it is well and truly stuck, they use Stilsons to turn it and free it manually. Sometimes when it sticks it has to be freed by a Fitter under a PTW system. 12(5)(a)

86. The CA was advised by the [redacted] that the rodder assembly did jam in operation both rotationally and during the stroke, and that it could be freed with Stilsons or light hammer taps, and that when there was a large blockage the rodder would be run at full speed towards the blockage to clear it, but it is not clear whether he was aware of this prior to the incident or was made aware of it following the incident. 12(3)

87. Indeed, Rhodia state that prior to the incident:

    (i) They were not aware that rodders were prone to jamming or sticking during use;

    (ii) They were not aware that it was normal custom and practise for employees to free a jammed rodder by means of striking it with a metal bar; and

    (iii) They were not aware that it was normal custom and practise for employees to free a jammed rodder by means of gripping it with Stilsons and forcibly turning it.

88. However, there are Plant Meetings held in the [redacted] three times a week (i.e. Monday, Wednesday and Friday) when issues of importance relating to both production and maintenance on the plant are discussed. Attendees include: the [redacted]; the [redacted] the [redacted] the [redacted] and the [redacted] (but not all are present all of the time), and the [redacted] states that the problem of jamming or sticking of the rodders would have been brought up at these meetings. 12(5)(a) 12(3) 12(3) 12(3) 12(3)

89. Rhodia hold no pre-incident documented procedures or specifications for freeing a jammed rodder.

The Incident

Apparent and approximate sequence of events:

**These items are extracts from notes made by the EA during the Incident De-brief of 08 Jan 2009 at Smethwick Police Station.*

1. At the time of the incident the plant was running 24 hrs/day, 7 days/week, 365 days/year.
2. Due to it being a site holiday there were approximately [redacted] employees on site. 12(5)(a)
3. **~08:00hrs –** [redacted] was rodded without any problems being noted. 12(5)(a)
4. **~12:00hrs –** [redacted] (i.e. [redacted] began his 4-hourly field checks, which included rodding both [redacted] and [redacted] 12(3) 12(5)(a)

5. He initiated the rodding sequence for [redacted] saw the rodder descend into the [redacted] and heard the rodder rotate. He states that it takes between 10-20 seconds for the rodder to move to full extension, so whilst that was happening (i.e. before he activated the withdrawal sequence to retract the rodder), he went next door to check other plant. Rhodia state, however, that the Operative completed the rodder entry sequence and then re-set the valves for the rodder withdrawal sequence (which takes approximately 1 minute) and that, in accordance with standard practice, he carried out a field check of the [redacted] (next door) during the rodder withdrawal sequence. Another witness also states that the Operative reported that he walked away as the rodder was retracting. Indeed it would appear to be the case that he had initiated the withdrawal sequence for it was as the rodder retracted from the plant that the loss of containment occurred. 12(5)(a) 12(5)(a)

6. **~12:06hrs** – The rodder failed.

7. [redacted] heard that the rodder had stopped rotating and thought he heard a cracking sound and possibly air escaping. He returned to [redacted] and saw a metre length yellow flame coming from the [redacted] He dashed to the [redacted] (in an adjacent building), notified [redacted] (i.e. [redacted]) and then returned to [redacted] He saw a dark grey cloud building up under the roof and a dense white cloud leaving the building. 12(3) 12(5)(a) 12(5)(a) 12(3)

8. Upon approaching the plant, [redacted] noted a lot of fume outside but did not feel anything on his skin. Upon entering the plant he saw a flame coming out of [redacted] and dense white fumes coming from the area under pressure. He could not at that stage see that the rodder had come out of the [redacted] as the fume was too dense. He used a fire hose to put water on the flames to try to damp them down and see what was happening. 12(3) 12(5)(a) 12(5)(a) 12(5)(a)

9. They attempted to shut the manual isolation valve between the [redacted] and [redacted] but it would not close. 12(5)(a)

10. **~12:08hrs** – The Lobby Commissionaire was advised of smoke around the [redacted] He attempted to view the area via CCTV (see Annexe 14) but it was obscured by a cloud which was white in appearance and was travelling from north to south along the ground. He phoned the [redacted] and, after apparently longer than usual, someone responded saying that no one [i.e. the Operatives, presumably] was there. He radioed the Shift Manager to notify him. The Shift Manager radioed back confirming the incident and asking the Lobby Commissionaire to sound the General Alarm, which he did, thereby signalling that the on-site emergency plan had been activated. He then gave an 'all stations' call over the site radios. 12(5)(a) 12(5)(a)

11. He recorded the weather at the time as being fair, bright and very still, with a wind from the NE of either 4.9m/s or 2.7m/s (i.e. his notes taken at the time of the incident were not clear on this matter, but it was later confirmed by another witness that the Lobby Commissionaire had reported to him that the wind speed was from the NE at ~2m/s).

12. Rhodia have around [redacted] personnel who are trained to operate as Fire Officers, [redacted] of whom were on duty at the time. One of them heard the General Alarm and saw a plume of white smoke drifting from the [redacted] in a southerly direction with large amounts of smoke coming across the yard. 12(5)(a) 12(5)(a)

13. Within 5-10mins the Shift Manager asked the Lobby Commissionaire to call West Midlands Fire Service (WMFS), which he did.

14. The QA Shift Manager assumed the role of Works Incident Controller (WIC).

15. **~12:12hrs** – Rhodia state that fumes or a very light haze were seen going off-site. According to them it was the Process Shift Manager who noticed this when he arrived on-site to take on the role of Technical Incident Controller (TIC). However, there is confusion here as the TIC states that he was on-site at the time of the incident and that he first became aware of it when he heard a radio conversation followed by the General Alarm.

16. The fumes/cloud left site in a roughly southerly direction. See Annexe 15 – Reported photo of cloud (from Express and Star newspaper website).

17. **~12:12hrs** – Rhodia state that their [redacted] site Fire Officers arrived at the scene. One of them states that he smelt phosphorus smoke and saw an 18" long blue gassy flame coming from [redacted] 12(3) 12(5)(a)

18. The Casualty Officer arrived and saw Operatives directing a hose at the fire. He did the same. He states that he could hear the flame but could not smell or feel anything.

19. The Fire Officers state that they could not operate the fire pumps or provide full breathing apparatus support as there were only [redacted] of them, so they relieved the Plant Operatives (who were using hose reels on the fire) so that they could get their BA and do any necessary isolations. 12(3)

20. Further attempts were made to close the isolation valve in the [redacted] but these were unsuccessful. 12(5)(a)

21. **~12:15hrs** – The [redacted], who was off-site (i.e. [redacted], was telephoned by the Lobby and assigned the role of Works Main Controller 1 (WMC-1). He had not performed this role before other than during training and tests. He liaised via telephone and radio with the Works Incident Controller (WIC) and the Technical Incident Controller (TIC) but did not attend site at any time during the incident. 12(3)

22. The WMC-1 was told that there was a 'white-out' on the plant but he understood, from information provided to him, that boundary effects at that stage were minimal. He did not ask for patrols to go to the site boundary but assumed that someone had arranged this in accordance with the emergency plan.

23. The TIC saw fume coming from the plant roof; it was greyish in colour. He was not aware of any smell or irritation. He approached the scene but couldn't see anything in the plant because of the fumes, although he did see someone spraying water over the [redacted] 12(5)(a)

24. The WIC saw white smoke floating south from the plant. The cloud was hugging the ground and he and others were standing in it. The smoke was dense and smelt like P_2O_5 but he didn't feel anything on his skin. It was decided that the cloud was P_2O_5 and steam and was irritant and not toxic.

25. The WIC saw that the [redacted] was leaking at the [redacted] and water was being applied around the [redacted] area. He did not consult Emergency Advice Cards, nor did he complete a Summary Action Card. He did not send out patrols to assess the off-site effects because he didn't think it was that bad. He did not feel that there were going to be any off-site problems as it wasn't toxic, i.e. it was a *'very mild acid rain'*. He did not consider the incident to present a significant off-site risk or effect. 12(5)(a)

26. The TIC noted that the cloud was quite dense and his impression was that it would have an off-site effect. The WIC and TIC had an exchange of views and discussed how to handle the situation. Boundary patrols were not sent out.

27. As the manual isolation valve in the [redacted] between the [redacted] and [redacted] could not be closed it was deduced that the rodder had snapped and was stuck in the valve and that they would have to wait until the fire died down. Engineers and Chemical Engineers were called to see if they could shut the reaction down quicker than the [redacted] it was estimated that it would take. 12(5)(a) 12(5)(a)

28. **~12:19-12:30 hrs** – The shutdown of [redacted] was initiated, [redacted] to the [redacted] was stopped, heat to the [redacted] was switched off and the emergency crash-cool was initiated. 12(5)(a)

29. **~12:20hrs** – Rhodia state that their [redacted] Fire Officers tackled the fire using hoses and that they were effective in controlling the phosphoric acid plume, although the fire itself could not be fully extinguished. 12(3)

30. **~12:23hrs** – Rhodia state that WMFS notified the local Police, the Highways Agency (HA) and relevant rail and gas companies of the incident.

31. **~12:25-12:30hrs** – Rhodia state that WMFS arrived on-site. They were provided with the Plant Dossier and the WIC told them that the cloud was P_2O_5. Rhodia state that both the WMFS and the Police were already in possession of a copy of their document entitled *'Rhodia UK Ltd Oldbury Site – HSE Procedure P06 – Site Emergency Procedure – Issue November 2007'* and that the WMFS took a decision not to immediately try to tackle the fire as it did not present an immediate danger to life.

32. **~12:30hrs** – Rhodia state that the shutdown of [redacted] was initiated. 12(5)(a)

33. **~12:40hrs** – Rhodia state that a [redacted] Site Fire Officer arrived at the scene having travelled in from home. 12(3)

34. WMC-1 checked with the site ~30mins into the incident and understood there still to be no off-site effects. He remained off-site throughout the incident but was in regular communication with those on-site. He states that he did not keep a chronological record of the incident because he couldn't concentrate on doing that and being WMC. Throughout his time in the role he treated the incident as on-site and had no information passed to him to suggest otherwise. No one reported to him that the cloud was going or had gone off-site.

35. At lunchtime Police informed the Asda Supermarket (on Wolverhampton Road – see Annexe 2 – Map of Local Area) of a chemical leak in the area. Upon Police advice Asda switched off the store's air conditioning and closed the external doors to prevent anyone from leaving, advising their in-store customers as to what was happening. They also notified customers in the car park (via a notice board at the entrance) that the store was closed and advised those trying to get into the store to return to their cars and close the windows. After 10-15mins many of the customers inside the store had left upon their own insistence, and those that remained had become agitated but, upon Police advice, Asda did not permit anyone else to leave the store.

36. During the incident a dark grey cloud was seen over the front of the store moving from right to left. Employees on the counters near the doors reported that they could taste something and felt sick. Security Personnel and Managers stationed at the doors reported that they could taste something metallic. Asda contacted the Police about every 10mins for advice.

37. **~12:47hrs – WMFS told the Police that the cloud was moving towards Langley (in case evacuation was necessary).*

38. **~12:51hrs – The Police asked to meet WMFS at the site but changed their agreed rendezvous point from Wolverhampton Road to North Gate Trinity road when it was realised that they had incorrect information regarding wind direction (i.e. confusion over whether it was 'going to' or 'coming from' the NE).*

39. **~12:57hrs** – It is understood (from the Incident De-brief attended by the EA) that the Police began to issue a warning to members of the public in the area to stay indoors. The EA provided a map showing the area (marked by a red line) within which the Police issued this warning (see Annexe 16 – Map of area confined by Police).

40. **~13:00hrs** – Rhodia's [redacted] (who was off-site) was telephoned and asked to attend site in order to relieve WMC-1 (i.e. take on the role of WMC-2). 12(3)

41. **~13:03hrs – An air exclusion zone was established to avoid downwash from helicopters blowing the cloud around.*

42. ** Rhodia were asked to send someone to Silver Control but did not.*

43. **~13:15hrs** – WMFS set up a high-level platform and sprayed the roof of the plant with water to set up a curtain and knock down the fume.

44. **~13:15hrs** – In response to the incident, as instructed by their Controller, two Highway's Agency (HA) Traffic Officers first closed then re-opened J1 M5 Southbound. They were then instructed to close the exit slip at J2 M5 Southbound.

45. **~13:20hrs – The Health Protection Agency (HPA) was informed of the incident.*

46. **~13:22hrs – M5 J1-3 is closed but no one is sure who authorised this.*

47. **~13:27hrs – The message goes out that the M5 is to remain open.*

48. **~13:30hrs** – Rhodia's [redacted] arrived on-site. 12(3)

49. **~13:30hrs** – Whilst driving to site WMC-2 saw wisps of cloud on Titford Road (See Annexe 2 – Map of Local Area) and smelt what he recognised as combustion products of phosphorus. He cannot recall whether he mentioned this to the [redacted] upon arriving at site, but according to Rhodia, as WMC-2 he would not have to report his observations to anyone. 12(3)

50. Upon his arrival at site, WMC-1 handed over to him (via telephone) and he discussed with the Site Manager/Director whether to sound the off-site alarm as Police were alerting members of the public. WMC-2 states that the Site Manager/Director had liaised with WMFS and he believes that the latter did not want the Off-site Alarm sounded.

51. WMC-2 states that he did not keep a chronological record of the incident because he was too busy.

52. **~13:30-13:45hrs** – The HA Traffic Officers arrived at Junction 2 (see Annexe 2 – Map of Local Area) to find an Incident Support Unit (ISU) in attendance. One of them described the weather at the time as being overcast with some sun, dry and cold. They exited their vehicle to put the closure in place. One of them saw smoke coming from the site and fire-crews fighting the fire. He also saw a *'haziness'* over the carriageway which was a lot thicker over the site. The other saw the fire-brigade fighting the fire. He also saw a silvery cloud low in the sky away from Rhodia over Langley. They did not know what the cloud was.

53. [redacted] 12(3)

54. **~13:40hrs** – Rhodia state that WMFS indicated that they did not want to sound the Off-site Alarm as they were concerned about alarming the public.

55. **~13:40hrs** – A member of the public left her home on All Angels Walk (see Annexe 2 – Map of Local Area) in order to walk to work at [redacted] on Wolverhampton Road. She describes the weather as being cold, dry, overcast and not particularly windy at the time. 12(3)

56. **~ 13:50hrs** – She approached the canal bridge at Langley and met Police who asked her where she was going and told her to hurry. She walked along the canal path to the exit at the Navigation Pub on Titford Road. She heard a loud speaker but not what was being said and [redacted] She saw a grey cloud at the Rhodia-end of Titford Road and saw Police wearing face masks. The Police had closed Titford Road and they asked her what she was doing out. They told her that there had been a chemical leak and to go home and shut the windows. She explained where she was going and that it would be better to continue, which she did. [redacted] She started work on the [redacted] An ambulance was called which took her home. She reported [redacted] She stated that she knows what Rhodia's Off-site Alarm sounds like from the annual test and that if it had been sounded she would not have left home. 12(3) 12(3)

57. **WMFS formally instigated the Off-site Plan (some parts were already in progress anyway).*

58. **~13:52hrs – The Police reported the cloud across Birchley Island.*

59. **~13:58hrs – The cloud moved towards the Wing Wah Restaurant on Wolverhampton Road.*

60. **~14:00 hrs** – The [redacted] liaised with WMFS and then reported to the WMC-2 that the incident was to be declared off-site and the Off-site Alarm was to be sounded. He began to make his way to the Gatehouse to do this. 12(3)

61. **~14:03hrs – The Ramada Hotel was keeping everyone indoors, as were Dunelm, Halfords, Asda and the AA.*

62. **~14:15hrs** – Rhodia state that the broken rodder was re-inserted into the [redacted] which eliminated the fire and stopped the fumes. 12(5)(a)

63. The WMC-2 received a radio message that the fire had been extinguished and the orifice in the [redacted] had been plugged. He agreed with the [redacted] that sounding the Off-site Alarm was now no longer appropriate. 12(5)(a) 12(3)

64. **~14:15hrs** – the on-site 'all-clear' was given by WMC-2.

65. **~14:15hrs** – The Traffic Officers arrived at hospital but apparently were not expected. They were assessed and their clothing was removed and bagged. Once the nature of the substance was known they were asked to shower and were provided with clean clothing.

66. **~14:50hrs – The air exclusion zone was lifted.*

67. **~15:15hrs** – Rhodia state that WMFS gave the 'all-clear'.

68. **~15:20hrs – The Police lifted road closures and started to inform the public (via Community Support Officers) that it was safe to come out of doors.*

69. **~18:00hrs** – The Traffic Officers at hospital were advised how to decontaminate their work clothing and allowed to go home.

70. **~22:46hrs – The Police completed their patrols of the affected area.*

Outcome and Consequences

1. Rhodia reported that the substances released during the incident would be those normally present within the headspace of the [redacted] and the [redacted], i.e. a [redacted] 12(5)(a)

2. Phosphorus and phosphine are both spontaneously combustible and would ignite upon contact with air to form phosphorus pentoxide. Whilst it is understood that the probability of phosphine ignition varies according to e.g. the presence of contaminants, there is no reason to suppose that anything other than negligible quantities of the phosphine and phosphorus vapour released failed to ignite and be converted to phosphorus pentoxide. The phosphorus pentoxide would be released from the fire in the form of very fine particles of fume which would react with moisture in the air to form a fine mist of phosphoric acid.

3. Rhodia stated that it is not possible to stop phosphine production from the [redacted] instantaneously and that the reaction continues for [redacted] after the [redacted] to the [redacted] is stopped. They also stated that in an emergency situation the reaction will continue even if the [redacted] to the [redacted] is stopped. 12(5)(a)

4. They provided an estimate of the rate and quantity of substances released (see Annexe 17). The CA, however, identified certain errors in Rhodia's calculations and carried out their own, which they reported to Rhodia (i.e. Rhodia's calculations with the CA's annotated in red) – see Annexe 18.

5. Rhodia later stated that, "*The amount of phosphoric acid released can be calculated using three different methods: Bernoulli effect calculation, compressible flow in pipes (isothermal) and compressible flow in pipes (adiabatic). This would give a worst case scenario of between* [redacted] *Please refer to exhibit 18* [i.e. in Rhodia's Voluntary Statement of 20 Jul 2010] *which sets out a detailed calculation of the material released. However, in reality the amount of substance released would have been less than this. This is because the phosphorus feed was shut off 13 minutes into the incident, even though steam continued to be fed in to avoid the risk of a "froth-over" of* [redacted] *into the downstream hot condenser unit. Consequently the proportion of phosphorus and phosphine in the gas released would have reduced over time. Dispersion calculations indicate that the concentration of phosphoric acid at the Site boundary was within normal occupational exposure standards and did not pose a risk to health. The worst case ground level concentration of phosphoric acid mist in the air would have been* [redacted] *at the nearest house to the Site boundary during the incident. This is below the most relevant short term Workplace Exposure Level of* [redacted] *for 15 minutes. It is important to emphasise that the* [redacted] *figure is a worst case scenario from the point of view of the release rate. It does not take into account the fire fighting measures and "fume knock down sprays" that were applied to the fume. These factors would have reduced the concentration of phosphoric acid mist to a level considerably below the worst case scenario.*" 12(5)(a) 12(5)(a) 12(5)(a) 12(5)(a) 12(5)(a) 12(5)(a)

6. The CA, however, estimates that [redacted] of phosphine and [redacted] of phosphorus vapour were released from the [redacted] These spontaneously ignited upon contact with air to produce approximately [redacted] of phosphorus pentoxide, which would react with moisture in the air to produce approximately [redacted] of 100% phosphoric acid as a mist. This mist would attract more water and be diluted further, but it is not possible to say what dilution would be reached. This mist travelled across the site and went off-site to the surrounding area of mixed residential / industrial / retail / hospitality / school / care / office / etc. premises. (It should be noted here that the incident occurred on Friday 02 January 2009, which means that some of these premises may not have been occupied or fully occupied). 12(5)(a)

7. It is reasonable to assume that the estimates of flow and total quantity of material released are conservative (i.e. higher rather than lower than that actually released) because the inputs (i.e. raw materials, [redacted] and [redacted] to the [redacted] and [redacted] were stopped after [redacted] minutes, so that after this time the phosphine production rate would decline, but there would be considerable residual heat within both the [redacted] and [redacted] to keep producing phosphorus vapour and the CA has not attempted to factor these effects into their calculation. 12(5)(a)

8. In terms of dispersion of the release and the potential consequences for people on- and off-site, HM Specialist Inspector (Predictive) produced a report (see Annexe 19) – [redacted] 12(5)(a)

9. During the incident:

   (i) Other than the immediate vicinity of the plant, no part of the site was evacuated;

   (ii) No one on-site required first-aid or medical treatment; and

   (iii) Rhodia did not sound either their Toxic Gas Alarm or their Off-site Alarm.

10. Whilst there were no associated cases of ill-health or injury reported to the HSE under RIDDOR, as previously described, an [redacted] (walking to work in the vicinity of the site) and [redacted] Highways Agency Traffic Officers (working at J2 of the M5) all state that they suffered ill-health effects as a consequence of the incident. 12(3)

11. The [redacted] also stated that she was suffering various ongoing ill health effects but the CA has not investigated this further. 12(3)

12. The two HA Traffic Officers reported that they attended hospital, and it is understood that there were numerous other maintenance workers in the vicinity of J2 of the M5 at the time of the incident and that they also attended hospital as a consequence.

13. On 17 August 2011 the CA wrote to Sandwell Hospital enclosing letters of authority from the [redacted] Traffic Officers and requesting details of their symptoms and the treatment they received. The CA also requested the same (but non-personal) information regarding the reported (but anonymous) maintenance workers. On 20 January 2012 Sandwell Hospital responded saying that despite an exhaustive search the relevant A&E cards could not be located from their off-site storage facility for the attendance date. 12(3)

Investigation Chronology and Action Taken

1. **The incident started at 12:06hrs on Fri 02 Jan 2009.** Rhodia's RIDDOR notification (F2508) was received by the ICC on Fri 02 Jan 2009 at 14:47hrs (Ref: 02393090). HSE's local office, however, was unaware of the incident until it was brought to their attention on Mon 05 Jan 2009 and confirmed via a news website. The RIDDOR notification was 'accepted' by HID on 06 Jan 2009 – see Annexe 1.

2. **On Mon 05 Jan 2009**, the CA visited site. They served Rhodia with a Form LP12 'Direction to Leave Undisturbed' regarding the longer section of the rodder that remained within the plant and instructed them to remove and decontaminate both the shorter section of the rodder (i.e. that which was drawn out of the [redacted] by retraction of the rodder assembly at the start of the incident) and the [redacted] HM Specialist Inspector (Process Safety) took photographs. 12(5)(a) 12(3)

3. **On 06 Jan 2009**, the CA visited site. In the early stages of the incident the plant had undergone an emergency shut down which had left significant inventories of dangerous substances within the plant, and in the latter stages of the incident the hole in the [redacted] had been sealed by the re-insertion of the shorter section of the rodder and the fitting of a blanking plate, but this left the detached longer section of the rodder still within the [redacted] (see Annexe 20 – Schematic of Post-incident Rodder), [redacted] The substances and the rodder had to be removed and the plant decontaminated and made safe prior to any repair and ultimate return to service. The CA advised Rhodia that this remedial work must be carried out in such a manner as to avoid any further fires or loss of containment. In particular, the removal of the rodder from the [redacted] presented a number of safety issues that needed careful evaluation and the CA required Rhodia to submit a Method Statement to them for consideration. The CA took into possession the shorter section of the rodder and the [redacted] for further investigation. 12(5)(a) 12(5)(a) 12(5)(a) 12(5)(a)

4. **On 07 Jan 2009**, Rhodia submitted their Draft Method Statement to the CA (see Annexe 21); it being their intention to remove the rodder the following day. The CA, however, had a number of concerns regarding the statement, not least the lack of information it contained, and HM Inspector (Regulatory) advised Rhodia (via telephone) that they were minded to serve a Prohibition Notice regarding the proposed activity. The CA then provided some initial feedback to Rhodia (also via telephone) and indicated that more would follow once HM Specialist Inspector (Process Safety) had had time to consider the document. However, due to the latter's sudden absence (due to ill health), a second HM Specialist Inspector (Process Safety) was drafted in at short notice but, having no knowledge of the plant or process, he was unable to comment on the Draft Method Statement in isolation. It was thus agreed with Rhodia that the CA would visit site the following day in order to discuss the document.

5. **On 08 Jan 2009**, the CA visited site. Rhodia's [redacted] reported that the rodder in [redacted] had been in place since September 2007 and that the rodder in [redacted] had been in place for 3 months. He also reported that the rodder assembly did jam in operation both rotationally and during the stroke, but that it could be freed with Stilsons or light hammer taps, and that when there was a large blockage the rodder would be run at full speed towards it to clear it (but it is not clear whether he was aware of this prior to the incident). 12(3) 12(5)(a)

6. He showed the CA a used rodder but was unsure of its age or origin (i.e. [redacted]. The CA measured this rodder (using an uncalibrated tape) as being [redacted] long. It was corroded at the free end, Stilson marks were evident and there were helical markings that indicated contact with a surface, such as the [redacted] (i.e. item 2 on drawing 4341). 12(5)(a)

7. On looking at the plant, the CA noted that the air supply to both the motor and the slide on [redacted] were adjusted by movement of valves and it was apparent that the speed of the motor and the speed of the slide were left to the Operative to decide – up to the maximum that could be delivered by the site air pressure. The CA noted that the air supply pressure gauge read [redacted] They took the reducing set into possession for further investigation, but advised Rhodia that they did not wish to take the rodder from [redacted] into possession as it had been in place for only 3 months. 12(5)(a)

8. Rhodia advised the CA that since the incident (i.e. 6 days, including the weekend) they had located a source of suitable length bar from which to manufacture one-piece rodders and that they intended to replace the two-piece rodder in [redacted] with one of these, and to rod every 2 hours (i.e. rather than every 4 hours as they had been doing). Rhodia also volunteered to remove the new one-piece rodder from [redacted] after 3 months in order to examine it, replace it with a new one-piece rodder and remove this at 6 months in order to examine it, replace it again with new and remove this at 12mths to examine it, with a view to building up a picture of any degradation. The CA agreed to this on condition that Rhodia carried out calculations to determine the fatigue in the rodder. Rhodia were also advised to consider the adequacy of both the seal on the [redacted] and the isolations around the [redacted] and the [redacted] (bearing in mind that the longer section of the rodder had stuck in the isolation valve in the [redacted] . 12(5)(a)

9. Rather than compromise safety by insisting on saving the fracture surface on the longer section of the rodder that remained in [redacted] the CA advised Rhodia that they would not require the bottom half of the fracture and they lifted the 'Notice to Leave Undisturbed' (although they had yet to agree Rhodia's Method Statement for the rodder's removal in order for the work to proceed). [redacted] HM Specialist Inspector (Mechanical Engineering) took photographs. 12(5)(a) 12(3)

10. The CA provided Rhodia with a copy of their initial feedback regarding Rhodia's Draft Method Statement and proceeded to discuss the latter at length. As a consequence, Rhodia were required to prepare three further documents and submit them to the CA for consideration, i.e:

    (i) A Hazard Review that checked the instrumented readings of the process up to and immediately after the fire;

    (ii) A reviewed/revised Risk Assessment; and

    (iii) A reviewed/revised Method Statement that included the additional safeguards identified as being necessary.

11. **On 12 Jan 2009**, Rhodia forwarded the above documents to the CA.

12. **On 13 Jan 2009**, the CA provided (via email) their initial feedback regarding the above documents. The CA also pointed out to Rhodia that whilst they had volunteered to adjust their rodding frequency from every 4 hours to every 2 hours, their 2007 COMAH Safety Report does in fact state that it is done hourly. (As previously described, elsewhere in the same Safety Report it also states that it is done every 2 hours).

13. Rhodia confirmed that they would amend their Method Statement to take account of the issues raised by the CA and that they would then proceed in accordance with the method to remove the remaining section of the rodder from the plant.

14. Further detailed feedback was later (i.e. on 02 February 2013) provided to Rhodia by the CA regarding the documents received from them on 12 Jan 2009, but in brief:

    (i) The Hazard Analysis Review appeared to be reasonable;

(ii) The Risk Assessment, however, was weak. The existing format had not been fully utilized in recording all the measures planned or taken. Significant findings of the assessment process included within the Method Statement appeared to have been omitted from the Risk Assessment. Failure to fully document risk controls led to the development of a Method Statement that would have omitted the nitrogen purge (a key fire-prevention measure) during the cutting operation. It was difficult to see how the Risk Assessment informed the development of the Method Statement. Indeed, based on the evidence presented, it appeared that the Method Statement may have been developed before the Risk Assessment was carried out, thus the two documents did not match up. If this was the case it was not good practice and could lead to risk controls being omitted or overlooked; and

(iii) [redacted] 12(5)(a) [redacted] Again (i.e. as for the Risk Assessment) it appeared that the Method Statement may have been developed before the Hazard Review was carried out.

15. The CA also made a number of recommendations for the future:

(i) In the aftermath of this incident there was no clear mechanism, or mode of operation, that supported careful hazard analysis, risk assessment and method development, in that order. There should be clear division of responsibility between the various disciplines involved in planning, and a forum for discussion and resolution of conflicting priorities between, investigation and recovery. Under no circumstances should methods for work on the plant be developed in advance of, and independently from, proper hazard analysis and risk assessment. Rhodia should review the way in which the safety management system operates during plant upset or emergency, and the discipline with which the existing systems are applied;

(ii) The risk assessment initially presented to the CA was weak and poorly presented. Rhodia should ensure that the team conducting and recording the significant findings of risk assessments are competent in the techniques to be applied, and that all the relevant risk controls and mitigation are included (or referenced) on the assessment. The assessment should make use of (or reference) more detailed assessments made previously, such as those required for dangerous substances and flammable atmospheres; and

(iii) The risk assessments and method statements provided by Rhodia have gone through a number of iterations and changes; these should be captured by the safety management system. Documents should be re-numbered following changes. It is important that the discipline of auditable change-management be maintained, even during periods of rapid development and upset operation, so that review after the incident can identify significant learning events.

16. Rhodia agreed to the above.

17. **On 14 Jan 2009**, the CA visited site. They noted that the rodder assembly had been dismantled on [redacted] and it was apparent that most of the rodder still remained inside the plant, with the paddle-end resting inside the [redacted] and the other end jammed inside the [redacted] 12(5)(a) [redacted] such that the valve provided to enable the [redacted] to be isolated from the [redacted] could not be closed.

18. Whilst on site, the CA took the used rodder (seen on 08 January) into possession in order to assist with their understanding of the construction of the failed bar.

19. The CA also inspected the rodder assembly and [redacted] on [redacted] and noted Stilson marks on the rodder near to the motor end. The CA also noted that the air pressure to the rodder assembly was reading [redacted] after the reducing set. [redacted] was not in use at the time and was at ambient temperature. The CA asked that [redacted]s rodder be operated and [redacted], HM Specialist Inspector (Mechanical Engineering) took an audio/visual recording of the operation. He noted that it was very smooth, with no undue noise or vibration (see Annexe 22 – Recording [redacted] 14 Jan 2009). [redacted] HM Specialist Inspector (Mechanical Engineering) also took photographs. 12(5)(a) 12(5)(a) 12(3) 12(3)

20. Rhodia's [redacted] provided the CA with a set of papers, advising that they related to the rodder motor, gearbox and slide used on [redacted]. These papers were the technical specification sheets for each item issued by the manufacturer. Rhodia had highlighted motor models [redacted] and [redacted] a [redacted] ratio gearbox of [redacted] and the [redacted] diameter [redacted] stroke slide. From this the designed operation of the rodder assembly could be derived. The data shows that the speed and torque of the motor and gear box are linked to the air pressure supplied to the motor. The maximum operating pressure of the slide is given as [redacted]. It is assumed that this means [redacted] as this aligns with the pressure gauges used for the process. The effective force is given at [redacted] (again assume [redacted]) as [redacted] 12(3) 12(5)(a) 12(5)(a) 12(5)(a) 12(5)(a)

21. With regard to Rhodia's Method Statement (for the removal of the section of the rodder that remained in [redacted], the CA advised Rhodia that they (i.e. the CA) had clearly set out the hazards, given strong warning about the risks involved, and had provided Rhodia with appropriate advice, and that Rhodia appeared to have acted upon this advice, and as such, the CA was not now minded to prohibit the activity. 12(5)(a)

22. **On 16 Jan 2009**, having sourced bar of sufficient length and having manufactured a one-piece rodder from it, Rhodia installed the new rodder.

23. **On 19 Jan 2009**, Rhodia provided a copy of the Operating Instructions for the rodder, dated May 2007 (see Annexe 13) which, as previously described, provide little information beyond the actual mechanics of the operation (i.e. [redacted] and [redacted] etc.). 12(5)(a)

24. They also provided an extract from their 1980 HAZOP (see Annexe 23) which was current at the time of the incident. It does not consider the issue of rodder failure or blockage of the isolation valve by the rodder.

25. **On 20 Jan 2009**, the CA asked Rhodia for the names of persons in certain roles at the time of the incident (e.g. Plant Operatives; Supervisors; Managers; Incident Controller; etc.).

26. **On 21 Jan 2009**, Rhodia provided the above names, but asked the CA to elaborate on what they wanted this information for.

27. **On 23 Jan 2009**, the CA visited site. They saw the sleeve (i.e. Item 5 on drawing 4341) after it had been removed from the [redacted] and cleaned of dangerous/hazardous substances. It was noted that this item had been involved in the fire and as such was considered by the CA to be contaminated evidence, so they did not take it into possession. 12(5)(a)

28. Whilst on-site, the CA also observed the operation of the rodder on [redacted] under normal working conditions. The CA measured the stroke at approximately [redacted] and noted that the operation was jerky and that the motor speed appeared higher than previously seen. At the bottom of the stroke the rodder assembly could be heard to strain and there was a clear vibration induced into the floor. 12(5)(a)

29. **On 24 Jan 2009** it is understood that Rhodia re-started [redacted] 12(5)(a)

30. **On 26 Jan 2009**, the CA responded to Rhodia's query of 23 January 2009, explaining that the reason for asking for the names of certain persons was that, as part of their investigation into the incident, the CA would wish to speak with 'witnesses of fact' and take statements from them.

31. The CA received a letter from the [redacted] (dated 16 Jan 2009 and forwarded to the CA by Sandwell Communities and Regulatory Services) in which he asked about the measures being taken to find the cause of the incident. 12(3)

32. **On 28 January 2009**, Rhodia provided a Memo entitled 'Estimation of Quantity of Material released during Phosphine Incident of 2/1/2009', with the covering email stating *'Summary is worst case phosphine discharge of* [redacted] *and worst case phosphoric acid liberated is* [redacted] (see Annexe 17 – Co estimate of quantities released). 12(5)(a)

33. The CA asked Rhodia (via email) to arrange for their welder to make up (in the presence of HM Specialist Inspector, Mechanical Engineering): (i) two sample weld coupons of exactly the same geometry as the rod in [redacted] (i.e. threaded bar / welded); and (ii) one sample threaded bar (joined but unwelded), and explained that it was their intention to carry out mechanical testing on these samples, looking at torsion, tensile strength and possibly fatigue. 12(5)(a)

34. **On 29 Jan 2009**, the CA emailed Rhodia indicating which personnel they wished to take witness statements from and the proposed dates.

35. **On 02 Feb 2009**, the CA identified several errors in Rhodia's calculations of 28 Jan 2009 and estimated [redacted] of phosphorus vapour, [redacted] of phosphine and [redacted] of P_2O_5 (see Annexe 18 – CA estimate of quantities released). 12(5)(a)

36. The EA advised the HSE that they had spoken with Rhodia who had indicated that the witnesses that the CA wished to take statements from wished to be accompanied by either a work mate, a Union Rep, Rhodia's [redacted] or Rhodia's Solicitor. 12(3)

37. The CA sent a letter to Rhodia regarding their Method Statement and requiring a time-bound programme for completing certain work required of them.

38. **On 03 Feb 2009**, Rhodia asked if it was possible for HM Specialist Inspector (Mechanical Engineering) to meet with the Welder (who was to prepare the test samples) in advance in order to explain the reasoning behind the work and to generally put him at ease and minimise any pressure he might feel due to working under the observation of HM Specialist Inspector.

39. Rhodia confirmed that rodding frequency had been changed post-incident from four-hourly to two-hourly.

40. The CA provided Rhodia with comments regarding Rhodia's estimate of quantities released, pointing out that (i) the equation used to calculate flow rate was not quoted directly; (ii) the CA did not arrive at the same gas density as that quoted by Rhodia; (iii) Rhodia's final calculation of the P_2O_5 equivalent for the release included the contribution from phosphorus alone and not that from phosphine; (iv) using a different equation from another source (and bearing in mind that the worst case was based on the initial flow rate at the start of the release, whereas in practice the flow would be likely to reduce after the inputs to the [redacted] were stopped) the CA had calculated that over the [redacted] of the incident, worst case [redacted] of phosphorus vapour and [redacted] of phosphine could have been released, which would have burned to produce [redacted] of P_2O_5 equivalent. 12(5)(a)

41. **On 04 Feb 2009**, having arranged to take witness statements on 10 and 11 Feb 2009, [redacted] in liaison with the HSE's Legal Advisors Office (LAO), HM Inspector (Regulatory) drafted a letter for the attention of the witnesses (i.e. explaining the statement-taking process and who may be in attendance etc.) and forwarded it (via email) to Rhodia, asking their [redacted] to pass a copy on to each of the witnesses (see Annexe 24 – CA Email re – Witnesses and Annexe 25 – CA Letter re – Witnesses). 12(5)(a) 12(3)

42. Rhodia's [redacted] telephoned HM Inspector (Regulatory) saying that he was unwilling to forward the letters to the witnesses because he felt that the letters would do more harm than good and that Rhodia had a duty of care to protect their employees from what they believed was wrong. HM Inspector (Regulatory) asked Rhodia's [redacted] for the home addresses of the witnesses in order that she may forward the letters direct to them, but he refused to provide this information stating that it was confidential (although Rhodia did subsequently provide the address of the witness who had retired post-incident). In liaison with HSE's LAO, HM Inspector (Regulatory) then agreed to withdraw the letters and confirmed this by email to Rhodia's [redacted] (see Annexe 26 – CA Email re – Witnesses (2)). 12(3) 12(3) 12(3)

43. Rhodia had indicated that the majority of the witnesses wished to be accompanied by a union representative and that two of them (i.e. the Managers: WMC-1; and WMC-2) wished to have the Co's Solicitor present whilst providing their statement. HM Inspector (Regulatory) referred Rhodia to HSE's Enforcement Guide regarding the above and suggested that if, after having read the guidance and discussed it with their Solicitor, the situation remained the same, they should provide the Solicitor's name and contact details in order that HSE's LAO may contact them to discuss (and resolve) any issues in terms of e.g. conflict of interest.

44. Rhodia forwarded to the CA a letter addressed to them from their Solicitor (DLA Piper) regarding the above matter (see Annexe 27 – Co Letter re – Witnesses). HM Inspector (Regulatory) again sought advice from HSE's LAO.

45. Rhodia also responded to the CA's comments regarding their estimate of quantities released, stating that they had re-calculated using both the correct gas density value and the contribution from phosphine. They stated that they had re-done the calculations using four different methods (which they provided) and concluded that their results were very close to, but slightly lower than, the CA's.

46. With regard to Rhodia's request for HM Specialist Inspector (Mechanical Engineering) to meet with the Welder and explain to him the reasons behind the work required of him (in terms of preparing the test samples), the CA advised Rhodia that the reason for the work was to enable the CA to look at the welding conditions: typical weld set-up; pre-weld cleanliness and inspection; how the weld is laid; interpass cooling; final pass cooling; final weld inspection and then machining – all of which could influence weld toughness and hence the fatigue life of the weld – and not to assess the competence of the Welder. Rhodia responded, suggesting that the work be done w/c 16 Feb 2009.

47. **On 05 Feb 2009**, the CA emailed Rhodia advising them that they wished to postpone the statement-taking (scheduled for Tues 10 and Weds 11 Feb 2009) until such time as the apparent dispute regarding the procedure for taking the statements (i.e. in terms of 3rd party attendance) had been resolved. HM Inspector (Regulatory) continued to liaise with HSE's LAO regarding this matter.

48. **On 06 Feb 2009**, West Midlands Police confirmed by email that the estimated number of persons 'confined' during the 2 – 3 hours of the incident was 4,514 – see Annexe 28.

49. The CA responded to the [redacted] letter (of 26 Jan 2009), explaining what the investigation entailed and agreeing to write to him once the investigation was complete. 12(3)

50. Rhodia again asked for further explanation of the CA's reasoning behind the preparation of the weld test samples. The CA again provided further information regarding the matter.

51. **On 09 Feb 2009**, the EA forwarded an extract of Rhodia's Community Newsletter (Jan 2009) to the HSE. In it Rhodia stated that their use of PA systems and tannoys was appropriate on this occasion as the cloud was neither toxic nor poisonous and that, unfortunately, not all the media coverage which followed the incident was factually correct in this regard. They also stated that this was a fire and not a toxic gas release – see Annexe 29.

52. The CA submitted the required Short Report to the European Commission via the MARS database.

53. **On 10 Feb 2009**, RCA's [redacted] confirmed that he would attend HSL the following day, indicating that he would take the remaining piece of the failed rodder (now recovered from the plant) with him. 12(3)

54. **On 11 Feb 2009**, RCA's [redacted] attended HSL. He had with him what he reported to be a section through the weld from the rodder taken from [redacted] (which had seen 3 months service). The CA took this into possession for analysis by HSL. 12(3) 12(5)(a)

55. **On 12 Feb 2009**, Rhodia responded to the CA's letter of 02 Feb 2009 (regarding their Method Statement), agreeing to complete the work required of them by end of May 2009. HM Specialist Inspector (Process Safety) agreed to this timescale and suggested that further follow-up by the CA regarding the matter was not required and that it should be left to Rhodia to complete the work.

56. Rhodia reported by email that the removal of the remaining piece of rodder from the plant had actually taken approximately 15 mins and *'... there were no resultant HSE issues whatsoever.'*

57. **On 23 Feb 2009**, Rhodia emailed the CA, again expressing their concern regarding the CA's forthcoming visit to observe the test sample welding, stating that they had a duty of care to their employees and they were concerned about the signs of stress that were being shown by the welder in relation to the visit, reporting that he was worried about being blamed for the incident and that his Union Reps had expressed concerns regarding his level of stress. Rhodia went on to ask whether it would be possible for the CA to minimise the number of HSE Observers and to explain the purpose of the work to the Welder and his Union Rep at the start of the visit, and could they use two welders rather than one, and could they not wait to do the work until after the main metallurgical tests on the failed rodder have been completed, when it may be found that the work was not in fact necessary?

58. **On 24 Feb 2009**, the CA responded, stating that only one CA person would be observing; the point of the exercise would be explained to the Welder and his Union Rep at the start of the visit; the purpose of the visit was not to look at the Welder but the design of the weld etc; that two welders may be used (working in parallel), but if this was the case, then a second CA observer would attend; and that the work was relevant to the investigation and could not be second-guessed from metallurgy.

59. **On 25 Feb 2009**, Rhodia agreed to the above visit, indicating that they would use two welders but that they would work in series so only one CA observer was required.

60. RSA produced their report entitled *'Finite Element Analysis of* [redacted] *Rodding Device'* (see Annexe 30), a copy of which was subsequently provided to the CA. 12(5)(a)

61. **On 26 Feb 2009**, the CA emailed a letter to Rhodia from HSE's LAO. The letter confirmed that the CA did not object in principle to an employee being accompanied by a union representative (so long as that union representative was not connected with the investigation), but that they remained concerned that the two managers wished the Co's Solicitor to be present. The letter explained the CA's position regarding this matter and the email asked Rhodia to respond, confirming which of the witnesses were willing to provide a voluntary statement; which wished to be accompanied by a third party; and who that third party was.

62. **On 27 Feb 2009**, the CA visited site in order to witness the welding of the test coupons. They took into possession three coupons of stainless steel bar; two welded and machined; and one machined only. The reason for arranging this work to be done was that the CA wished to acquire a better understanding of how the weld had been made in the failed rodder and they thus asked Rhodia to prepare three sets of bars, machined and ready to weld.

63. The bars had been prepared by drilling and cutting a thread in one part and machining a matching thread on the other part. The two parts were then tightly screwed together by hand with no lubrication. They were then set on rollers and checked for alignment. A soft hammer was used to get the bars as close as possible to straight. Two of the assemblies were then taken to the weld shop but the third was retained, unwelded, for further investigation.

64. Two welders then welded the assemblies together. They both used a TIG process with an argon shielding gas. One welder used 90 amps and the other 75 amps. Both used 316L wire. The area to be welded was brushed clean and the alignment was checked with a straight edge. One tack weld was put into the weld groove and then the assembly turned over. It was again checked for straightness and then a second tack weld was added. The welder then deposited a full weld around the joint – one welder did this in one continuous weld, turning the assembly as he went, the other welder stopped and started as he turned the assembly. The first run nearly filled the weld preparation groove. The weld was left to cool for over 20 minutes, no thermometer was used and the welders relied on touch.

65. Both welders again checked alignment and used a soft hammer to tap the assembly back towards true; there was a noticeable deflection at the weld. Then a capping weld was applied using the same weld parameters and procedures as before, the welders tried to remove distortion by careful selection of the starting position. Again the weld was left to cool. After cooling there was a clear deflection of the assembly at the weld.

66. Once the weld had cooled sufficiently to be handled it was returned to the machine shop and placed on a lathe. One assembly had a deflection of [redacted] and the other [redacted] at the weld. The [redacted] told the CA that his target straightness was [redacted] and he proceeded to try to straighten out the assembly by hitting the weld with a soft hammer. He managed to get a reading of [redacted] on the dial test indicator but could not improve on this. He then machined the cap off the weld and left a small step – he told the CA that this was typical of the bars he had produced although the step was normally limited to about [redacted] On completion of the work it appeared that the target was to get the bars straight between the lathe stocks so that any remaining distortion was limited to the area near to the weld

12(5)(a) 12(5) 12(5)(a) 12(5)(a)

67. The CA took the welded bars and the assembly that had not been welded into possession and submitted them to HSL for further investigation.

68. Whilst on site the CA asked to look again at the [redacted] rodder assembly to check site measurements against drawings. It was noted that the rodder [redacted] into the [redacted] was approximately [redacted] out from the side of the [redacted] There was a rolling bearing at the bracket (denoted 4366 on drawing 4341) and this moved with the slide – this bearing was approximately [redacted] from the motor end of the rodder bar. Fully inserted, the end of the rodder bar was [redacted] from the [redacted] – see Annexe 31.

12(5)(a)

69. The CA also took measurements of the rodder position for [redacted] when it was fully inserted into the [redacted] and found that the length of bar from the [redacted] to the end of the bar contained within the mechanism gear box was [redacted] The [redacted] bush into the [redacted] had a length of [redacted] and then the soft packing [redacted] giving a total length of rodder to this point of [redacted] – approximately the position of the weld on the rodder.

12(5)(a)

70. Using drawing 4341 and the measured stroke of the rodder of [redacted] it can be seen, in Annexe 32, that with the paddle just out of [redacted] from drawing 4341C in the raised position – it cannot enter [redacted] as the paddle prevents this – the paddle must be fully into the [redacted] and clear of the Hastelloy sleeve that enters the [redacted] in the fully inserted position. In this position the paddle cannot be jamming on product within the Hastalloy sleeve as it is not actually within the sleeve. Drawing 4341 does not show the rodder fully inserted to the position measured (on 27 Feb 2009), i.e. the rodder actually inserted approximately a further [redacted] from the position shown on the drawing. 12(5)(a)

71. Whilst on site, the CA was advised by Rhodia's [redacted] that the rodder and rodder assembly were set up in the cold condition, with the [redacted] at ambient temperature, and that there was no adjustment for the thermal expansion that the [redacted] would see as it was brought up to operating temperature. 12(5)(a)

72. The [redacted] is made from stainless steel and this is known to expand uniformly in all planes as it is heated. This is a physical property of all metals and, in the case of stainless steel, the thermal expansion is linear and relates to the original length, the change in temperature and the coefficient of linear expansion. Using this knowledge and the fact that the rodder assembly was not subject to temperature changes led the CA to the conclusion, by simple calculation, that if the rodder assembly was not adjusted to take account of the thermal expansion of the [redacted] then it could be around [redacted] out of alignment when it was in operation, i.e. 12(5)(a)

    Expansion = original length x temperature change x thermal coefficient

    For stainless steel the thermal coefficient is known to be 16 x 10-6/C, so for a 1m length and temperature rise of 1 degree the steel will increase in length by 0.016mm

    For 100 degrees this increase becomes 1.6mm and for 200 degrees 3.2mm

73. The CA looked again at the [redacted] taken from [redacted] (Item 2 on drawing 4341) and noted that the bush was worn in one area only. There was no reference to show the orientation of the bush when it was fitted to the [redacted] but the wear clearly indicated that the rodder was coming into contact with just one part of the [redacted] This indicated that there was misalignment between the rodder and the [redacted] if this had not been the case then the CA would have expected to see uniform wear around the full circumference of the bush. The CA asked HSL to look at this scenario and relate such a misalignment to the stresses seen by the rodder. 12(5)(a)

74. At this time the CA suspected that thermal expansion was a contributory factor in the failure of the rodder and was concerned that the [redacted] could see cyclic loading during the rodding operation. The CA asked Rhodia to check this [redacted] with dye penetrant testing to look for any signs of fatigue crack initiation. Rhodia later reported back that no crack-like indications had been found. 12(5)(a)

75. The CA also asked Rhodia to check the [redacted] during rodding operations with a dial test indicator (DTI) to see if there was any movement. A DTI uses a plunger to register very small movements in one direction and these movements are displayed on a dial that typically uses one full rotation for 10mm of movement; this allows very small movements to be detected. The use of a DTI would show whether the rodder was moving into the [redacted] without putting strain onto the [redacted] bush and would thus demonstrate whether the rodder was correctly aligned to the [redacted] 12(5)(a)

76. **On 02 Mar 2009**, the CA emailed Rhodia, confirming the actions detailed during the above visit as being required of them.

77. [redacted] 12(5)(b)

78. [redacted] 12(5)(b)

79. [redacted] 12(5)(b)

80. [redacted] 12(5)(b)

81. [redacted] 12(5)(b)

82. [redacted] 12(5)(b)

83. [redacted] 12(5)(b)

84. [redacted] 12(5)(b)

85. [redacted] 12(5)(b)

86. [redacted] 12(5)(b)

87. [redacted] 12(5)(b)

88. [redacted] 12(5)(b)

89. [redacted] 12(5)(b)

90. [redacted] 12(5)(b)

91. **On 19 Mar 2009**, LAO responded to DLA Piper stating, [redacted] 12(5)(b)

92. **On 31 Mar 2009**, Rhodia provided, amongst other things, a copy of the two most recent HAZOPs, i.e. the 1980 HAZOP (which was current at the time of the incident) and the HAZOP carried out post-incident (see Annexe 33), along with documents describing their basis of safety.

93. **On 15, 16 and 21 Apr 2009**, the CA attended site to take voluntary statements from those witnesses who had not asked to be accompanied by Rhodia's solicitor.

94. **On 15 May 2009**, the CA visited site. Rhodia's [redacted] advised them that the required DTI work (see 27 Feb 2009) had not been completed. 12(3)

95. The CA asked to see the operation of the [redacted] rodder. The [redacted] was at full operational temperature and the use of the new one-piece rodder was observed (i.e. the rodder was activated three times, one immediately after the other). The CA noted significant vibration as the rodder reached the end of the stroke. It appeared to jam on three occasions each time and then move slightly further forward and slowly rotate. The CA could feel the loading transmitted through the floor that supported the [redacted] 12(5)(a)

96. It was clear that the rodder was in contact with the [redacted] (i.e. item 2 on drawing 4341) as a gap could be seen between the [redacted] above the rodder. This gap was not apparent when the rodder stroke had been started, thus the rodder was set lower than the [redacted] and, as the distance between the fixed part of the rodder and the [redacted] decreased, then the flexibility of the bar decreased. It appeared that the rodder was pushing downwards onto the [redacted] and the [redacted] was distorting downwards but had enough 'spring' due to its length to allow the rodder bar to move further into the [redacted] before finally jamming. Once the rodder assembly was reversed the rodder appeared to withdraw easily from the [redacted] Each application of the rodder resulted in the same jerky action with the rodder mechanism close to full insertion into the [redacted] The CA could clearly feel the strain transmitted through the [redacted] into the [redacted] and then into the floor plating on which they stood – this was low frequency strain that clearly corresponded to each forward movement of the rodder bar. Following the third rodding operation the CA noted that the rodder was wet with a substance which ignited as it was withdrawn from the [redacted] and a small flame was seen – this corroborated witness evidence that product is sometimes seen on the retracting rodder which fumes and sparks, and it indicated that the rodder was acting as a pumping mechanism to draw product from the [redacted] 12(5)(a)

97. The CA expressed their concern to Rhodia regarding what they had witnessed and served two HSWA Enforcement Notices (Serial Numbers: P/KEB/15/05/09/01 and 02) prohibiting the use of the [redacted] and [redacted] and [redacted] until Rhodia had: 12(5)(a)

    (i) Assessed the thermal expansion of the [redacted] and the [redacted] and 12(5)(a)

    (ii) Realigned the rodder systems to take account of the thermal expansion; and

    (iii) Inspected those [redacted] on the [redacted] and the [redacted] that are associated with the rodder systems for the purpose of detecting fatigue cracking; and 12(5)(a)

    (iv) Taken the remedial measures identified as being necessary; or

    (v) Taken any other equally effective measures.

98. The Prohibition Notices were deferred for 48 hours to allow Rhodia to bring [redacted] and [redacted] to a safe state (i.e. shut down the Plant safely) – See Annexes 34, 35, 36 and 37 – Prohibition Notices and Schedules for [redacted] and [redacted] 12(5)(a)

99. The CA also advised Rhodia that they were of the opinion that the DTI work (which Rhodia had been asked to do but had not done) would have shown that the rodder was not aligned to the [redacted] 12(5)(a)

100. The CA then advised Rhodia that they were minded to serve an Improvement Notice requiring a design-review of the plant. They also advised them to review and clarify their criteria for the sounding of the Toxic Gas Alarm and the Off-site Alarm, which Rhodia agreed to do.

101. **On 20 May 2009**, Rhodia confirmed that they had complied with the Prohibition Notices in that they had:

(i) Assessed the thermal expansion of the [redacted] and [redacted]; 12(5)(a)

(ii) Realigned the rodders to take account of thermal expansion; and

(iii) Inspected the [redacted] and found no evidence of fatigue cracking. 12(5)(a)

102. **On 21 May 2009**, the CA visited site to take a voluntary statement from another witness who had not asked to be accompanied by Rhodia's solicitor.

103. Rhodia provided the CA with documentation and photographs regarding isolation.

104. Rhodia also provided the CA with documentation to explain the decrease in phosphine held in the [redacted] during the period of ~12:15-15:15hrs on 02 Jan 2009. 12(5)(a)

105. Rhodia confirmed that they intended to start [redacted] that evening and [redacted] the following day. 12(5)(a)

106. **On 02 Jun 2009**, the CA provided Rhodia with a Draft Schedule for the Improvement Notice that they had indicated (on 15 May 2009) that they were minded to serve requiring a design-review of the plant, as follows:

1. Appoint one or more competent person(s) to assist you in undertaking the measures you need to take to comply with the legal duties imposed upon you;

and

2. Ensure that the competent person(s) has the time available and the necessary means and information at their disposal to fulfil their function;

and

3. Arrange for the competent person(s) to review the plant/process in terms of:

a) the process chemistry and operating conditions; and

b) the design of the plant and the materials of construction and their compatibility with the substances involved; and

c) the Hazard Identification and Risk Assessment (HIRA); and

d) the pathways for uncontrolled release of dangerous substances; and

e) the HAZOP for process deviations; and

f) the basis of safety; and

g) the process instructions and safe operating procedures; and

h) the procedures for plant/process changes; and

i) the way in which the system may degrade over time; and

j) the inspection/examination regime required for timely detection of degradation (WSE); and

k) the maintenance regime for the plant; and

l) the routine checks/audits of the safety systems; and

m) the emergency arrangements,

and

4. Based upon the findings of the above review, draw up a time-bound programme ('action plan') for the implementation of whatever remedial work is identified as being necessary to ensure the suitability of the [redacted] *and associated pipe work and equipment for the use for which it is provided;* 12(5)(a)

or

5. Take any other equally effective measures.

107. **On 08 Jun 2009**, at Rhodia's request, HM Inspector (Regulatory) and HM Principal Inspector (Regulatory) visited site and met with Rhodia's Senior Management (including their [redacted] to discuss, amongst other things, the Improvement Notice that the CA had indicated they were minded to serve. Rhodia explained that they had information that would, in their opinion, address some (if not all) of the issues required by the Draft Schedule. The CA agreed to meet with Rhodia at a later date when Rhodia would present this information for discussion. Following that meeting a decision would then be made as to whether the proposed Improvement Notice was still appropriate. 12(3)

108. [redacted] 12(5)(b)

109. [redacted] 12(5)(b)

110. [redacted] 12(5)(b)

111. [redacted] 12(5)(b)

112. [redacted] 12(5)(b)