

113. On 13 Jul 2009, Rhodia emailed the CA regarding the work they had done to comply with the Prohibition Notices. They provided their calculations etc. and reported that their findings meant that they now saw no need to realign the rodder to compensate for thermal expansion and that they had returned the rodder to its original 'cold' alignment position. They also provided their NDT findings and reported that the cracks found in the [REDACTED] were crater-cracking with no in-service extension. They also provided a schematic of the [REDACTED] and Rodder, showing the position of the rodder post-incident (see Annexe 20). (12(5)(2))
114. [REDACTED] (12(5)(b))
115. On 20 Jul 2009, the CA emailed Rhodia stating that the findings of Rhodia's calculations (regarding thermal expansion) differed from those of the CA's and that the CA did not accept Rhodia's findings and would contact them shortly to arrange a visit to discuss the matter, and that in the interim Rhodia should treat their measurements with extreme caution and ensure that the rodding systems were set up, operated and maintained so as to be suitable for use, in accordance with the requirements of the Prohibition Notices.
116. On 23 Jul 2009, the CA visited site to discuss the above matter. It was decided that Rhodia were not in breach of the PN's but that further work was required of them in terms of both finding the optimum position for the rodgers and determining any [REDACTED] strain. (12(5)(2))
117. Whilst on site, the issue of the Improvement Notice that the CA was minded to serve regarding the design-review of the plant was discussed. HM Specialist Inspector (Mechanical Engineering) and the Environment Agency's Inspector were both of the opinion that Rhodia had now provided the CA with sufficient information to render the serving of the IN unnecessary. However, HM Specialist Inspector (Process Safety) had been unable to attend site due to sudden ill health and his opinion was required before a decision could be made. He subsequently indicated his agreement with his colleagues and the Improvement Notice was not served.
118. [REDACTED] (12(5)(b))
119. [REDACTED] (12(5)(b))
120. On 26 Aug 2009, the [REDACTED] of Sandwell MBC's Resilience Unit contacted the CA asking for the current status of the investigation and whether a report would be forthcoming in the near future. (12(3))
121. In Aug 2009, HSL finalised their report regarding the rodder-failure (see Annexe 38), a copy of which was subsequently provided to Rhodia.
122. On 07 Oct 2009, Rhodia provided the CA with a copy of a report by AV Technology (AVT) entitled, 'Proposal 6429 [REDACTED] - Stress Assessment on [REDACTED] During Rodding Operation - Prepared for Rhodia UK Ltd, Oldbury Site - dated 22 September 2009' (see Annexe 39). This related to the work agreed in August and Rhodia were seeking the CA's confirmation that this methodology would provide the information required in order to determine whether or not the nozzles were exposed to stresses. It was Rhodia's intention to start the work during site shut-down on 12 Oct and they requested a rapid response from the CA. (12(5)(2))
123. On 08 Oct 2009, the CA provided their response, agreeing that the above was a good way forward but providing critical comment regarding certain aspects and asking Rhodia to provide AVT's findings from the work.

124.

[REDACTED]

12(5)(b)

125.

[REDACTED]

12(5)(b)

126.

[REDACTED]

12(5)(b)

127.

[REDACTED]

12(5)(b)

128. On 21 Oct 2009, Rhodia provided the CA with a copy of a report by RCA Laboratories entitled 'Technical Report – Failure Analysis of the [REDACTED] Rodder – Report Reference: 0901/002 – 18<sup>th</sup> September 2009 – Prepared for [REDACTED] Rhodia UK Limited, P.O. Box 80, Trinity Street, Oldbury, West Midlands, B69 4LN – Client Reference: [REDACTED] (see Annexe 40).

12(5)(a)

12(5)

12(5)(a)

129.

[REDACTED]

OUTSIDE  
SCOPE  
OF  
REQUEST

130. On 10 Mar 2010, having received a request from Sandwell MBC's [REDACTED] for a report of the investigation, the CA responded that the investigation was ongoing and that they would provide information regarding relevant aspects in due course.

12(3)

131. On 05 May 2010, having been reminded by Sandwell MBC's [REDACTED] that a further two months had passed and that the report appeared to be well outside the [REDACTED] the CA responded, 'The investigation is progressing but is as yet incomplete. This was a Major Accident and the investigation is complex. Rest assured that once I am in a position to provide you with relevant information I will do so.'

12(3)

132. On 17 May 2010, upon request, Rhodia provided the CA with a copy of the Lobby Commissionaire's Log of the incident. It describes the wind speed as being '2.7 from N.E.'

133. On 10 Jun 2010, the CA wrote to Rhodia inviting them to attend a PACE interview on either 29-30 June 2010 or 19-20 July 2010, and indicating the broad areas to be explored as including:

- (i) The initial design and operation of the rodder and rodder assembly on [REDACTED]
- (ii) Subsequent changes to the design and operation of the rodder;
- (iii) The procedure for constructing, welding and inspecting the two-piece rodder;
- (iv) The procedure for setting the rodder in the rodder assembly and aligning it with the [REDACTED]
- (v) The consideration of thermal expansion of the [REDACTED] when aligning the rodder;
- (vi) The procedure for operating the rodder;
- (vii) Why, on occasion, the rodder jammed during operation;
- (viii) The procedure for freeing the jammed rodder;
- (ix) Why the rodder failed on 02 January 2009;
- (x) The quantities and dangerous/hazardous nature of the substances involved in the incident;
- (xi) The measures taken by employees to protect their health and safety at the scene;
- (xii) The activation of the Toxic Gas Procedure and sounding of the Toxic Gas Alarm;
- (xiii) The measures taken by employees to contain the incident;
- (xiv) The measures taken by WMFS to contain the incident;
- (xv) The posting of patrols at the site perimeter;
- (xvi) Liaison with Bronze / Silver / Gold Control (i.e. information provided and when);
- (xvii) Liaison with other relevant outside agencies (i.e. information provided, to whom and when);
- (xviii) Liaison with off-site vulnerable premises (i.e. information provided, to whom and when);
- (xix) The keeping of a chronological record of the incident;
- (xx) First indications that the cloud from the incident might go / was going / had gone off-site;
- (xxi) The dangerous/hazardous nature of the cloud that left the site;
- (xxii) Further liaison with WMFS and other relevant outside agencies and vulnerable premises (i.e. information provided, to whom and when);
- (xxiii) The activation of the Off-site plan and sounding of the Off-site Alarm;
- (xxiv) First indications of persons off-site suffering ill-health effects due to the cloud;
- (xxv) Training of employees in site emergency procedures;

12(5)(a)

12(5)(a)

12(5)(a)

(xxvi) Work done to recover the affected plant;

(xxvii) [REDACTED] letter of 04 February 2009 to the witnesses; and

(xxviii) The provision of legal representation to the witnesses.

134. On 18 Jun 2010, Rhodia responded saying [REDACTED]

12(3)

12(3)

135. [REDACTED]

12(5)(b)

136. [REDACTED]

12(5)(b)

137. [REDACTED]

12(5)(b)

138. [REDACTED] 12(5)(b)
139. [REDACTED] 12(5)(b)
140. [REDACTED] 12(5)(b)
141. [REDACTED] 12(5)(b)
142. [REDACTED] 12(5)(b)
143. [REDACTED] 12(5)(b)
144. [REDACTED] 12(5)(b)
145. On 11 Aug 2010, there was a further request from Sandwell MBC's [REDACTED] suggesting that the time was [REDACTED] HM Inspector (Regulatory) referred him to her Line Manager who emailed him the following day, repeating that the incident was still very much under investigation and, as such, there were constraints on the information that could be released, and to use him (the B2) as the contact regarding this matter in future. 12(3)
146. On 23 Sep 2010, the CA emailed Rhodia asking for the findings of the work they were required to repeat in terms of determining [REDACTED] 12(5)(a)

147. On 01 Oct 2010, further to the CA's email of 08 Oct 2009, Rhodia provided the CA with a copy of a report from AV Technology (AVT) entitled 'Report 6429\_R2 - [REDACTED] Stresses On [REDACTED] During Rodding Operation - Prepared for Rhodia UK Ltd - 27 September 2010'. (See Annex 44). The CA and Rhodia arranged to meet on 16 Nov 2010 in order to discuss (amongst other things) the findings of this report. However, on 09 Nov 2010, the CA had to postpone the site visit due to HM Specialist Inspector's (Mechanical Engineering) admission to hospital.

12(5)(a)

148. On 15 Dec 2010, in preparation for the re-scheduled visit (i.e. now arranged for 02 Feb 2011), at Rhodia's request the CA provided them with an indication of the specific areas that they wished to discuss during the visit.

149. [REDACTED]

12(5)(b)

150. [REDACTED]

12(5)(b)

151. [REDACTED]

12(5)(b)

(i) They wished to video the operation of the rodding mechanism during normal operation of the plant and to take certain dimensional measurements; and

(ii) They wished to take into possession the following items:

a) The [REDACTED] (item 1 on Drawing 4341, dated:13/4/89) which was on the plant at the time of the incident;

12(5)(a)

b) The [REDACTED] (items 3 and 4 on the above drawing) which were on the plant at the time of the incident;

12(5)(a)

c) 100mm samples of what appears to be the [REDACTED] (shown on the above drawing between items 2 and 4 and items 3 and 4) which were on the plant at the time of the incident; and

12(5)(a)

d) Assuming that Rhodia had changed out items 1, 2, 3 and 4 since the incident ... the used parts or, if they were not available, a report on their condition after use.

152. On 26 Jan 2011, the CA sent a letter and report to Rhodia regarding (amongst other things) the issue of [REDACTED] (See Annexes 47 and 48)

12(5)(a)

153. On the same day, Rhodia emailed the CA indicating that all the items that the CA wished to take into possession (see the CA's email of 20 Jan 2011) had been disposed of and that they had no reports on the condition of them after use. They offered to provide new versions of the items.

154. On 27 Jan 2011, Rhodia emailed the CA suggesting an alternative date of 03 Mar 2011 for the site visit (i.e. that postponed twice by the CA) and stating [REDACTED]

12(3)

155. [REDACTED] 12(5)(b)
156. [REDACTED] 12(5)(b)
157. [REDACTED] 12(5)(b)
158. [REDACTED] 12(5)(b)
159. [REDACTED] 12(5)(b)
160. [REDACTED] 12(5)(b)
161. On 28 Feb 2011, Rhodia asked if the above [REDACTED] strain work was part of the investigation. The CA responded that it was. 12(5)(4)
162. On 03 Mar 2011, the CA attended site and [REDACTED] HM Specialist Inspector (Mechanical Engineering) took an audio/visual recording of the plant in use (see Annexe 49) and took certain measurements and photographs and identified certain items to be taken into possession. 12(3)
163. On 14 Mar 2011, the CA attended site and took the above items into possession.
164. On 24 Mar 2011, as agreed, Rhodia forwarded their [REDACTED] measurements to the CA. 12(5)(2)
165. On 29 Mar 2011, HSL finalised their report regarding [REDACTED] strain – 'Review of strain measurements taken at Rhodia' (see Annexe 50), a copy of which was provided to Rhodia. 12(5)(4)
166. On 30 Mar 2011, Rhodia were asked – with HM Inspector (Regulatory) using her HSWA s20 powers – to provide:
- (i) All records of planned and/or preventive maintenance that took place in the [REDACTED] 12(5)(2)
  - (ii) All records of unscheduled and/or breakdown maintenance that took place in the [REDACTED] and [REDACTED] 12(5)(2)

(iii) All 'permit-to-work' / 'permit' / 'work permit' papers or electronic certificates or forms relating to work carried out on or in connection with the rodder / rodder assembly / [REDACTED]

12(5)(a)

for the period 02 Jan 2004 to 02 Jan 2009 inclusive.

167.

12(5)(b)

168.

12(5)(b)

169.

12(5)(b)

170. On 15 Apr 2011, Rhodia provided an electronic record of 6,978 Work Orders (WOs) raised for both planned and unplanned maintenance on the [REDACTED] for 05 Jan 2005 to 02 Jan 2009 (see TRIM: 2011/239565). They reported that they were unable to provide those for 02 Jan 2004 to 04 Jan 2005 as they were on an older version of their SAP database. They also provided hard copies of 125 Permits to Work (PTWs) raised for both planned and unplanned maintenance on the [REDACTED] and [REDACTED] rodgers, rodger assemblies, [REDACTED] for Mar 2008 to 02 Jan 2009. They reported that all PTWs prior to this date had been destroyed as they have a policy of retaining PTW books for only 3 years.

12(5)(a)

171. There then followed numerous emails etc. between the CA and Rhodia (i.e. until 06 Oct 2011) as the CA attempted to identify relevant Work Orders and relate them to relevant PTWs (both of which were, in some cases, unclear in terms of the plant and/or work that they related to).

172.

12(5)(b)

173.

12(5)(b)

174. On 14 Nov 2011, the CA attended site to interview witnesses with regard to the PTWs.

175.

[REDACTED]

12(3)

176. On the same day, the CA emailed Rhodia asking them to provide copies of all PTWs relating to the investigation/freeing/release of a jammed/stuck [REDACTED] rodder on both [REDACTED] for the period from the date of the incident of 02 Jan 2009 to the date of the planned plant shut-down in Sep 2011 (i.e. a period of 2 years 9 months). The CA also asked Rhodia to provide a copy of the written procedure for installing and aligning the [REDACTED] rodder on [REDACTED] (which was drawn-up and put in place following the incident) and to confirm the date that the procedure was put in place.

12(5)(a)

177. On 17 Nov 2011, as requested, Rhodia provided a copy of their post-incident procedure for the alignment of the rodder and confirmed that it was drafted and used in the first shutdown following the incident (i.e. Sep 2009) and was reviewed and finalised on 09 Jul 2010 – See Annexe 51.

178. On 21 Nov 2011, the CA responded to Rhodia's query of 15 Nov 2011 regarding off-site persons affected by the incident, stating that they were not at liberty to provide Rhodia with individuals' names or details at this time, but thanking them for the offer of the services of their company Doctor and information regarding the chemicals.

179. On 23 November 2011, in response to the CA's request of 15 Nov 2011, Rhodia emailed just three PTWs: (see TRIM: 2011/609114) for the period from the incident of 02 Jan 2009 to the planned shut-down in Sep 2011.

180. On 01 Dec 2011, with regard to off-site persons affected by the incident, Rhodia asked if it would be possible for the CA to provide generic information such as confirming whether people were affected, the number of people affected, their position in relation to the site at the time of the incident and the symptoms they reported.

181. On 05 Dec 2011, the CA responded that, until such time as they reached the stage of the investigation where they were able to provide more specific detail, they would advise Rhodia that witnesses report having been in the vicinity of either: J2 of the M5; Titford Road; or ASDA at the time of the incident and they report that they were contacted by substances leaving the site during the incident and that they subsequently sought medical attention for symptoms consistent with their having been exposed to substances hazardous to health.

182. On 21 Dec 2011 Rhodia sent the CA a lengthy email with regard to the issue of off-site persons affected by the incident. They stressed that they had not requested individuals' personal details (... but they had, i.e. in their email of 15 Nov 2011 they asked, [REDACTED])

12(3)

183.

[REDACTED]

12(5)(b)

184.

[REDACTED]

12(5)(b)

185.

[REDACTED]

12(5)(b)

186.

[REDACTED]

12(5)(b)

187.

[REDACTED]

12(5)(b)

188. On 08 Mar 2012, WMFS [REDACTED] asked if they could see the Investigation Report as they were in the process of reviewing the Off-site Emergency Plan.

12(3)

189. On 15 Mar 2012, the CA responded to WMFS, stating that the investigation was not yet complete but with regard to their reviewing the OffSEP, there should be:

(i) Clarity in terms of the circumstances that require the OffSEP to be implemented;

(ii) Arrangements in place to ensure that when an incident occurs an informed decision regarding the above is made by persons competent to do so and that this is reviewed on an ongoing basis throughout the incident, as appropriate;

(iii) Clarity in terms of the roles and responsibilities of the various responders (including the COMAH Operator); and

(iv) Arrangements in place to ensure that all those that might be adversely affected by the incident are promptly notified by the agreed method (be it house calls / loud hailer / site alarm / etc.) ... this includes not only members of the public but also the responders themselves ... and that they know what remedial action to take.

190. [REDACTED] 12(5)(b)
191. [REDACTED] 12(5)(b)
192. [REDACTED] 12(5)(b)
193. [REDACTED] 12(5)(b)
- [REDACTED]
- [REDACTED]
- [REDACTED]
- [REDACTED]
- [REDACTED]
- [REDACTED]
194. [REDACTED] 12(5)(b)
- [REDACTED]
- [REDACTED]

12(5)(2)

197.

On 07 Jan 2013, the CA responded – see Annexe 60 – stating:

(ii)

12(5)(b)

12(5)(b)

195. On 25 Jun 2012, the CA provided Rhodia with a report (and covering letter) – see Annexes 57 and 58 – regarding their inspection of 26 Mar 2012. This required Rhodia to (amongst other things):

- (i) Review the plant/process design of the [REDACTED] and [REDACTED] (and relevant associated plant and pipe work) giving full consideration to the information contained in this report with regard to the rodding mechanism and the overflow pipe;
- (ii) Consider alternative means of preventing/clearing blockages in the overflow pipe between the [REDACTED] and [REDACTED];
- (iii) Consider the provision of local exhaust ventilation or other secondary containment etc. for the purpose of mitigating against a loss of containment of hazardous/dangerous substances from the [REDACTED] and/or [REDACTED] and
- (iv) Provide the CA with a full account of their methods and findings regarding (i) to (iii) above, and a risk-based justification for their time-bound actions and proposals,

12(5)(a)

12(5)(a)

12(5)(a)

by 25 September 2012.

196. On 25 Sep 2012, Rhodia responded to the above – see Annexe 59 – a stating:

12(3)

Alternative means of preventing/clearing blockages in the overflow pipe between the [REDACTED] (i.e. in the current configuration)

- (i) We note your response regarding either not rodding at all, or else providing alternative means of clearing the overflow pipe between the [REDACTED] and the [REDACTED]
- (ii) We are inclined to agree with you that neither of the options put forward would appear to be viable for the plant in its current configuration. You thus appear to be left with little alternative but to review the design of the [REDACTED] and the [REDACTED] (and associated plant and pipe work), as you were asked to do (see below).

Reviewing the design of the [REDACTED] and [REDACTED] (and associated plant and pipe work)

- (i) We note your response that it may be possible to prevent blockages in the overflow pipe between the [REDACTED] and the [REDACTED] by significantly increasing its diameter and your conclusion that, based upon cost, such work would not be reasonably practicable.
- (ii) In this action we were not, in fact, asking you to maintain a means of clearing the overflow pipe in its current configuration, rather we were asking you to reconsider and review the overall design of the [REDACTED] the [REDACTED] and relevant associated plant and pipe work, for the purpose of either eliminating the risk of loss of containment from this current potential weak point or else reducing the risk to ALARP.
- (iii) Re-designing the [REDACTED] and associated plant and pipe work would undoubtedly be costly and may indeed exceed the sum of [REDACTED] suggested by you as being justifiable. However, the [REDACTED] are replaced at relatively short intervals (i.e. every 2yrs) so the [REDACTED] figure you suggest would appear to be somewhat spurious, i.e. the actual cost of the project would be the cost of the [REDACTED] etc. (and, perhaps, supporting metal framework) plus the design costs themselves, rather than the entire replacement. This is, of course, for you (as the Operator) to explore, but we are of the opinion that you have not given this matter sufficient consideration and would currently struggle to make your ALARP demonstration.
- (iv) With regard to your reporting that rodders are in use on all [REDACTED] around the world; if this is the case then the use of rodders may well be deemed 'industry practise' but it does not necessarily qualify it as being 'Industry Best Practise'. Either way, the issue here is not whether rodders are in use elsewhere, but whether you can demonstrate ALARP for their use at your establishment.
- Giving full consideration to the information and guidance contained in both this letter and all previous relevant correspondence, you should continue with your review of the plant/process design of the [REDACTED] and [REDACTED] (and relevant associated plant and pipe work) for the purpose of identifying an alternative, more suitable design that either eliminates or reduces the risk of loss of containment of COMAH dangerous substances from this part of the plant to ALARP. Upon completion of your review, you should provide information to the CA by which to make your ALARP demonstration.

(COMAH Regulation 4 – By 08 April 2013)

(\* On [REDACTED])

Provision of LEV or other secondary containment

- (i) You were asked to consider the provision of LEV or other secondary containment etc. for the purpose of mitigating against a loss of containment of hazardous/dangerous substances from the [REDACTED]. The reason behind this was that it might have offered a relatively quick and easy short-term measure that could be implemented before the vessels are due for replacement. (12)(5)(2)
- (ii) Your estimated costs of [REDACTED] for LEV and [REDACTED] for containment seem to us to be a little on the high side but we do not, at this stage, propose to challenge the figures and we agree that containment would not necessarily cover all scenarios. (12)(5)(2)
- With the above in mind, the CA proposes to take no further action regarding this matter on this occasion, but may seek to revisit it at a later date (i.e. depending upon the outcome of the above plant/process review).

198. The CA continues to monitor Rhodia's progress with this work via the Site Intervention Plan.

Various email correspondence followed, checking evidence & procuring CA statements etc., then ...

- 20 May 2013 – [REDACTED] transferred to CEMHD4A. (12)(3)
- 26 Jun 2013 – [REDACTED] finished writing Investigation/PR Report & submitted it for approval.
- 06 Aug 2013 – [REDACTED] approved Investigation/PR Report & [REDACTED]  
– [REDACTED] forwarded it to EA / Solicitor Agents / Litigation Officers.
- 29 Aug 2013 – Finalised Predictive Report received.
- 23 Oct 2013 – [REDACTED] held Review Meeting with [REDACTED] / Solicitor Agent / EA.  
– L sent to Co, advising:  
(i) Investigation complete;  
(ii) CA considering what further legal action to take; &  
(iii) Action required of Co as a consequence of investigation.
- 24 Oct 2013 – [REDACTED] asked for all COIN/TRIM records to be saved to disc for Solicitor Agent.
- 26 Oct 2013 – Admin reported delays with above due to problems with TRIM format plus sheer volume of records (i.e. ~1,000 on TRIM + ~300 on COIN).
- 29 Jan 2014 – Admin provided records to Solicitor Agent for them to work through.
- 31 Mar 2014 – [REDACTED] returned to CEMHD2C.
- 24 Apr 2014 – [REDACTED] held Review Meeting with [REDACTED] / Solicitor Agent / EA.
- 28 Apr 2014 – [REDACTED] approached [REDACTED] re - his providing further Process Safety information (as identified by Solicitor Agent) to supplement his initial report. He responded that he was committed to another MA Investigation & suggested his B2 be approached.
- 06 May 2014 – [REDACTED] approached Process Safety B2 re – [REDACTED] availability.

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30 Apr 2014	– EA reported that a colleague ( ) recalled an earlier rodder-failure. SA requested further details.
06 May 2014	– Process Safety B2 indicated that ( ) unavailable.
07 May 2014	– Finalised ME Statement received.
08 May 2014	– Further Drawing (referenced in their docs) requested from Co. – ( ) approached Process Safety B1 re – ( ) unavailability.
12 May 2014	– Highway's Agency & West Midlands Police approached for material obtained during their investigation. Highway's Agency returned nil response.
13 May 2014	– Process Safety B1 responded that ( ) not available, but he would find alternative.
15 May 2014	– EA advised that colleague ( ) unable to locate diary for time in question so unable to provide evidence.
02 Jun 2014	– Process Safety B1 offered ( ) as alternative to ( ) – ( ) provided questions to ( )
16 Jun 2014	– ( ) indicated unable to respond until mid- to late-July.
01 Aug 2014	– Co changed name to Solvay Solutions UK Ltd.
04 Aug 2014	– Site intervention re – E- preparedness/response (in accordance with plan).
05 Aug 2014	– West Midlands Police provided copy of their log for day of incident.
12 Aug 2014	– A Cox provided response re – PS issues.
20 Aug 2014	– Solicitor Agent finalised briefing for Counsel.
16 Sep 2014	– ( ) (ME) taken ill (i.e. approximate date).
25 Sep 2014	– Solicitor Agent met with Counsel.
30 Sep 2014	– ( )
10 Oct 2014	– Meeting between Solicitor Agent & ( ) to discuss conversion of latter's statement to a report + a covering statement.
31 Oct 2014	– Case Conference ( ) / ( ) / ( ) [EA] / Solicitor Agent / Counsel). – Counsel indicated a wish to discuss certain ME issues with ( )
06 Nov 2014	– ( ) (ME B2) agreed to respond to any questions on behalf of ( )
12 Nov 2014	– ( ) provided copies of relevant reports etc. to ( )
13 Nov 2014	– ( ) provided required report & statement.
17 Nov 2014	– ( ) approached HSL for copies of their correspondence with ( )
18 Nov 2014	– HSL provided required information & ( ) forwarded it to ( )

12(3)

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- 20 Nov 2014 – Solicitor Agent requested copies of documents referred to in [REDACTED] Report.
- 25 Nov 2014 – [REDACTED] requested statements from HSL [REDACTED] & [REDACTED]).  
– HSL advised [REDACTED] that [REDACTED] retired. [REDACTED] agreed to respond on his behalf.
- 02 Dec 2014 – [REDACTED] provided Solicitor Agent with required copies of documents referred to in [REDACTED] Report.
- 04 Dec 2014 – [REDACTED] (HSL) provided his statement.
- 10 Dec 2014 – Case Conference [REDACTED] / [REDACTED] / [REDACTED] / Solicitor Agent / Counsel).  
– [REDACTED] agreed to identify which evidence relies solely upon [REDACTED] & determine the best way to address that. He also agreed to consider calling [REDACTED] back [REDACTED] as a witness.
- 15 Dec 2014 – [REDACTED] (HSL) provided his statement.
- 19 Dec 2014 – [REDACTED] arranged for [REDACTED] (ME) to review the reports of [REDACTED] & HSL, with a view to producing a new ME Report (i.e. rather than a simple peer review statement) which would allow certain areas to be clarified, as necessary.
- 05 Jan 2015 – Solicitor Agent asked if others witnessed plant vibration [REDACTED] described in his report. [REDACTED] had no record of it in her notebook & nor did [REDACTED].
- 09 Jan 2015 – [REDACTED] responded (re – plant vibration issue) that he'd been unable to locate [REDACTED] notebooks [REDACTED] & had approached him direct. [REDACTED] had indicated that he did witness the vibration.
- 12 Jan 2015 – [REDACTED] confirmed that he'd witness the vibration & offered to provide a statement.
- 27 Jan 2015 – Solicitor Agent confirmed that Counsel would not commence proceedings until it was confirmed that he could work from [REDACTED] report, or if not, a replacement report. [REDACTED] had indicated that we could not work from [REDACTED] report & would have to wait for [REDACTED] replacement report.
- 02 Feb 2015 – [REDACTED] confirmed to [REDACTED] & Solicitor Agent the issues he was asking [REDACTED] & HSL to clarify.
- 05 Feb 2015 – Solicitor Agent confirmed which areas in particular he wishes [REDACTED] to review/clarify.  
– Solicitor Agent requested copy of 2007 SR.
- 06 Feb 2015 – [REDACTED] confirmed to HSL the additional work required of them.
- 09 Feb 2015 – [REDACTED] provided Solicitor Agent with 2007 SR Conclusions Letter etc.
- 10 Feb 2015 – Solicitor Agent collected 2007 SR from Birmingham Office.
- 13 Feb 2015 – Solicitor Agent confirmed to [REDACTED] the issues that [REDACTED] needed to consider when providing his ME Report.
- 16 Feb 2015 – [REDACTED] confirmed to [REDACTED] the issues that his report needed to address.
- 17 Feb 2015 – Solicitor Agent forwarded docs to [REDACTED] for consideration in his report.

12(3)

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- 21 Feb 2015 – Solicitor Agent requested information regarding maintenance records plus MAPP/SR.
- 24 Feb 2015 – [REDACTED] responded to Solicitor Agent regarding MAPP/SR issues. 12(3)
- 27 Feb 2015 – [REDACTED] (HSE) reported concerns expressed (during CIA meeting) by [REDACTED] regarding time spent to close out investigation.
- 02 Mar 2015 – [REDACTED] responded to [REDACTED]
- 06 Mar 2015 – [REDACTED] contacted [REDACTED] & [REDACTED] (Solvay, Oldbury) to discuss Solvay's concerns.
- [REDACTED] (Solvay HQ) emailed D Bagnall asking him to get in touch. [REDACTED] was now on leave & [REDACTED] (deputising) was not at work.
- 09 Mar 2015 – [REDACTED] asked KB to arrange for evidence (rodders etc.) to be returned from Birmingham Office Evidence Room to HSL.
- 09 Mar 2015 – [REDACTED] emailed [REDACTED] again, asking his availability for a discussion. [REDACTED] (deputising) was out inspecting.
- 10 Mar 2015 – [REDACTED] saw the above email & responded that [REDACTED] was on leave & suggested that it would be best for him [REDACTED] to wait for his return.
- 10 Mar 2015 – [REDACTED] statement re – plant vibration received.
- 13 Mar 2015 – HSL collected evidence items from Birmingham Office.
- 23 Mar 2015 – [REDACTED] spoke with [REDACTED] (Solvay) re – his concerns.
- 17 Apr 2015 – [REDACTED] provided [REDACTED] (Solvay) with status update.

The current tally of records saved = ~ 1704 (i.e. ~1386 on TRIM & ~318 on COIN).

Note – The above is an account of key correspondence (via email/letter unless otherwise indicated) between the CA and Rhodia/Solvay, & the actions taken. There is, however, a considerable amount of further correspondence & documentation held on the CA's COIN & TRIM databases & in the relevant hard-copy files.

Various CA meetings / case conferences / etc. then took place to ensure that all evidence was ready.

- 26/06/15 – [REDACTED] notified [REDACTED] (Solvay) re PR (via telephone).
- 22/07/15 – [REDACTED] advised Site Union Representatives (Unite / GMB) re PR (during site visit).
- 25/08/15 – Summonses served.

**Subsequent findings and action taken**

## Safety Management System (SMS)

### COMAH Safety Report 2007

#### Plant description and controls

1. The Safety Report (SR) provides an overview of the plant and processes involved, including reference to the rodder and the frequency of rodding, although the latter is contradictory, i.e. as previously described: on page 178 it states that rodding is done hourly; whilst on page 191 it states that it is done every two hours.

#### Consequences of a release

2. The likely consequences of a phosphine release are described in the SR. Indeed Rhodia (in their Voluntary Statement) direct the CA to pages 476 and 496 of the SR and state [REDACTED]

12(5)(2)

3. However, in their Plant Emergency Dossier, March 2005, page 7, paragraph 1.4.9, it states [REDACTED]

12(5)(2)

## HAZOP

#### Rodder failure

4. The 1980 HAZOP (i.e. current at the time of the incident) did not consider the failure of the rodder.
5. The post-incident HAZOP, however, does, i.e. it describes the 'Deviation' as [REDACTED] and the 'Consequence' as [REDACTED] and, interestingly, 'No HSE issue', with the 'Cause' being, [REDACTED] and the 'Existing Barriers/Actions' being, [REDACTED]

12(3)

See Annexe 33 for both HAZOPs.

6. Rhodia state that:
  - (i) Both the 1980 [i.e. current at the time of the incident] and the current [i.e. post-incident] HAZOP dealt with the risk of the rodder sticking as a production issue, but did not deal with catastrophic failure of the rodder because this was unforeseeable;
  - (ii) The 1980 HAZOP does not highlight straightness/distortion as a potential deviation, so the Company could not reasonably have known that the impact of the rodder not being perfectly straight would have led to it failing;

- (iii) There had never been any suggestion that minor stresses and strains could cause a rotating bend failure, and that given that rotating bend failure was unforeseeable it could not have been guarded against as this would have required them to first foresee it;
- (iv) The rodder failed not due to jamming/sticking but because it was not precisely straight when manufactured, leading to rotating bending fatigue, and the risk of failure occurring from rotational stresses was not identified in the HAZOP because it was unforeseeable;
- (v) Immediately after the incident, no-one (including the HSE's Mechanical Engineering Specialist Inspector) could understand how the rodder bar had failed. After completion of the metallurgical studies on the failed rodder (commissioned by the Company) the HSE's Mechanical Engineering Specialist Inspector informed the Company that, until that point, the HSE had "been scratching their heads on this". He stated that they could not see how sufficient force could be imparted to the rodder to break it at the joint. Clearly even following the incident its cause had not been foreseeable, let alone prior to its occurrence.

7. From this it would appear that:

- (i) They were aware, prior to the incident, that the rodder stuck (although this is not implicit in the 1980 HAZOP);
- (ii) They are confused as to the purpose of a HAZOP in terms of identifying foreseeable deviations; and
- (iii) They are of the opinion that if the cause of failure is not immediately apparent to the CA, then it cannot have been foreseeable.

#### Blockage of isolation valve

- 8. Neither the 1980 nor the post-incident HAZOP appear to consider the blockage of the isolation valve (in the [REDACTED] by the rodder. 12(5)(4)
- 9. Employees were unable to close the isolation valve between the [REDACTED] and the [REDACTED] due to the position of the broken rodder. When asked whether this scenario had been considered previously, for example during the HAZOP, Rhodia stated that rotating bend failure had not been foreseen and that whilst the HAZOP dealt with the risk of the rodder sticking as a production issue, it did not deal with catastrophic failure of the rodder because this was unforeseeable. 12(5)(4)
- 10. Rhodia holds no documentary evidence of the scenario of a broken rodder blocking the isolation valve having been considered previously.
- 11. The issue of isolation is one that is now being progressed via the CA's Intervention Plan.

#### Design / Management of Change / Design Review

12. Rhodia state that:

- (i) The rodder was a bespoke design and no recognised standards were available for such devices in 1989, so it was designed to good engineering practice standards and the adequacy of the design was assessed by A&W's Technical Development Department;
- (ii) Whilst they are sure that the changes from manual to pneumatic, and from a

one-piece to a two-piece rodder, would have been assessed via A&W's Management of Change process, these changes occurred in the 1980s and there were no arrangements in place to ensure retention of records to present day, so they are unable to provide records of any management of change assessments carried out. However, the failure of the rodder arose because the rod was not precisely straight when manufactured, and the 1980 HAZOP does not highlight straightness/distortion as a potential deviation, so they could not reasonably have known that the impact of the rodder not being perfectly straight would have led to it failing. Therefore it cannot reasonably be expected that any management of change risk assessment (whether relating to the change from manual to pneumatic operation, or to the change from a one piece to two piece rodder) would have identified this risk; and

- (iii) In the intervening years (i.e. since these changes and since they took over the site), in terms of design review (i.e. for the purpose of comparing the design of the rodder and rodder assembly with up-to-date design principles and considering the measures that need to be taken in order to reduce the risk to ALARP) the adequacy of plant design has been assessed every five years via their COMAH report and their SRD (HAZOP) Studies, copies of the most recent versions of which were sent to the CA (i.e. COMAH Safety Report on 02 April 2012 and the HAZOP on 31 March 2009). However, it was not reasonably foreseeable that the impact of the rodder not being perfectly straight would have led to it failing. On that basis reviews of plant design prior to the incident could not be expected to highlight this causative issue.

13. As previously described, the purpose of the rodder is to remove deposits of [REDACTED] that collect in the [REDACTED] but when asked how they calculated or otherwise determined the required strength of the rodder to undertake this task, Rhodia responded that the required strength of the rodder to undertake the removal of deposits in the [REDACTED] has no relevance to the incident.

12(5)(2)

#### Maintenance

14. As previously described, there are Plant Meetings held in the [REDACTED] three times a week (i.e. on Monday, Wednesday and Friday) when issues of importance relating to production and maintenance on the plant are discussed. Attendees include the [REDACTED] the Plant Supervisor, the Process Engineer, the [REDACTED] and the Electrical/Instrumentation Engineer, but not all would necessarily be present all of the time. The [REDACTED] reports that the problem of jamming or sticking of the rodgers would have been brought up at these meetings.

12(5)(2)

12(3)

12(3)

15. Rhodia report that:

- (i) To the best of their knowledge the rodder involved in the incident had never become sticky and had never been turned by a spanner;
- (ii) They monitor downtime and causes on the [REDACTED]
- (iii) They audit a wide range of Permits to Work (PTW) across site; a process that is designed to monitor the efficacy of the PTW system, i.e. it does not look in detail at the specific jobs detailed on the PTWs;
- (iv) There are zero PTWs from 2008 that relate to the [REDACTED] rodder jamming or sticking;
- (v) In contrast, the [REDACTED] rodder did stick on a number of occasions during 2008 but this did not cause a safety issue;
- (vi) [REDACTED] did stick on a number of occasions but no failure occurred, whereas there

12(5)(2)

12(5)(2)

12(5)(2)

12(5)(2)

were no incidents of sticking on [REDACTED] but a failure did occur.

16. In response to the CA's request, Rhodia provided a total of 6,978 Work Orders raised for both planned and unplanned maintenance on the [REDACTED] for 05 Jan 2005 to 02 Jan 2009 and, whilst they reported that they had split out those relating to the maintenance of the [REDACTED] rodder and had identified one WO that had been incorrectly assigned to the [REDACTED] rodder when it actually related to the [REDACTED] rodder, as the CA wished to establish the maintenance history for both [REDACTED] and [REDACTED] rodgers, rodder assemblies, [REDACTED] and [REDACTED], they analysed all 6,978. (Rhodia reported that they were unable to provide those for 02 Jan 2004 to 04 Jan 2005 as they were on an older version of their SAP database).

17. Rhodia also provided a total of 125 PTWs raised for both planned and unplanned maintenance on the [REDACTED] and [REDACTED] rodgers, rodder assemblies, [REDACTED] and [REDACTED] for Mar 2008 to 02 Jan 2009, and these were also all analysed. (Rhodia reported that PTWs prior to this had been destroyed as they have a policy of retaining PTW books for only 3 years).

18. Analysis of the WOs and PTWs showed that:

- (i) Not all WOs appeared to have a corresponding PTW and vice versa; and
- (ii) Not all WOs or PTWs were clear in terms of the plant and/or work involved (or, indeed, the persons responsible for the work).

19. However, bearing in mind the above it would appear that:

- (i) On 01 Sep 2007, the [REDACTED] was removed (for routine statutory examination) and replaced and a new rodder was provided;
- (ii) On 12 Sep 2008, the [REDACTED] was replaced again (i.e. 12mths earlier than usual; apparently due to concerns regarding corrosion found on [REDACTED]);
- (iii) Rhodia state that the rodder underwent its annual inspection (for corrosion) at this time and was found to be satisfactory and was replaced without repair. So, as they state, the rodder that failed on 02 Jan 2009 was 15 months old.
- (iv) There are no PTWs relating to the freeing of a jammed/stuck rodder on [REDACTED] in the 12 month period prior to the incident. That said, it is known that not all cases of a jammed/stuck rodder were referred to the Maintenance Department to be addressed under a WO and PTW regime, i.e. the Operatives would sometimes attempt to free the rodder themselves and would report it to the Maintenance Department only if their attempts were unsuccessful.
- (v) There are, however, the following PTWs relating to the [REDACTED] rodder\* for the same 12 month period:

Date:	Ref:	Task:	Completed** after:
02 Feb 2008	14970	Re-attach coupling on rodder	1 hour
31 Mar 2008	10576	Check and repair rodder	3 hours
Apr 2008	Various	Replacement of [REDACTED] and rodder	N/A
08 Sep 2008	15002	Remove rodder for inspection	8 hours
12 Sep 2008	15104	Replace rodder	N/A
03 Oct 2008	18775	Check rodder and gland	2 hours

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

10 Oct 2008	15604	Free rodder	5.5 hours
17 Oct 2008	15623	Free rodder	3 hours
20 Oct 2008	15630	Check and repair rodder	1.25 hours
28 Oct 2008	15663	Check and repair rodder	1 hour
04 Nov 2008	15697	Check and repair rodder	1 hour
10 Nov 2008	17993	Rodder jammed in down position	?
13 Nov 2008	17907	Check and repair rodder (jammed)	0.25 hours
20 Nov 2008	?	Free up sticking rodder	0.25 hours
23 Nov 2008	17937	Free sticking rodder	1.25 hours
28 Dec 2008	16805	Free up rodder (jammed at top end)	0.5 hours

\* At this point of the investigation it was discovered that there is a further rodder on both [REDACTED] and [REDACTED] (i.e. the [REDACTED] but these are configured differently to that which failed and are not under investigation. This investigation deals solely with the rodgers used to clear the [REDACTED] between the [REDACTED] & [REDACTED] and [REDACTED]

12(5)(a)

\*\* The above PTWs were all completed and not 'suspended' (i.e. the work was not stopped for a period before it was completed and then re-started). Suspended work would require either the PTW to be revalidated upon re-starting the work or else a new PTW to be issued. The latter would give rise to more than one PTW for the same task. So each of the above PTWs relates to a discrete task and not the same task interrupted and then re-started.

20. In response to the CA's request, Rhodia provided just 3 PTWs relating to the investigation/freeing/release of a jammed/stuck [REDACTED] rodder on both [REDACTED] and [REDACTED] for the period from the date of the incident of 02 Jan 2009 to the date of the planned plant shut-down in Sept 2011 (i.e. a period of 2 years 9 months) (see TRIM: 2011/609114):

12(5)(a)

Date:	Ref:	Task:	Plant
07 Dec 2010	034563	Repair rodding unit (Jammed)	?
28 Jan 2011	027279	Free rodder – stuck	[REDACTED]
08 Feb 2011	027349	Free rodder	[REDACTED]

12(5)(a)

21. It should be noted, of course, that the plant may have been in shut-down more often during this period than it had been prior to the incident.

#### Information, Instruction and Training

22. At the time of the incident there were no documented procedures and/or specifications for either:

- a) Constructing the screw joint of the two piece rodder;
- b) Constructing, inspecting or testing the weld on the two-piece rodder;
- c) Adjusting the rodder to ensure the necessary level of straightness;

- d) Setting up the rodder assembly;
- e) Setting up the rodder;
- f) Aligning the rodder with the inlet [REDACTED] or
- g) Freeing a stuck/jammed rodder.

12(5)(a)

23. And, whilst there were some (brief) instructions (dated May 2007) regarding the operation of the rodder, the two Operatives (i.e. Team Leader and Deputy Team Leader) were both unaware of them.

24. At the time of the incident:

- (i) The [REDACTED] had been trained how to machine the rodder by the [REDACTED]
- (ii) The Welders, whilst Coded, had been trained how to weld the rodder by other Welders and/or the [REDACTED]
- (iii) The [REDACTED] worked from general engineering principles; and
- (iv) The Operatives had been trained how to use the rodder and free a stuck/jammed rodder by other Operatives.

12(3)

12(3)

12(3)

#### On-site and Off-site Emergency Plans (On-SEP and Off-SEP)

25. Rhodia's 'HSE Emergency Procedure P06' dated November 2007 was current at the time of the incident and not the version dated December 2008 (which was marked 'Draft' and was provided to the CA in March 2009).
26. Those Rhodia employees having key roles in the On- and Off-SEPs were all aware of the contents of Rhodia's 'Emergency Procedure P06' and had received both in-house and external training. They are also involved in periodic desk-top exercises and weekly emergency drills which, Rhodia report, include the use of breathing apparatus, radio control and management, etc.

#### Availability of key personnel

27. When asked how many employees were on site at the time that the incident started, Rhodia responded that there were a number of employees on site and that the number present was in excess of that required for the Company's safety procedures to be appropriately implemented and managed. The Lobby Commissionaire, however, states that there were around [REDACTED] people on site on the day.
28. According to pages 97-99 of the 2007 COMAH Safety Report (i.e. diagrams showing employee distribution across the site) it would appear that on weekdays there are around [REDACTED] employees on site; on week nightshift there are around [REDACTED] and at the weekend there are around 50, so 15 employees would appear to be a relatively small number. That said, the day of the incident was a site holiday and, it is understood, only the [REDACTED] was in operation.
29. Rather than stating the minimum number of employees required to be present in order that the On-SEP and Off-SEPs may be implemented, Rhodia's Emergency Procedure P06 states that the following persons *must* attend incidents:

12(5)(a)

12(5)(a)

- (i) [REDACTED] and

12(3)

(ii) [REDACTED]

and the following persons *should* attend incidents:

(i) [REDACTED]

(ii) [REDACTED]

(iii) Quality Assurance Shift Manager;

(iv) Process Shift Manager; and

(v) [REDACTED]

30. When asked whether all of the above did attend, Rhodia responded that all those required to attend did so.

31. When asked specifically if the [REDACTED] and [REDACTED] attended, Rhodia responded that the incident occurred on a Bank Holiday and was thus 'out of normal hours' and that their Emergency Procedure P06 allows for this and ensures that all key roles can be filled at any time. (It should be noted here that whilst Friday 02 January 2009 may have been a site-holiday, it was not in fact a Bank Holiday).

32. It is noted that the WMC-1 stated that he advised the Lobby Commissionaire to contact the [REDACTED] regarding press interest, but it is not clear from this whether the [REDACTED] was on- or off-site at the time as the WMC-1 was himself off-site.

33. Witnesses state that the QA Shift Manager and Process Shift Manager were on-site at the time of the incident and that the [REDACTED] attended site during the incident (albeit not arriving until ~13:30hrs; some 1hr 24mins into the incident), but the CA has not sought to establish whether the remaining required personnel did in fact attend.

34. With regard to the WMC-1 being off-site during the incident, whilst the 2007 COMAH Safety Report states (on page 67) that he will be positioned in one of the Emergency Control Rooms, Rhodia's Emergency Procedure P06 issue November 2007 (page 114) lists which managers may assume the role of WMC and states that outside normal office hours, if none of the listed managers are in position in a control room, then the Duty Manager should take up the role remote from site until another senior manager can take up position in one of the emergency control rooms.

35. During this incident the WMC-1 worked remote from site [REDACTED] from 12:15hrs until he handed over to WMC-2 (who was on-site) at 13:30hrs, i.e. 1hr 15mins later.

#### On-site Alert

36. The site has been equipped with a Toxic Gas Alarm for over 20 years and:

[REDACTED]

[REDACTED]

12(5)(a)

37. Whilst the General Site Alarm was sounded during the incident, the Toxic Gas Alarm was not.

38. When asked why this was, the WIC responded that the incident was a fire and not a toxic gas situation, and Rhodia responded that it was because the incident was not one of a toxic gas nature, i.e. whilst phosphine gas is toxic, it is also highly flammable and thus burned immediately on contact with air to produce phosphorus pentoxide / phosphoric acid mist, which is not toxic, so they had not released a toxic gas.

39. Rhodia also state that the incident did not involve a 'significant phosphine release' because it was fully burnt, and that it was not thought that any 'breathing difficulties' would be likely to be experienced by anyone in the vicinity of the emission – but this contradicts information they provide elsewhere in terms of both possible on- and off-site effects.

40.

12(3)

41. Rhodia state that they have never had a toxic gas release. This is not strictly true, i.e. on 26

June 2007 there was a release of Phosphorus trichloride ( $\text{PCl}_3$ ) and Phosphorus oxychloride ( $\text{POCl}_3$ ), both of which are 'Very Toxic' (as classified by CHIP) and both of which react vigorously and exothermically with water and water-containing substances (including moisture in air) to produce, amongst other things: Phosphorus Pentoxide ('Corrosive'); Phosphoric Acid ('Corrosive' or 'Irritant' depending upon concentration); and Hydrogen Chloride ('Toxic' or 'Corrosive' or 'Irritant' depending upon concentration). Rhodia's [REDACTED] states that the Toxic Gas Alarm was sounded on this occasion but, again, this is not the case and, following the CA's investigation into the incident, Rhodia were asked to review their emergency arrangements for the sounding of the Toxic Gas Alarm, which they agreed to do.

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#### Managing the phosphine fire

42. [REDACTED]

12(5)(a)

[REDACTED]

[REDACTED]

43. However, during the initial stages of the incident, upon seeing flames coming out of the [REDACTED] employees used water hoses to direct water onto the flames in an effort to damp them down and to see what was happening. When asked whether this contravened or compromise their health and safety management or emergency arrangements, Rhodia responded that it did not, and went on to say that employees were using water to damp down the fumes to try and see clearly the leak source, and to note that at this temperature it would not be possible to extinguish the phosphine fire. They do not, however, appear to have considered the risks of water entering the [REDACTED] and/or otherwise contacting the phosphorus/phosphine.

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12(5)(a)

#### Provision and Use of RPE

44. [REDACTED]

12(5)(a)

[REDACTED]

[REDACTED]

45. However, witnesses state that because there were only [REDACTED] (of the possible [REDACTED] Fire Officers on site at the time, they could not operate the fire pumps or a full breathing apparatus service. Rhodia, however, state that there were sufficient resources for Rhodia personnel to use breathing apparatus at all times and that their procedures do not require Fire Officers to be on-site, and either way, a [REDACTED] officer came in from home at 12:40 [i.e. some 34 minutes into the incident].

12(5)(a)

46. However, Rhodia's Breathing Apparatus Entry Control Procedure (P06, page 79) states that

their Senior Fire Officer will give orders that breathing apparatus will be used if any doubt exists as to the safety of working conditions and describes how this entry control will be maintained and what will be done in the event of a breathing apparatus wearer failing to withdraw at the proper time. It also states that breathing apparatus teams are to consist of no fewer than two wearers and that they are not to enter or be left in a risk area alone, and that where possible two breathing apparatus wearers should be kept available at the Entry Control Point for emergency purposes.

47. In the early stages of the incident employees entered the plant and attempted to fight the fire with water hose reels and to close the isolation valve. When asked whether the fact that they were not wearing breathing apparatus at the time contravened or compromised their health and safety management or emergency arrangements Rhodia responded that it did not, and went on to state that employees took a conscious decision not to use breathing apparatus in the first instance because they could see both the flame and the plume and therefore could avoid the fire, and that at all times their Fire Officers wore protective fire fighting clothing and breathing apparatus when they were at risk of coming into contact with the fumes.
48. With regard to Rhodia's claim that their procedures do not require Fire Officers to be on site, that would appear to be incorrect, i.e. the presence of their own fire brigade and fire appliance (manned and operated by volunteers) is described as part of their overall emergency response arrangements.
49. The 2007 COMAH Safety Report and Rhodia's Emergency Procedure P06 issue November 2007 both describe the duties of the Site Chief Fire Officer and the Site Fire Brigade Members in the event of an incident; indeed P06 does this in the section entitled '*Key Personnel Duties*'.
50. They state that the role of Chief Fire Officer is assumed by the most senior member of the Site Fire Brigade and that he will take advice from the WIC. They state that it is his responsibility to limit the spread of any fire and, if appropriate, set up an Entry Control Point to a fume-laden building (this latter being described as being '*Of particular importance*') and provide an Entry Control Officer and ensure adequate supplies of breathing apparatus are available. His duties are further described as:
  - (i) Ensure maximum turn-out of the Works Fire Brigade members;
  - (ii) Ensure attendance of the Works Fire Brigade appliance at the scene;
  - (iii) Deploy the Works Fire Brigade men and equipment to best effect to limit the spread of fire until such time as the West Midlands Fire Service attend;
  - (iv) Consider the need to open the meter bypasses on the towns water supply for additional water;
  - (v) Take up an advisory role for the West Midlands Fire Service and provide any assistance required;
  - (vi) Set up emergency communication point at a location agreed with the WIC using signs from the fire appliance/chemsafe tender; and
  - (vii) Give authority to sound the 'all-clear' following incident.
51. The Site Fire Brigade Members duties include making the fire appliance ready and attending the scene.
52. If it was the case that none of the above actions were required, or would only be available when suitably qualified employees were on site in sufficient numbers, then Rhodia's emergency procedures would presumably state this and would describe alternative controls, but they do not appear to do so.

Assessing Likely Off-site Effects

53. With regard to assessing the likely off-site effects:

Rhodia's Emergency Procedure P06, November 2007, page 23, paragraph 8, requires the Works Incident Controller (the WIC) to:

*'Consider the offsite effects likely to be created and take action to inform outside emergency services, and send out patrols to assess the extent of offsite effects.'*

54. The WMC-1 (who was off-site throughout and was at no time informed that fumes were going, or indeed had gone, off-site) assumed that patrols had been sent out.

55. The TIC's impression was that the incident would have an off-site effect.

56. The WIC, however, did not feel that there were going to be any off-site problems as it wasn't toxic, i.e. it was a [REDACTED] (Indeed Rhodia stated that it [i.e. phosphoric acid] is

12(3)

57. The TIC states that he and the WIC had an exchange of views and discussed how they should handle the situation, but no patrols were sent out.

58. When asked why patrols were not sent out during the incident and whether this contravened or compromised their health and safety management or emergency arrangements, Rhodia responded that their arrangements were not contravened or compromised and that they did a worst case analysis of the concentration of phosphorus pentoxide and phosphoric acid that would or could be at the perimeter fence and that it was well below the level for occupational health.

59. When it was pointed out to Rhodia that this modelling of concentrations etc. appeared to have been done via computer, Rhodia's [REDACTED] (who was authorised to speak on behalf of Rhodia) agreed with the CA that it would have been difficult to do this assessment actually during the incident itself.

12(3)

60. When asked whether the above assessment was carried out during or after the incident, Rhodia state that the decision not to send out boundary patrols was based on a 'visual assessment' made shortly after 12:12 hrs (i.e. when they apparently first became aware that fumes were going or had gone off-site) that the fumes were not likely to create a problem off-site as the mist was high in the air, indicating even further dilution. They state that this was a significant factor in determining that there were not going to be any off-site effects and that a distinction must be drawn between the cloud going off-site and the potential for impact, i.e. the phosphoric acid mist was high up in the air and was not a danger to public health.

61. It should be noted, however, that witnesses describe the cloud when it was in the yard as being either 'on the ground' or 'hugging the ground' and one states that he and others were standing in it.

62. Rhodia state that these types of scenario were assessed prior to the incident in the COMAH Report (see p476). However, when asked how they could be sure of the concentrations at the time, Rhodia state that they do not model these types of scenario as they are known not to have a significant offsite impact. These two statements appear to be contradictory.

63. Rhodia state that at ~14.00hrs it was decided, by the [REDACTED] in collaboration with WMFS, that the off-site alarm would need to be sounded. Rhodia state that this was in order to ensure consistency with the actions being taken by the Police who were informing people with loud hailers to stay indoors and setting up road closures, etc. Rhodia's [REDACTED] however, states that it was because they were beginning to get concerned at that point of the concentrations.

12(3)

#### Off-site Alert

64. It is the duty of the Local Authority (LA) to draw up the Off-SEP in liaison with the Operator. In the case of Rhodia's site, it is understood that the LA delegated this work to the WMFS. The duty to implement the Off-SEP however, lies with Operator and the LA (or in this case WMFS), and they are deemed to have discharged this duty when there are systems in place to ensure that there are no unreasonable delays between the discovery of a major accident, or an incident that may lead to a major accident, and activation of the Off-SEP.
65. Publication HSG 191 'Emergency Planning for Major Accidents' (first published in 1999 and available from HSE Books) provides guidance on good practice for emergency planning and states that the plans must specify the name(s) or position(s) of the people authorised to initiate them and that the On-SEP should also specify who is responsible for sounding any alarms in the event of a major accident.
66. Rhodia's site has been equipped with an Off-site Alarm (i.e. siren) for over 20 years and their Emergency Procedure P06, November 2007, page 100 states:

*'An off-site Alarm is also available should the situation warrant it.'*

67. Rhodia state that the purpose of sounding this alarm is to warn the public of a toxic gas release. It has never been sounded other than for test purposes and, following the MA of 26 June 2007, Rhodia were asked to review/revise their arrangements for the sounding of both on- (including toxic) and off-site emergency alarms, which they agreed to do.
68. With regard to alerting members of the public liable to be affected in the event of a COMAH Major Accident MA (i.e. those within the Public Information Zone - 'PIZ') there is no specific requirement for a COMAH Operator to provide an off-site siren/alarm, i.e. the public may be alerted by means of e.g. telephone, loud hailer or some other system (or, as is often the case, a combination of two or more of these), and the means of alerting those within the PIZ is for local agreement and recording in the Off-SEP.
69. It should also be remembered that a siren/alarm may be of limited value in terms of alerting those within the PIZ who are either visiting the area or are travelling through at the time of a MA, and such persons (who would be unlikely to be privy to the information provided by the Operator in accordance with COMAH Regulation 14 and thus may be unaware of the significance of the siren or the action to take upon hearing it) would be reliant upon other means of raising the alert.
70. It is, however, vital that whatever system of alert is agreed upon, it is used in accordance with the agreed protocol as defined in the site's Off-SEP.
71. In terms of Rhodia's off-site alarm, the WIC states that it would be sounded for anything [REDACTED] 12(5)(a)  
[REDACTED] He saw no need for it to be sounded on this occasion and states that it is left up to the WMFS to decide whether the Off-site Plan should be activated.
72. The WMC-1, however, states that the decision regarding the sounding of emergency alarms is down to the WMC, and Rhodia's Emergency Procedure P06, November 2007, page 114 does indeed require the WMC to consider instructing the Lobby man to sound the Off-site Alarm, normally after consultation with the WIC and the Senior WMFS Fire Officer and the Senior Police Officer.

73. Rhodia's procedures also require the WMC to maintain a speculative review of possible developments throughout the incident. When asked why the WMC-1 (on duty from the onset of incident until approximately 13:30hrs) was at no time notified of the fact that the cloud of smoke/fume from the incident was either going, or had in fact gone, off-site, Rhodia responded that the WMC-1 was in regular communication with other persons on-site until 13:30hrs and during this time there was not considered to be a risk of off-site impact and that the important point here is not whether the cloud migrated off-side but whether there was off-site impact.
74. On his way to site WMC-2 observed wisps of cloud from the incident and smelt combustion produces of phosphine on nearby Titford Road. He stated, when questioned, that he could not remember whether, upon arrival at site, he mentioned this to the [REDACTED]
75. When asked who in the company the WMC-2 reported his observations to, Rhodia responded that as WMC-2 he would not have to report it to anyone. This seems unlikely as one would have expected information such as the sighting of the cloud off-site as being critical to their management of the incident and of particular relevance to all those contributing to the ongoing (i.e. dynamic) assessment of the risks.
76. Rhodia state that they did not sound the Off-Site Alarm at the time of the incident as a result of careful consideration having been given to the potential impact of the fire on the surrounding area, and that this was discussed between them and WMFS shortly after the latter attended site, and that as part of this discussion they gave WMFS details of the wind direction and speed using information from the weather data logging system installed in the Lobby. The consensus was not to raise the Off-site Alarm. Rhodia state that they did not believe it was an off-site incident and so did not declare it as one.
77. The WMC-2 states that at around 13:30hrs the Site Manager/Director reported to him that he had liaised with WMFS and that they did not wish the off-site alarm to be sounded at that time. Rhodia state that it was agreed with the WMFS [REDACTED] that an off-site impact should not be called at that time despite the police's actions (i.e. they were setting up road blocks and advising locals to stay indoors). Rhodia also state that following a further discussion between the Company and WMFS at around 13.40pm, WMFS indicated that they did not want to sound the Off-site alarm as they were concerned about alarming the public.
78. When asked whether the decision to not sound the Off-site Alarm contravened or compromised their health and safety management or emergency arrangements, Rhodia responded that it did not.
79. As previously described, however, at around 14:00hrs the [REDACTED] reported to the WMC-2 that he had again liaised with WMFS and that the incident was to be declared off-site and the off-site plan was to be activated and the Off-site Alarm sounded. Rhodia state that this was in order to ensure consistency with the actions being taken by the Police who were informing people with loud hailers to stay indoors and setting up road closures, etc. Rhodia's [REDACTED] however, states that it was because they were beginning to get concerned at that point of the concentrations.
80. Rhodia did not, however, sound the off-site alarm because, at around 14:15hrs, the rodger was re-inserted into the [REDACTED] at which point the fire was extinguished and, as Rhodia state, in collaboration with WMFS they agreed that as there was going to be no further fume emission, sounding the alarm would not be necessary.

12(5)(b)

12(3)

12(3)

12(3)

12(5)(a)

81. Rhodia state that they did liaise with the emergency services during the incident and that Bronze Control was established by WMFS on-site and they liaised closely with them on a regular basis about the actions that were being taken to tackle the fire.
82. Contrary to the notes taken by the EA during the incident de-brief, Rhodia state that they were not asked to attend Silver Control (which had been set up at a local police station) and that the [REDACTED] did speak with two of the Police Officers who attended site, but that by this time the Police had already initiated the vast majority of their actions as per the Off-SEP, and that closer liaison (i.e. between Rhodia and the Police) may have led to a more consistent approach. They also state that Gold Control was also set up but they were not asked to attend. 12(3)
83. When asked whether there were any off-site incidents that did not require the sounding of the off-site alarm, Rhodia responded that some incidents (e.g. spillage to canal) do not require the sounding of the offsite alarm.
84. The Off-site Alarm has never been sounded other than for test purposes.

#### **Contacting Vulnerable Premises**

85. Rhodia's site is surrounded by a mix of residential / industrial / retail / hospitality / school / care / office / etc. premises. (It should, of course, be noted that the incident occurred on Friday 02 January 2009, which means that some of these premises may not have been occupied or fully occupied).
86. Pages 268-270 of Rhodia's Emergency Procedure P06 November 2007, lists a total of 43 'vulnerable' premises around the site (identified according to colour-coded sectors).
87. These 43 include: railway stations; schools; a PO sorting office; industrial units; offices; churches; a temple; a swimming centre; a community centre; libraries; a residential home; an adult training centre; a physically handicapped centre; superstores and other retail units; youth centres; a Citizens Advice Bureau, a health centre; a neighbourhood office; a family centre; etc.
88. The Lobby Commissionaire states that he announced on the site radio that the affected areas on-site were brown, green and purple (see Annexe 61). Assuming that these colours correlate to those in Rhodia's Consultation Zone, and they appear to do so, then there were 15 vulnerable premises relevant to the incident, i.e:
- (i) 2 superstores;
  - (ii) 1 primary school;
  - (iii) 1 family centre;
  - (iv) 1 adult training centre;
  - (v) 1 physically handicapped centre;
  - (vi) 4 churches;
  - (vii) 1 community centre;
  - (viii) 1 office;
  - (ix) 1 library;
  - (x) 1 residential home; and

(xi) 1 Christian centre.

89. However, there appears to have been some confusion as to the wind direction, so it may well be the case that other vulnerable premises were in fact relevant.
90. Rhodia's Emergency Procedure P06, November 2007, page 28 requires the WMC to ensure that nearby neighbours, and in particular local schools, are informed if they are likely to be affected, and page 114 again requires the WMC to ensure nearby neighbours are informed and refers him to the above list of vulnerable premises. (With regard to the schools, it could be argued that they would most likely be empty due to it being a school holiday, however some schools do, of course, open for other activities/clubs etc. during holidays. Either way, schools are not the only vulnerable premises).
91. Rhodia state that they did not contact vulnerable premises because they reached a consensus with WMFS that neighbours were not likely to be affected, but that the Police did make contact.
92. When asked which premises were contacted and what information was provided and at what time, they responded that the CA should obtain this information from the Police.
93. When asked what relevant information they provided to the Police (or any other relevant outside agency) for them to provide to vulnerable premises, and at what time, they responded that the police had their own plan of action which was implemented in their own timeframe.
94. When asked if they checked with the Police (or any other relevant outside agency) that they had provided relevant information to vulnerable premises, Rhodia responded that the Police were already contacting the general public in accordance with their own plan.
95. When asked at what time they checked, or if they didn't check, why not, Rhodia referred to their above responses and provided no further information.
96. Rhodia state that there were no risks to vulnerable persons off-site.
97. However, Plant Emergency Dossier, March 2005, page 7, paragraph 1.4.9 states:

[REDACTED]

12(5)(2)

98. When asked whether the substances contained in the cloud that went offsite were dangerous and/or hazardous to health, for example for vulnerable persons, Rhodia referred to their above responses and provided no further information.

#### Keeping records

99. The CA publication HSG191 'Emergency Planning for Major Accidents' describes the 'Site Main Controller' (e.g. Senior Manager, Manager or Director who has an overall knowledge of the site) as having overall responsibility for directing operations from the on-site Emergency Control Centre (ECC). It describes the Site Main Controller's responsibilities as including arranging for an ongoing record to be kept of the emergency and the responses undertaken to mitigate its effects, to provide evidence of the decisions made, the mitigatory action taken, and to ensure that lessons are learned from the response to the emergency;
100. Rhodia's Emergency Procedure P06, November 2007, page 29 paragraph 14, requires the Works Main Controller to:

*'Arrange for a chronological record of the emergency to be maintained'* and it provides the form at appendix 1.A6.1 to be used.

101. However, no such record was kept by either of the two WMCs, who stated that they were either too busy or else couldn't concentrate on doing both this and being WMC, although one stated that he did keep some notes.
102. When asked why the required chronological record was not kept, Rhodia responded that people were too busy dealing with the main emergency and didn't have time to write the chronological statement.
103. When asked whether it was important that the chronological record be kept, Rhodia responded that they're sure it is but that this was a reaction to an emergency situation and that if they were to insist that such records were always kept this could prove a dangerous distraction from the employees' main roles in dealing with the incident.

#### Mechanical/Metallurgical Analysis

##### Royal and Sun Alliance Engineering (RSA)

1. Rhodia provided the CA with a copy of a report by RSA (Document number: SS/0917617, dated 25/02/09, Author: [REDACTED] – Annexe 30). The report discusses the potential for the rodder to overload due to the rodder becoming stuck. 12(3)
2. The report considers the forces placed on the rodder by the motor, the gear box and the slide and concludes that the stresses within the rodder are within industry norms for the material using design stresses from PD5500. It does not consider the welded section of the failed rodder or any loading of the rodder due to misalignment, either in the weld itself or between the rodder and the [REDACTED]. It also models a one-piece rodder and uses only one loading case, and does not give any reasons as to why the weld failed in the [REDACTED] rodder. 12(5)(a)

##### RCA Laboratories (RCA)

3. Rhodia provided the CA with a copy of a report by RCA (Report Ref: 0901/002, dated 18 September 2009, Author: [REDACTED] – Annexe 40). The report discusses the mode of failure of the rodder weld. 12(3)
4. It refers to the failure of the [REDACTED] rodder, but this is an error and, as confirmed by Rhodia, the report actually relates to the failed rodder on [REDACTED]. 12(5)(a)
5. The section of bar examined by RCA was the section that remained inside the [REDACTED] during the incident (i.e. HSL inspected the section that was withdrawn from the [REDACTED] at the start of the incident). The two failure areas do match. 12(5)(a)
6. The report does not include any calculations to demonstrate the forces required to initiate crack formation and there is no reference to the RSA report. The report states 'In summary, the following hypothesis was developed as the likely cause of the rodder failure' and summarises this hypothesis as that:
  - (i) The rodder weld was not straight;
  - (ii) Operation of the rodder produced sufficient stress to initiate a crack opposite the depression in the weld after some unknown period of operation; and
  - (iii) The cracks then grew over some period until they were sufficiently large to cause the failure seen.

7. The report mentions an area of the rodder that has been damaged by external forces – such as interaction with a Stilson – but says that these were caused after the failure of the weld by the withdrawal of the rodder from the [REDACTED]. There is no evidence to support this statement as the rodder was not seen immediately prior to the incident and other rodgers were seen to have mechanical damage from Stilsons or similar tools.

12(5)(a)

8. RCA saw only a small section of the bar and so they present no evidence regarding the condition of the remainder of the bar.

#### **Health and Safety Laboratories (HSL)**

9. HSL examined the following items submitted to them by the CA:

(i) The failure surface of the [REDACTED] rodder and the [REDACTED] taken into possession on 06 Jan 2009;

12(5)(a)

(ii) The used rodder taken into possession on 14 Jan 2009;

(iii) The [REDACTED] air reducing set taken into possession on 08 Jan 2009; and

12(5)(a)

(iv) The weld samples taken into possession on 27 Feb 2009.

10. In addition [REDACTED] (RCA metallurgist employed by Rhodia) submitted two samples described as: (i) the fracture surface on the lower half of the rodder from [REDACTED]; and (ii) a section through the weld in the rodder that had been removed from [REDACTED] after the incident on [REDACTED]

12(5)(a)

11. HSL were also provided with the drawings and data etc. regarding the rodder assembly, as submitted by Rhodia to the CA on 14 Jan 2009.

12. From the above, HSL produced their report Ref: ES/MM/09/34, entitled 'Investigation of a failed rodding bar and associated items from Rhodia UL Ltd, Oldbury', dated August 2009 – Annexe 33.

13. In August 2012, HSL were provided with copies of Rhodia's RSA Report (dated 25 February 2009) and Rhodia's RCA report (dated 18 September 2009) and asked to comment on each. They produced the letter/reports dated 09 Aug 2012 and 10 Aug 2012.

14. HSL concluded that the [REDACTED] rodder had failed by rotational bending fatigue with the weld section failing first and failure progressing from the root of the weld, and then the screwed central hub of the weld assembly failing some time afterwards.

12(5)(a)

15. The weld was competently made but the design of the weld allowed a large lack of fusion to be left between the root of the weld and the central hub.

16. The stresses induced in a straight rodder by the rodder assembly motor in the correctly aligned condition, even with blockages caused by [REDACTED] were not of sufficient magnitude to cause a rotational bending fatigue fracture of the weld.

12(5)(a)

17. This meant that there had to be another reason why the rodder weld failed by rotational bending fatigue, i.e. there had to be another force acting on the weld in addition to the normal forces from the [REDACTED]

12(5)(a)

18. Calculations by HSL demonstrated that a misalignment of the rodder assembly with the rodder [REDACTED] on the [REDACTED] could produce sufficient cyclic strain in the rodder to cause rotational bending fatigue failure in the rodder weld and subsequently in the central hub.

12(5)(a)

19. The HSL work shows that either a misalignment in the weld or a misalignment between the [REDACTED] and the rodder assembly was required to induce the failure seen.

12(5)(a)

20. The used rodder taken into possession on the 14 Jan 2009 did not contain a weld and was made using a single piece of bar. The evidence presented by this rodder is of helical scoring on the metal surface that shows that the rodder was in contact with a material of sufficient hardness to score its surface as it rotated and slid in and out of the [REDACTED]. The position of the scoring is consistent with the position of the rodder as it reaches full insertion into the [REDACTED] and close examination of the markings shows that circumferential scoring becomes helical [REDACTED] from the end of the rodder. 12(5)(a)
21. This rodder was not seen fitted to the rodder assembly and so no measurements could be taken, but assuming that the bar was inserted into the [REDACTED] with [REDACTED] staying out of the [REDACTED] then the scoring would align with the inserted end of the bronze bush (i.e. Item 2 on drawing 4341). It should be noted here that the failure in the weld on the [REDACTED] rodder was approximately [REDACTED] from the top end of the rodder, and the used rodder in this position shows significant helical markings. 12(5)(a)
22. The used rodder also shows a significant surface disruption towards the free end that is consistent with the use of Stilsons to free a rodder that had become stuck. This can be seen clearly in Figure 4 of the HSL Report – see Annexe 38.
23. HSL further report in section 2.3 that the sample of the failed rodder exhibited a limited number of isolated examples of heavy longitudinal scoring, which had apparently been caused by mechanical contact during longitudinal movement. These marks are on a section of the rodder that would not have been inserted into the [REDACTED] so they cannot be related to contact between the rodder and the [REDACTED]. The reason for these marks has not been established. No helical pattern was reported, as seen on the used rodder, but it must be noted that the lower section of the bar below the weld was not inspected. 12(5)(a)
24. The HSL Report (Annexe 33) figure 10 shows the rodder as received. A mottled section of the rodder can be seen near to the ruler. Initially HSL were not asked to report on this section but after further close visual inspection the CA asked that a sample be taken to discover what had caused this effect. The mottled area is around [REDACTED] to [REDACTED] from the free end of the rodder. The HSL letter of 10 Aug 2012 reports that this area has been subject to burning phosphorus. 12(5)(a)
25. The sample welds clearly demonstrated the difficulty of producing a straight bar using the method of manufacture demonstrated to the CA. The step height in the weld was approximately [REDACTED] after machining. If the angular displacement reported by HSL had not been corrected during manufacture then the paddle of the bar would have been approximately [REDACTED] out of line with the shorter end of the bar when this was held square in the motor/gearbox assembly. Even with the smaller deflection noted in paragraph 2.4.4 of the HSL report of [REDACTED] degrees the paddle would have been approximately [REDACTED] out of line. 12(5)(a)
26. The compressed air reducing set taken from the [REDACTED] rodder assembly was set to give no, or very limited, reduction between supply pressure and delivery pressure to the rodder motor and slide. Therefore the pressure to the rodder assembly would be limited only by site compressed air supply pressure. 12(5)(a)

#### Analysis of findings and Conclusions:

1. It should be noted that use of the rodder was, from 1981 to 1989, a manual operation with a handle of just [REDACTED] diameter provided for the Operative to turn and push against. Therefore it must be concluded that the torque required to keep the [REDACTED] between the [REDACTED] and the [REDACTED] clear of [REDACTED] build-up is very low and, for 8 years, was achieved by manpower alone. 12(5)(a)
2. The CA has seen nothing to suggest that the substances in the [REDACTED] have become more difficult to shift since 1989 and so the input power from the motor and gearbox assembly needed only to match one man power. 12(5)(a)

3. With the compressed air setting to the motor seen, the motor (at [REDACTED] was expected to produce [REDACTED] This power was converted to torque in the gearbox to give an output of [REDACTED] This is far in excess of what a man could produce with a [REDACTED] diameter handle. From this it is hard to see why the rodder might jam on product (as Rhodia suggested) when a man could keep the overflow clear by hand. It may be that Operatives used the rodder as a hammer rather than as a rotating tool and in reality the mechanised rodder can give a far better cleaning stroke than could be expected from a manual rodder. 12(5)(a)
4. Although the CA did not see precisely how the rodder assembly was set up at the time of the incident, it is clear that the weld in the rodder failed by rotational bending fatigue and that under normal operation, with a correctly aligned straight bar, there was insufficient cyclic strain to produce a fatigue failure. The step, reported by RCA, near to the weld is not considered to have influenced the failure and no evidence is presented by RCA that cracking initiated in this area. Furthermore, no calculations are offered by RCA to demonstrate where the stresses required to initiate crack growth were generated from.
5. The HSL calculations clearly support the view that bending of the bar was required to produce the rotational bending fatigue seen. It was thus concluded that there had to be cyclic forces acting on the bar in addition to normal rotation of the bar in order to produce the failure seen. Without additional cyclic forces the failure seen on the rodder weld was not credible.
6. Typically rotational bending fatigue failure of shafts is seen after a very high number of cycles. The actual number of cycles to failure is dependent upon the stress range applied, i.e. the larger the stress range, the fewer the cycles required to fail the weld.
7. In the extreme case, one application of stress can lead to failure but this is termed as an overload, whereas a few cycles to failure is termed low cycle fatigue and typically involves stresses between yield and failure stress. Typically design will be for millions of stress cycles and the S-N curves used by HSL have a limit of 10000 cycles – although PD5500 Appendix C has an S-N curve that extends the typical curves down to 100 cycles.
8. For a rotational bending fatigue failure of the type seen it is expected that the stresses are below yield but well above a threshold stress where crack initiation is not predicted. At some very low stress range, failure is never predicted.
9. Damaging cycles are cumulative so a few large stress ranges can be added to a number of smaller stress ranges to add up to the total number of cycles to failure. As fatigue cracks progress, the stress in the remaining ligament increases and therefore it is expected that crack growth per cycle increases until just one cycle completes the failure.
10. In the case of the rodder, larger stress ranges may be seen on start-up or on jamming, with much smaller stress ranges during normal operation. The failure surface seen on the rodder demonstrates the crack growth per cycle – these marks are called 'striations'. A rough count of the visible striations on the fracture surface seen in figure 11 of the HSL report (Annexe 38) gives an approximate value of 8200.
11. The rodder was used for 15 months and was operated approximately every 4 hours. If each operation had three cycles that caused vibration into the converter floor (as witnessed on 15 May 2009) then, over a 15 month period of operation, there would have been an estimated  $15 \times 30 \times 6 \times 3 = 8,100$  damaging rotational bending cycles.
12. Without these bending cycles it can be seen that over a 15 month period, and conservatively taking 5 minutes to complete each rodding operation (i.e. the measured time for the rodding operations witnessed was far less than 5 minutes), it can be seen that a conservative estimate of the actual rotational cycles can be found as  $15 \times 30 \times 6 \times 5 \times 75 = 1,012,500$  cycles.

13. Looking at typical S-N curves for fatigue failure of welded steels, the stress range required for failure in one million cycles is dependent on the weld detail and, using the S-N curves, the stress range varies from approximately 60MPa for the poorest weld quality to approximately 180MPa for the best quality welding; so the actual stress range required for the rodder weld to fail by fatigue will be somewhere between these two figures.
14. Assuming weld quality F (this aligns with the HSL findings that the weld was correctly made) then the stress range to failure is expected to be approximately 80MPa from the S-N curve.
15. The RSA report is clear that the [REDACTED] alone could not produce this stress range – RSA say that the maximum stress in the rodder shaft is 60MPa at start up – and this is the worst case. Even conservatively assuming that the rodder jams 5 times on each use (and there is no evidence to support such frequency) then these stresses would be seen 10 times per use or  $10 \times 6 \times 30 \times 15 = 27,000$  times until the failure. Partial jamming would not produce the same level of stress in the bar as a full jam and re-start, and thus the stresses induced in the bar during partial jamming is lower than the 60MPa quoted by RSA. Using the 60MPa stress swing and the lowest quality of welding leads to a life of 1.7 million cycles and this rises to 8 million cycles for weld quality F. (2)(5)(a)
16. Thus, with the rodder working normally, there are not enough damaging cycles to cause the weld to fail. The weld, however, did fail, and so there had to be another force acting on the rodder to cause it to fail within 15 months.
17. Whilst on the plant on 15 May 2009, the CA experienced high forces transmitted by the rodder jamming in the [REDACTED]. Working backwards from the knowledge that the weld failed by rotational bending fatigue, and using the forces experienced as a method for counting cycles, it can be seen from the S-N curve that for quality level F welds a stress range of above 400MPa is required to fail the weld in the 8100 damaging cycles calculated above. (2)(5)(a)
18. This level of stress range cannot come from the normal operation of the rodder but requires the rodder bar to bend during each of the damaging cycles. The intensity of the stress range then becomes a function of the distance between the fixed points given by the rodder assembly and the [REDACTED]. The shorter this length, the higher the stress range. If the rodder was correctly aligned the stresses in the rodder bar would remain constant within the limits given by the RSA report for removal of the [REDACTED]. (2)(5)(a)
19. It is the opinion of HM Specialist Inspector (Mechanical Engineering) that if Rhodia had been aware of the rodder jamming as it approached the end of its stroke then they should have carried out an investigation into the cause of the jamming, and that in doing so:
- (i) They would have found the wear on the [REDACTED]. (2)(5)(a)
  - (ii) They would have noted the vibration;
  - (iii) They would have realised that in the jammed position the rodder paddle was inside the [REDACTED] so was not sticking/jamming on product in the [REDACTED] and (2)(5)(a)
  - (iv) They would have concluded that the rodder and the [REDACTED] were not correctly aligned and that they needed to be correctly aligned in all conditions of use. (2)(5)(a)
20. Thermal expansion of metals is a physical fact. As temperatures rise metals expand and as temperatures fall they contract. This expansion is linear and is well known and can be described by a simple formula:
- Expansion = Original length x temperature change x thermal coefficient
21. For stainless steel the thermal coefficient is known to be  $16 \times 10^{-6}/^{\circ}\text{C}$  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.

22. In the case of the [REDACTED] the point of interest was the bottom of the [REDACTED] (Item 2 on drawing 4341). The CA asked Rhodia to measure the height of this point above the [REDACTED] support structure. Expansion above the support structure would be upwards, and below the support structure downwards. Rhodia's [REDACTED] provided (by email dated 06/03/09 08.44) a [REDACTED] surement of [REDACTED] and a temperature differential between cold and full operation of [REDACTED]. This led the CA to conclude that the [REDACTED] at the [REDACTED] would rise relative to the [REDACTED] by in the region of [REDACTED] between cold and full operating temperature.
23. The [REDACTED] has a cooling water jacket that will give a temperature gradient across the [REDACTED] the inside of the shell being close to the contents temperature (i.e. approximately [REDACTED]) and the outside of the shell (in contact with the water in the cooling jacket) being at close to the water temperature (i.e. between 80 and 100°C). This makes the actual movement of the [REDACTED] (that does not have a water jacket and is at an upward angle) difficult to predict.
24. It should also be noted that the alignment of the rodder to the [REDACTED] at the time of the incident is not known; all that is known is that it had been aligned by eye in the cold condition. So the use of the deflection values given by the HSL report should only be read as informative to demonstrate the stress ranges in the rodder that would be induced by a misalignment between the rodder and the [REDACTED]. This misalignment can induce the stress ranges required to cause rotational bending fatigue failure of the rodder within the 15 month period and this correlates with the CA's experience of the operation of the [REDACTED] rodder assembly with the [REDACTED] in the hot condition.
25. The [REDACTED] was on a different platform to the [REDACTED] and was maintained at ambient temperature; the structure being fully open to the elements [REDACTED]
26. On 02 Jan 2009 the mean temperature is reported as zero centigrade with the minimum at -5 and the maximum +4. Therefore it can be seen that the [REDACTED] was much cooler than the [REDACTED] and the steel work supporting the assembly can be expected to contract slightly from the position it would have occupied in warmer months. There were no arrangements in place to ensure any compensation for these changes.
27. The ambient temperature on 02 January 2009 at the time of the incident is reported as zero centigrade. This would have the net result of increasing any misalignment between the rodder assembly and the hot [REDACTED] from the case described by HSL where an ambient temperature of approximately 20 C is assumed.
28. If the rodder assembly had been correctly aligned when cold, and then not realigned for the rise in temperature of the [REDACTED] this would leave the rodder assembly too low. This would not be apparent with the rodder fully withdrawn from the [REDACTED] as the length of the exposed rodder would compensate for this misalignment. But, as the rodder was inserted into the [REDACTED] this misalignment would become more of an issue. In the case of full insertion the motor assembly would be trying to hold the rodder down, whereas the [REDACTED] would be trying to lift the rodder up. As the rodder continues to rotate, these two opposing forces would act on the rodder in a cyclic manner so that at one half rotation a point on the rodder is in compression, and at the next half rotation the same point is in tension.
29. The HSL calculations show that sufficient stress range is generated in this scenario to cause the weld in the rodder to fail by rotational bending fatigue. The amplitude of 246 Mpa quoted by HSL is for the difference between the general stress in the rodder from the fully withdrawn to the fully inserted positions, and it is then shown that with full insertion and rotation, stresses swing in one point on the bar from positive 246 MPa to negative 246 MPa – a swing of around 500 MPa. This leads to the conclusion (using the S-N curve approach for a quality level F weld) that the rodder would be expected to fail in less than 10000 cycles – this aligns well with the striation count on the fracture surface of approximately 8200.

12(5)(a)

- 12(3)

12(5)(a)

12(5)(a)

12(5)(a)

12(5)(a)

12(5)(a)

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30. HSL note that the misalignment could come from two areas, or a mixture of both. They point to thermal misalignment and also to misalignment in the weld itself.
31. With regard to misalignment in the weld, looking closely at the evidence the following has to be considered:
- (i) The rodder seen in use on 15 May 2009 did not have a weld and was considered to be straight;
  - (ii) The short end of the failed welded rodder was held in the [REDACTED] by a keyway and as such can be expected to have been square and rotate with no deviation. If a weld misalignment is then put in the remaining [REDACTED] of the rodder, as it rotates it makes a conical shape with the apex at the weld and the base at the paddle. The deflection along the cone will increase from zero at the weld to a maximum at the paddle, and from the weld tests this was found to be about [REDACTED]. Such a cone shape movement of the bar would be expected to wear the [REDACTED] all the way around and not just in the one position that was found following the failure; and
  - (iii) During manufacture, the rodder is aligned between the head stocks on a lathe so that it is generally straight between the two points on the lathe but can have some distortion, quoted by Rhodia's [REDACTED] as a target of [REDACTED] between those two straight points. This straightness is generated by plastic deformation of the bar using a soft mallet.
32. So there can be misalignment at the weld but this is only a local effect and it can be seen that the fatigue cracking has not started at this discontinuity – or directly opposite to it.
33. With regard to thermal misalignment between the rodder assembly and the [REDACTED] this would explain the vibrations experienced by both rodder assemblies that the CA saw tested at operating temperature and the fact that at ambient temperature the rodder assembly on [REDACTED] ran smoothly. Whereas if weld misalignment was a significant factor then the assembly would be expected to struggle with the bar fully withdrawn but then to free up as the bar was inserted.
34. The CA also notes that when they saw [REDACTED] tested at full temperature on the 15 May 2009, a fire started on the surface of the bar after the third rodding sequence. Clearly the evidence in the HSL report demonstrates that this had happened to the failed rodder in nearly the same position. It is the CA's understanding that the section of the rodder examined by HSL was fully retracted from the [REDACTED] at the start of the incident and so the heat damage reported by HSL must have been on the rodder section prior to the incident. This means that operators must have seen fire with the rodder fully inserted on at least one occasion before the incident but the CA has seen no evidence that this was investigated by Rhodia.
35. It should be noted that the fire damage on the failed rodder indicates that the bar was inserted further into the [REDACTED] than the measurements the CA took on the 27 Feb 2009 (i.e. [REDACTED]). The evidence from the failed bar may indicate that the insertion was to around [REDACTED] of bar remaining out of the [REDACTED] and this would move the weld at full insertion to a point inside the [REDACTED] diameter part of Item 1 on drawing 4341 revision C. The significance of this is that the rodder weld moves from an area of soft packing to the hard stainless steel part of Item 1; the weld would have had some freedom of movement within the soft packing but this would be resisted within the stainless steel part. Unfortunately Item 1 was involved in the fire and so was not taken as evidence, although the CA did note wear in the [REDACTED] diameter part of Item 1 when it was looked at on site.

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36. It should be noted that the used rodder showed clear evidence of an alignment issue, i.e. its surface had helical scoring and the position of the marks and the direction in which they move do, in the CA's opinion, strongly suggest that the rodder was in contact with a hard surface as it rotated. It should be noted that there are no helical marks on the part of the rodder that would not have entered the [REDACTED]. It is possible that the marks were sustained during manufacture of the bar, but this is unlikely as Rhodia required a completely straight bar and such markings would surely have been seen to be detrimental to good [REDACTED]-sealing capability (i.e. the helical marks might help move product through the [REDACTED] seal).
37. These marks should have been seen when the bar was removed at the end of its service life, and if they were seen then the reasons for the scoring should have been investigated. Again, it is the opinion of HM Specialist Inspector (Mechanical Engineering) that such an investigation would have concluded that there was an alignment issue between the rodder assembly and the [REDACTED].
38. There is no clear evidence that previous [REDACTED] used on the [REDACTED] (Item 2 on drawing 4341) have sustained the wear seen at the time of the rodder-failure. Rhodia were unable to produce inspection reports for parts discarded during routine maintenance. It is the CA's opinion that parts removed during maintenance should always be subjected to close inspection to allow for confirmation that the operating conditions and periodicity of inspection are correct. It would appear, however, that the only driver for planned maintenance on the rodder assembly etc. was the condition of the paddle, as this was known to be subject to corrosion inside the [REDACTED].
39. It is clear, from the used rodder, that Stilsons had been used on it and it is known that Stilsons were used to free-up a sticking/jammed rodder.
40. Rhodia are firmly of the view that the rodder jams due to the build up of [REDACTED] and appear to be either unwilling or unable to consider any alternative causes for the jamming.
41. As explained above, the stress range induced into the bar by stopping and starting is not sufficient to cause the rotational bending fatigue failure seen. Had Rhodia investigated the reasons for the rodder jamming and considered the position of the rodder when the jamming occurred, they would have found that misalignment between the rodder assembly and the [REDACTED] contributed to the number of jamming incidents seen. They would also have found that the rodder could not have been sticking/jamming on the product because it was already in the [REDACTED].
42. It should also be noted that the step seen at the weld on the failed rodder would have induced stress concentrations (in addition to the stresses due to the rotation of the bar) but that there is no evidence in the RCA report that cracking initiated from this step. These additional stress concentrations were not modelled within the HSL calculation as it was clear that they could not cause the bending required for rotational bending fatigue.
43. Although there is no record of the orientation of the [REDACTED] at the time of the incident (Item 2 on drawing 4341), the wear pattern on it demonstrates that it had been in close contact with the rodder, leading to wear in just one area. This is an indicator that there was a misalignment between the rodder assembly and the [REDACTED]. With the correct alignment the rodder should run true through the [REDACTED] and wear would be expected to be uniform and not concentrated in one area.
44. Rhodia commissioned a finite element assessment of the rodder by RSA and the report of the findings was clear that, under normal conditions of operation, there were insufficient strains on the rodder for it to fail. The report does not, however, consider the rodder to contain the failed weld, nor does it consider a step in the weld or misalignment of the rodder assembly to the [REDACTED].

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45. One issue with this investigation was that it initially appeared that this rodder was no different to other rodgers that had been made and used in the same way since 1989, with no reported failures. This led to a concern as to why this bar should fail when all others have survived for their two year operating period.
46. There are, however, a number of credible explanations as to why an ageing process might materialise on one rodder but not on others that appear to be identical, e.g:
- (i) The other rodgers' raw bar material was stronger;
  - (ii) The other rodgers' welds were deeper;
  - (iii) The other rodgers' welds were on the point of failure when the rodgers were replaced;
  - (iv) The other rodgers saw fewer cycles; or
  - (v) The other rodgers were better aligned with the [REDACTED] etc.
47. Another explanation might be that not all other rodgers since 1989 were in fact welded, i.e. not only were there no records for the management of change from a one-piece to a two-piece rodder, and not only did the design drawings not show the weld, but, other than the failed rodder and that in use on [REDACTED] the only other rodder that Rhodia were able to produce was not a recently discarded welded two-piece rodder, but a used one-piece rodder. So, bearing in mind that Rhodia only make the rodgers as and when they need them, and regardless of their apparent policy of discarding used parts, it would appear that they kept this particular rodder for 20 years.
48. Rodders without a weld are far stronger and would require far higher cyclic loads to cause a fatigue failure. Noting that use is limited to 2 years due to paddle corrosion then it is clear that even with the foreseeable misalignment between the rodder assembly and the [REDACTED] that it is unlikely that an unwelded bar would contain a large enough defect to lead to a fatigue failure, i.e. using the S-N curve for the highest quality welds it can be seen that for a stress range of 400MPa the number of cycles to failure is in the region of 100000 compared to 40000 for a class F weld. No fatigue-type indications were found on the used bar examined by HSL despite the Stilson marks and the helical grooving.
49. What is not clear is why Rhodia chose to make at least two rodgers (i.e. the one that failed and that in [REDACTED] with a weld. Lengths of bar of up to [REDACTED] in length are readily available and would be far straighter than the rodder produced with a welded joint. Clearly Rhodia had sourced long enough bar in the past and their drawings expected a single length of bar. Furthermore, following the incident they had no problem sourcing bar of sufficient length and straightness to not require a weld.
50. The CA can offer no explanation as to why there was a move to a welded rodder. Such a move increased both production time and effort for no increase in the integrity of the bar – in fact quite the opposite; the move significantly decreased the strength of the bar and also compromised its straightness.
51. This change in design of the rodder did not in itself lead to the failure of the rodder in [REDACTED] on 02 Jan 2009, but without this change the bar is unlikely to have failed in a 2 year operating period.
52. The fact that there was sufficient cyclic bending loading to break the rodder led to another concern for the stresses in the [REDACTED] i.e. this [REDACTED] is not designed for high levels of cyclic loading. Without removal of damaging cyclic stresses from the rodder there is a potential for the [REDACTED] to fail by fatigue; for with a solid rodder the [REDACTED] would appear to be the next weakest point in the system.

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53. The CA has not asked Rhodia for any detailed fatigue calculations for the [REDACTED] but they did ask them to complete surface non-destructive testing (NDT) of the [REDACTED]. Rhodia did this with dye penetrant and reported that no crack-like defects were found. The CA notes that dye penetrant inspection would not find crack initiation so lack of indication does not mean that there is no fatigue damage. Furthermore, the inspection was limited to the outer surface of the [REDACTED] so any cracking on the inner surface would not be detected. Rhodia have, however, since improved their Written Scheme of Examination (WSE) for the [REDACTED] to include close inspection for fatigue cracking.

12(5)(a)

**B2 - Preventative measures taken by the duty holder(s) BEFORE the incident**

1. There was an On-SEP and an Off-SEP for the site, both of which were subject to periodic test and review. Rhodia employees involved in the implementation of these emergency plans were provided with information and instruction by both colleagues and external training-providers in the form of both verbal and documented procedures. However, certain relevant aspects of the emergency procedures were not followed during the incident.
2. Rhodia reported that they had arrangements in place for the management of change. However, there were no records regarding the change from manual to automated rodder, or from one-piece to welded two-piece rodder. These changes apparently took place prior to Rhodia's ownership of the site, but planned periodic design-review of the plant and process by Rhodia in the intervening years seemingly failed to recognise and/or act upon the significance of these changes.
3. Rhodia reported that they had arrangements in place for the planned, periodic-design-review of plant & process, yet the HAZOP reported as being current at the time of the incident was dated 1980 and appeared to be unchanged (i.e. not revised) and did not consider either failure of the rodder or blockage of the isolation valve by the rodder.
4. There were design drawings of relevant parts of the plant which included those dated from the time that the plant was first designed, installed and commissioned, plus subsequent revisions. The drawings did not, however, show the welded joint on the rodder.
5. The plant was subjected to planned periodic maintenance, i.e. the rodder assembly was inspected daily by Plant Operatives, six-monthly by the Maintenance Team, and annually by the Plant Engineering Team, and the rodder (in recent years) was replaced every 2 years. However, records were not kept of the findings of these inspections and, either way, they appeared to be mainly for the purpose of assessing the level of corrosion of the rodder and did not include e.g. examination of surface scoring on the rodder and a check of the clearance of the bush in the [REDACTED] (an investigation of which would have concluded that there was an alignment issue between the rodder assembly and the [REDACTED]).
6. There were thrice-weekly Plant Meetings held in the Control Room and attended by management, engineers, etc. when issues of importance relating to both production and maintenance on the plant were discussed. However, incidents of the rodder jamming/sticking were either not considered or else their significance (as an indicator of a potential alignment issue between the rodder assembly and the [REDACTED]) was either not considered or was not acted upon.
7. PTWs were monitored. Again, however, incidents of the rodder jamming/sticking were either not considered or else their significance (as an indicator of a potential alignment issue between the rodder and the [REDACTED]) was either not considered or was not acted upon.
8. Rhodia reported that they had arrangements in place for developing suitable methods for the recovery of plant following an incident, but the method statement they produced was inadequate.

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9. Relevant persons either followed engineering principles or else were provided with verbal instruction and training by their colleagues regarding the manufacture, installation, inspection and maintenance of the rodder. However, apart from brief instructions regarding the operation of the rodder (of which the Operatives interviewed were unaware) there were no documented procedures and/or specifications for the manufacture, installation, alignment and maintenance of the rodder.

**B3 - Health and safety management BEFORE the incident**

1. On-SEP and Off-SEP.
2. Arrangements for MoC.
3. 1980 HAZOP.
4. COMAH Safety Report 2007.
5. However, certain aspects of the above were inadequate, and/or certain information contained in them was contradictory, and/or certain of the procedures described in them were not followed (see above for details).

**B4 - Preventative measures taken by the duty holder(s) AFTER the incident**

1. Rhodia reported that they have taken steps to improve liaison with the emergency services during an incident, including agreeing standard definitions of the different levels of emergency.
2. Rhodia reported that they have reviewed their emergency procedures to clarify when to sound the Off-site Alarm.
3. With regard to management of change, Rhodia reported that they are taking steps to ensure that relevant documentation regarding high-hazard plant is retained in perpetuity.
4. Rhodia reviewed/revised their HAZOP to consider the issue of 'rodder distortion', but appear to conclude that rodder failure is a production issue rather than one of H&S. It is proposed that they be asked to review/revise their HAZOP again to consider the H&S issues arising out of or in connection with rodder failure, including the potential for a failed rodder to block the isolation valve.
5. Rhodia reported that they are reviewing the shutdown procedures for the [REDACTED] with a view to enabling it to be shut down faster in an emergency situation.
6. Rhodia elected to increase the frequency of rodding.
7. Rhodia were required (by two PNs, i.e. one for [REDACTED] and one for [REDACTED] to assess the thermal expansion of the [REDACTED] and [REDACTED] and to realign the rodgers accordingly. Rhodia reported that they initially adjusted the rodder to compensate for thermal expansion (i.e. it was reported that [REDACTED] aluminium packers were provided at either end of the air piston to allow for thermal expansion during heating-up) but they subsequently reported that, in their view, thermal expansion was not an issue and that re-alignment to take account of it was not necessary (i.e. their measurements indicated that thermal expansion would result in a deflection of [REDACTED] and much of this would be compensated for by the [REDACTED] and any remaining flex would not have a significant effect upon the loads on the rodder, and that the rodder would actually flex by more than [REDACTED] under its own weight). The CA required them to carry out further work to establish the optimum position of the rodgers, which they agreed to do.

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8. According to Rhodia's [REDACTED] (on 20 July 2010), the rodders don't stick at all now (although he believed this to be due, in the main, to them rodding more frequently). Either way, it would appear that they stick/jam much less frequently, i.e. Rhodia were able to produce only 3 PTWs relating to the investigation/freeing/release of a jammed/stuck [REDACTED] rodder on both [REDACTED] and [REDACTED] for the period from the date of the incident of 02 Jan 2009 to the date of the planned plant shut-down in Sept 2011, i.e. a period of 2 years 9 months, although it should be noted that the plant may have been in shut-down more often during this period than it had been prior to the incident. The CA deemed the PNs to have been complied with. 12(3)  
12(5)(a)
9. It was reported that in the event of a rodder sticking or jamming, Rhodia no longer use Stilsons on the rodder itself but free it by separating the coupling and using the coupling to rotate the rodder.
10. It was reported that a locking device is now provided to prevent the rodder slipping down into the [REDACTED] 12(5)(a)
11. Rhodia were required (by the above PNs) to inspect relevant [REDACTED] on the [REDACTED] and the [REDACTED] for fatigue cracking (i.e. signs of strain) and to take the remedial measures identified as being necessary. Rhodia reported that they had done this and had found no fatigue cracking but had improved their written scheme of examination (WSE) to include close inspection of the [REDACTED] for fatigue cracking in future. The CA deemed the PNs to have been complied with. 12(5)(a)
12. Rhodia were required to review the plant/process design of the [REDACTED] and [REDACTED] (and relevant associated plant and pipe work), and to consider alternative means of preventing/clearing blockages in the overflow pipe between the [REDACTED] and to consider the provision of local exhaust ventilation or other secondary containment etc. for the purpose of mitigating against a loss of containment of hazardous/dangerous substances from the [REDACTED] and/or [REDACTED]. The CA proposes to monitor Rhodia's progress with this matter via the Site Intervention Plan. 12(5)(a)
13. With regard to design drawings etc., Rhodia reported that they are ensuring (in the long term) that they have documented specifications for all mechanical components used in safety-critical or business-critical components, where these are manufactured in-house.
14. Rhodia elected to find (and, in fact, quickly identified) a source of suitable bar of sufficient length, and straight away began manufacturing one-piece rodders without the need for a welded joint. They report that the rodders are now manufactured to a precise straightness tolerance.
15. Rhodia 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 and determining the frequency & scope of future rodder inspection and maintenance. They reported that no evidence of metal fatigue was found following 3 months use. The CA has not asked them to report their findings of the 6 month or 1 year examination. 12(5)(a)
16. Rhodia reported that they now have a documented planned preventative maintenance regime for the rodding system (i.e. rodder and rodder assembly) and that in addition to their inspection of the rodder paddle (for corrosion), the rodder shaft itself is inspected every twelve months, checking the outside tolerance of the internal bush, and ensuring that the rodder straightness follows the tolerances as specified by British standard BS EN 10278.
17. Rhodia were required to review/revise their arrangements for hazard identification & analysis, risk assessment & development of method statements for plant recovery following incidents, which they agreed to do. The CA proposes to monitor Rhodia's progress regarding this matter via the Intervention Plan.

18. Rhodia reported that they now have documented procedures for the manufacture, installation, inspection and maintenance of the rodder (and have improved the existing one for the use of the rodder) and have put arrangements in place to ensure their correct implementation.
<b>B5 - Health and safety management changes <u>AFTER</u> the incident</b>
1. See above.

**LIST OF ANNEXES:**

1. F2508
2. Map of local area
3. Map of site
4. Map of plant
5. Block diagram of process
6. Schematics of [REDACTED] 12(5)(2)
7. Schematic of rodder, [REDACTED] 12(5)(2)
8. Drawing 18196/2 (dated 20/05/81): General arrangement and details of [REDACTED] 12(5)(2)
9. Drawing CP4353A (dated 02/05/84)
10. Drawing 4341 (dated 13/04/89)
11. Drawing 4366 (dated 19/05/89)
12. Drawing 4341 Revision C (dated 03/07/89): Arrangement and details of rodding facility between [REDACTED] 12(5)(2)
13. Instructions for Rodder Operation (dated May 2007)
14. CCTV footage
15. News-site reported photo of cloud
16. Map of area confined by Police
17. Rhodia estimate of quantities released
18. CA estimate of quantities released
19. CA Report: HM Specialist Inspector, Predictive

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20. Schematic of post-incident rod, [REDACTED] 12(5)(a)
21. Rhodia Draft Method Statement
22. CA Recording: [REDACTED] 14 Jan 2009 12(3) 12(5)(a)
23. Extract from 1980 HAZOP
24. CA Email re – Witnesses 04 Feb 2009
25. CA Letter re – Witnesses 04 Feb 2009
26. CA Email (2) re – Witnesses 04 Feb 2009
27. Rhodia Letter re – Witnesses 04 Feb 2009
28. Police estimate of numbers confined
29. Rhodia Newsletter Jan 2009
30. RSA Report SS/0917617 by [REDACTED] 25 Feb 2009 12(3)
31. Diagram of relative position of rod components with rod fully inserted into [REDACTED] 12(5)(a)
32. Diagram of position of rod paddle with reference to [REDACTED] during the rod stroke 12(5)(a)
33. Pre- & Post-incident HAZOPs
34. [REDACTED] Prohibition Notice 12(5)(a)
35. [REDACTED] Prohibition Notice Schedule 12(5)(a)
36. [REDACTED] Prohibition Notice 12(5)(a)
37. [REDACTED] Prohibition Notice Schedule 12(5)(a)
38. HSL Report ES/MM/09/34 Investigation of a failed rod bar and associated items from Rhodia UK Ltd, Oldbury – Aug 2009
39. AVT Report 6429 [REDACTED] 22 Sep 2009 12(5)(a)
40. RCA Report 0901/002 18 Sep 2009
41. Rhodia Voluntary Statement
42. Rhodia Covering Letter
43. Rhodia Exhibits
44. AVT Report 6429 [REDACTED] 27 Sep 2010 12(5)(a)

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- 45. Rhodia/DLA Letter re – Foreseeability 10 Jan 2010
- 46. Rhodia/DLA Note re – Foreseeability 10 Jan 2010
- 47. CA Letter re – [REDACTED] Strain 26 Jan 2011 12(5)(a)
- 48. CA Composite Inspection Report re – [REDACTED] Strain 26 Jan 2011 12(5)(a)
- 49. CA Recording: [REDACTED] Px 03 Mar 2011 12(3)
- 50. HSL Report re - [REDACTED] Strain 26 Mar 2011 12(5)(a)
- 51. Post-incident instructions re – rodder installation 17 Nov 2011
- 52. CA Letter re – written PACE questions 16 Feb 2012
- 53. CA written PACE questions 16 Feb 2012
- 54. Rhodia Letter re – written PACE questions 30 Apr 2012
- 55. CA Letter re – written PACE questions 31 May 2012
- 56. Rhodia Letter re – written PACE questions 14 Jun 2012
- 57. CA Letter re – plant inspection 25 Jun 2012
- 58. CA Report re – plant inspection 25 Jun 2012
- 59. Rhodia Letter re – inspection 25 Sep 2012
- 60. CA Letter re – inspection 07 Jan 2013
- 61. Map of affected areas

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**LIST OF REFERENCE DOCUMENTS** (i.e. in addition to those listed above):

1. All relevant correspondence and other documents held in: HSE's COIN/TRIM databases and files
2. HSE Report – 22 Jan 2009 – [REDACTED] – HM Specialist Inspector (Process Safety) 12(3)
3. HSE Report – 24 Jun 2010 – [REDACTED] – HM Specialist Inspector (Process Safety) 12(3)
4. HSE Report – 27 Nov 2012 – [REDACTED] – HM Specialist Inspector (Mechanical Engineering) 12(3)
5. HSE Report – [REDACTED] – HM Specialist Inspector (Predictive)
6. CJA s9 Voluntary Statements provided by:
 

[REDACTED]	Rhodia Unite Employee Representative / [REDACTED]	12(3)
[REDACTED]	Rhodia Lobby Commissionaire	
[REDACTED]	Rhodia Electrician / Fire Officer	
[REDACTED]	Rhodia PAF Plant Team Leader / Casualty Officer	
[REDACTED]	Rhodia [REDACTED]	
[REDACTED]	Rhodia Welder	
[REDACTED]	Rhodia [REDACTED] Team Leader / Operative	
[REDACTED]	Rhodia QA Shift Manager / Works Incident Controller (WIC)	
[REDACTED]	Rhodia Welder	
[REDACTED]	Rhodia Process Shift Manager / Technical Incident Controller (TIC)	
[REDACTED]	Rhodia Deputy Team Leader / Operative	
[REDACTED]	Rhodia [REDACTED] / Works Main Controller (WMC-1)	
[REDACTED]	Rhodia [REDACTED] / Works Main Controller (WMC-2)	
[REDACTED]	Asda [REDACTED]	
[REDACTED]	Asda [REDACTED]	
[REDACTED]	HA [REDACTED] (Highways Agency)	
[REDACTED]	HA [REDACTED] (Highways Agency)	
7. PD5500 Specification for unfired fusion welded pressure vessels
8. [REDACTED] (1993). Toxicity Review 30. Phosphoric acid, phosphorus pentoxide, phosphorus oxychloride, phosphorus pentachloride, phosphorus pentasulphide. HSE Books, PO Box 1999, Sudbury, Suffolk CO10 6FS ISBN 0-7176-0669-4 12(3)
9. HSE (2007). EH64 Workplace Exposure Limits: Diphosphorus pentoxide
10. HSE internal documents on establishing a DTL for phosphorus pentoxide (MH91-43a, MH91-43b). [REDACTED] 12(3)
11. L111 'A guide to the Control of Major Accident Hazards Regulations 1999 (as amended)'
12. HSG 191 'Emergency Planning for Major Accidents'
13. Gas Explosions in Buildings and Heating Plant by [REDACTED] 12(3)
14. Transcripts of Rhodia's PACE Interview of 20 Jul 2010
15. Rhodia UK Ltd COMAH Safety Report 2007
16. Rhodia UK Ltd Oldbury Site – HSE Procedure P06 – Site Emergency Procedure – Issue November 2007

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17. Rhodia UK Ltd - Oldbury Site - HSE Procedure P06 - Site Emergency Procedure - Issue December 2008 - amendments provided March 2009
18. [REDACTED] - Plant Emergency Dossier - Issue March 2005 (2)(5)(a)
19. [REDACTED] - Operating Instructions - Issue May 2007 (2)(5)(a)
20. Consolidated Variation of Permit SP3339BL - 7 November 2007
21. Variation Notice KP3330XQ 29 May 2008
22. Extract from Application for Permit
23. Rhodia's Data sheets for [REDACTED] VA2J&X (2)(5)(a)
24. Rhodia's Data sheets for [REDACTED] 3J 40:1 (2)(5)(a)
25. Rhodia's Data sheets for [REDACTED] P120/L28 (2)(5)(a)
26. HSL Letter dated 4th April 2011 'Review of strain measurements taken by AV Technology at Rhodia UK Ltd, Oldbury, West Midlands'
27. HSL Letter dated 11 May 2011 'Metallurgical examination of further components associated with the Rhodia rodding shaft failure'
28. HSL Letter dated 9<sup>th</sup> August 2012 'Rhodia UK Rodding bar rotating bending fatigue failure.'
29. HSL Letter dated 10<sup>th</sup> August 2012 'RCA Laboratories Technical report 0901/002 'Failure analysis of the [REDACTED] rodder.' (2)(5)(a)
30. Drawing CP4361 Revision A Details of line 'clean out' poker.
31. Weather report for 2<sup>nd</sup> January 2009 taken from 'wunderground.com'.
32. Contemporaneous Notebook Records of HM Inspectors and HM Specialist Inspectors

