COMAH Control of Major Accident Hazards

COMAH Competent Authorities

Operational Delivery Guide

Inspection of COMAH Operator Flood Preparedness

HSE Environment Agency SEPA Cyfoeth Naturiol Cymru Natural Resources Wales ONR Office for Nuclear Regulation

Title

COMAH CA Operational Delivery Guide: Flood Preparedness Inspection

Open Government status

Fully open

Target audience

All relevant COMAH Competent Authority (CA) staff (HSE/ONR/EA/SEPA/NRW)

Contents

Summary

1. Flood Preparedness is recognised by both Government and industry as high priority. Recent flooding events have affected a number of major hazard establishments that are subject to regulation under the Control of Major Accident Hazards Regulations (COMAH) 2015. Such events can disrupt critical infrastructure and interrupt business continuity. Flood preparedness has been designated a strategic topic by the COMAH Strategic Forum[1]. The COMAH Competent Authority (CA) will undertake targeted inspections on this topic between 2017and 2022.

2. This delivery guide (DG) has resulted from collaborative work between the CA partners and industry through the COMAH Strategic Forum. It is supported by the CDOIF Guidance document 'Preparing for a flood: Guidance and Best Practice'. It establishes a clear framework for the inspection of flood preparedness at COMAH establishments where flooding has been identified as a risk with the potential to initiate or aggravate a major accident.

3. This DG applies to COMAH establishments that have been assessed as either being directly at risk of flooding or where indirect flooding may aggravate the response to a major accident on site or challenge layers of protection. It ensures the requirements of Regulation 25 of the COMAH 2015 Regulations are delivered adequately and consistently by the CA. CA inspectors should use this guidance to verify where appropriate that COMAH operators have identified and characterised the flood risk to their establishments (both direct and indirect) and implemented all appropriate risk reduction measures so far as reasonably practicable. This may involve multi-disciplinary inspection by the CA to establish the effectiveness of measures in place and assess the challenges to applicable existing layers of protection from flooding.

1. Introduction

4. This Delivery Guide (DG) supports the Competent Authority's (CA) programme of regulating major hazards by establishing a clear and consistent framework for inspecting flood preparedness arrangements for at risk COMAH establishments. Flooding can initiate and/or escalate loss of control, challenge safety barriers and lead to serious danger to people and the environment. Inspection under this DG looks at the influence flooding has on prevention and mitigation of major accidents to people and the environment.

5. The inspection approach builds on the Major Hazard Regulatory Model and the principals that the CA follows to direct its resources to activities that give rise to the greatest risk or are managed least effectively. Regulation 25(3) of the COMAH 2015 Regulations requires the CA to have a system of inspections incorporating a list of establishments where external risks or hazard sources could increase the risk or consequences of a MA. This DG is a major part of the CA's approach to meeting this duty.

6. COMAH establishments at risk of flooding have been categorised according to four "Flood Major Accident Scenarios" (FMAS 1-4). These are explained in Appendix 1. This should enable interventions at COMAH establishments to be prioritised according to the potential impacts associated with flooding and appropriate

[1] The COMAH Strategic Forum is a high level joint chemical industry and regulator forum working to improve major accident hazard management and raise standards across industry.

inspection plans instigated within the proposed 4 year intervention programme for the DG. Timescales for any improvements identified through these inspections should be determined locally and may not be required to be completed within this timeframe.

7. COMAH establishments where there is no risk from flooding (direct or indirect) shall not be inspected using this DG.

8. Previous inspections of key risk control systems may have examined the impact of flooding on their effective operation. Where this has verified that adequate measures are in place to ensure resilience to flooding, this work should not be duplicated. However, where the potential impacts from flooding have changed further assessment may be required ensuring where possible that overlaps are minimised. The findings should be used in conjunction with any further inspection required by this DG to provide a comprehensive assessment of operator performance.

9. The COMAH intervention manager (CIM) will consider the flooding scenarios identified and previous intervention history when identifying the relevant specialist disciplines required for flood preparedness inspections at a particular establishment.

2. Purpose

10. The principal aim of this DG is to support CA Inspectors and Officers when planning, inspecting and rating the inspection of flood preparedness at COMAH establishments.

11. It may also assist operators to discharge their duties under the following provisions of COMAH 2015:
    - Schedule 2 (Requirements and matters to be addressed by safety management systems),
    - Schedule 3 (Minimum data and information to be included in a safety report), in particular part 5 (a) (iii)[2] (Identification and accidental risks analysis and prevention methods),
    - Regulation 5 (General duties of operators) to take all measure necessary to prevent major accidents and limit their consequences for human health and the environment.

3. Scope

12. This DG is aimed at upper and lower tier COMAH establishments identified as being at risk of flooding where:
    - the flooding could directly initiate a major accident at the establishment; or
    - where the wider impacts of flooding also need to be considered due to the potential impact on managing a major accidents and challenges to the layers of protection on site, for example the ability of emergency responders to attend a major accident.

[2] Schedule 3, 5 (a) (iii): Identification and accidental risks analysis and prevention methods—(a) a detailed description of the possible major accident scenarios and their probability or the conditions under which they might occur including a summary of the events which may play a role in triggering each of these scenarios, the causes being internal or external to the installation; including in particular—(iii) natural causes, for example earthquakes or floods; operate their sites in a manner consistent with identified best practice, prepared to respond to the flooding incidents.

13. The scope of the inspection covers adequacy of risk assessments and identified risk reduction measures including flood resilience, resistance and response measures[3] which may need to be implemented to reduce the risk(s) to as low as is reasonably practicable.

14. The inspection approach described by this DG links risk assessment, internal and external emergency planning, human factors, mechanical, EC&I and process safety topics to enable the CA to determine whether the operator has taken all measures necessary to prevent and mitigate Major Accidents initiated or exacerbated by flooding at their establishment. For example, it may be possible depending on the site specific nature of the potential flood impacts to combine interventions on relevant preventive and mitigation measures where vulnerable layers of protection could be challenged by wider area flooding.

4. Background

15. Flood preparedness was designated a Strategic Topic by the COMAH Strategic Forum in 2016. A CDOIF working group was commissioned to develop a signposting document to promote current good practice and identify the guidance available to support improved resilience of industry to flooding.

16. A scoping exercise was undertaken between 2015 and 2017 to raise awareness of flood hazards and develop CA understanding nationally of the risk from flooding at every COMAH establishment. This identified sites and surrounding areas at risk from flooding using the most up to date flood risk information.

17. The study highlighted that not all establishments were adopting good practice with regard to:
    - flood hazard identification (sites had not identified all forms of flood hazard at their establishments);
    - reviewing good practice (lack of awareness of latest good practice guidance);
    - adoption of basic measures (operators not registered for flood warnings or integrated warning receipt into their emergency procedures)
    - understanding and addressing the impacts of flooding outside a site boundary on major accident response (this can significantly challenge layers of protection on a site including the availability of emergency response measures).

18. Based on this evidence the CA believed that continued risk from flooding due to severe weather events justified further action to be taken as part of the strategic topic. The use of a formal inspection guide was agreed by the CSF in May 2017.

5. Actions

19. **Core Interventions for all sites at risk from flooding or where indirect flooding may impact the response to a major accident on site.**

20. The DG builds on the CA's published methodology for prioritising operational work, which is based on an establishment's intrinsic hazards and operator performance against a number of strategic inspection topics. CIMs will also prioritise work that aligns with the delivery of each establishment's regulatory strategy.

[3] Flood resilience is defined as reducing the vulnerability of the receptor and/or reduce the exposure without negative impact on the hydrological system. Flood resistance measures are those capable of withstanding direct and prolonged contact with floodwaters sealing off points of entry.

21. The priority given to flood preparedness inspection by the CIM should reflect the outcome of the establishments' assessment of flood risk and scenario number as indicated by the FMAS, in particular any significant vulnerabilities to critical layers of protection identified as part of this process.

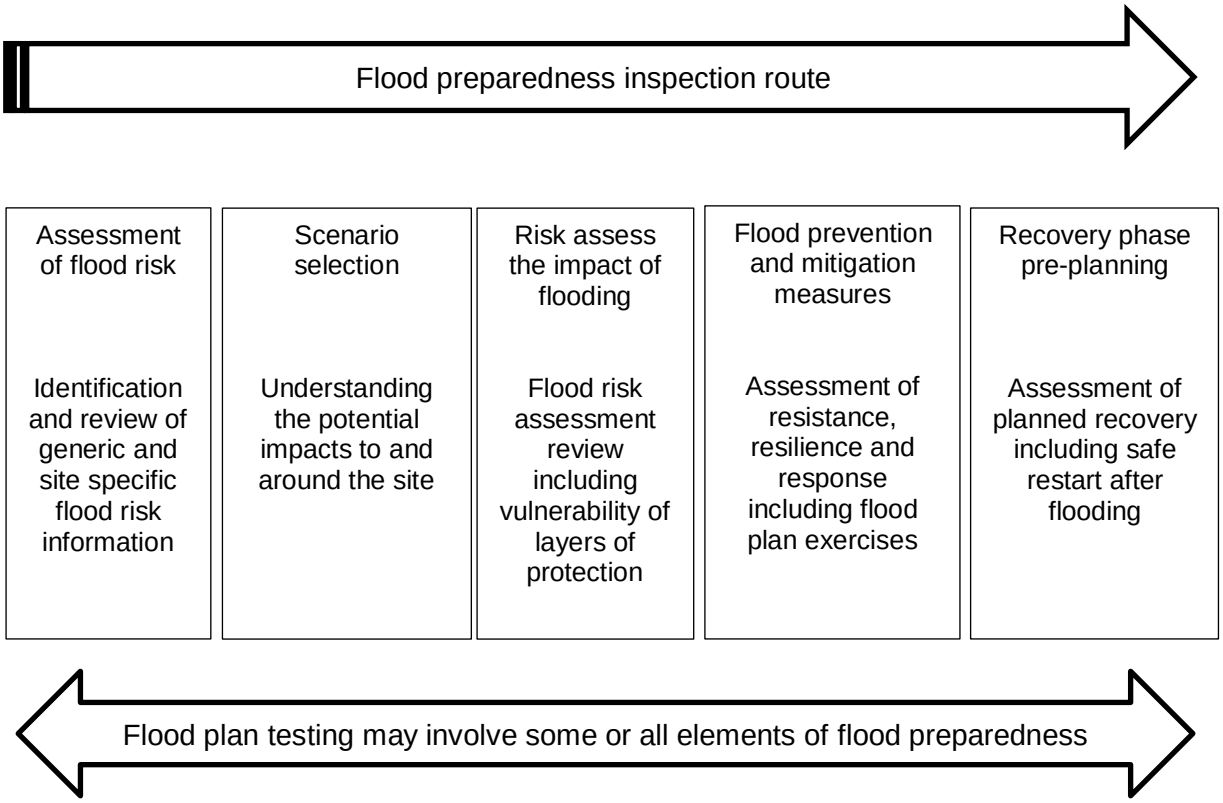
22. When preparing for inspections under this DG, Officers and Inspectors should refer to any key findings from previous flood preparedness interventions. Where relevant, these findings can be used to support the development of the rating of flood preparedness. Moreover, Officers should invite submission of evidence from Operators and this may shape the nature and extent of the intervention.

23. Where the flood preparedness intervention has identified potential shortcomings in key areas which require additional discipline specialist support, coordination of this work should be undertaken by the CIM in line with the current COMAH intervention planning procedures.

24. As intervention planning and establishment strategy is improved through the roll out of the Profiling, Targeting and Strategy Approach, dialogue with the CIM remains key. This should aim to identify appropriate sample point(s) such as physical location and assets, key risk control measures needed to allow meaningful assessment against this delivery guide. For establishments where the Profiling, Targeting and Strategy (PTS) approach has been deployed, susceptibility to flooding should be recorded in the 'Surrounding Environment' element of the establishment profile. Where a significant flooding threat is identified, dialogue between the CIM and Agency Officer (where these are not the same person) should inform the identification of suitable sample points and development of the overall strategy for the establishment.

25. It is expected that intervention programmes will have commenced for FMAS1 sites by the end of operational year 2019/20, FMAS 2 sites by the end of 2020/21 and FMAS 3 & 4 sites by end 2021/22. Further strategic topic development will explore tools and measures to support the programme that may allow for further optimisation and prioritisation of inspection, particularly FMAS 3 and 4 sites.

26. The main areas of inspection are outlined below:



27. Details for each of the main areas of inspection and the related success criteria are described in Appendix 2. It provides an overview of the area being inspected, the expected level of response an operator would provide and some key questions that may assist the inspection of the specific area. Appendix 3 provides further information on potential impacts from flooding and the layers of protection that may be threatened by this.

28. Where weaknesses are found, inspectors should explore whether these are the immediate manifestations of deeper-seated problems in the operator's safety management system (SMS) for major hazards. Required actions should focus on ensuring any problems at SMS level are addressed in order to achieve sustained compliance, rather than dealing only with rectifying immediate deficiencies.

6. Judging Success and Moving On - Performance Ratings for Flood Preparedness

29. Success criteria for flood preparedness inspections are defined in Appendix 2. By comparing key findings from the inspection with the relevant success criteria the COMAH operator's performance should be rated in line with the descriptions/scores provided in Appendix 4.

30. An operator should be advised of its establishment performance scores, which will also be recorded on their future intervention plans. The CIM and Inspector/Officer should be prepared to discuss these with the operator to ensure that there is clarity regarding how the score was derived and any remedial actions identified.

7. Enforcement Expectations

31. Inspectors and Officers should use the Enforcement Management Model, including assessment of factors that are specific to the COMAH establishment, to inform their regulatory decisions. Indicative enforcement expectations are included in Appendix 4. If using EMM to guide enforcement on environment matters then events with MATTE potential should be considered equivalent to “Serious personal injury” in terms of EMM guidance.

8. Recording and Reporting

32. When the inspection is complete, performance scores should be communicated to the COMAH operator and recorded in the CA inspection report.

33. Performance scores should be recorded on the appropriate COIN IRF Tab.

9. Review and Evaluation of the DG

34. The aim is to review the DG after 18 months to evaluate any evidence for improvement or modification based on feedback from inspections and ongoing development of the strategic topic with industry.

35. The CA will periodically review and evaluate outcomes of work undertaken through this DG and communicate key lessons learned to relevant parties and stakeholders. At the conclusion of the strategic topic a summary of findings will be shared with stakeholders.

10. Resources

36. This work is cross-referenced to work streams and delivery guides for safety report assessment (SRAM 2015), internal emergency planning and external emergency planning. These are located on the Competent Authority procedures and delivery guides page of the HSE website at http://www.hse.gov.uk/comah/ca-guides.htm.

37. Due to the potential multi-disciplinary nature of the DG multiple references are provided and linked within the document. Materials to support operators of establishments can also be found in the CDOIF Guidance on preparing for a flood: Good and best practice.

Appendices

Appendix 1: Flooding Major Accident Scenario (FMAS) explanations for CA work prioritisation

The FMAS approach is based on four Flooding Major Accident Scenarios and is a means by which the CA prioritise the inspection of establishments in scope of the strategic topic. The sites in scope are those at risk of flooding or where wider area flooding may impact on an establishments major accident response plans.

The major accident flood risk profile of an establishment i.e. the extent to which the major accident hazards identified have the potential to cause serious danger to human health and/or the environment, will determine which part of the CA organise and lead inspections.

These risks may change with time due to modifications at establishments or if new flood risk information becomes available. Information such as flood risk information revisions should be shared with the operator of the establishment as part of any ongoing discussion about flood preparedness and the CIM made aware of any developments.

Flooding Major Accident Scenario	Scenario Description	Typical site arrangement vs flood zones	Failure modes	Examples of previous incidents for FMAS scenarios
FMAS1	Flood within the establishment directly causes major accident (MA) through initiating fire/explosion/loss of containment	COMAH dangerous substances (DS)present in flood risk area	Floating tanks, broken pipework, debris impact, lifting flammables out of drains, warehousing impact, flooding location of prior MA.	Dronka Murphy Oil Argentina refinery CSG Sandhurst East Coast surge 2013 Arkema
FMAS2	Flood within the establishment can indirectly cause or escalate MA	No DS in flood area but MAH relevant equipment / utilities / access routes susceptible to challenge from flooding	Loss of power / comms Impact on Safety Systems Impact on emergency response equipment Impact on utilities / effluent	Flood impacts similar to those seem in winter 2015 floods on EPR and COMAH sites.
FMAS3	Flood outside establishment (but within local area exacerbates MA risk)	Establishment near flood risk areas which could challenge protection layers	Loss of access/egress Local Emergency response compromised Loss of power / comms Local workforce impacts	East Coast surge (non-flooded site loss of emergency route when dyke washed away)
FMAS4[4]	National wide area flooding exacerbates MA risk	Flooding in another part of the country but not near establishment	Emergency equipment e.g. HVPs not available including availability of national mutual aid. Designated authority resource compromised Multi-site operator resource stretched if simultaneous incidents occur	

[4] FMAS4 is designed to cover sites that rely on equipment or expertise that may be used in other locations during flooding. It should not include all COMAH sites by default.

Appendix 2: Details of inspection topics and success criteria

The following tables provide an overview of each of the 5 inspection areas required to ensure the establishment has identified and characterised the potential impacts of flood risk, implementing all appropriate risk reduction measures so far as is reasonably practicable to minimise the potential impacts of flooding.

The expectations and issues section should be considered in line with the flood risk identified for the site. You may not need to apply all of the listed expectations depending on the site specific nature of the work. However, although a site may be FMAS 3, the impact of flooding in the local area may produce an impact as significant as an FMAS 1 site depending on the major accident scenario/layers of protection challenged if the impacts of the flooding have not been considered.

The key questions are provided to assist in planning the intervention and gaining evidence to support your evaluation of the overall compliance of the site for flood preparedness.

Success criteria are provided for each of the 5 inspection areas highlighted and link to information provided in Section 6 of the DG. Not all of the criteria may be relevant dependant on the site specific nature of flood risk at the establishment.

Assessment step	
Assessment of flood risk: Ensure the information on current flood risk has been shared with the establishment operators, confirming agreement with the operators understanding of flooding as a hazard within their Major Accident Hazard identification. **Upper-tier sites:** Flood risk and any associated hazard identification should be included in the COMAH 2015 notification, safety report and reflected in the SMS. **Lower-tier sites**: The Major Accident Prevention Policy requires an SMS procedure to identify likely major accidents including flood risk.	
Expectation and issues	**Key questions**
The operator has considered the potential for flood risk from all mechanisms including fluvial and costal (if appropriate), surface water, ground water and reservoir. Direct flooding: The operator has a full understanding of the sites topography and any history of flooding. Evidence of this is presented in the COMAH 2015 notification, SMS and either the MAPP or SR. Indirect flooding: This should also have been considered to ensure any wider factors that may challenge existing layers of protection are considered. Consideration should be given to the availability of knowledge and any support from flood risk experts to support this.	What, if any additional analysis has been done for local flood risk assessment to improve resolution of flood risk mapping? When this was last reviewed/updated? What parameters are defined through the modelling and impact on any risks assessment e.g. water depth, velocity, extent of flooding or trigger levels and time to impact from notification? When was the sites topography established? Has recent construction or development been accounted for in this? Have wider flood risk scenarios been considered or reviewed as part of an assessment of staff or emergency services access or challenges to multiple layers of protection? Have the impacts of flooding outside the site been assessed i.e. where equipment is moved across the country to support flood response leaving exposure during a non-flood related incident? e.g. reliance on externally held high volume pumps or other supplies that may be impacted by flooding on a national scale such as Cumbria floods 2015. Are there any infrastructure issues related to flood risk such as defences managed by others or drainage systems that may introduce flood waters to site or impact on the dynamics of a flood if not correctly operated? Is it recognised that existing defences, like other barriers, might fail?
Success criteria	
• Flood risk information is confirmed and where appropriate more detailed site specific assessments have been made. • Site topography is available, up to date and understood. • Wider impacts of flooding on surrounding infrastructure have been considered and accounted for. • Indirect flood risks have also been considered and the history of local flood events is visible in considering the current risk of flooding. • Flood barriers are not assumed to be 100% effective – consideration given of flood impacts if defences fail.	

Assessment step
Scenario selection: Are the representative scenarios realistic in context of the site and its wider setting, the infrastructure on site and the potential impacts and the substances stored? Are the extent of the consequences to people and the environment identified and accounted for? Are the wider infrastructure elements considered e.g. drainage systems, on or off site effluent treatment plant, utilities and communications infrastructure etc

Expectation and issues	Key Questions
Consideration is given to the type of flooding and the impact on site operations related to the initiation and/or escalation of major accident hazards. Challenges to layers of protection from indirect flooding impacts should also have been considered. Examples of layer of protection and flood related challenges that may have been considered are shown in Appendix 3. Scenarios account for any increase in risk, over and above flooding alone. This may include external factors such as shore line debris, debris from damaged structures on or around a site or neighbouring sites where materials may be transported onto site causing e.g. primary containment breach after impact from a projectile while secondary containment is already underwater. Likewise release of materials including small tanks and waste from the site should have been considered from floatation risks. Scenarios need to be informed by past accidents.	Does the site layout create extra risks in terms of MAH or layer of protection challenge e.g. increased velocity of water channelled between structures impacting external equipment? What protection does the sites infrastructure i.e. site fences and barriers provide within the assessments to prevent ingress of debris from surroundings or on site if flooded? Is this reasonable? Are the real impacts of flooding on site considered e.g. if tankers are on site waiting to start deliveries, how much water/speed of water could cause an impact by moving the vehicle or preventing access and to removal of the vehicle. If a chemical leaked from a tanker what would the subsequent impact be with e.g. potentially changed pathways? Consideration should also be made of solubility in water, conservative level of dilution depending on chemical and /or secondary effects of e.g. a moving surface fire from fuels. Do scenarios consider the actual worst case e.g. fast spreading pool fire if bunds, drains and surrounding area are already full when a fuel tank is punctured and an ignition source causes a fire? Does the flood risk assessment include allowances for climate change in line with EA guidance Flood risk assessments: climate change allowances or SEPA Guidance: Technical Flood Risk Guidance for Stakeholders? This should allow operators to find out when and how to use climate change allowances in flood risk assessments and strategic flood risk assessments. Are the wider impacts of national flooding on major incident resilience considered?

Measure of success
• All appropriate scenarios are considered by the operator. Justification is provided where scenarios are discounted along with the associated assumptions. • Previous lessons learned from flood events are incorporated into the site specific scenarios (in particular under Sch 3, 5(c) in particular for UT sites. • Appropriate increases in potential effects are included in scenarios due to climate change.

Assessment step
Risk assess the impact of flooding: Has the operator of the establishment undertaken suitable and sufficient flood risk assessments for the scenarios identified? Are the assessments consistent with the SR or MAPP and other documentation on site i.e. SMS. Has the operator comprehensively assessed the potential flood resilience measures for the site to reduce Major Accident risk?

Expectation and issues	Key questions
Risk assessments should have been completed for the scenarios outlined. The operator should have considered the representative set of major accidents and identified the equipment, plant, resources and procedures required for mitigation. Recovery phase activities should also be covered by risk assessment. Assessments should include which hazard is being considered i.e. loss of containment into/onto flood waters (multiple mechanisms), shock cooling, loss of utilities etc. Other risks such as those linked to human factors should also be considered i.e. operator distracted by wider flooding impacts… my own home is flooded… triggering incorrect operation leading to MA. Preventative and mitigation factors should be considered for elements such as flood impact to: Primary, secondary and tertiary containment, Safety Critical Systems, utilities, communications networks and emergency arrangements. Potential impacts should also be considered for the identified top event i.e. impacts to people (gas release with cloud grounding on nearby village currently cut off by floods or large running pool fire).	What standard of risk assessment has been used to assess the risk? Has BS8533 been used or equivalent? For coastal flooding has reference been made to the EurOtop assessment manual? Has the interrelationship of threats been considered – i.e. at times of flooding, the lightning and general storm risks (e.g. high winds) may also be significantly greater. These are not independent threats. Have flood hazard and operability studies been undertaken (including the latest flood risk information) for the appropriate areas of plant or bow tie diagrams developed for appropriate top events to identify vulnerability of safety critical measures? Has sub-surface infrastructure been considered? Were similar/the same assessments made as part of any planning application referenced to PPS 25? Are risks to people and the environment covered based on the set of scenarios chosen? There may be multiple flood scenarios as well as multiple MA scenarios linked to this. Are flood defence structures treated as a layer of protection? If a flood defence structure fails, other layers of protection should as far as reasonably practicable be capable of preventing a COMAH major accident and avoiding a major business impact. Information on flood defence failure rates may be available from the local environmental agency (e.g. from fragility curves).

Success Criteria
• Risk assessments cover suitable scenarios and have been undertaken to an appropriate standard. • Suitable assessment of challenges to layers of protection have been made, identifying all layers of protection that may be impacted. • Detailed modelling including key trigger points has been used to inform assessment and consequences depending on scenarios and levels of risk. • All safety critical infrastructure vulnerable to flooding has been identified and resistance/resilience measures assessed.

Assessment step
Flood prevention and mitigation measures: ensuring that the actions on site are adequate and reflect the outcomes of any risk assessments. Are mitigation measures being appropriately assessed and are they practical? Is a specific flood plan in place for the site based on the thorough understanding of the risks and scenarios identified in steps 1 to 3 above? Does the risk assessment identify any required improvements or have adequate safety and reliability measures been identified? If improvements were required is there a plan for these? Cross discipline impacts should also be considered to ensure change management or emergency planning have incorporated flood impacts.

Expectation and issues	Key Questions
Safety critical infrastructure should be made flood resilient/resistant so far as is reasonably practicable – this should include ensuring necessary information remains available The site flood emergency plan should consider and take account of any Layers of Protection identified as at risk of flooding. Flood risk assessment and emergency plans should be reviewed on a regular basis to ensure they are up to date. The site flooding emergency plan should use the flood warnings or other appropriate mechanisms as trigger points to initiate the different stages of the plan. Emergency exercises have a vital role to play in ensuring an effective response to a flooding incident. When was the plan tested and what lessons learned have been used to develop the plan?	Is there evidence that other disciplines have considered the impacts of flooding at the establishment and taken appropriate action e.g. mechanical, EC&I, HF? When was the flood plan last reviewed? Is a flooding incident included in there Emergency Exercise schedule? What levels of advance notice are required/used for trigger points to act pre flooding? Are they clearly defined and who receives them? Have they been tested and are they realistic for the scenario? Have multidisciplinary considerations been made in the plan i.e. are the human factors consideration of a distracted operator being responsible for early shut down of a plant been accounted for in ensuring correct delivery to prevent a MAH? Do staff have clear criteria and proper authority to make decisions required in emergencies? Are the allocated staff assigned to tasks are appropriately trained to deliver them from receipt of weather or flood warning to recovery phase? What sources of real-time information does the plan require to manage the incident e.g. CCTV images? Will these be available if e.g. power is lost? Does the site have a “Plan B” if e.g. site access is not possible? Where is the information required to manage the incident stored and is this accessible even if the site is not?

Measure of success
• Safety critical equipment has been made flood resistant/resilient, so far as is reasonably practicable • The establishment has a flood plan or specific elements in the internal emergency plan. • The plan reflects the flooding scenarios established for the site. • Plans are tested and lessons learned are recorded and plans adapted accordingly.

Assessment step
Recovery phase pre-planning: Recovery phase activities are often as dangerous as the flooding event that caused them. Recovery may also begin before the end of the flooding event. The preparations that have been made prior to the event can be key to ensuring the risk to people and the environment is minimised. Consideration should be given to the safe implementation of these activities as well as recommissioning the operations if these were impacted by flooding.

Expectation and issues	Required Demonstrations
Plans should have assessed where water may be retained on site and how the water would be removed. Recovery plans should be linked to asset registers to ensure that recommissioning of plant is undertaken in an appropriate systematic manner. Inventory checks should be completed to allow losses of polluting, hazardous and radioactive materials to be specified before any recovery activates begin ensuring that they account for the presence of any materials. Impacts from a flooding event to a site should be captured and analysed to show how a site that requires significant repairs could be suitably re-engineered to prevent future impacts through the stop, slow or deflect principals.	Are existing call-off agreements for contractors suitable for this activity? What contingency plans exist if the normal contractor is also affected or diverted by other work if wider flooding impacts occur? Have the options for removal of water contaminated after a loss of containment been considered as part of the plan for the materials present of site? Have any site specific hazards been identified and planned for? Will flood damaged hazardous substance packaging require any specific precautions during recovery (e.g. fireworks)? Are established start up procedures to be used at site after a flood initiated shut down? Are appropriate pre start-up checks also included where water damage may cause problems with the potential for further major accidents? Do pre checks link to the asset register correctly and include checks for floating displacement or damage including flood water leaking into tanks, distorted pipe connections or damage due to displacement or thermal shock, testing of grounding integrity? Are checks on containment systems and infrastructure such as drains and interceptors included for e.g. debris obstructions or impact damage? Are infrastructure and safety systems included in checks before restart including switch gear, control systems including instrumentation and emergency equipment such as fire detection and suppression systems?

Measure of success
• Recovery is considered and accounted for in either a flood or emergency plan response and measures are consistent across various MAH scenarios. • Appropriate checks and approvals exist to ensure safe restart of the plant in the SMS. • Availability of key utilities such as electricity are accounted for and realistic for the establishment.

Appendix 3: Layers of protection that may be consider in assessment of flood impacts at COMAH establishments

The following table presents a selection of layers of protection and potential impacts that may occur from direct and indirect flooding challenging layers of protection or initiating major accident hazards at an establishment.

It is provided as a guide to assist selection of appropriate sample points for inspection in line with the success criteria listed in appendix 2.

It should not be used as a definitive list of assessments required on site. Many of the examples provided may not be relevant to a site due to the specific nature of flood related challenges to layers of protection.

As with other COMAH interventions, existing sites should apply measures to reduce the risk from flooding to a level as low as reasonably practicable (ALARP). The ideal should always be to avoid a hazard altogether, however actions to reduce risks from flooding should not adversely affect other risk reduction measures for different initiators.

Officers should therefore use their discretion and work in conjunction with operators to plan the intervention for the site specific risks.

Possible impact (this requires the appropriate layer of protection to be identified and assessment for the appropriate flood based scenario)	**Areas that may be considered for risk reduction** (this listing provides non exhaustive examples)
Flood preparedness	
Identification of flood relevant protection layers	• For all safety critical infrastructure, which is found to be vulnerable to flooding and where this is relevant to Major Accidents ensure measures necessary have been identified and planned for o Flood resilience o Flood resistance o Flood response
Emergency preparedness	• Ensure that all information necessary for emergency response is available to the operator and emergency responders in the case where the site is flooded, inaccessible and IT systems out of action. • Internal and External emergency tests can usefully exercise a flood scenario
Access and Egress	
Main or alternative access routes restricted or inaccessible for emergency access	• Ensure on and off site emergency plans contain suitable alternative arrangements if access to site for responders or staff has been compromised. • Ensure provisions for other MA scenarios are suitable if emergency services cannot respond due to wider flooding impacts e.g diverting resources

	• Ensure that staff management/welfare is covered in the scenarios to ensure tiredness/other distractions such as personal impacts of wider flooding are considered for any response (other human factors considerations) • Check that existing mutual aid arrangements available if a major accident occurs (non-flood) remain available during flood events elsewhere e.g. availability of high volume pumps. • Ensure there is access to emergency response materials and operational base if no/limited access to site when plans need to be executed. Does the operator have the ability to shut down a process off site if access problems arise?
Isolation of staff on/off site	• Ensure adequate control of personnel on site and assess how flood warnings are communicated. Are these provisions reasonable? • Review evacuation plan for flood including location of evacuation points vs predicted flood levels • Ensure other scenarios that may impact other locations within or around site e.g. consider the impact of flood if subsequent gas leak from fractured pipe and flooding means that staff/local residents may be unable to move away from this
Loss of utilities	
Production stopped suddenly due to loss of electricity supply	• Ensure process and associated infrastructure is fail to safe conditions • Consideration given to testing and restart if flooding infiltrates supply infrastructure. • Use of topographical survey and change management to ensure electrical equipment and cabling installed above the predicted maximum flood level • Specification of supply systems allow for submerged operation (probably extreme circumstances)
Wide spread power cuts (which might simultaneously impact on emergency responders)	• Ensure the plant can trip out to a safe condition. Essential utilities to facilitate safe shutdown and maintenance may need alternative primary power supplies, e.g. fire water supplies, instrument air etc and possibly cooling water for vigorous bio-reactions. • Ensure adequate on site ability to restart or continue safely i.e. with requirement for

	black start power supplies availability (local or remote) or site operations fail to safe condition to prevent accident scenario
DCS control equipment, cabling or PLC's become unavailable	• Where appropriate use the site topographical survey and change management processes to relocate as appropriate key control system components and cabling above the maximum predicted flood level • Availability and vulnerability of independent SIS in case of flood induced DCS failure (would SIS also fail in flood?).Ensure that all DCS systems forming one part of a LOP are supplied with a UPS and the capacity of the UPS is adequate.
Damage to process equipment • Moving mechanical parts including motors, drive connections and bearings etc • Hot process plant that will be subject to thermal stress if quickly cooled by flood water.	• Ensure that topographical survey data is used to define risks and trigger points for shut down especially for hot process plant • Ensure adequate protection from floating debris that may cause physical damage

Effluent treatment plant unavailable
• Water treatment chemical diluted or washed away by flood water
• Water treatment bacteria impacted by contaminants
• wash out of effluent treatment bacteria
• loss of process control
	• Ensure that plant is shut down and/or isolated
	  ○ inlet valves/pumps
	  ○ outlet valves/pumps
	• Is site drainage plan correct (e.g. impact/cross contamination from connected cable ducts)
	• Is potential ingress of flood water clearly understood and check that the plant cannot be protected in any other way
	• Is a restart/recovery plan in place for the effluent plant including production restart volumes vs time for effluent treatment plant to reach full treatment capacity
	• Ensure that sources of a fresh charge of appropriate effluent treatment biological material have been identified if prolonged ETP outage is safety critical.

Structural integrity	

Flood water affecting part of the site may float empty or part full stock tanks. The same may happen to empty or part empty product or waste containers. Flood water / debris can also disturb / impact above ground pipework, and other equipment in both processing and storage areas All of these may result in either a loss of containment or further physical damage as the tank/container floats through the sites other infrastructure. Similar impacts may also occur for underground tanks.	• Ensure tanks and other equipment are bolted down correctly and foundations are correctly specified • Ensure securing arrangements are adequately inspected and maintained • Post full topographical survey relocate storage tanks or smaller storage vessels area above maximum predicted flood level. Similar may be required for pipework and EC&I systems • Ensure that site boundaries have appropriate barriers such as fences that may prevent smaller containers floating off site or other objects floating into site initiating a MA (where this is alongside a watercourse it should not restrict flows i.e. impounding)

Flood water and /or increased levels of ground water may cause erosion of foundations, pipe supports or other steel and concrete structural components. Structural heave is also possible and may damage the integrity or alter capacity of bunds or move pipework.
 	
Previous events should be considered in assessing impacts i.e. have design tolerances been passed based on amounts of corrosion.
	• Maintenance programmes based around structural integrity are used and complied with.
	• Change management ensures that lessons learned from previous events are captured in new structural design
	  ○ Structural integrity (re engineer design tolerances)
	  ○ Location of key infrastructure on site for significant changes/development to remove impact by situating infrastructure above flood levels including understanding of topography and other factors linked to location i.e. safe offloading on level ground
	  ○ Other forms of protection provided
	  ○ Compliance with CP i.e. where improvements are being made such as removing pipes through bund walls

Process interruption	
Direct interruption to production • Trigger level reached for proactive safe shut down • Based on an advanced assessment of scale and duration of event (raw material availability, product storage capacity, staff availability • Advised by third party to shut down (e.g. trigger thresholds and comms as detailed in internal / external plans,	• Ensure that appropriate assessment / modelling has been completed to determine correct trigger points • Ensure that adequate time has been factored in to allow completion of required actions within flood impact timeframes (lessons learned from exercising the plan) • Ensure appropriate plans in place to ensure any systems that may be affected

including overlaps with national flood action plans with elements such as advice from BEIS to flood alerts or central government – e.g. COBRA led)	are made safe i.e. draining down of process fluids. • If applicable, ensure adequate suitable on site storage. Depending on event and warnings adapt plans for deliveries of raw materials to site[5] and of products from site to customers. • Alternatively adapt plans to use appropriate offsite storage with lower flood risk • Depending on duration of event and warning timescales could sister site/third party manufacture be utilised with advanced safe shut down of site at risk of flooding
Process contamination • Potential reaction of raw materials/products/intermediates with water or each other • Generation of waste and potential to be combined with loss of containment • Potential for overloading dewatering arrangements	• Ensure procedures in place to enable timely shut down of process • Ensure that appropriate trigger levels are developed based on flood risk and response times to allow all actions to be completed • Ensure that change management procedures consider this to existing process or potential to relocate above expected flood level when significant changes are made.
Loss of utilities • Communications • Heat / Power • Others e.g. compressed air for process control • Effluent treatment onsite or third party (More detail on the protection of individual utilities can be found below) • Effective oil interceptors	• Ensure that appropriate assessment / modelling has been completed to determine risks • Ensure that adequate time has been factored in to allow completion of any actions within flood impact timeframes • Position electrical switchgear, communications equipment, process control equipment at levels above predicted flood level OR consider protection if appropriate. • Records storage should also be included in these considerations for key response, compliance and commercial information • Consideration given to wider impacts i.e. if comms are used as part of emergency response plans what consideration / alternative is available if floods take out any element of this (flooding or other incident during a flood) • Consider if production to continue as normal and unaffected by flood but effluent treatment plant is/may be effected

[5] Providing storage arrangements are considered to be adequate and other factors would allow safe use of such a mechanism e.g. impact of future restricted access/egress to site for staff or emergency services.

	how operations will be maintained to prevent event escalation
Loss of containment Materials stored on site reacting with water (other contamination of flood waters)	• Where appropriate use the site topographical survey and change management processes to relocate as appropriate stores of vulnerable materials above maximum predicted flood level • Is there a plan or procedure for moving all stocks to an area above the maximum predicted flood level if storage area at risk of flooding.
Contamination of other non-reactive materials stored site	• Where appropriate use the site topographical survey and change management processes to relocate/adapt as appropriate stores of vulnerable materials above maximum predicted flood level • If materials contaminated and become waste consideration given to plan for disposal

Preventative systems for e.g. high pressure relief correct function during flooding	• Check the capacity of the process relief systems if their discharge point is below the maximum predicted flood level to ensure they will allow
	  ○ correct pressure relief if process remains operable
	  ○ cause a pollution incident if material is discharged without containment i.e. where effluent systems are flooded
	• Consider relocating discharge points above maximum predicted flood level

Processing of large quantities of effluent stored during and after flood event including contaminated flood waters e.g. from bunds and sumps	• Ensure integrity of lagoons is acceptable and access to isolation valves etc is possible in flood event scenarios • Design/adapt effluents systems to allow full isolation and appropriate temporary storage of liquid effluents to prevent contamination of flood water • Methodology considered for handling effluent and water volumes based on flood risk assessments (see above)

Appendix 4: Performance rating and success criteria

TOPIC PERFORMANCE SCORE					
60	**50**	**40**	**30**	**20**	**10**
Unacceptable	**Very Poor**	**Poor**	**Broadly Compliant**	**Fully Compliant**	**Exemplary**
Unacceptably far below relevant minimum legal requirements.	Substantially below the relevant minimum legal requirements.	Below the relevant minimum legal requirements.	Meets most of the relevant minimum legal requirements.	Meets the relevant minimum legal requirements.	Exceeds the relevant minimal legal requirements.
Most success criteria are not met.	Many success criteria are not fully met.	Several success criteria are not fully met.	Most success criteria are fully met.	All success criteria are fully met.	All success criteria are fully met.
Degree of non-compliance extreme and widespread.	Degree of non-compliance either extreme or widespread.	Degree of non-compliance either significant, or not easily remedied.	Degree of non-compliance minor and easily remedied.	No evidence seen of non-compliance.	Actively seek to further improve standards.
Failure to recognise issues and their significance, and to demonstrate adequate commitment to take remedial action.	Failures not recognised, with limited commitment to take remedial action.	Limited recognition of the essential relevant components of effective safety and environment management, but demonstrate commitment to take remedial action.	Management recognise essential relevant components of effective safety and environment management, and commitment to improve standards.	Management competent and able to demonstrate adequate identification of the principal risks, implementation of the necessary control measures, confirmation that these are used effectively; and subject to review.	Management competent, enthusiastic, and proactive in devising and implementing effective safety and environment management systems to 'good practice' or above standard.
INDICATIVE CA ACTION					
Prosecution / Enforcement Notice.*	Enforcement Notice* / Letter.	Enforcement Notice* / Letter.	Letter / Verbal warning.	None.	None.

*Regulation 27 of COMAH extends certain Health and Safety at Work Act 1974 (HSWA) powers to persons authorised by section 108(1) of the Environment Act 1995. This has the effect of permitting agency officers to carry out certain functions that they would not otherwise be able to do. Authorised persons may issue Prohibition Notices (PNs) under Regulation 23 of COMAH, and Improvement Notices (INs) under section 21 of HSWA but only insofar as the IN cites a breach of COMAH. Agency authorised persons do not have powers to serve INs under s21 for breaches of other legislation at COMAH establishments, nor can they serve PNs under HSWA s22. Agency officers do have powers to enforce under other environmental legislation.