EXTENDING THE HAZARD REGISTER

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When an emergency response plan is prepared one of the primary tasks is to address the guiding principles defined in the OCED for Chemical Accident Prevention, Preparedness and Response. These are divided into five main parts, Prevention, Preparedness/Mitigation, Response, Follow-up to incidents and Special Issues. The first step is to identify the hazards and address each of the five main parts for each identified hazard.

Although the idea of linking hazard identification with emergency response plannings well established, there is no set methodology for achieving the aim. This paper looks at a common method of structured hazard Identification, "The HAZID" which is used to produce a 'Hazard Register'. It will show how this process can be extended to establish a database which can be used to benefit a number of emergency response tasks. These include information used during actual events; developing and testing emergency response exercises; preparing specific action checklists and procedures. The database can be linked to systems to check that appropriate equipment, communication systems and facilities are available for emergency response, and that the staff who are expected to use them are familiar with them during an emergency.

The HAZID methodology commonly used to identify hazards on oil/gas or Petrochemical Plant provides a comprehensive list of hazards that detail both on-site and off-site risks. These hazards are presented in a 'Hazard Register' (a typical extract is given in Table 1), and provide a short description of each a hazard together with information concerning the hazard 'location' and 'area', 'type' and 'sub type', 'initiating event' and 'potential event', 'effect', 'safety function threatened', 'aggravating conditions', 'hazard risk and vulnerability classification' and 'mitigation measures'.

This list, which usually exists in the form of a spreadsheet can be extended and developed into a database that will produce many benefits throughout the emergency response organisation. As a simple example the 'Hazard Register' can be extended to include tables for the scenarios and strategies to be adopted for each identified hazard. If the process is continued tables can be added with descriptions of the roles and responsibilities and action check-lists for the entire emergency response team based on the requirements of the emergency plan. This includes all the incident responders expected actions over the first critical hour of an incident (the 'golden hour'). Action checklists are also included for each member of the crisis management, business support, and incident command and on-scene tactical response teams. Table 2 is an extract of such a database table.

This task is best undertaken during the preparation of emergency plans. Once the database is built it can gradually be populated as the plan is developed or when it is revised and updated. It can also be done when exercises are conducted or following incidents.

WALK-THE WALK; TALK THE TALK

A small team is required to complete a structured hazard analysis, this should consist of a person who is familiar with day to day site operations, a safety professional and an independent emergency response planning consultant. This team will 'walk-the-walk' and working with appropriate checklists, 'talk-the-talk' concerning each hazard for the entire establishment, changing the operation team member as appropriate for each site area.

Consider the requirement to produce a hazard register for an onshore oil and gas plant. A small multidisciplinary team start at the well-head where hazardous materials are produced and follow the hazardous products through flow lines to remote plant to a Central Degassing Stations – CDS. They then follow the product lines to tank farms and loading terminals. They include a study of pipeline transportation systems and receiving terminals to oil refineries, petrochemical plant and product distribution systems. External properties that could be adversely impacted by production operations are included in the hazard register. Figure 4 shows some of the hazards considered during a 2 day site visit by this type of team.

When considering the entire establishment several thousand hazards may be identified for an oil exploration and production company.

THE HAZID PROCESS

During the HAZID process, the team considers all realistic scenarios against pre-determined check-lists. As well as identifying the hazards the HAZID team discuss the emergency response strategy, and tactics for the emergency response organisation for each type of hazard. They also consider the status of required equipment and communications systems.

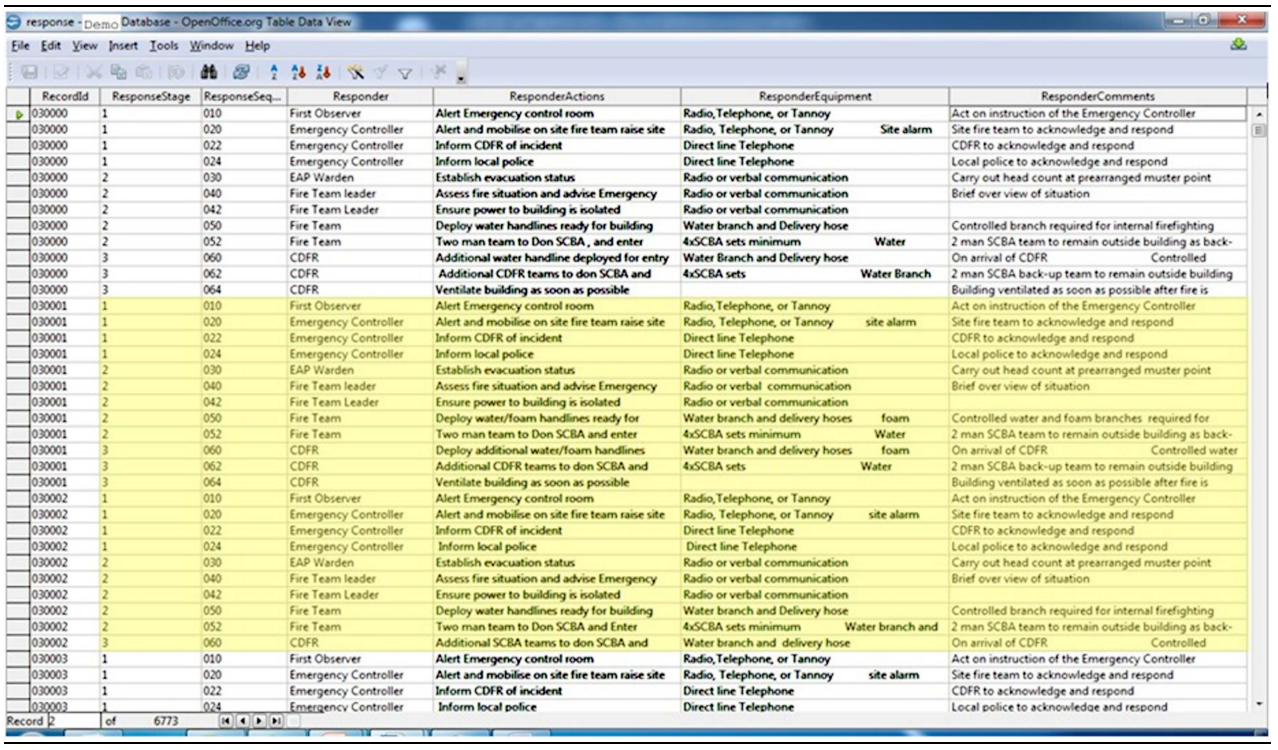
CASE STUDY 1

Consider a fire occurring in the area of the oil and gas production separators as illustrated in Figure 2. The hazard

Table 1. The Hazard Register

Record ID	Operational Area	Emergency Category/ Sub Category	Initiating Event	Potential Event	Effect	Safety Function	Aggravating Features	Hazard Class	Mitigating Measures
0001	CPP pipeline	Oil/gas Leak	Corrosion	Fire explosion	Fatality Deflagration	Fire damage	Size of leak Winddirection	High	ESD/gas Detectors
0002	Pipeline & Clusters	LOC Gas leak	Pressure leak test	Fire explosion	Loss of well control LOC	Explosion damage	Serious injury at site	Medium	ESD DHSV
0003	Island Cluster C Flowline	Blow out no ignition	Well Collapse	90 day sea spill	Abu Dhabi Air Polluted	N/A	Wind speed & direction	High	Water Screens
0004	Separator and CPP	Fire and explosion	Maintain Error	Fire explosion	Fatality Deflagration	Fire damage	Time to blow down	High	Response time
0005	Control room Complex	CPP Gas Leak	Maintain Error	Toxic gas in MCC	Fatality	Loss of CR control	Door open in MCC	Medium	Keep door sealed
0006	Oil transfer line	Gas leak toxic	Corrosion	Toxic gas Al Jazeer	Multiple fatality	N/A	Wind-speed direction	High	Smell of gas
0007	Roadside coffee shop	Gas leak toxic	Corrosion	Toxic gas in shop	Multiple fatality	N/A	Wind-speed direction	High	Smell of gas
0008	Wellhead Environment	Blow out no ignition	Well head impact	90 day land spill	population Air Polluted	N/A	Wind speed & direction	High	Water Screens
0009	CPP LOC Flowline leak	Gas leak jet fire	Corrosion	Fire explosion	Escalation jet fire	N/A	Shut remote flowline	Medium	Remote well esd
010	CPP LOC gas lift LP well	Gas leak toxic	Overpressure	Fire explosion	Escalation jet fire	N/A	Shut remote flowline	Medium	Remote well esd

Table 2. An extract from a table in an emergency response database



response - Demo Database - OpenOffice.org Table Data View

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RecordId	ResponseStage	ResponseSeq...	Responder	ResponderActions	ResponderEquipment		ResponderComments
030000	1	010	First Observer	Alert Emergency control room	Radio,Telephone, or Tannoy		Act on instruction of the Emergency Controller
030000	1	020	Emergency Controller	Alert and mobilise on site fire team raise site	Radio, Telephone, or Tannoy	Site alarm	Site fire team to acknowledge and respond
030000	1	022	Emergency Controller	Inform CDFR of incident	Direct line Telephone		CDFR to acknowledge and respond
030000	1	024	Emergency Controller	Inform local police	Direct line Telephone		Local police to acknowledge and respond
030000	2	030	EAP Warden	Establish evacuation status	Radio or verbal communication		Carry out head count at prearranged muster point
030000	2	040	Fire Team leader	Assess fire situation and advise Emergency	Radio or verbal communication		Brief over view of situation
030000	2	042	Fire Team Leader	Ensure power to building is isolated	Radio or verbal communication		
030000	2	050	Fire Team	Deploy water handlines ready for building	Water branch and Delivery hose		Controlled branch required for internal firefighting
030000	2	052	Fire Team	Two man team to Don SCBA , and enter	4xSCBA sets minimum	Water	2 man SCBA team to remain outside building as back-
030000	3	060	CDFR	Additional water handline deployed for entry	Water Branch and Delivery hose		On arrival of CDFR Controlled
030000	3	062	CDFR	Additional CDFR teams to don SCBA and	4xSCBA sets	Water Branch	2 man SCBA back-up team to remain outside building
030000	3	064	CDFR	Ventilate building as soon as possible			Building ventilated as soon as possible after fire is
030001	1	010	First Observer	Alert Emergency control room	Radio,Telephone, or Tannoy		Act on instruction of the Emergency Controller
030001	1	020	Emergency Controller	Alert and mobilise on site fire team raise site	Radio, Telephone, or Tannoy	site alarm	Site fire team to acknowledge and respond
030001	1	022	Emergency Controller	Inform CDFR of incident	Direct line Telephone		CDFR to acknowledge and respond
030001	1	024	Emergency Controller	Inform local police	Direct line Telephone		Local police to acknowledge and respond
030001	2	030	EAP Warden	Establish evacuation status	Radio or verbal communication		Carry out head count at prearranged muster point
030001	2	040	Fire Team leader	Assess fire situation and advise Emergency	Radio or verbal communication		Brief over view of situation
030001	2	042	Fire Team Leader	Ensure power to building is isolated	Radio or verbal communication		
030001	2	050	Fire Team	Deploy water/foam handlines ready for	Water branch and delivery hoses	foam	Controlled water and foam branches required for
030001	2	052	Fire Team	Two man team to Don SCBA and enter	4xSCBA sets minimum	Water	2 man SCBA team to remain outside building as back-
030001	3	060	CDFR	Deploy additional water/foam handlines	Water branch and delivery hoses	foam	On arrival of CDFR Controlled water
030001	3	062	CDFR	Additional CDFR teams to don SCBA and	4xSCBA sets	Water	2 man SCBA back-up team to remain outside building
030001	3	064	CDFR	Ventilate building as soon as possible			Building ventilated as soon as possible after fire is
030002	1	010	First Observer	Alert Emergency control room	Radio,Telephone, or Tannoy		Act on instruction of the Emergency Controller
030002	1	020	Emergency Controller	Alert and mobilise on site fire team raise site	Radio, Telephone, or Tannoy	site alarm	Site fire team to acknowledge and respond
030002	1	022	Emergency Controller	Inform CDFR of incident	Direct line Telephone		CDFR to acknowledge and respond
030002	1	024	Emergency Controller	Inform local police	Direct line Telephone		Local police to acknowledge and respond
030002	2	030	EAP Warden	Establish evacuation status	Radio or verbal communication		Carry out head count at prearranged muster point
030002	2	040	Fire Team leader	Assess fire situation and advise Emergency	Radio or verbal communication		Brief over view of situation
030002	2	042	Fire Team Leader	Ensure power to building is isolated	Radio or verbal communication		
030002	2	050	Fire Team	Deploy water handlines ready for building	Water branch and Delivery hose		Controlled branch required for internal firefighting
030002	2	052	Fire Team	Two man team to Don SCBA and Enter	4xSCBA sets minimum	Water branch and	2 man SCBA team to remain outside building as back-
030002	3	060	CDFR	Additional SCBA teams to don SCBA and	Water branch and delivery hose		On arrival of CDFR Controlled
030003	1	010	First Observer	Alert Emergency control room	Radio,Telephone, or Tannoy		Act on instruction of the Emergency Controller
030003	1	020	Emergency Controller	Alert and mobilise on site fire team raise site	Radio, Telephone, or Tannoy	site alarm	Site fire team to acknowledge and respond
030003	1	022	Emergency Controller	Inform CDFR of incident	Direct line Telephone		CDFR to acknowledge and respond
030003	1	024	Emergency Controller	Inform local police	Direct line Telephone		Local police to acknowledge and respond

Record 2 of 6773

register will identify the exact location and plant item. In this case the 'type' of hazard is a fire with a 'sub type': jet fire. A gland failure is say, the initiating event. The jet fire could impact on adjacent gas handling pipe-work which describes the 'potential escalation for the event'. The consequence or 'effect' could be an explosion with multiple casualties, damage to plant and adverse impact on the environment. Safety functions could be damaged in an explosion, there could be many aggravating conditions including the weather, time of day or other plant operations. The hazard risk and vulnerability classification may depend on specific site conditions. Mitigation measures could consist of comprehensive site fire fighting services or at remote sites the policy may be let it burn itself out without risk to the response team. This is usually the extent of the hazard register.

The extensions to the hazard register shown in Table 2, also include the emergency response actions, communications and emergency repose equipment required during the first 'Golden Hour'. Detailed checklists would be included for each of the members of the On Scene Command, Incident Command, Crisis Management and Business Support Teams, The On-Scene Commander and On- Scene Response Teams include process operations; fire fighting; search and rescue; hazardous materials; medics environmental protection. These are customised in the database against each identified hazard. The database action checklists for response team members detail the expectations of each team member for each type of hazard. As responders are assigned tasks the required equipment and communications systems and availability are linked to the database. This enables any member of an incident response team to assess exactly what is expected of them and how to respond for any particular hazard. It also shows what equipment and communications procedures are required.. This information is particularly useful when developing emergency exercises.

EMERGENCY RESPONSE DURING THE GOLDEN HOUR

CASE STUDY 2

Consider the multidisciplinary team discussions for the hazard of a loss of containment incident occuring at the first and second stage separators which could result in a large release of toxic gas, a pool fire, flash fire jet fire or an explosion.

This could occur as a result of impact, corrosion, maintenance, human error, instrumentation and control failure. A separator or similar vessel that is partially engulfed by fire could rupture and cause a boiling liquid expanding vapour explosion commonly known as a BLEVE. For crude oil and gas separators the actual explosion could be much more powerful than for a liquid petroleum gas (LPG) vessel if the pressure is higher. In this case if the crude light ends are above their boiling point a larger fraction could boil off, depending on the temperature reached before the vessel ruptures. The crude products would quickly "rain out" however it is unlikely to contribute to a fire ball. The time taken for the necessary heating of a vessel by a jet

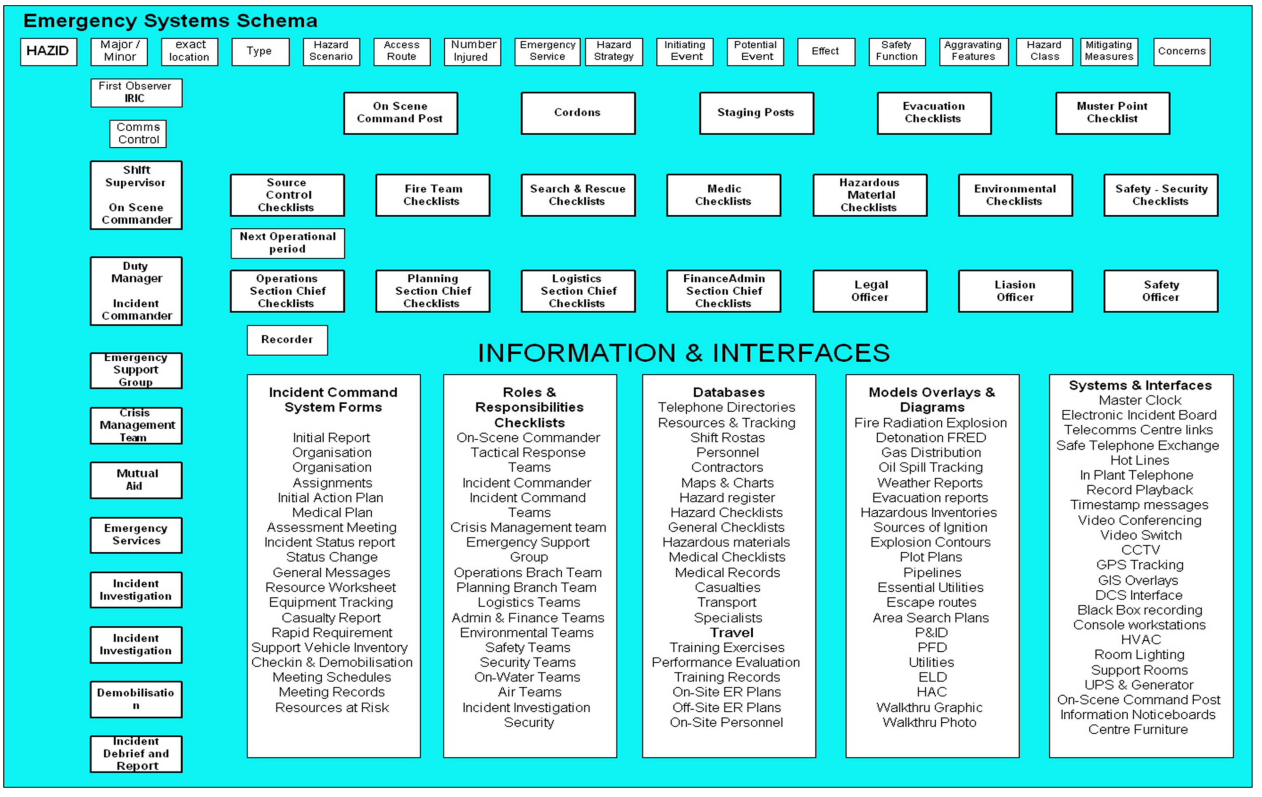

Figure 1. Conceptual schema for emergency response information

fire could be as short as two or three minutes if a jet flame impinges directly on the upper part of the vessel. A more normal period though is 10 to 30 minutes. If the vessel can be completely depressurised in this time, the chance of a BLEVE becomes remote. Although firewater sprinklers and deluge systems are known to be ineffective in completely preventing jet fire effects on vessels leading to BLEVE, they do slow the process down. As a result, a combination

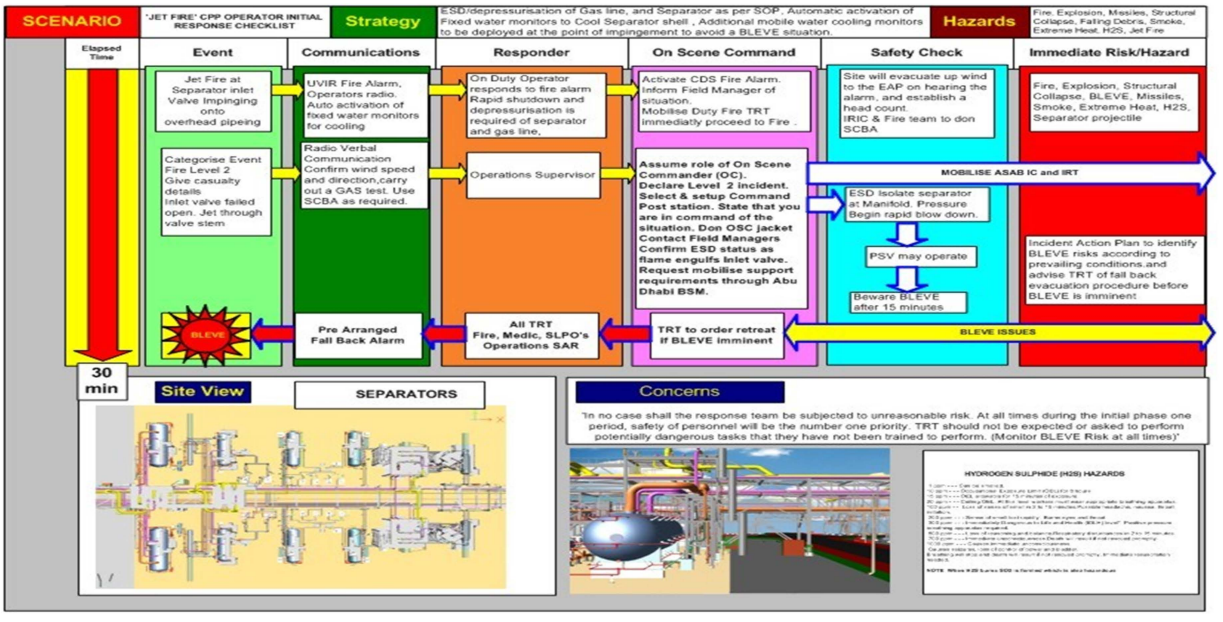

Figure 2. Parallel on scene tactical response team operations during the golden hour

of pre- aimed falling spray from a fire water monitor, depressurisation within 15 minutes and fire water monitors aimed directly at the flame impingement point would reduce the risk at the separators by a significant factor. The application of monitors, if it is to be done, should be within the first 5 minutes of the release, after which all persons in the hazard area should retreat to a safe position. If the vessel does undergo a BLEVE, the area affected by the fire ball can be very large. For 32. m3 of crude oil in the vessel the fire ball size was calculated to be 47.5 m in radius, assuming 15% of the crude oil enters the fire ball. The distance at which heat radiation causes injury is even larger, 240 m. radius, with duration of 7.4 sec. In addition, large parts of the vessel could be thrown, typically up to 200 m.

A Chemical Safety Board video shows the tragic results of a fire fighting team that thought that they would be safe when deployed with their water hoses perpendicular to a large cylindrical LPG vessel as these vessels tend to explode through the ends of the vessel.

EXTENDING THE HAZARD REGISTER

With the hazards identified above in mind the HAZID team extended the database for the Emergency Response Actions and the 'dynamic risks' that the On-Scene Commander might consider. For each identified hazard the table identified the responders and their actions over the golden hour. It also showed the equipment and essential communications between the emergency response teams. The first observer becomes the IRIC (Initial Response Incident Commander) and takes charge of the on-scene incident until relieved by a superior responder. The Incident Commander mobilizes the incident command team, and if necessary the Crisis Management Teams and the Business Support Teams. The actions of the Emergency Response teams are added to the database in separate tables. The emergency response database can include a customized set of Incident command system forms. If these are completed for a selection of identified hazards the result is a comprehensive tool for developing Emergency Response exercises because we can evaluate the expectations of each team member against their actual performance.

For example anyone can check at any time what resources are currently available if an incident occurs. When a job change occurs or a new role in the incident command team is undertaken each person can check that they have the appropriate training. When preparing emergency response exercises, the scenarios in the database (verified by experience site operators and senior staff) are available to assist in the exercise preparation.

Whenever an incident occurs the database is refined and checked against how well teams are prepared for the incident against what actually occurred to identify appropriate lessons.

TRAINING

Training sessions for large or complex incidents often reveal the difficulty inexperienced team members have in realizing the large number of tasks that are being carried out in tandem by an Emergency Response Organisation.

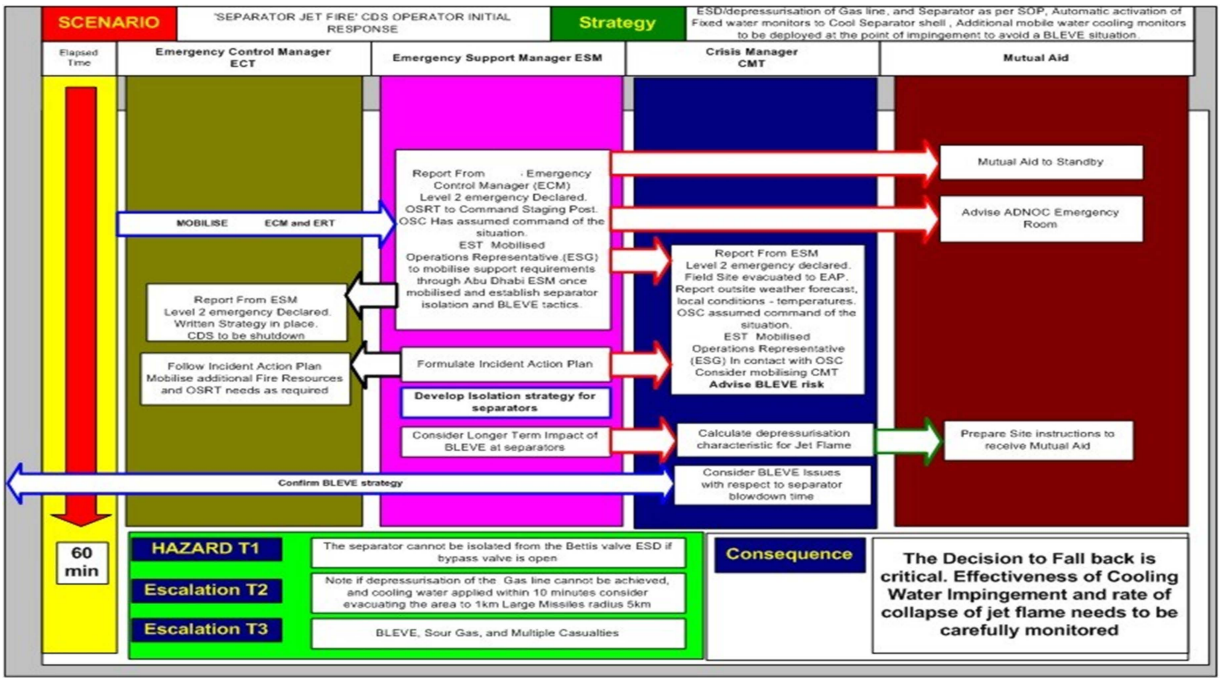

Figure 3. Parallel incident command operations during the golden hour

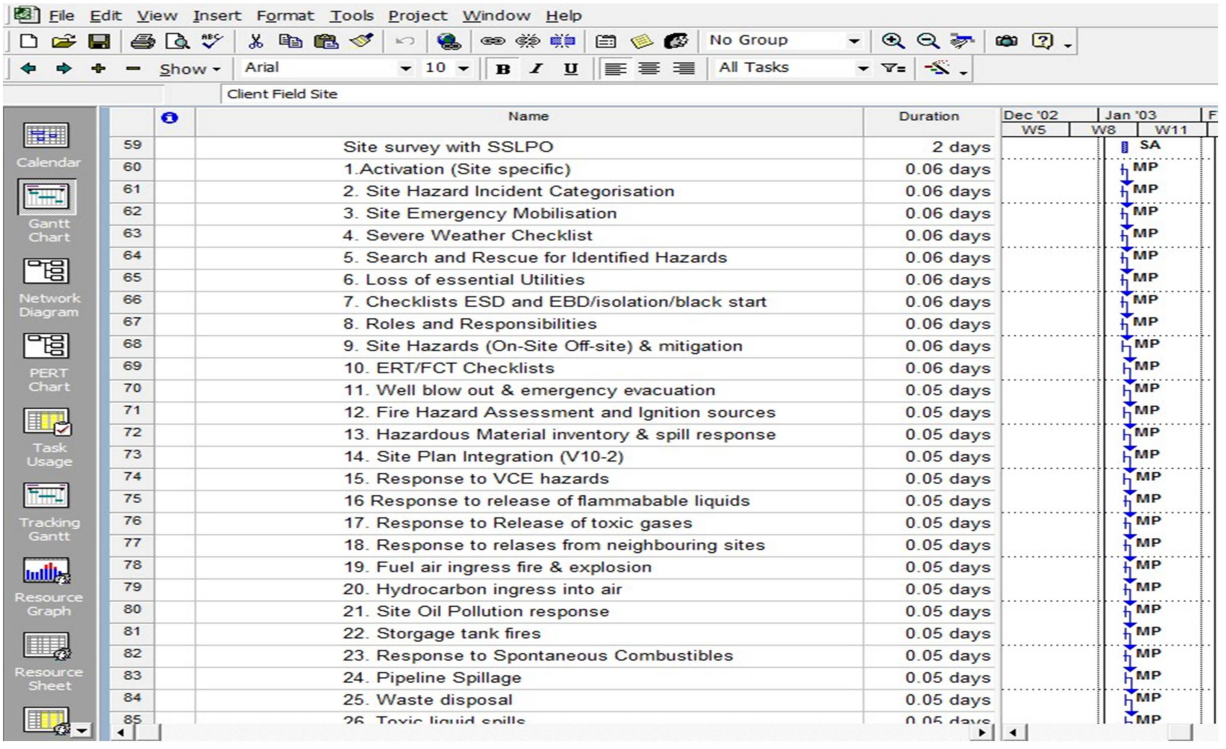

Figure 4. Extract from 2 day HAZID site survey plan

Figure 2 illustrates the parallel operations undertaken by On Scene Tactical Response Team Operations during the Golden hour. The diagram shows the scenario, the strategy to be adopted and the hazards associated with the event. The communications and equipment required as well as safety issues and concerns are also given. Figure 3 is similar showing the parallel operations of the incident commander and the Incident Command teams during the Golden hour. This diagram also shows when notifications are made and when business support, mutual aid and crisis management teams get involved in the incident.

When the hazard register has been extended into a database with associated emergency response information, parallel operations over the golden hour of an incident can be readily be seen.

With a comprehensive emergency response database a site supervisor is able to see all of the tasks that they and their subordinates could be required to do for every identified hazard should an emergency occur. The database can identify risks that on-scene commanders team are exposed to and the equipment and personal protective equipment that the team will need to be familiar with and will be required to use. It can also show the state of this equipment and when it was last used if the database is linked to other operational databases. The training records will show which team members have been trained on specific equipment and how they performed.

The supervisor will also know what ‘mission critical communication’ should be taking place throughout the emergency response organisation and have checklists so see the actions that have been completed or are still pending during the response.

The task of writing or reviewing emergency response plans for a large organisation can be complex and involves very large amount of interrelated information. This is best stored in a database which be used to produce detailed reports for the emergency response plan.

The database, when established, can be used during actual incidents by operations and planning teams to show what strategies have been considered for the incident and what hazards and escalation might occur within a given timescale.

The database can be used by the emergency response coordinator to check emergency preparedness of personnel, equipment and emergency facilities.

Emergency response exercises can be selected based on information in the database. It is important to run exercises that will have a positive result. The expectations of each person involved in the exercise will be defined as well as their deputies when key people are not available.

The database can be developed over a number of years to produce sophisticated emergency response tools. The reality of an incident is often far more complex than any exercise. However the database extending the Hazard Register over a number of years could prove invaluable.