FIGHTING THE SHELL PULAU BUKOM FIRE: SCDF'S EXPERIENCE

Introduction

The Shell Pulau Bukom oil refinery fire occurred on 28th September 2011. More than 100 firefighters and 40 appliances from the Singapore Civil Defence Force (SCDF) and Shell's Fire Department were deployed to fight the 32-hour blaze. At the height of the incident, the SCDF activated the Operations Civil Emergency Plan, a national-level emergency response framework for major incidents in Singapore.

At approximately 1320 hrs on 28th September 2011, a fire started at the Shell Eastern Petroleum (Pte) Ltd oil refinery, on Pulau Bukom, an offshore island about five km from mainland Singapore. This island houses the largest Shell refinery in the world in terms of crude distillation capacity.

Responders faced a situation where the highly erratic fire had engulfed large parts of the pump house and was threatening to spread to nearby fuel storage tanks. The complexity of the blaze was compounded by the existence of different types of fires.

In Singapore, a Civil Emergency (CE) is defined as a sudden onset of incident involving a massive number of casualties and/or damage to property on a large scale. Such a situation is likely to pose grave implications for Singapore at the national, diplomatic or political fronts, and managing the consequences will require a multi-agency response.

In this incident, Operation Civil Emergency was declared at 1830 hrs on the same day and personnel from the relevant ministries and public sector agencies were mobilised to support SCDF in managing the incident. While the fire took 32 hours to extinguish, the entire operation lasted for eight days and involved a total of some 40 firefighting and support appliances, along with more than 100 personnel from SCDF, Shell's in-house firefighting team, and several public sector agencies.

Description of Incident

The fire started at the west end of Pump House 43, which is a large and open pit approximately the size of one-and-a-half soccer fields, with varying floor depths of 0.3 to 2 metres. Numerous overlapping and criss-crossing pipes of different diameters form a dense three-dimensional network of pipelines in this pit. A metal walkway above the pipelines allows human access and a central drain across the floor of the pump house removes rainwater and minor spills into a holding basin.

The erratic fire moved across the pit, then receded several times and many fire spots developed in various areas of the pump house. The intensity and size of the fire at each hotspot changed frequently.

The presence of a variety of liquid and gaseous hydrocarbons exacerbated the situation as firefighters had to deal with pool fires, flange fires, jet fires and flowing liquid fires. Owing to the complexity of the dense network of pipes, as well as the impaired visibility caused by the flames and smoke, there was no certainty as to the type of hydrocarbon fuelling each individual fire.

About five hours into firefighting operations, just as it appeared that the blaze was under control, the first escalation took place. Multiple explosions caused a large fireball to shoot into the air. Subsequently, fires developed at three main hotspots at the west end, centre and east end of the pump house. Firefighting efforts continued round the clock. By the morning of the next day, one single area of fire remained.

While efforts were underway to isolate the pipelines thought to be fuelling the remaining spot of fire, a second escalation took place, again with multiple explosions and fireballs. The fires reignited at the same three main hotspots. Despite the setback, firefighters battled the fires relentlessly. The fires were fully extinguished by the evening of the second day.

Whole-of-Government Approach to Disaster Management

Among the strategies that worked for the SCDF during this incident was the whole-of-government approach to disaster management. In 1997, the SCDF was appointed by the Ministry of Home Affairs (MHA) as the Incident Manager (IM) for Civil Emergencies (CE). As no single agency has all the resources to handle major contingencies alone, the IM not only has to organise and direct the rescue forces' response, but also lead, coordinate and integrate inter-agency plans from across the government to tackle any major disaster swiftly.

SCDF's contingency planning for CE is dominated by the urban landscape, i.e. structural fires; collapsed buildings; transport incidents on land, sea and air; industrial accidents; release of toxic industrial chemicals; and terrorist attacks using chemical, biological and radiological agents. Every category of CE has a corresponding plan that sets out a plausible scenario and defines the roles and responsibilities of every agency involved in the response. This forms the basis for an effective and coordinated multi-agency incident management system, under the framework of Operations Civil Emergency, to have the expertise and resources of other government and quasi-government agencies on tap in a major disaster.

Personnel from the various agencies, brought together as Joint Planning Staff during Operations Civil Emergency, are responsible for providing specialist advice to the IM and coordinating their respective ground deployment resources at the incident site. This framework was utilised during the Shell Pulau Bukom fire - the Singapore Police Force, Police Coast Guard, Maritime and Port Authority of Singapore, National

Environment Agency and the Singapore Armed Forces were mobilised to the SCDF Tactical Command Post at the incident site to support the IM in planning and coordinating the overall response to the incident.

A Multi-Pronged Firefighting Strategy

Another element that proved vital in the response to this incident was a multi-pronged firefighting strategy. Owing to the large area of operation and the complexity of the fires that had developed at different parts of the pump house, the SCDF adopted a multi-pronged response strategy, together with Shell's in-house Company Emergency Response Team (CERT). The vast area of operation at the pump house was divided into three sectors. Shell's CERT was assigned to the western sector, while SCDF personnel managed the middle and eastern sectors of the pump house.

Mitigation tactics at the pump house itself included isolation of fuel supply and offensive firefighting operations with foam application. In addition to the deployment of foam monitors, firefighters gained access via the metal walkways above the pit to put out other deep-seated pool fires within the pump house.

Where there were flowing fires and pressurised gas fires, a defensive firefighting strategy was used to control the fire and allow the fuel to burn itself out. Beyond the pump house, boundary cooling and exposure protection operations prevented the intense heat emanating from the burning pump house from affecting the surrounding oil tanks, hydrocracker units and substations. Foaming operations were also carried out at the nearby holding basin and pipe tracks to prevent the spread of fire.

Responders' Safety

Throughout operations the safety of responders was the top priority. On a few occasions when the fire escalated and threatened to spiral out of control, all responders were withdrawn from the risk zone and regrouped at the rehabilitation area. Where possible, appliances were also pulled back to safer places.

As part of the swift responders' evacuation procedure, all key commanders within each sector were constantly connected on the radio network to coordinate and account for all their respective personnel prior to evacuation. A final head count was conducted once all evacuated personnel were safely housed at the rehabilitation area. When the explosions were over, a reconnaissance team comprising commanders from the SCDF and Shell CERT returned to the pump house to assess the situation before developing the next course of action. Firefighters were then reorganised for the prolonged operation and re-deployed back to the pump house to continue the mitigation efforts.

Notwithstanding the precarious nature of the week-long operation, there were no major injuries sustained by any emergency responder. This was primarily attributed to the strong emphasis on personnel safety and the adoption of prompt and proper responders evacuation procedures.

Onsite Command as Key to Effective Incident Management

Onsite command and control is one of the key principles in the SCDF's concept of operations and was key to effective incident management. The activation of resources, based on the Task Force Concept, ensures that resources are deployed promptly and adequately to the incident site. The level of command presence at the incident site is also calibrated to the nature and size of the incident. In this instance, both the Fire Station Commander and the Division Commander were mobilised to assume command during the initial phase of the operation. As the incident escalated, Commissioner of the SCDF assumed overall command and management of the incident.

The early presence of SCDF Commanders at the various stages of operations was a pivotal factor to the overall success of the operations. Key strategic decisions were executed promptly. Reinforcement of personnel and additional firefighting appliances were requested and managed in a timely and effective manner. The presence of senior SCDF Commanders at the incident site also enabled the decision to activate Operations Civil Emergency swiftly, so specialist advice and national assets could be mobilised and made readily available to the Incident Manager.

The establishment of an onsite command post on Pulau Bukom (set up in Shell's indoor badminton court at the eastern part of the island, about 1.5 km from the fire ground) provided a critical platform for the Ground Commander to plan, coordinate and execute the operational plans. Following the activation of Operations Civil Emergency, the Tactical Headquarters was deployed at Pasir Panjang Ferry Terminal (mainland) to manage the incident and coordinate a multi-agency response.

Emergency Preparedness through Contingency Planning and Exercises

Prior to this incident, operational response systems and procedures had been developed and validated with Shell through contingency planning and joint exercises over the years. In fact, both the SCDF and Shell had held a joint fire exercise on Pulau Bukom, based on an oil tank fire scenario, at the beginning of 2011. Hence, transition of command and control, coordination between SCDF firefighters and Shell CERT, sea transport arrangements and logistical support worked well during the incident and this enabled both SCDF and Shell to focus their efforts on mitigating the fire.

Despite the challenge of accessibility to the offshore island, firefighting resources and logistical supplies were transported to Pulau Bukom smoothly. At the outset of the incident, ferries, fast craft and barges were swiftly put on standby at Pasir Panjang Ferry Terminal to transport SCDF responders and appliances from mainland Singapore to Pulau Bukom. Over at the Pulau Bukom Ferry Terminal, vehicles from Shell were readily available to ferry SCDF responders to the incident site.

As the initial crew of SCDF responders had travelled to Pulau Bukom by fast craft, they had reached the offshore island before the SCDF appliances, which were transported by a relatively slower barge. As every second counted, Shell had made ready a vehicle equipped with firefighting equipment, known as the Civil Defence truck, for the initial crew of SCDF responders to utilise upon their arrival at the incident site.

Another noteworthy aspect of contingency planning is the Emergency Mutual Aid Scheme – a self-help framework established by the companies of the oil, petrochemical, chemical and storage terminal industries in Singapore – which proved its worth in this incident. This framework advocates mutual assistance among the participating companies to provide resources, for example foam, firefighting equipment and portable pumps, to the premises of an affected participating company in the event of a major fire. During this incident, the Emergency Mutual Aid Scheme was activated by Shell after the first fire escalation. Foam and firefighting equipment from participating companies arrived within three hours of activation.

Synergistic Work

Throughout the entire operation, the SCDF worked closely with the management team from Shell as well as its CERT and Emergency Operations Committee (EOC). This enabled both SCDF and Shell to share crucial information relating to the mitigation of the fire and to discuss strategies at appropriate intervals during the operation.

At the heart of the operation site, SCDF constantly worked as a synergistic team with Shell CERT and conducted regular onsite updates and briefings. Although SCDF was the Incident Manager within the established command and control structure, the strategy for mitigating the fires at the various sectors were discussed and mapped out together with Shell's CERT prior to any deployment. This meant both parties had a common understanding of the actions that were being taken. The SCDF Incident Commander also met with Shell Bukom's General Manager and EOC daily at 1000 hrs for updates and assessments of the latest situation.

Conclusion

The last major fire on Pulau Bukom was in 1981, involving a 60-metre diameter floating roof tank containing gasoline. With a continual focus on workplace safety, higher industry safety standards and advancement in fire protection systems, incidents like the Shell Pulau Bukom fire incident in 2011 should be few and far in between. Nonetheless, it is imperative that emergency responders continue to train, improve and be well prepared to respond to new challenging encounters. While the incident management system and whole-of-government response framework proved to be effective in the Shell Pulau Bukom fire incident, industries and authorities must continue to work closely together to ensure the robustness of joint response to any emergency situation that may arise.

Written by:

COL Ling Young Ern
Commander 4th SCDF Division
Singapore Civil Defence Force

&

COL Anwar Abdullah
Director of Operation Department
Singapore Civil Defence Force