Central Control Room Explosion in a Gas Treatment Plant

“A freak Accident”

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INTRODUCTION

On Wednesday July 16th 2008 around 18:00 hours, RAKGAS's Plant Control Room, consisting of the Central Control Room (CCR) and Motor Control Room (MCC), exploded from within. The roof and side walls were blown off. The entire control room and control panels were destroyed thereby disabling the 2 main processing trains and various utility systems. All of a sudden the plant could not be controlled anymore. This could be compared with "a body without brains"

Ten people were injured in the blast suffering various degrees of burns. Nine were inside and one just outside the control room. All survived.

It does not often happen that a control room of a plant is blown away in an explosion. A control room is considered to be a safe haven in any plant. So why did this freak accident happen?

As it often happens also here it is the historical development of the plant that partly shapes the event.

SITUATION DESCRIPTION

The gas treatment plant in Ras al Khaimah(RAK), United Arab Emirates, is located at the Arabian Gulf. It collects raw gas and condensate from various gas fields: 1) offshore Musandam, which belongs to Oman; 2) from Ras al Khaimah itself although almost depleted and; 3) from Umm al Qawain, an Emirate directly south of RAK.

The Gas plant was first built in 1985 and consisted of a few simple modules. The modules were equipped with their own control panels. Gradually over the years more automation was installed and the need for a Central Control Room (CCR) became apparent. A corner of the Motor Control Center (MCC) became the CCR, used for coordination and control, using computers and telephones.

In 2006 a new gas contract was negotiated, requiring a substantial expansion of the current plant. A new (second) processing train was installed over 2007/8 and was being commissioned in the month of July.

Figure1: Installation of the new processing train

EXPLOSION

On this particular day the gas export compressors ran for the first time in anger. Because the normal flare seemed to get overloaded it was decided to light the standby ground flare. As the ignition panel was already broken for years the ground flare was lit using a stick with petrol filled cotton at the end. A cigarette lighter was collected from outside and tried inside the CCR, as it was perceived to be the safe haven in the plant.

The result was an explosion and a fire.

Figure 2: The Central Control Room annex Motor Control Center after the explosion.

Ten people were injured in the blast suffering various degrees of burns. Nine were inside and one just outside the CCR. They were quickly evacuated by cars, and taxi's and the last one by ambulance. All survived.

Due to the explosion most of the incoming and outgoing fluid streams in the plant stopped, but not all and not according to plan. The Emergency Shutdown Button (ESD) had not been pressed and employees were reluctant to be responsible for a complete system shutdown. As a result excess gas and liquids were either sent to flare or vented off, which created a spooky, noisy and eerie atmosphere.

Some people ran away, others ran to the fire to fight it. All contractor staff ran to the assembly point. Nobody was missing. Civil defense was warned and arrived 15 minutes later. The COO was called immediately and arrived 30 minutes after the incident. By this time the resulting fire was extinguished.

ACCIDENT INVESTIGATION TEAM (AIT)

During that same evening an Accident Investigation Team was set up. A gas production expert from another Gas & Oil company was offered to be the team leader. Together with the Commercial Manager and the COO (me) a team was formed.

That the cigarette lighter was the trigger for the explosion was quickly discovered, but why was there a flammable mixture in the Control Room? How did it get there and why?

All members of staff had to be at the plant the next morning at 8 am. Those, who witnessed the blast were asked to write down what they saw and were interviewed. The AIT emphasized that “no blame” would be given in any given situation. It was essential we created a “safe” environment for people to speak up and speak out. It became clear that people were very keen to tell their stories and to present their assumptions of probable cause or causes.

Findings

The people involved with fighting the resulting fire all told the story that each time the fire was extinguished it started up again as if something was feeding the fire.

The only system, which could feed such fire, was the pneumatic regulator. Most instrumentation was pneumatically based and the regulator was installed in the CCR annex MCC. Air samples were taken from the air storage vessels and indeed (2 days later) traces of hydrocarbons were found in the samples. How could this have happened?

Figure 3: The pneumatic system with regulator after the explosion.

The day of the explosion was different from other days in the sense that the large gas export compressors ran in anger for the first time. This gave rise to the idea that somehow the gas compressors were linked to the air system.

By studying the gas control panel of the 3 export compressors it was discovered that the ¼" tubing of air was erroneously connected with the ¼" tubing of the gas control lines.

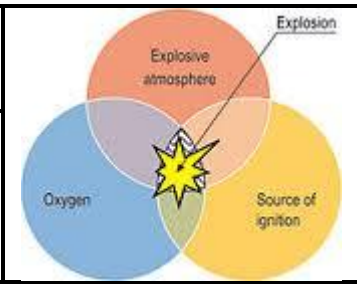
Figure 4: Gas Control Panel of the gas export compressor skid

Gas pressure was around 400 psi, while the instrument air pressure was only 120 psi. As a result gas migrated through the air system and through the regulator into the control room

As a result the flammable mixture of clean, sweetened, **odorless gas** migrated from compressors to the pneumatic regulator into the CCR.

Even though the cigarette lighter was the source of ignition it could easily have been another source in the control room, due to the nature of the MCC/CCR at the time.

Table 1: Possible other sources of ignition in the Control Room:

Electric Panels	**Computers**	
Chargers	**Or any other instrument creating a spark**	

The AIT investigation led to some honest and painful revelations as to what the causes were which lead to the explosion. See Table 2 & Table 3

Table 2: Immediate Causes

1. Failure to follow rigorous new plant construction inspection and process commissioning procedures, resulting in an incorrect connection being made and not detected between plant air and process gas systems
2. The control room contained electric panels and pneumatic piping.
3. Failure to maintain existing process equipment to normal industry standards

Table 3: Basic and Underlying Causes

1. RAKGAS Plant Operations Personnel and Consultant Startup Crew were under considerable pressure to achieve startup.
2. Insufficient focus by both RAKGAS and Consultant on safety engineering aspects of new process design (like HAZOP), startup procedures and operating procedures.
3. Insufficient management focus on control of POB within the plant compound
4. Lack of an HSE culture that assures the employees that they are empowered at all times to act when they feel a situation is unsafe, i.e. operating an ESD push button during a plant fire
5. Lack of an effective Management of Change system for process alterations.
6. Failure to replace equipment that had reached technical obsolescence and was no longer supported by its manufacturer. (Ignition panel of ground flare)
7. There was a culture of minimizing expenditure into extreme

CRISIS MANAGEMENT TEAM (CMT)

On the evening of the explosion it became clear that the plant had to be up and running in the shortest possible and safest way.

As soon as possible a Crisis Management Team was set up. An acting plant manager was appointed, as the plant manager was one of the victims in hospital. Together with the head of maintenance and the COO (myself) the following objectives of the team were outlined:

- Re-establish full or part gas flow to customers a.s.a.p., hereby securing cash flow
- Address the causes of the accident (as discerned by the AIT)
- Review all safety and process systems and procedures
- Re-build confidence among staff
- Build a new control room outside the plant

CRISIS MANAGEMENT TEAM AND COMMUNICATION.

Before the crisis

Before the explosion a general crisis scenario had been prepared. In this scenario the plant manager played the main part and the control room was the central location, as it was considered a safe haven. As known now both main components were not valid as the plant manager was one of the victims and the control room was wiped out due to the explosion.

One of the aspects discussed in this scenario was the dissemination of “bad news”. It is very important not to beat about the bush, but to tell bad news as it is: factual and direct. Don’t first digress about the weather or the latest football game, but tell the bad news to the person immediately in a gentle, direct and factual manner.

During the crisis

Immediately after the explosion the COO was phoned and he drove to the plant. During driving he tried to get more information about the injured ones. Whilst driving he told the production supervisor, coming from the Indian subcontinent, to inform the Indian injured ones and he told the Philippino supervisor to inform the injured Philippino's. The COO (being Dutch) would phone the English wife of the plant manager, who was among the injured ones. It is important that the people were addressed with bad news in their own cultural way.

Meanwhile the civil defense was warned and showed up on site within 15 minutes and extinguished the fire, helped by a few brave people on site.

Most people on site, including contractor staff, had assembled on the assigned spot just outside the plant. Some had been running to the explosion site to extinguish the fire.

Whilst the COO was at the plant during that fateful evening to ensure the plant was emptied from all its ingredients and was safe, virtually all the staff, often accompanied by their families, had returned to the plant, alarmed by their colleagues. This is also part of the culture.
The COO told all the staff to go to the hospital to visit the injured ones and to return to the plant the next day by 0800 hrs.

Before leaving the site, the COO phoned the 2 oil companies which provided the raw gas to the plant and informed them of the situation. One of the companies offered immediately to send an experienced production engineer to contribute to the investigation team. This was gladly accepted.

So during this same evening 2 teams were set up: the Accident Investigation Team (AIT) and the Crisis Management Team.

The Commercial manager, who was tasked to receive the injured ones at the hospital, phoned up all the customers and explained the situation. He also phoned Dolphin Energy, a supplier of sweet gas from Qatar. They helped Rakgas for a couple of weeks and sold to Rakgas a part of the shortfall of sweet gas.

All personnel went to the hospital in town. The COO also visited the Sheikh, the Ruler of Ras al Khaimah, to explain what happened and to suggest investigative and remedial actions. He gave his full support. The Ruler stayed in close contact during the following days.

The next day at 8 am the COO addressed all personnel and asked all staff who had witnessed the explosion to write down what they had seen. All others could go home. The AIT emphasized that "no blame" would be attached in any given situation. It was essential Rakgas created a "safe" environment for people to speak up and speak out. It became clear that people were very keen to tell their stories and to present their assumptions of probable cause or causes. This process became essential. One must realize that in this part of the world people get blamed very quickly. Hence it is hard for companies or organizations to learn from their mistakes made.

The explosion never made the headlines in the newspapers nor on television.

The police made an inquiry, particularly to ensure no act of terrorism was involved. They accepted Rakgas' version of the story.

Results of the CMT

Through quick decision making, short communication lines between decision makers (the CMT members) concrete action plans were executed almost immediately. Some objectives were met in the early days of the explosion and some of the objectives took 2 years to be reached. See table 4

Table 4: Objectives and results:

• Re-establish full or part gas flow a.s.a.p. hereby securing cash flow
  ○ 30% of Gas flow was back on line within 3 days.
  ○ The full 100% took 8 months
	• Build a new control room outside the plant
	  ○ Carried out within a year

• Address the causes of the accident.
  ○ Checking connections and redesign critical elements
  ○ Replacing instrumentation
	• Review all safety and process systems and procedures
	  ○ Took 2 years with use of a consultant.

• Implement the Control Recovery Project costing $ 3 million (of which $ 2 million was reimbursed by the insurance company).	• Re-build confidence among staff. ○ Took 3 months before the compressors ran in anger again.

LEARNING POINTS

The learning points of this incident have been plentiful. It is important that they don't get lost in everyday work. We have tried to incorporate all our findings into processes, procedures and company core values. Below you will find a summary, by no means complete, of our learning points.

- Beware of how "history" shapes your company: from MCC and modular based plant to more automation and CCR in MCC
- Emergency response manual was based on plant manager in control and the CCR as base.
  - As it happened the plant manager was injured and the CCR was blown away.
  - Have a flexible manual and ensure the CCR is truly a safe haven
- Interviews are essential in case of an incident. Use open questions. People who actively witnessed the incident wanted to tell their stories and their assumptions of possible causes
- A new "real" control room and office block was built outside the premises of the plant with only fiber optic cables and computers, i.e. no pneumatic system nor any electric panels
- An emergency room was introduced with all drawings, procedures and communication tools put together
- The injured had burns in the face and on the arms. From then on coveralls had to have **long** sleeves.

- Everybody has the authority to push the ESD button.
- POB system is essential: who, where and when on plant site
- Next expansion project had a company project management team with the various disciplines (mechanical, electrical, instrumentation, process and safety): no accidents occurred
- As an aside, in this part of the world it is often common that the companies and organizations have rules and procedures for employees and different ones for Management. To my opinion this is not correct. I certainly believe in the role model of Management. People look up to the managers and if the managers don't behave in accordance with procedures or rules, what can you expect from the employees.