THE BAKER REPORT – HOW FINDINGS HAVE BEEN USED BY JOHNSON MATTHEY TO REVIEW THEIR MANUFACTURING OPERATIONS†

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This paper describes the process used in the review of Johnson Matthey's Syngas Catalyst manufacturing plants around the world. Following the Baker report describing the findings and failings contributing to the BP Texas City Incident Johnson Matthey's senior management requested all operating units to evaluate their own vulnerabilities. We will explain how site teams reviewed The Baker Report to evaluate their own vulnerabilities with regard to the issues identified in the report.

INTRODUCTION

On March 23, 2005, the BP Texas City refinery experienced a catastrophic process accident. It was one of the most serious U.S. workplace disasters for more than two decades, resulting in 15 deaths and more than 170 injuries. In the aftermath of the accident, BP followed the recommendation of the U.S. Chemical Safety and Hazard Investigation Board and formed an independent panel to conduct a thorough review of the company's corporate safety culture, safety management systems, and corporate safety overview at its U.S. refineries. James A Baker III, who had served in several senior government positions including secretary of state and secretary for the treasury, headed the Investigation board.

The final report published in January 2007 was henceforth internationally recognized under the name of 'The Baker Report.'

In the wake of the report the management of Johnson Matthey recognized that there might be aspects of it which were relevant to their own manufacturing operations. With this in mind each of the manufacturing units undertook a program of evaluation of the findings of the Baker Report, with a view to identifying those of particular relevance to their specific operations. Following that evaluation further processes were established to assess the vulnerabilities highlighted by reference to the findings, and hence the institution of procedures designed to address those vulnerabilities.

DISCUSSION

In short, the incident at the refinery occurred during the start up of the octane boosting isomerisation unit. A distillation column and associated blow down drum were overfilled with highly flammable hydrocarbons, which were subsequently vented and ignited by the idling engine of a nearby diesel pick up truck. The resulting explosion and fires caused 15 fatalities and 170 injuries, mainly involving the occupants of nearby temporary accommodation.

The following factors were highlighted in the Baker Report as contributing to the occurrence of the accident:

- Failure to open a drain valve to allow liquid to flow from the distillation column to associated storage tanks. This was contrary to the documented start up procedure (also the storage tanks were believed to be nearly full).
- There were no automatic control systems fitted to prevent overfilling of the vessels in question.
- It was clear that a number of deviations from standard procedures were commonly followed (custom and practice).
- Instrumentation designed to warn operations personnel of impending problems failed to operate.
- A reduction in staffing of 2 to 1 increased the workload of the operator. At the same time the operator was also given increased responsibility in the form of an additional operating unit.
- Operator fatigue was a significant concern as the operator had worked 12-hour shifts for 29 consecutive days.
- Process safety management systems were not fully implemented, (e.g. hazard analysis, operator training, preventative maintenance, management of change reviews.)
- Failure to complete a pressure relief study which was found to be 13 years overdue.
- Failure to fully investigate accidents and near misses.
- The closure of maintenance actions which were incomplete.
- Failure to apply the learning generated from internal audits and any investigations that had been carried out.
- Cost cutting with respect to maintenance and operator training, combined with an overall lack of investment.

The focus of the investigation into the incident was predominantly around 'process safety' rather than 'personal safety' and this was taken as the theme for the deliberations of the Johnson Matthey team.

The JM Clitheroe manufacturing team view on personal safety, which is often referred to as occupational safety, is that it focuses on the hazards that are more directly related to individuals in an organisation. Typically, personal safety addresses the risk of physical injuries due to such things as, slips, trips and falls, items striking an individual, physical strains, electrocution, automobile incidents etc.

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Controls applicable to personal safety would include training, guarding, and the supply of personal protective equipment for example.

Process safety, however, we believe refers to the prevention and mitigation of unintentional releases of potentially dangerous materials or energy. The management of process safety involves a particular type of risk management – identifying and controlling the hazards from a process, such as prevention of leaks, spills, equipment malfunctions, over-pressure situations, excessive temperatures, corrosion, metal fatigue etc.

Programs addressing process safety would therefore focus on the design and engineering of facilities, process hazard assessment, the management of change process, equipment inspection regimes, and the testing and maintenance of equipment, including the testing of process alarm and trip systems. Also within this we would see effective process control, training of personnel, and the appreciation and assessment of other human factors.

THE PROCESS

Cross functional teams were put together at the Johnson Matthey manufacturing facilities at Clitheroe in the UK, and at Panki in India, in order to review the Baker Report with a view to using the findings to help evaluate vulnerabilities at the two sites.

The teams identified process safety issues for each site and using a template (Appendix 1) developed and built around the findings of the Baker Report, areas were highlighted where it was felt we might be vulnerable. Once the vulnerabilities were identified, actions were developed to address the issues raised.

The template was constructed using the following categories:

SCENARIO

This section outlines a brief description of the risk/hazard:- What can go wrong? What are the immediate causes? – e.g. the primary failure mechanism, usually categorised by conditions or situations that challenge the integrity of the plant or equipment. E.g. pipe or tank failure may be as a result of corrosion, damage or under/over pressurisation.

RISK CONTROLS IN PLACE TO PREVENT AN INCIDENT

In this section the current state is described, this includes the risk control systems currently installed which help prevent the incident happening. The effectiveness of the risk control measures depend upon their relevance to the possible causes identified for a particular incident. For instance if 'wear and tear 'was identified as a possible cause of an unsafe situation then one possible risk control system would be the existence of a preventative maintenance routine.

RELEVANT AUDIT FINDINGS OVER THE LAST 5 YEARS

This section includes the results of any relevant HAZOPs, HAZIDs (Hazard Identification relating to COMAH classified materials), and Process Hazard Reviews (PHR) etc. The main aim in reviewing these documents is to establish that all actions identified in the audits were followed up and closed out.

KEY EVENTS/ISSUES OVER THE LAST 5 YEARS

Here we look at all of the accidents, incidents, near misses etc that have been recorded in the last 5 years. This review could highlight situations which either approximated to or could lead to the incident detailed in the scenario.

IDENTIFY CRITICAL PROCESS SAFETY INDICATORS

It is necessary to identify the key risk control systems responsible for preventing the occurrence of incidents or mitigating the consequences of such incidents. From this analysis it is possible to derive those critical process indicators that will aid in the prevention of the incidents identified. The following were some of the questions found to be useful in this analysis:

- Why do we have this risk control system?
- What does it deliver in safety terms?
- What would be the possible consequences of not having the system in place?

SET LAGGING INDICATORS

Lagging indicators are used in the form of a reactive monitoring system, which requires the reporting, and investigation of incidents and occurrences. The aim of the monitoring system is to identify weaknesses in the safety systems. The incidents or occurrences concerned do not have to have resulted in injury, major damage, or loss of containment but those that represented a failure of a significant control system designed to guard against such events. For example in the case of a system designed to control risk by plant inspection and maintenance, one lagging indicator may be 'The number of expected failures due to component wear and tear of safety critical equipment'.

SET LEADING INDICATORS

In contrast to the above leading indicators are used in a proactive way focused on monitoring a few critical risk control systems to ensure their continued effectiveness and reliability. As such leading indicators require routine systems that key actions or activities are undertaken as intended. They can be considered as a measure of a process or an input which is essential to deliver the desired safety outcome. Multi-level auditing would be an example of such indicators.

HAZARDS & VULNERABILITIES IDENTIFIED

Hazards were identified as possible scenarios to be fitted to the template which had been developed, the list below whilst not exhaustive represents our view on the most important:

- Hazardous gas release from the metal dissolving vessels (MDV)
- Package boiler incident
  - Over pressure
  - Vessel failure
- Hydrogen Incident
  - Fire
  - Explosion
- Furnace Incident
  - Fire
  - Explosion
- Loss of Containment
  - Acid
  - Other Hazardous Process Chemicals
- Legionella

After the list was finalised each item was taken in turn and a template completed (see Appendix 2), on which the main vulnerabilities were highlighted. By way of an example the list of vulnerabilities shown below was developed for the first hazard on the list above i.e. Hazardous Gas Release From the Metal Dissolving Vessel: – (some are relevant to other process hazards scenarios of course)

- All HAZOP/Process Hazard Review actions implemented?
- Have the process operators been trained with respect to the high hazard situation?
- Are alarms effective?
- How are the alarms responded to by the operators?
- Has a review of the design and engineering integrity of the MDV been carried out recently?
- No strategy exists for the replacement of the MDV.
- Lack of awareness of process hazards on site?
- Effectiveness of shift handovers? (It takes more than one shift to start up the MDV)
- Are all duty managers trained to deal with a hazardous gas release?
- Off site communications system in place?
- Operating procedures up to date and recently reviewed?

Each item on the list above was visited and the actions developed from the findings were then used to form part of the site EHS plan.

THE WAY FORWARD

In order to gain benefit from all of the work already undertaken the actions generated need to be completed in a timely manner and as most people will appreciate this is the difficult part! Of course ensuring that the actions are carried out is down to robust management and in order to aid the process two items were highlighted:

- Process Hazard Reviews are to be integrated into the ongoing management of the production sites.
- Process hazards which are identified for attention are elevated to 'Top 6 Hazard' status (a method used by Johnson Matthey as a way of focussing on the most important safety issues) until all actions associated with them are completed.

CONCLUSIONS

Major incidents and accidents sadly will continue to happen; the responsibility we all have as chemical plant operators is to investigate those incidents that have already happened in order to generate methods we can employ to ensure that the re-occurrence of similar incidents and accidents is minimised.

It is hoped that in producing this paper we at Johnson Matthey have encouraged the readers to examine their systems and procedures alongside the findings of The Baker Report with a view to making their operations safer.

The learning we have gained from this exercise on relatively small operating units has been invaluable, and there is no reason to believe that it would be of any less value to the operators of world scale ammonia plants.

ACKNOWLEDGEMENT

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APPENDIX 1

SCENARIO		
Risk controls in place to prevent an incident - outline of current state		
Relevant audit findings over the last 5 years e.g. HAZOP, PHR, HAZID		
Key events/issues over last 5 years (accidents and near miss reports)		
Process Safety Issue	**Relevant (Y or N)**	**Comments**
Design and engineering of facilities		
Hazard assessment & identification		
Management of change		
Inspection, testing & maintenance of equipment		
Effective alarms		
Effective process control		
Staff training and competence		
Human factors		
Operating procedures		
Communication		
Emergency arrangements		
Other		
Main Vulnerabilities	**Actions**	

APPENDIX 2

SCENARIO	Hazardous gas release due to uncontrolled metal dissolving reaction
Risk controls in place to prevent an incident - outline of current state	Trips and alarms/Operating procedures/Training/Instrument controls
Relevant audit findings over the last 5 years e.g. HAZOP, PHR, HAZID	PHR on Metal Dissolvers - Commissioning HAZOP
Key events/issues over last 5 years (accidents and near miss reports)	Operating at higher than normal operating temperature/ Choking/Solids in Dissolver/Variations in acid strengths

Process Safety Issue	**Relevant (Y or N)**	**Comments**
Design and engineering of facilities	Y	Risk Based Inspection (RBI) studies done on vessels
Hazard assessment & identification	Y	PHRs not completed for some Dissolvers
Management of change	Y	Unlikely that mods have been introduced without formal authorisation
Inspection, testing & maintenance of equipment	Y	Fit for purpose. Reliant on specific individuals
Effective trips and alarms	Y	Alarms often not responded to. Assume that Dissolving alarms are responded to?
Effective process control	Y	How do we assure that we only put correct acid in Dissolver?
Staff training and competence	Y	No high hazard training for pasting operators
Human factors	Y	Starting up Dissolver takes more than one shift/trip testing validation
Operating procedures	Y	Updating of operating procedures not robust (JM Audit finding 2007)
Communication	Y	High hazard operations not formally communicated to site (Improvement opportunity rather than concern)
Emergency arrangements	Y	Off-site communication/Duty Manager and Manufacturing Shift Leaders (MSLs) readiness to deal with a hazardous gas release
Senior management responsibility	Y	What are the key senior management EHS responsibilities and how do they impact on high hazard operations

Main Vulnerabilities	**Actions**
Unsure whether actions of Cu PHR and Ni HAZOP have been implemented and sustained	Find PHR/HAZOP and review actions with relevant parties
Not all Dissolvers have been formally reviewed in terms of design and engineering integrity	Conduct RBIs for all Dissolvers
PHRs not completed for some Dissolvers	Conduct PHRs for those Dissolvers not already done
Modplan system robustness in terms of new projects	Check whether a modplan has been raised for 3C1**(Complete)**
Alarms potentially not responded to	Investigate differentiation of alarms / identification of spurious alarms
No high hazard training for pasting operators	Develop high hazard training for pasting operators
More than one shift to start up Dissolver	Ensure that hand-over procedures formally covers dissolver start-up **(Covered on PHR - action complete)**
How to ensure effective trip testing	Investigate means to ensure trip testing leaves trips intact
Updating of operating procedures not robust (JM Audit finding)	Update operating procedures for high hazard operations by March 2008
Create site awareness of high process hazards	Identify appropriate process to communicate high process hazards for the site
Means of official off-site communication not in place	Develop a mechanism to communicate to off-site stakeholders during an emergency
Duty Managers/MSLs not ready to deal with hazardous gas	Develop a scenario/s to train Duty Managers/MSLs **(Complete)**
No replacement strategy for dissolvers	Put in place a replacement strategy for dissolvers