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Integration of a Reactive Chemicals Program into the Process Hazard Analysis Process at The Dow Chemical Company

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ABSTRACT

Dow's Reactive Chemicals Program has been in place since 1967 and has been utilized globally by Dow to reduce the hazards associated with reactive chemical scenarios. With the evolution to a broader Process Hazard review, Dow has integrated the Reactive Chemicals program into the framework of the PHA reviews.. The current Reactive Chemicals/Process Hazard Analysis (RC/PHA) program involves an interaction with several diverse technical experts to study the chemistry and processing activities, looking for any potential risk reduction opportunities. By completing this review and the associated follow up, the facility or Project helps to fulfill compliance with Dow's Process Hazard Review requirements, as well as those of several regulatory directives such as OSHA PSM and Seveso II Directive for Process Hazard Analysis. This paper describes the basic operation of this process and includes a description of the overall Dow Reactive Chemical program and guidelines, the utilization of experimental testing facilities and subject matter experts, the creation and makeup of site and business RC Committee, structure of the RC/PHA review, global RC/PHA communications, employee training, and other aspects of the program.

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Abstract

This paper provides an overview of Dow's Reactive Chemicals program. It describes the basic operation of the overall program and guidelines, the utilization of experimental testing facilities and subject matter experts, the creation and makeup of site and business RC Committee, including the structure of the RC/PHA review, global RC/PHA communications, employee training, and other aspects of the program. It addresses Dow's definition of Reactive Chemicals, the history of how we came to work on this issue the way we do. In addition it reviews some of the tools and recent improvements that have been made over time to the Dow Reactive Chemicals Process.

Introduction

Dow's Reactive Chemicals Program has been in place since 1967 and has been utilized globally by Dow to reduce the hazards associated with reactive chemical scenarios. With the evolution to a broader Process Hazard review, Dow has integrated the Reactive Chemicals program into the framework of the PHA reviews. The current Reactive Chemicals/Process Hazard Analysis (RC/PHA) program involves the interaction of several diverse technical experts to study the chemistry and processing activities, looking for any potential risk reduction opportunities. By completing this review and the associated follow up, the facility or project helps to fulfill compliance with Dow's Process Hazard Review requirements, as well as those of several regulatory directives such as OSHA PSM and Seveso II Directive for Process Hazard Analysis. This paper describes the basic operation of this process and includes a description of the overall Dow Reactive Chemical program and guidelines, the utilization of experimental testing facilities and subject matter experts, the creation and makeup of site and business RC Committee, structure of the RC/PHA review, global RC/PHA communications, employee training, and other aspects of the program. This paper will provide an overview of the Reactive Chemicals Program as practiced at Dow. It will address Dow's definition of Reactive Chemicals, the Dow Reactive Chemicals review process, and the history of how we came to work on this issue the way we do. In addition it will review some of the tools and recent improvements that have been made over time to the Dow Reactive Chemicals Process.

Within Dow we have defined a broad scope for Reactive Chemicals. This broad scope says that any time we have the potential for losing control of any of our chemistries, we are calling it a potential Reactive Chemicals event. Such an event or potential event requires significant analysis, communications, and follow up actions. One important point we make here is that reactive chemicals events do not have to occur rapidly. They do not have to result in a fire or an explosion for us to classify it a reactive chemicals event. Through our history we have seen a number of significant events that did not involve fire or explosions that have created significant losses or potential losses.

We treat our Reactive Chemicals program as a Core Competency. We think several parts of the way we practice it are fairly unique in the industry. The effort fits well within the Dow Matrix organization where multiple functions have ownership in a portion of the process.

Origin of Dow's Reactive Chemicals Program

Our Dow Reactive Chemicals program has its origin linked to an accident that occurred 35 years ago in our Texas Operations facility. This accident involved an uncontrolled chemical reaction that caused a very large explosion. The accident occurred during a blending operation that was taking place in a rail tank car. Propargyl bromide and 1-3, dichloropropene and chloropicrin were being mixed using a gear pump. The people doing this job for the first time did not recognize that the materials were shock sensitive. This accident resulted in three fatalities.

Earl Barnes, our Dow US Area President at the time, made the following statement that has endured through the years and has become the motivating basis for our current Reactive Chemicals Program.

“Each supervisor is charged with the primary responsibility for the safety of the people in their area. In the future if any employee is responsible for an incident which occurs because the Reactive Chemicals program procedures have not been followed, they should remember that their job and their life as well as the lives of others are in jeopardy.”

Key Features of Dow's Program

Some of the key characteristics of the Dow Reactive Chemicals Program that have been implemented over the 35 years since its inception are:

- Utilization of a standardized review format and protocol for all facilities globally.
- Multiple function involvement for providing consultation expertise to the reviews.
- Utilizing reviewers from outside the technology or business to help identify hazards that may have been overlooked.
- Having a free form discussion format where the reviewers are not constrained by a rigid protocol and can ask questions (sometimes unusual) that probe for hazards
- Focusing heavily on visualization of potential accident scenarios.

Our hazard analysis is dependent on the definition of good Reactive Chemicals incident scenarios. We have learned it is very important to make sure the scenarios are credible. Each scenario also requires the defining of “key lines of defense” to prevent the scenario as well as “key response methods” should the scenario occur. We focus on scenarios that could injure people, cause a monetary loss, or result in environmental harm. Another key feature is our integration of five of our previous process safety reviews into a single review to remove redundancies and become more efficient. We call this our RC/PHA (Reactive Chemicals/Process Hazard Analysis). One of the key historic attributes of our Dow Reactive Chemicals process is the requirement of having a new Production Leader present a review to a committee of experts to demonstrate their knowledge of Reactive Chemicals of the facility they are leading. This review is required to occur within 90 days of taking over the new role. In Dow we have done this review for about 25 years. It was one of our company's original Management of Change requirements that was practiced before the MOC concept was adopted generally in the industry.

Our reactive chemicals hazard assessment includes probing for three basic types of scenarios that could result in a reactive chemicals event. These include:

- Inadvertent Mixing
- Reaction Loss of Control
- Instability of Materials (flammability, dusts, pyrophorics, high surface area issues, etc)

We have observed that some company's tend to limit the scope of their reactive chemical assessment to just the first area, "Inadvertent Mixing". At Dow we have deliberately chosen to make the definition and the scope of reactive chemicals to be broad. We have defined the scope to almost literally fit the definition of an "uncontrolled chemical reaction". Another broad scope issue is one that has us probing for scenarios that can involve uncontrolled reactions that do not involve a rapid energy release. That is, it does not have to blow up or catch fire to be a reactive chemicals event. We have had significant losses and potentially severe incidents that involved events like accelerated corrosion or a toxic chemical being generated due to an uncontrolled reaction over a considerable amount of time. These events did not involve a rapid energy release but did have a significant loss or injury potential. In addition we also include broad hazardous scenarios involving flammability from static electricity, unusual ignition sources or pyrophoricity.

Another reason for this broad definition is that we believe this permits a more efficient use of our consulting experts in hazard reviews. Most of our experts have knowledge and ability in all these broad hazard areas that are within our scope. We have found that having one broad review is more efficient than having several separate reviews.

Our four primary deliverables from our Reactive Chemicals Process are project hazard reviews, existing facility hazard reviews, new leader reviews, and a training and awareness program. These products are supported by several strengths that we work to maintain within our company. These include maintaining an effective Reactive Chemicals testing program and database, a rigorous Process Hazard Analysis process, supported by a group of highly skilled people who make up the Reactive Chemicals supporting review committees. We have found it essential to keep our program and reviews focused on credible scenarios. In support of this we have implemented a company wide database that contains credible reactive chemicals scenarios and key lines of defense for all technologies.

We have found that the multiple discipline aspect of the review process is essential to having an effective well-integrated review. The four disciplines that we rely heavily on include Research, Manufacturing, Technology Centers including engineering, and Process Safety.

Reactive Chemicals Culture

We have identified two of the key attributes that comprise our Reactive Chemicals Culture at Dow. One of these is "Owner Responsibility". We believe that the Production Leader needs to be intimately involved with and take responsibility for the reactive chemicals issues within the facility. The new leader reactive chemicals review is an obvious demonstration of this.

The second concept is making sure that everyone within our facilities has knowledge of the reactivity of the chemicals that they work with. We strongly recommend annual training for reactive chemicals hazards. We support an extensive testing program to make sure we know and understand the hazards. The testing information supports not only our hazard analysis, but also our training. One of our goals is to establish in every employee the "Corporate Memory" of reactive chemicals incidents that have happened in the past. We have a definition of what we call "corporate memory" within Dow. As an example of what we are talking about, one of the typical comments we hear from the people involved in Reactive Chemicals incidents is: "I didn't know that could happen?" And: "I did not know that had happened before?" The success in establishing a good "Corporate Memory" is measured by never to have to pay for an incident more than once. The challenge here is to learn from our history and successfully leverage that learning across all plants and technologies. Learning from other companies is a valuable supplement to this effort. Within Dow we have responsibilities assigned to our Technology Centers for establishing our "Corporate Memory". We recommend that our "worst case scenarios and key lines of defense" be included in our memory training and communication efforts.

Reactive Chemical Performance Data, Training, and Communications

Dow maintains a database of reactive chemical incidents and near miss events which provides us with measures of effectiveness of our existing program as well as direction for future emphasis. While we feel that our overall performance in the area of reactive chemicals is good, the data provides information where there may be a need to focus our efforts on training, operating discipline and establishing our "Corporate Memory".

Dow continually provides and promotes reactive chemicals training and awareness. Our efforts include monthly newsletters to summarize reactive chemicals incidents sent to about 4000 readers across the company. This company wide monthly newsletters is part of our leveraging of training and awareness for our overall "Corporate Memory" regarding reactive chemical hazards and prevention. Specific training and awareness is supported by topic specific Reactive Chemicals Newsletters that we send out about 10 times per year.

Utilization of internal company web sites for Reactive Chemicals and Process Safety is also a key part of Dow's overall reactive chemical training efforts. This includes making web based self-training programs for reactive chemicals. Technology aligned Reactive Chemicals training is currently being developed in all of our technologies.

The Review Process

We have recently consolidated our Reactive Chemicals hazard review process with our other Process Safety reviews to become more efficient. We did this carefully so as to avoid losing any emphasis on Reactive Chemicals or other potentially high-risk areas.

Historically the Reactive Chemicals Review has been the most significant tool in reviewing process hazards within Dow. Up until four years ago we did have additional Process Safety reviews. These included Loss Prevention Reviews, Technology Center Reviews, and Process Risk Reviews. Most of these reviews had redundant topics and questions. There was also the needed for a more consistent approach to our review processes at all locations within the company. To solve these problems, we consolidated all of our reviews into a single review that we call the Reactive Chemicals Process Hazard Analysis (RC/PHA). The RC/PHA builds on the historic strength of our Reactive Chemicals Reviews by consolidating the other Process Safety hazard reviews into the protocol. This eliminated the redundant aspects of the reviews as well as eliminated the multiple efforts to deliver the reviews. The current RC/PHA is single global protocol that is adaptable to multiple review situations such as, existing facilities, research facilities, capital projects, management of change, and new leader reviews. It allows us to meet our Dow global requirements as well as the regulatory requirements in all the areas around the world. The new RC/PHA utilizes a macro driven MS Excel workbook. This allows use of an electronic format for distributing and archiving the review materials. This format permits ease of updating and preparing for periodic future reviews. The MS Excel workbook contains a master list of questions that probe for hazards. The workbook utilizes macro driven filtering of the master list of questions depending on the type of review that is being preparing for. The types of reviews to choose from are Project, Existing Facility, New Production Leader or Research Facility. By saving the answers to the questions a facility may transition from a project to an existing facility as the construction goes from the design stage to completion. This occurs with out having to reenter answers to previous questions. The answers only need to be reviewed.

The RC/PHA protocol automatically defines triggers for higher-level process risk reviews if they are required. It also calculates a relative measure of reactive chemicals hazard present within the facility based on the answers to specific questions.

The protocol allows the variation of review frequency for an existing facility based on the level of process risk and overall safety performance. We typically vary the interval for the RC/PHA for

existing facilities from between three and five years. The documentation generated by the protocol meets the regulatory requirements. We have this review integrated with our Technology Center review process to make sure we have the appropriate experts present as well as remove the redundancy between reviews.

Additional Tools and Efforts

We have several tools and guiding documents that support our overall Reactive Chemicals Process. We have established two guiding global documents for our reactive chemical efforts. We have a Global Reactive Chemicals Safety Standard that defines the basic requirements, and responsibilities that every facility must comply with. We also have a Reactive Chemicals Program Guideline that defines recommendations on "how to" implement a program in order to comply with the standard.

We have reactive chemicals databases for capturing all of our reactive chemicals test results as well as 22 years of Reactive Chemicals incident history. These databases are accessible via the Dow Intranet to nearly all employees. They are searchable by chemistry, technology and location. In order to promote standardization and sharing across technologies, we have established a reactive chemicals worst case scenario and key lines of defense database. This is also easily accessible and searchable by chemistry or technology.

In conclusion, we believe that at Dow we have developed the appropriate culture, protocols and tools for effectively addressing reactive chemicals and avoiding accidents. We believe that this type of overall reactive chemical program is essential to the continued safe operation of our processes which involve reactive chemicals related hazards and to the construction of safe new facilities.