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Chapter 1 : HAZOP â€“ Health Safety & Environment

Manufacturing Technology Committee - Risk Management Working Group Risk Management Training Guides Hazard & Operability Analysis (HAZOP) Page 1 of 9 1 Overview Hazard and Operability Analysis (HAZOP) is a structured and systematic technique for.

Technical risk analysis and hazard studies Introduction Before risk can be managed, organisations and projects must understand what could happen and what it could lead to in terms of their goals and objectives. Risk identification and analysis should always involve the application of a system that helps us discover and understand risks. Sometimes we may need to use additional technical tools to gain further insight into the risk of a project, operation or activity. Technical risk analysis and hazard studies cover a broad range of techniques, many of which Broadleaf offer. In particular, due to the capability and experience of several of our personnel, we focus on technical risk analysis and hazard studies that are complex, high profile, urgent, critical or where there are potential issues to manage between the stakeholders involved. The methods we use include: The form and timing of technical risk and hazard assessments depends on the information available at the time and the requirements of the design, construction, operations and approval authorities. Examples of risk identification studies A SWIFT analysis is usually performed early in the design process when there is less detailed information. A HAZOP study is a detailed and systematic examination of a process or design, structured around a set of guidewords, to identify and assess the risks and operability problems and the existing controls. It systematically considers the potential deviations from the design intent. Our wide experience in planning and leading HAZOP studies across many different kinds of systems allows us to tailor the guidewords effectively and conduct HAZOP studies to provide high quality outcomes. It can also be applied to other systems and processes that can be tested through consideration of deviations from the design intent, such as procedures, organisational changes and contracts. Broadleaf often facilitates such design reviews. FMEA involves reviewing the components, assemblies, and subsystems of a design to identify failure modes, and their causes and effects. FMECA is a similar study, but takes into account the criticality of each failure and assesses the risk associated with the failure mode; this is usually a qualitative process, but sometimes quantitative methods are used as well. Examples of risk analysis studies Fault tree analysis and event tree analysis are tools that allow the causes of a failure FTA or the development of the consequences of a failure ETA to be represented. Failure rate data and probabilities allow FTA and ETA to be used to calculate the frequency of a failure or the likelihood of a particular consequence for comparison with acceptance criteria. Figure 2 shows a simplified example of a fault tree for the failure of a pump at a coal terminal. Figure 3 is the linked event tree. Example fault tree Figure 3: Example event tree We conduct safety integrity level or SIL studies, but our activities are usually limited to the calculation of the required SIL and not the complete verification process. Associated studies We conduct fire safety studies FSS , often required as part of the approval process for new developments. An FSS can identify the sources of fire and explosion, evaluate the consequences and outline the prevention, detection and protection systems required. We also undertake detailed root cause analyses, for both failures accidents and incidents and successes. The aim of root cause analysis is to understand how existing controls worked or failed to work and to develop actions to ensure similar successes are repeated and similar failures are avoided. As well as generating lessons from the success or failure, our approach to root cause analysis concentrates on how the organisation can learn from its past experiences. Related international standards Many of the techniques noted above are described in more detail in international standards.

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Chapter 2 : HAZOP method, deviation analysis - apppm

The hazard and operability (HAZOP) study is the most commonly used process hazard analysis (PHA) method in the world today. It is one of the techniques commonly accepted by regulators.

This article is a straightforward and informal guide with illustrations aimed at helping beginners to understand HAZOP Analysis principles. Deviations from design or operational intent may constitute or produce a hazard. Hazards are the focus of HAZOP Analysis , and it should be noted that a single process hazard could potentially lead to multiple forms of harm. Harm Physical injury or damage to the health of people or damage to property or the environment. Harm is the consequence of a hazard occurring and may take many forms: Risk Combination of probability of occurrence of harm and the severity of that harm. However, risk assessment teams may choose to rate these factors in order to further quantify and prioritize risks if needed. Incident An undesired circumstance that produces the potential for an accident. Accident An undesired circumstance that results in ill health, damage to the environment, or damage to property. This is a kind of process hazard analysis. The dominant partner was Brunner-Mond which had been founded in by Ludwig Mond and John Brunner to manufacture sodium carbonate in Northwich, Cheshire. They have been used extensively by many companies around the world. Acceptance and propagation in the industry due to: Easy to learn and apply. Adaptable to most operations in the process industries. Does not require a specific academic level. Allows the exchange of experience and knowledge of the engineers involved. Helps to anticipate potential accidents. They started with a technique called critical examination which asked for alternatives, but changed this to look for deviations. The method was further refined within the company, under the name operability studies, and became the third stage of its hazard analysis procedure the first two being done at the conceptual and specification stages when the first detailed design was produced. The Hazop Analysis is a type of process hazard analysis hazop pha. Is a set of organized and systematic assessments of the potential hazards associated with an industrial process.

Chapter 3 : Technical risk analysis and hazard studies â€“ Broadleaf

The Hazard and Operability Study or HAZOP is a detailed, systematic study of the process design and outline operating and maintenance procedures to identify the.

The commissioning of new power plants is rarely without difficulties. Some of the problems encountered, generally unforeseen in the original design process, can result in delays long enough to impact project financing. Unfortunately this is not the end of it. Once the commissioning stage is finished, the plant operator may find new and unexpected problems, mainly during the first years of commercial operation. Although a trial run period is included in all power plant projects, this is not enough to reveal all the hidden issues of the design under a wide range of operating regimes, output power levels, weather conditions, etc. Even in the case of plants that have been running for long periods, operators may find themselves unexpectedly in risky situations with potential for major failures in the plant. Due to the high degree of competition in most electricity markets, this is not a state of affairs that can be allowed to continue. It has become necessary to adopt a truly proactive attitude when dealing with design-related operational problems. A "wait and see" policy is no longer acceptable. The plant is located 50 km from Buenos Aires, Argentina. Genelba started its commercial operation in as a merchant power plant in the deregulated and competitive Argentine market. Once in commercial operation, in Genelba registered its quality management system in accordance with ISO Within this framework, and having adopted the "continuous improvement" culture at an early stage, the plant has implemented an effective deviation control procedure, consisting of several detection instruments and a robust follow-up process. However, even when each identified deviation was successfully dealt with, and repetition was effectively prevented, there was an issue that disturbed the plant personnel every time it happened: And the question "How can we attack them in a really proactive way? HAZOP is a methodology for detecting operational hazards and problems in the process industry. In particular HAZOP techniques have been well established for many years in the petrochemical sector, which in fact gave birth to the concept. It involves both a multidisciplinary team working in a creative environment of brainstorming, and, at the same time, a systematic methodology to ensure that every aspect of a system is analysed. The design phase of new facilities is the ideal time to begin studies of this type. In this phase, improvement recommendations arising from the study can be rapidly introduced. Then, during the construction and assembly phase, it must be verified that the project has been developed according to what was previously planned. In this case, conducting the studies is much more complicated since it is known beforehand that certain features of the facilities cannot be modified because it would not be affordable. However, experience has shown that the method is effective anyway, and that it is fairly easy to improve most weak aspects that may appear. Thus it is necessary to strategically choose the plant sections to be analysed and the priority systems. HAZOP should be applied to the following systems in the case of a combined cycle plant using natural gas: The fuel system can also be analysed, especially in plants using liquid fuels or coal gasification. As a guideline, it should be noted that a complete HAZOP study of a turbine lube oil system takes a trained team about working hours. In general nodes involve the main components of the system under study. For instance, the nodes for a turbine lube system are: In the next step, starting with one of the nodes, the team identifies the physical parameters that are representative of the node operating condition. The typical parameters are: In the third step, the team identifies possible node deviations by combining the physical parameters with the so-called HAZOP "guide words". Typical guide words are: Each guide word is applied to every one of the physical parameters of the node. For example, the following guide words are applicable to the pressure parameter of the main lube oil pump node: Not all guide words are applicable to all parameters. What is more the team can apply a new guide word to a specific physical parameter in a particular node. The method involves the combination of parameters with guide words and ensures that the team faces all possible deviations in the node under study. Then brainstorming begins with the analysis and discussion of the possible causes leading to these deviations. Every cause is recorded. The next step is to analyse the consequences of the identified deviations. Both the consequences in the system under study and in the node itself are considered. This analysis also involves looking at safety issues effects on personnel. When there are no safeguards or when they do not provide enough protection against associated consequences, team members discuss actions required to solve the problem and formulate relevant recommendations. When the HAZOP study team cannot easily come up with a solution to address a particular weakness, a recommendation is made to investigate the matterfurther. All the nodes in a system are analysed one by one. Once all the possible deviations in a node are checked the team continues with another node of the system. The whole analysis is thoroughly recorded during the study. In order to do that, there is a log for every parameter of every node. This log must be completed with all the findings. The final outcome of the HAZOP study is a set of recommendations which, as a whole, potentially minimise the risk level of the system under study. A suibsequent analysis should assess every recommendation and its related risks in order to determine the actions to be implemented. Team members do not generally possess these skills since teams are formed bearing in mind the aspects of the process itself. That is why it was necessary to incorporate other studies to detect risks in these areas: The analysis is guided by possible failures and modes of failure of the different components connected to the control system inputs and outputs. The following devices are analysed: The following guide words are applied to each device: These guide words are applied to every plant device. An assessment is made of the possible causes of deviation, previous warnings to the operator, automation malfunction, actions required by the operator and existing redundancies. Direct redundancies double application of instruments to measure the same variable at the same point as well as indirect redundancies existing instruments in other points in the process that can help detect problems in the first set of instrumentation are considered. Recommendations are issued based on the results of this assessment and critical aspects of the control system under study. In this first phase, a log for every device should be completed. Each type of device has its own tailored log to allow proper assessment of its modes of failure. This phase involves an analysis of the hardware used in the control system; that is, possible hardware failures and their consequences are assessed. Information from phase 1 with regard to existing redundancies for each device needs to be borne in mind when checking that no single hardware failure can lead to the loss of a measure and its existing redundancy. Of course, no single failure should result in a turbine or plant trip. Any malfunction should be recorded and new recommendations must be issued. Lastly, since complex control loops and sequential logics need special treatment, What if? These questions are experience-based and focus the discussion on key aspects of the processes, limiting the open-ended discussions of traditional HAZOP. HAZOP 6 When the plant is out of service, and during the time it takes the steam turbine to get cool, service water is used instead of auxiliary cooling water for lube oil system cooling. This operation is risky every time service water pressure is higher than oil pressure in the cooler. In case of pipe puncture, the oil system would be contaminated by water. Due to the plate position, when the filter is carelessly purged the oil in the system at bar would bounce over the plate reaching the operator and components at high temperature. Although the filter is outside the lube oil system, should it collapse, impurities and filter parts would get into the tank, representing a serious risk for pumps and the rest of the equipment. An automatic pump shutdown was configured, since the side filter pump is not an essential piece of equipment for normal plant operation. This rearrangement has proved satisfactory since after the modifications there have been a large number of events where, if the original arrangement had not been changed, plant availability would have been reduced. An anti-bounce logic system was therefore implemented. When one of the signals was diverted or its measure became bad quality, the measure was eliminated from the mean value calculation, but as soon as the signal returned, it was included again in the calculation without the need for operator confirmation. If there were an intermittent failure in a particular measurement, calculation of the mean value would experience strong oscillations, causing some instability in the process that might result in a plant trip. Consequently the original 2 out of 3 logics for drum levels and other critical measurements were redesigned. In case of a fault on this single source, it would lead to a plant trip. An automatic start-up and synchronisation operation mode was designed for them due to the lack of a 6. Water spray from the fire fighting system could have caused problems for this pump. Lessons learned While HAZOP applied in the petrochemical industry helps identify mostly safety problems, Genelba experience has shown that HAZOP used in a combined cycle power plant fuelled with natural gas mainly helps detect operational problems related to quality such as plant availability and reliability issues. HAZOP application in a plant in operation requires a great deal of effort and dedication. People clearly have other responsibilities that may hamper, prolong, and reduce the quality of the HAZOP study. So to succeed, the study must be part of the plant "vision" and so should be understood by every member of the plant staff. HAZOP teams will rarely unearth serious problems. In an operating plant, there are usually experienced staff able to recognise and solve obvious problems, so a special study is not required to detect them. However, consider how many minor problems have led to plant trips in your own power plants! Sometimes, it is not easy to determine how important a specific finding is since there may be no previous experience with it. The prevalent implicit belief is "Every dog is allowed one bite". On the basis of the Genelba experience, the effort involved in the application of HAZOP to an operating CCGT plant is cost-effective if just one gas turbine trip can be avoided; subsequently, all the further benefits arising from the HAZOP study are profitable for the business. HAZOP should be a must in every new power plant design process. The intense competitive pressures and the present rather poor profitability in the power industry do not really allow the luxury of a "wait and see" policy for identifying power plant problems in operation. Competence and experience are not enough to achieve the standards of reliability called for nowadays; systematic studies sre also needed.

Chapter 4 : What Is HAZOP? | Graphic Products

Hazard and operability (HAZOP) methodology is a Process Hazard Analysis (PHA) technique used worldwide for studying not only the hazards of a system, but also its operability problems, by exploring the effects of any deviations from design conditions.

The operability study method was created. This event might have been avoided by assessing possible deviations of the plant. Since that date, the deviation analysis process has been applied in many projects from various types of company. Discussions and research have highlighted its usefulness in project management, but they have also unveiled some limits. When to perform this method The Hazard and Operability Analysis should be performed when the project members aim to check a design or running instructions; to decide the location of a construction; to decide whether to buy a piece of equipment; to obtain a list of questions to put to a supplier; or to improve the safety of existing facilities. Nowadays, HAZOP is particularly used in the process industries, such as oil and gas, chemical, petrochemical, fertilizers, power generation, but also in mining, ore extraction, pharmaceutical manufacturing, food additives manufacturing, water and waste water treatment. Operational and procedural controls Assess engineered controls, sequences of operations, procedural controls such as human interactions Assess different operational modes such as the start and the shutdown of the system, the normal operation, the unsteady states of some functions, the emergency shutdown When a company estimates a project involving mechanical parameters requires a structured risk analysis, HAZOP may be proceeded. These members are from various domains. The basic team is composed of [5]: Project engineer Process engineer: He is usually specialised in mechanical design, has been involved with the design of the system and will be concerned with the project cost. He designs and selects the control systems for the plant. Safety engineer Depending on the process, the team may also be composed of: For instance, if the plant includes chemical processes, a chemical engineer would step up the identification of deviations related to the chemical process. Once the team is composed, members agree on the focus of the study, on the meeting dates, and they assure everybody knows and will use the right HAZOP terminologies. The facilitator must ensure that team members have the same terminologies. This agreement on terminologies avoids assessment mistakes generated by misunderstanding. Physical or chemical property associated with the process. Set of words triggering the deviation Deviation: Departures from the intention which are discovered by systematically applying the guide words to process parameters e. Reasons why deviations might occur. Once a deviation has been shown to have a credible cause, it can be treated as a meaningful deviation. These causes can be hardware failures, human errors, an unanticipated process state e. Results of deviations e. Engineered system or administrative controls to prevent the causes or mitigate the consequences of deviations e. Suggestions for design changes, procedural changes, or areas for further study e. They are the foundation of the HAZOP analysis, and each team member has to acknowledge their definitions. It helps to define the boundaries of the system the team is going to study. The team wants to study a specific pump operating system taking water from a tank, and releasing it in a motor. They could only consider the pump system. Therefore, the chairperson must organise meeting dates and supply the necessary resources for the meetings. Tools and diagram define the system and allow the team to understand and overcome the operating system features, such as: Process flow diagram for the production of benzene by the hydrodealkylation of toluene Source: It is mainly used in chemical and process engineering, though its concepts can also be applied to other processes as well. Series of symbols and notations describe the process on the diagram or sheet. Piping and Instrumentation Diagram for the production of benzene by the hydrodealkylation of toluene source: It is more accurate than the previous diagram. It schematises the relationships between the functions of the piping. The Piping and Instrumentation Diagram is the last step in process design.

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Chapter 5 : Hazop definition/meaning

The HAZOP study technique is also readily and successfully applied to other systems such as control systems (CHAZOP studies) and electrical systems. It can also be applied to other systems and processes that can be tested through consideration of deviations from the design intent, such as procedures, organisational changes and contracts.

The goal is to find potential situations that would cause that element to pose a hazard or limit the operability of the process as a whole. There are four basic steps to the process: Forming a HAZOP team Identifying the elements of the system Considering possible variations in operating parameters Identifying any hazards or failure points Once the four steps have been completed, the resulting information can lead to improvements in the system. The key requirements are an understanding of the system, and a willingness to consider all reasonable variations at each point in the system. For each element, the team will identify the planned operating parameters of the system at that point: Consider the Effects of Variation For each parameter, the team considers the effects of deviation from normal. What if the pressure was unexpectedly low? Would the rate of change in pressure delta-p pose its own problems here? Document this concern, and estimate the impact of failure at that point. Then, determine the likelihood of that failure; is there a realistic cause for the harmful variation? HAZOP can be used when planning a new process, or for improving an existing process. Where a HAZOP study is performed in the planning stage of a new process, completing the study means that all potential causes of failure will be identified. The HAZOP team will write an assessment weighing the potential deviations, their consequences, their causes, and the protection requirements. From this point, changes to the plan can be made to prevent problems from arising, or to mitigate their effects. In existing facilities, a HAZOP may be ongoing, working to improve the process without any specific end date. In both cases, when a hazardous condition is identified, recommendations may be made for process or system modifications, or further study by a specialist may be required. A review of existing protection system designs by a specialist Adding or modifying alarms that warn of deviations Adding or modifying relief systems Adding or modifying ventilation systems Increasing sampling and testing frequency Each of these steps might be recommended as part of the overall Hierarchy of Controls. This way of addressing hazards is intended to prioritize the most effective steps. Analysis and maintenance, as well as ordinary, day-to-day operation, require workers to navigate these systems. To allow effective work, system components such as pipes, valves, instruments, and vessels must be identified and labeled. Often, safely maintaining a system will require monitoring. When measurements must be taken at the same point in a system, it makes sense to clearly mark that point with an indication of the test to be performed. Bad data will ruin the usefulness of any monitoring system. Opening the wrong valve, or cutting into the wrong pipe, have often been the causes of serious accidents. The rules are meant to give workers the information they need to be safe, and effective labeling serves that goal. Labeling and signage are critically important in these cases. The DuraLabel line of printers from Graphic Products can help your facility create the signs and labels that you need.

Chapter 6 : Hazard and Operability Studies (HAZOP) | BTS Training & Consultancy

Hazard & Operability Study (HAZOP) HAZOP study is to carefully review a process or operation in a systematic manner to determine whether deviations from the design or operational intent can lead to undesirable consequences. This technique can be used for continuous or batch processes.

Chapter 7 : When "wait and see" isn't good enough: applying HAZOP at Genelba - Modern Power Systems

A hazard and operability (HAZOP) study is used to identify major hazards, including the release of hazardous materials or energy, or operability issues related to design, installation and operation within a facility.

Chapter 8 : Hazard and operability study - Wikipedia

- How the HAZOP technique is applied at the different stages of a project's lifecycle such as FEED, detailed design, revalidation and decommissioning, and for different types of process operations, i.e. continuous and batch.