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GCI TECH NOTES©

GCI 的工艺摘要

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安全的管理系统内
造成灾难性事故的种种因素
Catastrophic Accidents
Caused by Multiple Failures of Elements within a Safety Management System

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There have been some rather spectacular catastrophic accidents at hazardous waste management facilities during the last few years. The explosion of a rail car at a hazardous waste fuels facility near Logansport, Indiana in February of 1999 probably being the most spectacular. Rarely are such incidents the result of a single event. While a specific event does immediately precede such a catastrophic accident, this event alone will not in-and-of-itself cause the accident to happen.

于过去的几个年头里[在美国]，一些危险废物管理设施里曾经发生过一些非常骇人的灾难性事故. 1999 年的二月，一辆铁路卡车在印第安那州的 Longansport 地方的一家废物燃料生产设施里发生一次可能是最惊人的爆炸事故. 这类事件的发生不应归咎于单一的事件. 虽然在灾难性事故之前刚发生过一件事，但那事件不会是因为它本身的原因而造成这次的事故。

An examination of the multiple elements needed to result in a fire is an example of this. To have a fire, whether it is to warm your house or to burn a forest, requires three things; fuel, oxygen and an ignition source. Remove any one of them and a fire cannot occur. This same principle may be applied to devising safety systems for industrial facilities and can be extended to prevent a wide range of potential accidents.

以那次造成的火灾为例，有必要审查多方面的因素. 要生火燃烧，无论是家里生火取暖，或者火烧森林，有三个条件；燃料、氧气和点火源. 去掉其中之一就烧不成.
同样的原理可以用来设计安全系统，应用于工业设施，而且延伸到防止各种可能发生的事故。

法规的要求从不足够 Regulatory Requirements Will Never be Adequate

The EPA mandates a number of requirements in its regulations; requirements regarding the prevention of accidents, personnel training and contingency planning to name a few. Clearly the regulations can never enumerate all of the necessary considerations that facility management must address to ensure the safe operation of the facility to secure the protection of human health and the environment. Nor would the hazardous waste management industry survive such an enumeration and subsequent bureaucratization of endless regulatory requirements. Indeed the EPA has an entire program dedicated to raising our awareness of accident prevention <http://yosemite.epa.gov/oswer/ceppoweb.nsf/content/index.html>

［美国］环保当局在所定的规章理由有好多规定；如关于防止事故的发生、人员的训练和意外事故的对策等等. 最清晰的规章也绝对不可能把所有的需考虑的事都列出来，强制设施的管理必须遵守，以保证设施的安全运作，保护人们的健康和环境. 危险废物管理工业也不可能在那么些不胜枚举和不断定出的法规之下幸存. 环保当局［美国］确实是有一整套的方案为了加强人们认识到防止事故发生的重要性. 这个方案可在以下网站找到：

<http://yosemite.epa.gov/oswer/ceppoweb.nsf/content/index.html

In one document, a case study of an explosion at a fuel blending facility in Oklahoma, the EPA stated in the introductory paragraph: "Major chemical accidents can not be prevented solely through command and control regulatory requirements; understanding the root causes of accidents, widely disseminating these lessons learned into safe operations are also required." (EPA 550-F00-001, April 2000, http://yosemite.epa.gov/oswer/ceppoweb.nsf/vwResourcesByFilename/chiefinl.pdf/$File/chiefinl.pdf

其中一个文件，是对于奥克拉荷马州一家［废物］燃料调配设施里，发生的爆炸事件的个案研究，环保局在介绍段落里写道：『重大化学事故并非通过命令和法定的要求可以完全避免的；必须了解造成事故的根源，广泛地宣传，吸取教训也是必要的.』(全文可以在网上找到 EPA 550-F00-001, April 2000

<http://yosemite.epa.gov/oswer/ceppoweb.nsf/vwResourcesByFilename/chiefinl.pdf/$File/chiefinl.pdf>

Let us repeat that: "Major chemical accidents can not be prevented solely through command and control regulatory requirements…" an amazing admission from one of the government's most regulation prolific agencies. The EPA is right, but be warned! The fact that the EPA is making an effort to raise industries' awareness of accident prevention will not preclude them from adding additional regulations particularly if industry does not respond. Herein lies the purpose of this TechNotes.

让我们重复：『重大化学事故并非通过命令和法定的要求可以完全避免的…』这是来自政府机构中发表最多法规的机构之一的惊人的坦白承认。 环保局说得对，但是应该警惕！事实上环保局在不断地尽力提高工业界防范事故的意识，如果工业界并不响应的话，不排除他们会定出更多的法规. 写这份'工艺摘要'的目的就是要提醒诸位。

安全管理系统 Safety Management Systems

The management of hazardous waste is inherently complex. Unlike a chemical production facility, which handles tons of the same 10 or 15 chemicals year after year, a hazardous waste facility handles tons of maybe 100, 200 or more chemicals each year and often at a receipt frequency that lulls management into a routine that has not addressed all of the variabilities that each waste receipt presents. Hazardous waste after all, is a waste not a specification product. This is what is left over (or mistakenly produced) during the production of a product or the completion of a service.

管理危险废物有它的固有复杂性. 不像一家生产化工品的工厂，他们处理以吨计的 10 至 15 种的化学物质，年复一年，而一个危险废物调配设施每年处理以吨计的 100、200 种或者更多的化学物质，而且时常由于收取的次数频繁，使得管理层麻木松懈，而习以为常地并不留意每种收取的废物都可能存在的可变性. 危险废物毕竟是一种没有规格的产品. 这是于生产某种产品时的留下废料（或者是不合格的产品），或者某种工程完成后留下的.

It is safe to say that every receipt should be approached as if it were a "surprise" no matter how often similar material has been received or how consistent the generator has been. Yet, exhibiting safe practices beginning at time of receipt is starting way too late. The safe management of hazardous wastes has to start when the facility is first planned and the people first hired and must be systematically unrelenting there after. This may seem boringly obvious and our emphasis of it overly dramatic, but multiple failures of elements of a safe hazardous waste management program are the cause of catastrophic accidents, not that last fatal act by an unaware operator.

为了安全起见每次接受废物时，因该当作是对待另一次的"意外惊奇"，不管有多长久收到同样的物质，或者废物产生者以往的一贯性. 然而，在收取废物时才开始履行安全惯例已经太迟. 安全管理危险废物应该从设施的初步计划时，人员聘用后即开始，而且必须往后有计划地、无情地严格执行. 这似乎颇为明显，也许有人认为我们强调它是过于引人注目，但是好多对危险废物管理方案的疏忽，是造成灾难性的事故的原因，而不是由于最后 一个不经意的操作人员所作出的致命行为。

审查一件事故能指出许多系统里的缺点
Examination of One Accident Points out Many System Failures

In the case study noted above, the story is quite simple. About 200 gallons of waste solvent was mixed with about 2 gallons of dry oxidizers; a mixture of chlorates, perchlorates and nitrates. In less than a minute this exploded out of the mixer fatally engulfing one man and starting a large fire in a building storing flammable liquids. Clearly, mixing flammable liquids with oxidizing chemicals is an unbelievably stupid thing to do - but it happened.

在上面提到的个案研究，内情很简单. 大约 200 卡伦的废溶剂与 2 卡伦干的氧化剂混合；那就是氯酸盐、高氯酸盐和硝酸盐的混合物. 于不够一分钟的时间内，从混合器里爆炸出来的火焰吞噬了一个人，随即引发储存易燃液体的厂房大火. 很清楚，混合易燃液体与氧化化学品是难以置信的愚蠢行为，但是还是发生了.

It happened because the full nature of the chemical characteristics was not investigated and understood, so that a plan of action could be proposed, that proposal evaluated for safety and the approved plan presented as a standard operating procedure (SOP) and the operators trained to safely execute the SOP. It may be that there was no safe way of doing this, but in that case the initial investigation would have made that determination.

发生的原因是化学制品的全面本质、特性没有经过审查和了解，否则的话可以订出一个执行程序，这个程序经评估为安全的，那么把这个核准了的程序作为一个标准的操作程序（SOP），操作人员应该经过训练，能安全地执行这个守则. 如果在那场合里没有更安全的办法可以做，那么于最初调查时就应该作出判断[即禁止执行]。

In the end the preventative steps drawn from an examination of this one simple incident are the same ones GCI has advocated after every accident we have investigated and prior to operation of every facility we have set up. Quoting directly from the case study, those preventive steps are:

从研究这一件简单的事故中衍生出来的防御步骤，就像 GCI 对每个发生过的事故所作的研究那样，把它应用在每个我们建立的设施[废物燃料调配设施]. 那些防御措施是：

- The chemicals and reaction mechanisms associated with the substances mixed or blended must be well understood and documented.

  Facilities need to conduct the necessary information searches or laboratory tests to ensure that all reaction mechanisms are known and documented, especially those that may trigger fires or explosions as a result of abnormal situations or changes in chemicals mixed.

- Chemical and process hazards must be understood and addressed.

  Once the reaction mechanisms are well understood, facilities need to ensure that process equipment, controls, and procedures are designed, installed, and maintained to safely operate the process. A formal hazard review using techniques like 'What-If' or 'Hazop' can help identify opportunities for failure (e.g., human error, mechanical failure) and layers of protection to minimize the consequences of such failures, based on established codes and standards, industry practices, regulations (federal or state) and common sense.

- 物质的混合或调配的有关化学反应机制必须彻底明了和记录下来

  废物燃料调配设施[包括使用危险废物或污泥作燃料的水泥厂]，需要进行资料搜查，或者化验室测试以保证所有反应机制清楚明了，而且记录下来，特别是那些于不正常的情况下，或者化工品的搀和转变可能触发火灾或爆炸。

- 化工品和处理过程的危险性必须明白并且设法对付

  待反应机制完全明了之后，设施需要保证处理的设备、操控装置和程序都得设计、安装和保持能安全操作整个过程. 根据已经建立了的规则和标准，工业惯例，法规和常识，作一个正式的危险性复查，使用技巧如“如果发生了什么”或者“危险与运作能力的复审”可以帮助认清疏忽的机会（如：人为的错误，机械故障），和保护的层次以减轻由于疏忽造成的后果。

- All employees need to understand the chemical and process hazards.

  All personnel should openly communicate information about hazards and process conditions and understand the consequences of deviations and unusual situations. Facilities should establish mechanisms for documenting and sharing such information.

- Standard Operating Procedures (SOPs) are essential to safe operations.

  Facilities should establish a system to develop and maintain written SOPs and ensure that they are understood and followed at all times. The SOPs must address all phases of operation, safe limits for operation, consequences of deviation, and identification of corrective measures during emergency situations.

- Before starting a process or procedure that has been changed or modified, the chemical and process hazards must be evaluated.

  Abnormal or non-routine circumstances are a leading factor in chemical accidents. Facilities should make use of management of change (MOC) and pre-startup safety review techniques to ensure that modified processes or procedures will function as intended without unanticipated impacts on other operations.

- Employees must be properly trained in the processes they work on using the SOPs for that process or job tasks.

  Training must include potential hazards, reduction of those hazards, safety consequences if procedures are not followed, and proper emergency response to abnormal situations. Training should contain clear and concise objectives that can be easily evaluated for operator competence.

- 所有员工需要明白化工品和处理的危险性

  所有员工应该公开地传布信息，关于危险性、处理的条件和清楚明白不遵守[守则]的后果，以及不正常的情况. 设施也应该建立一个机制来记录和分享那些信息。

- 标准操作程序(守则)是安全操作的基本

  废物燃料调配设施［包括使用危险废物或污泥作燃料的水泥厂］，应该建立一个系统来发展和保持文字守则的更新，和保证员工明白和完全遵守这个守则，其中必须包括针对全面的运作，操作的安全极限，越轨的后果，和识别在紧急情况下应该采取的措施。

- 一个转变过的或者是修改过的工序或程序在执行之前，该化工品和处理的危险性必须接一评估。

  不正常或非常规的情况是导致化工品事故的首要因素. 设施应该使用管理改变(MOC)【注】与开始前的安全复查技巧，以保证修改过的工序或程序会引起的作用是意料之中的，对其他操作没有意料之外的影响。

- 员工必须经过恰当的训练，在他们所在的岗位上使用标准守则处理或执行任务

  训练必须包括认识潜在危险，减低那些危险，对安全有威胁的后果（如果不遵守程序），和在不正常的情况下恰当的紧急应变. 训练应该有清晰和简洁明了的目标，能够容易评估操作人员的能力。

In some of the more spectacular incidences that GCI has examined every one of these steps were either ignored or truncated.

在一些 GCI 已经研究过的惊人事故里，以上提及的步骤不是忽视了就是简略了

【注】改变的管理　Management of Change (MOC)

由于复杂的工序对些微的改变会很敏感，恰当地对改变的管理是有必要的,而且被视为对工业设施与工序的安全至为重要.　在美国，职业安全和健康总局(Occupational Safety & Health Administration 或 OSHA) 由法规，规定怎样执行改变和记录.　主要的要求是彻底复审提出的改变，由跨专业的团队执行以保证概括许多可能的观点，尽量减低可能疏漏了的危险性. 上文所提的改变的管理被称作 **Management of Change** 或者 **MOC**。

(Remark: Searched Result)

Since complex processes can be very sensitive to even small changes, proper management of change to industrial facilities and processes is recognized as critical to safety. In the US, OSHA has regulations that govern how changes are to be made and documented. The main requirement is that a thorough review of a proposed change be performed by a multi-disciplinary team to ensure that as many possible viewpoints are used as possible to minimize the chances of missing a hazard. In this context, change management is known as Management of Change, or MOC. It is just one of many components of Process Safety Management, section 1910.119(l).1

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