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危险与适用性的复查

HAZOP REVIEWS

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Recently Gossman Consulting, Inc. had the opportunity to perform a HAZOP (hazard and operability) review for a facility in Europe. While such a review is common for industrial facilities in Europe, it is only commonly performed in the United States at chemical facilities usually as a requirement of the OSHA Process Safety Management regulations (29 CFR 1910.119). A more common practice in the United States is a facility audit which looks at a variety of health, safety and regulatory issues and may loosely prioritize a series of recommended improvements as a result. The more formal HAZOP review uses a list of keywords to examine each part and operation of a facility to determine both the probability and consequence of each mode of failure. Based on this combination of probability and consequence, the risk is determined. Any unacceptable risk requires a high priority corrective action.

近来高士曼咨询有限公司(GCI) 有机会于欧洲为一个设施做一次危险与适用性

(HAZOP 是 Hazard and Operability 的简称) 的复查. 虽然这种复查在欧洲的工业设施里是很普遍, 然而在美国通常只有化工厂出于职业安全当局的法规 (29CR 1910.119) 的规定才需要做, 在美国的一个普遍的习惯是对设施作一个审计; 对种种有关健康、安全和法规要求的问题作审核, 审核的结果是有可能随意提出一系列的改善. 更正式的 HAZOP 复查是按一张关键词清单来审核每一个设施运作的步骤, 以确定每一个故障的情况发生的可能性及其后果. 根据这个可能性与后果的结合, 风险就可以确立. 任何不可接纳的风险必须优先采取纠正的措施.

The first step in a HAZOP is to break the facility down into subsections, either lines or individual pieces of equipment such as a tank, pump, agitator, etc. The degree to which this first step is done often determines how rigorous the HAZOP will be. HAZOPs are often done to different levels of rigor. We performed, and I will be describing, a medium level HAZOP; although different companies have established company/industry specific definitions and procedural issues for such levels.

Figure 1 provides a form that can then be used to evaluate a specific line or piece of equipment. Table 1 provides a list of guide words and deviations that are used to evaluate each piece of equipment/line. Given a *guide word* and *deviation* produced by a theoretical *cause* the *consequences* must then be determined. Each *consequence* is evaluated against frequency and severity. Finally, after each *consequence* is evaluated, a form similar to Figure 2 is completed to determine corrective actions for each unacceptable *consequence*.

A HAZOP review can be performed based on drawings prior to construction, just prior to startup or periodically during operation of a facility. The review can identify significant flaws in facility design and operations and thereby reduce the risks to human health and safety and the environment.

HAZOP 复查的第一步是把设施分成一些小组，有的小组是线、或者单一的设备为一小块；如储存库、泵、搅拌器等。第一步骤进行的力度往往决定 HAZOP 的严格程度。HAZOP 复查往往是以不同水平的严格程度进行的。我们所做的可以说是中等水平的 HAZOP 复查；然而那些水平，在不同的公司有他们本身已经建立的公司/工业的特别的定义和程序的问题。

图一是一个表格可以用作评估一条生产线或者单一的设备。表一的引导词和偏差是用来评估单一的设备/线。给予一个引导词和偏差的条件下，根据理论可能造成的后果，必须加以确定。每一个后果对其频率和严重性作出评估。最后，待每个后果经评估后，另一个表格类似图二的需要填写好，来确定对每个不可接受的后果应该采取的纠正行动。

执行一个 HAZOP 复查可以根据建造前的图则，即将开始前，或者设施在运作中定期执行。这种复查能发现设施的设计和运作的严重的缺陷，然而减少对人们的健康、安全和环境的风险。

危险和适用性的研究工作单

HAZARDOUS AND OPERABILITY STUDY WORKSHEET

地点 Site:

设施名称 Plant:

生产线/设备 Line/Equipment

Guide Word	Deviation	Cause	Consequence	Action
引导词	偏差	原因	后果	行动

图一 Figure 1

表一 Table 1

<u>Guide Word 引导词</u>			<u>Deviation 偏差</u>	
	Flow 流动			More 多了 No 没有 Less 少了 Reverse 反向 Other 其他 Also 并且
	Pressure 压力			More 多了 Less 少了
	Temp 温度			More 多了 Less 少了
	Viscosity 黏度			More 多了 Less 少了
	Relief 放气			Other 其它
	Samples 样品			Other 其它
	Instruments 仪表			Other 其它
	Corrosion 侵蚀			More 多了
	Erosion 腐蚀			More 多了
	Services 服务			Other 其它
	Maintenance 维修			Other 其它
	Static 静电			Other 其它

表 2 Table 2
安全、健康与环境的优先化问题
PRIORITIZATION OF SAFETY, HEALTH AND ENVIRONMENT ISSUES
估计关键 ASSESSMENT KEY

CONSEQUENCE 后果等级 CATEGORY	建议需要的费用 ROPOSAL FOR EXPENDITURE - 改善安全、健康或环境 SAFETY, HEALTH OR ENVIRONMENT IMPROVEMENT				
五级 最坏的严重后果 CATEGORY 5 EXTREMELY SERIOUS CONSEQUENCE	可容忍的地带 TOLERABLE BAND				
四级 大范围的后果 CATEGORY 4 MAJOR CONSEQUENCES	可容忍的地带 TOLERABLE BAND			不可接受 UNACCEPTABLE	
三级 剧烈的后果 CATEGORY 3 SEVERE CONSEQUENCES			可容忍的地带 TOLERABLE BAND		
二级 危急的后果 CATEGORY 2 SERIOUS CONSEQUENCES		可以容忍 TOLERABLE		可容忍的地带 TOLERABLE BAND	
一级 重要的后果 CATEGORY 1 SIGNIFICANT CONSEQUENCES					可容忍的地带 TOLERABLE BAND
年中 发生的次数 EVENT FREQUENCY PER YEAR	10-7 EXTREMELY UNLIKELY 非常不可能	10-6 10-5 VERY UNLIKELY 很不可能	10-4 10-3 UNLIKELY 不可能	10-2 0.1 POSSIBLE 可能	1 PROBABLE 有可能
频率等级 FREQUENCY CATEGORY	1	2	3	4	5
例如 Example	三级后果为 3		频率等级为 4		以 3-4 表示 3-4

PRIORITIZATION OF SAFETY, HEALTH AND ENVIRONMENT ISSUES GUIDANCE FOR CONSEQUENCES CATEGORIES

	CATEGORY 1 EVENT SIGNIFICANT CONSEQUENCES	CATEGORY 2 EVENT SERIOUS CONSEQUENCES	CATEGORY 3 EVENT SEVERE CONSEQUENCES	CATEGORY 4 EVENT MAJOR CONSEQUENCES	CATEGORY 5 EVENT SERIOUS CONSEQUENCES
TYPICAL MEDIA ATTENTION	Noted in Local Press, TV & Radio Few telephone calls	Significant local attention, interviews Adverse local comment	Considerable local, some national attention Local outcry	Headline national , continuing local attention	International news, outcry threatens to close operation
TYPICAL ACTION BY Authorities	Notifiable	Warning	Prosecution	Severe Fine	Prohibition
ACUTE INJURY INCIDENT - on-site effects	Minor/classified injury Low probability of Lost Time Accident	Lost Time Accident Low probability of major injury	Major injury Multiple injuries Low probability of fatality	Fatalities or few employee fatalities Low probability of many fatalities	Many fatalities (ie 5 or more)
ACUTE INJURY ACCIDENT - off-site effects	Nuisance off-site- see Environmental	People affected- short term minor	Few people require hospital treatment	Serious injuries 10s in hospital	Fatality or fatalities off site; many injuries
CHRONIC HEALTH OR PHYSICAL CONDITION - on-site effects	Occasional releases above Occupational Limits - OEL or STEL - low hazard materials Unpleasant conditions	Persistent releases above limits - 2 to 6 times Occupational Limits - non-carcinogen Harmful conditions	Distressing <i>exposure</i> Significant health effects Harmful, irreversible, unacceptable effects Sensitization effects	Employee <i>exposure</i> to high levels of carcinogens, e.g. asbestos, benzene, vinyl chloride, or life-threatening conditions	Many cases of ill health and resultant fatalities Health risk unacceptable due to continuous or discrete large releases

安全、健康及环境的优先化问题 后果等级的指导

后果	一级 发生 重要后果	二级 发生 危急的后果	三级 发生 剧烈的后果	四级 发生大 范围的后果	五级 发生危急 的后果
典型 传媒的 注意力	引起当地的 报刊、电视与电台 的注意及 一些电话来讯	引起当地严重 关注和采访。 当地的负面评论	引起当地和全国 范围内的注意 当地的强烈抗议	全国头条新闻 继续得到 当地的关注	国际新闻 激烈抗议, 威胁关闭工厂
当局的 典型行动	勒令申报	被警告	被起诉	被严厉罚款	颁布禁令
急性受伤 事件 现场的影响	被认为轻微受伤, 因工业安全导致失 去时间的事故的机会低	失时事故, 较大的受伤 机会低	有交大受伤、 多人受伤, 伤亡的机会低	有伤亡或 几个员工死亡, 但是更多死亡 的机会低	有很多死亡 (如超过 5 人)
急性受伤 事件 场外的影响	有关环境问题的麻 烦事	人们受到的影响 短期有轻微	有数人需要 入医院治疗	十个或以上 的人严重受伤, 进院治疗	死亡或 场外伤亡 众多
慢性健康 或身体状况 现场的影响	迹而发表 超过职业安全暴露 限度, 或短期暴露 限度的情况, 危险性低的 物质 不舒服的情况	持续发表超标两 至六次职业暴露 限度, 无至癌物质 危险情况	灾难性暴露 对健康有 重大影响, 有害、不可逆转 的、无可接受的影 响 和敏感的效果	员工暴露 于高水平 致癌物质, 如石棉、笨氯乙 烯, 或者有生命 危险的情况	有好多损害健康 的事件, 而且因此 有致命的风险. 由于连续大量的 报道, 情况 无可接受

【注】 Industrial safety 工业安全 OEL = Occupational Exposure Limit 职业暴露限度

STEL = Short Term Exposure Limit 短期暴露限度

危险及适用性研究的行动表[建议]
HAZARD AND OPERABILITY STUDY ACTION SHEET
DATA FILE:

ACTION ON: 行动针对	RESPOND BY: 负责者
ACTION NO: 行动编号	MEETING DATES: 会议日期
DOCUMENT REFERENCE: 参考文件	REVISION: 复查
TITLE: 文件标题	
ITEM: 项目	
CAUSE: 原因	
CONSEQUENCE: 后果	
SAFEGUARDS/COMMENTS: 防范措施/评语	
ACTION: 行动	
RESPONSE: DATED: 回复: 日期:	
SIGNED: 签名	

图二 Figure 2