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Risk assessment of cryogenic installations – implementations applicability of methodologies and challenges at CERN

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CERN

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Introduction

- What is a risk assessment?*
  - Process of systematic examination of workplace hazards and evaluation of risks to workers arising from them. It consists of:
    - Identification of what could cause injury or harm;
    - Assessing whether the hazards could be eliminated and, if not;
    - Set out preventive or protective measures are, or should be, in place to control the risks.
- Legal context
  - Directive 89/391/EEC – OSH “Framework Directive”:
    - Obliges employers, public and private, to ensure the safety and health of workers in every aspect related to the work by taking necessary measures, including prevention of occupational risks, provision of necessary organization and means, provision of information and training;
    - Introduces the principle of risk assessment, obligation for employer to be in possession of an assessment of the risks to safety and health at work.

* As per defined by EU-OSHA, adapted from Fact Sheet 80, http://hw.osha.europa.eu

Introduction

- Risk assessments are compulsory at CERN
- Motivation on CERN Safety Policy:
  - *“Ensuring best possible protection in health & safety matters of workers and population living in the vicinity, and limiting environmental impact”*.
  - Commitment to continuous improvement of Safety based on “*definition, follow-up and updating of prevention objectives based on* ***risk assessment*** *and experience gained*”
- Explicit requirement in Safety Rules SR-M, GSI-M-4

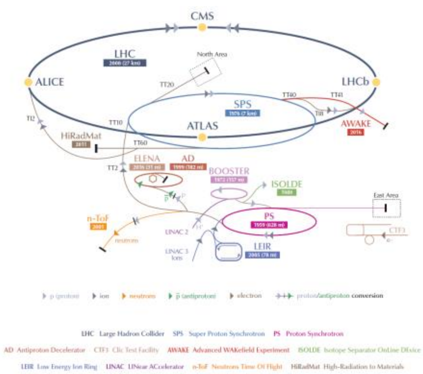
No Methodology, criteria, specified in the regulation. Users/owners free to choose best fit to installation/process.

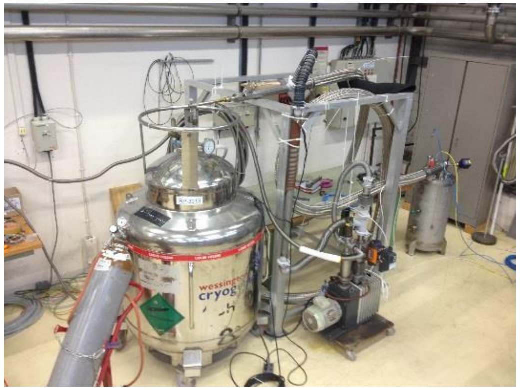
Goals for risk assessments

- RA to be a reliable, live tool for both users & management to be able to:
  - Determine whether the health & safety of people and protection of the environment may be assured;
  - Promptly identify emergent risks;
  - Define risk mitigation measures that are effective and commensurate.
- Concept of RA to be familiar at all levels of the organization, at every department, experiment, etc.
- Reliability and credibility achieved through simple yet robust methodology, consistent across the array of activities of CERN.
- Methodology needs to be useful, flexible and scalable to large variety of activities.

RA at CERN - challenges

- Defining scope of RA, large array of activities, varied types of activities and level of complexity:
  - Big-scale, highly automated systems (LHC, ATLAS, CMS,…)
  - Medium-sized installations (ISOLDE, COMPASS, SM18), with different types of activity co-existing.
  - Small-scale experimental setups, manually operated.
  - Workshops/laboratories, from large facilities (main workshop – machining, forming, surface treatment, hot works) to small work benches with few tools.





RA at CERN - challenges

- Multiculturalism – diversity in backgrounds, safety culture, level of engagement with Organization’s values
- General inexperience with Risk assessment methodologies, systematic approach
- People rotation, management changes, traceability of decisions over time

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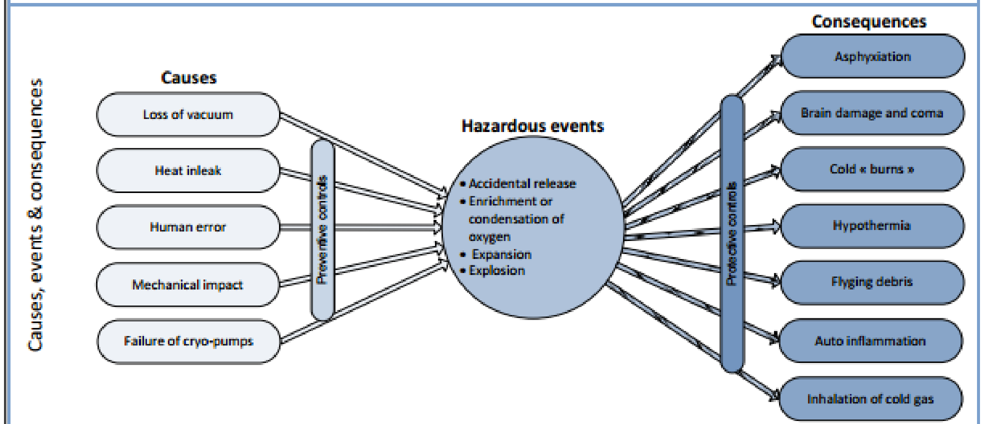
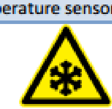
6.1.4 Cryogenic fluid

Safety rules	Activities involving cryogenic fluids shall comply with the following applicable CERN Safety rule: • Safety Instruction IS 47 - Use of cryogenic fluids.
Causes, events & consequences	

Control measures

	E.g. of preventive controls	E.g. of protective controls
Engineering controls	Design & manufacturing according to: • EN 13458, EN 14197 – Cryogenic vessels; Process control and instrumentation.	Collector (vent line) of released helium to safe place; Oxygen level detectors (fixed or mobile); Vacuum sensors (in insulation vacuum); Ventilation system; Temperature sensors.
Signage/warnings	 **Figure 6 – Asphyxiation**	 **Figure 7 – Low temperature**
Administrative controls	Restricted Access Area; (C) Formation masque auto-sauveteur (self rescue mask) (EDH inscription); Safety Training: • Level 4 Safety courses (ATLAS, CMS, LHCb, LHC machine) on SIR (C) for access to underground areas; • Cryogenic safety course level 1 and	Oxygen Deficiency Alarm; Evacuation Procedures.

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Safety Guideli

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Abstract
The purpose of this Safety Guideline is to aid in the implem
framework of the Safety Regulation SR-OHS – Occupational H
Furthermore and according to the current European legislati
plans, programmes and projects likely to have significant eff
assessment prior to their authorisation.
This Safety Guideline provides information on:
- hazards frequently present in CERN activities and equipm
- hazardous events associated to such hazards as well as th
- relevant preventive and protective measures taken to co

This Safety Guideline is intended for those who are involved
equipment, use of electricity, exposure to substances or p
physical agents, exposure to biological agents, etc.

DOCUME

Reference documents:
[1] SR-OHS – Occupational Health and Safety (in preparation)
[2] Safety Form OHS-0-0-1 – Risk assessment (EDMS No. 111
[3] Safety Form OHS-0-0-2 – Risk assessment (excel sheet) (E
Further readings:
[4] Council Directive 89/391/EEC of 12 June 1989 on the intr safety and health of workers at work.
[5] Directive 2001/42/EC of the European Parliament and o effects of certain plans and programmes on the environm
[6] Council Directive 85/337/EEC of 27 June 1985 on the projects on the environment.
[7] OHSAS 18001:2007, Occupational health and safety mana
[8] ISO 31000:2009, Risk management – Principles and guidel
[9] EN 13701:2001, Space systems, glossary of terms.
[10] OHSAS 18002:2008, Guidelines for the implementation o

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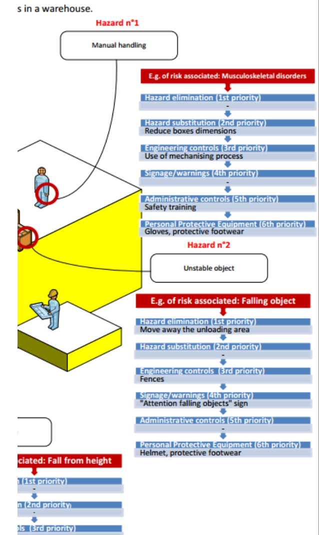
s in a warehouse.



HSE approach to RA at CERN

- **Risk matrix**: scoring system for risks, classification in terms of ‘acceptability’ of the risk (severity * likelihood). Definition process ongoing.
- Important aspects:
  - Granularity vs. simplicity – needs to accommodate to CERN’s activity diversity, yet simple enough to be effective.
    - 5 levels of severity, from Negligible to Catastrophic
    - 5 levels of likelihood, from Extremely improbable to Frequent
  - Severity estimates mostly **qualitative** – material damage, injuries may be quantified; other aspects such as environmental impact or harm to reputation are more difficult to quantify.
  - Likelihood estimate **semi-quantitative**– lack of track record at CERN and/or similar institutions.
  - 4 areas for severity evaluation: people, environment, material, image.

HSE guidelines to RA

- Timing: as early as possible in the development cycle – cost effective to overcome potential deficiencies identified by the RA at the design phase.
- Multidisciplinary effort
- 2-step risk analysis:
  - First **unmitigated risk** evaluation – provides idea of extent of control measures necessary, provides an 'unfiltered' idea of the extent of the risks.
  - Final **residual risk** – must be within acceptable margin, or ALARP.
- Main steps :
  - Definition of perimeter
  - Hazard identification
  - Risk evaluation
  - Determining controls
  - Risk re-evaluation
  - Prioritization of controls to take

Methodologies

- FMEA/FMECA – Failure Modes and Effects (& Criticality) Analysis
  - Decomposition of a system into its more basic elements, study of failure modes of each element independently, with analysis of causes and consequences.
  - **Pros**: flexible, can be equipment or process-focused, efficient when applied to elements that can cause a failure of the entire system. May be applied to various levels of system decomposition.
  - **Cons**: difficult for complex systems with multiple functions involving different sets of system components. Identifies hazards arising from single-point failures, may fail to identify hazards caused by combinations of failures.
  - Examples:
    - SM18 Cluster D, COMPASS, HIE-ISOLDE, B180 Magnet test facility

Methodologies

- HAZOP – Hazard and Operability Studies
  - Deliberate search for deviations from the design intent
  - Especially useful for systems involving the treatment of a fluid medium or other material flow, sequential activities.
  - **Pros**: systematic and comprehensive. Should identify all hazardous process deviations.
  - **Cons**: optimized for process hazards
  - May be used in conjunction with other risk analysis methods such as FMEA or FTA.
  - Less used at CERN.
  - Examples: SM18 Test Bench Cluster A.

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