



BSI Standards Publication

Maintenance — Risk control processes of energies and fluids risks in maintenance activities — Guidance

National foreword

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Maintenance - Risk control processes of energies and fluids risks in maintenance activities - Guidance

Maintenance - Processus de maîtrise des risques liés
aux énergies et fluides lors d'opérations de
maintenance - Recommandations

Instandhaltung - Verfahren zur Kontrolle der Risiken
von Energien und Fluiden bei Instandhaltungsaufgaben -
Leitfaden

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European foreword

This document (EN 17975:2025) has been prepared by Technical Committee CEN/TC 319 “Maintenance”, the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2025, and conflicting national standards shall be withdrawn at the latest by December 2025.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

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Introduction

Many occupational accidents are caused by a failure to manage energy & fluid sources during maintenance activities and can result in serious impact on people, assets, and activities.

This standard is concerned with occupational safety and how to best control the risks related to energies & fluids linked to maintenance activities.

The safety and health of workers prior to, and during, maintenance tasks on items involves a series of practices and procedures aimed at controlling all energy & fluid sources. These practices and procedures enable a worker to be sure that they can work on an item without any accidental reconnection of energies or fluids and avoid being exposed to a hazardous working environment.

Depending on the task, items and related risk analysis, the safety of workers is based on the individual or combined implementation of the following specific processes for each energy & fluid:

- Reinforced Isolation by lockout/tagout of energies & fluids (RI);
- Standard Isolation by lockout of energies & fluids (SI);
- Neutralization of energies & fluids by the control systems (N);
- Specific Provisions for activities involving energies & fluids (SP).

On its own, reinforced isolation by lockout/tagout of energies & fluids ensures the full protection of workers. However, the design of existing items or the type of operations does not always enable such an approach to be applied, which therefore imposes use of one of the three alternative processes set out below.

Various industrial sectors (for example: chemical, metallurgy, agrifood, energies & fluids production and power distribution) have adopted their own “energies & fluids lockout” terminologies. Each industry has defined a formal system for risk analysis and operating procedures for securing each of the energies & fluids it works with. Depending on the sector, the terms used for “energies & fluids lockout” include, but are not limited to:

- reinforced lockout/tagout,
- standard lockout/tagout,
- lockout of released energies & fluids,
- LOTO - Lock Out, Tag Out,
- LOTOTO - Lock Out, Tag Out, Try Out (see OSHA 29 CFR 1910.147),
- administrative lockout,
- etc.

1 Scope

This document provides users with guidance that help manage risks related to energies & fluids during maintenance activities on items when in use. It is the responsibility of each employer, according to the terms commonly used in the company, to:

- Set out the correlation between the processes described in this document and standard practices,
- Define the roles and responsibilities of the people involved in the energies & fluids lockout process.

This document refers to concepts, definitions, rules, recommendations, and best practices taken from national and international documents (*lockout/tagout* – “*administrative lockout*” – *Lockout/Tagout (LOTO)* – *Safe isolation*) that cover activities to ensure the safety of workers with respect to energies & fluids.

This document deals with the prevention of energy & fluid (e.g. powders, gases, liquids, etc.) related risks; it is noted that some are covered by specific regulations or standards, such as the electrical risk. Environmental issues related to energies & fluids are not in the scope of this document. Danger associated with energies & fluids can be direct (e.g. contact, absorption, etc.) or indirect by reaction (e.g. mixing, heating, etc.). The scope includes all fluids because they can be intrinsically dangerous or become dangerous.

The recommendations given in this document have been drawn up with a view to ensure the safety and health of workers around hazardous energies & fluids, and situations when they are conducting actions related to maintenance, settings or changing formats, regardless of the type of activity.

The recommendations relate to activities carried out on items. They are applied before, during and after the operation to:

- The energies & fluids supplied, contained, transported, or released by items, products,
- Risks related to the presence of hazardous energies & fluids for the worker and the surrounding personal.

This document is a methodological guideline within the maintenance standards.

NOTE Particular cases such as risks of lack of presence of vital elements for the worker (e.g. breathable air) are in the scope but will not be detailed.

2 Normative references

The following documents are referred to in the text in such a way that some or all their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the last edition of the referenced document (including any amendments) applies.

EN 13306, *Maintenance — Maintenance terminology*

3 Terms, definitions, and abbreviations

For the purposes of this document, the terms and definitions given in EN 13306, and the following apply. ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp/>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 Terms and definitions related to items and activities

3.1.1

item

part, component, device, subsystem, functional unit, equipment or system that can be individually described and considered

Note 1 to entry: In the context of this standard, we consider as items things that are commonly called installations, process line, machinery, items, production line, plant, working equipment, etc.

[SOURCE: EN 13306:2017, 3.1, modified – modification of note to entry 1 and removal of notes to entry 2 and 3]

3.1.2

release

authorization for a temporary transfer of responsibility from the operating officer to the operation manager within the scope indicated in the release document

Note 1 to entry: The release, for works, testing, etc. is an authorization given to a works officer, test officer, etc. in order to work on disabled items or items in use.

3.2 Terms and definitions related to energies & fluids lockout

3.2.1

energies & fluids supplied to items

energies & fluids supplied to the items by external sources

Note 1 to entry: Energies and fluids can be necessary for items' operation.

3.2.2

contained energies & fluids

internal, stored, residual or converted energies & fluids

3.2.3

lockout/tagout

LOTO

lockout/tagout is a process which contains different steps of securing energies & fluids

<lockout> placement of a lockout device on an energies & fluids isolating device, in accordance with an established procedure, ensuring that the energies & fluids isolating device and the equipment being controlled cannot be operated until the lockout device is removed

<tagout> placement of a tagout device on an energies & fluids isolating device, in accordance with an established procedure, to indicate that the energies & fluids isolating device and the equipment being controlled should not be operated until the tagout device is removed

[SOURCE: OSHA CPL 02-00-147]

3.2.4

lockout/tagout/try-out

LOTOTO

LOTO improvement highlighting the phase of verification of absence of energies & fluids (Try-Out step) before any intervention

3.2.5**process**

set of interrelated or interacting activities that use inputs to deliver an intended result

Note 1 to entry: In the context of this standard, items perform processes that use energies & fluids.

[SOURCE: EN ISO 9000:2015, 3.4.1]

3.2.6**energies & fluids lockout**

all activities and measures related to energies & fluids, hazardous products or the removal of vital elements that ensure the safety of maintenance workers during their activities on, or near to, items or within their working environment

Note 1 to entry: Securing should combine various processes that are specific to each energy & fluid listed in this document, through:

- Reinforced isolation by lockout/tagout of energies & fluids (RI);
- Standard isolation by lockout of energies & fluids (SI);
- Neutralization of energies & fluids by the control systems (N);
- Specific provisions for activities involving energies & fluids (SP).

In addition to the processes listed above, collective, and individual protections or organizational measures (procedures, requirements, working methods, permits-to-work, etc.) enable the maintenance worker to carry out activities whilst controlling the risks.

Note 2 to entry: See the list of energies in Annex C “Non-exhaustive list of energies & fluids sources and phenomena”.

3.2.7**reinforced isolation by lockout/tagout of energies & fluids**

RI

process that results in the removal – by separation or by a combination of isolating and opening devices (e.g. valve, tap, etc.) – of all energies & fluids where the presence, accidental retention, unintended appearance does not have hazardous consequences for workers, the environment, and items

Note 1 to entry: Depending on the energies & fluids present, bleed, discharge, release, clean-up, or mechanical blocking activities could be necessary.

Note 2 to entry: The RI process involves all the activities and provisions that enable an item to be secured and kept secure, so that the workers can conduct their maintenance activities.

3.2.8**standard isolation by lockout of energies & fluids**

SI

process that results in the removal – by locking in position a single or double isolating device – of all energies & fluids where the presence, accidental retention, unexpected appearance does not have hazardous consequences for workers, the environment, and items

Note 1 to entry: Depending on the energies & fluids present, bleed, discharge or release activities should be necessary.

Note 2 to entry: The SI process involves all the activities and provisions that enable an item to be secured, so that the workers can conduct their maintenance activities.

Note 3 to entry: It is important to monitor the efficiency of isolation throughout the intervention (no leaks or leaks controlled).

3.2.9

neutralization of energies & fluids by the control systems

N

process that, through design of the control systems, shuts down an item of equipment so that a list of pre-determined tasks can be conducted in safety

Note 1 to entry: The control systems fulfilling safety functions meet reliability requirements, considering the risk of failures. The design rules are defined in the design standards (EN 60204-1, EN ISO 13849-1 and EN IEC 62061).

Note 2 to entry: Based on risk assessments, various performance levels are determined with control system architectures adapted to the level of risk.

Note 3 to entry: Securing through control systems addresses risks related to the energies & fluids supplied to the item. Additional measures should be implemented to interrupt or reduce contained energies & fluids.

3.2.10

specific provisions for activities involving energies & fluids

SP

process that results in the implementation of organizational or technical measures enabling observation, diagnostics, testing activities and work on settings for the item in service to be carried out safely, with energies & fluids present

3.2.11

separate

action of creating an interruption through a combination of systems, specific systems, or the temporary removal of an element of the system to permanently guarantee a lack of energies & fluids between the item and each of the energies & fluids present

Note 1 to entry: Terminology related to the process of reinforced isolation by lockout/tagout of energies & fluids.

Note 2 to entry: Shared terminology, applicable to all energies & fluids.

3.2.12

isolate

action of creating an interruption through an action and/or a system to manage a lack of energies & fluids between the item and each of the energies & fluids present for a given period

Note 1 to entry: Terminology related to the process of standard isolation by lockout of energies & fluids.

3.2.13

lockout

placement of a lockout device on an energies & fluids isolating device, in accordance with an established procedure, ensuring that the energies & fluids isolating device and the equipment being controlled cannot be operated until the lockout device is removed

3.2.14

lockout device

strong mechanical element used to maintain the energies & fluids lockout components in a given position

Note 1 to entry: The removal of the lockout device should only be performed as part of a removal procedure by an authorized person.

Note 2 to entry: To remove the device, dedicated equipment defined in the procedure shall be used (example: a key or another equivalent system).

3.2.15

tagout

placement of a tagout device on an energies & fluids isolating device, in accordance with an established procedure, to indicate that the energies & fluids isolating device and the equipment being controlled should not be operated until the tagout device is removed

3.2.16

try-out

actions related to the verification of the absence of energy or fluids

3.3 Terms and definitions related to risks and hazardous phenomena

3.3.1

hazard and hazardous phenomena

potential source of harm

[SOURCE: EN ISO 12100:2010, 3.6, modified – removal of notes to entry]

Note 1 to entry: Although the occupational risk is the main stake, risks to consider might be also damages to population, assets, and environment.

3.3.2

risk

combination of the probability of occurrence of harm and the severity of that harm

[SOURCE: EN ISO 12100:2010, 3.12]

3.3.3

risk analysis

process implemented to understand the type of a risk and to determine the level of risk

Note 1 to entry: The risk analysis provides the foundation for assessing the risk and the decisions related to dealing with the risk.

Note 2 to entry: The risk analysis includes an estimation of the risk.

[SOURCE: ISO 31000:2009, 2.21]

3.3.4

risk assessment

process comparing the results of the risk analysis with risk criteria, in order to determine if the risk and/or its scale are acceptable or tolerable

Note 1 to entry: The risk assessment helps with decision-making on how to deal with the risk.

Note 2 to entry: Risk control, used in this standard, is defined below.

[SOURCE: ISO 31000:2009, 2.24]

3.3.5

risk control

risk control processes are operational steps that control the risks « on the field »

Note 1 to entry: The standard is not explaining more general risk management issues – it would duplicate risk management systems standards.

3.4 Terms and definitions related to organization

3.4.1

lockout procedure

organizational procedure setting out the rules for fitting and removing component lockout devices as part of energies & fluids lockout

3.4.2

energies & fluids lockout device identification sheet

document identifying the energies & fluids and the energies & fluids lockout devices for the items in question

Note 1 to entry: It lists all the energies & fluids of the item in question (supplied, contained and residual energies & fluids).

Note 2 to entry: It lists the energies & fluids separation, isolation and dissipation devices marked beforehand using tags (see Annex F).

Note 3 to entry: It lists the energies & fluids separation, isolation, and dissipation activities with the reference of the relevant handling sheet.

3.4.3

operating procedure for energies & fluids control

document determining the type and order of the various states and handling activities involved neutralising energies & fluids during an operation on an item

Note 1 to entry: The operating procedure considers all the energies & fluids and defines, as per requirements, the initial state and expected final state of the position of the valves.

Note 2 to entry: Depending on the complexity of the items, it should refer to the application of several handling operation sheets.

3.4.4

handling operation sheet

document, specific to a type of energies & fluids that indicates the type, the state and order of the actions to be carried out for the process of reinforced isolation by lockout/tagout of energies & fluids or standard isolation by lockout of energies & fluids

Note 1 to entry: Several handling operation sheets should be grouped together within a single document.

3.4.5

work-permit

document issued by the employer providing formal authorization to carry out an operation, after a risk analysis and definition of the prevention and protection measures

Note 1 to entry: Work-permit is also commonly known as work authorization.

3.4.6**energies & fluids lockout certificate**

document delivered before work begins formalising the securing of all the energies & fluids for an item

3.4.7**energies & fluids lockout proficiency certificate**

document through which the employer formally recognised an employee's ability to secure the energies & fluids of an item

3.4.8**degraded situations**

abnormal use of equipment, caused by a technical, human, or organizational failure or deviation (e.g. incorrect use of standard operating procedure)

3.5 Terms and definitions related to people**3.5.1****employer**

person or legal entity who employs members of staff and has authority over them

3.5.2**plant manager**

person who is responsible for an operating site, and is accountable of the whole site safety (responsible authority)

Note 1 to entry: This responsibility can be subdivided and delegated.

3.5.3**ordering party**

person or legal entity that has the authority to contract a service provider to perform activities in relation to an order

3.5.4**operations manager**

person in charge of managing operating activities (operation, surveillance, maintenance, etc.) for an item

3.5.5**lockout/tagout officer**

person capable of analysing the risks and defining the actions to be taken on the energies & fluids, in order to carry out or have carried out the process of reinforced isolation by lockout/tagout of energies & fluids or the process of standard isolation by lockout of energies & fluids

3.5.6**lockout officer**

person capable of analysing the risks and defining the actions to be taken on the energies & fluids, in order to carry out or have carried out the process of standard isolation by lockout of energies & fluids

3.5.7**lockout/tagout manager**

person in charge of coordinating the actions of the lockout/tagout officer and the lockout officer and ensuring that all the energies & fluids lockout devices have been put in place for an item

3.5.8

maintainer

person performing a maintenance activity

3.5.9

works officer

person in charge of managing works

3.5.10

activity officer

person in charge of managing interventions and, where appropriate, carrying them out

3.5.11

operator

person in charge of carrying out an operation

3.5.12

test officer

person in charge of managing tests; he/she takes the measures needed to ensure his/her own safety and that of any third parties involved during tests

3.5.13

safety supervisor

person with the knowledge required to monitor one or more people during completion of an operation in accordance with given instructions, as a compensatory measure

3.6 Abbreviations

ALARP	As Low As Reasonably Practicable
ATEX	Atmosphere Explosive
CMMS	Computerized Maintenance Management System
HSE	Health, Safety and Environment
SOP	Standard Operation Procedure
UPS	Uninterruptible Power Supply

4 Links between securing energies & fluids and maintenance processes

4.1 Boundaries and interfaces

This standard only applies to professional activities.

This standard interfaces with the notions of HSE (Health, Safety and Environment) risk control, mentioned in EN 13460:2009, Annex B (work permit within work order).

This standard focuses on “Maintenance” activities, which will be defined and distinguished from design and production management activities using EN 17007 and EN 13306.

Risks not directly related to energies & fluids during maintenance activities will not be considered, for example: fall from height, level fall, handling cuts. Principle safety management issues are covered by safety standards, this document covers the very specific risk analysis within maintenance activities, related to hazardous energies & fluids.

This standard does not supersede existing standards that cover specific risks, in particular but not exclusively:

- Operations on electrical structures and installations in the surrounding area (best covered by EN 50110-1),
- Working in confined spaces,
- Radioactivity, ionising radiations,
- The design of equipment as defined in the “Machinery directive” 2006/42/EC and the “Pressure Equipment Directive” 2014/68/EU.

This document has not been written to deal with items (reminder: item can be a set of items; item can be a single equipment up to a whole item – see definition chapter) that are subject to very specific requirements and are submitted to specific regulations or standards because of the major risks they may present (e.g. nuclear item or viruses in a laboratory).

In the event of decommissioning of items, utilities, networks, or processes working equipment, etc., this final stage of the service life of the item could require specific additional procedures not included in this document.

4.2 Place of securing energies & fluids within maintenance processes

This standard focuses on the specific risks related to energies & fluids during maintenance tasks. This standard relates to the maintenance processes described in EN 17007. It concerns more particularly the following processes:

- “Ensure personal health and safety to individuals and preserve environment in maintenance” (referenced as HSE process in EN 17007),
- The processes for carrying out the maintenance tasks; and more especially the process “Act preventively and/or correctively on the items to maintain” (referenced as ACT process in EN 17007):
 - Rank the events,
 - Prepare for the tasks,
 - Set in order the tasks,
 - Schedule the tasks,
 - Begin the scheduled tasks,
 - Perform the maintenance tasks,
 - Finish the tasks.

As shown in Figure 1, the core of this standard is the risk analysis step and the choice of the appropriate risk control process (Reinforced isolation, standard isolation, neutralization etc. described later in this document) for each energy & fluid.

Maintenance processes shall include activities dedicated to HSE risks control. It is then a support for HSE risk control within maintenance processes.

It also relates with the maintenance workflow and work order information and purpose described in EN 13460:2009, Annexes B and C.

4.3 Interactions with other safety mitigation in maintenance

An efficient and controlled maintenance activity (in terms of quality and HSE risks) shall be properly planned. This planning shall identify and manage all the risks control related to the activity and define the appropriate prevention and protection tasks.

The risk analysis phase related to maintenance activities, in the broadest sense, should integrate energies & fluids issues. This is relevant because there are harmful interactions that aggravate accidents, between risks related to energies & fluids and common risks, e.g.:

- The fall from a height caused by a reflex reaction to the sudden release of energies & fluids (e.g. compressed air),
- Fracture, cut or damages due to the attempt to protect oneself from a falling mass (release of mechanical energies & fluids),
- Falling to the ground on a floor made slippery by unanticipated leaks,
- Poisoning by penetration of substances carried by a steam jet, that aggravates burn damages, etc.

Energies & fluids could increase the severity of an existing risk (e.g. falling in rotating gears), or increase its occurrence (fall from height caused by a release of pressure). Manage the specific aspects related to energies & fluids during maintenance activities risks should therefore be integrated into the organization's risk management process.

4.4 Equipment design and modification

Design for maintainability and especially the ability to easily disconnect, isolate, purge, separate and protect against energies & fluids is important for safety. This is most efficient to act on maintainability during the earliest design/modification phases of the items.

To do this, the control of risks related to energies & fluids should be an input and a factor to be considered in the process of design, modification, improvement, construction and acceptance of equipment and installations. In particular:

- Technical equipment (e.g. block and bleed to release safely – double valve system with purge),
- Padlocking capability of the safety devices,
- A complete list of energies & fluids within the item (supplied and contained),
- Identification of the right safety devices, by energies & fluids (as-built drawings, diagrams, sketches, Piping and Instrumentation Diagram, etc.),
- Standard and emergency operating procedures,
- etc.

When an item is modified, risk analysis should be performed to define new standard operating procedures for the safety of operators and maintenance activities.

4.5 Relation to severe hazard and emergency response management

A risk management system shall define actions for prevention (reducing exposure to threats and occurrence of hazardous events), mitigation (reducing impact and severity) and protection (elimination of risk). Periodic controls (e.g. emergency services exercises) shall ensure that the crisis/emergency management will work if required.

Additionally, relevant maintenance activities with the possibility of uncontrolled release of energies & fluids shall be considered by the emergency response management (e.g. reach the maintenance person where they work, such as on a roof or inside equipment).

As shown in Figure 1, this standard will not explore this topic; although the energy and fluid risk analysis provides for a safety process and compensatory measures in the event of a sudden release of energy or fluid (emergency), safety management systems and emergency response/crisis management systems standard are helpful for their design and implementation.

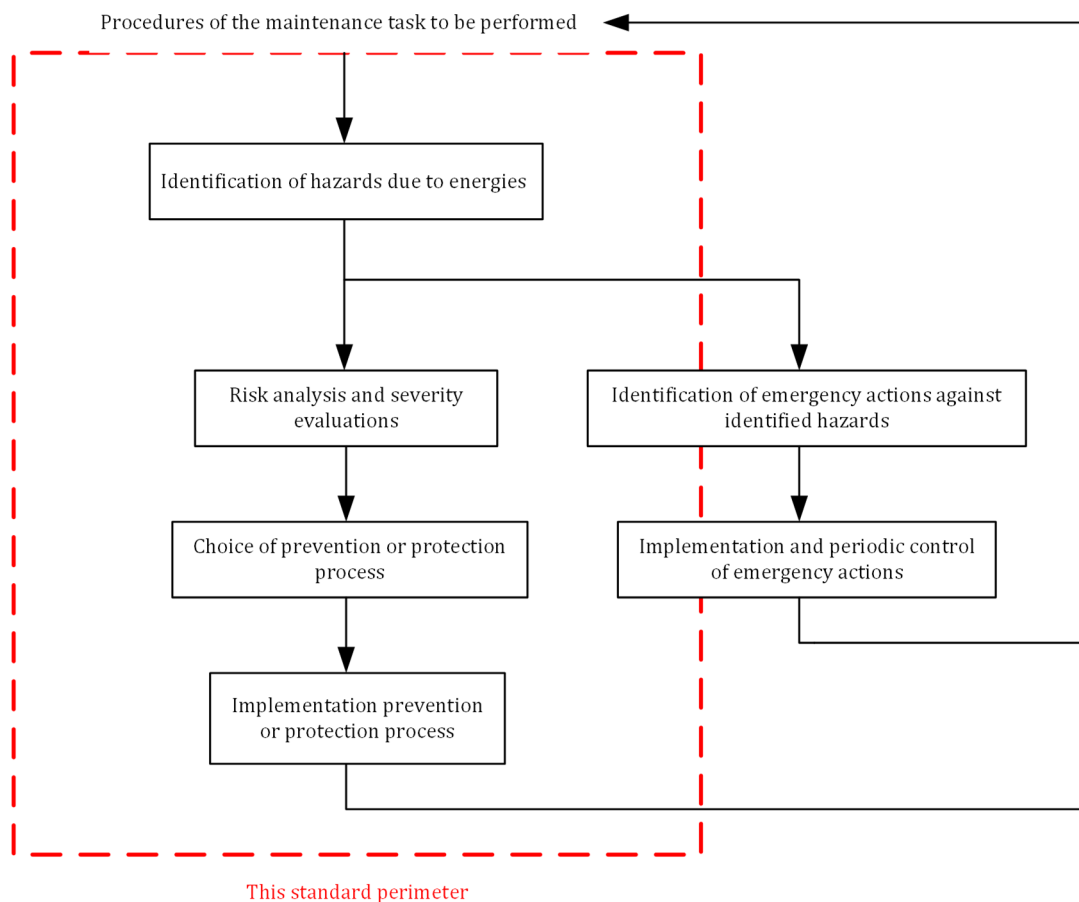


Figure 1 — Place of this standard within management risk control systems

4.6 Boundaries between maintenance and operating activities

Potential organizational overlaps and unclear divisions of responsibilities between maintenance and operation processes could be a source of accidents (e.g. first level maintenance).

The scope of activities performed by the operator and the maintainer and thus the leading process of these activities (operations or maintenance process) should be formally clarified.

Most of the time, maintenance activities carried out by the operators are performed according to production processes (recurring operator's tasks, protected by machine design standards).

Situations where production operator could apply an unsafe standard operation procedure or diverge from a safe one can occur because of:

- modifications made to the equipment, including “temporary repair” that is not fixed and in fact changed the equipment functions,

- the item integration into another system in the plant (interactions between the equipment and the system raise new risks to consider, that are not known before the integration),
- unclear documentation / lack of configuration control,
- incompatibility of certain safety procedures with production requirements,
- additional tasks assigned to operators that are not planned for commissioning, etc.

Any actions taken by the operator that exposes to an energies & fluids risk (e.g. adjustment of set limits) should be clearly risk assessed, documented, and communicated to the stakeholder. Similarly, any activities performed by the maintainer (e.g. reset of a part of the system) should be documented, risk assessed and communicated to the operator.

Table 1 explains the nature of the “grey zone” tasks that should be clarified in the organization.

Table 1 — “Grey zone” of recurring maintenance tasks performed by operators

Tasks and activities	Maintenance	“Grey zone”	Operations
Who perform the tasks	Maintainers	Both maintainers and operators	Operators
Leading process	Maintenance process	Operating process	Operating process
Tasks recurrence	Various tasks, occasional	Recurring maintenance tasks	Recurring operation tasks
Risks control	Equipment, tasks, context, etc. are various; uncertainty when corrective maintenance occurs; hurry is the rule. Systematic risk assessment Locks required	These risks control should be clearly defined.	Driven by the Council Directive 89/391/EEC of 12 June 1989 Recurring risks are identified, analysed; preventive safety actions are setup. Usually, a standard operating procedure is defined. Padlocking is used to prevent entrapment (CE)
Who shall supervise risks control	Lockout/tagout officer	Lockout officer	Production manager

Examples of “grey zone” tasks

- greasing operation,
- bolt / sensor adjustment,
- cleaning / unblocking,
- tool change,
- restart after energies & fluids shutdown.

Maintenance tasks should be risks analysed and if required should be performed with a work-permit. But for most of the recurring tasks (grey zone), a proper risk analysis can be done by anticipation and define a relevant and safe standard operating procedure (SOP). This SOP allows a process that is more efficient (time to operate) and safer, thanks to an analysis carried out with all the skills and time required (see SOP subclause 5.6.2).

5 Risk analysis

5.1 General issue: Systematic risk analysis mindset

Lack of preparation is one of the factors that increase risks, like lack of skills, bad documentation, etc.

Giving to the context, maintainers usually face three broad maintenance situations:

- Well prepared, planned maintenance tasks (typically preventive maintenance);
- Maintenance with little preparation (typically corrective maintenance);
- “Unprepared” maintenance – e.g. unexpected and urgent maintenance (typically temporary repair for emergency corrective maintenance solution).

However, for all these situations, risk assessment should be done. A change of mindset and behaviour should introduce a systematic risk analysis step – to a level commensurate to the risk – before any maintenance task:

- In a formal and structured way for planned maintenance,
- With systematic risk analysis for unplanned maintenance.

It is up to each organization to define clearly how these situations will be managed (process, documents, responsibilities, safe job analysis, toolbox talk, etc.).

5.2 Risk analysis methodology when applied to maintenance tasks

Risk analysis should be performed before, during and after all maintenance activities (see below maintenance tasks milestones). These analyses can be recorded or not in specific signed documents.

The risk analysis process of a maintenance task includes the following steps:

- Step 1 Identification of maintenance task to be performed
- Step 2 Identification of hazards linked to maintenance tasks
- Step 3 Risks analysis and severity evaluations
- Step 4 Choice of risk prevention and/or protection processes
- Step 5 Implementation of risk control process
- Step 6 Feedback loop reporting of risk control (continuous improvement)

These risk analysis steps should be applied at each milestone during the whole time-scheme of the maintenance activity:

- Initial assessment of the event,
- Diagnostic,
- Preparation of the workplace,
- Dismantling / disassembly,
- Replacement, adjustment, repair, etc.,
- Partial tests on components,
- Reassemble,
- Functions check-out,
- Return to service,
- Detection of any change during follow-up: items, task nature and duration.

Communication process should ensure that key information about each step circulates properly.

- Reporting of the risk control activity,
- Reporting of any event or change,
- Feedback loop for continuous improvement.

NOTE 1 More information about safety and risk analysis can be found in standards like ISO 31000 and EN ISO 45001.

NOTE 2 More information about HSE risks control within maintenance process can be found in EN 17007.

5.3 Specificities of risk analyses related to energies & fluids within maintenance tasks

5.3.1 Maintenance risk control methodology for energies & fluids within maintenance tasks

This standard follows the risk analysis approaches established by the occupational safety and risk control standards.

All types of energies and fluids risks must be considered. A non-exhaustive list of sources and phenomena to be considered within the framework of the prevention of energy and fluids-related risks during maintenance activities is established later in subclause 5.4.

Lockout devices, item documentation, skills, tags, material safety data sheets, etc. should be considered within the steps of the risks analysis process.

The specificities to be considered for risks related to hazardous energies & fluids are shown in Table 2.

Table 2 — Risk control of energies & fluids steps details

Step	Details
1. Identification of maintenance task to be performed	• Items and their technical neighbourhood (other items, energies & fluids networks, etc.); functions linked to the item • Maintenance task nature, method, duration, tools, personnel, etc.
2. Identification of hazards linked to maintenance tasks	• Sources: supplied to or contained (items, neighbourhood, and tasks) • Identification of energies & fluids to consider for this maintenance • Risk factors: Technical, Organizational and Human
3. Risks analysis and severity evaluations	• Severity: consequences on people • Probability of occurrence of the hazard and exposure of people (duration, reliability of barriers, etc.)
4. Choice of risk prevention and/or protection processes	• Ensures that both the prevention (removal and/or neutralization of the energies & fluids) and the protection (compensatory measures) are securely in place. Follow-up (maintenance and safety management)
5. Implementation of risk control process	• Risk analysis checks that the conditions for removing and/or neutralising the energies & fluids are consistent with those planned. • Prevention & protection process are applied • Follow-up
6. Feedback loop reporting of risk control (continuous improvement)	• Ensures that the removal and/or neutralization of the energies & fluids (prevention) and compensatory measures (protection) are maintained. • Considers any changes in at-risk situations, their levels of acceptability and means of control. • Checks that there are no risks during the return-to-service of the item (leaks, vibration, etc.), its process and its neighbourhood. • Safety and maintenance continuous improvement

5.3.2 Main elements to be considered when analysing maintenance activity

The risk analysis method is based on EN ISO 12100 “Safety of machinery — General principles for design — Risk assessment and risk reduction”, from December 2010 and ISO 31000 “Risk management — Guidelines”. These standards are useful for risk analysis in the broad sense and not only energies & fluids one.

For each maintenance task, it is essential to perform a risk analysis, considering all the energies & fluids (hazards) *in situ* related to:

- The scope of the maintenance task: list of the items concerned by the task and their functions;
- The maintenance tasks to perform and the tools used;
- The working environment (technical neighbourhood, confined space, etc.) and especially co-activity (other maintenance or operating activities, etc.).

The input data required to conduct the risk analysis are essential, the maintenance organization should ensure that all the relevant and up-to date information is available when an analysis is performed.

See Annex B for more details about input data for risk analysis:

- The technical documentation for the item (inexhaustive list) and the item’s neighbourhood;
- The working environment (inexhaustive list);
- Maintenance task (maintenance work orders).

Risk assessment should consider:

- Risk control choice criteria,
- Risk control follow-up,
- Recommended documents.

5.3.3 Impact of safety device technology

5.3.3.1 General

Prevention and protection mean often use safety devices to stop, separate, purge, isolate, etc. energies & fluids. All technologies and technical design are not equally reliable and effective. The analysis shall assess if the device efficiency and reliability is acceptable, up to the risk severity.

Technical studies considering the context specificities, can be carried out to establish the recommended solutions (devices technologies and technical procedures) in a maintenance technical means policy.

In addition to these technical and design choices, an appropriate maintenance plan shall be implemented to guarantee reliability of the safety devices.

5.3.3.2 Effects of valve technologies

When handling isolating equipment, valves, fittings, and pipes may break due to the fragility of the equipment. Internal and external leaks may also occur.

Equally, the technology of the equipment, such as the valves and fittings, meets internal sealing classes and categories and cannot guarantee the absence of leaks.

It is therefore essential to consider these types of failures during the risk analysis for a safer risk control process.

The safety of the workers during activities depends on the sealing of the valves and fittings. It is therefore necessary, depending on the risk analysis (e.g.: burns, anoxia) to conduct a sealing test of the in-line valves, to prove their isolating capability. The validity period of the test shall be limited over time, defined by the risk analysis. Beyond this limit, periodical tests shall be conducted.

5.3.4 Effects of items configurations

Depending on the configuration, an operating procedure is necessary to ensure that the energies & fluids are effectively neutralized and drained from the section to isolate (example: discharge of the bleed, air intake in energies & fluids pipes, etc.).

These precautions are essential and shall be included in the operating modes.

The purging of a loaded or pressurized pipe shall not be performed by a gradual loosening of flange nuts. If it is technically impossible to take these precautions, a risk analysis considering the environment, the facilities, the equipment, and the working method shall be formally drafted and lead to effective risk control.

5.4 Sources of the main hazards to be considered (energies & fluids, products that are sources of dangerous phenomena)

Non-exhaustive list of energies & fluids sources and phenomena to be consider during maintenance activities.

Energies & fluids

- Acoustic radiation,
- Electricity (alternating and direct currents),
- Combustible or Explosive substance (e.g. gaseous hydrogen),
- Ionizing radiation,
- Light radiation,
- Electro-Magnetic,
- Mechanical – kinetic and potential (e.g. power transfer hydraulic – ventilation – wind (meteorological)),
- Non-ionizing radiation,
- Pressure (e.g. pneumatic),
- Thermal (e.g. heat distribution and transfer hydraulic).

Energies & fluids and products

- Biological (e.g. legionella),
- Chemical (e.g. carbon monoxide, sulfuric acid),
- Physical (e.g. asbestos).

NOTE Risk analysis can include hazard detection operations (e.g. heavy gas accumulation detection at bottom of the pit).

Annex C gives a more extensive list of energies and fluids hazards.

5.5 Design and methodology for selecting an energies & fluids lockout process

5.5.1 Introduction – energies & fluids risk control process

In situ risk analysis lead to choose for each energy & fluid between four processes risk control:

- Reinforced Isolation by lockout/tagout of energies & fluids (RI),
- Standard Isolation by lockout/tagout of energies & fluids (SI),
- Neutralization of energies & fluids by the control systems (N),
- Specific Provisions for activities involving energies & fluids (SP).

Before implementing these processes, the following is required:

- An inventory of the energies & fluids by item, considering the supplied and contained energies & fluids and their effects on people, property, and the environment,
- Identification and mapping/tagging of the separating, isolating and dissipation devices,
- Identification sheet of the energies & fluids, the components and lockout devices.

Solutions that do not require disassembly will be preferred for energies & fluids lockout.

5.5.2 Flowchart of risk analysis

The choice of the right energies & fluids control process can be described through the flowchart (see Figure 2):

- The risk assessment step will help the proper choice.
- The default choice should be reinforced isolation unless difficulties prevent it.
- There should be no maintenance task performed at component level and compensatory measures are mandatory with Neutralization or energies & fluids presence control processes.

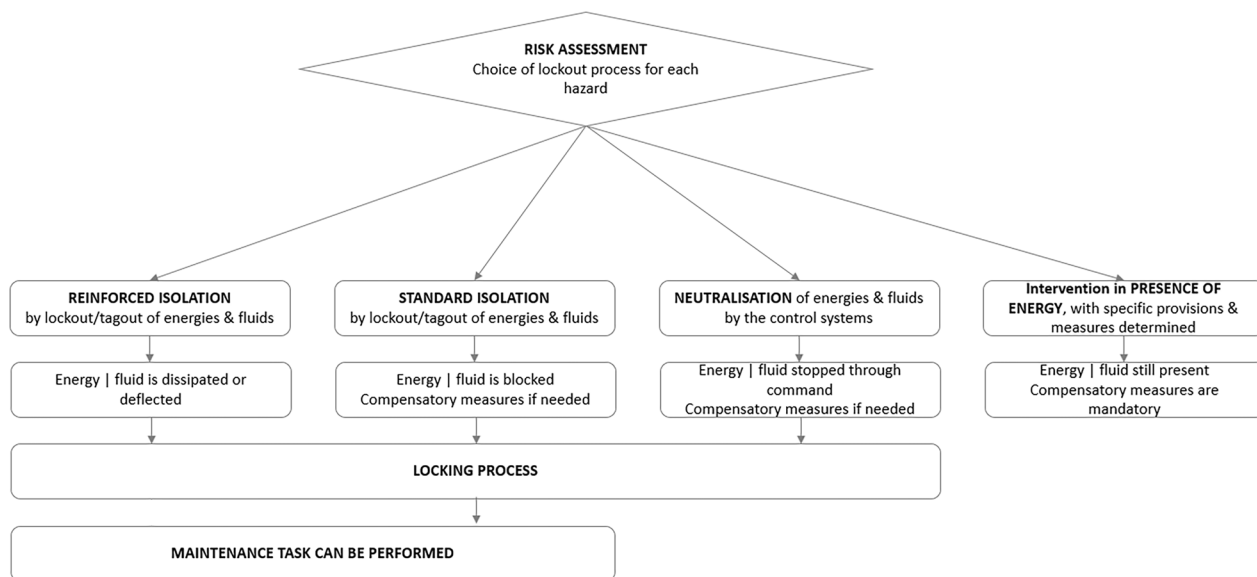


Figure 2 — Flowchart of risk analysis

5.5.3 Process application table

Before conducting maintenance activities, three stages shall be passed:

- Request for provision, specifying the expected state of the item;
- Item provisioning, by the operation manager; that shall be approved;
- Securing by the lockout/tagout officer: preparation and securing process.

The choice of the securing processes should be justified by risk analysis for each energy & fluid to consider, conducted using the decision-making flowchart in Figure E.1.

The following Table 3 details the steps of each securing process.

Table 3 — Process application

Preparation of energies & fluids lockout				
Energies & fluids to consider Risk analysis and risks assessments Risk control process definition See chapter 6 for more details of this preparation step				
Securing of workers process by:				
PROCESS	REINFORCED ISOLATION by lockout/tagout of energies & fluids (RI)	STANDARD ISOLATION by lockout of energies & fluids (SI)	NEUTRALIZATION of energies & fluids by the control systems (N)	SPECIFIC PROVISIONS for activities involving energies & fluids (SP)
Document sections	6.1.2	6.1.3	6.1.4	6.1.5
↓ ↓ ↓ ↓				
Operation	Maintenance with tasks on components	Maintenance with tasks on components	Maintenance without tasks on components	Maintenance: diagnostics, observation
Pre-existing level of risk ^a	High risks	Medium risks	Medium risks	Low risks
State of the item	Item shut down energies & fluids-free	Item shut down energies & fluids-free	Item shut down	The item should be operating for diagnostics or observation, or when the design of the item requires the implementation of unusual provisions
energies & fluids	Presence and unexpected reconnection of the energies & fluids supplied to the item or contained within it made impossible by separation or reinforced isolation of the energies & fluids source	Presence of the energies & fluids supplied to the item or contained within it made highly unlikely by single or double isolation of the energies & fluids source	Presence of the energies & fluids supplied to the item neutralised by deactivation of the control systems Potential presence of energies & fluids contained within the item	Potential presence of energies & fluids supplied to the item or contained within it
Level of risk after application of process	Removal of risk related to energies & fluids in question	Low risk or rendered low by use of compensatory measures	Risk rendered low by technical measures neutralising the control systems. (Risk related to controls overridden manually are not covered)	Risk rendered low by specific provisions detailed in written instructions (work-permit)
^a See subclause 5.5.4 Risk prioritization and mitigation				

5.5.4 Risk prioritization and mitigation

5.5.4.1 Risk mitigation selection

Either the risk mitigation target is “zero risk”, or the process tries to define an ALARP risk level. This “acceptable” residual risk level is defined up to the organization safety policy.

An assessment grid and process shall be set up in the organization, it defines the several levels of acceptable risk (e.g. high, medium, and low). That level shall be common and accepted by all the actors (maintenance, operations, safety, managers, etc.).

It is a key point, in an organization, to ensure that all the actors (maintenance, operator, external company, work officer, etc.) involved in the energies & fluids control process share the same vision of this “acceptable” risk level. Discrepancy between actors is a cause of accident, because an actor can think that the risk is “obviously” controlled by another actor, but this other actor thinks that this same risk is “obviously” acceptable and to be care...

The safety behaviour and safety management are then a key issue for energies & fluids risk control.

The implementation of a safety standard such as EN ISO 45001 will strongly reinforce the effectiveness of this energies & fluids standard.

By the way, the acceptance level should be improved by a safety continuous improvement system.

5.5.4.2 Involving relevant stakeholders

In many organizations, there are bodies in charge of health, safety or working conditions. This should be a medical service in the company and/or a specific information / consultation committee between employer and staff representatives and/or any other form of social dialogue. It is important to involve them in the design of the safety policy, to make sure they are aware of the risks and of the preventive measures and to report significant incidents to them for analysis.

5.5.5 Application to degraded (abnormal) situations

A degraded situation is caused by a failure or a deviation. This deviation could be technical (e.g. after a temporary repair), human (e.g. replacing one operator with a less skilled one) or organizational (e.g. using the equipment for an unusual process).

The fact that the situation is degraded should be clearly known before any maintenance activity. Indeed, the prevention measures usually implemented and controlled (technical, organizational, and human prevention measures) should not necessarily have the same scope and effectiveness. If the degraded situation is not known, the risk analysis for the maintenance activities could be based upon wrong information.

It is recommended to set up devices that will inform maintenance people (but also production one) that a degraded operation is occurring, like a sticker on the machine, information in the Computerized Maintenance Management System, information in the operating manuals, visual management poster, etc.

The risk analysis before the intervention can thus be carried out with full knowledge of the facts.

This point is even more important as a degraded situation should last a long time or even be forgotten (lack of time, resources, follow-up, etc.) and possibly become the “new normal” situation (but not documented).

NOTE In the Total Productive Maintenance approach, one of the first steps is an assessment of the machine that identify any abnormality.

5.6 Updating energies & fluids specific risk analysis

5.6.1 Updating the risk analysis during a maintenance activity

Any change of the key information related to the risk analysis should be considered and trigger an update:

- Change in the duration or the schedule: this can lead to new risks of co-activity, the need for coordination between shifts.
- Change of the maintenance activity's nature defined in the preparation phases (that could be the pre-diagnosis for troubleshooting): this can lead to change which parts of the machine will be dismantled, which spare parts will be changed, which tools will be used, and which technique will be implemented (e.g. welding/grinding).

The follow-up and reporting tasks should ensure that all these changes are managed.

5.6.2 Updating the risk analysis before applying Standard Operating Procedures (SOP)

The operating procedures that will allow a safe maintenance on an equipment can be prepared in advance, particularly in the context of preventive maintenance or recurrent corrective maintenance. In this context, activities are described step by step in a SOP that should allow a safe of energies & fluids hazards work.

These standard operating procedures are defined in a pre-identified context that should be checked (environment of the operation, co-activity, how the equipment is used, etc.) before the maintenance activity occurs.

For example:

- Major scheduled preventive maintenance is most often associated with a planned shutdown of the equipment by production. The situation that the equipment is not currently used by the production team protects against co-activity: the maintenance activity is planned at a time when there is no other use of the equipment. This situation is an input of the risk analysis that proceed the standard operation procedure creation.
- A standard operating procedure of adjustment and format change considers that the equipment is in a perfect working order that is there are no recent breakdowns or degraded situation.
- A pump or a valve change standard operating procedure should consider that the circuits have been flushed upstream and that there is no energies & fluids or residual product that could directly or indirectly (chemical reaction by combining residual products and products brought in by the maintenance activity) dangerous.

Any assumptions relating to the standard operating procedure should be clearly identified in its preliminary stage. That should avoid any ambiguity as to whether -or not- the SOP can be applied.

Therefore, a risk analysis should be triggered if it is detected or doubted that the reality of the current situation does not correspond to the one described in the preliminary stage of the standard operating procedure.

6 Energies & fluids safety processes

6.1 Energies & fluids lockout process

6.1.1 General

The four energies & fluids lockout processes are:

- Reinforced isolation by lockout/tagout (RI)
- Standard isolation by lockout (SI)
- Neutralization and management of energies & fluids by the control systems (N)
- Specific provisions for activities involving energies & fluids (SP)

Table 4 shows three lockout processes.