International Standard

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Remediation techniques applied at contaminated sites

Techniques de dépollution appliquées aux sites pollués

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 190, *Soil quality*, Subcommittee SC 7, *Impact assessment*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 444, *Environmental characterization of solid matrices*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

In the context of contaminated land, if unacceptable risks associated with a site are identified following a risk assessment and should be managed, remedial actions are required to prevent, minimise, remedy or mitigate the effects of the unacceptable risks. The choice, implementation and verification of remediation techniques require detailed site characterization and risk assessment.

A remediation strategy should be set up encompassing these actions by implementing technical and organisational actions on contaminant source(s), transport and exposure pathways and/or receptors, aiming to control the unacceptable impacts and associated risks that have been established following the investigations and risk assessment. Amongst these actions are the implementation of individual, or combinations of, remediation techniques aiming to address contaminants that can be present within the soil, water, soil gas or ambient air, including non-aqueous phase liquids (NAPL).

This document provides requirements and guidance on key aspects for effective implementation of individual or combinations of in situ and on-site remediation techniques. It was developed in response to demand for minimum specifications for the selection and verification of remediation strategies to manage the risks from contaminated sites.

It is intended to inform practitioners and stakeholders about the main characteristics of commonly used remediation techniques. It can also help practitioners to select technically feasible approaches within the options appraisal phase, based on the state of the art of remediation technologies.

NOTE 1 Some of the on-site techniques presented in the document can also be used within off-site treatment facilities but the latter are not covered (e.g. this document covers incineration on-site, but not incineration at a permanent off-site installation).

NOTE 2 There is a continuous development of remediation techniques. It is possible that this document does not reflect all knowledge that is gained as techniques are improved.

NOTE 3 Not all available techniques are covered. Those not covered include: electrokinetic methods to remove contaminants or to improve the effectiveness of other methods (e.g. electrokinetic enhanced bioremediation), and phytoremediation.

Remediation techniques applied at contaminated sites

1 Scope

This document provides requirements and guidance on key aspects of remediation techniques. It describes the principles, main characteristics, advantages and limitations to be considered in the selection within an option appraisal of individual or combinations of in situ and on-site remediation techniques, including:

— the type of contaminants to be dealt with;

— current and/or intended site use;

— local legal, policy, socio-economic and environmental contexts.

This document is applicable to the remediation of contaminated sites, i.e. where soil, or soil gas, ambient air or groundwater are contaminated. It identifies which phase/matrix can be targeted by a technique, e.g. fluid (groundwater, gas, non-aqueous phase liquid) or solid, and which contaminant it can applied to. This document also provides information on hazards that can be associated with the implementation of remediation.

This document does not provide:

— an exhaustive list of remediation techniques;

— guidance on sites contaminated with radioactive substances, pathogenic or infectious agents, or "pyrotechnic devices" (e.g. unexploded ordnances);

— guidance on ex situ techniques that are set up off-site;

— a framework that covers all individual situations, or prescribes which technique(s) to use in a specific context.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
contaminant linkage
presence and relationship established between contaminants, preferential pathways and receptors

3.2
engineering-based technique
civil engineering technique (e.g. excavation, containment, hydraulic control) used to remove the contaminant source or soil material or to modify pathways without necessarily removing, destroying, or modifying the source

Note 1 to entry: Some of these techniques can be considered when implementing protective measures.

[SOURCE: ISO 11074:2015, 6.2.1, modified — in the term, “methods” has been changed to “technique”; Note 1 to entry has been added.]

3.3
environmental medium
soil, underlying material, sediments, surface water, groundwater, soil gas, and ambient air that can contain contaminants

[SOURCE: ISO 21365:2019, 3.4, modified — “ambient” has been added before “air”.]

3.4
ex situ treatment technique
treatment technique applied to medium to be treated (e.g. soil, groundwater) after extraction from the ground

[SOURCE: ISO 11074:2015, 6.2.2, modified — in the term and the definition, “method” has been replaced by “technique”.]

3.5
hazard
property of a substance or material or situation that in particular circumstances can lead to harm or pollution

[SOURCE: ISO 11074:2015 5.2.15]

3.6
in situ treatment technique
treatment technique applied to medium to be treated (e.g. soil, groundwater) without extraction from the ground

Note 1 to entry: The remediation installation is built on-site and the treatment of the contaminants is applied directly to the subsurface.

[SOURCE: ISO 11074:2015, 6.2.3, modified — in the term and the definition, “method” has been replaced by “technique”; Note 1 to entry has been added.]

3.7
off-site treatment
treatment applied away from the site to be remediated

[SOURCE: ISO 11074:2015, 6.2.4]

3.8
on-site treatment
treatment applied on the site being remediated

Note 1 to entry: In the case of contaminated ground, treatment is applied after extraction of *environmental medium* (3.3) material from the ground.

[SOURCE: ISO 11074:2015, 6.2.5, modified — Note 1 to entry has been added.]

3.9
remediation
process of dealing with contaminated soil, groundwater, or site to eliminate, reduce or control *risks* (3.12) to human health or the environment

Note 1 to entry: A remediation can rely on an individual remediation technique or a combination of remediation techniques.

[SOURCE: ISO 11074:2015, 6.1.17, modified — “reduce” has been added after “to eliminate”; Note 1 to entry has been added.]

3.10
remediation strategy
remedial design
one or more *remediation* (3.9) technologies and associated works that meets specified contamination-related *risk* (3.12) reduction objectives

Note 1 to entry: The choice of methods can be constrained by a variety of site-specific factors such as topography, geology, hydrogeology, underground services, propensity to flood and climate.

[SOURCE: ISO 18504:2017, 3.5, modified — the admitted term “remedial design” and Note 1 to entry have been added.]

3.11
sustainable remediation
elimination, reduction and/or control of unacceptable risks in a safe and timely manner whilst optimising the environmental, social and economic value of the work

[SOURCE: ISO 18504:2017, 3.10, modified — “reduction” was added after “elimination”.]

3.12
risk
combination of the probability or frequency of occurrence of a defined *hazard* (3.5) and the magnitude of the consequences of the occurrence

[SOURCE: ISO 11074:2015, 5.2.24]

3.13
unacceptable risk
level of *risk* (3.12) that requires *remediation* (3.9)

Note 1 to entry: The level of risk may be evaluated by comparison to a relevant numeric threshold or by benchmarking against a narrative definition. Different levels of risk are deemed unacceptable in different countries or even by different laws within a country.

[SOURCE: ISO 11074:2015/Amd 1:2020, 6.5.10]

4 Abbreviated terms

BTEX	benzene toluene ethylbenzene xylene-isomers
COD	chemical oxygen demand
DNAPL	dense non-aqueous phase liquid
DPLE	dual pump liquid extraction
ECH	electric conduction heating
EHS	environment health and safety
EISB	enhanced in situ bioremediation
ENA	enhanced natural attenuation
FAG	funnel and gate
GAC	granular activated carbon

HDPE	high density polyethylene
HRC®	hydrogen release compound
ISC	in situ combustion
ISCO	in situ chemical oxidation
ISCR	in situ chemical reduction
ISTD	in situ thermal desorption
ISTR	in situ thermal remediation
LCA	life cycle assessment
LNAPL	light non-aqueous phase liquid
MNA	monitored natural attenuation
MPE	multi phase extraction
MTBE	methyl ter-butylether
NOD	natural oxidant demand
NSZD	natural source zone depletion
ORC®	oxygen release compound
ORP	oxydation reduction potential
P&T	pump-and-treat
PAH	polyaromatic hydrocarbon
PBDD	polybrominated dibenzo-p-dioxin
PBDF	polybrominated dibenzo furan
PCDD	polychlorodibenzodioxines
PCDF	polychlorodibenzofuranes
PCBs	polychlorobiphenyls
PCE	perchloroethylene or tetrachloroethylene
PFAS	per-and polyfluoroalkyl substances
PRB	permeable reactive barrier
PVC	polyvinyl chloride
POPs	persistent organic pollutants
ROC	return on capital
RoC	radius of capture
ROI	return on investment