

SAFE REMOVAL OF UNDERGROUND ASBESTOS-CEMENT WATER PIPES

INAIL

Operating instructions for the protection
of workers and living environments

2020



FIBRONIT
OPPY MERRANI

T 197

COLLANA **SALUTE E SICUREZZA**

SAFE REMOVAL OF UNDERGROUND ASBESTOS-CEMENT WATER PIPES

INAIL

Operating instructions for the protection
of workers and living environments

2020

Publication by

Inail

Department of Technological Innovation and the Safety of Plants, Products and Human Settlements (Dit)

Scientific coordinator

Federica Paglietti

Authors

Federica Paglietti, Sergio Malinconico, Beatrice Conestabile della Staffa, Sergio Bellagamba, Paolo De Simone

With the participation of: Crescenzo Massaro, Daniele Taddei, Ivano Lonigro

Images

Sergio Malinconico

Collaborators

Adriano Paolo Bacchetta¹, Riccardo Melloni², Marco Morone³, Adriano Albonetti³, Federico Bracciotti³, Annalisa Lantermo³

¹ European interdisciplinary applied research center of safety (Eursafe)

² Modena and Reggio Emilia University (Unimore) - Centre of Interdepartmental Research on Safety and Risk Prevention (Cris)

³ Interregional technical coordination for prevention in the workplace, through the Regional Authorities of Lombardy, Piedmont, Tuscany and Emilia Romagna

Ministry of Health.

Ministry of Environment

Ministry of economic development

Authority for Electricity, Gas and Water system

Association of Water, Energy and Environmental Companies

Regulatory authority for energy networks and environment

Municipality of Varese and Viadana

National Institute of Health

National Institute for Environmental Protection and Research

Regional Agency for Environmental Protection - Region of Calabria, Emilia Romagna, Friuli Venezia Giulia,

Piedmont, Puglia, Tuscany

Company of Infrastructure and telecommunications for Italy

Water supply system companies

for information

Inail - Department of Technological Innovation and Safety of Plants, Product and Human Settlements
via Roberto Ferruzzi, 38/40 - 00143 Rome (RM)

dit@inail.it

www.inail.it

© 2020 Inail

ISBN 978-88-7484-653-5

The authors are fully responsible for the opinions expressed in this publication, which are not to be understood as official opinions of Inail. The publication is freely distributed and its sale or reproduction by any means are forbidden. Citations may be used as long as the source is indicated..

Preamble

The Italian National Institute for Insurance against Accidents at Work (Inail), through the Directorate for Research (DR), coordinates 3-year research plans regarding all aspects of health and safety at the workplace. Two research units are devoted to research: the Department of technological innovations and safety of plants, products and anthropic settlements (Dit) and the Department of Medicine, Epidemiology, Workplace and Environmental Hygiene (Dimeila). The research develops cutting-edge new operating procedures, methodologies, equipment, systems, and insights.

Both Departments pay considerable attention to the complex issue of asbestos. In particular, the Laboratory 9 of the Dit works at the development of methods, procedures and models for risk assessment in the presence of hazardous substances released by production materials and processes, both in work and living environments. Thus, the lab identifies measures for risk mitigation, the protection of workers and the safeguard of residential communities.

In this framework, the asbestos research team of Lab 9 prepares technical reference documents at national and international level, in collaboration with public authorities, research bodies and universities. Target of these documents are sector operators, businesses and other stakeholders involved in protecting workers and living environments.

The present paper is one of these documents. It addresses the safe removal of underground asbestos-cement water pipes. The main purpose of the document is to integrate and harmonize the operations and safety procedures adopted, indicating criteria of ease of planning, reproducibility and homogeneity of operations to facilitate the work of sector operators and of local supervisory bodies.

Inail in this way promotes a systematization process and a complex project of collaboration between public and private entities.

The end goal is to build a participatory process, in which field research leads to the effective transferability of results, providing data useful to working environments and risk prevention, as well as promoting the circular nature of technical and scientific knowledge in national and international communities.

Carlo De Petris
Director of Dit

Edoardo Gambacciani
Director for Research

Table of Contents

Preamble	
List of acronyms	6
Inail Dit - Asbestos research team	7
Introduction	9
Context of reference	13
1. Removal of underground asbestos-cement water pipes: programmable activities	20
1.1. Technical operating instructions	20
1.2. Safety procedures, protection equipment and controls	31
2. Removal of underground asbestos-cement water pipes: emergency activities:	36
2.1. Technical operating instructions	36
2.2. Safety procedures, protection equipment and controls	44
3. Conclusions	49
Frequently asked questions (Faq)	50
Acknowledgements	52
Bibliography	53
Italian and European Regulatory References	55

List of acronyms

ACM - Asbestos containing material
ACW - Asbestos containing waste
ARO - Asbestos risk officer
CPE - Collective Protection/Protective Equipment
CP - Characterisation Plan
DCU - Decontamination Unit
DIT - Department of technological innovation and safety of plants, products and anthropic settlements
EM - Employer
FFP3 - P3 level face masks
FTIR - Fourier Transform Infrared Spectroscopy
GIS - Geographic Information System
HEPA - High Efficiency Particulate Air Filter
IARC - International Agency for Research on Cancer
IBAS - International Ban on Asbestos Secretariat
INAIL - Italian National Institute for Insurance against Accidents at Work
ISO - International Organization for Standardization
ISPRA - Higher Institute for Environmental Protection and Research
LOW - European List of Waste
LPHS - Local Public Health Service
MATTM - Ministry for the Environment and the Protection of Land and Sea
OSP - Operational Safety Plan
PCM - Phase contrast microscopy
PPE - Personal Protection/Protective Equipment
RAC - Regional Asbestos Centres
RAD - Risk assessment document
RPES - Regional Public Environmental Service
RSRI - Remediation Site of Regional Interest
SEM - Scanning electron microscope
SINFI - National Federated Infrastructure Information System
SLIE - Sporadic and Low-Intensity Exposure
SPSWE - Service for Prevention and Safety in Work Environments of HPLS
SS - Superfund Site
UNI - Italian Organization for Standardization
WHO - World Health Organization
WP - Work Plan
XRD - X-ray diffractometry

Inail Dit - Asbestos research team

The activity of the team consists of both institutional and innovative scientific research. In particular, the group:

- provides technical and scientific support to public and judicial authorities by participating in national and regional expert meetings/approvals; sanctions procedures and processes on a case-by-case basis and develops site-specific remediation procedures and/or information campaigns on asbestos risk;
- identifies sites contaminated with asbestos, jointly with other competent authorities, and assesses risk priorities, in order to include them in national or regional Remediation Plans;
- helps identify and manage problems relating to the existence of asbestos minerals on national soil, in Superfund Sites and in sites identified by mapping the areas of land in Italy affected by asbestos (pursuant to Italian Law 93/2001 and related Ministerial Decree 101/2003);
- drafts technical and scientific consultancy reports on health and safety in working and living environments in relation to the Emergency Safety Implementation Projects, Characterization Plans, Preliminary, Final and Executive Remediation Projects, as well as Work Plans, developed for sites contaminated with asbestos;
- performs inspection surveys and specific environmental monitoring campaigns, in collaboration with public authorities and regional and local supervisory authorities, the Carabinieri (military police) Land Protection Division and Anti-Fraud Unit and Firemen, aimed at identifying the concentration of asbestos found in the soil, in waste, airborne, in surface water and underground water. These environmental surveys, in both work and living environments, are undertaken with the support of three Environmental Compartment Analysis Laboratories (LAMA), of which two are cutting-edge mobile facilities capable of providing analysis results in situ and in real time;
- carries out research into the analytical methods to be applied to the environmental situations (air, water and soil, and waste) containing or contaminated by asbestos;
- undertakes research for the identification, study and mapping of situations of risk caused by human activity or arisen naturally, including through the use of remote sensing with multiband sensors;
- performs the georeferenced mapping of sites contaminated by asbestos;
- drafts specific technical and scientific consulting reports on the management and safety of asbestos-containing waste, including through the identification and mapping of preliminary or final deposit plants found on national soil;
- organizes the analysis of the available means and safety measures adopted in asbestos inertization plants on a national and international scale;
- organises operational training courses for Prevention and Protection Officers,

Asbestos Risk Officers and for operators working in the remediation and management of asbestos containing waste;

- organises training and information activities for sector operators and for the various technical bodies of public authorities (training for (LPHS), local technical offices, supervisory bodies, etc.).

Guidelines, Best Practices and Operating Instructions have been developed in support of the operational management of the asbestos problem and are available on the institutional website for domestic and international use.

This document and all related procedures are based on extensive asbestos-cement pipe removal operations performed under specific and rigorous experimental conditions, numerous expert opinions issued for the Ministries of Labour, Health and the Environment. In addition, these document benefits from information gathered through participation in expert meetings, (national and local) approvals and permits procedures with regional authorities, regional and local supervisory authorities and consultation with leading Italian sector experts and trade associations.

Federica Paglietti
Scientific Coordinator

Introduction

The word Asbestos derived from the Greek term, which means “inextinguishable”. According to Italian law (Leg. Decree 81/2008 and subsequent additions and amendments), the generic term asbestos identifies certain naturally occurring fibrous silicate minerals that are exploited commercially (chrysotile, crocidolite, amosite, tremolite, anthophyllite, and actinolite).

From a mineralogical point of view, there is no group of minerals called asbestoses, but there are various mineral forms that are distinguished according to their chemical composition and morphological characteristics (fibrous structure).

Today, there are many countries around the world that have banned this carcinogenic substance (International Ban Asbestos Secretariat (IBAS), October 23, 2018): Algeria, Argentina, Australia, Austria, Bahrain, Belgium, Brazil, Brunei, Bulgaria, Canada, Chile, Croatia, Cyprus, Czech Republic, Denmark, Djibouti, Egypt, Estonia, Finland, France, Gabon, Germany, Gibraltar, Greece, Honduras, Hungary, Iceland, Iraq, Ireland, Israel, Italy, Japan, Jordan, South Korea, Kuwait, Latvia, Lithuania, Lichtenstein, Luxembourg, Macedonia, Malta, Mauritius, Monaco, Mozambique, The Netherlands, New Caledonia, New Zealand, Norway, Oman, Poland, Portugal, Qatar, Sweden, Switzerland, Taiwan, Turkey, United Kingdom, Uruguay.

Italy was among the first European countries to ban asbestos, with Law 257/1992, and was among the first to issue technical sector regulations for the protection of workers and living environments. There are still some countries where asbestos extraction continues today, mainly in Asia (transcontinental Russian Federation). The biggest users/consumers of asbestos are developing countries undergoing strong economic and industrial growth, which are sometimes also the “producers” of the substance. India and Indonesia, for example, are big consumers of asbestos, imported mostly from Russia.

From the post-war period onwards, a total of around 3,800,000 tons of raw asbestos were produced in Italy, with imports of around 1,900,000 tons.

Commercial success, in particular for the minerals chrysotile, crocidolite and amosite was determined by their peculiar, “unbeatable” technical characteristics because they display the simultaneous resistance to fire and heat, chemical and biological agents, abrasion and wear. These minerals are also easy to spin and can be woven. They are also sound-absorbing and insulating. They bind easily with other substances (lime, chalk, cement) and with certain polymers (rubber, PVC,

etc.). Some of these properties are listed under the product definition of asbestos, identified in the Dizionario di Merceologia (Product Dictionary; 1972) as a “mineral that, duly prepared, provides fibres used for spinning and resistant to heat, with sufficient flexibility, great dielectric strength and high chemical resistance”. The technical characteristics of this substance, together with its low cost, led to the creation of different mixtures (e.g. asbestites known commercially in Italy as siritte, eternite, marinite, syndanio, etc.) and the processing and production of over three thousand types of products containing asbestos with content varying from 10% to 99% in weight.

These products included asbestos-cement pipes, used for decades for civil and military purposes. They were widely used throughout the country due to the following properties:

- affordability of material;
- resistance to the aggressive nature of the waters carried and the ground soil;
- insensitivity to stray currents;
- strong traction resistance;
- low roughness (flow resistance);
- limited alteration over time;
- lightweight compared to reinforced concrete and pre-compressed reinforced concrete pipes, therefore lower transport and laying costs;
- low thermal conductivity coefficient, around 130 times lower than that of iron, enhanced by relatively high thickness;
- total impermeability;
- insensitivity to roots: test laying in ground full of tree roots has proved that the pipes are impenetrable, even if they had the roots wrapped around them.

Until recently, these pipes were used not only in building industrial plants, but also to create utility networks (water, sewers, communications, gas, etc.).

Asbestos-cement pipes¹ are made of a special cement mortar, to which asbestos was added (normally crocidolite or chrysotile, with amosite added in particular cases). There is no standard composition of asbestos-cement mixtures, insofar as it was prepared on the basis of the desired end product. However, the type of cement, the type of asbestos mineral (chrysotile, crocidolite, amosite) and the percentage weight and fibre length of the asbestos used did vary. The quality of the extracted raw material and the place of origin were fundamental to optimizing the end product. In addition, the mixtures varied according to the producer (Eternit, Fibronit, Sacelit, Cemater, Materit, etc.).

¹ Products classified under Category IV “Asbestos-Cement” as part of Inail’s publication “Classification and management of asbestos containing waste - Inail operating instructions for the protection of the health and safety of workers and working environments” (2014)

Even the pipe joints, despite following the same principle to guarantee the water tightness (joints, connectors and special parts in cast iron, or even in asbestos-cement), were specific to the individual producer.

For pipes, initial guidelines on the type of asbestos-cement mixture were included in the Italian Ministerial Decree of 10 January 1943-XXI. These guidelines considered asbestos-cement products to be “all products made exclusively from asbestos fibres and cement-700, with or without the addition of colouring or coating with paint”. In particular, with regard to the manufacture of pressure and sewer pipes, the regulations indicated the proportions and the quality of asbestos fibre (length and origin) to be added to the mixture based on the diameter of the pipe to be manufactured. For pipes intended for use in sewers, the mixture could also be composed of cement, asbestos fibres and plant fibres (cotton waste, jute, hemp, linen and similar). The pipes were manufactured by pressing together concentric layers of mixture on a rotating roller with a diameter equal to the internal diameter of the pipe (Figure 1). The thickness of the pipe varied according to the pressure to which the material was subjected. The process caused the fibres to be arranged in such a way that they acted like a reinforcement for the concrete—a result not dissimilar from rebar reinforcement. Further tricks were used to improve the characteristics of the material during production (selection of cement additives to improve the adherence of the fibres and reduce the permeability of the pipe walls, choice of cement according to the ground in which the pipes are to be laid and the type of water they have to carry. Pozzolanic cement was recommended for pure water and ferric cement for sulphate waters).

Subsequently, the sector was regulated by national and international UNI (Italian Organization for Standardization) and ISO (International Organization for Standardization) technical standards. In particular, asbestos-cement pipes had to comply with UNI4372/76, 5341/76, 7515/76 and 7516/76. The first two standards, applicable to asbestos pipes for channels under pressure and for urban sewer pipes, respectively, complied with ISO R160 and ISO R881. UNI 4372/76 for channels under pressure envisaged nominal diameters from 50 to 1,000 millimetres (mm) (even 2,000 mm for special products) with lengths usually varying between 3 and 4 metres (m), depending on the diameter. The length of the pipes had to be a multiple of 0.50 m. Instead, the thickness varied according to the nominal diameter, pressure class and length. In confirmation of the above, for pipes intended for carrying particularly aggressive waters or to be laid in aggressive soil, UNI ISO 4482/80 required that the manufacturer be informed of the nature of such waters or soil, in order to optimise the composition of the material or recommend suitable treatments, such as bituminous or other type of coating.

Finally, for the correct installation of underground pipes, great care had to be taken in the handling, transport and positioning of the pipes, with the prior leveling and stabilisation of the bottom using suitable ground (sand); indeed, any unexpected collapse of the ground could cause the pipes to break in two.

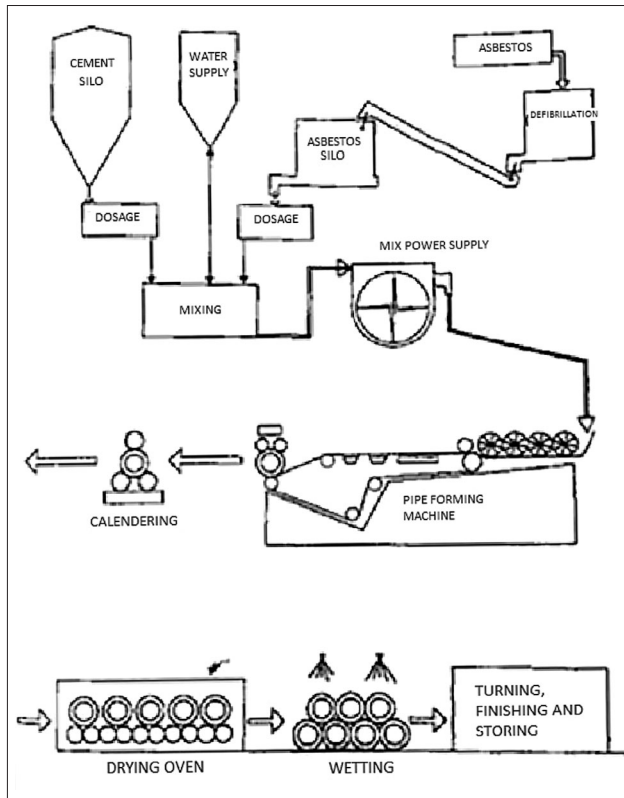


Figure 1 - Example of processing asbestos-cement
(Asbestos remediation project, Broni Site for remediation of National Interest)

Context of reference

Asbestos-cement pipes are not in themselves a primary source of danger to public health when underground, intact and still in place, insofar as the main asbestos-related health risk is inhalation.

It must be remembered that asbestos fibres are micrometric in size and are considered dangerous when they reach "standard" dimensions in the airborne count, with length > 5 microns, diameter < 3 microns and length/diameter ratio > 3:1. Studies are currently examining the carcinogenic nature of respirable fibres smaller than the standard, especially in the case of inhalation in high concentrations.

As for the risk caused by ingesting these fibres, in the light of numerous studies investigating this problem, the international scientific community believes that there are only significant risks in the case of ingesting extremely high concentrations exceeding hundreds of thousands, if not millions, of fibres per litre.

Cement asbestos pipes can, however, generate situations of risk when they are subject to removal or maintenance that involves their partial or total exposure to ambient air with the possible dispersion of fibres into the air. The risk is particularly high when the outer surface of the product is degraded (Figure 2), even only partially, and when the cement matrix and exposure of the fibres disintegrate, or when the pipes are cut or handled incorrectly. Therefore, situations of risk for operators or for the living environments surrounding the area of operations can be created unless specific prevention and safety measures are adopted.

In fact, operators must not work with asbestos-cement pipes unless they have been trained in the proper handling procedures and have access to suitable Personal Protection Equipment (PPE) pursuant to Legislative Decree 81/2008 (Italian code on health and safety at work) and subsequent additions and amendments.



Figure 2 - Tubazione idrica in cemento amianto lesionata.

Having taken into consideration the extreme variability of the situations that may be encountered in the field, this paper will address methods for handling asbestos in underground pipes known to contain the material as well as for cases in which there is no prior information on the presence of asbestos but it is discovered during operations. It should be noted that in management of water supply systems, work on underground pipes is often mostly performed in emergency conditions, i.e. following reports of a more or less massive leak in the network that requires immediate action to restore the service for customers.

After digging and checking the type of material, on the basis of the pipe diameter and the type of break, pipes suspected to be made of ACM must be sealed with a stainless steel repair clamp around the outer surface of the pipe to make it water tight and stop the leak.

This primary maintenance intervention, which does not require any cutting, can be followed some time later by the replacement of the damaged section of pipe, subject to prior characterisation to be performed according to the specific procedures outlined in this document.

Italian law requires notice to the Local Public Health Service (LPHS) Authority for maintenance activities that may involve the risk of exposure to asbestos, such as laying a seal with a stainless steel repair clamp. This notification can be given electronically. The notice at a minimum must include the following:

- a) location of the construction site;
- b) types and quantity of asbestos to be handled;
- c) relevant activities and procedures to be applied;
- d) number of workers concerned;
- e) beginning date and duration of expected works;
- f) measures to limit the exposure of workers to asbestos.

The employer also provides this notification to workers for their knowledge. The employer, whenever a change in working conditions can lead to a significant increase in exposure to dust from asbestos or from materials containing asbestos, must send a new notice.

Once the presence of asbestos is confirmed, actions must be taken to remove the pipe in compliance with the general principles of prevention and precaution established by the applicable Italian rules then in force.

It should be noted that all operations involving the demolition or removal of asbestos containing materials - therefore also for operations involving the demolition and removal of underground asbestos-cement pipes or parts thereof - Italian rules require the submission of a specific Work Plan (WP) to the Local Public Health Service (LPHS) responsible for the area. The remediation company must draw up the plan and provide specific data on the asbestos risk and the measures necessary to guarantee the worker's health and safety and the protection of the environment around the intervention area. The obligation to present the WP applies

to any asbestos containing products is independent from the type and quantity of products that contain asbestos and from the concentration of asbestos in these materials. The asbestos WP, in particular, must include and contain the following information:

- a) details on the removal of asbestos or asbestos-containing materials prior to the application of demolition techniques;
- b) details on suitable personal protective equipment for workers;
- c) certification that there are no more risks at the end of the demolition or removal of asbestos;
- d) suitable measures for the protection and decontamination of the personnel in charge of the works;
- e) suitable measures for the protection of third parties and for the collection and disposal of materials;
- f) if the limit values of 0,01 f/cm³ are exceeded, the adoption by the employer of suitable measures to protect workers (like providing workers with an adequate respiratory protection device , pose pannels to indicate that the exposure limit value is expected to be exceeded, etc.). The employer is requested adapting them to the particular needs of the specific job;
- g) nature of the works, starting date and expected duration;
- h) the place where the works will be carried out;
- i) working techniques adopted for the removal of asbestos;
- l) characteristics of the equipment or devices that are intended to be used to implement the provisions of letters d) and e).

These indications represent the minimum information content; we therefore recommend the presentation of a WP containing additional elements.

The legislation provides for the presentation of the WP to the LPHS with an obligation of notice of thirty days before the works begins. In urgent situations, this obligation does not apply but, in addition to the work starting date, an indication of the starting time of the activities must be provided by the Em. In general, we can speak of "urgent cases" when there are proven and serious reasons for public health and safety, extraordinary natural events or emergencies (the legislation does not give specifics in this sense). In some cases, the supervisory body requests the preparation / compilation of a specific "Request for activation of the urgency procedure" in which the reasons that cause the urgency and, if necessary, a report certifying the same must be reported. If the starting date indicated in the WP needs to be changed, the new date must be communicated in advance to the LPHS before the works beginning. Even if the activities are not undertaken for the scheduled starting date, this information must be notified to the LPHS.

The examination of the WP may be subject to prescriptions by the LPHS; this-one has the possibility to formulate motivated requests for integration or changes to the WP, as well as to issue operating prescriptions. The request for additions or changes is generally made in the presence of WPs lacking for mandatory points,

unclear or inadequate / insufficient in some of their parts. The company will have to adapt the WP to what LPHS requested before the works execution. On the other hand, the release of operating provisions is normally linked to the work operations that are intended to be carried out. The company will have to observe them when carrying out the works themselves.

In case of non-formulation of prescriptions by the LPHS within the term of 30 days, the rule of silent assent will apply. Inspections on the actual execution of what is foreseen in the project can be carried out by the Control Body.

If, on the construction site, there is the simultaneous presence of several companies participating in the remediation works, each company must present its own WP, for the part of sub-contracted works, demonstrating that have correctly planned the intervention.

It is recommended that this document be drawn up by an “asbestos coordinator”, authorized with a specific 50-hour training course.

Following in this section, we will describe the Inail Dit proposed methodological procedure for the removal of underground asbestos-cement water pipes, in order to facilitate the work of operators and of the local control bodies. This procedure facilitates criteria of programmability, reproducibility and homogeneity of operations on a national scale.

The guidelines outlined in the following paragraphs concern the partial or total removal of asbestos-cement pipes, performed using traditional open-air digging methods, irrespective of the restoration of network function.

However, operations using alternative no-dig or trenchless techniques, used to repair (cured-in-place, pipe lining, etc.) and/or replace existing pipes, and/or for laying new network infrastructures, using limited open-air digs (digging 10-15% of that required for traditional methods) are not considered.

These technologies undoubtedly offer the advantage of reducing operation time, being less costly and less invasive than traditional methods, but in the case in question, they are not always applicable to underground asbestos-cement pipes. There are no-dig technologies that preserve the existing pipes, even if damaged or simply to be preserved, by rebuilding the inner surface with products and/or materials compatible for use in contact with drinking water. These technologies include both internal lining with cement mortar or resin (if the existing pipe still has the necessary static resistance) and inserting a structural liner into the pipe capable itself of withstanding the functional stresses, leaving the old pipe solely as a guide. It must be noted that one of the no-dig techniques sometimes used to replace existing asbestos-cement pipes, especially in urban environments, and not compliant with the provisions of current legislation on asbestos, is “pipe bursting”, which involves demolition of the existing pipe without removal and the simultaneous insertion of a new, even larger diameter, pipe. In particular, the operation consists of making two digs, one at either end of the section to be replaced, and introducing a head into the existing pipe that breaks it into pieces, simultaneously packing

the fragments into the surrounding earth. As the intrusion moves forward, the bursting head breaks up the old pipe, which is simultaneously replaced by the new pipe. This technique, despite having the undeniable advantage of ease of execution and reduced operation time, causes the deliberate break-up of the asbestos-cement pipes, increasing the dispersion of fibres into the ground and leaving in place fragments of ACM, with the possible future risks this entails.

One further technology that is based on the pipe bursting principle, in combination with the microtunnelling technique, is the pipe replacer. This involves the pipe being broken up by an expansion cone and the debris is then sucked up with the removed earth as the digging head advances. Studies on the safe application of this technology are still ongoing. In any case, where applied, it falls under the category of removal operations, which means an appropriate WP must be submitted for approval to the supervisory body.

In the case of decommissioning sections of pipe made of ACM, for programmable activities, one solution is to lay new pipes, leaving the old section in place, connecting the new pipe with by-pass valves. This by-pass solution allows the old ACM pipe to be used in the event of emergency problems with the new section, ensuring minimal disruption to services. The new pipe can follow the same course as the existing pipe or, due to varying constraints, it may be necessary to identify a different route even at a considerable distance. These constraints can include restrictions above ground, such as changes to road systems or overlying buildings, or the existence of underground utilities. These situations are more frequent when operations are in an urban environment.

In the event that the new pipes are laid following the same route as the existing section and is less than around 1.5 m from the axis of the pipe already in place, it is recommended that you remove the old ACM pipe. If the decision is made instead to leave it in place, the solution adopted must be subject to appropriate risk assessment by the Em, who must also report the situation in the WP. Controls and checks must be performed on the section of network temporarily out of service, similar to that implemented for the pipes in operation. In this case, the documents containing the georeferenced mapping of the route must be retained and the Risk assessment document (Rad) for asbestos risk must be updated.

The Rad, in Italy, is the document that includes risks and prevention measures for health and safety in the workplace, and is mandatory for all companies with at least one employee. The person in charge of the Rad is the Em who cannot delegate this activity but can decide to rely on a technician specialized in the field of work safety. The only entities exempt from the obligation of the DVR are self-employed workers and family businesses. The Rad identifies all possible risks to prevent accident or occupational diseases. The Rad in particular must:

- identify the dangers resulting from working activities or other factors (proximity to sensitive points or other risk situations);
- establish who could be damaged and how (by identifying the groups of workers who could be at greater risk, the different tasks, etc.);

- evaluate the quantitative elements: the number of people exposed, the frequency and duration of the exposure, the possible effects;
- establish whether the existing precautions are adequate or whether further hazard prevention and / or control measures have to be introduced;
- involve workers and workers' representatives in the Rad (the results of the risk assessment, the prevention and protection measures chosen and the reasons for the choices must be made available for consultation);
- consider the skills of the individual worker in general and the factors of specific risk;
- plan how the necessary measures will be implemented, deciding who is in charge of carrying out certain actions and when;
- monitor implementation;
- record the results;
- review and update the process.

The issue is really complex considering different specific regulations, concerning both worker safety regulations as well as environmental regulations. There is also no available complete map in Italy of underground asbestos-cement pipes; there is currently only fragmentary data referring to a limited number of municipalities, mostly concerning water supply networks. Of these, to date, only a small proportion have been removed.

For the purposes of the proper management of operations, the companies and/or municipal authorities should thus organise the precise identification and localization of all the utility networks found in the area, both in asbestos-cement and otherwise. Therefore, they need to gather all the technical documents available showing the maps of underground networks, their type, the year they were laid/put into use for each individual area of operation. This information must be made available on a computer platform (preferably via the implementation of a special GIS) for easy use by operators assigned to both programmable and emergency activities. The system must be continuously updated after completion of each operation. Having considered all of the above and the widespread nature of asbestos-cement pipes used to supply water (not sewers), their age and the increasing demand by municipal authorities for their removal, we understand the need to make available technical and operating instructions for the purpose of protecting sector operators and the surrounding living environments. These procedures, which refer to “programmable” and “emergency” activities, are outlined in detail in the paragraphs below.

We point out that an activity is “programmable” when its execution is not of urgent nature and can be scheduled. Such activities include conservation and redevelopment for the renewal, renovation, improvement and functional adaptation of existing networks and systems, with also the aim of an implementation of local area planning.

“Emergency” operations instead require the execution of quick measures due to structural collapse, leaks or dispersion in the network that cause irregularities or

interruptions to service or danger to third parties. These operations must be performed as soon as possible, twenty-four hours a day, all year round.

The majority of “emergency” activities are performed in urban areas and require small road work sites to be opened for limited periods, with the aim of avoiding disruption to traffic. They require smooth organisation, with the rapid set-up and disassembly of worksites and the initiation and completion of work in as short a time as possible for the service to be restored.

Below, we describe in detail the technical and operational procedures to be adopted for the two cases outlined above: programmable and emergency activities.

1. Removal of underground asbestos-cement water pipes: programmable activities

1.1. Technical operating instructions

Prior to performing programmable activities, all information available on the identification, localisation and characterisation of all utility networks found in the area must be gathered. Generally, the the Asbestos Risk Assessment Document of the water supply manager/construction company should already contain such information since their personnel are at risk of exposure to asbestos. Subsequently, the information should be integrated with site-specific surveys (if available) including the following:

- geological-geotechnical surveys for the choice of type of operation,
- geophysical surveys to identify the existing pipes and their route (e.g. georadar, etc.),
- inspections and video-inspections of the channels and wells for visual inspections.

In any programmable intervention, it is necessary to take both possible land containment measures according to the depth of the dig.

In the event that ACMs are potentially present, the pipes must be characterised considering the pipe section uniformity.

Early indications on the characterisation of the product can be obtained using field analysis methods such as portable infrared instruments, stereo optical microscopy, PCM, micro-XRF, portable XRD, etc.

Legally required investigations that confirm preliminary findings can be performed by sampling small parts of the material (indicatively 5x5 cm) and sending them to the laboratory for analysis. Wetting with water is required during sampling, before and during operations and, where possible, the sampling area should be treated with a Type D encapsulation coating. Encapsulating prevents the dispersion of dust into the ambient air during sampling or remediation activities or ACWs management. It is required that the material used be of a contrasting color with that of the substrate. The supplier must indicate the thickness of the dry film, the quantity to be applied per square meter and the drying time. We recommend photographing the sampling area and affixing suitable warning identification signs.

Samples must be properly recorded, sealed, labelled and accompanied by the completed sampling sheet and must be sent to the approved laboratory (pursuant to Ministerial Decree of 14 May 1996) for analysis. If results are positive, as a precaution and where possible, preliminary surveys should be performed of any wells/shafts found along the section of network involved in the works, in order to determine whether there are any fibrous deposits to be analysed (e.g. connection points, etc.). Asbestos PPE must always be used during these investigations.

If the pipes subject to remediation are made of asbestos-cement, and the company executing the removal is not suitably equipped and qualified, operations must be suspended immediately, reporting the event to the contractor. The contractor must act immediately to bring the work site and removal operation in line with existing legislation regarding works on Acms and within the guidelines in this document. While proper planning is undertaken, the dig area must be covered immediately with polyethylene sheets at least 0.15 mm thick.

Please note that a number of the steps described above are not necessary if the managing company has provided a complete and appropriate Asbestos Risk Assessment Document, which forms the basis for the programmable activities.

In all cases of operations to remove asbestos-cement pipes, the Em must submit a specific asbestos WP to LPHS. This document must include the measures necessary to guarantee the health and safety of workers and the protection of the surrounding environment. In any case, the Em must ensure the assessment of all the risks tied to the work activities in the Operational Safety Plan (OSP), as required by Title IV of Legislative Decree 81/2008 and subsequent additions and amendments (e.g. slips and falls, falls from height of equipment/material/suspended loads, manual handling of loads, crushing/burial, noise, electrocution, striking by vehicles, explosion, blows/cuts/impact/injuries to the hands, biological risk, etc.).

The removal of ACMs or soil contaminated by asbestos must be performed by companies registered on the National Register of Environmental Managers and in particular for the "Remediation of property containing asbestos" (Category 10), at least in the sub-category 10A (works on asbestos cement), and by qualified personnel. For finely crushed material, it remains at the discretion of the local authorities to evaluate the need for the company executing the works to be registered in Category 10 B (works on friable asbestos). The transfer of Acws have to be executed by companies registered on the National Register of Environmental Managers in the sub-category 5 (for dangerous wastes) or 2-bis (for wastes less than 30 Kg managed by the producer).

The following technical and operational instructions must be adopted in general for the removal of asbestos-cement pipes:

1. The work site area, in relation to the type of works performed, must be surrounded by a fence suitable to preventing access by unauthorised persons; we recommend using a mobile fence of at least two metres in height. All the safety measures in terms of signage must also be adopted (access prohibited to

unauthorised persons, asbestos hazard warning, etc.) and daytime/night-time work site notices must be displayed.

2. In the case of activities in which the work site areas are immediately adjacent to highly populated areas, the work site area must be fenced off as described in part 1, with a blackout net laid over the fence (made of high density polyethylene (PEHD) or similar), with closed mesh (dustproof), resistant to mechanical stress, tearing and ageing from exposure to atmospheric agents, laid in such a way as to limit dust dispersion as much as possible. This also prevents outsiders from seeing into the work site. It is recommended that the materials used labelled with European Waste Code (EWC) 15.02.02* - "Absorbents, filter materials, wiping cloths, protective clothing contaminated by hazardous substances" - be disposed of as asbestos containing waste upon completion of work. Alternatively, panels made of wood, plastic or other material can be used (suitable for perimeter fencing and containment - parts 1 and 2), to be washed and encapsulated after use. These are recommended for short stretches of perimeter only.
3. In addition, for operations in highly populated areas, where operations include pipe separation/cutting, the area must also be closed off (metal poles, polyethylene sheets, etc.). This is to protect the area from wind and/or air movement caused by work site vehicles and/or vehicles travelling in adjacent areas. This precaution is not necessary if the glove-bag technique is used, as outlined in part 15.
4. Where possible and applicable, the supply of utilities that uses the network subject to operations should be interrupted before operating on ACMs. Where this is not possible, the relative risks must be assessed and specific precautionary measures taken.
5. By way of precaution, the stages and time frame for the removal of pipes and all excavation material must be reduced to a minimum.
6. According to the actual depth of the dig and the nature of the soil, the static safety of the walls must always be guaranteed, including via the use of provisional works (e.g. reinforcements, formwork, pillars, etc.), in order to operate in safety and subsequent additions and amendments (consider, however, that water supply pipes are usually laid no deeper than 1.5 metres). Any cement box surrounding the pipe must also be removed.
7. The surface must first be milled and, once the asphalt layer has been removed, the position and depth of the pipe channel can be identified using a suitable probe. The subsequent dig must reach 15 cm above the upper generatrix of the pipe, even by means of lateral deepening of the trench. During this stage, it is recommended that you wet the ground with water, even using spray irrigation systems, avoiding the formation of pools or streams, in order to limit dust emission during excavation.
8. The Em, if necessary for the specific situation, may justify the need to perform digs with depths other than 15 cm, depending on the specific site situation, in the WP sent to the LPHS in charge.

9. The parts of pipe affected by separation/breakage/cutting must be completely uncovered using hand tools (shovels, spades, trowels, etc.), taking care not to scrape the outer surface of the asbestos-cement pipes. In the event that the ground is not in a mud or liquid state due to possible water leakage, approximately 15 cm of dirt immediately surrounding the separated/broken/cut parts of pipe (and not along the whole section uncovered) must be removed (Figure 3). This portion of dirt could be contaminated by asbestos fibres and, therefore, it must be packaged and disposed of as hazardous waste. In this case, the ground must be wetted with water, even using spray irrigation systems, avoiding the formation of pools or streams, in order to reduce the dispersion of any fibres into the air. The operating methods to be implemented for this type of ground must be presented to the local supervisory body in charge.
10. In the case of pipes located below groundwater level, techniques must be adopted that allow operations to be performed in dry conditions, to be evaluated according to the hydraulic model of the subsoil (e.g. simple bailing, well-point system, etc.). In this case, given that the ground is already steeped in water, there is no need to wet the earth with irrigation systems.

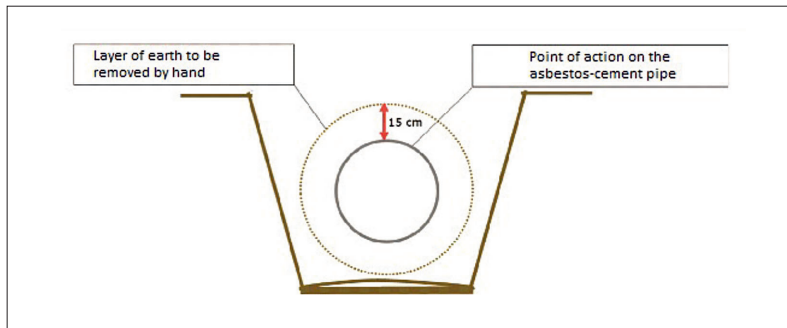


Figure 3 - Uncovering an asbestos-cement water pipe.

11. With the pipe fully uncovered and partially suspended, it is recommended that you lay a high-density polyethylene sheet at least 0.15 mm thick, or an equivalent "geotextile non-woven fabric" sheet between the pipe and the underlying earth. This is to be placed at least under every area of separation/breakage/cutting and extended according to the specific operating conditions. In the case of the presence of water in the dig, the specific operating methods are to be evaluated to guarantee its effectiveness (e.g. sheet suspended under the pipe, etc.). There is no need to lay a sheet in the case of using the glove-bag technique referred to in part 15 below.
12. If water is at the bottom of the dig, it can be allowed to drain naturally or flow into the sewer using a suitable channel. Emptying with a bucket is not consid-

ered appropriate. Dispersing water on impermeable paving (e.g. asphalt, cement, etc.) is forbidden as it could dry off and lead to the dispersion of fibres into the atmosphere. Thus, it must be collected and sent for disposal. As a precaution, it is recommended that you dispose of this water according to EWC 16.10.01* ("Aqueous liquid wastes containing hazardous substances. Following analysis, the relative mirror EWC can be adopted (16 10 02 - Aqueous liquid wastes, different from EWC 16 10 01*). In non-built-up areas, it can be discharged into the ground using a suitable channelling system.



Figure 4 - Channelling the water at the bottom of the dig and discharging into the sewer.

13. Once the section of pipe has been uncovered and any water removed from the dig, prior to any separation/cutting, all the equipment necessary for performing the operation must be placed in the dig, or left alongside the trench, far from the edge and in a safe position, in order to reduce the need to enter the dig during operations, which could lead to the contamination being exported to the other areas of the work site.
14. The outer surface of the pipe must then be cleaned thoroughly, in particular the area/s affected by the separation/cutting. The exposed outer surface must then be sprayed continuously with water or a biodegradable encapsulating product Type D. In the case of terminal section of the network, well joint or coupling, encapsulation should also be required, where possible, for the inner surface of the conduit that has to be removed.
15. Subsequently, where technically feasible, the section to be removed should be isolated, preferably without cutting or breaking. As a final solution, where it is technically impossible to use existing joints without cutting or breaking, operators may use the glove-bag technique or cut the pipe, using one of the methods outlined in part 16 below, only after having ensured that the cutting points and uncovered section of pipe have been encapsulated, as mentioned above. It is recommended that you spray the operation area, preferably with a mist

cannon, whilst the pipe is being uncovered. This is not required in the case of the glove-bag technique.



Figure 5 - Mist cannon in the operation area.

16. The pipe cutting operations must be performed using suitable instruments, including:
- a. hand saw (dry sawing, Figure 6) for small diameter pipes, to be used only when operating under forced suction using HEPA H13 (or above) absolute filters or continuous spraying of the cutting area using Type D encapsulation coating, preferably one that is biodegradable. At the end of the operation, the saw must be encapsulated, sealed in a bag and sent for disposal at the end of the work day (considering its rapid wear and low cost). It is recommended that you dispose of the used HEPA filters as asbestos containing waste pursuant to EWC 15.02.02* - "Absorbents, filter materials, wiping cloths, protective clothing contaminated by hazardous substances";



Figure 6 - Cutting a pipe with a hand saw (Inail Dit).

- b. low-speed petrol jigsaw (Figure 7), only if fitted with integrated systems for continuously spraying the cutting area with water or impregnating encapsulating solution, to be used preferably for pipes with diameter and thickness compatible with the length and characteristics of the saw blade; at the end of operations, the blade and the saw must be wet cleaned as far as possible and stored in a dedicated sealed container;



Figure 7 - Cutting a pipe with a low-speed petrol jigsaw.

- c. hand chain pipe cutters (dry cutting, Figure 8), to be used only when operating under forced suction using HEPA H13 (or above) absolute filters or continuous spraying of the cutting area using Type D encapsulation coating, preferably one that is biodegradable. At the end of operations, the tool must be wet cleaned and stored in a dedicated sealed container. It is recommended that you dispose of the used HEPA filters as asbestos containing waste according to rule EWC 15.02.02* - "Absorbents, filter materials, wiping cloths, protective clothing contaminated by hazardous substances";



Figure 8 - Cutting a pipe with hand chain pipe cutters.

The work equipment must be chosen according to the specific work conditions, with the aim of reducing dust to a minimum. Any visible swarf produced during cutting (Figure 9) must be collected, whether in powder or mud form.



Figure 9 - Residue after cutting.

Where operations are performed on water networks and water is present, equipment suitable for the operating environment must be used to prevent electric shocks.

It must be pointed out that it is forbidden to use medium/high speed cutting instruments, even if fitted with integrated systems for continuously spraying the cutting area with water or impregnating encapsulating solution (e.g. chainsaws, etc.). In the future, the use of such tools may be permitted only following testing and monitoring to assess their effectiveness and the levels of exposure generated for workers and living environments. This type of tool is preferably used for pipes with diameters exceeding 800 mm and/or of significant thickness; at the end of operations, the tool must be wet cleaned as far as possible and stored in a dedicated sealed container.

We remind you that the use of angle grinders (Flex grinders), which generate high fibre dispersion and significant risks for operators and surrounding living environments, is always forbidden. Additional medium/high speed, dry-use electric tools, such as the electric jigsaw, are forbidden.

17. The glove-bag technique may also be used to remove sections of asbestos-cement pipes. This method, considering its inherent limits and the objective difficulty of its application in digs, may be adopted only after specific feasibility analysis and practical tests conducted by the company, which must determine in advance the maximum diameter and length for which the technique may be applied. The feasibility analysis must take into account all the different work stages, establish special procedures, including the choice of cutting tool/method, the treatment of any water that accumulates in the glove bag and the method of collecting, handling and disposing of the waste produced.

18. The limited amount of dirt removed must be considered as contaminated soil. Specifically all the following situations:
- a. the amount corresponding to approximately 15 cm of dirt removed from around the separation/break/cutting sections;
 - b. any dirt removed from below the cutting area for operations performed without a protective polyethylene sheet or filtering geotextile sheet or without applying the glove-bag technique;
 - c. dirt from sampling and analysis at the bottom of the dig before filling it in;
 - d. possible waste core samples;
 - e. or other similar types of removed soil.

With the exception of samples to be sent for laboratory analysis, which must be sealed separately, labelled and accompanied by a special sampling report, the remaining material must be packaged in special polyethylene bags and placed in Big Bags, which are to be sealed and labelled with the name of the waste producer, an asbestos warning and code R (hazardous waste). These bags must then be placed alongside the dig, away from the edge at a distance ensuring the safety of operators working in the dig, in order for them to be removed from the work site together with other hazardous waste, to be sent for disposal. For this waste, we recommend following EWC 17.05.03* - "Soil and stones containing hazardous substances", without their characterization in laboratory, in consideration of the proven difficulty in characterising ground containing or contaminated by asbestos, avoiding too long and costly analysis for reaching Italian TLV in industrial and residential sites = 1000 mg/kg or in agricultural sites = 100 mg/kg.

19. Whenever cutting and replacement operations are undertaken for a damaged pipe section, we recommend replacing the whole section of pipe (from joint to joint) that includes the damaged part (Figure 10). This prevents possible further breakage close to the section due to the settling of the pipe bed after the pipe has been repaired and covered over and is a more cost efficient process.



Figure 10 - Detail of the connecting joint (left); section of new pipe replacing the damaged pipe (right).

Before laying/connecting up a new replacement pipe, the connection points with the old pipe must be wet cleaned or vacuumed using forced suction with absolute filters (HEPA H13 or above), followed by the further preliminary spraying of the outer surface of the pipe using a (preferably biodegradable) Type D encapsulating coating. Whenever possible, we recommend avoiding trimming, filing or shaping the two ends of the old pipe. Should this be necessary, it must be undertaken using the same operating methods and precautions required for separation/cutting. In any case, it is advisable to prohibit the use of angle grinder (Flex grinder) type tools, which generate high fibre dispersion and significant risks for operators and for the surrounding inhabited areas. The goal is to prevent the potential dispersion of fibres into the atmosphere.

20. The separated piece/s of pipe must be harnessed and lifted to be sprayed again with (preferably biodegradable) encapsulating liquid, focusing particularly on the outer surface, breakage points, cutting faces of pipes or sections and spraying inside the pipe too, where possible.
21. The removed pipes can be laid on the ground, on suitable sheets, to be wrapped in sealed packages and labelled (Figure 11) with the name of the producer of the waste, an asbestos warning and the code R (hazardous waste). We recommend following the EWC 17.06.05* normative- "Construction materials containing asbestos". The pipes must be packaged either at the bottom of or alongside the dig, depending on the specific situation, whilst the material is still wet.



Figure 11 - Detail of waste packaging.

22. After packaging properly and cleaning the outside of the packages, all the waste produced (dirt, pipes, PPE, etc.) must be removed from the work site area with suitable vehicles, preferably on the same day or upon reaching a first payload. This waste can then be sent for temporary or preliminary storage or final disposal in hazardous waste landfills or non-hazardous waste asbestos mono-landfills or landfills with asbestos mono-cell. Disposal requires avoiding mixing hazardous waste with other waste categories
23. We recommend the use of vehicles fitted with a loading bed with sides and a fixed or mobile cover system, to ensure protection of the load, for the transport

- of the waste produced, to be undertaken using vehicles duly authorised and registered on the Environmental Managers Register (Category 5 for the transport of hazardous waste or 2-bis for quantities below 30 kg managed by their producer).
24. If the pipes break or are found already partially worn and broken, any sharp fragments or visible residue (of both pipes and bundles of mineral fibres left in the ground following the disintegration of the cement matrix) must be sprayed with Type D encapsulating liquid (preferably biodegradable), removed manually and bagged in special sealed packages (preferably rigid in the case of sharp fragments) or in polypropylene raffia sacks and then placed immediately in Big Bags (waterproof if using raffia, pursuant to Ministerial Decree of 6 September 1994); this prevents the packaging from tearing or breaking open. Any large fragments must not be broken up on the work site to be fitted into the Big Bags, but instead must be sealed separately using polyethylene sheets of suitable thickness and size and then labelled to prevent the potential dispersion of asbestos fibres into the air.
 25. Any other waste produced on the work site must be duly sealed in special packages, labelled with the name of the waste producer and the EWC of the waste contained.
 26. Any polyethylene or geotextile sheets, as outlined in part 11, removed from the dig must be sprayed with Type D encapsulating liquid and bagged in special sealed packages and correctly labelled as waste. We recommend classifying them according to EWC 15.02.02* "Absorbents, filter materials, wiping cloths, protective clothing contaminated by hazardous substances" and sending them to temporary storage or appropriate landfill.
 27. At the end of the project, once the dig has been cleared and before it is filled in, according to the WP, a visual inspection must be performed to check the actual removal of all waste potentially contaminated by asbestos. This check should be performed by the company executing the works together with the Works Management.
 28. Once the visual inspection has been completed successfully, where there are no polyethylene or geotextile sheets laid as outlined in part 10 nor has the glove-bag technique been used, a sample must be taken from the bottom of the dig to ensure that there is no contamination by loose asbestos fibres in the ground below.
 29. A sample of approximately 1 kg of dirt must be taken at the separation/break/cutting point for operations involving a maximum of 20 linear metres of pipe; for longer pipe sections, one sample must be taken for every 100 m and, in relation to the size of the section on which the works were performed, the Sampling Plan may be subject to site-specific evaluation by the LPHS. Each individual sample must be made up of multiple portions of dirt, taken from multiple points along the section in question. All samples must be tripled in size to have sufficient quantity for controls and checks by the authorities in charge. After packaging, the sample must be sent to an approved laboratory for asbestos

content analysis. The results must be communicated to the operator as soon as possible in order to prevent disruption to operations. Should the results show values exceeding legal limits previously mentioned in point 18, an additional layer of soil must be removed of at least 15 cm in all the separation/break/cutting zones and the checks must be repeated until analysis shows the ground is free from contamination. The company is responsible for keeping records (even producing a special final explanatory plan) of where the samples are taken from the bottom of the dig to ensure the removal of any contamination.

30. In the case of operations within Superfund Sites (Ss) or Remediation Sites of Regional Interest (RSRIs) subject to specific preliminary Characterisation plans (Cps), all the analysis parameters indicated in the Cp approved for the area in question must be researched, in addition to the asbestos parameter, in the ground analysis for classification and subsequent transport to final destination.
31. The contractor must keep hold of all information relating to the operations performed, producing a final document that describes precisely the operations undertaken; we recommend, where possible, the use of geolocation devices on the sections identified (e.g. radio frequency devices). The information must be entered and stored on a dedicated IT platform (preferably via the implementation of a GIS/SIT) and continuously updated, as well as recorded in the DVR.
32. We recommend, at the end of each year, to the Em to send at Inail Dit (dit@inail.it) all data relating to the individual operations undertaken during the preceding business year (contractor, company executing the works, work site location, number of workers employed on the work site, pipe diameter, linear metres removed, amount of ACW produced and relative EWC, place of storage, etc.) for research purposes. Similarly, we recommend to send all data also to the regional authorities, for updating the National Asbestos Mapping.

1.2. Safety procedures, protection equipment, controls

33. Access to the work site is forbidden for personnel with inadequate training on the operations underway and the specific risks related to the activities to be performed, and most specifically asbestos risks.
34. Where asbestos-cement pipes are identified, we advise, as a precaution, that the owner or manager of the network appoint one supervisor in charge of the whole network or section within 60 days. This person is similar to an Asbestos risk officer (Aro), and must have undergone appropriate and certified training. The designated supervisor should be chosen from among the more highly qualified operators working for the network owner or manager. The role of the individual appointed to be supervisor would be as following:
 - monitor and coordinate all maintenance and removal activities that may -verify the creation of and keep documents showing the location of asbestos containing materials;

- maintain suitable documentation of the operations performed and to be performed involving asbestos containing materials;
 - indicate the general measures to be adopted to comply with safety procedures during the maintenance and removal of asbestos containing materials, possibly even coordinating the activities of third companies.
35. Given that the work site area must be off-limits to unauthorised personnel, all personnel not assigned to direct operations on asbestos-cement pipes must be kept away from the area during operations.
 36. According to the results of the risk assessment suitable Personal Protection Equipment (PPC and PPE) must be used (such as high-visibility clothing, protective helmet, protective glasses and ear defenders/earplugs, etc.). In particular, to ensure the protection of the health of operators assigned to direct contact with asbestos-cement pipes, these operators must be equipped with specific Category III PPE that, if reusable, must be individually labelled with the name of the worker. The assigned workers must use appropriately the personal protection equipment provided, in compliance with the information/education and practical training received, and must report immediately any equipment defects to the Em, supervisor or person in charge.
 37. For all Category III PPE intended to protect from the risk of death or serious and permanent injury as well as information and education activities, users must receive adequate practical training. In particular, attention must be given to the correct use of specific asbestos PPE (disposable masks must not be reused; masks must not be worn around the neck or on the head and used only during quickly actions; the hood of the bodysuit must not cover the eyes during operations; etc.).
 38. The suitability and adequacy of the PPE to be supplied, whether asbestos specific or not, must always be checked as to type and wearability. PPE must comply with technical standards in terms of the risk prevention and protection for which it is used and also be ideally suited to the comfort, shape and health requirements of the individual who wears it. Every Em must therefore take great care when choosing the type, size and number of PPE to be provided at the work site and to each worker (e.g. not buy one size of bodysuit for all operators, with the risk of them being too big and an impediment, for some and too small, with the risk of tearing at the seams, for others).
 39. In particular, we recommend the use of gloves, non-woven, Category 3, Type 4-5 or similar disposable bodysuits with hood to be worn underneath the helmet and with seams covered with adhesive tape. In the case of operations without a personal decontamination unit (DCU), in order to guarantee maximum worker safety, we advise wearing two bodysuits, one over the other. Workers must also wear rubber boots or waterproof safety footwear (to be washed thoroughly with water at the end of each shift).



Figure 12 - Operator wearing special Personal Protection Equipment.

40. The trousers of the bodysuit must be pulled down over the boots or footwear and sealed with tape. The gloves and bodysuit cuffs must also be sealed with tape. The use of non-woven or similar slippers must be avoided.
41. With regard to respiratory protection, we recommend the use of disposable P3 filter face masks (FFP3) or half face masks with P3 filter, to be worn under the hood of the bodysuit to enable correct decontamination when leaving the work site. It must be remembered that beards, moustaches and long sideburns must be prohibited because they interfere with the seal of respiratory protection devices, preventing them from fitting perfectly to the face.
42. In order to facilitate the correct decontamination of operators during operations lasting more than 3 consecutive days or that involve the removal of over 300 linear metres of pipe, we recommend the use of a 4-stage DCU for the greater protection of workers.
43. In the event of operations without a specific DCU (programmable removal of short sections of pipe), the removal of PPE must require the disposable bodysuit to be taken off whilst still wearing the respiratory protection device and actions must be performed in the following order:
 - a. before undressing, wet the outside of the bodysuit, gloves and footwear with water (spray/mist); therefore, there must be a suitable water supply in the work site;
 - b. remove the tape used to seal the gloves and footwear;
 - c. undo the velcro parts of the bodysuit (at the neck and along the zip);

- d. remove the gloves;
- e. open the zip of the bodysuit;
- f. take down the hood;
- g. start to remove the bodysuit, taking care to roll it down from top to bottom and towards the outside to contain the contaminated part;
- h. slip the feet out of the bodysuit;
- i. place it immediately into a sealed disposable bag together with the tape removed in part a) and the gloves;
- j. place the bag in a dedicated sealed sack, to be put in Big Bags later;
- k. remove the work footwear after cleaning thoroughly with water;
- l. in the case of double bodysuits, the one underneath must be removed in a non-contaminated zone whilst still wearing the FFP3 mask, which must only be removed after everything else.

Finally, only after everything else has been removed, the respiratory protective device may be removed. Reusable PPE must be washed and stored in a sealed bag; disposable PPE must be placed in a sealed bag separate from the other PPE or waste, prior to disposal. Please note that disposable protective bodysuits, being sealed, are inevitably damaged/torn when opened or removed. This is why they must be replaced even only after going to the bathroom. After undressing, hands must be washed with neutral soap and lots of water before leaving the work site and performing activities such as smoking, eating, touching habitually used objects, etc.

44. In the event of the need to wear high-visibility clothing, such clothing must be worn by personnel only outside the dig. At the end of operations, these items must be placed in a closed and sealed bag to be reused in another work site with ACMs or packaged in Big Bags to be disposed of as waste. The Big Bags must then be sent to temporary or preliminary storage or final disposal, as asbestos containing waste. We recommend the use of EWC 15.02.02* - "Absorbents, filter materials, wiping cloths, protective clothing contaminated by hazardous substances".
45. Workers assigned to packaging and moving asbestos containing waste within the work site may take off their PPE only after cleaning the packages of waste.
46. PPE used by personnel who have worked in direct contact with asbestos containing materials and removed after wetting must be duly packaged and labelled with the name of the waste producer, an asbestos warning, the identification code R (hazardous waste and the EWC of the waste contained.) In particular, we recommend that PPE be classified and disposed of with code 15.02.02* - "Absorbents, filter materials, wiping cloths, protective clothing contaminated by hazardous substances" - and sent to suitable temporary or preliminary storage or landfill. We remind you, to this regard, that current regulations require that such hazardous waste be sent to the category of landfill corresponding to the waste being processed. Therefore, this type of waste, if produced by the removal of compact and intact pipes, can be disposed of in non-

hazardous waste asbestos mono-landfills or landfills with asbestos mono-cell. In the event that asbestos containing waste in friable matrix is produced during operations, the PPE must be classified with the same EWC 15.02.02* but disposed of in hazardous waste landfills.

47. In the event of particularly adverse climatic conditions (e.g. strong winds), we recommend suspending operations to protect the workers.
48. Specific decontamination procedures (preferably at the bottom of the dig) must be implemented for the manual or mechanical work tools used. These must be washed with water, where possible laying a filtering sheet in the area that allows water to pass through and withholds any asbestos fibres. Upon completion of operations, the filtering sheet must be treated with encapsulating solution, placed in a sealed bag and these sealed bags are placed in a special Big Bag until it is full. The various Big Bags can be sent to temporary or preliminary storage or disposed of as asbestos containing waste. We recommend using the EWC 15.02.02* - "Absorbents, filter materials, wiping cloths, protective clothing contaminated by hazardous substances".
49. All the workers assigned to operations in direct contact with the asbestos-cement pipes, such as those assigned to separation/breaking/cutting operations, must be trained in the correct use of PPE and attend specific courses, of 30 hours for workers assigned to removal, disposal and remediation activities (operational) and 50 hours for those who coordinate and supervise removal, disposal and remediation activities (managerial). The specific training must also cover the risk of asbestos in these operations, including on the basis of the indications found in this document, which can be a useful reference for planning specific training courses. These workers must also have certification of attendance of the relative refresher course, preferably every five years.
50. It is preferable for the work stages for the removal of underground pipes to be coordinated and supervised by an "Asbestos Coordinator" having 50 hours of training.
51. In the case of subcontracting asbestos remediation operations, the subcontracted company must always submit to the relevant LPHS its own WP and company details and must meet the professional technical requirements.

The Technical Operating Instructions and the Safety Procedures, Protection Equipment and Controls relating to programmed operations, which are of general nature for the purposes of homogeneity of operations on a national scale, may be adapted to specific contexts.

2. Removal of underground asbestos-cement water pipes: emergency activities

2.1 Technical operating instructions

In addition to the activities mentioned in Chapter 2, the management of water distribution networks requires frequent emergency operations following reports of leaks, making immediate interventions to restore the service for users essential. Therefore, in these cases, it is impossible to programme the work precisely or draft a specific preliminary plan. Therefore, in such situations, operations follow general guideline procedures that must be adapted to the site-specific situation on a case-by-case basis.

For all operations involving the demolition or removal of asbestos containing materials - therefore also for operations involving the demolition and removal of underground asbestos-cement pipes or parts thereof - regulations require the submission of a Work Plan (WP) to the Local Public Health Service (LPHS) responsible for the area. Maintenance activities that may involve the risk of exposure to asbestos, such as laying a seal with a stainless steel repair clamp, instead require notification to be sent to the LPHS.

In emergency situations, a WP must still be filed by the EM but no thirty day warnings are required.

In order to respond to emergencies quickly and appropriately, we recommend preparing a 'standard' WP, agreed upon with the relevant LPHS. This WP should include the operating methods to be adopted and all the possible related risks. Therefore, in the event that an asbestos-cement pipe is found unexpectedly and, having properly considered the type or extent of the breakage, the repair team decides to restore network function by separating/cutting and removing the damaged section (instead of simply laying a containment clamp), the Em can send a specific WP immediately, according with the "standard" WP. In addition to including the date and time of the start of activities, the WP must disclose the reasons why it is an emergency and attach any report that substantiates the emergency.

Modern telematics communication methods allow the WP to be sent very quickly and even outside of normal working hours (where the operations are performed at night or on national holidays).

However, where the repairs involve the separation without cutting and removal of

asbestos containing materials, the Em must send notification, to the competent local supervisory body.

Before performing any emergency operations, all information available on the underground utilities found in the area concerned must be gathered. Such information must identify, localise and characterise all utilities present. The operators assigned to the activities performed according to the WP must be suitably equipped and qualified pursuant to the regulations in force.

As soon as an asbestos-cement pipe is identified and prior to commencing any repairs, the work site manager should warn the Em. Activities may proceed only when the workers, vehicles and equipment used (including the personal protection equipment (PPE)) meet the requirements of existing regulations and comply with the guidelines in this document. Where there is a failure to meet requirements, operations must be suspended immediately, reporting the event to the Contractor so that it may organise the implementation of the safety measures required to resume operations as soon as possible. Pending the implementation of necessary safety measures, the dig area must be covered immediately with polyethylene sheets at least 0.15 mm thick.

All repairs involving direct contact on ACMs must be performed by qualified personnel and by companies registered on the National Register of Environmental Managers for the "Reclamation of property containing asbestos" (Category 10), at least in the sub-category 10A. The transport of waste containing asbestos or contaminated by asbestos must be performed by companies registered under Category 5 or 2-bis (look at pag. 23). The technical and operating instructions to be adopted in general for the emergency removal of asbestos-cement pipes are given below:

1. Even for short operations, the work site must be properly fenced off using easily removed devices (board signs, stands, cones, two-tone tape, etc.) of sufficient number to guarantee full identification and visibility even at night (lamps, etc.). Asbestos hazard warning signs must also be displayed and, where necessary, mobile road work site warning signs, in order to eliminate or reduce interference between the work site area and the surrounding areas. Access must always be prohibited to unauthorised persons and anyone not engaged in the repairs must be denied access to the work site, where possible, informed of the work in progress.
2. Where possible and applicable, the supply of utilities that uses the network subject to operations should be interrupted before operating on ACMs. Where this is not possible, the relative risks must be assessed and specific precautionary measures taken.
3. By way of precaution, the stages and time frame for the removal of pipes and all excavation material must be reduced to a minimum.
4. According to the actual depth of the dig and the nature of the soil, the static safety of the walls must always be guaranteed, including via the use of provisional structures (e.g. reinforcements, formwork, pillars, etc.), in order to oper-

ate in safety (consider, however, that water supply pipes are usually laid no deeper than 1.5 metres). Any cement box surrounding the pipe must also be removed.

5. In the event of a massive leak, the pressurised water that leaks from the pipe usually causes the complete washout of the soil surrounding the underground pipe and often the erosion causes the (full or partial) collapse of the road pavement. In such cases, the pipe is usually completely immersed in mud at the breakage point and operations are particularly complex.

Such operations require the following considerations:

- It is common practice, after removing the asphalt layer and the first layer of semi-solid sludge, to identify the position and depth of the pipe using a special probe.
 - Once the position of the pipe has been identified, digging of the semi-solid mass vertically down the sides of the pipe can proceed to reach the depth of the pipe channel.
 - Having considered the amount of water leaked from the pipe from the time of breakage to the moment the gate valve was closed requires understanding the drainage conditions and the likelihood that the drainage is impaired. Depending on the amount and density of water/mud in the dig, the liquid mass may be removed using a submersible centrifugal pump placed at the bottom of the dig or a mud pump installed on the edge of the dig, in order to speed up repair operations. The delivery pipe must in any case channel the liquid into the sewer to avoid dispersion on impermeable pavement (asphalt, cement, etc.), as it could dry off and lead to the dispersion of fibres into the atmosphere. Where this is not possible, the liquid must be collected and sent for disposal. As a precaution, it is recommended that you dispose of this liquid with EWC 16.10.01* - "Aqueous liquid wastes containing hazardous substances". This is by way of precaution, given that there is no prior knowledge of the concentration of fibres it contains, or, following analysis, the relative mirror EWC can be adopted. In non-built-up areas, the liquid can be discharged into the ground using a suitable channelling system.
6. For operations in dry conditions, or in the case of semi-solid sludge, the following actions should be taken (Figure 13):
 - Once the asphalt layer and first layer of soil have been removed, identify the position and depth of the pipe using a dedicated probe.
 - The Em may justify the need to perform digs with depths other than 15 cm, depending on the specific site situation, in the WP sent to the LPHS in charge.
 - In the case of water in the bottom of the dig, it can be allowed to drain naturally or flow into the sewer using a suitable channel. The dispersal of water on impermeable paving (e.g. asphalt, cement, etc.) is not allowed as it could dry off and lead to the dispersion of fibres into the atmosphere. Alternatively, the liquid must be collected and sent for disposal. It is recom-

mended that you dispose of this water with EWC 16.10.01* - "Aqueous liquid wastes containing hazardous substances"; this is by way of precaution, given that there is no prior knowledge of the concentration of fibres it contains, or, following analysis, the relative mirror EWC can be adopted. In non-built-up areas, it can be discharged into the ground using a suitable channelling system.

- The earth on top of and surrounding the pipe must be removed by hand, where present and semi-solid.

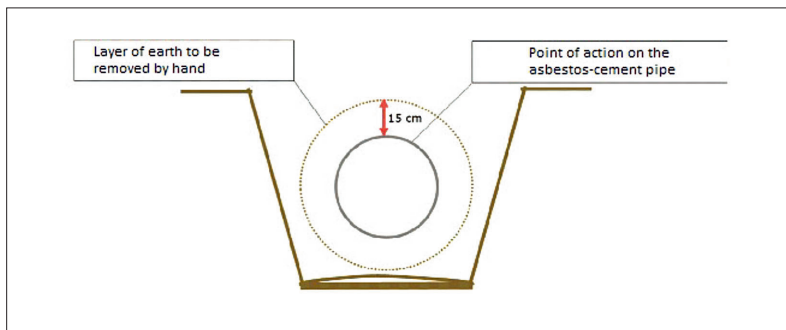


Figure 13 - Uncovering an asbestos-cement water pipe.

- To complete the pipe cleaning operation, the sections affected by separation/breakage/cutting, unless already thus following soil erosion by the pressurised water leaking from the pipe, must be fully uncovered using hand tools (shovels, spades, trowels, etc.), taking care not to scrape the outer surface of the asbestos-cement pipe (Figure 14).



Figure 14 - Uncovering an asbestos-cement pipe using hand tools.

- The outer surface of the pipe must be sprayed with (preferably biodegradable) Type D encapsulating liquid (pursuant to Ministerial Decree of 20 August

- 1999). In the case of terminal section of the network, well joint or coupling, encapsulation should also be carried-out, where possible, for the inner surface of the conduit to remove.
9. With the pipe fully uncovered and partially suspended, where the glove-bag technique is not used, a high-density polyethylene sheet at least 0.15 mm thick, or an equivalent "geotextile non-woven fabric" sheet between the pipe should be laid on the underlying soil. These underlays are to be placed at least under every area of separation/breakage/cutting and extended according to the specific repair conditions. In the case of the presence of water in the dig, the specific operating methods are to be evaluated to guarantee its effectiveness (e.g. sheet suspended under the pipe, etc.).
 10. Before starting separation/cutting, all the equipment necessary for performing the repair must be placed in the dig, or left alongside the trench, far from the edge and in a safe position, in order to reduce the need to enter the dig during repairs, which could lead to the contamination being exported to the other areas of the work site.
 11. Repairs should identify and utilize joint, where technically feasible, to separate the section to be removed from the next section, preferably without cutting or breaking. As a final solution, where it is technically impossible to use existing joints without cutting or breaking, operators may use the glove-bag technique or cut the pipe, using one of the methods outlined in part 12 below, only after having ensured that the cutting points and uncovered section of pipe have been encapsulated. It is recommended that you spray the operation area, preferably with a mist cannon, whilst the pipe is being uncovered. This is not required in the case of the glove-bag technique.
 12. The pipe cutting repairs must be performed using suitable instruments, including:
 - hand saw (dry sawing) for small diameter pipes, to be used only when operating under forced suction using HEPA H13 (or above) absolute filters or continuous spraying of the cutting area using Type D encapsulation coating, preferably one that is biodegradable. At the end of the operation, the saw must be encapsulated, sealed in a bag and sent for disposal at the end of the working day (considering its rapid wear and low cost). It is recommended that you dispose of the used HEPA filters as asbestos containing waste with EWC 15.02.02* - "Absorbents, filter materials, wiping cloths, protective clothing contaminated by hazardous substances";
 - low-speed petrol jigsaw fitted with integrated systems for continuously spraying the cutting area with water or impregnating encapsulating solution. Such instrument must be used for pipes with diameter and thickness compatible with the length and characteristics of the saw blade. At the end of operations, the blade and the saw must be wet cleaned as far as possible and stored in a dedicated sealed container;
 - hand chain pipe cutters (dry cutting, Figure 15 with forced suction and HEPA H13 (or above) absolute filters or continuous spraying of the cutting area using

Type D encapsulation coating (preferably biodegradable). At the end of repairs (or work-day), the tool must be wet cleaned and stored in a dedicated sealed container. It is recommended that you dispose of the used HEPA filters as asbestos containing waste with EWC 15.02.02* "Absorbents, filter materials, wiping cloths, protective clothing contaminated by hazardous substances".



Figure 15 - Detail of machining using hand chain pipe cutters.

All work equipment must be chosen according to the specific site conditions, with the aim of reduce dust to a minimum. Any visible swarf produced during cutting must be collected, whether in powder or mud form.

Where operations are performed on water networks where water is present, the equipment must prevent electric shocks.

Medium/high speed cutting instruments fitted with integrated systems for continuously spraying the cutting area with water or impregnating encapsulating solution (e.g. chainsaws, etc.) cannot be used. In the future, the use of such tools may be permitted only after appropriate testing and monitoring to assess their effectiveness and the levels of exposure generated for workers and the environment. These type of tools should be used for pipes with diameters exceeding 800 mm and/or of significant thickness; at the end of operations, the tool must be wet cleaned as far as possible and stored in a dedicated sealed container.

Angle grinders (Flex grinders), which generate high fibre dispersion and significant risks for operators and surrounding living environments, are always forbidden. Additional medium/high speed, dry-use electric tools, such as the electric jigsaw.

The glove-bag technique may also be used to remove sections of asbestos-cement pipes. This method may be adopted only after a site specific feasibility analysis and practical tests to determine in advance the maximum diameter and length of the pipe segments for which the technique may be applied. The

feasibility analysis must describe the operating stages and specific procedures, including the choice of cutting tool/method, the treatment of any water that accumulates in the glove bag and the method of collecting, handling and disposing of the waste produced.

13. Before laying/connecting up the new replacement pipe, the connection points with the old pipe must be wet cleaned or vacuumed using forced suction with absolute filters (HEPA H13 or above). In addition, the outer surface of the pipe must be sprayed with a (preferably biodegradable) Type D encapsulating coating. We recommend avoiding, trimming, filing or shaping the two ends of the old pipe. But should these methods become necessary, the same precautions required for separation/cutting must be implemented. This prevents the potential dispersion of fibres into the atmosphere.



Figure 16 - Detail of the branch point.

14. Wherever possible, instead of simply cutting and replacing a damaged section of pipe, we recommend replacing the whole section of pipe (from joint to joint) that includes the damaged part (Figure 10) to prevent possible further breakage close to the section due to the settling of the pipe.
15. The separated piece/s of pipe must be harnessed and lifted to be sprayed again with (preferably biodegradable) encapsulating liquid, focusing particularly on the outer surface, breakage points, cutting faces of pipes or sections and spraying inside the pipe too, where possible.
16. The removed pipes can be laid on the ground, on suitable sheets, to be wrapped in sealed packages and labelled (Figure 11) with the name of the producer of the waste, an asbestos warning and the code R (hazardous waste). We recommend using the EWC 17.06.05* - "Construction materials containing asbestos". The pipes must be packaged either at the bottom of or alongside the dig, depending on the specific situation, whilst the material is still wet.
17. All the waste produced (earth, pipes, PPE, etc.) must be removed from the work site area on suitable vehicles, preferably on the same day or upon reach-

- ing a first payload and, in any case, within the deadline indicated for temporary storage. This waste can then be sent for temporary or preliminary storage or final disposal in hazardous waste landfills or non-hazardous waste asbestos mono-landfills or landfills with asbestos mono-cell.
18. We recommend the use of vehicles fitted with a loading bed with sides and a fixed or mobile cover system, to ensure protection of the load. The vehicles should be registered on the Environmental Managers Register for the transport of hazardous waste (Category 5 or 2-bis for quantities below 30 kg).
 19. If the pipes break or are found already partially worn and broken, any sharp fragments or visible residue (of both pipes and bundles of mineral fibres left in the ground following the disintegration of the cement matrix) must be sprayed with Type D encapsulating liquid (preferably biodegradable), removed manually and bagged in special sealed packages (preferably rigid in the case of sharp fragments) or in polypropylene raffia sacks and then placed immediately in Big Bags (waterproof if using raffia), to prevent the packaging from tearing or breaking open. Any large fragments must not be broken up on the work site to be fitted into the Big Bags, but instead must be sealed separately using polyethylene sheets of suitable thickness and size and then labelled to avoid the potential dispersion of asbestos fibres into the air.
 20. Any other waste produced on the work site must be duly sealed in special packages, labelled with the name of the waste producer and the EWC of the waste contained.
 21. Any polyethylene or geotextile sheets, as outlined in part 11, removed from the dig must be sprayed with Type D encapsulating liquid and bagged in special sealed packages and correctly labelled as waste. We recommend classifying them with EWC 15.02.02* "Absorbents, filter materials, wiping cloths, protective clothing contaminated by hazardous substances" and sending them to temporary storage or appropriate landfill.
 22. The limited quantity of soil removed from under the section of pipe affected by the cutting operations (in the absence of a protective sheet or filtering geotextile sheet, or in the case of activities performed without applying the glove-bag technique) must be considered to be contaminated. Therefore, it must be packaged in special polyethylene bags and placed in Big Bags, which are to be sealed and labelled with the name of the waste producer, an asbestos warning and code R (hazardous waste). These bags must then be placed alongside the dig, away from the edge at a distance ensuring the safety of workers, and be removed from the work site together with other hazardous waste, to be sent for disposal. For this waste, we recommend following EWC 17.05.03* - "Soil and stones containing hazardous substances", without their characterization in laboratory, in consideration of the proven difficulty in characterising ground containing or contaminated by asbestos, avoiding too long and costly analysis for reaching Italian TLV in industrial and residential sites = 1000 mg/kg or in agricultural sites = 100 mg/kg.

23. In the case of repairs that extend beyond the working day, the dig must be kept covered and secure until work resumes the following day.
24. At the end of the repairs, once the dig has been cleared and before it is filled in, according to the WP, a visual inspection must be performed to check the actual removal of all waste potentially contaminated by asbestos.
25. Once the visual inspection has been completed successfully, unless polyethylene or geotextile sheets were laid (as outlined in part 9) or the glove-bag technique used, at least 15 cm of soil underlying the separation/breakage/cutting area must be removed. Then the bottom of the pipe trench can be levelled and compacted and the dig filled in. In this case, legally compliant inert material must be used before installing the new pipe.
26. The contractor must maintain records of all procedures and create a final report that describes precisely the repairs undertaken. Whenever possible, the use of geolocation devices on the sections identified (e.g. radio frequency devices) should be used. The information must be entered and stored on a dedicated IT platform (preferably via the implementation of a GIS/SIT) and continuously updated, as well as recorded in the DVR.
27. At the end of each year, the Em should send to Inail Dit (dit@inail.it) all data relating to the individual repairs undertaken during the preceding business year (contractor, company executing the works, work site location, number of workers employed on the work site, pipe diameter, linear metres removed, amount of ACW produced and relative EWC, place of storage, etc.) for research purposes. Similarly, we recommend all data also be sent to the regional authorities, for updating the National Asbestos Mapping.

2.2 Safety procedures, protection equipment and controls

28. Access to the work site is forbidden for personnel with inadequate training on the operations underway and the specific risks related to the activities to be performed, and most specifically asbestos risks.
29. Where asbestos-cement pipes are identified, we advise, as a precaution, that the owner or manager of the network appoint one supervisor in charge of the whole network or per section within 60 days. This person is similar to an Asbestos risk officer (ARO), and must have undergone appropriate and certified training. The designated supervisor should be chosen from among the more highly qualified operators working for the network owner or manager. The role of the individual appointed to be supervisor would be as following:
30. monitor and coordinate all maintenance and removal activities that may involve asbestos containing materials;
31. verify the creation of and keep documents showing the location of asbestos containing materials;

- maintain suitable documentation of the operations performed and to be performed involving asbestos containing materials;
 - indicate the general measures to be adopted to comply with safety procedures during the maintenance and removal of asbestos containing materials, possibly even coordinating the activities of third companies.
32. During removal operations, it is strictly forbidden to smoke, eat or drink in the whole work site area.
 33. Given that the work site area must be off-limits to unauthorised personnel, all personnel not assigned to direct operations on asbestos-cement pipes must be kept away from the area during operations.
 34. According to the results of the risk assessment suitable Personal Protection Equipment (PPC and PPE) must be used (such as high-visibility clothing, protective helmet, protective glasses and ear defenders/earplugs, etc.). In particular, to ensure the protection of the health of operators assigned to direct contact with asbestos-cement pipes, these operators must be equipped with specific Category III PPE that, if reusable, must be individually labelled with the name of the worker. The assigned workers must use appropriately the personal protection equipment provided, in compliance with the information/education and practical training received, and must report immediately any equipment defects to the Em, supervisor or person in charge.
 35. For all Category III PPE intended to protect from the risk of death or serious and permanent injury, as well as information and education activities, users must receive adequate practical training. In particular, attention must be given to the correct use of specific asbestos PPE (disposable masks must not be reused; masks must not be worn around the neck or on the head and used only during one-off actions; the hood of the bodysuit must not cover the eyes during operations; etc.).
 36. The suitability and adequacy of the PPE to be supplied, whether asbestos specific or not, must always be checked as to type and wearability. PPE must comply with technical standards in terms of the risk prevention and protection for which it is used and also be ideally suited to the comfort, shape and health requirements of the individual who wears it. Every Em must therefore take great care when choosing the type, size and number of PPE to be provided at the work site and to each worker (e.g. not buy one size of bodysuit for all operators, with the risk of them being too big and an impediment, for some and too small, with the risk of tearing at the seams, for others).
 37. In particular, we recommend the use of gloves, non-woven, Category 3, Type 4-5 or similar disposable bodysuits with hood to be worn underneath the helmet and seams covered with adhesive tape. In the case of operations without a personal decontamination unit (DCU), in order to guarantee maximum operator safety, we advise wearing two bodysuits, one over the other. Operators must also wear rubber boots or waterproof safety footwear (to be washed thoroughly with water at the end of each shift).

- 37 The trousers of the bodysuit must be pulled down over the boots or footwear and sealed with tape. The gloves and bodysuit cuffs must also be sealed with tape. The use of non-woven or similar slippers must be avoided.
- 38 With regard to respiratory protection, we recommend the use of disposable P3 filter face masks (FFP3) or half face masks with P3 filter, to be worn under the hood of the bodysuit to enable correct decontamination when leaving the work site. It must be remembered that beards, moustaches and long sideburns must be prohibited because they interfere with the seal of respiratory protection devices, preventing them from fitting perfectly to the face.
- 39 In the event of operations without a specific DCU (programmable removal of short sections of pipe), the removal of PPE must require the disposable bodysuit to be taken off whilst still wearing the respiratory protection device and actions must be performed in the following order:
 - a. before undressing, wet the outside of the bodysuit, gloves and footwear with water (spray/mist); therefore, there must be a suitable water supply in the work site;
 - b. remove the tape used to seal the gloves and footwear;
 - c. undo the velcro parts of the bodysuit (at the neck and along the zip);
 - d. remove the gloves;
 - e. open the zip of the bodysuit;
 - f. take down the hood;
 - g. start to remove the bodysuit, taking care to roll it down from top to bottom and towards the outside to contain the contaminated part;
 - h. slip the feet out of the bodysuit;
 - i. place it immediately into a sealed disposable bag together with the tape removed in part a) and the gloves;
 - j. place the bag in a dedicated sealed sack, to be put in Big Bags later;
 - k. remove the work footwear after cleaning thoroughly with water;
 - l. in the case of double bodysuits, the one underneath must be removed in a non-contaminated zone whilst still wearing the FFP3 mask, which must only be removed after everything else.

Finally, only after everything else has been removed, the respiratory protective device may be removed. Reusable PPE must be washed and stored in a sealed bag; disposable PPE must be placed in a sealed bag separate from the other PPE or waste, prior to disposal. Please note that disposable protective bodysuits, being sealed, are inevitably damaged/torn when opened or removed. This is why they must be replaced even only after going to the bathroom. After undressing, hands must be washed with neutral soap and lots of water before leaving the work site and performing activities such as smoking, eating, touching habitually used objects, etc.

40. In the event of the need to wear high-visibility clothing, this must be worn by personnel only outside of the dig. At the end of operations, they must be placed in a closed and sealed bag to be reused in another work site with ACMs

or packaged in Big Bags to be disposed of as waste. The Big Bags must then be sent to temporary or preliminary storage or final disposal, as asbestos containing waste. We recommend the use of EWC 15.02.02* - "Absorbents, filter materials, wiping cloths, protective clothing contaminated by hazardous substances".

41. Workers assigned to packaging and moving asbestos containing waste within the work site may take off their PPE only after cleaning the packages of waste.
42. PPE used by personnel who have worked in direct contact with asbestos containing materials, removed after wetting, must be duly packaged and labelled with the name of the waste producer, an asbestos warning, the identification code R (hazardous waste and the EWC of the waste contained; in particular, we recommend that PPE be classified and disposed of with code 15.02.02* - "Absorbents, filter materials, wiping cloths, protective clothing contaminated by hazardous substances" - and sent to suitable temporary or preliminary storage or landfill. We remind you, to this regard, that current regulations require that such hazardous waste be sent to the category of landfill corresponding to the waste being processed. Therefore, this type of waste, if produced by the removal of compact and intact pipes, can be disposed of in non-hazardous waste asbestos mono-landfills or landfills with asbestos mono-cell. In the event that asbestos containing waste in friable matrix is produced during operations, the PPE must be classified with the same EWC 15.02.02* but disposed of in hazardous waste landfills.
43. Specific decontamination procedures (preferably in the bottom of the dig) must be implemented for the manual or mechanical work tools used. These must be washed with water, where possible laying a filtering sheet in the area that allows water to pass through and withholds any asbestos fibres. Upon completion of operations, the filtering sheet must be treated with encapsulating solution, placed in a sealed bag and these sealed bags are placed in a special Big Bag until it is full. The various Big Bags can be sent to temporary or preliminary storage or disposed of as asbestos containing waste. We recommend using the EWC 15.02.02* - "Absorbents, filter materials, wiping cloths, protective clothing contaminated by hazardous substances".
44. All the workers assigned to operations in direct contact with the asbestos-cement pipes, such as those assigned to separation/breaking/cutting operations, must be trained in the correct use of PPE and attend specific courses of 30 hours for workers assigned to removal, disposal and remediation activities (operational) and 50 hours for those who coordinate and supervise removal, disposal and remediation activities (managerial). The specific training must also cover the risk of asbestos in these operations, including on the basis of the indications found in this document, which can be a useful reference for planning specific training courses. These workers must also have certification of attendance of the relative refresher course, preferably every five years.
45. It is preferable for the work stages for the removal of underground pipes to be

coordinated and supervised by an “Asbestos Coordinator” having 50 hours of training..

46. We remind you that, in the case of subcontracting asbestos remediation operations, the subcontracted company must always submit to the relevant LPHS its own WP and company details (pursuant to the provisions of article 256 of Leg. Decree 81/2008 and subsequent additions and amendments) and must meet the professional technical requirements as outlined above.

The Technical Operating Instructions and the Safety Procedures, Protection Equipment and Controls relating to programmed operations, which are of general nature for the purposes of homogeneity of operations on a national scale, may be adapted to specific contexts.

3. Conclusions

What we have illustrated herein is the result of a preliminary study on a national and international scale of the problem of ACM removal as well as research conducted in the field and observation of actual work sites over many years and basic and operational research by means of field experiments, as well as many years' experience. It is also the result of cooperative effort between public and private authorities.

The document includes, in the form of a user manual, sector regulations that influence the implementation of removal operations and indicate the procedures to be adopted prior to these operations and during work in order to ensure maximum protection of workers and of the environment surrounding the area of operations. These procedures may be subject to periodic updating on the basis of feedback following their application.

These procedures were developed because of the need to provide precise guidelines as a national reference, due to a lack of specific sector regulations. This lack has led, in some cases, to uncertainty over the authorisation, operational methodologies and supervisory procedures to be applied and consequently to different applications in most of the Italian regions .

The study also has the aim of encouraging the collection of data on underground asbestos-cement pipes and their remediation, with subsequent notification to the regional authorities. The purpose of this is to implement the mapping of national areas affected by the presence of asbestos. Indeed, knowledge of specific data on the diffusion of underground utility networks in asbestos-cement and their georeferencing may enable the medium and long-term planning of pipe removal operations, on both regional and local scale. Over time, these pipes are becoming increasingly obsolete and require gradual replacement. Such planning is important in order to prevent the continuation of spot operations involving the partial removal of certain sections of pipe that lead to greater overall costs, in the long term, of national remediation operations.

Frequently asked questions (Faq)

Q. What are the requirements for companies undertaking the removal of asbestos-cement pipes?

A They must be registered on the National Register of Environmental Managers, Category 10 and the operators must be qualified and have undertaken due theoretical and practical training;

Q Do you have to submit a Work Plan (WP) to the LPHS for the replacement/cutting and removal of underground asbestos-cement pipes?

A Yes, always.

Q Who has to coordinate the correct execution at the work site of works to replace/cut and remove underground asbestos-cement pipes?

A The work stages must be supervised by an asbestos coordinator who has undergone 50 hours' training.

Q Do workers engaged in replacing/cutting and removing pipes have to wear a normal bodysuit?

A No, they must wear specific Personal Protection Equipment (PPE).

Q Does the bodysuit have to cover the head?

A Yes, always. The non-woven fabric or similar bodysuit must only leave the face uncovered, which must in turn always be protected, as regards the airways, by a suitable P3 filter face mask.

Q Does the mask go over or under the bodysuit?

A The mask must always be worn under the bodysuit, so that the operator's airways are always protected during undressing, when fibres may be dispersed into the air.

Q What airway protection PPE must be used?

A The choice of suitable PPE depends on the machining to be undertaken and must be assessed in the Risk Assessment Document (Rad). In general, for operations on asbestos containing materials in compact matrix, half-masks with P3 filters or P3 filter face masks. (FFP3) are used.

Q Can you use non-woven fabric slippers or similar?

A It is not recommended, insofar as work is undertaken in an outdoor environment on rough and abrasive surfaces and ground, which often cause them to tear. This constitutes an undue risk for workers.

Q Can disposable bodysuits be thrown away in the skip?

A No, it must be bagged and collected in special packages, to be labelled and managed as hazardous waste containing asbestos.

Q Who is the person mainly responsible for protecting the workers' health?

A The Employer (Em).

Q What are the obligations of the Em with regard to the use of PPE?

A He must assign each PPE to individual use; he ensures that the PPE is used only for its intended purpose; he informs workers on the risks from which the PPE protects them; he ensures workers receive adequate training; he organises, where required or in any case recommended, specific practical training; he provides clear instructions for workers; he makes available in the company adequate information on PPE; he keeps the PPE in good working condition and ensures conditions of good hygiene by means of maintenance, repair and replacement, where necessary; where circumstances require the use of the same PPE by multiple workers, he takes appropriate measures to ensure such use does not cause any health or hygiene issues for the different users; he provides workers with instructions on using and returning PPE.

Q What are the workers' obligations with regard to the use of PPE?

A They must follow the theoretical and practical training programme organised by the Em; they must use the PPE provided by the Em; they must take good care of the PPE provided; they must not make any alterations to the PPE without permission. Workers must report immediately any PPE defect or glitches to the Em or director or person in charge.

Q Which is the body responsible for supervising compliance with the application of the occupational safety and health regulations that the Em must adopt?

A The Local Public Health Service (LPHS).

Q What is spray encapsulation?

A It is the dispersion of micronized fluid into the air to suppress dust during digging and any fibres released during the handling of ACMs.

Q During replacement/cutting, what is the function of the encapsulating fluid?

A It is a coating that is sprayed on the asbestos-cement pipes to make the surface fibres stick to the cement substrate, thus preventing their dispersion.

Q Do the equipment and vehicles used in the work site have to be washed at the end of the day?

A Preferably yes, for precautionary purposes.

Acknowledgements

We would like to thank the following for their invaluable technical and scientific contribution:

- Marco Giangrasso and Elvio Cipollone (ISPRA); Biagio Bruni (ISS);
- Nicoletta Cornaggia (Lombardy Regional Authority); Giorgio Schellino (Piedmont Regional Authority);
- Pier Giuseppe Calà (Tuscany Regional Authority);
- Emanuela Bregolato, Duccio Calderini, Giovanna Cozzi, Carmine Scalone (ATS Insubria);
- Alberto Righi, Giuseppe Ortu, Marco Solci (ATS Valpadana- Mantova); Angelo Robotto, Paola Balocco, Albino De Filippi (RPES Piemonte); Glauco Spanghero, Itala Pellegrini (RPES Friuli Venezia Giulia);
- Adriano Fava, Tiziana Bacci (RPES Emilia Romagna); Manuela Laterza (RPES Puglia);
- Silvia Bucci (RPES Toscana);
- Teresa Oranges, Luigi Dattola, Francesco De Vincenti, Natalia Fera, Luisa Ferro (RPES Calabria);
- Lorenzo Bardelli (ARERA) Chiara De Blasi (ANEA);
- Mariano Grillo e Raffaele Rizzo (MATTM); dott. Pietro Abbati Marescotti (Infratel Italia Spa);
- Paolo Carta, Lorenzo Lama, Elena Mauro, Bernardo Piccioli, Valeria Rossi, (Utilitalia Spa);
- Gian Paolo Montermini (Iren Spa); dott. Marcello Togni (HERA Spa);
- Valeria Dal Borgo, Andrea Bertacchini, Dario Mamma Zagarella (Aimag spa).
- We also thank the following for their invaluable technical, operational and logistical contribution during experimental activities:
- Alessandro Vedani, Samuele Salvo, Gianmarco Bonenti, Alice Bagni, Luciano Mesiti, (Vedani srl);
- Paolo Reggiani, Matteo Benassi, Vittorio Asplanato, Luca Iembo, Christian Marchetti, Luca Zaffanella, Tristano Caramaschi, Paolo Zago (Ireti spa);
- Paolo Subacchi, Giorgio Cavandoli, Luciano Coccolini (Iren Spa); Carmine Laudando, Andrea Tisi (Tre emme snc).
- Anna Grassini, J.D.

Bibliography

- American Water Works Association, "Asbestos-Cement transmission pipe, 18 in. through 42 in. (450 mm through 1,050 mm), for water supply service", ANSI/AWWA C402-00, Sept. I, 2000.
- American Water Works Association, "The selection of asbestos-cement transmission pipe, 18 in. through 42 in. (450 mm through 1,050 mm), for water supply service", ANSI/AWWA C403-00, Sept.1, 2000.
- American Water Works Association, "Asbestos-Cement pressure pipe, 4 in. through 16 in. (100 mm through 400 mm), for water distribution systems", ANSI/AWWA C400-93, Jan.25, 1998.
- American Water Works Association, "Installation of asbestos-cement pressure pipe", ANSI/AWWA C603-96.
- EU-OSHA- Agenzia Europea per la Sicurezza e la Salute sul Lavoro, "Guida alla campagna sulla salute e sicurezza negli ambienti di lavoro in presenza di sostanze pericolose", ISBN 978-92-9496-411-3.
- Institut National de la Recherche Scientifique: Santé et sécurité au travail, "Travaux sur canalisations enterrées en amiante-ciment", brochure INRS, Janvier 1998.
- Keyes D.L., Bertram P.P., Chesson J., "Guidance for controlling Asbestos-Containing Materials in Buildings", Report EPA 560/5-85-024, June1985.
- Marinaccio A. Binazzi A., Bonafede M., Branchi C., Bugani M., Corfiati M., Di Marzio D., Scarselli A., Iavicoli S., Verardo M., Mirabelli D., Gennaro V., Mensi C., Schallenberg G., Fedeli U., Negro C., Romanelli A., Chellini E., Grappasonni I., Masanotti G., Romeo E., Trafficante L., Angelillo I.F., Cavane D., Cauzillo G., Tallarigo F., Tumino R., Melis M., Mazzoleni G., Carrozza F. e gruppo di lavoro ReNaM, "Il registro nazionale dei mesoteliomi - VI rapporto", Inail - Milano, settembre 2018. ISBN 978-88-7484-122-6
- Massachusetts Department of Environmental Protection (MassDEP), "Asbestos-cement pipe guidance document and conditional enforcement discretion", June 2011, amended May 22, 2015.
- Milano V., "Acquedotti -Guida alla progettazione", Hoepli, 1996.

- Occupational Safety and Health Administration, Department of Labor, "Asbestos", Occupational Safety and Health Standards, Toxic and Hazardous Substances, OSHA Standard Number 1910.1001.
- Paglietti F., Malinconico S., Conestabile della Staffa B., Bellagamba S., De Simone P., "Classification and management of asbestos-containing waste: European legislation and the Italian experience", Waste Management, Volume 50, Elsevier-2016, pp. 130-150. Impact Factor: 3.220; 5-Year Impact Factor: 3.522, ISSN: 0956-053X.
- Paglietti F., Bellagamba S., Malinconico S., Conestabile della Staffa B., De Simone P., Santurri E., "Classificazione e Gestione dei Rifiuti contenenti Amianto - Istruzioni operative Inail ai fini della tutela della salute e sicurezza dei lavoratori e degli ambienti di vita", Edizione Inail 2014. ISBN 978-88-7484-420-3.
- Paglietti F., Conestabile della Staffa B., Bellagamba S., "Mappatura delle discariche che accettano in Italia i Rifiuti Contenenti Amianto e loro capacità di smaltimento passate, presenti e future", Edizione Inail 2013. ISBN 978-88-7484-337-4.
- WHO Regional Office for Europe, "Air quality Guidelines for Europe", Copenhagen, 2000.
- United States Department of Labor, "Requirement for tapping or tying-in to asbestos-containing cement water pipes in construction", Standard Interpretation of 05/29/2008.
- United States Department of Labor, "The use of pipe cases" manufactured by Therm-Equip., Inc., in lieu of standard glove bags", Standard Interpretation of 12/12/1995.

Italian and European Regulatory References

- Memorandum of the Ministry of Labour and Social Policies of 25 January 2011 on the "Sporadic and low-intensity exposure (SLIE) to asbestos during the activities outlined under art. 249, par. 2 and 4 of Leg. Decree no. 81 of 9 April 2008"
- Presidential Decree of 8 August 1994, "Guidelines and coordination of the autonomous regions of Trento and Bolzano for the adoption of plans of protection, decontamination, disposal and remediation of the environment, for the purposes of defence from the dangers of asbestos", published in Official Journal no. 251, General Series, Part I of 26 October 1994.
- Ministerial Decree of 6 September 1994, "Regulations and technical methods of application of art. 6, par. 3 and art. 12, par. 2 of Law no. 275 of 27 March 1992 on ending the use of asbestos", published in Ordinary Supplement no. 156 of Official Journal no. 288 of 10 December 1994.
- Legislative Decree no. 114 of 17 March 1995, "Implementation of Directive 87/217/EEC on the prevention and reduction of environmental pollution caused by asbestos", published in Official Journal no. 92, General Series, Part I of 20 April 1995.
- Decree of the Ministry of Health of 14 May 1996, "Regulations and technical methods for remediation operations, including those to render asbestos harmless, provided for by art. 5, par. 1, letter f) of Law no. 257 of 27 March 1992, including: "Rules on ending the use of asbestos", published in Official Journal no. 251 of 25 October 1996, General Series.
- Ministerial Decree of 20 August 2000, "Extension of the regulations and technical methods for remediation operations, including those to render asbestos harmless, provided for by art. 5, par. 1, letter f) of Law no. 257 of 27 March 1992, including the rules on ending the use of asbestos", published in Official Journal no. 249 of 22 October 1999.
- Decree of the Ministry for the Environment and the Protection of Land and Sea no. 468 of 18 September 2001, "National programme of remediation and environmental recovery of contaminated sites", published in Ordinary Supplement no. 10 of Official Journal no. 13 of 16 January 2002.
- Decree of the Ministry for the Environment and the Protection of Land and Sea no. 101 of 18 March 2003, "Regulations for the mapping of areas of national territory affected by asbestos pursuant to article 20 of Law no. 93 of 23 March 2001", published in Official Journal no. 106 of 9 May 2003.

- Decree of the Ministry of Health of 14 December 2004, "Prohibition of the installation of materials containing intentionally added asbestos", published in Official Journal no. 31 of 8 February 2005.
- Legislative Decree no. 152 of 3 April 2006, "Environmental regulations", published in Ordinary Supplement no. 96 of Official Journal no. 88 of 14 April 2006.
- Legislative Decree no. 81 of 9 April 2008, "Implementation of article 1 of Law no. 123 of 3 August 2007 on the protection of health and safety in the work place", published in Official Journal no. 101 of 30 April 2008.
- Legislative Decree no. 106 of 3 August 2009, "Provisions for the integration and amendment of Legislative Decree no. 81 of 9 April 2008 on the protection of health and safety in the work place", published in Official Journal no. 180 of 5 August 2009.
- Legislative Decree no. 33 of 15 February 2016, "Implementation of Directive 2014/61/EU of the European Parliament and of the Council of 15 May 2014, including measures to reduce the costs of installation of high-speed electronic communication networks", published in Official Journal no. 57 of 9 March 2016.
- Decree of the Ministry for the Environment and the Protection of Land and Sea of 27 September 2010, "Definition of the criteria of admissibility of waste in landfills, in replacement of those included in the Decree of the Ministry for the Environment and the Protection of Land and Sea of 3 August 2005", published in Official Journal no. 281 of 1 December 2010.
- Legislative Decree no. 205 of 3 December 2010, "Provisions of implementation of Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste repealing certain directives", published in Ordinary Supplement no. 288 of 10 December 2010.
- Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste repealing certain directives, published in Official Journal of the European Union no. L 312/3 of 22 November 2008.
- Law no. 257 of 27 March 1992, "Rules on the end of the use of asbestos", published in Ordinary Supplement no. 64 of Official Journal no. 87 of 13 April 1992.
- Law no. 93 of 23 March 2001, "Environmental provisions", published in Official Journal no. 79 of 4 April 2001.
- Regulation (EC) no. 1272/2008 of the European Parliament and of the Council of 16 December 2008 on the "classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) no. 1907/2006", published in Official Journal of the European Union no. L 353/1 of 31 December 2008.