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Paper 1

SAFETY AT WORK MANAGEMENT DURING NO-DIG TECHNOLOGIES APPLICATION

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ABSTRACT: No-dig technologies, or trenchless technologies, are certainly among the most effective technologies as they allow a low environmental impact and, at the same time, a significant reduction in the social/ environmental costs of pipe rehabilitation works. However, on the subject of prevention and protection of workers' health and safety, it is necessary to operate a deep investigation into some issues that, depending on construction sites' organizational arrangements, as also represented by the photographs and films disseminated for promotional purposes, appear improvable. In particular, in addition to standard prevention measures that must necessarily be adopted regarding road construction site establishment, two main issues deserve particular attention: one relating to confined spaces activities safety legislation application and, the other, looking to activities into Asbestos-Cement (AC) existing pipes. Concerning the first issue, this involves defining a better organization of the worksite with the elaboration of specific procedures that take into account operational management under ordinary conditions but, in particular, define the actions to be put in place in case of allowing an adequate response in case of unexpected situations due to failures or change in the operating environment. Among the situations attributable to the possible "evolutionary risk," certainly the management of a possible medical emergency assumes a fundamental role, especially for all those so-called "time-dependent" pathologies, concerning which, in addition to adequate first aid personnel training, a precise definition of the "who does what" and the preparation of technical rescue equipment suitable for the specific context of use is necessary. Concerning the second issue, it should be pointed out that any activity to be carried out inside operating AC pipes (e.g., internal mechanical cleaning, relining, etc.), involves the need to deal with potentially contaminated materials and/or equipment and, therefore, the definition of specific operating and authorization procedures is necessary.

1. INTRODUCTION

Renewal of damaged and worn pipes is becoming a significant maintenance concern for commercial industries and municipalities collection systems (water and wastewater underground infrastructure) that have reached beyond the ends of their service lives. Many water utilities throughout the country, have a lot of aging pipes yet, that need maintenance or to be replaced. Traditionally, underground pipe rehabilitation was accomplished using an open-cut method in which the entire old pipe is excavated, opened to the ambient air and removed for disposal. In case of Asbestos-Cement (AC) pipelines, AC pipes are wet-cutted into short sections using a snap cutter or similar tool, wrapped for containment and, then, removed for disposal. The old pipe, in this case, is totally replaced with the new pipe. Applying this technique, works give important adverse impacts on people's daily life and business activities involved in the area close to the rehabilitation worksite. A trench is dug to expose the damaged pipe, which is then cut into manageable-size pieces and removed to waste dump. Cured-In-Place-Pipe (CIPP) rehabilitation allows users to renew existing underground pipes without using open cut methods and should become a standard method to rehabilitate damage pipes (Hsu and Shou, 2022). It allows to restore functionally a full length of an existing damaged pipe (sewer or drinkable water), from manhole to manhole. The technology consists of installing a resin-impregnated flexible tube, either inverted or pulled into the existing pipe, and then, after expanding the tube to fit tightly against the interior diameter of the main it was installed in by the use of water or air pressure, curing/hardening the resin by elevating the temperature of the fluid (water/vapor/air) used for the inflation to a sufficient level for the initiators in the resin to affect a reaction. The process final result, provide the structural and hydraulic renewal of the existing pipe that became a form-fitted, structurally reinforced resin pipe within the existing host pipe, designed as a standalone pipe capable of meeting design requirements, including internal and external pressure and seismic loads. The main advantage for this technology, is the possibility to rehabilitate buried piping systems in-situ, without requiring excavation or disturbance of adjacent systems or components. In fact, the installation process itself reduces the cost of labor associated with traditional pipe repair and replacements or spending more money to restore the area. Taking into account the undoubted advantages of applying this technology, trenchless rehabilitation technologies, both safety at work and environmental aspects (air, water, and soil), need more research and data collection to better evaluate the impact of these technologies. Recent studies have been questioning the environmental impact of this technology. In 2018, Ra et al. (2018) proposed a critical review on the surface water and stormwater quality impacts of CIPP repairs, raising environmental, occupational, and public health concerns regarding chemical emissions into air and water. More recently, Kaushal and Najafi (2020) compared the environmental impact of Open-Cut (OC) pipeline replacement interventions and trenchless CIPP renewal method for sanitary sewers. The results showed that CIPP renewal interventions cause less environmental impact (-68%), lower impact on human health (-75%), and reduced resource depletion (-62%) as compared to the OC replacement interventions. Specifically, the higher environmental impacts of OC are due to longer project durations and more equipment requirements compared to the CIPP, i.e. the power consumption of construction equipment and the pipe material have the greatest environmental impacts. The results of a recent literature review confirm these results, suggesting that material production consumes a large amount of the energy required for CIPP repairs and is a major contributor of greenhouse gases emissions (Kaushal et al., 2020). Hence, the comparison of the environmental impacts from pipeline renewal and replacement is an important element when considering a sustainable underground infrastructure development (Kaushal and Najafi, 2020). Suitable precautions have to be taken to eliminate hazards to personnel during construction activities involving working with scaffolding, use of chemicals that can pose a risk of significant irritation and occupational disease, use of steam or hot water, use of pressurized air, fell into the excavation, entering confined spaces, investment persons by vehicles and contacts with material contain asbestos (AC pipes). In this document, for CIPP technologies, we will analyze two of these topics: one relating to confined spaces safety activities and, the other, is relating to activities involving habits of AC existing pipes.

2. Confined spaces activities

Generally, pipe restoration requires the team to have access to both sides of the damaged pipe. A liner is inserted, through existing access point (manholes), for all the length of the pipe from the upstream point and to the endpoint. Typical access points include maintenance holes, outfalls, vaults, spool ends, basins, and cleanouts. If there aren't external access points, the restoration team can excavate one or both ends of the damaged pipe and remove valves or spool pieces. These two different techniques, involve different suggestions regarding confined space access. In fact, if in the first case accessing confined spaces activity is clearly identified, in the second one is necessary to clarify if excavation done is classifiable as confined space. An excavation, generally, is definable as any means any man-made cut, cavity, trench, or depression in an earth's surface, formed by earth removal. Excavation and trenching are dangerous operations that can include: cave-ins, falling loads, hazardous atmospheres, hazards from using heavy equipment. They also present many of the hazards associated with confined spaces and safety managers and workers should consider every excavation as a potential confined space and, doing so, triggers additional procedural and equipment requirements that will help prevent incidents (Hughes and Ferrett, 2021; Singh and Goel, 1999). The potential presence of high concentrations of gaseous hazardous chemicals, explosive gases and poisonous substances in these spaces poses a high risk to the health and safety of the workers required to perform excavation and trenching operations. Additional risk factors, are due to the limited dimensions and means of entry/exit for rescue operations in case of emergency, the limited amount of time available for emergency and other urgent interventions, the instable conditions of the walls and the consequent probability of landslides, sharp rise in groundwater and displacement of the protections (Smolyak and Baran, 2020). By definition, any excavation more than 1.22m (4 ft) deep should be looked at a confined space, until all of the potential, associated hazards have been ruled out by a competent person, and they have some sort of staircase or sloping in that excavation that gives them decent access for rescue. Companies may choose to exceed OSHA's minimum requirements and classify excavations/trenches as confined spaces and, for this, follow all of the confined space requirements as stipulated in 1926.1200 Subpart AA (OSHA, 2015). Normally, CIPP lining activities take place in trenches that are specific types of excavations in which the depth exceeds (is bigger than) the width (OSHA defines that the trench width measured at the bottom is not greater than 4.6m (15 ft). In other words, all trenches are excavations, however not all excavations are trenches. Said this, the question is to define if CIPP activities done inside excavation area, are activities under these specific safety standards. OSHA Construction Industry

Confined Space Standard Subpart AA 1926.1201(b)(1) states that this standard does not apply to construction work regulated by 1926 Subpart P—Excavations, but works can shift to the regulations of 1926.1200 Subpart AA in an excavation or trench environment when it's necessary for workers to enter structures like precast pipe, manholes and vaults or other similar configurations that meet the confined space definition:

1. is large enough and so configured that an employee can bodily enter it;
2. has limited or restricted means for entry and exit; and
3. is not designed for continuous employee occupancy

and, for example, entered upstream and downstream manholes to manually cut away excess sections of cured liner or come through host pipe to open laterals after relining (when remote cut method by using hydraulic powered robotic cutter specifically designed for this purpose it's not possible or the host pipe diameter is greater enough), are certainly confined spaces activities under 1926.1200 Subpart AA that must be applied to non-excavation work within a confined space located in an excavation. If we look at the Italian National laws regarding workplaces that could be considered analogous to Confined Spaces (Ministero del Lavoro e delle Politiche Sociali, 2011), we found that "trenches" (as general definition that, unlike what is present in the US legislation, don't give precise numerical indications that allow to discriminate whether an excavation is a trench or when could became a confined space) are included in the list among the places for which companies that carry out activities inside them, must possess specific qualifications requirements. Somebody might think that an excavation or trench in the ground isn't a confined space, but that would be an incorrect assumption considering that these spaces could meet the criteria for limited entry and exit, space, and habitation and, in addition, in the excavated area there are some risks to be taken into account. In fact, beyond the definition, the most important thing is to identify hazards present or that could arise during the work and carry out an adequate risk assessment to identify the necessary prevention and protection measures to be adopted for workers' safety protection. Overall oxygen-deficient, toxic, or flammable atmospheres can occur in trenches, displacing the normal air, as could reasonably be expected such as in excavations in landfill areas or excavations in areas where hazardous substances are stored nearby or where endogenous gases could be present in geothermal areas. Some of the most common gases of concern are carbon monoxide, methane, and hydrogen sulfide (Stojković, 2013). These gases should be suspected whenever trenches are near combustion engines, sewage lines, landfills, swamps, leaking underground storage tanks, or when decomposing organic matter is nearby (hydrogen sulfide is heavier than air and may fill the trench starting from the bottom). Seismic hazard, if present relating to the area, has also to be taken into account. Trenches without adequate sloping, or other protection from collapse, create the potential for entrants to be engulfed in a cave-in of the surrounding earth. Excessive rainwater, groundwater, or liquid from leaking or damaged pipes also may create conditions for engulfing trench entrants (Smolyak and Baran, 2020). In addition, access into trenches over 1.22m (4 ft) in depth can usually be accomplished only by ladders, which poses known risks of slipping and falling and that are restricted means of entry-exit in case of management of a possible emergency situation due to worker's accident or illness (Hughes and Ferrett, 2021). When starting a CIPP project, engineers must considering that prior to entering confined spaces, such as manholes or inspection hatches, to perform inspections, cleaning operations, liner insert, place thermocouples before curing, cutting the excess liner, protruding service lateral connections (when remote cut method by using hydraulic powered robotic cutter specifically designed for this purpose it's not possible), in accordance with safety regulations, must be performed the evaluation of the atmosphere to determine the presence of toxic gasses, flammable vapors or lack of oxygen. If hazardous atmospheric conditions exist, or may reasonably be expected to develop in an excavation, the employer must ensure that adequate precautions are taken to prevent employee exposure to those conditions and, such precautions, this could include providing workers with proper respiratory protections, check for natural / mechanical ventilation and ensure the ready availability of emergency rescue equipment (safety harness and line, basket stretcher, etc.). This equipment must be attended when in use. In addition, when controls are used to reduce the level of atmospheric contaminants to acceptable levels, testing must be conducted as often as necessary to ensure that the atmosphere remains safe. The field workplace must be managed by established safety procedures and employees should follow confined space entry protocols outlined according to safety regulations, including monitoring of hazardous atmospheres that could be generated during the installation process (including exposition to resin vapors airborne during liner cured in place using heat from steam or near-boiling water).

Work to conform to all applicable safety regulations training compliance in the following:

1) Confined space entry procedures.
2) Atmospheric monitoring and ventilation methods.
3) Personal protective equipment.
4) Interpretation of Material Safety Data Sheets (MSDS).

MSDSs for process ingredients indicated hazardous chemicals with inhalation and dermal exposure routes that can be controlled with ventilation and chemically resistant gloves. Employees should not eat, drink, or smoke in areas where these materials are used. Employees should wash their hands and face before eating. According to the risk assessment carried out and the operating procedures developed, employees must wear the harness with a rope attached properly secured to a tripod winch placed for safety reasons, that must not be used to hoist materials out of the manhole while the employee was still in the hole. Time spent in the confined space of the manhole should be minimized when possible. The manhole should be ventilated with a blower ventilator fan every time an employee enters the manhole and for the entire duration of the employee's stay within the confined space. Another important topic that must be considered, depending on the work being done, is to evaluate if Confined Space Rescue Team (CSRT) may be necessary. Beyond just knowing when a confined space rescue team is needed, working with experienced done is critical. The risk of falls, asphyxiation, injuries, and entanglements are just some hazards that workers deal with in confined spaces. Asphyxiation by gases is the primary cause of death in confined spaces (Stojković, 2013). A recent study reveals that the persons who are participating in rescue interventions in confined spaces are in most cases co-workers, not or emergency medical service personnel (Stojković, 2013). Rescue operations in confined spaces are high-risk activities that require trained personnel and specialized equipment. When dealing with confined spaces involving CIPP lining, the need for a company CSRT with proper rescue equipment and knowledge about rescue methods can address operations to save victims from emergencies. The identification of an optimum training plan for rescue personnel in confined spaces, is necessary to ensure the efficacy of interventions and the safety of both the personnel in the CSRT and employees (Pupăzan et al., 2017). People often think that a CSRT is unnecessary because they will be able to simply use the rescue winch the entrant is (should be) connected to and retrieve the individual in jeopardy out of the space. However, it will not work if there are multiple incidents, the entrant removes himself from the line, the space is so configured there are obstacles in the way and many other scenarios that could hinder this process. When an emergency occurs within a confined space, you must act in the best possible manner related to the potential complex hazards. You do not want to have to organize or coordinate in the moment: every second is invaluable. Having the right people on-site, in fact, will not only help to keep employees safe, but it will also minimize worksite risk and lower the potential for litigation down the line (Ross, 2007). All technical rescue incidents on-site, must be managed by trained on-duty CSRT members, that must follow a structured intervention management system compliant with laws requirements and using judgment and their experiences to adapt to the specific situation (Lushch et al., 2020). Also, emergency response plans are fundamental for employee safety and are legally required when working in industrial permit-required confined spaces (Wilson et al., 2012). Depending on the kind of work that must be performed and the worksite characteristics, the necessity of confined space rescue teams on-site or on standby must be assessed. If Immediately Dangerous for Health or Life (IDHL) atmospheres can happen, then on-site CSRT that can respond promptly is needed at all times. If there are situations that have a potential for entrapment, may be able to use standby teams instead, but they must be close by so they can respond promptly. To perform the best rescue if someone becomes injured, incapacitated, or trapped in a space and has to be rescued, all rescuers must be fully briefed on their assignments, formulated rescue plan emergency procedures have to be established and understood by all. To obtain good performances, rescue drills can provide personnel with the experience of working through different scenarios to familiarize themselves with situations they could encounter in confined spaces. Conducting rescue drills helps prepare teams for working in confined spaces, when necessary, rescuing coworkers. Each scenario shall be evaluated using the same evaluation mechanism and adaptations made for the current operation as required by the configuration of manholes, trenches, or excavations to define what kind of rescue must be performed: Self-Rescue, Non-Entry Rescue, and Entry Rescue (Pearce and Rusczek, 2017; Sargent, 1999; Selman et al., 2019). As knows, Self-rescue involves an entrant leaving the space under their own power, either because they have identified a hazard or are feeling ill, and removes the need for other people to enter the space, but also requires that the individual has been fully briefed or trained on safe self-exit procedures. Non-entry rescue, instead, uses assistive tools to eliminate the need for additional people to enter the space and these tools might include a harness that the entrant dons and is then lifted by pulleys and ropes. This technique requires careful consideration (i.e., retrieval systems won't get snagged or caught on obstacles in either emergency or non-emergency situations) and practice to make equipment function and rescue technicians know how to use it. Even in situations where Non-Entry Rescue techniques are deemed primary, an CSRT must be available. Entry Rescue, involves that trained CSRT members entering the confined space to perform the rescue. No CSRT members shall enter an unprotected confined space to render patient care or perform trench disentanglement operations, without having tacked the necessary safety precautions. Emergency personnel should protect all confined spaces and trenches using approved methods before entry and shall wear appropriate Personal Protective Equipment (PPE) while working inside. Considering that many rescues require lifting equipment to remove a person from a confined space, and that lifting equipment will need to attach to a full body harness, the harness plays an important role in both vertical rescues to help lift a worker out of a space, and horizontal rescues to help place the worker on a stretcher or rescue board. Without a full body harness, rescues can become much more difficult and time-consuming, considering the difficult to place a full body harness on an inert body, particularly if CSRT is performing a time-sensitive rescue. For this, there must be a general rule that every person who enters a confined space has to be wearing a harness. Before starting a rescue operation, First-on-Place (FOP) rescuers have to make an initial scene size-up, including a primary assessment of the scene to determine what has happened and what are immediate needs. At the same time, all potential hazards to all rescuers must be assessed: ensuring all utilities are controlled, including water, gas, sewer, and electrical in the trench and the surrounding scene. Minimum two ground ladders for emergency exit must be placed and must remain within 7.6m (25 ft) of personnel for emergency access. All trench rescues must also follow the guidelines for a confined space rescue regarding monitoring and ventilation. If necessary, ventilate the trench until air quality returns to an acceptable range in all categories. Rescuers have to take contact with the victim(s) to determine their level of consciousness and must remain in contact with them throughout the rescue operations. Technical rescue personnel and patient care personnel must rest in coordination at all times during patient extrication. CSRT members must guarantee that injured workers' life functions are supported as required and that the victim is evaluated for signs of crush syndrome, which is common in trapped victims of collapsed trenches and confined space entrapments, to take the necessary prompt care treatment within the area of entrapment. After the assessment, they must evaluate if to remove the victim from the trench, by methods and packaging devices selected according to intended routes for removal and vertical lift. Is necessary, also evaluate if total extraction time meets time constraints for medical management. FOP CSRT member must be equipped with devices that are able to call the National Emergency Responders for help. When terminating a technical rescue operation, recordkeeping and documentation occur. Post-event analyses must conduct to identify any critical steps in rescue procedures that need to be improved for the future.

3. Asbestos cement pipe renewal

Asbestos has been used in the manufacturing of different products, which can be found in either friable or non-friable form. Products containing asbestos are also known as asbestos-containing materials (MCA). These products include construction materials, sprayed insulation, boiler insulation and pipe lagging. Demolitions might release asbestos fibers from friable asbestos-containing materials. However, non-friable asbestos products that have been damaged throughout the whole-building demolition may also become friable (Perkins et al., 2007). Asbestos fibers released during demolitions — even low exposure to them — are a health risk and can cause lung damage, including cancer (Ramada Rodilla et al., 2022). When residences containing asbestos are renovated or torn down, or when the asbestos is disturbed, minute asbestos fibers may be released into the air. These fibers, are so small that they often cannot be seen with the naked eye and can be inhaled without one even knowing, underscoring how dangerous asbestos can really be. AC pipes account for approximately 12-15% of the total length of water distribution system piping in North America. These pipes are also used across Europe, Australia and Japan in water distribution networks. The water distribution network of The Netherlands contains around 30,000 km of AC pipes, which constitutes around 25% of the total dutch water distribution network (van Laarhoven et al., 2021). In Italy, asbestos fibers were found in about 300,000 km of water distribution pipes (Osservatorio Nazionale Amianto, 2023). The asbestos release from AC pipes, is possible when one or more of the cement constituents are dissolved and chemically inert asbestos fibers lose their mechanical support (Zavašnik et al., 2022). The asbestos fibers are being released from deteriorated pipes even more abundantly when subjected to vibrations such as road proximity, railroads, construction works, earthquakes, water flows, etc. (Ratnayaka et al., 2009). Pipe renewal activities are needed to maintain these pipes as they deteriorate, but concerns over the environmental impact and regulations associated with these construction methods are largely misunderstood (Matthews and Stowe, 2015). When renewing AC pipes with either open-cut or trenchless methods, there is concern that the asbestos fibers could become friable and potentially hazardous to workers. In 2015, the East Bay Municipal Utility District of Oakland, CA (USA) and the Water Research Foundation proposed a management strategy for AC pipes, recommending the use of structural rehabilitation as an alternative to open trench replacement (Sweet and Katzev, 2018; Water Research Foundation, 2015). Normally, during CIPP lining, a liner is inserted through the length of the pipe from the upstream point and to the endpoint. At the beginning of the process for renewal of AC pipes, all available information related to their identification, location, and characterization that have to be processed to define the activities must be collect: pipes diameter/length, manholes depths and groundwater depth, pipe's location, and other important conditions (e.g., soil type, overhead power lines, railway, backyard easement, excessive sewerage flows, etc.). Among various operators, it seems that there is often the conviction that insertion into the existing pipe occurs without having to expose workers to MCA and that workers do not have to worry about accidentally inhaling fibers. The existing pipes, however, must be inspected with Closed Circuit Television Video (CCTV) technology for debris, roots, damage, offset joints, or any other incongruity that may impede proper CIPP installation. Internal pipe surface preparation is a key component of successful pipe lining. The requirements for the surface may vary depending on the liner and the original surface of the pipeline shall be prepared in such a way as to provide the best lining surface. Pipe preparation may involve internal cleaning by water-jetting (in some regulations high-pressure water spray on AC pipes is prohibited – i.e. Asbestos-Cement Water and Sewer Pipe Management Guidelines 2021) or by mechanical cleaning methods (such as. brushes, chain flails, grinders, balls, swabs, bucket machine or other methods) to remove sharp edges, roots, protruding laterals, encrustations, or other impediments in the existing pipe. Both these methodologies can lead to potential pollution with MCA and can create friable asbestos material. Considering the main installation techniques, which have the same technical equivalence, and should be evaluated by the designer-contractor according to the site, both can lead to potential pollution with asbestos-containing materials, albeit in a different way. During the inversion process (air/water), the liner is applied by turning it upside down and laying it using water and/or air. The two fluids are used with equal principle for thrust, controlled advancement, and then laying. Considering the development of the process, which involves the turning upside of the liner into the host pipe, there are normally no traces of material containing asbestos on the external surface of the liner protruding from the terminal of the renewed pipe, protruding part that will be cut. In the insertion/towing process, instead, the liner is placed on a slip film (such a film may already be embedded in the liner), the air is used as the pressurization fluid, and the liner is inserted inside the pipe to be rehabilitated using a cable and a winch. In this case, as in the CCTV inspection, equipment surfaces can be contaminated by asbestos-containing material, due to rubbing against the internal surface of the AC pipes that, after long time service, should be deteriorated. The slurry of cleaning water discharged during the cleaning operations and the material that has been brushed and brought outside the pipe, can contain a high concentration of asbestos fibers that had to be assessed and appropriately disposed. Normally, materials that comes out from the pipe to be renewed is wet and looks like mud, however, particularly caution bust be taken to avoid any contact with the skin and to not inhale asbestos fibers. These materials can dry on workers' clothes, the ground, and the equipment used, all of which must be thoroughly cleaned before work is shut down. Furthermore, when an item contacts the asbestos-containing mud, it becomes a potential source of future asbestos fiber release if and when the mud dries, adding later decontamination measures that increase the potential for asbestos exposure. Mud must be disposed of as soon as practical or, anyway, at the end of each work day. Workers must wear disposable coveralls, gloves, and respiratory PPE that must be disposed of as MCA, and equipment must clean adopting specific decontamination measures. Dispersion into the soil both materials, that have been brushed and brought outside the pipe, and water-cleaned drain must be avoided. Dispersing water on impermeable paving (e.g. asphalt, cement, etc.) is forbidden as it could dry off and lead to the dispersion of fibers into the atmosphere. Discharge in the sewer of this water, and water coming from equipment cleaning that might contain asbestos fibers, could normally be admitted only after filtration. If this is not possible, the wastewater must be collected and sent for disposal, by the statutory provisions, together with the brushed pipe materials that has been carefully collected to avoid any soil contamination. It is recommended to lay a high-density polyethylene sheet at least 0.15 mm thick, or an equivalent “geotextile non-woven fabric” sheet, to avoid fibers dispersion into the soil. Mud, waste materials coming from decontamination activities, worker’s worn disposables and the filtrate (filter included), must be placed in containment, entrusted to specialized companies in possession of the by law required requisites and disposed of according to current laws. All of this being said, referring to the applicable specific legislation, it’s necessary to define if these activities should be assimilated to materials containing asbestos removal activities. This is because is known that any activities regarding asbestos removal (activities that produce waste materials to be disposed of as asbestos-contained materials) must be carried out by specialized companies with specific requirements and that employ workers with a specific license as operators in charge for asbestos, that are subject to regular health surveillance by physician. All activities, have to be analyzed in an asbestos risk assessment document to identify prevention and protection measures for the personnel performing the activities (i.e. workers must wear specific PPE, due to the type of task performed and consequent possibility of risk of contamination to asbestos fibers) and for the surrounding living environments to the areas of intervention, that if specific prevention measures are not adopted and security, can generate a risk of asbestos fibers exposure. To prevent the risk of exposure to asbestos fibers for the population and employees, the Italian law provides that must write a plan containing the methods with which the work is to be carried out. This plan, that must be notified to the local inspection Safety at work Board will be evaluated and, if necessary, binding operating instructions should be issued in compliance with current legislation. Only in particular cases, for exposures of short intensity, at national level a "simplified" procedure is allowed. These cases generally concern workers who find themselves in the need to intervene occasionally and for short times on small quantities of materials containing asbestos. In any case, asbestos exposure risk must be carefully assessed and performed activities must be compliant with current laws.

4. Conclusions

The aim of our work, as a private research institution, is to identify the conditions to increase the safety at work of workers that work in particular areas in which could be possible to identify high-level hazards. Confined Spaces and asbestos are two topics about which we did more experience over the last few years. We have identified some critical contextual factor shapes key mechanisms that, in our opinion, are related with Cured-In-Place Pipe (CIPP) relining activities. Both for Asbestos Cement (AC) pipes relining and Confined Spaces activities in trench. CIPP, trenchless pipes repair method that involves inserting and curing a resin-impregnated jointless, seamless pipe

within an existing deteriorated pipe, is one of the most effective technologies as they allow a low environmental impact and, at the same time, a significant reduction in the social/environmental costs of pipe rehabilitation work. Normally, CIPP does not require excavation to rehabilitate a pipeline that is either leaking or structurally unsound because the liner is often installed through manholes or other existing access points. Depending upon design considerations, however, an excavation may be made to create access-exit points at both sides of the damaged pipe. Furthermore, any activity involving AC pipes, could to deal with potentially contaminated materials and/or equipment and, therefore, the definition of specific operating and authorization procedures is necessary.
Personnel from trenchless technology firms, should deep analyze some topics, among which included:

– excavation and trench activities,
– pipe rehabilitation and repair AC pipes

in order to define operating procedures suitable for guaranteeing the safety of the operators, as well as identifying the methods by which to manage the phases of a possible emergency for the rescue of an injured or taken ill worker. Also, chemical risk assessment must be performed. Evidence (Seyedeh et al 2017), indicates that chemical emissions from steam and hot water cured CIPP sewer pipe repair activities can pose a risk to human health and the environment. Regarding the prevention and protection of workers' health and safety, it would be appropriate to operate a deep investigation into these issues that, depending on construction sites' organizational arrangements, as also represented by the photographs and films disseminated for promotional purposes, appear improvable. Further research, would be very useful to capture the experiences and perspectives of the company that works in CIPP relining field, asking them to voluntarily participate in studies on the general theme of safety workplace during CIPP activities. Including realist tests about normal and emergency operating procedures, might be possible to improve and extend general knowledge on the topics that we have discussed in this contribution.

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