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Insulation Advances: Mitigating noise and CUI in your processing plants

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Introduction

When one thinks about potential hazards in an industrial setting such as a refinery, petrochemical plant, or liquified natural gas (LNG) terminal, elevated noise levels might not be a primary concern. But in fact, occupational hearing loss is a more common, and serious, work-related hazard than many may realize. One main reason why elevated noise is ignored or goes unnoticed is that the adverse effects of elevated noises are not always immediate and can build up over time.

In a plant, noise can originate from several sources within piping systems and equipment:

- Flow induced turbulence
- Cavitation and flashing
- Pumps and compressors
- Pressure fluctuations
- Valves or other pressure-reducing devices
- Change of pipe diameter.

Regardless of the source, heightened noise levels are harmful to the well-being and productivity of a plant's personnel as well as the surrounding environment. By some estimates, approximately 22 million US workers are exposed to hazardous noise levels at work on an annual basis.[1] Repeated exposure to loud noise, which is typically defined as noise levels high enough to require workers to speak in raised voices to be heard, can lead to a range of long-term problems—both for the individual worker and for the efficiency of plant operations.

In terms of physical problems, prolonged loud noise exposure can lead to permanent hearing loss or tinnitus (ringing in the ears). Studies have shown that sustained loud noise can cause physical and psychological stress on workers, leading to depression. There have also been studies to investigate the link between occupational noise exposure and hypertension in workers.[2]

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[1] Tak S, Davis RR, Calvert GM. Exposure to hazardous workplace noise and use of hearing protection devices among US workers--NHANES, 1999-2004. Am J Ind Med. 2009;52(5):358-371. doi:10.1002/ajim.20690

[2] Penney PJ, Earl CE. Occupational noise and effects on blood pressure: exploring the relationship of hypertension and noise exposure in workers. AAOHN J. 2004;52(11):476-480.

Hearing loss can also reduce a worker's productivity by disrupting communication and reducing their ability to concentrate on the task at hand. This loss of productivity can impact the plant as a whole, by limiting the worker's ability to concentrate and complete tasks.

High noise levels can also lead to serious safety issues and accidents in the plant. Imagine the risks to safe plant operations if employees are unable to detect warning signals such as a honk of the horn, fire alarm or evacuation siren.

Excessive noise can also put plants at odds with their neighbors. Even though the plant might have been operating for decades, surrounding communities, residential areas and neighborhoods may have built up around them. Plant managers may need to now consider their neighbors and limit their noise levels to meet regulations set up by the local government and to protect nearby wildlife. Taking steps to limit noise levels will also help the plant's image within the community, by being seen as a "good neighbor" who is concerned with the welfare of the surrounding neighborhoods and towns.

With excessive noise presenting so many financial and health and safety risks, plants need reliable, cost-effective noise-reduction solutions. This white paper will discuss one proven solution: stone wool insulation systems for pipes, vessels, and other plant equipment. The following sections will review stone wool insulation's unique properties that make it an effective noise suppressor and the design and testing standards that the industry is turning to. The paper will specifically discuss the unique properties and benefits that ProRox stone wool insulation products deliver to reduce noise from operations to below industry standards while also delivering proven solutions for the pervasive problem of corrosion under insulation (CUI).

How Can Workplace Noise Be Reduced?

There are a number of methods and solutions that can be implemented to reduce workplace noise in any number of industrial settings. The US National Institute for Occupational Safety and Health (NIOSH) has developed a 'Hierarchy of Controls" that occupational safety and health professionals use to determine which noise controls are most effective for a given application and how to apply them.[3]

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[3] Noise Controls, NIOSH website, https://www.cdc.gov/niosh/topics/noise/reducenoiseexposure/noisecontrols.html

The hierarchy categorizes noise controls on a scale, from most effective to least effective. The most effective methods—eliminating the noise entirely or buying quiet equipment and tools—are not feasible, either practically or profitably, in a plant setting. Noise generated in the plant can originate from multiple sources such as pumps, valves, and the turbulent motion of gas and liquids in piping. Designing and building this equipment to make them operate silently would require significant design upgrades and changes to materials of construction. In the end, this option would be cost-prohibitive to implement across an entire plant.

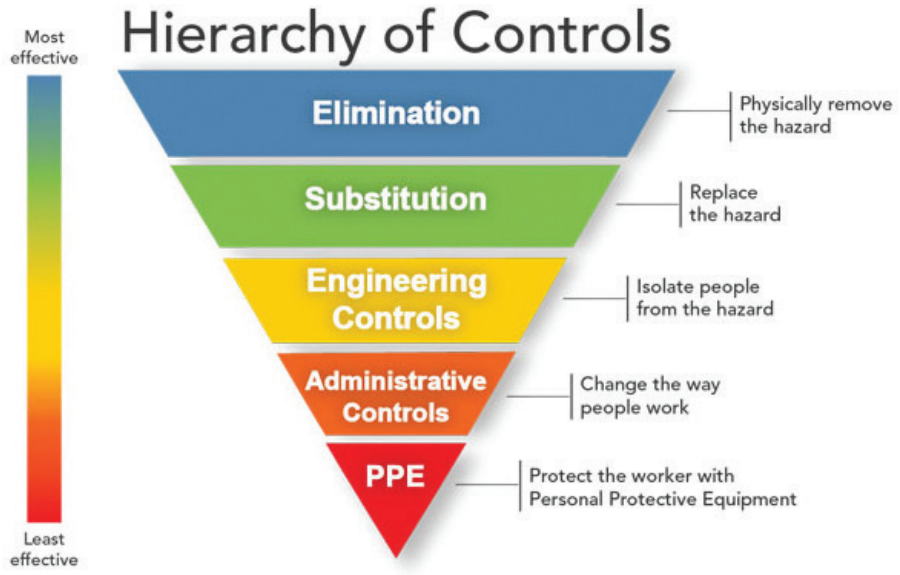


Figure 1. The NIOSH Hierarchy of Controls.

The other end of the hierarchy includes the use of protective personal equipment (PPE) such as ear plugs or sound-dampening headphones. Other solutions include changing the way that people work by limiting their time of exposure in a noisy environment. While both of these options are widely implemented in many industrial plant settings, they are generally the least effective at protecting workers from the long-term hazards of noise exposure.

This brings us to the final control option, which is to isolate workers from the hazard by controlling the noise at the source. This is most commonly achieved by applying sound-suppressing insulation materials around piping and other plant equipment emitting high levels of noise. The NIOSH hierarchy generally classifies such measures as having mid-range effectiveness (more effective than PPE, less effective than eliminating the noise). However, insulation advances have made this a cost-effective option. And when combined with other measures like PPE and exposure time limits, noise threats to workers are dramatically reduced.

Consultation with the original equipment manufacturers should be considered before applying noise suppression insulation to equipment such as pumps, fans and motors. Some of this equipment is designed to dissipate heat to the surrounding environment. If the equipment was encased in insulation, there may be a danger of overheating, so it's important to check with the designers before applying insulation simply to suppress sound.

Stonewool excels as a noise suppressant in the network of pipes running through a process plant. Noise in pipes is typically generated by turbulent flow of fluids in the pipe or equipment connected to piping that cause vibrations. These vibrations are the source of the noise and the individual fibers within stonewool reduce noise by dampening vibration. Noise levels coming from the piping network are typically greater than 100 dB, a level at which sustained exposure can cause permanent hearing damage.

Proper selection and installation of insulating materials can bring noise levels down below generally accepted limits. In the plant, 80 dB at 3 ft from the source is the acceptable limit to avoid hearing loss, while outside the property line of the plant, the limit generally drops below 55 dBA.

Review of standards and design issues around acoustics pipe insulation
Acoustic pipe insulation must meet certain industry standards to be accepted in many applications.

Table 1 – ISO 15665 classes for acoustic pipe insulation (A, B, and C) as well as the Class D specifications adopted by Shell.

Class		Diameter in mm	Octave band centre frequency						
			125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz
ISO	A1	< 300	-4	-4	2	9	16	22	29
ISO	A2	≤ 300 < 650	-4	-4	2	9	16	22	29
ISO	A3	≤650 < 1000	-4	2	7	13	19	24	30
ISO	B1	< 300	-9	-3	3	11	19	27	35
ISO	B2	≤ 300 < 650	-9	-3	6	15	24	33	42
ISO	B3	≤650 < 1000	-7	2	11	20	29	36	42
ISO	C1	< 300	-5	-1	11	23	34	38	42
ISO	C2	≤ 300 < 650	-7	4	14	23	34	38	42
ISO	C3	≤650 < 1000	-1	9	17	26	34	38	42
SHELL	D2	≤ 300 < 650	-3	4	15	36	45	45	45
SHELL	D3	≤650 < 1000	3	9	26	36	45	40	40

The ISO 15665 standard specifies three types of construction that will meet these acoustic performance classes. Furthermore, it defines a standardized test method for measuring the acoustic performance of any type of construction, thereby allowing existing and new insulation constructions to be rated against the three classes.

ISO 15665 is applicable to the acoustic insulation of cylindrical steel pipes, valves and flanges. It is valid for pipes up to 1 m in diameter and with a minimum wall thickness of 4.2 mm for diameters below 300 mm, and 6.3 mm for diameters from 300 mm and above. However, it is not applicable to the acoustic insulation of rectangular ducting and vessels or machinery.

ISO 15665 covers both design and installation aspects of acoustic insulation and provides guidance to assist noise control engineers in determining the required class and extent of insulation needed for a particular application. It gives typical examples of construction methods, but the examples are for informational purposes only and not meant to be prescriptive.

CINI 9.2.11. The Committee Industrial Insulation Standards Foundation (or CINI), a Dutch institute for standardization of thermal insulation for the petrochemical and process industries, has developed its own acoustics standard. CINI 9.2.11 specifies that different insulating materials, including stone wool with metal cladding, may be applied to a pipe, provided they comply with the acoustics requirements set by ISO 15665 (Chapter 4).

CINI 9.2.11 specifies three classes for the application of acoustic insulation:

- Class A: Applications in which flanges, valves, and pipe support are not insulated
- Class B: Applications in which flanges and valves are insulated but pipe supports are not
- Class C: Applications in which flanges, valves, and pipe supports are all to be insulated

This specification also requires that an insulated system meet the required noise reduction for its class, and can utilize a mass or anti-drumming layer under the metal jacketing. Independent test reports validating a system's insertion loss performance are also required.

Figure 2. A sound room is used to measure insertion loss after acoustic insulation is applied, per ISO 15665.

PIP INSA 100. A third common standard, PIP INSA 100, sets acoustics standards for insulation systems that are designed in accordance with ISO 15665. While this standard does not have specific requirements for valves and flanges, it does place a high focus on specific installation details per the type of application.

The ISO 15665 standard requires testing to measure insertion loss, which is a measure of the decibel reduction after acoustic insulation is applied. Testing is done in a sound room with a single steel pipe running the length of the room (Figure 2). Noise is introduced at one end of the pipe via a loudspeaker and terminated at the other end by noise dampening materials that do not allow any noise to escape. A microphone is used to measure the noise before and after the installation of insulation to determine the total insertion loss.

ProRox solutions

While many insulation materials are available in the marketplace to minimize noise, stone wool has built a reputation as a proven acoustics suppression solution for more than 80 years. Stone wool insulation systems from ROCKWOOL Technical Insulation offer time-tested insulation solutions for a plant's thermal, fire-resistant, water repellant, acoustic, and energy efficiency needs.

And when it comes to acoustic insulation, ProRox delivers several tangible, cost-effective benefits.

ROCKWOOL delivers effective acoustics performance with less thickness. ProRox insulation technologies, which include stone wool as their base material, effectively meet ISO 15665 standards for recommended insertion loss levels for Class B and Class C – at half the required maximum thickness for the standard. Compared to other stone wool solutions on the market, ProRox solutions deliver the same noise reduction, at less than 50% the thickness. Less thickness translates to a more efficient and cost-effective install, thanks to lower installation costs, more effective use of installation crews, less storage space required for inventory, and lower transportation costs.

ROCKWOOL delivers proven, durable insulation solutions. ProRox products are subjected to pre-heat stress tests of 482°F/250°C for 24 hours. After this temperature and time, the insulation stays well within industry-standard boundaries for effective acoustics suppression and water repellency. ProRox insulation is one of the only to be successfully tested to these conditions, which represent the most stringent and severe testing criteria in the industry.

ROCKWOOL products ensure fast and easy installation for plant applications. Only one insulation product and one heavy mass layer are necessary to provide the acoustics insulation performance required. This solution eliminates the need to glue individual layers and avoids the use of specialized PPE or other special safety requirements during installation. An easier, faster install also translates to less downtime. Getting the insulation installed more quickly and efficiently helps the owner finish the project sooner and get back to profitable operation.

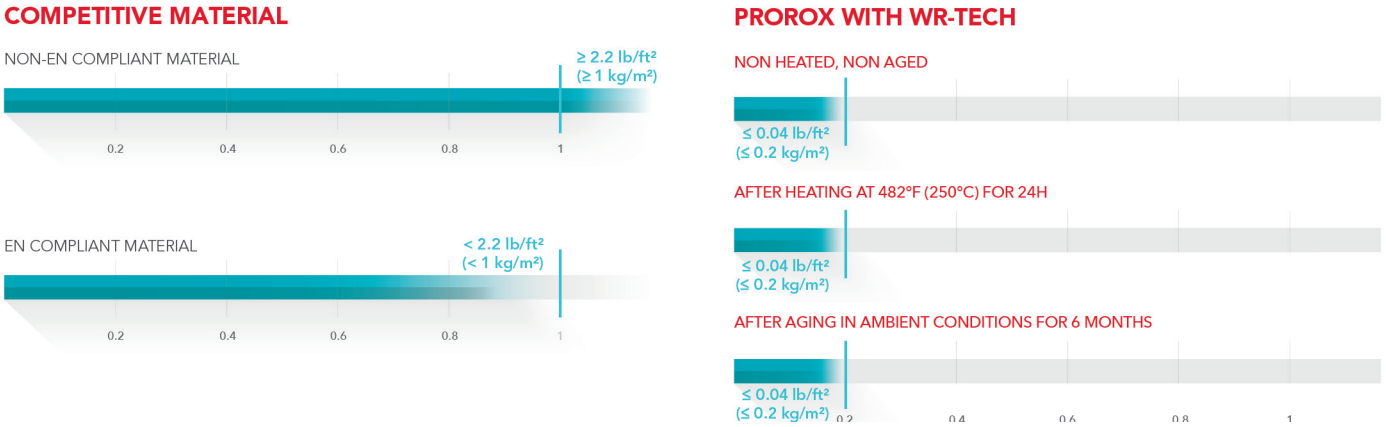
ProRox solutions for CUI mitigation

In many plant operations, the ingress of water through the insulation and onto the metal surfaces of pipes and other equipment can cause aggressive corrosion under insulation (CUI). The severity of the CUI is related to the temperature of the pipe or equipment—higher temperatures translate to more aggressive and higher corrosion rates. Many plant applications, including some applications within an LNG plant, have critical areas that operate at elevated temperatures. As a result, CUI poses a higher risk in these operations.

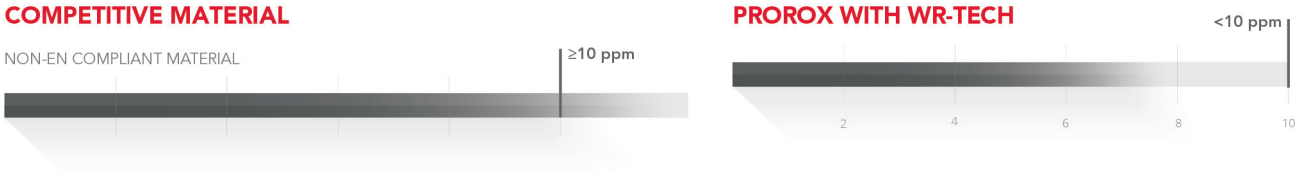
For these applications, ProRox insulation materials treated with ROCKWOOL's Water Repellency Technology (WR-Tech) mitigates the risk of CUI. This binder technology coats each individual fiber of the ProRox stone wool insulation with an inorganic, hydrophobic additive during the manufacturing process. This ensures that the stone wool maintains superior water repellency, even at elevated operating temperatures, while preserving the insulation's thermal and acoustics performance as well.

ProRox with WR-Tech dramatically lowers CUI and extends the piping network's operating life in several ways.

Lowest water absorption. WR-Tech imparts a high degree of water repellency to the insulation. The treated insulation has five times lower water absorption than the best available standard EN 13472 product. The insulation maintains this water repellency, even after heating and aging.



Low water leachable chloride content. ProRox with WR-Tech is safe to use over steel, and complies with strict industry standards ASTM C795 and EN 13468.



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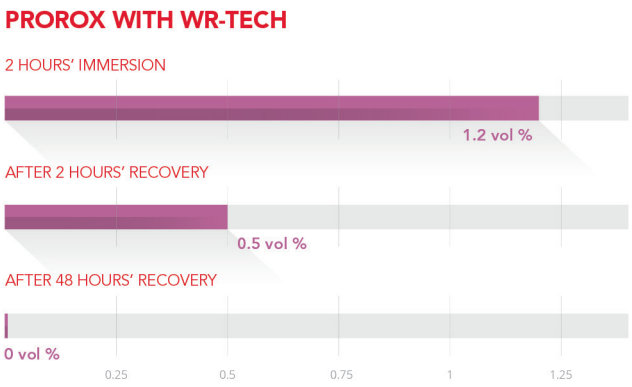

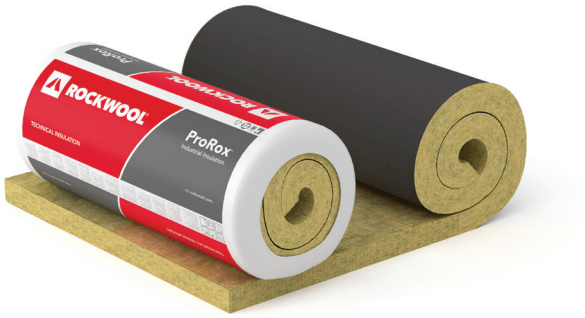

ProRox solutions for acoustics/CUI mitigation on more complex equipment geometries

WR-Tech was first successfully launched on ROCKWOOL's ProRox mandrel wound pipe sections. Recently, the technology was expanded to ProRox Mat (Wrap) insulation products, to provide effective CUI protection while insulating large-diameter pipework, vessels, columns, or applications requiring design flexibility.

Specifically, ProRox MA 961 is a rolled, stone wool mat (wrap) insulation for large-diameter plant piping and equipment that provides a number of installation, insulation, and CUI benefits over other types of insulation materials (see comparison table below).

Summary and Conclusions

Excessive noise levels generated by piping systems and equipment in a refinery, petrochemical plant, or LNG terminal can have serious consequences—both in terms of personal safety and the overall productivity and operability of the plant. The application of noise-suppressing insulation such as stonewool is a proven mitigation solution. ROCKWOOL Technical Insulation's ProRox stonewool insulation materials effectively meet ISO 15665 standards for insertion loss levels, at half the thickness required for the standard. ProRox materials maintain their acoustics performance after pre-heat stress testing and are easily installed to minimize plant downtime. Finally, these insulation solutions also mitigate against the common challenge of corrosion under insulation, with water repellency properties that significantly slow the ingress of water to the pipe's metal surface.

Want to learn how ProRox insulation technologies can help minimize your plant's noise and corrosion challenges? Contact ROCKWOOL Technical Insulation today.

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