Specifying Alarms

Identifying Alarm Properties that Support a World Class Safety Culture

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SHARING COMPETENCE

Pfannenberg
ELECTRO-TECHNOLOGY FOR INDUSTRY

Table of Contents

1 Workplace Safety

Dear customer and interested public,

Workplaces have always been dangerous. Heavy machinery, industrial vehicles, dangerous chemicals, high speed equipment, distant exits, fire hazards, all contribute to an elevated level of risk in workplaces around the world. Despite ongoing efforts to make workplaces safer, the International Labor Organization estimates that every day over 800,000 workers suffer a work-related accident.

While the human cost for work-related accidents and death is incalculable, the ILO estimates the costs to businesses from accidents at 4% of global domestic product. And in a world where companies are increasingly evaluated by workers, communities, the press and even shareholders on the sustainability of their practices, addressing the chronic problems found in hazardous workplaces has become a business imperative.

Volker Matthies
Global Product Manager
Signaling Technology

2 Signaling TechnologyAlarm Systems

2.1 Alarm System Considerations Common to Plant Environments

In industrial and process environments no aspect of safety is more vital than an alarm system that preserves lives and prevents injury. That's why it's imperative to establish an Alarm Management Standard similar to the one specified in the ANSI/ISA-18.2 Management of Alarm Systems for the Process Industries. While the full document describes in detail the development, design, installation and management of alarm systems, this paper presents some additional context for the kind of alarm properties best suited for establishing and managing alarm systems within the standards prescribed.

At least three factors common to plant environments threaten an alarm system's effectiveness and place personnel at increased risk.

- Machinery originally equipped with a manufacturer specified (low-cost) audible alarm system may not perform adequately in the given plant environment. ANSI/ISA-18.2 specifies, "In environments where an audible indication of an unacknowledged alarm is not effective, (e.g., high ambient noise level environments), a clear visual indication of an unacknowledged alarm that is always within view of the operator should be used, (e.g., a light or series of lights)."
- The close proximity of multiple pieces of equipment increases the likelihood of "alarm flood." ANSI/ISA-18.2 defines alarm flood as "a condition during which the alarm rate is greater than the operator can effectively manage (e.g., more than 10 alarms per 10 minutes)." This is also addressed in OSHA Standard 1910.165 (Employee alarm systems), which states: "The employee alarm shall be capable of being perceived above ambient noise or light levels by all employees in the affected portions of the workplace." Additionally, "The employee alarm shall be distinctive and recognizable as a signal to evacuate the work area or to perform actions designated under the emergency action plan."
- Personnel can be unsure how to properly respond to an alarm system either because of improper training or because the alarm system has been poorly designed and/or was not adequately tested. ANSI/ISA-18.2 specifies, "Operators shall be trained on the response to all new or modified highly managed alarms prior to the operator assuming responsibility for responding to the new or modified alarms." In an increasingly competitive labor market the need for training increases as new employees are added and/or new responsibilities are assigned.

2.2 Signaling Flexibility

Due to the differences found across workplace environments there is no single alarm system that is best for all situations. Additionally, the evolving nature of workspaces -- through adding equipment, modifying processes, etc. -- means that a previously established alarm system may need to be altered based on those changes. For these reasons, signaling devices that can offer a customizable range of tones, levels, and/or visual signals positions the workplace for changes required by monitoring and assessment of its alarm safety system.

In the book, Advances in Applied Social Psychology, the authors cites a number of qualities that an audio warning system should have. These include "audible (heard above background noise)," "discriminable (easy to differentiate from other signals)," and "non-masking (not prone to interfere with other functions by drowning out other audio signals)." These qualities depend on the conditions found in each particular

workplace, there are no inherent “best” signals for any alert system. For this reason, increasing the variety of signaling options available from one device or system, the consistency of signal characteristics across the devices (signaling precision), and the ability to easily implement new or additional signals based on changing conditions should all help maintain the integrity of a robust signaling system.

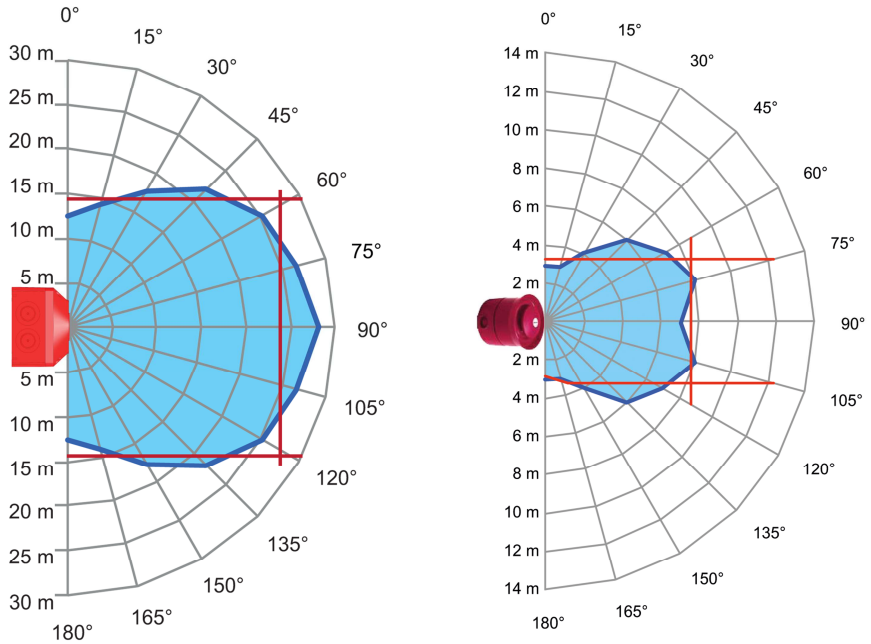
Investing in customizable signaling devices provides many benefits in today’s workplace. The investment indicates that the organization is serious about safety, a necessary component in building a sustainable safety culture. Having customizable alarm signaling already in-place speeds up the ability to change a signaling system based on an evolving workplace, while also avoiding the added costs of replacement, maintenance hours, and production time lost during installation.

2.3 Discernibility

When it comes to evaluating the effectiveness of an audible alarm device there are more factors than just the output dB level which should be considered. That’s because the effective range of the signal can vary depending on the tone selected and propagation capabilities of the horn. ANSI/ISA-18.2 specifies, “Implementation of a new alarm or a new alarm system includes the physical and logical installation and functional verification of the system.... Since operators are an essential part of the alarm system, operator training is an important activity during implementation. Testing of new alarms is often an implementation requirement.”

A well designed audible alarm device can offer vastly superior performance even though the specification may read similar to another design. Selecting higher performance devices not only improves safety, but can also reduce costs since fewer devices may be needed to ensure coverage of the desired area. Below is the effective range of two audible alarms -- both marketed on their published specification sheets as 100 dB devices -- but with markedly different effective ranges.

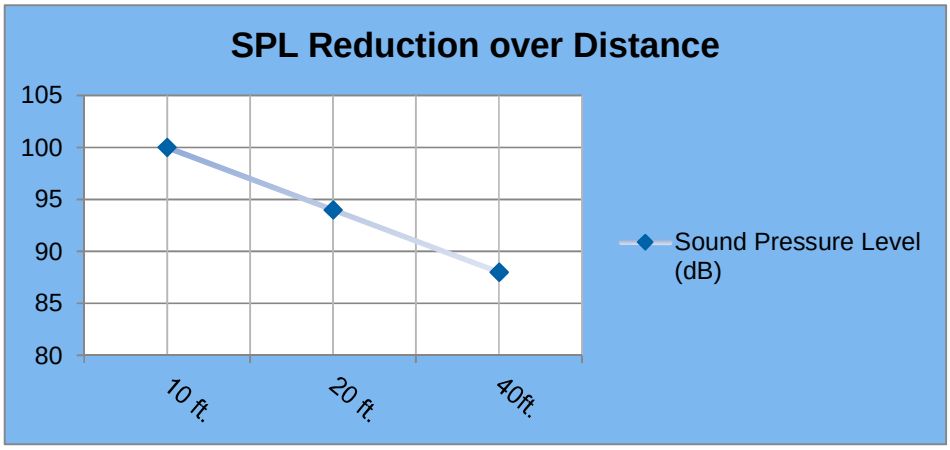
Tested Coverage Area Difference between two 100 dB Audible Notification Appliances:



Workers need to be able to perceive an alarm signal, and also able to distinguish the signal from other alarm types. As revealed in testing, the effective range for a suitable sound pressure level (SPL) can vary significantly between devices that appear to be very similar on paper. In short, the quality of design for audible alarms does matter.

One of the primary criteria for audible alarm selection is the coverage area or distance over which the output signal must be noticed. For this, there are three issues to be concerned with: 1) The distance from the notification appliance over which the audible signal must be noticed. 2) The ambient noise level over which the audible signal must be heard. 3) The desired SPL offset over the ambient noise level that will be acceptable.

To assist with this task one must understand the dissipation characteristic for sound, which is a 6 dB reduction for each doubling of distance. In other words, 100 dB at 10 feet becomes 94 dB at 20 feet and then 88 dB at 40 ft. Below is a graphical representation of this example.



In addition, an acceptable alarm guideline must be adhered to. In some instances an Authority Having Jurisdiction (AHJ) or code approval authority may have the final say on this. OSHA suggests that machinery alarms should be at least 6 dB over ambient noise levels. NFPA states that audible signals shall be 10 dB over ambient conditions for private mode alarms and 5 dB above the maximum SPL having a duration in excess of 60 seconds. Measurements with sound level meters and noise dosimeters can be used to ascertain the SPL of the ambient environment.

The NFPA offers the following examples for industrial areas:

Location	**Average Ambient SPL (dB(A))**
Business occupancies	55
Industrial occupancies	80
Mechanical rooms	85
Storage occupancies	30
Thoroughfares, high-density urban	70
Thoroughfares, medium-density urban	55

2.4 Reducing Alarm Complexity

Plant alarm systems typically share responsibilities with monitoring quality and productivity. While essential to plant operations, these shared responsibilities can affect plant safety by increasing the phenomenon

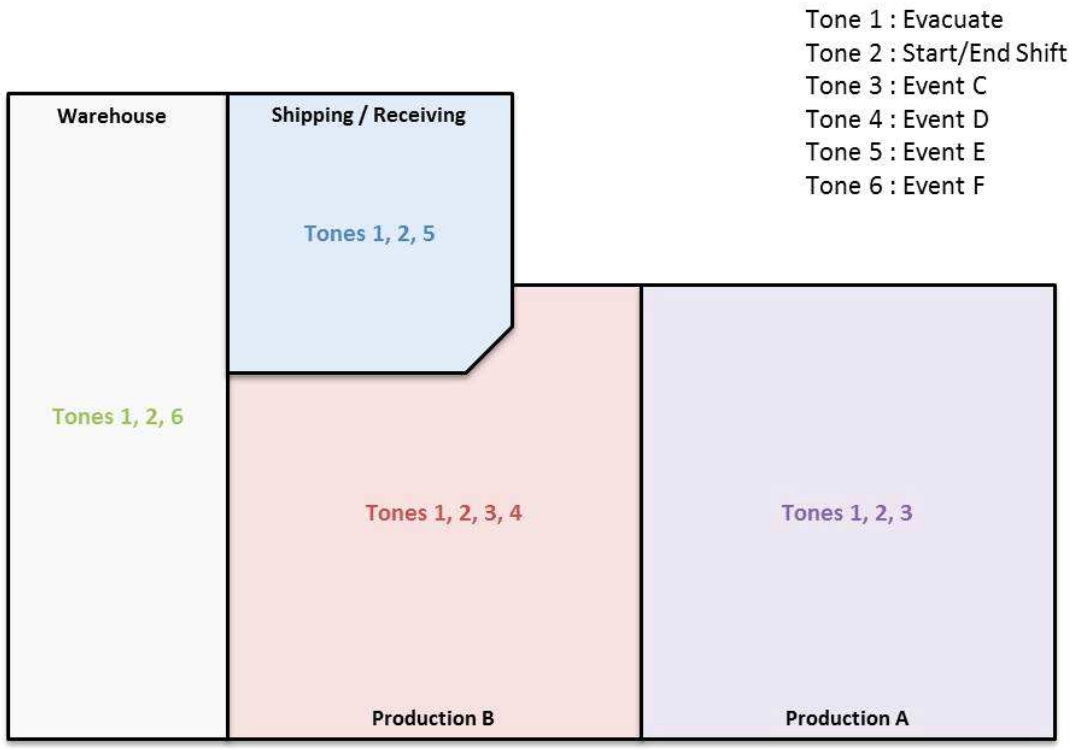
known as “alarm flood.” ANSI/ISA-18.2 specifies, “Alarm types should be selected carefully based on engineering judgment. Certain types, such as rate-of-change, deviation, bad measurement, and controller output alarms, are common sources of nuisance alarms during process upset conditions if they are not applied appropriately.”

For this reason, signaling devices that offer the ability to provide a variety of alarm types can help operators distinguish between signals that monitor quality and production (warning) versus those that affect safety (alarms). Also, by establishing a common set of alarm types that correspond to events throughout the plant, the extent of training and retraining required can also be reduced while maintaining a higher level of safety.

2.5 Signaling Uniformity

Modern electronic sounders offer the advantage of choosing a unique audible alarm tone from a selection of multiple tones stored on a memory chip. Furthermore, some units offer multiple alarm stages – the ability for the same unit to generate different tones for multiple events. This versatility allows a unique alarm tone to stand out from some of the many other industrial alarm signals that all share the same vibrating horn sound. By assigning a specific and unique tone to a particular type of event, operators can become “tuned in“ to its meaning and therefore able to react more quickly and efficiently. Adopting such a uniform signaling protocol offers a higher level of safety and efficiency for the factory environment.

The below layout is an example of how a manufacturing facility could utilize multiple alarm stages to create a more effective alarm system. In this example, they use common tones for the same event facility wide, but then have the flexibility to alarm unique events specific to a given area.



3 Conclusion

Workplace safety is a growing concern globally, and organizations that are able to prioritize safety will have a decisive advantage in protecting their workforce, attracting labor and investment, and maintaining healthy community relations. Investing in signaling (alarm) devices that can be distinguished in a variety of environments, that can be customized as the workplace evolves, and that reduce distractions resulting in “alarm flood” will be an essential first step in building and maintaining a world class safety culture.

Disclaimer:
All details were carefully researched in May 2015.
We can, however, not offer any guarantees with regard to the completeness and correctness of the stated information.

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