AT-A-GLANC
A Proven Technique t
Mismatches & Cros

By Jean Ndana

THE OSHA HAZARD COMMUNICATION STANDARD, 29 CFR 1910.1200, was the second most cited standard in general industry for fiscal years 2018 and 2019, with 4,170 violations in 2019 alone. Section 1910.1200(f)(6), relative to workplace labeling, was among the top five sections cited, with a total number of 352 cases (Druley, 2019). Each case cited will likely carry either a recommended or a mandatory penalty.

Beyond the financial losses, these violations imply countless potential for human suffering (e.g., injuries, illnesses, emotional distress) and organizational loss. Chemical exposure may cause or contribute to many serious health effects (e.g., heart ailments, central nervous system, kidney and lung damage, sterility, cancer, burns, rashes). Some chemicals may also pose safety hazards and have the potential to cause fires, explosions and other serious incidents.

Considering these potential negative impacts, every workplace, no matter the size, should prioritize the development of a system designed to, at least, promote the systematic labeling of containers, regardless of where the company uses, stores, labels or disposes of chemicals. The author's former employer developed such a system and reaped benefits well beyond avoiding OSHA fines and promoting worker safety and health.

The Case

A 700-person manufacturing plant specializing in motor vehicle components faced several challenges. The round-the-clock plant operated at an anemic 49% efficiency (corporate management expected a minimum of 85%), had a total case incidence rate of 12.6 (3.5 points higher than the industry average), high worker turnover, high workers' compensation costs and a strained relationship with Michigan OSHA. Hourly workers presented persistent criticism of virtually every aspect of the plant, safety and health in particular.

The plant investigated the contributing factors to systemic challenges to identify what was going wrong. Table 1 summarizes the key concerns captured from the investigation. The investigation revealed that the high incidence rate stemmed from mismatches and cross contaminations of hydraulic oils. A mismatch occurs when a hydraulic oil is transferred to the wrong machine. A cross contamination occurs when incompatible oils are mixed either in a portable container or in a machine's tank. The mismatches and cross contaminations resulted in worker injuries and hospitalizations and affected machine operation and productivity.

An at-a-glance labeling system was employed to address the findings. The plant found the system to be easily executable, actionable and in a practical form that can be implemented quickly by other organizations facing similar issues. This article details the investigation findings, the at-a-glance labeling system, the nine-step process to implement the system, and the results experienced.

KEY TAKEAWAYS

- **At-a-glance labeling is a user-friendly visual aid system that uses color-coded shapes and symbols, as well as portable secondary containers to reduce or eliminate chemical mismatches and cross contamination.**
- **The at-a-glance system helps operators navigate around what was nicknamed "the oil maze."**
- **The benefits of implementing an at-a-glance system include reduction of injuries and illnesses related to mismatches and cross contamination; increased continuity in plant operations due to machine and worker availability; compliance with OSHA regulations; reduced costs associated with workers' compensation and machine maintenance and repair; increased equipment effectiveness and daily product throughput in a plant; ability to train machine operations on multiple machines; and reduced duration on temporary worker training.**

The Investigation

An analysis of past workers' compensation documents and incident and illness records showed that maintenance activities (e.g., clean and remove chips from machines; replace seals, spindles, spindle bearings and hydraulic oil and filters; check air and oil mixing valve lines; drain, clean and refill coolant tanks; service hydraulic pumps and motors) and unhealthy quality of the ambient air on the shop floor [e.g., metalworking fluids (MWFs) mist or aerosol above OSHA permissible exposure limits (PELs), foul smell (rancidity), aerosolized into the air as part of the mist of microorganisms] contributed to the majority of the plant's OSHA recordable incidents.

The identified trend warranted further investigation of the plant's machines, storage areas and maintenance activities. The plant had about 100 computer numeric control machining centers (machines) of different types and brands. Equipped with powerful spindles and ball screws, the machines were able to remove metal and make holes on various shapes of raw materials using a combination of a rotating, multiedge cutting tools and multiaxis movement of each workpiece. During grinding, cutting or boring op-

CE LABELING
to Minimize Chemical
ss Contaminations

erations, MWFs were used to lubricate, cool, prevent corrosion of and remove chips from tools and metal parts. To run smoothly, each machine required six different oils. Some oils were critical to maximize the performance and life of hydraulic pumps, motors and other components. Other oils cooled or lubricated metal workpieces when they were being machined. The oils also reduced the heat and friction between the cutting tool and the workpiece and prevented burning and smoking. At the time, two OSHA air contaminant PELs applied to MWFs. They were 5 mg/m^3 for an 8-hour time-weighted average (TWA) for mineral oil mist, and 15 mg/m^3 (8-hour TWA) for particulates not otherwise classified (i.e., applicable to all other metalworking fluids; OSHA, n.d.-a; n.d.-b).

The plant also investigated the bulk storage area where the different oils were kept. As needed for their machine, machine operators would go to the storage area and fetch oil using a portable container. Observations showed that many of these portable containers were mismarked or unlabeled. Interviews with the machine operators revealed that machine operators were often unsure of which specific oils their machine needed, resulting in numerous mismatches and cross contaminations. On average, five mismatches occurred per month. Sometimes the mistakes had relatively minor consequences (e.g., discarding wasted oil). However, other times the results were more significant and resulted in machine failures and worker injuries. Some of the injuries included several maintenance workers suffering from superficial thermal burns resulting from inadvertently touching a hydraulic pump or a bearing that overheated due to the wrong oil being used, resulting in the wrong viscosity. These injuries affected productivity and incurred unplanned direct and indirect costs related to machine maintenance and medical treatment.

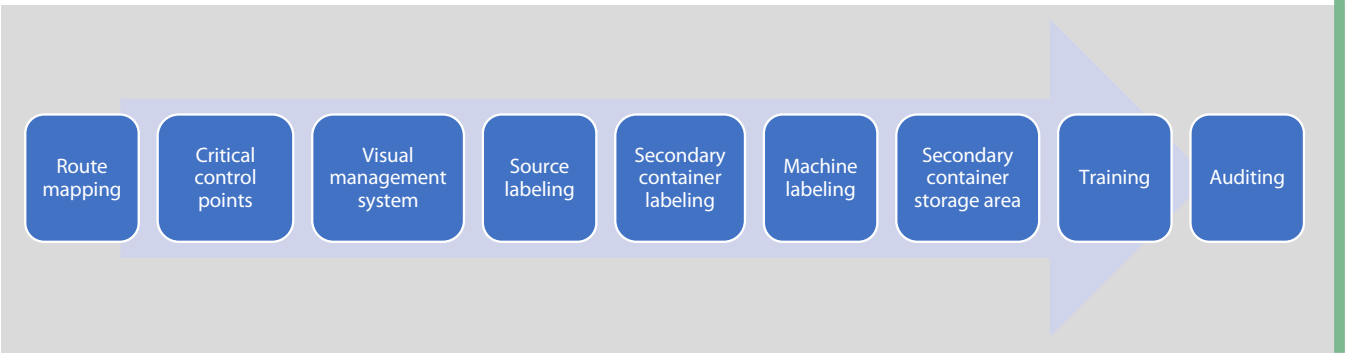
Frequent cross contaminations also led to an excess generation of MWFs mist or aerosol above OSHA PELs that affected the ambient air quality throughout the production floor. Workers experienced skin rashes and breathing problems when exposed to MWFs, and some workers with preexisting health conditions experienced bronchitis and were hospitalized because inhaling unhealthy mists or aerosols worsened their condition. It was observed that mist or vapor generations increased significantly when the MWF (more often the water-based MWF) was contaminated with tramp oil, or oil used for lubrication of the machines (e.g., hydraulic oil, gearbox oil and other lubricants). Because several machines were old (and did not have adequate enclosure), the poorly designed ventilation system coupled with the fact that reducing operator access to the process was not always feasible, the excess generated mists and aerosol dirtied the ambient air and made it unhealthy. Contamination of MWF with tramp oils occurred due to a leak. Leaks occurred because of damaged seals. Seals became damaged because two oils were accidentally mixed, which led to the incorrect hydraulic oil viscosity. Tramp oil that leaked into the MWF contributed to microbial growth by being a source of nutrients for bacteria, and by creating various conditions for anaerobic microbial growth.

Additionally, frequent mismatches led to repeated machine breakdowns and high repair rates. Using the wrong oil in a machine caused equipment damage, an increase in corrective maintenance and a significant increase in the maintenance workload throughout the plant. Machine spindle replacements alone due to mismatches cost the plant a minimum of $60,000 each year. Interviews with workers showed that these occurrences diminished or tainted their ability to work safely and increased stress and fatigue among maintenance workers. Since the machines were the backbone of the plant's production system, maintenance and repair were high priorities each time a machine was down and needed to be performed as quickly as possible. Working under pressure and limited time constraints led to even more worker injuries, including lacerations and injuries to muscles, bones and joints. Although maintenance workers were well-meaning, motivated and experienced, the one-on-one interviews conducted during the course of the investigation revealed that maintenance person-

TABLE 1
KEY CONCERNS CAPTURED FROM PLANT INVESTIGATION

Safety & health concerns	Other issues
•High rate of maintenance-related injuries •High rate of breathing issues due to toxic smokes and clouds throughout the plant floor •High rate of injuries due to mixing incompatible oils •Mismarked or unlabeled secondary containers of oil	•Production downtime •Oil wasted due to cross contamination •Reduced machine operator productivity resulting from excessive time spent determining machine oil requirements

FIGURE 1
NINE STEPS TO IMPLEMENT THE AT-A-GLANCE LABELING SYSTEM



nel experienced reduced alertness and took shortcuts to get the job done quickly.

The investigation also revealed another challenge related to educating temporary workers on locating the correct oil for their assigned machines in the plant's chemical bulk storage area. This was a time-consuming effort; the plant devoted a lot of time to educate temporary workers with the old system, sometimes requiring the trainers to shadow temporary workers for at least a week, if not more, to determine whether they could locate the correct oils.

The Action

To overcome the investigation findings, the plant developed and implemented at-a-glance labeling, a cost effective, practical system. This user-friendly system employs different color-coded shapes and portable oil containers to reduce chemical mismatches and cross contamination.

Steps to Implement At-a-Glance Labeling

The plant used a nine-step process to implement the labeling system throughout the manufacturing area. The plant assembled a joint multidisciplinary team comprised of labor and management representing various departments (e.g., purchasing, tool crib, maintenance, engineering, production, safety) to develop and implement each step. In a nutshell, these steps were used to accomplish the following: quickly identify lubricants with a color-coded chart, clearly mark equipment with color-coded labels, and easily identify products with color-coded storage, handling, dispensing equipment and containers. Figure 1 depicts an overview of the nine steps.

Step 1 is route mapping. The plant observed workers and mapped the route traveled by every portable container from the bulk storage tank area to the machine's oil tank. A complete, accurate mapping of the routes traveled is fundamental in the identification of critical control points to see where interventions are needed to stop mismatches and cross contaminations.

Step 2 identifies critical control points within each mapped route. These are identified points where a mismatch must be controlled to prevent using the wrong oil in a machine. The plant identified two critical control points: At the source where oil is transferred from the bulk storage tank to the portable container and at the lubrication point (also known as the point where the machine operator transfers oil from the portable container into the machine's storage tank). The plant identified the critical control points on the mapped routes.

Step 3 creates a visual management system, assigning each oil a shape (e.g., star, cross, diamond, oval, square, rectangle) and a color (e.g., red, gold, purple, black). Figure 2 illustrates the shapes and colors used. Creating a visual management system is key because it serves as the blueprint for categorizing each oil and the model the plant will follow when container labeling occurs.

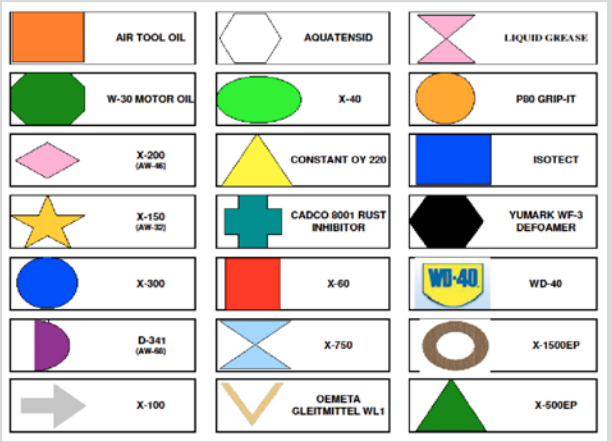
Step 4 is source labeling, where the plant places colored shapes and hazardous material identification system (HMIS) labels on corresponding bulk storage tanks and faucets (Photos 1, 2 and 3). Proper source labeling is key to help workers visually see the colored shapes and associate them with the assigned oil. The plant placed the assigned shape close to each lockable self-closing faucet so workers can easily match the colored shapes to the oil and eliminate any possible guessing and hesitation.

Step 5 involves secondary container labeling. Because the shape of all of the portable containers was nearly identical, the plant used colors to identify the oil in each container. The portable container's lid color matched the color of the shape and these containers were labeled with the same shape and HMIS label as the corresponding bulk storage tank. Container labeling is a critical step in the at-a-glance labeling system. The overall effectiveness of the system depends on proper labeling since portable containers are the lynchpins between the bulk storage area and the machines; it is a critical control point that the plant needed to capture in the system. Photo 4 shows the color-coded shapes on portable containers.

Step 6 is machine labeling. The appropriate colored shape was placed at each machine's lubrication point. Figure 3 shows shapes placed at lubrication points on one machine. Machine labeling is essential to prevent mismatches. Each shape is a permanent visual reminder that functions as a safety sign. Machine labeling not only helps machine oper-

FIGURE 2
VISUAL MANAGEMENT SYSTEM

Visual management system displaying assigned shapes and colors for different oils.



ators locate all of the lubrication points at each machine, it also makes it easier for the operator to determine whether the shape on the portable container matches the shape at the lubrication point, with a match meaning the correct oil is being placed into the machine.

Step 7 establishes a secondary container storage area to create dedicated storage areas for portable containers. A dedicated space prevents containers from being stored in many locations, reduces the chance of a mismatch and helps machine operators easily find a container to retrieve their oil. Figure 4 shows portable containers stored at their designated areas.

Step 8 is training, which rolls out the plan throughout the plant and educates workers on the system. A match game was implemented to help workers understand the system. The game involved helping workers understand the color-coding system by matching up shapes to confirm that they have the correct oil from the source, that they are using the right container, and that the oil going into the machine is correct to avoid mismatches and cross contamination. Photos 5, 6 and 7 (p. 44) were used in the match game to educate workers. The plant established an annual refresher training program to continually remind workers of the labeling system in place.

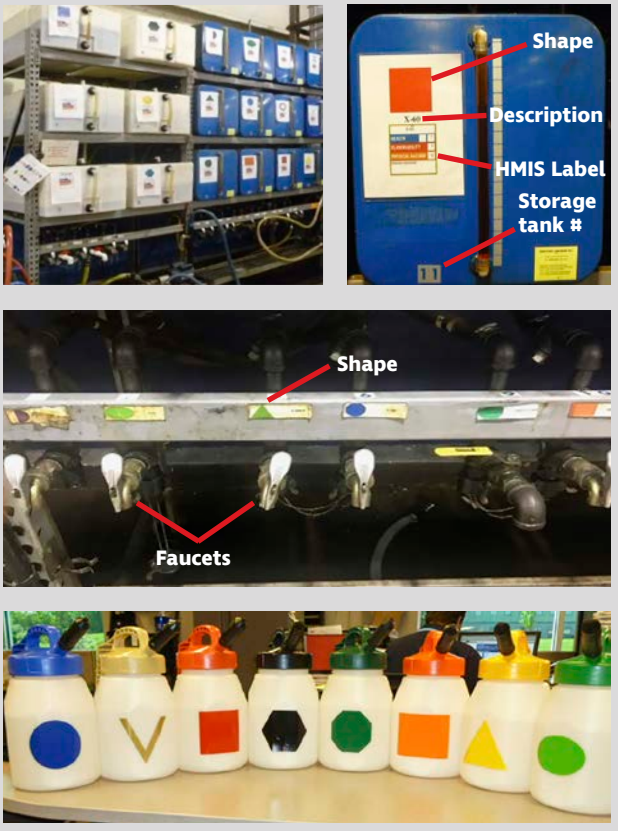


Photo 1 (top left): Bulk storage area showing oils marked with colored shapes to help workers easily identify each oil. Photo 2 (Top right): Source (bulk storage tank) labeling, which shows the assigned colored shape (red square) and corresponding HMIS label. Photo 3 (middle): Source (self-closing faucets) labeling, showing the assigned color shape for each oil dispensed in each faucet. Photo 4 (bottom): Color-coded shapes on portable secondary containers.

Step 9, auditing, evaluated the at-a-glance labeling system to determine its effectiveness. Led by the plant's safety committee team, this effort audited the system and its use monthly. Committee members maintained the labeling system by replacing any peeling labels or shapes in a timely manner and replacing containers as needed. The auditing step was important to maintain the integrity of the labeling system and to identify systemic issues for ongoing improvements.

The Results

The at-a-glance labeling system eliminated all of the plant's maintenance-related injuries caused by mismatches, as well the illnesses and injuries caused by cross contamination. The plant's total case incidence rate dropped 40% from 12.6 to 7.5, moving the plant below the industry average. Reducing the risk for injuries and illnesses increased worker morale and allowed continuity in the plant's manufacturing process, avoiding delays due to finding replacements for injured or ill workers or waiting for machine repairs.

Within a year, the company saved about $3.6 million related to costs for workers' compensation and machine maintenance and repair. The plant operated self-insured workers' compensation programs and workers' compensation costs experienced a 40% reduction from $1.5 million to $600,000.

FIGURE 3
SHAPES AT LUBRICATION POINTS

Shapes placed at lubrication points to identify which oil should be placed in one machine.

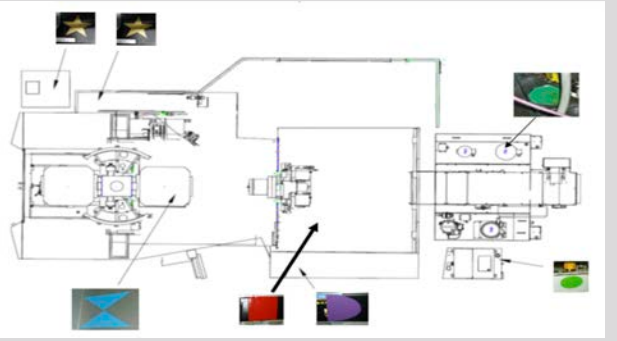


FIGURE 4
PROPER STORAGE & LABELING

Labeled portable containers stored at their designated area.

The at-a-glance labeling system also helped the plant comply with the OSHA Hazard Communication Standard. The plant labeled all containers according to the globally harmonized system labeling rules, avoiding OSHA citations and associated costs.

Implementing the system also streamlined the plant's processes and made workers more productive because they could more quickly find the oil they needed to maintain their machines. Reducing the maintenance and repair of each machine increased the plant's overall equipment effectiveness, thus increasing daily product throughput. Clarifying oil types and use also helped the plant reduce waste oil.

Implementing this system also yielded an unexpected result: Production supervisors were able to rotate machine operators more easily. Before implementing the system, machine operators were comfortable with one particular machine and resisted moving to a new machine where they had to learn a new oil regime because they did not want to make a mistake. Now, because it was easier to identify which oil goes into each machine, machine operators were more apt to learn how to operate new machines. The ability to rotate machine operators increased flexibility in the plant's operations. Production supervisors were able to leverage that flexibility when, for example, a machine operator called in sick and had to be replaced with another operator.

Finally, the plant experienced a positive impact in the onboarding process of temporary workers. Adopting the at-a-glance labeling system simplified and drastically reduced the duration of training for temporary workers. Observations showed that a 15-minute round of explanation and demonstrations effectively provided the temporary worker with enough information to understand the whole concept. The plant observed success in mastering the system even for temporary workers whose primary language was not English. One machine operator joked that this new system equips operators with a sort of GPS to help them navigate their way around what was nicknamed "the oil maze," indicating that the labeling system was a success.

Conclusion

In organizations where several different types of hydraulic oil are used or where some machines need several kinds of oil to run smoothly, chances for mismatches and cross contaminations are high. The at-a-glance labeling system is a user-friendly visual aid system that uses different color-coded shapes and portable containers to reduce or eliminate mismatches and cross contamination occurrences. With several safety and health challenges, the plant experienced productivity losses, incurred machine and repair costs, and frequently experienced worker injuries and illnesses due to using the wrong oil in machines. The at-a-glance labeling system helped the plant overcome these issues using a nine-step implementation process that can be easily implemented at other organizations experiencing similar issues and concerns. The company reaped benefits far beyond safety and health. After implementing the system, the efficiency rate increased by 31% (from 49% to 64%). Regardless of size, any organization that uses, stores, labels and disposes of chemicals can employ this labeling system to improve the recognition of chemicals and help alleviate user error when using portable containers. **PSJ**

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Photos 5, 6 and 7 are from the match game. Photo 5 (left) shows matching colors and shapes from the source to the portable container. Photo 6 (center) shows matching colors and shapes from the portable container to the machine. Photo 7 (right) shows mismatching oils.