

OCCUPATIONAL ASSESSMENT OF OCULAR SAFETY HAZARDS OF SMALL
BUSINESS AUTO-MECHANIC SHOPS

By

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BUSINESS AUTO-MECHANIC SHOPS

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Has been approved

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Doctor of Optometry Paper
Approval and Release

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I, Jennifer Jane Shaba, hereby release this paper as described above to Ferris State University with the understanding that it will be accessible to the general public. This release is required under the provisions of the Federal Privacy Act."

ABSTRACT

Purpose: An occupational assessment was conducted to evaluate ocular safety controls in small business auto-mechanic shops and the specific chemicals used in these environments. Compiled data was analyzed and distributed for optometrist to be knowledgeable with the specific chemicals that pose an ocular threat to the eye and comfortably recommending the proper ocular safety devices. *Methods:* Five worksites of small automotive and mechanical businesses were evaluated by walk through site observation throughout the Detroit Metropolitan area. This study was limited to only quick oil change, general auto-mechanics and small business care dealerships. Evaluation of employee work environment and safety controls were compiled for analysis against OSHA guidelines in regards to how the facilities maintained a safe and healthy ocular environment. Approximately 20 Interviews were conducted with employers and their employees to understand the implementation and enforcement of safety eye wear. Each individual who participated signed a consent form which was approved by the Ferris State University human subjects review committee. This study presents different types, amount, causes and cost incurred of eye injuries over a five year period. *Results:* One out of five sites presented with a decent eye wash station. Fortunately during a five year period only two out of five places actually sought a professional eye care provider due to an eye injury. None of the auto mechanic shops had a formal education on ocular hazards, but enforcement of eye protection around specific machinery was implemented. This awareness lessened the chances of ocular injury.

Fortunately, the same chemicals were found in each facility with greater emphasis on systemic versus ocular hazards.

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INTRODUCTION: Almost all ocular injuries can be prevented through sufficient knowledge, heightened awareness and familiarity of an individual's working environment. An occupational assessment was conducted to evaluate ocular safety controls in small business auto-mechanic shops and the specific chemicals used in these environments. Compiled data was analyzed and distributed for optometrists to be knowledgeable with the specific chemicals that pose an ocular threat to the eye and comfortably recommending the proper ocular safety devices. Information will be published in The Michigan Optometrist magazine. There is sufficient information for the general public in regards to the importance of eye safety protection while operating mechanical machinery, however there are still numerous ocular injuries associated with mechanics in the workforce annually. This study will help give the background knowledge needed to familiarize the eye doctor with the hazardous chemicals and proper safety precautions needed to maintain good eye-health.

Every facility should have readily available and accessible updated Material Safety Data Sheets (MSDS) specific to the used chemicals. The information contained in the MSDS provides exact chemical composition, which aids in the eye physicians' treatment and prognosis of the ocular insult. Also MSDS are to be used by employers, who may occupationally be exposed to a hazard, to become familiar with storage methods and for safety.¹ The specific chemicals observed in these environments include; brake cleaner, engine coolant, engine oil, transmission fluid, starting fluid, brake parts cleaner, brake cleaner, and engine degreaser. According to a few interviewed employees, fiber from asbestos tends to be a problem encountered long ago but is still on the list of health hazards from brake lining.

Chemical trauma can have a variety of effects on the ocular surface ranging from mild non-specific irritation to severe destruction of the corneal layers, vision loss and possible loss of an eye.²The offending chemicals may be in forms of either a solid, a liquid, such as solvents, a powder, a mist or a vapor. The severity of the chemical injury is proportional to the pH, the volume, the duration of contact and toxicity of the chemical compositions. The most severe chemical injuries tend to be caused by strong alkalis and, on the lower end of the pH spectrum, by acids. Strong alkalis have the tendency to raise the pH of ocular tissues and cause saponification of fatty acids in cell membranes, leading to cellular disruption. Alkali solutions readily penetrate the corneal stroma upon epithelial disruption and rapidly destroy the proteoglycan substance and collagen fibers of the stromal matrix. Intraocular chemical penetration is often troubled by cataract formation and secondary glaucoma.^{1 2}

METHODS: Five worksites of small automotive and mechanical businesses throughout the Detroit Metropolitan area were evaluated by a walk-through site observation. This study was limited to only quick oil change, general auto-mechanics and small business care dealerships. Evaluation of employee work environment and safety controls were compiled for analysis against OSHA guidelines in regards to how the facilities maintained a safe and healthy ocular environment. Approximately 20 Interviews were conducted with employers and their employees to understand the implementation and enforcement of safety eye wear. Each individual who participated signed a consent form which was approved by the Ferris State University human subjects review committee. This study presents different types, amount, causes and cost incurred of eye injuries over a five year period. A checklist was prepared to collect the data and for consistency of identifying specific criteria for this study. Observation of poor hygiene and maintenance was marked along with any eye level ocular hazards. Appendix C is a copy of the observation checklist that was used for this study.

RESULTS: Through observation, many mechanical hazards for ocular surface insult included toolbox drawers open at eye level, batteries on the floor near liquids, opened cap bottles without labels, food near polluted material, air from fumes in car exhausts. Warning signs were present but useless and unnoticeable above eye level range. Many of these avoidable circumstances may be less injurious by heightened awareness of employers. "Non-smoking" signs were not placed at eye level and thus the customers were unaware of the specific designated areas. The welding unit was equipped with the speedy glass helmet that darkened to protect the eyes from the intense UV exposure. Most employers enforced maximum protection protocols to employees around welding machines. The drill press/metal grinding machine did not have a safety guard over the top it, which is a threat to the operator. Safety glasses with full cover side shields need to be employed. In addition, the operator should be wearing a face shield for maximum protection.

Each facility had MSDS sheets of the specific chemicals used by employees. MSDS were made available to the employees for reference. First aid kits were not readily accessible and many outdated. Fortunately, many of the facilities did not need to use them in the last five years. However if an eye injury did occur, an employee may urgently need the kit and therefore not able to employ temporary self-treatment.

Shockingly, no facility installed a formal eye wash station. A two faucet deep sink was the closest to the best observed eye wash station. Some facilities utilized a hose hooked up to the sinks. Others used 7 ounce bottles filled with distilled water to be used for ocular emergencies. However, due to the bottles unsanitary

condition, they were not recommended for use, in the event of introducing unnecessary bacteria to the eye. Fire extinguishers were updated regularly. The employees knew the location of their improvised eye wash station and were aware to keep an unobstructed access and clutter free environment around it. Some better than others were observed for unsanitary habits.

Employees wore safety approved ANSI standard corrective lenses. Some utilized side shields and others did not think to wear them. Baseball caps were a good form of engineering control in that it was utilized by employees, who wore contact lenses, as a partial protection from working underneath the cars. However upon chemical contact, the lenses could cause greater ocular insult due to increase exposure and chemical volume. Fortunately this protocol seemed to have worked for many years and the number of eye injuries incurred was minimal at each facility. Visitors were told to not enter the designated areas where the employees worked. However if visitors needed to go to designated areas, they were not given any eye safety protection. This problem was discussed with the supervisor for implementation. No formal ocular education was given to employees besides a stipend or vision insurance coverage to obtain ANZI standard safety glasses. Side shields were not implemented for use on a consistent basis. Education consisted of a handbook given to employees from OSHA.

Safety goggles were provided through company vendors; however, safety goggles were not being utilized for the handling of dusty wheels and tires which stood above eye level. These falling particles could cause unnecessary and

avoidable foreign body damage to the eyes. Hub caps "rims" were held by strings on the ceiling where individuals walked underneath which was a hazard.

The gathered types of eye injuries were reported to be multiple minor dust particles in the eye which required no medical attention. In the past 5 years only 2 major ocular injuries required medical attention and fortunately visual prognosis was excellent. Minor abrasions included metal foreign body removals on the superficial corneal surface. One incidence occurred when the employee was taking fuel filter out from underneath a vehicle and was suddenly exposed to gas and break cleaner. Eyes were immediately flushed out with copious irrigation and vision was fully restored. The workers made a noteworthy point of their contact with rust and dirt that the Michigan cars collect and knew that they would be at risk of ocular assault. Safety goggles were not being worn on a consistent basis of the observed employees working underneath the vehicles.

Other non-ocular safety controls included the observation of light bulbs covered by metal wires. Other engineering controls included ventilation systems and fans throughout the building for fumes and exhaust removal around working areas. There were no "safety zone markings on the floor" due to limited building space.

A machine called a wheel weight cuts shaved pieces of metal because a tire needs to hold legal weight limits and the operator of this machine should be wearing safety glasses with side shields and a plastic protective shield due to the flying metal particles. A high speed balance consists of the wheel that turns with a plastic cover overlay for debris spread, the machinist was observed not wearing any protection. Glasses were stored away and not readily accessible for use when using the metal

grinder which had the highest potential for ocular abrasions and trauma. An air hose used for rims in loosening and tightening bolts was not being implemented with concomitant eye safety protection. The flying motion of these objects was not thought of.

The following discussion contains information regarding the common chemicals used. Knowing the pH of a solution can be crucial to implementation of treatment. The definition of pH identifies a solution as being acidic, basic or neutral. There are ranges for each category and are as follows, acidic between 0.0 and 7.0, neutral at 7.0 and basic also known as alkaline is between 7.0 and 14.³

The use of penetrating catalyst oil is intended for loosening the surface tension of frozen parts and further protection against rust and corrosion. Routes of entry included eyes, skin, inhalation, and ingestion. Sequelae from this include respiratory tract irritation, dermatitis, swelling and hyperemia. Reports have associated overexposure to these solvents, revealing permanent CNS abnormalities. Remedy upon exposure includes immediate copious irrigation with water or saline for 15 minutes before seeking medical attention. Chemical goggles are used for splashing fluids, such as oil. Therefore, recommending personal protective eye wear with standard safety glasses for eye sight and chemical goggles overlay provides higher safety measures. The pH was not available for this product.⁴

Antifreeze and coolant provide protection against any damaging corrosion and rust in automobiles. Their vapors are known to cause eye trauma, but fortunately corneal injuries are unlikely as stated in the MSDS. This product was found to have far worse systemic severity on the CNS, kidney and liver

abnormalities secondary to prolonged and excessive exposure. Signs an individual should be aware of include but not limited to nausea or vomiting from the narcotic or anesthetic effects. Also contact lenses are not recommended to be worn around these specific chemicals. This product contains ethylene glycol and diethylene glycol. After these chemicals are metabolized the side effects can harm the body systemically causing metabolic acidosis and renal tubular injury. The physician should order a urinalysis and look for signs of albuminuria, hematuria and oxaluria. There should be particular emphasis on acid-base balance and renal function tests.⁵

The pH of this chemical is 8, slightly basic. Ethylene glycol has produced dose-related teratogenic effects when studied on rats and mice. Pregnant females should avoid inhaling because it was shown to cause maternal toxicity and developmental anomalies. Previous known injuries according to MSDS included minor transient iritis, conjunctival irritation and discharge.⁵

Transmission oil is known to cause mild irritation, stinging, hyperemia and dermatitis. The injuries produce necrosis of underlying tissue that requires immediate emergency personnel due to the high pressure hydrocarbons exposure. This material is not considered hazardous according to OSHA. Mist or vapors inhalation may cause respiratory irritation.⁶

Engine cleaner may cause severe irritation. Prolonged ocular exposure may lead to ocular burns. Recommendation by MSDS is fully protective goggles or a face shield. It was inadvisable to wear contact lenses when handling this chemical.⁷

Starting Fluid contains pressurized diethyl ether which wasn't as toxic for the eyes as it was for the gastrointestinal system causing nausea, strong anesthesia and cramps upon inhalation.⁸

Eye contact with brake fluid may diminish sensation, cause irritation and conjunctivitis. The systemic effects are far more hazardous. The pH is 9.5-10.5.⁹

Tire sealant, which consisted of the use of soap and water, checks for any holes found in the tire with a bubbling signal. Ocular safety should be implemented because of the dust and liquid that may be splashed into the eyes.

Discussion: During a worksite evaluation, the doctor should be aware of the types of hazards and tasks that could cause hazards. A modified version of Table 1 obtained from the United States Department of Labor Hazard Assessment includes specific types and examples of ocular hazards.¹⁰

Table 1 modified- United States Department of Labor Hazard Assessment

| Hazard Type | Examples of Hazard | Common related tasks |
|-------------------|--|---|
| Impact | Any flying object -dust -dirt -sand -woody chips | Drill press, grinder, chipping, sawing, sanding, Wheel weight machine, high speed balance machine |
| Heat | Extreme heat emitted--UV light | Welding, car exhaust |
| chemicals | Vapor, splash, mists, gas fumes exposure | Degreasing tires, acid handling, tire sealant, engine cleaner, transmission oil |
| Optical Radiation | Glare, intense UV light, radiation | Welding, torch cutting, soldering |

Safety eye wear should have the markings of ANSI "Z87.189." Side shields may be clip on or permanent type. While welding, standard ANSI approved safety glasses should be worn under the ultraviolet welding shield protector. Welding units should always come with ultraviolet protected filter on the face shield when using oxyacetylene tank torch. As an engineering control, the metal grinder should have a safety guard attached to protect the user from flying debris. In addition, safety glasses and plastic face shield should be readily accessible. Metal shards from the drill press have a high risk of corneal injury and intraocular trauma.

To decrease the incidence of eye injury, personal protective equipment should include ANSI standard safety glasses, face shields, and tinted goggles.

Definitely educate the contact lens wearer to be aware that they still need goggles to protect their eyes from airborne particles as no protection leads to increased risk of harming their eyes. Non-ocular safety materials should include gloves, boots or gym shoes, ear plugs or ear muffs and a protective suit.

During my evaluations of the worksites, one out of five sites presented with a decent eye wash station. Fortunately during a five year period only two out of five worksites had an eye injury where they actually sought a professional eye care provider due to an eye injury. The injuries were due to car exhaust gas exposure causing intense ocular burning and irritation. Luckily the patient had full visual recovery because of the immediate medical attention. None of the auto mechanic shops had a formal education program on ocular hazards, but enforcement of eye protection around specific machinery was implemented. This awareness lessened the chances of ocular injury.

As for chemicals hazards, the same chemicals were found in each facility. These chemicals have greater systemic hazards/side effects than ocular hazards. Exposures to many chemicals used were found to cause lung, kidney, liver, cancers, and birth defects to unborn children. Many chemicals if inhaled or absorbed through the skin find their way to the bloodstream and were known to cause secondary nervous system and brain damage.

Signs placed throughout the facilities should be placed at eye level. The significance includes a heightened awareness of designated areas to any individual in the environment. Emergency stations, such as eye wash or shower, should be readily accessible and maintained on a regular basis. Eye/Face wash units should

be located within 10 seconds of the hazard and on the same level as the hazard with an unobstructed path. The delivered water needs to be tepid (lukewarm).

Maintenance of the eye/face wash units includes activating eye/face wash at least weekly and inspected annually for compliance with ANSI Z358.1 Emergency Eyewash and Shower Equipment standard. A highly visible sign needs to be apparent for any individual in the workplace area. A formal eye wash station must deliver at least .4 gallons (1.5 liters) of water per minute for 15 minutes. An outlet head needs to be positioned between 33 to 45 inches from the floor and at least 6 inches from the wall or nearest obstruction. Airborne contaminants may inhabit the eye wash spray heads and therefore should be capped for protection. In one second or less the "hands-free" stay open valve should activate. The unit must connect to uninterruptible water supply that delivers at least .4 gallons per minute. ¹¹

OSHA interprets the phrase "within the work area" to require that eye/face wash units and emergency deluge showers be located within 100 feet of unimpeded distance from the corrosive hazard or within the distance recommended by a physician or appropriate official the employer consulted. ¹²

Poor ventilation in these facilities may expose individuals to experience dry eye symptoms, and therefore as eye physicians we must educate and address their concerns accordingly. Any contact lens wearer should be counseled about purchasing safety goggles for use while at work to prevent vapors or mists from inhabiting the contact lens. Educate patients about the importance of purchasing the highest protective eye and face protection by properly labeled ANSI Z.87.1 patent. Face shields are a necessity for certain machinery as an added ocular protection

which in addition to goggles are essential. In addition to ocular protection, educate the patient on dermatological body protection through the use of gloves. This, in turn, advises against irritant chemical skin contact. Nitrile material gloves were a suggested protective material by OSHA measures.¹³

The patient should familiarize themselves with all the chemicals they are handling in their work environments as to prevent any irritant from harming their bodies. The employees should know how to easily access the MSDS and the exact location of their eye wash station, shower station or first aid kit. These proper precautions and measures may increase the chances of immediate ocular insult relief in emergent situations.

Also since some of these chemicals are known to be teratogens, women employees who are pregnant should be aware of the chemical hazards in their environments. In addition, companies should be careful of allowing pregnant females into their facilities where chemicals could pose a threat to their unborn child.

As part of the eye examination, the doctor should immediately check for cranial nerves damage paying attention to the 1) trigeminal nerve for any loss of facial or ocular sensation, 2) facial nerve for any bilateral facial paralysis, 3) vestibulocochlear nerve for decreased auditory skills and 4) glossopharyngeal nerve for dysphagia. Initial assessment must assess any associated inflammatory signs such as hyperemia, swelling, heat or pain to the area of concern.

The treatment protocol on the management of any chemical assault to the ocular surface begins with immediate copious irrigation in both eyes and should be continued for at least 15 minutes until the person is seen by an eye care specialist.

However, to avoid delaying any possible treatment, if eye wash stations or eye wash bottles are not onsite and handy, then any non toxic, non-polluted solutions such as a soda can be used.

Upon presenting in your office, instill an anesthetic and irrigate the eye until the pH of the conjunctival sac normalizes. To check the pH, use a pH strip. Due to the toxic release of chemicals on the ocular surface, if a solid chemical is found, remove the offending chemical through the slit lamp with 1) cotton tipped applicator or 2) forceps. Next, the doctor should look for inflammation or corneal damage. In addition, the doctor should take a proper intraocular measurement if possible. If need be, debride the necrotic epithelium to promote the growth of new healthy epithelium.

The first line of treatment for chemical injuries includes intensive lubrication with non-preserved artificial tears. To promote ocular comfort, a bandage contact lens may be used in cases where a foreign body was removed. In addition to the bandage contact lens, concomitant use of an antibiotic is needed to prevent any secondary infection. Topical cycloplegics are recommended for patients that present with any cells or flare. Patients should be monitored with proper steroid treatment and tapering management when applicable. High dose ascorbic acid is believed to promote collagen synthesis in the alkali burned eyes because ascorbic acid, vitamin C, is required as a cofactor for this synthesis. The primary care physician should be notified of any new or potential use of medications and carefully monitoring of the kidney function should be employed when recommending high dose vitamins.²

CONCLUSION: This research study was conducted to educate employers and employees on the proper eye safety in hopes of decreasing the amount of eye injuries and costs. Effective communication is needed between employers and employees to improve eye related safety measures. Performance of a worksite evaluation of a business not only strengthens the ties between the patient and doctor but the knowledge gained from the experience allows the optometrist to confidently recommend proper safety eye wear protection. In this study, formal eye wash stations need to be installed in all of these facilities. In addition, employers need to raise the awareness of the chemical hazards that employees are dealing with on a daily basis. It is important that optometrists know the general types of personal protective equipment that meet or exceed ANSI Z.87.1 protection. As eye care providers, we should seize the opportunity for formal eye wear safety education to all patients who work in industrial settings.

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APPENDIX A

APPLICATION FOR APPROVAL OF A PROJECT INVOLVING HUMAN SUBJECTS
INITIAL REVIEW



Connie Meinholdt, Ph.D.
Psychology Program
820 Campus Drive
Ferris State University
Big Rapids, MI 49307
(231) 591-2759

To: Dr. Robert Buckingham, Ms. Jennifer Shaba & Mr. David Felger
From: C. Meinholdt, HSRC Chair
Re: HSRC Applications #080301 (Title: Worksite eye safety evaluation)
Date: April 18th, 2008

The Ferris State University Human Subjects Research Committee (HSRC) has reviewed your application for using human subjects in the study, “Worksite eye safety evaluation” (#080301) and approved it under the category of *exempt – 1C*.

Your application has been assigned a project number (#080301) which you may wish to refer to in future applications involving the same research procedure. All project approvals receive an expiration date one year from the date of approval. As such, you may collect data according to procedures in your applications until March 29th, 2009; you must apply for a renewal if data collection continues beyond this date. Finally, it is your obligation to inform the HSRC committee of any changes in your research protocol that would substantially alter the methods and procedures reviewed and approved by the HSRC in this application.

Thank you for your compliance with these guidelines and best wishes for a successful research endeavor. Please let me know if I can be of future assistance.

APPENDIX B

PARTICIPANT CONSENT FORM

Information for Participants
*Occupational Assessment of Ocular Safety Hazards of Small Business
Auto-Mechanic Shops*

An occupational assessment will be conducted to analyze safety controls in small business auto-mechanic shops. Individual interviews will be a part of the process to understand truly how effective communication between employers and employees is in relation to eye injuries.

Objectively inspect work demands and compare with OSHA guidelines about maintaining a safe and healthy environment. Inspection of specific work zones nearby each individual worker will be analyzed for potential eye injuries. Subjective input by conducting interviews to employers and their employees shall be used to understand the implementation and enforcement of safety eye wear. Inquiry of the number of eye injuries and causes per time frame along with the cost bearing on the individual businesses of safety eye wear will be reviewed.

This assessment will be conducted throughout Detroit, MI in small automotive-business. Data collected will knowledge optometrists in eye safety awareness and chemicals used in these environments. Approximately 25 individuals such as employers and employees of the small business will be interviewed. The small shops include quick oil change, general auto-mechanics, small business car dealers and gas-stations with mechanic garages.

The volunteer is at no risk, physical or otherwise.

Participation is voluntary; volunteers may choose not to participate at all, may refuse to participate in certain procedures or answer certain questions or may discontinue the survey/interview at any time without penalty or loss of benefits to which the volunteer is otherwise entitled.

The volunteers will remain anonymous in any report of research findings. All data will be reported in aggregate groups. Your privacy will be protected to the maximum extent allowable by law.

If the volunteer has any questions regarding the study, Dr. Robert Buckingham may be contacted at 231-591-2202. Questions regarding volunteer's rights as research participants or complaints about the manner in which the study is conducted (ethical, moral or otherwise) may be directed to the Human Subjects Research Committee (HSRC) by contacting Dr. Connie Meinholdt at (231) 591-2759 or via email at Connie_Meinholdt@ferris.edu.

Participant Consent Form

- 1 I have read and understood the information for volunteers on the above research study.
- 2 I am aware of the requirements involved in the study and satisfy the requirements.
- 3 I freely choose to participate in this study and understand that I can withdraw without penalty at any time.
- 4 I understand that the research study is strictly confidential.
- 5 I hereby agree to participate in this research study.

Name: _____

Signature: _____ Date: _____

APPENDIX C

WORKSITE OBSERVATION CHECKLIST

Worksite Walkthrough Safety Checklist

- Look for different types of hazards (mechanical, chemical, biological, radiant)
- Hazard Location? (entire building, specific rooms, areas, equipment, tasks)
- Who is at risk? (worker, supervisor, visitor)
- How is hazard controlled? (Engineering control - shields, administrative control – protocol, pp – goggles/right kind/compliance?)
- Administrative controls (warning signs/location/clarity/visibility?)
- What kind of eye safety/specific precautions are being taken?
- How often being checked for abnormalities?
- Easily Accessible and known by employees of workplace?
- Location and testing of eyewash fountain / first aid supplies (do employees know where to go in case of emergency?) unobstructed access? Clean?
- What are the known chemical irritants used and exposed in the workplace?
- Are the MSDS sheets readily accessible?
- What type of personal protective equipment is available to employees in the workplace?
- If available, by whom are they supplied?
- Is there enforcement to wearing eye wear?
- How many eye related injuries occurred in past 3 years?
- What were the causes and types of injuries?
- Any measures taken to prevent these from happening?
- What type of management is implemented to employees regarding eye safety?
- Are there meetings to ensure safety of workplace?