Environment Health and Safety at WPI Project

http://www.mysafetysign.com/signs/wear-personal-protective-equipment-floor-sign/sku-sf-0228.aspx

Project By: Kathleen Ross, Alan Worrest, and Edward Graff

1.0 Abstract:

This project was initiated to improve health and safety at Worcester Polytechnic Institute (WPI) and verify or reject concerns regarding unsafe practices being performed by students, faculty, and staff. It was hypothesized that WPI has a systemic problem: across many or all the labs and departments, some people are not wearing the necessary personal protection equipment (PPE). Data were collected in the form of accident reports, lab observations, and professor interviews. It was found that this systemic problem does exist and that it is caused by numerous factors including negligence, unavailability of PPE, and unavailability of accessible safety information. Departments were subsequently asked to stock the missing PPE and a myWPI organization was created to make safety information accessible.

Table of Contents

2.0 Introduction

This interdisciplinary qualifying project (IQP) team was formed to improve health and safety at WPI. This topic was brought to the attention of the advising professor through second hand accounts of unsafe practices being used by students, faculty, and staff on campus. The project has several goals. The first objective is to verify the existence of a problem regarding safety through data collection and observation. Then, if confirmed, the second objective is to identify a subset of the problem that can be improved. After the scope is narrowed, the team is to investigate the cause(s) of the problem and search for solutions. The final goal is to implement the solutions decided upon by the group. The completion of these goals will benefit the WPI community and improve safety.

3.0 Methodology

3.1 Accident Reports

In the first stage of the project, the team analyzed data from incident reports regarding safety at WPI that encompassed many departments for the years 2007 through 2012. David Messier provided accident and injury summary reports for the team to analyze. These reports contained statistics on how many accidents happened in a specified year and in which department and/or division the injuries occurred. The reports also stated the number of accidents that resulted in lost time, accidents that did not result in lost time, and the number of workers compensation incidents. Finally, the reports categorized the accidents by type: contact or struck by an object, weather-related falls, not weather-related falls, lacerations, movement related and miscellaneous.

After discussing the data amongst the team, the findings were brought before the project advisors. It was then decided that trying to lower the number of accidents in the Facilities Department, the one with the highest number of accidents annually, was beyond the scope of the project. The Academic Division had the second highest accident occurrences, so the team made investigating it an attainable goal. The team requested a more detailed report that only focused on the Academic Division from David Messier. These reports focused solely on the accidents that occurred while in a laboratory environment. The accident reports obtained helped the team find data that validated or challenged the second hand accounts concerning safety at WPI.

3.2 Observing the Laboratory Situation

The accident reports suggested that most of the accidents were caused by a lack of correct PPE usage. The group began an investigation of the laboratories at WPI in order to determine the extent and cause of the current problem. The team thought the best way to determine this was observe the labs directly. For a few weeks, the team split up and observed a few of the undergraduate teaching labs. These labs included chemical engineering's Unit Ops labs, general chemistry's Forces and Bonding labs, mechanical engineering's ME 1800 lab, and a biomedical lab. The team also observed the graduate research labs in Gateway Park by accompanying David Messier during several of his lab inspections. While observing these labs, the team members took detailed notes on their observations so the group could discuss and analyze them as a team later.

3.3 OSHA Safety Standards and Industry Safety Standards

The team researched what the OSHA safety standards are and what the required PPE is as determined by OSHA. This was necessary so the team could have a proper frame of reference

when comparing the safety practices and standards at WPI to OSHA's standards. Likewise, the team researched the safety standards that are adhered to in industry for the same reason. The companies that were researched for comparison were Whitcraft and Spirol.

3.4 Prescription Safety Glasses & Over-the-Glasses Safety Goggles

The analysis of the team's observations in the labs and the complaints of fellow students lead the team to investigate the availability of prescription safety glasses and over-the-glasses safety goggles at WPI. The information compiled about prescription safety glasses includes the company WPI buys the prescription safety glasses from for its employees, the discount that is offered to WPI employees, the cost of the safety glasses, and the price that a student would have to pay with the discount. The team tried and failed to initiate a policy in which WPI would help subsidize part of the cost of the prescription safety glasses for undergraduate students.

Another element of the safety glasses problem is the complaints and legitimate safety problems with the safety goggles currently supplied by the WPI bookstore, as they do not stock safety glasses that fit comfortably over prescription glasses. The group researched different over-the-glasses safety glasses to find a pair that was both comfortable and met OSHA standards. After identifying such a pair, the group asked the bookstore to stock this type of goggles for the next academic school year.

3.5 Availability of PPE necessary in Laboratories at WPI

The group ascertained through their observations that part of the problem was availability of PPE in some labs. Certain labs did not provide some of the PPE that is required in the lab, or stock it for students who may want it even if it is not required. When one such lab was identified, the team members informed the department head of this issue and asked that they might buy a small supply of the missing PPE for the specified laboratories. This communication happened mostly via email with the department heads involved and to any individual the department head brought to the group's attention. Two such labs were the chemical engineering Unit Ops labs and the mechanical engineering machine shops.

3.6 Professor Interviews

In the team's observations, it was apparent that some of the students in graduate labs were wearing proper PPE more often than other students in different graduate labs. To find out why this was, the team interviewed a few of the professors who were in charge of the graduate research labs where proper use of PPE was common. In these interviews, the team asked the professor about their policies regarding their graduate research lab, the use of PPE in their lab, and what safety training measures they require the students to go through.

3.7 WPI Laboratory Safety Information Gathering & Supplying

The team and project advisors determined that WPI's safety website was not very accessible to college students and was lacking in several aspects. To address this, the team decided to make an Organization on myWPI's Blackboard designed for college students to obtain quick information on PPE. The team members emailed professors in all the departments with labs asking to be provided with the lab safety policies and requirements for those labs. The information that was received was gathered, along with other pertinent safety information regarding the use of PPE, and uploaded or linked to on the organization.

4.0 Results and Discussion

4.1 Accident Reports

The report that summarized the laboratory accidents specified whether the injured person was a professor, post-doc student, graduate student, or an undergraduate student and with what department they are affiliated. Then, it briefly described the type of injury that they sustained. These descriptions revealed that there was a problem. The injuries recorded on the report included the following: hand and finger lacerations form contact with glassware and scalpels, hand burns, leg burns from contact with steam, throat irritation form inhalation of chemicals, eye irritation from dust-like material in eye, skin irritation from contact with acid or base solution or chemicals, and a lab rate bite to the finger. Most of these injuries are preventable by wearing the correct PPE while working in the lab. For example, wearing the correct protective gloves for the situation will prevent hand and finger lacerations, burns, or the irritation due to chemicals, acid or base solutions. Likewise, proper use of safety goggles prevents "dust-like material" from getting into a person's eyes. Finally, wearing long sturdy pants can prevent burns and other injuries to a person's legs such as the burn from steam reported.

4.2 Observation of Laboratories

4.21 Chemical Engineering: Unit Ops Observations

11/19/13

Nine students, one teaching assistant (TA) and one professor were observed in the Chemical Engineering lab in Goddard Hall. All of the people in the lab were wearing the requisite hard hats. Of the students, three were not wearing safety goggles or glasses, two were wearing only prescription glasses, and four were wearing the required safety goggles. The TA was wearing only prescription glasses and the Professor was wearing prescription lab safety glasses.

11/20/13

On the top level of the lab, there were three professors, six students, and one TA present. The TA was not wearing a hard hat but the other students and professors in the lab were wearing them. The Students did wear heavy duty gloves while working with a beaker of hot liquid. One student was going to grab the beaker and potentially get burned but was told by the professor that the beaker was hot before the student was harmed. Another student of the top level was even wearing a dust mask when they thought that it was needed. On the middle level of the lab, there were two students and one TA. All of them were wearing hardhats, goggles, and long pants but were also wearing short sleeves. These students were working with glycerin, steam and ice. When they were working with the steam, the students put on heavy duty gloves. On the lowest level of the lab, there were five students: all of which were wearing hardhats, three were wearing safety goggles, and two were wearing prescription glasses.

11/21/13

There were four people on the top level of the lab: three students and one TA. The TA and two of students were wearing safety goggles while one of the students wasn't wearing any eye protection. Similarly, all of the three students were wearing gloves and the TA was not. In this case, the students were working in a hood with an experiment while the TA was observing them and so had no need of gloves. On the middle level of the lab, there were three students and one TA; all of them were wearing hardhats and all but the TA, who was wearing prescription glasses, were wearing safety goggles. Finally, on the lowest level of the lab, there were only two students who were both wearing hardhats and goggles. One of the students from the middle level

of the lab came in and was handling a bucket of potentially hot/scalding material. This student was wearing heavy duty gloves, a hardhat, and safety goggles.

4.22 Chemistry – CH1020 Forces and Bonding

11/19/13

In this lab, a general chemistry lab in Goddard Hall, there was one TA, twenty-one students, and a professor who was going back and forth between this lab and another lab. Of the students, only two were not wearing safety goggles and only put them on an hour into the lab. These students had been working in the fume hood without the safety goggles and were actually working together. Everyone in the lab had gloves on. The TA seemed to be very good about reminding the students to wear them and when to change them as to not contaminate their experiment. The students were working on the Liquid Project. In this, they work with: Acetone, Acetonitrile, cyclohexane, 1,2-dichloroethane, dichloromethane, ethanol, Ethyl acetate, hexane, isopropanol, methanol, methyl acetate, and n-pentane as well as salt crystals for the IR spectroscopy.

11/20/13 (lab 1)

At the beginning of observations there were eighteen students and one TA in this lab and they were all wearing safety goggles and gloves. Later, a student was observed to put on a new pair of gloves before handling the salt crystals without needing to be told too. As time passed, one student took off his gloves in order to write in his lab notebook. It was later confirmed with more observation that this student never put his gloves on even when working with his experiment in the hood and/or the salt crystals. Another student had his safety goggles on top of his head while he was working in the hood with the experiment. About 10 minutes later he realized this and put them on correctly. This student does this repeatedly throughout the lab; he puts his goggles on top of his head and forgets about them and then puts them on later and so on.

11/20/13 (lab 2)

Similar to the first lab, there were eighteen students and one TA in this lab at the beginning of observations and all but one of them were wearing safety goggles and gloves. There were six students and one TA in the IR Spectrometer room at the start of the observation time. Everyone was wearing safety goggles and gloves. There was one student who was not wearing any personal protection equipment (PPE). Instead of safety goggles, he was wearing glasses. These glasses did not meet the requirements for the lab because they did not have side guards on them and they did not cover an adequate surface area. This student also didn't seem to be doing any work because he was never observed to work with the experiment in the hood or even touch any of the material involved. This student continued in this fashion for the whole lab class. Also, the TA was observed to work with a student's experiment in the hood without putting gloves on beforehand.

4.23 ME1800 Lab

In this lab, both positive and negative observations were made. It shall be noted that these observations were made by a student enrolled in the class.

This lab did many procedures correctly. First, students were required to take an online safety quiz before entering. There were also several signs about safety posted on the walls. Second, hearing and eye protection were provided to students in the lab. Students were observed looking out for one another's safety throughout the lab. Third, relevant safety topics had been

discussed in the course lecture, and pertinent safety information regarding potential hazards and issues were included in the assigned pre-labs.

There were several observations regarding the neglect to follow proper safety procedures in the lab. There were unlabeled containers and some chemicals were stored above eye level. The safety signs that were present did not feel adequate. Also, the safety glasses provided were unsanitary and the lab did not provide supplies to clean them. It was not clearly described or labeled where a student is required to use hearing protection. The peer learning assistants (PLAs) exhibited a lenient attitude towards safety and failed to enforce proper safety attire on the first day, but somewhat improved throughout the course. Gloves were not required or even provided for students working with jagged or rough materials. Finally, the aforementioned safety quiz could be completed without a proper understanding of the safety documentation assigned.

4.24 Biomedical Lab

The observed biomedical undergraduate lab had 12 students present, one TA, one lab manager, and one professor There were many positive observations made in this lab. First, all the students were wearing lab coats and bite proof gloves were provided for handling the rats. Also, nitrile gloves, safety glasses, and face masks were provided and worn by students.

There were also several negative observations that were made in this lab. One of the observations noted that some containers and syringes that were unlabeled or could have been labeled better. Also, there were chemicals stored at eye level. Another observation was that the lab tech and professors did not wear correct PPE, gloves in particular, when aiding the students. The most appalling observation had to do with an announcement that was made in which the professor stated that goggles and face masks were optional. This was at a point in the lab when students were cutting into the rat's carotid artery and could be sprayed with blood. This was distressing because blood can pose a major health risk for the students and a face shield should be worn and required at all times blood is present.

4.25 Graduate Research Labs in Gateway Park

The Gateway labs had many signs posted telling people to wear their safety equipment and informing people of hazards. Many of the things seemed to be labeled, though the labeling is not consistent or very clear. There were many Broken Glass Containers present for the disposal of hazardous glassware. Most fume hoods were orderly and did not break any rules of operation. Waste storage was clearly labeled and checked regularly. Combustibles were labeled and secure. General spill solvent and phones with contact information were readily available at all stations in case of emergency. Samples at lab stations were labeled and sealed when not in use. Also, generally speaking, there were clean sample and specimen storage refrigerators. The labs provided a lot of PPE for people to wear including gloves, safety glasses, and lab coats. Overall, there was a good waste disposal system in place.

There were many storage issues in the Gateway labs. There were chemicals stored above eye level, it was very cluttered and disorderly, the shelves did not have weight ratings marked on them, heavy boxes were placed on the top shelves, and many cabinets were mislabeled or not labeled at all. Storage was clearly a problem on the chemistry lab floor where there were fewer shelves because there were many hoods. In this case, chemical storage around the fume hoods for substances not actively in experiments was subpar, but this was due to a lack of adequate storage space opposed to neglect or intention. There seemed to be a meat slicer in the lab, though its purpose was not apparent. Also, safety glasses, even though they are provided, were rarely

worn. Finally, the shower inspection seemed out of date and there was brown water coming out of the eyewashes.

4.26 Discussions on All Observations

In all labs observed, the most prevalent issue was the number of people who were not wearing safety goggles. One reason that so many people were not wearing the safety goggles is because they have prescription glasses. People who have glasses generally say that the over-the-glasses safety goggles that are sold in the book store are extremely uncomfortable. The goggles provided in Gateway Park cannot fit over glasses at all. In some cases, people mistakenly believed that the sole use of prescription glasses was sufficient. Also, people who wear contacts cannot wear the safety glasses that are stocked because they do not meet OSHA's requirements for this type of use. They do not seal against the face. This is important to protect a person's eyes from fumes and splashes of chemicals that can get trapped under the contacts. As a result, some departments have accepted that those who wear prescription glasses need not also provide safety glasses. This does not meet accepted standards and is the cause of the group's efforts toward supplying better over-the-glasses safety goggles and research on prescription safety glasses.

Another issue common to every lab was a general lack of understanding of safety protocols and a lack of available information. As observed in the chemical engineering unit ops lab, a student almost burned himself by reaching for a scalding container with his bare hands. If the professor was not there to stop him, he could have been injured. In this case, the student was not negligent or refusing to wear the PPE. He just did not know that the container was hot and that he should be wearing gloves/mitts. This is a problem for the machine shops and mechanical engineering labs as well. The students do not know what PPE to wear when working on the different machines.

For the chemical engineering labs, there is a minor problem with people not following the hardhat policy. Students are required to purchase or rent their own hardhat for use in the lab. However, when a student forgets to bring it, they might be allowed to work in the lab rather than retrieve it or rent one from the stock room. Also, there were professors and other students who do not need to work in the main lab that requires a hardhat but walk through this lab to get to other labs. These students and professors are often seen walking through the lowest level of the lab without a hardhat on. This is in direct violation of the hardhat area policy. In order to prevent this, the chemical engineering department should purchase a small supply of hardhats for use in the lab by those few people who forget their hard hat. A supply of about 5-8 would be sufficient for this purpose. In addition, students, staff, and faculty should be directed not to walk through the main lab without the appropriate PPE.

The mechanical engineering lab had some storage problems and concerns. This lab contained some unlabeled containers and some materials were stored above eye level. It was surprising that the lab did not provide any gloves. There are many situations in a machine shop setting in which gloves are dangerous, but there are also many situations where they are needed. More importantly, clearer communication and signage needs to be put in place to inform people of when it is safe to use them or not. Also, this lab provided hearing protection that was rarely used because people were not told where it is located or in which situations it should be used. The current safety glasses storage system confuses some students. The current lab safety goggles set up looks like it is a storage space for people to put their own safety goggles instead of a place students can borrow communal safety glasses. Another problem with the provided safety glasses

is that they are unsanitary with no adequate cleaning supplies available in the lab. It would be beneficial to have sanitizing wipes to clean them before use. Also, the PLAs in this lab exhibited a lenient attitude towards safety and failed to enforce proper safety attire on the first day. For example, gloves were not required or even provided for students working with jagged and rough materials. The safety quiz that students were required to complete before they were allowed into the lab could be completed without a proper understanding of the safety documentation assigned.

This biomedical lab also had a storage problem in that chemicals were stored above eye level. There were containers and syringes that were unlabeled or poorly labeled as well. Another problem for this and other labs is that the professors and teaching assistants do not always wear correct PPE when aiding the student with the experiments. This exposes them to potential injury and sets a bad example for the students. Also, when working with blood, students should be required to wear face masks and safety goggles. In this lab, however, the professor made an announcement that the goggles and face masks were optional. Students should never be informed that it is acceptable to not use the proper PPE when dealing with blood. The use of such PPE should be strictly enforced.

The labs in Gateway Park were extremely disorganized. There were labelled drawers that did not contain what the label described and others were not labeled at all. There were several shelves full of containers stored above eye level without easily visible step ladders in every lab. Also, in these labs there were sections of the labs that had computers in them where PPE was not required. These sections were well within spilling distance of an experiment that went wrong or an accident at the lab benches. Some students occasionally brought experiments to those desks when that should be explicitly prohibited. That said, the people in this area should be required to wear PPE unless the departments decided to put up some kind of shield to block any chemicals and accidental spills from crossing over into the computer area.

4.3 Prescription Safety Glasses & Over-the-Glasses Safety Goggles

After looking into prescription safety glasses and contacting Laurie Colella, the group found that there are two companies that WPI affiliated personnel receive discounts. One of these companies is called Bello Opticians. It is located on 348 Shrewsbury Street in Worcester Massachusetts. They offer WPI students a 10% discount on their frames and regular lenses and a 5% discount on contact lenses. This includes prescription safety glasses. The discounts cannot be used in conjunction with any insurance coverage. Also these discounts require a valid WPI ID. The other company is Metz Opticians located on Park Avenue in Worcester. Metz offers a 20% discount on a complete pair of glasses. This discount also cannot be used with insurance coverage and requires a valid WPI ID. The average cost of a pair of prescription safety glasses without the discount is around $200. The group tried and failed to initiate a policy where WPI would cover some of the cost of the safety glasses.

The other angle that the group tried in order to promote the use of safety goggles had more success. The group found that Guardian over-glasses safety goggles were comfortable to wear over glasses and met OSHA standards since they conform to the shape of to a person's face when worn. After finding these safety glasses, the group asked the bookstore to stock them. The bookstore is currently in the process of supplying them for the next academic school year. This means that people who have contacts will be able to wear them in the laboratories if they wear these safety goggles. It also means that the people at WPI who wear glasses will have a more comfortable option available to them.

4.4 Availability of PPE in Laboratories

As shown in the observations of the labs, there are some labs that do not provide necessary PPE for the students to wear. The team found two such labs in their observations: the chemical engineering unit ops lab and the mechanical engineering machine shop. In the machine shop, they do not provide gloves to students even though they are working with rough and jagged metal pieces that can cut their hands. In the chemical engineering lab, even though it is a hard hat area, they do not provide extra hard hats for the few students who forget their hard hats every now and then. In order to fix this, the team contacted the department heads. Professor DiBiasio responded to this request by saying that there were some hard hats for this purpose but to contact him again if the supply had dwindled. The team investigated further and found that there were two hard hats dedicated to this purpose. After finding this out, the team sent another email to Professor DiBiasio so that he could orchestrate the purchase of these hard hats for the lab. The same was done for the mechanical engineering department to procure a supply of gloves for use with the jagged metal and other things that require gloves.

4.5 Professor Interviews

4.51 Professor Emmert

Professor Emmert primarily works with students that intend to work with her for an extended period of time. Her policy regarding lab safety is that they need to read and sign to a thorough group agreement sheet. She sees student safety as a very important part of one's education, is strict with PPE in her lab, and makes sure her students know the risks of not wearing PPE in a practical, personal way. Proper PPE is to be worn at all times in her lab, even when working with innocuous things like de-ionized water. Throughout the semester, her lab group holds group meetings where they can touch base and report lab problems in a group setting. She also goes through labs on the weekends and leaves post-it notes on her students' experiments.

4.52 Professor Sisson

Professor Sisson, as dean of undergraduate studies, sees all of the research proposals for graduate students. He makes sure they include a detailed report of the required equipment and hazard analysis and safety precautions for their work. The labs that he works with directly also have a lab manager and they both supervise all activity that happens within the labs. Students who violate the safety policies are sternly informed of their infraction. Continued violation has direct consequences for the students, ranging from losing time for working to a pay deduction if they are paid. There is a weekly technical seminar that is mandatory for grad students to attend, and when an issue is encountered, it is brought up at the beginning at the seminar so everyone knows what was wrong and why it was wrong. Their biggest problem in the lab, he admitted, was poor labeling of acids used in etching and proper waste management.

4.53 Professor Gericke

As department head and professor of chemistry and biochemistry, Professor Gericke often works with hazardous materials, especially strong acids. His department has long held a strict policy regarding lab safety for students and faculty regarding eye and skin protection. In the labs he works with, eye protection is required at all times except for viewing through a microscope. Those with prescription eye glasses are to wear goggles or safety glasses shaped to wrap around their regular glasses without exception. Professor Gericke tries to increase

awareness of proper personal protective equipment in his students so that those practices become habitual, and the sooner those practices become habits the better. When one is off in their job, they may not have the opportunity to go back home to get their safety equipment or wear proper attire without getting written up or fired first. Currently, the biggest safety issues in his department and the university as a whole is the transfer of chemicals from one lab to another, especially when one lab is in Goddard Hall and the other lab is in the Life Sciences & Bioengineering Center, and some inconsistent safety practices across all labs at WPI that are in the process of homogenizing.

4.54 Professor Heilman

Professor Heilman is a professor of chemistry and biochemistry. He works with a "small group of animal viruses that produce proteins able to selectively destroy cancer cells" in his research lab with his graduate students. His belief is that if the students like the PPE, they will be more likely to use it. With this in mind, he allows his graduate students to personalize their PPE. He views safety as extremely important, so he offers to buy his students prescription safely glasses at the expense of the lab. There is also rigorous mandatory safety training that his students have to go through in order to work in his lab.

4.55 Discussion of the Interviews

After interviewing Professor Emmert, the group discussed her methods of encouraging and enforcing safety and the use of PPE in her labs. This is so that the group can identify methods that succeed that can be recommended to other professors. In her case, it seems that a group agreement, extensive group time, and teaching awareness of the risks are why her students observe proper safety procedures. Also, there is an element of mutual observance in the group that keeps everyone looking out for each other's safety. In this way, these students can work safely while supervised and unsupervised.

In the case of Professor Sisson, his methods of encouraging and enforcing safety are slightly different. He is more hands on and directly involved in supervising the students to make sure they follow safety policies. Like Emmert, he also believes in making the students aware of the hazards involved in the research they are doing. This is why he makes them write a report analyzing the hazards involved, precautions needed, and the PPE necessary for their work. Unlike Emmert, he does not leave it to the other students to catch violators and keep them on track. He enforces the policies very strictly and there are consequences for the violators. The existence of consequences keeps the students in line where the knowledge of the hazards fails. In short, supervision is a big part of active safety protocol enforcement, discipline is strict, and the students are forced to know what to do in case of emergency.

Professor Gericke's goal is to make wearing proper PPE and following proper safety policies a habit for the students so that it becomes second nature to them. He does this in order to prepare them for industry where there are fired if they are caught in violation of safety policies. He is particularly strict when it comes to eye and skin protection. Like the other two professors, Gericke strives to cultivate awareness in his students so that they will follow the safety policies of their own accord.

Professor Heilman has a very different approach to PPE than the other professors do but it still seems to be effective. He allows his students to personalize their safety equipment in the hopes that they will take ownership of their PPE and wear it more often. If students have glasses, he offers to buy them prescription safety glasses. If they are uncomfortable in the gloves

provided, he lets them pick some other type of gloves and buys them for the lab. He was also one of the professors who were instrumental in the purchase of the lab coats for the chemistry labs in Goddard Hall and the labs in Gateway Park.

5.0 Conclusions and recommendations

There is a large problem regarding safety culture here at WPI. In the undergraduate teaching labs, the personal protection equipment is poorly organized, unsanitary and rarely cleaned, unavailable or a combination of all of these. Even when the PPE is available, the use of them is not enforced and sometime not even encouraged. Also, some professors, TAs, and PLAs are poor examples to the students by aiding them in their work without wearing the proper PPE themselves.

Another problem with the undergraduate labs is that the training required for most is very limited. This leads to having students in the lab who are not aware of the hazards and can get hurt. Also, the safety website that WPI currently has is incomprehensible to a college student and difficult to navigate. Students need to educate themselves on safety before they enter the lab. For this purpose every lab should make their safety policies clear and accessible to the students. The group has made a resource that may be helpful to students in the future but it is up to the labs and departments to supply the information to the students in order to minimize potential accidents.

Our group recommends that each lab organize their available PPE so that students know what is available and where it is in the lab. The labs should also provide sanitation wipes to clean the communal PPE after use. The lab instructors should take responsibility for teaching the students what PPE is required when working with different things in the labs. There should also be strict enforcement of the policies and constant supervision for the students in the labs.

For the graduate labs, the lack of PPE was found to be more apparent than in the undergraduate labs. A large portion of this is students' not wearing eye protection. Hopefully, the better safety goggles come into the bookstore in the fall so that there is a decrease in this problem. The team also believes that the lack of supervision in the graduate labs is allowing them to be negligent in their following of the safety policies. Professors who have successfully increased the use of and attention to safety equipment in their labs have done so through supervision, educating their students to the risks associated with their work, having consequences for violations, and allowing the students to personalize their PPE.

Everyone at WPI who is going to use a lab should educate themselves of the hazards involved before entering the lab. They should find out what is the proper PPE to wear in that situation. If a student sees a peer in a lab without the appropriate PPE, that students should conform the peer for the safety of the student body. If we implement a system where student are looking out for each other's safety, as well as being supervised, the number of accidents will decrease.

Appendices

Appendix A

These are the accident reports used for the preliminary analysis of safety at WPI. These forms were used to determine the state of PPE use in WPI labs initially. They were also used to determine what division/Department at WPI this project would try to improve.

2012 Accident Summary Report

Total number of reported accidents:	33
No lost time incidents:	27
Lost time incidents (< 5 days lost):	4
Workers comp incidents (> 5 days lost):	2
Total lost work days:	309
Annual cost:	$ 47,893

Accidents by department/division:

Facilities Department:	14
Academic Division:	10
Athletic Department:	3
Campus Police Dept.:	2
Student Services Div.:	1
CPE Div.:	1
HR Div.:	1
University Advancement:	1

Injury type:

Strains/sprains/bruises:	22	Lacerations:	4
Irritations:	4	Burns/bite:	3

Workers Comp Cases:

- Grounds keeper sustained a shoulder/elbow injury; caused by repetitive motion of equipment use such as leaf blower, etc. Lost work days: 287.
- Campus Police officer sustained a wrist injury while apprehending a crime suspect. Lost work days: 62.

David Messier, EOS Manager
1/29/13

Accident Reports that are specific to the laboratories at WPI

Lab-related accident for 2007-2012

2007 – BME undergraduate student (UGS), hand laceration, contact with lab glassware.
MSE graduate student (GS), hand burn, contact with hot metal (aluminum).

2008 – BBT GS, leg burn, contact with steam.
BME GS, finger laceration, contact with lab glassware.
BME GS, " , " scalpel.
CBC GS, throat irritation, inhalation of chemical substance.
BBT professional staff, skin burns, contact with steaming sterile water. This is the only case in which the victim lost work time (workers comp case).
CBC UGS, finger laceration, contact with lab glassware.

2009 – CBC GS, hand laceration, contact with lab glassware.
BBT UGS, finger laceration, " scalpel.
BME UGS, finger laceration, " "

2010 – BBT UGS, finger laceration, contact with scalpel.
CBC UGS, hand laceration, " lab glassware.
CBC GS, finger laceration, " "
BBT UGS, " " scalpel
2011 – CM post doc, eye irritation, dust-like material in eye.
BME UGS, hand laceration, contact with scalpel.
CBC UGS, " "
CEE UGS, " " lab glassware.
BBT UGS, " " scalpel.

2012 – BBT GS, hand burn, contact w/open flame.
CBC UGS, skin irritation, contact with base solution.
CBC UGS, " "
BME GS, skin irritation, contact with chemical.
BBT GS, finger laceration, contact w/lab glassware.
BME UGS, finger bite from lab rat.

Please let me know if I can provide additional information.

Dave Messier, EOS Manager

Appendix B

OSHA 300 forms reporting accidents that happened at WPI for 2011 and 2012. These forms are public record for anyone to see.

OSHA's Form 300 (Rev. 01/2004)

Log of Work-Related Injuries and Illnesses

Attention: This form contains information relating to employee health and must be used in a manner that protects the confidentiality of employees to the extent possible while the information is being used for occupational safety and health purposes.

Year 2010

U.S. Department of Labor
Occupational Safety and Health Administration

Form approved OMB no. 1218-0176

You must record information about every work-related injury or illness that involves loss of consciousness, restricted work activity or job transfer, days away from work, or medical treatment beyond first aid. You must also record significant work-related injuries and illnesses that are diagnosed by a physician or licensed health care professional. You must also record work-related injuries and illnesses that meet any of the specific recording criteria listed in 29 CFR 1904.8 through 1904.12. Feel free to use two lines for a single case if you need to. You must complete an injury and illness incident report (OSHA Form 301) or equivalent form for each injury or illness recorded on this form. If you're not sure whether a case is recordable, call your local OSHA office for help.

Establishment name: Worcester Polytechnic Institute

City: Worcester State: Massachusetts

Identify the person		Describe the case				Classify the case											
(A) Case No.		(C) Job Title (e.g., Welder)	(D) Date of injury or onset of illness (mo./day)	(E) Where the event occurred (e.g. Loading dock north end)	(F) Describe injury or illness, parts of body affected, and object/substance that directly injured or made person ill (e.g. Second degree burns on right forearm from acetylene torch)	CHECK ONLY ONE box for each case based on the most serious outcome for that case:				Enter the number of days the injured or ill worker was:		Check the "injury" column or choose one type of illness:					
						Death	Days away from work	Remained at work		Away From Work (days)	On job transfer or restriction (days)	(M) Injury	Skin Disorder	Respiratory Condition	Poisoning	Hearing Loss	All other illnesses
								Job transfer or restriction	Other record-able cases								
2011-01		Custodian	1/7/2010	Lee Street Building	Left Knee Pain when slipped on ice		X			205		X					
2011-02		Custodian	1/15/2010	Lee Street Building	Lower back strain from throwing away trash		X			3		X					
2011-03		Custodian	2/1/2010	Lee Street Building	Pain in the back of the knee when lifting a bucket of water		X			87	33	X					
2011-04		Mail Services Coord	2/10/2010	Loading dock	sprain upper back/lower neck unloading mail packages		X			6	6	X					
2011-05		Crew Coach	3/11/2010	Comfort Inn Cocoa Beach Fl	Lower Back strain from lifting rowing machine, had x-rays done				x			X					
2011-06		Custodian	4/3/2010	Lee Street Building	Swollen left knee from vacuuming		X			9		X					
2011-07		Custodian	4/22/2010	Higgins Labs	While mopping, the door closed and hit his elbow causing it to swell. Had X-Rays and medical treatment				x			X					
2011-08		Police Officer	4/25/2010	Back of ambulance on route to hospital	Back injury from being struck several times by a person		X			32		X					
2011-09		Utility Worker	05/04/10	Corner of Institute & Park Ave	Shoulder Sprain-Having Surgery 2/15/11		X			11		X					
2011-10		Gardener	05/16/10	Main Campus on the Quad	Ankle Sprain		X			9		X					
2011-11		Research Asst	6/2/2010	303 Belmont St	Rat bit her. No missed time, just received medical treatment				x			X					
2011-12		Custodian	8/10/2010	Dumpster behind building	Fell from dumpster and hurt right and left wrists, elbow, and face		X			1		X					
2011-13		Custodian	08/25/10	Lee Street Building	Ankle Sprain			X			4	X					
2011-14		Mail Clerk	9/1/2010	Boynton Hall	Struck by elevator door and got a cut on his head. No lost time but received stitches				x			X					
2011-15		Custodian	9/29/2010	Fuller Labs	Walking down stairs, missed a step and fell. Left and right legs were injured			X			4	X					
2011-16		Gardener	9/28/2010	Outside of WPI	Sawing trees when the saw fell and cut his hand. Received stitches			X			9	X					
2011-17		Custodian	10/11/2010	WPI	Moving chairs and tables, received a pain in shoulder			X			48	X					
2011-18		Director, Facilities	10/21/2010	37 Lee St	Slipped and Fell on stairwell, Sprained foot, fractured toe. No lost time, received x-rays				x			X					
2011-19		Planned Giving Officer	11/13/2010	Milwaukee, WI	Auto collision with one other car. Burns, bruises, muscle strains		X			2		X					
2011-20		Gardener	12/12/2010	Next to Alumni Field	While sailing, his vehicle was struck by an out of control car. Hands, knees, and back were cut/sore			X			7	X					
2011-21		Custodian	12/27/2010	Morgan Hall	Shoveling snow, slipped on ice. Right shoulder and arm were injured		X			2	27	X					
					Page totals	*0*	*11*	*5*	*5*	*366*	*138*	*21*	*0*	*0*	*0*	*0*	*0*

Be sure to transfer these totals to the Summary page (Form 300A) before you post it.

Injury	Skin Disorder	Respiratory Condition	Poisoning	Hearing Loss	All other illnesses
(1)	(2)	(3)	(4)	(5)	(6)

OSHA's Form 300 (Rev. 01/2004)

Log of Work-Related Injuries and Illnesses

Attention: This form contains information relating to employee health and must be used in a manner that protects the confidentiality of employees to the extent possible while the information is being used for occupational safety and health purposes.

Year 2011

U.S. Department of Labor
Occupational Safety and Health Administration

You must record information about every work-related injury or illness that involves loss of consciousness, restricted work activity or job transfer, days away from work, or medical treatment beyond first aid. You must also record significant work-related injuries and illnesses that are diagnosed by a physician or licensed health care professional. You must also record work-related injuries and illnesses that meet any of the specific recording criteria listed in 29 CFR 1904.8 through 1904.12. Feel free to use two lines for a single case if you need to. You must complete an injury and illness incident report (OSHA Form 301) or equivalent form for each injury or illness recorded on this form. If you're not sure whether a case is recordable, call your local OSHA office for help.

Form approved OMB no. 1218-0176

Establishment name: Worcester Polytechnic Institute

City: Worcester State: Massachusetts

Identify the person		Describe the case			Classify the case											
(A) Case No.	(B)	(C) Job Title (e.g., Welder)	(D) Date of injury or onset of illness (mo./day)	(E) Where the event occurred (e.g. Loading dock north end)	(F) Describe injury or illness, parts of body affected, and object/substance that directly injured or made person ill (e.g. Second degree burns on right forearm from acetylene torch)	CHECK ONLY ONE box for each case based on the most serious outcome for that case:				Enter the number of days the injured or ill worker was:		Check the "injury" column or choose one type of illness:					
						Death	Days away from work	Remained at work: Job transfer or restriction	Remained at work: Other record-able cases	Away From Work (days)	On job transfer or restriction (days)	(M) Injury	Skin Disorder	Respiratory Condition	Poisoning	Hearing Loss	All other illnesses
2011-01		Research Asst.	1/3/2011		particle in eye				x			x					
2011-02		Assoc Dir Alum Rel	1/25/2011	Snow covered stairs	bruise/swelling on the right foot				x			x					
2011-03		Custodian	2/3/2011	Riley Hall	Slammed door on her thumb				x			x					
2011-04		Dir Spon Prgm	2/7/2011	20 Trowbridge Rd	Fell on icy sidewalk in front of office. Hit head, small cuts on head and arm, hyper extended finger				x			x					
2011-05		Asst Dir Res Serv	2/8/2011		Broken Leg		x			61		x					
2011-06		Custodian	2/20/2011	Truck on Campus	Truck door closed on finger		x			3		x					
2011-07		Dir Academic Ops	2/25/2011	Institute Rd	Fell on ice and broke right wrist		x			3		x					
2011-08		Nurse	3/4/2011	32 Hackfeld Rd	Slipped on ice in parking lot and sprained ankle				x			x					
2011-09		Custodian	5/6/2011	Salisbury Labs basement	Left hand was closed in a classroom door			x			184	x					
2011-10		Assc Dir Annual Giving	5/16/2011	85 Prescott St	Injured left leg when hit by a car while crossing road				x			x					
2011-11		VP Student Affairs	5/17/2011	Campus Center	Fell down stairs, bruised and swollen leg				x			x					
2011-12		Student	6/30/2011	Kaven Hall Laboratory	Dropped flask in sink and it broke and cut his hand				x			x					
2011-13		Asst CIO	7/29/2011		Hand slipped while installing something and hit a metal bar, fractured right ring finger				x			x					
2011-14		Groundskeep	8/3/2011	Campus lawn	Mowing lawn, stepped into a ditch and sprained ankle		x			7		x					
2011-15		Campus Police	8/21/2011	Women's Locker Room	Slipped on the floor and twisted right knee		x			21		x					
2011-16		Printing Services	8/23/2011	Boynton Hall	4 stitches in left thumb from cutting it on the paper cutter				x			x					
2011-17		Custodian	9/2/2011		Slipped on stairs and twisted right leg			x			33	x					
2011-18		Custodian	10/11/2011	Stairs	Sweeping stairs, fell backwards and hit her head, torso, and arm		x			5		x					
2011-19		Groundskeep	10/31/2011	West street, in front of Stratton Ha	Plow tractor struck object, hurt neck and right foot		x			6		x					
2011-20		Electrician	11/9/2011	Washburn Shops Room 252	Fell off ladder, hurt back and had abrasions				x			x					
2011-21		Printing Services	12/8/2011	Boynton Hall	Cut left thumb on paper cutting machine, got stitches				x			x					
					Page totals	0	7	2	12	106	217	21	0	0	0	0	0

Be sure to transfer these totals to the Summary page (Form 300A) before you post it.

Public reporting burden for this collection of information is estimated to average 14 minutes per response, including time to review the instruction, search and gather the data needed, and complete and review the collection of information. Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number. If you have any comments about these estimates or any aspects of this data collection, contact: US Department of Labor, OSHA Office of Statistics, Room N-3644, 200 Constitution Ave, NW, Washington, DC 20210. Do not send the completed forms to this office.

Injury	Skin Disorder	Respiratory Condition	Poisoning	Hearing Loss	All other illnesses
(1)	(2)	(3)	(4)	(5)	(6)

OSHA's Form 300 (Rev. 01/2004)

Log of Work-Related Injuries and Illnesses

Attention: This form contains information relating to employee health and must be used in a manner that protects the confidentiality of employees to the extent possible while the information is being used for occupational safety and health purposes.

Year 2012

U.S. Department of Labor
Occupational Safety and Health Administration

You must record information about every work-related injury or illness that involves loss of consciousness, restricted work activity or job transfer, days away from work, or medical treatment beyond first aid. You must also record significant work-related injuries and illnesses that are diagnosed by a physician or licensed health care professional. You must also record work-related injuries and illnesses that meet any of the specific recording criteria listed in 29 CFR 1904.8 through 1904.12. Feel free to use two lines for a single case if you need to. You must complete an injury and illness incident report (OSHA Form 301) or equivalent form for each injury or illness recorded on this form. If you're not sure whether a case is recordable, call your local OSHA office for help.

Form approved OMB no. 1218-0176

Establishment name: Worcester Polytechnic Institute

City: Worcester State: Massachusetts

Identify the person			Describe the case			Classify the case				Enter the number of days the injured or ill worker was:		Check the "injury" column or choose one type of illness:					
(A) Case No.	(B) Employee's Name	(C) Job Title (e.g., Welder)	(D) Date of injury or onset of illness (mo./day)	(E) Where the event occurred (e.g. Loading dock north end)	(F) Describe injury or illness, parts of body affected, and object/substance that directly injured or made person ill (e.g. Second degree burns on right forearm from acetylene torch)	CHECK ONLY ONE box for each case based on the most serious outcome for that case:						(M)					
						Death	Days away from work	Remained at work		Away From Work (days)	On job transfer or restriction (days)	Injury	Skin Disorder	Respiratory Condition	Poisoning	Hearing Loss	All other illnesses
								Job transfer or restriction	Other record-able cases								
2012-01		Graduate Assistant	1/30/2012	Gateway Park	Burns on left and right hands				x			X					
2012-02		Grounds Crew	02/01/2012	On Campus Grounds	Hurt right elbow		x			100	10	X					
2012-02		Operations Mgr	2/14/2012	Higgins Labs	Bruising & discomfort of right knee, elbow, neck, back, and wrist				x			X					
2012-03		Plumber	3/5/2012	Boynton Hall	Fixing sink in Men's Room, hit head		x			2		X					
2012-04		Custodian	4/11/2012	Beach Tree Circle	Achilles tendon flare up		x			20		X					
2012-04		Police Officer	4/19/2012	10 Regent St	Sprain/fracture left wrist		x			84		X					
2012-05		Assoc Athletic Dir	5/5/2012	Alumni Gym Stairs	Fell, hurt right knee				x			X					
2012-05		Administraitve Assistant	5/14/2012	Atwater Kent Supply Closet	Cut Finger on Right Hand, received stitches				x			X					
2012-09		Police Officer	09/11/2012	Schussler St	Sprain left arm , wrist, and forearm		x			6		X					
2012-11		Mail Clerk/Student	11/7/2012	Goddard Hall	bitten by lab rat on right index finger				x			X					
2012-12		Custodian	12/4/2012	60 Prescott St	Difficulty breathing, chest pain				x			X					
					Page totals	*0*	*5*	*0*	*6*	*212*	*10*	*11*	*0*	*0*	*0*	*0*	*0*

Be sure to transfer these totals to the Summary page (Form 300A) before you post it.

Injury | Skin Disorder | Respiratory Condition | Poisoning | Hearing Loss | All other illnesses

Public reporting burden for this collection of information is estimated to average 14 minutes per response, including time to review the instruction, search and gather the data needed, and complete and review the collection of information. Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number. If you have any comments about these estimates or any aspects of this data collection, contact: US Department of Labor, OSHA Office of Statistics, Room N-3644, 200 Constitution Ave, NW, Washington, DC 20210. Do not send the completed forms to this office.

(1) (2) (3) (4) (5) (6)

Appendix C:

This is the form that is used during lab inspections wt WPI.

Laboratory Safety Inspection Form

General Information

- Are work spaces neat and clean? Cluttered?
- Any evidence of food or drink in lab area?
- Proper attire for lab personnel? Open-toe shoes? Shorts?
- Is PPE available and in use? Gloves? Safety glasses?
- Are gas cylinders in use? Secure? Proper tubing/clamps?
- Are refrigerators/freezers properly labeled? Food or drink present?
- Is moving equipment adequately guarded? Shakers? Vac. Pumps?
- Are water hoses properly clamped?
- Radiological material in use? Appropriate signage?

1. Chemical Information

- Chemical containers properly labeled? Any unknowns?
- Open chemical containers?
- Peroxide-forming chemicals dated properly? Type?
- Compatible chemical storage?
- Combustibles stored in flammable storage cabinet?
- Acids/Bases stored in corrosive storage cabinet?
- Excessive quantity of chemicals on lab bench? >Day's supply?

2. Biological Safety Information

- Name of biohazards in use?
- Bio Safety Level (BSL) designation?
- Are work areas neat and clean? Evidence of spills?
- Are "sharps" controlled? Proper containers?
- Bio Safety Cabinet in use? Certification current?
- Proper bio waste management? Waste containers?

3. Hazardous Waste Management

- Open containers?

- Proper labels? Abbreviations? Hazards checked? Dates?
- Secondary containment?
- Proper signage in place? Emergency response information?
- Spill control material available? Adequate supply?
- Weekly inspection conducted?

4. Electrical Safety

- Proper use of extension cords? Temporary use?
- Proper use of power strips? Need for additional circuits?
- Any frayed or damaged wires? GFCI's tested?

5. Safety Equipment

- Eye wash unit/shower accessible? Tested regularly?
- Fume hood accessible? Tested regularly?
- Fume hood storage acceptable? Clean and orderly?

6. Emergency Preparedness?

- Is fire extinguisher accessible? Inspected monthly?
- Is there 18" clearance of all sprinkler heads?
- Are exits and aisles clear of obstructions?
- Are exit signs readily visible?

Appendix D: List of PPE to be used on campus

CATEGORY (EYE/HEAD/HEARING/etc. PROTECTION)	MAJOR/LAB	STANDARD	COMMENTS
Body Protection	Animal Experiments	Lab coat or gown is to be worn at all times within the lab	
Body Protection	Bloodborne Pathogens	Lab coat or gown is to be worn at all times within the lab	Applies to Biosafety Level 2 and 3 organisms
Body Protection	Bloodborne Pathogens	Respirator with full body suit and dedicated air supply must be worn at all times within the lab	Only applies to Biosafety Level 4 organisms
Body Protection	Manufacturing lab	if someone is welding in the weld shop, always put on a weld coat before entering the room	
Body Protection	Chemical Labs	Lab coat is recommended if available to protect from splashing or spills.	Lab coat is mainly to be treated like clothing instead of full equipment.
Clothing	Universal	Close-toed shoes must be worn at all times	
Clothing	Universal	Long pants must be worn at all times	
Clothing	Universal	Long hair is to be tied back at all times	
Clothing	Liquid Nitrogen	Long sleeves are strongly recommended	
Clothing	Manufacturing lab	Feet should be enclosed in appropriate footwear. No open-toed or open-heeled shoes of any kind are allowed o be worn in the shop	
Clothing	Manufacturing lab	Do not wear loose clothing that could get caught in a machine. Always tie back long hear and anything handing from your neck.	
Clothing	Universal	Loose clothing is to be restrained	Reduces fire hazard, contamination, and mechanical interference
Clothing	Universal	Torn and/or skimpy clothing offers little protection from impact and splashing.	
Eye protection	Manufacturing lab	Safety glasses must be worn at all times within the lab	Glasses provided, ANSE Z87.1 standard glasses
Eye protection	Animal Experiments	A minimum of safety glasses must be worn at all times within the lab	Glasses provided, ANSE Z87.1 standard glasses
Eye protection	Animal Experiments	Goggles and a mask or a chin-length face shield must be worn	Required for infectious/hazardous materials or if splashing/spray is a possibility
Eye protection	Laser Lab	Eye protection is required at all times within the lab	EOS office will provide proper protection for specific laser operation
Eye protection	Bloodborne Pathogens	Safety glasses must be worn at all times within the lab	Only applies to Biosafety Level 2 organisms
Eye protection	Bloodborne Pathogens	Goggles and a mask or a chin-length face shield must be worn at all times	Only applies to Biosafety Level 3 organisms
Eye protection	Liquid Nitrogen	Goggles are to be worn at all times within the lab	
Eye protection	Manufacturing lab	if someone is welding in the weld shop, always wear the appropriate eye protection before entering the room	
Eye protection	Chemical Labs	Safety glasses must be worn at all times within the lab	ANSE Z87.1 standard glasses minimum
Hand Protection	Animal Experiments	Minimum of rubber gloves must be worn at all times	Non-latex, provided
Hand Protection	Bloodborne Pathogens	Rubber gloves must be worn at all times within the lab	Non-latex, provided
Hand Protection	Laser Lab	Insulating rubber gloves may be worn as needed	
Hand Protection	Liquid Nitrogen	Protective gloves must be worn at all times within the lab	Must be able to be removed quickly
Hand Protection	Chemical Labs	Nitrile gloves are expected to be worn at all times inside the lab	Take gloves off before leaving the lab area, get new ones when you return to prevent contamination
Head Protection	Goddard Labs	Hard hats must be worn within the two-floor labs at all times	ANSI Standard Z89.1-1986 hard hats
Hearing Protection	Manufacturing lab	Required if exposed to environments of at least 85 db	
Respiratory Equipment	Bloodborne Pathogens	Respirator may be worn as needed within the lab	Only applies to Biosafety Level 3 organisms
Respiratory Equipment	Bloodborne Pathogens	Respirator with full body suit and dedicated air supply must be worn at all times within	Only applies to Biosafety Level 4 organisms

Appendix E: Prescription Safety Glasses Calculations

Cost per pair of Glasses	cost if wpi could get 25% discount	WPI pays(50%)	Student pays(50%)
$ 200.00	$ 150.00	$ 75.00	$ 75.00

Number of undergrads	Assume 50% wear glasses	Assume 75% participation	WPI initial cost (Freshman-Seniors)	WPI Cost Per year after initial startup (IE: only made available to freshman - expected to last 4 years)
4012	2006	1504.5	$ 112,837.50	$ 28,209.38