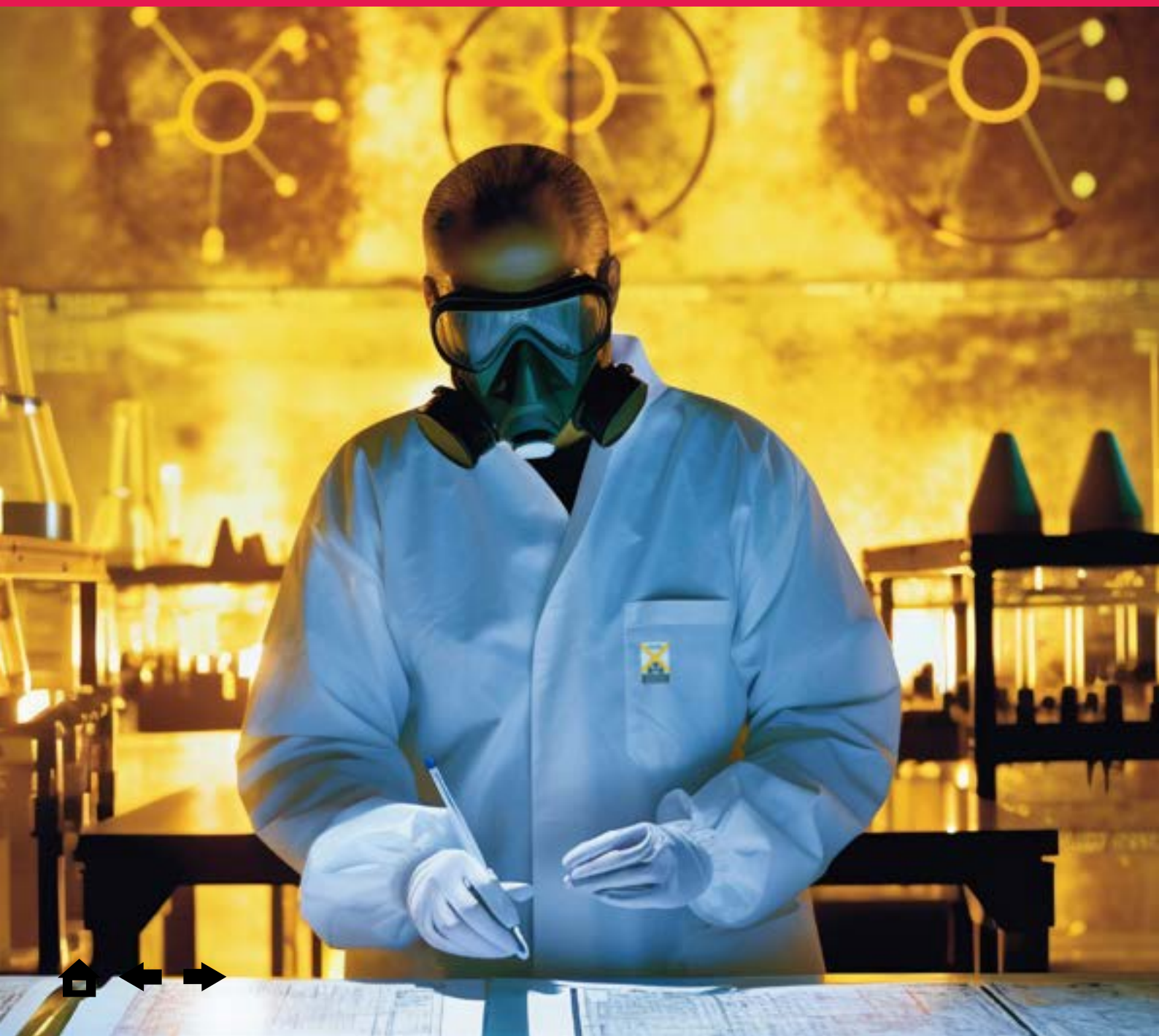
SECTION

2

SAFETY IN THE AEROSPACE LABORATORY



Core Concepts in Aerospace Engineering

Fundamentals of Flight

INTRODUCTION

Welcome to Section 2 of this Manual. We will now discuss safety as observed in the aerospace laboratory. Life is very precious but fragile and as such should be handled diligently. For this reason, the implications of safety practices in aviation and aerospace engineering, especially in the laboratory, are vital. It is important to know about safety to avoid unnecessary accidents or incidents in the laboratory. In this section, you will learn about safety regulations in the aerospace laboratory and see case studies of some laboratory accidents, how these accidents can be dealt with and how they could be prevented.

Let us now consider the information below to understand the importance of safety in the aerospace laboratory.

At the end of the section, you will be able to

- Discuss the advantages of adhering to safety precautions in the laboratory
- Explain safety precautions in the laboratory

Key ideas

- **Safety** – A state where there is freedom from harm or danger
- **Ethics** – Rules of behaviour about what is morally good and accepted in the laboratory
- **Precautions** – Something that is done to prevent possible harm or trouble from happening
- **Regulations** – Official rules or laws that say how something should be done
- **PPE** – Personal protective equipment that keeps the engineer safe in the laboratory and even on the field.

SAFETY IN THE LABORATORY: SAFETY PRACTICES AND RECOMMENDATIONS IN THE AEROSPACE LABORATORY

Have you noticed that there are some things we do and do not do in our everyday lives if we do not want to injure ourselves while going about our duties?

Have you ever wondered why you do not take off the hot cooking pot from the fire with your bare hands? Well, one can conclude that covering your hands before taking off something hot from fire even in our homes is a safety measure and what you use to cover your hands is personal protective equipment (PPE). Similarly, there are measures taken in any laboratory to ensure safety.

Introduction to Safety

Like many other engineering disciplines, aerospace engineering has a laboratory component. It is crucial to know about safety precautions in this space. Safety regulations in the laboratory are a set of rules or laws stipulated to govern activities in the laboratory to ensure safety.

Activity 2.1

Take a sheet of paper, write, and discuss this with your friend.

Make a list of safety measures you observe at home in everyday life.

Activity	Common hazards	Safety practice
Example 1: *Cooking*	Skin burns	Never touch hot utensils with bare hands. Always use a cloth
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Reflection:

1. What make the safety measures you have outlined important?

2. What other ways can you modify the ones you think cannot provide adequate protection?

Now let us consider some safety regulations that are in the aerospace laboratory

Safety Regulations in the Aerospace Laboratory

1. The laboratory is a safe environment, and "horseplay" (rough and noisy play) is discouraged.
2. Learners are not allowed at any time to work alone in the laboratory.
3. Always wear the prescribed personal protective equipment, i.e., hearing protection, goggles, dust masks, gloves, helmet etc.
4. Contact lenses should not be worn in the laboratory in situations where vapours or fumes are present.
5. Learners must know the location of emergency equipment including fire extinguishers, first aid kit, alarm bells, etc. in the laboratory.
6. All learners must be familiar with emergency response procedures.
7. All electrical devices must be grounded before they are turned on. Worn or frayed extension cords or those with broken connections or exposed wiring must not be used.
8. Learners must always adhere to laid-down equipment operating procedures.
9. All laboratory aisles and exits must remain clear and unblocked.
10. Learners are prohibited from sniffing, breathing, or inhaling any gas or vapor used or produced in any experiment.
11. All containers must be labelled as to the content, composition, and appropriate hazard warning: flammable, explosive, toxic, etc.
12. Learners must read and ensure to abide by the instructions on all warning signs in the laboratory.

13. All liquid and solid waste must be segregated for disposal.
14. Eating, drinking, use of any tobacco products, gum chewing, or application of makeup is prohibited in the laboratories, shops, and storage areas.
15. All injuries, accidents, and "near misses" must be reported to the laboratory technician immediately
16. No tools, supplies, or any other items may be tossed from one person to another or carried out of the laboratory.
17. Compressed gas cylinders must be secured. Proper safety procedures must be followed when moving compressed gas cylinders. Cylinders not in use must be capped.
18. Learners are never to play with compressed gas hoses or lines or point their discharges at any person, neither should they use adapters nor try to modify any gas regulator or connection.
19. There will be no open flames or heating elements used when volatile chemicals are exposed to the air.
20. Flammable chemicals will be exposed to the air only under a properly ventilated hood or in an area which is adequately ventilated.
21. Personal items brought into the laboratory must be limited to those things necessary for the experiment and the safe operation of the equipment in the laboratory.

Personal Protective Equipment in the Aerospace Laboratory

Please Note:

This lesson will take place in the Aerospace Engineering Laboratory. Make sure you arrive early at the laboratory. Keep note of all signs and directions given at strategic points. Be safety conscious and listen attentively to your teacher or laboratory assistant. Make notes of the things you learn, as you will discuss them later in class.

What is Personal Protective Equipment (PPE)?

Personal protective equipment or PPE is equipment that are generally worn on the body or used to prevent or minimize exposure to hazards. Hazards at the laboratory can be in the following forms:

1. Biological hazards
2. Chemical hazards
3. Radiological hazards
4. Electrical hazards
5. Mechanical hazards etc.

Common Personal Protective Equipment (PPE)

1. **Protection of the Eyes:** Goggles and safety glasses protect the eyes and facial area near them. Eye protection is required in the laboratory because there is a risk of flying debris and airborne particles.
2. **Respiratory Protection:** A breathing apparatus is required when learners are exposed to dangerous materials that can be inhaled. This could be a mask with filters or as complex as a whole breathing system, sometimes with an oxygen tank connected to it. The respiratory protection equipment must be examined regularly to ensure it is working properly.
3. **Protection for the Ears:** Those who use the laboratory are usually subjected to high levels of sound on a regular basis. While some may use foam ear plugs, extreme noise levels need professional earmuffs that cover the full ear.
4. **Whole Body and Skin Protection:** Full body protection like chemical protective clothing is essential in the case of continuous exposure to hazardous surroundings. PPE includes a full suit, gloves, boots, helmet, goggles, and face shroud etc.
5. **Protection for Arms and Hands:** Arm guards and medical gloves are regularly used to provide limb protection. Learners must still be able to work in the laboratory, although leather protective material is frequently used to avoid temperature-related injuries like burns.

In the laboratory, there is some personal protective equipment (PPE) that is very mandatory as they protect against any possible harm. Some of these have been indicated in the figure below:

Fig 2.1: Personal protective equipment

Activity 2.2

Listen carefully as your tutor or laboratory assistant shows or demonstrates the use of certain protective gear and safety practices. Now select a protective gear and demonstrate its use in the laboratory

Write this in your book, and present this to your friends in class:

Safety gear/ practice	Use	Importance
Example 1: ***Helmet*** Properly wear a helmet according to the manufacturer's instructions	Worn on the head to protect the head.	To protect the head against falling objects or injuries during a trip or fall.
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Reflection:

1. How easy or difficult was it for you to put on or use a certain protective gear?

2. What additional protection gear may be needed in your school's laboratory?

3. What safety measures will you suggest to your friends to observe when working in the laboratory?

Safety Signs in the Laboratory

Safety signs serve as visual communication to convey important information about safety and hazards. Here are some common safety signs and their meanings:

1. **Prohibition Signs**: Indicate actions that are not allowed. They are usually red and show a crossed-out symbol.
2. **Mandatory Signs**: Instruct you to do something. They are often blue and show a specific action.
3. **Warning Signs:** Warn of potential dangers. These are yellow and indicate caution.
4. **Safe Condition Signs**: Show safe areas or exits. They can be followed to safety.
5. **Fire Equipment Signs**: Indicate the location of fire equipment

Fig. 2.2: Sample Safety Hazard Signs

Activity 2.3

Watch the videos below:

https://www.youtube.com/watch?v=VnQR0WnRxdo

https://www.youtube.com/watch?app=desktop&v=_X6cCpONibE

In your book, write down the protective equipment and safety measures you observed.

Safety gear/practice	Use	Importance
Example 1: Helmet	Worn on the head to protect the head.	To protect the head against falling objects or injuries during a trip or fall.
2.		
3.		
4.		
5.		
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7.		
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Reflection:

1. What protection gear may be needed in your school's laboratory?

2. What safety measures will you suggest to your friends to observe when working in the laboratory?

Activity 2.4

Consider this scenario:

A group of Aerospace Engineering students in one of the STEM schools in Ghana are working in the laboratory. Whilst using a hot glue gun to join pieces of Styrofoam boards to create a foam airplane, a student playing around randomly pushes the hot glue gun onto his friend's arm. This causes serious skin burns. The student is rushed to the school's clinic for immediate medical attention.

Analysis:

What could have been done to prevent this accident from happening?

EXTENDED READING

Click on the links below for more information on laboratory safety

- Laboratory safety - Wikipedia
- Aerospace Engineering | Lab Safety | Penn State Engineering (psu.edu)
- labsafety.pdf (iastate.edu)
- Aviation safety - Wikipedia

Review Questions

1. Consider the incidents reported below and identify some preventive measures and some safety precautions that you would employ to avoid such incidents in the laboratory.

Case Study:

a. In January 2010, a chemistry lab at Texas Tech University exploded while two students were conducting some experiments to make derivatives of an explosive substance called nickel hydrazine perchlorate. They made a dangerous mistake: they created 10 grams of the substance, despite the warning from the supervisor not to make more than 100 milligrams (about the weight of a business card). When one of the students crushed the substance with a pestle, a terrible explosion occurred. Fortunately, no one died, but the student suffered from burns and lost three fingers

b. In 1997, the famous chemist, Karen Wetterhahn died because some drops of dimethylmercury fell on her hands despite wearing gloves. The drops penetrated those gloves, reached the skin, and entered her body. After a few months, she began to experience symptoms of mercury poisoning, such as loss of balance and poor speech, vision, and hearing ability. She then entered a coma and died.

Incident	Precautionary measures

2. What steps would you take to prevent similar incidents the next time you work at the Aerospace Laboratory?

3. Make posters of at least four safety hazard signs in the aerospace laboratory and paste them in your classroom or laboratory.

4. Consider your school's aerospace laboratory. Outline the significance of keeping to the laboratory safety precautions.

Answers To Review Questions

1.

   a. Explosion – pay attention to precision and accuracy of measurements
   b. Explosion – use the right tool for the right job
   c. Exposure to harmful chemicals – wear proper skin protection gear

2.

   a. Plan the process of activity for the session
   b. Share the plan with the tutor and friends
   c. Create a list of possible hazards and incidents and how to mitigate them
   d. Make a list of first aid and emergency equipment you will need in case of emergencies
   e. Share the session's activity among group members to ensure correlation.

3. Make posters

4.

   - Prevention of accidents and injury
   - Protection of the environment from the release of hazardous substances
   - Preservation of laboratory equipment

REFERENCES

1. McDuffie, T. E., Longo, J., & Neff, B. (1999). Handle with care. The Science Teacher, 66(9), 32–35. National Science Teaching Association.
2. Purvis, J., Leonard, R., & Boulter, W. (1986). Liability in the laboratory. The Science Teacher, 53(4), 38–41. National Science Teaching Association.
3. Rainer, D. (2000). The power and value of environmental health and safety audits. Chemical Health and Safety, 7(3), 20–25. American Chemical Society.
4. Summerlin, L. R., & Summerlin, C. B. (1999). Standard safety precautions: Developing a practical approach to chemistry laboratory management. The Science Teacher, 66(9), 20–23. National Science Teaching Association.

ACKNOWLEDGEMENTS

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