CENGAGE

7TH EDITION

AUTO BODY REPAIR TECHNOLOGY

James E. Duffy | Jonathan Beaty

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AUTO BODY REPAIR TECHNOLOGY

James E. Duffy | Jonathan Beaty

CENGAGE

Australia • Brazil • Mexico • Singapore • United Kingdom • United States

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***Auto Body Repair Technology,* 7th Edition**
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Library of Congress Control Number: 2020937407

Book Only ISBN: 978-0-357-13979-0

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Printed in the United States of America
Print Number: 01 Print Year: 2020

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Contents

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SECTION 5
Damage Analysis and Estimating

SECTION 6
Painting and Refinishing

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Preface

Welcome to the rewarding world of auto body repair! Whether you simply want to make minor repairs on your own car or to become an I-CAR- or ASE-certified collision repair technician, you will find this book a valuable resource.

Auto Body Repair Technology details how to properly restore a damaged vehicle to a "like new" condition from "start to finish." It is designed to help you work on any make and model passenger car, pickup truck, van, or sport utility vehicle (SUV).

Auto body repair, also called collision repair, is an exciting area to study. With millions of vehicles on the road today, there is a strong demand for well-trained collision repair technicians. Thousands of technicians are needed in the industry every year. Just look online, and you will find numerous openings for skilled technicians to work in collision centers. With today's high-tech vehicles and varied construction methods and repair techniques, competent collision repair takes well-trained, knowledgeable professionals.

Section 1, Non-Structural Analysis and Damage Repair, provides an introduction to the industry and all the relevant information to be able to safely and effectively complete minor repairs and to be able to disassemble and reassemble most automobiles.

Section 2, Welding, explains how to properly set up welding equipment and to perform the necessary welding operations of repairing damaged automobiles.

Section 3, Structural Analysis and Damage Repair, covers the areas of analyzing structural body damage and frame damage, how to replace welded panels, and the corrosion protection aspect.

Section 4, Mechanical and Electrical, covers areas such as steering and suspension, brake components, electrical systems service and diagnosis, restraint systems, and hybrid vehicle systems.

Section 5, Damage Analysis and Estimating, has new material on computer-based estimating programs and customer relation skills.

Section 6, Painting and Refinishing, covers all the preparation and refinishing procedures on how to properly prep, mix, and tint paint and how to effectively paint the vehicle.

The sections have been renamed and reorganized to be more aligned with I-CAR and ASE tests. If a student completes each specific section and all the necessary hands-on work, they can take the ASE tests based on the information they have just studied. This also makes it easier for instructors to have all the relevant chapters for each section that are now grouped together.

This edition of *Auto Body Repair Technology* is the most readable edition ever published. We have worked hard to make the book easier to understand without diminishing its technical completeness. Textbooks are just one part of career and technical education; it is our sincere desire that this book adds something positive to that education.

Unless you are experienced in collision repair, you will have to learn hundreds of new technical terms, which make up the language of collision repair personnel. These vocabulary terms are highlighted so that you know that the word must be learned and understood before reading on. Every effort has been made to help you identify new key terms and explain them on first use.

Auto Body Repair Technology has been used by thousands of students and continues to this day to be a market leader. All the people involved in the publishing of this book hope that you will appreciate its improvements. Most of all, we hope that the students hoping to become collision repair professionals will take from this book the information they need to get started the right way.

NEW TO THIS EDITION

- Reorganization of the chapters to be more industry aligned and more easily delivered to the students. Instructors now have the content grouped together and renamed to match the titles of the tests they will take afterward.
- Content was added in the areas of nitrogen plastic welding, resistance spot welding, waterborne paint mixing and applications, updated estimating content, and customer relation skills.
- The entire book has been updated throughout to ensure all necessary ASE competencies have been addressed and correlated.

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Safety is emphasized throughout the text. Safety cautions and warnings appear frequently, and we worked to make sure that all the illustrations represent safe practices.

We are anxious to know what you think of the effort to update and upgrade *Auto Body Repair Technology*. Send letters or call the publisher so that I can hear what you think.

We hope you will find this book a useful resource for many years to come.

Sincerely,

Jonathan Beaty
Collision Repair
Instructor

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Acknowledgments

REVIEWERS

The authors and publisher would like to thank the following instructors for their help with reviewing this and previous editions of the book.

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Diman Regional Vocational Technical High School
Fall River, MA

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Freeport, IL

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The publisher would like to especially acknowledge W. Jack Charles, Lakeshore Technical College, Cleveland, WI, for his contributions.

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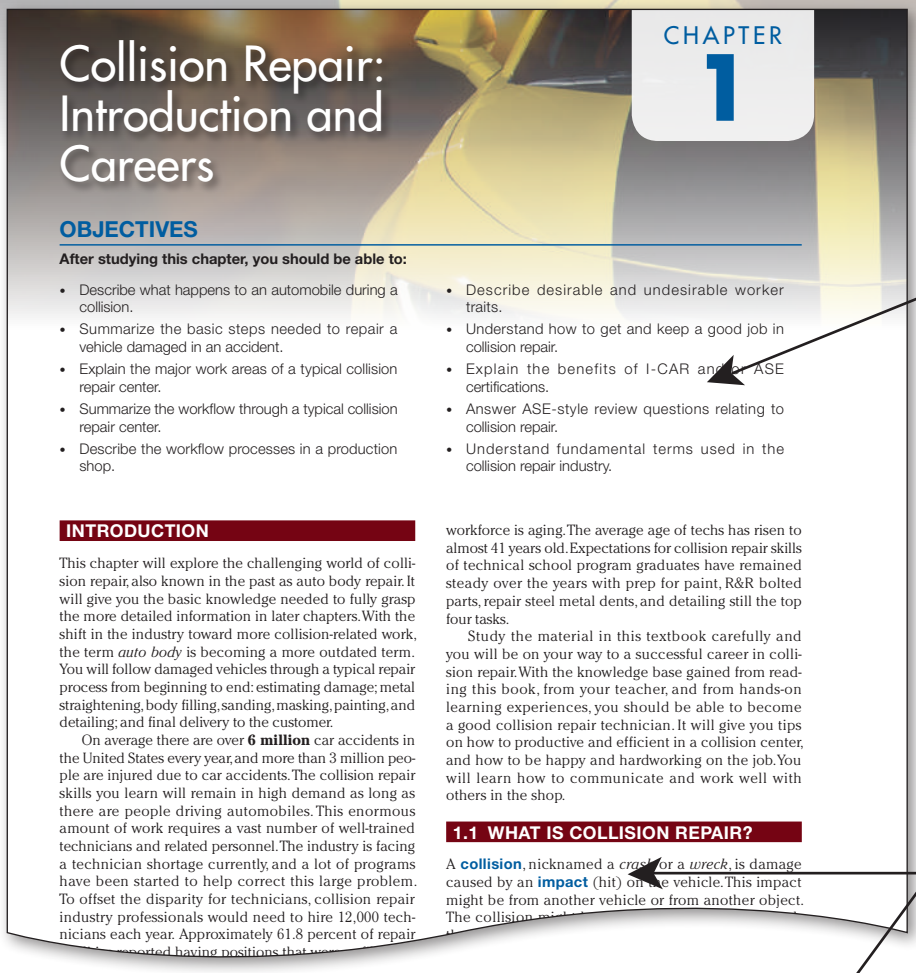

CHAPTER 1

Collision Repair: Introduction and Careers

OBJECTIVES

After studying this chapter, you should be able to:

- Describe what happens to an automobile during a collision.
- Summarize the basic steps needed to repair a vehicle damaged in an accident.
- Explain the major work areas of a typical collision repair center.
- Summarize the workflow through a typical collision repair center.
- Describe the workflow processes in a production shop.
- Describe desirable and undesirable worker traits.
- Understand how to get and keep a good job in collision repair.
- Explain the benefits of I-CAR and ASE certifications.
- Answer ASE-style review questions relating to collision repair.
- Understand fundamental terms used in the collision repair industry.

INTRODUCTION

This chapter will explore the challenging world of collision repair, also known in the past as auto body repair. It will give you the basic knowledge needed to fully grasp the more detailed information in later chapters. With the shift in the industry toward more collision-related work, the term *auto body* is becoming a more outdated term. You will follow damaged vehicles through a typical repair process from beginning to end: estimating damage; metal straightening, body filling, sanding, masking, painting, and detailing; and final delivery to the customer.

On average there are over **6 million** car accidents in the United States every year, and more than 3 million people are injured due to car accidents. The collision repair skills you learn will remain in high demand as long as there are people driving automobiles. This enormous amount of work requires a vast number of well-trained technicians and related personnel. The industry is facing a technician shortage currently, and a lot of programs have been started to help correct this large problem. To offset the disparity for technicians, collision repair industry professionals would need to hire 12,000 technicians each year. Approximately 61.8 percent of repair [illegible] reported having positions that [illegible]

workforce is aging. The average age of techs has risen to almost 41 years old. Expectations for collision repair skills of technical school program graduates have remained steady over the years with prep for paint, R&R bolted parts, repair steel metal dents, and detailing still the top four tasks.

Study the material in this textbook carefully and you will be on your way to a successful career in collision repair. With the knowledge base gained from reading this book, from your teacher, and from hands-on learning experiences, you should be able to become a good collision repair technician. It will give you tips on how to productive and efficient in a collision center, and how to be happy and hardworking on the job. You will learn how to communicate and work well with others in the shop.

1.1 WHAT IS COLLISION REPAIR?

A **collision**, nicknamed a *crash* or a *wreck*, is damage caused by an **impact** (hit) on the vehicle. This impact might be from another vehicle or from another object. The collision [illegible]

[illegible]

On a separate sheet of paper, complete the following learning activities for this chapter. Write definitions for the key terms and answer the ASE-style review questions, essay questions, critical thinking problems, and math problems. You can also do the outside activities, possibly for extra credit.

Key Terms

accident report
adhesion
Automotive Service Excellence (ASE)
collision
collision repair center
comeback
contaminants
damage estimate
dealership collision center
deductible
direct repair program
elements
estimating
estimator
head-on collision
(I-CAR) Inter-Industry Conference on Auto Collision Repair
impact
independent collision center
The insurance adjuster
major body damage
metalworking areas
minor body damage
paint runs
post-painting operations
productivity
professional
Quality
reliability
repair order
salvage yard
social skills
specialty shop
systematic approach
total loss
wash-up
worker characteristics
wrecker

ASE-Style Review Questions

1. Technician A says there are more than 6 million auto accidents each year. Technician B says that to offset [illegible]

2. Technician A says that when two cars hit head-on at 50 mph, it is like hitting a brick wall at 100 mph. Tech- [illegible]

OBJECTIVES

Each chapter begins with a list of cognitive and performance-based *objectives*. The objectives state the knowledge and skills that should be learned after reading the entire chapter. This feature is an excellent way for the reader to gain a quick overview of the essential material within the chapter that will be learned before the reading begins.

KEY TERMS

The *Key Terms* are the most important technical words you will learn in the chapter. These are listed at the end of each chapter and appear in bold print where they are first defined. For added study, you can write the key terms on a sheet of paper with their definitions to make sure you can explain the terms. These terms are also given in the Glossary at the back of the book.

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DANGER

Danger notes summarize critical safety rules. They alert you to operations that could hurt you or someone else. They do not only appear in the safety chapter; you will find them throughout the text where they apply. Read and remember all dangers. Your health is invaluable.

DANGER

Dangers in the metalworking area are many and varied—tasks such as cutting metal, straightening frames, welding, grinding, and sanding can all result in injuries. Do not attempt to work in the metalworking areas of a collision center until you have studied the basic safety rules and repair methods that are explained in later chapters of this book.

WARNINGS

Warnings provide important information to help prevent the kinds of accidents that can damage parts or tools. They are common mistakes that should be avoided. They appear throughout the text where they apply to the instructions being given.

WARNING

Always refer to factory service information, or OEM repair procedures, for details on how to do a proper and thorough repair. Factory publications will give specifications, detailed procedures, and other information specific to the exact make and model vehicle being repaired. This information is often needed to do professional, quality work!

SHOP TALK

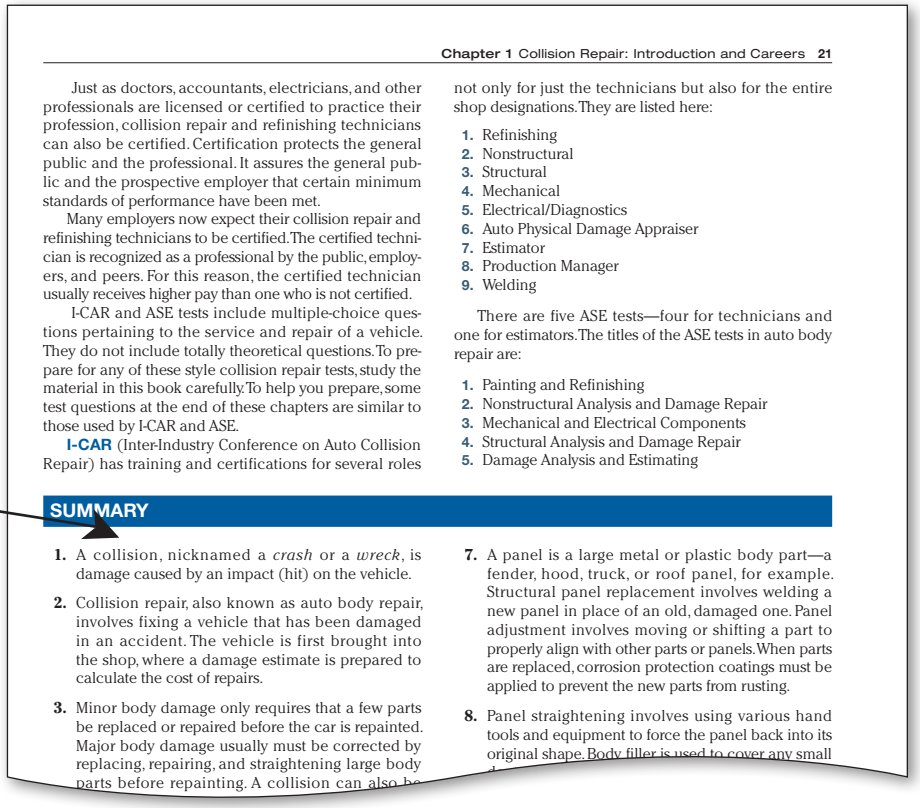
Shop Talk notes give added information to help you complete a particular procedure successfully or to make a task easier. They are hints to help you work more efficiently and profitably.

SHOP TALK

Always remember to follow all safety rules. When you cut corners and break safety rules, you put the health and safety of yourself and your coworkers in danger.

CHAPTER SUMMARY

Each *Chapter Summary* gives a brief list of the most important information in the chapter. It will help you review and understand which points were the most important.



Chapter 1 Collision Repair: Introduction and Careers **21**

Just as doctors, accountants, electricians, and other professionals are licensed or certified to practice their profession, collision repair and refinishing technicians can also be certified. Certification protects the general public and the professional. It assures the general public and the prospective employer that certain minimum standards of performance have been met.

Many employers now expect their collision repair and refinishing technicians to be certified. The certified technician is recognized as a professional by the public, employers, and peers. For this reason, the certified technician usually receives higher pay than one who is not certified.

I-CAR and ASE tests include multiple-choice questions pertaining to the service and repair of a vehicle. They do not include totally theoretical questions. To prepare for any of these style collision repair tests, study the material in this book carefully. To help you prepare, some test questions at the end of these chapters are similar to those used by I-CAR and ASE.

I-CAR (Inter-Industry Conference on Auto Collision Repair) has training and certifications for several roles not only for just the technicians but also for the entire shop designations. They are listed here:

1. Refinishing
2. Nonstructural
3. Structural
4. Mechanical
5. Electrical/Diagnostics
6. Auto Physical Damage Appraiser
7. Estimator
8. Production Manager
9. Welding

There are five ASE tests—four for technicians and one for estimators. The titles of the ASE tests in auto body repair are:

1. Painting and Refinishing
2. Nonstructural Analysis and Damage Repair
3. Mechanical and Electrical Components
4. Structural Analysis and Damage Repair
5. Damage Analysis and Estimating

SUMMARY

1. A collision, nicknamed a *crash* or a *wreck*, is damage caused by an impact (hit) on the vehicle.
2. Collision repair, also known as auto body repair, involves fixing a vehicle that has been damaged in an accident. The vehicle is first brought into the shop, where a damage estimate is prepared to calculate the cost of repairs.
3. Minor body damage only requires that a few parts be replaced or repaired before the car is repainted. Major body damage usually must be corrected by replacing, repairing, and straightening large body parts before repainting. A collision can also be
7. A panel is a large metal or plastic body part—a fender, hood, truck, or roof panel, for example. Structural panel replacement involves welding a new panel in place of an old, damaged one. Panel adjustment involves moving or shifting a part to properly align with other parts or panels. When parts are replaced, corrosion protection coatings must be applied to prevent the new parts from rusting.
8. Panel straightening involves using various hand tools and equipment to force the panel back into its original shape. Body filler is used to cover any small

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collision
comeback
contaminants
damage estimate
dealership collision center
deductible
direct repair program
elements
estimating
Inter-Industry Conference on Auto Collision Repair
impact
independent collision center
The insurance adjuster
major body damage
metalworking areas
minor body damage
paint runs
post-painting operations
productivity
Quality
reliability
repair order
salvage yard
social skills
specialty shop
systematic approach
total loss
wash-up
worker characteristics
wrecker

ASE-Style Review Questions

1. Technician A says there are more than 6 million auto accidents each year. Technician B says that to offset the technician shortage, the industry would need to hire 12,000 technicians each year. Who is correct?
   A. Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B
2. Technician A says that when two cars hit head-on 50 mph, it is like hitting a brick wall at 100 mph. Technician B disagrees and says that it is like hitting a brick wall at only 50 mph. Who is correct?
   A. Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B

REVIEW QUESTIONS

Review Questions will help you to measure the skills and knowledge you learned in the chapter. To check your "brain power," different types of questions are given: ASE, Essay, Critical Thinking Problems, and Math Problems. The ASE questions will help you prepare to pass auto body repair certification tests.

2. Write the ... repair sequence so you can memorize what is done when a vehicle enters a collision center.
3. Why is cooperation between employees in a collision center important?
4. Why is reliability such an important factor in a successful workplace?

Math Problems

1. A technician is paid $45 per hour. The repair will take 11.5 hours. Parts for the repair will cost $176.25 plus 7 percent tax. What is the total of the estimate?
2. An older car is valued at $2,500. The parts for the repair will cost $1,500. How many hours of labor at $35 per hour can be completed before the car should be declared totaled?
3. An independent collision center made $33,507 total in a one-month period. The cost of labor was $45 per hour with a total of 200 hours of labor. Parts cost the repair shop $14,000. Power and property bills cost a total of $3,500. After these costs are taken into account, what did the repair shop make in profits for the month?
4. By learning how to do her job more efficiently from continued study, a technician increased her income by 20 percent. If this technician was earning $35,000 per year before, how much is she earning per year now?

Activities

1. Take a field trip to a local collision repair center. Have the shop owner or supervisor give you a guided tour of the repair operation. Discuss what you learned during the field trip in class the next day.
2. Ask a technician or shop owner to visit your classroom to describe their duties and answer questions.

ACTIVITIES

These are practical, hands-on activities that challenge the student to apply the skills learned in the chapter to real-life experiences. *Activities* often include going to a body shop or other workplaces to gather some type of research for analysis. This feature is a wonderful way to teach students how and where they will eventually use their skills.

PHOTO SUMMARY

Estimating Repair Costs

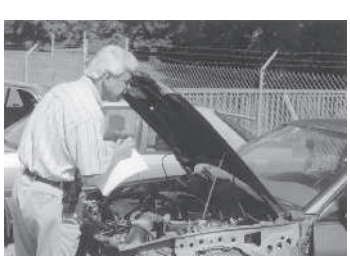

FIGURE P25–1 The estimator must understand all aspects of collision repair to make accurate calculations of repair costs.

FIGURE P25–3 Today's estimators use PCs and specialized software to automate the estimating process.

PHOTO SUMMARIES

Several step-by-step photo summaries illustrate common auto body repair procedures.

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Supplements

STUDENT TECHNICIAN'S MANUAL

Written by an experienced automotive collision repair teacher, the Student's Technician's Lab Manual has been developed as a supplemental learning tool. The job sheets have been heavily overhauled with new content and more relevant hands-on procedures and tasks. They outline and question students as they complete competency-based learning tasks.

INSTRUCTOR COMPANION WEBSITE

The Instructor Companion Website, found on cengagebrain.com, includes the following components to help minimize instructor preparation time and engage students:

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- ASE Education Foundation Correlations, in which the current ASE Collision Repair & Refinish Program Standards are correlated to the chapter of the core text and all relevant Student Technician's Manual job sheets.
- End-of-Chapter Review Questions, which are provided in MS Word format.

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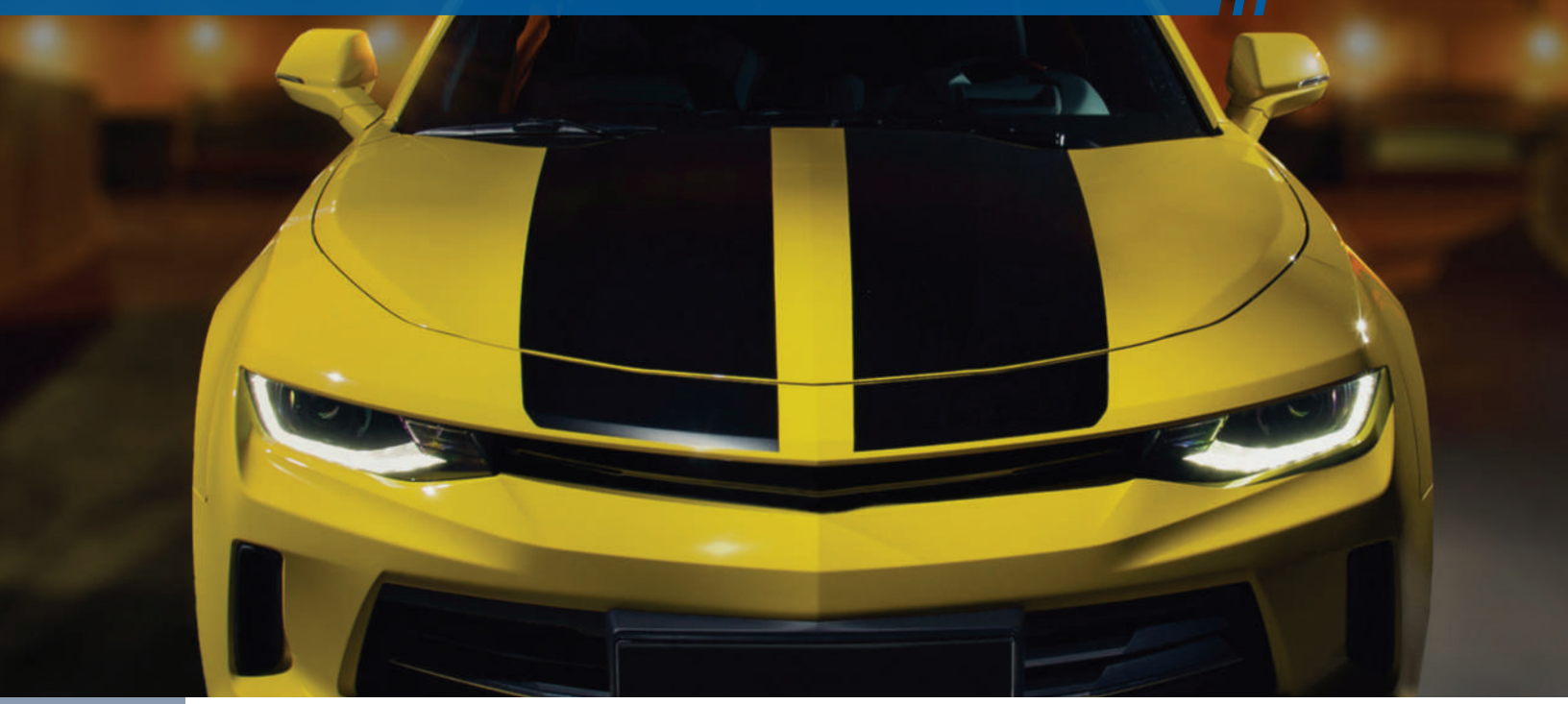
SECTION 1

Non-Structural Analysis and Damage Repair



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CHAPTER 1

Collision Repair: Introduction and Careers

OBJECTIVES

After studying this chapter, you should be able to:

- Describe what happens to an automobile during a collision.
- Summarize the basic steps needed to repair a vehicle damaged in an accident.
- Explain the major work areas of a typical collision repair center.
- Summarize the workflow through a typical collision repair center.
- Describe the workflow processes in a production shop.
- Describe desirable and undesirable worker traits.
- Understand how to get and keep a good job in collision repair.
- Explain the benefits of I-CAR and/or ASE certifications.
- Answer ASE-style review questions relating to collision repair.
- Understand fundamental terms used in the collision repair industry.

INTRODUCTION

This chapter will explore the challenging world of collision repair, also known in the past as auto body repair. It will give you the basic knowledge needed to fully grasp the more detailed information in later chapters. With the shift in the industry toward more collision-related work, the term *auto body* is becoming a more outdated term. You will follow damaged vehicles through a typical repair process from beginning to end: estimating damage; metal straightening, body filling, sanding, masking, painting, and detailing; and final delivery to the customer.

On average there are over **6 million** car accidents in the United States every year, and more than 3 million people are injured due to car accidents. The collision repair skills you learn will remain in high demand as long as there are people driving automobiles. This enormous amount of work requires a vast number of well-trained technicians and related personnel. The industry is facing a technician shortage currently, and a lot of programs have been started to help correct this large problem. To offset the disparity for technicians, collision repair industry professionals would need to hire 12,000 technicians each year. Approximately 61.8 percent of repair facilities reported having positions that were unfilled for more than three months. The industry is growing but the workforce is aging. The average age of techs has risen to almost 41 years old. Expectations for collision repair skills of technical school program graduates have remained steady over the years with prep for paint, R&R bolted parts, repair steel metal dents, and detailing still the top four tasks.

Study the material in this textbook carefully and you will be on your way to a successful career in collision repair. With the knowledge base gained from reading this book, from your teacher, and from hands-on learning experiences, you should be able to become a good collision repair technician. It will give you tips on how to productive and efficient in a collision center, and how to be happy and hardworking on the job. You will learn how to communicate and work well with others in the shop.

1.1 WHAT IS COLLISION REPAIR?

A **collision**, nicknamed a *crash* or a *wreck*, is damage caused by an **impact** (hit) on the vehicle. This impact might be from another vehicle or from another object. The collision might be minor enough to only scratch the paint, or it might be severe enough to cause thousands of dollars' worth of damage to numerous types of body parts.

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HISTORY NOTE

Believe it or not, the very first "motor car" ever built was in an accident the first time it was driven on public roads. The huge, crude car looked something like a steam locomotive. It was being test-driven down a country road. Chugging over a hill, the steel-wheeled, "smoke-belching monster" almost ran over a horse-drawn carriage. The car's startled driver had to swerve off the narrow dirt road to avoid running over the horses, and he plowed into a brick wall. After the first car crash, plow horses had to be used to tow the "horseless carriage" back to the barn for body shop repairs.

A **head-on collision** results when two vehicles driving toward each other accidentally collide. It is often the worst type of accident because the speed of both vehicles must be combined to determine the force of the impact. For example, if both vehicles are travelling 70 miles per hour (mph), the impact is similar to one vehicle smashing into a stationary brick wall at an astounding 140 mph. Refer to Figure 1–1.

Because cars can weigh well over a ton (2,000 to 3,000 pounds or more) and some trucks and sport utility vehicles (SUVs) can weigh over 2 tons (4,000 pounds or more), body parts are often crushed, bent, and torn in a collision. Major body/frame parts can even be forced out of alignment due to the tremendous energy dissipation produced when such heavy objects strike each other.

Collision repair involves fixing a vehicle that has been damaged in an accident. With minor damage, this might only involve sanding and repainting a fender. With more serious damage, a large section of the frame or body might have to be straightened and numerous parts replaced.

Courtesy of Saab Cars USA, Inc.

FIGURE 1–1 During a major collision, like this head-on crash test, tremendous energy is dissipated into the body/frame structures of both cars. Modern vehicles are designed to absorb this energy by controlled collapse of structural body/frame members. The front and rear ends of the vehicles are designed to crush or collapse while keeping the passenger compartment intact. With today's front and side air bags and seat belts, the drivers and passengers would suffer little or no injury in this violent collision.

ACCIDENT SCENE

An **accident report** summarizes what happened during a collision and lists information about the drivers, their vehicles, and their insurance companies. Even after a minor accident, the police are usually called so that an accident report, or crash report, can be filled out. The police officer will ask the drivers questions about the accident and write down what happened so that the insurance companies can determine what caused the accident and who might be at fault. The car owners will also call their insurance companies to report the accident.

A **wrecker** is a truck equipped with special lifting equipment for raising and transporting a damaged vehicle away from an accident scene. Most wreckers have a power-operated cable or a large hydraulic arm for lifting one end of the damaged vehicle for towing. A flatbed wrecker has a winch for pulling the whole vehicle up and onto the bed of the truck for transport.

If the car is no longer driveable, a wrecker will tow the damaged vehicle to a body shop or **salvage yard**, a business that resells parts from collision-damaged vehicles. Look at Figure 1–2.

COLLISION REPAIR CENTER

A **collision repair center** has well-trained technicians, specialized tools, and heavy equipment for restoring damaged vehicles to their pre-accident condition. There are several ways to classify a body shop. A few of the most common are discussed in the following section (Figure 1–3).

An **independent collision center** is owned and operated by a private individual. The shop is not associated with other shops or companies. An MSO which means a multi-shop operator, also known as a franchise body shop, is a large chain of collision

MSPhotographic/Shutterstock.com

FIGURE 1–2 If the accident results in major damage and the vehicle cannot be driven, a wrecker is called to tow the car. Proper tow methods are needed to avoid further damage when moving the wrecked car.

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FIGURE 1–3 The modern body shop is equipped with specialized equipment and well-trained personnel. It can be a safe and enjoyable place to work if safety rules are followed. If not, it can be a very dangerous place!

repair centers owned by one organization. MSOs can be all over the country or in one certain region. These collision repair centers may be run by different people, yet they still operate under the rules of the main company and are tied to a main headquarters that regulates and aids the operation of the shop. The shop logo, materials used, fees, and so on are all set by the corporate headquarters, and the franchisee must follow these guidelines.

A **dealership collision center** is owned and managed under the guidance of a new car dealership, such as General Motors, Chrysler, Lexus, Toyota, Jaguar, or Ford. This type of shop often concentrates on repairs of the specific make of cars sold by the dealership.

A *progression* or *production shop* often has an assembly line organization with specialists in each area of repair. These shops can have several different roles for technicians. Nonstructural technicians are for smaller type repairs mostly consisting of the outer body parts of the vehicle. Some shops may be large enough that they will have their own assembly technicians specifically for the disassembling and reassembling of the automobiles before and after the repairs have been completed. Structural technicians are for the more heavier type repairs, consisting of either replacing or repairing large portions of structural components of the vehicle. The service department has auto technicians for diagnostic, mechanical, and electrical repairs. Prep technicians, or preppers, are for making sure the surface of the body and components are correctly prepped for the refinishing stages. Refinishing technicians, or painters, are for ensuring proper color match, and all aspects of the refinishing stages are performed correctly. The vehicle will move from one area and specialist to the next until fully repaired.

A **specialty shop** performs only specific types of repairs. For example, the collision repair center might send a damaged automobile with suspension damage to an alignment shop after parts replacement and repairs have been completed.

A collision repair center that provides *complete collision services* might do wheel alignments, cooling system repairs, electrical system diagnosis and repair, suspension system work, and other repairs. Today, more and more collision repair centers are offering complete collision services. They have both a collision repair area and a service department area.

DAMAGE ESTIMATING

A vehicle involved in a collision is first brought into the shop, where a **damage estimate** is prepared to calculate the cost of repairs. This method is also called blueprinting (Figure 1–4).

Estimating involves analyzing damage and calculating how much it will cost to repair a vehicle. It is critical that the quote on the repair be neither too high nor too low. If the estimate is too high, another shop with a lower bid will usually get the job. If too low, the profits may not be enough to cover the cost of repairs, and the shop could lose money.

In most shops, a well-trained **estimator** makes an appraisal of vehicle damage and determines what must be done to repair the vehicle. These people must also be well versed in how vehicles are designed, good skills with computers, and have great customer relations skills. An estimator at work is shown in Figure 1–5.

Minor body damage is considered mainly nonstructural damage that requires only a few parts be replaced or repaired before being refinished or painted. Minor damage is often due to a low-speed "fender bender" in which two cars hit at low speed or one car runs into something. Such damage might be as minor as a tiny "door ding" that occurs when someone accidentally opens a car door into the side of another car, making a small paint chip or dent.

Major body damage is considered mainly structural damage that must usually be corrected by replacing, repairing, and straightening large body parts before refinishing. Parts might have to be cut off and new ones welded into place. Though severe, repairing the damage is less than the cost of vehicle replacement or less than the value of the vehicle.

A collision can also be severe enough to cause a **total loss**, in which repairs would be more expensive than buying another car. In this case, the insurance company does not pay for repairs but instead gives the driver enough money to purchase another similar year, make, and model vehicle.

Remember that some damaged automobiles can be restored to a safe, driveable condition if the vehicle owner or insurance company is willing to pay for the repair. It is the cost that is the major consideration (Figure 1–6).

The estimate is usually given to the customer, who submits it to the insurance company. **The insurance adjuster** reviews the estimates and determines which one best reflects how the vehicle should be repaired. The adjuster may inspect the wrecked car to determine that

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Daisy Daisy/Shutterstock.com

A The estimator must study the damage carefully to determine the cost of repairs. Today's estimators often use a tablet, laptop, or phone to take pictures and upload to the estimating software database.

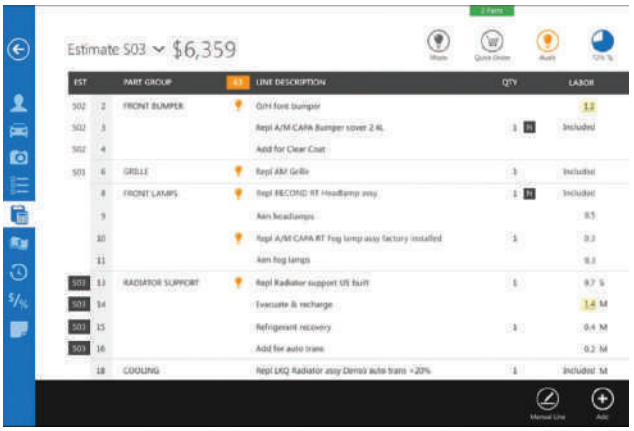
B The vehicle interior is often damaged in a major collision. Replacing deployed air bags is expensive and must be included in the estimate.

C Damage to the engine, engine mounts, pulleys, and underbody parts must be accounted for in an estimate. Sometimes the vehicle is raised on a lift for undercarriage inspection.

FIGURE 1–4 Estimating is done to evaluate the extent of the damage and to arrive at a cost for repairing the vehicle.

Louis-Paul st-onge Louis/Alamy Stock Photo

A Here a technician is performing a pre-accident scan on the computer to check for mechanical/electrical problems.



CCC Information Services Inc.

B Data is uploaded into the computerized estimating software that will configure labor rates, parts costs, and help factor in other repair considerations.

FIGURE 1–5 Once damage has been inspected, a computer is used to streamline estimating and ordering parts.

stockfour/Shutterstock.com

FIGURE 1–6 Once the estimate has been created, a printout of the estimate summarizing what must be done to repair the vehicle and the repair costs is given to the customer and/or insurance adjuster.

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the repairs will be done in a cost-effective fashion. The insurance company usually co-writes a check to the owner of the damaged vehicle and to the collision repair center to cover the cost of the repair, minus any **deductible** (amount the owner agrees to co-pay on the insurance policy). If the shop is on what is called a **direct repair program** with that particular insurance company, then all the customer has to do is drop off the car at the desired collision center, and they will take care of all the communication and estimating processes with the insurance company. This way it is less hassle on the customer.

1.2 COLLISION CENTER REPAIRS

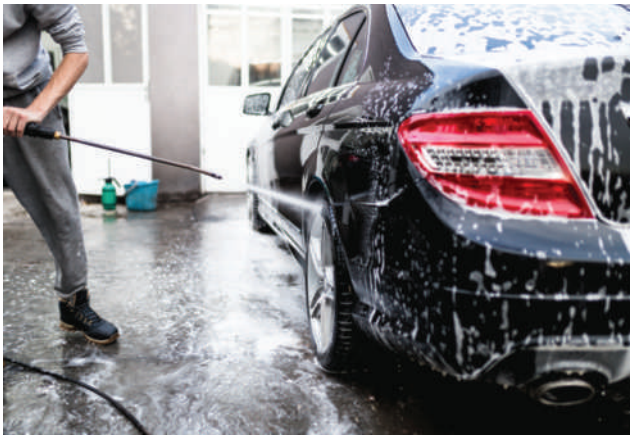
Once the owner and the insurance company approve the repairs, the vehicle is turned over to the shop supervisor. The shop supervisor, sometimes with the help of a technician, will then review the estimate to determine how to do the repair.

Repair instructions are summarized on a printed **repair order** (RO), and the repairs are carried out according to these instructions. Once the RO is received in the shop, collision center repair procedures follow a general sequence. The basic repair sequence for a vehicle that has major frame/body damage is as follows:

1. Clean vehicle thoroughly before moving it into repair area.
2. Study the RO and vehicle damage to determine repair procedure.
3. Remove badly damaged bolt-on parts.
4. Measure damage.
5. Straighten frame/unibody damage on frame rack.
6. Replace badly damaged welded-on parts.
7. Straighten minor body damage.
8. Apply body filler and coarse-sand repair area.
9. Fine sand and featheredge repair area and mask area for primer.
10. Apply a primer-filler around body-filled area.
11. Fine sand repair area and all parts to be refinished.
12. Mask areas not to be painted.
13. Clean surfaces to be painted.
14. Refinish (seal, base, clear) damaged body parts.
15. Detail vehicle (unmask, clean, de-nib, and polish) as needed.

WASH-UP AREA

When a car is brought into the shop, the first step is usually wash-up. **Wash-up** involves a thorough cleaning of the vehicle with soap and water. This is followed by wiping the body down with wax and grease remover. These steps will remove mud, dirt, wax, and water-soluble **contaminants** (unwanted substances). These substances must be cleaned off before starting bodywork because they could contaminate the paint and cause paint problems later. The car or truck should be completely dry before being moved to the repair area. Look at Figure 1–7.



hedgehog94/Shutterstock.com

FIGURE 1–7 Before starting repairs, collision centers usually wash the vehicle thoroughly to remove road dirt. Keeping the shop clean is important to refinishing quality because it keeps paint contaminants out of the shop work areas.

METALWORKING AREAS

The **metalworking areas** are shop locations where damaged parts are removed, repaired, and installed. Such damage can result from either a collision or part deterioration. The metalworking area is where the shop performs most of the collision repair tasks. Because of all of the grinding, sanding, and welding, this area tends to become dusty and dirty quickly.

DANGER

Dangers in the metalworking area are many and varied—tasks such as cutting metal, straightening frames, welding, grinding, and sanding can all result in injuries. Do not attempt to work in the metalworking areas of a collision center until you have studied the basic safety rules and repair methods that are explained in later chapters of this book.

WARNING

Always refer to factory service information, or OEM repair procedures, for details on how to do a proper and thorough repair. Factory publications will give specifications, detailed procedures, and other information specific to the exact make and model vehicle being repaired. This information is often needed to do professional, quality work!

Before starting work in this area, the body technician must first study and diagnose the damage that has occurred. Body technicians use the information on the RO to determine what repairs are needed. The technician may

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need to consult with the estimator before proceeding. It is then up to the technician to decide how to accomplish the repairs outlined on the estimate and RO.

Once the damage and repair methods are analyzed, the repairs must be completed in a systematic manner. For example, if a panel is creased, torn, or caved in, it can be straightened using hammers, hydraulic jacks, and other dent repair equipment. If the panel is badly crushed and folded, it must be replaced. If the unibody or frame is damaged, it must be straightened or parts replaced according to factory recommendations.

A *stall* is a work area for one vehicle, often marked off with painted lines on the floor. Also termed a *bay*, each stall is large enough so that the technician has room to work all the way around the vehicle.

Often, one of the first steps completed in the metalworking area is part removal. Badly damaged bolt-on parts must be removed to gain access to hidden damage. This might involve unfastening the bumper, grille, or fenders, for example Figure 1–8.

VEHICLE MEASUREMENT

Vehicle measurement helps determine the extent and direction of major damage. If the vehicle has been in a serious accident, vehicle measurement is often done to find out whether the frame/unibody has been forced out of alignment. Specialized measuring tools are used to measure across specific reference points on the vehicle to find out whether body damage exists.

Measurement systems are specialized tools and equipment that allow the technician to check for frame or body misalignment resulting from a collision. Various types of gauges and measuring devices can be used to compare *body specifications* to actual measurements taken from the damaged vehicle. The measurements will help determine what must be done to straighten any frame or body misalignment. If any measurement is not within factory specifications, the frame or unibody must be forced back into alignment using powerful hydraulic equipment (Figure 1–9).

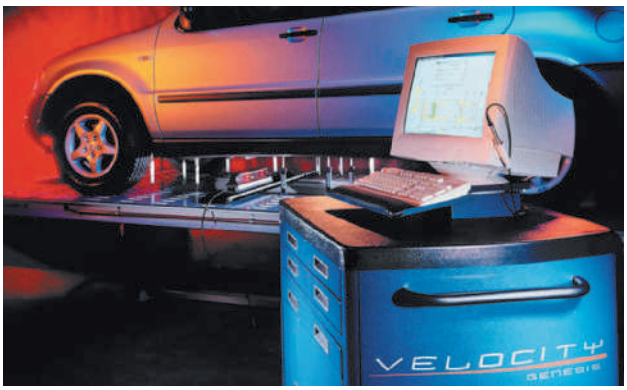
Vereshchagin Dmitry/Shutterstock.com

FIGURE 1–8 To start work, you must normally remove damaged outer body parts to gain access to hidden parts that require straightening or replacement. Here the technician is removing a front fender.

FRAME/UNIBODY STRAIGHTENING

Once the extent and direction of frame misalignment are known, frame (unibody) straightening equipment can be used to pull the frame or body structure back into alignment.

Frame straightening equipment (also called a *frame rack*) uses a large steel framework, large steel towers, pulling chains, and hydraulic rams to pull the frame or body back into its original position (Figure 1–10).



Chief Automotive Technologies

A To use this modern computerized measuring system, targets are hung from specific points on a vehicle. Laser light is reflected off the targets to make quick, accurate readings of the distance between targets.

Chief Collision Technology

B Computers can quickly compare known good specifications with laser measurements to calculate whether any section of a vehicle has been pushed out of alignment by a collision.

FIGURE 1–9 A measuring system is used to determine whether major body parts have been forced out of alignment by a major collision.

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FIGURE 1–10 A frame rack is a heavy steel framework with hydraulic equipment for forcing major structural parts back into alignment. The vehicle is anchored to the rack so it cannot move. Then pulling towers and chains can be attached to the damaged section of the vehicle to pull out the structural damage.

The vehicle frame or unibody is clamped down onto the frame equipment so it cannot move. Clamps and chains are then fastened to the damaged portion of the vehicle. Tremendous hydraulic pulling force is then applied to the chains to force the frame or body in the opposite direction of the collision impact. Refer to Figure 1–11.

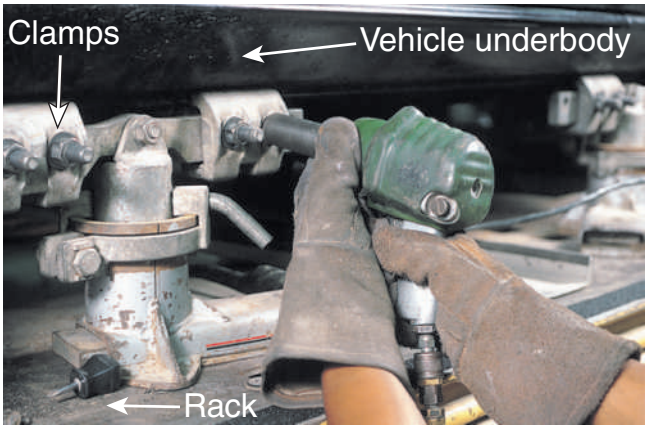
After pulling, more measurements are taken to determine whether everything has returned to specification (Figure 1–12).

PANEL REPLACEMENT

A *panel* is a large metal or plastic body part—a fender, hood, deck lid, or roof panel, for example. A vehicle body is made up of numerous panels welded, chemically bonded, or bolted together.

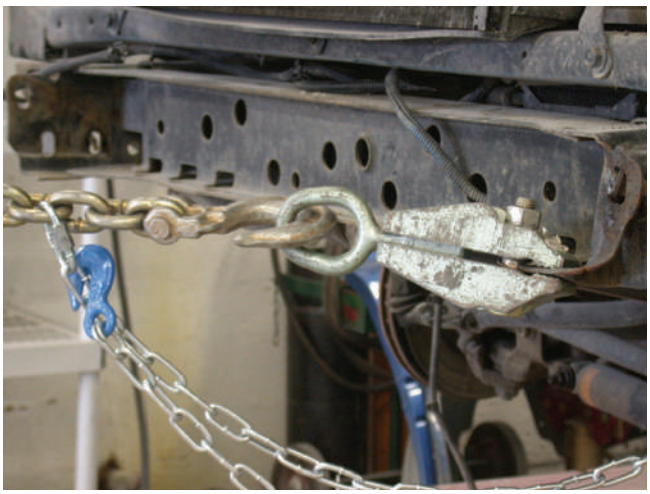
Panel replacement involves removing a panel or body part that is too badly damaged to be fixed. The new part has to be properly fit and fastened in place on the vehicle. This takes considerable skill (Figure 1–13).

Structural panel replacement involves researching the OEM repair procedures and either gluing with panel bonding adhesive or welding a new panel in place of an old and damaged one. First, the badly damaged part is removed by drilling or grinding off its spot welds. Then the new parts are fitted into place while part locations are measured. Clamping pliers, also known as vise grips, or self-taping screws are used to hold the new panel in place while welding or gluing with panel bonding adhesive. First, for welding you would use a welder to tack weld and fuse the part in place. Before final welding, measurements are again taken to make sure the new part is aligned properly. If correct, all final welds are now made. For panel bonding, make sure to test fit the panel for alignment and clamp in place with vise grips or sheet metal screws. If aligned, remove panel and begin the steps to apply weld bond adhesive. Then clamp in place once positioned to properly cure. Look at Figure 1–14.



A First, the vehicle is clamped down to the frame rack using large clamps on the bottom of the unibody or frame. The vehicle must be anchored securely before pulling. Here pinch weld clamps are being installed to secure the vehicle while applying straightening force.

B After the vehicle is anchored, pulling clamps and chains are attached to the area to be straightened.



C Pulling power is applied to remove damage opposite to how it occurred. When pulling damage, you must be careful not to overpull. Metal will only flex back a small amount after releasing pulling force. If you overpull, it may be impossible to repair without part replacement.

FIGURE 1–11 Note how the technician is using a frame rack during a major repair.

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FIGURE 1–12 Constantly measure as you pull out damage. This will let you pull in the right direction with the right amount of power. Here the tram gauge has been set to vehicle specs and compared to reference points on the damaged vehicle. If the tram gauge does not align with reference points on the vehicle, further pulling is needed until the points are lined up to specifications.

A Here a technician uses a plasma arc cutter to slice off a part for replacement.

B Many parts or panels are attached with spot welds. A spot weld remover, a specialized drill, is often used to cut out each spot weld for part removal.

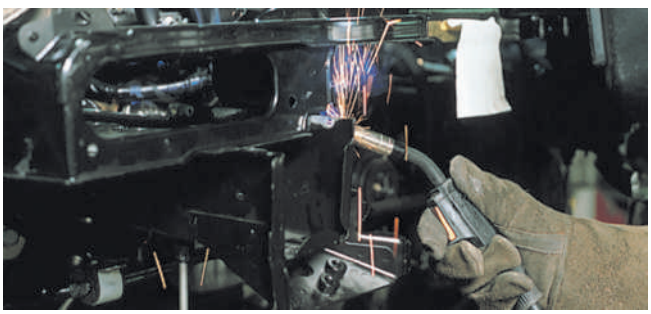
FIGURE 1–13 After the frame or unibody is straightened, you can then cut off damaged parts that require replacement.

Panel adjustment involves moving or shifting a part to properly align it with other parts or panels. Accurate adjustment of body assemblies, such as hoods, deck lids, and doors, is often made by the technician. For example, if a door is not adjusted correctly, it may be difficult to close or rub against an adjacent panel. The poorly adjusted door might also leak air and water. Such failures by the technician are bound to cause customer complaints.

A New structural parts must be temporarily held in place with clamping pliers or screws.

B First, tack weld parts in place, using only a few welds to hold the parts in alignment.

C After tack welding a part, measure its location before final welding. You may need to adjust a part's position while it is still tacked in place.



D If aligned properly, weld the structural parts into their final position following manufacturer recommendations. Proper welding skills are needed to do major collision damage repair. You may want to sign up for a welding class to further your career opportunities.

FIGURE 1–14 Replacing welded-on structural parts takes skill and training.

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When weld parts are replaced, *corrosion protection* coatings must be applied to prevent the new parts from rusting. Weld-through primer and other materials are applied to the new parts to protect them from the **elements**—moisture, road salt, mud, and so on (Figure 1–15).

A technician must be able to hang the door in proper alignment and also transfer all internal parts (window mechanism, door handle, latch, wiring harness, and trim panel) to the new door. Look at Figure 1–16.

An air bag can cause injury if it fires accidentally. A technician replacing a side air bag should stand to one side of the bag in case it accidentally deploys. Refer to Figure 1–17.

FIGURE 1–15 You must restore corrosion protection to all repair panels. Various products are available to prevent corrosion or rusting of new panels.

FIGURE 1–16 Here the entire door frame and skin had to be replaced because it was too damaged to be repaired.

FIGURE 1–17 A technician replaces a small air bag located on the inside of the door frame. Note how the technician stays to one side in case the air bag accidentally deploys. Air bags deploy with a "bang" and can cause injury to your arms, hands, and face.

PANEL STRAIGHTENING

Panel straightening involves using various hand tools and equipment to force a damaged panel back into its original shape. Body hammers, body filler, and sanders are a few of the tools and materials used to repair panel damage. A somewhat different approach is needed with plastic panels. Small parts (trim pieces, emblems, wiper blades, and so on) are removed before panel straightening to protect them.

With damage to a metal panel, a grinder is first used to remove the paint from the damaged area. Then small pull pins are welded to the lowest area of the dent. A puller can then be attached to the pins to force the dent back out. Once the area is almost back to its original contour, the welded pull pins can be ground off. Dent repair stations can be used to perform faster metal working techniques, and no grinding off the heads of the welded pins. Less grinding on the surface means less heat generated and less chance of further damage to the panel. See Figure 1–18.

When you can access the back of the panel, leave the paint on until the panel is straightened as close to its original contour as possible. The reflection of light off the shiny paint surface will reveal highs and lows when you use straightening tools on the back side of the damage.

Body filler is used to cover any small imperfections remaining in the worked panel. Use compressed air to blow dust off the area so that the filler will stick or bond to the area securely. Mix *hardener* into the body filler to make the material *cure*. Use a plastic *spreader* to apply the body filler over the repair area on the panel. The filler cures or hardens quickly, so skill is needed to properly apply the body filler.

When partially cured, a coarse file or sanding block with coarse grit sandpaper is often used to knock off the high spots in body filler. This will save sanding time. After the filler fully cures, the area is coarse sanded to the original panel contour.

The mixing, application, filling, and sanding of body filler is shown in Figure 1–19.

Coarse sanding is done by the metalwork technician using an abrasive coated paper to level and smooth the body surface that is being repaired. Coarse, rough sandpaper may be used to level body filler. Once body filler has reached its desired shape, sand with fine grit to smooth the surface for masking off and primer application.

PAINT PREPARATION

In *paint preparation*, the vehicle is fine sanded and cleaned to prepare surfaces for the refinishing process. Fine, smooth sandpaper is used to lightly scuff old paint so the new paint will stick. The vehicle is moved from the metalworking area to a prep area in the shop. Dust is blown off the vehicle with compressed air (Figure 1–20).

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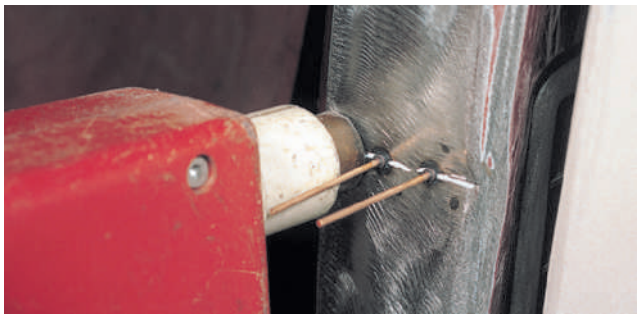
A

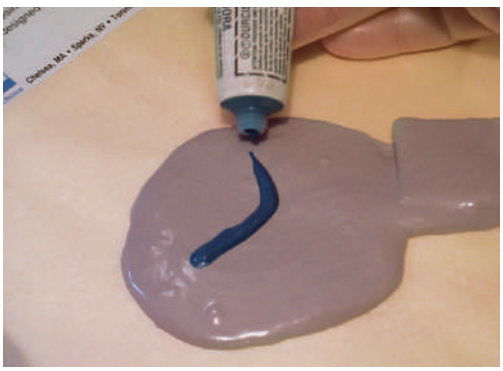
C



B

D

FIGURE 1–18 Note the basic steps for removing a dent from a metal part. (A) Often panels have minor damage that can be repaired. The cost of labor and materials must be weighed against the cost of new or salvaged parts. (B) When a dent cannot be hammered out from inside the panel, a stud pin welder or stud gun can be used. The stud gun welds metal pull pins onto the damaged panel. (C) With pull pins welded into the dent, attach a puller to each pin for forcing out the low spot. Metal must be straightened to within 1/8 inch of the original contour so that the body filler is not too thick. (D) After pulling damage, cut and grind off the pins until they are almost flush with the panel surface. A slight depression is needed for body filler.



A

C

B

D

FIGURE 1–19 Body filler is commonly needed to smooth and level metal that has been straightened. (A) Mix body filler and hardener in correct proportions. As a general rule, for each golf ball-size lump of filler, use a 1-inch (25 mm) bead of hardener. If the amount of filler is as "big as a baseball," use a 6-inch (152 mm) bead of hardener. Do not stir hardener into body filler or you can cause air bubbles and pin holes. Wipe back and forth to mix ingredients completely. (B) Apply the body filler to the clean body surface right away. It will start to harden in a few minutes. Try to spread it out to match the body shape to reduce filing and sanding times. (C) As soon as filler starts to solidify, if needed use a coarse "cheese grater" file to rough out the shape. File in multiple directions until the filler is contoured properly. Do not file too much. You want the filler to stick up above the panel surface a little so it can be sanded smooth. (D) After grating the filler, use an air sander and coarse grit sandpaper to cut the filler down more. Finish with a fine grit sandpaper. Featheredge the filler and old paint for a smooth transition into the panel.

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FIGURE 1–20 Before masking and priming, use a blowgun to clean the vehicle of dust and debris. Aim the blowgun down into all gaps between parts that could hold dust and dirt. Do this before final masking and moving the vehicle into the paint booth.

Masking is used to cover areas that are not going to be painted to protect them from paint spray and physical damage. Parts of the car that are not to be painted—windows, chrome, lights, and so on—should be removed for proper masking of the surrounding areas. If they are simply covered with masking material, such as paper, plastic, tape, or a water-based spray-on coating, they might be subject to overspray or improper tape lines that are very hard to remove once the paint has cured (Figure 1–21).

In large shops, the sanding jobs and masking are handled by the prep person, whereas the refinish operation is performed by the painter. In small shops, the final prep jobs are usually done by the painter or a helper.

A spray can or spray gun is used to apply a self-etching primer to all exposed metal surfaces.

A *2K Urethane Primer* is applied to bare metal and body filler before painting. *Priming* is necessary because paint alone will not properly adhere to or stick to bare metal (Figure 1–22).

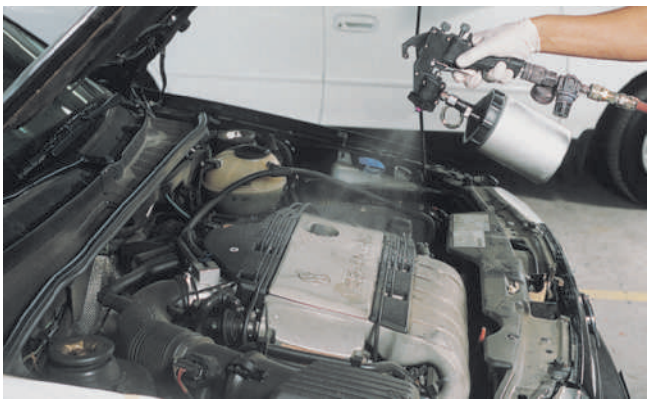
Fine sanding is done to smooth down the primed surface and also to scuff unrepaired areas so that the new paint will not peel off. All surfaces to be painted must be fine sanded or scuffed to provide a good bond between the old paint and the new, fresh paint. Refer to Figure 1–23.

Wax and grease remover is then wiped over the surfaces to be refinished to remove any remaining contaminants. A rag soaked in the cleaning agent is wiped over the body surfaces. A second clean, dry rag is used to wipe off the solvent while the surface is still wet. Look at Figure 1–24.

MIXING ROOM

The *mixing room*, or *mixing lab*, is a power-ventilated area where refinish or paint materials are mixed and prepared for application. Most large body shops have an in-house mixing room. Smaller shops have their materials mixed by an outside paint supplier (Figure 1–25).

A Here a technician uses masking tape and masking paper to cover the area not to be painted.



B Spray-on masking material is handy when masking a large area, such as underhood components. It is water-based masking coating and can be washed off with soap and water after painting.

C Plastic wheel masks are installed over tires to protect them from paint spray.

FIGURE 1–21 Masking is used to protect parts of the car that are not going to be painted.

Paint mixing involves carefully measuring out the correct amount of refinish ingredients following manufacturer instructions. For example, when mixing a paint color, it is critical that the correct color pigments be added so that the new paint matches the existing color on the vehicle. Mixing usually involves adding reducer to make the paint the right viscosity (thickness or fluidity) for

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FIGURE 1–22 Self-etch or epoxy primer must be sprayed over all bare metal to bond to the metal. Primer-surfacer is often sprayed over body filler and the repair area to help level the repair area. Allow each coat of primer to flash properly before applying the next coat.

A A large sanding block is commonly used to smooth and level the repair area with the surrounding undamaged areas.

B An orbital sander or hand sanding with a block and fine sandpaper is needed to scuff the old paint to prepare it to accept and bond with the new paint.

FIGURE 1–23 Finish sanding is needed between priming and painting to final smooth out the repair area.

spraying. With water-based paints, distilled water is used to reduce the paint to a sprayable consistency. Mixing might also involve pouring in a recommended amount of *catalyst* (hardener) to make the top clearcoat cure or dry (Figure 1–26).

FIGURE 1–24 Before painting, use two lint-free shop towels to wipe the repair area clean. First, use a shop towel soaked with wax and grease remover to remove any surface contaminants. Then use a clean shop towel to wipe the surface while the solvent is still wet.

FIGURE 1–25 Most large body shops have their own paint mixing room. It has all color pigments and other ingredients for mixing paint materials. Mixing rooms also have forced ventilation to prevent buildup of paint fumes.

REFINISHING

The vehicle's paint, or *finish*, performs two basic functions—it beautifies and it protects. Can you imagine what a car body would look like without paint? For a day or so, it would be the drab, steel gray of bare sheet metal. Then, as rusting eats into the metal, the body would turn an ugly, reddish brown. This degeneration, or oxidation, would continue until the body was solidly coated with rust.

The term *paint* generally refers to the visible topcoat. The most elementary painting system consists of a primer and final topcoat over the *substrate* (body surface material). This process can vary considerably and generally is more complex, as you will learn later.

Refinishing, or *repainting*, involves the steps needed to properly restore the vehicle's finish. Refinishing is a very important part of the auto repair process.

Damage caused by both minor and major accidents usually requires some painting. However, many older automobiles are repainted to simply enhance their beauty. New and used-car dealers repaint automobiles to attract buyers. Sometimes an owner simply gets tired of looking at the same old color.

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A Mix paint according to label directions or instructions given on the manufacturer technical data sheet that is available online mostly in pdf formats. The products tech sheet gives prep procedures, temperature recommendations, gun size and setup recommendations, application procedures, flash and cure times, and also mix ratios for reducer, catalyst, and paint.

B A computerized electronic scale aids in mixing paint ingredients. They will give an electronic readout that tells you how much of each ingredient to add while mixing.

C Filter everything that goes into the spray gun cup. (Left in picture) Most PPS cups have a built-in filter in the lid for filtering out dirt and debris. One piece of dirt or cured paint can ruin a paint job.

FIGURE 1–26 Paint mixing is like working in a chemistry lab. All ingredients must be added accurately to produce the correct color and chemical content.

With today's high-tech paint materials, it is critical that painters wear proper safety gear (Figure 1–27).

Courtesy of Team Blowtherm

FIGURE 1–27 Refinish technicians must wear safety gear and be highly skilled at using painting tools and equipment. Here the technician is turning on the fans in a paint spray booth.

A car's finish consists of several coats of multiple different materials. The most basic finish consists of:

1. Primecoat
2. Primer-sealer
3. Basecoat (color)
4. Mid coat or *ground coat* (pearl, only if necessary)
5. Topcoat (clearcoat)

The *primer* is used to improve **adhesion** (sticking) of the topcoat. It is the first coat applied. Paint alone will not stick or adhere as well as a primer. If you apply a topcoat to bare substrate, the paint will peel, flake off, or look rough. This is why you must apply a coat of primer between the substrate (car body) and the topcoat. Primer-sealers also prevent any chemicals from bleeding through and showing in the topcoats of paint.

The terms *topcoat* and *colorcoat* refer to the paint applied over the primer-sealer coat. This usually consists of several thin coats of paint. The topcoat is the clearcoat that is the outermost layer of protection and features the eye-catching gloss.

Basecoat/clearcoat paint systems use a colorcoat applied over the primer-sealer with a second layer of transparent clearcoat over the colorcoat. The basecoat can be either a solvent-based paint or a water-based paint. Water-based paint is becoming a more used system in today's collision centers. Although not all shops use it yet, it is a highly environmental friendly product with great qualities that you will learn about in later chapters. Basecoat/clearcoat is the most common paint system used today. The clear paint brings out the richness or shine of the underlying color and also protects it. The resulting *gloss* is superior to that of standard paint systems.

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FIGURE 1–28 The spray gun is the main tool of a refinish technician. It must be adjusted properly to produce a smooth, even paint film on the vehicle.

A *spray gun* uses compressed air to break the liquid paint into a fine mist so that the paint is deposited smoothly on the vehicle body. The *paint booth* is a clean room with filtered air circulation so that dirt does not get in the paint when spraying (Figure 1–28).

Spraying is the physical application of paint using an air pressure-powered paint spray gun. The technician methodically moves the spray gun next to the body while spraying accurate layers of paint onto it. This requires a high degree of skill to prevent **paint runs** (when excess paint flows down or runs) and other painting problems. Refer to Figure 1–29 and Figure 1–30.

In addition to being able to apply the new finish properly, the painter or refinishing technician must have knowledge of paint products and how to mix and match them. If the refinishing job looks good and the color matches well, the customer will usually be satisfied with all of the other repair work.

REMEMBER *The car owner notices the quality of the metal straightening and paint job more than any other aspect of collision repair.*

ECO-TECH

Eco-tech stands for ecology technology. Eco-tech deals with how a collision center can conserve materials to reduce the amount of air, water, and ground pollutants resulting from vehicle repairs. As you learn the information in this textbook, you will be given many tips for avoiding material waste and for recycling all useful materials. The information in this book will stress the recycling of unused paint solvents, metal body panels, plastic parts, air conditioning refrigerant, paper, antifreeze, motor oil, and other materials.


Dmitry Kalinovsky/Shutterstock.com

A


loraks/Shutterstock.com

B

FIGURE 1–29 Excellent hand–eye coordination and specialized knowledge is needed to be a professional painter. (A) When painting a vehicle, keep the gun the correct distance from the surface. Also keep the gun parallel with the surface. (B) When painting, try to move the spray gun smoothly and evenly. Use straight line paint strokes that overlap evenly. If you move the gun at different speeds or move it further or closer to the surface, paint problems will result.


hedgehog94/Shutterstock.com

FIGURE 1–30 Here a refinish technician is spraying the colorcoat along the bottom and side of the car body. This will be followed by spraying the clearcoat to bring out the gloss or shine.

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DRYING

Drying involves using different methods to cure the fresh paint. If only partially dry when returned to the customer, the new paint can be easily damaged.

Air drying is done by simply letting the paint dry in the atmosphere. This can take a long time with enamel paint if a hardening agent is not added before applying the paint.

Forced drying uses special heat lamps or other equipment to speed the paint curing process. Most shops use drying equipment to speed up drying.

POST-PAINTING OPERATIONS

Post-painting operations include the tasks that must be done after painting but before returning the vehicle to the customer. These tasks include removing masking tape, de-nibbing and polishing, reinstalling parts, and final detailing the vehicle.

Once the paint is hard enough so that it will not be easily damaged by being touched, any parts removed for repairs or painting must be reinstalled. This is done carefully, often by the original technician (Figure 1–31).

If the painted surface has a rough, textured surface like that of an orange peel, or any dirt nibs that fell into the paint job, you may have to extra-fine sand and polish the hardened paint. This will remove the surface roughness of the paint.

Wet sanding involves using a water-resistant, ultrafine sandpaper and water to level the paint. It can sometimes be done to fix small imperfections (orange peel, dirt, runs, and so on) in the paint. Dry ultrafine sanding uses 1,000 grit or finer sandpaper on an air sander to repair minor paint imperfections.

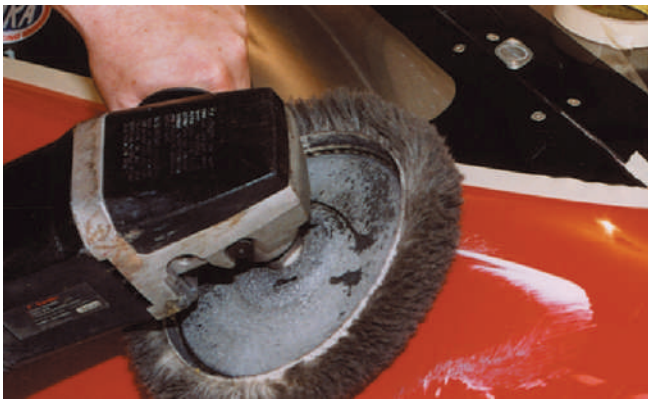
Compounding, or buffing, may be required to smooth newly painted surfaces, after wet sanding, for example, or to remove a thin layer of old, dull paint. Compounding makes the paint smooth and shiny. An air or electric buffing machine equipped with a soft pad is used to apply buffing compound to the paint. The abrasive action cuts off a thin layer of topcoat to brighten the color and shine the paint (Figure 1–32).

Detailing is a final cleanup and touch-up on the vehicle. It involves washing any unpainted body sections, cleaning and vacuuming the interior, and touching up any chips in sections not painted. Detailing can also involve tasks such as cleaning compound out of panel gaps and door jambs, cleaning glass, installing trim, vacuum out the interior, washing the car, and cleaning the wheels and tires. This will ready the vehicle for return to the customer.

Nejron Photo/Shutterstock.com

FIGURE 1–31 After the car body is painted, parts must be reinstalled. Here the technician is reinstalling the headlamps for proper fit up.

A After paint cures properly overnight, it may be necessary to wet sand out any imperfections, such as a small dirt nib or adjust the orange peel. Use a small sanding block and ultrafine (1000 or finer grit) sandpaper, and be careful not to cut through the clearcoat, or repainting will be required.



B After ultrafine wet sanding, compound the area to revive the paint's gloss. When machine buffing, be careful not to cut through paint on body contours or panel edges. Most technicians like to apply masking tape to sharp edges to protect the finish from burn-through.

FIGURE 1–32 Minor problems in the paint, such as small dust or dirt particles, can often be removed without repainting.

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MECHANICAL/ELECTRICAL REPAIRS

Mechanical repairs include tasks such as replacing a damaged radiator and/or A/C condenser, or identifying suspension component damage. Mechanical components like these are often damaged in a major collision. Many mechanical parts are easy to replace and can be done by the collision repair technician. However, other mechanical repairs may require special skills and tools. In this case, the vehicle would be sent to a professional service technician or to the mechanical service repair area of the shop (Figure 1–33).

Electrical repairs include tasks such as repairing severed wiring, replacing engine sensors, and scanning for computer or wiring problems. During a collision, the impact on the vehicle body and the resulting metal deformation can easily crush wires and electrical components. For this reason, today's auto body technician must have the basic skills needed to work with and repair electrical/electronic components.

Courtesy of Hunter Engineering Company.

A A technician uses special equipment to adjust wheel alignment. This must be done if suspension parts are damaged in an accident.

Courtesy of Hunter Engineering Company.

B Mechanical skills are helpful to the collision repair technician.

FIGURE 1–33 Mechanical–electrical repairs are sometimes done in larger body shops.

FotoDuets/Shutterstock.com

FIGURE 1–34 A final cleanup of the interior and exterior of a repaired vehicle is important. You want the first impression customers have of your work to be pleasing so they will return to your shop again someday.

COMPLETE COLLISION SERVICES

More and more body shops are offering complete collision services, such as:

- Wheel alignment
- Cooling system repairs
- Electrical repairs
- Suspension repairs
- Air conditioning repairs
- Glass replacement

Many of these repairs are still done by auto specialty shops, which only do one type of repair (glass, air conditioning, and so forth). However, the expanding scope of the collision repair center has made it necessary for the body technician to have some knowledge of these repairs.

As a collision repair technician, it is critical that you learn to repair a damaged vehicle properly. Your reputation as a professional technician and the safety of the occupants of the repaired vehicle depend on how well you do your work (Figure 1–34).

NOTE *Several chapters in this book are devoted to helping you learn to work on mechanical and electrical systems.*

1.3 COLLISION REPAIR CAREERS

Collision repair technicians are skilled, knowledgeable people who know how to use specialized equipment and highly technical methods to restore severely damaged vehicles. A collision repair technician must be a "jack-of-all-trades." They must have basic skills in the following eight areas:

1. *Metalworker*—A collision repair technician must be able to do all types of metalworking to properly form and shape sheet metal car bodies after an accident.

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2. *Welder*—A collision repair technician must weld and cut steel, aluminum, and plastic efficiently during major body repairs.
3. *Automotive service technician*—A collision repair technician must be able to remove and install mechanical systems; this requires some skill in automotive service technology.
4. *Sculptor*—A collision repair technician must form body filler to match body shape, much like a sculptor shapes a piece of art.
5. *Plumber*—A collision repair technician must work with numerous lines, hoses, and fittings during power steering, brake system, and fuel system service.
6. *Electrician*—A collision repair technician must be good at testing and repairing wiring and electrical components after damage. Being able to find shorts, opens, and other wiring problems is essential with today's computer-controlled vehicles.
7. *Air-conditioning technician*—A collision repair technician may be required to work on air-conditioning systems.
8. *Computer technician*—A collision repair technician should be able to scan and repair computer problems stemming from collision damage.

Obviously, today's collision repair technician must be a highly trained professional. Individuals who lack specialized skills can no longer survive and earn a living with modern, complex automotive technology.

A professional technician:

- Is customer oriented
- Is up-to-date on vehicle developments
- Keeps up with advancements in the repair industry
- Pays attention to detail
- Ensures that their work is up to specification

Some shops have specialized technicians who concentrate their knowledge and skills in one area of collision repair.

Body technicians are skilled at part removal/replacement, part repair, welding, and the use of body filler. They can also use frame straightening and measuring equipment to repair vehicles with frame damage.

Refinish technicians, also called painters or refinishers, specialize in vehicle prep and spraying. They are versed in paint mixing, color matching, and the use of spray equipment. These people must have good color perception and excellent hand–eye coordination.

Helpers work under the supervision of one or more professional technicians. They might help a technician mask a car before painting, install a hood, run for parts, or help clean up the work area at the end of the day. The helper is often an *apprentice* who is learning the trade by working with an experienced technician.

OTHER COLLISION REPAIR PERSONNEL

Foremost in any collision repair business are the collision repair and paint technicians. However, there are other jobs that must be done as well. This section describes other personnel who work in and with the staff of a collision repair center.

The *shop owner* must be concerned with all phases of work performed. In smaller shops, the owner and shop manager is usually the same person. In large operations or dealerships, the owner might hire a shop manager. In all cases, the person in charge should understand all of the work done in the shop as well as its business operations.

The *shop supervisor* is in charge of the everyday operation of the shop. This job involves communication with all personnel who contribute to the body shop's success.

The *parts manager* is in charge of ordering all parts (both new and salvaged), receiving all parts, and seeing that they are delivered to the right technician. Because not every collision repair center has a parts manager, the task of ordering parts can fall on all employees at one time or another.

The *bookkeeper* keeps the shop's books, prepares invoices, writes checks, pays bills, makes bank deposits, checks bank statements, and takes care of tax payments. Many shops hire an outside accountant to help perform these tasks.

The *office manager's* duties include various aspects of the business—handling emails, estimates, and workflow, for example. In many small shops, the office manager also acts as the parts manager and bookkeeper.

A *receptionist* is sometimes employed to greet customers, answer the phone, route messages, and do other tasks.

Larger shops generally have trained *tow truck operators* to operate their wrecker(s). Rather than own these expensive pieces of equipment, many smaller shops depend on independent towing services or sublet out such work to other repair facilities.

SHOP TALK

It is important for body shop personnel to have good communication and cooperation skills. Everyone in the shop should work as a team member to make the facility profitable, enjoyable, and safe. "A chain is only as strong as its weakest link"—this saying applies to the smooth operation of a collision center. If anyone—from the estimator to the painter—does not do the job right, everyone suffers. Customers will not return to the shop, and everyone's paycheck will be affected in the long run.

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There are other career openings in the collision repair field. Some of these include:

- Insurance adjuster or appraiser
- Vocational/technical instructor
- Salvage yard technician
- Dealership parts counterperson
- Paint company representative
- Auto manufacturer representative
- Equipment salesperson

To research these and other career opportunities, talk to your instructor or guidance counselor, or search the Internet. There you can obtain more detailed information on the qualifications and training requirements for each position.

1.4 COLLISION REPAIR GOALS

What is your ultimate goal in becoming a collision repair technician? How far do you want to go in your professional life or career? These are important questions to consider.

Many technicians find collision repair extremely rewarding. They take a bashed and mangled vehicle, and restore it to a safe, beautiful, and functional vehicle again. They find working with their hands and their minds to be very rewarding.

PROFESSIONALISM

Professionalism is a broad trait in a worker that includes everything from being able to follow orders to taking pride in workmanship. A **professional** does everything by the book. Professionals never cut corners (for example, leave out the hard-to-reach bolt) when trying to get the repair done. The professional always take the time to do everything the right way. Always think, dress, and act like a professional.

Professionals are:

- Customer oriented
- Up-to-date on vehicle and product developments
- Aware that vehicle safety and integrity depend on repair quality
- Attentive to detail
- I-CAR or ASE certified
- Confident in their repairs
- Always eager to learn something new to improve their skills
- Clean and organized, especially when it comes to their tools
- Helpful to other technicians when they need it

AVERAGE VERSUS PROFESSIONAL

A professional technician takes time to research OEM repair procedures and to repair their customer vehicles correctly the first time. They will be rewarded by happy customers who return again and again to get their cars and trucks fixed properly and with pride.

Unprofessional technicians cut corners trying to make more money. If you try to cut corners and get too much done too quickly, quality will suffer. You must use proper work habits, common sense, and hard work to be productive. Their poor work habits will often result in comebacks.

A **comeback** is a repaired vehicle that is returned to the shop by an unsatisfied customer. The technician who did the original repair as well as other workers in the shop may have to do the repair over again. This means redoing the job for free or without pay. And no one is happy doing that, so make sure to take just a little extra time to repair it correctly the first time.

1.5 WORKER CHARACTERISTICS

Worker characteristics are the little things, besides skills, that make a good or bad employee. These often determine whether you keep a good job or get fired. The most important work traits are detailed in the following section.

RELIABILITY

Reliability means being at work on time, being at work every day, and doing a job right. This is the most important job trait. Without it, you will have a difficult time keeping a job.

If you always miss work, you negatively affect everyone in the shop. If a vehicle has been promised on Friday and you are not there, either someone else has to do your work, or the vehicle may not get repaired. Then the customer will be unhappy and will not return to your shop again. If this continues, word of mouth will ruin the reputation of the shop, and profits will decline.

SOCIAL SKILLS

Social skills are important so that other workers and customers like you. Many times you will need the help of another worker to complete a difficult, two-person task. If you are unliked by coworkers, you will find many tasks almost impossible.

A good collision repair center will have a team of workers who help each other succeed and prosper. They will exchange information, help each other with small tasks, and most of the times enjoy working together. You spend much of your life on the job, so why not try to enjoy it?

It is important for collision center personnel to have good communication and cooperation skills. A wise old saying goes, "A chain is only as strong as its weakest link." This applies to the smooth operation of a collision center.

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If anyone from the estimator to the employee responsible for the final detail does not do their job right, everyone suffers. Customers will not return to the shop, and everyone's paychecks will go down.

PRODUCTIVITY VERSUS QUALITY

Productivity is a measure of how much work gets done. A highly productive technician will turn out a large amount of work. This will result in higher pay for the technician and more profits for the shop. **Quality** means that you do every step of a repair correctly so that the repair is strong, reliable, and attractive. You want to balance productivity and quality.

SYSTEMATIC APPROACH

It is important that you develop a systematic approach for doing your job. A **systematic approach** involves organizing and using a logical sequence of steps to accomplish a task or job. This will result in more efficient ways of working and will also help prevent the kinds of mistakes that can affect repair quality.

Ask yourself these kinds of questions:

- Did I take all needed tools to the vehicle?
- Is there a better tool for a specific task?
- Have I been reading the manufacturer's instructions (paints, body filler, equipment, and so on)?
- Is my body in the right position to protect myself and perform the repair comfortably?

AUTOMOTIVE-RELATED PROFESSIONS

The career potential in automotive-related fields is very large. Besides the thousands of people who repair vehicles, there are countless other related fields that support our nation's transportation industry. Automobile-related professions are jobs that require an understanding of collision repair. By understanding collision repair and furthering your education, you might be able to get a job at a variety of businesses:

- Insurance company—adjuster, agent
- Materials manufacturer—paint or other repair products
- Parts suppliers—new, used, and remanufactured parts
- Auto manufacturer—new or used car sales, factory representative, designer, or engineer
- Instructor—teaching collision repair classes

CAREER ADVANCEMENT

Even if you have a good job as a collision repair technician, always consider career advancement. Maybe you can find a better paying job or one with better working conditions.

Job openings are common, as people move up into other positions and retire. Always check online to stay aware of job prospects. Some may offer a higher salary or better benefits (for example, insurance, vacation time, and holiday pay) than your present job.

Try to learn something new that is job-related every day. Always learn from your mistakes. Read technical magazines and other collision-related articles. While accomplishing tasks, try to think of more efficient ways of working. Consider new tools and techniques. Participate in trade associations, such as SCRS, I-CAR, NACE, and ASE. This kind of attitude will help you become more productive.

1.6 INDUSTRY CERTIFICATIONS

There are multiple associated certifications for collision repair, but I-CAR is the most relevant and desired from collision repair owners and insurance companies also. ASE used to be the premier training provider; some shops still want ASE certifications and that is fine. But to keep up with the industry and its future, I-CAR is the way to go for collision repair work (Figure 1–35).

Source: I-CAR

A

B

FIGURE 1–35 Here are the top Certifications for the Collision Repair industry. These will show you have knowledge in the field and are certified as well.

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Just as doctors, accountants, electricians, and other professionals are licensed or certified to practice their profession, collision repair and refinishing technicians can also be certified. Certification protects the general public and the professional. It assures the general public and the prospective employer that certain minimum standards of performance have been met.

Many employers now expect their collision repair and refinishing technicians to be certified. The certified technician is recognized as a professional by the public, employers, and peers. For this reason, the certified technician usually receives higher pay than one who is not certified.

I-CAR and ASE tests include multiple-choice questions pertaining to the service and repair of a vehicle. They do not include totally theoretical questions. To prepare for any of these style collision repair tests, study the material in this book carefully. To help you prepare, some test questions at the end of these chapters are similar to those used by I-CAR and ASE.

I-CAR (Inter-Industry Conference on Auto Collision Repair) has training and certifications for several roles not only for just the technicians but also for the entire shop designations. They are listed here:

1. Refinishing
2. Nonstructural
3. Structural
4. Mechanical
5. Electrical/Diagnostics
6. Auto Physical Damage Appraiser
7. Estimator
8. Production Manager
9. Welding

There are five ASE tests—four for technicians and one for estimators. The titles of the ASE tests in auto body repair are:

1. Painting and Refinishing
2. Nonstructural Analysis and Damage Repair
3. Mechanical and Electrical Components
4. Structural Analysis and Damage Repair
5. Damage Analysis and Estimating

SUMMARY

1. A collision, nicknamed a *crash* or a *wreck*, is damage caused by an impact (hit) on the vehicle.
2. Collision repair, also known as auto body repair, involves fixing a vehicle that has been damaged in an accident. The vehicle is first brought into the shop, where a damage estimate is prepared to calculate the cost of repairs.
3. Minor body damage only requires that a few parts be replaced or repaired before the car is repainted. Major body damage usually must be corrected by replacing, repairing, and straightening large body parts before repainting. A collision can also be severe enough to cause a total loss, where repairs would be more expensive than buying another car.
4. Repair instructions are summarized on a printed repair order (RO), and the repairs are carried out according to those instructions. The metalworking areas are shop locations where damaged parts are removed, repaired, and installed. A stall is a work area for one vehicle, often marked off with painted lines on the floor.
5. Vehicle measurement is done to determine the extent and direction of major damage. Measurement systems are specialized tools and equipment that help the technician to check and measure for frame or body misalignment resulting from a high-impact collision.
6. Frame straightening equipment (also called a frame rack) uses a large steel framework, pulling chains, and hydraulic power to pull or force the frame or body back into its original position.
7. A panel is a large metal or plastic body part—a fender, hood, truck, or roof panel, for example. Structural panel replacement involves welding a new panel in place of an old, damaged one. Panel adjustment involves moving or shifting a part to properly align with other parts or panels. When parts are replaced, corrosion protection coatings must be applied to prevent the new parts from rusting.
8. Panel straightening involves using various hand tools and equipment to force the panel back into its original shape. Body filler is used to cover any small dents remaining in the worked panel. The vehicle is sanded and cleaned to prepare surfaces for the painting process.
9. Masking is done to cover areas that will not be painted. Priming is done to cover bare metal before painting. The mixing room or mixing lab is a power-ventilated area where refinish materials are mixed or prepared for application.
10. The vehicle's paint or finish performs two basic functions—it beautifies and it protects.
11. Refinishing or repainting involves the steps needed to properly restore the vehicle's finish (paint).
12. The primecoat is used to improve adhesion (sticking) of the topcoat. The terms *topcoat* and *colorcoat* refer to the paint applied over the primecoat. Basecoat/clearcoat paint systems use a colorcoat applied over the primer-sealer with a second layer of transparent clearcoat (topcoat) over the colorcoat.

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13. Spraying involves using precision paint spray guns and a spray booth to apply refinish materials to the car body. A spray gun uses compressed air to break the liquid paint into a fine mist so that the paint is deposited smoothly on the vehicle body.
14. The paint booth is a clean room with filtered air circulation so that dirt does not get into the paint when spraying. In the drying room, infrared lights are used to speed up the paint curing or drying process by warming the paint.
15. A detailer performs all the last tasks needed to prepare the vehicle for return to the customer.
16. Collision repair technicians are skilled people who know how to use specialized equipment and highly technical methods to restore severely damaged vehicles.
17. Professional is a worker with a broad range of skills that include everything from being able to follow orders to taking pride in workmanship.
18. A "comeback" is a repaired vehicle that is returned to the shop by an unsatisfied customer.
19. Reliability means being at work on time, being at work every day, and doing the job right. This is the most important job trait.
20. Social skills are important so that other workers and customers like you. Many times you will need the help of another worker to complete difficult tasks.
21. Various companies and professional associations offer certification programs and training in collision repair subjects.

EXERCISES

On a separate sheet of paper, complete the following learning activities for this chapter. Write definitions for the key terms and answer the ASE-style review questions, essay questions, critical thinking problems, and math problems. You can also do the outside activities, possibly for extra credit.

Key Terms

accident report
adhesion
Automotive Service Excellence (ASE)
collision
collision repair center
comeback
contaminants
damage estimate
dealership collision center
deductible
direct repair program
elements
estimating
estimator
head-on collision
(I-CAR) Inter-Industry Conference on Auto Collision Repair
impact
independent collision center
The insurance adjuster
major body damage
metalworking areas
minor body damage
paint runs
post-painting operations
productivity
professional
Quality
reliability
repair order
salvage yard
social skills
specialty shop
systematic approach
total loss
wash-up
worker characteristics
wrecker

ASE-Style Review Questions

1. Technician A says there are more than 6 million auto accidents each year. Technician B says that to offset the technician shortage, the industry would need to hire 12,000 technicians each year. Who is correct?
   A. Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B
2. Technician A says that when two cars hit head-on at 50 mph, it is like hitting a brick wall at 100 mph. Technician B disagrees and says that it is like hitting a brick wall at only 50 mph. Who is correct?
   A. Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B

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3. An independent collision center is owned by an individual and does not have ties to a major auto manufacturer. True or false?

4. What task involves analyzing damage and calculating how much it will cost to repair the vehicle?

A. Repair
B. Estimating
C. Calculating
D. Measuring

5. Technician A says that a collision can be severe enough to cause a total loss. Technician B says that the repairs would be more expensive than buying another car. Who is correct?

A. Technician A
B. Technician B
C. Both A and B
D. Neither A nor B

6. Collision center repairs are carried out according to the instructions on which form?

A. Repair order
B. Estimate
C. Quote
D. Data sheet

7. Technician A says that a damaged vehicle does not have to be cleaned before starting repairs. Technician B says that wash-up will remove mud, dirt, wax, and water-soluble contaminants that could affect the paint job. Who is correct?

A. Technician A
B. Technician B
C. Both A and B
D. Neither A nor B

8. Technician A says that vehicle measurement is done to determine the extent of major damage. Technician B says that it is also done to determine the direction of damage. Who is correct?

A. Technician A
B. Technician B
C. Both A and B
D. Neither A nor B

9. Technician A says that various types of gauges and measuring devices can be used to measure vehicle damage. Technician B says that you can compare known good body specifications (normal measurements from an undamaged vehicle) with the actual body measurements on the damaged vehicle. Who is correct?

A. Technician A
B. Technician B
C. Both A and B
D. Neither A nor B

10. Technician A says that a frame rack can be used to do a wheel alignment. Technician B says that a frame rack uses mechanical power to pull or force the frame or body back into its original position. Who is correct?

A. Technician A
B. Technician B
C. Both A and B
D. Neither A nor B

11. Technician A says that panel replacement involves removing a panel or body part that is too badly damaged to be fixed. The new part would have to be bolted or welded in place on the vehicle. This takes considerable skill. Technician B says that structural panel replacement involves welding a new panel in place of the old, damaged one. Who is correct?

A. Technician A
B. Technician B
C. Both A and B
D. Neither A nor B

12. Workers who fail to get to work on time do not exhibit which desired trait?

A. Quality
B. Productivity
C. Reliability
D. Systematic approach

13. Which term refers to a worker who can follow orders and shows pride in workmanship?

A. Certified
B. Professional
C. Average
D. Comeback

14. Technician A says that MSOs are shops that perform only specific types of repairs. Technician B says that MSOs are shops that have several locations from the same company name. Who is correct?

A. Technician A
B. Technician B
C. Both A and B
D. Neither A nor B

15. Technician A says that panel straightening involves using various hand tools and equipment to force the panel back into its original shape. Technician B says that body hammers, body filler, and sanders are a few of the tools and materials used to fix panel damage. Who is correct?

A. Technician A
B. Technician B
C. Both A and B
D. Neither A nor B

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Essay Questions

1. What happens to a vehicle during a collision?
2. Explain the difference between a door ding and a total loss.
3. What is estimating?
4. Describe the differences between panel straightening and panel replacement.
5. Define the term *collision*.
6. Name two contaminants that must be cleaned off before starting bodywork.
7. Why is estimating the cost of a repair such an important step to consider for a collision center?

Critical Thinking Problems

1. How would you determine whether a car is a total loss?
2. Write the 14 steps of a basic repair sequence so you can memorize what is done when a vehicle enters a collision center.
3. Why is cooperation between employees in a collision center important?
4. Why is reliability such an important factor in a successful workplace?

Math Problems

1. A technician is paid $45 per hour. The repair will take 11.5 hours. Parts for the repair will cost $176.25 plus 7 percent tax. What is the total of the estimate?
2. An older car is valued at $2,500. The parts for the repair will cost $1,500. How many hours of labor at $35 per hour can be completed before the car should be declared totaled?
3. An independent collision center made $33,507 total in a one-month period. The cost of labor was $45 per hour with a total of 200 hours of labor. Parts cost the repair shop $14,000. Power and property bills cost a total of $3,500. After these costs are taken into account, what did the repair shop make in profits for the month?
4. By learning how to do her job more efficiently from continued study, a technician increased her income by 20 percent. If this technician was earning $35,000 per year before, how much is she earning per year now?

Activities

1. Take a field trip to a local collision repair center. Have the shop owner or supervisor give you a guided tour of the repair operation. Discuss what you learned during the field trip in class the next day.
2. Ask a technician or shop owner to visit your classroom to describe their duties and answer questions.

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CHAPTER 2

Shop Safety

OBJECTIVES

After studying this chapter, you should be able to:

- List the general rules regarding personal safety while working.
- Summarize the major shop areas and safety rules that apply to each.
- Summarize the importance of wearing a respirator when airborne contaminants are present.
- Explain how to fit and adjust a respirator.
- List the types of safety gear needed when working in a body shop.
- Review precautions for using hand tools and power equipment.
- List the types of accidents that can occur in an auto body shop.
- Describe how to prevent auto body shop accidents.
- Explain what to do in case of a shop fire.
- Summarize important methods of handling hazardous waste materials found in a body shop.
- Explain Right-to-Know Laws.
- Answer ASE-style review questions relating to shop safety and efficiency.

INTRODUCTION

This chapter summarizes the types of hazards present in a body shop. You will study how to best avoid these potential injuries and how to work with hazardous materials and equipment.

True professionalism and shop safety begins with how technicians perform their given work tasks. A professional understands the ever-present dangers in a body shop and strives to avoid making dangerous mistakes.

NOTE *A body shop can be a very safe and enjoyable place to work if everyone follows standard safe work procedures (Figure 2–1). Conversely, a body shop can be a very dangerous, even deadly place to work, if you or another worker fails to follow basic safety rules.*

HISTORY NOTE

The book stresses the importance of abiding by **Occupational Safety and Health Administration (OSHA)** standards. OSHA was established by Congress in the Occupational Safety and Health Act of 1970. This law was enacted to ensure that every American worker had safe and healthy working conditions. OSHA has a staff of over 2,000 people and an annual budget of several hundred million dollars.

OSHA works with the **National Institute for Occupational Safety and Health (NIOSH)**. NIOSH does scientific and technical research to establish basic safety standards. OSHA then enforces these standards by doing surprise inspections of workplaces to make sure established safety standards are being followed.

2.1 SHOP ACCIDENTS

Shop accidents are unplanned mishaps that hurt people, damage parts or tools, and result in other adverse effects on the shop and its employees. Because a body shop has so many potential sources of danger, safety must be everyone's primary concern (Figure 2–2).

The most important action taken in any body shop is accident prevention. Carelessness and the lack of safety habits frequently cause accidents that can result in serious injury and even death. Thousands of auto body technicians are injured or killed on the job each year. Ignoring and/or violating safety rules caused most of these accidents.

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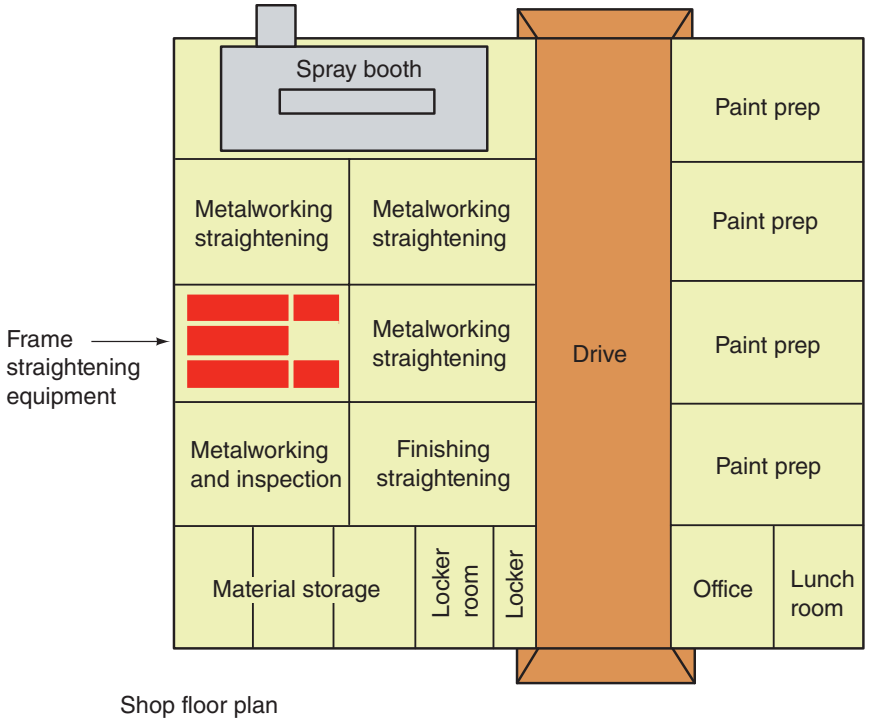


Shop floor plan

FIGURE 2–1 As soon as you get a job in a collision repair facility, become familiar with the shop's layout. Know the location of fire exits, fire extinguishers, a first-aid kit, telephones, and the eye flushing station.

ECO-TECH

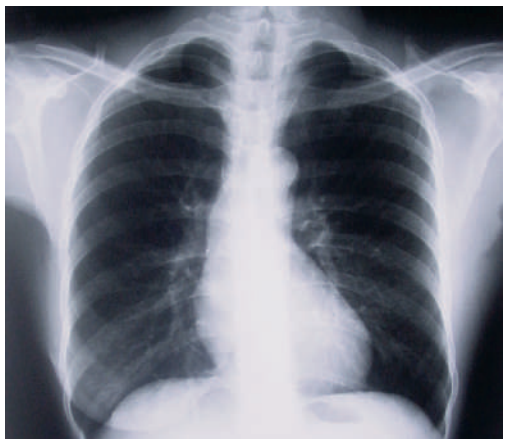
In the collision repair industry, safety and efficiency go "hand in hand"! By working efficiently and avoiding waste, you make your work environment safer for yourself and your coworkers. By not mixing too much and wasting paint, by not wasting sandpaper or oversanding, by adhering to all safety and procedural rules, you reduce shop overhead costs while also improving your working conditions and work environment.

SAFETY PROGRAM

Accidents have far-reaching effects, not only on the victim, but also on the victim's family and society in general. Therefore, all shop employees must foster, develop, and promote a safety program to protect the health and welfare of those involved.

A *safety program* is a written shop policy designed to protect the health and welfare of all employees. It provides rules on everything from equipment use to disposal of hazardous chemicals.

A This technician almost lost an eye when a small cutting disc shattered and shot debris into his eye. Safety glasses would have prevented this injury.



B Breathing problems and even lung, throat, and nose cancer can result if you fail to wear an approved respirator to keep toxic materials out of your respiratory system.

FIGURE 2–2 A smart, professional technician understands the importance of wearing appropriate protective gear when working in a body shop. Every shop area, except the office, requires the use of safety clothing, eye protection, respirators, and so on.

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MANUFACTURER'S INSTRUCTIONS

Manufacturer's instructions are the detailed procedures for products provided by the manufacturer. They are written to guide you in the use of a specific item, whether it is a piece of equipment or a certain type of paint.

Generally, instructions take the form of the owner's or instruction manual for tools and equipment. With paint and chemicals, they are normally printed on the container label. Always refer to manufacturer's instructions when in doubt about any task.

NOTE *Other chapters in this text give more specific safety rules and cautions. However, these safety rules are generic and cannot cover every challenge you will encounter in the body shop. For this reason, you should always refer to manufacturer's instructions for specific tools and make/model vehicles before you undertake repairs.*

IN CASE OF AN EMERGENCY

You should know what to do in the event of an emergency, whether it be an injury, a shop fire, or another accident.

All shops should have a list of *emergency telephone numbers* clearly posted next to all telephones. These important phone numbers include the police, the fire department, poison control, an ambulance service, a doctor, the nearest hospital, and so on.

Know the location of your shop's first-aid kit. A **first-aid kit** includes many of the medical items needed to treat minor shop injuries. It will have sterile gauze, bandages, scissors, antiseptics, and other items to help treat minor cuts and burns. A fully stocked first-aid kit should be kept in a handy location, usually near the office or rest room (Figure 2–3).

FIGURE 2–3 The shop's first-aid kit will have antiseptics, bandages, and other medical items for treating minor injuries. Know its location and help keep it stocked with supplies. Inform the boss if any item needs to be reordered.

An **eye flushing station** is equipped with fresh water and nozzles for washing out your eyes if you get anything in them (Figure 2–4). You should know where the eye flushing station is located and how to use it. These must be located within 10 seconds or 55 feet of the potential hazard. Make sure to wash your eyes out for 15 minutes to help remove the contaminants or hazards. You may use an eye wash bottle to flush your eyes out as well; however, these should not be the only source of eye wash in the facility. These are for short-term flush and do not provide the continuous flow of water necessary for your eyes.

Safety signs provide information that helps to improve shop safety. Signs often mark the locations of fire exits and fire extinguishers, dangerous or flammable chemicals, and other information. Safety signs should be located throughout the shop. Make sure you read and understand them.

A Wearing proper safety gear and using safe work habits helps prevent having to use this safety equipment.

B With your eye held open, allow the pure flushing water to flow over your eyeball to wash away chemicals.

FIGURE 2–4 This eye flushing station is used if chemicals splash into a technician's eyes.

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TYPES OF ACCIDENTS

Technicians can help to prevent several kinds of accidents—asphyxiation, chemical burns, electrocution, fires, and explosions.

- **Asphyxiation** refers to anything that prevents normal breathing. There are many mists, gases, dusts, and fumes in a body shop that can damage the lungs and affect the ability to breathe. As you will learn, there are several things you can do to protect yourself from these airborne dangers.
- *Chemical burns* result when a corrosive chemical comes into contact with the skin or eyes. These can result from various chemicals in a body shop: paint removers, part cleaners, refinish materials, and other common shop chemicals.
- **Electrocution** results when electricity passes through a person's body. Severe injury or death can result. Electric power tools, drop lights, and other equipment operating on either 120 or 240 volts can all cause electrocution. You will learn several ways to avoid electrocution.
- A *fire* is rapid oxidation of a flammable material, producing high temperature. A burn from a fire can cause horrible, permanent scar tissue and death. There are numerous combustibles (paints, thinners, reducers, gasoline, and dirty rags) in a body shop, any of which can quickly cause a fire.
- *Explosions* are fast-moving air pressure waves that result from extremely rapid burning. For example, if you were to weld on or near a car's gas tank, the fumes in the tank could ignite and explode. The metal tank would act like a powerful bomb that could send metal shrapnel into the work area. There are many other objects in the body shop that can explode if mishandled: welding tanks, propane tanks, etc.
- *Physical injury* is a general category that includes cuts, broken bones, strained backs, and similar injuries. To prevent these painful injuries, you should constantly evaluate repair techniques—always think about what you are doing and try to do it better.

SHOP TALK

A young auto body repair student was helping a friend work on his car at home. He started cleaning greasy suspension system parts with gasoline. He noticed that the gasoline seemed very cool to the touch. The gasoline felt cool because it was evaporating into an invisible but highly explosive vapor (invisible cloud of gasoline fumes).

The pilot light from a hot water heater ignited the gasoline fumes and the student was engulfed in flames. His friend grabbed a fire extinguisher, but before he could put out the fire, the pupil suffered third-degree burns over 50 percent of his body. He almost died and still has terrible physical and emotional scars.

2.2 PERSONAL SAFETY

This section details some very important personal safety rules that must be heeded while working.

Horseplay is unacceptable! Proper, professional conduct can also help prevent accidents. Horseplay is not fun when it sends someone to the hospital. Such things as air nozzle fights, creeper races, or practical jokes do not have any place in the shop. Stay away from anyone who does not take shop work seriously. Remember, a joker is "an accident waiting to happen."

Dress like a technician. Remove rings, bracelets, necklaces, watches, and other jewelry. These items can get caught in engine fans, belts, and drive shafts, causing severe and permanent injury. Also, roll up long sleeves and secure long hair, which also can get caught in spinning parts.

Work like a professional. It is easy to get excited about your work, but never let this excitement prompt you to work too fast. Then you might overlook an important repair procedure or safety rule. In the end, you won't save time by trying to work too fast.

There is usually a "best" tool for each repair task. Always use the right tool for the job; using the wrong tool will slow your work and can result in inferior repairs. It can also be dangerous. It pays to consider whether one tool will work better than another, especially when you run into difficulty.

SHOP TALK

An apprentice mechanic was using an air impact wrench to tighten large clamps on a frame rack. This technician mistakenly used a nonimpact-type universal joint on the extension and socket setup. When high torque from the wrench was applied, the universal joint broke and almost cut off one of the mechanic's fingers. The extension then flew off and broke the windshield of the pickup truck parked in the next stall.

By using the wrong tool, the apprentice was badly injured, and he had to pay for the broken windshield.

Remember, customers and all nonemployees should never be allowed in any of the shop's work areas.

AIR PASSAGE AND LUNG SAFETY

There are many airborne materials in the body shop that can cause health problems, particularly with repeated exposure. These airborne contaminants include:

- Abrasive dusts from sanding and grinding
- Welding flux and soldering fumes
- Vapors from caustic solutions, primers, paints, and solvents
- Spray mists from undercoats and painting materials

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All these materials present dangers to your air passages and lungs, especially when you are surrounded by them day in and day out.

RESPIRATORS

Respirators are often needed in the collision repair facility to keep airborne materials from being inhaled into your nose, throat, and lungs. Respirators are recommended even when adequate ventilation (outside airflow) is provided in the shop area.

Dust Respirator

A paper filter that fits over your nose and mouth to block small airborne particles is called a **dust respirator** (Figure 2–5). This type of respirator will help keep dangerous dust particles from entering your nose, throat, and lungs. A dust respirator should be worn when sanding, grinding, or blowing off dirty panels with a blow nozzle (Figure 2–6).

A This type of inexpensive, disposable respirator should be worn when power sanding and grinding. The filter will trap harmful paint dust and dirt that would otherwise enter your lungs.

B A dust respirator should fit snugly on the face to keep debris from going around outside of the mask.

FIGURE 2–5 A dust respirator is like an "air filter" for your nose, mouth, throat, and lungs.

FIGURE 2–6 Always put on a dust particle mask before grinding or sanding. The dust can be very toxic and harmful with prolonged exposure.

Sanding operations create dust that can cause bronchial irritation and possible long-term lung damage. Protection from this health hazard is often overlooked. Just because sanding dust does not cause immediate symptoms does not mean that there will not be problems later in life. An approved dust respirator should be worn anytime as particles could be in your breathing air.

Follow the instructions provided with the dust respirator to ensure a proper fit. Bend or shape it so that air cannot leak around your face, nose, and mouth. Note that a dust respirator will not work properly if you have a large beard or facial hair.

Cartridge Respirator

A **cartridge filter respirator** protects against vapors and spray mists of one-part enamel (no hardener added), lacquers, and other nonisocyanate materials. Cartridge filter respirators should be used only in well-ventilated areas. They must not be used in environments containing less than 19.5 percent oxygen.

The cartridge filter respirator typically consists of a rubber face piece designed to conform to the contour of your face to form an airtight seal (Figure 2–7). This type of respirator includes replaceable prefilters and cartridges that remove solvent and other vapors from the air (Figure 2–8). The cartridge filter respirator also has intake and exhaust valves, which ensure that all incoming air flows through the filters.

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FIGURE 2–7 A cartridge-type respirator will filter fine particles, mists, and some fumes that a dust respirator will not stop.

Courtesy of PPG Industries

FIGURE 2–8 Cartridge-type respiratory masks will filter finer particles than fiber dust masks. They provide adequate protection from most primers, sealers, and noncatalyzed paints.

Cartridge filter respirators are available in several sizes. Purchase and use one that fits your face. To maintain the cartridge filter respirator, keep it clean and change the prefilters and cartridges as directed by the manufacturer.

Welding Respirator

A **welding respirator** has special cartridge inserts designed to trap welding fumes. Welding fumes are most dangerous when the metals being fused are zinc-coated steel for improved rust resistance.

Air-Supplied Respirator

An approved **air-supplied respirator** typically consists of a hood with a clear visor and an external air supply hose. Clean, breathable air is pumped through the hose from a separate air source and into the hood or helmet (Figure 2–9).

Courtesy of PPG Industries

FIGURE 2–9 This refinish technician is wearing a state-of-the-art, air-supplied respirator while painting a car. It uses a lightweight hood with a clear lens. The hood keeps the head clean and also allows circulation of fresh breathing air.

An air-supplied respirator provides protection from inhaling extremely dangerous airborne materials: paint with added hardener, isocyanate paint vapors and mists, and hazardous solvent vapors. An air-supplied respirator is the safest type of protection and is highly recommended when spraying all types of primers, sealers, and paints (Figure 2–10).

An air-supplied respirator is comfortable to wear and does not require fit testing (Figure 2–11).

The air-supplied respirator may include a self-contained oilless pump to supply air to the hood or half-mask respirator. The shop may also have additional filters to prepare, dry, and clean main shop air pressure for use in air-supplied respirators (Figure 2–12).

The pump's air inlet must be located in a clean air area. Some shops mount the pumps on an outside wall, away from the dust and dirt generated by shop operations. If shop compressed air is used, it must be filtered with a trap and carbon filter to remove oil, water, scale, and odor.

The air supply must have a valve to match air pressure to respirator equipment specs and an automatic control to sound an alarm or shut down the compressor in the event of overheating and contamination. Overheating causes carbon monoxide contamination of the air supply (Figure 2–13).

DANGER

Isocyanate resin is a principal ingredient in some urethane hardeners. Because this ingredient has toxic effects, you must always wear a NIOSH-approved respirator. Hardened primers and paints can actually cure when inside your lungs!

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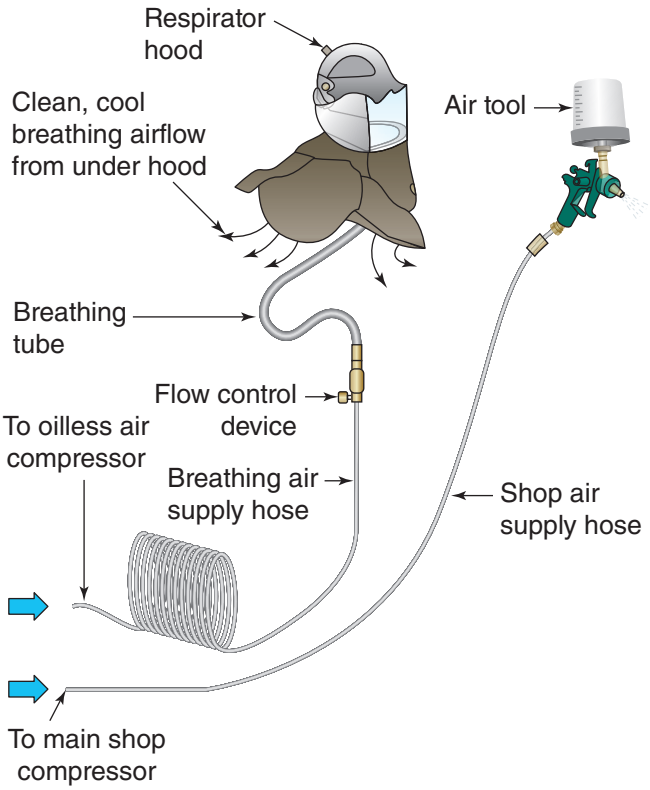

Supplied-air respirator component schematic

FIGURE 2–10 Note parts of a fresh-air respirator that is fed from its own oilless air compressor located outside of the paint booth. This one uses an air visor that affords protection but still allows for good vision. Cool breathing air circulates around your face and head. A shop air line can only be used for air tools because it is not pure enough for breathing.

FIGURE 2–11 Today's multistage, catalyzed refinish materials are much more harmful to your lungs than old lacquer and single-stage enamels. You should wear an air-supplied visor, hood, or respirator when spraying these materials.

Respirator Testing and Maintenance

It is very important that an air-purifying cartridge filter respirator or half-mask fit securely around your face. This will prevent contaminated air from bypassing the filters and entering your lungs.

Courtesy of PPG Industries, Inc.

FIGURE 2–12 When mixing paints, you should work in a well-ventilated area or a power-ventilated mixing room and wear a cartridge respirator.

FIGURE 2–13 You can sometimes breathe a large quantity of toxic materials without feeling immediate illness. The resulting sickness will show up as major health problems after a few years of not wearing an approved respirator. Look and feel professional by wearing all necessary safety gear when working.

To check for air leaks, a **respirator fit test** should be done prior to using the respirator. Perform both negative and positive pressure checks.

To make a *negative pressure test*, place the palms of your hands over the cartridges and inhale. A good fit will be evident if the face piece collapses onto your face when breathing normally.

To perform a *positive pressure test*, cover up the exhalation valve and exhale or breathe out. A proper fit is evident if the face piece billows out without air escaping from the mask when breathing normally.

Another form of fit testing consists of exposing amyl acetate (banana oil) near the seal around the face. If no odor is detected, the mask fits properly. Follow the

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manufacturer's instructions to ensure proper maintenance and fit of respirators.

Replace the prefilters when it becomes difficult to breathe through the respirator or after manufacturer-recommended intervals. Replace the cartridge(s) at the first sign of solvent odor. Regularly check masks to make sure they do not have any cracks or deformities. Store respirators in airtight containers or resealable plastic bags to keep them clean.

Remember that facial hair may prevent an airtight seal, which presents a health hazard. Therefore, refinishing technicians with facial hair should use an air-supplied respirator.

HEAD PROTECTION

Be sure to tie long hair securely behind your head before beginning to work on a vehicle. Hair that becomes tangled in moving parts or air tools can be torn out and mutilation can occur.

Your hair should also be protected from dust and spray mists. To keep hair clean and healthy, wear a cap at all times in the work area. Wear a protective painter's stretch hood in the spray booth.

There are numerous objects in the shop that can cause painful head injuries: car body panels, frame rack towers and chains, and other heavy equipment. Be careful not to accidentally hit your head on these objects while working in the body shop.

SHOP TALK

Several years ago, a newly hired apprentice was helping a technician find an abnormal driveline noise. The car was on a lift running in drive while he listened for the odd noise. The apprentice accidentally got his hair caught in the rotating drive shaft. The shaft pulled his head and face up against the floor pan before ripping out a huge chunk of hair and skin, resulting in the young man being "scalped." It took several hundred stitches and hours of surgery to reattach his scalp and hair, and the scars are still obvious. Remember to keep long hair tied up or under a cap.

A body technician should consider wearing a padded bump cap or welder's cap when working beneath hoods, under cars, or on a frame rack.

EYE AND FACE PROTECTION

Eye protection—safety glasses, goggles, face shields, hoods, or helmets—is required at all times in most shops to comply with OSHA or insurance company requirements. Some type of eye protection should be worn at all times when working in the shop (Figure 2–14).

Safety glasses are sufficient eye protection when doing tasks such as hammering, drilling, and cutting. Safety glasses are not sufficient when doing tasks that could lead to major injuries to your face. Also remember to wear safety glasses when others in the shop are grinding, sanding, and so forth.

Goggles should be worn when handling fluids that could burn your eyes. For example, wear goggles when working with solvents that could splash into your eyes. See Figure 2–15 and Figure 2–16.

Welding goggles with a shaded lens are often used when heating and cutting with a gas torch outfit (Figure 2–16). The flame from the oxyacetylene gas is not as bright as that produced when electric arc welding.

When doing more dangerous operations, wear a **full face shield** to protect your eyes and your face from

FIGURE 2–14 Dress like a professional when at work. This technician is wearing lightweight and attractive safety glasses to protect his eyesight, something that cannot be replaced!

FIGURE 2–15 Goggles are better than safety glasses when a spill of a chemical might splash into your eyes. These are vital tools that can protect you from eye injuries and even blindness.

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FIGURE 2–16 These tinted goggles should be worn when flame heating and torch cutting. Their shaded lens is dark enough for the brightness of a welding flame, but not dark enough to protect your eyes when electric welding.

injury. For example, wear a full face shield when using an air grinder or bench grinder. It is possible that the grinding disc or wheel could break and shoot large pieces of abrasive into your face. A face shield will prevent deep lacerations and scars.

REMEMBER *When you are in the shop, there is always the possibility that flying objects, dust particles, or splashing liquids could injure your eyes. Not only can this be painful, but it can also cause loss of sight. Your eyes are irreplaceable. Get in the habit of wearing safety goggles, glasses, or face shields in all work areas.*

A **welding helmet** that covers your whole head has a dark, shaded lens that must be worn when electric welding (Figure 2–17). The helmet will protect your face from extreme heat and flying pieces of molten metal. The shaded lens will protect your eyes from the extremely bright, harmful rays generated by the electric arc (Figure 2–18 and Figure 2–19).

NOTE *Sunglasses are not adequate protection when gas welding, cutting, or heating! As shown in Figure 2–20, ultraviolet light can cause severe burns and permanent eye damage.*

DANGER

Do *not* weld any parts made of lightweight magnesium. Magnesium burns with tremendous heat. In fact, large, 10-foot-long "burning rods" made of magnesium are used to cut up and scrap the heavy plate steel used in U.S. Navy ships. Once magnesium starts to burn, it is very difficult to put out the fire.

A This welding helmet has a self-darkening lens. It is only lightly shaded until you start welding and then it darkens enough to protect your eyes.

B Controls on the inside of the self-darkening helmet allow you to adjust how fast and dark the lens gets when you are welding.

FIGURE 2–17 A welding helmet is needed to protect your eyes and face from the extreme light of an electric arc when MIG or TIG welding.

FIGURE 2–18 This technician is wearing a welding-type cartridge respirator and an automatic dimming welding helmet while making plug welds during panel replacement. Both are needed for protection when arc welding today's steel and aluminum panels during structural body repair.

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EAR PROTECTION

Ear protection—ear plugs or earmuffs—is needed when *decibel* (sound) levels are high, for example, when using air-powered cutting tools, such as an air chisel (Figure 2–21).

FIGURE 2–19 Here a body technician is welding during major repairs of this sports car. Note the brightness of the MIG welding arc.

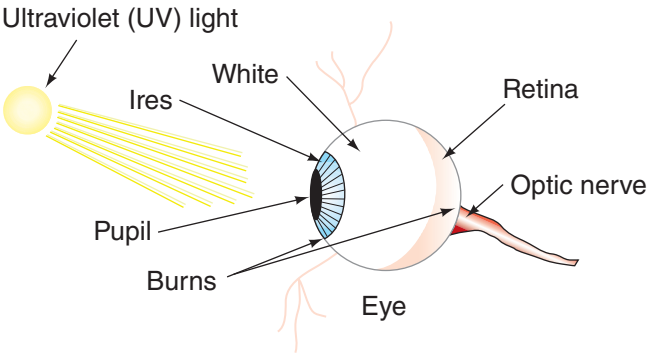

FIGURE 2–20 Electric welding generates powerful ultraviolet rays that can badly burn your eyes. Even though its light does not hurt immediately, never watch a weld arc without proper eye protection.

FIGURE 2–21 Many shop tools produce very high decibel levels. This air chisel being used to remove a badly rusted exhaust system is a good example. Its sound level is loud enough to cause permanent hearing loss.

The level of noise in a body shop—the noise of panel beating, the piercing sound of sanding, even a radio playing full blast—may be enough to deafen a person if proper precautions are not taken. When in metalworking areas, wear earmuffs to protect the eardrums from damaging noise levels. Earmuffs can also help prevent molten metal from getting into the inner ear when performing overhead welding.

BODY PROTECTION

Loose clothing, unbuttoned shirt sleeves, dangling ties, and shirts hanging out are very dangerous in a body shop. Instead, wear approved shop coveralls or jumpsuits (Figure 2–22).

Keep clothing away from moving parts when an engine or a machine is running. Any loose or hanging clothing (shirttails, ties, cuffs, scarves, and so on) presents a risk for catching in moving parts. This can cause serious bodily injury. Also be sure to remove all jewelry before working.

Your pants should always be long enough to cover the tops of your shoes. When welding, for example, this will prevent hot sparks or beads of molten metal from going down into your shoes, causing painful burns to your feet. For added safety, leather welder's pants, leggings, or spats are often worn to prevent molten metal from burning through your clothing. Upper body protection should include either a welder's jacket or leather apron.

A clean jumpsuit or lint-free coveralls should be worn when you are in the spray area or paint booth. Clean coveralls will protect the vehicle paint from dirt contamination and will also protect your body from chemical contamination.

If you spill chemicals (cleaning solvents, reducers, thinners, paint removers, and so forth) on your clothing, remove the clothing right away. Dirty, solvent-soaked clothing will hold these chemicals against your skin, causing irritation, a rash, or even a severe chemical burn.

FIGURE 2–22 A smart technician knows that taking the time to put on safety gear is time well spent. Health is something often taken for granted until an illness hits with debilitating or deadly force.

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HAND PROTECTION

The harmful effects of liquids, undercoats, and finishes on the hands can be prevented by wearing work gloves.

Impervious gloves should be used when working with any chemical that can be harmful if exposed to your skin, such as solvents or two-part primers and topcoats. Chemical impervious gloves offer special protection from the materials found in two-component refinish or paint systems (Figure 2–23). These gloves can be different kinds for different reasons.

Latex gloves are used a lot in the collision industry. They do not offer as good of protection as nitrile gloves do. A lot of people can have an allergic reaction to latex, so these are not quite as recommended as other gloves now. Light-duty nitrile gloves are recommended for small general tasks. Medium-duty nitrile gloves should be used when working with chemicals solvents and adhesives and can also be reused. Neoprene gloves are designed to be used if you are dealing with any corrosive acids such as battery acids. These will protect your skin from the harmful acids and are also designed to be reusable as well.

NOTE *Some thin, inexpensive plastic gloves dissolve when exposed to certain chemicals. Make sure the gloves you are wearing are resistant to the solution you plan to handle. Material safety data sheets (MSDS) and product labels often give glove recommendations.*

Wear rubber or safety gloves to prevent chemical burns while handling paints and thinners. If any of these materials get on the skin, promptly wash the affected area with soap and water. Cleaners, some paints, refrigerants, and solvents can cause skin and eye burns. Make sure you wear long sleeves for complete protection (Figure 2–24).

DANGER

Chemical paint remover is very powerful. When using remover, exercise extreme caution and wear all recommended protective gear for your hands, body, face, eyes, and lungs.

FIGURE 2–23 When working with chemicals, take the time to slip on plastic or rubber gloves. Make sure the plastic gloves are a type that will not be dissolved by the chemicals you are using.

Courtesy of PPG Industries, Inc.

FIGURE 2–24 This technician wisely wears rubber gloves and long sleeves when mixing chemicals in the paint mixing room.

Thick, strong work gloves should be worn in the prep area to avoid cuts or abrasions. Sheet metal can cut your skin as easily as a knife, and if an air grinder easily cuts metal, it can do the same to flesh and bone. Always wear leather gloves, ear protection, and a full face shield when grinding.

Keep hands away from the moving parts of a running tool. Never clear chips or debris when a tool such as a drill or power saw is turned on. Stop the tool or use a brush to remove debris from the workpiece.

Stay away from engine fans, which have been compared to a "spinning knife." An engine fan can inflict serious cuts and major injuries. Parts or tools dropped into a running fan can fly out and hit a person with incredible force. Remember that electric engine fans can turn on even with the ignition key off!

Always remember to wash your hands thoroughly before leaving the shop area. This provides protection from ingesting any harmful elements that may have been touched. Wash your hands with a proper hand cleaner. At the end of a day's work, it is wise to oil or moisten your skin a little by applying a good skin conditioner or moisturizer.

Do not use paint thinner or reducer as a hand cleaner ever. Many chemicals can be absorbed into the skin, causing severe illnesses in your body later on.

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FOOT PROTECTION

It is best to wear *safety shoes* that have metal toe inserts and nonslip soles. The steel inserts protect the toes from falling objects; the soles help prevent falls. In addition, good work shoes provide arch support and comfort while standing and walking all day at work (Figure 2–25).

Never wear gym shoes, dress shoes, sandals, or any open toe shoes, which do not provide adequate protection in a body shop. It is easy to drop heavy tools and parts and break bones in your feet.

When working in the paint booth, many technicians wear disposable shoe covers. They help keep work shoes clean. In general, disposable garments (paint suits, shoe covers, and slip-on hoods) are becoming more common in the body shop.

Knee pads are good when you have to kneel on the floor while working (Figure 2–26). These will save the longevity of your knees over your lifetime. Many technicians do not use them and have health issues in their knees when they get older from being up and down on concrete all their life in shops. Take care of your body as often and as much as you can. There are no original replacement parts for your body.

FIGURE 2–25 Quality leather work shoes will protect your feet much better than tennis shoes. Many shops will not let their technicians wear tennis shoes, to avoid foot injuries from falling objects.

FIGURE 2–26 Knee pads are often worn when you have to kneel next to a vehicle being repaired. They are much softer than the concrete shop floor and will prevent knee injury over time.

BACK PROTECTION

It is very easy to injure your back when working in a body shop. Once your back is injured, recovery can take a long time (Figure 2–27). I cannot stress enough how important it is to take proper care of your back. Many technicians do not ask for help with lifting parts and risk developing back problems. Do not be that person. Ask for help with heavy objects and save your back.

Never overreach when working on a vehicle. Overreaching can easily injure your back. Maintain a balanced stance to help avoid slips and falls.

When you have to lean over a fender or panel, rest your arm or arms on the panel to avoid back strain. If you have to lean over while doing a repair operation, stand up and stretch now and then to avoid back spasms.

A *back support* is an elastic brace that wraps around your back and stomach to prevent injury to the lower spine. The back brace should be stretched tightly around your torso and secured with Velcro straps. The brace then lifts up on your chest cavity to remove body weight from your back. It also helps hold your spine in proper alignment while working. If you ever feel back pain, a back brace is a good investment.

Courtesy of Miller Electric Manufacturing Co.

FIGURE 2–27 When lifting and carrying heavy objects in the shop, stay balanced and keep your back straight to avoid strain.

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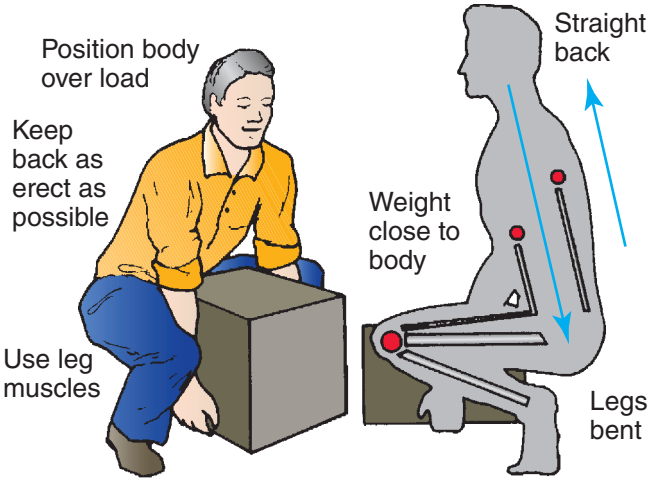

FIGURE 2–28 Study the proper way to lift objects to prevent back injury.

FIGURE 2–29 Know the location of all power shutoff switches in the shop in case of an emergency.

Lifting improperly can cause long-term back problems! When lifting and carrying objects, bend with the knees, not the back. Keep your back straight when picking up objects. Bending from the waist when lifting increases your risk for back injury (Figure 2–28).

Heavy objects should be lifted and moved with the proper equipment for the job (floor jack, roll-around cart, engine crane, forklift, and so on). There are many assemblies that are extremely heavy (doors, hoods, deck lids, front clips, transmissions, rear axles, transaxles). These heavy, and sometimes clumsy, parts or assemblies require equipment or the help of another technician during removal and installation.

2.3 GENERAL SHOP SAFETY PROCEDURES

In addition to personal safety, body/paint technicians must be aware of general shop safety procedures. This section outlines some of the rules and precautions that should be observed.

ELECTRICAL SAFETY

Electrocution results when a small amount of electric current passes through the human body. This can affect heart and brain functions, possibly causing death.

Disconnect electrical power supplies before performing any service on a machine or tool (Figure 2–29).

Keep all water off the floor. Water conducts electricity and presents a serious shock hazard if a live wire falls into a puddle in which a person is standing. Floors must be dry where electric power tools are used.

Make sure electric tools and equipment are properly grounded. If the third, round, ground prong on the tool cord is broken off, replace it before using the tool. Check for cracks in wiring insulation, as well as for bare wires.

To prevent serious injury, make sure the switch is off before plugging in any electric tool. When you are not using an electric tool, turn it off.

If an electrical breaker, machine, or piece of equipment is damaged or requires maintenance, always use a lockout/tagout (LOTO). This is a lock or a tag to keep the machine or the breaker from being used and to ensure someone does not get seriously injured until it can be serviced and/or repaired.

ENVIRONMENTAL SAFETY

Environmental safety includes those procedures that protect people and the Earth's resources (land, water, and air) from **toxic** chemicals. People working in body and/or paint shops are often exposed to dangerous levels of various gases, dusts, and vapors. Because of this exposure, control measures should be established for air contaminants and other hazardous substances.

Do not breathe contaminated air! Proper ventilation is very important in areas where caustics, degreasers, undercoats, sanding dust, and finishes are used. The vapors from thinners used in most paints have a narcotic effect, and long-term exposure can cause serious illness.

Ventilation can be provided by means of an air-changing system, extraction floors, or central dust extraction systems. These systems use large fans to pull contaminated air out of the paint booth or work area.

For the spray booth, adequate air replacement is necessary not only to promote evaporation and drying of paint materials, but also to remove harmful mists and vapors (Figure 2–30). Always remember to turn on the air exchange system when working in the paint booth or paint mixing room.

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