# Table of Contents

## Chapter 1: An Introduction to the IDEA Residential Sectional Door Systems Technician Certification
- Why is this all worth your time and energy? ........ 7
- A Brief History of Sectional Doors.................. 7
- Description of Sectional Doors..................... 8
- Overview of Industry Organizations............... 8
- IDEA Programs and Services ..................... 11

## Chapter 2: Understanding Codes and Standards
- Published Standards .................................. 13
- Building Codes ....................................... 13
- Licensing .............................................. 14
- Lead Renovation, Repair and Painting ............... 14
- Wind Load Requirements ............................. 15
- Garage Doors and High Wind Events ................. 18
  (DASMA TDS #152)
- Vertically Reinforcing Sectional Garage Doors..... 18
  for Wind Load Conditions (DASMA TDS #153)

## Chapter 3: Residential Sectional Door Construction
- Section Materials ................................... 20
- Wood Door Construction ............................ 21
- Door Style .......................................... 22
- Types of Door Sections ................................ 23
  - Pan Door Sections .................................. 23
  - Insulated Sandwich Door Sections ................. 23
  - Full Vision Sections ............................... 24
  - Wood Sections .................................... 24
- Section Joint Profiles ................................ 24
- Sectional Door Lites ................................ 25
  - Lite Construction .................................. 25
  - Lite Materials ..................................... 25
  - Coatings and Surface Treatments ................. 26
- Insulation ............................................ 28
- R-Value ............................................. 27
- K-Factor ............................................ 27
- U-Factor ............................................ 27
- Method of Determining Thermal Performance ...... 28
  - Expanded Polystyrene (EPS) ....................... 28
  - Polyurethane (PUR) .............................. 28
  - Flame Spread ..................................... 28
  - (Surface Burning Characteristics) ............... 28
- Smoke Developed ................................... 29
- Sound Transmission ................................ 29
- Air Infiltration ...................................... 29
- Thermal Bowing (DASMA TDS #185) ............... 29

## Chapter 4: Residential Sectional Door Components
- Hardware Components .............................. 32
  - Bottom Corner Brackets .......................... 32
  - Hinges ............................................. 32
  - Rollers ............................................ 33
  - Top Fixtures ...................................... 33
  - Low Lift Top Fixture .............................. 33
  - Operator Brackets ................................ 33
  - Locks ............................................ 34
  - Struts ............................................ 35
- Counterbalance Components ......................... 36
  - Torsion Shafts ................................... 36
- End Bearing Plates .................................. 36
- Center Bearing Brackets ............................ 37
- Shaft Bearings ..................................... 37
- Torsion Springs .................................... 37
- Cycles .............................................. 38
- Spring Cones ...................................... 39
- Cable Drums ....................................... 40
- The Relationship between Drums and Springs ... 41
- Cables .............................................. 41
- Extension Springs .................................. 42
- Track Components .................................. 44
  - Track Mounting .................................. 44
  - Vertical Track .................................... 44
  - Jamb Brackets .................................... 44
  - Horizontal Track .................................. 44
  - Horizontal Track Angle ........................... 45
- Flag Bracket ....................................... 45
- Headplate .......................................... 45
- Types of Residential Sectional Door Lifts ......... 46
  - Standard Lift Track ............................... 46
  - Low Lift Track (Low Headroom) .................. 47
- ANSI/DASMA 102 Standard – Specifications for Sectional Doors ... 48

## Chapter 5 Fundamentals of Residential Installation
- Quality .............................................. 53
- Productivity ........................................ 53
- Company Policies .................................... 54
  - Outline of a Company Policy ...................... 54
- Truck, Tools and Equipment ........................ 54
  - Power Tools and Equipment ....................... 54
  - Truck Inventory ................................... 55
- Recommended Tool List ................................ 55
- Truck Recommendations ............................ 55
- Installing a Residential Sectional Door .......... 56
  - Ordering the Door ................................ 56
  - Receiving the Door ................................ 56
  - Safety Awareness .................................. 57
  - Preliminary Safety Precautions .................... 57
  - Getting Started ................................... 58
  - Site Inspection .................................... 58
  - Removing an Existing Door ....................... 58
  - Installation Preparation ........................... 58
  - Assessing the Opening ............................. 59
  - Sizing the Opening ................................ 59
  - Headroom Requirements .......................... 59
  - Job Site Organization .............................. 60
  - Installation Technique ............................ 60
  - Installing the Hardware ........................... 61
  - Placing the Bottom Section ....................... 62
  - Installing the Vertical Track ....................... 62
  - Stacking the Intermediate Sections ............... 62
  - Install the Horizontal Tracks ...................... 63
  - Install the Top Section ............................ 63
  - Installing the Counterbalance Assembly ......... 63
  - Applying Spring Tension ........................... 64
  - Back Hang Installation ............................ 65
  - Test the Door for Proper Operation .............. 66
<table>
<thead>
<tr>
<th>Chapter 6 Methods of Operation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual Push-up Operation</td>
<td>69</td>
</tr>
<tr>
<td>Residential Electric Operators</td>
<td>69</td>
</tr>
<tr>
<td>External Obstruction or Anti-Entrapment Devices</td>
<td>69</td>
</tr>
<tr>
<td>Photoelectric Sensors</td>
<td>70</td>
</tr>
<tr>
<td>Edge Sensors</td>
<td>70</td>
</tr>
<tr>
<td>Radio (Remote) Controls</td>
<td>71</td>
</tr>
<tr>
<td>Types of Radio Controls</td>
<td>71</td>
</tr>
<tr>
<td>Digital Switch Sets</td>
<td>71</td>
</tr>
<tr>
<td>Keyless Entry Systems</td>
<td>72</td>
</tr>
<tr>
<td>Other Accessories</td>
<td>72</td>
</tr>
<tr>
<td>UL 325 Overview</td>
<td>73</td>
</tr>
<tr>
<td>Underwriters Laboratories</td>
<td>73</td>
</tr>
<tr>
<td>UL 325 History</td>
<td>73</td>
</tr>
<tr>
<td>Standards Development</td>
<td>73</td>
</tr>
<tr>
<td>UL 325 Standard – Layout</td>
<td>74</td>
</tr>
<tr>
<td>Impact</td>
<td>74</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 7 Installation of Residential Operators</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Important Safety Precautions for</td>
<td>75</td>
</tr>
<tr>
<td>Electric Operators</td>
<td>75</td>
</tr>
<tr>
<td>Chain-Drive Garage Door Operators</td>
<td>76</td>
</tr>
<tr>
<td>Attach Rail to Operator</td>
<td>76</td>
</tr>
<tr>
<td>Attach Chain to Sprocket</td>
<td>76</td>
</tr>
<tr>
<td>Adjust Chain Tension</td>
<td>76</td>
</tr>
<tr>
<td>Header Bracket Location</td>
<td>77</td>
</tr>
<tr>
<td>Installing the Header Bracket</td>
<td>77</td>
</tr>
<tr>
<td>Connecting Rail to Header Bracket</td>
<td>77</td>
</tr>
<tr>
<td>Positioning Operator</td>
<td>77</td>
</tr>
<tr>
<td>Hanging the Operator</td>
<td>78</td>
</tr>
<tr>
<td>Installing the Pushbutton</td>
<td>78</td>
</tr>
<tr>
<td>Installing the Light Bulb(s) and</td>
<td>79</td>
</tr>
<tr>
<td>Lens Cover</td>
<td>79</td>
</tr>
<tr>
<td>Release Handle</td>
<td>79</td>
</tr>
<tr>
<td>Installing Photo-Eyes</td>
<td>79</td>
</tr>
<tr>
<td>Wiring Photo-Eyes</td>
<td>80</td>
</tr>
<tr>
<td>Operator Bracket and Door Arm</td>
<td>80</td>
</tr>
<tr>
<td>Installation</td>
<td>80</td>
</tr>
<tr>
<td>Connecting Operator to Power Source</td>
<td>80</td>
</tr>
<tr>
<td>Cord and Outlet Connection</td>
<td>80</td>
</tr>
<tr>
<td>Permanent Wiring</td>
<td>80</td>
</tr>
<tr>
<td>Aligning Photo-Eyes</td>
<td>81</td>
</tr>
<tr>
<td>Setting Limits</td>
<td>81</td>
</tr>
<tr>
<td>Programming and Testing the</td>
<td>81</td>
</tr>
<tr>
<td>Radio Controls</td>
<td>82</td>
</tr>
<tr>
<td>Force Adjustment</td>
<td>82</td>
</tr>
<tr>
<td>Reversal Test</td>
<td>82</td>
</tr>
<tr>
<td>Using the Garage Door Opener</td>
<td>82</td>
</tr>
<tr>
<td>Opening the Door</td>
<td>82</td>
</tr>
<tr>
<td>Closing the Door</td>
<td>82</td>
</tr>
<tr>
<td>Stopping Door Mid-Travel</td>
<td>82</td>
</tr>
<tr>
<td>Manual Operation</td>
<td>82</td>
</tr>
<tr>
<td>Optional Wall Station Features</td>
<td>83</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 8 One Piece Doors</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Types of One Piece Hardware</td>
<td>84</td>
</tr>
<tr>
<td>Jamb Type</td>
<td>84</td>
</tr>
<tr>
<td>Jamb Type with Track</td>
<td>84</td>
</tr>
<tr>
<td>Major Components of One Piece Doors –</td>
<td>85</td>
</tr>
<tr>
<td>Jamb Type</td>
<td>85</td>
</tr>
<tr>
<td>Major Components of One Piece Doors –</td>
<td>86</td>
</tr>
<tr>
<td>Jamb Type with Track</td>
<td>86</td>
</tr>
<tr>
<td>Maximum Door Weights and Sizes</td>
<td>87</td>
</tr>
<tr>
<td>Light Duty Jamb Type</td>
<td>87</td>
</tr>
<tr>
<td>Medium Duty Jamb Type</td>
<td>87</td>
</tr>
<tr>
<td>Heavy Duty Jamb Type</td>
<td>87</td>
</tr>
<tr>
<td>Jamb Type for Special Applications</td>
<td>87</td>
</tr>
<tr>
<td>Jamb Type with Track</td>
<td>87</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 9 Residential Door Service and Repair</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>91</td>
</tr>
<tr>
<td>Safety Checklist</td>
<td>91</td>
</tr>
<tr>
<td>Counterbalance Assembly</td>
<td>91</td>
</tr>
<tr>
<td>Track Assembly</td>
<td>92</td>
</tr>
<tr>
<td>Servicing a Sectional Door</td>
<td>93</td>
</tr>
<tr>
<td>Rollers</td>
<td>93</td>
</tr>
<tr>
<td>Hinges</td>
<td>93</td>
</tr>
<tr>
<td>Cables</td>
<td>93</td>
</tr>
<tr>
<td>Sections</td>
<td>93</td>
</tr>
<tr>
<td>Track</td>
<td>93</td>
</tr>
<tr>
<td>Counterbalance</td>
<td>94</td>
</tr>
<tr>
<td>Customer Relations</td>
<td>94</td>
</tr>
<tr>
<td>Service Techniques</td>
<td>95</td>
</tr>
<tr>
<td>Changing a Tension Spring</td>
<td>95</td>
</tr>
<tr>
<td>Changing Extension Springs</td>
<td>96</td>
</tr>
<tr>
<td>Resetting and Changing Cables</td>
<td>97</td>
</tr>
<tr>
<td>Changing and Reinstalling Rollers</td>
<td>98</td>
</tr>
<tr>
<td>Replacing Track</td>
<td>98</td>
</tr>
<tr>
<td>Replacing Sections</td>
<td>98</td>
</tr>
<tr>
<td>Conclusion</td>
<td>99</td>
</tr>
<tr>
<td>Measuring Springs</td>
<td>100</td>
</tr>
<tr>
<td>Wire Size</td>
<td>100</td>
</tr>
<tr>
<td>Spring Length</td>
<td>101</td>
</tr>
<tr>
<td>Inside Diameter</td>
<td>101</td>
</tr>
<tr>
<td>Determining the Hand of a Spring</td>
<td>102</td>
</tr>
<tr>
<td>Safe Operation of Sectional Doors</td>
<td>103</td>
</tr>
<tr>
<td>Troubleshooting Residential Sectional Doors</td>
<td>105</td>
</tr>
<tr>
<td>Troubleshooting Residential Sectional Door</td>
<td>106</td>
</tr>
<tr>
<td>Operators</td>
<td>106</td>
</tr>
</tbody>
</table>
# Table of Contents (CONTINUED)

**Chapter 10 The Importance of Safety**
- Introduction ........................................... 107
- Safety and the Company .......................... 107
- Safety and the Certified Door Technician ... 111
- Personal Safety ....................................... 111
- Tools and Equipment ............................... 112
- Safe Driving .......................................... 112
- Safety at the Worksite ............................. 112
- Organizations and Federal Guidelines ........ 113
- Hazard Assessment ................................... 113
- Eliminating and Controlling Hazards ............. 114
- Introduction to OSHA ............................... 117
- General Types of OSHA Standards ............... 117
- Non-Compliance is NOT an Option ............... 118
- Recordkeeping and Documentation ............... 119
- Shop and Jobsite Inspections ..................... 119

**Chapter 11 Basic Math**
- Introduction .......................................... 123
- Addition of Whole Numbers ....................... 124
- Subtraction of Whole numbers .................... 125
- Multiplication of Whole Numbers ............... 126
- Division of Whole numbers ....................... 129
- Fractions ............................................. 130
- Decimals ............................................. 131
- Percentages .......................................... 134
- Answers to Math Practice Problems ............. 134

**Chapter 12 Glossary of Terms** ................................ 136

**Chapter 13 DASMA Standards and** ................................ 155

**Technical Data Sheets**
Chapter One

An Introduction to The IDEA Residential Sectional Door Systems Technician Certification

This study guide has been created by the Institute of Door Dealer Education and Accreditation as part of its goal to establish the door systems industry as a profession, and to recognize the skilled individuals who work within the industry as professional technicians. This is the fundamental objective of the IDEA Residential Sectional Overhead Door Systems Technician Certification program, and all other professional designation courses offered by IDEA.

Although it is intended that all applicants for certification will learn some valuable new concepts in studying the curriculum, it is essential that each applicant begin the process with a broad base of knowledge and experience in the installation and service of residential sectional door products and accessories.

Why is all this worth your time and energy?

A professional can be defined as one possessing a high degree of skill or expertise. Individuals trained and experienced in installing, servicing or repairing residential sectional doors, operators and accessories meet that definition. Most people engaged in the door systems industry on a full-time basis would agree that they should be viewed as professionals. However, it is just as important that end-users and the general public share in that view.

Professionalism goes beyond the pure technical knowledge of an industry’s practitioners. Professionals bring additional qualities to the industry: customer relations, safe work practices, leadership among colleagues, communication skills, and a comprehensive understanding of the industry and the organizations that support it.

A Brief History of Sectional Doors

The upward-acting sectional garage door was invented by C.J. Johnson in 1921. Before this, larger residential door openings were often covered by large swinging doors on hinges from a side jamb. With Johnson’s invention, the door and counterbalance system could be stored between the top of the opening and the garage ceiling. The one-piece door also joined the sectional door as an alternative to the side-swinging door.

As these door systems gained popularity, door designs advanced into the early version of the garage door industry we know today using doors primarily constructed of wood. In the 1950’s and ‘60’s, new materials such as fiberglass, aluminum, and steel entered the market for commercial and residential sectional garage door applications. Due to its ease to
operate and conform to more opening sizes, the sectional door has become the dominant type of door over the years.

Around 1978, the first steel raised-panel door revolutionized the appearance and durability of garage doors. This was followed a few years later by the insulated sandwich door. Both of these styles still occupy a large part of the market today.

As the industry moved forward with new styles of steel doors, the carriage house look made its debut in the new millennium and an explosion of designs, colors, and finishes has expanded to this day. Track configurations such as high lift and vertical lift, once seen only in commercial applications, have become common in today’s larger homes with tall garage ceilings.

**Description of Sectional Doors**

As the name implies, a sectional door consists of a series of sections connected by hinges. The sections are connected in such a manner that the door can open and close easily, yet provide a tight barrier against wind and rain when closed.

Although the description of a sectional door might appear obvious, there are other specialized components that require a high degree of expertise when installing and servicing sectional doors. In addition to sections and hinges, the door parts include rollers, track, counterbalance and weather seal.

When the hardware is attached to the door, and the tracks and counterbalance system are installed, the final product is a complete upward acting sectional door. Sectional doors can be operated manually or automatically using a variety of automatic control systems.

**Overview of Industry Organizations**

**Door & Access Systems Manufacturers’ Association (DASMA)** is North America’s leading trade association of manufacturers of garage doors, rolling doors, high performance doors, garage door operators, vehicular gate operators and access control products. Formed in 1996, DASMA member companies manufacture products sold in the United States, Canada and more than 70 other countries worldwide. DASMA members produce more than 95 percent of the U.S. market for the door and access systems industry.

**International Door Association** (IDA), the industry’s authoritative voice to dealers, was formed in 1995 with the consolidation of the Door & Operator Dealers Association and the Far West Garage Door Association. IDA is the industry network for professional door and operator dealers and installers, along with their suppliers. While IDA represents the entire door and operator industry by promoting the use of professional dealers and installers, it is a membership driven association, relying on the input and feedback of its members to create and deliver programs of value.

**IDA Affiliate Organizations**

The International Door Association maintains an alliance with other door systems industry organizations, known as IDA Affiliates. These organizations are independent associations involved in a variety of educational, training and social activities. Many companies maintain membership in more than one of these associations, as well as with IDA. Each group has its own board of directors and annual activities plan.
The IDA Affiliates are:

- Australian Garage Door Association
- California Operator and Door Association
- Canadian Door Institute
- Central States Door Dealers Association (U. S. Midwest)
- Florida Operator and Door Association
- Garage Door Association of Arizona
- Indiana Garage Door and Operator Association
- Michigan Door and Operator Dealers Association
- Northeast Garage Door Association
- Northwest Door & Operator Association (Pacific Northwest)
- Professional Door Association of New England

**Institute of Door Dealer Education and Accreditation (IDEA):** A non-profit educational foundation established by ARDI, DASMA and IDA to provide professional door, gate and operator dealers with the knowledge and skills required to be competitive in today’s rapidly changing business environment. IDEA’s goals are to provide the educational resources necessary to develop and maintain a successful business, and to validate and accredit those door and operator dealers whose standards can meet IDEA’s demanding criteria of business excellence. ARDI and DASMA have since merged, leaving IDA and DASMA as the sponsoring organizations of IDEA.

Institute of Door Dealer Education and Accreditation
28 Lowry Drive
West Milton, OH  45383
Tel: (937) 698-1027
www.dooreducation.com

**American National Standards Institute (ANSI):**
A private, non-profit organization that oversees the development of voluntary consensus standards for products, services, processes, systems and personnel in the United States. ANSI also coordinates U. S. standards with international standards so that American products can be used worldwide. The organization facilitates the development of American National Standards by accrediting the procedures for organizations who work cooperatively to develop voluntary national consensus standards.

**Occupational Safety and Health Administration (OSHA):**
Created by the Occupational Safety and Health Act of 1970, OSHA promulgates and enforces safety and health standards in the workplace, and provides consultative services to businesses. OSHA regulations impact virtually every job site in America.

**Underwriters Laboratories ® (UL):**
An independent product safety certification organization, UL tests products and writes standards for safety. UL tests more than 19,000 types of products, components, materials and systems each year. UL is an important organization to the door and access systems industry, due to UL 325 – Standard for Door, Drapery, Gate, Louvre, and Window Operator Systems, which sets forth safety performance requirements for door and gate operator systems.

**National Fire Protection Association (NFPA):**
A non-profit organization founded in 1896, AFA’s mission is to reduce the worldwide burden of fire and other hazards on the quality of life, by providing and advocating consensus codes and standards, research, training and education. NFPA is the world’s leading advocate for fire prevention and an authoritative source on public safety. This organization is important to the fire door industry due to NFPA-80, Standard for Fire Doors and Other Opening Protectives. NFPA-80 regulates the installation and maintenance of door systems used to protect openings in walls, floors and ceilings against the spread of fire and smoke.

**American Fence Association (AFA):**
A trade association representing the fence, deck and railing industries in the United States and Canada. Founded in 1962, AFA, with its 31 member chapters, offer educational and certification programs, along with networking opportunities. AFA played the major role in developing the curriculum on which the IDEA Automated Gate Operator Installer Certification program is based, and continues to play a role in the maintenance and periodic updates of the curriculum. AFA and its chapters also host certification testing opportunities for automated gate operator installers.
Consumer Product Safety Commission (CPSC): A federal agency charged with protecting the public from unreasonable risks of serious injury or death from thousands of types of consumer products under the agency’s jurisdiction. The CPSC is committed to protecting consumers from products that pose a fire, electrical, chemical or mechanical hazard or can injure children. The CPSC’s work to ensure the safety of consumer products includes door and access systems.

FM Approvals: An enterprise of FM Global, provides independent third-party certification of products for manufacturers. FM Approvals tests property loss prevention products and certifies those that meet rigorous loss prevention standards.

International Building Code (IBC): A model building code developed by the International Code Council (ICC), the International Building Code has been adopted throughout most of the United States. A large portion of the IBC deals with fire prevention. It addresses fire prevention in regard to construction and design and fire prevention in regard to the operation of a completed and occupied building. The IBC applies to all structures in areas where it has been adopted, except in one and two family dwellings.

Canadian Standards Association (CSA): A not-for-profit membership-based association serving business, industry, government and consumers. The organization develops standards that address needs such as enhancing public safety and health, advancing the quality of life, helping to preserve the environment and facilitating trade. CSA functions as a neutral third party in testing products and developing consensus standards.

Underwriters Laboratories of Canada (ULC): An independent product safety testing, certification and inspection organization. ULC supports governmental product safety regulations and complements federal, provincial and municipal public safety initiatives. ULC also works with other government and international safety systems to help further international trade. ULC is now merged with UL.

Warnock Hersey: A division of Intertek, provides independent third-party certification of product safety and performance for building and construction products. Warnock Hersey tests and certifies products to indicate compliance to relevant building codes, association criteria, and product safety and performance standards. Warnock-Hersey is a common listing agency for Fire Doors and Fire Rated Countertops.

Texas Department of Insurance (TDI): An agency which regulates the state of Texas insurance industry and issues product evaluations for garage door windload performance for use in the state of Texas.


Miami-Dade County Product Control Division: An internationally recognized government agency which provides product approvals through the issuance of a Notice of Acceptance (NOA) indicating building code compliance for windload and other products used in Miami-Dade and surrounding counties of Florida.

United States Environmental Protection Agency (EPA): A US federal government agency created for the purpose of protecting human health and the environment. Most noted in the garage door industry for its regulations for Lead Renovation, Repair and Painting (RPP).
IDEA Programs and Services

IDEA was created in 1995 as an independent credentialing and educational institute by a coalition of industry groups following more than a decade of discussions and negotiations on how to advance door and access systems dealers as members of a professional industry.

The Door & Access Systems Manufacturers Association (DASMA), the International Door Association (IDA) and the American Rolling Door Institute (ARDI) agreed to establish IDEA as an independent entity in which the three organizations would share through the allocation of directorships. The two manufacturer's organizations would hold six seats on the newly created Institute’s board of directors, matched by six seats held by IDA. (In 2006, ARDI merged with DASMA, leaving the 6-6 share of IDEA leadership positions equally divided between IDA and DASMA.)

Dealer Accreditation was the first professional recognition credentialing program launched by the new organization. The first accreditation examinations were offered at the 1997 International Garage Door Exposition in Nashville, Tennessee. Since that time, IDEA has created a series of programs designed to help dealers train new installers, develop professionals in the field and create career paths for technicians.

The accreditation curriculum consists of six parts:

- Accounting and General Business Principles
- Insurance and Legal
- Safety and Health Compliance/Loss Control Management
- Technical Basics – Residential
- Technical Basics – Commercial
- Sales and Marketing Management

Dealers must pass a written examination for each section. At least one person within each applicant company must pass all six of the examinations. The reason for this policy is to expose accreditation applicants to all phases of business management. Although there are more issues involved in managing a successful door company, these six fields of study generally represent a broad spectrum of business management for door dealers.

In 2001, the IDEA Train-the-Trainer program was launched. Since that time, the one-day course which teaches experienced installers to train other employees and coworkers has had a significant impact on a dealer’s ability to recruit and train new workers, as well as develop company-wide training programs to improve overall productivity and increase awareness of the industry at all levels within a company. The Train-the-Trainer program teaches training skills, evaluation techniques, communication methods and other qualities that are as important to the educational process as knowing how to install and service a door system. IDEA created the Train-the-Trainer program in recognition of the fact that dealers train on-the-job, with few exceptions. The Train-the-Trainer program was designed to create a network of experienced and skilled trainers.

Since the establishment of the Dealer Accreditation program, IDEA has been actively producing a variety of educational programming for dealers, and has developed five installer/technician certification programs.

- Residential Installer Certification (2002)
- Rolling Steel Fire Door Certification (2004)
- Commercial Rolling Door Systems Technician Certification (2007)
- Automated Gate Operator Installer Certification (2008)
- Certified Door Dealer Consultant (2011)
While Dealer Accreditation is awarded to companies, certification credentials are issued to individuals. The intent is to build a professional community of dealers and technicians that will aid the general public when seeking these products and services. This is a market-driven effort, with no federal, state or local requirements that companies or technicians hold the credentials in order to sell or install the products. However, as a form of voluntary self-regulation, credentials are important to consumers. The door and access systems industry produces products that are essential components in home and property security and safety. The industry has recognized that to provide the highest level of safety and security, the products must be installed, maintain and serviced properly.

IDEA also recognizes Automated Access Systems Master Technicians. These are technicians who have achieved certification in all four of the door related certification programs; Residential Installer Certification, Rolling Steel Fire Door Certification, Commercial Sectional Door Systems Technician Certification, and Commercial Rolling Door Systems Technician Certification.

One additional, but very critical, aspect of IDEA is Education. IDEA is responsible for creating the professional development seminars at each International Garage Door Exposition. Since being given that task, and focusing hundreds of hours each year in time and energy formulating a workshop schedule that will meet the most pressing needs of the industry from year to year, attendance at educational seminars at the International Garage Door Expo has increased tremendously. Door dealers today crave information. They recognize the importance of staying on top of industry changes and knowing what's going on in the market place.
Chapter Two
Understanding Codes And Standards
There are basic aspects associated with residential sectional doors that require installers to have an understanding of codes and standards. Compliance with existing standards is essential to professional installation, but having the ability to explain codes and standards to customers is evidence of a high level of experience, and grants additional credibility to the professional and the company.

Published Standards
Published standards applicable to residential sectional doors are referenced in various building codes. Usually, these codes also contain additional applicable provisions. Historically, there have been a number of “model” building codes and code agencies throughout the United States.

Building Codes
Published standards applicable to residential sectional doors are referenced in various building codes. Usually, these codes also contain additional applicable provisions. Historically, there have been a number of “model” building codes and code agencies throughout the United States.

These model building codes may be adopted at the state level with or without state amendments and may even be adopted at the municipal level with or without local amendments. Larger cities and counties may even write their own building codes. The two most prominent “model” building codes are the International Building Code (IBC), issued by the International Code Council (ICC), and NFPA 5000, Building Construction and Safety Code, issued by NFPA. The ICC model codes are those predominantly adopted throughout the U.S. The ICC represents – as of January 1, 2000 – a merging of three code agencies:

- Building Officials & Code Administrators (BOCA), historically a Northeastern United States influence, which formerly published the National Building Code (NBC).
- Southern Building Code Congress International (SBCCI), historically a Southeastern United States influence, which formerly published the Standard Building Code (SBC).
- International Conference of Building Officials (ICBO), historically a Western United States influence, which formerly published the Uniform Building Code (UBC).

In addition, DASMA is an approved standards development organization accredited by the American National Standards Institute (ANSI). DASMA has published a number of voluntary standards relating to residential sectional doors and operators. Various DASMA standards are approved and still others are undergoing the ANSI recognition process and will be published with the ANSI/DASMA designation upon final ANSI approval.
These three former model codes are no longer enforced.

One of the best things a professional door technician can do is verify the code that is in place in the community where the door is being installed. Remember that even neighboring communities may have differing codes.

Local building codes and officials are only one example of entities which may impose requirements on residential sectional doors. Often times, architects, insurance underwriters, risk management individuals, etc. can impose requirements above and beyond those required by the local building codes. It is imperative to determine these requirements well in advance of ordering the door to ensure the door meets the performance specifications.

**Licensing**

Some states and local areas may require a specific license to install or service residential sectional doors and/or some portions of a door system. Many regions do not allow contractors to perform work without becoming licensed. To become licensed, it is typically required for a business to submit an application, demonstrate a number of years of experience, and to pass a series of exams which can range in topics such as construction, business, law, contracts, and contractor level information. These exams are rarely particular to sectional doors, but rather usually over general construction practices and business operation. It is often required by law to advertise your license number and list it on contracts and quotations. Violating licensing laws in areas which require them can result in penalties of fines, forfeiture, and imprisonment. Research the licensing requirements in the areas where you do work to ensure your company is compliant.

**Lead Renovation, Repair and Painting**

In April 2008, the Environmental Protection Agency’s Lead Renovation, Repair and Painting (RRP) rule went into effect. The RRP rule requires that any home or child occupied facility built before 1978 follow certain rules regarding lead paint if they disturb 20 square feet exterior or 6 square feet interior of lead paint. The RRP Rule requires two separate certifications and specific training for those involved on the job site.

The first certification is for the firm or dealer contracted to do the work. The company must register with the Environmental Protection Agency. Upon approval the dealer will have certain responsibilities. They must assign a certified renovator to each job it performs. They must use only certified or properly trained workers to perform the renovations. Most importantly, they must follow record keeping requirements and work place standards in the regulation. This certification is good for 5 years.

The second certification is for the individual or individuals performing the work. They must become a Certified Renovator by completing an 8 hour class and passing a written exam as well as a practical test. This certification is good for 5 years. The Certified Renovator is responsible for training all of the non-certified workers that will be doing the actual work. The Certified Renovator must post signs before starting any work and set up the containment area. They are responsible for making sure all other workers are following lead-safe work practices and they are also responsible for maintaining records of compliance throughout the duration of the job. Once the job is completed they are responsible for the work area being cleaned and must perform a cleaning verification.
The following states have developed their own RRP programs which may have different requirements; AL, DE, GA, IA, KS, MA, MS, NC, OK, OR, RI, UT, WA, and WI. Verify the specific RRP requirements in your area.

The International Door Association (IDA) has compiled the following additional information and documents on their website to help dealers and technicians with RRP compliance:

- EPA’s Lead Program Rule At-A-Glance
- RRP Project Checklist
- Important Definitions
- Recording of Initial Training for Non-Certified Worker
- Lead Hazard Information Pamphlet Occupant Receipt Confirmation
- Renovator’s Self-Certification Option
- Determining Whether EPA RRP Requirements Apply to the Renovation
- Record of Tenant Notification Procedures
- Notice and Authorization for Lead-Based Paint Testing
- Test Kit Documentation Form
- Renovation Notice for Renovations of Common Areas of Multi-Family Housing
- Warning Lead Work Area Sign
- Post-Renovation Cleaning Verification
- Renovation Recordkeeping Checklist

Wind Load Requirements

Wind is the organized translation of large amounts of air at one time. It can shape landforms, transport dirt and debris miles away, uproot trees, and damage buildings. From a windy day, to tornadoes and hurricanes, Mother Nature can produce unexpected high winds virtually anywhere in the world. This section aims to give a technician a general understanding of wind loads and garage doors.

Studies of damage to buildings as a result of hurricanes found that one common cause of catastrophic building failure was a pressure buildup within the building. Much like inflating a balloon until it pops. Researchers found that the cause of this pressure buildup was a breach somewhere in the exterior envelope of the building which allowed high winds to enter. With nowhere to exit, these high winds cause an increase in pressure that eventually can blow out windows, walls, or even blow off roofs.

A sectional door is significant in a building’s ability to withstand high winds because it often closes the largest opening(s) on a building. An open sectional door, or one which fails during high winds, can create a very large breach in the outer envelope. This opening can allow large amounts of wind to enter at once and rapidly increase the internal pressure until the building fails. This is just one reason why it is important for sectional doors to carry the wind load rating for the location it will be installed.

Winds are often measured by their speeds. Meteorologists use a measuring instrument called an anemometer to measure the wind speed and often report the speed of the peak gusts during a given wind event. The smoother the terrain, the faster the wind speeds can become. Similarly, the more obstructions the wind encounters, the less speed can develop. Required wind load ratings are typically higher in areas near the coast of a
large body of water, where there are no obstructions, than in urban areas where numerous closely spaced obstructions are present.

In terms of wind speed it is important to understand the units of wind are different whether you talk to a meteorologist or an engineer. The unit of wind speed used by the media to discuss weather (especially when identifying Hurricane Categories) is the one-minute sustained wind speed, vs. the building codes, that use 3-second peak gust. The difference is that the building code units are approximately 15mph higher for the three second-peak gusts. In building design, it is helpful to gauge wind in terms of the load it exerts on objects it encounters, such as sectional doors. Because of this, required wind load ratings are often specified in psf, or pounds per square foot. This is the amount of force exerted by the wind in each square foot of exposed area. Conversion of wind speed to psf can be a complex calculation and different methods are used from one building code to the next. DASMA has published a series of Technical Data Sheets (TDSs) which help to clarify the conversion of wind speed to psf as well as the wind load requirements of various building codes.

Winds can impart forces on a sectional door, and building, in two different directions. The first is called Positive wind load. In the positive direction, winds hit the door directly and attempt to blow the door into the building, similar to the sail on a sailboat. The second direction is called Negative wind load. Typically caused by crosswinds on the side of the building and turbulent suction on the trailing end of the building. Negative wind loading attempts to suck the door outward. Both loading directions must be accounted for in the door design to ensure proper performance.

Another wind load related performance requirement in some areas is for Impact resistance. High wind events can involve flying debris which can crash into a garage door. These impacts can cause damage to the door
which lessens its wind load resistance, particularly if windows are involved. Impact rated doors have undergone special testing to ensure the wind load performance is maintained after several impacts. The testing involves firing a 2x4 out of a cannon at 34 miles per hour and impacting numerous key areas of the door. To pass this testing, the impact cannot result in a hole in the door exceeding the allowable limits. In addition, the door must then endure prescribed cyclic wind load testing to ensure the wind load resistance has not been compromised.

Impact rating is most commonly required in hurricane prone regions near the coast, but can be required outside of this region. According to the International Building Code, the wind-borne debris region is where glazing is required to be impact rated. Increasing requirements for impact resistance have most recently been driven in part by the insurance industry in an effort to reduce the amount of water damage caused by impact penetration of the outside envelope of the building.

There are typically two classifications for sectional doors with respect to wind protection. The first is wind load rated products that are designed to meet a specific pressure rating. These doors have pressure ratings in both the positive and negative direction. The second, in addition to an assembly being rated for pressure, it is design evaluated to meet the enhanced protection standards that require the complete door assembly to have been evaluated for impact-resistance, including the glazing if the door has glass. For most of the US, the doors must be designed in accordance with the International Building Code, but for some parts of the U.S. it is required that the doors have approvals from certain approval agencies. Examples of these include: Florida Product Approval - required for all doors installed in Florida, Miami-Dade Notice of Acceptance - required for Dade and Broward counties in Florida, and Texas Department of Insurance Wind Storm Inspection - required for areas along the Texas coast that need wind storm inspections. No matter which level of protection that the job requires, it is critical that only the components listed on the wind load design drawing are utilized and no components are being substituted unless obtaining approval from the manufacturer.

When ordering a door, it is critical to check with the building specifications, as well as the local authority having jurisdiction, to ensure that a product is ordered that will be in compliance with the wind load requirements. As mentioned previously, DASMA has published a number of Technical Data Sheets (TDSs) that can help determine the required wind load ratings in your area.

Specification of higher wind loads for residential sectional doors can result in many product changes which may not be obvious to the untrained eye. It is important to understand the implications of specifying higher wind loads because these changes can increase the cost of the door. First, additional and/or larger/thicker struts may be added to the door. The sections may be built utilizing thicker steels and may require special backup plates within the sections and the hardware may interface differently to handle the added hinge loads. Additional jamb brackets and thicker gauge track may be required. Many of these items of course cause the balance weight to go up which could result in requiring bigger springs. Some doors vertical reinforcement systems which require the user to install post(s) across the opening when a high wind event is expected. It may not be possible to convert a door to handle higher wind loads in the field if the door was not ordered with the proper rating.
Garage Doors and High Wind Events  
(DASMA TDS #152)

Garage doors are typically in the largest openings associated with building structures. There are several items that should be kept in mind regarding a garage door’s wind load performance in high wind events accounted for in building codes.

1) A garage door is subject to either being blown into the garage or pulled out of the opening. Therefore, backing a vehicle against a garage door is not recommended. Further, this may damage the vehicle. The appropriate protection is provided with a garage door that is wind resistant to local requirements.

2) A garage door should be closed prior to a high wind event. The door should be wind resistant to local requirements. Keeping a garage door open during a hurricane leaves the interior walls, ceilings and roof structure vulnerable to structural damage and possible collapse of the structure.

3) DASMA does not recommend the operation of garage doors, grade level or loading dock, during high wind events. The increased operational force needed to manually open or close the door may cause injury to personnel.

4) Adding weight, particularly non-manufacturer-specified reinforcement, to a door can create a dangerous situation that may result in property damage and/or personal injury. Owners should avoid adding reinforcement to a garage door themselves. This will increase the weight of the door and may result in failure or collapse of the supporting tracks or other components that may not be suitable to carry the extra weight. Upgrading garage doors by adding reinforcement must be performed as a package that includes appropriate springs and hardware and supporting track. Contact a trained door systems technician regarding this matter. In addition, please refer to DASMA Technical Data Sheet #153 for guidance concerning vertically reinforcing sectional garage doors.

5) There are some coastal areas that are subject to storm surges where it is more important that the door “break away” from the structure rather than resist wind load. Contact your local building department if the structure in question may be included in this requirement.

6) If you question your garage door’s ability to resist high winds, contact a design professional to evaluate both the door and the surrounding frame of the opening. Keep in mind that the attachment of both the door track, and the door jamb to the structure, are just as critical as the strength of the door itself.

Vertically Reinforcing Sectional Garage Doors for Wind Load Conditions  
(DASMA TDS #153)

Introduction

According to individual manufacturers’ requirements, the panels of a sectional garage door may require horizontal reinforcement to minimize the deflection of the door when in the fully open position. Horizontal reinforcement may also be needed to reinforce the top section of the door for use with a trolley/drawbar type operator. This reinforcement may not be sufficient to resist the structural requirements of wind loads when the door is in the fully closed position. One alternative to adding additional horizontal structural members to the door for resisting wind loads is the vertical post concept.

Common Vertical Post Concept Options

Common scenarios of the vertical post concept include:

1. A post system integrated into the door design. Here the homeowner is required to secure the post in accordance with the
manufacturer's instruction, usually by some mechanical means such as the turning of a crank or movement of a lever.

2. **A post system supplied with the door by the manufacturer.** The door manufacturer supplies the homeowner with instructions, and the homeowner must secure the post by an established assembly procedure.

3. **A post system that a homeowner may purchase as an aftermarket product.** Homeowners should also fully investigate whether or not the existing garage door is acceptable per the reinforcement system manufacturer's requirements, and should ensure that the reinforcement system is installed per the manufacturer's instructions. Homeowners are encouraged to contact the garage door manufacturer if they have any question regarding whether the warranty of the existing garage door may be affected.

### Compliance with Relevant Standards

Doors using vertical reinforcement posts as a component of a new door system should comply with industry standards such as ANSI/DASMA 102. This standard contains specifications for garage doors. Doors using posts should have been tested in accordance with a nationally recognized uniform static air pressure testing standard and meet the acceptance criteria. DASMA has published ANSI/DASMA 108, which contains a uniform static air pressure testing method and acceptance criteria relevant to garage doors.

### Support from Existing Building Structure

Vertical posts transmit wind load forces to the garage door-opening header and to the garage floor. A design professional should perform an assessment of the building structure prior to the installation of any vertical post reinforcement. It is strongly advised that either the garage door manufacturer or a trained garage door service technician be contacted in regard to any questions or concerns related to sectional garage doors and vertical reinforcement.

### Homeowner Responsibility

In all cases the homeowner must accept responsibility for properly securing the vertical post in position in anticipation of a hurricane or other high wind event. For retrofitted doors, the door installer should explain the installation instructions. For new construction, the building contractor should explain these instructions.

### Building Department Involvement

If a building inspector is required to inspect a vertically reinforced door, as part of a door permitting process, such reinforcement should be installed and fully engaged at the time of the inspection.

### Labeling

Manufacturers may also choose to create labels. One label could be a general instructions-oriented label advising that the post system be installed/engaged when hurricane or other high wind warnings are issued. Another label could contain product-specific instructions for preparing the garage door and for installing/engaging the post system.

### Conclusion

Homeowner education is the key to successful use of vertical reinforcement for sectional garage doors to resist high winds. Effective education should result in the use of such reinforcement being no different than homeowners securing doors and windows during such events. Any questions about specific products should be directed to the post manufacturer.
Chapter Three

Residential Sectional Door Construction

There are many different styles of homes for residential sectional doors. Each garage has its own requirements for the aesthetics and performance characteristics of the door. Because of this, the residential sectional door has evolved with many different types of door styles, construction, available finishes, and materials.

The core defining feature of a sectional door is the section. Sections are the garage door component that extends the full width of an opening, usually joined together by hinges. Multiple sections stacked upon one another makes up the face of the door. Generally speaking, door sections are numbered from #1 at the bottom, continuing with section #2, #3 and so on until reaching the top section. Depending on the door height, the section sizes can vary from 18 inches up to 32 inches tall in various combinations. The most common residential section sizes are 18 inch, 21 inch, and 24 inch.

At first glance, all door sections may look alike. However, there are often important differences of which an installer must be aware. The bottom section may have a larger rail or added internal reinforcement since it must support the entire weight of the door. The top section may have a larger rail than the intermediate section rails and may not have the joint contours across the top. The top section may also be internally reinforced or have an extra center stile for the operator attachment. The lock section, usually the second section up from the bottom, may have predrilled holes or an extra stile for mounting the lock assembly. Lites, the industry term for windows, may be installed in some or all of the sections.

There are many types of materials used to build residential door sections. The customer can select from steel, aluminum, wood, various plastics, and others. As years have passed, engineers have searched for alternative materials to improve performance, lower door cost, and meet special needs or overcome the shortcomings of other materials and fluctuations in material availability and cost.

Steel has become the material of choice in most residential sectional door applications. Steel is strong, durable, dimensionally stable, and lower cost than many alternative materials. The paint and galvanizing systems have been developed to provide protection against rust for many years without repeated painting in most environments. The weight remains constant and consistent. Steel doors are generally lighter in weight, making them easier to handle and operate.

Section Materials

In the doors of today, the buyer has a choice of many materials. In addition to traditional wood, the buyer can select from steel, aluminum, various plastics, and fiberglass.

Wood is a renewable resource that has been used in construction for many years. It is easily cut, shaped and glued together to build doors. It is easy to paint or stain and can be shaped into decorative patterns. Scrap pieces can often be re-used by gluing edge to edge to make panels or end to end using finger joints to make rails and stiles. Selection of wood will have a considerable effect on the durability of
the door. The hardwoods (Oak, meranti) are generally the most expensive and most durable. Cedar has special insect and rot resistant characteristics. The soft woods (pine, luan) are the most available species, but also have a shorter life. Most wood composite materials are used only as panel inserts due to their low strength and relatively poor weather resistance.

Wood "breathes" continually, absorbing moisture and drying out so that its weight is constantly fluctuating. This may make it difficult to keep a wood door well balanced. As the moisture content changes, so does the shape to a minor degree through warping, twisting and swelling. Add microscopic organisms and the wood begins to rot. Therefore, it is necessary to maintain a good coating of paint or stain on the door to control the ill effects of moisture.

Steel has come of age to address many of these wood problems. Steel does not breathe like wood, although it will rust if not protected. Factory finishes have been developed to provide protection against weathering for many years without frequent refinishing. The weight remains constant and consistent. Steel doors are generally lighter in weight, making them easier to handle and operate. As the cost of steel doors lowered over time, the industry shifted away from wood towards steel. Today, steel is the most prevalent material used to build garage doors.

Aluminum is used as the primary material in sectional doors where large windows are needed, the appearance of aluminum is desired, or there are special corrosive needs. The usual construction is rail and stile, much like wood door panels. The rails are extruded so they are small yet strong, leaving much of the door surface available for glass. Aluminum doors are generally more expensive than their wood or steel counterparts.

Specialty engineered materials have emerged as yet another alternative section material. Plastic is one example of material which offers dent, scratch, and corrosive advantages. These sections are typically constructed of an outer plastic skin reinforced with steel or aluminum internal rails. PVC (Polyvinyl Chloride) is a low cost plastic with good properties for door construction. It is dent and water resistant and is the same color throughout so that scratches are less apparent. Forming methods allow decorative shapes and simulated wood grains to be embedded into the surface for unique and realistic finishes. On the down side, the same flexibility that promotes its dent resistance results in a door that will sag too much if not supported by other materials. Painting plastics require special procedures which should be specified by the manufacturer when needed. PVC is a thermoplastic, meaning it softens with elevated temperatures, so dark colors in direct sunlight and use in high temperature regions should be avoided. Other plastic materials may be used to address some of these limitations, but typically come at a higher cost.

Fiberglass sections are another alternative engineered material. These sections are typically comprised of a fiberglass outer section skin combined with steel section construction. Similar to plastic sections, fiberglass is resistant to dents, cracks, splintering, and rust, but fiberglass adds higher temperature stability to resist expansion and contraction.

**Wood Door Construction**

The most basic wood door construction is made by building a frame of rails and stiles. These horizontal rails and vertical stiles serve as frames for panels that make up the majority of the door face. The panels provide rigidity to the frame much like cross bracing. In addition, the panels can be made in decorative patterns to improve the appearance of the door. The horizontal rails provide a continuous structural member to support the weight of the sections.
The vertical stiles are a relatively low cost part to separate the rails and provide fastening points for hinges and hardware. Each assembly of rails, stiles, and panels form a section. Multiple sections are used to make a complete door, thus the term sectional door.

Another variation of the wood door is the flush model. These doors still have the wood frame of rails and stiles, but sheets of plywood or wood composite are laminated on top of the frame on both sides, covering the entire surface. This design provides hollow cavities inside the door that can be filled with insulation or remain void.

As wood sections are stacked one on top of one another, it can be difficult to get a close fitting joint between them. Wood expands and contracts with moisture, temperature and other conditions, so that parts that match today may not match later. Keeping a tight connection is desirable to minimize the amount of air and light passing through a door. In response to these considerations, a multi-faceted joint was developed. Many variations have been tried during the years, but today only a few remain as dominant: shiplap, and tongue and groove. Each of these provides at least one step to block light and air while concealing the imperfections of the joint itself. In addition, these joints are oriented to provide an upward step as viewed from the outside as a hindrance to the entry of driving rain.

**Door Style**

One of the most common styles for residential sections is the raised panel. For steel doors, a decorative profile is stamped directly into steel sections as they are manufactured. These can be short panel, long panel, or some other stamped shape. The raised panels are sometimes spaced to align with the attachment locations of the hinges. These sections are usually embossed with a wood grain pattern.

A newer and popular style of door that has emerged is the carriage house design. These are sectional doors with outside facing designs that mimic traditional wood construction swing door appearance. Decorative hardware can be affixed to the face of the door simulating side swing hinges and handles to accent this appearance. These come in a wide variety of vertical, horizontal, and diagonal designs to provide customized appearances.

Another section style is the overlay design. These doors are constructed by attaching a variety of materials to the face of the door to achieve a desired three dimensional appearance. These first emerged as decorative magnetic overlays applied to the face of a steel door to mimic the look of traditional wood doors. Advancements in attachments, adhesives, and materials have caused an explosion into a wide variety of materials and attachment methods used today for overlay sections. This style is particularly useful in creating carriage house style appearances.
Wood doors are available in many varieties of appearance. The paneled door construction offers a range from plain, flat panel to raised panels. The raised panels can be basic or routed for a custom appearance. The panels can be nearly square to long rectangular in shape. Flush doors are available with finishes ranging from smooth, to plywood, to very rough cut wood grain. Higher end wood species are often overlaid on flush wood sections to give any appearance desired.

The One-Piece garage door is still offered by some manufacturers. With improvements in the manufacturing process, these doors allow a two man crew to completely install a two car garage door in about 30 minutes. Compared with the hours it took to custom cut doors in the past, this can provide a substantial increase in productivity.

**Types of Door Sections**

**Pan Door Sections**

A pan door is comprised of sheet metal pan door sections. The sheet metal starts in a coil form and is roll formed to create a pan. The pan can be roll formed with either a ribbed design or flush design. The flush design can be stamped with raised panels. The steel, in most cases, is embossed with either a wood grain or pebble grain finish prior to roll forming. End and center stiles are added for vertical reinforcement, hinge attachment, and to create a rigid garage door section.

Pan door sections can be insulated for improved thermal performance. Insulated pan door sections are comprised of a standard pan door section, with insulation added to fill the voids in the pans surrounding the stiles. Various back cover materials can be used to cover and protect the inside face of the insulation. Common back covers are made from sheet metal or plastic. In addition, the foam insulation itself may have an integrated back cover material.

Pan door sections are available in a variety of standard and custom finishes and colors. The bare steel is coated with a galvanized coating ranging from G-30 to G-90 for corrosion protection. They are then most commonly finished with a paint system which includes a primer and finish coat prior to roll forming.

**Insulated Sandwich Door Sections**

Insulated Sandwich Door sections are constructed using an interior and exterior skin with an insulating foam core material. Expanded polystyrene foam can be cut to size and glued to the inner and outer skins, or polyurethane foam can be foamed-in-place between the skins to chemically bond the foam to the skins to create a rigid section. The inner and outer skins of the section may be kept separated during assembly to act as a thermal break. Steel backer plates or continuous reinforcement strips can be installed during the assembly of the section to accommodate various on-door hardware requirements and end caps are added to complete the section.
The skins of the insulated sandwich sections range in thickness from 16 to 28 gauge steel and are available in a variety of standard and custom finishes and colors. The interior skin is often a different thickness than the exterior skin. The bare steel is coated with a galvanized coating ranging from G-30 to G-90 for corrosion protection and they are most commonly finished with a paint system which includes a primer and finish coat prior to roll forming.

**Full Vision Sections**

Full vision sections are constructed from aluminum extrusions which are cut and machined to create vertical stiles and horizontal rails. The stiles and rails are fastened together to create a section frame. The open areas of the frame can be filled with various glass or plastic glazing, or solid aluminum sheet, hardboard with an aluminum laminate, insulation with an aluminum laminate, or other material that will not create electrolytic corrosion. Common glazing materials are DSB Glass, tempered glass, insulated glass, polycarbonate, acrylic and wire reinforced glass.

The aluminum frame can be finished in a number of ways. Typical finishes are anodized, primed and painted, or powder coated.

**Wood Sections**

The most basic wood sectional door construction is made by building a frame of rail (horizontal) and stile (vertical) members around decorative panels. These parts, once assembled, serve as the sections of the door. Multiple sections are used to make a complete door.

Another variation of the wood door is the flush model. These doors still have the wood frame of rails and stiles, but sheets of plywood or wood composite are laminated on both sides, covering the entire surface. This design provides hollow cavities inside the door that can be filled with insulation.

**Section Joint Profiles**

The mating edges of the sections have special profiles for preventing the passage of light and water when the door is closed. There are four predominant section joint profiles used for this purpose.

A shiplap section joint, sometimes called a rabbeted joint, steps up from one level to a second level from the outside of the door section to the inside. This step allows the sections to overlap, preventing light from passing through the section joint. The higher step towards the inside of the section prevents water from channeling through the section joint to the inside of the opening.

A Tongue and Groove section joint is commonly composed of a middle protrusion on a garage door section edge mating with a middle groove on an abutting section edge. The tongue will be located on the lower section, creating the upward step to prevent light and water passage. The groove will be located on the upper section to mate with the
tongue on the lower section.

Angled section joints are commonly used on wood doors in which the entire door is assembled as one piece, and then sawed into sections. The lower section will have an upward sloping angle from the outside to the inside to prevent light and water passage and the upper section will have a corresponding angle to mate with the lower section. The overlapping sections prevent light penetration and the upward sloping angle prevents water passage.

Pinch Resistant section joints are designed to prevent entrapping, crushing, breaking, severing or dislocating a person’s finger. The lower section will have a male protrusion for blocking light and water passage and the upper section will have a corresponding female profile for mating to the lower section. The profile of the section joint is designed to match the articulation of the section through the track radius in order to keep the section joints in close proximity to one another and prevent insertion of a person’s fingers.

A weather seal, called a joint seal, may be added between the sections to further prevent the passage of air, water, and/or light and to improve the thermal performance of the section joint.

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**Sectional Door Lites**

It is often desired for residential sectional garage doors to have windows to provide visibility and/or passage of light through the door.

A single window in a sectional garage door is called a *Lite*. The glass, plastic, or other material used to fill the window is called *Glazing*. A section which contains lites is called a *lited section*, or a *glazed section*. A section without lites is called a *solid section*.

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**Lite Construction**

Lited sections are created by cutting one or more holes through the section. Inside and outside lite frames, primarily made from plastic, assemble to sandwich the glazing and the section together between the two frames in the section cutout. The frames can snap together or assemble with screws on the interior side of the section. Weatherseals are used on the exterior perimeters of the frame in contact with the section and the glazing to prevent water penetration.

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**Lite Materials**

There are various materials used for sectional door lites ranging from 3/32 to 1/2 inch thick. The most basic lite material is annealed glass. Annealed glass has undergone a heat treatment to make the glass more stable. Glass which has not been annealed is likely to break easily when subjected to a relatively small temperature change or mechanical shock.

Tempered glass, also called toughened glass, is a type of safety glass with special thermal or chemical treatments to increase its strength. Tempered glass, when broken, will crumble into small granular chunks instead of splintering into jagged shards. Tempered glass is most commonly known for its application in the automotive industry to improve the safety of a broken car window.

There are two grades of glass common to the garage door industry. SSB (Single Strength Billet), sometimes called single strength glass,
refers to regular strength plate glass between 0.085 to 0.100 inches thick. DSB (Double Strength Billet), sometimes called Double Strength Glass, is a grade of window glass lighter than plate glass between 0.118 and 0.133 inches thick.

Wire glass has a wire mesh pattern embedded in the glass for security. It is produced by placing wire mesh between two pieces of hot glass and using rollers to squeeze the glass and mesh together into one. The wire mesh will retain the pieces of glass if the glass is broken.

Insulated glass, sometimes called double glazing, is used to improve the thermal performance of garage door lites. It is comprised of two layers of glass separated by a perimeter spacer that creates a cavity between the two pieces of glass. The cavity is filled with air or other gasses to reduce the heat transfer through the window. Insulated glass can also improve sound transmission.

Acrylic and Polycarbonate are available plastic alternatives to glass that offer improved strength, impact resistance, and insulation benefits. While plastic glazing materials are safer than glass due to their resistance to breakage, they offer little resistance to scratches.

Coatings and Surface Treatments

Clear glass, as the name implies, is completely transparent. This allows light and full visibility through a window.

Obscure glass is the general term for a window that allows the passage of light, but obscures visibility for privacy. From the outside, the glass will have an opaque appearance, such as frosted, mirrored, dark tinted, bronze, reeded, etc.

Alternately, light filtering glass is available with films which lessen the passage of light and/or UV rays. These windows allow visibility while reducing the passage of light.

Low e glass, or Low emissivity glass, is glass which has a special coating to improve the thermal efficiency. This coating reflects radiant energy which tends to prevent radiant heat from transferring through the window. Low e coating may be applied to plate glass or used in combination with insulated glass.

Weatherseals

Weatherseals are used to limit air and water infiltration around the perimeter of the door. Residential sectional doors utilize several different types of weatherseals depending upon the application and the level of protection desired.

The most common weatherseal on virtually every door is a Bottom Weatherseal, sometimes called an astragal. This is a weatherstrip attached to the bottom rail of a door to seal against the floor when the door is closed. These are typically bulb shaped. The bottom weatherseal will attach directly to the bottom section, or there may be a separate retainer used to hold it in place.
Stop mould is another common perimeter weatherseal used on sectional doors. Stop mould consists of a rigid trim piece that is nailed to the perimeter of the opening and has a flexible flap which seals against the outside face of the section. When sealed properly, the flexible flap will prevent air and water infiltration when the door is closed. Stop mould is most commonly used on residential doors with wood jambs.

Another type of perimeter seal available utilizes a rigid retainer to attach a vinyl flap or a brush seal to the jambs and header. Brush seal utilizes a large number of bristles crimped tightly together to block air and water passage. The multiple bristles remain flexible for tightly sealing against the door. Brush seal is most commonly used in more extreme weather applications.

**R-Value**

R-Value is used to measure a material’s resistance to heat flow and is the most commonly used measure for determining the performance of an insulating product. A product’s R-Value is its ability to retard heat flow. R-Values are presented in numerical form with a high number indicative of good insulating performance and a low number indicative of poor insulating performance. Thus, a product with an R-Value of 4.00 is more efficient at retarding heat flow than a product with an R-Value of 2.00.

**K-Factor**

K-Factor is used to measure an insulation material’s thermal conductivity. Thermal conductivity is defined as the degree to which a material facilitates the flow (conduction) of heat. K-Factors are presented in numerical form (typically decimals) with a high decimal value indicative of high conduction, which is detrimental to insulating performance, and a low decimal value indicative of low conduction which is beneficial to insulating performance.

K-Factor can be calculated by dividing 1 by a product’s insulation R-Value. An example of this calculation is as follows:

**Material**: 1.00# Density EPS with an R-Value of 3.85 per inch.

**K-Factor Calculation**: 1 divided by 3.85 (R-Value) = .259 (K-Factor)

**U-Factor**

U-Factor is used to measure the overall thermal conductivity of a wall system, or in this case, an installed sectional door system, by taking into account the thermal conductivity of all of the components within the system. Much like a K-Factor, a door system’s U-Factor will
typically be presented in decimal form with a low decimal value being more desirable than a high decimal value. The U-Factor of an assembly cannot be determined by dividing 1 by the R-Value of the section. See DASMA TDS-163 for further information.

Method of Determining Thermal Performance

The thermal performance ratings (Section R-value, insulation K-factor, and assembly U-factor) can be determined either by calculations or by testing. Values derived by calculations are often based solely on the mean section profile and do not account for complexities such as section joints and building interfaces. Values derived by testing come directly from test results on a complete installed door system. It is important to recognize the method used to derive published thermal performance ratings when comparing two products because the two methods produce different results which are not comparable. See DASMA TDS-163 for further information on manufacturer's published insulation values.

Expanded Polystyrene (EPS)

Expanded Polystyrene is a type of foam insulation commonly used to insulate pan doors and sandwich doors. Polystyrene beads are manufactured from various petroleum and chemical by-products. EPS foam is made by introducing steam to a given amount of polystyrene beads typically contained within a mold. The polystyrene beads expand and fuse to form a homogenous block. This block or billet of EPS foam can be cut to size with a hot wire knife. Cut to size pieces of EPS foam can be used to insulate pan doors and wood doors, or glued to metallic substrates to make a sandwich door. EPS foam densities can range from 1 to 2 pounds per cubic foot. The insulating property of EPS foam typically provides an R-value of 4 per inch of thickness.

Polyurethane (PUR)

Polyurethane is a type of foam insulation commonly foamed in place by manufacturers of garage door sections. Polyurethane foam’s individual components are produced from various petroleum and chemical by-products. The chemical reaction of a two-part mixture of Isocyanate and Polyol make polyurethane foam. Polyurethane foam can be molded into a homogenous block or billet and cut to size with a hot wire knife. Cut to size pieces of polyurethane foam can be used to insulate a pan door. Additional properties of the chemical reaction also promote natural adhesion to various metallic substrates. This in turn makes up the unitized/composite sandwich doors used within the garage door industry. Polyurethane foam densities can range from 2 to 3 pounds per cubic foot. Both chemical and physical blowing agents are contained within the Polyol. A variety of blowing agents can be used to vary polyurethane foam properties like R-value & density. The insulating property of Polyurethane foam per inch of thickness will range from R5 to R7 depending upon the blowing agent contained within the foam’s cells.

Flame Spread (Surface Burning Characteristics)

The numeric flame spread rating for any material is a relative comparison to the flame spread ratings of cement asbestos board (0) and red oak (100). Flame spread is tested and measured in the Steiner Tunnel Testing
Machine. The Steiner test method involves placing the material to be tested in the ceiling of the tunnel where it will be exposed to flame and observed through a glass wall for burn characteristics.

A gas burner propagates flame at one end of the tunnel and the extent of flame propagation along the sample material suspended at the tunnel ceiling is measured and compared to that of cement asbestos board and red oak. Typical building codes require that the flame spread rating for materials used in residential construction applications not exceed 75.

**Smoke Developed**

The numeric smoke developed rating for any material is determined by a measuring device, which is installed in the outlet of the Steiner Tunnel Testing Machine. As material is burned by the Steiner Test method, the smoke generated during the test is ducted out of the tunnel where its density is measured and recorded.

Typical building codes require that the smoke developed rating for materials used in residential construction applications not exceed 450.

**Sound Transmission**

Noise reduction is measured with either STC (Sound Transmission Class) or OITC (Outdoor-Indoor Transmission Class) ratings, and is roughly the measure of the decibel reduction in noise that occurs in a building partition, such as a sectional door. For example, if an 80 decibel sound on one side of a door is reduced to 60 decibels on the other side, that door is said to have an STC of 20.

**Air Infiltration**

Air infiltration ratings are a measure of the leakage or passage of air through a door system. These ratings are measured by physical testing of a standard sized door, usually 10’x10’ for sectional applications. A pressure differential simulating a 15 to 25 mile per hour wind is applied to the exterior of the door and a flow meter is used to measure the air leakage. The result is published in cfm, or cubic feet per minute. The lower the CFM value, the better the air leakage resistance of the door.

**Thermal Bowing**

*Reference DASMA TDS #185*

Thermal bowing is a term used to describe a common phenomenon where high temperature difference between the interior and exterior sides of the door causes the sections to bow, or smile over their length. It is an inherent characteristic on garage doors with insulated bonded core sections and is not considered a product defect. Insulated bonded cores are associated with sandwich insulated panel construction, predominantly featuring steel facings and foam cores.

Thermal bowing occurs in a fully closed garage door due to a combination of insulated panels restrained from horizontal movement at each end and a high temperature difference between interior and exterior door skins. It is important to recognize this inherent phenomenon and apply an appropriate garage door manufacturer recommended solution.
All insulated panels will exhibit some thermal bowing when subjected to a temperature difference from one side of the insulated panel to the other. However, the amount of thermal bowing can vary greatly depending on many factors. One thing to remember is that thermal bowing is always in the direction of the hotter surface as the molecules on the warmer side are trying to expand more than the molecules from the cooler side.

Influences that can Create Thermal Bowing:

- **Amount of temperature difference** – The greater the temperature difference from the outside environment to the inside garage space, the greater the potential thermal bowing. However, thermal bowing is not restricted to outward movement. For example, in a cold winter environment a heated garage might mean that a garage door might have a tendency to bow inward.

- **Door size** – The larger the door, the more potential bow. Without proper reinforcement, the thermal bow on a 20’ wide garage door could exceed several inches.

- **Darker color door** – A brown, insulated garage door facing the sun on a hot day with an air conditioned garage or warehouse space will have more thermal bowing than an equivalent white garage door in the same application. As with a greater outdoor temperature than indoor garage temperature, thermal bowing will be outward. The darker color, the more this tendency exists when facing the sun.

- **Door design** – Door designs that prevent heat transfer from the exterior to interior, or vice versa, have the potential for greater thermal bowing than garage doors that don’t prevent this heat transfer. Insulated garage doors that are “thermally-broken” inhibit heat transfer, since the heat transfer path is ‘broken’ from one side of the door to the other.

Besides a measurable bow, field issues reported with thermal bowing include top section rubbing on the top of the garage door opening header (outward thermal bow) or a gap between the top section and the top of the opening (inward thermal bow).

While thermal bowing cannot be eliminated when the previous influences are present, it can be minimized to where it has no appreciable effect on garage door performance. Preventive measures typically involve door reinforcement that reduces thermal bowing. This could include, but is not limited to, the application of horizontal struts across the back of the garage door. The size and number of struts across the back of the door can vary depending on the various factors listed above and the amount of thermal bow. Extreme instances of thermal bowing might require more extensive reinforcement, e.g. a 1) large, dark colored, thermally-broken (non-thermally-conductive material placed between the door’s exterior and interior facings) insulated garage door, 2) facing the sun on a hot day, and 3) with air-conditioned garage door space, might require more extensive reinforcement.

Other techniques to address thermal bowing depend on the door system and the adjustability of either the track assembly or the jamb/header seal. Please contact the product manufacturer for their recommendations on minimizing thermal bowing.
Chapter Four

Residential Sectional Door Components

Throughout this Study Guide, there are references to the hand of the door components, such as right-hand and left-hand. As an industry standard, all points of reference to sectional doors are viewed as standing inside the garage and looking out, unless otherwise noted.

This study guide also assumes that all doors will be installed in a normal situation, with the door facing the exterior and opening toward the interior of the building.
Hardware Components

Bottom Corner Brackets

A bottom corner bracket, or bottom fixture, is a structural support located on the bottom section that holds the track roller and may also provide for attachment of lifting cables. These brackets generally support the entire weight of the door and are often designed so that a portion fits underneath the bottom of the door to reduce the load on the fasteners. Bottom corner brackets are typically handed for the left and right side of the door.

The cables attach to bottom brackets using two different pin types. A milford pin is a mushroom shaped pin that is stamped into the bottom bracket. The cable loop slides over the large portion of the milford pin and cable tension keeps the loop tight to the smaller diameter portion. Heavier duty doors utilize a clevis pin to attach the cables. A clevis pin is a steel pin with a head on one end. The pin is slid through the bottom bracket, through the cable loop, and secured in position with a cotter pin.

Most manufacturers follow ANSI/DASMA 103, a standard which requires the use of red color coded or tamper resistant fastener(s) to attach the bottom corner brackets to the bottom section. Other special design bottom corner brackets exist that prevent access to the assembly screws while tension is present on the cables. Bottom brackets often also include a safety warning label to warn of high spring tension.

Outside hookup bottom brackets are commonly used for low lift doors where the cable is routed outside the tracks. These typically have an extra strap which reaches around the track to the proper cable attachment location.

Optional Cable Tensioners can be mounted on the bottom corner bracket to help maintain cable tension. These are commonly used to help prevent the cables from slacking on the drums in certain lift conditions. A spring is mounted to the bottom corner bracket and hooks over the cable to pull out any excess slack during operation.

Hinges

A hinge is used to join the door sections together, allowing the sections to pivot independent of one another as the door follows the track profile. They are also used to keep the outer face of abutting sections flush with one another. End hinges are mounted at the ends of the sections and hold the rollers while center hinges are mounted on the intermediate stiles.

There are various types of hinges depending upon the door type. The most common type of hinge is a leaf hinge. The upper and lower portions of the hinge that attach to the door are triangular shaped. They are hinged together at the pivot point with a flared tube that can also be used as the roller carrier for #1 hinges. Leaf hinges are available in several different thicknesses depending upon the size and weight of the door.

Another common type of hinge is a box hinge. These hinges are very similar to leaf hinges, but the triangular sections are removed to create a more compact hinge. These are commonly used on
sections with narrow meeting rails or where the added strength of a full size leaf hinge is not required.

Graduated edge hinges are used at the ends of the door sections to ensure flush fit of the door against the jambs when closed. For 2 inch track, they are usually numbered starting with 1 on the first section on up. For 3” track, they are usually numbered starting with 3 on the first section on up. This aligns the bottom roller with the track and the graduation of the edge hinges positions the roller at an increasing distance from the door opening in order to match up to the slope of the vertical track, approximately 1/8” per foot. This design assures that the door will be in close contact with the interior surface of the opening when it is completely closed providing a weather tight fit. The slope of the track assures that the door will pull away from its tight fit to the jambs, eliminating friction as the door travels.

Rollers

Rollers are used for guiding the door sections along the track. They consist of a tire assembled to a stem. The tire is sized to match the track, usually 2 inch or 3 inch depending on the size and weight of the door, and is made from plastic or steel. The tire will contain a bearing or be made of bearing materials for ease of rotation. The stem is staked through the tire and has a cylindrical body which extends into the end hardware of the door. Wider doors will utilize long stem rollers to interface with double end hardware. The stem usually has a standoff to space the roller away from the door section and prevent the door from hitting the track during operation.

Top Fixtures

A Top Fixture is a bracket for positioning the top roller on the top section of the door. The bracket usually consists of two parts, a base and a slide. The base is commonly “A” shaped and provides the mounting locations for attaching the top fixture to the section. The slide contains a curl to accept the top roller stem and can be adjusted on the base for alignment of the top roller to the track.

Low Lift Top Fixture

A low lift top fixture is used on doors with low lift (low headroom) track to reduce the high-arc travel of the top section as the door is opened. These top fixtures are often flat and roller position adjustment is achieved by raising and lowering the attachment location of the top fixture on the top section.

Operator Brackets

The purpose of an operator bracket is to provide a connection point for a drawbar operator that adequately applies the lifting force to the top section of the door. They can be as simple as an angle bracket for thicker, heavy duty doors to full section height brackets that interface with the intermediate hinge and the top strut on thinner, lighter duty doors. Operator brackets are typically supplied with the operator, but may also be supplied with the door in some instances. It is important to check with the door manufacturer for the appropriate mounting of operator brackets to verify the top section is properly reinforced for the attachment of the operator.
Locks

There are various types of locking mechanisms used on sectional doors to secure the doors to the vertical track(s) in the closed position. These locks may engage a striker plate or go directly through cutouts in the track itself. Once secured, the door cannot be opened until the lock mechanism is released.

One type of sectional door locking mechanism is an Automatic Latch. As the name suggests, the automatic latch will automatically engage a striker plate in the closed position and secure the door. The latch must be manually released each and every time the door is operated.

Another common sectional door locking mechanism is an inside lock. This is a spring loaded, sliding deadbolt lock or spring latch operable only from the interior side of the door. The inside lock deadbolt will engage the track or a striker plate. The deadbolt may contain means for padlocking the door or rely on the security of the inside access only for preventing unwanted operation of the door.

Exterior locks are available when outside access to the door is desired. A key activated handle will be located on the outside of the door and a square shaft, called a chill, will penetrate through a hole in the door section connecting to the inside lock set. A decorative plate, called an escutcheon, will be used to surround the outside portion of the lock assembly and cover the hole through the section. A lock cylinder in the handle will accept the access key and contain the locking pins. The outside keyed handle can be aligned to the side of the door or located at the center. Depending on the section construction, the lock handle may need to align with a stile on the inside of the door for structural support. Lock sections sometimes have an extra stile at the lock end of the door for mounting the lock.

Exterior lock assemblies often utilize a lock bar with cremone on the inside of the door. The square shaft (chill) from the outside handle penetrates the door section and engages a lock bar disc (cremone) which is attached to one or more lock bars. Rotating the cremone forces the lockbar(s) to slide towards the track to engage the striker plate or vertical track. Rotating the cremone in the opposite direction pulls the lockbar(s) back and provides access to operate the door. The cremone is often notched such that a night lock deadbolt can be mounted on the inside of the door. The exterior key cylinder may be separate from the handle and rely on activating the night lock dead bolt.

Locks should be removed or disabled on electrically operated doors to prevent the operator from attempting to lift a locked door. Failure to disable the locks can result in damage to the door and an unsafe condition if electrical operation is attempted while the locks are engaged.
Struts

A strut is a support stiffener to reduce deflection, or sag, of the door sections while in the horizontal position. They are also used to increase the windload resistance of a door. Struts, when needed, will attach to the inside face of the door and may be factory or field attached. Struts will run the length of the section and may be shortened at the ends to avoid interference with end hardware.

Small metal plates, called strut clips, are sometimes used to share strut fasteners with hinge fasteners. There are various sizes and thicknesses of struts used with the most common struts being 2 inch and 3 inch tall. Very large or heavy wind load rated doors may utilize larger C-channel or trusses in place of struts.
Counterbalance Components

The torsion spring counterbalance system is comprised of a shaft, drums, springs, cables, coupler (when necessary) and bearing brackets. These components, when properly installed, should precisely balance the door for easy operation.

Torsion Shafts

Torsion spring doors utilize a torsion shaft that is installed parallel and level to the top edge of the door. The spring(s) required to balance the door must be attached to this shaft. All spring torque, regardless of the number of springs, is delivered equally to both ends of the shaft.

Torsion shafts can be tubular or solid. Tubular shafts are used on lighter doors that do not require a shaft mounted operator. The tube shaft length will run the full width of the door and various wall thicknesses of the tube can be used depending on the torque requirements. The most common size for tubular shafts is 1 inch diameter.

Solid shafts are used on heavier doors or when chain hoist or jackshaft operation is desired. The shaft is keyed either at the ends or for the full length in order to engage the cable drums, spring cones, couplers, and/or drive sprockets. The most common shaft size for residential doors is 1 inch diameter.

Couplers are used to join two solid shaft segments together end to end. They typically provide a way to adjust the rotation of the two shafts relative to one another in order to properly tension the cables during installation and service.

End Bearing Plates

End bearing plates, sometimes called headplates, support the counterbalance shaft at each end. They will position the shaft a fixed distance from the jambs to provide clearance for the cable drums and springs and contain bearings so the shaft can turn freely. End bearing plates are typically attached to the horizontal track and/or the wall and are often handed for the left and right side of the door. The cable drums will assemble to the shaft tight against the end bearing plates to prevent shaft movement during operation of the door.
**Center Bearing Brackets**

Center bearing brackets are used at the center, and sometimes various other intermediate width locations, to align and support the torsion shaft. They are often also used to anchor the stationary spring cone(s) to the header or other building support. A bearing is used to prevent shaft wear due to rotation. The bearing can be assembled to the bracket when used as a stand-alone shaft support, or installed within the stationary cone of the spring when used as a spring anchor. Some center bearing brackets contain various arrangements of slots to accommodate various spring sizes and to provide in and out adjustment to the centerline of the shaft relative to the header.

Center bearing brackets can be open or closed style. Open style brackets allow the counterbalance shaft to be installed and removed while the center bracket remains attached to the spring pad. Closed style center bearing brackets require installation and removal of the bracket with the shaft and spring(s).

**Shaft Bearings**

Shaft bearings are used to maintain shaft alignment and reduce friction as the shaft(s) rotate. They are typically integral to the end bearing plates and one or more mounted at the center brackets. These may be bushings on lighter doors or ball bearings on more heavy duty doors.

The most common bearing used on sectional doors is the flange bearing. These roller bearings are formed with a flanged housing which can be pressed or staked into end and/or center bearing plates or inserted between the spring cone and center bracket during installation. The inner race turns with the shaft as it rotates and spins on the bearing rollers to eliminate friction. Flange bearings are available with a variety of load ratings depending on the application.

Bushings are sometimes used in place of flange bearings on light duty doors, mainly at the center bracket location(s). The bushing is made from a low friction material and the shaft turns on the inner race. The shape and field application is the same as flange bearings.

An Oval Bearing, sometimes called a football bearing, is a flange bearing pressed into an oval mounting plate. They are used to support the shaft at center brackets where there is not a spring fitting to hold the bearing. These are commonly used on rear mount center brackets when the springs are mounted to track brackets or when the spring fittings are not designed to receive a flange bearing.

**Torsion Springs**

A spring is defined by three characteristics. Coiled length is the distance from one end of the spring to the other. Wire diameter is the size of the wire used to coil the spring. Inside diameter is the distance across the inside of the spring. Wire diameters range from 0.1875 inches up to 0.625 inches and inside diameters range from 1-19/32 inches up to 7-5/8 inches. Common inside diameters for residential doors are 1-3/4, 2 and 2-5/8 inches.

The spring can be coiled in two different directions, left hand or right hand. A simple way to distinguish between these two types of
springs is that a right hand wound spring would screw clockwise into the ground in the same fashion as a wood screw would rotate into the floor.

Torsion spring manufacturers buy wire, which is received in large diameter spools. These manufacturers order the wire from their vendors in the wire diameter and material necessary. The spring manufacturer coils this wire with an initial tension which allows the wire to coil uniformly. The wire is normally coiled with a stud or arbor in an automatic coiling machine or sometimes coiled around a mandrel or spool. Most torsion springs used to counterbalance garage doors are made from oil-tempered steel, although other materials can be used. Some spring materials are more accessible in various parts of the world.

Torsion springs develop internal stress when they are wound. This stress is removed by heating the springs after they are coiled. Stress relieving is also referred to as baking or bluing. Torsion springs are typically coated or galvanized to improve their appearance.

Torsion springs do not develop torque until the wire is wound into coils. In order to properly create torque in a torsion spring, it must be wound in the direction it was coiled. Spring turns must be applied in the direction the end coil is pointing. With standard lift sectional doors, the standard orientation is to wind springs upward. Therefore, a left hand wound spring must be installed on the right side of the door. A right hand wound spring must be installed on the left side of the door. Some spring manufacturers color code spring ends or cones to eliminate confusion. Black color-coded springs are those on the right side of the door, and red color-coded springs go to the left side of the door. Many times, only one spring will be needed. When referring to spring location, always refer to the spring anchor point as being the center of the installation.

Torsion springs are also often color coded to identify the wire diameter using a label or a splash of paint. These color codes are used by most of the industry spring suppliers and are defined in DASMA TDS #171. Some of the most common color codes for residential door torsion springs are:

<table>
<thead>
<tr>
<th>Size</th>
<th>Color</th>
<th>Size</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.192</td>
<td>Orange</td>
<td>0.234</td>
<td>Brown</td>
</tr>
<tr>
<td>0.207</td>
<td>Yellow</td>
<td>0.2437</td>
<td>Green</td>
</tr>
<tr>
<td>0.2187</td>
<td>White</td>
<td>0.250</td>
<td>Gold</td>
</tr>
<tr>
<td>0.2253</td>
<td>Red</td>
<td>0.2625</td>
<td>Blue</td>
</tr>
</tbody>
</table>

Torsion springs develop torque. Torque can be described as a twisting force around an axis. In the garage door industry, that axis is the torsion tube or shaft. It is measured in inch pounds. An inch pound is the amount of torque needed to balance one pound with a 1-inch lever arm. As wire size increases in diameter, the spring is capable of increased torque. A door needs a predetermined amount of inch pounds at the cable drum’s lever or moment arm to be balanced at any given point in its travel.

The necessary total torque will determine how many times the spring must be turned. Normally a torsion spring is wound at a quarter of a complete turn at a time, by inserting winding bars. One bar is inserted into the winding cone, and then the spring is turned one-quarter revolution. At that time, another hole in the casting is accessible and the other
bar is inserted. When it is secure, the first winding bar is removed. The second bar is used to add another quarter turn on the spring, and this process is repeated until the total number of specified turns is reached.

Torsion springs are made in combinations of wire size and coil diameter to operate safely and efficiently. Springs are always kept within specific Index Ratios (IR) for manufacturability. The IR is the ratio of wire size to coil diameter. Common residential inside diameters range from 1-19/32 through 2-5/8 inches. Depending on requirements, wire diameters typically range from .187 to .2625 inches.

Inside diameter does not directly affect the power of torsion springs. Wire diameter and length of the uncoiled spring wire are the determining factors in how much torque a torsion spring develops. In other words, the same length and diameter of unbent wire can be bent into multiple different coil diameters resulting in multiple different spring lengths that will all balance the door the exact same way.

**WARNING!** Torsion springs are under extreme tension and can pose serious hazards if improperly handled. Severe injuries and even deaths have resulted from improper installation, use of improper winding methods or failure to use proper safety precautions. The professional installer is the key in ensuring that installation and service procedures follow manufacturers’ instructions and that all precautions are taken to minimize risk.

**Cycles**

A cycle is defined as one opening plus one closing of a door. The springs are engineered to last a predetermined number of operational cycles. Most sectional doors manufactured today are engineered with 10,000 cycle minimum springs. Higher cycle springs are available from manufacturers, and are typically specified as 25,000, 50,000 and 100,000 cycles.

Selection of higher cycle springs should be based on the anticipated usage of the door in application. A door which is expected to be opened and closed many times throughout the course of a day would require higher cycle springs than a door which is only opened and closed once at the beginning and end of the day. It is important to assess the application’s anticipated duty cycle in advance of ordering the door such that the springs can be designed for sufficient cycle life.

The result in specifying higher cycle springs is the use of larger diameter spring wire and longer springs. These larger springs are stronger and therefore last longer.

**Spring Cones**

Spring cones are aluminum or steel castings which are installed into the ends of a torsion spring. They are sized to match the inside diameter of the springs.

There are generally two types of spring cone engagements with the spring; friction and mechanical. Friction spring cones have a gradually increasing tapered thread profile which screws into the torsion spring creating a compression fit. As the spring is wound, the inside diameter gets smaller and squeezes down on the spring cone. These cones rely on friction alone to maintain engagement with the spring and are mainly utilized on lower torque spring applications.
Mechanical engagement spring cones utilize various types of mechanical locking methods to physically secure the end of the spring to the cone. The most common type of mechanical engagement is a cone that slips or threads into the end of the spring and the end of the spring wire is heated up and bent to retain the spring onto the cone. The mechanical engagement cone type is utilized on larger, high torque spring applications.

There are two types of spring cones; stationary cones and winding cones. The stationary cone is attached to the spring and anchored to the header or other support using the center bearing bracket. The inside of the stationary cone is often sized to hold a shaft bearing when the cone is installed.

The winding cone is attached to the spring and controls the spring tension as it is applied and locked to the counterbalance shaft. It has outwardly radiating holes to receive winding bars for applying spring tension. Winding cones are most commonly sized to attach to 1 inch and 1-1/4 inch torsion shafts.

Set screws in the winding cones are used to secure the spring tension to the torsion shaft once tension is applied. Winding cones used on solid shaft doors may also utilize a key when secured to the shaft. Most manufacturers follow ANSI/DASMA 103 by utilizing red color coded set screws to secure the winding cone to the shaft.

Winding cones are also often color coded for convenience to identify the installation location on the door. Black identifies a part for the right side of the door (left wound spring) and red identifies a part for the left side of the door (right wound spring).

Cable Drums

Cable drums are aluminum castings and come in pairs. One end of each of the lift cables attaches to the drum. The drums convert the torque of the springs into a lifting force used to counterbalance the weight of the door. As the door is opened, the cables wrap around and collect on the drums.

Set screws in the cable drums are used to secure the drum to the counterbalance shaft. Cable drums used on solid shaft doors may also utilize a key when secured to the shaft. Most manufacturers follow ANSI/DASMA 103 by utilizing red color coded set screws to secure the cable drums to the counterbalance shaft.

Cable drums are also often color coded for convenience to identify the installation location on the door. Black identifies a drum which installs on the right side of the door and red identifies a drum which installs on the left side of the door.

In most cases, a slot in the cable drum is used to attach the cable. The cables must have the proper length to provide the correct amount of pre-wrap on the drums in the closed position.
In some cases, cable drums may utilize a third set screw for adjusting the cable length in the field.

**The Relationship between Drums and Springs**

To operate a door properly, the drums and springs are engineered to balance the door of a specific weight. The spring is determined by the combination of drum size, door weight and door height. Changing any one of these factors will affect the others.

For example, if the door weight is less than the spring is designed to balance, the door could open on its own at an accelerated speed. This can lead to possible damage or injury. Conversely, if the door weight is greater than the spring is designed to balance, the door would not open without a great deal of assistance and could drift downward on its own, also creating the potential for damage or injury.

The relationship between drum and spring size is also important. In most cases, a drum cannot be replaced with another size drum without changing the spring size to one that matches the new drum. Failing to observe this principle could result in an improperly balanced door.

**CAUTION:** Professional technicians should never make changes to a counterbalance system without first consulting the door manufacturer and ensuring the proper match between the drums and the springs.

**Cables**

Cables are used to transfer the spring torque through the cable drums into a lifting force to balance the door. The cables lift the door from each end and must be equal length to ensure the door travels level as it is opened. The cables will attach to both the cable drum, and the bottom of the door. As the door is opened, the cables will collect onto the cable drums.

Cables are constructed of multiple steel wires woven together to make a strand. Then multiple strands are woven together around a core strand to make a rope.

The cable construction is commonly identified using a designation consisting of number of strands x number of wires per strand. The most common cable constructions are 7x7 and 7x19. Cables with 7x19 construction are made using 7 strands with 19 wires per strand. It is important to verify the cable construction whenever replacing cables to ensure the proper load rated cables are used.

The ends of the cable are formed for interfacing with the door and the cable drums. The door end is typically looped to wrap around a pin at the bottom bracket. The loop is formed by looping the cable through a sleeve and may be reinforced with a teardrop. The loop must be properly sized to ensure proper engagement with the lift pin.

The cable drum end of the cable assembly typically contains a cable stop that is crimped.
to the cable to engage a slot in the cable drum. This stop is crimped at a specific location to establish the proper cable length. Some applications utilize a free-floating stop that can be field crimped for adjusting the cable length.

**Extension Springs**

Another type of counterbalance used on sectional doors is Extension springs. These springs typically require less headroom than torsion spring doors and can be easier to install because the shaft, end bearing brackets, cable drums, and spring fittings are eliminated. Extension springs attach directly to the door with cables that travel on sheaves, or pulleys. These springs must be safely restrained utilizing a restraint cable that runs through the center of the spring to contain the spring intact in the event of breakage and prevent potential damage or injury.

Extension springs develop pull force by being stretched. These springs are directly connected to the door using cables and the opposite end is typically anchored to the back hang angle or an attachment point at the end of the horizontal track. As the door is closed, the cable pulls the end of the spring causing it to stretch and generate force. This force is used to counterbalance the door. Similarly, as the door is opened, the stretch is gradually reduced. It is necessary to select springs that will stretch to a proper length, while delivering the proper counterbalancing force. In addition, the springs are produced with a preload, or a force holding the coils compressed together, which typically ranges from 10% to 20% of the total pull and helps hold the door in the open position.

Extension springs are designated using a code comprising **Length-Stretch-Pull**. Proper length of the spring is 30 percent of the door height. The amount of stretch equals half of the door’s height, and the pull rating of the spring is equal to the door’s weight. Hence, a pair of 25-42-200 springs is needed for a 7-foot high door weighing 200 pounds. This spring is 25 inches long and will exert 200 lbs pull per spring at 42 inches of stretch. The pulley on each spring divides the load to lift the door in half resulting in 200 pounds pull on the door for a pair of 200 pound springs. The stretch of the spring will create the balance force needed to lift the door.

There are three common end types used to connect extension springs when they are installed. The first is a single open loop. These springs have just over half a coil bent 90 degrees to create an open loop that can be hooked onto the back hang angle and connected to the sheave. The second end type is a double closed loop. This is essentially the same as a single open loop, except two coils are bent creating a closed loop that can be used to hook the springs. The third loop style is clipped ends, in which a metal strap is connected to the end of the spring in place of the closed and open loops. Clipped ends are most common on larger, higher load extension springs.
Extension springs are often color coded to identify the pull rating of the spring using a label or a splash of paint. The color codes are used by most of the industry spring suppliers and are defined in DASMA TDS #171. Some of the most common color codes for residential door extension springs are:

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<td>Red</td>
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Because a pair of extension springs mount independently, it is necessary to adjust the initial stretch on these springs to ensure equal pull force is applied to both sides of the door. Heavy gauge backhang angles are required for larger, heavier doors to hold the large pull forces of the spring(s).

Larger, heavier doors may require Tandem Extension Springs. These utilize 2 pair of extension springs to make up the total balance weight of the door. For example, 2 pair of 160 lbs extension springs may be used in a tandem arrangement to balance a 320 lbs door. A special hook plate is used to connect the two springs at the sheave.

![Diagram of door spring system](image)

**WARNING!** Extension springs are under extreme tension and can pose serious hazards if improperly handled. Severe injuries and deaths have resulted from improper handling and failure to use restraint cables.
Track Components

There are various different components that make up a track system depending upon the application and type of lift. Portions of the track system can be factory assembled for ease of installation. The following outlines the assemblies types and key components which make up a residential sectional door track system.

Track Mounting

Most residential doors utilize *bracket mounted track* to attach the vertical tracks to wood jambs. As the name describes, the track is attached to the jamb by using angle brackets, called jamb brackets. This type of mounting is commonly used on smaller doors and keeps the fasteners away from the opening edge so as not to break or split out wood jambs.

Vertical Track

Vertical track refers to the portion of the track system that is oriented vertically and is adjacent to the jamb. This track assembly is made up of a section of track and multiple jamb brackets used to secure the track to the jambs.

The shape of the track profile provides clearance for the roller to travel up and down, but with a narrow opening to prevent the roller from unintentionally exiting the track. It is manufactured from galvanized steel coil in a variety of gauges ranging from 12 through 18. The door weight, size, and mounting method of the track assembly must be considered when choosing the proper gauge of the door track. Track is available in 2 inch and 3 inch sizes, depending on the diameter of the roller which will operate in the track.

Vertical track is sloped away from the jambs at an increasing distance going up the opening. This slope is typically 1/8” per foot and is used to ensure that the door will pull away from its tight fit to the jambs, eliminating friction as the door travels. The graduated edge hinges of the door are designed to mate up with this slope resulting in a tight fit to the jambs in the closed position, and smooth, frictionless motion as the door is opened.

Jamb Brackets

Jamb brackets are “L” shaped angle brackets used to connect the vertical track to the door jamb when bracket mounted track is used. The small leg of the angle is used to fasten the bracket to the jambs and the long leg is used to space the vertical track out to align with the rollers. Jamb brackets are often slotted to provide in and out adjustment of the vertical tracks to properly seal the sections to the opening.

Jamb brackets are assembled to the vertical track using track bolts, or they can be welded or riveted to the vertical track at the factory. Some jamb brackets are numbered in graduation from the bottom to the top of the door to prevent the jamb bracket from sticking out past the vertical track. When field assembly is required, refer to the manufacturer’s jamb bracket schedule for proper jamb bracket locations.

Horizontal Track

Horizontal track is the horizontal segment of the track system that supports the weight of the
sectional door in the open position. This track will utilize the same profile as the vertical track. It is used in pairs and is formed from galvanized steel in a thickness designed for the application. It is formed on one end with a sweeping radius to allow the rollers to transition smoothly from the vertical to the horizontal position while the door is in operation. The radius of the track is the vertical distance from the radius end of the track up to the bottom of the horizontal portion. The most common sizes are 12 inch and 15 inch radius, however various other sizes up to 32 inch are available from many manufacturers. Like vertical track, the horizontal track is made in both 2 inch and 3 inch sizes depending on the size of the roller.

**Horizontal Track Angle**

A Horizontal Track Angle is a reinforcing angle formed from galvanized steel that is attached to the horizontal track. It is sized to support the weight of the door when the door is in the open position. This angle is welded or bolted to the horizontal track and may run the entire length of the horizontal track, or may be shorter on smaller doors where extra reinforcement is not required. The horizontal track angle typically extends beyond the radius enough to be attached to the flag bracket, header plate, or vertical angle that is attached to the jamb.

**Flag Bracket**

One common method of attaching the vertical and horizontal tracks is the use of a flag bracket, or flag angle. A flag bracket is a vertical angle with a splice plate protruding for joining the vertical and horizontal track angles. The upward extending portion of the flag bracket is used for ease of attaching the horizontal reinforcing angle. The jamb leg of the flag bracket is used to attach the flag bracket to the jambs. Flag brackets can be made as a single stamped part, or for larger doors, a splice plate may be riveted or welded to a length of angle.

**Headplate**

Another common method of assembling the vertical and horizontal track is the use of a headplate. The headplate is used as the end bearing plate to support the counterbalance assembly, but it can also be used to attach the horizontal track at the radius and/or the horizontal reinforcing angle at the same time. Similar to a flag bracket, the headplate will attach to the header or vertical tracks for ease of installation of the horizontal tracks.
**Types of Residential Sectional Door Lifts**

**Standard Lift Track**

The most common type of lift for a residential sectional door is Standard lift. This type of track system has a single set of vertical and horizontal tracks with a smooth radius between the two. The horizontal tracks are positioned so that the door clears the opening in the open position. The radius portion of the track can utilize multiple different sizes ranging from 10 inch up to 32 inch radius. The most common track sizes are 12 inch and 15 inch radius.

The first spiral on standard lift cable drums is usually stepped slightly larger, referred to as the **High Spiral** of the drum. This region of the drum has a larger moment arm to compensate for the initial upward travel of the door in which spring turns are reducing, but the door weight is unchanged because the top section hasn’t entered the horizontal tracks. When the door is in the closed position, there should be ½ to ¾ turns of cable prewrapped on the cable drums.

The balance of the spirals on a standard lift drum are flat.

The High Spiral Portion (A) of the drum starts the door in motion from the floor until the top roller enters the flat section of the horizontal track. Cable will begin to fill the flat portion (B) of the drum after the top rollers enter the horizontal tracks. The actual cable transfer from high spiral to flat will vary slightly depending on lift, radius, and/or shaft centerline. The height of the door determines how much of the flat portion remains unused with a door fully opened.

With a door in the closed position, the correct cable lengths will wrap 1/2 to 3/4 of the cable drum high spiral (solid arrow). To further verify cable length (hollow arrows), raise the door until the top bracket roller exits the radius and enters the horizontal track. The cables should be leaving the high spiral and entering the flat portion of the drums.

Cable drums for doors with larger track radius, such as 32 inch, may have more than one high spiral and require additional cable pre-wrap in the closed position.
**Low Lift Track (Low Headroom)**

Low lift track, often called low headroom track, is used when you have reduced clearance above the door. A low lift track system will incorporate a double horizontal track and a shortened vertical track. The upper horizontal track lowers the high arc travel of the top section as the door is opened which reduces the required headroom. Only the top roller on the top section will travel in the upper horizontal track.

Low lift track should only be used if there is not enough clearance for a standard radius track system as low lift doors require more force to push the top section in place and do not balance as well as standard lift doors. The slight curve of the upper horizontal track pushes the top section against the jambs when the door is closed. Without this feature, a drawbar operator is required to push the top section against the jambs when the door is closed.

Low lift doors utilize the same cable drums as standard lift. This track system typically utilizes outside hookup cables, where the cable and drums are positioned outside of the tracks and an outside hookup bottom bracket is used. This is because the upper horizontal track interferes with the path of the cable when inside hookup cables are used.

The springs can be mounted at the front or rear of the track. Rear mounted springs are used when very limited headroom is available. By moving the springs to the back end of the horizontal tracks, the springs can be lowered requiring less clearance. A sheave, or pulley, is mounted to the horizontal tracks near the opening and the cable is routed up and over the sheave and back to the cable drums at the rear of the track. Rear mounted springs may also utilize special track brackets for mounting the springs to avoid mounting the springs to back hang angle.

There are a variety of other methods used to achieve low lift track other than using a double horizontal track system. Special low lift hardware can be used to reduce the high point of travel of the top section by pivoting the section back from the opening into standard radius track. These systems are often used to convert existing doors in the field with tight headroom to provide clearance for a trolley operator. Low lift hardware designs typically require motor operation or utilize a special double roller top bracket to close the top section against the opening. They may also require longer horizontal tracks to clear the brackets in the open position.
Among the primary activities of DASMA is the publication of standards for the Door and Access Systems industry. ANSI/DASMA 102 is a voluntary standard defining minimum design and performance requirements for Sectional doors. This standard is outlined below to aid in understanding the performance requirements and specifications of sectional doors and related components.

1.0 Scope
1.1 Inclusions. This specification for sectional doors, as defined in Section 2, is intended to cover residential and commercial type doors normally used on garages, warehouses, factories, service stations, and other places requiring doors generally used for vehicular traffic.
1.2 Exclusions. It is not intended to cover doors generally used for pedestrian traffic nor other types of overhead doors such as rigid, folding, multi-leaf, rolling curtain doors, or special application doors.

2.0 Definitions – See Glossary of Terms at the back of this manual.

3.0 Referenced Standards – Refer to DASMA publication for referenced standards.

4.0 Installation/Operation – the door system manufacturer shall furnish standard details and instructions for proper installation and operation. Such instructions shall include warnings relative to the installation and operation of the door system.

5.0 Maintenance – the door system manufacturer shall furnish a listing of those components requiring regular maintenance with instructions and frequencies for such maintenance.

6.0 Durability
6.1 Residential and commercial door systems shall be designed to operate at a minimum of 10,000 cycles when they are properly selected, installed, operated, and maintained. A door system shall be designed to operate the specified cycle life when more than 10,000 cycles are specified.
6.2 When testing is performed to determine cycle life, testing shall be conducted in accordance with ANSI/DASMA 109.

7.0 Identification – each door system shall be labeled to identify the name and address of the door system manufacturer.

8.0 General Requirements
8.1 Hand Chain Hoist Operation – Hand chain hoists shall not be used on standard lift and low headroom applications unless provisions are made to maintain adequate cable tension as specified by the door system manufacturer.

8.2 Power Assisted Operation
8.2.1 Motorized jackshaft operators shall not be used on standard lift and low headroom applications unless provisions are made to maintain adequate cable tension as specified by the door system manufacturer.
8.2.2 If a drawbar operator is used, additional door reinforcement may be required upon installation. Reinforcement requirements for drawbar attachment shall be specified in the door system manufacturer’s installation instructions.
8.2.3 If an operator is listed as part of the door system, such operator shall be designed in compliance with the applicable sections of the...
8.3 Counterbalance Assemblies
8.3.1 Counterbalance assemblies shall meet the requirements of ANSI/DASMA 103.
8.3.2 Torsion spring counterbalance assembly design shall be in accordance with Section 9.3.
8.3.3 Extension spring assembly design shall be in accordance with ANSI/DASMA 103.

8.4 Sectional Door Interfaces and Lift Handles. Residential doors shall meet the requirements of ANSI/DASMA 116.

8.5 Thermal Transmittance/Air Infiltration. Published thermal transmittance and air infiltration values of installed residential and commercial doors shall be in accordance with the test methods specified in ANSI/DASMA 105.

8.6 Published steel gauge numbers shall be in accordance with Chart 1.

8.7 Foam Plastic Insulation. Foam plastics used in sectional doors shall meet requirements established by the authority having jurisdiction for flame spread and smoke development.

9.0 Loads
9.1 Windloads
9.1.1 Residential or Commercial Door System. A door system shall be designed to withstand a minimum wind load as required by the authority having jurisdiction over the geographic location where the door is to be installed. When required by the authority having jurisdiction, structural tests shall be in accordance with ANSI/DASMA 108 or other accepted means required by the authority having jurisdiction.

9.1.2 Where resistance to windborne debris is required by the authority having jurisdiction over the geographic location where the door is to be installed, a door system shall meet the requirements of ANSI/DASMA 115 or other accepted means as required by the authority having jurisdiction.

9.2 Dead Loads
9.2.1 Residential and Commercial Door Sections. Door sections, including their reinforcement, hinges, roller assemblies, and method of attachment to the door, shall be designed to support their own weight when in the horizontal position and not deflect more than 1/120th of the door width. Deflection shall be measured after the door has been in the horizontal position for at least 24 hours.

9.2.2 Horizontal Track Assembly. The horizontal track assembly, including installation hardware, shall be designed to support a dead load equal to the door weight when in the horizontal position and not deflect more than 1/240th of the door height. Deflection shall be measured after the door has been in the horizontal position for at least 24 hours. Twist, deflection, or deformation of the track shall not interfere with the operation of the door. The manufacturer shall specify the point(s) where attachment to the horizontal track shall be made for the purpose of suspending the track from the building.

9.2.3 Bottom Corner Bracket. Each bottom corner assembly, and
its method of attachment to the door, shall be designed to support a dead load equal to the weight of the door, and all on-the-door hardware, multiplied by a safety factor of 2.

9.3 Torsion Spring Counterbalance Assembly. The torsion spring counterbalance assembly shall be so designed and constructed to provide for a safe and durable conversion of spring torque to lifting power for balancing the weight of a sectional door as stated in paragraphs 9.3.1-9.3.6. Torsion springs shall not be used to balance sectional doors employing an index ratio of less than 6 to 1 (mean coil diameter six times wire diameter).

9.3.1 Torsion Shafts

9.3.1.1 Tubular steel torsion shafts shall be of a sufficient wall thickness to prevent a torsional (radial) deflection of the shaft in excess of 1.5 degrees per foot (305 mm) of shaft length from the torque source to point of delivery. Linear deflection of a torque shaft shall not exceed one-tenth inch (2.5 mm) per foot (305 mm) of shaft length with proper supports in position.

9.3.1.2 Solid steel torsion shafts shall be of a diameter and composition sufficient to prevent torsional (radial) deflection of not more than 2 degrees per foot (305 mm) of shaft length from the torque source to the point of delivery. Linear deflection of the torque shaft shall not exceed one-tenth inch (2.5 mm) per foot (305 mm) of shaft length with proper shaft supports in position. (Reference publication for shaft formulas)

9.3.2 Cable drums shall be so designed to allow cable to be accumulated or dispensed in an orderly manner and to prevent lapping or cable chafing. Cable drums shall be selected with a minimum safety factor of 4, based on the maximum torque for the applied load requirements.

9.3.3 Spring Fittings

9.3.3.1 Winding device shall have a torsional safety factor of 4. The portion of the winding device interconnecting with the spring shall be of a design that properly retains a torsion spring when fully wound or unwound, and withstands the radial and lateral forces exerted by the torsion springs.

9.3.3.2 Spring retainers and stationary sleeves shall have a torsional safety factor of 4. Spring retainers, or stationary sleeves, shall be so designed to withstand the radial and lateral forces exerted by the torsion spring to properly retain the spring when fully wound or unwound and
allow the application of torque.

9.3.4 Each side bearing plate shall be designed to support the weight of the counterbalance assembly, plus the total door weight, multiplied by a safety factor of 2. They shall be adequately reinforced to resist any lateral force exerted by the torsion shaft and properly retain the shaft bearing in alignment with the torsion shaft.

9.3.5 Spring anchor plates shall be so designed as to adequately transmit torque from the stationary end of a torsion spring to the building structure and, at the same time, support the weight of the torsion shaft, multiplied by a safety factor of 2, in a level attitude. The anchor plate shall be able to withstand the lateral forces exerted by torsion spring.

9.3.6 Shaft bearings shall be of a type and design that adequately support the radial forces dictated by the weight of the counterbalance assembly and door weight, lateral forces exerted by the torsion shaft, and shall be able to tolerate minor shaft misalignment conditions.

9.4 Cable Assembly. The cable assembly that transmits door load shall be selected using a safety factor of 5. Cable shall be securely anchored at each end. Cable diameters shall not be greater than 5% of the diameter of the cable drum or cable sheave with which it will be used.

10.0 Responsibility of Others

10.1 Transmitted Loads

10.1.1 The track system shall be attached to the building at the points specified by the manufacturer (Section 9.2.2) using a method capable of supporting the door loads at each point. In addition, the supports shall resist twisting and swaying loads imposed on them by the track system.

10.1.2 The installation instructions shall advise that it is important that forces transmitted from an installed door system to the building structure be considered in the design of building openings for doors. These forces are evident at the building jambs when a door is subjected to wind pressure, at each spring anchor pad and its connection to the building header, and at all points where the horizontal track is attached to the building. Since these forces will vary, installation instructions shall specify that load information may be obtained by contacting the door system manufacturer.

10.1.3 The spring system shall be installed with fasteners supplied by the manufacturer, in accordance with the manufacturer’s installation instructions.

11.0 Disclaimers

11.1 Certification that a door system meets this standard does not constitute a warranty that the system will perform in accordance with the standards set forth in this standard, including but not limited to durability, thermal transmittance/air infiltration, or loads. Certification implies only that the design of the listed door system, when tested in accordance with these standards (which may be random testing, if so specified), meets the applicable tests.

11.2 Many tests required by this standard are inherently hazardous and
adequate safeguards for personnel and property must be employed in conducting such test.

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<td>0.0105</td>
<td>0.0107</td>
<td>0.0110</td>
<td>0.0115</td>
</tr>
</tbody>
</table>

**NOTES:**
- CHART REPRESENTS MINIMUMS (IN INCHES) PER GAUGE NUMBER AND SEVERAL COMMON GALVANIZING WEIGHTS.
- CHART IS BASED ON ASI REFERENCES AND TOLERANCES.
- BARE STEEL THICKNESSES REPRESENT STEEL WITHOUT THE ADDITION OF GALVANIZING.
Chapter Five

Fundamentals of Residential Installation

Quality

A professional door systems technician should always seek perfection and always provide the end user with all warning stickers, placards, and owner’s manuals. Failure to do so not only leaves the job site incomplete but also exposes the company to unnecessary risk exposure.

Consumers expect high quality at a fair price. In addition to knowing the mechanical functions that cause a door system to work properly, the professional technician must be equally skilled in educating end-users regarding the safety and maintenance of the product. All mechanical aspects of the garage door must be fully functional and all equipment must be properly installed before releasing the door for use.

Conduct an operational test with the customer while the door is in manual mode. Open and close the door several times feeling for any areas of binding. Whether the customer plans on using an operator or decides to use the door manually, a quality installation will enable the door to operate smoothly from the full open position to the fully closed position.

An effective method of ensuring the successful completion of a quality installation is to develop a systematic process of installation. Although there will be unique aspects to each job, having a standard method of installation allows the technician to work more efficiently.

Productivity

Economic reality creates advantages to those who operate at the highest levels of productivity. The overhead door industry is a perfect example of this principle. As with many mechanical objects, door systems have undergone constant technological advancements, and the means by which they are installed has become more systematic.

Early doors were constructed of wood, which was readily available and inexpensive. Problems arose from the lack of standardization of openings. The horizontal rails, vertical stiles and cross braces were individually cut for each installation. Over time, standards were developed to facilitate the mass production of overhead doors which significantly reduced the time required to complete a job.

Advances in tools and equipment have increased efficiency. An earlier generation of installer used hand-driven tools, such as hand crank drills, ratchets and screwdrivers. The development of electric and cordless tools has provided the industry the ability to increase productivity by leaps and bounds.

Many tools used today are the same type used decades ago. Hammers, open-ended wrenches, pliers, and screwdrivers look the same, but the use of lighter weight ladders, circular saws, and rapid spinning battery powered impact wrenches have replaced much of the manual force once exerted.

Another notable enhancement has been the evolution of the door systems truck. Standard pick-up and flatbed trucks have been replaced by service vehicles featuring storage, tool bins, racks, and organized work areas, which allows a technician to transport everything needed for a day on one truck.

It is important that quality not be compromised for the sake of productivity. Although productivity is an essential element in today’s competitive market, the skill and expertise of the technician creates the value demanded by consumers. Increased productivity should never be confused with shortcuts. Manufacturing standards, installation methods, power tools and service vehicles enhance productivity, but the value to the customer always begins and ends with the technician’s commitment to quality.
Company Policies

One important step towards becoming a professional is to learn about your company and understand its policies.

What is important to understand is that company policies do not exist to hinder your performance or restrict your activities. They exist to help you promote a positive company image, to enhance your individual professionalism, to protect against physical injury, to ensure a quality work environment for all employees and to maximize the potential of each member of the organization.

In this section, you will learn about your company and its policies. Your supervisor will help you to understand not just the meaning of the policies, but the reasons why they exist. You will find freedom in thoroughly understanding these policies, as quality work habits are an essential part of being a professional.

Outline of a Company Policy

Each employer establishes policies to provide a clear understanding for all personnel regarding what is expected of them, and what they can expect from the company. The following is an outline of a typical company policy:

1. History of the Company
   a. Company’s Founding
   b. Goals and Objectives
   c. Mission Statement

2. Representing the Company
   a. Appropriate Attire
   b. Personal Appearance
   c. Vehicle Appearance
   d. Customer Service
   e. Driving Requirements

3. Pay Schedules, Benefits, Etc.
   a. Regular Pay
   b. Overtime
   c. Scheduling
   d. Paid Holidays
   e. Probationary Period
   f. Personal Leave
   g. Jury Duty
   h. Vacation
   i. Travel Expense Reimbursement
   j. Alcohol and Drug Testing
   k. Break and Lunch Allowances
   l. Develop Good Work Habits
   m. Employer-provided Tools
   n. Employee-provided Tools
   o. Vehicle Maintenance

4. Organizational Chart

5. Job Descriptions

6. Reprimand and Disciplinary Actions
   a. Unexcused Absences
   b. Tardiness
   c. Policy Violations

Truck, Tools and Equipment

The following section regarding Truck, Tools, and Equipment, is meant to be used as a recommendation only for minimum standards for installers. Markets will vary and require special needs. Training in the safe and proper use of each of these tools is part of a comprehensive training program provided at the dealer level.

Power Tools and Equipment

- Drill Motor – electric or cordless
- Impact Drive – electric or cordless.
- Circular Saw
- Reciprocating Saw
- Mini-Grinder
- Cable Puller
- Come-A-Long
- Extension Cords - one 25’, one 100’
- Electrical Gang Box
- Angle Iron Cutter
**Truck Inventory**

- Hinges - #1 through #5 (maximum four each)
- 2” short stem and long stem rollers
- Top Corner Brackets (one pair)
- Bottom Corner Brackets (2” inside; one pair / 2” outside; one pair)
- Low Headroom Top Brackets (one pair)
- Step Plates and Lift Handles
- Cable – one pair for 7’and 8’ high torsion and extension spring doors
- One pair 4 inch standard lift cable drums
- 1” bearings (2)
- Universal Spring Anchor Brackets (2)
- End Bearing Plates (one pair)
- Back Hang Angle (minimum four 8 foot lengths)
- 5’ or 6’ Step Ladder
- Fasteners; assorted per door brand
- Push button wire (2-lead)
- Wall push button
- Stud and Clevis Pulleys (one pair each)
- Saw Horses
- Inside Lock
- Complete outside keyed lock
- Bottom Astragal for Wood Door
- Touch Up Paint (per door mfg.)
- Jamb Brackets / Flag or Joint Brackets

**Recommended Tool List**

- Level – 12 inch and 4 foot
- Wrenches; Open Box End 3/8”, 7/16”, 1/2”, 9/16”
- “C” Clamps (at least two pair)
- Ratchet; 3/8” and 1/2” drive
- Locking Pliers; 9” (at least two pair)
- Sockets: 3/8”, 7/16”, 1/2”, 9/16” deep well

**Truck Recommendations**

- Extension for Ratchet; 3” and 6”. 3/8” and 1/2” drive
- Pry Bar
- Assorted Flat and Phillips Screw Drivers
- Assorted Chisels (wood and steel)
- Flashlight
- Hacksaw with blades for wood and steel
- Drill Bits – 3/16” thru 1/2”
- Wire Cutters (diagonal cutter)
- 25’ Tape Measure
- Tool Pouch
- Caulking Gun
- Hammer – minimum 16 oz. Straight claw
- Winding Bars – 1/2” OD cold rolled steel
- Nut Drivers (1/4” thru 7/16”)
- Impact Sockets (3/8”, 7/16”, 1/2”, 9/16”)
- Staple Gun (round staples)
- Adjustable Wrench
- Metal Cutters (straight)
- Cable Cutters
- Needle Nose Pliers
- Speed Wrench
- Compass With Pencil
- Uni-bit

- ½ Ton Rated Suspension
- Add-on Storage Box for Pick-ups
- 12 Foot Overhead Rack or Longer
- Fire Extinguisher
- First Aid Kit
- Caution Tape
- Hard Hat
- Safety Glasses
- Map or GPS
- Spare Tire and Jack
- Gloves
- Vehicle Registration and Proof of Insurance
Installing a Residential Sectional Door

Ordering the Door

Ordering the door should be accomplished with care and foresight. An installer may be consulted in this process and should be knowledgeable with regard to the product and its application. Rules governing the installation of sectional doors not only follow specifications, but also the law and local building codes. The proper action taken to ensure the correct door is ordered is an important step in the installation process.

A professional installer will also perform a site survey prior to ordering the door to verify field dimensions against requirements including opening size, side room, head room, etc. Note the condition of the jambs and if their construction is suitable for the door installation. All jambs must be plumb, level and square. Check floor conditions, side room requirements, jamb conditions and overhead clearances and spring and bearing support pads are secure and flush with jambs. Taking the extra steps to ensure accuracy from the initial stages of the process will enhance the efficiency and profitability of the project.

Receiving the Door

Once the door has been ordered and shipped the next step is proper receiving of the material. Once a product is received, counting and checking the material before the truck has left the dock is required. In many cases, shipping miscues involving missing items or damage may delay the start of a project. An even worse scenario is to discover missing parts or specialty hardware once an installation is well under way.

When all is received and accounted for, storage and handling is the next step. The door should be stored indoors away from the outside elements. Careful attention must be given to storage of the sections. These can be heavy and can be easily damaged if dropped. Some doors may have a special finish. In this
case, the final product will be expected to appear as a finished product. Damaged parts can result in costly replacement expense and additional delays in the installation project.

**Safety Awareness**

Before covering installation, it is of vital importance to establish that safety should always be the installer’s primary concern. As a professional, it is the installer’s responsibility to always make safety and quality a priority. These two priorities go hand in glove.

Like it or not, an installer may be liable for an installation in the event of an accident. We often hear of door systems related accidents where children or adults have been seriously hurt, some even fatally, due to an improper installation.

We also hear of lawsuits where defendants have been awarded tremendous amounts of money. Some of these suits were the direct result of careless workmanship. So, in order to assure customer safety and satisfaction; **ALWAYS FOLLOW THE MANUFACTURER’S INSTALLATION SPECIFICATIONS AND INSTRUCTIONS.**

The installer can assure their own personal safety by always wearing the correct safety equipment including a hard-hat, safety glasses and steel-toed shoes. Making safety a number one concern will help keep the installer on the job for years to come and help to insure the profitability of the business.

**Preliminary Safety Precautions**

1. Wear protective gloves to avoid lacerations from sharp metal edges.
2. Always wear eye protection to avoid potential serious eye injuries.
3. Avoid installing a new door on windy days. The door could fall during installation causing severe injury or death.
4. In general, doors 12’0” wide and over or with heavier sections should be installed by two persons to avoid possible injury. Reference company policies.
5. Operate door ONLY when properly adjusted and free of obstructions.
6. Keep door in full view while operating it. Watch the door open or close completely before leaving the area.
7. Should the door become hard to operate or completely inoperative, a qualified door agency should correct the problem to prevent damage to the door or serious personal injury.
8. DO NOT PERMIT children to play with the garage door or the electrical controls. Fatal injury could result, should the child become entrapped between the door and the floor.
9. To prevent serious injury or death, avoid standing in the open doorway or walking through the doorway while the door is moving.
10. Use lift handles/step plate when manually operating the door. DO NOT place fingers into section joints when operating the door.
11. Pull rope must be removed and locks must be removed or disabled if door is operated by an electric opener.
12. Door is constantly under EXTREME SPRING TENSION. To prevent possible serious injury or death, adjustments, repairs, removal, or installation, ESPECIALLY of SPRING ASSEMBLIES, CABLES, or BOTTOM BRACKETS, should be performed ONLY by qualified door service people.
13. Check door and its hardware monthly for loose, worn, or broken parts. Have any repairs or adjustments made by a qualified door agency.
14. Test electric operator’s safety features monthly.
15. Have the door professionally inspected once a year.
Getting Started

Prior to loading material on the truck, check that all paperwork is complete and correct. All crates and boxes must be accounted for and loaded. It is important to read all instructions carefully, checking shop drawings supplied for any special conditions. Open all crated materials and check with attached parts list prior to installation. All parts supplied should correspond with the type of door being installed. All special devices should be reviewed prior to installation.

Site Inspection

Once at the job site, check in with the homeowner and review all paperwork and job requirements prior to proceeding. Review all conditions and area required for the installation. Be sure that other persons will remain outside of the work area for safety reasons. In some situations, installing caution tape may be required.

Removing an Existing Door

Often, the installation of a new door will begin with the removal of an existing door. The technician should take special precautions when removing an existing door to avoid dangerous situations and safety risks. This is especially important when the installer encounters components which may be unfamiliar. When in question, contact the original door manufacturer for door removal instructions. Installation instructions are typically not intended to cover the removal of an existing door.

The first step in removing an existing door is to disconnect and remove any electric operator to prevent unintended door operation. Use caution to properly disconnect power before working on an electric operator to avoid the risk of electric shock.

The next, and most important step, is removal of spring tension and the counterbalance system. Counterbalance spring tension must be relieved before removing any hardware. Do not release spring tension unless you are qualified, experienced, and familiar with the counterbalance system of the existing door. Always use properly sized winding bars when removing torsion spring tension and never cut cables as a method of removing tension. Contact the original door manufacturer for removal instructions anytime an unfamiliar component is encountered, especially if the counterbalance system is unfamiliar.

Once the spring tension and counterbalance system is removed, the door can be disassembled by removing the hardware and unstacking the sections one at a time starting with the top section. After all of the sections have been removed, remove all remaining track and hardware from the jambs and begin to prepare the opening for the new door.

Installation Preparation

The very first step of an installation begins long before one arrives on the job site. For most, it means getting the truck cleaned and ready to load. One should double check the door being loaded to make sure it is the proper door (refer to the work order). Load the door onto a suitable rack or smooth, clean surface to prevent unnecessary scratching or denting.

Upon arriving at the job site, the installer should double check the address or lot
number. The truck should be parked close to the work area, but out of the way of other contractors – allowing access for others to the residence. In retro-fit conditions, be conscious of the customer’s property. If the truck leaks oil or other fluids, take the necessary precautions to prevent customer complaints.

Before taking the door or any tools off the truck measure the garage door opening and check for proper headroom according to the door brought to the job. Also, make sure the opening has been correctly framed.

All jambs should be at least 1-1/2 inches thick and nailed securely to the garage-framing studs. This assures that the lag bolts that will be used throughout the installation will have a substantial fastening surface. The use of 3/4 inch stock for a garage door jamb is not acceptable.

If the door being installed has a torsion spring, pay particular attention to the spring pad. Make sure it is securely fastened with long framing nails. Re-nail or screw in a few lag screws if unsure.

The final preparation step is to create enough room to work inside the garage (if necessary). This may entail moving bikes, mowers, construction material and equipment. One should ask the question, “Have I made myself a safe place to work?”

Assessing the Opening

All jambs must be plumb, level and square. Check floor conditions, side room requirements, jamb conditions and overhead clearances and spring pads are secure and flush with jambs. If removing an old door, all jambs must be clean of existing welds and debris from the prior door mounting material. After the door is removed and jambs are cleaned and prepared, the jambs and attachments must be checked and repaired as necessary before the installation can proceed.

Part of the installer’s responsibility is to verify that the jamb conditions are suitable for the type of door being installed. For instance, if a sectional door was intended to be installed on wood jambs, and the jambs are discovered to be deteriorated, this condition must be reported and addressed. This is the responsibility of the installer to address this situation before proceeding. Proceeding with the installation when the opening is not adequate to support the door can result in project delays and complications, along with increased liability to the installer and the company.

Sizing the Opening

The opening dimensions and clearances must be verified with manufacturer installation instructions. Verify opening width and height. In addition the opening surfaces should be plumb, and the floors and lintels level. If they are not, compensation for these conditions must be addressed in the beginning. Adequate side room clearances must be available. Typical installations require at least 4” of sideroom. If the proper room is not available, these conditions must be corrected before the installation can begin. Doors must be installed according to the manufacturer’s instructions.

Headroom Requirements

Here again, dimensions and clearances must be verified with the manufacturer installation instructions. It is important that the owner understand nothing should be attached to the door, and that objects should not be stored or
installed in a manner that might obstruct the door.

Job Site Organization

It is important that all material be organized to be sure that a safe and efficient installation process is achieved. Layout tracks in adjacent area to the wall, sections, counterbalance shaft and hardware should be placed clear of the opening to prevent tripping hazards during installation. Layout all hardware and fasteners to check for proper count and type. If the provided hardware cannot be used, substituted hardware must be approved by the manufacturer.

Once everything has been accounted for, and the job has been checked, installation can begin. Taking the proper steps prior to beginning installations will save time and increase efficiency by avoiding complications.

Installation Technique

There are several different common methods used for stacking sections during installation of a residential sectional door. The preferred method may vary for each job depending on site conditions, weather, installer preference, number of installers, type and size of door, etc. In all cases, it is imperative to select the method which provides for the safest installation. Three of the most common techniques used are described below.

Technique #1

The first common technique used to install a sectional door is to stack all of the sections in the opening prior to installing the vertical tracks. This method simplifies the installation of the vertical tracks because they can be easily spaced off the ends of the sections. The drawback is that the installer(s) must prevent the sections from falling until the vertical tracks are installed. Nails or screws are often used at the ends of each section to temporarily hold them in place until the tracks are installed.

Technique #2

Another common technique is to install only one side of the vertical track prior to stacking the sections. The bottom section is used to space and plumb the vertical track. The lower portion of the track is fastened to the jambs and the remaining track fasteners are installed gradually as each section is stacked. Each of the sections being stacked is brought in at an angle to insert the roller into the vertical track. The section is then pivoted and placed on top of the lower section. Once all of the sections are installed, the second vertical track is installed. This method may be more difficult for wider or less rigid sections.

Technique #3

The third technique is similar to the second, except both vertical tracks are installed prior to stacking the sections. The bottom section is used to space and plumb the vertical tracks. The lower portions of both tracks are fastened to the jambs and the remaining track fasteners are installed gradually as each section is stacked. The sections can be stacked by lifting each section to the top of the vertical tracks to insert the rollers, or one end of the section
Installing the Hardware

A door is stacked in sections from bottom to top with the first section being designated as #1, or bottom. The next section to be stacked is the #2, or intermediate section, and so on until you reach the top section. The hardware is often applied to the sections prior to stacking them in the opening to save time climbing and moving ladders once the sections are stacked. Lay each section on saw horses and install the hardware outlined. Use appropriate support to minimize section damage and bowing.

Starting with the bottom section, attach the cables to the bottom fixtures. Now attach each bottom fixture to the bottom corner of the section. Use only the fasteners supplied by the manufacturer. Attach the bottom seal to the bottom of the section if required. It may be necessary to notch the bottom seal around the bottom corner brackets. Attach both sets of graduated end hinges and all of the intermediate hinges to the section in the appropriate locations. The graduated end hinges for 2 inch track typically start with a #1 hinge on the bottom section and graduates up for each section. 3 inch track typically starts with a #3 hinge and graduates up. Some manufacturers start with a single barrel hinge, others may start with a double barrel hinge. Verify the appropriate end hinge graduation with the manufacturer’s instructions. The hinges should be oriented so that the number and any text stamped into the hinge are legible when the section is stacked in the opening.

If one or more struts are supplied for the bottom section, attach them at this time. Use appropriate saw horsing to ensure the section is not bowed when struts are installed. Installing a strut on a bowed section could cause the section to be bowed when stacked in the opening. Once the bottom section hardware is attached, set the section aside and proceed to the intermediate sections.

Intermediate sections are typically all the same, unless a lock, lite, or full view window section is supplied. Determine the appropriate #2 section and attach the end hinge to one end of the section only. Unless otherwise specified by the manufacturer, the #2 section will use a #2 hinge for 2 inch track or a #4 hinge for 3 inch track. Refer to the manufacturer’s instructions. Attach all center hinges in the appropriate locations. If struts are supplied for the #2 section, lay them out along with hinges and attach at the same time following the guidelines above. Repeat this procedure for all intermediate sections in order with proper end hinge graduation and leaving the end hinges off the same side of each section.

Assemble the top section hardware to the top section of the door in the same way. Assemble the top fixture base and slide and attach them to the top ends of the section. Install the strut to the top section if applicable. If a drawbar type operator is being utilized, install the operator bracket and/or top section reinforcement kit at this time.

Also perform any necessary track assembly at this time. If jamb brackets require field assembly, refer to the manufacturer’s installation instructions for the proper jamb bracket schedule and assemble them to the vertical track. Attach flag brackets to the vertical tracks if applicable. Assemble the horizontal reinforcing angle to the horizontal track if needed.
Install rollers in the graduated tube of the end hinges, top fixtures and bottom fixtures of all sections. Reference the manufacturer’s instructions to verify if roller spacers are required on the bottom rollers.

**Placing the Bottom Section**

Center the bottom section in the opening and level using shims if required. If a shim is used to level the bottom section, the track on that side must be raised the same amount. Allow the shim to stick out far enough for the tracks to rest on as well. Secure the bottom section from falling until the vertical tracks are installed. A common method of securing the bottom section from falling is to use clinch nails. Temporarily drive a nail or screw into the jambs at each end of the section and bend the nail/screw over the section edge.

**Installing the Vertical Track**

Stand one hand of the vertical track and twist into position, inserting the top and bottom rollers of the bottom section into the track profile. String the cables to the top of the track so they will be properly positioned once the sections and the track are in place. If a shim was used to level the bottom section, the track must rest on this same shim to raise the track the same amount. This will ensure that the left and right tracks are level with one another. Follow the manufacturer’s specifications for track spacing. Typical track spacing provides 1/2” to 3/4” clearance between the end of the sections and the vertical track.

Plumb the vertical track to the bottom section while maintaining this spacing and fasten the bottom two to three mounting locations to the jambs. Repeat this step for the opposite vertical track.

**Stacking the Intermediate Sections**

Locate the next section to be installed. This section should have only one end hinge and roller on one end. While holding the section at an angle away from the opening, insert the roller into the vertical track. Swing the section towards the opening to lock the roller in the track and stack the section on top of the lower section.

Place a roller into the roller carrier of the appropriately numbered end hinge for the opposite end of the section. Pivoting the roller into the vertical track, position the hinge on the section and fasten in place. Attach the end and
intermediate hinges from the lower section to the upper section.

Repeat these steps for each of the remaining intermediate sections. As each of the sections is installed, verify it is centered and level. Progressively fasten the vertical track and flag angle if applicable to the jambs as the sections are stacked, ensuring the tracks are plumb to the sections and the proper spacing is maintained. Do not install the top section.

Install the Horizontal Tracks

Once the bottom and intermediate sections are stacked and the vertical tracks are secured to the jamb, install the horizontal track. Raise one of the horizontal tracks into position. Using track bolts and/or splice plates, connect the vertical track end to the horizontal track end. Attach the horizontal reinforcing angle to the front flag bracket, wall angle, or headplate and secure to the jambs. Temporarily support the rear of the horizontal tracks and repeat for the other side.

Install the Top Section

Raise the top section and stack on top of the rest of the sections following the same procedure used for the intermediate sections. Use a nail or other appropriate method to temporarily secure the top section to the header until the top fixtures and rollers are installed. Fasten the top fixtures with rollers on each end of the section. Adjust the top bracket slide so that the top roller pushes against the track and seals the top section tightly across the header. Remove the temporary fastener securing the top section to the header.

Installing the Counterbalance Assembly

Assemble both end bearing brackets to the horizontal reinforcing angles and fasten to the jambs on both sides of the door. The wall mounting flange should align with the fasteners for the vertical track. When lag screws are used to secure the end brackets to the jambs, be sure to pre-drill the proper size to achieve proper fastening strength and to prevent splitting the wood.

The springs, bearings, support brackets, center coupler (if applicable) and drums must be assembled in the proper positions on the shaft(s). Most manufacturers use color coding to aid in this identification. The spring cones and drums will be color coded red or black. The red cable drum goes on the left side of the door and the black drum goes on the right. The set screws of the drums will face the springs. The spring with red color coding is a right hand wound spring that installs on the left side of the door. Similarly, the spring with the black color coding is a left hand wound spring that installs on the right side of the door. Position the counterbalance components on the shaft(s) in the proper location.

Lift the shaft and spring assembly and insert the shaft into one end bearing bracket. Slide the shaft in far enough to get the shaft into the opposite support and slide back into place.
Repeat for opposite shaft if two piece shaft is used and center the shaft assembly in the opening.

Measure the vertical distance from the top of the top section to the center of the shaft at the end bearing brackets. Transfer this measurement to the center bearing bracket installation locations. This marks the vertical location of the centerline of the shaft. When lag screws are used to secure the center bearing brackets to the jambs, be sure to pre-drill the proper size to achieve proper fastening strength and to prevent splitting the wood. Also, when installing center bearing brackets to wood spring pads mounted over masonry, be sure to utilize proper length lag screws to prevent contacting the masonry. Position the center bracket such that it is plumb and will locate the shaft in line with the mark and fasten to the spring pad. Repeat if multiple center bearing brackets are required.

**Warning!** Failure to follow the manufacturer’s instructions and safety precautions could result in sudden spring tension release, causing severe injury or death.

Assemble the stationary ends of the springs and the bearing(s) to the center bearing brackets following the manufacturer’s instructions. If slotted and/or adjustable center bearing brackets are used, be sure to position the springs such that the shaft is the same centerline distance from the jambs and spring mounting pads. If a split shaft assembly is supplied with a coupler, do not bolt the coupler together until the cables are set.

The next step in counterbalance assembly is drum and cable installation. Cable drums should always be installed starting on the left hand side first. The cable drums tend to rotate slightly when the set screws are tightened. By installing the left hand drum first, this rotation is minimized, making it easier to get equal cable tension. Starting from the left side, slide the left hand cable drum against the left hand end bearing bracket and secure to the shaft by tightening the set screws. If solid keyed shaft is used, insert the drum key into the drum and shaft keyways prior to tightening the set screws. Do not over tighten the set screws as drum damage may occur. There must be a minimum of 1/2 pre-wrap of cable on the cable drums.

Attach the left hand cable to the drum by pulling it through the entrance slot until the stop catches. Rotate the drum and shaft around in the direction to open the door until the cable is tight. Secure the shaft into place with locking pliers. Repeat the drum installation for the right hand side. If a one piece shaft is supplied, connect and tighten the cable prior to tightening the drum set screws. If a split shaft is supplied, follow the same procedure for the right side and lock the second shaft into place with locking pliers.

### Applying Spring Tension

Putting tension on springs must be done with safety in mind first. Place a straight line on the springs with soap stone, chalk, paint, etc which can be used to count the number of turns on the spring as they are applied. Make sure the door is level and place a pair of locking pliers above one roller on each side of the door to
prevent it from rising once the springs are wound. Reference the manufacturer’s instructions and/or spring tag information to determine the required number of spring turns.

Winding bars must be of the proper size, length, and material type per the manufacturer’s specifications. The winding bar should be the same diameter for its full length and should not be hardened or of a material stronger than recommended by the manufacturer. Proper winding bars are designed to bend prior to reaching torque levels sufficient to damage the spring cones.

**Warning!** Never use screwdrivers or incorrectly sized winding bars. Winding bars must fit snuggly into holes in spring winding cones. Attempting to wind springs with loosely fitting rods, screwdrivers or other improper tools can result in severe injury or death.

Determine the proper direction for winding the springs. Turns will be applied to the spring by winding the end in the direction the cable drums will turn as the door is closing. This direction should correspond to the direction the end coil of the spring is pointing. For inside hookup doors, the springs will wind upwards.

Stand to the side of the winding bars and be sure to insert the bars all the way into the hole. Utilizing the proper sized winding bars, insert one winding bar into the winding cone and rotate the spring upwards 1/4 turn until the next winding hole is accessible. Insert the second winding bar into this hole. Once the second winding bar is inserted and holding the spring tension, remove the first winding bar and apply ¼ turn using the second winding bar. Continue applying turns using this 1/4 turn alternating pattern until the required turns are applied.

While holding spring tension, insert key stock if required and stretch the spring 1/4 inch by lightly tapping on the winding bar. Tighten the set screws in the spring winding cones to secure the spring tension to the shaft. Do not over tighten the set screws as this could damage the spring cone. Once the set screws contact the shaft, tighten the screws one full additional turn. With setscrews tightened, apply pressure in the opposite direction with the winding bar to verify the sets screws are secure. Repeat spring winding for the remaining springs if applicable.

After winding all of the springs, install the coupler assembly bolts if the door utilizes a two piece shaft. Remove the locking pliers from the spring shaft(s). Be sure all ladders, scaffolding, etc. has been cleared from the travel area of the door.

**Back Hang Installation**

Installation of the back hang is a critical point in the installation. Verify the type and weight of the steel to be utilized. Once the proper size
has been determined, locate the structural members of the building to attach to. Proper size of fasteners must also be selected. Refer to the manufacturer’s instructions for reference. An under rated fastener or angle iron that is too light can be catastrophic.

Test the Door for Proper Operation

Remove the locking pliers from the tracks and test the door operation. Verify clearances between the door and the vertical and horizontal tracks. When the door is in the up position, verify that both cables are taut. When raising and lowering the door it should stop at any point and stay, except when the rollers are in the radius of the track or if the door has heavy glazed sections. When operating the door, verify the door rolls freely throughout travel. Verify the cable properly spools onto the cable drum as the door is opened and that the cable is not rubbing against the track or sections during operation.

Verify the door seals properly to the opening in the closed position. Loosen and adjust the vertical track, if applicable, so the sections seal to the opening properly.

Lubricate all rollers, hinges, and springs. If the door does not have outside weather-strip, adjust the track tight to the jambs making sure the door will move with little resistance.

Once the door is operating properly, the next step is to install the weatherstrip. Adjust the vertical track of the door to create a 1/8” to 1/4” gap between the door and jamb. Position the weatherstrip so that the seal touches the face of the door and secure per the manufacturer’s instructions. Install the lock components at this time if required.

Install all warning stickers, tags and labels. Clean the door and your work area when finished. Do not leave any paper or boxes on the job site.
Demonstrate for the customer how to use the door in a proper and safe manner. Allow the customer to operate the door and verify they are satisfied before you leave the job. Upon gaining the approval of the customer, have them sign all paper work for their approval and distribute all warranty papers, etc.

**Low Lift Track Installation**

**Front Mounted Springs, Low Lift (Low Headroom) Track Installation**

A front mounted spring system is one of two types of low lift track utilized when headroom is not available for a standard lift door. The track is installed the same way as standard headroom track, except the vertical track is shorter and the horizontal tracks have a dual track profile arrangement. The rollers of the top fixtures will ride in the upper horizontal track and the rest of the rollers ride in the lower horizontal track.

Most front mounted low lift track systems utilize outside hookup cables. This requires special outside hookup bottom corner brackets and the cable drums are mounted on the outside of the vertical tracks. In this configuration, the red cable drum still goes on the left side of the door and the black cable drum on the right, but the drum is reversed so that the cable spools onto the front of the drum (away from the jambs) instead of the back. The springs, however, flip sides such that the black color coded spring (left wound) installs on the left side of the door and the red color coded spring (right wound) installs on the right. When the spring tension is applied, the springs will be wound downward instead of up.

**Rear Mounted Springs, Low Lift (Low Headroom) Track Installation**

The second type of low lift track utilizes rear mounted springs. As the name implies, this track is installed with the spring and shaft assembly located at the rear of the horizontal tracks to allow a door to be installed in as little headroom as possible. A sheave will be mounted on the track near the header of the door for translating the cables back to the rear mounted drums.

The track is identical to front mount low lift track and these doors also utilize outside hookup cables and bottom corner brackets. The drums mount on the outside of the track with opposite orientation - the black cable drum on the left and the red cable drum on the right. When center mounted, springs have the same orientation as standard lift such that the red color coded spring (right wound) installs on the left side of the door and the black color coded spring (left wound) installs on the right.

Some manufacturers mount rear mounted springs on spring plates located at the ends of the tracks. When the springs are end mounted, the color code must be reversed such that the black color coded spring (left wound) is installed on the left side of the door and the red color coded spring (right wound) is installed on the right side of the door. When in question, reference the manufacturer’s instructions for spring orientation.

When the spring tension is applied to rear mounted springs on low lift track, the springs will be wound upward the same as standard lift.

**Important Note:** When utilizing low lift track, it is very important that the vertical track length measurement is followed. Low lift track is opposite of standard headroom track when raising and lowering the track in the field. If the low headroom vertical track is cut down, the high arc of the door will be increased.
When Installing with an Operator

To prepare a door for an operator, proper reinforcement must be installed to the top section. Improper installation of reinforcement can cause damage to the door as well as personal injury. Refer to the manufacturers’ installation instructions for proper reinforcement and attachment.

Extension Spring Assembly

An extension spring door follows a similar installation process already reviewed with a few exceptions. Assemble sheaves to the horizontal angle previously assembled using appropriate fasteners. Hook the clevis (fork) through one end of the extension spring and attach the sheave to the clevis. Fasten an eye bolt to the perforated track hangers 6 to 8 inches above the horizontal tracks and hook the loop of the spring over the eye bolt. An eyebolt is not necessary if using open loop springs.

Slowly raise the door to the full open position and secure from closing. YOU MAY NEED ASSISTANCE WITH THIS PROCEDURE. Attach cable to the stud on the bottom bracket. Feed the cable up to the cable sheave above, keeping it between the vertical track, the end of the door, the roller shafts, and the wall. The cable should feed up over the sheave and over the top of the sheave attached to the spring(s) and down through the clevis. Attach an “S” hook to the cable using a cable end and hook to the horizontal angle. Repeat procedure for the opposite side.

Remove clamps and open and close the door a few times to test the operation. The door is considered reasonably balanced when it will stay (not fall or raise) in a partially open position. If the springs need adjustment, prop the door in its full open position and move the adjusting “S” hook forward for more tension or backward for less tension. BE SURE TO ALWAYS MAINTAIN EQUAL SPRING TENSION ON BOTH SIDES.

Install spring containment kit as outlined in the following instructions.

Uncoil the spring containment wires and lace them through the springs. Secure each wire by wrapping it around the back support and then winding it back upon itself. Pull the wire(s) tight and secure to the front. It may be attached to the vertical flag bracket, or to the header with screw eyes. In either method, the wire should be aligned closely with the travel of the spring to minimize the noise caused by rubbing. Attach a spring warning tag to the eye bolt at each side, where the extension springs are hooked at the back hanger.

When balance is achieved, adjust stops and/or track as well as the top fixture for proper seal at the jambs and the header. Raise the door halfway and check the side clearance between the door and the horizontal track. Both horizontal tracks must be spaced the same as the vertical tracks. If adjustment is necessary, RETURN THE DOOR TO THE CLOSED LOCKED POSITION and adjust the hangers and add braces as necessary. Repeat procedure until spacing is correct. When correct, MAKE SURE all hangers are secure and adequately braced. NOTE: Hangers and braces are not supplied by the manufacturer.

Lightly lubricate spring wire and all moving parts with oil. Install spring warning tags and post owner’s manual and/or the instruction manual adjacent to the door in a protected place to make available to the end user. The door installation is now complete.
Chapter Six

Methods of Operation

Manual Push-up Operation

The simplest way to operate a residential sectional door is manual push-up operation. The door is manually lifted from the closed position and pushed up to the open position. Most doors are very heavy so springs are used to counterbalance the weight of the door. For taller doors, a pull down rope will be connected to the bottom bracket to pull the door down into reach. It is important to properly locate lift handles and step plates to aid with operating a manual push-up operation door to avoid potential pinch points at the section joints, hinges, etc.

Residential Electric Operators

Residential operators, also known as residential openers, were created for the primary purpose of lifting to open and pushing to close the garage door. In the early stages of development, most were belt and chain driven and were activated with pushbuttons. Over time, accessories have been developed so that operation can be done from outside the garage using remote controls.

Today, there are three common types of drawbar garage door operators; chain, belt, and screw drive. Chain Drive is operated using a roller chain and sprocket system. Belt Drive operates with a cogged belt and pulley system, and Screw Drive uses a worm gear and a threaded shaft similar to that of a screw. Products certified by a nationally recognized testing laboratory, such as UL or ETL, are designed to have “fail safe” components in the operation of the residential operator.

It should be noted that the only reason than an operator is used is for convenience purposes. If and when the operator is disconnected, the door can be operated manually because the counterbalance system is designed to assist in operating the door.

These operators are designed for use on standard lift or low headroom residential doors and are normally mounted on the centerline of the door and parallel to the floor. Most operators require 2.5 inches (6.35cm) clearance over the high arc of the door and 48 inches (1.2m) behind the door when it is fully opened.

The drawbar operator connects to the door using an adjustable arm. Operators also have provisions to disconnect the operator so that the door can be operated manually during power failures or in an emergency if entrapment were to occur.

Another type of electric operator is a residential jackshaft. These operators mount at the side and turn the counterbalance shaft to move the door. When installing these operators, it is critical to observe manufacturer’s instructions and they should be installed with a cable tension monitor.

External Obstruction or Anti-Entrapment Devices

With the addition of the November 1990 amendment to the Consumer Product Safety Improvement Act, it was required that effective January 1, 1993, all residential garage door operators sold in the United States must be
constructed to comply with and tested to Underwriters Laboratories (UL) Standard 325, the manufacturing standard for Door, Drapery, Gate, Louver, and Window Operators and Systems.

Among the requirements of UL 325 is for the operator to include an external obstruction or anti-entrapment device. Currently there are two types of entrapment protection devices that may be added to a residential garage door operator: Photoelectric Sensors and Edge Sensors.

**Photoelectric Sensors**

Photoelectric sensors are devices that project an invisible light beam across the door opening. If the beam is interrupted a closing operator will reverse and an operator in the fully open position will not close.

The most common beam system is a through beam, constructed with a transmitter and a receiver. These systems operate in the infrared band or frequency of the light spectrum. Infrared is used because it has the most tolerance to sunlight. The units are to be mounted no more than 6” above the floor and no farther than 6” back from the door opening. The set is then typically connected to the operator with wires running from the receiver to the input terminals on the operator’s head unit. Some units also operate wirelessly. One should refer to individual operator manufacturer’s instructions for mounting and wiring of Photoelectric Sensors.

The transmitter sends the light beam to the receiver and the receiver then sends a pulsing signal or a voltage level to the operator’s motor control which monitors this information. If it does not receive the correct pulse or voltage reading because of an interruption of the beam or an electrical or mechanical failure, it will reverse the operator’s travel in the down direction or will not allow the operator to close from the fully open position. It will not operate until the obstacle or malfunction is corrected.

**Edge Sensors**

Edge sensors are devices installed along the lead edge or bottom edge of the door. The edge senses an obstruction when it comes in contact with that object and sends a change of status signal back to the operator’s control board. The control board monitors the input and tells the operator system to reverse if it is moving in the down direction. If the operator is in the fully open position, it will not close.

The type of edge sensor that is currently available for use on residential garage door operators is a unit constructed with two electrical contact strips spaced apart and enclosed in a neoprene rubber tube or other waterproof material. The pulse or voltage signal is generated by an electronic board or component mounted at the very end of the edge sensor. This creates a pulse or voltage level that the motor control board monitors as the standard signal input into the board. When the two contact strips come together during contact with an object, or if the edge sensor has an electrical or mechanical failure, the signal changes and informs the operator that there is a problem or contact with the edge. The signal is typically sent to the operator head input through a coil cord connection from the edge to a junction box or connector. The wires then run from the junction to the operator head connections. Some units also operate wirelessly.
Radio (Remote) Controls

Radio systems to control garage door operators have been in use for over 50 years. The systems have evolved from the tube radio unit as large as a loaf of bread, to mini transmitters the size of a matchbook.

The radio system is comprised of two components; 1) the transmitter, which is the mobile part of the system (located in the car, pocket or other location), and sends the radio frequency signal out, and 2) the receiver that is either attached to or built into the garage door operator and receives the coded signal from the transmitter, checks it for the proper code, and sends input to the garage door operator to activate.

The standard transmitter/receiver set is a one button or one channel system. Manufacturers do produce systems with multiple buttons or channels for special applications and activation of two or more operators from one transmitter/receiver set.

The transmitter is comprised of two parts: 1) the front end or the section of the unit that generates the radio frequency and carries the code to the receiver, and 2) the back end or the section of the unit that creates the code that the receiver accepts.

This special code is created by way of a dip or trinary switch set and/or an encoder I.C. chip or microprocessor I.C. chip. This special code is then used to modify the carrier radio frequency that is sent to the receiver.

The receiver also has two parts: 1) the front end or the section of the unit that accepts the signal from the transmitter, and 2) the back end that decodes the signal and, if it is the correct code, sends an input to the device to which it is attached.

The radio frequency band, or area in which this type of system is allowed to operate, is managed by the FCC. They define the allowable output power that these units can transmit.

Types of Radio Controls – Digital Switch Sets

Some transmitters and receivers are built with a binary or trinary dip switch set that creates the modified signal that is used. This type of coding is limited. There are a limited number of codes that can be generated by these switches; the standard binary switch with 10 switches will create 1,024 codes and the standard trinary switch with 9 switches will create 19,683 codes.

Embedded Code Sets. One of the more recent radio control design innovations is the embedded code type of units. The transmitter uses a microprocessor type of I.C. chip and is coded by the manufacturer with one of a million or more codes. The code is built into the transmitter and cannot be changed. The receiver is a “smart” or programmable unit and is programmed with the total number of transmitters used with this one operator. This type of system is limited by the receiver and the number of transmitter codes that it will store in memory.

Code-Rotating or Code Changing Sets. A manufacturer typically now uses a code changing radio set. This system uses a microprocessor I.C. chip and algorithm to change the code every time it transmits. The receiver has the same I.C. chip installed and is programmed to recognize each transmitter’s program and accept its code signal. The advantage of this type of system is that it cannot be copied by any outside device and is considered the most secure of the three systems in use today.
Keyless Entry Systems

One of the more innovative products introduced to the industry is the keyless entry system. This device is offered in two different designs: 1) the wired entry, and 2) the wireless entry.

**Wired Entry System.** The keypad module is wired to the processor module and the processor module has a set of wires directed to the operator’s input connections. The disadvantage of this entry type is that a hole may need to be drilled into the door jamb for mounting the wires running from the processor module to the operator-input connection.

**Wireless Entry System.** The wireless system has a radio transmitter built into the module and utilizes a radio frequency signal to send the activation command to the operator’s radio receiver. The unit is self-contained and mounts anywhere without the need to run wires to the operator head, thus speeding up the installation time.

Other Accessories

**Wall Push Button.** This switch device is mounted inside the building and may be hard wired to the operator’s input connections or may operate wirelessly. When activated, it sends a start/stop command to the operator.

**Multi-Function Wall Station.** This accessory is mounted to the building and hard wired to the operator’s input connections or may operate wirelessly. It allows the user to utilize built-in functions with the garage door opener. The module acts as a start/stop activation device for the garage door operator and can turn the lights of the operator on and off. In some cases, it shuts down the control inputs to the operator so that when the user is on vacation or leaves the building for an extended period of time, the operator will not activate.

**Emergency Vault or Cable Release Lock.** This device allows the user to open the door from the exterior in cases of power failure or electrical/mechanical problems. The unit is comprised of a lock cylinder with a length of cable attached. The mounting of the device requires drilling a hole through the door and attaching the release arm to the operator. When the key is inserted and turned, the cylinder comes forward and allows the user to pull the cable, release the emergency disconnect, and open the door.

**Timers.** A timer is an adjustable electronic device that will automatically close the door after a given or adjustable time period. Note: UL325 requires both visual and audible alarms prior to this operation.

Wireless transmitters, wireless keyless entry systems, and wireless wall stations often utilize batteries for power. When using these systems, take the time to explain to customers that these batteries require replacement periodically to avoid range issues.
UL 325 Overview

Underwriters Laboratories

Underwriters Laboratories (UL) is a safety consulting and certification company that provides safety-related certification, validation, testing, inspection, auditing, advising and training to a wide range of clients and categories of products. They have participated in the drafting of safety standards for electrical devices and components. One such standard effecting residential garage door operators is UL 325 for Door, Drapery, Gate, Louver and Window Operators and Systems.

UL 325 History

The first edition of UL 325 was published in April 1973. This was the recognition that motorized operators were coming into their own as a product category. Prior to that, operators were treated as electric motors. The recognition included the realization that operators were more than just motors and should include additional safety requirements.

In 1982, the timed reversing requirement became effective. This meant the operator had to automatically reverse the door to the open position if the close limit was not made after 30-seconds had passed after the close command. Prior to that, contact reversing was the single entrapment protection requirement of residential operators.

In 1990, the Consumer Product Safety Commission (CPSC) started its involvement with UL 325. This was the result of a grass roots movement to legislate safety requirements for residential garage door operators. The effect was to redesign operator controls to require external entrapment safety devices such as photoelectric and edge sensors. Not only were these devices required, but they had to be monitored to ensure they were functional before closing a door from either a remote or single push of a wall control. This became effective January 1, 1993.

The CPSC regulations are also captured in UL 325. After January 1, 1993, it is allowable to demonstrate compliance by applying the UL mark, i.e. all testing and evaluations are done by UL or the manufacturer must test using an independent test lab that certifies that the products comply with UL 325.

Testing is accomplished by type testing a representative sample of the design under evaluation. Ongoing compliance is managed through a series of quarterly factory audits.

In 2008, regulations were updated to require the operator to reverse a minimum of 2 inches upon encountering an obstruction.

Then in 2009, UL 325 regulations were again updated to include rules for allowing unattended door closing features such as timers-to-close or smart phone applications.

Standards Development

The development process for UL Standards provides for the participation and comment from the affected public as well as the affected industry. In the case of UL 325, the operator industry has worked with UL through a Standards Technical Panel (STP). The operator manufacturers’ associations also participate on this STP.

The STP consists of volunteers from the various manufacturers who may or may not be members of a manufacturers group as well as other interested parties.

The process is such that anyone can submit comments, changes, and proposed revisions to
The STP then follows a process to comment and vote on the appropriateness of any proposed change.

UL standards are “living” documents. As such, revisions to the standards may occur at any time. The edition may or may not change with the revisions. If the edition does not change, the revised pages will be issued to the appropriate parties. Any UL standard, including UL 325, is current only if it incorporates the most recently adopted pages.

While UL 325 is the standard for Door, Drapery, Gate, Louver, and Window Operators and systems, it relies on and incorporates many other UL standards for test purposes. Some examples are:

- **UL 498** Attachment Plugs and Receptacles, Electrical
- **UL 817** Cord Sets and Power Supply Cords
- **UL 1004** Motors, Electric
- **UL 746** Polymeric Materials
- **UL 796** Printed Wiring Boards, Electrical
- **UL 94** Plastic Materials for Parts in Devices and Appliances, Tests for Flammability
- **UL 506** Transformers, Specialty
- **UL 991** Tests for Safety Related Controls Employing Solid State Devices

**UL 325 Standard – Layout**

The standard contains the following sections:

- **Contents** – Introduction including scope, units of measure, terminology, and glossary.
- **Construction** – General descriptions of frame and enclosures, mechanical assembly, etc.
- **Protection Against Risk of Injury to Persons** - Moving parts, surface temperatures, pedestrian doors and operators, industrial doors and operators and commercial vehicular door operators, residential garage door and door operator systems, and gate operator systems.

- **External Entrapment Protection Devices** – Photoelectric sensors, edge sensors, instructions for residential garage door and door operators.
- **Performance** – Test descriptions and acceptance criteria for leakage current tests, for leakage current tests following humidity conditioning, input current test, normal temperature test, dielectric voltage withstand test, insulation resistance test and dielectric voltage withstand test, metallic coating thickness test, accelerated aging of gaskets, tests on switches and controls, strain relief test, puncture resistance, permanence of marking tests.

- **Manufacturing and Production Tests** - Dielectric voltage withstand test, grounding continuity test.
- **Instruction Manual** - Details, field installed labels.
- **Marking** – Details.
- **Appendix A** – Standards for components.

**Impact**

This standard covers the design, manufacture and installation of the products. Even the instruction manuals are evaluated when the type testing is accomplished. Any changes made to the products during installation can void the manufacturer’s warranty, and create an unreliable, or worse, an unsafe product.

Every installation should have the proper product selected. Use the correct tool for the job. Always follow the installation instructions. Always use the field-installed labels that are supplied with the product. Educate the users in the proper and safe use of the product.

A commercial operator cannot be used in residential applications because it does not meet the residential regulations of UL 325.
Chapter Seven

Installation of Residential Operators

Important Safety Precautions for Electric Operators

**WARNING!** To reduce the risk of injury or death, read and follow all manufacturers’ instructions and safety precautions.

Professional installers should observe the following safe installation precautions and procedures. The installer should also follow all of the manufacturer’s installation instructions and safety precautions:

**Before Installation:**
1. Verify that the operator is proper for the type, size of door and frequency of use per the operator specifications.
2. Power should always be disconnected whenever installing, wiring, or servicing a door operator or automatic door system. Not only is the chance of electric shock thus eliminated, but the moving chains in most door operators can catch clothing or fingers and cause severe injury.
3. Installation and wiring must be in compliance with local building and electrical codes.
4. Place controls far enough from the door so that a user cannot touch the door when operating the controls.
5. Controls must be at a minimum of 5’ above the finished floor.
6. Controls should be placed so the user has full view of the door when operating.
7. Test door and service monthly. If adjusting limit travel, retest the door opener. Failure to adjust the door may cause death or injury.
8. Keep doors properly balanced. An improperly balanced door could cause severe injury. Qualified service personnel should make repairs to the door if needed.
9. Use emergency manual operation mechanisms only when the door is closed. Use caution when using this release with the door open. Weak or broken springs may cause the door to fall rapidly.
10. The installer is responsible for assuring that the owner of the door system understands its basic operation and safety. In particular, be sure the owner/end-user understands the location and operation of the manual disconnect.
11. Point out to the owner/end-user of the door system that children or pets should not be allowed to play on or near the door or any part of the system, and that the safety instructions supplied with the operator are the responsibility of the owner/end-user.
12. Leave the installation and maintenance manual for the operator as well as any additional information supplied with the operator or any other components of the door system with the owner/end-user.
13. If you have any questions about the safety of the door operating system, do not install the operator.

**Important Note:** Before an operator is installed, be sure the door has been properly aligned and is working smoothly. Although each installation will vary due to particular building characteristics, refer to the following general procedures to install the operator.
Chain-Drive Garage Door Operators

Attach Rail to Operator

- Place operator head on garage floor with cardboard underneath to protect the finish.
- Slide trolley onto rail facing the correct direction.
- Fasten the rail to the operator head using the fasteners provided.

Attach Chain to Sprocket

- Avoid moving the trolley during chain connection to save pre-adjusted door limits if applicable.
- Pull chain from rear of rail and position it on the operator sprocket

Adjust Chain Tension

There are numerous different types of chain adjustment systems on the market today. Verify the correct chain tension adjustment procedures with the operator manufacturers’ instructions.
- Typically, the chain is adjusted by turning an adjustment nut located at the wall end of the rail or sometimes on the trolley.
- Tighten the nut until the chain is slightly above the bottom of the rail at the center point. **Do not over tighten the chain.**
- Secure chain adjustment by tightening the lock nut.
- NOTE: It is normal for the chain to have a small amount of slack. A chain too tight or too loose will cause excessive gear noise and wear.
- Install the sprocket cover over the sprocket and chain if applicable.

Header Bracket Location

- Close the door.
- From inside the garage, use a pencil to mark the vertical centerline of the door on header wall and on the top panel of the door.
- Examine the area above the center of the door on the door header wall for a header bracket mounting location.
- Open the door to the high-arc point (the point where the top edge of the door is highest above the floor). Use a level to transfer the high-arc to the header.
- Close the door and mark the header bracket mounting location. If the door is a sectional or one piece door with track, mark the header 1” higher than the high-arc measured. If the door is a one piece door without track, mark the header 2” higher than the high arc.
- NOTE: In some installations, the header bracket location will be higher than the door header. This will require adding a 2 x 4 (or larger) cross piece to the wall studs to provide a mounting location for the header bracket.
- On sectional doors with low headroom, the header bracket can be attached to the ceiling up to 6” back from the header wall.
Installing the Header Bracket

The header bracket can be fastened to the door header wall or to the ceiling. Select the location that suits the installation. A 2 x 4 cross piece may be required to mount the bracket if a flat mounting surface does not exist.

Attaching Header Bracket to Wall

- Hold the header bracket on the centerline drawn above the door with the bottom edge of the bracket on the line marking the header bracket location.
- Use a pencil to mark the centers of the bracket holes.
- Pilot drill holes and fasten the bracket with the lag screws provided.

Attaching Header Bracket to Ceiling

NOTE: On a finished ceiling, be sure there is a joist to fasten to under the sheetrock where the header bracket will be located (use a stud finder). If there is none, install a 2 x 4 cross piece between the two closest joists to fasten the header back onto.
- Extend the centerline drawn on the header wall along the ceiling.
- Hold the header bracket on the centerline with the edge of the bracket no further than 6" from the header wall.
- Use a pencil to mark the centers of the bracket holes.
- Pilot drill holes and fasten the bracket with the lag screws provided.

Connecting Rail to Header Bracket

- Place assembled operator on the empty carton on the floor, with rail towards the door. NOTE: If door is equipped with a torsion spring, it may be necessary to place the operator head on a ladder so the rail will clear the spring.
- Align the holes in the end of the rail with the holes in the header mounting bracket.
- Insert header mounting bracket pin and secure.

Positioning Operator

Sectional and One-piece Doors with Track

- Raise the operator head and set it on top of a ladder. Use extra spacers on top of ladder if it isn't tall enough to clear the door.
- Carefully open the door to the full open position. Be sure the rail and trolley clears the door.
- Lay a 2 x 4 across the top section of the door to rest the rail on. NOTE: The 2 x 4 spacer protects the door as well as provides the correct amount of space between the door and rail for hanging the operator.

One Piece Doors without Track

- Raise the operator head and set it on top of a ladder. Use extra spacers on top of ladder if it isn't tall enough to clear the door.
- Carefully open the door, noting when the door goes past the high-arc point. Stop the door at the high-arc point if possible.
- Raise or lower the operator head until the rail clears the top of the door by about 2" at the high-arc point.
- Support the operator at the point determined above until it can be hung (next step).

**Hanging the Operator**

Installation requirements vary with garage construction. Hanging brackets should be angled to provide rigid support. Hanging material is not provided. Angle iron and lag screws are recommended. Following are typical operator hanging methods. Certain installations will require improvised methods.

- Center operator head and rail with centerline mark on the top of the door.
- On finished ceilings, an angle iron crosspiece between the two closest joists above the operator will be required. Mark mounting hole locations, pilot drill 3/16" pilot holes and attach the piece with two 5/16" lag screws.
- Measure the distance from each of the operator hanging tabs to the structural support or angle iron cross piece.
- Cut two angle iron pieces to the required lengths for hanging brackets. Bend brackets if required.
- On unfinished ceilings, hold each bracket in place and use a pencil to mark the locations where they will be attached to the joists.

Drill 3/16" pilot holes and attach the pieces with two 5/16" lag screws.

- On finished ceilings with an angle iron cross piece, attach the two hanging brackets to the cross piece.
- Attach operator to hanging brackets. For best balance, mount the hanging brackets to the operator mounting slots closest to the front of the operator.
- Tighten all fasteners to secure operator.
- Open and close the door manually. The door should clear the rail by at least one inch at all travel locations. NOTE: Operators installed on one-piece doors without a track will be at a slight angle. The operator head should be lower than the header bracket.

**Installing the Pushbutton**

A standard wired pushbutton is typically supplied with the operator. Optional upgraded wall controls may also be available.

- Strip ¼" of insulation from one end of the 2-conductor black and white wire supplied with the operator
- Connect the wires to the two terminals on the back of the pushbutton. Follow the polarity requirements if provided on the push button terminals.
- Select a convenient location for mounting the wall station near an access door. **The garage door must be clearly visible from the wall station.** Use the screws provided to mount the wall station at a minimum height of five feet, where children cannot reach it and away from all moving parts of the door.
- Route the wire to the back of the operator. Use staples to secure the wire. Staples must straddle both wires to avoid electrical shorts.
- Cut the wire, leaving about 6" of slack, strip back each conductor about ¼".
- Connect the black wire to the black pushbutton terminal and the white wire to
the white pushbutton terminal on the back of the operator.

- **Apply the User Safety Instruction Label** to the wall next to the pushbutton. Use staples or tacks to help the label remain in place over time.

### Installing Light Bulb(s) and Lens Cover

The plastic lens cover protects the light bulb(s) and diffuses the light from the bulb(s).

- Install a light bulb in each of the lamp sockets. Do not install bulbs that exceed the wattage rating marked on the operator.
- Position the plastic lens cover and secure in place.

### Release Handle

The trolley release handle is used to disengage the operator from the garage door. It can be used during power failures to allow manual operation of the door.

- Thread one end of the rope supplied through the hole in the trolley release handle. Tie an overhand knot in the rope so it won’t slip through the hole.
- Thread the other end of the rope through the hole in the trolley release lever. Adjust the length so the handle is at least 6’ above the floor. Tie an overhand knot in the rope so it won’t slip through the hole.
- Cut off excess rope. Seal the cut with a match or lighter to prevent unraveling.

**NOTE:** Both knots should be about 1” from the ends of the rope to prevent slippage.

### Installing Photo-Eyes

The safety beam must be installed so the path of the light beam is not obstructed by the sections, tracks, springs, hinges, rollers or any other part of the door mechanism. Photo-Eyes can be mounted to the track or directly to the wall. It may be necessary to add a piece of wood to the wall at mounting locations to insure proper clearance or for installation on masonry wall construction. **NOTE:** The detector must be installed on the “shade” side of the garage door, where sun will not shine directly into the detector lens.

- Assemble the mounting brackets if necessary.
- Assemble the sensors to the brackets if necessary.
- Position the units at the same height and no more than 6” above the floor. The clear emitter infrared light must point towards the clear detector lens. If wall mounted, use a pencil to mark the locations for the screws for wall or floor mounting.
- Mount the brackets to the track, wall or floor at the locations marked.
Wiring Photo-Eyes

The photo-eyes transmit signals to the operator using two wires.
- Strip ¼” of insulation from the wires. Attach them to the terminals on the first photo-eye.
- Route wires up the wall, over the door and down the other side to the detector.
- Cut the wires (leaving about 6" slack) at the detector. Strip ¼” of insulation from the wires and attach them to the terminals on the detector.
- Strip ¼” of insulation from another set of wires and attach them to the terminals marked on the detector.
- Route the wires up the wall, halfway over the door, along the top of the rail using zip-ties or across ceiling and back of the operator head, leaving about 6” slack.
- Strip ¼” of insulation from the wires and attach them to the terminals on the operator.
- Secure all the wires to the wall and ceiling with staples. Staples must straddle both wires to prevent shorts.

Operator Bracket and Door Arm Installation

- From the inside of the door, centered on the top sectional panel, hold the door operator bracket on the vertical centerline drawn on the door. Use a pencil to mark the mounting holes of the bracket.
- Attach the door operator bracket to the door using the fasteners recommended by the manufacturer.
- Pin the curved end of the curved door arm to the door operator bracket.
- Disengage trolley by pulling trolley release handle.
- Insert the single hole end of the straight door arm into the trolley. Slide the pin through the hole and secure.
- Rotate the curved door arm upward to meet the straight arm connected to the trolley. Align the two door arms so that the holes in both arms overlap. NOTE: The straight door arm should not be past vertical. It should be angled towards the operator head or vertical. If the holes don’t match, slide the trolley toward operator head until a match occurs.
- Connect the arms together using the fasteners provided.
- Raise the door manually until the trolley engages the traveler on the rail. NOTE: If door is difficult to raise, pull the arm toward the operator while lifting the door.

Connecting Operator to Power Source

Cord and Outlet Connection

- The operator should be connected to a grounded receptacle on the ceiling or near the operator head. If none is available which will accept the grounded operator plug, one should be installed by a qualified electrician. Do not use an extension cord.
- Plug operator into grounded receptacle.

Permanent Wiring

Some local electrical codes require permanent wiring to the power source through conduit. Follow these steps only if permanent wiring is required.

- Be sure power cord is disconnected.
- Cut the power cord about 1" from the strain relief bushing on the operator.
- Remove the cover of the operator.
- Remove the strain relief bushing and discard.
- Remove the outer insulation from the power cord and strip the white, black and green wire insulation back about ¼".
- Pull white (neutral), black (hot), and green (ground) wires through conduit.
- Connect the conduit to the operator with the appropriate termination.
- Use wire nuts to connect the wires to the matching color wires inside operator head. NOTE: Be sure the wires inside the operator are clear of the gears and all moving parts.
- Replace the operator cover.
- Connect conduit wires to power source at junction box.

**Aligning Photo-Eyes**

The photo-eyes consist of two units, an emitter and a detector. The emitter constantly sends a narrow beam to the detector. If the door is moving down and an obstacle interrupts the beam, the sensor will signal the operator to result in a reversal, causing the door to go up. **If the door is up and there is an obstacle interrupting the beam, or the beams are not aligned, the radio transmitter will not function.** The operator will only run the door down if constant pressure is applied to the wall station pushbutton.
- Be sure power is applied to the operator.
- Loosen the mounting nuts and align the photo-eye beams. Watch the lights on the detectors for alignment feedback.
- NOTE: If detector alignment fails, check for the following: 1) Dirt on detector lens, 2) Sunlight shining on detector causing interference, 3) Short in wires (from staples or at screw terminals), 4) Incorrect wiring.
- **With trolley disengaged,** press the wall station button to run the traveler to the up position.

- Push the wall station button again. While the traveler is moving to the down position, block the sensor beam. **THE TRAVELER MUST STOP, THEN REVERSE TO THE UP POSITION.**
- Leave an object in the path of the infrared light beam. Verify that constant pressure on the wall station pushbutton is required to cause the traveler to move to the down position. Release the wall station pushbutton before the traveler stops, verify that the traveler returns to the up position. NOTE: The garage door operator will not respond to a CLOSE command from a radio transmitter if the photo-eye beam is obstructed.

**Setting Limits**

Limits may be factory preset or field adjustment may be required. The limit adjustments are located on the operator head. They control how far the door will open or close. In some cases the limit travel is controlled with adjustment screws and other cases are controlled electronically. Follow the operator manufacturer’s instructions for specific limit adjustment. The limits should be set so that the door clears the opening and closes tight at the floor.

**Programming and Testing the Radio Controls**

The radio receiver is located inside the operator. A small external wire serves as the antenna for the receiver. More transmitters can be added for additional users of the door operator.
- Follow the manufacturer’s instructions for programming the remote(s) to the operator head.
- Straighten out the antenna wire so it points down toward the floor.
- Stand clear of the door, press transmitter button and verify the operator starts.
**Force Adjustment**

The operator force must be in proper adjustment at all times. This ensures that the garage door will reverse its direction in the event that an obstruction is encountered during downward travel and stop its motion in the event that an obstruction is encountered during upward travel. In some cases operator force is controlled with adjustment screws and other cases are controlled electronically. Follow the operator manufacturer’s instructions for force adjustment. Perform reversal test monthly or anytime operator forces are manually adjusted.

**Reversal Test**

- Start with the door in the up position.
- Lay a 2 x 4 flat on the floor as an obstacle where it will be struck by the center of the door as it closes.
- Activate the operator and verify the door reverses when it strikes the obstacle. The door MUST reverse its direction of travel within 2 sections after it strikes the obstacle. NOTE: If the door stops after encountering the obstacle and does not reverse, then down force or down limits require adjustment.
- Repeat test until the door reverses within 2 seconds of striking the obstruction.

**Using the Garage Door Opener**

**Opening the Door**

- Press the wall station pushbutton or activate a wireless remote control transmitter to activate the operator.
- When the operator is activated, the courtesy lamp will light and the door will begin to open.
- The door will open until the up limit is reached (unless an obstruction is encountered, which will stop the door).
- The courtesy lamp will typically remain lit for several minutes after the operator stops.

**Closing the Door**

- Press the wall station pushbutton or activate a wireless remote control transmitter.
- When the operator is activated, the courtesy lamp will light and the door will begin to close.
- The door will close until the down limit is reached (unless an obstacle is encountered, which will stop and reverse the door).
- The courtesy lamp will typically remain lit for several minutes after the operator stops.

**Stopping the Door Mid-Travel**

- Each operator has the ability to be stopped mid-travel by activating the wall station push button a wireless transmitter.
- Reference operator instructions for activation sequence when using mid-travel stop.

**Manual Operation**

- The trolley release handle is used to disengage the operator from the garage door. It can be used during power failures or emergencies to allow manual operation of the door.
Only pull the trolley release handle when the door is in the closed position.

With the door in the closed position, pull the trolley release handle to disengage the door.

The door can now be raised or lowered manually.

Reengage the trolley release lever to resume electric operation. It may be necessary to move the door manually until the trolley engages the traveler on the rail. It will engage with a snap.

Care for the Garage Door Operator

Seasonal weather changes affecting the door could require fine tuning of the operator’s adjustments over time. Wooden doors can swell and gain weight during wet weather, sectional door hinges and rollers might bind during cold periods, etc.

Monthly Testing

- With the door closed, pull the trolley release handle to disengage the trolley from the rail.
- By hand slowly open the door all the way, and then close it all the way. Notice if there is any binding, sticking or rubbing caused by the hardware, track rollers or doorframe. The door should travel smoothly.
- Raise the garage door about halfway up. Release your hold on the door and see if the door balances. It shouldn’t go up or down on its own. Close the door.
- Reengage the trolley.
- NOTE: If the garage door is unbalanced or if the door travel isn’t smooth, the door should be repaired by a qualified garage door installation technician.
- Perform limit adjustments as described in the operator’s instructions.
- Verify force settings by performing a Reversal Test.

Bi-Annual Testing

- Check the chain or belt tension (if applicable) and adjust it if necessary.

Yearly Maintenance

- Lubricate door hinges, springs, rollers and bearings according to door manufacturer’s recommended procedures.

OPTIONAL WALL STATION FEATURES

Wall Station Vacation Lock

- A lock switch or button on the wall station can activate a vacation lock to prevent operation.
- Activating the vacation lock will often include an indicator on the wall control. A light may flash or turn off to indicate the vacation lock is active.
- Deactivate the vacation lock to return the operator to normal operation.

Wall Station Light Control

- If the operator’s courtesy lamp is off, pushing the wall station’s light button will turn the operator’s lamp on. The lamp will remain on until the light button is pressed again, or the operator is cycled.
- If the operator’s courtesy lamp is on, pushing the wall station’s light button will turn the operator’s lamp off.

Verifying photo-eye alignment by performing the test in the Aligning Photo-Eyes section.

Perform limit adjustments as described in the operator’s instructions.

Verify force settings by performing a Reversal Test.
Chapter Eight

One Piece Doors

Types of One Piece Hardware

Jamb Type

Jamb type one piece door hardware is essentially a pair of hinges (four bar linkages) which mount to the door and to the door jambs. The motion of the door is controlled by the geometry of the hinges, and the weight of the door is counterbalanced by extension springs, which are attached to each hinge.

- Fewer components to install compared with jamb type track or with sectional doors. This results in less installation time.
- Less interference with beams and rafters in the garage since the door remains approximately half inside and half outside the garage in the open position.
- Less headroom is required, as little as 1-1/2" is available.
- Smoother operation with electric openers compared with jamb type track.
- Wide selection of jamb type hardware is available to accommodate door heights from 6'6" to 12’ and weights from 200 to 450 pounds. Hardware is also available for specialty applications such as electrically operated doors and flush mounted doors.
- Quieter operation than typical sectional doors.
- Less costly compared with installation using jamb type hardware with tracks or with sectional doors.
- Designer friendly.

Jamb Type with Track

Jamb type one piece door hardware with tracks is comprised of two pivot arms and two horizontally mounted tracks. The pivot arms mount to each door jamb and support the lower corners of the door while rollers, which ride in the tracks, support the upper corners of the door.
The benefits of a one piece door hung on jamb type hardware with track are:

- Fewer components to install compared with sectional doors.
- Less costly compared with installations using sectional doors.
- Typically, in the open position, the door is almost entirely inside the garage. This is beneficial if a door which extends beyond the building is undesirable or not in compliance with building codes.
- Designer friendly.

**Major Components of One Piece Doors - Jamb Type**

- **a. Master Plate:** for attachment to door jamb.
- **b. Master Arm:** the main load carrying member.
- **c. Door Angle:** for attachment to the door.
- **d. Kicker Assembly:** for attachment of the springs to the master arm and adjustment of spring force during the last ¼ of door travel.
- **e. Spring Connector Assembly:** for attachment of the springs to the kicker and to the chain or lower jamb connector. Also serves to contain the spring when the spring breaks.
- **f. Cantilever Arms:** for adjusting the vertical position and angle of the door in the closed position.
- **g. Extension Springs:** for counter balancing the weight of the door.
- **h. Spring Anchor Chain:** for attachment of springs to the jamb.
- **i. Lower Jamb Connector:** another method for attachment of springs to the jamb which makes it easier to install and adjust the tension on the springs.
- **j. Fasteners:** including pivot points which hold hinge components together, bolts which are used to adjust headroom, spring tension and mounting hardware.
- **k. Main Pivot:** the pivot point connecting the master arm to the master plate.
Major Components of One Piece Doors - Jamb Type with Track

a. Master Plate: for attachment to the door jamb.
b. Master Arm: the main load carrying member.
c. Anti-sway Brace: to help prevent the door from rubbing against the door jambs by stiffening the master arms against swaying.
d. Upper and Lower Weather Strip: for closing the air gap between the door and the door jambs.
e. Roller Bracket Assembly: for mounting rollers to the top two corners of the door.
f. Tracks: support the top corners of the door.
g. Track End Bracket: attaches the tracks to the header or jambs.
h. Door Shoe: attaches the master arm to the lower corners of the door.
i. Extension Springs: for counterbalancing the weight of the door.
j. Spring Connector Assembly: attaches the extension springs to the master arm.
k. Spring Anchor Assembly: attaches the extension springs to the door jamb and provides a means for adjusting the tension on the springs.
l. Main Pivot: the pivot point connecting the master arm to the master plate.
m. Fasteners: including pivot points which hold hinge components together, bolts that are used to adjust spring tension and mounting hardware.
Maximum Door Weights and Sizes

Light Duty Jamb Type

Designed for doors weighing up to 200 pounds and measuring between 6’10” and 7’4” tall. Light duty hardware is generally used on single garage doors up to 10’ wide, but is also used on up to 16’ wide aluminum and light weight steel doors.

Medium Duty Jamb Type

Designed for doors weighing up to 325 pounds and measuring between 6’10” and 7’4” tall. Medium duty hardware is generally used on double car garage doors up to 16’ wide. Wood doors wider than 10’ are required to have added stiffening supports, such as truss rods, to prevent the door from sagging in the open position. Medium duty hardware is also available with a heavy duty main pivot for longer cycle life.

Heavy Duty Jamb Type

Designed for doors weighing up to 350 pounds and measuring 6’10” and 7’4” tall. Heavy-duty hardware is generally used on double car garage doors up to 16’ wide. Wood doors wider than 10’ are required to have added stiffening supports, such as truss rods, to prevent the door from sagging in the open position.

Jamb Type with Track

Designed for doors weighing up to 300 pounds and measuring between 6’6” and 7’8” tall. This hardware is generally used on doors up to 16’ wide. Wood doors, wider than 10’ are required to have added stiffening supports, such as truss rods, to prevent the door from sagging in the open position.

Safety Considerations

Minimum Specifications for Jambs

It is recommended that both jamb type hardware and jamb type hardware with track be mounted on wood door jambs which comply with the following minimum specifications: 1) National Forest Products Association, National Design Standards, Table 8.1A, Group II or better material (i.e. Douglas Fir), 2) Minimum Specific Gravity of 0.51 (32 pounds per cubic feet), and 3) Minimum Dressed Size of 1-1/2” x 5-1/2”. If the door jambs are not made from wood, one should follow the manufacturer’s recommendations for jamb materials.

Safety Containment of Extension Springs

It is recommended that all garage door springs be equipped with a device capable of restraining the spring (or spring pieces) in the event that it breaks. Usually the springs will include an integral containment device. In the event of a spring, which is not equipped with a containment device, replace the spring with one that is properly equipped or contact the manufacturer for recommendations.

Spring Design Standard

Garage door extension springs are designed for a minimum cycle life of 10,000 cycles where one cycle is defined as on door opening and one door closing.
NOTE: All of the above are required by law in California as stated in California Administrative Code Title 24, Part 2, Section B1318, Chapter B-13.

Adjustment of Hardware and Springs

Three Headroom Adjustment Holes: These are used to adjust the path of the door to fit within available space between the top of the door and the garage ceiling or other obstructions such as beams or ducts. The offset cantilever arm is bolted to the appropriate hole in the master plate.

Cantilever Arm Adjustment: Used to adjust the position of the door angle. Two carriage bolts are loosened allowing the length of the arm to be increased or decreased. Adjusting the length of the arm allows the installer to position the door angle against the back of the door for mounting purposes and allows the angle of the door to be adjusted to plumb in the closed position.

Five Power Settings for Spring Adjustment: This is used to increase or decrease leverage in order to adjust spring tension and achieve a balanced door. The kicker is moved from hole to hole on the master arm.

Spring Pre-Stretch: This is the amount of stretch on the spring(s) when the door is in the open position. Springs should typically have between 1” and 2” of pre-stretch. If the spring is attached to the jamb using chain, adjustment is achieved by moving up or down one link in the chain. If an adjusting bolt is used to attach the spring, adjustment is made by loosening or tightening the nut on the bolt. Refer to Diagram 6.

Kicker Adjustment: Used to adjust the balance of the door in the last quarter of door travel when the door typically gets heavy and tends to fall closed. A bolt is adjusted up or down in the kicker slot to increase or decrease the “kick”, respectively. Refer to diagram 5.
Adjustment of Garage Door Opener

One should refer to garage door opener manufacturer’s installation instructions for attachment to one piece type garage doors.

Maintenance

Lubrication: All pivot points should be lubricated monthly following the manufacturer’s recommendations.

Door Balance and Spring Adjustment: Garage doors should be inspected periodically for proper balancing. If the door is electrically operated, the operator should be disconnected per the manufacturer’s instructions before testing or adjusting the balance of the door. Springs must be adjusted with the door securely propped in the open position.

- If the door is hard to pull down or goes up too fast in its upper 3/4 of travel, move the kicker up one hole at a time until door is balanced.
- If the door comes down too fast or is hard to lift up in its upper 3/4 of travel, the kicker must be moved down one hole at a time until the door is balanced.
- In the lower quarter of travel, the kicker can be adjusted as described in the section headed “Adjustment of Hardware and Springs”.
- It is best practice to adjust the springs in the same manner on both sides of the door.

Visual Inspection: The hardware and the door should be inspected regularly for signs of rubbing and binding which can be an indication of damaged hardware or maladjusted hardware.

Repair and Replacement

Spring Replacement. When replacing a broken spring, a minimum of one spring per side should be replaced to maintain even balancing. Springs tend to lose tension after years of operation. It is best practice to replace all springs if they are more than five years old. Refer to manufacturer’s instruction for spring replacement instruction.

Hardware Replacement. When replacing hardware, it is very important to inspect the jambs for damage such as splits, cracks, termite damage, dry rot or excessive numbers of drilled holes. The integrity of the jambs is of utmost importance because the weight of the door and the force of the springs are both acting on the lag screws that secure the master plate to the jamb. It is never acceptable to mount a new set of hardware using existing lag screw holes unless at least one of the following is done:

- Plug the existing holes using glue and wooden dowels.
- Drill through the entire jamb and bolt the hardware in place using grade 5 bolts and nuts.
- Add a steel support from the master plate up to the jamb.
- Replace the existing jambs with new jambs.

Refer to Safety Issues, Minimum Specifications for Garage Door Jambs for minimum jamb specifications. Refer to manufacturer’s instructions for hardware replacement.

Accessories

Truss Rod Kits. These kits are used for wood garage doors exceeding 10-feet in width to prevent door from sagging in the open position. Rods are typically mounted to the top and bottom rails of the door. Over an extended period of time, a door may tend to sag, in which case the truss rods may require tightening. Refer to manufacturer’s instructions for installation adjustment of truss rods.

Slide Bolt Lock. Designed for locking the garage door with a padlock. Typically, the side bolt is mounted 2 inch to 3 inch from the floor. A slide bolt may be used on each side of the door if desired.
Center Lock. An alternative to a slide bolt lock that is operated from the center of the door can provide locking on both ends of the door. Some center locks can also be operated from the inside of the garage.

Rubber Bumpers. These devices are used to prevent damage to the face of the door as it opens against the header. Bumpers are typically mounted to both ends of the header. Extra decorations on the face of the door must be considered when mounting the rubber bumpers. Bumpers can either be positioned to engage the thickest decorations, or they can be shimmed accordingly so the decorations do not interfere with the header.

Lift Handle. The lift handle is provided for manual operation of the door. Typically, door handles are mounted 18-inches to 2-feet from the floor.

Weather Strip. A weather strip should be mounted to the bottom and sides of the door to close the air gap around the door. Typically, weather strip is mounted to the sides of the door before the level of the master plate, and is mounted to the door jambs above the level of the master plate. Refer to the manufacturer's installation instructions.
Chapter Nine

Residential Door Service and Repair

Introduction

Residential door service and repair starts with reviewing the proper safety procedures required to complete the job without sustaining personal injury. Service work in the garage door industry exposes the technician to more potential hazards than in many other trades. This is due to the combined components of the equipment involved and the nature of both simple and complex service calls. Springs are charged with a load and cables carry the tension of the spring and the weight of the door. Open doors constitute a potential falling hazard and electric operators can malfunction causing entrapment or dangerous electrical conditions. Damaged sections and jammed operators can store a reflex tension that can be released once the opposing force has been removed.

Safety Checklist

1) **Proceed with Caution.** Check all “live” components before attempting to move the door or operator and initiate any repairs. Check torsion and extension springs, cables and cable ends, rollers, operator chain, visually damaged equipment, obstructions and the operator’s power source. Visually assess any potential risks.
2) **Careful Planning.** Decide on the safest course of action before coming into contact with any part of the door or operator. Ask the customer what happened in order to get as much information as possible.
3) **Check Troubleshooting Guidelines.** Refer to the manufacturer’s suggested solutions for the most common symptoms and then

investigate other factors that might be contributing to the problem.
4) **Use Your Best Judgment.** Follow a process of elimination to isolate the problem and determine the cause. Separate the door system into its individual segments and inspect each one closely. Take time to think about the possible result of what you are preparing to do. Use common sense.
5) **Isolate All Potential Risks.** Take action to prevent possible risks identified. Clamp off a door that may fall, lock-out power to a malfunctioning operator, etc. Always disconnect operator power prior to working on a door to prevent unexpected operations.

Use this foundation of safety consciousness as a guide as you take a closer look at what you might expect to find when you show up at a customer’s home in response to a call for service. This section will separate the door into its individual components and list a few of the most common things that can go wrong and then cover some specific techniques for the most typical residential service calls. Always refer to the manufacturer’s installation manual for safety warnings and specific instructions.

Counterbalance Assembly

<table>
<thead>
<tr>
<th>Component</th>
<th>Failure Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Springs</td>
<td>Broken or distorted coils, fatigued spring wire.</td>
</tr>
<tr>
<td>Cones</td>
<td>Hairline cracks, broken winding holes or flange, set screws missing, released from spring.</td>
</tr>
<tr>
<td>Cables</td>
<td>Broken strands, distorted wire, cable end rusted at bottom bracket, catching on door or track, unevenly threaded on</td>
</tr>
</tbody>
</table>
drum, off drum and wrapped around spring shaft.

**Shaft**
- Sheared partially or completely through at bearings or spring, twisted or bent, pulled out of bearing at either end or center coupler.

**Pulleys**
- Noise (lubrication), ball bearings worn or missing, pulley wheel separating, catching on track or sidewall/ceiling obstacle.

**Drums**
- Set screws missing, slipping or over tightened on spring shaft, rubbing against end bracket, cracked, broken, or worn.

**Bearings**
- Noise (lubrication), balls worn or missing, seized with rust.

**Brackets**
- Fasteners loose, mounted out of plumb, bottom corner bracket loose, damaged, or rusted.

**Track Assembly**

**Vertical**
- Track spacing too tight causing door binding. Spacing too wide causing excess side to side movement causing locks to not engage and roller stems to pull out of hinges. Track distorted or bent from being hit.

**Horizontal**
- Track spacing set too close or too wide at backhang. Backhang drops positioned out of plumb causing door to bind or rollers to pull out of hinges.

**Track**
- Jamb and header brackets loose or bent causing binding and erratic door travel.

**Sections**
- Sections distorted from impact or excessive weight causing binding as door travels through radius. Reinforcing struts or U-bars shifted sideways past the edge of the door catching on track.

**Hinges**
- Hinge fasteners loose or missing causing door sections to separate and hinges to bend or break. Edge hinges positioned out of order or upside down, creating spaces or binding at the jambs.

**Locks**
- Lock bars too long, catching on tracks (track spacing might be too narrow). Automatic latching lock cables/chains too slack – unable to turn handle far enough to unlock door. Lock bars or auto latches set too tight (too high) in track strikes making it difficult to disengage mechanism to unlock door.

Outside factors can also interfere with a door's ability to function properly. The main culprit is most often the electric operator that drives the door through its open/close cycle. If it has been mounted too high, it can create a hard start to close the door from the open position and even damage the top section. In this case, you will sometimes find the reversing sensitivity has been over adjusted to compensate for this hard start to a point that will not allow the door to easily reverse if it meets with an obstruction. The solution is to cut longer backhangs and remount the operator where the rail is situated within two inches above the top section of the door.

Other problems can arise from door stop moldings that are set too tight against the closed door, causing it to bind near the fully closed position. Obstructions within the garage can also get in the way of a door’s travel path such as brooms and shovels stored next to the vertical tracks or lumber, ladders, and other items hung from sidewalls and ceilings. Check the entire area around both sides of the vertical and horizontal tracks, above the open door and near the back of the door’s upward travel for items that may have shifted and moved into the door’s path.

Besides making a thorough investigation of all the door’s components, it is also necessary to double check the manufacturer’s troubleshooting guidelines and recommendations before beginning any repair work. This will insure that the warranty has not
been violated and minimize your exposure to any unforeseen hazards that might exist. On older doors with hardware and power assembly designs that are outdated and unfamiliar, it is important to take the extra time required to understand how it is designed to operate before attempting to move the door or make any adjustments or alterations. **Warning:** If you are not confident about an unusual situation, do not proceed with the service work!

## Servicing a Sectional Door

When servicing a sectional door, begin by discussing with the customer what problems they are experiencing. Inspect the entire door system.

### Rollers

Inspect the rollers for bent or rusty stems. Check for freedom of movement in the bearings and for side movement of the stem in the hinge barrel. Replace if necessary. If the rollers are in good condition, lubricate the stem and bearings.

### Hinges

Inspect the hinges for any cracks, bends or damage to the hinge barrel. Check to make sure all the fasteners are in place and tight. If the hinge is ok apply a small amount of lubricant to the pivot points.

### Cables

Inspect the cables for any abnormalities such as fraying or rust. Replace both cables even if only one is damaged. Explain to the customer this procedure ensures that both cables will stretch evenly and maintain an even wear cycle. Raise the door and verify the cables pivot freely on the bottom bracket when the bottom section rolls in the radius. Check that the cable is properly secured in the drum. If the cables are in good repair, apply a small amount of lubricant to the cable and the cable attachment at the bottom bracket.

### Sections

Inspect the sections for damage. Verify the stiles (if applicable) are properly secured. On insulated sandwich doors, check for separation of the interior and exterior skins, or splitting of the sections. Verify the struts are straight and securely fastened. Inspect the bottom seal for tears or shrinkage, and verify that it is securely attached. While damaged sections may still operate they could lack structural integrity and should be replaced. Inspect glazed section lites for cracks, leaks, or deteriorating seals.

### Track

Inspect the vertical track for damage. Verify that mounting hardware is securely attached. Roller stems should turn with a slight amount of resistance. With the door closed, attempt to turn the roller stems. If the roller stems will not turn, the track is set too tight. If the roller stems turn too freely, the track is set to loose. Readjust as needed. Run the door by hand inspecting for binding or sticking. If the door is difficult to raise, the track may be too tight to the wall at the bottom. If the door catches during travel, it may be the result of a protruding track bolt, use of the wrong type bolt in the track, misalignment between the horizontal and vertical track or contact between the top section and the springs or center bearing brackets.

When inspecting the horizontal track, inspect for damage or wear. Verify that back hangs are secure. With the door in the open position, check for proper alignment.
Counterbalance

Prior to checking the balance of the springs, inspect the condition of the spring assembly. Open and close the door to observe the shaft, checking for bending or bowing, replacing if necessary. While operating the door, listen for squeaks or grinding noises.

Verify that cables are properly wrapped and that the drums do not make contact with the track, header or end bearing brackets. Inspect for cracks in the drum or missing/loose set screws. Check the bearings in the end bearing brackets. Check for metal shavings below the bearing and verify that the shaft is centered in the bearing bracket. If either condition exists, replace the bearing, and if necessary, the torsion shaft. If the bearings are in good condition, apply lubricant to both sides of the bearings. Inspect the center bearing brackets to insure they are securely fastened and that the spring pads are in good condition.

In most applications, when springs are properly balanced the door should remain in place when left in a partially opened position. If the door continues to lower without force, more spring tension is required. Conversely, if the door raises without force, less spring tension is required.

When adjusting the spring, maintain the same tension – or number of turns – on each spring.

When working with springs, take note of the spring stretch. Spring stretch is the gap between coils of a wound spring. Too much stretch will cause the spring to lose its shape. Too little stretch will cause the spring to bind. Adjust spring stretch by moving the winding cone out an additional half inch after the spring is wound. Springs that are correctly stretched will freely move up and down when lifted in the center, and will maintain their original shape throughout the door’s cycle. Once the torsion spring assembly is inspected and balanced, lubricate each spring.

Customer Relations

Service and repair calls are among the best opportunities to better customer relations and enhance company professionalism. When it comes to repairing a door, you may not consider customer relations to be important to the task at hand, but that couldn’t be further from the truth. In many cases, your ability to relate to the customer can lead to additional sales, their willingness to cooperate moving garage items to make your job easier, etc. The service person is the best sales person on the job. Keep your customer happy and you will get more work from this and other customers as well, thus job security and more profits for your company. Here are a few things to keep in mind when dealing with customers.

If possible talk to the person in charge prior to doing the job. This will allow you to address any questions or concerns they may have.

Establish the customer’s expectations. You don’t want to do hundreds of dollars worth of repairs if the customer only wanted minimal work done. On the other hand, you don’t want to do minimal repairs when the customer wanted a complete rebuild.

Show interest in the customer’s property. You don’t want to take the three hour tour but a couple of quickly answerable questions and compliments show you are interested in the customer’s property.

Show respect for their property. Ask permission before moving items in the garage. Also work with them to insure they can access items in the garage if needed. Keep materials and tools picked up and organized and out of the way.

Keep in mind that in most cases when you are on a job someone is always watching you and how you conduct yourself. This can weigh heavily on whether or not you do work for that customer in the future.
Service Techniques

Following are a few specific techniques for handling some of the most common types of service calls. Although job conditions, equipment and exact techniques tend to vary greatly, the objective is to review the safest and most efficient methods that are widely known and accepted as standard procedures for most overhead doors.

Changing a Torsion Spring

The first step in changing a broken torsion spring is to identify the existing spring’s dimensions. Look for tag or stenciling identifying the spring size. If no information is available, it will be necessary to measure the inside diameter, wire size, and length of the spring in its unwound state. You will need to determine if the spring is right or left wound and it may also be necessary to note the type of spring ends. See the section on Measuring a Spring.

Measure the height and width of the door and the cable drum’s diameter. If there are two springs on the door, it is a good practice to measure the other spring in case there is any difference in dimensions. It is always recommended that all springs be replaced when one has failed due to the possibility of the unbroken spring failing in a short amount of time. Strongly advise the customer of this option and potential long term savings by not having to return for a second service call!

Determine how many turns are required on the springs. Look for this information indicated on the tag or by counting spirals on the spring. If the spring does not have spirals, draw a chalk line on the wound spring before unwinding so that turns can be counted when unwound.

The next step in replacing a broken torsion spring is to unwind the unbroken spring and make sure the full weight of the door is resting completely on the floor with no tension in the cables. To unwind the spring, insert a winding bar into the lowest accessible hole in the winding cone and hold it near the end.

Warning: The winding bars should be properly sized for the diameter of the winding cone holes and penetrating all the way to the bottom of the winding hole. Winding bars should be 18-inches to 36-inches in length.

Push up on the winding bar to control the spring tension and loosen the winding cone set screws.

Place the second winding bar in the next hole above it and push up slightly to release the tension off the lower bar so that you can remove it from its winding hole. Slowly lower the upper winding bar and repeat procedure one quarter turn at a time until the spring is completely unwound.

Some springs are unwound in the opposite direction when they are mounted with the stationary end facing the cable drums or in low headroom applications. In this situation, the cables are usually peeling off the opposite side of the drum, running down the outside edge of the vertical tracks and attached to an extended portion of the bottom corner bracket. Warning: If you are not sure about which way the spring is wound, do not attempt to unwind the spring!

If there were any problems while measuring the spring(s), it may be necessary to weigh the door in order to calculate the proper replacement spring(s). To field weigh a torsion spring door, position a scale under the center of the door with both springs completely unwound and slack in both cables. Check the door is not binding in the tracks or against the jambs and record the scale’s reading.
Next, remove the bolts on the end-bearing bracket on the broken spring side and slide the bracket off the end of the spring shaft. Loosen the setscrews on the cable drum, pull out the cable end and slide the drum off the shaft. Drape the cable end over the track.

Remove the bolts at the stationary end of the spring where it mounts to the spring anchor bracket at the header. Slide the two sections of broken spring off the end of the shaft. In cases where the shaft has become distorted or gouged from the cable drum and winding cone’s set screws, it may be necessary to file the damaged area with a semi-coarse flat file to allow the drum, bearing bracket and winding cone to slide freely off the end of the shaft.

Slide the new springs onto the shaft. Remount the end bearing bracket and the cable drum in their original positions and use locking pliers to secure the shaft to the header to hold equal cable tension on both sides. You may have to adjust the cable length in order for the drums to be positioned exactly the same at both ends of the shaft.

Clamp the door in the closed position and rewind the spring(s) using the reverse procedure described previously for unwinding. Make sure the winding bar is inserted fully into the winding hole before removing the second bar from its winding hole. Position ladders for greatest stability and position yourself to the outside of winding cone and wind along your side, not in line with your body.

Wind the spring(s) to the required number of turns. Unlock the door and check its balance through the open/close cycle. Add or remove tension one-quarter turn at a time until the door is reasonably balanced. Make sure the door is operating smoothly and consistently.

Changing Extension Springs

Extension springs are mounted in pairs at the rear of the door’s horizontal tracks and are stretched forward by means of cables fed through pulleys bolted to the front end of both springs. The upper portion of cable is fed over another pulley at the front of the horizontal tracks and runs down to attach to the door’s bottom corner brackets. The lower portion of cable is attached to one of a series of holes punched into the pulley angle where the spring’s tension can easily be adjusted by moving the cable’s S-hook either way along the angle.

The first step in changing a broken extension spring is to identify the existing spring’s dimensions. Measure the outside diameter of the spring body, the total compressed spring length, minus the looped ends, and the wire diameter. You’ll also need to measure the width and height and weight of the door.

An extension spring is rated using a three number system – compressed length, stretching capacity and the door’s total weight. For example, the spring for a typical 9 x 7 wood door would be referred to as a 27-42-150. In other words, this particular spring is 27 inches long in its compressed state, is able to increase in length by as much as 42 inches and will lift half a door’s weight rated at 150 pounds. You would need a pair of 27-42-150 springs to properly balance the door. Look for color coding that may indicate the spring sizes per DASMA TDS #171.

Extension springs can vary widely in outside diameter and spring size, but you only need to be concerned with the most critical factors of spring length, stretch and total door weight. Measuring the door’s unbroken spring may help you get a more accurate figure for the closest available replacement. However, spring measurements are not required if you are able to accurately measure the door size and weight.

To weigh a double-wide (two car) extension spring door, position a counterbalance and bathroom scale under the center of the door. Attach a come-along on the live spring side of
the door to relieve the spring’s tension from the cable. Make sure the door is free in the tracks and not binding on the jambs and take your reading as in the method described previously for weighing a torsion spring door. In smaller doors, it may be easier to lift and clamp the door, then to lower it onto the counterbalance arm to get the weight.

The next step in replacing a broken extension spring is to lift the door into the open position. Hold it in place using locking pliers clamped to the track’s radius (upper curved portion) under the bottom roller on the broken spring side of the door. Clamp off the door in the same way with another pair of locking pliers to keep the door evenly positioned and to secure the door for replacing the unbroken spring also. *Warning: Both springs should be replaced at the same time to allow even operation of the door with new, equally rated replacements.*

Remove the cable from the S-hook assembly and unthread it back through the pulley. Remove the spring from where it is mounted at the rear of the horizontal tracks. Inspect the existing pulley for wear in the cable groove or excess play in the bearing and replace if necessary. Attach the new spring and thread the cable over the top and around the bottom of the pulley. Stretch the spring forward slightly and reattach to the pulley angle. When both springs have been replaced, remove the locking pliers and check the door’s operation for balance and even travel at both sides through the open/close cycle. *Warning: Restraint cables should be installed through each spring and secured near the front and at the back of both the horizontal tracks!*

### Resetting and Changing Cables

When resetting loose cables back into the cable drum grooves on a torsion spring door, it is necessary to first remove enough spring tension to get sufficient slack in the cable to work. If the door is closed, one quick way to get cable slack is to backwind the spring slightly. You can accomplish this by backwinding the entire spring assembly one quarter turn with a winding bar and holding the shaft in place with locking pliers. *Warning: Backwinding more than one spring using a single winding cone can exceed the torque rating of the cone causing cone failure. When resetting or replacing cables on a torsion spring door, the best approach is to remove the spring tension by completely unwinding all springs!*

Check to see that the cable is secured to the drum and refit the cable loops into the grooves one at a time. Slowly turn the locking pliers or winding bar until the cables are once again under full spring tension. Also, make sure that both cables have equal tension and that both drums are positioned exactly the same before attempting to operate the door.

On extension spring doors, you will have to open the door all the way and clamp off under the bottom rollers whether you are threading “jumped” cables or replacing broken ones. When replacing broken cables on torsion spring doors, unwind the springs and loosen the lag screws on the bottom track brackets so that you can get at the edge of the bottom corner bracket on the door where the cable attaches. In some cases, you may need to totally remove the bottom corner bracket in order to get at the connecting pin. *Warning: When replacing broken cables always use at least the same minimum diameter as the original cables. Do not modify the cable attachments in any way. Always use the manufacturer’s prescribed method and hardware!*

When making up new door cables from raw cable lengths, you will need to make new looped and fixed ends. Specially designed aluminum sleeves, or ovals (double holes for making loops) and round fittings (single hole for ends attaching to cable drums) are compressed with a swaging tool that forces the aluminum into the strands of the cable. For maximum holding strength under full spring
tension, it is important to swage these fittings properly.

Fittings are made to match cable diameters and should be compressed in two places when using sleeve for looped ends and once when making fixed ends. Swaging tools have multiple sets of compressing “teeth” that allow for accurate compression of small, medium and large fittings. Apply enough pressure to secure the fitting to the cable without too much distortion that will only cause the cable to fail under pressure. Practice on a small section of scrap cable until you are capable of making a properly swaged cable fixture before making one for use under spring tension.

Some torsion spring doors use a metal or nylon tear-drop shaped insert in the looped end of the cable to protect the strands from wearing through. This is used on some wood residential and most commercial wood and steel torsion spring doors because of the more direct pressure from the spring’s tension at the bottom corner bracket. Always install a new thimble in the looped ends of replacement cables for these heavier doors.

**Changing and Reinstalling Rollers**

Changing worn rollers on graduated end hinges starts by locking or securing the door in the down position. Remove the end hinge holding the worn roller and remove the roller. Slide the new roller into the track and refasten the hinge.

*Warning: When several rollers have come out of the track on a door that is in the open position, first secure the door from falling.*

**Replacing Track**

When vertical tracks have been hit and bent, they can either be straightened right on the wall, or with a track anvil when removed and laid on the floor. This tool is available from a few door hardware and tool suppliers. If the track is damaged beyond repair, it should be replaced with a completely new, full length piece. Splicing in shorter pieces is possible, but not recommended because it tends to weaken the track and cause roller wear.

To replace the vertical track, first close and lock the door. Unplug the operator, but leave it connected to the door. Drive a 16d nail inside the track and over the edge of each section. This will help stabilize the side of the door against the opening when the old track is being removed and the new one inserted. Mark the sides of the jamb brackets with a pencil at the front edge of the track. Remove all track bolts from the jamb brackets starting at the bottom and carefully twist out the damaged track from between the rollers and jamb brackets.

Cut a new piece of track to fit and slide it into place. Line up the front edge with your pencil marks and hold in place with C-clamp pliers for drilling out the new piece for the track bolts. Remove the 16d nails, unlock the door and slowly open the door. Realign the track splice where the new piece meets the radius of the horizontal track.

**Replacing Sections**

Replacing sections can be the most confusing type of service call for the new repair personnel and installers. This is because they sometimes think they need to completely disassemble the door in order to switch out the damaged section(s). The only real obstacle is getting around the spring tension which is accomplished in different ways depending on whether it is a torsion or extension spring door and which section is being replaced.

To change the bottom section on a torsion spring door, first raise it off the floor a couple of inches. Hold the upper sections in place with locking pliers clamped to the vertical tracks under the #2 hinge and roller on both sides of the door. Next, remove all the fasteners from
the bottom half of the hinge leaves and backwind the springs or spring shaft as described previously. One locking plier on one side of the track will prevent the bottom section from falling in toward the garage.

Slowly lower the bottom section to the floor. Continue backwinding another quarter turn until there is enough slack in the cables to safety remove the bottom corner brackets. You may have to loosen the bottom jamb brackets of the track to get enough side room for removing the section. Flip the hinge leaves up and swing the bottom section off the tracks. Transfer hardware to the new section and reverse procedure for installing the replacement section. Use this same technique to replace all the sections in a torsion spring door, except the top section which can be easily removed by clamping off and removing hinge fasteners and the top corner brackets.

On extension spring doors, you can use a similar method for all but the bottom section. Instead of “backwinding” the door to the floor, you should clamp a pair of locking pliers above the rollers on the section below the one to be changed. In this situation, the door would have to be resting completely on the floor. To replace the bottom section on an extension spring door, you will need to use a pair of come-alongs on the pulley brackets in order to take the tension off the cables. A much simpler method is to: 1) raise the door, 2) clamp off under the bottom rollers, 3) remove the cables from the bottom corner brackets to disconnect the springs and 4) lower door to the floor. From there, you can easily remove the top three or four sections to reach the bottom section for replacement.

On doublewide doors with extension springs, you will either have to use the come-along method or get someone to help you lower the door to the floor once the cables have been removed. Warning: If you have never attempted this procedure or used this type of equipment, do not attempt the section replacement!

**Conclusion**

This chapter on residential service should provide a solid background of basics with which to start. In order to become proficient, you must experience many different types of job situations and have the opportunity to work with seasoned door technicians. If you run into difficulty and do not have access to the manufacturer’s guidelines, you should always contact your supervisor or the manufacturer for the most effective and safest solution.

You must always work with an “attitude of safety” when working in the repair of overhead doors because of the potential danger that exists in a malfunctioning door. Use common sense and think about the consequences of what you do during each step of the repair process. Also, point out any potential problems you see to the customer and make your recommendations in writing. Document everything that was done on a service call and have the customer sign and keep a copy of the paperwork.

By taking these recommended steps, you will eliminate or limit potential liability to you or your company in the event that anything should go wrong with the door after you have completed your work. Most homeowners disregard their garage door’s need for lubrication or any kind of maintenance or service work until something goes wrong. Take a few minutes to explain routine maintenance procedures and attach garage door safety literature to the service paperwork.

*A safe door technician is a true professional who seriously considers the wellbeing of his/her customers along with his/her own.*
Measuring Springs

Throughout the course of installing and/or servicing sectional doors, the technician will encounter situations where it is necessary to measure springs. This may be to confirm spring sizes while investigating balance issues with a new install, or to determine the appropriate replacement for a broken spring service call. The following section outlines a number of common practices used for measuring springs.

Wire Size

The diameter of the spring wire is one of the most critical measurements of a spring. It is important to measure this accurately as very small differences in wire diameter can have a considerable impact on the spring tension produced. Wire size can be difficult to measure because the spring wire deforms slightly when coiled into a spring. There are a number of methods and tools available to aid in accurately determining the diameter of the spring wire.

The first, and perhaps most convenient method, is if the springs utilize color coding per DASMA Technical Data Sheet #171. A label or splash of paint will be applied to the spring indicating the size of the spring wire. These color codes are used by most of the spring manufacturers today, but one must use caution when dealing with older springs as the color codes had different meanings prior to publication of the DASMA TDS. Some of the most common color codes for Residential door torsion springs are:

<table>
<thead>
<tr>
<th>Size</th>
<th>Color</th>
<th>Size</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.192</td>
<td>Orange</td>
<td>0.234</td>
<td>Brown</td>
</tr>
<tr>
<td>0.207</td>
<td>Yellow</td>
<td>0.2437</td>
<td>Green</td>
</tr>
<tr>
<td>0.2187</td>
<td>White</td>
<td>0.250</td>
<td>Gold</td>
</tr>
<tr>
<td>0.2253</td>
<td>Red</td>
<td>0.2625</td>
<td>Blue</td>
</tr>
</tbody>
</table>

Another method of determining the spring wire size is to measure the length of 10 coils. Place the end of a tape measure between two coils and determine the length of 10 coils. Then divide this measurement by 10 to determine the size of one coil. For example, if 10 coils measures 2.5 inches, then the wire diameter is 0.25 inches. This method can be used with more coils for a more accurate result.

Similar to the 10 coil measurement is the use of a 20 coil ruler. This special ruler available from most spring manufacturers converts the length of 20 coils to a spring wire size for you. Simply place the ruler between two coils, count 20 coils and read the wire size off the ruler.

Another tool available for measuring wire diameter is a spring wire gauge. This tool has a series of
teeth cut into small metal plates. The teeth can be V shaped or curved and the pitch of the teeth is sized to match each spring wire diameter. By trial and error, each gauge is placed on the body of the spring until one is found where the teeth fit uniformly into the grooves of all of the coils. The spring wire diameter will be indicated on the matching gauge.

**Important Note!** Make sure there are no gaps between the coils when using multiple coils to aid in determining the spring wire diameter.

### Spring Length

Length is another measurement required to determine the size of a spring. Torsion spring designs are fairly forgiving of variations in spring length. A good measurement tolerance to target is ±1/2 inch.

It is important to remember to account for spring growth when attempting to measure spring length. A spring will grow in length by one coil for each turn applied. It is best to measure spring length when the spring is unwound because of this. If the spring cannot be unwound, then you must subtract the wire diameter times the number of turns from the length of the tensioned spring to determine the unwound spring length.

The simplest method of measuring spring length is to stretch a tape measure from one end to another. There must be no gaps between the coils and the spring must be straight and without sag. If the spring is broken, the length of each half can be measured and added together.

### Inside Diameter

An experienced installer will become accustomed to the standard spring inside diameters used by different door manufacturers and recognize them based on appearance. However, it may be necessary to measure a spring’s diameter from time to time when non-standard sizes are encountered or verification is necessary. Measuring the inside diameter directly can be difficult in some cases as the spring cones, door shaft, etc. may interfere with taking the measurement.

One simple, and often overlooked, method of determining the inside diameter of a spring is to look for spring cone marking indicating the size. Many spring cones used today have pattern marks indicating the cone manufacturer, spring size, and/or the code used by the cone manufacturer to identify the spring size. Inspect both the winding and stationary cones for these codes and check with the manufacturer for spring size guidance.
When it is necessary to measure the inside diameter of a spring, calipers or a tape measure can be used if there is access to the end of the spring coils. Measure the largest distance from the inside of one side of the spring coil to the other.

If the end of the spring is not accessible for any reason, it is possible to determine the inside diameter of the spring by measuring the outside diameter of the coils. To do this, measure the outside diameter and subtract 2 times the wire diameter.

**Important!** The diameter of a spring decreases when a spring is wound. All measurements of inside and outside coil diameter must be taken with all spring turns removed.

**Determining the Hand of a Spring**

Another important feature of a spring which must be verified from time to time is the direction the spring coils were wound. The spring wire can be wound in two different directions, termed left hand and right hand. Attempting to use the wrong hand spring for a particular application can result in performance issues and lead to premature spring failure.

The spring cones may be color coded indicating the hand of the spring. A red color coded spring cone is used on a right hand wound spring and typically installs on the left side of a door. Similarly, a black color coded cone is used on left hand wound springs which typically install on the right side of a door. Use caution when relying on the color code to identify the hand of a spring as many cones utilize universal threads and it’s possible to manufacture springs with incorrectly colored cones.

Determining the hand of a spring can be difficult to explain and even more difficult to comprehend. Because of this, it’s common to explain several different methods of determining the hand of a spring and allowing each person to select the method which makes the most sense to them. Regardless of which method is used, an installer should be able to effortlessly determine the hand of a spring on a regular basis.

**Method #1**

Compare the spring coils to the threads on a bolt. A right hand wound spring will screw clockwise into the ground just like a right hand threaded bolt.

**Method #2**

Look at the end of the spring with the end of the coil at the bottom. If the wire points to the right (counterclockwise), then you have a right hand wound spring. If wire points to the left (clockwise), then you have a left hand wound spring. See picture for example of a left hand wound spring.
Method #3

Use your left index finger and lay it over the end coil of the spring. If the end of the spring starts at the tip of your left index finger and wraps towards your palm, this is a left hand wound spring. Conversely, a right hand wound spring would start at the tip of your right index finger and wrap towards your right palm. See picture for example of a left hand wound spring.

Method #4

Hold the spring in your hand with your fingers placed around the outside of the body and your thumb pointing straight up. Similar to method number 3, if the last coil ends in the same direction that your fingers are pointing, than the hand holding the spring is the direction of wind of the spring.

There are various other methods installers have used for visualizing how to determine the hand of a spring. It is not necessary for an installer to know and understand each and every one of these different methods. It is only necessary for the installer to select one method that enables them to look at a spring and assess the direction of wind quickly and reliably.

Safe Operation of Sectional Doors

Sectional doors are large, heavy moving objects. When operated safely and correctly, potential hazards can be mitigated. It is essential for the professional technician to be intimately familiar with the safe operation of these doors not only to follow these procedures on the job site, but to educate the end users. Some of these procedures may seem like common sense, but it is important not to take them for granted and lose sight of their importance. The following is a list of guidelines to follow for the safe operation of Sectional Doors:

Door Operation

- Visually inspect the door for physical damage or defective components before and during each operation.
- Release all locking devices prior to operating the door. Attempting to operate a door while locks are engaged can cause damage to the lock and/or operating mechanisms.
- Only operate the door when it is in full view. User intervention can be much more effective in avoiding dangerous situations than relying upon any safety accessories the door may have.
- Operate the door only when it is properly adjusted and free of all obstructions.
- Always operate doors with smooth, controlled movements. Jerking hand chain, slamming doors open or closed, and sudden start/stop operator movements can cause damage and wear to the door and/or operator components.
- For manually operated doors, only lift the door using lift handles or suitable gripping points to avoid potential pinch points.
- Never leave a closing door until it has safely reached the closed position. The door should be observed for the duration of its movement to ensure safe closing.
- Do not walk or drive under a moving door regardless of if it is closing or opening.
- Keep people clear of the opening while the door is moving.
- Do not operate a door that is jammed, has a broken spring, or is damaged in any other way. Attempting to operate a damaged door could result in additional damage or injuries.
- Avoid stopping the door at locations other than open and closed.
- Secure all operator controls to prevent use by unauthorized personnel.
- Keep controls away from children. Do not allow children to play with, on, or around the door or operator.
- Do not pull electric operator hand chain or release during operation.

- Keep hands and other body parts away from a moving door.
- Should the door become difficult to operate or completely inoperable, a trained door system technician should perform immediate repairs.
- Follow proper lock-out/tag-out procedures to secure a malfunctioning or damaged door from operation until repaired to prevent safety risks to others.

Never disconnect the door from the operator in the open position. An underbalanced or otherwise damaged door could free fall causing injury or damage.
Troubleshooting Residential Sectional Doors

The chart below is a list of possible problems with the operation of a door. The possible causes listed are the most common, and are not meant to include all possibilities. With the variety of the product and the field conditions, other factors may be involved. If assistance beyond this troubleshooting chart is needed, please contact the manufacturer.

<table>
<thead>
<tr>
<th>TROUBLE</th>
<th>POSSIBLE CAUSE</th>
<th>REMEDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Door is difficult to open; closes easily</td>
<td>Insufficient spring tension</td>
<td>Increase spring tension</td>
</tr>
<tr>
<td>Door is difficult to close; raises easily</td>
<td>Too much spring tension</td>
<td>Decrease spring tension</td>
</tr>
<tr>
<td>Door jumps up from floor</td>
<td>Too much spring tension</td>
<td>Decrease spring tension</td>
</tr>
<tr>
<td>Door won’t stay open</td>
<td>Insufficient spring tension</td>
<td>Increase spring tension.</td>
</tr>
<tr>
<td>Door does not contact the floor on one side</td>
<td>Unequal Cable Lengths</td>
<td>Adjust cable drums to equal cable tension.</td>
</tr>
<tr>
<td>Door tracks to one side when opened or</td>
<td>Unequal cable lengths</td>
<td>Adjust cable drums to equal cable tension.</td>
</tr>
<tr>
<td>doesn’t travel level</td>
<td>Uneven floor</td>
<td>Adjust bottom seal.</td>
</tr>
<tr>
<td>Door is jammed</td>
<td>Broken spring</td>
<td>Check and repair.</td>
</tr>
<tr>
<td>Door only opens part way then locks up</td>
<td>Spring wound backwards</td>
<td>Verify proper hand and winding direction of spring(s).</td>
</tr>
<tr>
<td>Noisy hinges or rollers</td>
<td>Insufficient lubrication</td>
<td>Apply lubricant.</td>
</tr>
<tr>
<td>Spring is snaking</td>
<td>Too much stretch</td>
<td>Adjust spring stretch</td>
</tr>
</tbody>
</table>
Troubleshooting Residential Sectional Door Operators

In addition to troubleshooting problems with the door, it is also necessary to troubleshoot problems with electric operation. Many operators include electronic error codes to aid in troubleshooting problems. Reference the manufacturer's information for assistance with error codes. The following troubleshooting guide will help you identify the source of the problem for some common operator related symptoms.

Operators are tested and adjusted before shipping from the manufacturer. If a problem arises, in many cases it is after installation and external devices are connected. If after connecting external devices you encounter problems, the trouble often lies in the external devices themselves or in their wiring. Verify all external wiring making certain there are no wires pinched and that there are no voltages being sent into the control circuit.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Cause</th>
<th>Suggested Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Door will not respond to open or close push buttons.</td>
<td>Motor has overworked and the overload thermal protection has tripped.</td>
<td>Reset the overload protection will take place automatically when the motor cools down.</td>
</tr>
<tr>
<td>Circuit breaker tripped.</td>
<td>Fuse is blown.</td>
<td>Replace fuse. If control circuit fuse keeps blowing: Disconnect all external devices. Leave power terminals connected. (Remove power to terminals). Run the operator artificially by using jumpers and shorting out the appropriate terminals as indicated in the startup and testing guide. Then reconnect the various external devices one by one until you find the one causing the short to ground. Or, If you have an ohm-meter, use it to check all incoming wires for continuity to ground. The meter should read infinity in all instances. If there is conduction between and control circuit wire and ground, this indicates a leak to ground and this is why the control circuit fuse blows when power is applied. In some cases, the trouble is intermittent, i.e., the fuse only blows at certain times. This problem is difficult to detect, but again, disconnect all wires going to external devices and run the operator. If the fuse does not blow, this indicates the trouble lies in the external devices.</td>
</tr>
<tr>
<td>Door will not close but will open.</td>
<td>Safety Device not working properly</td>
<td>Replace or adjust.</td>
</tr>
</tbody>
</table>

**WARNING!** Repair all door defects prior to adjusting operator settings.

Always verify the safety devices installed on the operator are fully operational.
Chapter Ten

The Importance of Safety

Introduction

The door industry is a function of the importance of safety in our society. One of the common features of civilization is mankind’s progress in developing products, practices and policies designed to protect people and property. The ability to work safely and prevent injury to one’s self and to others is a prerequisite to being a profession door technician.

Safety has always been an important factor in the door systems industry, both from a professional and financial standpoint. However, as government regulations have become more pervasive and liability risk factors have expanded, safety has taken on an even higher priority.

Safety is no longer something just talked about or featured on a poster in the warehouse. Safety now requires the attention of all members of a business team, from the president to the newest hire. As a door technician, you are a key link in the safety management system, regardless of your rank and prescribed routine work duties. It is imperative that safety and loss control become an integral part of your daily work activities and professional development. A good safety and health program needs to involve everyone in the organization.

This section will discuss some of the common safety issues faced by door systems dealers. Too often employees view safety as penalty avoidance on the part of the employer, and fail to recognize that quality employers never put business ahead of the safety of employees.

Any successful business owner whose company is well established will have an inherent concern for the personal safety of employees. This is not to avoid government fines. It’s not to maximize profits from the workforce. And, it’s not to keep the cost of workers’ compensation insurance down. All of these things may be a result of an effective safety program, and appropriately so, but the fact is good business owners tend to be good citizens and concerned for the wellbeing of others.

If your employer is responsible for your participation in this certification program, you can take this to the bank: Your safety is more important than any sale, installation or service call. Safety is about you, your co-workers, your customers and their families. As a door technician, your strict adherence to safe work practices and service techniques impact many people who will occupy the facilities in which you work. Your skills in the field of safety are an asset to your employer and the community you serve. Never think for a moment that safety is simply about rules or the potential for fines.

Safety and the Company

Each company is required under law to maintain a safe work environment. Company safety policies are a very important part of an employee’s training and are discussed in this section. It is essential that each member of a
company team read and understand all company safety policies. For door technicians, the added responsibility of reinforcing safe work practices and insistence on following manufacturers’ instructions is matter of professionalism.

The single most important goal of any program is to stop accidents before they happen and thus avoid injury and illness to employees. The information contained in this text is intended to provide some basic, yet critical, information that should be used to ensure effective loss control and safety management. Companies often do not achieve the full benefit of their loss control and safety efforts because these issues are overlooked, or inadequately addressed. Strong loss control and safety management programs are the first steps to eliminating the cause of accidents in order to reduce injuries and contain operational costs. Additionally, these efforts will pay big dividends in terms of employee morale, productivity, customer satisfaction, and efficiency of operation.

Company safety and health programs should emphasize that the reason why it is important to comply with applicable OSHA standards. The most important reason to comply with these regulations is not to avoid trouble with OSHA, but rather because it is the right thing to do for all employees. This provides a better understanding of why it is important that your company programs and policies focus on the avoidance of recordable injuries and illnesses and the reduction of liability risk exposure relative to OSHA citations, fines and associated civil and criminal liabilities.

These are some of the common components of many typical safety manuals. Technicians should be thoroughly familiar with their company policies and be willing to bring suggestions to the attention of owners.

**Statement of Accountability** - Top level management must acknowledge their responsibility to establish and maintain such programs and policies as are necessary in order to ensure compliance with current regulatory standards. Do this through a policy statement that is combined with a summary of management’s position on safety in the workplace.

**Safety Goals Statement** – Establish some form of overall goals for your program what would be similar to a program-specific mission statement.

**Safety and Health Organizational Chart** – It is important to establish and document a hierarchy of authority within your safety system to facilitate effective communications and problem resolution.

**Safety Responsibilities and Task Assignments** – Define the roles of all levels of employees in the safety program so it is clear to everyone what their responsibilities are in terms of daily actions or activities.

**Record keeping and Documentation** – It is imperative to a successful safety effort that the basic ground rules for injury and illness record keeping be established and enforced. These guidelines can save a company thousands of dollars in unnecessary expense due to inaccuracy in their record keeping responsibilities.

**Access to Employee Medical and Exposure Records** – This information is required to be communicated to all employees and you should utilize some type of acknowledgement form to be signed by all employees verifying that they have received this information.
Awards and Incentives Program – Your organization may implement some form of an awards and incentive program. The important thing is that employees are recognized in some way for their contributions to the safety effort of the company. Be careful of using cash as an incentive form.

Disciplinary Action Policies – These policies are critical to your long-term success so you should consider them carefully and ensure that they are in line with any contractual agreements with labor representation. It is also important to hold management and supervisory personnel responsible for the compliance performance of those assigned to their supervision.

Incident Investigation Policy and Procedures – You should develop specific policies and procedures relative to incident investigation, to include a strict definition of what types of incidents your firm intends to investigate.

Outside Contractor/Subcontractor Management Program – Develop these policies to apply to all types of outside contractors, including construction-related activities. These policies are one of the single most important areas of concern relative to liability risk management.

OSHA Inspection Policies and Procedures - It is imperative that your organization establishes the ground rules for employee, and outside contractor participation in an OSHA inspection. It is also important to establish procedures for how the “post” inspection activities will be handled in order to ensure the best possible defense for your firm relative to any citations that may be issued.

Hazardous Work Permits - Safety policies will be necessary for any firm who qualifies for coverage under the Chemical Process Safety Standard, or for other operations where hazardous work activities are either periodic or frequent. An inventory of workplace hazards will determine the need for such policies.

These policies also frequently affect outside or subcontractors who perform work in hazardous environments.

Customer Safety and Health Standards – Establish policies relative to the compliance with customer safety and health standards in order to ensure complete compliance. These policies most commonly affect construction, and service related organizations.

Drug Free Workplace Policy – This policy normally relates to public sector construction activities, however, some type of Substance Abuse Policy is recommended for all types of organizations. You should consult with your legal counsel as to applicable laws in your state.

Personal Protective Equipment - Your organization needs to decide what types of personal protective equipment should be used as a matter of standard practice, and what types will be necessary for specialized work activities according to the hazards present. Provide for a cost sharing of such equipment with the employee, or provide it at the company’s expense. In order to reduce pilferage of such items, have the employees turn in the broken or worn item for replacement, or pay for replacement themselves.

Blood borne Pathogens Exposure Control Plan – If these standards apply to your type of workplace, you need to provide the basic personal protective equipment for cleanup of spills. You should also designate all employees either as “required” or “voluntary” responders to workplace emergencies/injuries/illnesses, and then train them accordingly. You also need to develop a standard operating procedure for the spill cleanup.

Fork Truck Operators Training Program – If these standards apply to your workplace, you need to select the personnel who will be allowed to operate this
type of equipment, and then design a training program around the provided guidelines that include both classroom training and practical skill demonstration. This training needs to be re-accomplished annually so as to maintain the operator’s certification.

**Hearing Conservation Program** – You should survey the entire working environment to determine which areas require the use of hearing protection, and thereby the implementation of a hearing conservation programs. These areas should be adequately posted as to such requirements and the affected personnel should be tested, along with providing them with the appropriate hearing protection.

**Respiratory Protection Program** – This program should be activated when the respiratory hazards dictate the need for such protection. Affected employees need to be medically screened and approved to use the protective equipment. They should be fit tested by a qualified person, and issued the appropriate type(s) of protective equipment for their use.

**Lock Out/Tag Out Program and Policies** – All systems and equipment within your working environment need to be clearly labeled (as to the system which they belong). An identifying characteristic such as numerical inventory numbering, or some other form of item identification needs to be attached to the components of the system. Next, you need to develop standard operating procedures for locking out and/or tagging out of all energy sources, systems, and types of equipment at energy isolating points. You should also develop lists of “qualified” and “affected” personnel, and perform the appropriate training for each classification. If outside contractors are required to utilize the host employers (customers) program and policies, the host employer needs to provide, or ensure that the appropriate training has been accomplished for those individuals.

**Assured Equipment Grounding Conductor Program** – Your Company should employ this program for their cords, cord and plug connected tools and equipment, and temporary sources. This program should be used in conjunction with the mandatory use of Ground Fault Circuit Interrupter (GFCI) protection.

**Employee Emergency Action Plan** – This plan should provide for the safe emergency egress of all personnel during emergency situations, and should identify the staging areas for head count and other required components. You should ensure that this information is relayed to all affected personnel as indicated in the training requirements. This plan should also include rescue procedures for an employee who has fallen if the new Fall Protection standards apply to your scope of operations.

**Hazardous Materials and Toxic and Hazardous Substances** - You should inventory the types and quantities of qualifying substances (see 29 CFR 1910.101-120, AND 1000-1050) for clarification of qualifying substances and materials present in your workplace. This section will also aid you in determining the requirements for the protective systems, protection, and other appropriate hazard control techniques. In many cases, these types of hazardous substances or materials require additional training for employees who are exposed to such, and additional program and policy development that is specific to the substance or material. Finally, the record keeping requirements for these types of items is usually more significant.
Safety and the Certified Door Technician

Safety is the door technician’s primary concern. As a professional, it is the technician’s responsibility to always make safety and professionalism a priority. Safety and professionalism go hand in hand. Make compliance with, and understanding of your entire safety and health program and all of its parts, a personal priority.

As a certified door technician, you may be well qualified within your company to recommend enhancements to your written safety policies. By taking this initiative, you can prevent injuries not only to yourself, but also to those with whom you work. This is what is meant by “safety is your primary concern.” You can demonstrate your leadership and expertise by speaking openly with your employer regarding safety in the field. Safety is the responsibility of every individual within a company. This responsibility is not limited to the owner.

In certain instances a technician may be held liable for an installation in the event of an accident. This will impact both the individual and the company in two ways, financially and professionally. There have been lawsuits where defendants have been awarded tremendous amounts of money. Improper door installations and use of improper parts could contribute to serious injuries and property damage.

It is important to understand that safety in the door industry is not just a workplace concern. The technician’s workplace is most often a residence or commercial property that will be occupied by countless people during the life of the door. There is no limit to the number of people – or the value of property – that will be protected by the professional services of a door technician in the course of one’s career. Likewise, there can be no value calculated to determine the consequences of a single failure. Never take shortcuts, always follow manufacturer instructions and insist – even to building owners if necessary – on following safe installation and service procedures.

This section will not cover all problems that may be encountered. Changes in products, technology, laws or regulations and home environments may present additional challenges to safe operations. Government regulations, industry standards, customer or site/facility standards are continually evolving and should take precedence over information and guidelines contained in this text.

Personal Safety

Make safety your number one concern. It will help you, the technician, stay on the job for years to come and help insure the profitability of the business.

Assure your personal safety. Always wear the correct safety equipment. Use the following general checklist to verify you have the minimum equipment:

- Hard hat
- Safety glasses issued directly to installer
- Steel-shank and steel-toed shoes
- First Aid Kit
- Fire Extinguisher

The above list represents only a sampling of safety equipment that should be on every job.
site. Due to the nature of a door technician’s duties, there are many instances where the building owner or general contractor involved will require additional safety equipment and maintain policies that go beyond those of the technician’s employer. Company policies should be examined for additional recommended or required personal protective equipment to ensure safety.

Tools and Equipment

Safety also includes ensuring the proper condition of tools and equipment. Inspect ladders, power tools and extension cords daily for visible signs of defects or wear. When problems or defects are identified, they should never be ignored. In such cases, the problems should be repaired, replaced or otherwise resolved immediately, especially if safety is at risk. Fix the problem on the spot, if possible.

- Ladders and scaffold systems should meet applicable standards and should be in good working order at all times.
- Extension cords should not be cracked or worn and should be appropriately rated for work conditions.

Inspect hand tools periodically for possible defects or wear. Defective hand tools can result in serious injury. Believe it or not, hand tools do wear out, especially if they have been abused or misused.

Safe Driving

Professional door technician safety also includes safe driving techniques. **WEAR SEAT BELTS AT ALL TIMES.** They can save lives in the event of an accident.

- Follow posted speed limits and drive in a safe, courteous manner. Company trucks are often lettered with the company name and phone number. There is nothing worse for the company’s image than to have an individual report that they have witnessed one of the company trucks driving recklessly.
- Properly secure all tools and equipment.
- Identify and secure all loads. If they are longer than the truck, be sure they are properly red flagged according to state law.
- Do not use cell phones or send and receive texts while driving. Always pull over to a safe location when required.

Safety at the Worksite

Safety on the job site begins from the moment a technician arrives. Here are some reminders:

- A truck should be parked in a position where it can be unloaded in a safe manner.
- A vehicle should be parked where it will not be a hindrance to others.
- Be conscious of the customer’s property. If the truck leaks any oil or other fluids, take the necessary precautions to prevent unsafe conditions or customer complaints.

Finally, determine if the work area is safe, and if not, corrective measures should precede the installation. This could mean moving inventory, products, work stations, construction material or other equipment...whatever it takes to create a safe place to work! If for some reason a safe work environment cannot be created, and existing policies do not exist to manage the situation, contact your supervisor to discuss the situation. Never proceed despite the hazard.

Nothing you do for your company or your customer is worth a serious injury to you or anyone else.
Organizations and Federal Guidelines

There are several agencies which impact the door industry in a variety of ways, beyond those mentioned previously in this text. It is not necessary for a professional door technician to learn, in detail, the volumes of rules and regulations. However, it is important to know who these organizations are and what areas of your job they influence. The following describes a few of the key organizations impacting the safety of the technician, customer, and company:

The US Consumer Product Safety Commission (CPSC) is an independent, federal, regulatory agency that was created in 1972 by Congress in the Consumer Product Safety Act. In that law, Congress directed the Commission to "protect the public against unreasonable risks of injuries and deaths associated with consumer products."

Consumer Product Safety Act: a law enacted in 1972 by Congress, which directed the CPSC to "protect the public against unreasonable risks of injuries and deaths associated with Consumer products."

The Occupational Safety and Health Administration (OSHA) is an organization formed under the United States Department of Labor to ensure a safe and healthful workplace for all American workers. OSHA has two methods of setting standards for the workplace. First, OSHA will work with other organizations on standards covering such issues as acceptable designs, construction, installation requirements, recommended safe work practices and unique work task requirements specific to their industry or area of jurisdictional control. If such standards do not exist, OSHA will develop necessary standards.

Occupational Safety and Health Act of 1970: To assure safe and healthful working conditions for working men and women by:

- Authorizing enforcement of the standards developed under the Act;
- Assisting and encouraging the States in their efforts to assure safe and healthful working conditions;
- Providing for research, information, education, and training in the field of occupational safety and health; and for other purposes.

Material Safety Data Sheets (MSDS) are detailed technical bulletins summarizing the hazards of a given chemical or substance.

The National Electric Code® (NEC) is a trademark name for NFPA 70, a standard established by the National Protection Association, Inc. to provide "practical safeguarding of persons and property from hazards arising from the use of electricity." Adoption and enforcement of the National Electric Code® protect public safety by establishing requirements for electrical wiring and equipment in virtually all buildings.

Hazard Assessment

One of the most valuable tools that any door technician can have relative to safety and health management is the ability to recognize, evaluate, and control hazards in the workplace. Many people make the mistake of putting blinders on and think that it is only the hazards that are addressed in the various OSHA standards that need to be controlled. This is not true. All hazards, whether OSHA has promulgated a regulatory standard for them or not must be addressed in terms of elimination and control. This is the result of the employer’s general duty responsibility to provide “employment and a place of employment that is free from known
or recognized hazards”. Approach your frequent and periodic inspections of the workplace from the following perspective, “If you observe that a hazard exists you should take appropriate action to eliminate such hazard. If this is not possible, initiate control action to minimize the potential exposure to all affected employees.” In other words, if it can get someone hurt or sick – do something about it!

This is, of course, easier said than done. Understanding the traditional methodology behind hazard assessment and job safety analysis should help you to be more effective in fulfilling these responsibilities.

**Eliminating and Controlling Hazards**

First, let’s look at the overall process of hazard assessment. When you encounter a hazard in the workplace, your first attempt should be to eliminate the hazard altogether (if possible). If you are successful in eliminating the hazard(s), there is no exposure, and no possibility of injury or illness.

However, many times it is not possible to totally eliminate these hazards, so the next best approach is to attempt to control or minimize the exposure and potential impact to the affected employees. This is usually best accomplished via one or more of these possible approaches:

- Engineering Controls
- Administrative Controls
- Job Safety Analysis and the development of Standard Operating Procedures
- Personal Protective Equipment (PPE)

It should be noted that in recent years, OSHA has begun to require that an employer attempt to implement engineering and administrative controls prior to utilizing personal protective equipment to control hazards. It should also be noted that safety “controls” is a general term used to describe the many different ways in which an employer can reduce the exposure and potential impact upon an employee in regard to the hazards that are present in the workplace – thus, the word “controls”.

The first option is to apply engineering type controls to the hazard. Examples of this type of control would be to place appropriate shoring in an excavation, to install an appropriate guard on a machine or tool, install ventilation equipment to achieve adequate air quality, or many other such applications. Usually the engineering control is mechanically and physically oriented.

If the engineering controls are not suitable to the hazard, or they alone do not adequately control the hazard, the next option should be to look at administrative type controls. Examples of these controls would be to develop a policy relative to a particular hazard such as establishing the work area as a “Limited Access Zone”, thus controlling which employees are allowed in that area, or establishing policies that require an employee get assistance to lift something that weighs more than a specific amount. Other examples of administrative controls would be the placement of hazard warning signs in appropriate locations. Again, these are intended to “control or minimize” the hazard(s).

If the first two methodologies are either not applicable, or insufficient to control a specific hazard, one should consider the use of the next option, which is job safety analysis and the development of standard operating procedures. Although this is represented as the third option in the process, you should consider this alternative for much more widespread application within your company. This option provides you with an opportunity to establish a standardized means of accomplishing given work tasks. This is
important from a management perspective because the more areas that your safety and health programs and policies allow for the individual employee to determine what is safe or unsafe work practice, the greater the possibility of injury or illness. You will, no doubt, get as many interpretations of that issue as you have employees. This leads to fluctuation in application, which inevitably leads to increased risk of injury, illness or property damage. Having an established way of accomplishing these work tasks (via the Standard Operating Procedure) provides for consistent application by all employees and creates a much more manageable environment for your staff. This type of application also leads to much better cost control and risk reduction for the employer.

The way to develop a Standard Operating Procedure is by starting with the process of job safety analysis. In layman’s terms, this means thinking through your work activity in advance in an attempt to address any potential problems that might arise in the process. These problems could also enhance existing hazards, thus increasing your changes of injury or illness. An individual can accomplish Job safety analysis in a very short period of time, or if the task warrants it, you may want to assign a team of personnel to address the activity and perform the evaluation. No matter how you accomplish this evaluation, the process remains the same. First, you develop a list of “basic job steps”. The key to success is to get very elementary in developing this list. Then, identify any hazards, injuries or illnesses that could result from that job step. Finally, identify all potential ways of addressing that step through safe work practices that address the hazards, injuries or illnesses you have identified.

Once you have completed this process, you need to focus on steps one and three. Continue by utilizing this information to develop your standard operating procedure (SOP). This is done by selecting from the options contained in step three (the safe work practices) those that provide the maximum level of protection possible, while achieving the highest level of compliance possible in applicable standards, and yet remain cost effective for your organization. You should also attempt to achieve the highest level of protection possible. Then, you simply list that job Step One is: (list the job step identified in step one of this process), and this is how it will be accomplished: (insert the safe work practice selected). The SOP should also contain a qualifying statement that identifies the work task being addressed, specific worker classifications who are authorized to perform this task (if necessary), a listing of any required personal protective equipment, accessory hazardous work permits necessary (if applicable), the tools and equipment that will be needed to accomplish the task, and the date of last revision or evaluation relative to the SOP.

Now, let’s look at the remainder of the hazard assessment process. Usually, one can find a suitable application or combination of applications from among the three methodologies found in step two of this process. However, many times you will also choose (due to requirement or choice) to utilize personal protective equipment as an additional control measure. Although it is acceptable to take this course of action, you need to understand why Personal Protective Equipment (PPE) is the last method of choice when addressing hazards in the workplace. This is especially important due to the fact that many employers bypass steps one and two and go directly to step three, the use of PPE, because it is often the easiest answer.

The problem with PPE is that, of all the potential control options presented, PPE is usually the least effective in regard to its ability to control the hazard. Another common problem with PPE is that it often times is misused and rendered ineffective. Some common examples of this are a hard hat being...
worn backwards, safety glasses that are lying on the workbench, and hearing protection that is hanging around an employee’s neck.

When addressing hazards and potential exposure to affected employees one should always consider the severity, duration, and frequency of the exposure(s). These factors will all play an important role in your decision-making relative to control selection.

In order that you clearly understand the application of this process, let’s look at areas where you should utilize this type of analysis and evaluation. Critical Operations Tasks and Limited Access Zones certainly qualify for this application, because these tasks and environments are by definition more hazard intensive. Anytime there is a distinct possibility of injury, illness, or property damage resulting from poor work practices, it is a good idea to develop a SOP for these tasks. In some areas of the standards, OSHA requires that your organization develop SOP’s such as in Lock Out/Tag Out, Permit Required Confined Space Entry, Blood borne Pathogens (spill clean-up), Non-routine tasks in Hazard Communication, Fall Protection, Employee Emergency Action Plan, and others. It is a good idea to employ this evaluation process anywhere you have experienced multiple injuries or illnesses.

When performing hazard assessment, it is always a good idea to develop some documentation of the evaluation process. Then, if OSHA questions your control decisions during an inspection, you can at least show an attempt to diligence by verifying your efforts to perform this analysis and being able to support your control decision. Usually, you will end up with some combination of the three steps in this process relative to your control decision. This is perfectly acceptable – it represents an attempt on your part to employ more than one control method relative to that hazard.

It is essential that you provide on-going training for all personnel as per your training agenda and calendar. Employee training systems should include weekly or bi-weekly training sessions that utilize multiple types of training aides. Your company may utilize services often provided by suppliers, local resources and equipment/tool rental firms for help in conducting many of the specialized training sessions.

Some examples of this include:

- A local department is an excellent resource for training in how to use a extinguisher
- An equipment supplier may provide training in regard to the equipment that you rent or buy from them
- A PPE supplier can train your personnel in how to properly wear and care for the personal protective equipment you have purchased.
- Insurance companies, specifically workers’ compensation carriers, offer loss control services that include training in these and other areas.

Many times, vendors and suppliers provide training services at no cost, as a benefit to purchasing or renting their products. Similarly, these services can be negotiated by your company at the point of purchase. However, prior to scheduling these services, you need to review a training plan to insure that they are covering necessary information and that it is not going to be a sales pitch, instead of training. Also, each work area should be monitored daily for compliance performance, enforcement of existing standards, and the correction of any hazards present.
An Introduction to OSHA

A federal agency familiar to most is the Occupational Safety and Health Administration (OSHA). This agency has regulatory authority over most businesses in the United States. Their reach can extend even to employees in certain cases involving serious violations of safety laws.

Compliance with OSHA regulations is a matter of law. In learning about these laws, one should not lose sight of the broader scope of safe work practices. The ultimate objective must be zero injuries. To achieve this objective, employers and employees must work together to reduce or eliminate hazards. OSHA regulations do not necessarily accomplish this. As far reaching as OSHA regulations may appear, they should be viewed as minimum safety requirements.

During the 1950’s and 1960’s federal lawmakers took action to reduce work related injuries, illnesses, and fatalities. These legislative activities resulted in the creation of a new agency empowered to enforce major safety laws, through the Occupational Safety and Health Act of 1970. Today, OSHA remains among the most feared of all federal agencies with the exception of the Internal Revenue Service. However, responsible door systems dealers and professional installers who share a genuine commitment to workplace safety have nothing to fear from OSHA.

The newly formed OSHA then began to promulgate the first set of standards meant to ensure a safe and healthful workplace for all American workers. They embarked upon this endeavor by first assembling a number of existing publications, guidelines, and standards which had been previously developed by entities outside of the OSHA system such as: the National Electrical Code (NEC), the National Protection Association (NFPA), and other existing standards. These became known as “consensus” and “proprietary” standards. These standards covered issues such as acceptable design, construction and installation requirements, recommended safe work practices, and unique work task application requirements which were specific to their industry or area of jurisdictional control. This documentation then served as the basis for development of the first OSHA standards, which are known today as the General Industry standards. They are designated as 29 CFR, Part 1910. The title given to these standards is due to the fact that they were developed for all industries, no matter what the scope of work, thus the name “general industry”.

General Types of OSHA Standards

After completing the development of this initial set of standards, OSHA realized that there were a number of industries which were so unique in nature that they really necessitated a specialized set of standards that were applicable to that industry. “Vertical” standards were developed which would speak to these special industries. An example of vertical standards is the OSHA Standards for the Construction Industry, which are designated as 29 CFR Part 1926. These construction standards are those most likely to be applied to your scope of operations in the door industry. There are other vertical standards that address various special industries, and you should ensure that your organization has current copies of all standards that apply to your scope of work.

Horizontal and the vertical standards are related. In many of the vertical standards, OSHA has “incorporated by reference” certain parts of the horizontal or “General Industry” standards that apply to specific work activities. What does this mean? Wherever this designation has been used, the “rule” developed for the horizontal standards will also apply to the vertical standard as
referenced, specific to a particular work activity or application. In other words, when OSHA utilizes “incorporation by reference” from one set of standards to another, or from outside documents such as ANSI, NFPA, or NEC standards, these “rules” which are incorporated by reference also become part of the vertical standard and carry equal weight in force of law as the vertical standard itself.

Many of the subparts of the various standards have appendices. These appendices can be mandatory or non-mandatory depending upon their designation. If an appendix is mandatory, this means it is part of the standard that is referenced and should be taken into account when reviewing the types of work activities the standard covers. This is necessary to understand the complete requirements, which OSHA has implemented relative to that particular work activity.

One of the most difficult skills to master is the ability to utilize the OSHA standards in an efficient, meaningful fashion. This is largely the result of not being aware of how these standards are formatted and the specific logic by which they are written.

If you have ever encountered portions of the standards that seem to be vague and ambiguous, this was probably done with intention. The reason for this is that OSHA tries to write the standards to be as specific as possible, but on the other hand, they want to leave the employer with as much latitude for compliance as possible so as not to unfairly discriminate against any category of employer.

Most of the more recent standards that have been developed have been in the category of “performance standards”. Basically, this means that OSHA is going to dictate what they want to see as an end result in terms of compliance, however, they will allow the employer to decide how to achieve such compliance. This can be good, or it can be bad, depending upon your understanding of certain characteristics that are incorporated into the existing OSHA standards.

Non-Compliance is NOT an Option

Compliance with safety regulations is not a personal choice. It is a condition of employment. The actions of any one worker can have an impact on the entire organization. Unsafe work habits do not only jeopardize the offending worker, but also can endanger others. Therefore, compliance with safety policies and federal regulations must be viewed as a team effort.

One of the most costly factors of non-compliance is low workplace morale when unsafe working conditions exist. This leads to reduced productivity, poor performance on a daily basis, and litigation initiated by the employees. These are all very costly in terms of potential impact on an organization.

The long-term effects are often not given due consideration. Once these problems take effect, such as excessive injuries and illnesses, poor working relationships between management and labor, it usually takes months, if not years, to improve these conditions back to an acceptable level.

- Productivity (losses due to loss of experienced worker(s))
- Damaged materials, tools, and equipment and related costs
- Retraining costs
- Out-of-pocket medical costs
- Absenteeism due to low morale
- Increases in insurance premiums
- Legal costs
- Case management costs

All of these undesirable circumstances can be avoided by implementing a strong safety and health program.
Recordkeeping and Documentation

The thought of more paperwork is not attractive to most technicians; however, if the recordkeeping system is properly organized and designed, the amount of paperwork needed to support an effective program should not take more than 10 to 15 minutes per day. As with most other governmental regulatory standards, it is imperative that the appropriate records and documents are established and maintained to reduce the potential risk for citations and fines relative to deficiencies in this area. Another important reason for good record keeping is that it can go a long way toward reducing your liability risk exposure relative to any civil or criminal litigation that might arise.

It is important to maintain the manufacturer’s specifications, data and recommendations for proper use and maintenance of equipment and tools. Any time that environmental monitoring is accomplished you should maintain a copy of such results and annotate the individual records of each employee who was exposed to any contaminants and hazards. If your company utilizes hazardous work permits, copies of such should be maintained after completion of the work activity. While this represents only a few of the areas where good recordkeeping and documentation can enhance compliance and reduce liability, there are many other areas where appropriate records should be established and maintained. You and your company should look carefully at establishing and maintaining a strong recordkeeping and documentation system in support of your programming. Remember that the quality and flow of information can be critical to the successful operation of your program.

Shop and Jobsite Inspections

It is necessary to conduct regular inspections of the workplace at large, and for specific work activities and types of equipment and tools. In addition, OSHA requires that some work practices and job procedures, such as those necessary to Lock Out/Tag Out be inspected on regular intervals (usually annually). In some cases, OSHA actually requires such inspections. Where this is the case, you should place such inspection intervals on the calendar of scheduled events relative to your loss control and safety management efforts. It is preferable to thoroughly document such inspections both for compliance, and liability risk management purposes. This documentation should be maintained on file for the specified time required, or for a standard period of three years where not otherwise designated.

For the most part, OSHA states that these inspections should be conducted regularly and frequently, although they do not formally state a specified time interval. What this means is that these inspections need to be conducted as often as is necessary to eliminate and/or adequately control the hazard(s) present in the workplace. However, in many cases relative to equipment and tools, OSHA states that the user must conduct a visual inspection on a daily basis. Even where OSHA does not require any inspection to be conducted, you should consider this action as a means of helping to control the costs and liability risks, as well as maximize compliance performance. These inspections also serve to help you prevent unnecessary losses and maintain a higher level of general safety awareness that enhances your overall loss control and safety efforts.
Self-Inspection Guidelines

Self-inspection is an essential part of your overall loss control and safety management program. These efforts preserve and protect resources and improve operational functions. The primary purpose of inspections is to identify hazards and eliminate or control them. When effectively planned and controlled, this process reduces the frequency and severity of unplanned interruptions in your business operations. Efficiency is also improved; productivity increases and costs are better controlled.

The process of identifying hazards must be expanded beyond those normally associated with employee injury potential in order to obtain the maximum benefit from self-inspection. It must be clearly understood that the intent is to correct any problem, which interferes with the most efficient use of time, material and equipment. Identification must include study of methods, behavior, layout, maintenance, critical operations and raw materials. All parts of the system used to produce profit are inspected on a planned basis to detect hazards and correct them prior to an unplanned occurrence that will interfere with optimum productivity.

Each company should conduct regular self-inspections. Experienced installers can be instrumental in this process by participating in keeping with the following guidelines:

- Follow a company policy of planned inspections of all operations, methods, work areas and equipment
- Assign responsibility, authority and accountability for the administration and operation of the program
- Develop inspection procedures to include specific duties for supervisors or others who will be involved in the hazard identification and correction process
- Establish lines of authority and communication for hazard correction and provide appropriate recordkeeping documents
- Arrange for training in planning and conducting inspections.

Measure the progress and benefit of such inspections by tracking the following items from before and after the implementation of the inspection requirements:

- Lost time due to injuries.
- Property damage to equipment, tools or materials.
- Productivity ratings.
- Improvements in quality and reduction in call-backs.
- Equipment repairs and breakdowns.
- Employee morale.
- Overall cost of operations.
- Profit margin.
- Increased business opportunities from a more proactive program.
- Customer satisfaction ratings.

In order that you are able to conduct effective inspections, the following items should be carefully considered and dealt with accordingly:

- Know what you are looking for. Finding and correcting hazards before the unwanted condition or action results in an unplanned work interruption or injury is the basic purpose of planned inspections.
- Review past accident records to determine where and how injuries have occurred in the past.
- Review past inspection records to identify the problems that have been previously observed or that tend to reoccur.
• Have a working knowledge of company policy and procedures so you will know the correct method which should be used.
• Know the company rules and standards for employee behavior and performance.
• Develop your own personal checklist of what to look for, where and when.
• Review maintenance work orders to determine operations or equipment requiring more frequent observation due to breakdowns or other problems.

**General Workplace Environmental Concerns**

The physical environment of the workplace plays an important role in the prevention of workplace accidents. This is especially true for door technicians, whose “workplace” changes with each installation and service call. The following areas of concern should be thoroughly evaluated during an inspection in order to ensure a safe workplace overall.

• Floor space allotted to materials should be adequate without approaching the aisle and working space. Aisles should be wide enough to allow for safe operation of equipment and/or vehicles. Storage racks and shelving should be of sound construction and capable of supporting the maximum intended loads. The load capacities for floors above grade level and storage racking or shelving systems should be clearly posted throughout the facility. Storage areas should be clearly marked as to intended use and rules of conduct.
• The floor surface should be of proper design and construction as to be capable of safely supporting the intended loads, and should be kept in good repair to avoid slip, trip and fall hazards, and hazards to operating equipment and vehicles. Good housekeeping should be maintained at all times.
• Stairs and steps should have treads of sufficient width and depth, as well as have slip resistant surfaces. Proper handrails should be installed and maintained.
• Ladders should be sufficient to allow for safe working conditions.
• The entire facility should be inspected for electrical shock hazards, proper grounding of permanent and temporary power sources, and safeguarding of electrical hazards.
• Overall housekeeping should be a constant priority and sufficient time should be allowed daily to clean up and dispose of unnecessary debris and waste.
• Material handling equipment and work practices should be carefully monitored and regularly inspected to avoid undue handling and equipment in disrepair.
• Traffic control should be carefully evaluated to ensure efficiency and safe operating conditions.
• Seasonal factors such as weather (ice, snow, wind, rain) should be taken into consideration when evaluating the premises and equipment.

**Required Inspections**

• Temporary and permanent fighting equipment and emergency alarm system(s).
• Cords and cord and plug connected tools and equipment.
• Operational and safety controls on vehicles.
• Fork trucks.
• Annual inspection of lock out/tag out procedure.
• Emergency evacuation procedures, and required employee response actions.
• Portable and fixed ladders.
• Machine guarding.
• Personal fall arrest equipment.
• Hand and power tools.
• Aerial lifts.
• Lift operations equipment.
• Welding, cutting and burning equipment.
• Personal protective equipment.
• Safety equipment such as eye wash stations and showers.
• Emergency exits and the pathways leading to them.
• Housekeeping

**Conclusion**

Safety is an essential professional skill.

It is a topic about which a top performing professional in any industry is acutely aware.

Professional baseball players don’t fuss about wearing batting helmets because they know and respect the danger of being hit by 90-mile-an-hour fastball.

Professional race car drivers surround themselves with every possible safety device because they, too, know the dangers of their craft and would consider it foolish and amateurish for anyone to do otherwise.

The examples could go on and on, but the point is, a professional door technician knows and respects the potential hazards associated with our industry. These hazards are mitigated by a high level of knowledge and professional work skills that reduce or eliminate these risks. Proper and safe service and installation is accomplished through experience, knowledge and skill, and that adds value to the product beyond the cost of the installation. Safe installation is derived through this value-added skill. By making safety the top priority while on the job, the installer protects himself, co-workers and the general public.
Chapter Eleven

Basic Math

Introduction

The main topics to learn and understand in this section are:

- Base 10
- The Decimal Point
- Place Values
- Good Habits

This manual is aimed to give you an overview of the rules of arithmetic that will make it easier for you when you encounter numbers as part of your work. With some luck, and some work on your part, you will be able to build your confidence when encountering problems that require basic math.

There isn’t any mumbo-jumbo when it comes to math. There are rules that apply that you need to learn and master in order to be successful. While there are some shortcuts, the real key to basic math is memorization of the basic facts of addition, subtraction, multiplication and division. This means that you must be able to recognize, without effort, that $6 + 7 = 13$ and $6 \times 7 = 42$. If you do not know these basic addition, subtraction, multiplication and division tables, you should learn these before proceeding any further.

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<td>19</td>
<td>20</td>
</tr>
</tbody>
</table>

Our number system is based on the number 10, which just happens to correspond to the number of fingers most people have. If necessary, don't be afraid to use your fingers as an aid. Do whatever is easiest and gives you the most confidence as long as you arrive at the correct answer.

In order to be successful at basic math, you will need to understand the value of a digit when recognizing it in its place. The number 7 standing alone means seven ones. With a zero (0) placed after it, the number becomes 70, which is our way of saying that the number represents seven (7) groups of ten (10) and zero (0) groups of one (1). Likewise, the number 752 (seven hundred fifty two) represents seven (7) groups of one hundred (100), five (5) groups of ten (10) and two (2) groups of one (1).

Each value to the left of the decimal point increases the value of a group by a factor of ten (10). Each value to the right of the decimal
point decreases the value of a number by one tenth \((1/10)\).

Some of you may already know this and some of you might be saying yourself, “OK, but what is a decimal point?” We’ve all seen them for sure. It’s that little period (.) that shows up in some numbers. The numbers to the left of the decimal points are whole numbers called integers. For example, the numbers 3, 6, 9, 28, and 125 are integers.

The numbers to the right of the decimal point are called decimal fractions and have a value less than one (1). For example, 0.5, 0.14 and 0.123 are decimal fractions.

This might be best illustrated by giving an example of something we use every day – money. You’ve all seen something that costs $9.99. What this really means is that it costs 9 whole dollars and 99/100\(^{th}\) of another dollar. Likewise, $5.25 means 5 whole dollars and 25/100\(^{th}\) (or 1/4) of another dollar.

You might want to even use the concept of money to make math easier. When you are adding a column of numbers, pretend that they represent dollar amounts that are owed to you. That way, you’ll want to make sure that the total is absolutely correct so that you can receive everything that’s owed to you.

While we have mentioned decimals above, we will leave them alone for now and concentrate initially on whole numbers. Decimals and fractions will be addressed later in this manual after you’ve had a chance to brush up on the basics.

One other helpful hint is that you try to develop good habits, which should help you reduce the chance of making mistakes. Some good habits to develop are:

1. Learn the addition and multiplication facts. If you can’t add or multiply basic single digit numbers, this manual isn’t going to be of much help to you.

2. Make sure you copy and write down your numbers clearly and correctly.

3. Try to keep your columns straight so that the 1’s place all align, the 10’s place all align, etc.

4. Do your addition from right to left.

This manual has been set-up to teach you the basic steps of arithmetic in a progressive manner. After a concept is introduced, you will be instructed to complete practice problems. Answers to practice problems can be found at the end of the study guide.

**Addition of Whole Numbers**

The main topics to learn and understand in this section are:

- Hints on Adding Mentally
- Adding by Partial Totals

The most basic of all math operations is the addition of numbers in columns. An example would be:

\[
\begin{array}{c}
4 & 2 & 8 \\
3 & 9 & 2 \\
\hline
1 & 4 & 5 \\
9 & 6 & 5
\end{array}
\]

When you add these numbers, the 1\(^{st}\) place to go is to the one’s place, that’s the column furthest to the right. Think 8+2 is 10 plus 5 = 15. This actually means 1 group of 10 and 5 ones. Write the 5 in the one’s place of the answer. Then you mentally carry, or exchange, the 10 ones for 1 ten. This number must be added to the numbers in the ten’s column. To add the ten’s column, you start with the number you carried, 1, plus 2 = 3. 3 plus 9 = 12. 12 plus 4 = 16. This 16 actually represents 16 groups of ten. Write the 6 in the ten’s column and exchange the 10 groups of 10 for 1 hundred. Remember, you must add this to the other numbers in the hundreds column. This column then becomes 1 plus 4 = 5. 5 plus 3 =
8. 8 plus 1 = 9. Write the 9 in the hundreds place. This gives you a final answer of 965.

PRACTICE PROBLEM A-1. Add the numbers:

a) 62  
+ 29  
   + 38  
   + 17  
   + 22  
   + 6  

b) 88  
+ 92  
+ 64  
+ 23  
+ 67  
+ 12  

c) 58  
+ 93  
+ 16  
+ 18  
+ 27  
+ 45  

d) 77  
+ 87  
+ 62  
+ 58  
+ 33  
+ 23  

PRACTICE PROBLEM A-2. Add the numbers:

a) 604  
+ 922  
+ 728  
+ 94  
+ 387  
+ 643  

b) 918  
+ 819  
+ 642  
+ 531  
+ 783  
+ 346  

c) 623  
+ 921  
+ 183  
+ 643  
+ 777  
+ 222  

One way to shorten the time it takes to add numbers is to learn ways to add mentally. For instance, there are several ways you can go about trying to add 28 and 36 together.

You can think 28 + 30 = 58 and 6 is 64.

You can think 20 + 30 = 50; 8 + 6 = 14 so 50 + 14 = 64.

You can think 30 + 36 = 66; 66 less 2 = 64.

You can think 28 + 40 = 68; 68 less 4 = 64.

PRACTICE PROBLEM A-3. Add the numbers mentally:

a) 16 + 24 =  
b) 31 + 19 =  
c) 26 + 34 =  
d) 9 + 72 =  
e) 72 + 18 =  

Another way in which you can approach addition is by doing what is called adding by partial totals. This is particularly useful if you have a long column of numbers. When using this method, you write down the actual sum of each column without carrying the remainder to the next column. You then add the column totals together to obtain the sum. See the example below.

\[
\begin{array}{cccc}
1 & 2 & 3 & 4 \\
9 & 6 & 6 & 8 \\
9 & 0 & 1 & 2 \\
4 & 7 & 5 & 6 \\
8 & 8 & 9 & 0
\end{array}
\]

\[
\begin{array}{c}
\text{sum of the one’s column} \\
\text{sum of the ten’s column} \\
\text{sum of the hundred’s column} \\
\text{sum of the thousand’s column} \\
\text{sum total}
\end{array}
\]

The nice thing about this method is that you can easily check your work by being able to add any column at any time.

PRACTICE PROBLEM A-4. Add the columns of numbers using the partial totals method:

a) 3,221  
+ 9,292  
+ 3,726  

b) 5,757  
+ 6,229  
+ 6,215  

c) 1,188  
+ 9,292  
+ 3,726  

Subtraction of Whole Numbers

The main topics to learn and understand in this section are:

- Using Place Values
- The Exchange or Borrow Method
- Subtraction of Three Place Numbers

One of the most important things to remember is that subtraction is the opposite of addition. If you can master addition, subtraction shouldn't be a problem. You simply need to remember the addition facts and apply them in reverse. If
you can do this, then you know subtraction facts.

For example, if $7 + 9 = 16$, then $16 - 9 = 7$. Similarly, if $9 + 7 = 16$, then $16 - 7 = 9$.

The most common method of subtraction is the exchange, or borrow method. To give you an idea in very basic terms what you are actually doing when you do subtraction, see the example below:

$$73 = 7 \text{ tens } 3 \text{ ones} = 6 \text{ tens } 13 \text{ ones}$$
$$- 47 = 4 \text{ tens } 7 \text{ ones} = 4 \text{ tens } 7 \text{ ones}$$
$$26 \quad \quad \quad 2 \text{ tens } 6 \text{ ones}$$

Starting in the one’s place, since you can’t subtract 7 from 3, you need to borrow or exchange one of the 7 groups of 10 for 10 ones leaving 6 tens and 13 ones. Subtracting 7 ones from 13 ones leaves 6 ones.

Next subtract the 4 tens from the 6 tens which leaves 2 tens. This makes the total difference 2 tens and 6 ones = 26.

As a quick check, add the answer to the smaller (or lower) number; $26 + 47 = 73$. Since this is the number you started with, the answer is correct.

**PRACTICE PROBLEM B-1.** Solve these subtraction problems:

a) 93  b) 77  c) 72  d) 91  e) 70
   - 27  - 18  - 32  - 83  - 61

The subtraction of 3 place numbers follows the same procedure as shown in the example.

$$483 = 4 \text{ hundreds } 8 \text{ tens } 3 \text{ ones} = 3 \text{ hundreds } 17 \text{ tens } 13 \text{ ones}$$
$$-296 = 2 \text{ hundreds } 9 \text{ tens } 6 \text{ ones} = 2 \text{ hundreds } 9 \text{ tens } 6 \text{ ones}$$

Start again at the one’s place. Since you can’t subtract 6 from 3, you need to exchange 1 ten from the 8 tens for 10 ones. This now becomes 13 minus 6 which leaves 7.

Subtracting in the ten’s place, you can’t subtract 9 from 7 (you started with 8 tens but you exchanged 1 group of ten for 10 ones leaving you with 7 groups of ten), so you need to exchange 1 of the hundreds for 10 tens, giving you 17 tens. Subtract the 9 tens from the 17 tens to get 8 tens.

In the hundred’s place, subtract the 2 hundreds from the 3 hundreds (again, you started with 4 hundreds but exchanged 1 group of hundreds for 10 tens leaving you with 3 hundreds) which leaves 1 hundred.

This then leaves you with 1 hundred 8 tens and 7 ones = 187 which is the answer.

Checking your work, you add $187 + 296 = 483$.

**PRACTICE PROBLEM B-2.** Solve these subtraction problems:

a) 632  b) 287  c) 756  d) 463  e) 456
   - 311  - 94  - 458  - 367  - 129

**Multiplication of Whole Numbers**

The main topics to learn and understand in this section are:

- What is Multiplication?
- Memorization
- Multiplying Two and Three Place Numbers
- Carrying
- Multiplying by Numbers Ending in Zero
- Shortcuts
- Checking

Multiplication is really nothing more than repeated addition in which you add a number to itself several times. For instance, 6 times 4 actually means $6 + 6 + 6 + 6 = 24$.

In order to be proficient in multiplication, there are no two ways about it – you must be able to
recognize, by sight, the product of any two numbers from 1 to 12. The product is what you call the result when you multiply two numbers together.

If you do not know these facts by sight, stop and study the multiplication tables for the numbers 0 to 9. Make sure you know these backwards and forwards before proceeding. Again, the only way to learn multiplication is to memorize the facts so make sure that you know them.

<table>
<thead>
<tr>
<th>Multiplication Table (0 to 9)</th>
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<tbody>
<tr>
<td>+</td>
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<tr>
<td>0</td>
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<td>9</td>
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</table>

In order to multiply a number, here is what actually is happening. Suppose you want to multiply 62 x 4. You could do this as:

\[(6\text{ tens }\times 4) + (2\text{ ones }\times 4) = 24\text{ tens }+ 8\text{ ones} = 240 + 8 = 248.\]

A shorter way would be to write this as

\[
\begin{align*}
62 & \times 4 \\
248 & 
\end{align*}
\]

What you’ve done is start in the one’s place and multiply 2 x 4 = 8. Place the 8 in the one’s column. Next multiply 6 tens x 4 and place the 24 in the tens and hundreds place. The product is then 248.

Of course, not all multiplication is that easy. Sometimes the numbers are bigger or not as easy as single digits. When the numbers get larger, you will need to “carry” to the next place. For example, suppose you make $126 per day and you want to figure out how much you earn on a weekly basis. You can add $126 + $126 + $126 + $126 + $126 to arrive at the answer, or you can multiply $126 x 5 to get the answer. Let’s try multiplication to arrive at the answer.

\[
\begin{align*}
126 & \times 5 \\
630 & 
\end{align*}
\]

First you multiply the 6 x 5 = 30. You write down the 0 in the one’s place and “carry” 3 tens. Next you multiply 2 x 5 = 10 + 3 (which you carried) = 13. Write down the 3 in the ten’s place and carry the 1 hundred. Multiply the 1 x 5 = 5 + 1 (which you carried) = 6. Write down the 6 in the hundred’s place giving you an answer of 630.

**PRACTICE PROBLEM C-1.** Solve these multiplication problems.

\[
\begin{align*}
a) & \quad 93 \times 4 \\
b) & \quad 66 \times 4 \\
c) & \quad 40 \times 3 \\
d) & \quad 22 \times 9 \\
e) & \quad 24 \times 7 \\
\end{align*}
\]

Another fact that you need to know is how to multiply by numbers that end in 0. When you multiply by 10, you can simply place a zero to the right of the number.

\[
\begin{align*}
16 \times 10 & = 160. \\
86 \times 100 & = 8600 \\
24 \times 1000 & = 24,000 \\
\end{align*}
\]
So here’s the rule you need to know when multiplying by numbers ending in zero. First, multiply the numbers together and disregard the zeros. Then count the number of zeros and place that many zeros to the right of the product.

For example: 12 x 30 = ? Think 12 x 3 = 36. There is 1 zero so add 1 zero to the answer to make it 360.

Another example: 25 x 300 = ? Think 25 x 3 = 75. There are 2 zeros in 300 so add 2 zeros to the answer which gives you 7500.

By learning this method, it will be possible to do many problems mentally.

**PRACTICE PROBLEM C-2.** Solve these multiplication problems containing zeroes:

a) 20 x 3 = 

b) 40 x 8 = 

c) 3000 x 4 = 

d) 20 x 60 = 

e) 300 x 11 =

There are many cases when you need to multiply larger numbers together. When faced with multiplying a 3-digit number by another 3-digit number, people who are not comfortable with math often feel defeated before they even start. It is not necessary to feel this way. The rules are the same as for smaller and simpler numbers. It just takes a little more time and you need to be a little more careful. Here you will find 2 methods for multiplying numbers. One is the long way to show as an example. The other way is the short form. Use whichever method you are most comfortable with.

**Example:**

<table>
<thead>
<tr>
<th>456</th>
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<th>456</th>
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<tbody>
<tr>
<td>x 2</td>
<td>x 80</td>
<td>x 700</td>
</tr>
<tr>
<td>(a) 912</td>
<td>(b) 36480</td>
<td>(c) 319200</td>
</tr>
</tbody>
</table>

This is the same as:

The same problem using the short method would be:

<table>
<thead>
<tr>
<th>456</th>
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<tbody>
<tr>
<td>x782</td>
</tr>
<tr>
<td>912 (a)</td>
</tr>
<tr>
<td>3648 (b)</td>
</tr>
<tr>
<td>3192 (c)</td>
</tr>
<tr>
<td>356592</td>
</tr>
</tbody>
</table>

a) You start writing the first partial product in the one’s place because you are multiplying by 2 ones.

b) Start writing the second partial product in the ten’s place because you are multiplying by 8 tens.

c) Begin writing the third partial product in the hundred’s place because you are multiplying by 7 hundreds.

**PRACTICE PROBLEM C-3.** Solve using either the long method or the short method:

<table>
<thead>
<tr>
<th>322</th>
<th>123</th>
<th>709</th>
<th>845</th>
<th>126</th>
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</thead>
<tbody>
<tr>
<td>x 294</td>
<td>x 678</td>
<td>x 213</td>
<td>x 312</td>
<td>x 318</td>
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</table>

There are some shortcuts in multiplication that come in useful. The rules governing multiplication when zeroes are involved can still be used even if the problem does not actually contain any zeros. This is done by regrouping your numbers.

Example: 23 x 8 = ?

Regroup your numbers into 20 x 8 = 160 and 3 x 8 = 24. 160 + 24 = 184

Example: 12 x 26 = ?
Regroup your numbers into $12 \times 20 = 240$ and $12 \times 6 = 72$. $240 + 72 = 312$

**PRACTICE PROBLEM C-4.** Solve these problems using shortcuts:

a) $15 \times 22 =$  
b) $302 \times 8 =$  
c) $49 \times 7 =$  
d) $22 \times 18 =$  
e) $64 \times 11 =$

**Division of Whole Numbers**

The main topics to learn and understand in this section are:

- Terms
- Remainers
- Learning Aids

Division is the process of finding equal parts of any quantity. It is the reverse of multiplication. In fact, you can use multiplication to check that your division has been done correctly. Basically, division is useful in finding the size or number of equal sized parts or smaller groups.

A typical way to indicate division is $45 \div 3$. This means you want to divide 45 into 3 equal parts. The number to be divided (45) is called the dividend. The number of equal parts into which you are dividing (3) is called the divisor. The result is called the quotient.

Suppose you wanted to know how many three-man crews you could have if you had 12 people. You simply take $12 \div 3 = 4$.

Of course life is not always that simple. What if you had 22 people and wanted to establish three man crews? You would figure this by writing $22 \div 3 = 7$ with 1 left over. The 1 leftover is called the remainder and must be less than the divisor.

There are several ways to do division but basically they all use the following procedure.

Example: Divide 74 by 5.

```
\begin{array}{c|c}
5 & 74 \\
\hline
 & 5 \\
\hline & 24 \\
\hline & 20 \\
\hline & 4 \\
\end{array}
```

*Step 1.* Estimate the final quotient in round numbers. You should be able to look at the problem and determine that the answer is at least 10 but less than 20.

*Step 2.* Ask yourself, how many times is 5 contained in 7? Try 1 as a trial quotient. Place it over the 7.

*Step 3.* Multiply 1 x 5 = 5. Subtract the 5 from the 7. The difference is 2.

*Step 4.* 2 is less than 5 so bring down the 4.

*Step 5.* Ask yourself, how many times is 5 contained in 24. Try 4 as a trial. Place it over the 4.

*Step 6.* Multiply the 4 in the quotient by the divisor and you get $4 \times 5 = 20$. Subtract 20 from the 24 and 4 is left over. Since the remainder (4) is less than the divisor (5), your answer is 14 with a remainder of 4. If no remainder were left over, the answer would have been exact. If the remainder is greater than the divisor, you need to go back and increase the quotient.

**PRACTICE PROBLEM D-1.** Solve these division problems.

a) $426 \div 7$  
b) $814 \div 9$  
c) $621 \div 3$  
d) $123 \div 4$  
e) $4567 \div 9$
Fractions

The main topics to learn and understand in this section are:

- Proper and Improper
- Raising and Reducing Terms
- Changing Whole Numbers to Fractions
- The Least Common Denominator

A fraction is any part of an object, quantity or digit. They are made up of 2 numbers. The top number is called the numerator. This number indicates a proportion of the whole or group. The bottom number is called the denominator. It tells how many equal parts there are in the whole or group. An example is shown below. Perhaps a simple way to remember is that the denominator is da number on da bottom!

numerator 3
denominator 4

Fractions can also be written with a slanted fraction line such as ¾.

While all fractions may look alike to you, there are two different types you will need to recognize. Their names are not important except in trying to explain about fractions. The two types are called proper fractions and improper fractions.

Proper fractions are those where the numerator is less than the denominator. This results in a value less than 1.

Improper fractions are those in which the numerator is greater than or equal to the denominator. An example would be 9/5. This means that an improper fraction has a value greater than or equal to 1.

When a whole number and a fraction are written together, such as 1-1/2, this is called a mixed fraction.

An important concept to learn when dealing with fractions is learning how to raise fractions to a higher term and reduce them to a lower term. This is helpful when adding fractions of different bases.

For example, suppose you wanted to add 1/8 inch + 1/8 inch. That’s pretty simple. But what if you wanted to add 1/8 inch + 3/16 inch? This becomes difficult unless you can raise and reduce fractions.

In order to raise a fraction to a higher term, you need to multiply the numerator and the denominator by the same number that results in the denominator that you want.

As an example, suppose you wanted to convert 1/2 inch into 1/16 inches.

Since 2 is now the denominator, you need to ask, 2 times what number equals 16? The answer is 8 so multiply the numerator and the denominator by that number. What this really does is multiply by 1, which won’t change the fraction, just the way it appears.

Example: $\frac{1 \times 8}{2 \times 8} = \frac{8}{16}$

so 1/2 inch = 8/16 inch

PRACTICE PROBLEM E-1. Convert these fractions:

a) $\frac{2}{3} = \frac{?}{15}$

b) $\frac{1}{5} = \frac{?}{25}$

c) $\frac{3}{6} = \frac{?}{24}$

d) $\frac{2}{7} = \frac{?}{21}$

e) $\frac{1}{6} = \frac{?}{18}$

In order to reduce a fraction to a lower term, you need to divide the numerator and the denominator by the same number that results in the denominator that you want. This is really what you learned above only in reverse. The other thing you need to do is to keep lowering the fraction until you get to the lowest terms. Reducing a fraction to its lowest terms means to bring the fraction down to the smallest whole number in both the numerator and the denominator without changing the value.
To reduce to the lowest terms, divide both the numerator and the denominator of a fraction by the highest number that can be evenly divided into both.

As an example, suppose you wanted to convert 6/24 inch into 8ths. Ask yourself, 24 ÷ ? = 8. The answer is 3 therefore 6 ÷ 3 = 2 but this is not the lowest term.

24 ÷ 3 = 8

Let us start over with 6/24. What numbers can be evenly divided into 6? [1, 2, 3 and 6]. What numbers can be evenly divided into 24? [1, 2, 3, 4, 6, 8, 12 and 24]. The largest divisor of both 6 and 24 is 6. Dividing both the numerator and the denominator by 6 results in 1/4. So, 6/24 = 1/4.

PRACTICE PROBLEM E-2. Reduce each fraction to its lowest term:

a) 8        b) 12    c) 16    d) 15    e) 14
14        21        36        35        16

It is often necessary to change a whole number into a fraction. For instance, change the number 4 into an improper fraction with seven as the denominator. Then raise the fraction to the higher term by multiplying both the numerator and the denominator by the same number (which just happens to be the number you want as the denominator). It should look like this:

4 x 7 = 28
1 x 7 = 7

To change a mixed number, such as 3-3/4, change the whole number part to a fraction with the same denominator as the fraction. Then add the two numerators together. Place the sum over the denominator. For example:

2 3/4 changed to a fraction would be:

2 x 4 = 8              8 + 3 = 11
1 x 4 = 4              4 + 4 = 4

PRACTICE PROBLEM E-3. Convert to Improper Fractions:

a) 4 2/3        b) 6 3/7        c) 4 5/16

d) 3 3/8        e) 2 7/8

PRACTICE PROBLEM E-4. Convert to Mixed Fractions:

a) 25/4        b) 33/8        c) 16/8

d) 19/4        e) 13/2

Decimals

The main topics to learn and understand in this section are:

- Comparing Values
- Decimals and Fractions
- Addition of Decimals
- Subtraction of Decimals
- Multiplication of Decimals
- Fractions and Decimal Relationships

Decimals should really be referred to as decimal fractions. That's because a decimal is a fraction in the sense that it is a method of indicating parts of a whole. The difference is that a decimal is a fraction with a denominator of 10, 100, 1000 and other multiples of 10 but it is written in a different format. Instead of a fraction line, decimals use a dot (.) called the decimal point.

Numbers to the left of the decimal point are whole numbers greater than 1. As you go from right to left, each place value increases by a factor of ten. This means that 10 can also be written as 10.0.

Numbers that appear to the right of the decimal point are less than 1. Starting at the decimal point and moving from left to right, each succeeding place value decreases by a multiple of 10. The 1st place value to the right of the decimal is the tenths place. The next is
hundredths. The next place value to the right is the thousands place and so on.

When reading a number that contains a decimal point, the unit is read based on the last (farthest to the right) decimal. For example, 3.47 is read as three and forty-seven hundredths because the last number (farthest to the right), is in the hundredths place. When a decimal ends in zero, it can be read a couple of ways. For example, 0.650 can be read as six hundred fifty thousandths. It can also be written as 0.65 and read as sixty-five hundredths. Both of these are equivalent.

In order to read a mixed decimal you should follow these rules:

1) Read the whole number as usual
2) Read the decimal point as "and"
3) Read the decimal portion, naming it according to the place value of the digit that is farthest to the right.

For example, 227.673 would be read as two hundred twenty-seven and six hundred seventy-three thousandths.

PRACTICE PROBLEM F-1. Place the corresponding letter of the decimals shown in Column B into the () shown next to the corresponding number written in Column A.

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) twenty four and ninety-five hundredths()</td>
<td>a) 227.4</td>
</tr>
<tr>
<td>2) four and six tenths()</td>
<td>b) .04</td>
</tr>
<tr>
<td>3) nineteen hundredths()</td>
<td>c) .6</td>
</tr>
<tr>
<td>4) two hundred twenty seven and four hundredths ()</td>
<td>d) 0.063</td>
</tr>
<tr>
<td>5) two hundred twenty seven and four tenths ()</td>
<td>e) 24.95</td>
</tr>
<tr>
<td>6) two hundred twenty seven and forty four hundredths ()</td>
<td>f) 227.04</td>
</tr>
<tr>
<td>7) four hundredths ()</td>
<td>g) 227.44</td>
</tr>
<tr>
<td>8) sixty three thousandths ()</td>
<td>h) 227.06</td>
</tr>
<tr>
<td>9) six and three tenths ()</td>
<td>i) .19</td>
</tr>
<tr>
<td>10) two hundred twenty seven and six hundredths ()</td>
<td>j) 6.3</td>
</tr>
</tbody>
</table>

PRACTICE PROBLEM F-2. Write these numbers in mixed decimal format:

a) five and three tenths
b) forty two and three tenths
c) forty two and three hundredths
d) forty two and thirty three hundredths
e) forty two and three thousandths

Comparing the value of decimal fractions is much easier than comparing values of proper fractions. For example, which is larger, 5/7 or 2/3? It’s not easy to tell by looking unless you convert both fractions to a common denominator.

With decimal fractions, it’s much easier to compare values. For example, which is larger, .4 or 0.07? The 1st number is 40/100 and the 2nd number is 7/100 so obviously .4 is larger.

To compare values, start at the decimal point and determine which number has more tenths. The one with the most is the larger number. If you have the same number in the tenths place, proceed to the next place to the right, which is the hundredths. Again compare values with the larger being the larger number. Continue to the right until you have determined which number is larger.

There are two rules to remember. Adding zeros to the right of the last place value where a number appears does not change the value of a number. For example, 0.5 = 0.50 = 0.500. Adding a zero anyplace other than to the right of the last non-zero number does change the value of a number. For example, 0.55 ≠ 0.055 ≠ 0.505.

PRACTICE PROBLEM F-3. Determine the largest number in each group:

a) .2 .7 .15
b) .42 .004 .042
c) 1.42 .142 11.42
d) .003 .3 .03
e) .31 .309 .311

There are several simple rules you can use to make adding and subtracting decimals easier. Some of these rules are:

1. Place the numbers in columns with the decimal points aligning in a column.
2. Keep your columns neat with place values aligned in columns. For example, keep the tenths under the tenths, the hundredths under the hundredths and so on.

3. When adding, add columns as you would for whole numbers keeping the decimal point in the answer aligned with the column of decimal points.

4. Make sure all numbers have the same number of place values. Add zeros if needed.

For example, find the sum of 4.32, 2.789 and 6.23. The first thing to do is to put these numbers in a column.

\[
\begin{array}{c}
4.32 \quad \text{or} \quad 4.320^* \\
2.789 \\
6.23 \\
\hline
13.339
\end{array}
\]

\[
\begin{array}{c}
2.789 \\
6.230^* \\
\hline
13.339
\end{array}
\]

\[
13.339
\]

*Note: Zeros have been added as placeholders to fill the empty spaces. This does not change the answer and helps to avoid errors.

PRACTICE PROBLEM F-4. Arrange the decimals shown below into columns and add or subtract as indicated:

a) \(.3 + .5 + 3.52\)

b) \(.33 + 1.46 + 3.256\)

c) \(6.92 + 8.1 + 18.032\)

d) \(4.65 + .079 + .063\)

e) \(18.574 + 103.62 + 10.5\)

PRACTICE PROBLEM F-5. Multiply the decimals:

a) \(.18 \times .12\)

b) \(3.25 \times 6.25\)

c) \(8.29 \times 5.1\)

d) \(12.125 \times 8.2\)

e) \(6.3 \times 1.33\)

Sometimes you will need to convert fractions into decimals. To change a fraction to a decimal, divide the numerator by the denominator. For example, to determine the decimal equivalent of \(1/8\) inch, divide 1 by 8 = .125

PRACTICE PROBLEM F-6. Determine the decimal equivalents of the fractions:

a) \(1/2 =\)

b) \(1/4 =\)

c) \(1/8 =\)

d) \(1/16 =\)

e) \(3/8 =\)

Multiplication of decimals follows the general rules of multiplication, but in the product, beginning at the right, point off as many decimal places as there are in the total number of decimal places in the numbers being multiplied. For example,

\[
\begin{array}{c}
4.21 \quad \text{(has 2 decimals)} \\
\times .89 \quad \text{(has 2 decimals)} \\
\hline
3789 \\
33680
\end{array}
\]

3.6469 (has 4 decimals, 2 + 2)
Percentages

The main topics to learn and understand in this section are:

- Discounts
- Commissions

Percentage is a way of expressing fractional parts of 100. It is denoted using the percentage sign (%). Percentage is really only a fraction with a denominator of 100 in which the % sign is substituted for the denominator. For example, 50% is really another way of writing 50 out of 100, 50/100 and ½.

Converting % to decimal is really quite easy. Simply, drop the % sign and multiply by 1/100 or .01. Another method is to move the decimal point 2 places to the left. For example, change 35% to a decimal:
  a) 35 x 1/100 = 35/100 = .35
  b) 35 x .01 = .35
  c) write the number 35 and move the decimal point two places to the left = .35.

PRACTICE PROBLEM G-1. Convert the percentages to a decimal:

a) 10%
b) 25%
c) 3%
d) 2.35%
e) 125%

To change a decimal to a percent, you just do the reverse of that shown above. Take the number as it appears in decimal form and multiply it by 100 and add the % sign. A short cut is to simply move the decimal point 2 places to the right. For example, .47 = .47 x 100 = 47%. Keep in mind that a whole number (a number greater than 1) is more than 100%.

PRACTICE PROBLEM G-2. Convert the decimals into percentages:

a) .45
b) .60
c) .04

d) 2
e) .105

One use of percent is in determining discounts. Suppose you offer a customer a 3% discount for paying with cash at the time of installation. The total cost of the job was $250. How much is the discount? You multiply the number by the percent changed into a decimal. For this example, $250 x 3% = 250 x .03 = $7.50.

Percentage can also be used to determine commissions. Suppose you receive a commission of 5% of everything you sell. You sell $1100 worth of product. What is your commission? First, convert the % to a decimal (5% = .05), and then multiply the 2 numbers together. So, $1100 x .05 = $55.00 which would be your commission.

PRACTICE PROBLEM G-3. Determine the discounts and commissions:

a) 6% of 500 = ?
b) 10% of 452 = ?
c) 100% of 32.95 = ?
d) 60% of 200 = ?
e) 25% of 300 = ?

Answers to Math Practice Problems

A-1: a) 174 b) 346 c) 257 d) 340
A-2: a) 3,378 b) 4,039 c) 23,396
A-3: a) 66 b) 59 c) 40 d) 8 e) 9
B-1: a) 321 b) 193 c) 298 d) 96 e) 327
C-1: a) 372 b) 264 c) 120 d) 198 e) 168
C-2: a) 60 b) 320 c) 12,000 d) 1,200 e) 3,300
C-3: a) 94668 b) 83394 c) 151017 d) 263640 e) 40068
C-4: a) 330 b) 2,416 c) 343 d) 352 e) 704
D-1: a) 60 r 6 b) 90 r 4 c) 207 r 0 d) 30 r 3 e) 507 r 4
E-1: a) 10 b) 5 c) 12 d) 6 e) 3
E-2: a) 4/7 b) 4/7 c) 4/9 d) 3/7 e) 7/8
E-3: a) 14/3 b) 45/7 c) 69/16 d) 27/8 e) 23/8
E-4: a) 1/4 b) 1/8 c) 2 d) 3/4 e) 6 1/2
F-1: 1) e) 2) c) 3) i) 4) f) 5) a) 6) g) 7) b) 8) d) 9) j) 10) h
F-2: a) 5.3 b) 42.3 c) 42.03 d) 42.33 e) 42.003
F-3: a) .7 b) .42 c) 11.42 d) .3 e) .311
F-4: a)4.32 b)5.046 c)33.052 d)4.792 e)132.694
F-5: a).0216 b)20.3125 c)42.279 d)99.425 e)8.379
G-2: a)45% b)60% c)4% d)200% e)10.5%
G-3: a)30 b)45.2 c)32.95 d)120 e)75
Glossary of Terms

References

Refer to the latest editions for the most current terms and definitions:

1. UL 325, Standard for Door Drapery, Gate, Louver, and Window Operators and Systems
2. DASMA TDS #160, Sectional Garage Door Terminology
3. NFPA 70, National Electrical Code
4. DASMA Technical Data Sheet #160, Sectional Garage Door Terminology
5. DASMA Standard #302, Garage Door Operator and Gate Operator Terminology

3-Hole Cable Clip

Metal clip tied to end of extension spring cable to allow length adjustment

Accent Molding

Half-round and square mouldings that provide a distinctive mode of expression to doors.

Accessory

Any supplemental item or device added to the basic gate or door system

Active coils

The number of working coils in a torsion spring

Adjustable Clutch

A friction device that is designed to slip when torque exceeds a defined threshold

Air Infiltration

The leakage or passage of air through a door system

Aircraft-Type Cable

Several strands of galvanized wire rope braided together

Angle Brace

Lateral brace attached to back hang and roof construction or ceiling

Angle Iron

Length of L-shaped steel material generally used to support and brace rear of horizontal tracks from roof construction or ceiling

Angle Mounted Track

A method of fastening vertical track to a door jamb using a full height continuous angle

Astragal

See Bottom Weatherseal

Astragal Retainer

See Bottom Weatherseal

Automatic Latch

An automatic door locking device

Back Hang

Hanger fabricated from angle iron, which attaches the end of the horizontal tracks to roof construction or ceiling

Backroom

Horizontal distance measured into a building from the face of the header above a garage door opening to the first obstruction at the required headroom

Ball Bearing

A load bearing device that uses trapped rolling balls to reduce rotating friction
<table>
<thead>
<tr>
<th><strong>Bar Joist</strong></th>
<th>A lightweight truss adaptable for the support of roof decks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bead</strong></td>
<td>A strip of metal, vinyl, or rubber used to secure glass around the periphery of a pane</td>
</tr>
<tr>
<td><strong>Black</strong></td>
<td>Color-marking convention to mark parts as Right Side, Left Wound</td>
</tr>
<tr>
<td><strong>Blind Rivet</strong></td>
<td>A type of fastener that mechanically joins two pieces of material together by means of a riveting tool</td>
</tr>
<tr>
<td><strong>Booster Spring</strong></td>
<td>Additional spring, usually an extension spring, provided to compensate for weakened counterbalance</td>
</tr>
<tr>
<td><strong>Bottom Bracket</strong></td>
<td>A structural support located predominantly on the bottom section that holds track rollers and may also provide for attachment of lifting cables. Bracket locations other than at bottom section corners are possible.</td>
</tr>
<tr>
<td><strong>Bottom rail</strong></td>
<td>The lower-most horizontal rail of a door section</td>
</tr>
<tr>
<td><strong>Bottom Weatherseal</strong></td>
<td>Weatherstrip attached to the bottom rail of a door to seal against the floor</td>
</tr>
<tr>
<td><strong>Bottom Weatherseal Retainer</strong></td>
<td>Channel used to attach the bottom weatherseal to the door section</td>
</tr>
<tr>
<td><strong>Bow</strong></td>
<td>Condition where a garage door bottom rail of a wood door is not level or straight, which is characterized by a closed door “smiling” (corners turned up)</td>
</tr>
<tr>
<td><strong>Bracket-Mounted</strong></td>
<td>Method of fastening vertical track to jamb using angle brackets</td>
</tr>
<tr>
<td><strong>Broken Cable Device</strong></td>
<td>A bottom fixture intended to prevent a door from falling in the event of cable breakage</td>
</tr>
<tr>
<td><strong>Bushing</strong></td>
<td>A fixed or removable lining used to constrain, guide, or reduce friction</td>
</tr>
<tr>
<td><strong>Cable</strong></td>
<td>See Aircraft-Type Cable</td>
</tr>
<tr>
<td><strong>Cable Clamp</strong></td>
<td>Manufactured device used to secure two pieces of cable to each other</td>
</tr>
<tr>
<td><strong>Cable Drum</strong></td>
<td>Grooved drum, fitted on a torsion spring shaft, onto which lifting cable is wound when the door is opened</td>
</tr>
<tr>
<td><strong>Cable Drum Set Screws</strong></td>
<td>Normally refer to set screws that attach the drum to the shaft/tube. One screw may secure the cable to the drum in order to secure proper cable length.</td>
</tr>
<tr>
<td><strong>Cable Length</strong></td>
<td>Specific amount of cable required to properly operate the door</td>
</tr>
<tr>
<td><strong>Cable Safety Device</strong></td>
<td>A bottom fixture designed to slow or stop the descent</td>
</tr>
</tbody>
</table>
of a door in the event of a cable breakage

**Cable Stop**  
A swaged fitting at the end of the cable to prevent slippage through a slot in a drum

**Cam**  
Rotating piece that transfers rotary motion into linear motion

**Cam Tube**  
Tube encasing a torsion spring assembly that imparts axial force

**Ceiling**  
Top horizontal surface in the interior of a garage

**Center Bearing Bracket**  
A bracket that houses a shaft bearing and aligns and supports the torsion shaft and spring(s) assembly. Also serves to anchor stationary cone(s) to header.

**Center Bearing Plate**  
A plate or bracket that can house a shaft bearing and is used to align and support the counterbalancing mechanism to the torsion shaft as well as anchor one end of torsion springs to the header.

**Center Bushing**  
Metal or plastic bushing used in a center bracket to support a torsion tube

**Center Hinge**  
A hinge generally located on the intermediate stiles to allow sections to pivot as door opens. Also used as graduated edge hinge between bottom and intermediate section

**Center Stile**  
Vertical member of a door section which provides structural rigidity and location for center hinge attachment

**Chain Hoist**  
Refers to sprocket or pocket wheel, connected to torsion spring shaft, imparting mechanical advantage to open and close a door

**Channel Frame**  
Frame used in jamb construction consisting of steel channel shapes installed where the flanges of the shapes wrap around the corners of jambs

**Chill**  
A square shaft that connects an outside handle to an inside lock set or night latch

**Clearance**  
The amount of side room, head room and back room required to properly install a sectional door

**Clevis Pin**  
A steel pin used in conjunction with a cotter pin to hold a counterbalance cable to a bottom bracket or an operator arm to an operator bracket

**Commercial Door**  
A sectional door which is intended for vehicular use at entrances of commercial buildings such as loading docks, service stations, parking garages, and manufacturing plants

**Containment Cable**  
A cable threaded through an extension spring to
retain the spring if it breaks

**Contour Track**
Horizontal track that follows the contour of roof construction or ceiling

**Cotter Pin**
A half-round metal strip bent into a pin, whose ends can be flared after insertion through a slot or hole

**Counterbalance**
To oppose or balance with an equal weight or force

**Counterbalance Shaft**
See Torsion Shaft

**Counterbalance System**
A system which counteracts the weight of a garage door to allow a reduced force to open and close the door.

**Counterbalance Tension**
See Counterbalance

**Coupler**
A device used to connect two counterbalance shafts together, end-to-end.

**C-Value**
Heat rate flow through an insulating material when there is a temperature difference from outer to inner surfaces; not normally used in conjunction with thermal transmittance through garage doors

**Cycle**
One complete cycle of a door beginning with the door in the closed position, then moving to the open position and back to the closed position

**Cylinder**
The part of a key operated lock that accepts the key and contains the locking pins

**Daylight Opening**
Opening dimensions taken between face and jambs and between floor and header

**Dead Coils**
The number of coils rendered inactive by the spring plugs

**Dead in the Head**
The lack of counterbalancing when the door is in the up position, failing to keep the door fully open

**Dead Load**
a static applied load, or a load without movement, generally referring to the weight of the door

**Decal**
A template of information attached to a garage door, or in its vicinity, to convey relevant information concerning the garage door system

**Design Wind Load**
Horizontal design load applied to a garage door based on such factors as wind speed, building height and door horizontal location

**Disconnect Chain**
Used in conjunction with industrial door operators to disengage operator and permit manual use of emergency hand chain to facilitate operation of door in event of power failure
<p>| <strong>Door Casing</strong> | The framing members with which a door opening is finished |
| <strong>Door Frame</strong> | The frame into which the door fits; consists of two door jambs and a door header |
| <strong>Door Header</strong> | The upper part of a door frame, consisting of the head jamb, head casing, stop and trim molding |
| <strong>Door Jamb</strong> | The upright framing on each side of the door opening |
| <strong>Door Opening</strong> | See Daylight Opening. |
| <strong>Door Schedule</strong> | A list of door sizes, locations and special requirements shown on a construction document |
| <strong>Door Section</strong> | A single segment of a sectional door |
| <strong>Door Size</strong> | Door dimensions characterized by the width first and the height second |
| <strong>Double Glazing</strong> | Any use of two thicknesses of glass within an opening to improve insulating value and/or reduce sound transmission |
| <strong>Double End Stile</strong> | When a door section utilizes two stiles adjacent to each other on each end of the panel |
| <strong>Double Strength Glass</strong> | A grade of window glass lighter than plate glass and usually 1/8&quot; thick |
| <strong>Double Top Roller Fixture</strong> | Fixture used at the top section consisting of two top brackets to incorporate a longer roller shaft. Usually requires double end stiles on top section |
| <strong>Double Track Low Headroom</strong> | Addition of second pair of horizontal tracks to reduce the high point travel of top section and permit door being mounted in area with minimum headroom facilities |
| <strong>Dowel</strong> | Wooden pin for fastening wood usually glued in between stiles and rails to strengthen a joint |
| <strong>Drawbar Operator</strong> | Electric operator which mounts above the door in the horizontal position and lifts door by pulling and pushing the top section. For normal headroom and low headroom doors |
| <strong>Drip Cap</strong> | A projection over the head of a door opening, or on the top of a wall, to throw water clear of the building |
| <strong>Drip Lap</strong> | An angled weather seal provided between sections on steel doors in lieu of a rabbeted joint to prevent entrance of the elements. |
| <strong>Drive Chain</strong> | A chain that connects to the final drive mechanism |
| <strong>DSB</strong> | Acronym for Double Strength Grade B Glass |</p>
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duplex Spring</td>
<td>A combination of two torsion springs of different diameters telescoped within spring fittings</td>
</tr>
<tr>
<td>Eave Height</td>
<td>Height measured from the floor to the underside of an eave</td>
</tr>
<tr>
<td>Edge Grain</td>
<td>Wood in which the rings form an angle of 45 degrees or more with the surface of the pieces</td>
</tr>
<tr>
<td>Edge Sensor</td>
<td>A sensor, attached to an edge surface of a door that detects obstructions and signals the operator to stop and/or reverse</td>
</tr>
<tr>
<td>Edge Transmitter</td>
<td>A wireless device used to transmit a signal from an edge sensor to a receiver connected to a gate or door operator which functions to stop and/or reverse direction</td>
</tr>
<tr>
<td>Electric Operator</td>
<td>An electrically-powered device to control the opening and closing of a door</td>
</tr>
<tr>
<td>Embossed Door Section</td>
<td>Door section featuring embossed panels</td>
</tr>
<tr>
<td>Embossed Panel</td>
<td>A panel containing surfaces raised in relief from a flat surface</td>
</tr>
<tr>
<td>Embossed Rosette</td>
<td>Special ornament or design accessory made of wood, hardboard, or aluminum with designs raised in relief from the surface</td>
</tr>
<tr>
<td>End Bearing Plate</td>
<td>Plate commonly used on torsion spring counterbalance units, which includes a ball bearing to support radial movement of a torsion shaft at each end</td>
</tr>
<tr>
<td>End Hinge</td>
<td>See graduated end hinge</td>
</tr>
<tr>
<td>End Stile</td>
<td>Stile located at each end of a door section which provides for attachment of graduated edge hinges</td>
</tr>
<tr>
<td>End Stile Sealing Strip</td>
<td>Foamed plastic strip to seal sections at end stiles of steel and fiberglass doors</td>
</tr>
<tr>
<td>Entrapment</td>
<td>The condition when an object is caught or held in a position that increases the risk of injury</td>
</tr>
<tr>
<td>Entrapment Protection Device</td>
<td>Any device intended to prevent persons from becoming entrapped by a door system.</td>
</tr>
<tr>
<td>Escutcheon</td>
<td>A plate surrounding the lock mechanism on outside of door</td>
</tr>
<tr>
<td>Exhaust Port</td>
<td>Opening in bottom section to accept hose to vent tailpipe exhaust</td>
</tr>
<tr>
<td>Extension Spring</td>
<td>Provides power or tension by stretching or pulling, and is usually mounted along the horizontal section of track extending from front of door opening to the back hang</td>
</tr>
<tr>
<td>Exterior Lock</td>
<td>Keyed lock on exterior of door</td>
</tr>
</tbody>
</table>
External Entrapment Protection Device
A device located outside the door operator, intended to prevent persons from becoming entrapped by the door system.

Extrusion
Fabricated shapes made by forcing hot aluminum, or plastic, billets through a die in an extrusion press.

Fault Condition
Detection of an operational error.

Faux Divided Lite
One piece of glass divided by muntons to appear as several lites.

Ferrule
Metal ring or cap which is affixed to a cable by compressing so as to form a button or loop on the end of the cable.

Finger Joint
Joint used in joining lumber together at ends of lumber pieces.

Flag Bracket
Metal bracket used to connect the counterbalance unit, vertical, and horizontal tracks together.

Flame Spread Index
A measurement of horizontal flame spread across a product specimen under controlled laboratory conditions; the product is compared to the performances of red oak, which is standardized to 100, and gypsum board, which is standardized to zero.

Flush door
Door comprised of section unbroken by visible rails and stiles where the facing of the entire door presents an even surface.

Follow-the-Roof Pitch
See Contour Track.

Follow-the-Roof Track
See Contour Track.

Front Mounted Low Headroom
Low headroom hardware where springs mount on torsion shaft above the opening.

Front Mounted Spring
A counterbalance spring that is mounted to the header above the door.

Full Vertical Lift
See Vertical Lift.

Full View Section
Full Vision Section (A totally glazed section with various types of glass or clear plastic. Section formed of aluminum extrusions which will marry with steel or aluminum sections above and below).

Galvanizing
Zinc coating to protect steel against corrosion.

Gauge
U. S. Standard, established by Congress in 1893, specifying that weight per square foot would be indicated by a numbering system; larger numbers indicate smaller thickness and vice versa.

Glazed
Fitted with panes of glass or clear plastic.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Glazing Strip</strong></td>
<td>Extruded plastic or rubber strips that against glazing and window frame to resist water infiltration</td>
</tr>
<tr>
<td><strong>Graduated Edge Hinge</strong></td>
<td>Hinge placed on edge of door sections allowing sections to pivot as door opens and closes. Hinges hold track roller and are graduated and numbered for correct placement to ensure flush fit of door against jambs when closed.</td>
</tr>
<tr>
<td><strong>Gusset</strong></td>
<td>Cast, extruded, stamped or rolled aluminum corner reinforcement which is fastened in corners to stiffen joints or corners</td>
</tr>
<tr>
<td><strong>Gusset Plate</strong></td>
<td>Hardware fastened to door header to help support the track assembly and spring assembly</td>
</tr>
<tr>
<td><strong>Hang Down</strong></td>
<td>The amount of the door that hangs down from the door opening when the door is in the open position</td>
</tr>
<tr>
<td><strong>Headplate</strong></td>
<td>The supporting plate for the lifting drum located in line with the outer edge of the door</td>
</tr>
<tr>
<td><strong>Headroom</strong></td>
<td>Vertical clear space required inside above the door opening, and below the lowest ceiling obstruction, required for proper operation of the door and its hardware</td>
</tr>
<tr>
<td><strong>High Arc</strong></td>
<td>The highest point of travel of the top panel as it travels through the track radius.</td>
</tr>
<tr>
<td><strong>High Cycle Spring</strong></td>
<td>Counterbalance springs with increased cycle life capability for high usage doors</td>
</tr>
<tr>
<td><strong>High Lift</strong></td>
<td>Distance from header to underside of horizontal track, when high lift track is required</td>
</tr>
<tr>
<td><strong>High Lift Drum</strong></td>
<td>A cable drum contoured to balance a high lift door</td>
</tr>
<tr>
<td><strong>High Lift Track</strong></td>
<td>Track and hardware that causes the door to rise vertically some distance above the top of the door opening before it levels out into a horizontal position</td>
</tr>
<tr>
<td><strong>High Moment Arm</strong></td>
<td>Radius of a cable drum, including cable, at point of cable peel off from the Drum in the closed position</td>
</tr>
<tr>
<td><strong>Hinge</strong></td>
<td>Hardware item that joins door sections together, and allows sections to pivot independent of each other</td>
</tr>
<tr>
<td><strong>Hinge Support Plate</strong></td>
<td>Plate used to support the hinge mounting area, i.e. a backup plate</td>
</tr>
<tr>
<td><strong>Hinge Tube</strong></td>
<td>Tube used to connect two hinge leafs together</td>
</tr>
<tr>
<td><strong>Horizontal Angle</strong></td>
<td>Angle used to stiffen horizontal track</td>
</tr>
<tr>
<td><strong>Horizontal Radius</strong></td>
<td>Section of track that transitions from vertical to horizontal track</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
</tr>
<tr>
<td><strong>Horizontal Rise</strong></td>
<td>The upward slope of the horizontal track which helps to start the door downward and helps maintain cable tension</td>
</tr>
<tr>
<td><strong>Horizontal Track</strong></td>
<td>Track used in the horizontal segment of a track assembly</td>
</tr>
<tr>
<td><strong>Horizontal Track Angle</strong></td>
<td>An “L” shaped angle affixed to the horizontal track to stiffen it</td>
</tr>
<tr>
<td><strong>Horizontal Track Assembly</strong></td>
<td>An assembly made up of horizontal track and reinforced with an angle that is used to both guide and support the door in the horizontal position</td>
</tr>
<tr>
<td><strong>Hot Off The Floor</strong></td>
<td>Condition where the door has a tendency to lift off the floor</td>
</tr>
<tr>
<td><strong>Inch-Pounds</strong></td>
<td>English unit of measurement of torque</td>
</tr>
<tr>
<td><strong>Inclined Track</strong></td>
<td>Tapered spacing of the vertical track away from the jamb, permitting weather tight closing of door against jamb and easy release for opening the door by eliminating friction</td>
</tr>
<tr>
<td><strong>Inside Hook Up</strong></td>
<td>Connection where the counterbalance cable is on the inside of the track, between the door panel and the vertical track</td>
</tr>
<tr>
<td><strong>Inside Hook Up Bottom Bracket</strong></td>
<td>Bracket corner bracket where the cable is routed between the vertical track and the door sections</td>
</tr>
<tr>
<td><strong>Inside Lock</strong></td>
<td>Spring loaded, sliding deadbolt lock operable only from interior of the door</td>
</tr>
<tr>
<td><strong>Installation</strong></td>
<td>Placing a door and/or access system in position for use</td>
</tr>
<tr>
<td><strong>Installer</strong></td>
<td>Technician placing the door and/or access system in position for use</td>
</tr>
<tr>
<td><strong>Insulated Door</strong></td>
<td>Door sections containing insulating material</td>
</tr>
<tr>
<td><strong>Insulating Glass</strong></td>
<td>Multi-pane glass assembly containing air space between panes for insulation</td>
</tr>
<tr>
<td><strong>Insulation</strong></td>
<td>Material having ability to reduce heat or cold transmission</td>
</tr>
<tr>
<td><strong>Intermediate Hinge</strong></td>
<td>See Center Hinge</td>
</tr>
<tr>
<td><strong>Intermittent Duty</strong></td>
<td>A limited duty operator with a determined maximum cycles per hour</td>
</tr>
<tr>
<td><strong>IPPT</strong></td>
<td>Acronym for Inch-Pounds Per Turn; torque rate of a spring, indicating the number of inch-pounds of torque delivered to a shaft for each turn the spring is wound</td>
</tr>
<tr>
<td><strong>ISLO</strong></td>
<td>An acronym for “inside looking out”</td>
</tr>
<tr>
<td><strong>Jackshaft-Type Operator</strong></td>
<td>An operator which is mounted on a wall or ceiling, with drive provided to turn a torsion shaft</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Jamb</td>
<td>The upright framing on each side of the door opening</td>
</tr>
<tr>
<td>Jamb Angle</td>
<td>L-shaped bracket used to facilitate the union between vertical and horizontal tracks</td>
</tr>
<tr>
<td>Jamb Bracket</td>
<td>L-shaped bracket used to connect the vertical track to the door jamb</td>
</tr>
<tr>
<td>Jamb Extension</td>
<td>Framing extensions of door jambs above the opening height. It is required to support the track, door and spring assemblies</td>
</tr>
<tr>
<td>Joint, Rabbeted</td>
<td>See Joint Shiplap</td>
</tr>
<tr>
<td>Joint, Shiplap</td>
<td>A raised back portion of a section joint, fitting with a lowered front portion of a section joint, to create a weather-tight seal between door sections</td>
</tr>
<tr>
<td>Joint, Tongue-And-Groove</td>
<td>A joint with an interior raised portion, fitting with a joint with an interior lowered portion, to create a weather-tight seal between door sections</td>
</tr>
<tr>
<td>Key</td>
<td>A square piece of steel that slides into a keyway to prevent parts from rotating on a shaft</td>
</tr>
<tr>
<td>Key Switch Control</td>
<td>Use of key to actuate a door operator in place of a push-button or transmitter</td>
</tr>
<tr>
<td>Keyway</td>
<td>A groove, milled into an object, which when used with a key will prevent an object from spinning on another subject</td>
</tr>
<tr>
<td>Keyed-Alike</td>
<td>Two or more lock cylinders intended to be opened with the same key</td>
</tr>
<tr>
<td>Keyed Shaft</td>
<td>A shaft that has an integrated keyway</td>
</tr>
<tr>
<td>K-Value</td>
<td>Laboratory-determined value of thermal conductance of a material</td>
</tr>
<tr>
<td>Lag screw</td>
<td>A heavy wood screw with a square or hex head and a coarse thread.</td>
</tr>
<tr>
<td>Lap Jamb</td>
<td>Condition where door sections lap the door opening on each jamb</td>
</tr>
<tr>
<td>Lateral Force</td>
<td>Force applied from or toward the side</td>
</tr>
<tr>
<td>Leading Edge</td>
<td>The most forward part of the gate or door while it is in motion</td>
</tr>
<tr>
<td>Left Hand</td>
<td>The left side determined from a position standing on the same side of the door as the operator looking at the door</td>
</tr>
<tr>
<td>Lift Clearance</td>
<td>See High Lift</td>
</tr>
<tr>
<td>Lift Clearance Track</td>
<td>See High Lift Track</td>
</tr>
<tr>
<td>Lift Handle</td>
<td>Handle for manually operating a sectional door</td>
</tr>
<tr>
<td>Line of Sight</td>
<td>The position of a control device located in such a way that the entire door or gate to be operated is</td>
</tr>
</tbody>
</table>
directly visible during the full travel of the door or gate to the person operating the control.

Lintel  Beam provided over an opening to carry wall and/or roof loads over an opening

Lite  Glazing that is mounted in a door

Lock  Device to secure door to vertical track(s) in the closed position

Lock Bar with Cremone  Rotating the cremone or lock bar disc from outside or inside will force lock bars into cut-outs in track to lock door

Long-Stem Roller  Roller with a shaft length of 7 inches or longer

Louver  An opening with slats or screening for ventilation

Low Lift Hardware  Low headroom accessories which enable a door system to operate in minimal headroom conditions

Low Lift Track  Addition of second part of horizontal tracks to reduce the high point of travel of top section and permit door being mounted in area with minimal headroom conditions

Low Moment Arm  Smallest radius, or distance from the shaft axis, to the center of the cable peel off point on cable drums

LSLO  An acronym for “left side looking out”

Lubricant  A substance used to lubricate

Lubricate  To make a surface smooth or slippery; to reduce friction

Maintenance  The act of keeping a door system in good working condition

Manual Disconnect  A device that allows for the physical disconnection of a gate or door operator and the manual operation of a gate or door

Master Keying  Arrangement whereby cylinder locks, although fitted with different keyed cylinders, can be opened or locked by means of one master key

Meeting Rail  The top horizontal rail or bottom horizontal rail of any section that meets and joins to form a weatherproof seal

Mill Certification  A report or document from the producing mill that provides all pertinent data relative to the composition, structure, heat, etc. of a given material, e.g. spring wire

Low Headroom Hardware  See Low Lift Hardware

Low Headroom Track  See Low Lift Track
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIP</td>
<td>Acronym for Maximum Inch-Pounds; (IPPT x Turns = MIP); used to describe the total torque required on a shaft to raise a given door weight from the floor, and is the measurement of the torque capacity of a particular wire size at a desired cycle level of operation</td>
</tr>
<tr>
<td>Opening Height</td>
<td>Distance from floor to the bottom of header</td>
</tr>
<tr>
<td>Opening Width</td>
<td>Distance between jambs of the door opening</td>
</tr>
<tr>
<td>Operator</td>
<td>Electric device used to control the up and down motion of the door</td>
</tr>
<tr>
<td>Mounting Plate</td>
<td>Flat steel or wood member placed on the wall to accommodate spring supports, spring shaft bearings, chain hoists and mounting for operators</td>
</tr>
<tr>
<td>Outside Hook Up</td>
<td>Connection where the counterbalance cable is on the outside of the tracks</td>
</tr>
<tr>
<td>Outside Hook Up Bottom Bracket</td>
<td>Bottom Corner bracket where the cable is routed outside the tracks</td>
</tr>
<tr>
<td>Muntin</td>
<td>A bar member supporting and separating panes of glass within a sash or door</td>
</tr>
<tr>
<td>Overlay</td>
<td>Decorative ornaments of metal, plastic, wood or hardboard used for outside decoration of garage door sections</td>
</tr>
<tr>
<td>N.E.C. (National Electric Code)</td>
<td>A code document intended to protect people and property by minimizing the risks caused by the use of electricity. The code covers most electrical installations including conductors and equipment that connects to the supply of electricity</td>
</tr>
<tr>
<td>Pan Door</td>
<td>A garage door composed of sheet metal door sections</td>
</tr>
<tr>
<td>Panel</td>
<td>A raised or decorative design on door sections</td>
</tr>
<tr>
<td>Pass Door</td>
<td>A swinging pedestrian door built into a sectional door. Not recognized as an exit door by model codes</td>
</tr>
<tr>
<td>Perforated Angle</td>
<td>Angled metal with a series of punched holes used to hang garage doors and operators</td>
</tr>
<tr>
<td>N.E.M.A. (National Electrical Manufacturers Association):</td>
<td>A non-profit, non-government trade association that sets voluntary standards for safety and performance of electrical products</td>
</tr>
<tr>
<td>Oil</td>
<td>See lubricant</td>
</tr>
<tr>
<td>Oil Canning</td>
<td>A slight buckling in sheet metal, causing the appearance of waviness or unevenness</td>
</tr>
<tr>
<td>Perimeter Seal</td>
<td>Weatherstrip installed at the perimeter of a garage door</td>
</tr>
</tbody>
</table>
Photoelectric Sensor
A sensor that consists of a light-emitting device and a light-receiving device. If the beam of light is blocked by an obstruction, the sensor signals the operator to stop and reverse.

Pinch Point
A point where an opening can be created, such as in a door section interface when the door is moved either from the closed-to-open position or from the open-to-closed position, such that an object placed in the opening may be held captive or damaged.

Pinch Resistant
Term for a door that has been designed to prevent entrapping, crushing, breaking, severing or dislocating a person’s finger.

Polyurethane
A type of foam insulation commonly foamed in place by manufacturers of garage door sections.

Pre-Finished
Finish characterized by galvanized steel painted with a primer, then given an oven-baked top coat.

Pre-Painted
See Pre-Finished

Prime
To lay on the first coat of primer paint.

Prime-Painted
Coated with primer paint

Pull Down Rope
A rope connected to the bottom bracket used to manually pull the door down.

Pulley
A wheel turning around an axis and having a groove on its rim in which runs a cable, chain, or rope.

Push Down Spring
Spring-activated push rods mounted on horizontal tracks to start door down during closing portion of door cycle; generally used with a jackshaft-type operator or a manual chain hoist.

Quarter Round
Plain molding showing a quarter circle in its cross section.

Quarter Turn
A unit of turn measurement when winding tension into a torsion spring.

Radial Force
A force generated from the center of an object toward the outside.

Radio Control
A wireless device that transmits or receives signals to the gate or door operator.

Rail
Horizontal member of a section.

Rain Stop
Ledge provided at the point where the bottom rail meets the floor to prevent water from running under the door and allowing for runoff of the water onto the drive or approach.

Raised Panel
A panel that is raised in relief from the surrounding panel surface which provides a third dimension to the door’s appearance.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate of Rise</td>
<td>Measurement of change per revolution of a drum’s moment arm</td>
</tr>
<tr>
<td>Rear Mount</td>
<td>When the counterbalance system is attached at the rear of the horizontal tracks</td>
</tr>
<tr>
<td>Red</td>
<td>Indicates color for Left Side, Right Wound</td>
</tr>
<tr>
<td>Regular Angle Mount</td>
<td>See Angle Mounted Track</td>
</tr>
<tr>
<td>Residential</td>
<td>A sectional door which is intended for vehicular use in a residential garage</td>
</tr>
<tr>
<td>Reversal</td>
<td>A change in door motion to the opposite direction, usually to change the closing motion direction to the opening direction</td>
</tr>
<tr>
<td>Reverse Angle Mount</td>
<td>An “L” shaped angle with the wall leg toward the door opening used to connect the vertical track to the jamb. Used in low headroom and sideroom restricted garages as well as lap joint.</td>
</tr>
<tr>
<td>Roller bracket</td>
<td>A device that is mounted to a door section and holds a track roller</td>
</tr>
<tr>
<td>RSLO</td>
<td>An acronym for “right side looking out”</td>
</tr>
<tr>
<td>R-Value</td>
<td>Thermal resistance value; inverse of U-Value</td>
</tr>
<tr>
<td>S-Hook</td>
<td>A type of hook used to connect a cable to a pulley assembly</td>
</tr>
<tr>
<td>Sash</td>
<td>The framework which holds the glass in a window or door</td>
</tr>
<tr>
<td>Sash Muntin</td>
<td>One of the rabbeted bars into which glass is fitted in a sash containing two or more lights</td>
</tr>
<tr>
<td>Scarf Joint</td>
<td>Method of joining pieces of lumber together by gluing and pinning with wood dowels</td>
</tr>
<tr>
<td>Scribing</td>
<td>Cutting a door bottom rail to mirror the contours of the floor</td>
</tr>
<tr>
<td>Section</td>
<td>Garage door component that extends the full width of an opening; usually joined together by hinges</td>
</tr>
<tr>
<td>Sectional-Type Door</td>
<td>Door made of two or more horizontal sections hinged together so as to provide a door capable of closing the entire opening and which is by means of tracks and track rollers</td>
</tr>
<tr>
<td>Servicing</td>
<td>To repair or provide maintenance for a door system</td>
</tr>
<tr>
<td>Shaft Bearing</td>
<td>A bearing that is used to maintain torsion shaft alignment and reduce friction</td>
</tr>
<tr>
<td>Sheave</td>
<td>A metal or plastic pulley that is designed to guide the cables employed in a counterbalance system</td>
</tr>
<tr>
<td>Sheave Fork</td>
<td>A yoke type device used to attach sheaves to extension springs</td>
</tr>
</tbody>
</table>
**S-Hook**
Hardware device used to connect an extension spring to a pulley. These are also used with other door related hardware (i.e. chain on locks)

**Shiplap Section Joint**
Section joint interface that steps up from one level to a second level from the front of the door to the back of the door

**Shop Drawings**
Drawings provided by the manufacturer or door supplier to the architect-engineer showing the plans, sections, elevations, and details of the work required, submitted to assure proper interpretation of the intent of the architectural drawings

**Side Bearing Plate**
See End Bearing Plate

**Sideroom**
A horizontal measurement from each side of the door opening, outward to the nearest obstruction within the garage.

**Single Car**
Commonly used to refer to smaller width doors used on one car openings

**Single Strength Glass**
See Single Thick Glass

**Single Thick Glass**
A type of sheet glass used in glazing sashes

**Slant**
The pitch of a roof

**Snap Latch**
See Automatic Latch

**Solar Glass**
A type of tinted glass

**Special Door**
Non-standard door which must be custom manufactured and/or specified

**Specifications**
A detailed statement of the quantity and quality of material to be used in the construction of a garage door

**Spring Assembly Closed Wound**
A coiled torsion spring with no gaps between the coils

**Spring Assembly Open Wound**
A coiled torsion spring with equal gaps between each coil

**Spring Balance**
The amount of turns needed to counterbalance the weight of the garage door

**Spring Bumper**
Spring mechanism mounted on horizontal track that eases the door to stop in its upward travel to reduce shock and prevent pull down rope breakage. Can be made from leaf springs or tension rods.

**Spring Constant**
Mathematically developed number from basic spring wire formulas, that applies to any specific wire size and coil diameter combination; used to determine the number of active coils a spring must contain
Spring Containment Device
See containment cable.

Spring Fitting
A plug or cone used to adapt the torsion springs to the torsion shaft and/or center bearing bracket. One piece is a stationary cone while the other fitting is a winding plug.

Spring Guard
Restricts access to winding cone/set screws after installation.

Spring Pad
Pad installed on header above the door to anchor the center bearing bracket. Can be mounted in various locations, not necessarily in center, depending on size of springs.

Spring Repair Block
Device used to temporarily clamp a broken spring.

Stationary Cone
Part that fits into the end of a torsion spring permitting the spring to be fixed to the center bearing bracket. May also incorporate a retainer for a ball bearing or bushing.

Stile
Vertical reinforcement member of a section.

Stile-and-Rail Garage Door
A sectional garage door featuring sections each made up of horizontal rail and vertical stile structural framing members that support panels connected to such members.

Stock Door
Door made to standard size and generally kept in inventory at either distributor or factory warehouse.

Stop Mould
Serves to seal the perimeter of the door against weather and light infiltration; usually nailed to the jamb, outside the door.

Stress
The amount of work required of a spring at a desired cycle level.

Striker Plate
A plate used in conjunction with a locking system to secure a lock mechanism.

Strut
Support stiffener to reduce deflection of the door sections in the horizontal position. Also, to increase windload capability or reduce thermal bowing of a door.

Step Down Plate
A means of closing a sectional door the last few inches of its travel.

Step/Lift Plate
A part that can be used as a step down plate and a lift.

Steel Jamb
Door framing made from either channel or angle iron.

Steel Jamb Mounted
A track system intended for mounting to a steel jamb.

T Handle
A handle in the shape of a “T”.

Test Wind Load
Specified difference in static air pressure (positive or negative), equal to a
specified percentage
greater than or equal to
100% of the design load

**Thermal Break**
The separation between
the outer and inner
surfaces of a door section

**Three Wire System**
Wire system composed of
a hot wire, a neutral wire
and a ground wire

**Tongue and Groove Section Joint**
Section joint interface
commonly composed of a
middle protrusion on a
garage door section edge
mating with a middle
groove on an abutting
section edge.

**Top Fixture**
A bracket for positioning
the top guide roller on the
top section of a door

**Top Rail**
Horizontal rail forming the
top of a door as
distinguished from the
meeting rails and bottom
rail

**Top Seal**
Weatherstripping that
fastens to the top of the
door to seal the door along
the top of the opening

**Torque**
The twisting force around
an axis

**Torsion**
Act of twisting or turning of
a torsion spring by the
exertion of forces tending
to turn one end about a
longitudinal axis while the
other end is held
stationary

**Torsion Bar**
A long metal element that
transfers torque from a
spring to a winding plug

**Torsion Shaft**
A shaft that transfers
torque from springs to load

**Torsion Spring**
A spring that works in the
manner of twisting one
end or part about a
longitudinal axis while the
other end is held or turned
in the opposite direction
developing torque.

**Torsion Spring Assembly**
Hardware used to make
up door counterbalance
assembly

**Track**
Channel shaped metal
bars or rails on which
upward acting doors
operate via track rollers

**Track Graduation**
The differential distance
from the track to the door
jamb, measured at the top
and bottom of the vertical
track

**Track Radius**
Curved portion of a track
segment that allows the
door to go from vertical to
horizontal, and vice-versa,
in its movement

**Track Roller**
Roller assembly for
guiding the door sections
along track

**Trajectory**
The arc of travel or sweep
of the top section as the
doors are raised from closed
to open position.

**Translucent Door**
Door that allows the
passage of light without
being transparent
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transom</td>
<td>A small window above a door</td>
</tr>
<tr>
<td>Transom Bar</td>
<td>A horizontal crossbar in a window, over a door, or between a door and window or fan light above it</td>
</tr>
<tr>
<td>Transom Section</td>
<td>An extra section above a garage door opening sometimes used to allow extra lift of the horizontal tracks to accommodate a trolley type operator</td>
</tr>
<tr>
<td>Trim</td>
<td>The finishing materials; such as the lock and handles on the door</td>
</tr>
<tr>
<td>Triplex Spring</td>
<td>Three springs of increasing diameter assembled one inside another using special spring fittings</td>
</tr>
<tr>
<td>Tubular Shaft</td>
<td>A hollow shaft</td>
</tr>
<tr>
<td>Turn</td>
<td>A 360-degree revolution of a component about its axis</td>
</tr>
<tr>
<td>Turns on Spring</td>
<td>See Winds on Spring</td>
</tr>
<tr>
<td>Twist</td>
<td>A form of warp caused by the twisting or winding of the edges of a rail</td>
</tr>
<tr>
<td>Two Wire System</td>
<td>Wire system composed of a hot wire and a neutral wire</td>
</tr>
<tr>
<td>U.L. (Underwriters Laboratories)</td>
<td>A non-profit, non-government organization that develops safety standards for devices, systems and materials, and labels and lists various products. The organization also operates laboratories for product testing</td>
</tr>
<tr>
<td>U - Value</td>
<td>Thermal transmission coefficient which is a measurement of heat, in BTU’s, transmitted through one square foot of material (the door) in one hour at a temperature difference of 1 degree from one side to the other</td>
</tr>
<tr>
<td>Upper Vertical Track</td>
<td>Track assembly section mounted above the opening of a high lift or vertical lift door</td>
</tr>
<tr>
<td>Vent</td>
<td>An opening located in the bottom section of a door for ventilation</td>
</tr>
<tr>
<td>Vertical Lift</td>
<td>Refers to a hardware design that causes doors to open vertically where no horizontal tracks are required</td>
</tr>
<tr>
<td>Vertical Lift Drum</td>
<td>A cable drum with changing radius grooves to negate spring tension</td>
</tr>
<tr>
<td>Vertical Track</td>
<td>The portion of track that is oriented vertically and is adjacent to the jamb</td>
</tr>
<tr>
<td>Vertical Track Assembly</td>
<td>An assembly made up of a piece of vertical track and a piece of continuous angle or jamb brackets used to secure the track to the jamb.</td>
</tr>
<tr>
<td>Vision Lite</td>
<td>Glazing that is mounted in a door</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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<td>----------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Wall Control</td>
<td>A device when activated initiates operation of the garage opening device</td>
</tr>
<tr>
<td>Warning Tag</td>
<td>A tag with warnings and/or instructions for safe operation</td>
</tr>
<tr>
<td>Water Seal</td>
<td>A coating of some kind used to prevent the absorption of water</td>
</tr>
<tr>
<td>Weatherstrip</td>
<td>Material used at the perimeter of a garage door, or between joints of a garage door, intended to improve a door's performance against air infiltration and thermal transmission</td>
</tr>
<tr>
<td>Wedge Connection</td>
<td>A device composed of a steel wedge and clip for securing the joint between vertical and horizontal track sections</td>
</tr>
<tr>
<td>Winding Bar</td>
<td>A solid rod that fits into a torsion spring permitting winding and tension adjustment</td>
</tr>
<tr>
<td>Winding Cone</td>
<td>Part that fits into a torsion spring permitting winding and tension adjustment</td>
</tr>
<tr>
<td>Winding Cone Set Screw</td>
<td>Set screw fasteners used to lock the winding plug to the torsion shaft</td>
</tr>
<tr>
<td>Winding Rod</td>
<td>A solid rod that fits into the socket of the winding plug to tension torsion springs.</td>
</tr>
<tr>
<td>Winds On Spring</td>
<td>The number of winding turns on a torsion spring</td>
</tr>
<tr>
<td>Wire Glass</td>
<td>Glass into which wire netting is woven to prevent splintering from heat or impact</td>
</tr>
<tr>
<td>Wire Size</td>
<td>The diameter of the wire in a spring</td>
</tr>
<tr>
<td>Wired Control</td>
<td>A control implemented in a form of fixed physical interconnections between the control, the associated devices, and an operator to perform predetermined functions in response to input signals</td>
</tr>
<tr>
<td>Wireless Control</td>
<td>A control implemented in means other than fixed physical interconnections (such as radio waves or infrared beams) between the control, the associated devices, and an operator to perform predetermined functions in response to input signals</td>
</tr>
<tr>
<td>Wood Jamb</td>
<td>Upright wood piece forming the side of an opening</td>
</tr>
<tr>
<td>Wood Jamb Mounted</td>
<td>Refers to mounting vertical track to wood jambs</td>
</tr>
<tr>
<td>Woodruff Key</td>
<td>Special half-moon shaped steel key</td>
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