

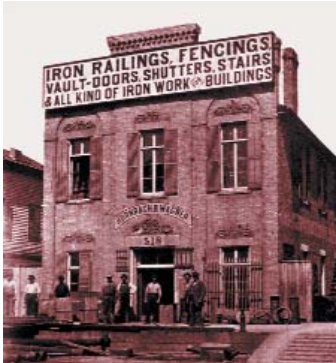
MISSION STATEMENT

Since our origin in 1850 the Wagner Companies has been dedicated and committed to creating and manufacturing innovative metal products for the fabricating industry in an atmosphere that is prosperous for our customers and employees.

Our mission is to maintain the highest standard of quality and service, and continuously improve our manufacturing methods.

We are proud of our progress and growth and are aware of the responsibility of maintaining our leadership and our reputation.

– Bob Wagner, President



Hornbach & Wagner circa 1850



Julius Wagner



J. G. Braun circa 1892



Adolph F. Wagner



1947 Adolph A. Wagner develops the first hydraulically operated tractor loaders and acquires the first patents. Wagner dominates the market until 1953 when other companies begin to compete with the loaders.

1955 Adolph finds his capacity for invention as strong as ever. At the age of 59, he begins working on the products that R & B Wagner, Inc. is famous for today. With his basement as his work shop, he designs approximately forty products – basic fittings including two sizes of elbows, flanges and connectors. Today those forty-some products have grown into over 11,000 catalog items.

1964 Advance Stamping Co., Inc. is purchased. The companies had been operating in the same location with Advance Stamping Co., Inc. manufacturing the products that R & B Wagner, Inc. distributed.

History of The Wagner Companies

- 1850** Julius Wagner starts a blacksmith shop in Buffalo, New York.
- 1870** Julius Wagner moves to Milwaukee, Wisconsin and opens an iron shop.
- 1890** Adolph F. Wagner begins working at the J. F. Wagner Iron Works and becomes owner in 1890.
- 1923** Adolph A. Wagner joins his father, Adolph F. Wagner, at the A. F. Wagner Iron Works in 1923.

Founder of what we now know as R & B Wagner, Inc., Adolph A. Wagner grew up in Milwaukee, Wisconsin. Under the Wagners' creative hands, the Iron Works becomes one of the city's largest and most important industrial enterprises. The company fabricates structural steel, miscellaneous and ornamental iron, wire work and metal products for all types of industrial, manufacturing, municipal and residential buildings; and bridge and viaduct railings. The A. F. Wagner Iron Works is known for bridges throughout the country.



Adolph A. Wagner



Florence Wagner



Gladstone Avenue Facility in Milwaukee, Wisconsin circa 1964



Bob Wagner
Owner
President



Barbara Karol
Owner
Treasurer



The Wagner Companies 2003

- 1965** Robert A. Wagner joins his father, Adolph A. Wagner, at R & B Wagner, Inc. with a Bachelor of Science in Mechanical Engineering.
- 1968** Barbara Wagner Karol joins the Wagner team.
- 1985** Advance Stamping purchases Superior Polishing to provide in-house polishing services.
- 1987** The company moves to a 77,000 square foot facility on Milwaukee's northwest side.

- 2001** R & B Wagner, Inc., J.G. Braun Co., Advance Stamping Co. Inc., Johann Tube and Pipe Benders, Inc. and Wagner Ornamental combine to form one legal entity – R & B Wagner, Inc.
- 2002** The three facilities of R & B Wagner, Inc. in Wisconsin move to one central location – 10600 West Brown Deer Road on Milwaukee's north side.



124th Street Facility in Wauwatosa, Wisconsin

- 2005** R & B Wagner, Inc. uses 33 presses – many with coil feeds, straighteners and coil handling equipment; 14 rotary benders; 2 induction benders; 2 roll benders, saws; cut-off machines; 12 polishing and finishing machines; welders; hand finishers; a complete tool and die shop with CNC milling and wire EDM machines; CNC lathe; and material handling and storage equipment to meet the needs of our customers. While we move forward toward ISO certification, our quality control department presently uses established standards that equal ISO requirements.



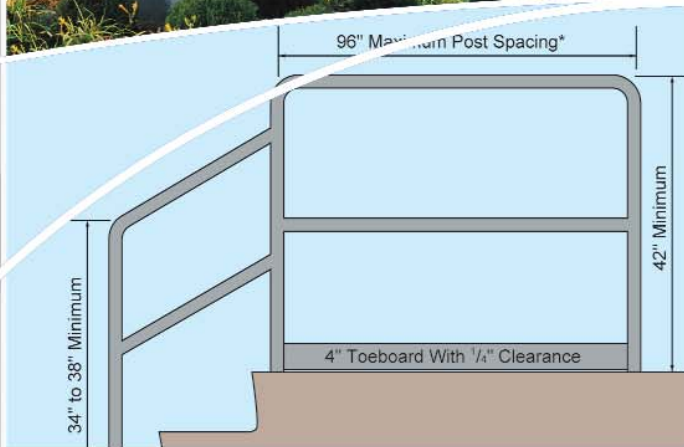
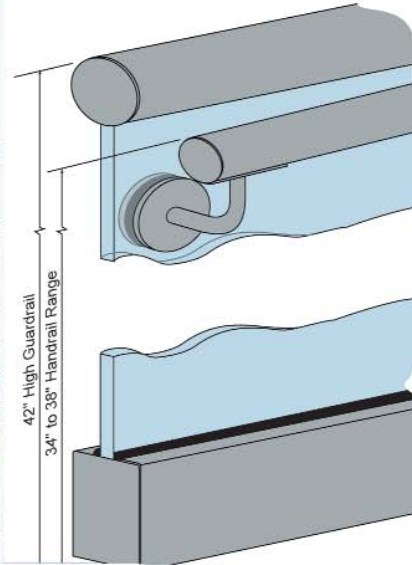
Henry Bills
Executive Vice President Emeritus

- 1993** Johann Tube and Pipe Benders, Inc. is purchased. Johann was established in 1935 to serve the bending and end forming needs of local industrial firms.
- 1997** J. G. Braun Co. of Skokie, Illinois joins the Wagner family. With a history that dates to 1887, the Braun reputation, product line and staff expertise add to the continued success and strength of Wagner.



The Wagner Companies

Appendix



APPENDIX

- General and Technical Information.
- Building and Accessibility Codes Updates including a Code Comparison Chart.
- Guide Specifications.
- Order Form and Credit Applications.
- Cable Railing Installation Guide

THE WAGNER COMPANIES



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www.rbwagner.com

J.G. Braun Company
www.jgbraun.com

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www.shopwagner.com

info@mailwagner.com

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Butler, WI 53007-0423

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Milwaukee, WI 53224



®

CATALOG ACCURACY

Great care is taken to ensure the accuracy of information and dimensions contained in this catalog. Despite this effort, errors and discrepancies may occur because we are constantly updating and revising our data. Product also may become obsolete – no longer produced – for various reasons. Where a product cannot be reproduced, **Wagner** will offer the closest possible substitute.

DAMAGE OR MATERIALS LOST IN TRANSIT

If you receive a delivery with visible damage, have the driver make an immediate notation of the damage on the freight bill. Count and inspect the material immediately and, if necessary, contact the carrier to schedule an inspection of the goods. This process will assist in damage recovery from the carrier without controversy. At no time will **Wagner** be responsible for losses or damages incurred in transit. Contact **Wagner** regarding replacement material.

SHORT SHIPMENTS

Wagner fittings are counted several times in the manufacturing process. However, shortages do occur. We require that shortages received in undamaged containers be reported to us within ten days of receipt of material.

DEFECTIVE PRODUCT

All **Wagner** materials are carefully inspected and tested before shipment, but it is sometimes impossible to detect all imperfections. **Wagner** will replace defective products as noted in our *Return Policy*.

In case any shipment of product proves unsuitable, it is understood that the buyer will immediately discontinue its use and advise **Wagner**. We insist on the opportunity to determine a resolution such that loss or damage to either party shall be prevented or minimized. No charges for labor or expenses required to repair defective goods or occasioned by them will be allowed.

RETURN POLICY

All returns must be authorized by **Wagner** and made within twenty (20) days of purchase. Returns are subject to a 25% re-stocking charge – minimum charge: \$40.00. After twenty (20) days, returns may still be considered but the restocking charge will increase to 50%. Cost of returning goods is the customer's responsibility unless the error is attributable to **Wagner**. Contact customer service to obtain return authorization. Refer to inside cover for further information.

CUSTOM PRODUCT TOLERANCES

For custom work, our quotation will be based on the tolerance chart on each drawing. If decimals are used, we will work to three places; if no tolerance is specified, we will work to the specifications of our standard railing products.

STANDARD TOLERANCES

Hole sizes are .015" – .025" over the listed dimensions unless specifically mentioned. Product ID and OD are produced within commercial dimensional tolerances. Bend tolerances and angle of bend are +/- 2°. Cutting tolerances on pipe and tube are +/- 1/16". Multiple bend tolerances are +/- 2° and +/- 1/8" center-to-center thru 2.50" OD and +/- 1/4" center-to-center above 2.50" OD.

VALUE ENGINEERING

Wagner provides in-house CAD assistance to augment customer designs and facilitate product and process development. Computerized bar-coded *Bill of Materials* and *Routings* are used to provide accurate, fast service and order delivery.

LOCATION

The **Wagner Companies** consolidated in 2002 with all manufacturing, administrative and warehouse operations now located at our 160,000 square foot facility in Milwaukee.

WAGNER COMPANIES ON-LINE

The **Wagner Companies** has multiple web sites including www.wagnercompanies.com, www.rbwagner.com and www.jgbraun.com. They are your links to the latest information on **Wagner** architectural and industrial products including fabrication details, drawings, catalog pages, company information, engineering data, guide specifications, alloy data, photos and more.

SHOP ON-LINE

Our newly designed e-commerce site is now open at www.shopwagner.com. In addition to placing orders and obtaining pricing, the site permits access to product availability; account review; and order status, history and tracking.

CAD DRAWINGS

CAD files for **Wagner** products may be downloaded at www.shopwagner.com. They are available in .dwg and .dxf formats. If you can not find the file you want online, contact **Wagner** directly.

SAMPLES

While the catalogs are helpful, we understand that nothing compares with having a sample in hand prior to purchasing. We are pleased to provide samples to qualified designers and fabricators. Contact our sales department with your request.

QUOTATION CHANGES

All quotations made by **Wagner** or its agents are subject to change without notice, subject to prior sale and, unless otherwise agreed, are binding only for immediate acceptance. All sales are made subject to strikes, accidents or other causes beyond our control.

CANCELATION

Special materials are not subject to cancelation or return without our written consent. Items remaining on hold for over thirty days may be billed at that time for materials and labor used and storage charges may be incurred. Quantities shipped may vary by +/- 5% on runs over 200 pieces.

QUALITY CONTROL

The **Wagner Companies** is committed to providing superior value to our customers through Advanced Quality Planning Activities, Process Innovation and Team-Based Continuous Improvement.

Wagner's in-house quality engineering staff employs quality tools to ensure parts are made to specification and processes are stable. Verification activities are always available for review.

QUALITY EXPECTATIONS

For: Architectural castings, forgings, and stampings; handrail mouldings and terminals; ball style fittings and architectural shapes:

The Wagner Companies sell these products for their uniqueness and aesthetic qualities, critical to the manufacture of beautiful railings. The components which make up these families of products are manufactured using methods, tooling and patterns which have been shown to exhibit variation over time. No two products can be expected to be exactly alike. Additionally, any dimensions indicated are for reference only. The buyer must expect some fabrication to occur, as these products are not meant for simple assembly. For example, a forged baluster may need occasional straightening. A terminal casting may show an inclusion when polishing is completed. Ornamental stampings may show varying levels of detail. Ball style fittings will vary in finish and dimension.

Continuous improvement of these products is essential to the success of our customers. We use the data collected from product feedback to determine when tooling or method modification is needed. These modifications must also be weighed against the traditional expectations of end-users. Change is not made unless expectations can be satisfied while still improving the product.

Recognizing that the uniqueness of the product may not work for all situations, customers are encouraged to evaluate samples whenever possible. Wagner sales staff will make every effort to satisfy inquires into a specific product or family of products. Should purchase be made and the product found to be unsuitable, the standard return policy of The Wagner Companies will apply.

CASTING POROSITY

Porosity is a normal attribute of cast products. Every effort is made to minimize the appearance of porosity but minor pitting can not be avoided and is to be expected.

ALUMINUM REACTION WITH CEMENT

When aluminum components come into contact with cement or lime mortar, exposed aluminum surfaces should be painted with heavy bodied bituminous paint, water-white methacrylate lacquer or zinc chromate.

DISSIMILAR METALS

Metals are rated according to their *nobility*. When dissimilar metals are in contact with each other in the presence of oxygen and moisture, the more noble metal will corrode the less noble. Contact between dissimilar metals should always be avoided. If contact can not be avoided, the adjacent surfaces should be painted with bituminous paint or zinc chromate primers or paints. Taping or gasketing with non-absorptive materials is also effective.

Care should be taken to prevent the wash from copper alloy surfaces onto adjacent, exposed, less noble metal surfaces since the traces of copper salts carried in the wash can accelerate the corrosion of less noble metals.

PRESSURE TREATED LUMBER

Pressure treated lumber – ACQ lumber – is treated with copper sulfate which will corrode steel. Use only stainless steel or heavily galvanized steel components with ACQ lumber products.

SPECIFYING PARTS FOR OD TUBE OR PIPE SIZE

IPS stands for *iron pipe size* – a standard that was originally developed for fluid transfer but has also become the standard for designating handrail sections in all alloys.

There is often confusion as to which size product the customer actually needs – *Pipe Size* or *OD Tubing Size*.

Keep in mind that pipe size refers to a *nominal* – not actual – inside pipe diameter. *Schedule* refers to the pipe's wall thickness. The dimensions provided for OD tubing on the other hand refer to the actual outside diameter and wall thickness.

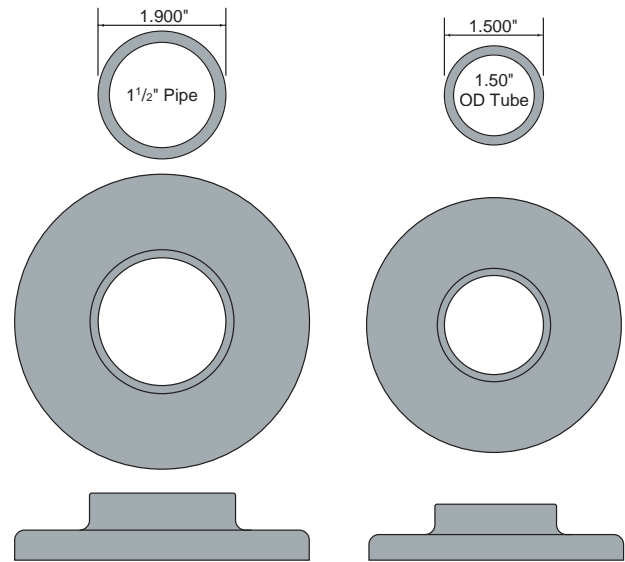
For example: 1½" pipe size flanges have an opening to fit over 1.90" OD – the actual outside diameter of 1½" pipe – while 1.50" OD tubing has a true 1.50" outside diameter and the flange is sized accordingly.

Refer to the chart below regarding actual dimensions for nominal pipe size.

ACTUAL DIMENSIONS FOR NOMINAL PIPE SIZE

Where OD = Outside Diameter; ID = Inside Diameter; and t = wall thickness, use the following formula to determine the ID for any given size pipe:

$$ID = OD - (2 \times t)$$



Nominal Pipe Size	Outside Diameter	Schedule (Wall Thickness)			
		Schedule 5	Schedule 10	Schedule 40	Schedule 80
½"	.840"	.065"	.083"	.109"	.147"
¾"	1.050"	.065"	.083"	.113"	.154"
1"	1.315"	.065"	.109"	.133"	.179"
1¼"	1.660"	.065"	.109"	.140"	.191"
1½"	1.900"	.065"	.109"	.145"	.200"
2"	2.375"	.065"	.109"	.154"	.218"
2½"	2.875"	.083"	.120"	.203"	.276"
3"	3.500"	.083"	.120"	.216"	.300"
3½"	4.000"	.083"	.120"	.226"	.318"
4"	4.500"	.083"	.120"	.237"	.337"
5"	5.560"	.109"	.134"	.258"	.375"
6"	6.630"	.109"	.134"	.280"	.432"

STAINLESS STEEL

Stainless steels contain at least 12% chromium and form a thin, invisible protective, corrosion-resistant, passive film on their surface. This film forms spontaneously when the chromium reacts with oxygen in air and water. If the film is damaged or removed during fabrication or polishing, it self-repairs immediately so long as the surface is clean. If stainless steel corrodes, typically highly localized metal loss or pitting occurs – rarely general or uniform corrosion of the entire surface.

While problems with stainless products are infrequent, the name *stainless* can be somewhat misleading. It is not actually, *stainless*, but *stain resistant* – it is a corrosion resistant alloy, not rustproof. Stainless steel may show some forms of corrosion and/or deterioration, dependent upon the degree of contaminants in its particular environment. Under certain conditions, it can rust unless a program of preventive maintenance is followed.

The environment in and around swimming pools and salt water contain salts which actively attack stainless steel. Heat and humidity increase the corrosive activity of chlorine and bromine salts. In addition, the corrosive action caused by salts that occurs from ice melting agents such as calcium chloride and sodium chloride can create the formation of rust. Other chemical reactions that can cause deterioration include carbon pick up from bending or fabricating tools, finishing equipment or steel covered work benches. It is also typical for contractors or masons to use muriatic acid solution on masonry – even the fumes from this liquid can attack stainless steel.

The material's mechanical finish – satin or mirror – also plays a role in corrosion resistance. Corrosion-causing agents will collect in the fine lines of a satin finish as opposed to the smooth surface of a mirror finish.

Stainless steel is manufactured in various formats and can sometimes be selected to perform better in certain environments or applications. They are identified by T-304, T-316, etc. as well as L Grades (low carbon).

If you experience difficulty with your stainless products, it is likely that there is a contaminant in the environment. The first step is to identify the contaminant and to eliminate it. After that, assure that a preventive maintenance program is in place and being followed.

Stainless Steel Preventive Maintenance Suggestions

- Inspect the installation on a frequent schedule taking note of discoloration and stains. Discoloration can and should be removed by cleaners recommended for stainless steel.
- Ongoing maintenance consisting of a fresh water wash and wiping with a clean cloth is recommended to minimize deterioration. In all but the most severe cases, this regular washing will eliminate the need for refinishing.
- Never use steel wool or harsh abrasive elements.

FINISHES

Many **Wagner** products are available pre-finished but others – in particular tubing, pipe and architectural shapes – are sold with a *mill finish*.

On long-length material, a *mill finish* indicates the finish on the material is as *extruded*, rolled, formed, etc. When anodizing aluminum, the best result is obtained if the material is satin finished prior to anodizing.

On brackets, elbows and fittings, *mill finish* material may have tool marks, minor dents or nicks that are the result of production processes. While **Wagner** makes every effort to minimize marking incurred during manufacturing, we must be notified at the time of order if standard *mill finish* is not acceptable.

Most items in this catalog can be provided polished, galvanized, zinc plated, anodized, satin finished or mirror finished. Contact **Wagner** with your specific requirements.

For more information on mechanical finish designations and our new line of polishing supplies, go to page 188.

AA-M32-C22-A41 CLEAR ANODIZED FINISH

Most **Wagner** Caps and Flanges are produced in alloy 3003-H14. Wagner bent aluminum elbows without seams are made of alloy 6063. To weld alloy 6063 to alloy 3003, use 5366 or 5856 rod for best color match. If the welded pieces are then to have a clear anodized finish, we recommend the following procedure:

1. Put on a satin finish.
2. 8 minute etch.
3. Up to 12 minute etch if finish is not clean or smooth.
4. Anodize 60 minutes at 15 volts.

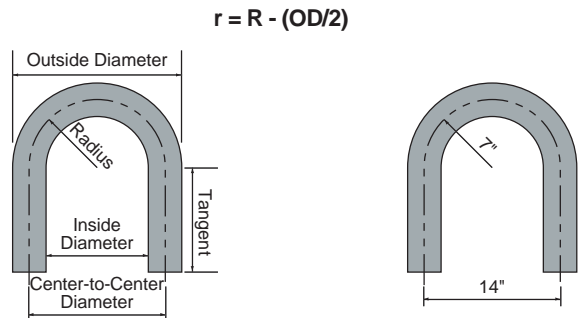
When Wagner slip flanges with set screws are mechanically attached to aluminum pipe and are anodized, finish must match 6063-T6 aluminum pipe with AA-M32-C22-A41 clear anodized finish, we recommend the flanges to be finished separate and anodized as follows: follow step number 2 and number 4 above but omit steps number 1 and 3.

When anodizing cast aluminum brackets alloy 214 or Almag 35:

1. 8 minute etch.
2. Up to 12 minutes etch if finish is not clean and smooth.
3. 30 minute anodize 12½ to 13 volts at low voltage.

RADIUS VS. DIAMETER DIMENSIONS

Bend radii and diameters will refer to either the inside or center line of a bend. There is often confusion between radius versus diameter. Note in the diagram below that the diameter is two times the radius. Therefore a 180° bend on a 7" center line radius would yield a 14" center line diameter (14.00" center-to-center). Throughout this catalog *r* is used to refer to inside diameter while *R* represents center line radius. The inside radius (*r*) is equal to the center line radius (*R*) less half the OD or width of the tubing being bent.



BUILDING CODES

Prior to using any railing products, it is incumbent on designers, fabricators and installers to make themselves familiar with local codes that apply to their applications.

Most municipalities and local code bodies do not write code – they adopt codes prepared by various code bodies. Historically, model codes were prepared by code bodies such as the Building Officials Code Administrators International, Inc. (BOCA), the Council of American Building Officials (CABO), the International Conference of Building Officials (ICBO), and the Southern Building Code Congress International (SBCCI). Other codes often referred to include the Occupational Safety and Health Administration (OSHA), the National Fire Protection Association (NFPA), and the *Americans With Disabilities Act Accessibility Guidelines (ADAAG)*.

ICC

Prior to 2000, BOCA, SBCCI and ICBO each prepared their own model codes that were regionally applied. In 1999, these three

organizations began to work together to prepare a unified code under the auspices of the International Code Council (ICC). The first set of *I Codes* were published in 2000 and included the *International Residential Code (IRC)* and the *International Building Code (IBC)*. The 2000 IRC and IBC model codes have since been adopted by states throughout the country.

In 2002, BOCA, SBCCI and ICBO officially merged to form the ICC and they approved an updated IRC and IBC most recently published in 2003.

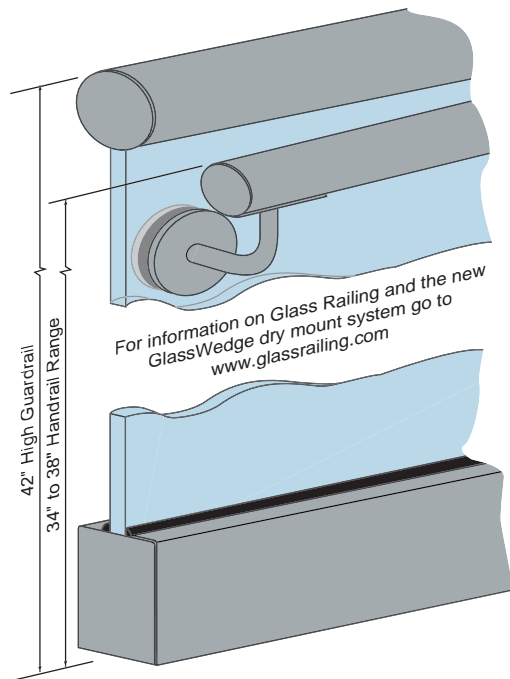
The code comparison chart on pages 220 to 223 provides information relating to handrailing listed in various codes. Consult your local authorities to see what codes apply to your project.

NFPA

The NFPA has recently chosen to enter the building code arena. It is expected that they will be publishing their own set of model codes in 2005. Some states have not adopted the ICC codes and are waiting for the publication of the NFPA code before choosing which to select as their model.

Handrail and Guardrail

Handrails are in place to provide guidance while the purpose of a guardrail is to prevent accidental falls.



Guards are generally required for ramps, stairs or landings above 30". The height will vary depending on the code. The IBC requires a guard to be 42" in height. Handrails are located between 34" and 38" and have dimensional limitations for graspability. As such, if a 42" guardrail is called for on a stair or ramp, it will also require a secondary handrail at the appropriate height. A guard top rail that is not used as a handrail would not have a graspability size limitation.

Guards also have opening limitations to consider. The most common requirement is that no opening be large enough to allow a 4" sphere to pass.

While a handrail may need to be installed on stairs less than 30" high, it does not have to meet the opening limitations required of guardrails. This is often being misinterpreted by local inspectors who have insisted on applying guard requirements to these applications.

Refer to *Accessibility Guidelines* below regarding similar height standards on accessible railing and the Access Board's recommendation for railing for children.

The Ladder Effect

The published 2000 IRC stated that guardrails *shall not be constructed with horizontal members or other ornamental pattern that results in a ladder effect*. The ladder effect has never been a part of the IBC.

The ladder effect was removed from the IRC during the 2001 code cycle. The change was noted in the 2001 IRC supplement and the current 2003 IRC contains no reference to the ladder effect.

However, some local code authorities are using older codes based on BOCA – the creator of the ladder effect wording – and the 2000 IRC. Many local code inspectors are not aware of the 2001 change and may reject guardrailings with infills they interpret as creating a ladder effect.

It is taking time for the 2001 IRC supplement and the new 2003 model codes to trickle down to the local levels. In the meantime, be prepared to address this issue should it come up in your area.

ACCESSIBILITY GUIDELINES

There are two references that are used throughout the country in relation to accessibility: *ICC/ANSI A117.1, Accessible and Usable Buildings and Facilities* and *The Americans With Disabilities Act Accessibility Guidelines (ADAAG)*

The Americans with Disabilities Act (ADA) became law in 1992. The ADA requires that all new places of public accommodation and commercial facilities be designed and constructed so as to be readily accessible and usable by persons with disabilities.

The 1992 ADAAG was prepared by The Access Board and was based on the 1986 CABO/ANSI A117.1, *Accessible and Usable Buildings and Facilities*. ANSI 117.1 has since been updated several times with 2003 being the most recent edition.

Following an extensive review process, The Access Board announced the release of a new ADAAG on July 23, 2004. One of the goals of the update was to bring harmony between the model building codes and industry standards. Items related to handrail are noted below or go to the Access Board's web site to view the entire 2004 ADAAG

The ADA is a civil rights law – it is not a building code. The ADAAG though has been incorporated into many state and local building codes.

The following references are taken from the new, 2004 *Americans with Disabilities Act Accessibility Guidelines*.

Handrail Dimensions

505.6 Gripping Surface. *Handrail gripping surfaces shall be continuous along their length and shall not be obstructed along their tops or sides. The bottoms of handrail gripping surfaces shall not be obstructed for more than 20 percent of their length. Where provided, horizontal projections shall occur 1½ inches (38 mm) minimum below the bottom of the handrail gripping surface.*

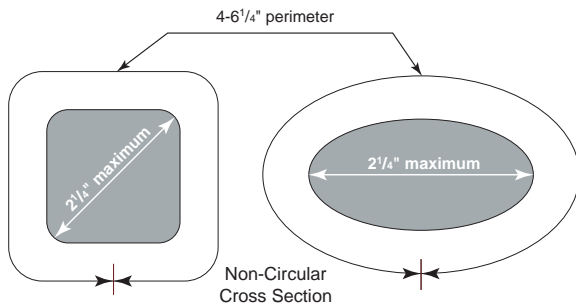
EXCEPTIONS:

1. Where handrails are provided along walking surfaces with slopes not steeper than 1:20, the bottoms of handrail gripping surfaces shall be permitted to be obstructed along their entire length where they are integral to crash rails or bumper guards.
2. The distance between horizontal projections and the bottom of the gripping surface shall be permitted to be reduced by ¼ inch (3.2 mm) for each ½ inch (13 mm) of

additional handrail perimeter dimension that exceeds 4 inches (100 mm).

505.7.1 Circular Cross Section: Handrails gripping surfaces with a circular cross section shall have an outside diameter of 1¼ inches (32 mm) minimum and 2 inches (51 mm) maximum.

505.7.2 Non-Circular Cross Sections: Handrail gripping surfaces with a non-circular cross section shall have a perimeter dimension of 4 inches (100 mm) minimum and 6¼ inches (160 mm) maximum, and a cross-section dimension of 2¼ inches (57 mm) maximum.



Handrail Clearance

While the 1992 ADAAG stated that the distance between the wall and handrail had to be 1½", all subsequently published model codes – including the new ADAAG – now state this to be a *minimum* requirement.

505.5 Clearance. Clearance between handrail gripping surfaces and adjacent surfaces shall be 1½ inches (38 mm) minimum.

It is important that you confirm all code issues with your local authorities since many have not updated their requirements to currently available model codes.

Railing Height

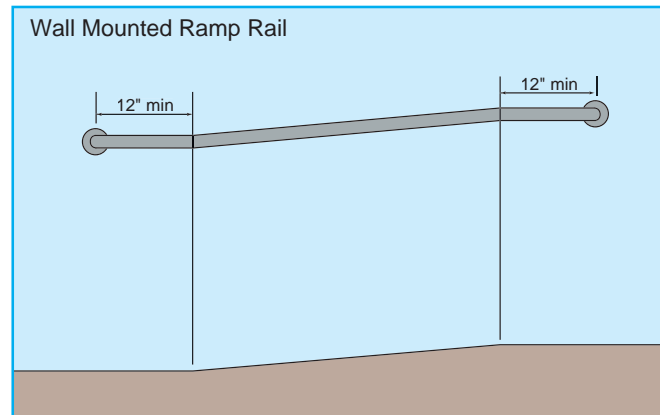
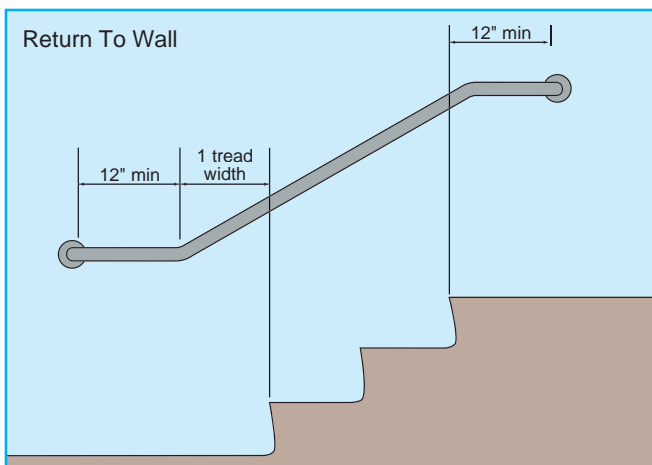
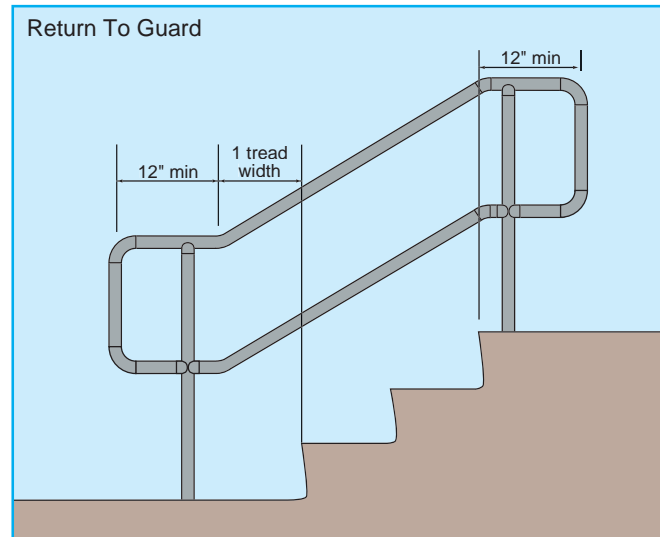
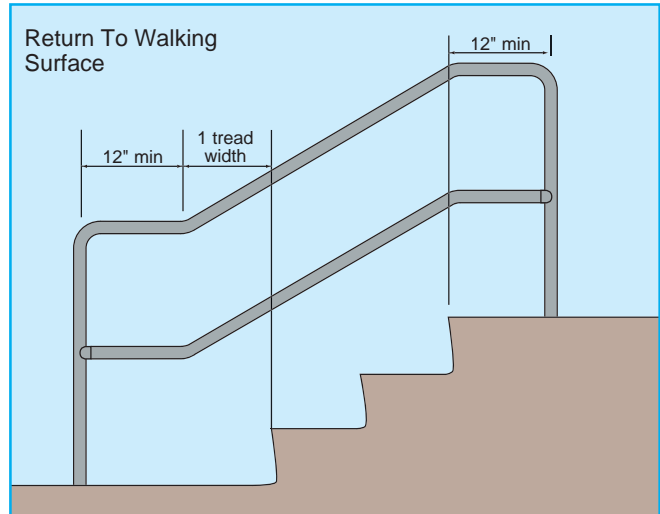
Top of gripping surfaces of handrails shall be 34" minimum and 38" maximum vertically above stair nosings and ramp surfaces. Handrails shall be a consistent height above stair nosings and ramp surfaces.

ADAAG Advisory: The requirements for stair and ramp handrails in this document are for adults. When children are the principle users in a building or facility (e.g., elementary schools), a second set of handrails at an appropriate height can assist them and aid in preventing accidents. A maximum height of 28 inches (710 mm) measured to the top of the gripping surface from the ramp surface or stair nosing is

recommended for handrails designed for children. Sufficient vertical clearance between upper and lower handrails, 9 inches (230 mm) minimum, should be provided to help prevent entrapment.

Railing Extensions

505.10.2 Top Extension at Stairs. At the top of a stair flight, handrails shall extend horizontally above the landing for 12 inches (305 mm) minimum beginning directly above the first riser nosing. Extensions shall return to a wall, guard,



or the landing surface, or shall be continuous to the handrail of an adjacent stair flight.

505.10.3 Bottom Extension at Stairs. At the bottom of a stair flight, handrails shall extend at the slope of the stair flight for a horizontal distance at least equal to one tread depth beyond the last riser nosing. Extension shall return to a wall, guard, or the landing surface, or shall be continuous to the handrail of an adjacent stair flight.

505.10.1 Top and Bottom Extension at Ramps. Ramp handrails shall extend horizontally above the landing for 12 inches (305 mm) minimum beyond the top and bottom of ramp runs. Extensions shall return to a wall, guard, or the landing surface, or shall be continuous to the handrail of an adjacent ramp run.

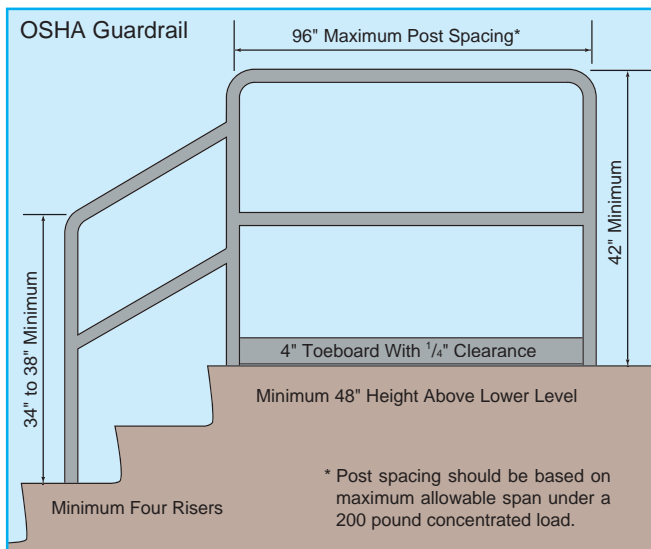
Handrail Continuity

Gripping surfaces shall be continuous, without interruption by newel posts, other construction elements, or obstructions.

FOR MORE INFORMATION

For current information on accessibility issues, refer to our website at www.wagnercompanies.com. You can also access current information at the ICC web site – www.intlcode.org – and The Access Board's site at www.access-board.gov.

OSHA STANDARD PIPE RAILING



1910.23 Guarding Floor and Wall Openings and Holes

- (e)(1) A standard railing shall consist of a top rail, intermediate rail, and posts, and shall have a vertical height of 42" nominal from upper surface of top rail to floor, platform, runway or ramp level.
- (e)(3)(i) For pipe railings, posts and top and intermediate railings shall be at least 1 1/2 inches nominal diameter with posts spaced not more than 8 feet on centers.
- (e)(3)(v) The anchoring of posts and framing of members for railings of all types shall be of such construction that complete structure shall be capable of withstanding a load of at least 200 pounds applied in any direction at any point on the top rail.
- (e)(4) A standard toeboard shall be 4 inches nominal from its top edge to the level of the floor, platform, runway or ramp. It shall be securely fastened in place and with not more than 1/4" above floor level.
- (c)(4) The railing shall be provided with a toeboard wher-

ever, beneath the open sides,

- (i) Persons can pass
- (ii) There is moving machinery, or
- (iii) There is equipment with which falling materials could cause a hazard.



RAILING FORMULAS

The following railing formulas may be used to determine maximum post spacing under a uniform load and stress at the base of the post under a concentrated load. Consult your local code to determine your structural requirements.

Uniform Load:

$$L = \frac{f_s \times S}{w/12 \times h}$$

Result will provide you with the maximum allowable span between the post centerlines.

Concentrated Load:

$$f = \frac{F \times h}{S}$$

Result will provide you with the stress at the base of the post. Compare to *Allowable Stress* for the aluminum alloy to determine its suitability.

- L = Span between center-line of posts (inches)
- f = Unit Stress (psi)
- f_s = Allowable Stress (psi)
- S = Section Modulus (in³)
- w = Uniform Load (lb/ft)
- F = Concentrated Load (lb)
- h = Post Height (inches)

Load Distribution:

In pipe railing load distribution is fairly uniform. On railings having two or fewer spans, multiply the concentrated load (F) by .85 for end posts and .65 for intermediate posts. On railings having three or more spans, multiply the concentrated load (F) by .84 for end posts and .60 for intermediate posts.

Aluminum Alloy		Allowable Stress (psi)	Minimum Yields (psi)	Modulus of Elasticity (psi x 10 ⁶)	
6061-T6 pipe		24,000	35,000	10.0	
6063-T6 pipe		18,000	25,000	10.0	
Pipe Size	Schedule	Outside Diameter	Inside Diameter	Wall	Section Modulus
1 1/2"	40	1.900"	1.610"	.145"	.326 in ³
1 1/2"	80	1.900"	1.500"	.200"	.412 in ³

Code Comparison Chart

The following information is based on information compiled by the National Ornamental and Miscellaneous Metals Association (NOMMA) as of June 2004.

Municipal and state authorities generally do not write their own code. They use these model codes and guidelines to create documents for use in their local jurisdictions.

Not all fabrications need to meet building codes. Some installations may be considered ornamental in nature.

Wagner manufactures products that will meet building codes and standards – when properly detailed and fabricated – however not all products in **Wagner's** inventory are suitable for all applications or codes. It is imperative that you familiarize yourself with local code requirements prior to specifying or purchasing any products in this catalog.

Guardrail Location Requirements

IRC 2000	30 inch (762mm) above floor or grade below.
IRC 2003	R312.1 Guards required. Porches, balconies or raised floor surfaces located more than 30 inches (762 mm) above the floor or grade below shall have guards not less than 36 inches (914mm) in height. Open sides of stairs with a total rise of more than 30 inches (762 mm) above the floor or grade below shall have guards not less than 34 inches (864 mm) in height measured vertically from the nosing of the treads. Porches and decks which are enclosed with insect screening shall be provided with guards where the walking surface is located more than 30 inches (762 mm) above the floor or grade below.
IBC 2000	Open-sided walking surfaces, mezzanines, industrial equipment platforms, stairways, ramps and landings more than 30 inches (762mm) above floor or grade below. Also located along glazed sides of stairways, ramps and landings that are located more than 30 inches (762mm) above floor or grade below where the glazing provided does not meet the strength and attachment requirements in Section 1607.7 Live Load.
IBC 2001	Amended to add the following: Exemption 2: The height in assembly seating areas shall be in accordance with Section 1008.12.
IBC 2003	Amended to add the following: Exemption 7. In assembly seating where guards in accordance with Section 1024.14 are permitted and provided.

Handrail Location Requirements

IRC 2000	Handrails required on at least one side of ramps exceeding a slope of 1:12. Handrail required on at least one side of stairway.
IRC 2001	Handrail required on at least one side of stairway with two or more risers.
IRC 2003	Handrails shall be provided on at least one side of each continuous run of treads or flight with four or more risers.
IBC 2000	Handrails required on both sides of stairs and ramps.
IBC 2001	Amended to add the following: Aisle stairs complying with Section 1008 provided with a center handrail need not have additional handrails.

Handrail Location Requirements (Continued)

IBC 2003	1009.11 Handrails. Stairways shall have handrails on each side. Handrails shall be adequate in strength and attachment in accordance with Section 1607.7. Handrails for ramps, where required by Section 1010.8, shall comply with this section. Exceptions: 1. Aisle stairs complying with Section 1024 provided with a center handrail need not have additional handrails. 2. Stairways within dwelling units, spiral stairways and aisle stairs serving seating only on one side are permitted to have a handrail on one side only. 3. Decks, patios and walkways that have a single change in elevation where the landing depth on each side of the change of elevation is greater than what is required for a landing do not require handrails. 4. In Group R-3 occupancies, a change in elevation consisting of a single riser at an entrance or egress door does not require handrails. 5. Changes in room elevations of only one riser within dwelling units and sleeping units in Group R-2 and R-3 occupancies do not require handrails.
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ANSI A117.1 Handrails required on both sides of stairs and ramps.

EXCEPTION: Aisle stairs and aisle ramps provided with a handrail either at the side or within the aisle width.

ADAAG Ramps - both sides, if rise exceeds 6 inches or a horizontal length more than 72 inches. Not required next to seating in assembly areas. Stairs - both sides.

IRC – International Residential Code
IBC – International Building Code
ANSI – American National Standards Institute
ADAAG – Americans With Disabilities Act Accessibility Guidelines

Live Load, Uniform

IRC 2000	50 lbs/ft
IRC 2003	200 lb. Uniform Live Load. Guard in-fill components (all those except the handrail), balusters and panel fillers shall be designed to withstand a horizontally applied normal load of 50 pounds on an area equal to 1 square foot. This load need not be assumed to act concurrently with any other live load requirement.
IBC 2000	50 lbs/ft in any direction (handrails and guards).
IBC 2003	Handrail assemblies and guards shall be designed to resist a load of 50 plf (0.73 kN/m) applied in any direction at the top and to transfer this load through the supports to the structure. 1607.7.1.2 Components. Intermediate rails (all those except the handrail), balusters and panel fillers shall be designed to withstand a horizontally applied normal load of 50 pounds (0.22 kN) on an area equal to 1 square foot (0.093m ²), including openings and space between rails. Reactions due to this loading are not required to be superimposed with those of Section 1607.7.1 or 1607.7.1.1.

Live Load, Concentrated

IRC 2000	200 lbs
IRC 2003	200 lb Uniform Live Load. A single concentrated load applied in any direction at any point along the top.
IBC 2000	200 lbs In any direction (handrails and guards).
IBC 2003	Handrail assemblies and guards shall be able to resist a single concentrated load of 200 pounds (0.89 kN), applied in any direction at any point along the top, and have attachment devices and supporting structure to transfer this loading to appropriate structural elements of the building.
ANSI A117.1	250 lbs (grab bars for toilets, tubs and showers)

Allowable Opening, Maximum

IRC 2000	4" sphere – general; 6" sphere – at triangle formed by riser, tread and bottom rail. Required guards shall not be constructed with horizontal rails or other ornamental pattern that results in a ladder effect.
IRC 2001	4" sphere – general; 6" sphere – at triangle formed by riser, tread and bottom rail. <i>Ladder Effect</i> removed.
IRC 2003	R312.2Guard opening limitations. Required guards on open sides of stairways, raised floor areas, balconies and porches shall have intermediate rails or ornamental closures which do not allow passage of a sphere 4 inches (102mm) or more in diameter. Exceptions: 1. The triangular openings formed by the riser, tread and bottom rail of a guard at the open side of a stairway are permitted to be of such a size that a sphere 6 inches (152 mm) cannot pass through. 2. Openings for required guards on the sides of stair treads shall not allow a sphere 4 ³ / ₈ inches (107mm) to pass through.
IBC 2000	4" sphere – general – to a height of 34"; 6" sphere – at triangle formed by riser, tread and bottom rail; 8" sphere from a height of 34" to 42" Exceptions: 21" sphere for elevated walk for electrical, mechanical and plumbing systems and Group I-3, F, H, or S occupancies, balusters, horizontal intermediate rails or other construction.
IBC 2003	3. In areas which are not open to the public within occupancies in Group I-3, F, H or S, balusters, horizontal intermediate rails or other construction shall not permit a sphere with a diameter of 21 inches (533 mm) to pass through any opening.4. In assembly seating areas, guards at the end of aisles where they terminate at a fascia of boxes, balconies and galleries shall have balusters or ornamental patterns such that a 4-inch-diameter (102 mm) sphere cannot pass through any opening up to a height of 26 inches (660 mm). From a height of 26 inches (660 mm) to 42 inches (1067mm) above the adjacent walking surfaces, a sphere 8 inches (203 mm) in diameter shall not pass.

Height Requirements, Minimum for Handrails

IRC 2000	Measured vertically above stair nosings and ramp surfaces: 34" minimum; 38" maximum.
IRC 2003	Handrail height, measured vertically from the sloped plane adjoining the tread nosing, or finish surface of ramp slope, shall be not less than 34 inches (864mm) and not more than 38 inches (965 mm).
IBC 2000	Measured vertically above stair nosings and ramp surfaces: 34" minimum; 38" maximum
ANSI A117.1	Measured vertically above stair nosings and ramp surfaces: 34" minimum; 38" maximum.
ADAAG	38" maximum. ADAAG Advisory: The requirements for stair and ramp handrails in this document are for adults. When children are the principle users in a building or facility (e.g., elementary schools), a second set of handrails at an appropriate height can assist them and aid in preventing accidents. A maximum height of 28 inches (710 mm) measured to the top of the gripping surface from the ramp surface or stair nosing is recommended for handrails designed for children. Sufficient vertical clearance between upper and lower handrails, 9 inches (230 mm) minimum, should be provided to help prevent entrapment.

Height Requirements, Minimum for Guardrails

IRC 2000	36" (residential) – porches, balconies, raised floor surfaces 34" minimum on open side of stairs.
IBC 2000	42" except where top rail also serves as a handrail it shall have a height not less than 34" and not more than 38".
IBC 2001	Amended to add the following: The height in assembly areas shall be in accordance with Section 1008.12.
IBC2003	Amended to add the following: Exemption 2: The height in assembly areas shall be in accordance with Section 1024.14.

Height Requirements (of Guardrails) For Balconies, Galleries & Bleachers

IBC 2000	All portions of the stairway width required for egress capacity are within 30 inches (762mm) of a handrail.
IBC 2003	Intermediate handrails are required so that all portions of the stairway width required for egress capacity are within 30 inches (762 mm) of a handrail. On monumental stairs, handrails shall be located along the most direct path of egress travel.

End Details, Handrails

IRC 2000	Ends shall return or shall terminate in newel posts or safety terminals.
IBC 2000	Return to wall, guard or the walking surface or continuous to the handrail of an adjacent stair flight.
ANSI A117.1	Return to wall, guard or the walking surface or continuous to the handrail of an adjacent stair flight.
ADAAG	Return smoothly to walls, post, or floors.

Code Comparisons

CODE COMPARISONS

Wall Clearance, Handrails

IRC 2000	1½ inch minimum.
IRC 2003	1½ inch (38mm) minimum between wall and the handrail
IBC 2000	1½ inch minimum.
IBC 2003	Clear space between a handrail and a wall or other surface shall be a minimum of 1.50 inches (38mm). A handrail and a wall or other surface adjacent to the handrail shall be free of any sharp or abrasive elements.
ANSI A117.1	1½ inch minimum.
ADAAG	1½ inch minimum.

Project from Wall, Handrails

IBC 2000	4.50" maximum.
ANSI A117.1	4.50" maximum.

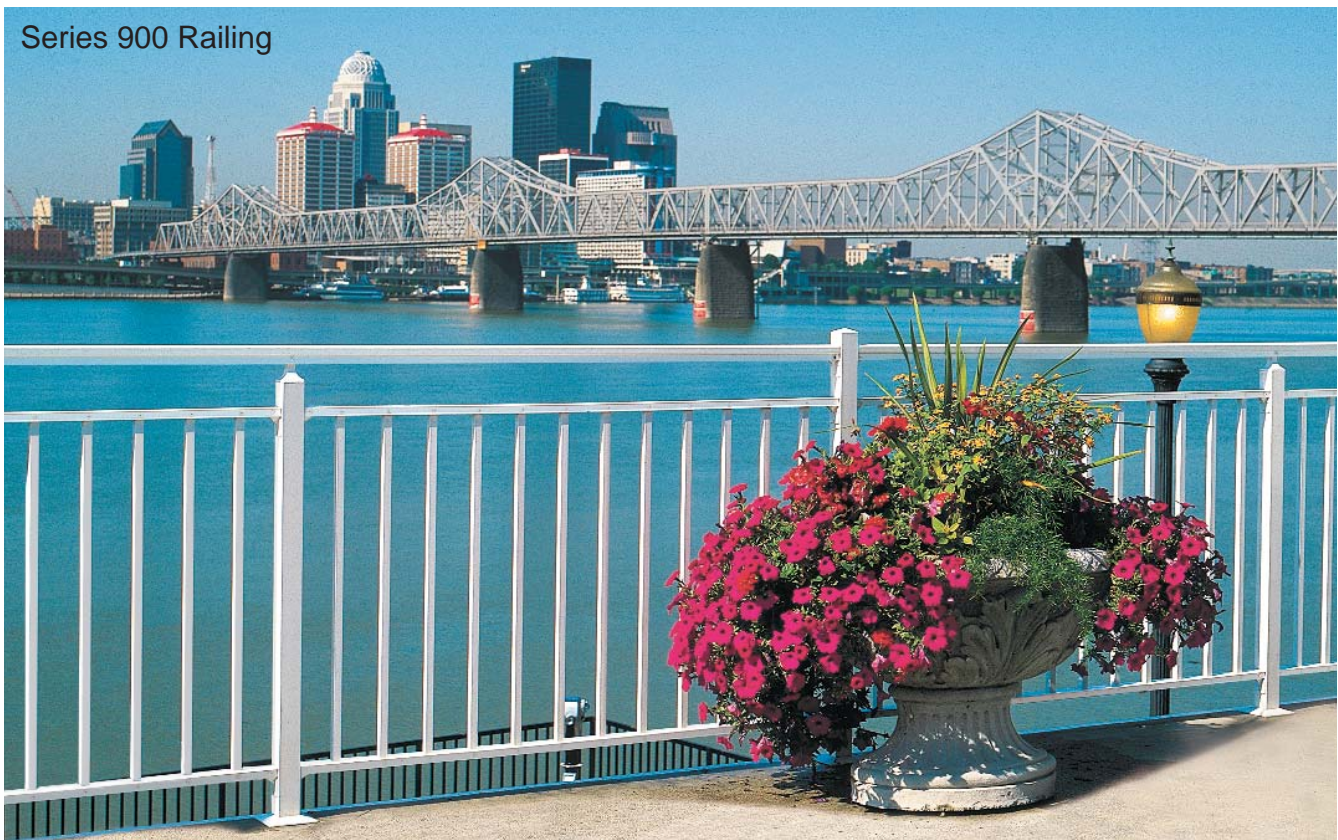
Intermediate Handrail Requirements

IBC 2000	All portions of the stairway width required for egress capacity are within 30" of a handrail.
IBC 2003	Intermediate handrails are required so that all portions of the stairway width required for egress capacity are within 30 inches (762 mm) of a handrail. On monumental stairs, handrails shall be located along the most direct path of egress travel.

Grip Size, Handrails

IRC 2000	Circular shapes: 1.25" minimum 2.625" maximum. Non-Circular: Other shapes that provide an equivalent grasping surface are permissible. Edges shall have .125" minimum radius.
IRC 2001	Type 1: Circular shapes: 1.25 inch minimum 2.625" maximum. Type 2: Handrails with a perimeter greater than 6.25" shall provide a graspable finger recess area on both sides of the profile. The finger recess shall begin within a distance of .750" vertically from the tallest portion of the profile and achieve a depth of at least .031" within .875" below the widest portion of the profile. This required depth shall continue for at least .375" to a level that is not less than 1.75" below the tallest portion of the profile. The minimum width of the handrail above the recess shall be 1.25" to a maximum of 2.75". Edges shall have a minimum radius of .010".
IRC 2003	Type I. Handrails with a circular cross section shall have an outside diameter of at least 1¼ inches (32mm) and not greater than 2 inches (51 mm). If the handrail is not circular it shall have a perimeter dimension of at least 4 inches (102 mm) and not greater than 6¼ inches (160 mm) with a maximum cross section of dimension of 2¼ inches (57 mm). Type II. Handrails with a perimeter greater than 6¼ inches (160mm) shall provide a graspable finger recess area on both sides of the profile. The finger recess shall begin within a distance of ¾ inch (19 mm) measured vertically from the tallest portion of the profile and achieve a depth

Series 900 Railing



Grip Size, Handrails (continued)

	of at least $\frac{5}{16}$ inch (8mm) within $\frac{7}{8}$ inch (22mm) below the widest portion of the profile. This required depth shall continue for at least $\frac{3}{8}$ inch (10mm) to a level that is not less than $1\frac{3}{4}$ inches (45 mm) below the tallest portion of the profile. The minimum width of the handrail above the recess shall be $1\frac{1}{4}$ inches (32 mm) to a maximum of $2\frac{3}{4}$ inches (70mm). Edges shall have a minimum radius of .01 inches (.25 mm).
IBC 2000	Circular shapes: 1.25" minimum 2" maximum. Non-Circular: Perimeter dimension 4" minimum a 6.25" maximum and 2.25" maximum cross-section. Edges shall have .125" minimum radius.
IBC 2001	No change to dimensions other than following: Edges shall have a minimum radius of .010".
IBC2003	1009.11.3 Handrail graspability. Handrails with a circular cross section shall have an outside diameter of at least 1.25 inches (32 mm) and not greater than 2 inches (51 mm) or shall provide equivalent graspability. If the handrail is not circular, it shall have a perimeter dimension of at least 4 inches (102 mm) and not greater than 6.25 inches (160 mm) with a maximum cross-section dimension of 2.25 inches (57mm). Edges shall have a minimum radius of .01 inch (.25mm) Exception 3. Handrail brackets or balusters attached to the bottom surface of the handrail that do not project horizontally beyond the sides of the handrail within 1.50 inches (38 mm) of the bottom of the handrail shall not be considered to be obstructions and provided further that for each .50 inch (13 mm) of additional handrail perimeter dimension above 4 inches (102mm), the vertical clearance dimension of 1.5 inches (38 mm) shall be permitted to be reduced by .125 inch (3 mm).
ANSI A117.1 and ADAAG	Circular shapes: $1\frac{1}{4}$ inch (32mm) minimum; 2 inch (51mm) maximum Non-Circular: Perimeter dimension 4 inch (100mm) minimum and $6\frac{1}{4}$ inch (160mm) maximum and $2\frac{1}{4}$ inch (57 mm) maximum cross-section. Edges shall be "rounded".

Extension Requirements at Ends

IRC 2003	R311.5.6.2 Continuity. Handrails for stairways shall be continuous for the full length of the flight, from a point directly above the top riser of the flight to a point directly above lowest riser of the flight. Handrail ends shall be returned or shall terminate in newel posts or safety terminals. Handrails adjacent to a wall shall have a space of not less than $1\frac{1}{2}$ inch (38mm) between the wall and the handrails. Exceptions: 1. Handrails shall be permitted to be interrupted by a newel post at the turn. 2. The use of a volute, turnout, starting easing or starting newel shall be allowed over the lowest tread.
IBC 2000	12" horizontally beyond top stair riser. Bottom of a stair flight, handrail shall extend at the slope of the stair flight for a horizontal distance equal to one tread depth beyond the last riser nosing. No extension required (residential).
IBC 2003	1009.11.4 Continuity. Handrail-gripping surfaces shall be continuous, without interruption by newel posts or other obstructions. Exceptions: 1. Handrails within dwelling units are permitted to be interrupted by a newel post at a stair landing. 2. Within a dwelling unit, the use of a volute, turnout or starting easing is allowed on the lowest tread. 3. Handrail brackets or balusters attached to the bottom surface of the handrail that do not project horizontally beyond the sides of the handrail within 1.50 inches (38 mm) of the bottom of the handrail shall not be considered to be obstructions and provided further that for each .50 inch (13 mm) of additional handrail perimeter dimension above 4 inches (102mm), the vertical clearance dimension of 1.50 inches (38 mm) shall be permitted to be reduced by .125 inch (3 mm).
ANSI A117.1	12" horizontally beyond top stair riser. Bottom of a stair flight, handrail shall extend at the slope of the stair flight for a horizontal distance equal to one tread depth beyond the last riser nosing. 12" horizontally after slope at bottom. 12" horizontally minimum beyond top and bottom of ramp runs.
ADAAG	12" horizontal at both top and bottom of ramp runs.

The Wagner Companies



GUIDE SPECIFICATIONS

These guide specifications are intended to be used as the basis for developing job specifications and must be edited to fit specific job requirements. Inapplicable provisions should be then deleted, while appropriate information should be provided in the blank spaces and provisions applicable to the job should be added as necessary. Items, which represent an option or choice, are enclosed in brackets. Notes to specifiers are given in *italics* directly following the paragraphs to which they apply.

These guide specifications may be downloaded in MSWord or text formats at www.wagnercompanies.com.

[SECTION 05521 -- SERIES 500 NON-WELDED PIPE] [SECTION 05521 -- SERIES 550 NON-WELDED PIPE] [SECTION 05521 -- SERIES 900 ALUMINUM] [SECTION 05521 -- SERIES 950 ALUMINUM] [SECTION 05720 -- (J.G. BRAUN ARCHITECTURAL GLASS)] [HANDRAILS AND RAILINGS] [SECTION 05720 -- HANDRAILS AND RAILINGS WITH (HORIZONTAL) (VERTICAL) CABLE RAILING COMPONENTS]

PART 1 – GENERAL

Section 1.01 WORK INCLUDED

- A. Furnish and install [aluminum] [brass] [bronze] [stainless steel] [steel] [pipe] [tube] railings and [horizontal] [vertical] cable railing components.
- B. WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS
 - 1. Furnish [anchors] [fabrications] to be cast in concrete to Section [03001 - Concrete] [03300 - Cast-in-Place Concrete].
 - 2. Furnish [anchors] [fabrications] for embedding in masonry to Section [04300 - Masonry Unit System] [_____].
 - 3. Furnish anchors for placement in [_____] walls to Section [_____ - _____].
- C. RELATED WORK
 - 1. Concrete: _____
 - 2. Cast-in-Place Concrete: _____
 - 3. Unit Masonry Systems: Grout
 - 4. Metal Finishes: _____
 - 5. Metal Fabrications: Welding Methods
 - 6. Metal Stairs: Handrailing at Stairs
 - 7. Rough Carpentry: _____
 - 8. Finish Carpentry: Wood Stairs
 - 9. Wood Stairs and Railings
 - 10. Painting: Paint Finish

Section 1.02 REFERENCES

Include only reference standards that are to be indicated within the text of this section. Edit the following, adding and deleting as required for project and product selection.

- A. Aluminum Association (AA)
 - 1. ABH-21 Aluminum Brazing Handbook
 - 2. ASD-1 Aluminum Standards and Data
 - 3. DAF-45 Designation System for Aluminum Finishes
 - 4. SAA-46 Standards for Anodized Architectural Aluminum
- B. American Architectural Manufacturers Association (AAMA)
 - 1. AAMA 605.1 Specification for High Performance Organic Coatings on Architectural Extrusions and Panels.
 - 2. AAMA 606.1 Voluntary Guide Specifications and Inspection Methods of Integral Color Anodic Finishes for Architectural Aluminum.
 - 3. AAMA 607.1 Voluntary Guide Specifications and Inspection Methods for Clear Anodic Finishes for Architectural Aluminum.
 - 4. AAMA 608.1 Voluntary Guide Specifications and Inspection Methods for Electrolytically Deposited Color Anodic Finishes for Architectural Aluminum.
- C. American Concrete Institute (ACI)
 - 1. ACI 347-78 Recommended Practice for Concrete Formwork
- D. American Iron and Steel Institute (AISI)
 - 1. Steel Products Manual; Stainless and Heat Resisting Steel.
- E. American National Standards Institute (ANSI)
 - 1. A21.1 Safety Requirements for Floor and Wall Openings, Railings and Toe Boards.
 - 2. A58.1 Minimum Design Loads in Buildings and Other Structures.
 - 3. A117.1 Accessible and Usable Buildings and Facilities. .
- F. American Society for Testing and Materials (ASTM)
 - 1. A 29 Specification for Steel Bars, Carbon and Alloy, Hot-Wrought and Cold-Finished, General Requirements for.

- 2. A 36 Carbon Structural Steel
- 3. A 53 Pipe, Steel, Black and Hot Dipped, Zinc Coated Welded and Seamless
- 4. A 108 Steel Bars, Carbon, Cold Finished, Standard Quality
- 5. A 269 Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- 6. A 276 Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
- 7. A 312 Specification for Seamless and Welded Austenitic Stainless Steel Pipe.
- 8. A 320 Alloy Steel Bolting Materials for Low Temperature Service
- 9. A 500 Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- 10. A 512 Specification for Cold-Drawn Buttweld Carbon Steel Mechanical Tubing.
- 11. A 554 Welded Stainless Steel Mechanical Tubing
- 12. A 582 Free Machining Stainless and Heat Resisting Steel Bars.
- 13. A 743 Specification for Corrosion-Resistant Iron Chromium, Iron Chromium-Nickel, and Nickel Base Alloy Castings for General Application.
- 14. A1264-1 Safety Requirements for Workplace Floor and Wall Openings, Stairs and Railing Systems
- 15. B 43 Specification for Standard Sizes of Seamless Red Brass Pipe.
- 16. B 211 Aluminum and Aluminum Alloy Bar, Rod and Wire
- 17. B 221 Specification for Aluminum-Alloy Bars, Rods, Wires, Shapes and Tubes.
- 18. B 429 Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
- 19. B 455 Specification for Copper-Zinc-Lead Alloy (Leaded Brass) Extruded Shapes.
- 20. B 483 Specification for Aluminum and Aluminum-Alloy Drawn Tubes for General Purpose Applications.
- 21. C 595 Specification for Blended Hydraulic Cements.
- 22. D 1730 Recommended Practices for Preparation of Aluminum and Aluminum Alloy Surfaces for Painting.
- 23. E 84 Test Method for Surface Burning Characteristics of Building Materials.
- 24. E 894 Standard Test Methods for Anchorage of Permanent Metal Railing Systems and Rails for Buildings.
- 25. E 935 Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings.
- 26. E 985 Specification for Permanent Metal Railing Systems and Rails for Buildings
- G. Americans with Disabilities Act Accessibility Guidelines (ADAAG)
- H. Copper Development Association (CDA)
 - 1. Standards Handbook, Wrought Copper and Copper Alloy Mill Products, Part 2 - Alloy Data.
 - 2. Standards Handbook, Cast Copper and Copper Alloy Products, Part 7 - Alloy Data.
 - 3. Copper, Brass and Bronze Design Handbook for Architectural Applications.
- I. General Service Administration (GSA) Federal Specifications (FS)
 - 1. DD-G 1403 Glass, Plate (Float), Sheet, Figured, and Spandrel (Heat Strengthened and Fully Tempered).
 - 2. QQ-C-390 Copper Alloy Castings.
 - 3. QQ-S-766 Stainless Steel, Class 302 or 304.
 - 4. TT-P-645 Primer, Paint, Zinc Chromate, Alkyd Type.
- J. International Code Council (ICC)
 - 1. International Building Code (IBC)
 - 2. International Residential Code (IRC)
- K. Military Specifications (MIL)
 - 1. MIL-A-46104 Aluminum Alloy Extruded Rod, Bar, and Shapes, 7001.
 - 2. MIL-C-5688 Pre-Stretching and Proof-Testing of Wire Rope Assemblies
 - 3. MIL-P-1144 Pipe, Corrosion Resistant, Stainless Steel, Seamless or Welded.
 - 4. MIL-P-25995 Pipe, Aluminum Alloy, Drawn or Extruded.
 - 5. MIL-R-36516 Rail, Restraint.
 - 6. MIL-W-87161 Wire Strand, Non-Flexible, for Aircraft Control. Oil Free Condition.
- L. National Association of Architectural Metal Manufacturers (NAAMM)
 - 1. Metal Finishes Manual
 - 2. Pipe Railing Manual
 - 3. Stair Manual

- M. National Fire Protection Association (NFPA)
 - 1. 101 Life Safety Code
- N. National Ornamental and Miscellaneous Metals Association (NOMMA)
 - 1. Metal Rail Manual
- O. National Institute of Building Sciences
 - 1. Metric Guide for Federal Construction
- P. Society of Automotive Engineers (SAE)
 - 1. SAE/AMS QQ-S-763 Steel Bars, Wire, Shapes and Forgings; Corrosion Resistant.

Section 1.03 REQUIREMENTS

- A. Check governing codes for requirements.
 - 1. [Handrail] [and wall rail] [Guardrail] assemblies and attachments shall withstand a minimum concentrated load of _____ pounds applied horizontally or vertically down at any point on the top rail.

- OR -

 - 1. [Handrail] [and wall rail][Guardrail] assemblies and attachments shall withstand a minimum uniform load of _____ pounds per foot applied [vertically down] [and] [horizontally], but not simultaneously on the top rail.
 - 2. Guardrail intermediate rails, balusters, panel fillers, posts or cables shall be designed for a uniform load of not less than _____ pounds per square foot over the gross area of the guard of which they are part. Reactions due to this loading need not be added to the loading specified for the main supporting members of the guardrails.
 - 3. Railing frame components and cable hardware shall be designed to withstand loads encountered without excessive deflection or distortion when cables are tensioned to conform to building code requirements.

Section 1.04 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section [01300] [01340].
- B. Indicate component details, materials, finishes, connection and joining methods, and the relationship to adjoining work.
- C. Submit manufacturer's installation instructions under provisions of Section [01300] [01340].
- D. Submit samples of the following:
 - 1. _____

Section 1.05 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Furnish references listing projects of similar size and scope
- B. Regulatory Requirements:
 - 1. Components and installation are to be in accordance with state and local code authorities
 - 2. Components and installation are to follow current ADA and ICC/ANSI A117.1 guidelines.
- C. Certifications
 - 1. Furnish certification that all components and fittings are furnished by the same manufacturer or approved by the primary component manufacturer.
 - 2. Furnish certification that components were installed in accordance to the manufacturer's engineering data to meet the specified design loads.
- D. Pre-Installation Meeting
 - 1. Prior to the beginning of work, conduct a pre-job conference at the job site.
 - 2. Provide seven calendar days advance written notice ensuring the attendance by competent authorized representatives of the fabricator, building owner's representative, architect and sub-contractors whose work interfaces with the work of this section.
 - 3. Review the specifications to determine any potential problems, changes, scheduling, unique job site conditions, installation requirements and procedures and any other information pertinent to the installation.
 - 4. Record the results of the conference and furnish copies to all participants.

Section 1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the job site in good condition and properly protected against damage to finished surfaces.
- B. Storage on site:
 - 1. Store material in a location and in a manner to avoid damage. Stacking shall be done in a way, which will prevent bending.
 - 2. Store material in a clean, dry location away from uncured con-

crete and masonry. Cover with waterproof paper, tarpaulin, or polyethylene sheeting in a manner that will permit circulation of air inside the covering.

- 3. Keep handling on site to a minimum. Exercise particular care to avoid damage to finishes of material.

PART 2 – PRODUCTS

Section 2.01 ACCEPTABLE MANUFACTURER

- A. Railing [pipe] [tube] and components shall be as manufactured or supplied by The Wagner Companies.; P.O. Box 423; Butler, WI 53007. Phone: 888-243-6914. Fax: 414-214-0550. Web site: www.wagnercompanies.com. E-mail: info@mailwagner.com.

Section 2.02 MATERIALS AND FINISHES

- A. Aluminum:
 - 1. Extruded Pipe: Alloy 6063-T6 meeting ASTM B 221
 - 2. Extruded Bars, Shapes and Mouldings: [Alloy 6063-T52] [Alloy 6063-T6] meeting ASTM B 221
 - 3. Castings: Almag 35 meeting ASTM B 26
 - 4. Finish (refer to NAAMM Metal Finishes Manual):
 - 5. Anodized finish shall be [AA-M10-C22-A31 (204R1)] [provided in accordance with AA-M____-C____-A____ and shall meet requirements of AAMA (606.1) (607.1) (608.1)]
 - 6. Painted finish shall be _____ type and _____ color and shall meet the requirements of AAMA 605.1 specification for high performance organic coatings.
- B. Stainless Steel: Type 304 (18-8)
 - 1. Tubing: ASTM A 269
 - 2. Cable: MIL-W-97161, Type II, Composition B
 - 3. Cable Hardware: ASTM A 276 and A 479, SAE/AMS QQ-S-763, Type 316
 - 4. Finish: [Ornamental Grade, AISI No. 4] [AISI No.____].
 - 5. [_____]
- C. Copper Alloys:
 - 1. Drawn Pipe: C23000 (Red Brass) meeting ASTM B 43
 - 2. Drawn Tube: C27000
 - 3. Castings: [C86500 meeting ASTM B 584 for sand castings]
 - 4. Extrusions: [C38500 (Architectural Bronze) meeting ASTM B 455] [C33000]
 - 5. Finish (refer to NAAMM Metal Finishes Manual):
 - 6. Mechanical: [M32-Medium Satin] [M - _____]
 - 7. Chemical: C _____ - _____
 - 8. Coating: [Clear Organic: O _____ - _____] [Laminated: L _____ - _____] [Wax: _____] [Oil: _____]
- D. Steel:
 - 1. Pipe: meeting ASTM A 53
 - 2. Tubing: meeting ASTM A 512
 - 2. Bars and Shapes: meeting ASTM A 36.
 - 3. Castings: [Malleable] [Ductile] [Cast] Iron meeting ASTM [A 47]
 - 4. Painted finish shall be _____ type and _____ color.

Section 2.03 RAILING SYSTEM

(WAGNER ARCHITECTURAL GLASS RAIL SYSTEM)

- A. Material shall conform to 2.02. and be finished in accordance with 2.02.
- B. Railing system shall be [surface] [flush] [fascia] mounted.
- C. Rails
 - 1. Fabricate rails from [aluminum] [bronze] [brass] [stainless steel] Wagner No. _____
- D. Posts
 - 1. Fabricate posts from [_____] inch outside diameter by [_____] inch wall [aluminum] [bronze] [brass] [stainless steel] tubing.
- E. Glass Structural Balustrade shall be [1/2] [3/4] inch tempered glass and conform to the safety requirements of ANSI Z97.1.
- F. Shoe Moulding
 - 1. Extruded aluminum alloy Wagner No. _____
- G. Cladding [aluminum] [brass] [stainless steel], Wagner No. _____.
- H. Fittings
 - 1. Fittings shall be of wrought material of [aluminum] [bronze] [brass] [stainless steel]. Miter elbows shall be of welded construction.
- I. Glazing Accessories
 - 1. Setting block shall be Wagner No. [GR9392] [GR9393].
 - 2. Protective insert shall be of polyvinyl chloride (PVC); Wagner No. GR9394

3. [Filler: Type _____ ; Color: _____] [Glass Wedge] [GR9500] [GR9750]
4. Shoe Moulding insert [GR9396] [GR9398]

- OR -

(ULTRA-TEC CABLE RAILING)

Specify horizontal or vertical cable railing system required for the specific application. When using horizontal cable railing, vertical elements should be specified with the thicker components. When using vertical cable railing, top and bottom rails should be specified with the thicker components. Delete choices not required. The cable railing system can be custom designed.

- A. Material shall conform to 2.02 and be finished in accordance with 2.02
- B. [Horizontal] [Vertical] Stainless Steel Cable Railing System: Ultra-tec Railing System.

Specify either Decorail or Contempo Rail style railing frame components in either carbon steel or stainless steel. Delete choices not required.

- C. Style: Decorail.
 1. Members: [1 ¼" pipe] [1 ½" pipe] [2" pipe]

- OR -

- C. Style: Contempo Rail
 1. Members: [3 inch x 1 inch rectangular structural tubing] [2 inch x 1 inch rectangular structural tubing] [2 inch x 2 inch square structural tubing]

Delete the bottom rail if not required. For the rails and posts, specify pipe for the Decorail style railing frame components and specify structural tubing and structural tees for the Contempo Rail style.

- D. Top Rail [and Bottom Rail]: [Schedule (40) (80) pipe] [Minimum (.120) (.188) inch wall thickness round or structural tubing].

- E. Intermediate Posts:
 1. [Schedule (40) (80) pipe] [Minimum (.120) (.188) inch wall thickness round or structural tubing] [Minimum .187 inch wall thickness 2 inch x 1 inch structural tee].
 2. Maximum Spacing: [_____ inches] [as indicated on drawings].
 3. Connect top rail to mounting surface.

- F. End Posts: [Schedule (80) (160) pipe] [Minimum .250 inch wall thickness 2 inch x 2 inch structural tubing] [Minimum .250 inch wall thickness 2 inch x 2 inch square tubing with 2 inch x 2 inch x ¼ inch bar size tee] [Two pieces of rectangular structural tubing, 2 inch x 1 inch with minimum .120 inch wall thickness, placed in tandem, separated by a minimum 5/8 inch diameter spacer] [Two pieces of rectangular structural tubing, 3 inch x 1 inch with minimum .120 inch wall thickness, placed in tandem, separated by a minimum 5/8 inch diameter spacer].

- G. Corner Posts:
 1. When Radiused Tubes Are Used: [Minimum Schedule 40 pipe] [Minimum .120 inch wall round or structural tubing].
 2. Single Post Corner: [Schedule (80) (160) pipe] [minimum .250" wall thickness 2 inch x 2 inch square tubing] [As indicated on drawings].

- H. Welded Receiver: [ASTM A 108, Type 1018 carbon steel] [Type 304 stainless steel]. Weld into outside wall of an end post. Hide weld by grinding welded surface to original contour.

- I. Welded Tab: [ASTM A 108, Type 1018 carbon steel] [Type 304 stainless steel]. Weld into outside wall of an end post. Hide weld by grinding welded surface to original contour.

- J. Invisiware Threaded Tab: Screws into drilled and tapped hole in the inside wall of an end post.

- K. Rail Height: [36 ½"] [42 ½"] [As indicated on the drawings].

- L. Pipe Railing End Post Transition to Top Rail: [Miter] [Radius] [Overhung] [As indicated on the drawings].

- M. Post Mounting: [Foot mounting] [6 inch extension into concrete] [As required for fascia mounting] [As indicated on the drawings].

- N. Intermediate Cable Braces: for horizontal cable railing
 1. Type: 1-piece.
 2. Size: ¼" x 1"
 3. Spacing: As indicated on the drawings.
 4. Material: [steel] [stainless steel]

- OR -

- N. Intermediate Rail Braces: for vertical cable railing
 1. Material: .625 inch diameter x .120 inch wall thickness [Type 4130 Chrom/Moly tubing] [seamless stainless steel tubing]
 2. Spacing: [Maximum 26 inches on center between end and/or intermediate posts] [As indicated on the drawings]

- O. Finish:
 1. [Mill] [Primed] [Primed and painted] [Powder coated].
 2. Apply final finish before installation of cable hardware and cables.

- P. Grommets:
 1. Material: UV-resistant HDPE.
 2. Cable Grommets: Provides barrier to abrasion of intermediate posts and cable braces bored for cables.
 3. Color: Black

- OR -

Specify the following if railing frame components are wood instead of metal. Consult Wagner for additional information regarding wood railing frame components. The Wagner Companies. does not provide wood railing frame components. Refer to Section 06430 - Wood Stairs and Railings.

- C. Wood Railing Frame Components: As specified in Section 06430.

-OR-

(ORNAMENTAL RAILINGS)

- C. Material shall conform to 2.02. and be finished in accordance with 2.02.

- D. Rails [and Posts]
 1. Fabricate [rails] [posts] [spindles] from [anodized] [painted] [aluminum] [bronze] [brass] [steel] [stainless steel] [wood] [Wagner No. _____]
 2. Railing Width: _____.
 3. Railing Cross Section Height: _____; Wagner No. _____.
 4. Railing End Style: _____, Wagner No. _____.

- E. Posts [and Spindles]
 1. Fabricate [posts] [spindles] from [anodized] [painted] [aluminum] [bronze] [brass] [steel] [stainless steel] [Wagner No. _____]

- F. Newel Posts:
 1. Wagner No.: _____.
 2. Height: _____.

- G. Balusters:
 1. Wagner No.: _____.
 2. Height: _____.

- H. Shoes and Knuckles:
 1. Wagner No.: _____.

- I. Scrolls:
 1. Wagner No.: _____.

- J. Rosettes, Leaves, and Ornaments:
 1. Wagner No.: _____.
 2. Diameter: _____.
 3. Dimensions: _____.
 4. Member Thickness: _____ by _____.

- K. Finials, Baskets, and Spears: Ornamentation for vertical members.
 1. Wagner No.: _____.
 2. Dimensions: _____.

- L. Fittings
 1. Fittings are to be of a cast alloy to best match the color of the handrail alloy

-OR-

- A. Material shall conform to 2.02. and be finished in accordance with 2.02.

- B. Railings:
 1. Baluster and Rail Configuration: Baluster connected to rail at top, substrate at bottom.
 2. Baluster and Rail Configuration: Baluster connected to rail at top, horizontal member at bottom, above substrate.
 3. Baluster and Rail Configuration: Baluster connected to horizontal member at top, below railing, and horizontal member at bottom, above substrate.
 1. Guard Rails: 42 inches (1067 mm) high to top of railing.
 2. Stairs: 34 inches (1067 mm) high to top of railing from nosing of stair tread.

- C. Ramps: _____ inches (1067 mm) high to top of railing.
- D. Baluster Spacing: _____ on center.
- E. Handrail Extension, Top and Bottom of Stairs: Comply with requirements of authorities having jurisdiction.
- F. Newel Post: Provide newel post at each end of railing and at _____ on center in railing run.
- G. Scrolls, Rosettes, Finials, and Other Ornaments and Fittings: Locate at _____.
- H. Shoes and Knuckles: Provide on every member, at bottom.

Section 2.05 FASTENERS

- A. All mechanical fasteners used in the assembly of stainless steel or aluminum railings shall be manufactured from stainless steel.
- B. Exposed mechanical fasteners for use with bronze materials shall be manufactured from yellow brass.
- C. Cement: Hydraulic, ASTM C 595, factory prepared with accelerator.

Section 2.06 CABLES AND CABLE HARDWARE

- A. Cables:
 - 1. Material: 1 x 19 Type 316 stainless steel strand.
 - 2. Compliance: MIL-W-87161, Type II, Composition B, Construction 1 right-hand lay or Construction 2 left-hand lay.

Fill-in the minimum breaking strength of the cable as found in Wagner product information. The minimum breaking strength depends on the cable diameter and cable construction.

- a) Minimum Breaking Strength, MIL-C-5688: _____ pounds.
- b) Diameter: _____.
- c) Orientation: [Horizontal] [Vertical] [Slope parallel to stair pitch] [As indicated on the drawings].
- d) Spacing: As indicated on the drawings
- 3. Finish: [Mill] [PVC coated: PVC coating Color: (_____) (As indicated on the drawings)].

B. Cable Hardware, General:

- 1. Stainless Steel: ASTM A 276 and A 479, SAE/AMS QQ-S-763, Type 316 stainless steel.
- 2. Swaging: Swage hardware onto ends of cables [in manufacturer's shop] [in field, using manufacturer's recommended methods] [as indicated on the drawings].

C. Cable Hardware Components:

- 1. Swaging Ferrule: Retains nonadjustable and adjustable clevis fittings onto cables.
- 2. Swaging Stud: Use with receiver to provide a means of tensioning cables. Use with welded receiver to connect to end post, non-tensioning end. Threaded surface treated with baked-on moly-based surface treatment to prevent thread galling and sticking.
- 3. Receiver: Invisiware Receiver. Allows tensioning hardware to be hidden within end post.
- 4. Nonadjustable Clevis Fitting: Fixed Jaw. Held onto cables by swaging ferrule. Connects to end post by means of welded tab or hole drilled in tee.
- 5. Adjustable Clevis Fitting: Adjust-A-Jaw. Provides a considerable amount of take-up in cables. Connects to end post by means of welded tab or hole drilled in tee.
- 6. Adjustable Fitting: Adjust-A-Jaw Body and Nut with Threaded Bolt: Screws into a drilled and tapped hole in the inside wall of an end post.
- 7. Radius Ferrule: Nonadjustable. Attaches cable to post with hardware hidden inside post.

Specify the following cable hardware if railing frame components are wood instead of metal. Consult Wagner for additional information regarding wood railing frame components.

A. Cable Hardware For Use With Wood Railing Frame Components:

- 1. Material: ASTM A 276 and A 479, SAE/AMS QQ-S-763, Type 316 stainless steel.
- 2. Swaging: Swage hardware onto ends of cables [in manufacturer's shop] [in field using manufacturer's recommended methods] [as indicated on the drawings].
- 3. Swaging Ferrule: Retains nonadjustable and adjustable clevis fitting onto cables.
- 4. Swaged Ferrule with Flat Washers: Retains washers on cables placed into counterbore. Use with counterbored hole in end post.
- 5. Hanger Bolt Fitting: Screw lag threaded end into end post. Expose fine screw thread for mating with body section of adjustable clevis fitting and lock nut.
- 6. Lag Eye Fitting: Screw lag threaded end into end post. Expose paddle-shaped eye to accommodate nonadjustable or adjustable clevis fitting.
- 7. Swaging Stud: Use with receiver. Provides a means of tensioning cables in as small an area as is feasible.
- 8. Receiver: Invisiware Receiver. Allows tensioning hardware to be hidden within end post. Use with [1/4"] [3/16" thick] x 1 inch wide flat bar attached to outside of end post with stainless steel flat head screws. Use with washer to place into counterbore. Use with counterbored hole in end post.

- 9. Nonadjustable Clevis Fitting: Fixed Jaw. Held onto cables by swaging ferrule.
- 10. Adjustable Clevis Fitting: Adjust-A-Jaw Tensioner. Provides a considerable amount of take-up in cables. Held onto cables by swaging ferrule.
- 11. Radius Ferrule: Nonadjustable. Attaches cable to post with hardware hidden inside post.

Section 2.07 HANDRAIL BRACKETS

- A. [Aluminum] [Bronze] [Stainless steel]; [cast] [extruded] [stamped] [machined]: Wagner No. _____

Section 2.08 FABRICATION

- A. Form [rail-to-end post connections and] all changes in rail direction by [miter] [radius] elbows.
- B. Cut material square and remove burrs from all exposed edges, with no chamfer.
- C. Make exposed joints butt tight and flush.
- D. Close exposed ends of [pipe] [handrail] by use of appropriate end cap.
- E. For posts set in concrete, furnish matching sleeves or inserts not less than 5 inches long.
- F. Locate intermediate rails [midway] [equally spaced] between top rail and finished floor or center line of tread.
- G. Verify dimensions on site prior to shop fabrication.

PART 3 – EXECUTION

Section 3.01 PREPARATION

- A. Supply items to be [cast in concrete] [embedded in masonry] [placed in partitions].
- B. Examine areas to receive cable railing system. Notify Architect if areas are not acceptable. Do not begin installation until unacceptable conditions have been corrected.

Section 3.02 DISSIMILAR METALS

- A. When bronze and aluminum components come into contact with dissimilar metals, surfaces shall be kept from direct contact by painting the dissimilar metal with [a heavy coat of a proper primer] [asphalt paint].
- B. When aluminum components come into contact with cement or lime mortar, exposed aluminum surfaces shall be painted with [heavy bodied bituminous paint] [water-white methacrylate lacquer] [zinc chromate].

Section 3.03 INSTALLATION

- A. Install in accordance with shop drawings [and manufacturer's instructions] at locations indicated on the drawings.
- B. Erect work [square and level,] [horizontal or parallel to rake of steps or ramp,] rigid, [and] free from distortion or defects detrimental to appearance or performance.
- C. Anchor cable railing system to mounting surface as indicated on the drawings.
- E. Use manufacturer's supplied cable hardware.
- F. Terminate and tension cables in accordance with manufacturer's instructions.
- G. Tension cables to a minimum of 400 pounds each in sequence in accordance with manufacturer's instructions.
- H. Ensure cables are clean, parallel to each other and without kinks or sags.
- I. Adjust cables and cable hardware as required to provide properly installed cable railing system as directed by Architect.
- J. Expansion joints shall be provided as needed to allow for thermal expansion or contraction.

Section 3.04 PROTECTION

- A. Protect cable railing system and finish from damage during construction.

Section 3.05 CLEANING

- A. As installation is completed, wash thoroughly using clean water and soap; rinse with clean water.
- B. Do not use acid solution, steel wool or other harsh abrasives.
- C. If stain remains after washing, remove finish and restore in accordance with NAAMM Metal Finishes Manual.
- D. Finish must not be removed from anodized aluminum. Reanodizing can only be done by removing railing and returning it to the anodizer.

Section 3.06 REPAIR OF DEFECTIVE WORK

- A. Remove stained or otherwise defective work and replace with material that meets specification requirements.
- B. Repair damaged finish as directed by Architect.
- C. Replace defective or damaged components as directed by Architect.

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BEFORE YOU GET STARTED

Rail Finish

If your rail is to be painted, powder coated or otherwise finished in any way, we strongly recommend that you apply the finish after all holes are drilled and prior to stringing the cable.

Materials Required

If screws for mounting Adjust-A-Jaw™ or Adjust-A-Body™ with Threaded Eye Tensioners and Ultra-tec® Fixed Jaws were not ordered from the factory, you will need one of the following screws for each of these items:

Adjust-A-Jaw or Adjust-A-Body Part No.	Fixed Jaw Part No.	Screw Required	Screw Part No.
CRAJ62 or CRAJTE6	CRFJ62	1/4"-28 X 1/2"	CRSC6
CRAJ82 or CRAJTE8	CRFJ82	3/8"-24 X 3/4"	CRSC8
CRAJ122	CRFJ122		

In areas prone to tampering, a permanent setting thread sealant is recommended for use with screws.

Tools Required



The tools listed here assume you will be swaging at least one end of the cable in the field using an INVISIWARE® Field Swager. If no field swaging is required, only those tools indicated with * may be required.

Cable Cutters. CRC9 for cables up to 3/16"; CRC12 for cables larger than 3/16".

Air Compressor. Minimum 5.8 c.f.m. at 90 p.s.i. and a minimum 20 gallon tank. Air pressure should be regulated not to exceed 140 p.s.i.

Ultra-tec® Portable Pneumatic/hydraulic Swager. If you are renting one from, be sure to specify the uncoated diameter of the cable you are swaging, so the correct swager will be supplied. Rented swagers generally come with most other special tools required to field swage and install cable, including hose fittings, cable grip locking pliers, cable cutter, and GO gauge for measuring the swaged diameter of INVISIWARE® Radius Ferrules. A pre-tensioner can also be furnished upon request.



***Ultra-tec® Pre-tensioning Tool (optional).** Since some INVISIWARE® hardware has a minimum of take-up on longer runs (over 30 feet) you may want to use a pre-tensioning tool. In ordering, be sure to specify the cable diameter you will be using it with.

***Cable Grip Locking Pliers.** To grip the cable while tensioning the end fittings without damaging the cable. (Available from the factory.)

***Wrenches.** If installing INVISIWARE® Receivers, an Allen wrench to tension the cable. See chart for size.

Cable Diameter	Receiver Used	Hex Hole Size
1/8" 3/16"	CRR6	3/16"
1/4" 5/16"	CRR8	7/32"
3/8"	CRR12	5/16"

If installing ADJUST-A-JAW™ or ADJUST-A-BODY™ Tensioners, set of open-end wrenches from 1/4" through 1 1/16".

Calipers, if you are swaging and installing INVISI-WARE® Radius Ferrules, you will need a means to measure the diameter of the swaged fitting. ("GO" gauges for this purpose are normally included with Ultra-tec® Portable Swagers when rented from the factory.)

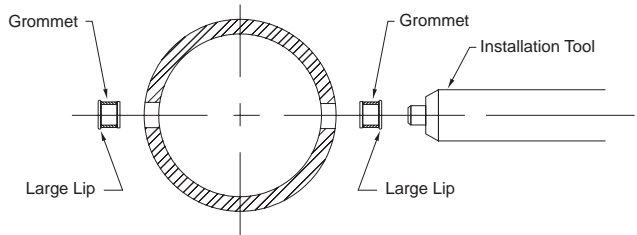
Grommet Installation Tool (available from the factory), and hammer if you will be installing grommets.

***Drills and Drill Bits as required**, if installing in a wood railing – see Wood Railings under "Measuring and Installing Cable – Horizontal Railings."

Installing Grommets

IMPORTANT NOTE: If grommets are being used on intermediate posts, cable braces, or in the cable exit hole of end posts, then grommets should be installed before cable is run.

To install grommets, see Fig. K below. Place the larger diameter of the grommet onto the grommet installation tool and the smaller diameter at the hole in the post. Tap the tool lightly with a hammer.



Installing Cable

MEASURING AND INSTALLING CABLE

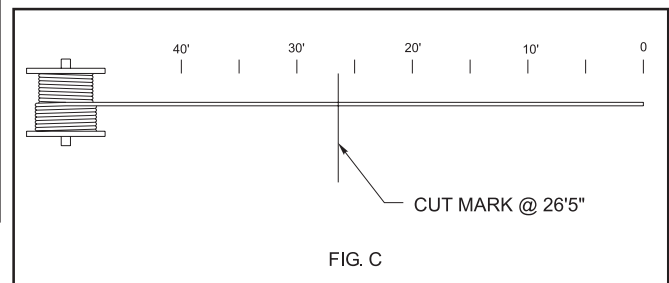
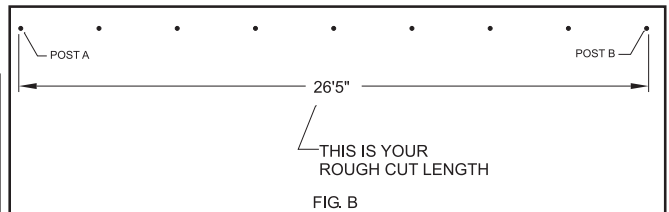
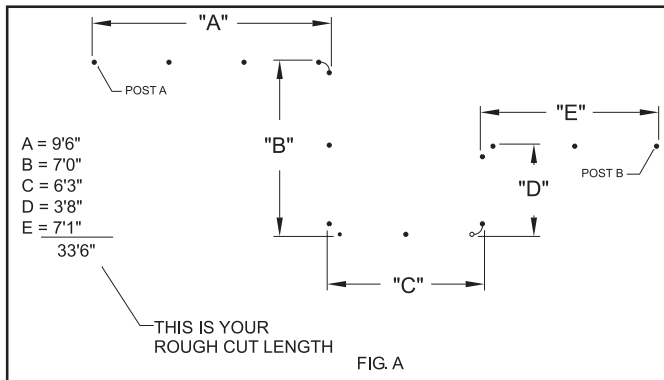
Horizontal Railings, Measuring Cable Lengths

If you have ordered your cables cut to length from the factory, you can skip this section on Measuring cable length.

- A. Measure the length of the run from the outside of one terminating end post to the outside of the other terminating end post. Over estimate as shown, when corners are involved. See Figures A & B below. Note that Post "A" is always the first end to which hardware is attached. When only one end has a tensioning device (Invisiware®

Receiver or Adjust-A-Jaw™ Tensioner), that tensioning device is attached to Post "B" and the non-tensioning device is attached to Post "A". Post "B" is always a tensioning end.

- B. Measure out cable on a relatively clean surface (see Figure C above). A lawn or swept concrete surface would be fine.
- C. Cut cable to length, using Cable Cutter.



NOTE: Make sure you have a positive holding device at the zero end. Cutting the cables takes very little time. It is best to have one person stand at the zero mark while another operates the cable cutter at the cut mark.

Cable Railing Installation Guide

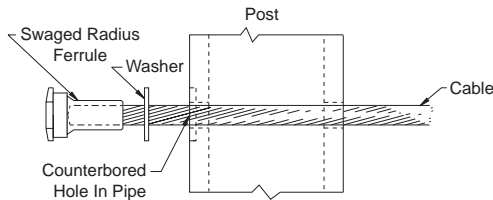
Installing Cable

- A. Unless already swaged, swage the fittings to be used on Post "A" onto one end of the cut cables (See "Swaging Instructions" section of these instructions).

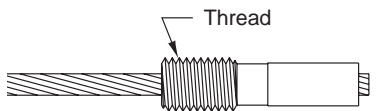
NOTE: Where only one end of the cable has an adjusting fitting (INVISIWARE® Receiver or ADJUST-A-JAW™ Tensioner), we recommend that you swage the unadjusting end, Post "A," first (before the cables are strung) and the adjusting end, Post "B," last (after the cables have been strung).

Where INVISIWARE® Radius Ferrules will be used:

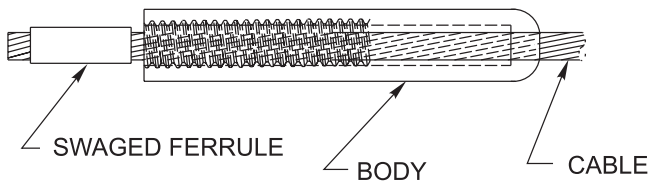
1. Slide the Washer onto the cable.
2. Swage the Radius Ferrule onto the end of the cable (see "Swaging Instructions").
3. Slide the washer over the body of the Radius Ferrule.
4. Feed the bare end of the cable through the hole in Post "A" from the back side, until the fitting's head with washer rests against the back side of the post (or in the counterbore if applicable).



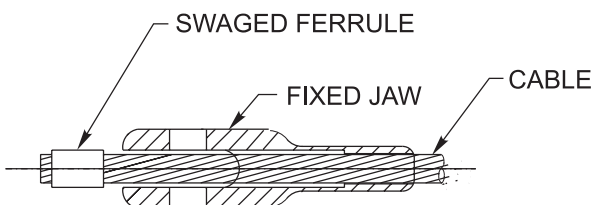
Where INVISIWARE® Receivers are being used, swage the Stud onto the end of the cable to be attached to Post "A" (see "Swaging Instructions").



Where ADJUST-A-JAW™ or ADJUST-A-BODY™ Type Tensioners are being used, slide the Body onto the cable and swage the Ferrule onto the end of the cable to be attached to Post "A" (see "Swaging Instructions").



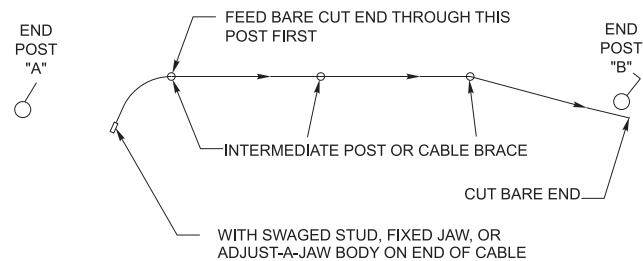
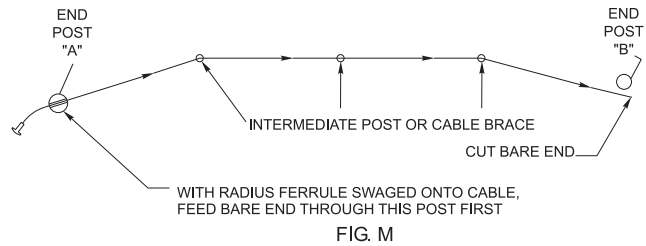
Where Ultra-tec® Fixed Jaws are being used, slide the Fixed Jaw onto the cable and swage the Ferrule onto the end of the cable to be attached to Post "A" (see "Swaging Instructions").



NOTE: If you are using Ultra-tec® "Clip-on" Fixed Jaws with the Ferrule already swaged onto the cable or Ultra-tec® "Clip-on" Stops you will have to feed the cable from the Post "B" end through all intermediate posts to Post "A," before installing the Fixed Jaw onto the Post "A" end of the cable. See "Ultra-tec® Clip-On Fixed Jaw Installation Instructions" or "Ultra-tec® "Clip-on Stop Installation Instructions" elsewhere in this guide for attaching the Fixed Jaw or "Clip-on Stop" to the cable.

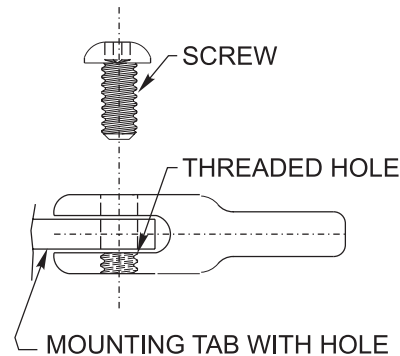
- B. String Cable through intermediate posts and braces to Post "B."

If you are using the Radius Ferrule, see Fig. M. For other devices, see Fig. M-A.



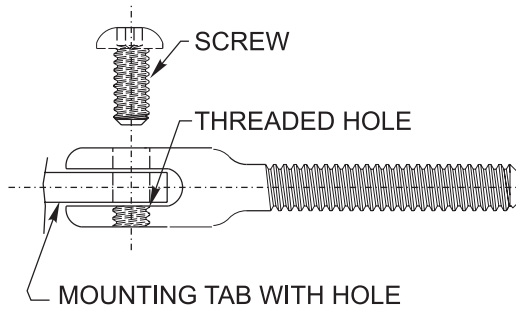
- C. Attach fittings to end Post "A."

If using Ultra-tec® Fixed Jaw, bolt the fitting to the tab, through the hole in the structural tee, or the lag eye (in wood post) on the end post, using the screws specified under "Materials Required."

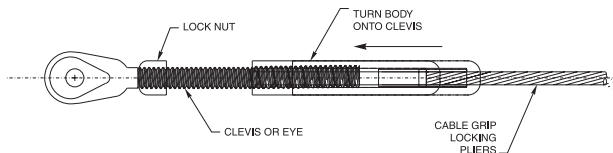


If using ADJUST-A-JAW™ or ADJUST-A-BODY™ with Threaded Eye Tensioners:

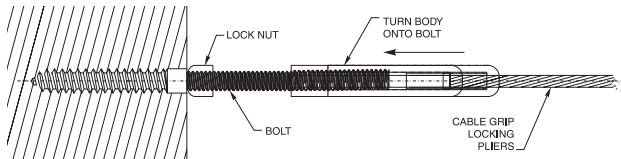
If you are installing the tensioner using tabs, holes in a structural tee or lag eyes (in wood) attach the clevis portion of the fitting to the tab, lag eye or through the hole in structural tee on the end post, using the screws specified under "Materials Required."



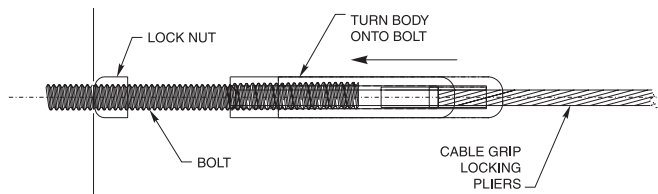
Screw the lock nut onto the threads of the Clevis or Eye, then hold the cable closely behind the body and turn the body by hand a minimum of 8 turns onto the threaded end of the Clevis. (See note)*



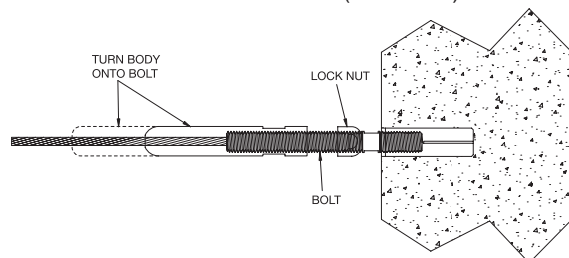
If you are installing into wood with a hanger bolt, screw the hanger bolt into a pre-drilled pilot hole in the post. Screw the lock nut onto the threads of the bolt, then hold the cable closely behind the body and turn the body by hand a minimum of 8 turns onto the threaded end of the bolt. (See note)*



If you are installing into a threaded hole in a metal post, screw the bolt into the threaded hole in the post. Screw the lock nut onto the threads of the bolt, then hold the cable closely behind the body and turn the body by hand a minimum of 8 turns onto the threaded end of the bolt. (See note)*

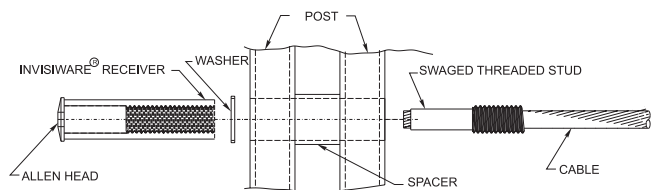
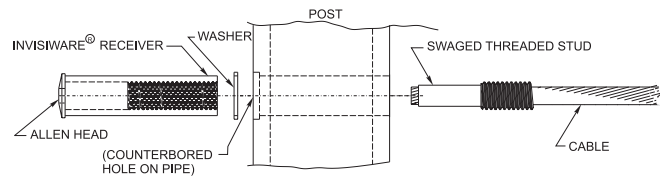


If you are installing an Adjust-A-Body™ concrete anchor bolt into a concrete anchor bolt, screw the bolt into the threaded hole in the anchor bolt. Screw the lock nut onto the threads of the bolt, then hold the cable closely behind the body and turn the body by hand onto the threaded end of the bolt at least 6 full turns. (See note)*



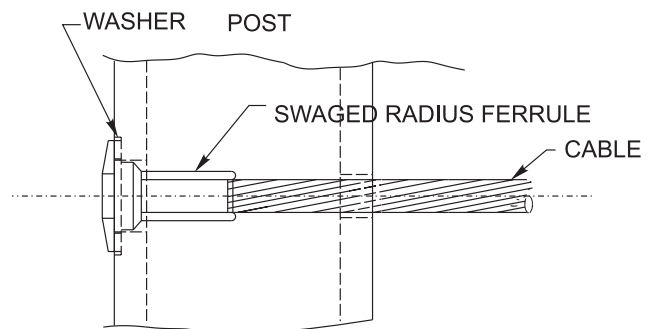
**NOTE: This will allow for maximum take-up. The fewer turns you make at this step, the more thread that will be exposed when the installation is complete. Each job is different, so we suggest that you string and lightly tension one cable between end posts, to determine how many turns you will make in turning the body onto the male threaded end in order to minimize the amount of exposed thread at both ends.*

If using an INVISIWARE® Receiver, slide the washer over the body of the Receiver, then feed the Receiver through the hole in back of the post and into the hole on inside wall of the post (metal). If you have a metal double post end post construction, be sure to place spacers between the double posts, as you feed the fitting through. By hand, screw the Receiver onto the threaded Stud at least 6 full turns.



For wood posts, follow the same instructions, except you will have to feed the cable (with the Stud swaged on the end) through the post from the inside to meet the Receiver inside the post, where you will turn the Receiver onto the Stud using an Allen wrench.

If you are using INVISIWARE® Radius Ferrule, make sure the fitting is through the hole in the back of the post with the head with washer resting against the back side of the post (or in the counterbore if applicable) as you proceed to the next step.



D. Pull cable toward end Post "B." Use Ultra-tec® Pre-tensioning Tool, if required (see Figure S).

E. Attach fittings at end Post "B"

If installing INVISIWARE® Receiver at Post "B"

NOTE: If installing INVISIWARE® Receiver on a stairway, see "Using INVISIWARE® Receivers on Stairways" before proceeding.

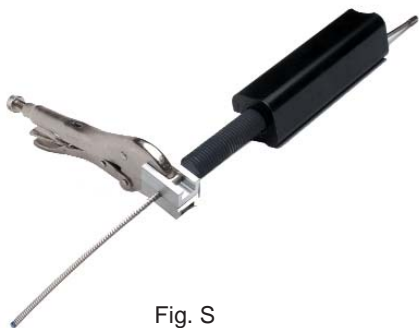


Fig. S

1. Cut Cable at Post "B" End. (Assumes cable is already attached to Post "A.") Mark and cut the cable at the location shown in relation to end Post "B" (see Figure R below for steel posts, Figure RW below for wood posts). **NOTE:** this cut mark will allow for maximum take-up. However, it may leave more thread exposed than necessary after tensioning. This length can be altered to achieve the most favorable results.

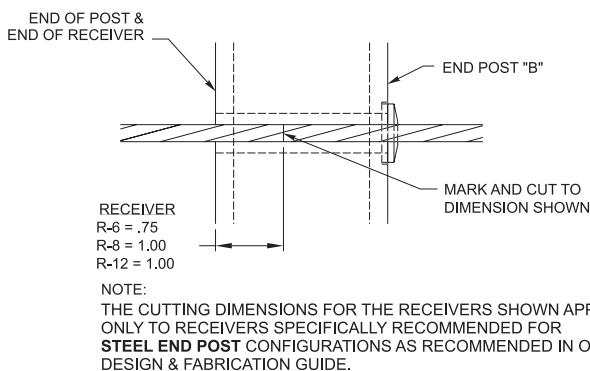


FIG. R

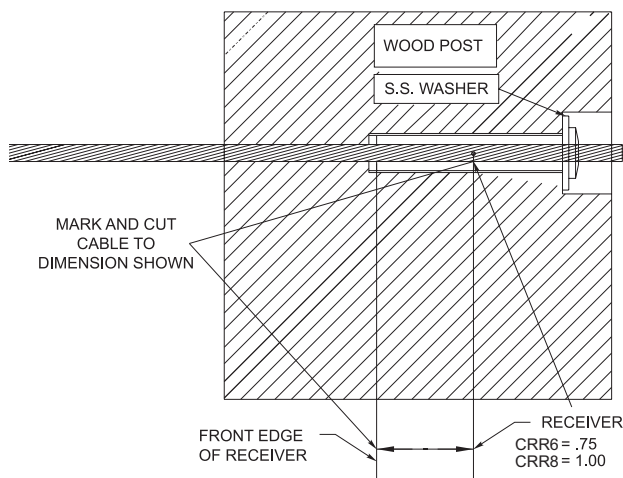
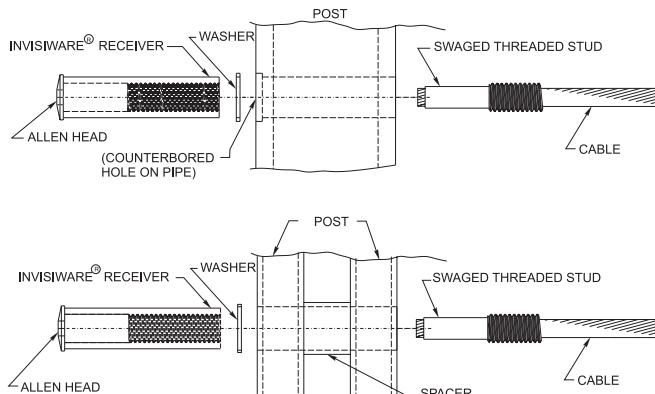


FIG. RW

2. Swage Stud onto cable (see "Swaging Instructions" section in these instructions).
3. Slide the washer over the body of the Receiver, then feed the Receiver through the hole in the back of the post. If you have a double post end post construction, be sure to place spacers between the double

posts, as you feed the fitting through. By hand, screw the Receiver onto the swaged Stud at least 6 full turns. Do not tension cables until all cables have been installed between end posts "A" and "B."



Double End Post Construction

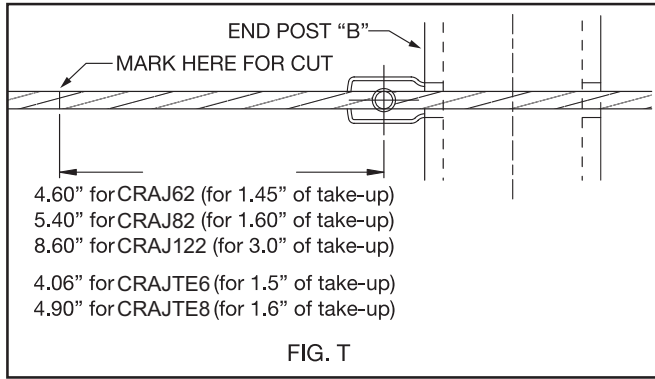
For wood posts, follow the same instructions, except you will have to feed the cable (with the Stud swaged on the end) through the post from the inside to meet the Receiver inside the post, where you will turn the Receiver onto the Stud using an Allen wrench.

4. Repeat above steps for each cable to be installed between end posts "A" and "B."
5. After all the cables have been installed, tension the cable (to approx. 400 lbs.) by holding the cable (using cable grip locking pliers) closely behind the Stud. Turn the Receiver clockwise with an Allen Wrench. See "Tensioning Cables" for sequence to use in tensioning cables.

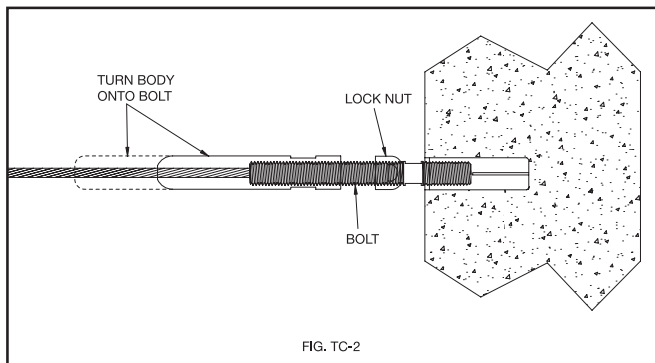
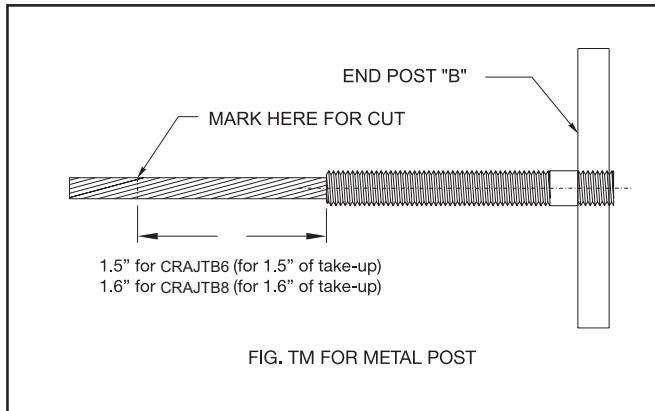
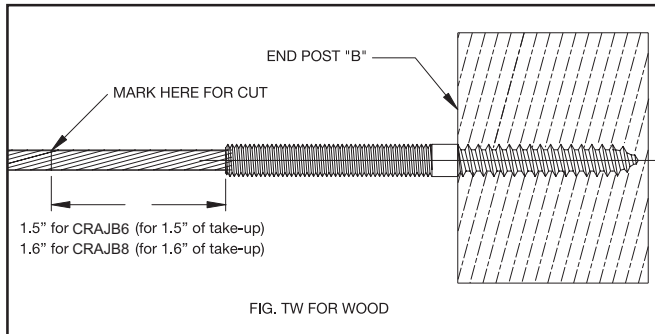


If installing ADJUST-A-JAW™ or ADJUST-A-BODY™ type tensioner at Post "B"

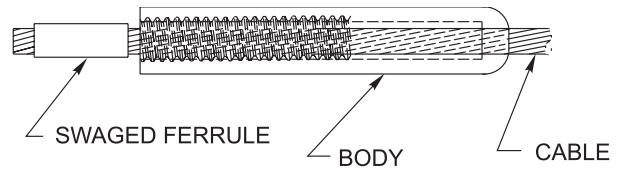
1. Cut Cable at Post "B" End. (Assumes cable is already attached to Post "A.") If you are attaching the tensioner to a tab, lag eye or hole in a structural tee, mark and cut the cable at the location shown in relation to the center of the mounting hole at Post "B" (see Figure T below). **NOTE:** this cut mark will allow for maximum take-up. However, it may leave more thread exposed than necessary after tensioning. This length can be altered to achieve the most favorable results.



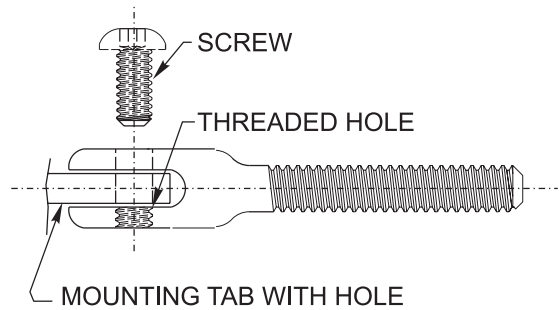
If the tensioner is mounted with the bolt screwed into a wood post, a threaded hole in a metal railing, or a concrete anchor, mark and cut the cable at the location shown in relation to end Post "B" (see Figures below). NOTE: this cut mark will allow for maximum take-up. However, it may leave more thread exposed than necessary after tensioning. This length can be altered to achieve the most favorable results.



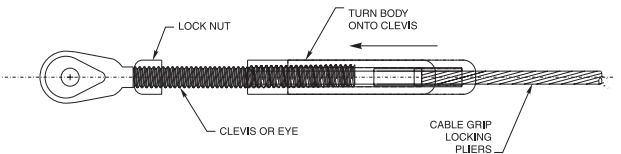
- Slide the Body onto the cable and swage the Ferrule onto the end of the cable (see "Swaging Instructions").



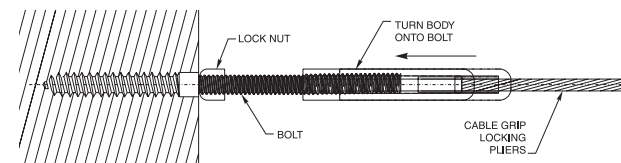
- Attach Tensioner to Post.
 If you are installing the tensioner using tabs, holes in a structural tee or lag eyes (in wood) attach the Clevis or Eye portion of the fitting to the tab, lag eye or through the hole in structural tee on the end post, using the screws specified under "Materials Required."



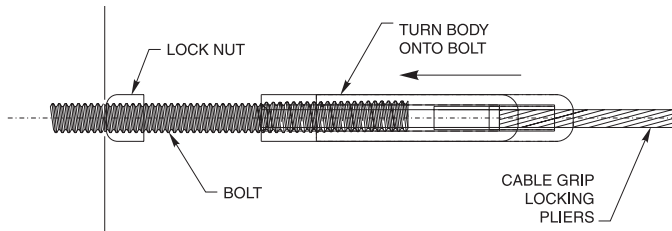
Screw the lock nut onto the threads of the Clevis or Eye, then hold the cable closely behind the body and turn the body by hand onto the threaded end of the Clevis at least 6 full turns.



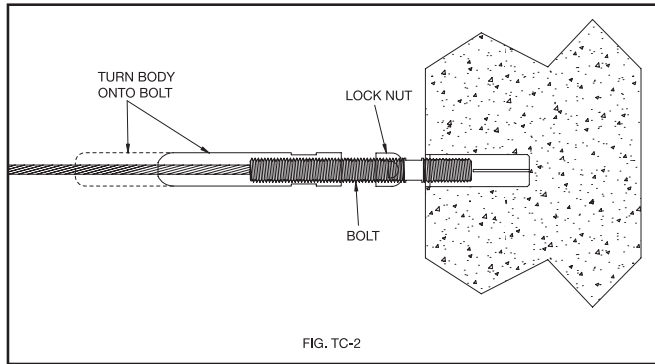
If you are installing into wood with a hanger bolt, screw the hanger bolt into a pre-drilled pilot hole in the post. Screw the lock nut onto the threads of the bolt, then hold the cable closely behind the body and turn the body by hand onto the threaded end of the bolt at least 6 full turns.



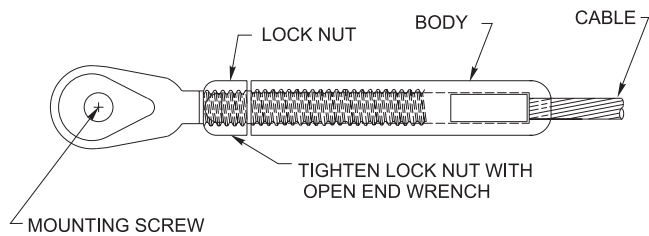
If you are installing into a threaded hole in a metal post, screw the bolt into the threaded hole in the post. Screw the lock nut onto the threads of the bolt, then hold the cable closely behind the body and turn the body by hand onto the threaded end of the bolt at least 6 full turns.



If you are installing an Adjust-A-Body™ concrete anchor bolt end into a concrete anchor bolt, screw the bolt into the threaded hole in the anchor bolt. Screw the lock nut onto the threads of the bolt, then hold the cable closely behind the body and turn the body by hand onto the threaded end of the bolt at least 6 full turns.



4. Repeat the above steps for each cable to be installed. Do not tension the cables, until all cables have been installed between end posts "A" and "B."
5. After all the cables have been installed, tension the cable (to approximately 400 lbs.) with an open end wrench, holding the cable with cable grip locking pliers to prevent it from rotating (see illustration below). See "Tensioning Cables" for sequence to use in tensioning cables.
6. If tensioners are mounted to tabs, structural tees or lag eyes, tighten the mounting screws.

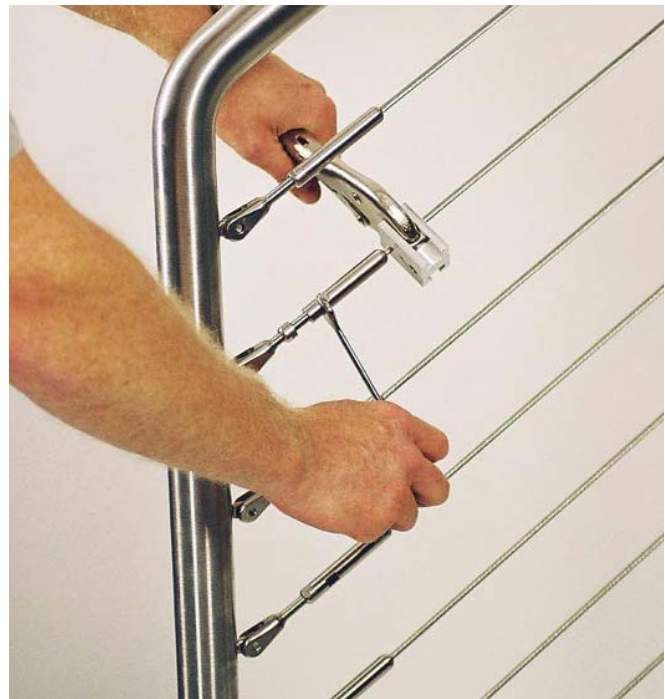
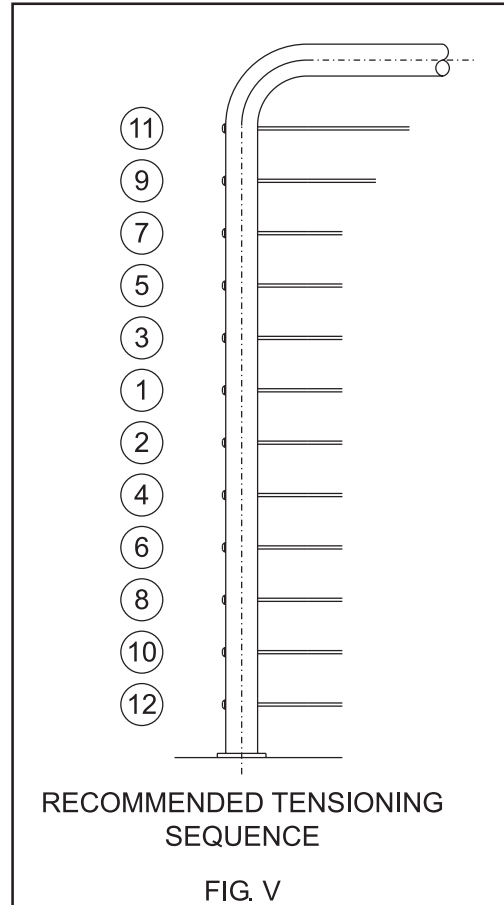


7. On all installations, tighten the lock nut against the body of the fitting with an open end wrench.

NOTE: In areas prone to tampering, the use of permanent setting thread sealant is recommended for mounting screws and lock nuts.

F. Tensioning cables

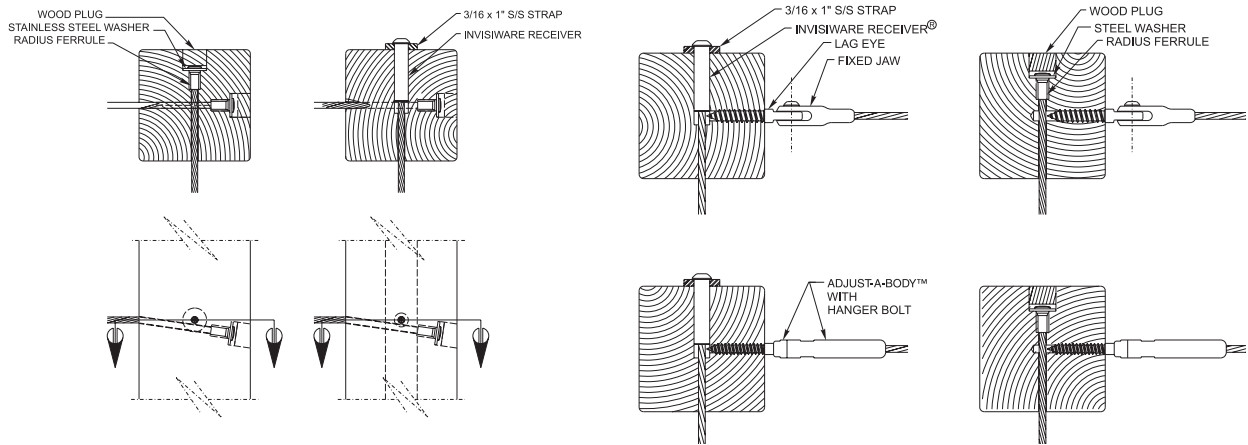
NOTE: Tension in sequence, beginning with cable nearest center of post (see Figure V below).



Cable Railing Installation Guide

WOOD POST OPTIONS

Following are illustrations of several hardware mounting alternatives and some techniques for mounting hardware to the end posts.



Drilling Holes in End Posts for Cable Mounting Hardware

Where Ultra-tec® Fixed Jaws are being used, drill holes in the end posts using the drill size shown on the following chart and screw Lag Eyes into the holes. Fixed Jaws will be mounted to the Lag Eyes (see "Installing Cable").

Cable Diameter	Using Lag Eye Part No.	Drill Size
1/8"	CRLE6	17/64"
3/16"	CRLE6	17/64"
1/4"	CRLE8	3/8"

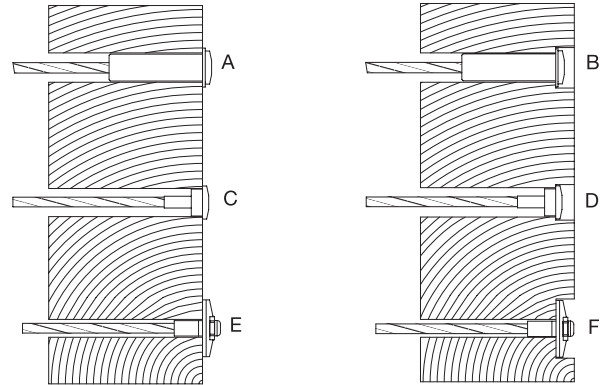
Where ADJUST-A-BODY™ with Hanger Bolt Tensioners are being used, drill holes in the end posts using the drill size shown on the following chart and screw the Hanger Bolt into the holes. Adjust-A-Body will be mounted to the Hanger Bolts (see "Installing Cable").

Cable Diameter	Using Adjust-A-Body Part No.	Drill Size
1/8"	CRAJB6 CRAJB6L	13/64"
3/16"	CRAJB6 CRAJB6L	13/64"
1/4"	CRAJB8	5/16"

**Due to the differences in different types of woods, slightly smaller or larger holes may be required for your particular application.*

Options for Mounting Invisiware® Receivers and Radius Ferrules.

When using Invisiware Receivers, Radius Ferrules and/or Clip-on Stops, see the illustration below for different mounting options. Drill holes in your end posts using sizes shown in the chart. Ultra-tec Receivers, Radius Ferrules and Clip-on Stops will be mounted in the drilled holes. The hole depth will depend upon the mounting option you choose and the thickness of the post.



Option	Cable Diameter	Drill Hole for Cable, Threaded Stud or Clip-On Stop	Diameter of Hole for Receiver or Radius Ferrule	Use Stainless Flat Washer	For Counterbore Diam of Hole for Flat Washer or Clip-On Stop Washer
A & B Mount: Receiver using Flat Washer (See Note below)	1/8" 3/16"	11/32"	29/64"	7/16"	15/16"
C & D Mount: Radius Ferrule using Flat Washer	1/4"	15/32"	35/64"	1/2"	1 3/32"
E & F Mount: Clip-On Stop	1/8" 3/16"	17/64"	NA	NA	15/16"

**Note: Do not counterbore if you are using CRR662 (3 1/2" long) Receivers in a 4x4 (3 1/2") post on a pitch.*

Drilling Holes in Intermediate Posts and Cable Braces

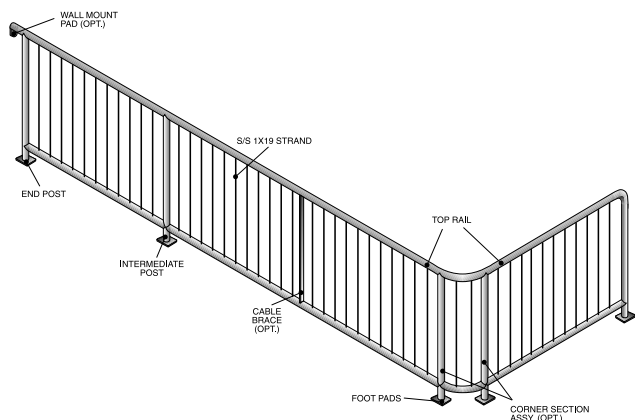
Cable Size	Hole Diameter Where Cables are supplied with fittings swaged on both ends		
	Hole Diameter Where Studs/Ferrules are swaged in the field	Using Threaded Studs	Using Ferrules for Clip-On Fixed Jaws or Clip-On Stop
1/8"	5/32"	11/32"	17/64"
3/16"	7/32"	11/32"	17/64"
1/4"	9/32"	15/32"	25/64"

Cable Railing Installation Guide

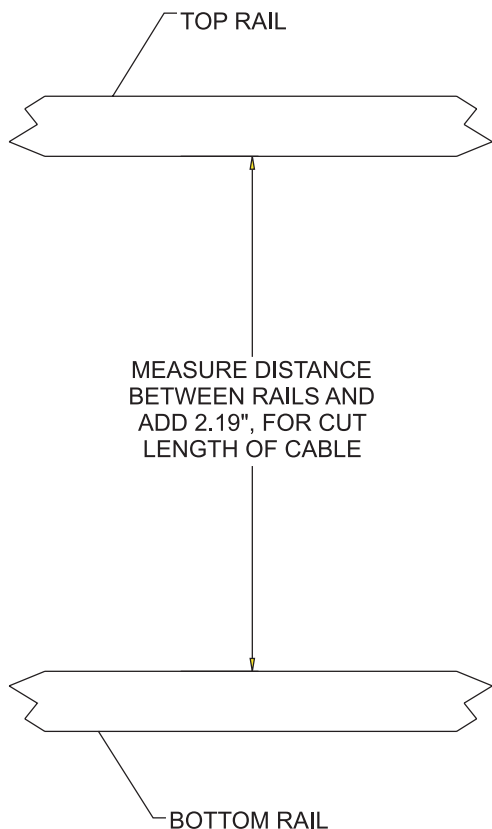
Vertical Railings

If you have ordered your cables cut to length from the factory, you can skip the steps indicated with * on measuring cable length and swaging fittings onto cable.

VERTICAL CABLE



- A. *Measure the distance between the bottom of the top rail to the top of the bottom rail and add 2.187" (2³/₁₆").
- B. *Measure out the cable on a relatively clean surface (see Figure C). A lawn or swept concrete surface would be fine. Cut cable to the length determined in Step A above, using Cable Cutter.



NOTE: Make sure you have a positive holding device at

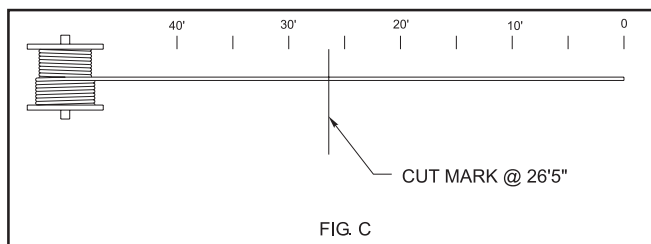
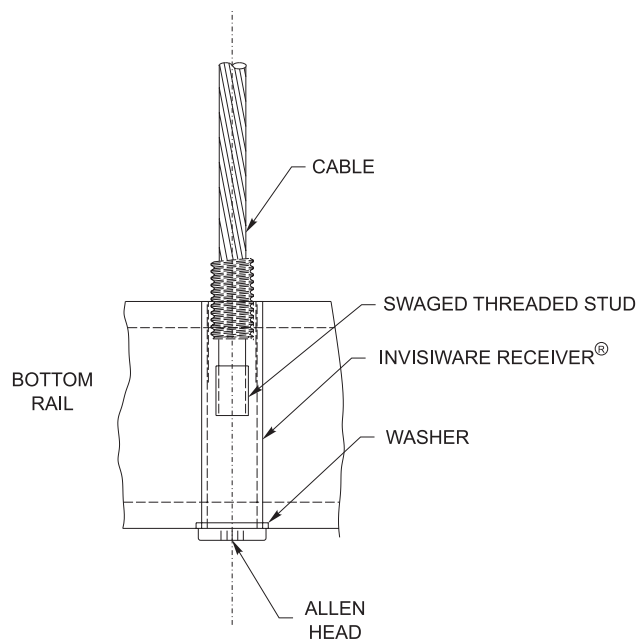


FIG. C

the zero end. Cutting the cables takes very little time. It is best to have one person stand at the zero mark while the other operates the cable cutter at the cut mark.

- C. *Swage a Stud onto each end of the cable (see "Swaging Instructions").
- D. Screw the swaged Stud on one end of the cable into the threads in the top rail, until the threads on the Stud are not showing.
- E. Slide the washer over the body of the INVISIWARE® Receiver, then feed the Receiver through the hole in the bottom of the bottom rail. Screw the Receiver onto the threaded Stud. Do not tension the cables until all cables have been installed between posts and/or cable braces.

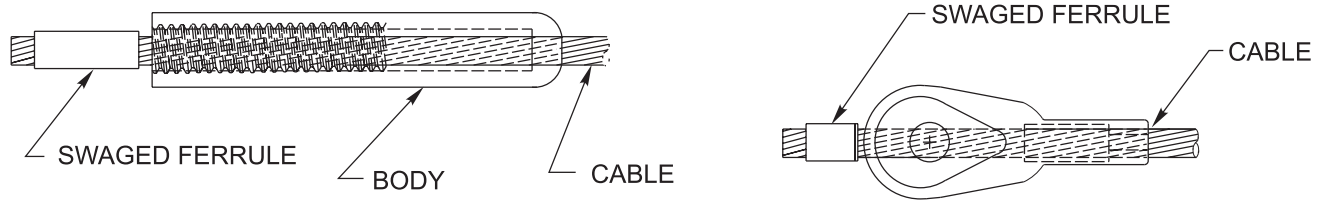


- F. Repeat above steps for each cable to be installed between posts.
- G. Tension the cables (to approximately 400 lbs.) by holding the cable (using aluminum jawed pliers) closely above the Stud in the bottom rail. Turn the Receiver clockwise with an Allen Wrench from underneath the bottom rail. First, tension the cable nearest the center point between posts and/or cable braces. Then, tension the rest of the cables in sequence, by alternating from one side of the center cable to the other, as you move outward toward the posts and/or cable braces. (For tensioning sequence illustration, see "Tensioning Cables" in preceding Installing Cables Section of this guide.)

Before you begin swaging

NOTE: If you are using coated cable, be sure to strip the coating from the end of the cable before swaging.

If you are using the ADJUST-A-JAW™ or ADJUST-A-BODY™ Type Tensioner or Ultra-tec® Fixed Jaw fitting, make sure the cable has been inserted through the body of the fitting prior to swaging the ferrule onto the cable. See illustrations below.



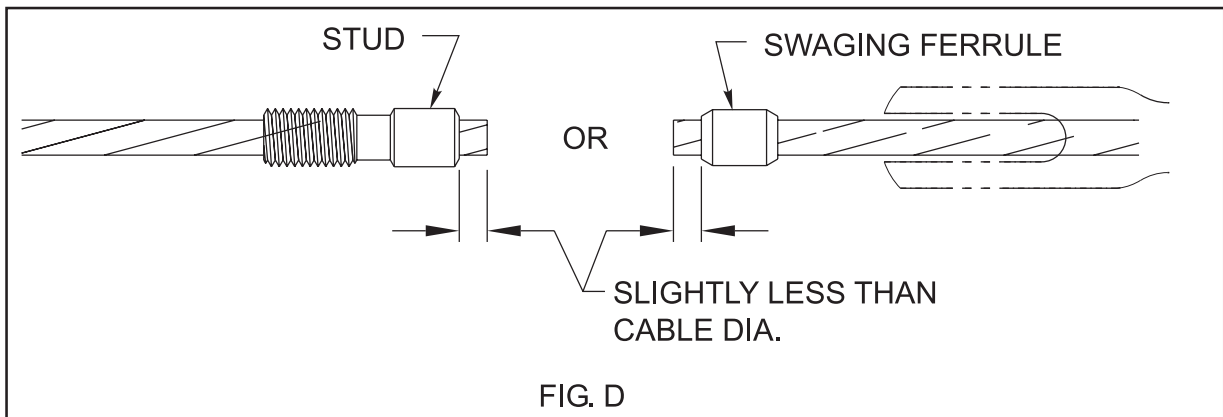
If you are using the INVISIWARE® Receiver or Welded Receiver (threaded receiver inside post), the Stud will be swaged onto the end of the cable and will install directly into the fitting.

If you are using the INVISIWARE® Radius Ferrule or Clip-on Stop, the fitting will be swaged onto the end of the cable and no further operation will be required.

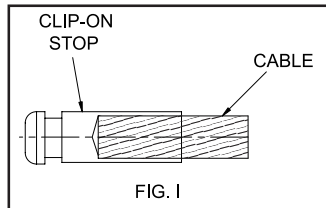
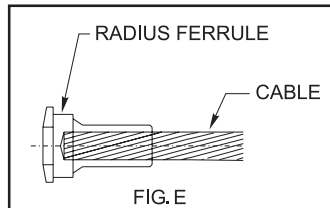
NOTE: Swage the fitting on one end of the cable only, before stringing cables through posts and braces. Where only one end of the cable has an adjusting fitting (INVISIWARE® Receiver or ADJUST-A-JAW™ or ADJUST-A-BODY™ Type Tensioner), we recommend that you swage the unadjusting end first and the adjusting end last (after the cables have been strung).

Swaging

- A. If you are using any fittings other than Radius Ferrules or Clip-on Stops, position the Ferrule or (threaded) Stud onto the Cable as shown in Figure D below.



If you are using Radius Ferrules or Clip-on Stops, slide the Cable into the open end of the fitting until it stops (see Figures E and I below).



- B. Place Ferrule or Stud into Open Swager Dies

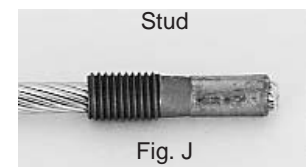
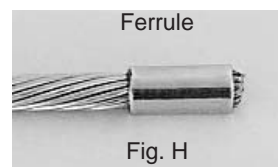
If you are using the Ultra-tec® Model 610 Portable Swager for 1/8" and 3/16" diameter cable (for CRS4 & CRS6 Studs and CRF4 & CRF6 Ferrules), see Figure F below.

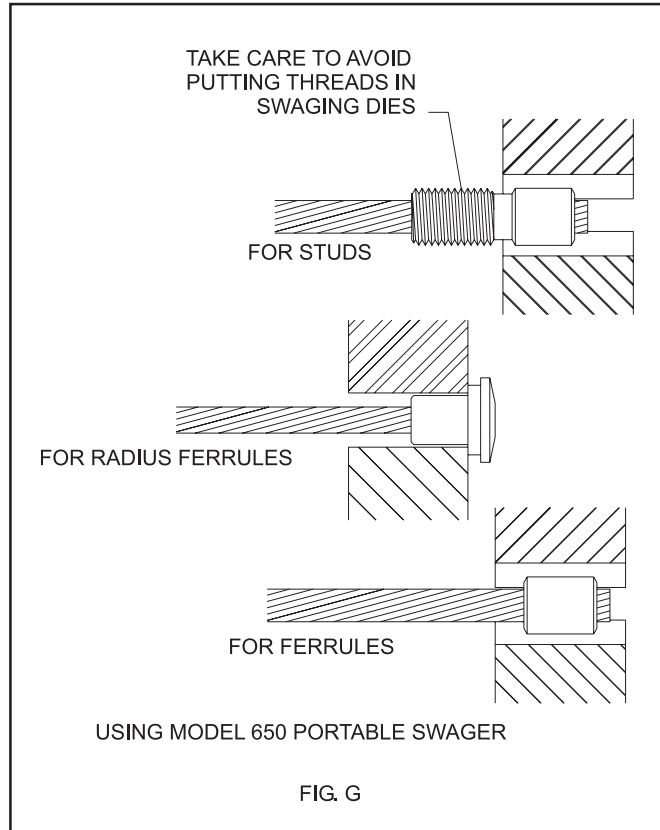
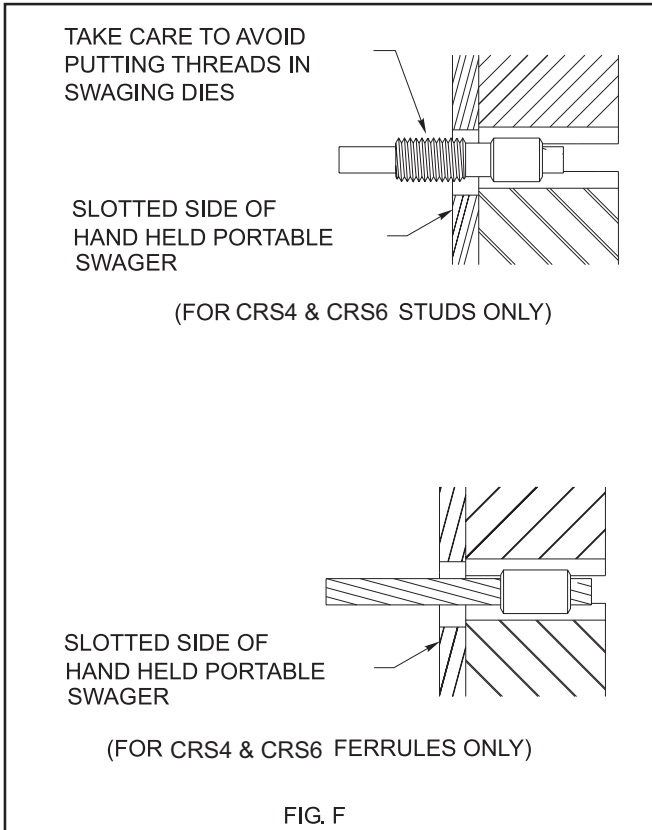
If you are using the Ultra-tec® Model 650 Portable Swager for all sizes of cable, see Figure G below. Make sure the die size you use in the swager is the one marked for the diameter of the cable onto which the fit-

ting is being swaged.

- C. Depress the foot pedal to introduce pressure into the swaging tool. Do not to let the dies close all the way on the first cycle.
- D. Release the foot pedal and apply foot pressure in the opposite direction (this will re-open the dies). Turn the fitting 45 degrees and repeat Step C. Do not let the die close all the way.
- E. Turning the fitting 45 degrees each time, swage the fitting, letting the die close completely at least three more times.

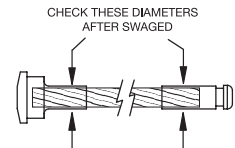
NOTE: When swaging a Stud, the non-threaded end of the Stud should face the end of the cable. When properly swaged, the Ferrule will look like Figure H and the Stud will look like Figure J below after swaging and will slide easily into the body of the fitting.





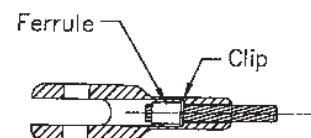
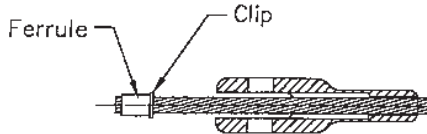
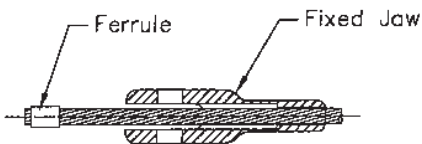
For the Radius Ferrule or Clip-on Stop, use the appropriate "GO" gauge. The swaged Radius Ferrule should fit the slot in the "GO" gauge when properly swaged. If you do not have a "GO" gauge, use calipers to check diameter of the swaged portion of the Radius Ferrule. See the chart below for the correct diameter of the Radius Ferrule after it has been swaged.

Radius Ferrule	Clip-On Stop	For Cable Diameter	Diameter of Swaged Portion of Fitting Should be
CRRF4 or CRRF6	CRCOS4 or CRCOS6	$\frac{1}{8}$ " or $\frac{3}{16}$ "	.250" Max.
CRRF8	NA	$\frac{1}{4}$ "	.375" Max.
CRRF10 or CRRF12	NA	$\frac{5}{16}$ " or $\frac{3}{8}$ "	.500" Max.



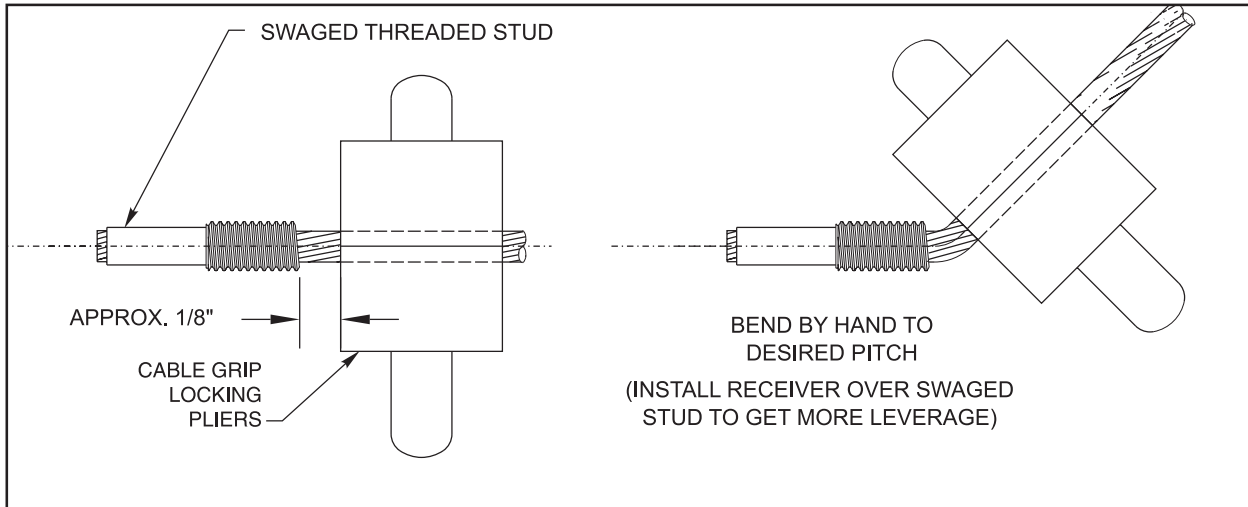
Ultra-tec® "Clip-on" Fixed Jaw Installation Instructions

- Slide Swaged Cable Ferrule end through throat of Fixed Jaw.
- Grasp top of Clip with pliers, and force Clip over Cable immediately behind Ferrule.
- Pull Cable back through throat of Fixed Jaw until it stops. Ferrule is captured inside Fixed Jaw.

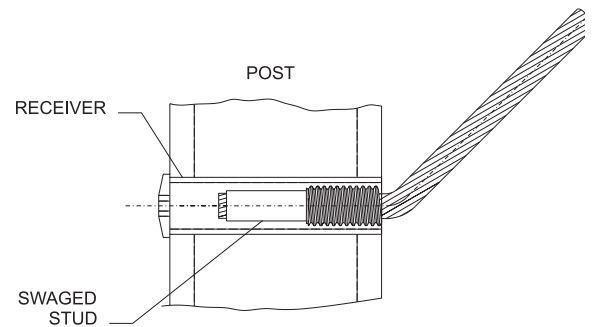


The following instructions illustrate how you can use an INVISIWARE® Receiver and Stud on stairway end posts, without having to drill holes on an angle.

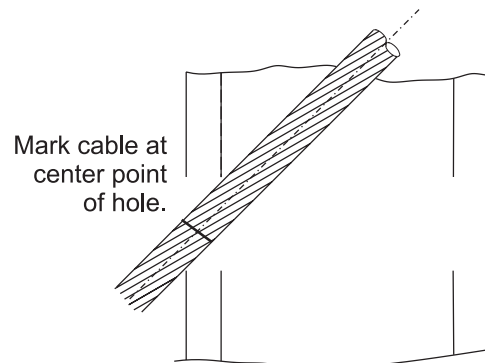
- A. Swage the Stud onto the end of the cable to be installed at the bottom of the stairway. See “Swaging Instructions.”
- B. Grip the cable with cable grip locking pliers approximately 1/8" from the swaged Stud. Screw the Receiver onto the Stud for leverage, and bend the cable by hand to the approximate angle desired. This bend does not have to be precise.



- C. Install the Receiver in the post at the bottom of the stairway, following the instructions in the Installing Cable section for installing INVISIWARE® Receiver at Post A. Make sure the stud is flush with the outside wall of the post. See illustration at right.



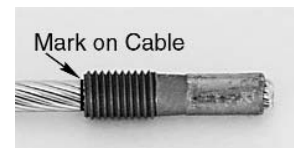
- D. Pull the cable to the hole in the post at the top of the stairway where the Receiver will be installed on the other end of the cable. Mark the cable at the center point of the hole. See illustration at right.



- E. Swage the Stud onto the end of the cable with the threaded end at the mark made in Step D. See “Swaging Instructions” and illustration at right. Cut off any excess cable, leaving a small "tail" out of the end of the Stud.

- F. Bend the cable to the approximate angle desired as done in Step B above. Make sure bends are on the same plane.

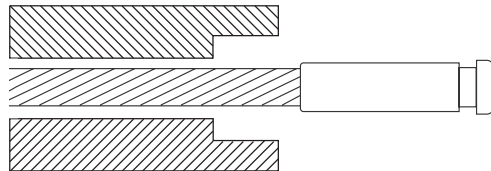
- G. Install the Receiver in the post at the top of the stairway, following the instructions in the Installing Cable section for installing INVISIWARE® Receivers at Post B. When tensioned, the cables will self-align at each end post.



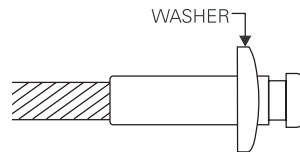
ULTRA-TEC® “CLIP-ON” STOP INSTALLATION INSTRUCTIONS

Feed cables through intermediate posts, and install “Clip-on” Stop first, before installing tensioning end of cable.

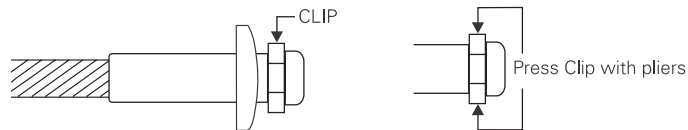
- A. Drill $\frac{17}{64}$ " (.266") hole all the way through the post.
- B. If you wish to countersink the Stop in a wood post, then drill a $\frac{15}{16}$ " (.938") hole to a depth of $\frac{3}{16}$ " in the back side of the post. If you are using steel pipe, see Fabrication Instructions. There should be a $\frac{17}{32}$ " (.531") hole counterbored to a .100" depth, so the full diameter of the Washer will rest on a flat surface in the pipe.
- C. From the inside side of the post, slide the cable through the hole, Stop end first, and out the back side of the post.



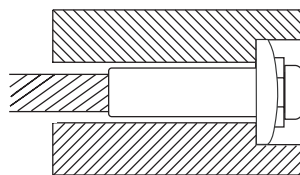
- D. Slide the Washer over body of the Stop.



- E. Force the Clip into the slot in the Stop, and press it in by hand. Press Clip with pliers to secure it in slot.



- F. Pull cable back through the hole, until the Washer stops against the post, with the Clip resting in the recess of the Washer.



- G. Install the hardware on the post at the tensioning end of the cable.

