

X-Line Rigging Manual

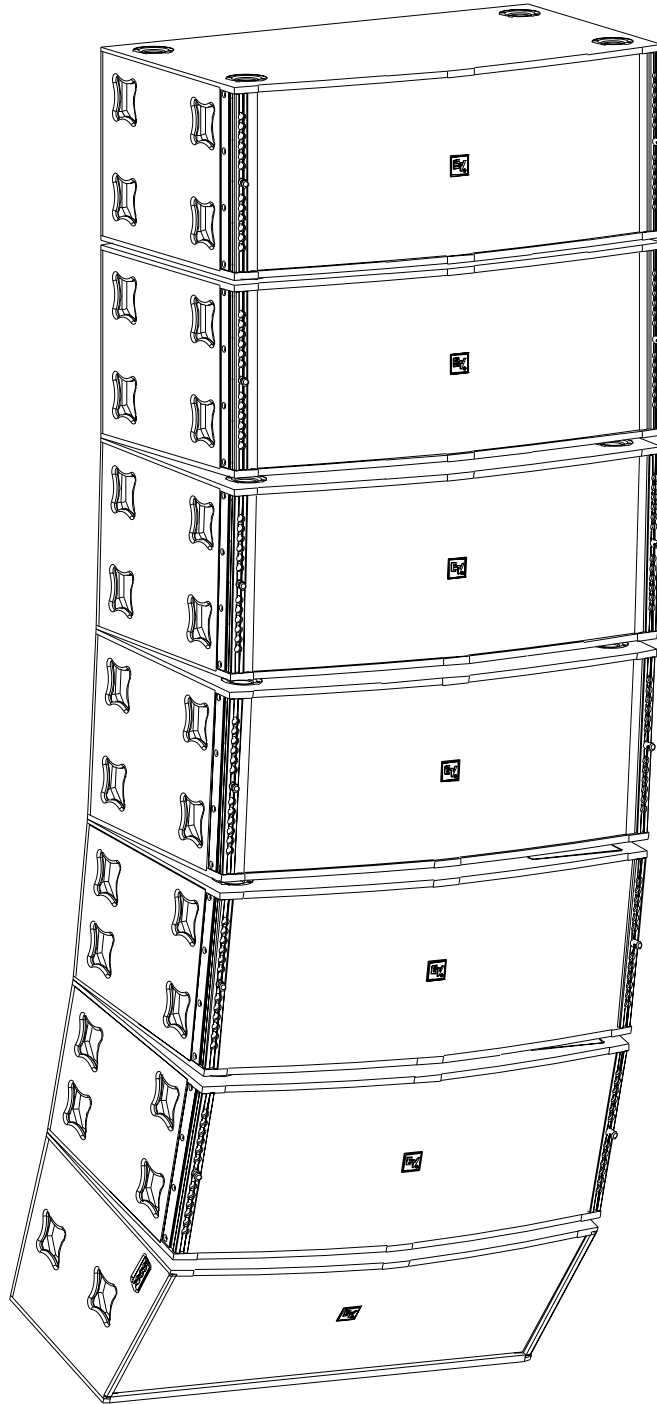


Table of Contents

<i>Rigging-Safety Warning</i>	2
0 <i>Introduction</i>	3
1 <i>X-Line Rigging System</i>	4
1.1 <i>Overview of the X-Line Flying System</i>	4
1.2 <i>Enclosure Rigging Hardware Details</i>	6
1.3 <i>Rear Rigging Hinge Details</i>	10
1.4 <i>Front Rigging Strap Details</i>	13
1.5 <i>Xvbp Pull-Up Bar Details</i>	16
1.6 <i>ATM X-Line Grid Details</i>	17
1.7 <i>RS-1B Double-Stud Rigging Fitting</i>	18
2 <i>X-Line Rigging and Flying Techniques</i>	19
2.1 <i>Array Considerations</i>	19
2.2 <i>Adjusting the Vertical Angles of the Enclosures</i>	19
2.3 <i>Deciding Whether to Use an Xvhg or Xvhl at the Grid</i>	21
2.4 <i>Rigging an Array with Boxes Using X-Line Dollies</i>	22
2.5 <i>Pull-Up Techniques</i>	25
3 <i>Rigging-Strength Ratings, Safety Factors, and Special Safety Considerations</i>	26
3.1 <i>Working-Load Limit (WLL) and Safety Factors</i>	26
3.2 <i>Structural Rating Overview</i>	26
3.3 <i>Simplified Structural-Rating Guidelines</i>	27
3.4 <i>Complex Structural-Rating Analysis</i>	30
3.5 <i>Wind Loading</i>	38
3.6 <i>Electro-Voice Structural-Analysis Procedures</i>	38
4 <i>Rigging Inspection and Precautions</i>	39
<i>References</i>	41
<i>Notes</i>	42

Rigging-Safety Warning



The exclamation point within an equilateral triangle is intended to alert the user to the presence of important operating and maintenance (servicing) instructions in the literature accompanying the product.

This document details general rigging practices appropriate to the entertainment industry, as they would apply to the rigging of Electro-Voice X-Line loudspeaker systems. It is intended to familiarize the reader with standard rigging hardware and techniques for suspending X-Line loudspeaker systems overhead. Only persons with the knowledge of proper hardware and safe rigging techniques should attempt to suspend any sound systems overhead. Prior to suspending any Electro-Voice X-Line loudspeaker systems overhead, it is essential that the user be familiar with the strength ratings, rigging techniques and special safety considerations outlined in this manual. The rigging techniques and practices recommended in this manual are, of necessity, in general terms to accommodate the many variations in loudspeaker arrays and rigging configurations. As such, the user is expressly responsible for the safety of all specific X-Line loudspeaker array designs and rigging configurations as implemented in practice.

All the general rigging material contained in this manual is based on the best available engineering information concerning materials and practices, as commonly recognized in the United States, and is believed to be accurate at the time of the original printing. As such, the information may not be directly applicable in other countries. Furthermore, the regulations and requirements governing rigging hardware and practices may be superseded by local regulations. It is the responsibility of the user to ensure that any Electro-Voice loudspeaker system is suspended overhead in accordance with all current federal, state and local regulations.

All specific material concerning the strength ratings, rigging techniques and safety considerations for the X-Line loudspeaker systems is based on the best available engineering information concerning the use and limitations of the products. Electro-Voice continually engages in testing, research and development of its loudspeaker products. As a result, the specifications are subject to change without notice. It is the responsibility of the user to ensure that any Electro-Voice loudspeaker system is suspended overhead in accordance with the strength ratings, rigging techniques and safety considerations given in this document and any manual update notices. All non-Electro-Voice associated hardware items necessary to rig a complete X-Line loudspeaker array (grids, chain hoists, building or tower supports and miscellaneous mechanical components) are the responsibility of others.

Electro-Voice
July, 2002

0. Introduction

The X-Line loudspeaker systems represent an important step in line-array technology for large-scale sound reinforcement. The individual loudspeaker drivers, acoustic lenses, acoustic waveguides, enclosures and rigging hardware were all designed specifically for the X-Line product line to not only achieve the highest acoustic output with the highest fidelity, but also to produce a precise wavefront from each element to achieve state-of-the-art line-array performance. A brief description of the product line is included below.

Xvls: Three-way, LF/MB/HF loudspeaker system with a 90°H x 5.0°V coverage pattern. The system includes two EVX155Plt 15-inch (381-mm) LF drivers, two ND08 8-inch (203-mm) MB drivers and three ND6-16 3-inch (76-mm) HF drivers. The Xvls utilizes the standard rectangular X-Line shell with rigging, and may be rigged or stacked right-side-up or upside-down for mirror image arrays.

Xvlt: Three-way, LF/MB/HF loudspeaker system with a 120°H x 8.5°V coverage pattern. The system includes two EVX155Plt 15-inch (381-mm) LF drivers, two ND08 8-inch (203-mm) MB drivers and three ND6-16 3-inch (76-mm) HF drivers. The Xvlt utilizes a trapezoidal enclosure with rigging that has the same outside dimensions as the rectangular X-Line shell. The enclosure is trapezoidal in the vertical plane (with a 5.0° total included angle) to minimize space between boxes with greater vertical splay angles. The Xvlt enclosures may be rigged or stacked right-side-up or upside-down for mirror image arrays.

Xsub: Subwoofer loudspeaker system with two EVX180B 18-inch (457-mm) woofers. The Xsub utilizes the standard rectangular X-Line shell with rigging, and may be rigged or stacked right-side-up or upside-down for mirror image arrays.

Xfil1 & Xfil2: Three-way, LF/MB/HF downfill loudspeaker systems with a 120°H x 40°V coverage pattern. The system includes two EVX155 15-inch (381-mm) LF drivers, two ND08 8-inch (203-mm) MB drivers and two ND6-16 3-inch (76-mm) HF drivers. The Xfil1 and Xfil2 utilizes a front-slanted enclosure with rigging that has the same outside dimensions as the rectangular X-Line shell. The enclosure slant allows for maximum downward coverage with a minimum space between it and the enclosure above. The Xfil systems may not be turned upside down so the Xfil1 and Xfil2 are mirror image systems. The Xfil1 has the HF on the right, while the Xfil2 has the HF on the left.

1. X-Line Rigging System

1.1 Overview of the X-Line Flying System

The X-Line loudspeaker systems have been designed to construct acoustic line arrays. Acoustic line arrays typically consist of independent columns of loudspeaker systems. Additional columns are sometimes added to cover different seating sections of a venue. Unlike cluster systems, when multiple line arrays are used, they are physically separated to minimize the acoustic overlap. This simplifies the rigging system.

The X-Line loudspeaker enclosures utilize a hinged rigging system that makes constructing arrays easy, predictable and repeatable. This rigging concept allows arrays to be constructed with minimal spacing between enclosures. The enclosures are hinged at the back corners using rigging hardware specially designed for the X-Line system. Adjustable rigging straps are installed at the front of the enclosure allowing the space between the front corners to be adjusted; hence, adjusting the relative angle between the enclosures.

A basic array is shown in Figure 1 that illustrates the integral components that make up a typical X-Line flying system. All of the flying X-Line loudspeaker systems utilize horizontal rigging-track hardware on the back of the enclosure (at both the top and bottom) and vertical rigging-track hardware on the front of the enclosures (at both the left and right sides).

Figure 1 illustrates an array column suspended with a grid. Like the loudspeaker systems, the grid utilizes horizontal rigging-track hardware at the back and vertical rigging-track hardware at the front like that on the enclosures. The top enclosure is secured to the grid with two quick-release Xvhg grid hinges at the rear, and two quick-release Xvsg short chain rigging straps at the front. The grid hinge has only one possible vertical attachment position on both the enclosure and the grid. The front straps, however, have multiple vertical attachment positions to choose from on the enclosure and one possible vertical attachment position on the grid. The grid hinges allow the enclosure to pivot from its top back corner. The vertical angle of the top enclosure, relative to the grid, is set by the linear position of the front rigging straps in the track on the front of the enclosure and on the grid.

The second enclosure from the top, shown in Figure 1, is linked to the top enclosure with two quick-release Xvhl linking hinges at the rear and two quick-release Xvsl long chain rigging straps at the front. The linking hinges allow the lower enclosure to pivot from the back corner of the top enclosure. The vertical angle of the bottom enclosure, relative to the top enclosure, is set by the linear position of the front rigging straps in the track on the front of the top and bottom enclosures. Additional enclosures may be linked together in the same fashion, as long as the working-load limits for any of the enclosures, rigging hinges or straps are not exceeded. When an Xfil1 or Xfil2 downfill is suspended from the bottom of the array, special-length Xvsd downfill rigging straps are used at the front, while the standard Xvhl linking hinges are used at the rear. An Xvbp pull-up bar may be attached to the rear rigging of the bottom box to adjust the vertical tilt angle of the entire array.

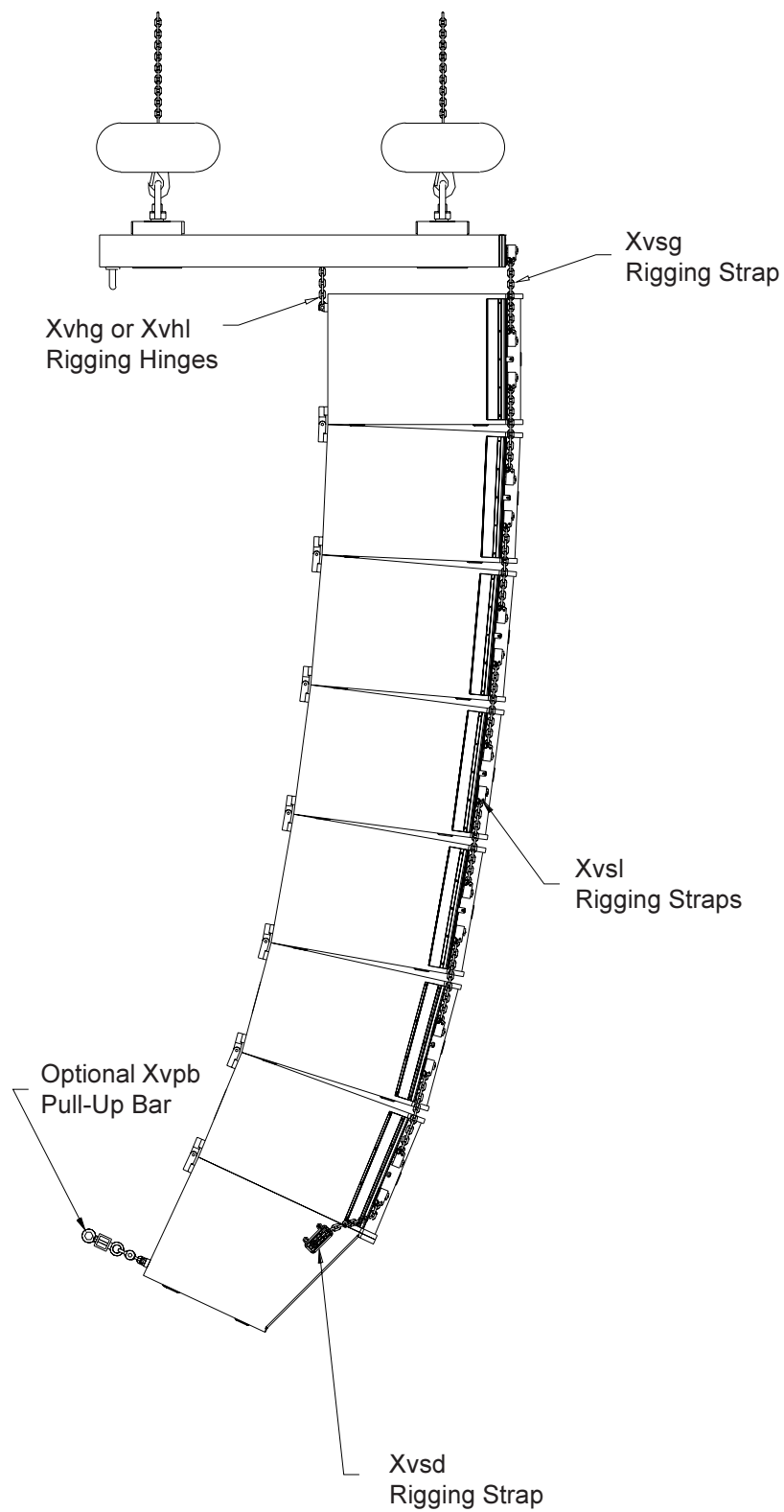


Figure 1:
Typical X-Line Flying System

The grid is suspended by two hoist motors that are attached to two pickup points on the top of the grid – one at the front and one at the back. The two grid pickup points are in line and are adjustable front to back to help distribute the loads between the hoist motors. For smaller arrays (8 boxes or less), two one-ton hoist motors are recommended. For larger arrays (more than 8 boxes), two two-ton hoist motors are recommended. Two one-ton hoist motors can be used; however, the front-to-back distribution of the weight becomes much more critical than with two-ton hoists.



Note that the weight of an array can be quite substantial and the grid, chain hoists and building structural supports used to suspend the array must be capable of supporting such a load with a sufficient safety factor. The reader is directed to References section of this manual for a list of rigging references (for background in general rigging practice) and mechanical engineering references (for background in structural engineering analysis).

1.2 Enclosure Rigging Hardware Details

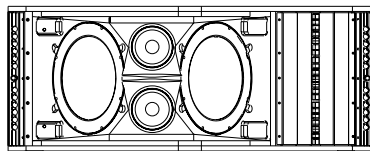
The X-Line loudspeaker systems have rigging at both the front and rear of the enclosures. The Xvls, Xvlt and Xsub systems all have the same rigging hardware on both the front and rear of the enclosures. While the Xfil1 and Xfil2 use the same rigging as the others on the rear of the enclosures, they use different rigging at the front. Figure 2 shows key dimensions, weights and centers of gravity for all of the X-Line loudspeaker systems. Figure 3 shows the enclosure rigging hardware details and key dimensions.

A proprietary high-strength aluminum-alloy track is used at the rear of the enclosures near the top and bottom for the attachment of two Xvhg rigging hinges, two Xvhl rigging hinges, two Xvhp pick-up hinges, or one Xvbp pull-up bar. The track/bracket assembly is extruded as a single piece. One assembly ties into the back and top of the enclosure, while a second assembly ties into the back and bottom of the enclosure. Four high-strength, aluminum-alloy bars inside the enclosure tie the top and bottom track/bracket assemblies together, minimizing the load applied to the enclosure shell. The cutouts in the rear rigging track are shown in Figure 3a and 3b. The large cutout at the end of the track is for inserting the rigging hinges. The small holes in the base of the track are for locking the rigging hinges. The round cutouts are provided so two Electro-Voice RS-1B double-stud swivel-ring fittings may be installed for light-duty lifting applications and for pull-ups. (The track is also compatible with the New Haven NH32102-2 double-stud fittings.)

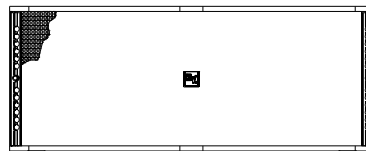
At the front of the Xvls, Xvlt and Xsub enclosures is another pair of proprietary high-strength, aluminum-alloy track/bracket assemblies, which are also extruded as a single piece. One assembly ties into the left side, top, bottom of the enclosure, while a second assembly ties into the right side, top and bottom of the enclosure. The front track extends from the top to the bottom on both sides of the enclosure, eliminating the load applied to the enclosure shell. On both sides of the enclosure, the front rigging track has six cutouts near the top and bottom, as shown in Figure 3c. The triple-stud fittings on the Xvsg and Xvsl chain rigging straps may be installed at any of the cutouts. The relative angle between a pair of enclosures (or the top enclosure and the grid) is set by the position of the front rigging-strap fittings in the track cutouts.

X-Line Xvls 90° x 5°
257 lbs (117 kg)

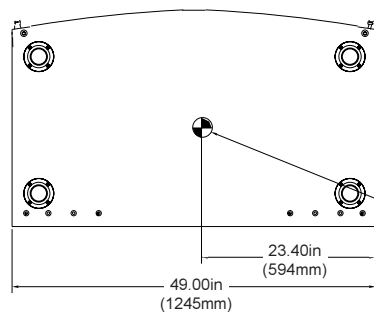
Front View (Without Grille)



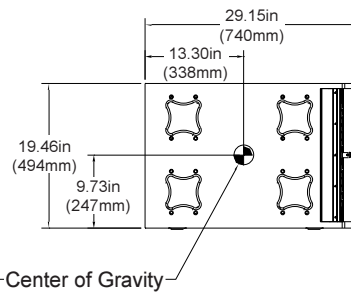
Front View (With Grille)



Bottom View



Side View

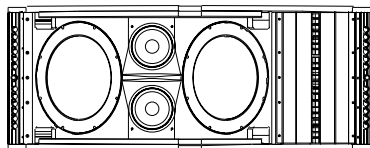


Center of Gravity

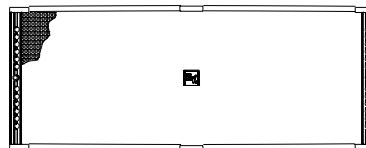
Figure 2a: Xvls Loudspeaker System

X-Line Xvlt 120° x 8.5°
253 lbs (115 kg)

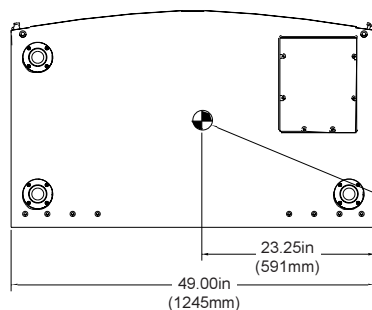
Front View (Without Grille)



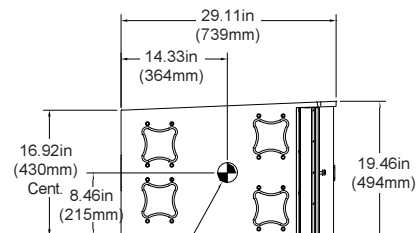
Front View (With Grille)



Bottom View



Side View

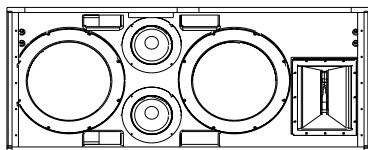


Center of Gravity

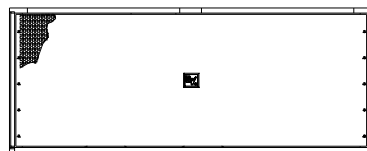
Figure 2b: Xvlt Loudspeaker System

X-Line Xfil1 & Xfil2 120° x 40°
 215 lbs (98 kg)
Xfil1 Shown. Xfil2 is Mirror Image of Xfil1.

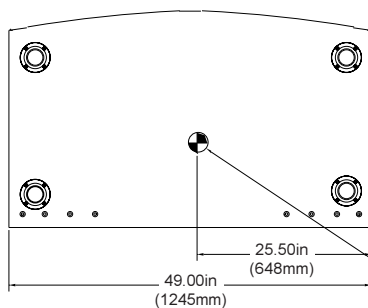
Front View (Without Grille)



Front View (With Grille)



Bottom View



Side View

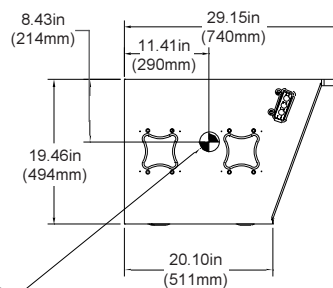
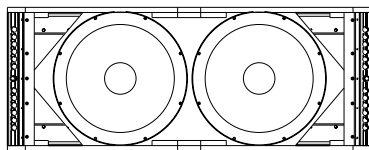


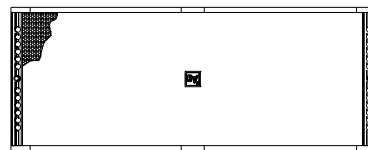
Figure 2c: Xfil1 and Xfil2 Loudspeaker Systems

X-Line Xsub
 202 lbs (92 kg)

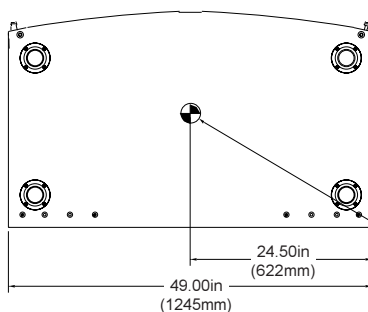
Front View (Without Grille)



Front View (With Grille)



Bottom View



Side View

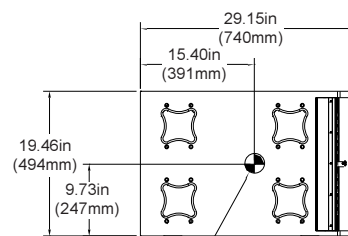


Figure 2d: Xsub Loudspeaker System

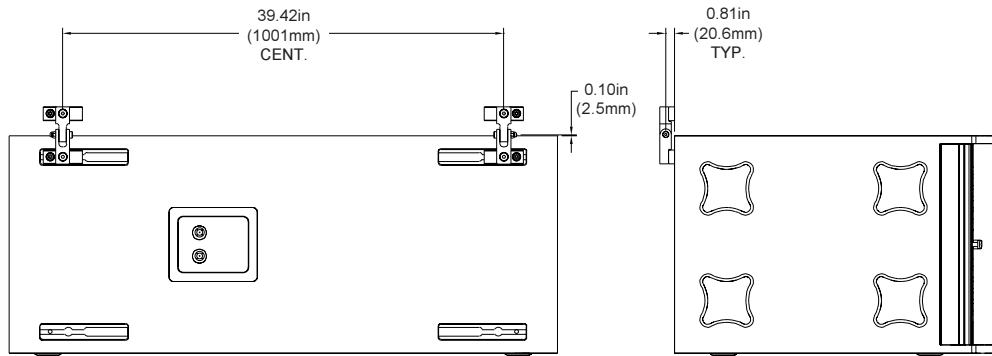


Figure 3a:
Xvls, Xvlt, Xsub, Xfil1 & Xfil2 Rear Rigging with Xvhl Hinges

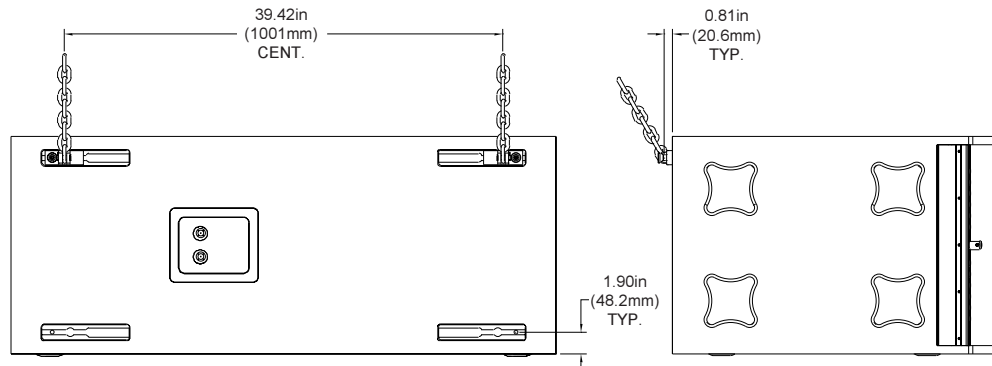


Figure 3b:
Xvls, Xvlt, Xsub, Xfil1 & Xfil2 Rear Rigging with Xvhg or Xvhp Hinges

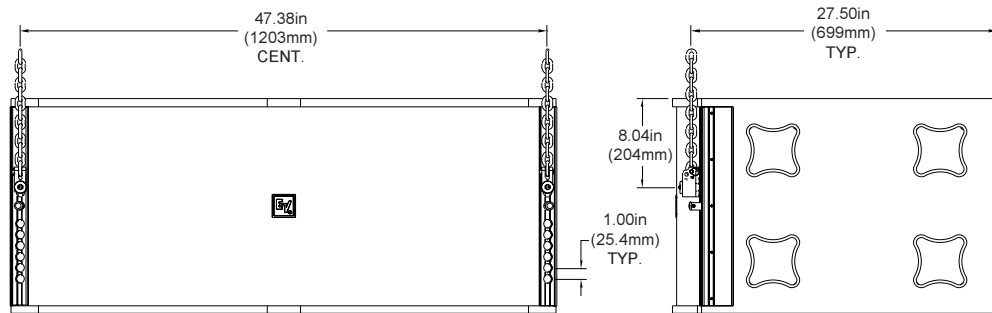


Figure 3c:
Xvls, Xvlt & Xsub Front Rigging with Xvsg, Xvsl Straps or Xvsf Fittings

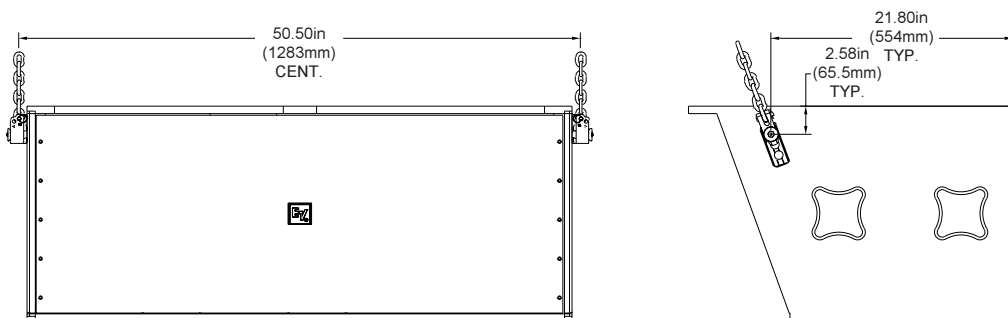


Figure 3d:
Xfil1 & Xfil2 Front Rigging with Xvsd or Xvhp Straps

The Xfil1 and Xfil2 enclosures use a slightly different rigging track arrangement at the front. In this case, another pair of proprietary high-strength, extruded aluminum-alloy track/bracket assemblies are mounted on the sides of the enclosure near the front, as shown in Figure 3d. Unlike the other models, there is only one rigging attachment position on these extrusions.

To facilitate the installation and removal of the linking hinges, alignment feet are installed on the top and bottom of the X-Line enclosures. Male feet (protruding feet) are located on the bottom of the enclosures, while female feet (concave dishes) are located on the top. When one enclosure is stacked or lowered on top of another, the male feet on the bottom of the upper enclosure slide into the female feet on the top of the lower enclosure, automatically aligning the enclosures. If the enclosures do not self align, a light side-ways push is all that is needed to make the feet engage and align. These features allow fast assembly and disassembly of large loudspeaker arrays in touring applications.

1.3 Rear Rigging Hinge Details

Figure 4 shows the X-Line external rigging hardware details and key dimensions.

Xvhg Grid Hinge: Two Xvhg grid hinges can be used to attach the back of an X-Line enclosure to the back of an X-Line-compatible grid. Each grid hinge consists of two precision-machined steel bases connected by an alloy-steel chain, as shown in Figure 4. Each grid-hinge base has a locking pin that locks the hinge in place horizontally in the track on the grid or X-Line enclosure.

The Xvhg grid rigging hinges need not be installed in the top enclosure and the grid simultaneously. The length of chain allows the grid hinges to be installed in the grid first. The grid can then be floated above the top enclosure while the other ends of the grid hinges are installed in the track at the rear of the enclosures. The grid hinges must be installed with the hinge bases located at the outside of the track towards the sides of the enclosure as shown in Figure 5 with the locking pins on the fittings located next to the sides of the enclosure.

To install an Xvhg grid hinge into the track of an enclosure, grasp one of the hinge bases and firmly insert it into the long cutout in the track, pressing in until the spring-loaded locking pin is fully retracted. Then apply pressure to slide the hinge base sideways towards the end of the track until the spring-loaded locking pin drops into the hinge-locking-pin hole in the base of the track. Once the locking pin is fully engaged, the grid hinge base will be immovable in the track. Use the same technique for installing the other end of the Xvhg grid hinge in the track at the rear of the grid. The user must be careful not to insert a twist in the chain when installing the second end. A twist will result in the grid hinge assembly being shorter and will introduce excessive forces in the chain.



ALWAYS CHECK TO MAKE SURE THAT THE GRID HINGE BASES ARE INSTALLED IN THE CORRECT ORIENTATION WITH THE HINGES AT THE OUTSIDE EDGES OF THE TRACK. ALWAYS CHECK TO MAKE SURE THE GRID-HINGE BASES ARE SECURELY LOCKED INTO THE TRACK, THAT THE LOCKING PINS ARE FULLY ENGAGED IN THE TRACK AND THAT THERE IS NOT A TWIST IN THE CHAIN BEFORE LIFTING ANY LOUDSPEAKER ENCLOSURES OVERHEAD.

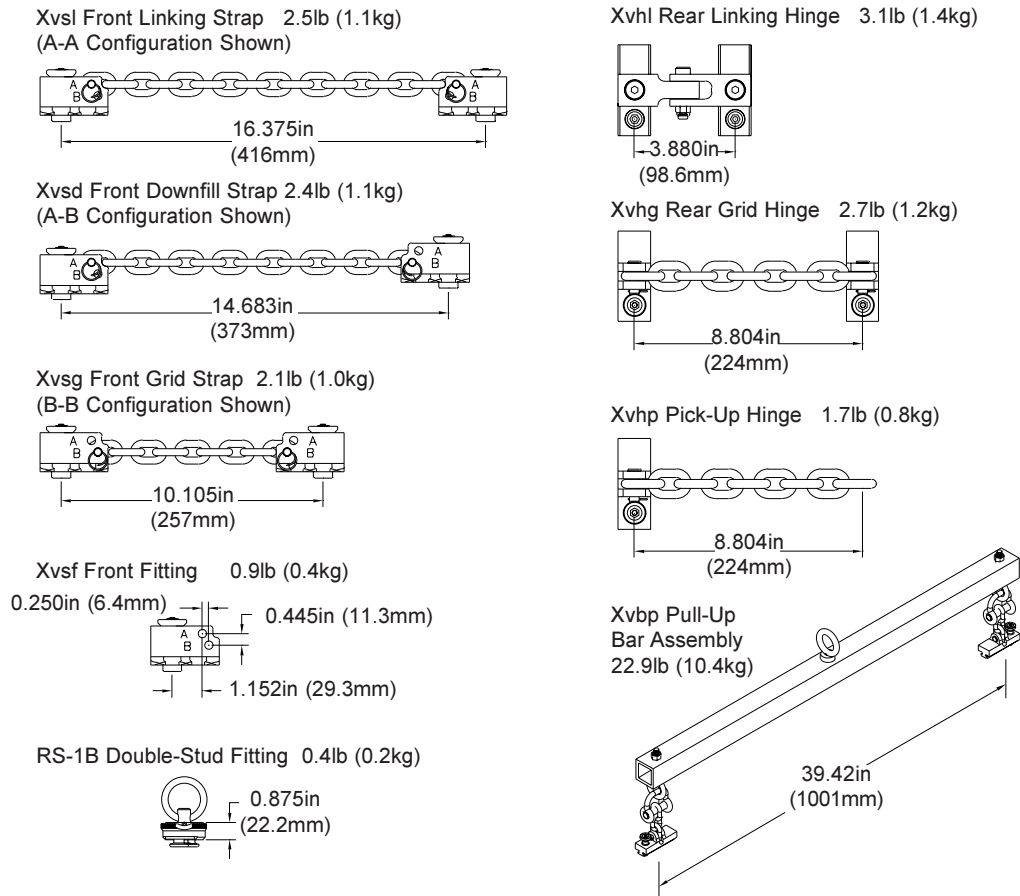


Figure 4:
External Rigging Hardware Details

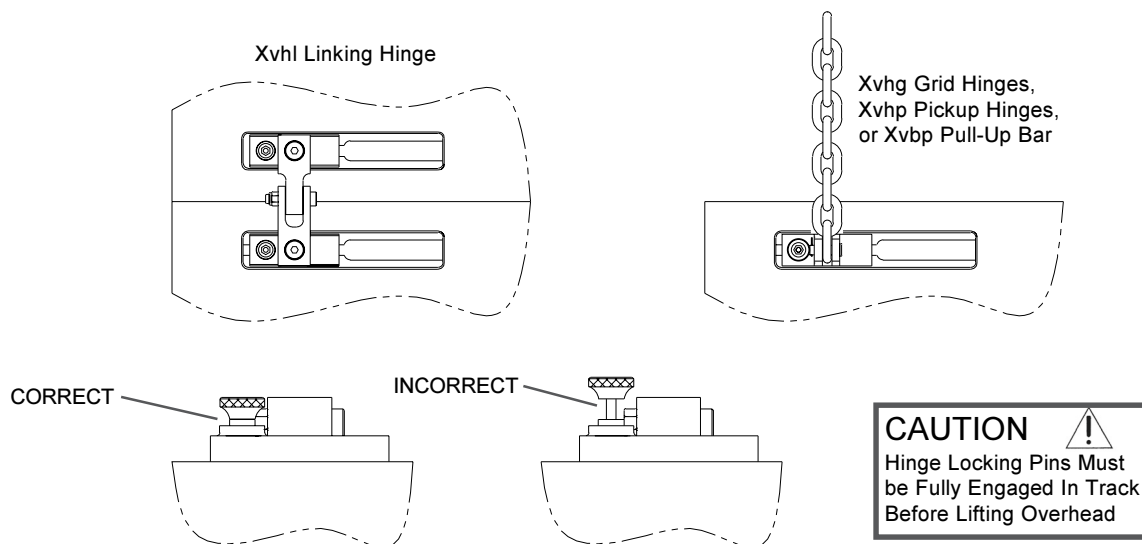


Figure 5:
Rear Rigging Hardware Installation Details

To remove the Xvhg grid hinge, grasp the locking-pin knob and pull out while applying pressure on the hinge to slide the hinge base toward the long cutout at the end of the track. The hinge base will come out of the track once it is aligned with the cutout. For added safety, the locking pin has a special shape that engages with the track to prevent it from vibrating out of the track hole during use. If the locking-pin knob seems difficult to pull out when removing the hinge, wiggle the hinge base while pulling out on the knob. When the hinge locking pin is centered in the track hole, the pin will easily release.

Xvhl Linking Hinge: Two Xvhl linking hinges are used to link a pair of X-Line enclosures together. In addition, two Xvhl hinges may be used to attach the top cabinet of an array to a grid. Each linking hinge consists of two precision-machined steel bases connected by a heavy-duty steel hinge, as shown in Figure 4. The hinge arms pivot, allowing the enclosures to pivot at their back corners. Each linking-hinge base has a locking pin that locks the hinge in place horizontally in the rear track of the enclosure.

An Xvhl linking hinge must be installed in the top and bottom enclosures simultaneously. The linking hinges must be installed with the hinge bases located at the outside of the track towards the sides of the enclosure as shown in Figure 5 with the locking pins on the fittings located next to the sides of the enclosure.

To install an Xvhl into the track of a pair of enclosures stacked one on top of the other, grasp both of the hinge bases and firmly insert both of the hinge bases simultaneously into the long cutouts in the track of both enclosures, pressing in until both spring-loaded locking pins are fully retracted. Then apply pressure to slide the hinge bases sideways towards the end of the track until both spring-loaded locking pins drop into the hinge-locking-pin holes in the base of the track on both enclosures. Once the locking pins are fully engaged, the linking hinge bases will be immovable in the track.



ALWAYS CHECK TO MAKE SURE THAT THE LINKING HINGE BASES ARE INSTALLED IN THE CORRECT ORIENTATION WITH THE HINGES AT THE OUTSIDE EDGES OF THE TRACK. ALWAYS CHECK TO MAKE SURE THE LINKING HINGE BASES ARE SECURELY LOCKED INTO THE TRACK, AND THAT THE LOCKING PINS ARE FULLY ENGAGED IN THE TRACK BEFORE LIFTING ANY LOUDSPEAKER ENCLOSURES OVERHEAD.

To remove the Xvhl linking hinge, grasp both of the locking-pin knobs and pull out while applying pressure on the hinge to slide the hinge base toward the long cutout in the track. The hinge base will come out of the track once it is aligned with the cutout. Like the grid hinge, the locking pin has a special shape that engages with the track to prevent it from vibrating out of the track hole during use. If the locking-pin knob seems difficult to pull out when removing the hinge, wiggle the hinge base while pulling out on the knob. When the hinge locking pin is centered in the track hole, the pin will easily release.

Xvhp Pick-Up Hinge: Two Xvhp pick-up hinges can be used to attach the back of an X-Line enclosure directly to a building structure or to a grid assembly that is not compatible with the X-Line rigging track. Each grid hinge consists of a single precision-machined steel base with an alloy-steel chain, as shown in Figure 4. The hinge base is identical to that on the Xvhg grid hinge. Each grid-hinge base has a locking pin that locks the hinge in place horizontally in the track on the grid or X-Line enclosure. A 3/8-inch shackle can be attached to the end of the chain.

The grid hinges must be installed with the hinge bases located at the outside of the track towards the sides of the enclosure as shown in Figure 5 with the locking pins on the fittings located next to the sides of the enclosure.

To install an Xvhp pick-up hinge into the track of an enclosure, grasp the hinge base and firmly insert it into the long cutout in the track, pressing in until the spring-loaded locking pin is fully retracted. Then apply pressure to slide the hinge base sideways towards the end of the track until the spring-loaded locking pin drops into the hinge-locking-pin hole in the base of the track. Once the locking pin is fully engaged, the grid hinge base will be immovable in the track.



ALWAYS CHECK TO MAKE SURE THAT THE PICK-UP HINGE BASES ARE INSTALLED IN THE CORRECT ORIENTATION WITH THE HINGES AT THE OUTSIDE EDGES OF THE TRACK. ALWAYS CHECK TO MAKE SURE THE PICK-UP HINGE BASES ARE SECURELY LOCKED INTO THE TRACK, AND THAT THE LOCKING PINS ARE FULLY ENGAGED IN THE TRACK BEFORE LIFTING ANY LOUDSPEAKER ENCLOSURES OVERHEAD.

To remove the Xvhp pick-up hinge, grasp the locking-pin knob and pull out while applying pressure on the hinge to slide the hinge base toward the long cutout at the end of the track. The hinge base will come out of the track once it is aligned with the cutout. For added safety, the locking pin has a special shape that engages with the track to prevent it from vibrating out of the track hole during use. If the locking-pin knob seems difficult to pull out when removing the hinge, wiggle the hinge base while pulling out on the knob. When the hinge locking pin is centered in the track hole, the pin will easily release.

1.4 Front Rigging Strap Details

The Xvsg, Xvsl, and the Xvsd chain rigging strap, shown in Figure 4, are identical except for their length. Figure 4 shows the X-Line external rigging hardware details and key dimensions.

Xvsg Grid Strap: Two Xvsg grid straps are used to attach the front of the top enclosure to an X-Line-compatible grid. Each grid strap consists of two rigging fittings connected by an alloy-steel chain. The Xvsg has the shortest chain of the three front rigging straps to minimize the space between that the top enclosure and the grid. Each fitting is a proprietary triple-stud fitting that has a large steel locating plunger. The plunger not only locates in the round cutouts in the track, but also extends into the base of the track for extra strength.

To install the Xvsg triple-stud fittings in the enclosure rigging track, grasp the fitting with one hand and pull the spring-loaded safety locking pin out with your free hand. Continue to pull until the locking pin retracts above the three stud feet of the fitting. Insert the three round feet on the end of the fitting into the round cutouts in the track and slide the fitting to the desired position. Center the locking pin of the fitting over one of the track cutouts. Release the locking pin. The pin should extend beyond the bottom of the fitting and should lock into the round recess in the base of the track with the locking pin retracting to its normal position. If the pin does not lock into the base of track, nudge it along the track and wiggle as necessary until it settles into position. When locked, the fitting will be immovable in the track. The user must be careful not to insert a twist in the chain when installing the second end. A twist will result in the grid hinge assembly being shorter and will introduce excessive forces in the chain.

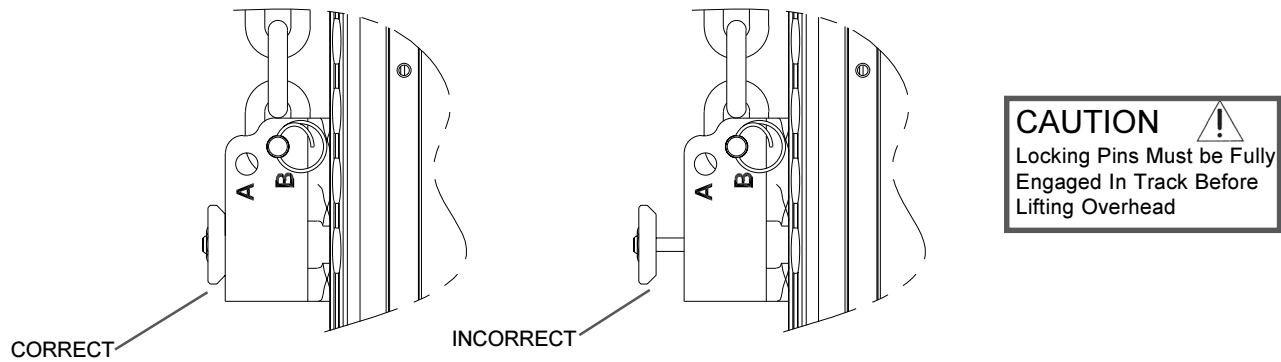


Figure 6:
Front Rigging Hardware Installation Details



ALWAYS CHECK TO MAKE SURE THAT THE GRID STRAP FITTING IS SECURELY LOCKED INTO THE TRACK, THAT THE LOCKING PIN IS FULLY SEATED INTO THE BASE OF THE TRACK AND THAT THERE IS NO TWIST IN THE CHAIN BEFORE LIFTING ANY LOUDSPEAKER ENCLOSURE OVERHEAD.

To remove the Xvsg grid strap, grasp the locking-pin knob and pull out while applying pressure on the hinge to slide the hinge base along the track. The three stud feet will come out of the track once they are aligned with the track cutouts. For added safety, the locking pin has a special shape that engages with the track to prevent it from vibrating out of the track hole during use. If the locking-pin knob seems difficult to pull out when removing the hinge, wiggle the fitting while pulling out on the knob. When the fitting locking pin is centered in the track hole, the pin will easily release.

Xvsl Linking Strap: Two Xvsl linking straps are used to link a pair of X-Line enclosures together. Each linking strap consists of two rigging fittings connected by an alloy-steel chain. The Xvsl has the longest chain of the three front rigging straps to allow maximum adjustability between the enclosures. Each fitting is a proprietary triple-stud fitting that has a large steel locating plunger. The plunger not only locates in the round cutouts in the track, but also extends into the base of the track for extra strength.

To install the Xvsl triple-stud fittings in the enclosure rigging track, grasp the fitting with one hand and pull the spring-loaded safety locking pin out with your free hand. Continue to pull until the locking pin retracts above the three stud feet of the fitting. Insert the three round feet on the end of the fitting into the round cutouts in the track and slide the fitting to the desired position. Center the locking pin of the fitting over one of the track cutouts. Release the locking pin. The pin should extend beyond the bottom of the fitting and should lock into the round recess in the base of the track with the locking pin retracting to its normal position as shown in Figure 6. If the pin does not lock into the base of track, nudge it along the track and wiggle as necessary until it settles into position. When locked, the fitting will be immovable in the track. The user must be careful not to insert a twist in the chain when installing the second end. A twist will result in the linking hinge assembly being shorter and will introduce excessive forces in the chain.



ALWAYS CHECK TO MAKE SURE THAT THE LINKING STRAP FITTING IS SECURELY LOCKED INTO THE TRACK, THAT THE LOCKING PIN IS FULLY SEATED INTO THE BASE OF THE TRACK AND THAT THERE IS NO TWIST IN THE CHAIN BEFORE LIFTING ANY LOUDSPEAKER ENCLOSURE OVERHEAD.

To remove the Xvsl linking strap, grasp the locking-pin knob and pull out while applying pressure on the hinge to slide the hinge base along the track. The three stud feet will come out of the track once they are aligned with the track cutouts. For added safety, the locking pin has a special shape that engages with the track to prevent it from vibrating out of the track hole during use. If the locking-pin knob seems difficult to pull out when removing the hinge, wiggle the fitting while pulling out on the knob. When the locking pin on the fitting is centered in the track hole, the pin will easily release.

Xvsd Downfill Strap: Two Xvsd downfill straps are used to attach an Xfil1 or Xfil2 downfill enclosure below any of the other X-Line enclosures. Each downfill strap consists of two rigging fittings connected by an alloy-steel chain. The Xvsd chain is shorter than that of the Xvsl and longer than that of the Xvsg. Each fitting is a proprietary triple-stud fitting that has a large steel locating plunger. The plunger not only locates in the round cutouts in the track, but also extends into the base of the track for extra strength.

To install the Xvsd triple-stud fittings in the enclosure rigging track, grasp the fitting with one hand and pull the spring-loaded safety locking pin out with your free hand. Continue to pull until the locking pin retracts above the three stud feet of the fitting. Insert the three round feet on the end of the fitting into the round cutouts in the track and slide the fitting to the desired position. Center the locking pin of the fitting over one of the track cutouts. Release the locking pin. The pin should extend beyond the bottom of the fitting and should lock into the round recess in the base of the track with the locking pin retracting to its normal position as shown in Figure 6. If the pin does not lock into the base of track, nudge it along the track and wiggle as necessary until it settles into position. When locked, the fitting will be immovable in the track. Although it is normal for the chain of the Downfill strap to wrap around the side of the enclosures, the user must be careful not to insert a twist in the chain when installing the second end. A twist will result in the downfill hinge assembly being shorter and will introduce excessive forces in the chain.



ALWAYS CHECK TO MAKE SURE THAT THE DOWNFILL STRAP FITTING IS SECURELY LOCKED INTO THE TRACK, THAT THE LOCKING PIN IS FULLY SEATED INTO THE BASE OF THE TRACK AND THAT THERE IS NO TWIST IN THE CHAIN BEFORE LIFTING ANY LOUDSPEAKER ENCLOSURE OVERHEAD.

To remove the Xvsd linking strap, grasp the locking-pin knob and pull out while applying pressure on the hinge to slide the hinge base along the track. The three stud feet will come out of the track once they are aligned with the track cutouts. For added safety, the locking pin has a special shape that engages with the track to prevent it from vibrating out of the track hole during use. If the locking-pin knob seems difficult to pull out when removing the hinge, wiggle the fitting while pulling out on the knob. When the fitting locking pin is centered in the track hole, the pin will easily release.

Xvsf Rigging Fitting: Two Xvsf rigging fittings can be used to attach the front of an X-Line enclosure directly to a building structure or to a grid assembly that is not compatible with the X-Line rigging track. The fitting is a proprietary triple-stud fitting that has a large steel locating plunger. The plunger not only locates in the round cutouts in the track, but also extends into the base of the track for extra strength. A 3/8-inch shackle can be attached to the end of the chain.

To install the Xvsf triple-stud fittings in the enclosure rigging track, grasp the fitting with one hand and pull the spring-loaded safety locking pin out with your free hand. Continue to pull until the locking pin retracts above the three stud feet of the fitting. Insert the three round feet on the end of the fitting into the round cutouts in the track and slide the fitting to the desired position. Center the locking pin of the fitting over one of the track cutouts. Release the locking pin. The pin should extend beyond the bottom of the fitting and should lock into the round recess in the base of the track with the locking pin retracting to its normal position as shown in Figure 6. If the pin does not lock into the base of track, nudge it along the track and wiggle as necessary until it settles into position. When locked, the fitting will be immovable in the track.



ALWAYS CHECK TO MAKE SURE THAT THE FITTING IS SECURELY LOCKED INTO THE TRACK, AND THAT THE LOCKING PIN IS FULLY SEATED INTO THE BASE OF THE TRACK BEFORE LIFTING ANY LOUDSPEAKER ENCLOSURE OVERHEAD.

To remove the Xvsf rigging fitting, grasp the locking-pin knob and pull out while applying pressure on the hinge to slide the hinge base along the track. The three stud feet will come out of the track once they are aligned with the track cutouts. For added safety, the locking pin has a special shape that engages with the track to prevent it from vibrating out of the track hole during use. If the locking-pin knob seems difficult to pull out when removing the hinge, wiggle the fitting while pulling out on the knob. When the fitting locking pin is centered in the track hole, the pin will easily release.

1.5 Xvbp Pull-Up Bar Details

The Xvbp pull-up bar is used at the bottom of an array in instances where more vertical splay is needed between cabinets than gravity allows, or when the entire array needs to be angled down more than gravity allows. The bar is attached to the bottom cabinet of an array and a nylon or polyester ratchet strap is connected between the center eye ring of the Xvbp and the grid suspending the array. Once the array is floated in the air, the ratchet strap may be tightened to remove the slack from the front linking straps and achieve the desired splay angles. The ratchet strap will be provided by the user and must have a working-load rating of 2000 pounds (907 kg).

The Xvbp consists of a bar with two hinge base fittings at the outside edges of the bar as shown in Figure 4. These fittings utilize the same rigging attachment base that is used on the Xvhg grid hinge. The pull-up-bar hinge bases must be installed with the hinge bases located at the outside of the track towards the sides of the enclosure as shown in Figure 5 with the locking pins on the fittings located next to the sides of the cabinet.



ALWAYS CHECK TO MAKE SURE THAT THE PULL-UP-BAR HINGE BASES ARE INSTALLED WITH THE CORRECT ORIENTATION WITH THE HINGES AT THE OUTSIDE EDGES OF THE TRACK. ALWAYS CHECK TO MAKE SURE THE PULL-UP-BAR HINGE BASES ARE SECURELY LOCKED INTO THE TRACK, AND THAT THE LOCKING PINS ARE FULLY ENGAGED IN THE TRACK BEFORE LIFTING ANY LOUDSPEAKER ENCLOSURES OVERHEAD. WHEN PULLING BACK WITH A PULL-UP ASSEMBLY, ONLY USE ENOUGH FORCE TO ELIMINATE THE SLACK FROM THE FRONT CHAINS. IF Xvhi LINKING HINGES ARE USED TO SECURE THE TOP ENCLOSURE TO THE REAR OF THE GRID, NEVER ALLOW THESE HINGES TO GO INTO COMPRESSION. IF Xvhg GRID HINGES ARE USED TO SECURE THE TOP ENCLOSURE TO THE REAR OF THE GRID, NEVER ALLOW THESE HINGES TO GO SLACK. IF FRONT AND BACK HOIST MOTORS ARE USED TO SUSPEND THE GRID, NEVER ALLOW THE REAR MOTOR TO GO SLACK.

1.6 ATM X-Line Grid Details

ATM Flyware manufactures the X-Line Grid, shown in Figure 7, specifically for the X-Line loudspeaker systems. The grid is completely compatible with the X-Line systems. There is rigging track on the front of the grid that matches the track on the front of the X-Line enclosures - with the exception that there is only one attachment position on the grid instead of six as on the enclosure. The Electro-Voice Xvsg front chain rigging straps are used to attach the front of the top enclosure in a column to the grid.

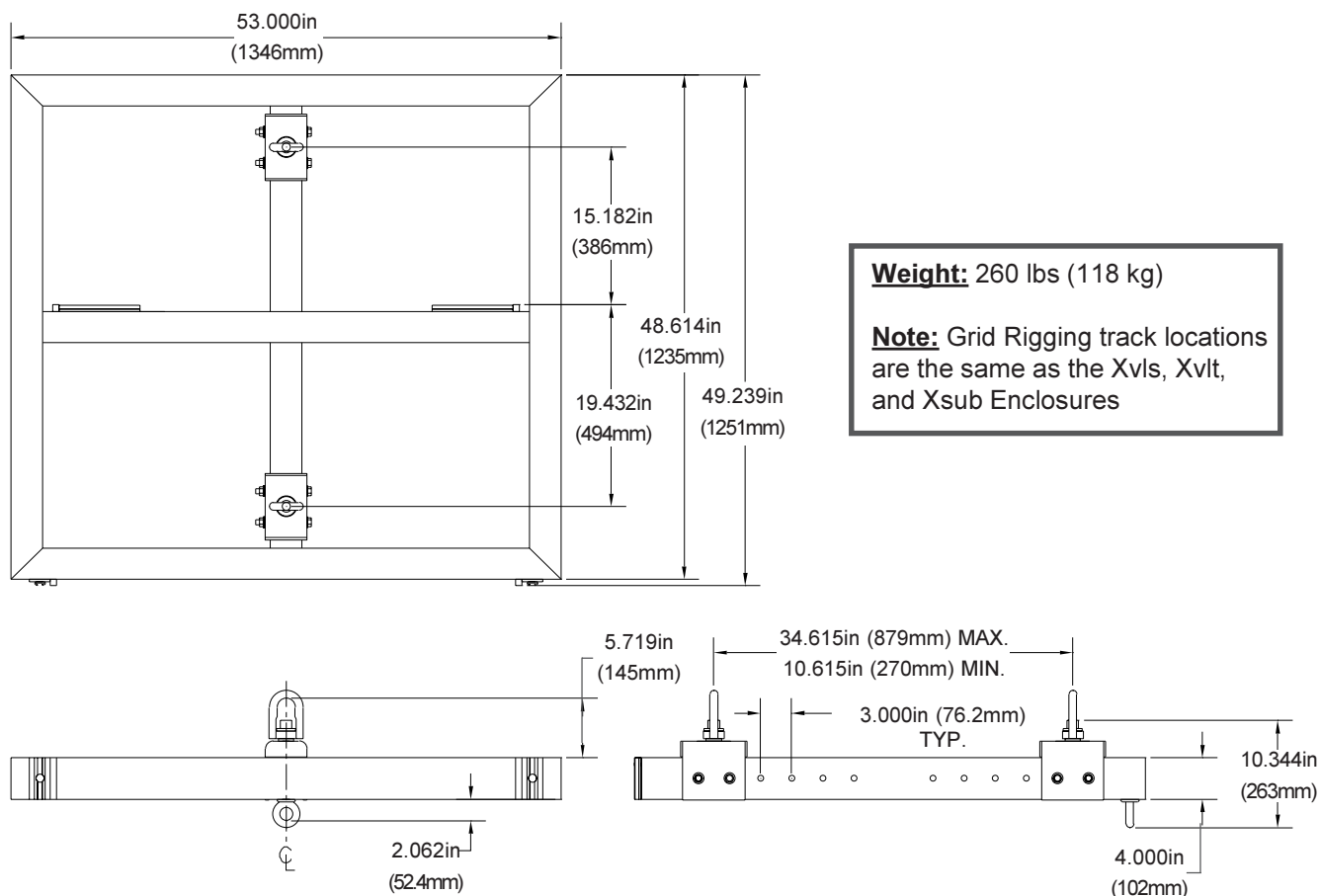


Figure 7:
ATM Flyware X-Line Grid

The grid also has rigging track on the middle crossbar that runs side to side that matches the track on the rear of the enclosures. Either the Electro-Voice Xvhg grid hinge or the Xvhl linking hinge may be used to attach the rear of the top box to the grid. There is a pad eye on the bottom of the rear crossbar of the grid that may be used for an optional pull-up from the bottom enclosure.

The grid is suspended over head by attaching two hoist motors to the two swivel rings on the top of the grid. The swivel rings are mounted on hangers that are in turn attached to the center bar of the grid that runs front to back. These hangers can be secured to the center bar at different locations. Changing the position of these hangers adjusts the load on the front and back hoist motors suspending the grid.

The ATM Flyware X-Line Grid was designed to suspend a column of X-Line loudspeakers with a maximum weight of 3400 pounds (1542 kg). When using the grid, always follow the manufacturer's instruction, recommendations and safety precautions, and never exceed any structural limits specified by ATM Flyware.

1.7 RS-1B Double-Stud Rigging Fitting

For special lightweight applications, the Electro-Voice RS-1B double-stud swivel-ring fitting (shown in Figure 4) may be useful for rigging X-Line loudspeaker enclosures. (The RS-1B is similar to the New Haven NH32102-2 double-stud swivel-ring fitting.) This fitting may be used on custom wire-rope assemblies for attachment to either the front or the rear of the enclosure. The reader is cautioned that the standard double-stud fittings ARE NOT AS STRONG as the Xvsl, Xvsg, Xvsd or Xvsf front rigging or the Xvhp, Xvhg and Xvhl rigging hinges. (See Section 3. Rigging Strength-Ratings, Safety Factors and Special Considerations for a detailed discussion of the structural strength of the RS-1B fittings and the rigging hinges.)

RS-1B fittings would most commonly be used for a pull-up assembly for a column of X-Line. Attach two RS-1B fittings to the rear rigging track on the back of the bottom enclosure. Attach a ratchet strap to the grid for the pull up. Then create a bridle between the two RS-1B fittings that is attached to the ratchet strap. This assembly should only be used for columns of eight enclosures or less. For larger arrays, use the Xvbp pull-up bar.

To attach the double-stud swivel-ring fittings to the enclosure rigging track, grasp the fitting between the thumb and first two fingers. Push in the spring-loaded safety locking pin with your free hand and lift the outer locking ring over the pin by pressing with your thumb. Continue to press with your thumb until the two legs of the fitting are fully exposed. Insert the two round feet on the end of the legs into the round cutouts in the track and slide the fitting to the desired position. Center the main body of the fitting over one of the track cutouts, with the feet located on either side (i.e., the feet positioned directly under the teeth of the track). Release the outer locking ring. The round protrusion on the bottom of the fitting should lock into the round cutout in the track, with the locking ring retracting to its normal position, allowing the safety pin to reappear and extend over the locking ring. If the fitting does not lock into the track, nudge it along the track and wiggle as necessary until it settles into position. If the outer locking ring does not fully re-tract, push the ring towards the track until the safety pin reappears and extends over the locking ring. When locked, the fitting will be immovable in the track and the locking ring of the fitting may not be lifted. To remove the fitting, reverse the procedure.



ALWAYS CHECK TO MAKE SURE THAT THE DOUBLE-STUD FITTING IS SECURELY LOCKED INTO THE TRACK, AND THAT THE SAFETY PIN IS EXTENDED OVER THE LOCKING RING BEFORE LIFTING ANY LOUDSPEAKER ENCLOSURE OVERHEAD.

2. X-Line Rigging and Flying Techniques

2.1 Array Considerations

The X-Line loudspeaker systems have been specifically designed to construct acoustic line-arrays. Line-array systems typically consist of independent columns of loudspeaker systems. The most common implementation would be a stereo sound reinforcement system with two columns (left and right). Additional columns of loudspeakers are sometimes added to cover different seating sections of a venue – seating areas that wrap around the side or back of a stage, for example.

Vertical line arrays typically consist of several Xvls 90°H x 5°V systems at the top, followed by several Xvlt 120°H x 8.5°V systems below. The exact number of Xvls and Xvlt loudspeaker systems in a column will vary depending on the vertical acoustic coverage required for the specific venue. Furthermore, the relative vertical angles between the boxes will also depend on the venue acoustic coverage requirements. When acoustic coverage is required immediately below the array, a single Xfil1 or Xfil2 downfill enclosure can be added at the very bottom of the array. (Acoustic design techniques are outside the scope of this document and the reader is directed to the X-Line modeling software available from the Electro-Voice website for acoustic design assistance.) It is also possible to construct subwoofer line arrays using the Xsub systems.

From Figure 2, the reader will note that X-Line full-range systems are not symmetrical left to right. When constructing a line-array column, it is essential that all Xvls, Xvlt, Xfil1 and Xfil2 enclosures are hung so that the high-frequency sections are all in a vertical straight line. In a stereo sound reinforcement application, the best results are achieved when the boxes in the left and right arrays are oriented so that the high-frequency sections are onstage (i.e., together towards the middle of the venue), making the left and right arrays a perfect mirror image. This requires that the Xvls and Xvlt loudspeaker systems on the house-right side be turned upside down. The grilles on the Xvls and Xvlt boxes on the house-right side array should be rotated so a consistent appearance is maintained between the left and right sides.

Because the downfill boxes cannot be turned upside down, the Xfil1 and Xfil2 loudspeaker systems have been designed as a mirror image pair. Thus, in a stereo system, the Xfil1 would be used at the bottom of the house-left side array, while the Xfil2 would be used on bottom of the house-right side array.

2.2 Adjusting the Vertical Angles of the Enclosures

The vertical angle of an enclosure may be adjusted relative to the enclosure immediately above by choosing different attachment locations for the front linking straps in the enclosure track. The locating holes in the enclosure rigging track are spaced 1.00 inch (25.4 mm) apart. Moving the attachment position one hole results in a 2° change in the enclosure vertical angle. However, angle adjustments of 0.5° are possible.

Each triple-stud fitting on the Xvsg, Xvsl and Xvsd front straps is attached to the chain with a pin that passes through a hole on the fitting and through the last link on the end of the chain. Note that there are two holes on each fitting that are labeled “A” and “B”. These two holes offer two attachment points that change the length of the linking strap assembly.

The rigging straps are shipped from the factory with chain connected in the “A” position on the fittings on both ends. (This would be denoted as an “A-A” length.) When the chain is connected in the “B” position on both fittings (known as the “B-B” length), the strap is 0.50 inches longer than when connected in the “A-A” position. This 0.50-inch change in length results in a 1°-angle adjustment. When the chain is connected in the “A” position on one fitting and the “B” position on the other fitting (known as the “A-B” length), the strap is 0.25 inches longer than when connected in the “A-A” position. This 0.25-inch change in length results in a 0.5°-angle adjustment. Thus, by adjusting the length of the straps and selecting their attachment position on the enclosure front track, the relative angles between boxes can be adjusted in 0.5° increments. When used with the “A-A” length, even-numbered angles result (0°, 2°, 4°, 6°, etc.) when changing the attachment position of the strap along the track, while odd-numbered angles result (1°, 3°, 5°, 7°, etc.) when used with the “B-B” length. With “A-B” length, in between angles are achievable (0.5°, 2.5°, 4.5°, etc.).

When planning angle adjustments between boxes, the shape of the enclosure must be taken into account. Two rectangular enclosures (Xvls, Xsub, Xfil) can be pulled up tight with their sides parallel, a 0° relative aiming angle exists between the enclosures (i.e., both are facing straight ahead and the sound from both is aimed straight ahead). When two trapezoidal enclosures (Xvlt only) are pulled up tight with their sides parallel, a 5° relative aiming angle exists between the enclosures (because the enclosure shape is a 5° wedge, the sound from both is aimed 5° apart). When a trapezoidal enclosure (Xvlt) and rectangular enclosure (Xvls, Xsub, Xfil1 or Xfil2) are pulled up tight with their sides parallel, a 2.5° relative aiming angle exists between the enclosures.

Figure 8 shows all of the possible combinations of rigging attachment locations and linking strap lengths. When designing an array using the X-Line modeling software, the program will automatically tell you what each front strap length is required (A-A, A-B or B-B) and at what position on the rigging they should be attached for each enclosure.

Rectangular Box (Xvls or Xsub) to Rectangular Box (Xvls or Xsub)			Rectangular Box (Xvls or Xsub) to Trapezoidal Box (Xvlt)			Trapezoidal Box (Xvlt) to Trapezoidal Box (Xvlt)		
Angle Between Boxes	Front Chain Configuration	Holes Showing In Front Rigging	Angle Between Boxes	Front Chain Configuration	Holes Showing In Front Rigging	Angle Between Boxes	Front Chain Configuration	Holes Showing In Front Rigging
0.0°	A-A	0	2.5°	A-B	0	5.0°	B-B	0
0.5°	A-B	0	3.0°	B-B	0	6.0°	A-A	0
1.0°	B-B	0	4.0°	A-A	1	6.5°	A-B	0
2.0°	A-A	1	4.5°	A-B	1	7.0°	B-B	1
2.5°	A-B	1	5.0°	B-B	1	8.0°	A-A	1
3.0°	B-B	1	6.0°	A-A	2	8.5°	A-B	1
4.0°	A-A	2	6.5°	A-B	2	9.0°	B-B	2
4.5°	A-B	2	7.0°	B-B	2	10.0°	A-A	2
5.0°	B-B	2	8.0°	A-A	3	10.5°	A-B	2
6.0°	A-A	3	8.5°	A-B	3			
6.5°	A-B	3						
7.0°	B-B	3						
Note: Accoustic gaps will occur with angles greater than 5.0° between Xvls systems.			Note: Accoustic gaps will occur with angles greater than 6.5° between Xvls & Xvlt systems.			Note: Accoustic gaps will occur with angles greater than 8.5° between Xvlt Systems.		

Figure 8:
Enclosure Vertical Angle Adjustments

In this document and in the software modeling program, the front rigging fitting attachment locations are denoted by the number of “holes showing” in the rigging track once a rigging strap is installed. On each side of the enclosures at the front, there is a pin in the middle of the rigging track that is used to secure the Front Dollies to the enclosures. When two enclosures are linked together so that they are tight packed with the sides of the enclosures parallel, the rigging fittings are installed near the middle of the rigging track in the last available rigging cutout next to the dolly pins. In this case, there are no cutouts in the rigging track visible because the rigging fittings and the chain cover up all of the track cutouts. Hence, this position is referred to a “No Holes Showing”. For example, when two rectangular Xvls enclosures are linked together using an Xvsl linking strap, and a relative angle of 0° is required between the boxes (i.e., the boxes are tight packed with both facing straight ahead), the rigging fittings of the Xvsl linking straps are installed in the middle next to the dolly pins for “No Holes Showing”. If a relative angle of 2° is required between the two Xvls boxes, then one of the rigging fittings must be moved one cutout in the track, leaving “One Hole Showing”. If a relative angle of 4° is required, then one of the rigging fittings must be moved two cutouts in the track, leaving “Two Holes Showing”. To get the correct angle between two boxes, it does not matter on which box the holes are showing. It is even possible to achieve the correct angle with holes showing on both boxes. However, there is an advantage in always having the holes showing on the bottom box only. When standing on the ground looking up at an array, the holes showing on the bottom box are always visible. If there are holes open on the top box, they may not be visible from the ground, because the view of those holes may be obstructed by the rigging fittings. Thus, it is always best to install the rigging fittings on the top box in the rigging-track cutout next to the dolly pin with no holes showing on the top box, then make all angle adjustments by changing the position of the rigging fitting in the track of the bottom box.

2.3 Deciding Whether to Use an Xvhg or Xvhl at the Grid

There are two pieces of rear rigging hardware and two pieces of front rigging hardware required for this purpose. The front hardware consists of two Xvsg chain assemblies. There are two types of rigging hardware, however, that may be used at the rear - either two Xvhg flexible-chain grid hinges or two Xvhl solid-arm linking hinges. Xvhg chain grid hinges allow a flexible attachment to the grid. This makes attachment to the grid faster; however, the grid will not be secure on top of the loudspeakers during transportation. Xvhl solid-arm linking hinges allow a rigid attachment to the grid. This makes attachment to the grid a bit slower; however, the height is less and the grid is secured on top of the loudspeakers during transportation. The Xvhg offers a higher rigging strength when the top box is angled down more than 20° , while the Xvhl offers greater rigging strength when the top box is angled down less than 20° . (Note that the Xvhl linking hinge is the same hardware used to link two enclosures together.) Either type of hardware will work for attaching any of the loudspeaker systems to the grid.

The decision of whether to use the Xvhg or Xvhl for the rear rigging hardware is left to the user. The “Simplified Structural Ratings” described in Section 3.3 always assumes the worst case (i.e., the lowest rating at any angle for either the Xvhg and Xvhl). This provides for quick evaluations with the highest margin of safety, but does limit the amount of weight that can be suspended. If the the “Detailed Structural Ratings” described in Section 3.4 are used, the user will find that a greater amount of weight and greater angles are possible while maintaining a sufficient safety factor. The X-Line modeling program will automatically calculate the structural capabilities using the more detailed structural analysis based on which piece of hardware is selected for rear attachment to the grid.

2.4 Rigging an Array with Boxes Using X-Line Dollies

Three dollies are available for transporting the X-Line loudspeaker systems. The actual array rigging technique will vary depending on which dollies are used to transport the systems.

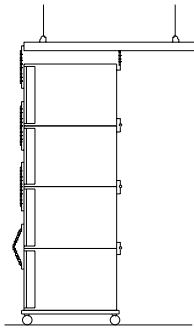
The Bottom Stacking Dolly can be used with the rectangular loudspeaker enclosures (Xvls, Xsub). Up to four loudspeaker systems can be stacked on top of a single dolly. The enclosures all sit upright as they would be arrayed. These dollies have sufficient clearance to allow the enclosures to travel with both the front and rear rigging hardware attached to the loudspeaker systems. This makes rigging set up and tear down extremely easy because the loudspeaker enclosures can be moved in blocks of four units. The Downfill Stacking Dolly can be used with one downfill enclosure (either the Xfil1 or Xfil2) and two Xvlt systems. The three loudspeaker systems are stacked so that the enclosures all sit upright as they would be arrayed. The dollies are designed to accommodate the slanted baffle of the Xfil1 and Xfil2 and the trapezoidal shell of the Xvlt systems. These dollies have sufficient clearance to allow the enclosures to travel with both the front and rear rigging hardware attached to the loudspeaker systems. Like the Bottom Stacking Dollies, this makes rigging set up and tear down extremely easy because the loudspeaker enclosures can be moved in blocks of three units.

The Front Dolly can be used with either the rectangular enclosures (Xvls or Xsub) or trapezoidal enclosures (Xvlt). The front dolly attaches to the front of a single loudspeaker system covering the grille and the enclosure front rigging track. This dolly allows the ease of moving one loudspeaker enclosure at a time; however, the rigging cannot remain attached to the enclosure during transport.

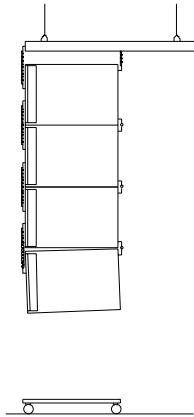
Because most arrays typically require more rectangular Xvls and Xsub systems than trapezoidal Xvlt systems, it would be common in a large-scale touring situation for the rectangular boxes to be transported on Bottom Stacking Dollies and trapezoidal and downfill boxes to be transported on Downfill Stacking Dollies. However, some users prefer to transport the trapezoidal boxes on front dollies. In cases where a venue will not accommodate the large bottom-stacked arrays and the boxes must be individually handled, front dollies must be used.

Figure 9 illustrates the technique used to construct a loudspeaker array with enclosures transported on Bottom Stacking Dollies. First, a stack of enclosures on a Bottom Stacking Dolly is rolled underneath the grid. The grid is lowered and the top box is attached to the grid. The Xvsg and Xvsl chain rigging straps are attached at the front to achieve the desired vertical angles. The four boxes are lifted high enough that another column of loudspeakers on a stacking dolly can be rolled in under the suspended array. The array is then landed on top of the next stack of loudspeakers and rigging hardware is attached between the flown stack and the stack on the dolly. The entire column of loudspeakers is then lifted overhead. The process is repeated as necessary to add more loudspeakers to the column. The process is identical for both the Bottom Stacking Dolly and the Downfill Stacking Dolly.

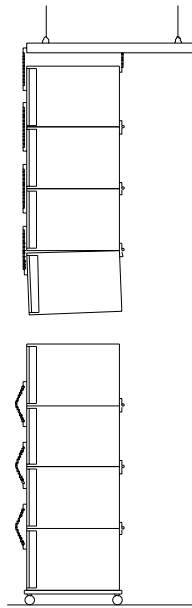
Figure 10 illustrates the technique used to construct a loudspeaker array with enclosures transported on Front Dollies. The figure starts out showing four enclosures suspended overhead. The array is lowered and a single enclosure on a front dolly is rolled into position behind the flown array. The array is lowered until the bottom corner of the bottom box of the array lines up with the rear corner of the box facing the ground on a Front Dolly. The Xvhl rear linking hinge is then simultaneously installed in the rigging on the suspended box and the box on the dolly.



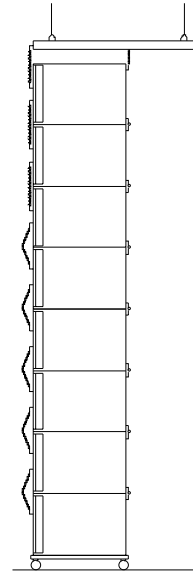
Step 1: Roll stack of boxes into position and attach the top box to the grid using the two grid straps at the front and two grid hinges at the rear. Attach rigging chain at the front to achieve the desired vertical angle.



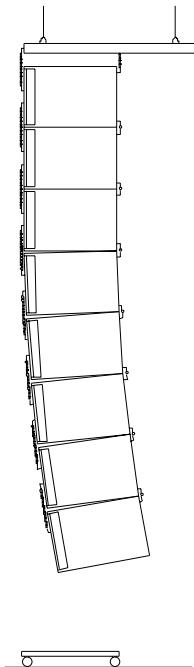
Step 2: Lift boxes off dolly.



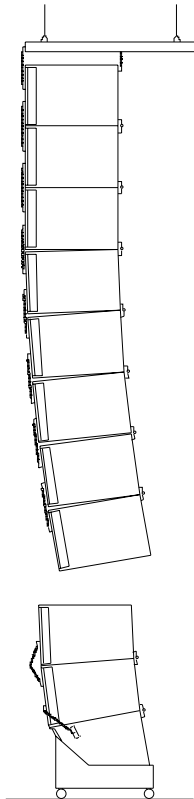
Step 3: Roll another stack of boxes into position under the suspended array. Attach rigging chain at the front to achieve the desired vertical angles for the next stack.



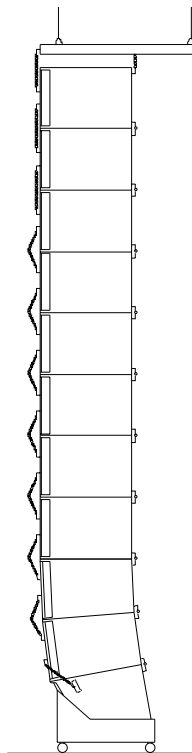
Step 4: Land the suspended array on top of the next stack. Attach the rear hinges between the two stacks. Attach rigging chain at the front between the two stacks to achieve the desired vertical angles.



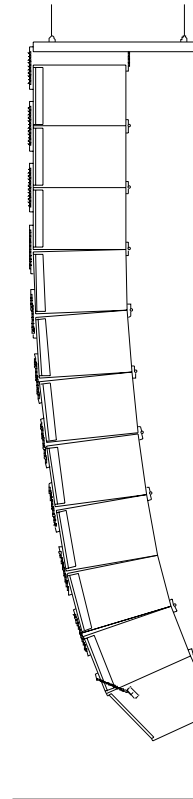
Step 5: Lift the entire array of boxes.



Step 6: Roll another stack of boxes into position under the suspended array. Attach rigging chain at the front to achieve the desired vertical angles for the next stack.



Step 7: Land the suspended array on top of the next stack. Attach the rear hinges between the two stacks. Attach rigging chain at the front between the two stacks to achieve the desired vertical angles.



Step 8: Lift the entire array of boxes.

Figure 9:
Flying with Stacking Dollies

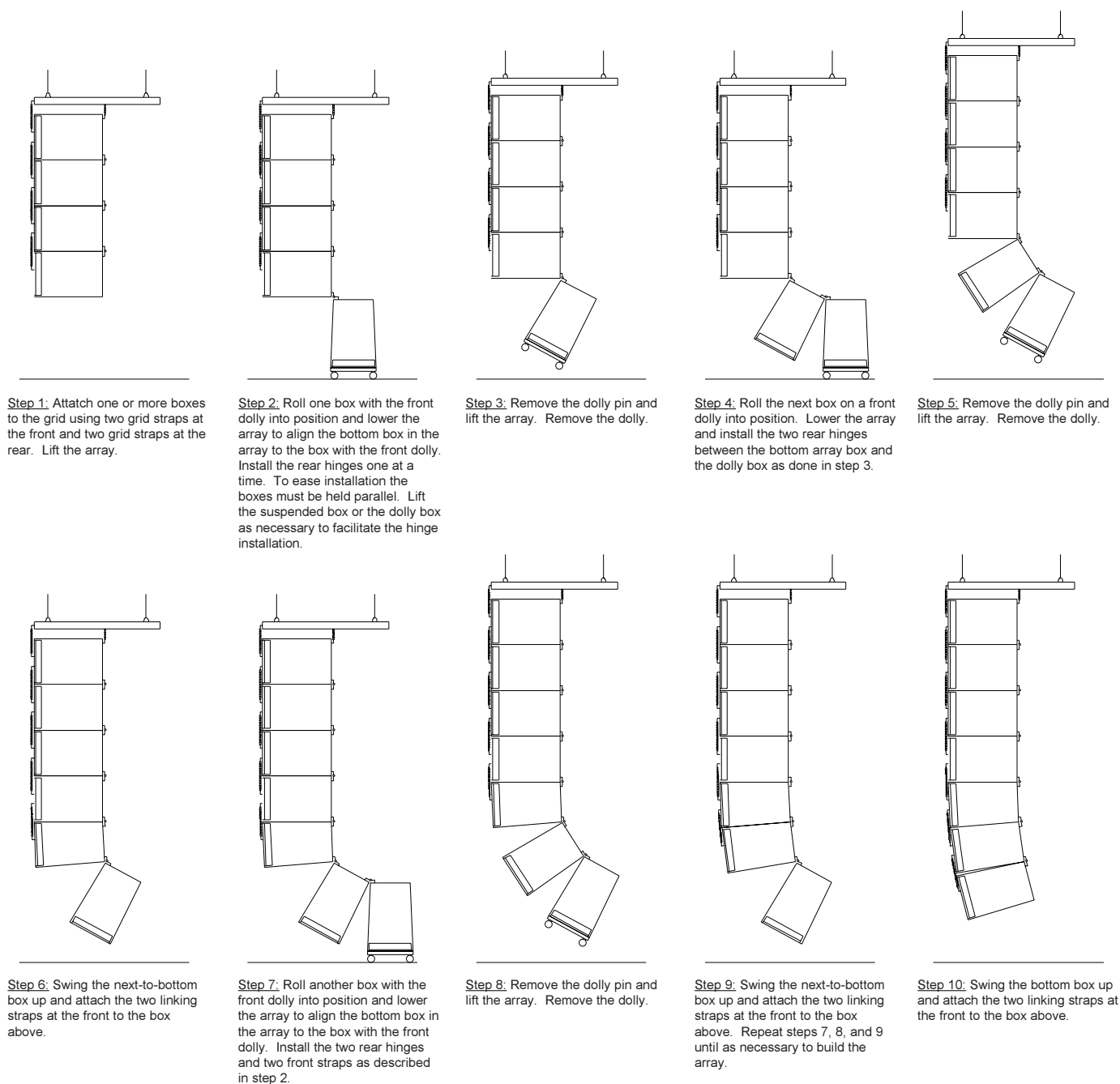


Figure 10:
Flying with Front Dollies

The two boxes must be held parallel during the installation of the rigging hinge. If there is a slight vertical misalignment that causes the hinge to bind during installation, either the suspended box or the box on the dolly may be manually lifted to facilitate the hinge installation. Once both rear hinges are secured, the array is lifted until the box on the Front Dolly is no longer contacting the ground.

The Front Dolly is then removed from the bottom box. Do not attach the front Xvsl rigging straps yet on the bottom box. The array is then raised and another box on a Front Dolly is rolled into position from behind the array. The two Xvhl linking hinges are then simultaneously installed in the rigging on the suspended box and the box on the dolly as previously described.

Once again, the array is lifted until the box on the Front Dolly is no longer contacting the ground and the dolly is removed from the box. At this point, the next to last box is manually lifted and the front Xvsl linking straps are attached between the box next to the bottom and the box above it. This process is repeated as necessary to add more loudspeakers to the column. When the last loudspeaker is in place at the bottom of the array, that box is manually lifted and the front Xvsl linking straps are attached between it and the box above it.

2.5 Pull-Up Techniques

In cases where gravity does not allow the cabinets to be angled down as much as necessary to meet the acoustic coverage requirements, a pull-up assembly will be necessary. The Xvbp pull-up bar (as described in Section 1.5) is recommended for this application. The Xvbp has two heavy-duty fittings that can be attached to the bottom of the bottom cabinet. The user can then attach a ratchet strap from the center eye ring on the Xvbp back up to the grid. The ratchet strap must only be tightened until the slack in the front rigging chain hardware is eliminated and the chains are taut. Attempting to tighten the pull-up assembly any tighter can introduce excessive forces in the rigging hardware.

When larger downward angles are required for the top cabinets in the array, the pull-up assembly will have to be attached behind the array (instead of the grid) to the building structure or a tower structure. In this case, either a ratchet strap or another chain hoist may be used to pull back. Again, the pull-up assembly must only be tightened until the slack is eliminated from the front chains. If Xvhl solid-arm linking hinges are used to secure the top cabinet to the rear of the grid, the user must never pull back so far that these hinges go into compression. If Xvhg chain hinges are used to secure the top cabinet to the rear of the grid, the user must never pull back so far that these hinge chains go slack. If front and back hoist motors are used to suspend the grid, the user must never pull back so far that the rear hoist motor goes slack.

An Xvbp pull-up bar may be used for a column of up to 16 Xvls, Xvlt, Xsub, Xfil1 and/or Xfil2 cabinets. For a column of eight or less X-Line cabinets, two RS-1B fittings may be bridled together (as described in Section 1.7) at the bottom of the bottom cabinet. A ratchet strap can then be attached from the center of the bridle back up to the grid. The same techniques and cautions described for the Xvbp above would apply to an RS-1B pull-up assembly.

The X-Line modeling program will tell the user when a pull-up assembly is required; however, the program cannot tell the user when too much pull-up force has been applied. The user is responsible for making sure an excessive pull-up force is not applied.

3. Rigging-Strength Ratings, Safety Factors, and Special Safety Considerations

3.1 Working-Load Limit and Safety Factor Definitions:

The structural ratings for all of the X-Line rigging components and complete loudspeaker systems are based on test results in which parts were stressed to failure. Manufacturers typically present the structural-strength ratings of mechanical components or systems as either the working-load limit (WLL) or the ultimate-break strength. Electro-Voice chooses to present the structural-load ratings of the X-Line loudspeaker systems as the working-load limit. The working-load-limit rating represents the maximum load that should ever be applied to a mechanical component or system.



THE USER SHOULD NEVER APPLY A LOAD THAT EXCEEDS THE WORKING-LOAD LIMITS OF ANY OF THE RIGGING COMPONENTS OR COMPLETE LOUDSPEAKER SYSTEMS DESCRIBED IN THIS MANUAL.

The working-load limits for the X-Line rigging components and complete loudspeaker systems described in this manual are based on a 5:1 safety factor. The safety factor is defined as the ratio of the ultimate-break strength divided by the working-load limit, where the ultimate-break strength represents the force at which a part will structurally fail. For example, if a part has working-load limit of 1,000 lb (454 kg), it would not structurally fail until a force of at least 5,000 lb (2,268 kg) was applied, based on a 5:1 safety factor. However, the user should never apply a load to that part that exceeds 1,000 lb (454 kg). The safety factor provides a margin of safety above the working-load limit to accommodate normal dynamic loading and normal wear.

CAUTIONS for Working-Load Limits and Safety Factors:

The working-load limits defined by the manufacturer of any rigging component should never be exceeded. Electro-Voice bases the working-load limits of its X-Line products on a 5:1 safety factor. A 5:1 safety factor is fairly common amongst rigging manufacturers because many regulatory agencies call for a minimum safety factor of 5:1.

The user is cautioned that some local regulations may require safety factors higher than 5:1. In that circumstance, Electro-Voice insists that the user maintain the higher safety factor as required by the local regulations throughout the entire X-Line installation. It is the responsibility of the user to make sure that any X-Line installation meets any applicable local, state or federal safety regulations.

3.2 Structural Rating Overview

There are two independent strength ratings that, together, give a complete description of the overall structural performance capabilities of any X-Line loudspeaker system. They are defined as follows:

- 1. The strength of each individual rigging point;** which is the combined strength of the rigging track mounted on the enclosure with the removable rigging-hinge and/or rigging-strap assemblies.
- 2. The total strength of the overall enclosure;** which is a function of the combined forces from all of the rigging points acting on the enclosure as a whole.

The array designer must be aware of the working-load limit ratings and the loads being applied to the individual rigging points and the overall enclosure. An X-Line loudspeaker system is only as strong as its weakest link. It is usually the case that one of the working-load limits will be approached sooner than the other.



WHEN SUSPENDING ANY X-LINE LOUDSPEAKER SYSTEM OVERHEAD, THE WORKING-LOAD LIMITS MUST NEVER BE EXCEEDED FOR EACH INDIVIDUAL RIGGING POINT, OR THE OVERALL ENCLOSURE.

The forces acting on each individual rigging point and on the overall enclosures in an X-Line flying system will vary with each array configuration. Determining the forces throughout an array requires complex mathematical calculations. Electro-Voice engineers have, however, defined a set of simplified structural-rating guidelines that eliminate the need for the complex calculations for most array configurations. The interaction of the complex forces throughout arrays were analyzed to develop this set of conservative guide-lines, presented below, to enable a rigger to immediately determine on site whether or not an array is safe without having to make weight-distribution calculations. The structural strength ratings of the individual rigging points and the overall X-Line enclosures are also presented below so that a complex structural analysis can be made for any array configuration. The reader should consult an experienced structural engineer to perform the complex structural analysis.

The reader is directed to the References section of this manual for a list of rigging references (for background in general rigging practice) and mechanical engineering references (for background in structural engineering analysis).

3.3 Simplified Structural-Rating Guidelines

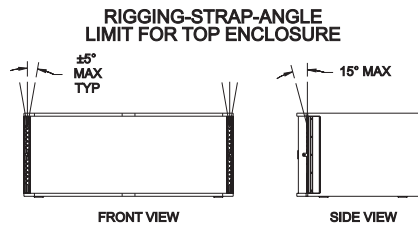
Electro-Voice engineers have defined a set of simplified structural-rating guide-lines that will enable a rigger to immediately evaluate the safety of an X-Line system on site without having to make complex force-distribution calculations. A combination of destructive testing and computer modeling were used to analyze the complex forces throughout arrays. Conservative working-load ratings were utilized to simplify the guidelines. Therefore, array configurations other than those illustrated in these simplified guidelines may be permissible for those applications, consult section 3.4 Complex Structural-Rating Analysis for a detailed structural analysis.

The simplified structural-rating guidelines are shown in Figure 11. (Note that there is a label on the back of each flying X-Line loudspeaker enclosure that includes the graphics shown in Figure 11.) These guidelines provide a simplified rating for typical arrays based on the:

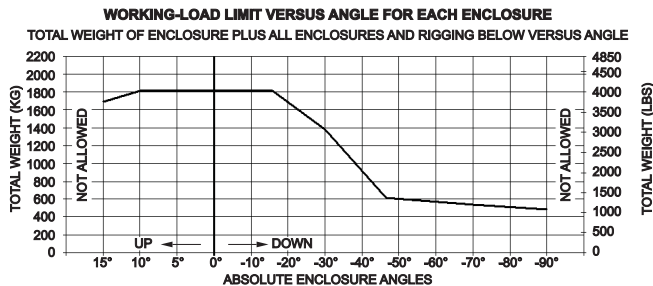
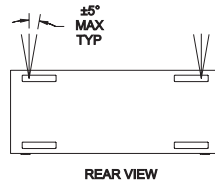
1. Vertical tilt angle of each enclosure
2. Total weight of that enclosure plus all of the enclosures and rigging hung below it.
3. Side-to-Side Angles of the front Xvsg, Xvsl or Xvsf rigging straps (or any custom front rigging straps) relative to the enclosures.
4. Side-to-Side Angles of the rear Xvhg grid hinges, Xvhl linking hinges or Xvhp pickup hinges relative to the enclosures.

SIMPLIFIED RIGGING-RATING GUIDELINES

- THESE SIMPLIFIED RIGGING-RATING GUIDELINES PROVIDE RATINGS FOR TYPICAL ARRAYS BASED ON THE:
 - VERTICAL ANGLE OF EACH ENCLOSURE.
 - TOTAL WEIGHT OF EACH ENCLOSURE PLUS ALL ENCLOSURES AND RIGGING SUSPENDED BELOW IT.
 - RELATIVE ANGLES OF THE RIGGING HARDWARE.
 DETERMINING THE FORCES THROUGHOUT AN ARRAY REQUIRES COMPLEX CALCULATIONS. THESE GUIDELINES ELIMINATE THE NEED FOR WEIGHT-DISTRIBUTION CALCULATIONS BY UTILIZING CONSERVATIVE WORKING-LOAD RATINGS. OTHER ARRAY CONFIGURATION MAY BE PERMISSIBLE - FOR THOSE APPLICATIONS, CONSULT THE X-LINE USERS GUIDE & ARRAY SOFTWARE.
- ONLY USE ELETRO-VOICE RIGGING HARDWARE.
- READ THE X-LINE USERS GUIDE BEFORE SUSPENDING ANY LOUDSPEAKERS OVERHEAD.
- ALL NON-ELECTRO-VOICE HARDWARE IS THE RESPONSIBILITY OF OTHERS.



XVHG OR XVHP RIGGING-HINGE-ANGLE LIMITS FOR TOP ENCLOSURE



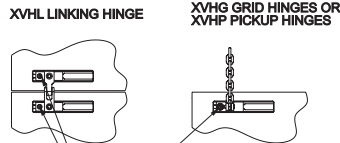
RIGGING INSTRUCTIONS

- INSTALL THE REAR HINGES. (THE REAR HINGES ARE THE PRIMARY STRUCTURAL SUPPORTS.)
- INSTALL THE FRONT STRAPS TO SET THE RELATIVE ANGLE BETWEEN ENCLOSURES AND GRID.
- IF ANY ENCLOSURES DO NOT ANGLE DOWN FAR ENOUGH, LEAVING SLACK IN THE FRONT STRAPS, USE A PULL-UP LINE TO TAKE THE SLACK OUT OF THE STRAPS.

CAUTION ⚠

HINGE LOCKING PINS MUST BE FULLY ENGAGED IN TRACK BEFORE LIFTING OVERHEAD

RIGGING HINGE INSTALLATION



CAUTION ⚠

HINGE LOCKING PINS MUST BE FULLY ENGAGED IN TRACK BEFORE LIFTING OVERHEAD

CAUTION ⚠

- ONLY USE PULL UP TO TAKE SLACK OUT OF THE FRONT STRAPS.
- NEVER PULL UP ENOUGH TO CAUSE TOP RIGGING HINGE CHAINS OR OR LINKING HINGES TO GO SLACK.

OPTIONAL PULL UP

CAUTION ⚠

NEVER EXCEED RIGGING-STRAP-ANGLE OR RIGGING-HINGE-ANGLE LIMITS FOR TOP ENCLOSURE.

XVHL, XVHG, OR XVHP RIGGING HINGES

XVSG OR XVSP RIGGING

UP

DOWN

CAUTION ⚠

FITTINGS MUST BE SECURELY LOCKED IN TRACK BEFORE LIFTING OVERHEAD.

CAUTION ⚠

NEVER EXCEED WORKING-LOAD-VERSUS-ANGLE LIMIT FOR ANY ENCLOSURE.

NOTE:

ADD 11 LBS. (4.99 KG) PER CABINET FOR RIGGING WEIGHT.

SEE INDIVIDUAL ENCLOSURE INPUT PANELS FOR CABINET WEIGHTS.

XVSD RIGGING STRAPS

535908 REV A

Figure 11:
Simplified Rating Guidelines

Figure 11 includes a graph of the working-load weight-versus-angle limit rating for the X-Line enclosures. This working-load weight limit is applicable to every enclosure in an array, and includes the weight of that enclosure plus the total weight of all enclosures and rigging hardware suspended below it. The absolute enclosure angle is the vertical angle of that enclosure, where 0° represents an upright enclosure facing straight ahead (0° elevation angle). These working-load-versus-angle limits take into account the complex forces generated in the front rigging straps, the rear rigging hinges, the enclosure and the (optional) pull-up line, as a result of the complex weight distribution throughout the array. Also included in the simplified structural-rating guidelines in Figure 11 are side-to-side and front-to-back angle limits for the front rigging straps on the top enclosure. These limits apply to the Xvsg and Xvsl rigging straps, as well as any custom rigging straps using the Xvsf fitting at the front of the top enclosure.

In addition, the guidelines in Figure 11 include a side-to-side angle limit for the Xvhg grid hinges and the Xvhp pickup hinges. Side-to-side angle limits are not necessary for the Xvhl linking hinges because side-to-side angles are impossible to achieve if the top rigging is within its limits. Front-to-back limits are not necessary for the Xvhg, Xvhl, and Xvhp hinges because the front-to-back angles are taken into account by the enclosure weight-versus-angle rating chart.

CAUTIONS for the Simplified Structural Rating Guidelines:



WHEN APPLYING THE SIMPLIFIED STRUCTURAL RATING GUIDELINES TO ANY X-LINE LOUDSPEAKER SYSTEM SUSPENDED OVERHEAD, THE USER MUST OBEY THE FOLLOWING RULES:

1. Never exceed the working-load-versus-angle limit for any enclosure in the array.
2. For the front of every enclosure in an array, never exceed the side-to-side angle limits for the Xvsg, Xvsl, Xvsd and Xvsf rigging assemblies.
3. For the back of every enclosure in an array, never exceed the side-to-side angle limits for the Xvhl linking hinges, Xvhg grid hinges, Xvhp pick-up hinges or Xvbp pull-up bar.
4. Always make sure that the rear hinge locking pins on every Xvhl linking hinge, Xvhg grid hinge, Xvhp pick-up hinge and Xvbp pull-up bar are fully engaged in the rigging track on the back of every enclosure (and grid, when applicable) before lifting overhead.
5. Always make sure that the locking pins on all the front triple-stud fittings on every front Xvsg, Xvsl, Xvsd and Xvsf rigging assembly are fully seated and locked in the rigging-track base on the front of every enclosure (and grid, when applicable). Always make sure that there is not a twist in these chains before lifting overhead.
6. Only use Xvhl linking hinges, Xvhg grid hinges, or Xvhp pickup hinges manufactured by Electro-Voice.
7. Only use Xvsg, Xvsl, Xvsd or Xvsf front rigging assemblies manufactured by Electro-Voice.
8. Only use Xvbp pull-up bars manufactured by Electro-Voice.
9. If RS-1B double-stud swivel-ring fittings are used, never exceed the working-load limit for the RS-1B at either the front or the back of any enclosure in an array.
10. When a pull-up assembly is used, never exceed the working-load limits of any of the components making up the pull-up assembly.
11. When a pull-up assembly is used, never apply a pull-up force greater than that required to eliminate any slack in the front rigging chains.

Discussion of Array Examples: For example, if the top enclosure in a column was angled down 10°, the enclosure working-load-versus-angle limit from the simplified structural-rating guidelines shown in Figure 11 would indicate that a total of 4,020 pounds (1,823 kg) could be safely suspended. This would include the weight of the top enclosure plus all of the enclosures and rigging suspended below.

If, however, the top enclosure in a column was angled up 15°, the total allowable weight would then only be 3,840 pounds (1,742 kg) - including the weight of the top enclosure plus all of the enclosures and rigging suspended below. The enclosure working-load-versus-angle limit shown in Figure 11 not only applies to the top enclosure in an array column, but also applies to every enclosure in an array column. In arrays where a pull-up line is not used, the top enclosure is always the limiting factor because it supports the most weight. However, in arrays where a pull-up line is used to achieve substantial downward angles, it is possible that a lower enclosure could be the limiting factor.

3.4 Complex Structural-Rating Analysis

For a complete structural-rating analysis, the forces in each individual piece of rigging hardware throughout the X-Line system must be determined, as well as the forces on each enclosure. Determining these forces requires complex mathematical calculations. All of these forces must then be compared to the working-load limits detailed below for each of the rigging points and the overall enclosures. The reader should consult an experienced structural engineer to perform the complex structural analysis.



WHEN SUSPENDING ANY X-LINE LOUDSPEAKER SYSTEM OVERHEAD, THE WORKING-LOAD LIMITS MUST NEVER BE EXCEEDED FOR EACH INDIVIDUAL RIGGING POINT, AND THE OVERALL ENCLOSURE.

Xvls, Xvlt, Xsub, Xfil1 and Xfil2 Rear Rigging Structural-Strength Ratings:

The working-load limit of each individual rigging point on the rear of an X-Line enclosure is dependent upon the rigging-track/bracket assembly as it is mounted in the enclosure, the specific removable rigging-hardware assembly and the angle of pull. The structural-strength ratings for individual Xvhg grid hinges and Xvhp pick-up hinges are shown in Figure 12, while the structural ratings for the Xvhl linking hinges are shown in Figure 13.

It should be noted that the front-to-back angle range shown in Figure 12 is only 270° for the Xvhg and Xvhp because the hinge chains can only be put into tension and the enclosure prevents a full 360° rotation. It also should be noted that all of the hinges are only rated for use over side-to-side pull angles of a maximum of $\pm 5^\circ$, as shown in Figure 12. There are two rigging points at the rear of the enclosures. The structural ratings shown in Figure 12 are for a single rigging attachment point. Each rigging point has the same rating.

The front-to-back structural-strength ratings for the Xvhl linking hinges shown in Figure 13 cover a full 360° rotation. Although it is not possible to put the hinge into tension over 360°, it is possible for the linking hinges to go into compression when pull-up straps are employed. Therefore, the 360° rating is necessary to accommodate both tension and compression. It also should be noted that the Xvhl linking hinges are only rated for use over side-to-side pull angles of a maximum of $\pm 5^\circ$ as shown in Figure 13. There are two rigging points at the rear of the enclosures. The structural ratings shown in Figure 13 are for a single rigging attachment point. Each rigging point has the same rating.

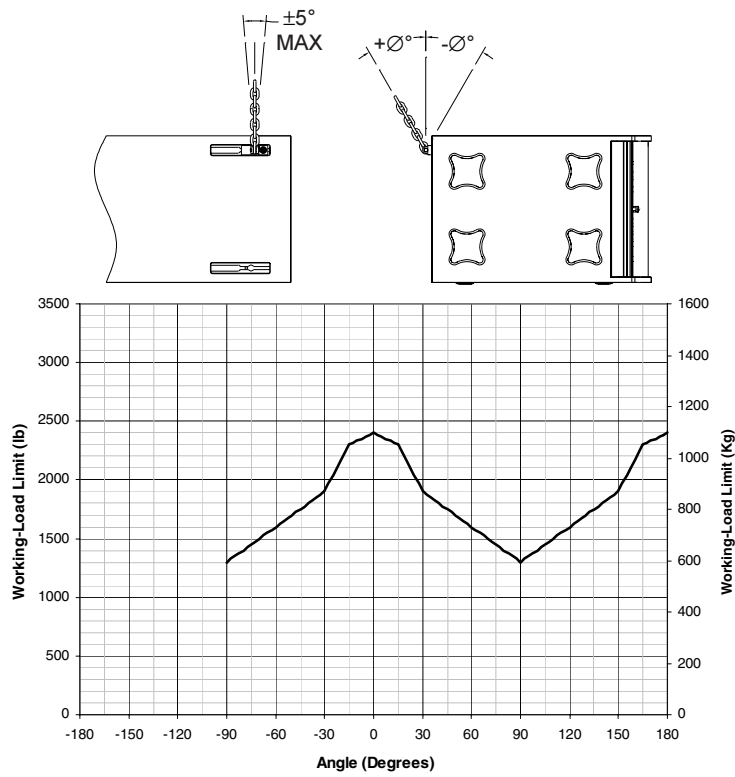


Figure 12:
Xvls, Xvlt, Xsub, Xfil1 & Xfil2
 Rear Rigging Point Structural Ratings with Xvlg and Xvhp

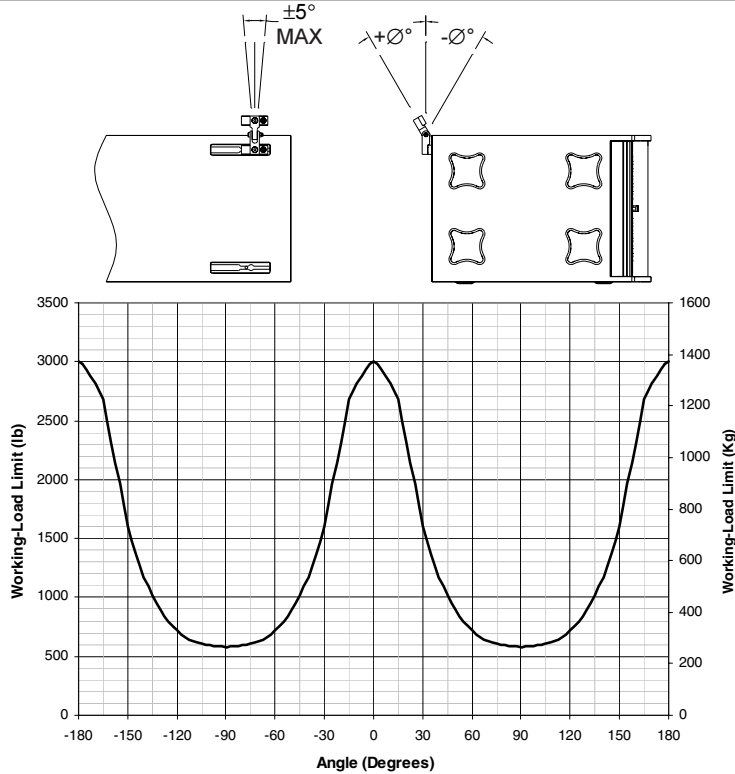


Figure 13:
Xvls, Xvlt, Xsub, Xfil1 & Xfil2
 Rear Rigging Point Structural Ratings with Xvhl

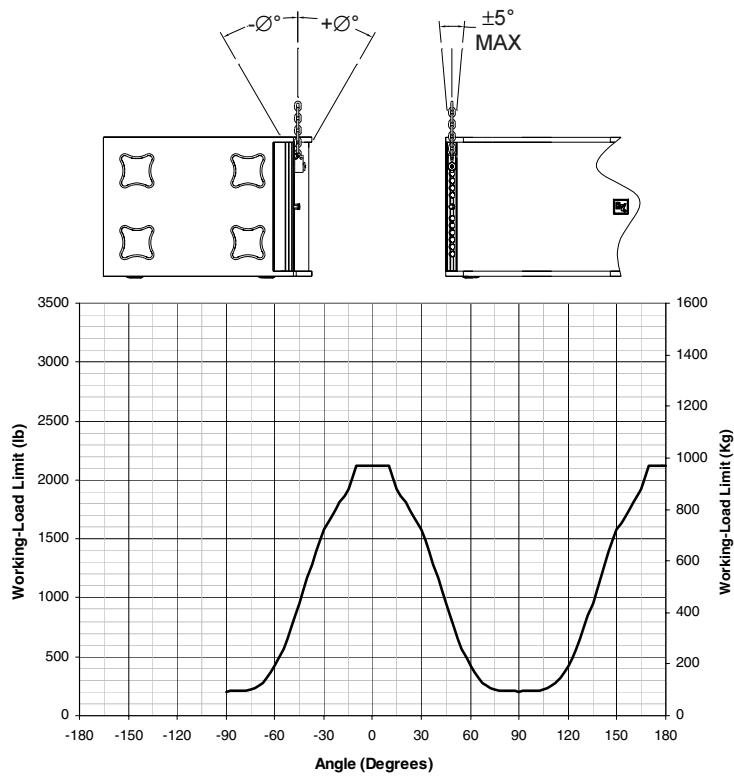


Figure 14:
Xvls, Xvlt & Xsub
 Front Rigging Point Structural Ratings with Xvsg, Xvsl, Xvsd and Xvsf

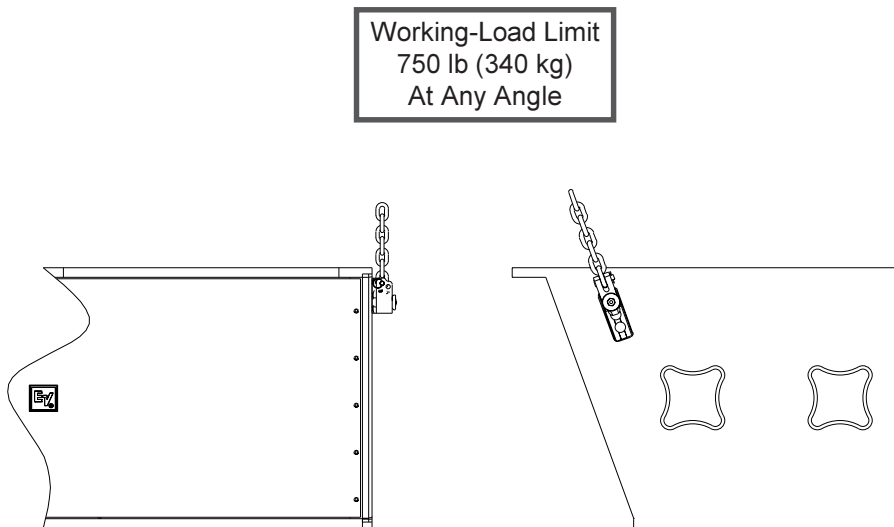


Figure 15:
Xfil1 & Xfil2
 Front Rigging Point Structural Ratings with Xvsg, Xvsl, Xvsd and Xvsf

Xvls, Xvlt, Xsub, Xfil1 and Xfil2 Front Rigging Structural-Strength Ratings:

The working-load limit of each individual rigging point on the front of an X-Line enclosure is dependent upon the rigging-track/bracket assembly as it is mounted in the enclosure, the Xvsg grid chain rigging strap, the Xvsl linking chain rigging strap, the Xvsd downfill rigging strap and the Xvsf fitting.

The Xvls, Xvlt and Xsub enclosures have identical rigging track at the front of the enclosure and have the same structural-strength ratings when used with the Xvsg, Xvsl, Xvsd and Xvsf, as shown in Figure 14.

It should be noted that the front-to-back angle range shown in Figure 14 is only 270° for the Xvsg, Xvsl, Xvsd and Xvsf because the front chains can only be put into tension and the enclosure prevents a full 360° rotation. It also should be noted that the Xvsg, Xvsl, Xvsd and Xvsf front chains are only rated for use over side-to-side pull angles of a maximum of $\pm 5^\circ$, as shown in Figure 14. There are two rigging points at the front of the enclosures. The structural ratings shown in Figure 14 are for a single rigging attachment point. Each rigging point has the same rating.

The Xfil1 and Xfil2 have their front rigging track hardware located on the sides of the enclosure, and have the same structural rating when used with the Xvsg, Xvsl, Xvsd and Xvsf, as shown in Figure 15. It should be noted that the structural ratings for the Xfil1 and Xfil2 enclosures are the same with any angle of pull. There are two rigging points at the front of the enclosures. The structural ratings shown in Figure 15 are for a single rigging attachment point. Each rigging point has the same rating.

Xvls, Xvlt, Xsub, Xfil1 and Xfil2 Overall Enclosure Structural-Strength Ratings:

The actual strength of the Xvls, Xvlt and Xsub enclosures will depend on the complex total of the combined forces from each of the rigging points acting on the enclosure as a whole and will vary with the array configuration. However, for the sake of simplicity, Electro-Voice chooses to define the working-load limit of the overall enclosures as the sum total of the weight of that enclosure plus the weight of all of the enclosures and rigging hardware suspended below. This simplified working-load weight rating of the overall enclosures is defined as being independent of the angles of pull on the individual rigging points. The Electro-Voice engineers have chosen to define the working-load limits of the individual rigging points as a function of pull angle so that they take into account any variations in enclosure strength that might occur as a function of pull angle. This approach allows the enclosure working-load limit to be defined as independent of pull angles, making the complex structural rating analysis easier. The overall enclosure strength ratings are identical for the Xvls, Xvlt and Xsub models, and are shown in Figure 16. The overall enclosure strength ratings are identical for the Xfil1 and Xfil2 models, and are shown in Figure 17.

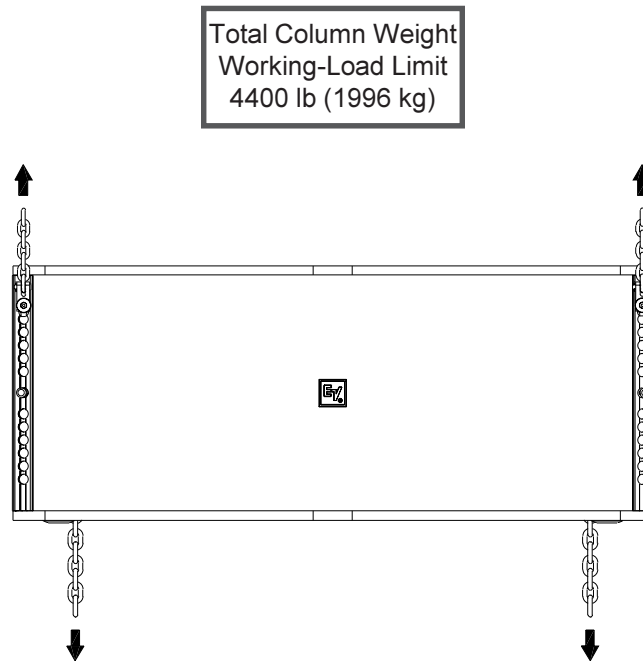


Figure 16:
Xvls, Xvlt & Xsub
Overall Enclosure Structural Ratings

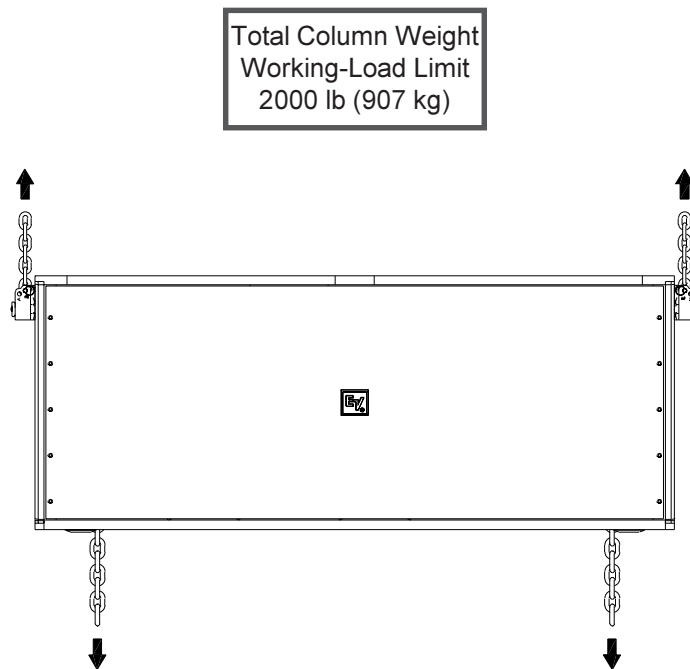


Figure 17:
Xfil1 & Xfil2
Overall Enclosure Structural Ratings

Xvbp Pull-Up Bar Structural-Strength Ratings:

The working-load structural-strength ratings for the Xvbp pull-up bar are shown in Figure 18. The structural ratings are independent of the angle of pull in the front-to-back direction; however, the Xvbp is only rated for use for side-to-side pull angles of a maximum of $\pm 5^\circ$, as shown in Figure 18.

A pull-up assembly is only necessary when the front rigging chains (Xvsg, Xvsl and Xvsd) go slack because gravity will not permit the cabinets to hang with the required vertical angles. The pull-up assembly must only be pulled back until the front chains are taut. Additional pull-up force can result in excessive forces in the rigging, or can result in load shifts between the front and back cabinet rigging hardware, the grid, or the hoist motors used to suspend the array. It is the responsibility of the user to make sure that an excessive pull-up force has not been applied.

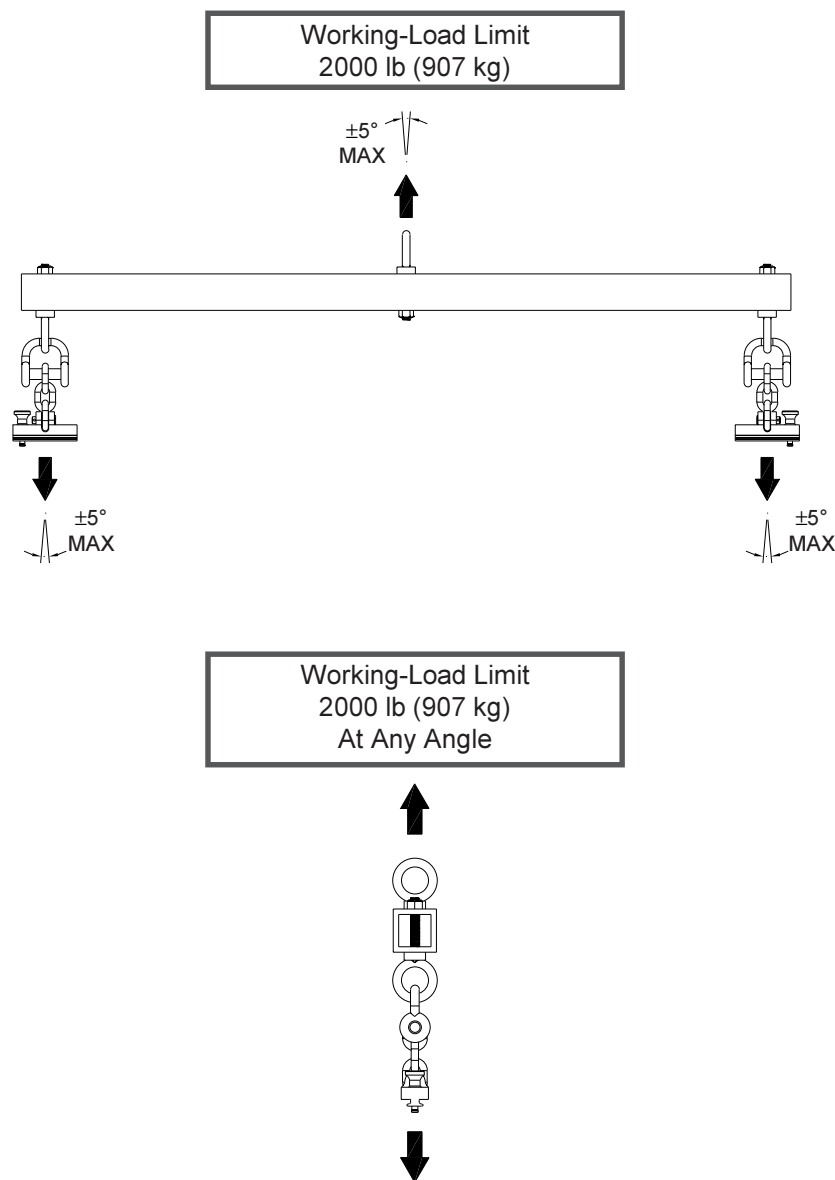


Figure 18:
Xvbp
Structural Ratings

RS-1B Structural-Strength Ratings:

The working-load limit of each individual rigging point on the rear of an X-Line enclosure is dependent upon the rigging-track/bracket assembly as it is mounted in the enclosure and the RS-1B swivel-ring double-stud fitting. The Xvls, Xvlt, Xsub, Xfil1 and Xfil2 enclosures have identical rigging track at the rear of the enclosure and have the same structural-strength ratings when used with the RS-1B, as shown in Figure 19a. It should be noted that the structural ratings are the same with any angle of pull. There are two rigging points at the rear of the enclosures. The structural ratings shown in Figure 19a are for a single rigging attachment point. Each rigging point has the same rating.

The working-load limit of each individual rigging point on the front of an X-Line enclosure is dependent upon the rigging-track/bracket assembly as it is mounted in the enclosure and the RS-1B swivel-ring double-stud fitting. The Xvls, Xvlt and Xsub enclosures have identical rigging track at the front of the enclosure and have the same structural-strength ratings when used with the RS-1B, as shown in Figure 19b. It should be noted that the front-to-back angle range shown in Figure 19b is only 270° for the RS-1B because the fitting can only be put into tension and the enclosure prevents a full 360° rotation. It also should be noted that, with these enclosures, the RS-1B fittings are only rated for use over side-to-side pull angles of a maximum of $\pm 5^\circ$, as shown in Figure 19b. There are two rigging points at the front of the enclosures. The structural ratings shown in Figure 19b are for a single rigging attachment point. Each rigging point has the same rating.

The Xfil1 and Xfil2 have their front rigging track hardware located on the sides of the enclosure, and have the same structural rating when used with the RS-1B, as shown in Figure 19c. It should be noted that the structural ratings for the Xfil1 and Xfil2 enclosures are the same with any angle of pull. There are two rigging points at the front of the enclosures. The structural ratings shown in Figure 19c are for a single rigging attachment point. Each rigging point has the same rating.

CAUTIONS for a Complex Structural Rating Analysis:



WHEN APPLYING A COMPLEX STRUCTURAL RATING ANALYSIS TO ANY X-LINE LOUDSPEAKER SYSTEM SUSPENDED OVERHEAD, THE USER MUST OBEY THE FOLLOWING RULES:

1. For the front of every enclosure in an array, never exceed the working-load-versus-angle limit for the Xvsg, Xvsl, Xvsd and Xvsf rigging assemblies. Never exceed the side-to-side angle limits.
2. For the back of every enclosure in an array, never exceed the working-load-versus-angle limit for the Xvhl linking hinges, Xvhg grid hinges, Xvhp pick-up hinges or Xvbp pull-up bar. Never exceed the side-to-side angle limits.
3. Always make sure that the rear hinge locking pins on every Xvhl linking hinge, Xvhg grid hinge, Xvhp pick-up hinge and Xvbp pull-up bar are fully engaged in the rigging track on the back of every enclosure (and grid, when applicable) before lifting overhead.
4. Always make sure that the locking pins on all the front triple-stud fittings on every front Xvsg, Xvsl, Xvsd and Xvsf rigging assembly are fully seated and locked in the rigging track base on the front of every enclosure (and grid, when applicable). Always make sure that there is not a twist in these chains before lifting overhead.

Working-Load Limit
500 lb (227 kg)
At Any Angle

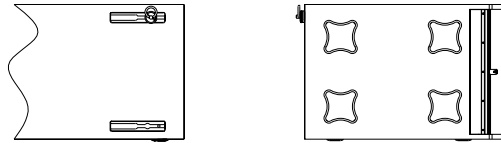


Figure 19a:
Xvls, Xvlt, Xsub, Xfil1 & Xfil2
Rear Rigging Point Structural Ratings

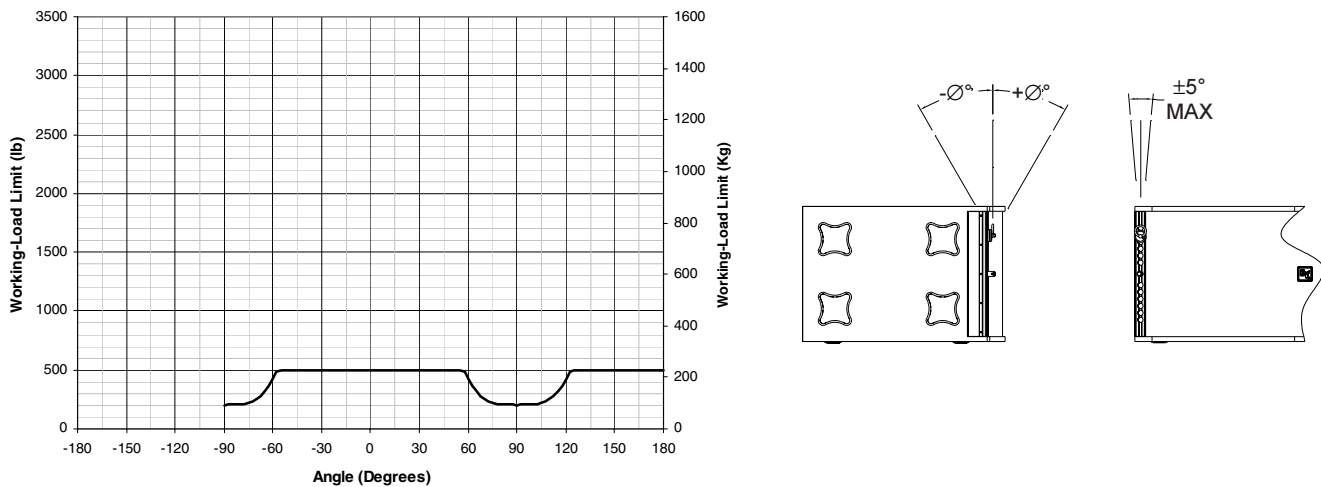


Figure 19b:
Xvls, Xvlt & Xsub
Front Rigging Point Structural Ratings

Working-Load Limit
500 lb (227 kg)
At Any Angle

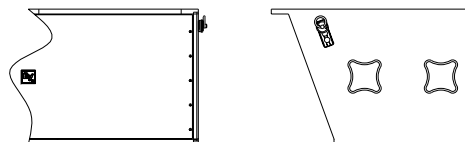


Figure 19c:
Xfil1 & Xfil2
Front Rigging Point Structural Ratings

CAUTIONS for a Complex Structural Rating Analysis (continued):

5. Only use Xvhl linking hinges, Xvhg grid hinges, or Xrhp pickup hinges manufactured by Electro-Voice.
6. Only use Xvsg, Xvsl, Xvsd or Xvsf front rigging assemblies manufactured by Electro-Voice.
7. Only use Xvbp pull-up bars manufactured by Electro-Voice.
8. If RS-1B double-stud swivel-ring fittings are used, never exceed the working-load limit for the RS-1B at either the front or the back of any enclosure in an array.
9. When a pull-up assembly is used, never exceed the working-load limits of any of the components making up the pull-up assembly.
10. When a pull-up assembly is used, never apply a pull-up force greater than that required to eliminate any slack in the front rigging chains.

3.5 Wind Loading

The X-Line loudspeaker systems have been designed to survive winds of up to 60 miles per hour (96.6 kilometers per hour) if the bottom cabinet is rigidly secured. For obvious safety reasons, Electro-Voice urges the user not to suspend any loudspeaker systems overhead outdoors when high winds are expected. When suspending X-Line loudspeaker systems outdoors, the user is strongly encouraged to rigidly tie off the bottom cabinets in all arrays as a safety precaution against unexpected high winds.

An Xvbp pull-up bar with an attached strap may be used to secure the bottom cabinets. Xvhp pick-up hinges may also be used. The tie-off assembly must have a working-load rating of 2000lbs (907kg). A ratchet strap with a 2000lb working-load rating must be used for the pull-up assembly.

3.6 Electro-Voice Structural-Analysis Procedures

Electro-Voice maintains a structural pull-test facility in Burnsville, Minnesota USA which includes load cells with digital-electronic display and recording. The load cells are calibrated annually by an independent laboratory to a standard traceable to the United States National Bureau of Standards. This pull-test facility is capable of pulling to destruction both individual rigging components and complete loudspeaker systems.

Electro-Voice utilizes state-of-the-art computer-modeling programs for structural analysis throughout the development of loudspeaker systems. The computer modeling enables the complex forces in the rigging components and enclosures to be analyzed for loudspeakers assembled into arrays in both static and dynamic conditions.

Structural testing and computer modeling were used throughout the engineering development of all the X-Line individual rigging components and complete loudspeaker systems described in this manual. Testing and modeling involving both anticipated use and anticipated misuse were performed as part of the analysis. Engineering prototypes were stressed to failure and designs were revised based on those test results. Production systems and components were stressed to failure for verification of the final designs.

4. Rigging Inspection and Precautions

Electro-Voice X-Line Loudspeaker Systems:

Prior to each use, inspect the loudspeaker enclosures for any cracks, deformations, missing or damaged components that could reduce enclosure strength. Inspect the track and bracket assemblies on the enclosures for any cracks, deformations, missing or loose screws which could reduce the flying hardware strength. Replace any loudspeaker systems that are damaged or missing hardware. Never exceed the limitations or maximum recommended load for the X-Line systems.

Electro-Voice X-Line Rear Rigging Hinges: Prior to each use, inspect the rigging hinges for cracks, burrs, corrosion or missing or damaged components that could reduce hinge assembly strength. Replace any rigging hinges that are damaged or missing hardware. Always double check that each rigging hinge is securely locked into position in the track on the X-Line enclosures and grids before lifting. Never exceed the limitations or maximum recommended load for the X-Line hinges.

Electro-Voice X-Line Front Chain Rigging-Strap Assemblies: Prior to each use, inspect the chain for cracks, burrs or corrosion that could reduce rigging strap strength. Inspect the rigging fittings for any cracks, burrs, deformation, corrosion or missing or damaged components that could reduce fitting strength. Replace any rigging straps that have damaged chain, or damaged or missing hardware. Always double check that each fitting on each of the rigging straps is securely locked into position in the track on the X-Line enclosures and grids before lifting. Never exceed the limitations or maximum recommended load for the rigging strap assemblies.

Electro-Voice X-Line Pull-Up Bars: Prior to each use, inspect the pull-up bar assembly for cracks, burrs, corrosion or missing or damaged components that could reduce hinge assembly strength. Replace any rigging hinges that are damaged or missing hardware. Always double check that each rigging hinge is securely locked into position in the track on the X-Line enclosures and grids before lifting. Never exceed the limitations or maximum recommended load for the X-Line pull-up bars.

Grid Assemblies: Prior to each use, inspect the grid assembly and associated hardware for any cracks, deformations, broken welds, corrosion, missing or damaged components that could reduce the grid assembly strength. Replace any damaged grid assemblies. Never exceed the limitations or maximum recommended load intended for grid assembly design. Never exceed the limitations or maximum recommended load for the grid assemblies.

Chain Hoists: Prior to each use, inspect the chain hoist and associated hardware (including motor, if applicable) for any cracks, deformation. Broken welds, corrosion, missing or damaged components that could reduce the hoist strength. Replace any damaged chain hoists. Never exceed the limitations or maximum recommended load specified by the hoist manufacturer. Always follow manufacturers' recommendations for operation, inspection, and certification. Always raise and lower the load slowly and evenly, avoiding any rapid changes in speed or shifting loads that could result in a sudden jolt to the suspended system.

Building, Tower or Scaffold Supports: Prior to each use, the strength and load-bearing capabilities of the building, tower or scaffold structural supports should be evaluated and certified by a professional engineer as being adequate for supporting the intended rigging system (including the loudspeakers, grids, chain hoists and all associated hardware). Prior to each use, inspect the building, tower or scaffold structural supports for any cracks, deformation, broken welds, corrosion, missing or damaged components that could reduce the structural strength. Damaged structural supports should be replaced or repaired and recertified by a professional engineer. Never exceed the limitations or maximum recommended load for the supports.

Miscellaneous Mechanical Components: Prior to each use, inspect all mechanical components (chain, wire ropes, slings, shackles, hooks, fittings, ratchet straps, etc.) for any cracks, deformation, broken welds, slipping crimps, fraying, abrasion, knots, corrosion, chemical damage, loose screws, missing or damaged components that could reduce the maximum strength specified by the component manufacturer. Replace any damaged mechanical components. Never exceed the limitations or maximum recommended load for the mechanical components.

References

Rigging References

- [1] W.E. Rossnagel, L.R. Higgins & J.A. MacDonald, Handbook of Rigging for Construction and Industrial Operations, McGraw-Hill Book Company, New York, NY, USA (1988).
- [2] J.O. Glerum, Stage Rigging Handbook, Southern Illinois University Press, Carbondale, IL, USA (1987).
- [3] P. Carter, Backstage Handbook, Broadway Press, New York, NY, USA (1988).
- [4] ATM Fly-Ware™, Riggermeister Production Rigging Guide, ATM Fly-Ware™, Carson, CA, USA (1995).
- [5] Wire Rope Technical Board, Wire Rope Users Manual, American Iron and Steel Institute, Stevensville, MD, USA (1985).
- [6] Broderick & Bascom Rope Company, Rigger's Handbook, Sedalia, MO, USA (1993).
- [7] MacWhite Wire Rope Company, Catalog of Tables, Data and Helpful Information, Kenosha, WI, USA (1991).
- [8] Acco Chain & Lifting Division, Chain Sling User's Manual, Acco Corporation, York, PA, USA (1992).
- [9] Newberry, W.G., Handbook for Riggers, Newberry Investments Company, Calgary, Alberta, Canada (1989).

Mechanical Engineering References

- [10] J.L. Meriam & L.G. Kraige, Engineering Mechanics, Volume One - Statics, John Wiley & Sons, Inc., New York, NY, USA (1992).
- [11] J.L. Meriam & L.G. Kraige, Engineering Mechanics, Volume Two - Dynamics, John Wiley & Sons, Inc., New York, NY, USA (1992).
- [12] J.E. Shigley & C.R. Mischke, Mechanical Engineering Design, McGraw-Hill Book Company, New York, NY, USA (1989).
- [13] A. Jensen & H.H. Chenoweth, Applied Engineering Mechanics, McGraw-Hill Book Company, New York, NY, USA (1983).

Notes

U.S.A. and Canada:

For customer orders, contact the Customer Service department at:

800/392-3497 Fax: 800/955-6831

For warranty repair or service information, contact the Service Repair Department at:

800/685-2606

For technical assistance, contact Technical Support at:

866/78-AUDIO

Specifications subject to change without notice.

All Other International Locations:

952-884-4051 Fax: 952-736-4212

www.electrovoice.com • Telex Communications, Inc. • www.telex.com

Printed in U.S.A

© Telex Communications, Inc. 9/2002

Part Number 38110-158 Rev A