



## Field Mechanization for Cladding Installation

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***Mechanization*** - Use of machine(s), either wholly or in part, to replace human or animal labor.

Site logistics and installation planning is a particular expertise of Enclos, and a practice that starts early in the design process, often as part of pre-sale efforts. Prior to ever stepping foot on a jobsite, we develop a plan of attack intended to maximize our field processes to provide the project team the greatest opportunity for success. Drawing on over three decades of company experience, our operations and field personnel develop a streamlined process for each new venture. This article will focus on the equipment used in support of our cladding installation processes by discussing project examples in which we have employed machine tools. Because every project is different, there is no “best solution” for facade installation. Instead, here you will find a resource showcasing options for optimal success.



CRANE & MECHANIZATION OVERVIEW

The construction industry is always searching for revolutionary ways to increase field productivity and minimize project duration. The use of mechanized systems in conjunction with unique installation strategies and approaches can reduce the construction duration of any project. At Enclos, we go one step further by maximizing off-site activities of the facade system to reduce our onsite schedule. Key factors in achieving this are the design approach of the system and minimizing site activities (field installation approach). Prior to project award, the Enclos sales team, in coordination with operational and field personnel, discusses installation strategies. Central to these discussions is how we are going to install the proposed facade design. Installation by crane is usually the preferred method; however, depending upon a variety of jobsite factors, additional approaches may need to be taken. There are multiple crane types and equipment to consider, and knowing the subtle differences in categories/types – along with picking capacities, initial setup and tear down – will greatly improve each project’s success.

1 MOBILE CRANES

A mobile crane is defined as “a crane that can move freely about the jobsite under its own power without being restricted to a predetermined travel path requiring extensive preparation” (Cranes and Derricks). Because the majority of Enclos’ work is on the exterior of the building, mobile cranes have proven quite useful and versatile in our operations. There are two main components to a mobile crane, the base and the lattice boom or telescoping cantilevered boom. The base (or carrier portion) of a mobile crane is what defines the crane as mobile – they are the means to move and maneuver the crane around the site. There are multiple types of bases used for mobile cranes, including: crawler base, truck carrier, all-terrain carriers, and rough terrain carriers. Jobsite conditions (i.e. terrain, access, congestion) are a key consideration regarding which base is most efficient.

Once a base is selected, the type of crane that will best suit specific installation requirements must be selected. The lattice boom crane has two key components, the upper-structure, which is the rotating structure that powers the crane, and the front end attachment (lattice boom), which is attached to the upper-structure and is the lifting apparatus of the crane. The second option is a telescoping cantilevered boom crane, which consists of a boom that is made up of several tubes that fit inside one another and extend out as the name suggests. Depending on the combination, a mobile crane can arrive at the jobsite ready to work, or require multiple deliveries of components for setup. If a crane requires an extensive setup, there will be a need to allow for adequate space on-site. At the very least, the ability should exist to extend the crane’s outriggers (if applicable) and be able to rotate the crane 360 degrees prior to ever picking a load. Mobile cranes will always require an operator. In addition,

depending on the crane’s configuration, a crane oiler may be required to lubricate machinery, change parts (i.e. jib extensions), and perform other routine machinery maintenance as required.

Beginning on the following page, examples of the more commonly used mobile cranes and carrier types are listed. Provided with the crane designation is the general capacity range (in tons), max boom reach (in feet), and additional reach with jib extensions (jibs are lightweight, boom-like structures added to the boom tip to increase the height of the crane lift). There are a variety of base and crane combinations offered, and each mobile crane listed includes its set of advantages and disadvantages with respect to the given application. The choice of the correct machinery is rooted in project specific requirements and jobsite conditions. It should be noted that as the load travels away from the crane the lifting capacity decreases.

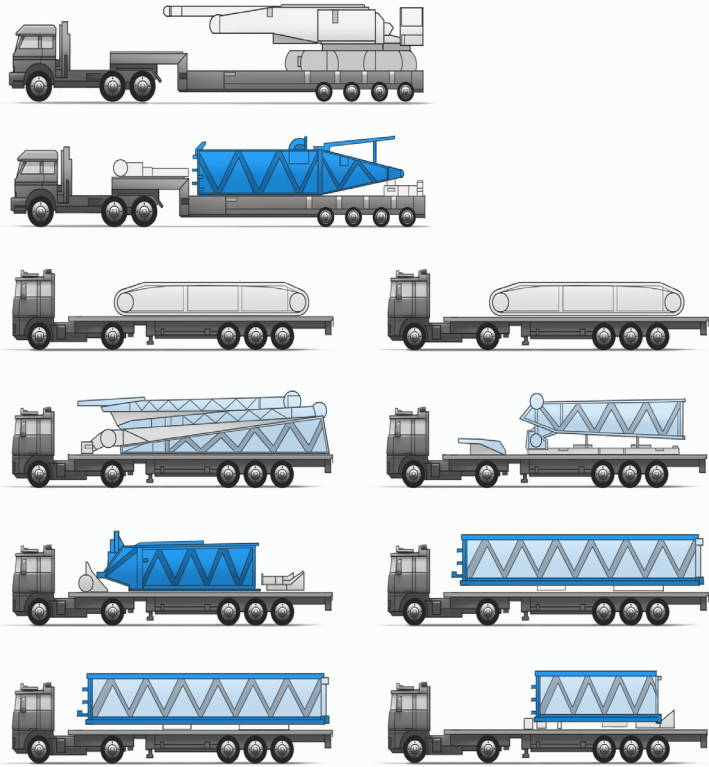


Figure 1: Example transportation requirements for a conventional crawler crane.



TYPES OF MOBILE CRANES

CARRY DECK

2-15 ton | Telescoping 50’ Max Reach | +20’ w/ Jib extension

Carry Decks are small telescoping cranes. Their size and configuration are similar to that of reach forklifts. They have a relative large picking load for their size, however their reach does not extend very far. Carry Decks do have the option for boom extensions similar to that of larger crane types. Carry Decks have crab steering, and drive and operate similar to reach forklifts. They will require delivery to site. We rent a reach forklift for multiple operations on almost every Enclos project, including material unloading, material staging, and other various operations. Because we often rent reach forklifts, the use of a Carry Deck is generally not needed, unless installing a heavy storefront or facade located beneath a soffit, which may require full-time use of this equipment.

BOOM TRUCK

17-25 ton | Telescoping 100’ Max Reach | +55’ w/ Jib extension

Boom Trucks are highly mobile cranes with the ability to pick a fairly significant load. They are flat bed trucks with a multiple-section boom crane. Their reach is very limited as their main purpose is to unload materials quickly and easily, without having to use the production crane or equipment for unloading. Enclos typically does not use Boom Trucks to install facade components, but rather for unloading facade materials.

CONVENTIONAL TRUCK CRANE

100-750 ton | Max Main Boom Reach 459’ | +168’ w/ Luffing Jib extension

A conventional truck crane has a truck carrier base with a lattice boom upper-structure. The upper-structure is composed of three sections: butt, insert and tip sections. Butt and tip sections make up the basic boom arrangement, which provides the crane’s maximum lifting capacity. The lattice boom is lighter in weight than a telescoping boom, and has the ability of adding ‘insert’ sections to increase its reach. Note that there are many different configurations with regards to this crane type, but the longest booms are approximately 350 feet in length. Although the truck carrier can travel on the highway to the jobsite, the upper-structure sections are generally trucked to the site separately, requiring additional transportation and setup costs for the rental. Prior to making a rental agreement, confirm that there is adequate space onsite for the upper-structure assembly, as it is typically assembled on the ground and then lifted into place. Also, proper space will be needed in the event of an emergency (i.e. high winds) and the upper-structure has to be laid down. Another consideration that must be accounted for is the addition of counterweights. Although the machine’s weight – coupled with the outriggers – provides a key role in resisting tipping, counterweights may need to be added to aid in tipping resistance.

TELESCOPING CANTILEVERED BOOM CRANE WITH TRUCK CARRIER BASE - HYDRAULIC TRUCK CRANE

35 to 110 ton | Max Reach 185’ | + 25-45’ w/ Jib extension

The hydraulic truck crane, or “Hydro” for short, has the same versatile features that conventional truck cranes have, with the exception that the boom is self contained. This means that the crane is ready to work upon arrival at the jobsite with only a short setup period. Adequate space around the crane will be needed to extend the outriggers, and also when rotating or “swinging” a load. These cranes also require a stable, relatively flat surface to operate from, unlike the RT or AT. There is no need for additional boom trucking as the telescoping boom extends out of itself hydraulically. There are several different sections that can be added to the tip to increase the boom length. There are also manual inserts (where the boom head is mounted on the insert and pinned), lattice extensions that are also pinned to the boom head, and various other jib types. Some of these jib sections can fold over to the side of the boom and be rotated back into place when needed, but generally they will need to be delivered separately to site. Other potential costs can include additional counterweight rentals and shipment, which depend on the load being lifted and the distance needed to reach.



Mobile cranes are not always the best solution. Selection considerations include cost, duration, jobsite access, and unique project requirements, and these considerations often favor the use of a fixed crane.

ROUGH TERRAIN CRANE

30-130 ton | 155' Max Telescoping Boom | +60' w/ Lattice Jib extension

Rough Terrain Cranes – or RT for short – can be driven to the jobsite, however they cannot travel at highway speeds and are generally shipped to the site instead. The carrier portion is composed of two-axels with four rubber tires, and can operate and move about jobsites with difficult terrain. This carrier drives the crane as well as powers the boom. RTs are included in the telescoping boom crane category, with a capacity that can reach upwards of 130-tons. They also have the ability to pick-and-carry loads, in addition to crab steering. These cranes typically only require a single operator, with an oiler, on-call for maintenance or repair as necessary. Again, jib extension and counterweights may need to be included based upon lifting requirements.

ALL-TERRAIN CRANE

35-320 ton | 200' Max Telescoping Boom | +275' w/Luffing Jib extension

All terrain cranes – or AT for short – combine the hydro truck and rough terrain cranes. These cranes can travel from jobsite to jobsite similar to a truck carrier, but are also capable of navigating challenging terrain similar to RT cranes. ATs can have multiple axels to allow for increased load capacity, combined with a telescoping cantilevered boom. Unlike the RT, the all-terrain crane has a cab for driving the carrier, and a separate cab for crane operation. Additional features of the AT are the ability to travel while carrying loads, and crab steering for moving in tight quarters. These driving operations can be executed while in the operator's cab to eliminate the need for multiple operators when executing pick-and-carry operations. Like the other mobile cranes, additional trucking may be required for jib extensions and counterweights.

AERIAL (HELICOPTER) CRANE

10,000 lbs

Aerial cranes are seldom used with respect to Enclos' work. The primary reason to use an aerial crane in construction is to access the top of a very tall building to install/remove heavy loads. Aerial cranes can accommodate loads up to 10,000 lbs (fuel weight has to be taken into consideration with the load). They can provide fast and efficient service to a jobsite with constrained accessibility.

2 FIXED & OTHER

Mobile cranes are not always the best solution. Selection considerations include cost, duration, jobsite access, and unique project requirements, and these considerations often favor the use of a fixed crane. This crane type is defined by a primary structure that is "fixed" in one location throughout the duration of its use. The most commonly used fixed crane is the tower crane, and it is also the most common choice for installing unitized curtainwall systems. However, there is various other mechanized equipment utilized as standalone options or in conjunction with mobile and/or tower cranes.

TOWER CRANE

2-45 ton | 275' Max Reach | Extension N/A

The tower crane is defined as a fixed crane because the main support base structure is fixed to the ground on a concrete pad. The primary benefit of the tower crane is that it has no height limitations. The mast (or tower) is periodically tied into the structure for bracing support, but can reach as high as 265' without bracing. The mast of these cranes are located either on the exterior of the structure, tying into the floor slabs or into a shear wall, or inside the structure (commonly in an elevator shaft). At the top of the mast is the slewing unit, which allows the crane to rotate. The main components of a slewing unit include: the horizontal jib (carries the load), the trolley (travels along the jib to move the load in and out), and the counter-jib (carries the counterweight opposite the jib). Atop the slewing unit is where you will find the operator's cab.

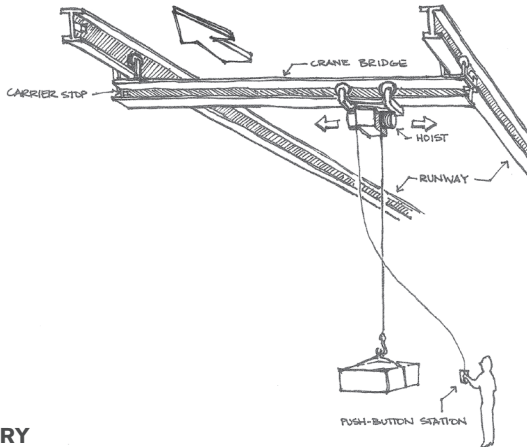
These cranes are capable of increasing their own height, or "self-climbing." This is done using a climbing frame (a section just below the slewing unit), which raises the slewing unit up off the mast. After the climbing frame has increased to the specified vertical distance to accommodate for the new mast section, the crane picks the new mast section and inserts it below the slewing unit. This process can be repeated as many times as necessary to achieve the desired height. To uninstall the crane, this process is repeated in reverse for an externally mounted mast. For internally mounted masts, additional equipment may be required to disassemble the crane. The maximum reach radius at the tip of the jib is around 275'±. Note that as the load travels further away from the mast, the lifting capacity decreases.

For tower cranes, the lifting capacity is often rated in ton-meters. A ton-meter is a measurement of distance multiplied by force. For example, when renting a crane that has a 250 ton-meter capacity, that crane can lift a load of 10 tons at 25 meters. This would also mean that a 250-ton load could be lifted at 1 meter, which is obviously incorrect. Most manufacturers begin their ratings at a few meters away from the mast, so it is best to consult the manufacturer or vendor on exact capacity prior to renting or executing a load of that magnitude.

Tower cranes are on the more expensive end of the spectrum for monthly rentals, with associated high setup and tear down costs. Provisions and planning need to be addressed with the structural engineer-of-record to ensure that the structure can accommodate the loads imposed by the tower crane during installation and while the crane is operating. Initial setup, teardown and rental costs can be offset by the high production rates achieved by tower cranes. For high-rise building construction in particular, tower cranes are very effective because of their extremely high line-speed, which allows materials to travel long distances (vertically) in a short amount of time. It should be noted that there are other various types of tower crane mounting and jib configurations, but the static base with saddle jib configuration described above is more commonly used.



Figures 2 & 3: An overhead bridge crane (above) and a hand-held push button on an overhead crane (right).



OVERHEAD BRIDGE AND GANTRY CRANES

Capacity varies | Reach varies

Overhead cranes, also called bridge cranes, consist of a hoist, crane and set of runways. The runways are fixed where the crane bridge spans across them perpendicularly and is able to slide along tracks to move the load. The hoist mechanism, which picks the load, also travels on tracks along the crane bridge to offer additional maneuverability. There are several types of overhead cranes, but we typically see floor-operated cranes in our shops at Enclos.

The gantry crane is very similar to the overhead crane, however the bridge is fixed atop vertical legs of a specified height, which

travel on a set of runways or wheels located at the base of the legs. These cranes are more applicable to our field skylight facade installation. These configurations have a large initial cost since they are generally designed, engineered, and constructed for each specific project. In addition, because gantry cranes are generally used for skylight installation, an additional crane will need to be rented to lift the gantry crane components to the top of the building for assembly. Accommodations for getting skylight materials onto the roof should also be considered. However, once the gantry crane is assembled and operating, there are no additional rental costs or fees.

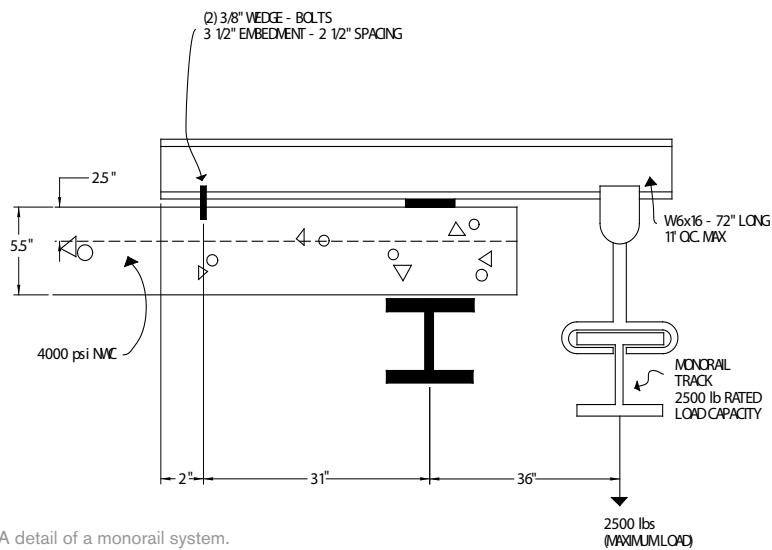


Figure 4: A detail of a monorail system.

MONORAIL SYSTEM

Monorail systems are composed of a monorail, I-beam kickers/supports, and an under-hung bridge crane. The monorail system is a highly effective mechanized system for installing single-span curtainwall units. The systems can be rented or purchased at a relatively low cost compared to a crane rental. The I-beam supports will need to be secured to the structure using anchor bolts or embeds, or with a floor-to-ceiling screw jack that holds the beam secure to the slab. If embeds are chosen, it is necessary to check with the structural engineer and coordinate with the general contractor so that embeds can be placed prior to the concrete pour. Having to drill into the slab can be very costly, especially if the slabs are pre/post-tensioned. Once the supports are secured, the monorail can be hung with the bridge crane hoist. The monorail system should always be set up as high in the structure as possible to minimize “jumps” or relocations. Jumps can take between one and two full working days, and depending on the building’s footprint, can shut down all curtainwall unit setting. In some cases, curtainwall units and monorail system components are able to fit into the man-hoist, but when they are not, other means to stock the floors with materials should be investigated. One way to stock the floor is with a Chicago boom derrick, which will be described in more depth below.

DERRICKS AND THE CHICAGO BOOM DERRICK

1/4 -35 tons | Boom length 10’ to 125’

A derrick, according to the ANSI Safety Code for Cranes, is “an apparatus consisting of a mast or equivalent member held at the head by guys or braces, with or without a boom, for use with a hoisting mechanism and operating ropes” (pg 42). The primary difference between a derrick and crane is that the crane’s hoisting mechanism is an integral part of the machine.

There are a variety of different derrick configurations, but for our purposes, the Chicago boom derrick configuration is the one that will most likely be of use. The Chicago boom, by and large, is installed on the exterior of the building, commonly on a column or building frame. Topping blocks or sheaves are located at the tip of the boom and at the pivot fitting on the support structure. The guy lines, which stabilize the derrick, are also used for the luffing operation (luffing defined as “changing the angle the main load-supporting member makes with the horizontal”). In other words, the load can be swung and maneuvered via the pivot fitting. Because of structural considerations, it is not recommended to place the derrick on the corners of the building, limiting the swing to 180 degrees.

The Chicago boom is a quick and efficient way to stock a building with materials. On a jobsite with limited delivery access, the Chicago boom can be positioned to unload delivery trucks in conjunction with stocking the building. Although this derrick could be used to perform facade installation, it is generally used in combination with a monorail, floor crane, or another installation method. The Chicago boom also may require a loading platform to land the materials depending on their size, weight, and ability to maneuver the picked load into the building.

Noteworthy is the large effort involved in setting up and relocating the derrick. The majority of this effort is involved in the pre-planning and engineering phase, but the physical setup and staging of the derrick’s components can cause issues. In some instances, an additional hoisting device may be needed to lift the derrick’s components to the installation location, as they may be too large or heavy to lift in the man-hoist. There are companies that offer both crane and derrick rentals, but depending upon the rental duration, it may be cheaper to engineer and fabricate rather than rent.

BUILD AND SLIDE

Job specific, must be engineered

The build-and-slide installation approach is more of a method than piece of equipment, however it is worth mentioning because of its use of mechanization principles. A build-and-slide operation is setup similar to that of a gantry system, and is typically used for skylight installation. All that is required for this setup are runways, several rolling platforms, and a winch. The runways are setup on either side of the opening, and the rolling platforms are positioned on the runways to build the first skylight or space frame section adjacent to the opening on the rolling platforms. Once a section is complete, the winch is rigged to the built section and rolled over the opening. The next set of rolling platforms is then placed on the runways and the next framing section assembled. This process can be repeated until the frame is complete, at which time it can be anchored to the supporting structure. Associated costs include the design and engineering of the runways and rolling platforms, as well as a winch with the capacity to pull the framing. In addition, a mobile crane will be required to stock the building materials and the build-and-slide system at the working location.

FLOOR CRANE

Up to 6,000 lbs | 3’ to 7’-6” reach

The floor crane is exactly as the name suggests. These small cranes are extremely portable, capable of fitting into the man-hoist and maneuvering through doorways and other tight areas. Floor cranes can be manually pushed or electrically operated similar to a pallet jack. Their hoisting mechanism is commonly operated by hydraulics, and can pick a load up to 6,000 lbs, depending on setup and counterweight. Some have a reach of up to 7’, although the bases and legs of some models may come too close to the edge of slab, thus not allowing the load to fully extend out of the building safely. As discussed, the further the load is extended out on the boom, the less capacity it has. Other considerations include the rigging equipment weight for unit and/or glass installation, head clearance inside the building, and slab capacity for equipment.



Figure 5: A mobile glass manipulator is of the mobile category, designed for field installation of large glass lites. This mobile glass manipulator can be purchased as shown; however, they are often customized to achieve the project’s requirements. This particular model can manipulate a 2,000lb piece of glass 6’ horizontally from the front of the machine’s wheels. These manipulators are often used if 2-3 men cannot handle a lite safely, there is limited access and clearance to install a lite, or just for the sake of production. They are also designed to fit through a standard doorway (3’ x 6’-8”) and fit into an elevator.



GLASS MANIPULATOR

Fixed weight and reach vary | Mobile machines capacity approximately 2,000 lbs with 6' horizontal reach /14' vertical reach

Fixed glass manipulators are often set up similar to a derrick or overhead crane with a vacuum cup attachment (discussed further in the rigging section) enabling a single user to “manipulate” a large piece of glass into a frame. These types of glass manipulators are often found in a factory or shop setting for mass production.

One advantage of the manipulator is that it is not actually classified as a crane. When a piece of equipment is categorized as a crane, complex and lengthy certification and approval processes can be involved. Drawbacks to a manipulator include a large initial cost, starting around \$40,000 and increasing significantly with project requirements. Counterweights must also be added to offset the large loads placed upon this otherwise small piece of equipment, especially if there is a large horizontal reach required.

WINCHES

2,000 2 Part Line

Winches also offer a significant lifting capacity while being extremely portable. It is easy to mount them to a variety of items, including carts, trolleys, concrete floors or columns, and other items. Enclos does not generally use winches for installation because variable line speeds are hard to control, ultimately complicating installation. Winches can be electrically or pneumatically operated. A common winch option is the GOLO product, which has a lifting capacity of 1,200 lbs. Another option is a “tugger,” which can come as an individual winch or on rolling carts. Consideration must be given to the difference between pulling and lifting capacity. Many times winches are rated by pulling capacity, which is substantially different (upward of 10,000 lbs) to their lifting capacity (typically 10% of the pulling capacity).

Enclos often chooses to **lift multiple units with a single pick** in an effort to decrease the total amount picks, thus **saving valuable installation time.**

3 RIGGING COMPONENTS

When lifting any item with mechanized equipment, rigging components and accessories are essential to securing and lifting a load. There are many different rigging accessories that can be utilized to lift a load, with some of the more common components used to lift facade units and components listed below.

HOOKS, SHACKLES, WIRE STRAND ROPE, FIBER ROPE, & SYNTHETIC SLINGS

Wire strand rope, fiber rope, synthetic slings, hooks, and shackles are all common elements that in some form or another, are used to rig a load in preparation for picking. Many of these items are used in conjunction with one another, or with one of the rigging accessories within this section.

Discussed following are considerations prior to using the materials for rigging and picking a load. When discussing any type of rope or sling – be it synthetic, natural, or wire – proper precautions should be followed prior to using them, including a capacity check prior to lifting any load, and inspection of the rope for any fraying, wear, or noticeable defects that could cause the rope to fail during picking. Hooks and shackles should follow a similar protocol prior to use. Check that the safe working load (SWL) is indicated on the hook or shackle. Hooks or shackles that are bent, deformed, spread, or display any other noticeable defects, should not be used.

SPREADER BAR

Most curtainwall units have two points of attachment for lifting the unit, referred to as picking points. Slings can be utilized for this operation, but the further the picking points are away from each other, the longer the sling cables need to be to reduce the sling angle. Sling angle is the angle created between the load and the sling cable. As this angle decreases from 90, the picking capacity for the slings decrease, increasing the bending forces at the picking points and creating both bending and shear forces. This is one reason for which Enclos employs spreader bars. Spreader bars are made out of steel tubing or plates, and are often engineered for each individual wall type. Because curtainwall unit sizes vary throughout a project, several sets of holes are created in the spreader bar to accommodate multiple picking point distances.

Spreader bars can also be used to eliminate the need for long sling cable lengths. Depending upon clearance issues, positioning the unit to the correct elevation with slings is often unachievable, and the spreader bar provides a means to shorten the hook-to-load distance.

Spreader bars can also be designed for picking multiple units. Enclos often chooses to lift multiple units with a single pick in an effort to decrease the total amount of picks, thus saving valuable installation time.



Figures 3 & 4: A multiple unit pick (top), and a spreader bar.





MGM CityCenter: Aria Resort & Casino | Las Vegas

## FLYING JIB

Flying jibs are used to install curtainwall units on high-rise buildings with a tower crane. The flying jib employs the same principles (and general setup) as the tower crane's horizontal jib. At one end of the flying jib is a hook with which to attach the curtainwall units, and at the other is a set of counterweights. Flying jibs are generally made of a steel I-beam with an off-center picking point for the tower crane hook attachment. The off-center picking point allows for an even balance when the curtainwall units are picked. Flying jibs are custom engineered for each project based upon the weight and quantity requirements of the cladding units.

The typical purpose for using a flying jib is to install curtainwall units in and under areas with setbacks (soffits) or when there are material debris nets on the project. The flying jib allows for clearance to keep the crane's main lines away from the structure or debris net, avoiding potential hazards. Most flying jibs are fabricated with fixed counterweights, although some are designed with an adjustable counterweight that moves and operates similarly to a trolley. The movable counterweight provides the ability to change the balance point of the load so that multiple sized curtainwall units with varying weights can be picked without having to change the flying jib.

## VACUUM (POWER) CUPS

up to 2,400 lbs, custom design

Power cups are the primary means for lifting large pieces of glass and flat metal panels. Due to the weight of these cladding materials and the difficulty in handling them, power cups provide the safest, most effective means to move these materials. A power cup is composed of a steel frame with multiple suction cups that utilize an electric-powered vacuum. The configuration of the vacuum cups can vary, but typical setups include; inline (4 cups), Quadra-tilt (4-8 cups), and a single large cup. Features sometimes allow for rotation and tilting, which give the ability

to manipulate the glass precisely into place. Choosing the correct configuration depends on the weight and dimensions of the material. For example, the weight can be large for insulated glazing units, affecting the power cup configuration. For general purposes, however, an inline cup can lift approximately 600-700 lbs. There are H-bars that allow two inline cups to tie together, doubling the capacity. Quadra-tilt capacities can range from 500-1400 lbs. On some quadra-tilt models, the four legs can be adjusted to accommodate odd shaped lites. Single large-cup unit capacities are approximately 300 lbs. Orientation of the lift and set can reduce the capacity of the power cup. It is imperative to read each power cup's specifications prior to use, with particular caution when applying to curved glass or rough panel surfaces.

## PORTABLE OVERHEAD HOISTS

Two of the more typical types of portable overhead hoists that Enclos uses are ratchet lever chain hoists (often referred to as chain falls) and pullers (or come-alongs). Both can be used as a means to install facades, although they are usually used in conjunction with a crane or another piece of mechanized equipment to assist in the installation. The main components of the ratchet lever chain hoists consist of an upper hook (from which the hoist is hung), a ratchet interlocking wheel, a lever, and a bottom hook. The lower hook is what connects to the load and is designed as the weakest part of the hoist. If the hook begins to bend it is a visual signal that the load is too heavy and needs to be lowered. The mechanical advantage of a chain hoist is about 22:1, and it can lift upwards of 50 tons. For portability reasons, typical chain hoists employed by Enclos generally fall into the ½ ton range. A puller is much smaller and lighter than a chain hoist. These can range from ¾ to 6 tons with a mechanical advantage of about 25:1. The chain fall is a very reliable option when needing to transfer the load from the crane. Come-alongs can also be used to transfer loads, or to pull units laterally to the correct layout location. Both rigging accessories are commonly found on Enclos jobsites.



4 FACADE TYPE & INSTALLATION METHOD

Each type of facade Enclos installs requires a custom installation method. Listed below are several categories of the more common facade types which we install, with a brief summary of the type of equipment we use to execute the installation.

CURTAINWALL: SINGLE SPAN



Monorail Installation Method

Here we install a monorail system as high on the structure as possible in order to limit the time required to 'jump' the system. Each floor is pre-loaded with bunked (crated) curtainwall units. Once the units are ready for installation they are pulled from their bunks, positioned near the edge of the floor slab using rolling carts, hooked up to the monorail system, and slid out of the building. The units are then positioned and lowered into place.

CURTAINWALL: SINGLE SPAN



Floor Crane Installation Method

A floor crane can be used where a monorail system is impractical. Furthermore, when a monorail is being jumped, floor cranes provide a means to keep installation going. The floor crane can also be used for glass replacement on large heavy lites, or in instances where a mobile crane or tower crane cannot reach the work area.

CURTAINWALL: DOUBLE SPAN



Tower Crane Installation Method

The most common approach used to install double span curtainwall units is with a tower crane. The units are shipped to the jobsite in bunks and set at the base of the tower crane (known as the "picking area"). The flexibility of the tower crane can accommodate the setting of multiple units with a single pick, decreasing the total number of picks and increasing productivity. In addition, the tower crane's high line-speed allows for shorter setting durations. Productivity rates for setting units vary widely as a function of unit size, design, building configuration, crew size, jobsite conditions, and other factors, but generally fall in the range of 16-20 units per eight-hour shift.

UNIQUE CONSIDERATIONS



New San Diego United States Courthouse

The units cladding the new San Diego United States Courthouse require a stringent blast rating, rendering each unit unusually heavy with additional steel support and stronger materials. We were unable to access soffit conditions with a typical mobile or tower crane, and this quickly became a key consideration of our installation strategy. For this unique application, multiple options were developed, including a floor crane with a large capacity GOLO and tugger.

**STRUCTURAL GLASS FACADES  
& GLASS STUCTURES**



Crawler Crane  
Howard Hughes Medical Center

The Howard Hughes Medical Institute: Janelia Farm Research Campus incorporates a very unique building footprint and challenging jobsite. Combined with custom structural glass features, the project required a complex installation strategy. A 150-ton crawler crane was used to install the facade as the optimal solution to navigate the difficult terrain and pick oversized heavy pieces of glass while maintaining a substantial reach. Lifting and transporting triple-ply glass components weighing 1,800 lbs each required a customized power cup configuration.

**STRONGBACK SYSTEM**



Rough Terrain Crane  
O.C. Performing Arts

This project integrated a large AESS strong-back system with curved glass lites for the building skin. Installation required equipment with the capacity to lift the large steel sections, and also have the finesse for flying in the curved glass lites. The equipment of choice for this demanding application was a rough terrain crane. The steel structure was rigged utilizing wire rope slings. To limit the number of crane setups, a jib extension was rented and utilized as necessary to extend the crane's reach. When setting the glass, a below-the-hook inline power cup was attached to the crane's hook to hoist the lites into place.

**TRUSS SYSTEM WITH  
POINT-SUPPORTED GLASS**



Hydraulic Truck Crane  
L.A. Live Tower & Residences: Podium

Because this project's tower crane was in high demand by multiple trades, another means of mechanized equipment had to be utilized to install the podium's point-fixed glass and AESS truss system. The working surface surrounding the jobsite was existing asphalt, allowing for the use of a truck crane to install these facade elements. The steel trusses were large, awkward, and heavy, but the biggest challenge proved to be limited reach of the truck crane. A pinned lattice boom jib extension was added to the truck crane as required to set some of the steel and glass components.

**CABLE NET**



RT Crane  
Station Place: SEC Headquarters\*

An RT crane was used on the SEC Headquarters to perform various installation requirements. There were three primary installation activities that required the RTs strength and agility:

1. Installation of a 60' AESS truss, weighing in excess of 12,000 lbs.
2. Hanging two preassembled cable nets.
3. Setting individual glass panels using a power cup attached to the crane's hook.

\*The project involvement was with ASI Advanced Structures, Inc. Enclos acquired ASI in 2007.



SKYLIGHTS & OTHER



Gantry Crane  
Shure Corporate Headquarters\*

A gantry crane was utilized to install skylights at this Chicago corporate headquarters building. Materials were loaded on the side of the opening, and the crane's rails/runways were placed back far enough from the opening to allow for material lay-down. The gantry bridge rolled down the rails to where the next row of material was stocked. The hoist then slid across the bridge to the stocked glass, picked a lite of glass, and then slid over the opening that was next in line to receive the panel.



Build and Slide  
Signature Resort, Maui\*

For this space frame structure, parts were delivered and staged on the roof. Runway tracks were installed along the opening in the roof. Two sets of rolling platforms/wheels were placed on each side of the track, one space frame section wide. Each section was assembled on the roof on top of the rolling platforms/wheels. As one section was completed, it was rolled over, and the next sets of rolling platforms/wheels were placed on the track ready for the next section to be assembled.



All Terrain Crane  
Casino Morongo\*

This AESS grid shell structure was prefabricated in large ladder sections off site. The factory prefabricated sections provided a higher finish quality while simultaneously reducing field labor costs. An all terrain crane was chosen because of its practicality, capacity, and maneuverability at the job site.



Aerial Crane  
Cira Center

The operations team for Cira Center created a benchmark for the installation and removal of a tower crane via the use of an aerial crane. Unique considerations for successful implementation often include street closure permits, coordination of the entire site and subcontractor operations, weather considerations at project location, and time of year.

\*The project involvement was with ASI Advanced Structures, Inc. Enclos acquired ASI in 2007.



Because we like to **minimize our on-site activities**, we **design and engineer the largest components and units** that we can safely install.

5 SAFETY

The biggest challenge for any building contractor is the work that takes place on the jobsite, and it is on this demanding playing field that Enclos most clearly differentiates itself. In addition to training our people in the discipline of relentless diligence as a means to optimum operational safety, we fine-tune our planning, strategies and tactics to the unique requirements of each individual building project we undertake. We have developed a unique expertise over decades of experience in cladding some of the most challenging building projects ever constructed. This experience has been documented in a concise compilation of best practices with respect to the operational safety of custom facade system installation, yet we recognize that each project presents a unique scenario, requiring contextual analysis as a means to anticipate potential challenges. Drawing upon this deep accumulation of experience, we craft a custom safety plan in direct response to each specific project context.

We typically design and engineer the largest components and curtain wall units that we can safely install, as a means to reduce installation schedule and provide optimum economy. The following section includes a few key considerations for logistics and jobsite planning with respect to mechanized equipment.

6 RIGGING, SIGNALING, & OTHER TESTS

Although Enclos generally does not operate the equipment we use to install our facades, each of our field workers is trained and often certified to understand the rules and guidelines associated with rigging practices. In addition, the safety department at Enclos gives a rigging test to each employee prior to allowing jobsite access. Each of the rigging components listed above are engineered and approved prior to Enclos utilizing them on site.

Because we also use cranes for many of our facade installations, teaching field workers how to properly signal the crane is crucial. Additional training is given to site workers as a prerequisite to directing any activities involving a crane.

7 OSHA: SUBPART CC CRANES & DERRICKS IN CONSTRUCTION

The Occupational Safety and Health Administration (OSHA) enforces laws and regulations with respect to construction. To the right is a quick checklist with regards to cranes and derrick usage that was put together by the Enclos safety manager, and provides a quick survey in which to verify that the jobsite is prepared to use mechanized equipment. If the answer to any of these questions is "no", the issue will need to be addressed immediately in order to provide a safe jobsite.

If specific information is needed, visit the OSHA site below:

[http://www.osha.gov/pls/oshaweb/owasrch.search\\_form?p\\_doc\\_type=STANDARDS&p\\_toc\\_level=1&p\\_keyvalue=Construction](http://www.osha.gov/pls/oshaweb/owasrch.search_form?p_doc_type=STANDARDS&p_toc_level=1&p_keyvalue=Construction)

An additional source for safety information regarding monorails and under-hung cranes is "ASME B30.11-2010 Monorails and Under-hung Cranes."

SUBPART CC-CRANES AND DERRICKS IN CONSTRUCTION § 1926.1400

This section applies to power-operated equipment used in construction that can hoist and lower by a winch and horizontally move a suspended load. Machinery is excluded if it has been converted or adapted for a non-hoisting/lifting use.

- Is assembly/disassembly being directed by a person who meets the criteria for both a competent person and a qualified person, or by a competent person who is assisted by one or more qualified persons ("A/D director")?
- Are site and ground conditions adequate to support the equipment for safe assembly/disassembly and hoisting operations?
- Is the operator licensed or certified to operate the specific crane that is being used?
- Is rigging and signaling being done by a qualified person holding a current certificate issued by an accredited agency or by Enclos? Are certification cards on site?
- Has there been a meeting with the equipment operator and other workers in the surrounding area of the equipment/load to review the procedures that will be implemented?
- Have crew members assigned to work with the equipment been trained for tasks assigned to them?
- Are synthetic slings protected from abrasive, sharp, or acute edges and configurations that could cause a reduction of the sling's rated capacity?
- Can any parts of the equipment, load line, or load (including rigging and lifting accessories) come closer than 20-50 feet to a power line during the assembly/disassembly and hoisting process? See Table "A" (§ 1926.1408) for safe operating distance.
- Has each operator and crew member assigned to work with the equipment been trained regarding the danger of electrocution in the event of electrical contact with a power line?
- Has post-assembly and daily inspections by a qualified person been conducted and documented?
- Has work area control been setup, including barricades and signage warning of hazards?
- Are all safety devices on equipment in good working order?
- Does the operator and qualified person have the authority to stop handling loads if safety is a concern?
- Has the operator, signal person and hook-on person contacted each other and agreed on the type of signals that will be used?
- Are the standard hand signal charts posted on the equipment or conspicuously posted in the vicinity of the hoisting operations?
- Has the swing radius of the crane been barricaded or roped off to eliminate the pinching or crushing of an employee against another part of the equipment or another object?

TABLE A – MINIMUM CLEARANCE DISTANCES

Voltage (nominal, kV, alternating current)	Minimum clearance distance (feet)
up to 50	10
over 50 to 200	15
over 200 to 350	20
over 350 to 500	25
over 500 to 750	35
over 750 to 1,000	45
over 1,000	(as established by the utility owner)





MGM CityCenter: Aria Resort & Casino | Las Vegas

## CONCLUSION

The use of mechanized equipment and the continual evolution of equipment technology has allowed Enclos to develop increasingly innovative facade installation processes. These new approaches have optimized field performance, decreased schedule durations, and most importantly, kept our work crews safe. As building designers and developers continue to push fundamental design boundaries, the significance of the facade contractor's role will continue to grow in years to come with an increased emphasis on jobsite activity.