Article: Corrosion Intercept tent packing and handling system for Donald Judd's brass and copper sculptures
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CORROSION INTERCEPT® TENT PACKING AND HANDLING SYSTEM FOR DONALD JUDD'S BRASS AND COPPER SCULPTURES: EXPERIENCES WITH PACKING AND HANDLING METHODS

Eleonora Nagy

Introduction

This paper discuses the latest result of our experiments at the Solomon R. Guggenheim Museum with various packing and handling systems for Donald Judd's brass and copper sculptures.

In the course of the last 30-some years, Donald Judd has emerged as a pivotal figure in the creation of a fundamentally new attitude toward the art process. Referred to as minimalism, this new approach rejected any reference to subject matter or the artist's emotions. It demanded a new way of defining what art is, and set forth a new philosophical base and a non-subjective aesthetic.

Judd, more than any artist before, explored and appropriated the wide range of industrial techniques and materials made available only in the last few decades of industrial evolution. His sculptures were made, or rather machined to specification, by a fabricator of industrial sheet metal products, using highly polished industrial brass and copper sheets. By providing drawings and precise measurements only for a fabricator and not building any of his works himself, Judd emerged as one of the pioneers erasing the artist's hand in the creation process.

Composed of immense, geometric shapes, Donald Judd's minimalist sculptures epitomize simplicity and perfection. The repeated identical units, free standing, in vertical stacks or horizontal progressions, display the characteristics of Judd's sculptures: flawless, highly polished, uniform surfaces of impeccable construction, meticulously executed precision, cleanness. Parts are repetitive, often equal and uninflected. A fusion of surface, substance and color takes place without the sensation of gravity. Juxtaposed with the highly polished metal, Judd often used sheets of vibrant colored Plexiglas.

The precise and uniform construction and the physical perfection are obvious qualities – so obvious, that people tend to forget how crucial they are to the work's visual power. One becomes painfully aware of the high degree of finish and the delicate use of materials when a work is damaged. In most traditional art, a small blemish can be absorbed or masked by the complexity of the compositional arrangement and by the variations on the surface. Minimalist art, in this respect, is much more vulnerable. In Judd's case, the slightest scratch or stain on the surface seriously jeopardizes the work. The damage destroys the work's visual consistency.

Since 1959, Judd was an articulate writer and extensively discussed many of the most pertinent issues of his art. Judd maintained that a natural and even tarnish layer on his sculptures was acceptable, but the slightest accidental damage, a dent, a scratch, fingerprint or stain would

destroy the material beauty and impeccable uniformity, and therefore the legacy of the sculpture. Also, Judd clearly expressed his disapproval in applying coatings on his metal sculptures. This legacy of Judd's severely impacts conservators who are responsible for the preservation of his artwork. Local repair of a small damaged area is nearly impossible without losing the meticulous uniformity and perfection of the surface. Often the entire surface of a sculpture has to be addressed for treatment any time the slightest damage occurs. With demanding exhibition schedules, treatment of these large scale and fragile surfaces is arduous and exorbitantly expensive. Conservators lack reference and established guidelines that define treatment of contemporary copper alloy sheet metals.

With Judd's sculptures, the need for a conservator's intervention most often stems from circumstances such as improper handling, installation, packing and storage. To prevent interventive treatments, such as re-polishing of the surface by the fabricator or the conservator, it is important to focus on packing and handling. The Guggenheim Museum has concentrated on preventive measures that have resulted in a packing system allowing handling of the sculpture from storage to installation without touching the surface of the works. It avoids direct contact of any packing material with the surface of the sculpture, and provides an enclosed controlled environment for the work in storage.

Before the system is presented, a few examples of various experiences will be discussed and new materials used in the system will be introduced.

Damage from Handling and Packing

It is well known that touching any highly polished brass or copper surface with bare hands will result in local tarnishing, which in the course of time, will etch into the metal. Almost without exception, in museum practice gloves are used. As latex and nitrile gloves may emit some volatiles or leave residues, generally cotton gloves are preferred. In the heat, sweat and effort of an installation, however, perspiration through the cotton gloves can be noticed. Perspiration marks usually last for a few seconds after the work is handled. This situation can be improved by a double glove method, by using a cotton glove over a latex one. Eliminating perspiration marks from the hands only drew our attention to the fact that other parts of the body, such as face, neck or lower arm occasionally come into contact with the metal surfaces. Handling larger sculptures and units with wrist-length gloves allows the bare lower arm to contact the metal. After these observations installation crews were asked to wear long sleeves.

The packing materials encountered in the past that were in contact with the surface of the sculpture have presented some problems. For example, Polyfoam™, a thin polyethylene foam, wrapped and secured with an ordinary paper masking tape leaves marks on the surface of the metal if the work remains wrapped for a long period of time. The wavy pattern from the Polyfoam™ transfers to the metal. The tape, though not in direct contact with the metal surface,

off gases and the sulfur from the masking tape leaves a clearly distinguishable blackish line on the surface.

Volara™, also a polyethylene foam, leaves the copper surface dark when it is in direct contact with the metal. The wooden storage crates, cushioned with Volara™ lined Ethafoam™ bumpers (Figure 1) were newly made, exactly one year before the date the damage shown in Figure 2 was noticed.

We have tentatively identified wrapping materials as the cause of the following surface marks: a straight disfiguring line across the surface of *Untitled 1973*, shown in Figure 3, and a startling pattern shown in Figure 4. The straight line in the first example (Figure 3) may be related to straight edges of wrapping papers. In the second example (Figure 4), contact with polyethylene sheet or a similar moisture barrier material is the suspected cause. Cotton twill tape or fabric placed in direct contact with the metal surface may leave transfer marks on metal surfaces. Transfer marks from contact with twill tape (Figure 5) and a cotton/polyester fabric were noticed on a contaminated copper surface after a year of storage. Consequently, materials that are normally considered archival have been found to leave disfiguring patterns on the brass and copper surfaces.

Corrosion Intercept®

The main cause of atmospheric corrosion of non-ferrous metals is the presence of sulfur and/or chlorine contaminants in the air. If these elements are eliminated from an enclosed environment containing the sculpture, the problem of maintaining the sculpture in pristine condition could be solved. The option became feasible by adopting a product called Corrosion Intercept® from the industrial market.

In the early 90's AT&T developed a product named Corrosion Intercept® to provide protection of non-ferrous metals from corrosion caused by atmospheric hydrogen sulfide, carbonyl sulfide, hydrogen chloride and other constituents. This brown, thin, heat-sealable barrier sheet is a polyethylene film which incorporates a semi-conductor (copper) that is covalently bonded to the polymer. The sheet is a lamination of three layers that are extruded at 280° F, and fused together without an adhesive. The polyethylene core layer provides the strength, and half the thickness of the sheet. The remaining two solid Intercept layers sandwich the polyethylene center. The Intercept component acts as a preferential corrosion site (sacrificial anode), whereby the covalently bonded copper additive becomes the sacrificial agent. The captured contaminants bond permanently with the additive and create stable bonds, thus leaving the object inside a Corrosion Intercept® sheet protected and unaffected by corrosive gases. Intercept does not contain volatile additives, so it does not contaminate the works it is used to protect. It does not need to contact the object to provide protection. When Corrosion Intercept® becomes ineffective and saturated with contaminants, the brown foil turns black, but does not release any contaminants to the

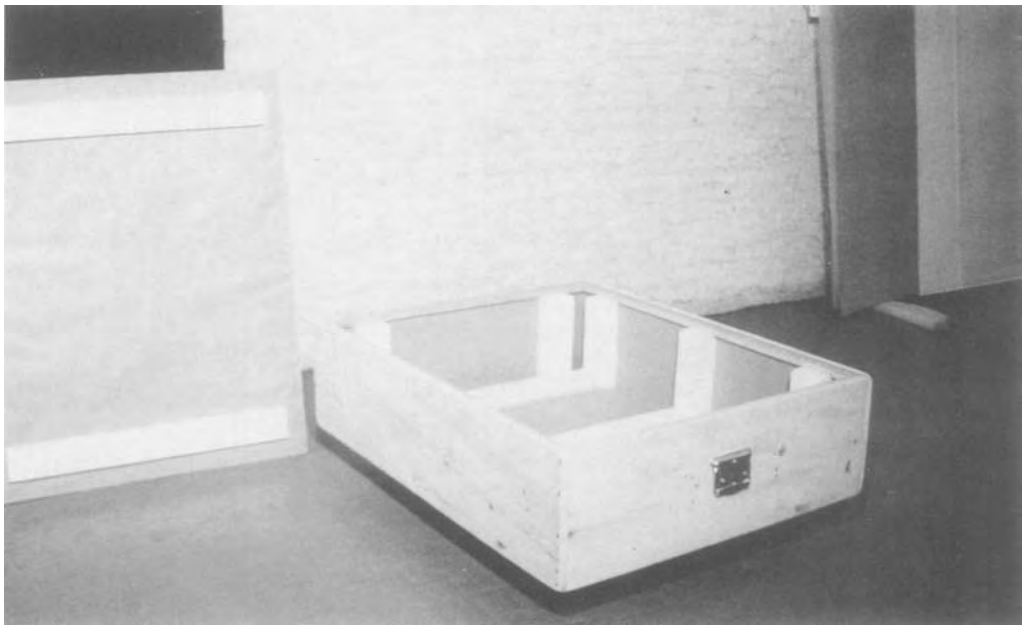


Figure 1. Storage crate, cushioned with Volara lined ethafoam bumpers for D. Judd: *Untitled 1969*, "Copper Stack".

Figure 2. Dark lines on the object (Judd: *Untitled 1969*, "Copper Stack") where it was in contact with the Volara bumpers.

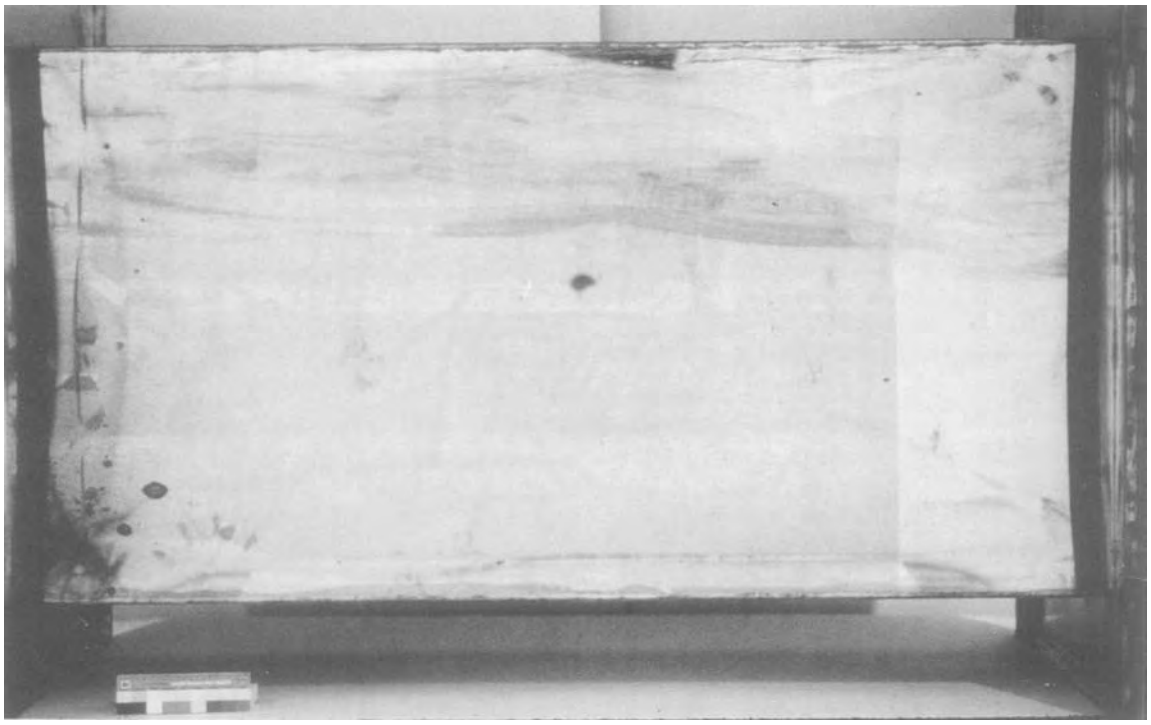


Figure 3. Straight lines of tarnishing on D. Judd: *Untitled 1973*, possibly from wrapping materials in contact with the surface.

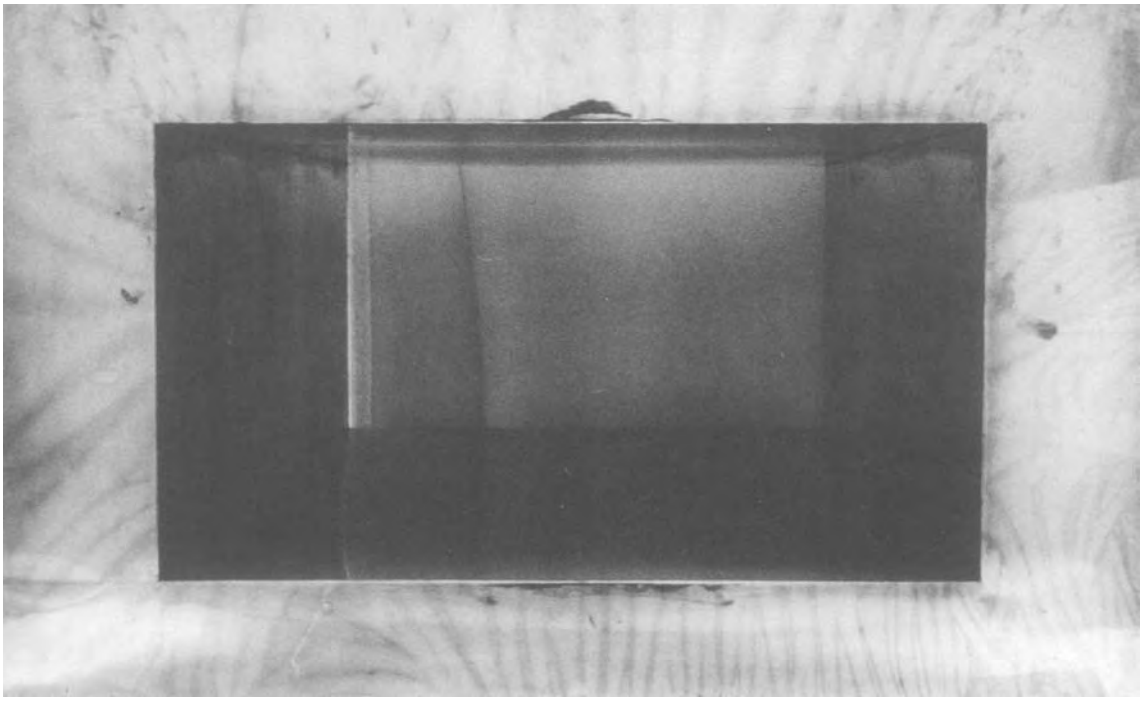


Figure 4. Pattern on the surface possibly from contact with polyethylene sheet. D. Judd: *Untitled 1973*, brass.

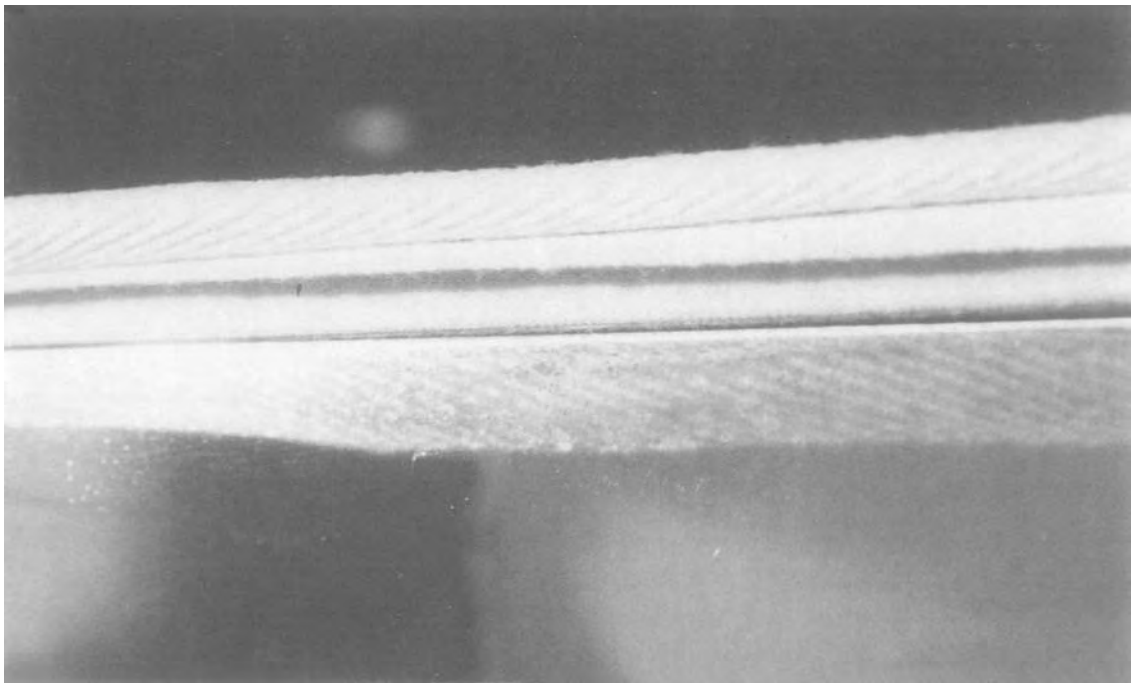


Figure 5. Transfer mark from twill tape on copper surface after one year storage. D. Judd: *Untitled 1969*.

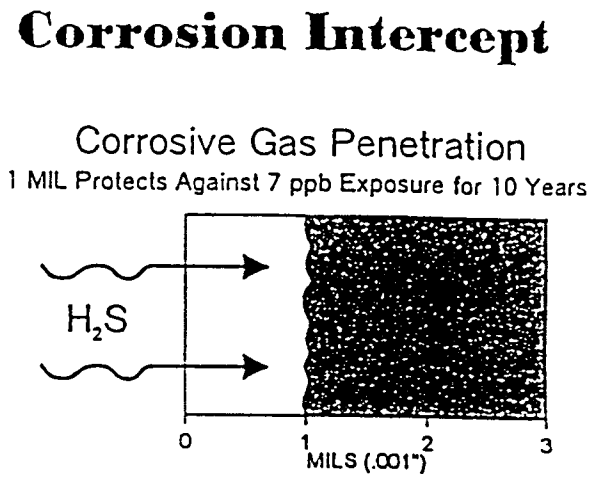


Figure 6. Source: "Inhibition of Metallic Corrosion by Reactive Polymers" in Bell Labs, *Technical Memo 11545-871009-17*, 11-12-1987. Permission by John Franey, co-author and member of Technical Staff, Lucent Bell Labs, Murry Hill, NJ.

surrounding environment. Based on testing done at Du Pont and AT&T it was determined that under average industrial levels of atmospheric sulfur and chlorine, it would take over 10 years for sulfur or chlorine to break through a 0.001" thick film (1 mil) of Corrosion Intercept® (Figure 6). Because the urban indoor environment has approximately 10 times lower average sulfur level than industrial environments, the life expectancy of a 3 mil Intercept in a museum environment can easily be expected well over 30 years (Figure 7). Results of corrosive gas protection of copper with the Intercept are published by the same company and are shown in Figure 8. Two commercial industrial corrosion inhibitors, Benzotriazole (BTA) and Imidazole (IMDA) were tested against Corrosion Intercept® at 5 ppm sulfur exposure, showing significantly better performance of Intercept as compared to the other tested materials. The water vapor permeability of an Intercept film is less than half that of a polyethylene with the same thickness (Figure 9). The price of Corrosion Intercept® is about the same as regular polyethylene sheets and can be purchased in the form of sheets, bags, corrugated board and other forms, in different thickness ranging from 2 mil-8 mil. The reactive polymer can also be formed into tubes, bubble pack, trays etc.

Previous Packing Experiences using Corrosion Intercept®

For six years the Guggenheim has been monitoring sculptures packed in Corrosion Intercept® sheet. The entire surface of the sculpture was wrapped first with a pre-washed cotton/polyester fabric followed by Corrosion Intercept®. Sculptures in pristine condition that were packed with this method have not changed their appearance in 6 years. As an example, Figure 10 shows a Copper progression which has been stored at the Guggenheim Museum with the pre-washed cotton fabric and Intercept wrapping system for 6 years. The piece was wrapped in pre-washed cotton fabric, then wrapped in Corrosion Intercept® and taped with an acrylic adhesive tape (Figure 11). As described in this example, sculptures can be adequately protected by simply wrapping them in the Intercept sheet, making sure that the edges of the Corrosion Intercept® sheet overlap. Alternatively, the edges can be sealed using a common, household vacuum–heat sealer. For this version, it is suggested to design an oversized bag, so the bag can be re-sealed and re-used a number of times. Experience at the Guggenheim Museum indicates that Corrosion Intercept® effectively protects the sculptures from pollutants in addition to being practical and economical. However, wrapping in fabric followed by Corrosion Intercept® was only successful for objects packed in pristine clean condition; a requirement no museum operating on a tight budget and exhibition schedule can afford. The metal surface had to be protected from contact with hands or wrapping materials and combined with the protection of Intercept.

Corrosion Intercept® Tent Packing and Handling System

The latest result of our experiments, the Corrosion Intercept®Tent Packing System, avoids contact with any surface of the sculptures. To understand the nuts and bolts of this system, it is helpful to first explain the construction method of Judd's sculptures.

Untitled 1972, shown in Figure 12, consists of six seemingly simple three-dimensional forms. The six identical cubes are equally spaced, forming a horizontal stack on the wall. Each cube is fabricated from two sheets of 1/16-inch sheet brass. The larger of the two sheets is bent twice to form the top, face and bottom of the cube. A smaller, separate sheet forms the back of the cube (Figure 13, left) When viewed in a cross section from the side, it is apparent that the larger sheet forms a big "U" into which the smaller "U" of the back sheet is inserted. The two sheets are joined, and form a double-sheeted lip along the top and the bottom of the cube. The reinforced lip along the top also functions as a hook to hang the pieces on the wall. Typically for Judd's sculptures, these lips hang on a galvanized sheet metal cleat that is attached to the wall (Figure 13, right).

Imagine a wall installation of a cube, with the lips secured to the wall, then rotate the image 90° degrees counter clockwise (Figure 14). The wall becomes a horizontal storage tray and the lips, secured to the cleats of the wall will be secured to the tray by clamps. The cubes, being secured with clamps to their tray, allow moving and transportation of the sculpture without touching it. A tent can be secured to this a tray, as illustrated in Figure 15, thereby creating a sealed microenvironment against pollutants.

For installation, the tent is taken off (Figure 16). A second tray, called the installation tray, is placed alongside the bottom of the cube, in contact with the bottom surface of the sculpture. The installation tray is secured to the storage tray. Holding on to the 2 trays, the work is rotated 90° degrees, to the vertical position it will hang on the wall. After the clamps of the storage tray are undone, and the storage tray is taken away, the work is properly positioned and prepared to be lifted up by the installation tray to be hung on the wall.

For de-installation the procedure is reversed. Using this system no handling of the work by hand is necessary. During the entire installation procedure only the bottom of the cube comes in contact with a packing material, and for no longer than 10 minutes. The only time the work has to be touched by hand is when the system is newly made and the work is placed for the first time on its new storage tray. Unless a conservation treatment requires complete dismounting of the object from its packing system, the work can be installed, de-installed, transported long distance and stored long term without touching the surface and thereby avoiding uneven tarnishing and corrosion.

Now let us go over a detailed step-by-step description of the system. First, a plywood tray 6 inches larger on each side than the footprint of a cube was made (Figure 17). Three inches are allowed for the inner space of the tent and three inches to secure the rims of the tent to the storage tray. The two long clamps, along the top and bottom lips were made of Masonite and plywood. The clamps glide out to lock, and in to open in two grooves which are secured with screws from the bottom of the tray (Figure 18). The top of these screws must be embedded into the surface of the clamp and covered. This precaution will avoid scratching the object accidentally with the top of a screw.

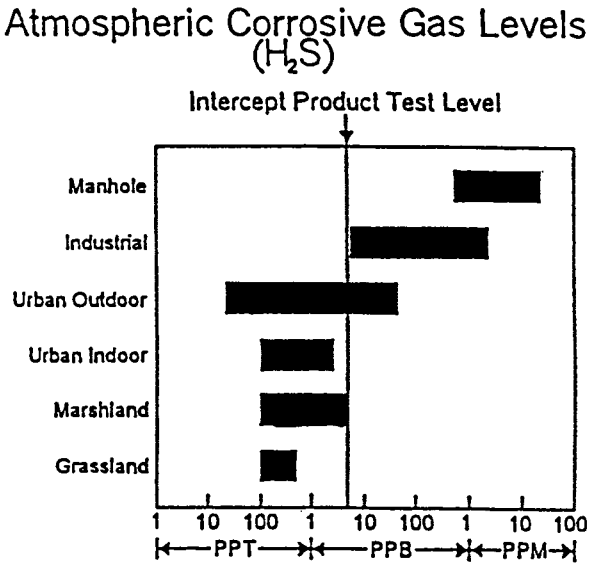


Figure 7. Source: Graedel, T.E.: "Concentrations and Metal Interactions of Atmospheric Trace Gases Involved in Corrosion", Reactive Polymer Presentation, Baxter Industrial Seminar, *International Congress on Metallic Corrosion*, Toronto June 3-7, 1984, pp 396-401. Permission by John Franey, co-author and member of Technical Staff, Lucent Bell Labs, Murry Hill, NJ.

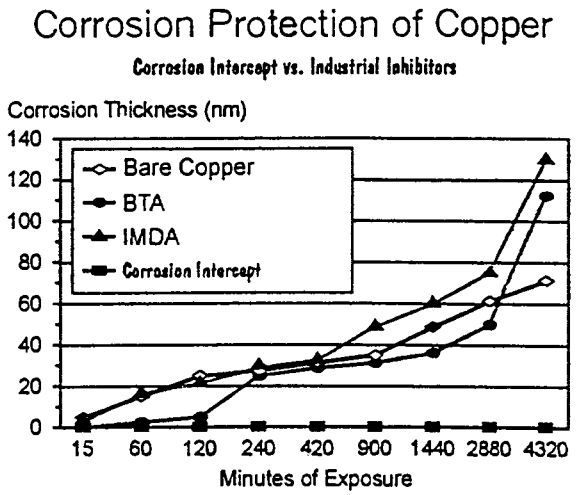


Figure 8. shows superior performance of Corrosion Intercept® compared to Benzotriazole (BTA) and Imidazole (IMDA). Source: Roberts, Hobbins, Graedel, Franey and Kammlott: "Relative Inhibitors of Copper Corrosion by Azoles", Corrosion Intercept Presentation, Bell Labs International *Technical Memo, TM 801517-34,* 1980. Permission by John Franey, co-author and member of Technical Staff, Lucent Bell Labs, Murry Hill, NJ.

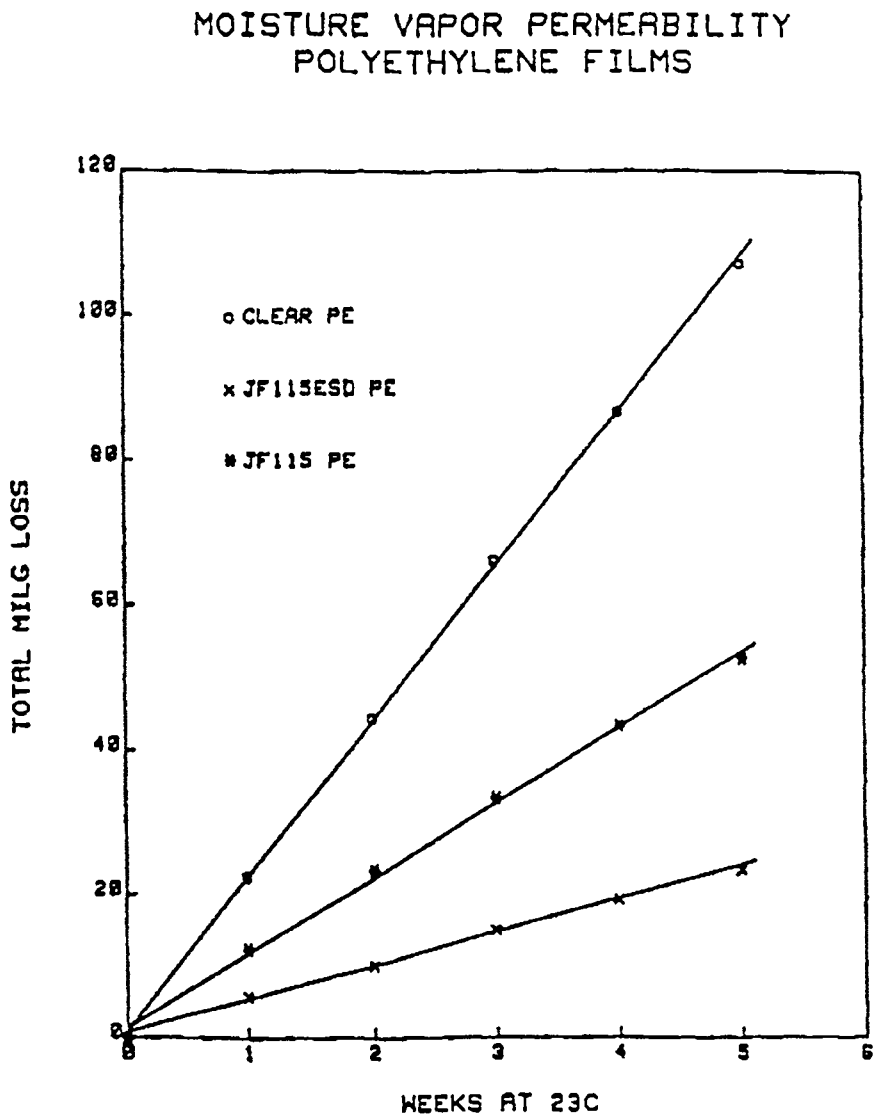


Figure 9. shows Corrosion Intercept®, seen under JF115 PE code name, the least permeable to moisture vapour among the tested materials. Clear Polyethylene (CLEAR PE) is the most permeable. *Static Intercept®* (seen under JF115ESD PE code name) shows about half of the permeability of a clear polyethylene sheet of the same thickness. Test performed in 1988, on 0.002" thick, that is 2 mil films using the ASTM cup method. Total MILG loss is in grams per hour, per centimeter, per millimeters of mercury. Source: Franey, J.P. and Graedel, T.E.: "A New Electrostatic and Corrosion Protective Polymer" Bell Labs *Technical Memo, TM-11538-901128-06*. JF116. Permission by John Franey, co-author and member of Technical Staff, Lucent Bell Labs, NJ.

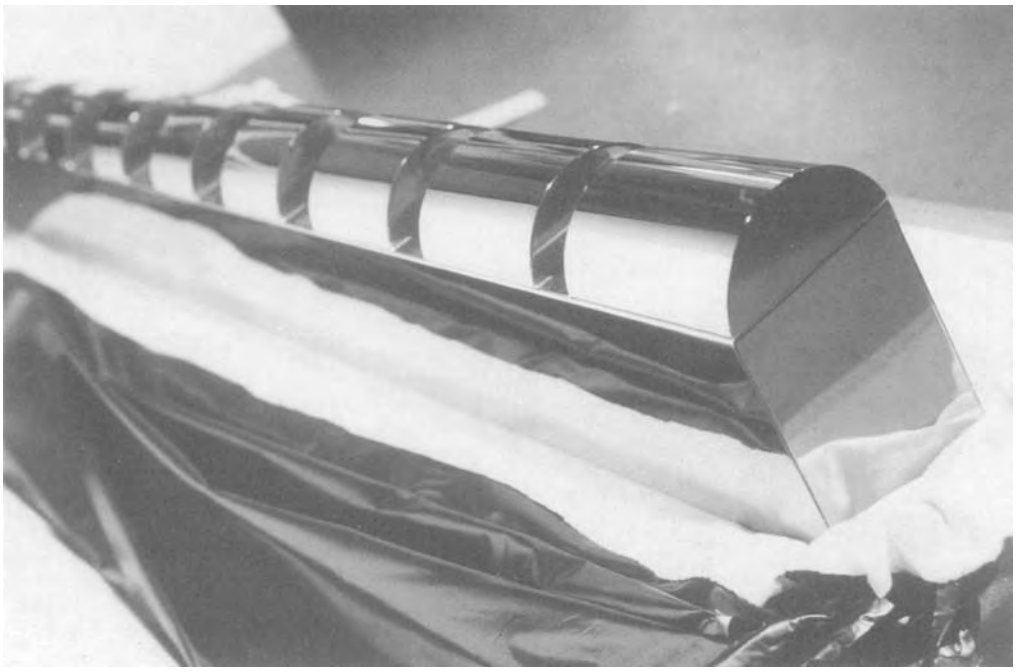


Figure 10. D. Judd: *Untitled 1970*. Copper Progression in pristine condition after six years of storage. Packing system shown: the piece wrapped in pre-washed cotton/polyester fabric, followed by Corrosion Intercept.

Figure 11. D. Judd: *Untitled 1970*. Copper Progression, wrapped in Corrosion Intercept. Packing system continued from Figure 10. Note the overlap of the Corrosion Intercept sheet and the Acrylic Adhesive tape to secure the Intercept in place.

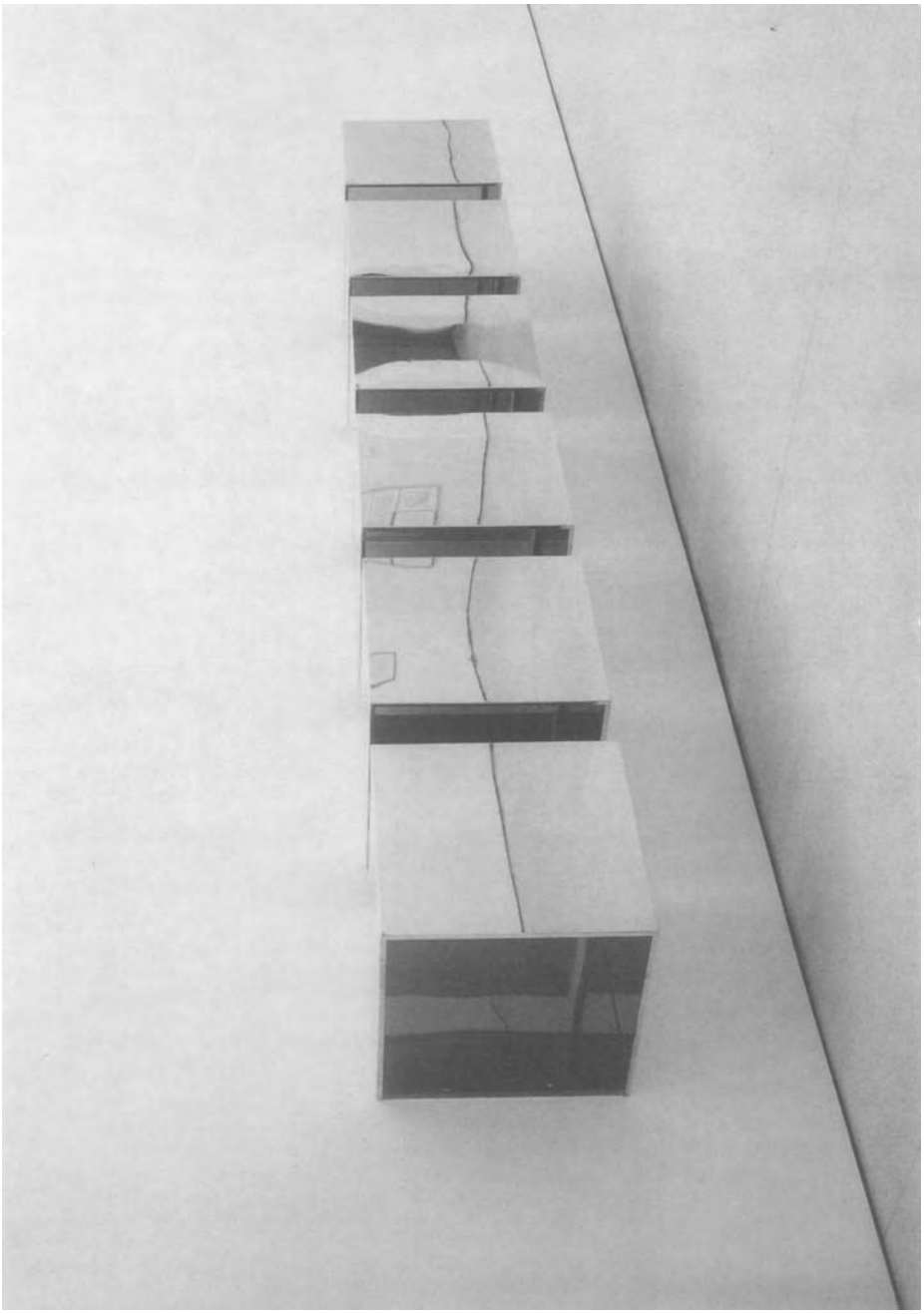


Figure 12. Donald Judd: *Untitled, 1972*. Six Cubes, each 34x34x34 inches. Brass and Plexiglas, Solomon R Guggenheim Museum, New York, Panza Collection, 1991. Photograph by David Heald© The Solomon R. Guggenheim Foundation, New York.

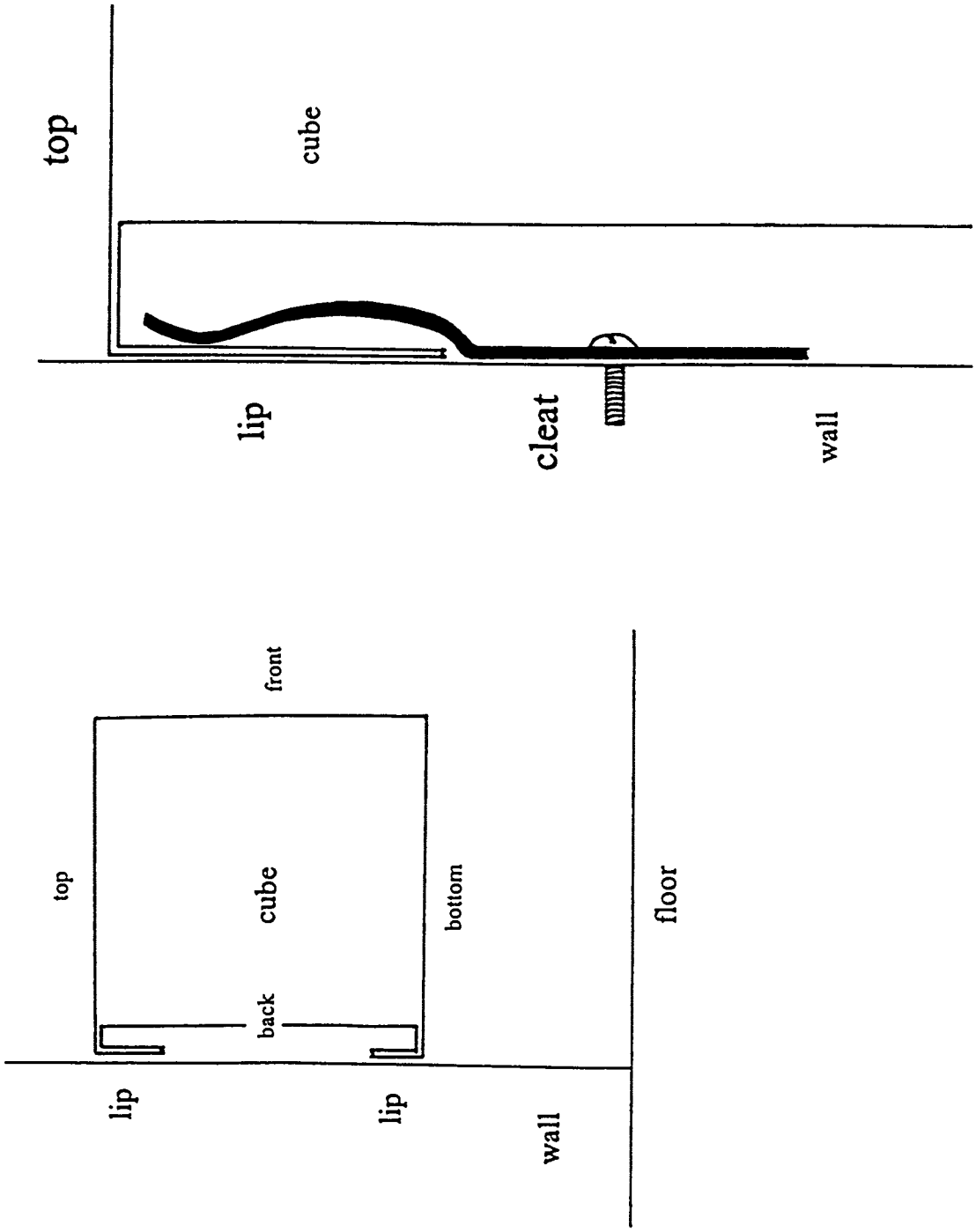


Figure 13. Mechanism of construction and method of hanging.

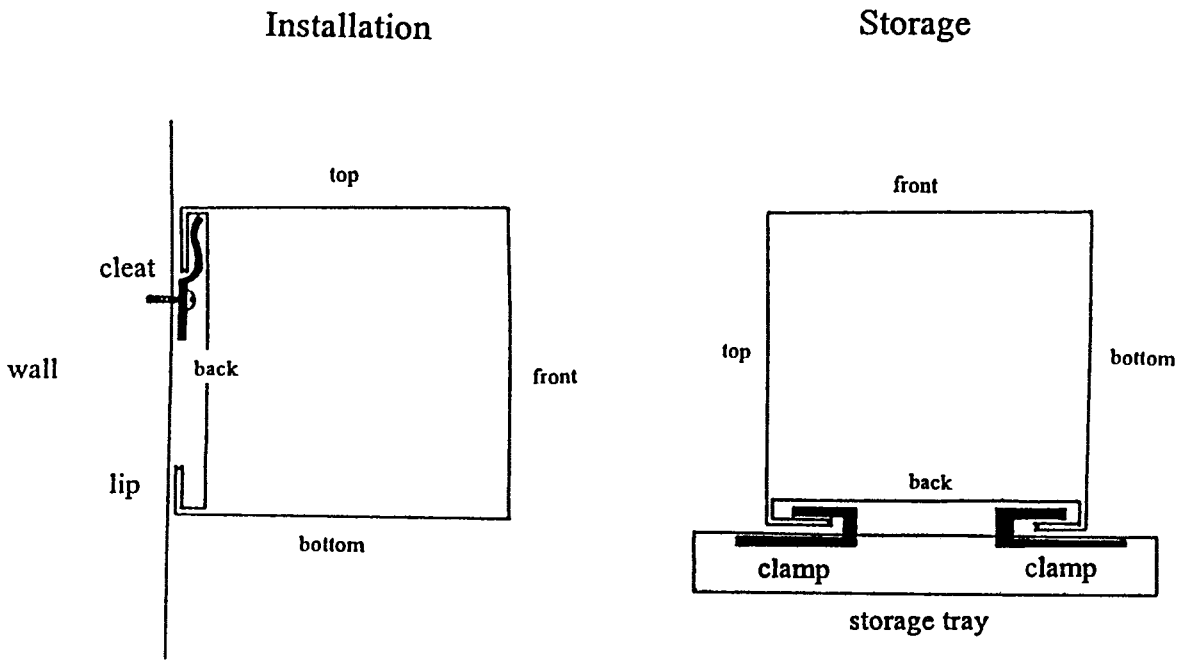


Figure 14. Cross sections of installation and storage mechanisms.

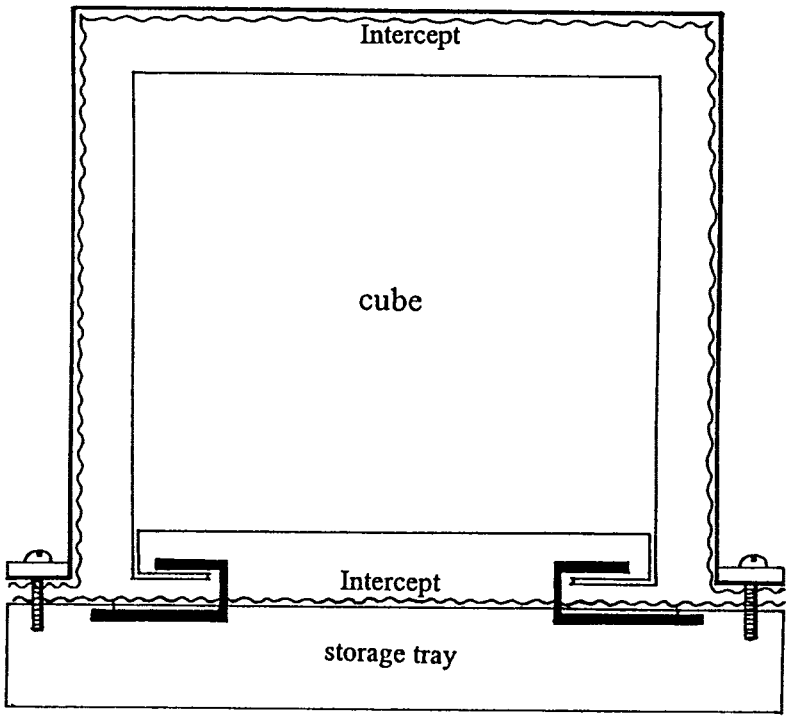


Figure 15. Cross section of Corrosion Intercept® tent on storage tray.

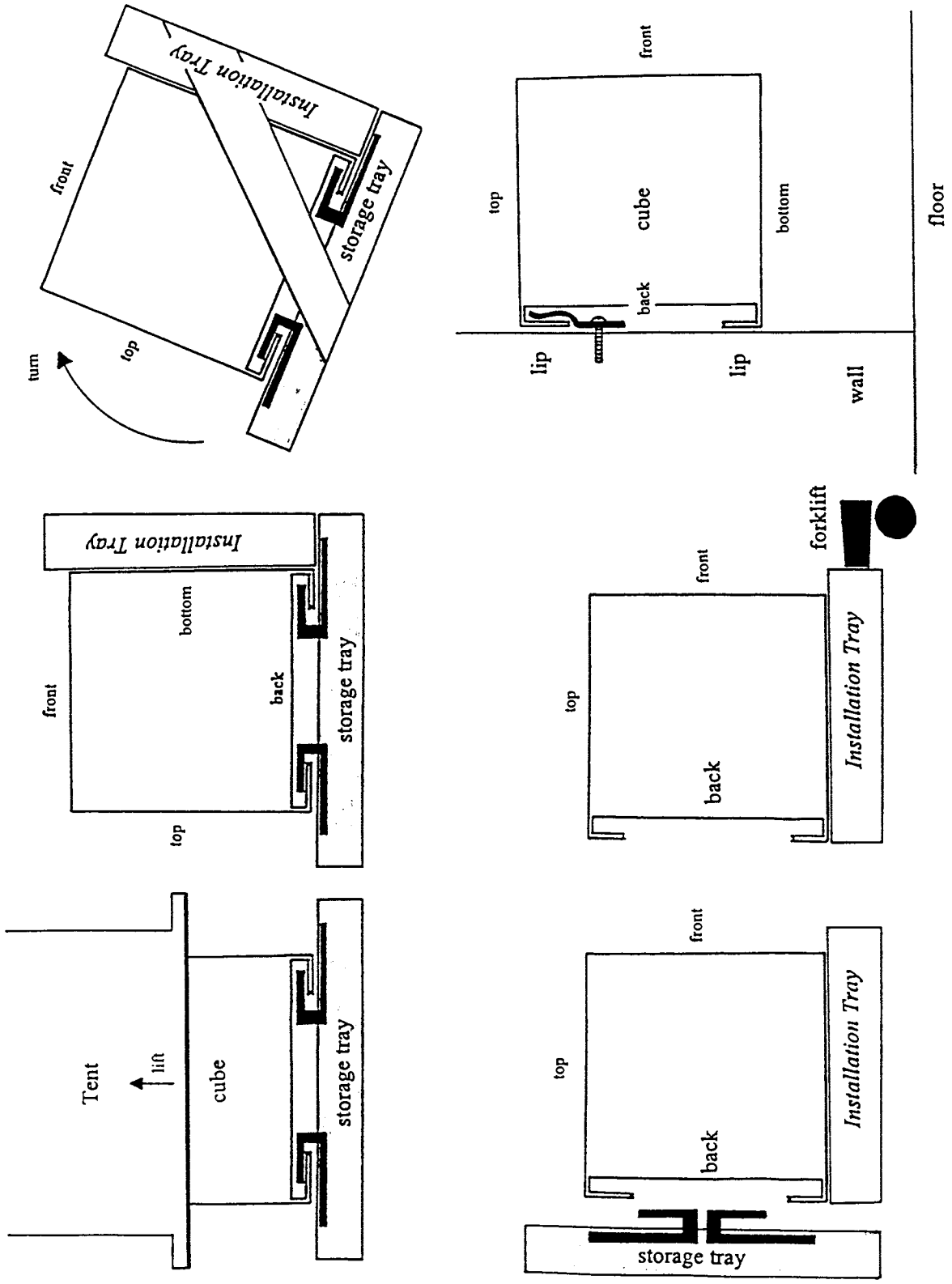


Figure 16. Cross sections showing sequence of object transfer from storage tray to installation.

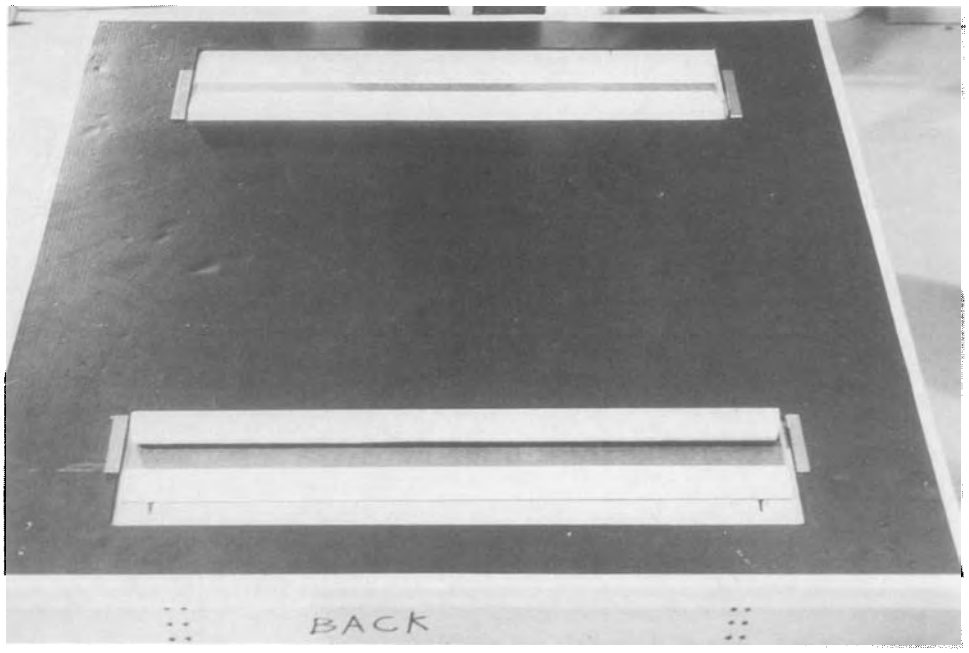


Figure 17. Storage Tray. 46" x46", plywood, covered with acid-free, single ply corrugated cardboard followed by 4 mil Corrosion Intercept and glued with Jade 711 adhesive. Note that the surfaces of the long clamps and the edges of the storage tray are sealed with white Acrylic Adhesive tape. No plywood surface is exposed to the object when the storage tray is in locked position.

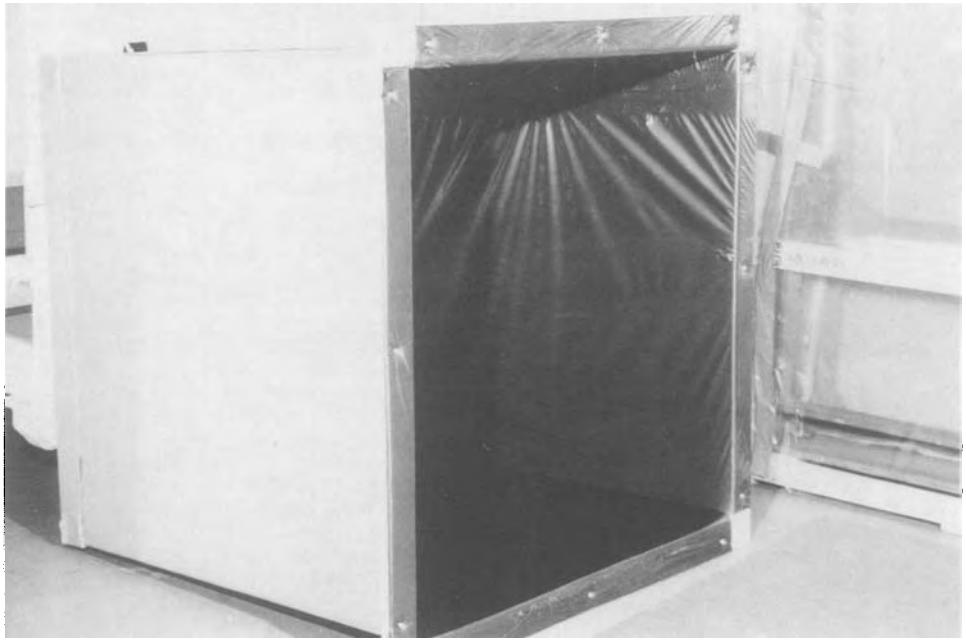
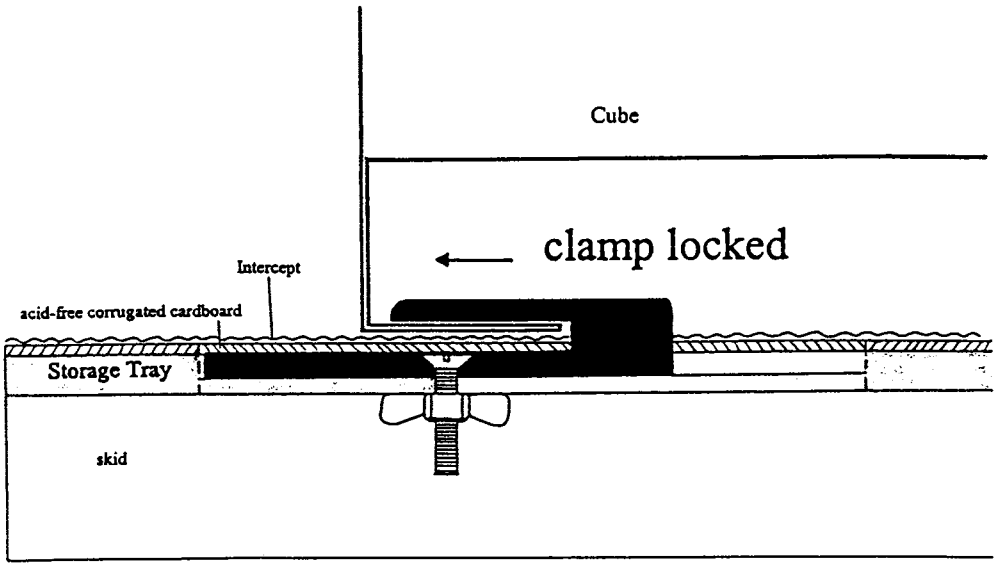


Figure 19. Corrosion Intercept Tent. W46"x D 46" x H40". One layer, acid free, single ply corrugated cardboard glued with Jade 711. The inside of the tent is lined with 3 mil Corrosion Intercept® that folds over the rims. No adhesive was used for lining the inside of the tent. The rim is re-enforced with plywood. Screw holes in the rim (three each side) are for securing the tent to the storage tray.



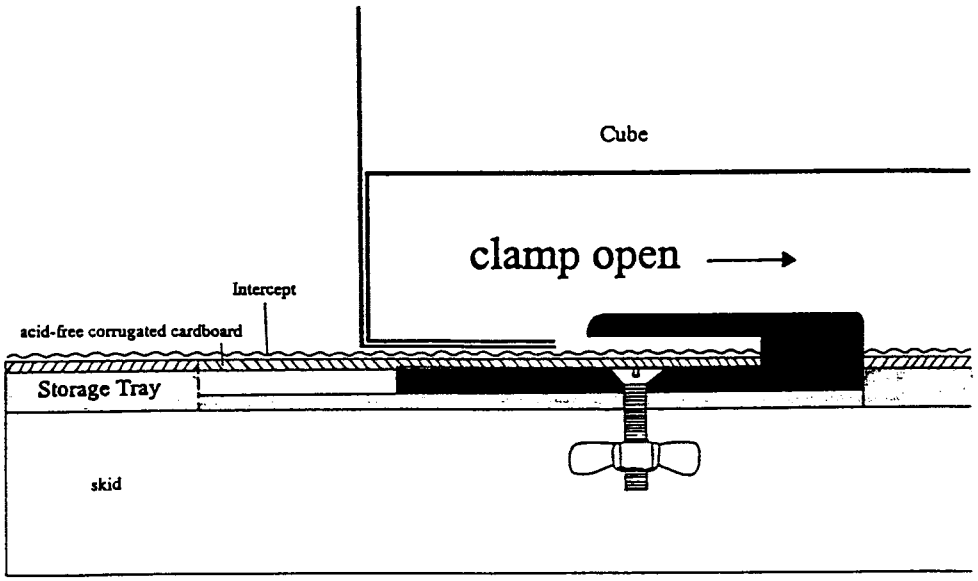


Figure 18. Detailed cross section of clamp mechanism on storage tray.

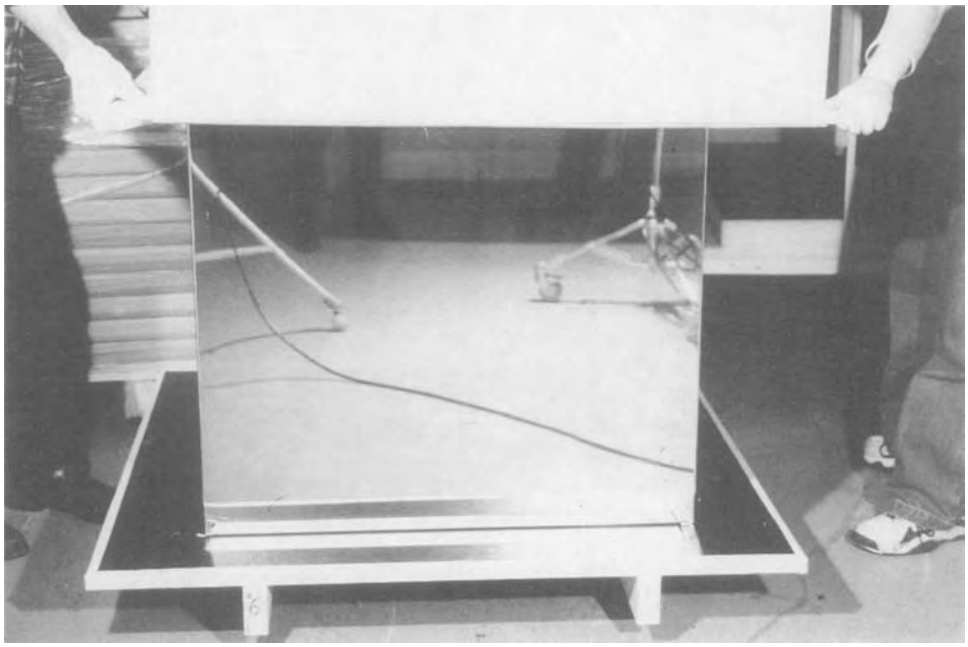


Figure 20. View of the object on the Storage Tray as the Tent is lifted up.

Figure 21. Installation Tray. 46" x 36". Plywood with footprint of the object. The rim around the footprint and the footprint are covered with Marvel-seal, which is heat-sealed. The footprint of the object aligns with the edge of the installation crate (edge seen at the floor).

It is essential to ensure that the clamps are in plane with the top of the storage tray, to allow free adjustments of the clamps while the object is placed on the tray. The top of the storage tray is padded with a layer of acid free corrugated cardboard and covered with a sheet of 4 mil Corrosion Intercept®, glued to the cardboard with Jade 711.

The tent is made of one layer of acid-free, single-ply corrugated cardboard and glued together using Jade 711. The tent allows three inches along the perimeter of the object. The inside of the corrugated cardboard tent is lined with 3 mil Corrosion Intercept that folds over the rims, as seen in Figure 19. No adhesive was used for the inner lining of the tent. The tent is secured to the storage tray with screws along the rims, creating a sealed environment.

For installation, the tent is lifted away, but the object remains clamped to the storage tray (Figure 20). A second tray, the installation tray, is made out of plywood. This tray, shown in Figure 21, must provide for the exact footprint of the bottom of the object, with extra width on the two sides for handling, and skids on the bottom for moving with a forklift. The footprint of the sculpture must be aligned on one side, the side that will be against the wall, with the edge of the installation tray. A small rim may surround the exact footprint of the bottom of the object, which will protect the object from slipping in case the tray is not held perfectly horizontal. Both the footprint and the rim have to be covered to protect the object from being scratched. In this example Marvelseal™ (aluminized polyethylene sheet) was used. Using Marvelseal™ for the installation tray ensures clear distinction between the storage and installation trays for installation crew members not familiar with the system.

The next step is transferring the sculpture from the storage tray onto the installation tray. One must place the installation tray in direct contact with the bottom of the sculpture, that is, the side that will be the bottom of the sculpture when installed (Figure 22) The installation tray must fit perfectly to the edge of the storage tray and allow openings for bolting. Note that the installation tray is usually the depth of the storage tray. This allows for easier alignment when the two trays are bolted together. However, one must make sure that, in the case of a sculpture of repeated units, the depth of the installation tray comfortably fits into the smallest space between the units. The installation tray and the storage tray are bolted together and reinforced by two cross bars on the sides. Then, grabbing by the trays only, the object is rotated 90 degrees (Figure 23). The vertical installation tray rotates to a horizontal position (Figure 24). After the clamps holding the lips of the sculpture to the storage tray are unlocked, all bolts and cross bars are undone and the storage tray removed, the sculpture stands on its installation tray, ready to be picked up and installed on the wall (Figure 25). Note that the backside of the sculpture, which will contact the wall, forms a continuous plane with the very edge of the installation tray for perfect contact with the flat wall. It is worthwhile to point out that, for sculptures of repeated identical units, only one installation tray has to be made, as one unit is installed at a time.

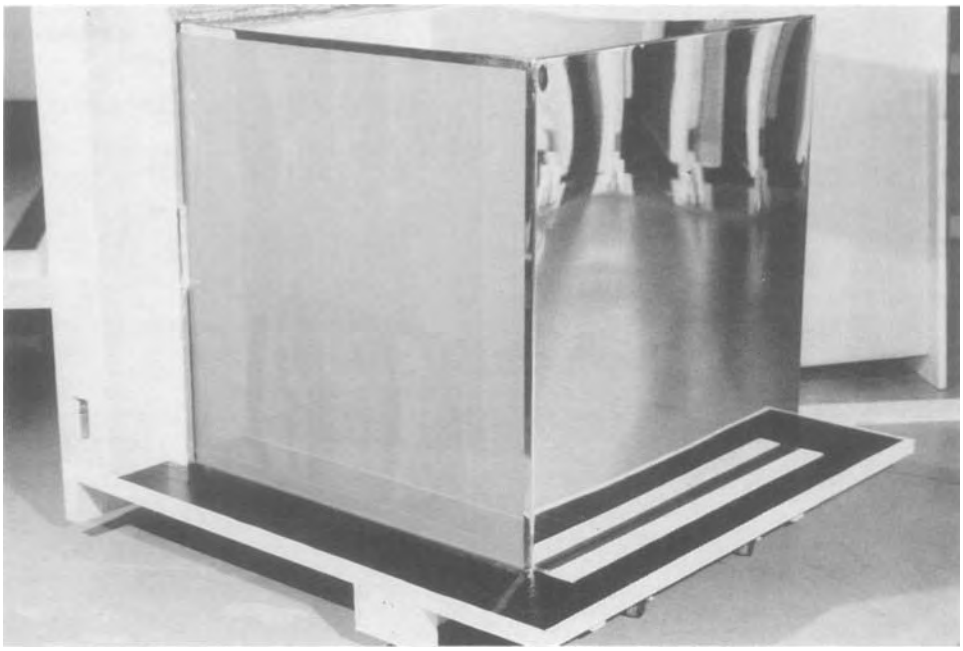


Figure 22. Object clamped to the Storage Tray (seen in horizontal position) and Installation Tray positioned. Note that the installation tray is in contact with the side of the object which will become the bottom when installed. The width of the installation tray is the width of the storage tray.

Figure 23. The two trays bolted and reinforced with cross bars are being rotated 90 degrees.

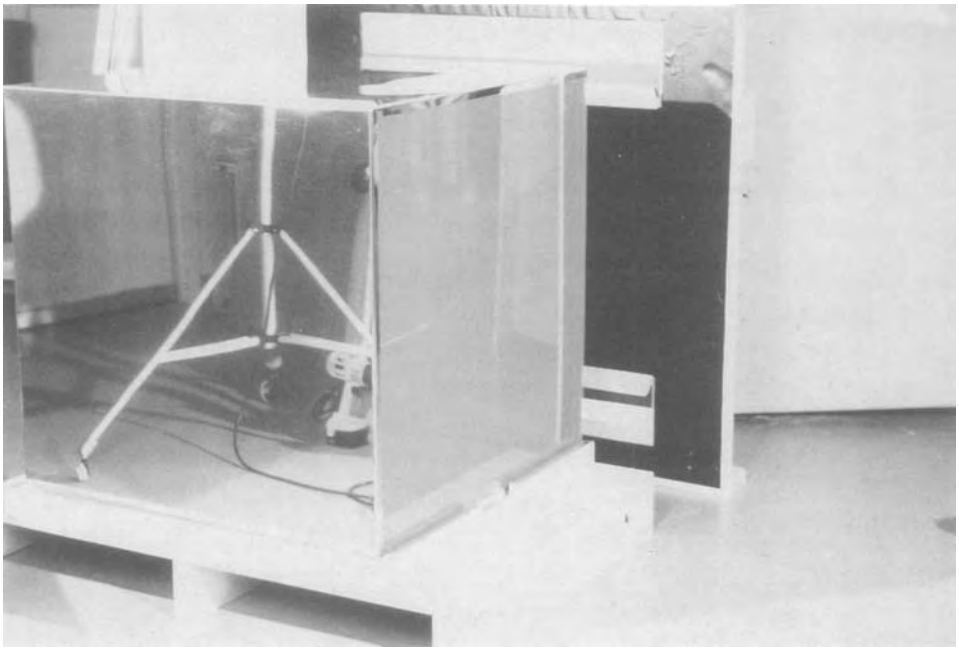


Figure 24. Object standing on the Installation Tray after rotation. The Storage Tray is already unclamped and standing behind the object.

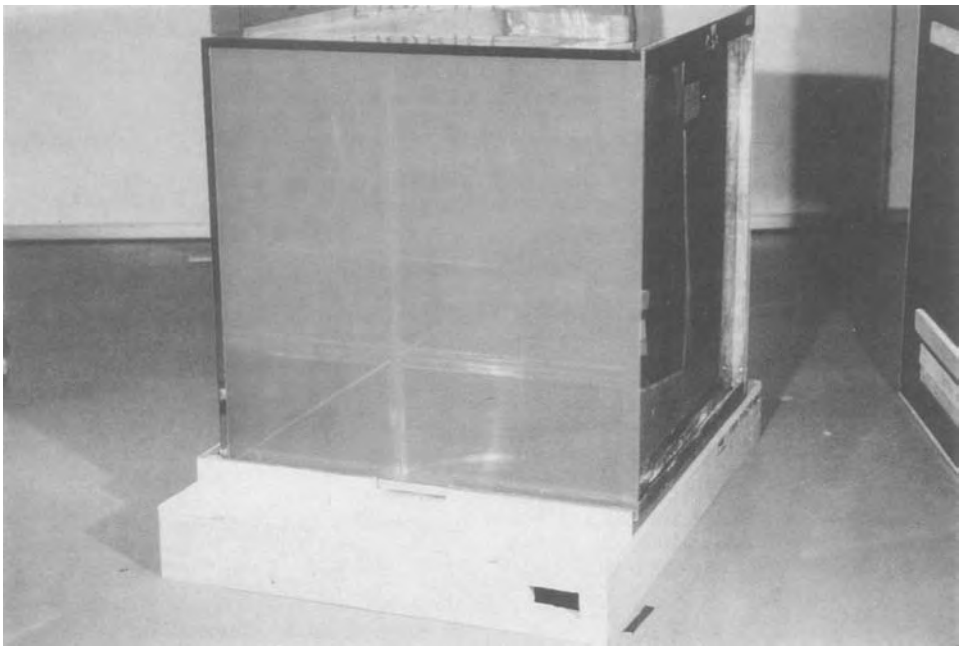


Figure 25. The object standing on the Installation Tray, ready to be installed. Note that the back of the object (the side which will be in contact with the wall) is aligned with the edge of the Installation Tray (seen on the right side). The object can be lifted up by a forklift, accessing the Installation Tray from the front of the object (left side on the image), or can be hand lifted using the cut-out handle.

Conclusion

Various versions of Corrosion Intercept® packing methods have been successfully used and have been continuously monitored since early 1994 at the Solomon R. Guggenheim Museum Conservation Laboratory.

The new Corrosion Intercept®Tent Packing System presented here proved to be the most successful and practical method for the long-term preservation of Donald Judd's highly polished brass and copper sculptures. The system is economical and materials are easy to obtain. Costs are equivalent or lower than standard crate or packing prices. The system is easy to construct, long-lasting and does not need maintenance. It solves frequent storage, handling, installation and transportation problems in one. Sculptures can be successfully preserved and protected long term regardless of their stage of deterioration. Experience at the Guggenheim Museum shows that handling and installation of sculptures using this system is approximately two to three times faster than installations using traditional methods. The Corrosion Intercept®Tent Packing System can be adopted not only to Donald Judd's non-ferrous sculptures, but also to similar modern and contemporary metal sculptures.

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Endnotes

i The black color of a saturated and used *Corrosion Intercept* ® should not be mistaken for the black color of a similar product by the same company, called *Static Intercept*®. Static Intercept was developed for *ferrous* metals. However, it can be used for non-ferrous metals as well.

ii For further information on testing Intercept products see the attached Bibliography or visit the website: *www.staticintercept.com*

iii A decision was made to pre-wash all fabric before use in order to avoid contamination of the metal surface with residues of starch and brighteners applied to the fabric surface by the manufacturer. All fabric was washed in 2% Orvus solution, then repeatedly rinsed in tap water.

100% cotton jersey and a cotton/polyester 50/50% fabric were used for this type of packing system.

iv Jade 711 tested negative for sulfur (test performed by the author) using the *Lead Acetate Test* kindly provided by Jean Tetreault, Canadian Conservation Institute, 1030 Innes Road, Ottawa, ON K1A OC8, Canada. 613-998-3721.

v After the corrugated cardboard/Intercept lined tent was constructed, a new product appeared on the market providing another option for creating the tent. The product's name is *Coroplast™ Corrosive Intercept®*. It is 100% Intercept-Polypropylene resin, extruded. It can be heat sealed or stapled to create a box. Coroplast Static Intercept® may be used for the same purpose as well.

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Suppliers

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