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## SECTION 02871 OR MASTERFORMAT (2004) SEC. 129313 - BICYCLE STORAGE LOCKERS

### PART 1 – GENERAL

#### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.02 SUMMARY

- A. This Section includes the following:
1. Sheet molded fiberglass-reinforced plastic bicycle storage lockers.
- B. Related Sections include the following:
1. Division 2 Section "Bicycle Racks" for non-enclosed, ground mounted bike racks.
  2. Division 3 Section "Cast-in-Place Concrete" for concrete mounting pads.
  3. Division 5 Section "Metal Fabrications" for pipe bollards to protect bicycle storage lockers.
  4. Division <Insert Division number> Section "<Insert Section Name>" for <Insert description of related work>.
- C. Electronic key dispenser shall be integrated with the security access control system specified in Division 13 Section "Security Access," which also defines systems integration.
- D. Alternates: Work of this Section is affected by Alternates. Refer to Division 1 Section "Alternates" for description of Work in this Section affected by alternates.

#### 1.03 PERFORMANCE REQUIREMENTS

- A. Delegated-Design Requirements:
1. Provide bicycle storage locker assemblies complying with specific performance and design criteria indicated, including necessary modifications to maintain visual design concept.
    - a. Contract Documents indicate design features, performance requirements, and primary components required, but do not cover details of design and construction, and do not purport to identify nor solve problems of thermal or structural movement, anchorage, or moisture disposal. Requirements shown by details are intended to establish basic dimension of unit, visible lines and profiles of members.
    - b. Compliance with requirements of authorities having jurisdiction is the responsibility of Contractor.
  2. Design bicycle storage locker assemblies to accommodate expansion and contraction due to structural movement, movement within system, movement between system and anchorage attachments, dynamic loading and release of loads, and deflection due to external loads, without detriment to appearance or performance, and without damage to bicycle storage lockers system or components.
  3. Design bicycle storage locker assemblies and provide clearances that will allow for installation tolerances, expansion and contraction of adjacent materials, and free unobstructed access for users.
  4. Design bicycle storage locker assemblies to be free from vibration harmonics, rattles, and noise due to thermal and structural movement, and wind pressure.
  5. Design attachments to accommodate anticipated movement with no possibility of loosening, weakening, or fracturing connections between adjoining system components or between system components and building structure.

6. Design anchors, fasteners and braces to be structurally stressed not more than 50 percent of allowable stress when maximum loads are applied.
  7. Assemble units with concealed fasteners or locate fasteners in areas inaccessible when locker units are closed.
- B. Structural Performance: Provide bicycle storage lockers capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Wind Loads:
    - a. Specified Design Wind Loads: **<Insert design wind load> [As indicated]**.
    - b. Specified Design Wind Loads: **<Insert design wind load> [As indicated]**, but not less than wind loads applicable to Project as required by ASCE 7 "Minimum Design Loads for Buildings and Other Structures": Section 6.0 "Wind Loads."
    - c. Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour (meters per second) at 33 feet (10 m) above grade, according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."
      - 1) Basic Wind Speed: **[90 mph (40 m/s)] <Insert value>**.
      - 2) Importance Factor: I.
      - 3) Exposure Category: **[A] [B] [C] [D]**.
  2. Snow Loads: Provide bicycle storage lockers capable of withstanding the effects of snow loads determined according to **[ASCE 7, "Minimum Design Loads for Buildings and Other Structures," Section 7, "Snow Loads.]" <Insert applicable code requirement>**
  3. Seismic Performance: Provide bicycle storage lockers capable of withstanding the effects of earthquake motions determined according to **[ASCE 7, "Minimum Design Loads for Buildings and Other Structures," Section 9, "Earthquake Loads.]" <Insert applicable code requirement>**
  4. Live Loads: Provide bicycle storage lockers capable of withstanding **[300-lbf/sq. ft. (14.4-kPa)] <Insert value>** on roof without permanent deflection.
- C. Thermal Movements: Provide bicycle storage lockers that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- D. External Surface Heat Build-Up: Construct bicycle storage lockers of external surface materials that remain below 130 deg F (112 deg C) and safe to human touch under anticipated Project environmental conditions.

#### 1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
  1. Include construction details, material descriptions, dimensions of individual storage units and profiles, and finishes.
  2. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
- B. Shop Drawings: Show fabrication and installation details.
  1. Submit structural design calculations for resistance to design loads.
- C. Samples for Initial Selection: For units with integrally pigmented or factory-applied color finishes for each type of finish indicated.
  1. Include similar Samples of accessories involving color selection.

- D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- E. Qualification Data: For **[Installer]** **[manufacturer]** **[professional engineer]**.
- F. Material Test Reports: For exterior shell material **<Insert other material>**. Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- G. Material Certificates: For exterior shell material **<Insert other material>**, signed by manufacturer. Prepare written statements on manufacturer's letterhead certifying that products and materials comply with requirements in the Contract Documents
- H. Manufacturer Certificates: Prepare written statement on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- I. Maintenance Data: To include in maintenance manuals.
- J. Warranties: Special warranties specified in this Section.

#### 1.05 QUALITY ASSURANCE

- A. Installer Qualifications: A firm or individual with sufficient trained staff to install manufacturer's products according to specified requirements.
- B. Manufacturer Qualifications: Company specializing in manufacturing Products specified in this Section with minimum five **<Insert number>** years documented experience.
- C. Source Limitations: Furnish products from one manufacturer who is capable of showing prior successful production of units similar to those required for entire Project, unless otherwise acceptable to Architect.
- D. Product Options: Information on Drawings and in Specifications establishes requirements for bicycle storage locker aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
- E. Product Options: Drawings indicate size, profiles, and dimensional requirements of bicycle storage lockers and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
  - 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
- F. Fire-Test-Response Characteristics: Provide products with the following flammability characteristics as determined by testing identical products by the following method:
  - 1. UL 94 Flammability Rating: Not less than V-2.
- G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers with seals unbroken and bearing manufacturer's labels indicating brand name and directions for storage.
- B. Store materials to comply with manufacturer's directions to prevent deterioration from moisture, heat, cold, direct sunlight, or other causes.

#### 1.07 PROJECT CONDITIONS

- A. Field Measurements: Indicate measurements on Shop Drawings.

#### 1.08 COORDINATION

- A. Coordinate installation of anchorages for bicycle storage lockers. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

#### 1.09 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Warranty: Submit a written warranty executed by the manufacturer on manufacturer's standard form in which manufacturer agrees to repair or replace components of bicycle storage lockers that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:
  1. Structural failures including, but not limited to, excessive top or wall panel deflection, panel delamination, water absorption, surface fiber blooming, spalling, chipping, splitting, cracking, flaking, blistering, and **<Insert type of failure>**.
  2. Failure of system to meet performance requirements.
  3. Faulty operation of doors, locks, and access hardware.
  4. Deterioration of shell materials, metals, finishes, and other materials beyond normal weathering.
- C. Warranty Period: **Five (5)** years from date of Substantial Completion.
- D. Warranty Period for Locks: **Two (2)** years from date of Substantial Completion.
- E. Warranty Period for Solar-Power Distribution System: **One (1)** years from date of Substantial Completion.

#### 1.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Door Panel Assembly: Full-size preassembled units, less lock assembly, equal to **<Insert number>** percent of amount installed [**for each size indicated**], but no fewer than **<Insert number>** units.
  2. Lock Assembly: Lock units equal to **<Insert number>** percent of amount installed, but no fewer than **<Insert number>** units.

3. Lock Cylinders: Lock cylinders equal to <Insert number> percent of amount installed, but no fewer than <Insert number> units.
4. Door Check Assembly: Door check assembly units equal to <Insert number> percent of amount installed, but no fewer than <Insert number> units.
5. One <Insert number> aerosol can of spray touch-up paint in color matching units provided.
6. <Insert Product Description> Units: [Full-size units] <Insert detailed description of material and form making up a unit> equal to <Insert number> percent of amount installed [for each size indicated], but no fewer than <Insert number> units.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

- A. Basis-of-Design Product: The design for bicycle storage lockers is based on **[ProPark Bicycle Security Locker] [Cycle-Port Undercover Bicycle Parking]** by Cycle-Safe, Inc., 4630 Ada Drive, Suite B, Ada, MI 49301, 888-950-6531; fax 616-954-0290; <http://www.cyclesafe.com>. Subject to compliance with requirements, provide the named product or a comparable product by another manufacturer acceptable to the Architect.

### 2.02 MATERIALS

- A. Fiberglass Reinforced Plastic (FRP): Compression molded, fiberglass reinforced polyester, sheet molding compound (SMC) composed of a layer of fiberglass sandwiched between two layers of through-color-pigmented thermoset polyester resin, extruded into flat sheets, and formed to final shape in heated two-piece matched metal molds. Laminated fiberglass with brittle gel coats are not acceptable for exterior materials.

PROPERTIES	ASTM TEST RESULTS
Impact Strength	12-14 ft-lbs minimum (ASTM D256) (Izod Notched)
Flexural strength	28,000-32,000 psi minimum (ASTM D790)
Flex modulus	1.5 x 10 <sup>6</sup> psi minimum (ASTM D790)
Tensile strength	12,000-16,000 psi minimum (ASTM D638)
Compressive strength	28,000-32,000 psi minimum (ASTM D695)
Water Absorption & Porosity	0.2 % maximum (ASTM D570)
Glass content	32 to 34 minimum percent by weight
Flammability	V-2 Self Extinguishing (UL 94)
Heat Distortion Temperature	350 degrees F (ASTM D648)
Density	0.072 lb/in <sup>3</sup> minimum

- B. Fiberglass Reinforced Plastic (FRP): Manufacturer's standard molded, fiberglass reinforced polyester, composed of polyester resin base and glass fiber reinforcement.

PROPERTIES	ASTM TEST RESULTS
Impact Strength	5 ft-lbs minimum (ASTM D256) (Izod Un-notched)
Flexural strength	20,000 psi minimum (ASTM D790)
Flex modulus	0.9 x 10 <sup>6</sup> psi minimum (ASTM D790)
Tensile strength	12,000 psi minimum (ASTM D638)
Water Absorption & Porosity	1.4% maximum (ASTM D570)
Glass content	25 minimum percent by weight
Flammability	Class A (ASTM E84)
Heat Distortion Temperature	150 degrees F (ASTM D648)
Density	0.049 lb/in <sup>3</sup> minimum

- C. Stainless-Steel Sheet: ASTM A 666, Type 302 or 304, stainless-steel sheet, leveled to stretcher-leveled flatness.
- D. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
- E. Aluminum:
  - 1. Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 6061-T6.
  - 2. Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T6.
- F. Aluminum-Alloy Rolled Tread Floor Plate: ASTM B 632/B 632M, Alloy 6061-T6.
- G. Oriented Strand Board: DOC PS 2, **[Exposure 1, Structural I] [Exposure 1]**.
  - 1. Thickness: Not less than **[19/32 inch (15 mm)] [15/32 inch (12 mm)]**.
- H. Slotted Channel Framing: Cold-formed metal channels with continuous slot complying with MFMA-3.
  - 1. Size of Channels: **[1-5/8 by 1-5/8 inches (41 by 41 mm)] [As indicated]**.
  - 2. Material: Galvanized steel complying with ASTM A 653/A 653M, **[commercial steel, Type B] [structural steel, Grade 33 (Grade 230)]**, with G90 (Z275) coating; **[0.108-inch (2.8-mm)] [0.079-inch (2-mm)] [0.064-inch (1.6-mm)]** nominal thickness.
- I. Concrete Pads: Refer to **[Division 2 Section "Cement Concrete Pavement."]** **[Division 3 Section "Cast-in-Place Concrete."]**
- J. Anchorages: Anchor bolts, **[hot-dip galvanized according to ASTM A 153/A 153M] [stainless steel]**.
  - 1. Provide security-type internal fasteners **[for open-front lockers without doors]**.

## 2.03 LOCKER FABRICATION

- A. Provide a complete, integrated set of manufacturer's standard, mutually dependent components that form bicycle storage lockers, ready for installation on Project site. Bicycle storage lockers shall be capable of withstanding structural and other loads indicated, thermally induced movement, and exposure to weather without failure or infiltration of water into interior.
  - 1. Style: **[Entry from two sides] [Entry from one side] [As indicated on Drawings]**.
  - 2. Tiers: **[One] [Two] [As indicated on Drawings]**.
  - 3. Doors: **[Left-hand swinging doors] [Without doors] [As indicated on Drawings]**.
  - 4. Dual Bike Unit Size: Nominal 38 by 79 inches (965 by 2007 mm) **<Insert size>**.
  - 5. Ganged Unit Capacity: **[Two bicycles] [Four bicycles] <Insert Number of bicycles> [As indicated on Drawings]**.
- B. Fabricate bicycle storage lockers of fiberglass reinforced plastic material as modular units allowing for removal and replacement of any unit without disturbing adjacent units (non-cumulative assembly).
  - 1. FRP Composite Side, Door, and Roof Panels and Frames: Manufacturer's standard thickness, but not less than 0.165 inch (4.2 mm).
    - a. End panels: High-impact ABS plastic material, 0.250 inch (6 mm) thick with FRP return flange.
  - 2. Interior Partitions (end wall and intermediate panels): **[Manufacturer's standard] [Resin impregnated OSB panels, 19/32 inch (15 mm) thick, coated with manufacturer's standard semi-transparent stain coating and with edges sealed with acrylic lacquer] [ABS material, 0.250 inch (6 mm) thick] <Insert other>**, and pre-drilled for attachment.

## 2.04 HARDWARE

- A. Locking Mechanism: High-security, NAMA standard approved vending machine type pop-out T-handle assembly as manufactured by Complex Lock Co. **[or another lock manufacturer approved by Architect.]**
1. Fabricate locks with the following standard features:
    - a. Lock, cylinder and handle fully countersunk within door face.
    - b. Removable high-security inner cylinder; UL 437 Listed as manufactured by Abloy Lock Co. **[or another lock manufacturer approved by Architect.]**
    - c. Polished chrome housing fully countersunk from door face.
    - d. Escutcheon Plate: 0.050 inch (1.3 mm) thick brushed stainless steel, recessed into door surface surrounding the countersunk lock mechanism area.
    - e. Contract restricted key system, individually keyed with three duplicate keys per cylinder.
    - f. Full length stainless steel latch bars and concealed hinges, attached with not less than five 5/16 inch (7.9 mm) diameter threaded fasteners.
  2. Fabricate locks with the following optional features:
    - a. U-Bolt Locks: Provide U-bolt door hardware to allow user to insert bike lock through projecting U-bolts to block access to the locker locking mechanism. Provide T-handle lock mechanism less cylinder.
      - 1) Door Holder: Manufacturer's standard door check and hold-back.
    - b. Hasp Locks: Provide hasp and staple to allow user to pull-down and padlock to block access to the locker locking mechanism. Provide T-handle lock mechanism less cylinder. Padlocks not included.
    - c. Coin Locks: Provide lock mechanism designed to accept **[tokens]** **[or]** **[coins]** for access.
  3. Keying System: **[Factory registered, and]** as follows:
    - a. No Master Key System: Cylinders are operated by change keys only. Furnish locks factory installed.
    - b. Master Key System: Cylinders are operated by a change key and a master key. Furnish locks packaged separately for field installation.
    - c. Existing System: Master key or grand master key locks to Owner's existing system. Furnish locks packaged separately for field installation.
  4. Keys: Nickel silver.
    - a. Quantity: In addition to one extra key blank for each lock, provide the following:
      - 1) Cylinder Change Keys: Three.
      - 2) Master Keys: Five.
  5. Key Control System: During construction, tag and log key sets with appropriate locker door numbers. Deliver keys and completed log to **[Owner]** **[by security courier shipment]**.
  6. Key Control Cabinet: BHMA A156.5, Grade **[1]** **[2]**; metal cabinet with baked-enamel finish; containing key-holding hooks, labels, 2 sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers; with key capacity of **[150]** **<Insert number>** percent of the number of locks.
    - a. Wall-Mounted Cabinet: Cabinet with hinged-panel door equipped with key-holding panels and pin-tumbler cylinder door lock.
    - b. Portable Cabinet: Tray for mounting in file cabinet, equipped with key-holding panels, envelopes, and cross-index system.
- B. Locker Door Hinges: Full length, concealed, 0.0625 inch (1.59 mm) thickness stainless steel.
- C. Leveling Brackets: Concealed adjustable leveling brackets to allow maximum 4-1/2 inch (114 mm) vertical adjustment.
- D. Identification Number Plates: Manufacturer's standard etched, embossed, or stamped aluminum plates, concealed mounting, sequentially numbered with numbers and letters at least 3/8 inch (9 mm) high.

## 2.05 ACCESSORIES

- A. Accessories: Provide the following for each bicycle storage locker:
1. Equipment storage bin, screw mounted to inside door panel.
  2. Interior coat/backpack hook.
  3. Cyberlock intelligent access control system.
  4. Inspection [**window**] [**skylight**] [**viewer in door panel or frame**].
  5. Door Holder: Manufacturer's standard door check and hold-back.
  6. <Other>
- B. Accessories: Provide the following for each bicycle storage locker group:
1. Display frames for [**one**] [**both**] end panel[s] to hold display signage provide by [**Owner.**] [**Division 10 Section "Signage."**].
  2. Security key dispenser.
  3. Electric bike recharging station as follows:
    - a. Provide factory installed solar-power distribution system in [**indicated**] [**each**] locker unit [s]; Model US 64 by Uni-Solar or equivalent. Solar-power distribution system shall have the following nominal electrical characteristics:
      - 1) Rated Power (Wp): 64
      - 2) Operating Voltage VMPP (V): 16.5
      - 3) Operating Current IMPP (A): 3.88
      - 4) Open Circuit Voltage VOC (V): 23.8
      - 5) Short Circuit Current ISC (V): 4.8
    - b. Make provisions for hardwired GFRC outlet in [**indicated**] [**each**] locker unit[s].
  4. <Other>
- C. Accessories: Provide one each of the following:
1. <Other>

## 2.06 FINISHES, GENERAL

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Finish shall enable the removal of graffiti without damage to finish.

## 2.07 PLASTIC FINISH

- A. FRP Plastic Finish: Manufacturer's standard factory applied, semi-gloss, acrylic-aliphatic urethane finish system with stipple texture.
1. Color: [**Manufacturer's standard**] [**Sandstone finish panels framed with taupe reveals**] [**As selected by Architect from manufacturer's full range**] [**Custom to match Architect's sample**].

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine areas[, **with Installer present,**] for suitable conditions where bicycle storage lockers will be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION

- A. Comply with manufacturer's written instructions for installation of bicycle storage lockers.
- B. Install bicycle storage lockers on 4-inch- (100-mm-) thick concrete bases reinforced with 6x6x10/10 wire mesh unless otherwise indicated. Finish surface with minimum 2 percent slope for drainage. Form mounting pads 9 inches (228 mm) larger than assembled lockers in both width and length unless otherwise indicated.
- C. Set bicycle storage lockers plumb and aligned. Level base true to plane. Slope to drain.
- D. Fasten bicycle storage lockers to **[concrete bases with expansion anchors [slotted channel framing securely attached to mounting substrate].**
- E. Accessories:
  - 1. Identification Plates: Identify bicycle storage lockers in sequence indicated on Drawings or, if not indicated, as approved by **[Architect] [Owner]**.

### 3.03 ADJUSTING AND CLEANING

- A. Adjust doors and hardware to operate smoothly, easily, properly, and without binding. Confirm that locks engage accurately and securely without forcing or binding.
- B. Lubricate hardware and other moving parts.
- C. Remove protective coverings from lock cover plates and other surfaces.
- D. After completing installation, inspect exposed finishes and repair damaged finishes.
- E. Touch up marred finishes, or replace lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 02871

The following table describes the various processes of panel manufacture and the advantages and disadvantages of each. The table is not intended to be included with the final specification.

TABLE OF PLASTIC FABRICATION PROCESSES			
PROCESS	ADVANTAGES	DISADVANTAGES	EXAMPLES
<p><b>SMC Molding</b> This stands for 'sheet molding compound". A layer of fiberglass material is sandwiched between 2 layers of thermoset polyester resin and extruded into flat sheets. The sheets are pressed into final form by heated 2-piece molds</p>	<p>Creates very tough parts which can be subjected to high impacts, precision molding, extra-thickness and combined part features</p>		<p>Automotive &amp; truck fender-hood, doors, body panels, furniture, personal watercraft hulls, aircraft components, stadium seating, pole line hardware, railroad hopper car covers, car door and liners, telephone switch box housings, third-rail insulators, outboard motor housings, tractor housings</p>
<p><b>Wet Spray up, Lay-up Molding</b> A process in which glass fibers and resin are simultaneously deposited in an open mold. Roving is fed through a chopper and ejected into a resin stream directed at the mold. The mix is then rolled by hand before curing. Parts are made in layers according to a lay up schedule. Parts are cured at air temperature. Parts are only released after several hour mold cycles. Hand lamination with operators, hand rolling out air bubbles with squeegee</p>	<p>Very large parts can be manufactured, very low tooling costs</p>	<p>Slow cycle times mean high piece prices. Narrow range of materials. Reduced strength and stiffness composites than machine made SMC's. Hands-on process with variations from operator errors, each layer is cured, higher reworked parts (or scrap rates). Some surface voids, resin rich areas, thickness variations are typical due to low control of hand built part. Parts are smooth finished only on one side, interior is rough surfaced. Parts need to be hand trimmed with routers to cut off flash, with fit variations (to mating locker parts), scrap disposal. Gel coats are brittle and UV limits durability. High VOC emissions, solvents for tool and gun clean-up, worker risk of exposure to hazardous materials</p>	<p>Camper tops, dock boxes, housings, building cladding, pool panels (typically finish coated), boat hulls, decks, canoes, shower stalls</p>
<p><b>Rotational Molding (ROTO)</b> Hollow molds filled with powdered plastic are secured to a pipe-like spokes which extend from a central hub. The molds rotate or tumble on 2 separate axes at once. The hub swings the entire mold into an enclosed furnace room which causes the powder to melt and stick to the insides of the tools. With the molds still tumbling slowly, the tools swing into a cooling room where sprayed water causes the plastic to harden into a hollow part</p>	<p>Very large parts can be manufactured. Chemical waste and storage tanks up to 2,500 gallons. Very low tooling costs</p>	<p>Slow cycle times mean high piece prices. Narrow range of materials</p>	<p>Agriculture tanks of all kinds, fuel tanks, large outdoor toys, soft vinyl automotive armrests, spherical shapes and toy balls</p>