Designer and Manufacturer of Rotation Fixtures

- Flotron headquartered in Vista, California
- Established in 1957

Agenda:

- Intro
- Flotron Improvements
- Review of Flotron’s capabilities
- New Off-the-Shelf options
- New products

Flotron improvements:

- New facility, doubling production capacity and increased ceiling height
- Certified QMS, ISO-9001:2015
- Recertified welding procedures and welders
- New tools and talent
    - Engineering: Ansys Workbench FEM SW, templates for Mathcad hand calcs and deliverable stress reports. Engineering talent.
    - Manufacturing: HAAS Mill & Lathe, Welding Machines
    - Inspection: Leica AT401 Tracker, FARO Arm, Large Granite Surface Plate

ISO 9001 Certified Quality Management System

ZERTIFIKAT • CERTIFICATE • 認證證書 • СЕРТИФИКАТ • CERTIFICADO • CERTIFICAT

TÜV SÜD America

CERTIFICATE

The Certification Body of
TÜV SÜD AMERICA INC.

hereby certifies that

FLOTRON®

FLOTRON, Inc.
2630 Progress Street
Vista, CA 92081 USA

has implemented a Quality Management System
in accordance with:

ISO 9001:2008

The scope of this Quality Management System includes:

Designs and Manufacturers Rotational Holding Fixtures and Circuit Card Extraction Tools.

Certificate Expiry Date: July 7, 2018

Certificate Registration No: 951 12 6009

Effective Date: July 8, 2015

TÜV SÜD ISO 9001

Gary W. Minks
VP, Regulatory Affairs

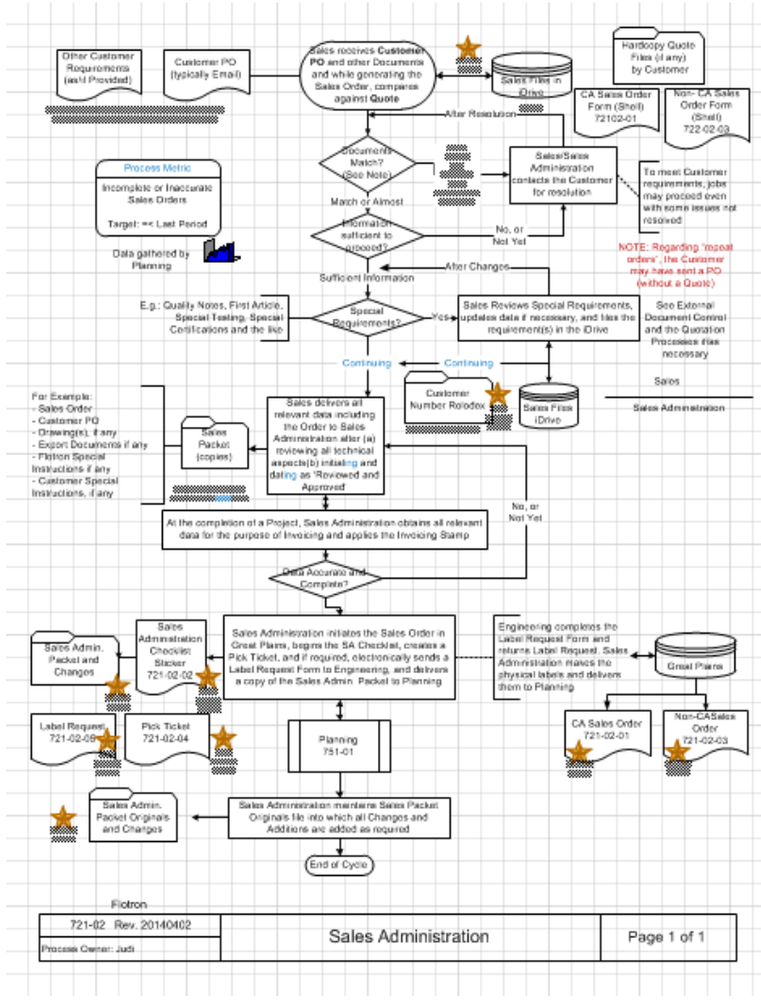
ANAB ACCREDITED
MANAGEMENT SYSTEMS CERTIFICATION BODY

TÜV SÜD AMERICA INC • 10 Centennial Drive • Peabody, MA 01960 USA • www.TUVamerica.com TÜV®

Flotron's Quality Policy

It is the policy and the commitment of the Management and Employees of Flotron that we:

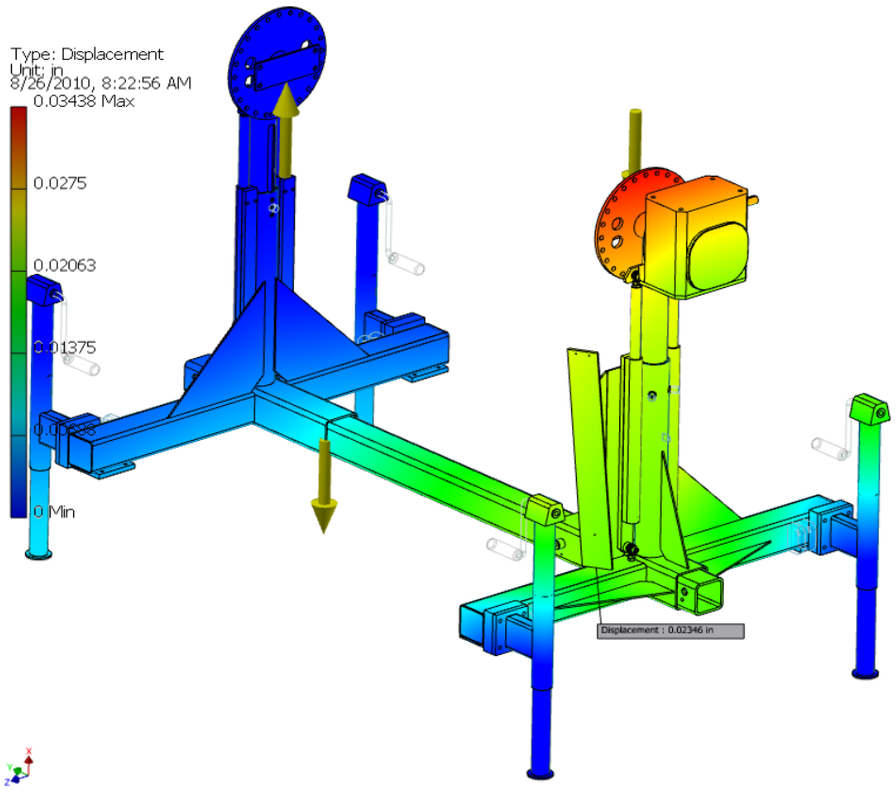
- *Maintain a reputation of excellence with our Customers in knowledge and ability in high-end Rotational Holding Fixtures and Printed Circuit Board Extractors;*
- *Consistently meet our customer's expectations for responsiveness, quality, and delivery;*
- *Create a work environment that develops Employee skills that foster pride and personal responsibility;*
- *Ensure continuous improvement through the establishment, measurement, and review of the effectiveness of our **Q**uality **M**anagement **S**ystem.*
- *Consistently work within the standards, statutory, and regulatory requirements for our industry.*



Certified Welders

Templates setup for hand calculations & deliverable reports

ANSYS



1.2 Margin of Safety Summary Table

Load Case			FEA Analysis	Required Factor of Safety		Stress in Part	Strength of Material in High Stress		Factor of Safety		Margin of Safety		Reference	
Load Case Number	Orientation	Area Probed	Failure Theory	Yld.	Ult.	ksi	Yld. (Ksi)	Ult. (Ksi)	Yld.	Ult.	Yld.	Ult.	Report Page Number	Flag #
2	Payload Horiz.	A500 Gr. B Tube HAZ	Von Mises	3	5	8.85	33.60	46.40	3.80	5.24	0.266	0.049	18	1
2	Payload Horiz.	Weld	Von Mises	3	5	9.17	68.10	80.90	7.43	8.82	1.475	0.764	19	2
3	Payload Horiz.	A500 Gr. B Tube HAZ	Von Mises	3	5	9.10	33.60	46.40	3.69	5.10	0.231	0.020	20	3
3	Payload Horiz.	Weld	Von Mises	3	5	9.01	68.10	80.90	7.56	8.98	1.519	0.796	21	4
4	Payload Horiz.	A500 Gr. B Tube HAZ	Von Mises	3	5	9.26	33.60	46.40	3.63	5.01	0.210	0.002	22	5
4	Payload Horiz.	Weld	Von Mises	3	5	10.14	68.10	80.90	6.72	7.98	1.239	0.596	23	6
5	Payload Horiz.	Weld	Von Mises	2	3	21.00	68.10	80.90	3.24	3.85	0.621	0.284	24	7
6	Payload Horiz.	A36 Plate	Von Mises	2	3	11.14	36.00	58.00	3.23	5.21	0.616	0.735	31	10
6	Payload Horiz.	Weld	Von Mises	2	3	10.84	68.10	80.90	6.28	7.46	2.141	1.488	31	11
7	Payload Horiz.	A36 Plate HAZ	Von Mises	2	3	10.55	28.80	46.40	2.73	4.40	0.365	0.466	34	12
7	Payload Horiz.	Weld	Von Mises	2	3	9.16	68.10	80.90	7.43	8.83	2.717	1.944	34	13
10	Payload Horiz.	A36 Plate HAZ	Von Mises	1	1	11.45	28.80	46.40	2.52	4.05	1.515	3.052	37	14
10	Payload Horiz.	Weld	Von Mises	1	1	8.85	68.10	80.90	7.69	9.14	6.695	8.141	37	15
11	Payload Horiz.	A500 Gr. B Tube HAZ	Von Mises	1	1	20.26	33.60	46.40	1.66	2.29	0.658	1.290	39	16
11	Payload Horiz.	Weld	Von Mises	1	1	16.98	68.10	80.90	4.01	4.76	3.011	3.764	40	17

Table 1: Margin of Safety Summary – Payload Horizontal

Load Case			FEA Analysis	Required Factor of Safety		Stress in Part	Strength of Material in High Stress		Safety Factor		Margin of Safety		Reference	
Load Case Number	Orientation	Area Probed	Failure Theory	Yld.	Ult.	ksi	Yld. (Ksi)	Ult. (Ksi)	Yld.	Ult.	Yld.	Ult.	Report Page Number	Flag #
2	Payload Vert.	A36 Plate HAZ	Von Mises	3	5	5.28	28.80	46.40	5.45	8.79	0.82	0.76	43	18
2	Payload Vert.	Weld	Von Mises	3	5	4.97	68.10	80.90	13.70	16.28	3.57	2.26	44	19
3 (+Long)	Payload Vert.	A36 Plate HAZ	Von Mises	3	5	4.51	28.80	46.40	6.39	10.29	1.13	1.06	46	20
3 (+Long)	Payload Vert.	Weld	Von Mises	3	5	4.09	68.10	80.90	16.65	19.78	4.55	2.96	47	21
3 (-Long)	Payload Vert.	A36 Plate HAZ	Von Mises	3	5	8.33	28.80	46.40	3.46	5.57	0.15	0.11	50	23
3 (-Long)	Payload Vert.	Weld	Von Mises	3	5	8.70	68.10	80.90	7.83	9.30	1.61	0.86	51	24
4	Payload Vert.	A36 Plate HAZ	Von Mises	3	5	5.86	28.80	46.40	4.91	7.92	0.64	0.58	54	26
4	Payload Vert.	Weld	Von Mises	3	5	4.45	68.10	80.90	15.30	18.18	4.1	2.64	55	27
10 (+Long)	Payload Vert.	Weld	Von Mises	1	1	28.77	68.10	80.90	2.37	2.81	1.37	1.81	57	28
10 (-Long)	Payload Vert.	A36 Plate HAZ	Von Mises	1	1	27.26	28.80	46.40	1.06	1.70	0.06	0.7	60	29
10 (-Long)	Payload Vert.	Weld	Von Mises	1	1	36.51	68.10	80.90	1.87	2.22	0.87	1.22	61	30
11	Payload Vert.	A36 Plate HAZ	Von Mises	1	1	20.09	28.80	46.40	1.43	2.31	0.43	1.31	63	31
11	Payload Vert.	Weld	Von Mises	1	1	18.36	68.10	80.90	3.71	4.41	2.71	3.41	64	32

Table 2: Margin of Safety Summary – Payload Vertical

Note: Margin of Safety = (Allowable stress / (FOS X Calculated Stress)) -1

New Production and Inspection Tools

- Typical Flotron Applications & Payloads Supported

Typical Flotron Applications:

- Assembly, integration and test
- Finish operations
- Paint booth
- Thermal-Vac.
- Transportation
- Storage

Typical Payloads Supported by Flotron Rotation Fixtures:

- Propulsion Systems: Turbomachinery, nozzles, inter-propellant plates
- Small Satellites
- Aero-Structures: Inner Fixed Structure (IFS), Pickle Forks, Double Plus Chords
- Solar Array
- Solar wing
- Equipment panels
- Antennas
- Optical instruments and other payloads
- Composite structures
- Mid-Size Space Vehicles

Review of Flotron's capabilities:

- How to specify an Off-the-Shelf Flotron
- Defining Modified Standards
- Flotron Custom Solutions

How to specify an Off-the-Shelf Flotron:

- Flotron.com / Rotation Fixtures / Off-the-Shelf
- Flotron Series ID: Capacity, swing radius, torque rating, easy crank torque
- Creating A Model Number → Call Flotron and speak with an Application Engineer
- CAD Model, quotation and published price list

Off-The-Shelf

Request a CAD Model

Flotron's Off-the-Shelf product line of rotation fixtures ranges from a 50 lbs capacity bench top solution to a 14,500 lbs capacity motorized solution with swing radii up to 88 inches.

---

	200 Series	300 – 400 Series	500 Series
			
Load Rating:	50 – 130 lbs	80 – 115 lbs	175 – 500 lbs
Swing Radius:	13.3" – 15.2"	31.2"	27.0" – 31.2"
Max Torque:	1,050 in-lbs	1,050 in-lbs	1,275 in-lbs
Easy Crank:	300 in-lbs	300 in-lbs	300-700 in-lbs

	600 Series	700 Series	800 Series
			
Load Rating:	520 – 760 lbs	800 – 1,330 lbs	1,900 – 2,600 lbs
Swing Radius:	36.3" – 66.5"	28" – 54"	33.7" – 57.7"
Max Torque:	5,400 in-lbs	5,400 in-lbs	9,400 in-lbs
Easy Crank:	2,000 – 3,000 in-lbs	2,000 – 3,000 in-lbs	5,100 in-lbs

Flotron considers Sfy = 3 & Sfu = 5 in addition to a simultaneous dynamic loading conditions of 0.5G horizontal (worst case direction) and 1.0G vertical. Flotron also considers stability (0.5G for 600 series and up & 0.33G for 500 series and below).

Off-the-shelf / 700 Series

Flotron's 700 series holding fixtures are standard off-the-shelf units and are offered in three models with single or double beam configurations & manual or assisted height adjustment. They are normally supplied with heavy-duty gearboxes to handle large, off-center loads during assembly stages. These models are especially suited for handling different types of spacecraft & aircraft assemblies along with other heavier parts. See below for comparative data on the different 700 series models and click on any image for additional information about a particular fixture.

XD739

Load Rating: 1,330 lbs

Swing Radius: 28"

Max Torque: 5,400 in-lbs

Easy Crank: 2,000 in-lbs

XD747

Load Rating: 1,300 lbs

Swing Radius: 36"

Max Torque: 5,400 in-lbs

Easy Crank: 2,000 in-lbs

XD759

Load Rating: 960 lbs

Swing Radius: 48"

Max Torque: 5,400 in-lbs

Easy Crank: 2,000 in-lbs

XD739DB

Load Rating: 1,330 lbs

Swing Radius: 31.7"

Max Torque: 5,400 in-lbs

Easy Crank: 2,000 in-lbs

XD747DB

Load Rating: 1,300 lbs

Swing Radius: 40.7"

Max Torque: 5,400 in-lbs

Easy Crank: 2,000 in-lbs

XD759DB

Load Rating: 1,230 lbs

Swing Radius: 54"

Max Torque: 5,400 in-lbs

Easy Crank: 2,000 in-lbs

XD739-HYD

Load Rating: 800 lbs

Swing Radius: 28"

Height Range: 32.8" – 38.7"

Max Torque: 5,400 in-lbs

Easy Crank: 2,000 in-lbs

XD747-HYD

Load Rating: 800 lbs

Swing Radius: 36"

Height Range: 38.7" – 46.7"

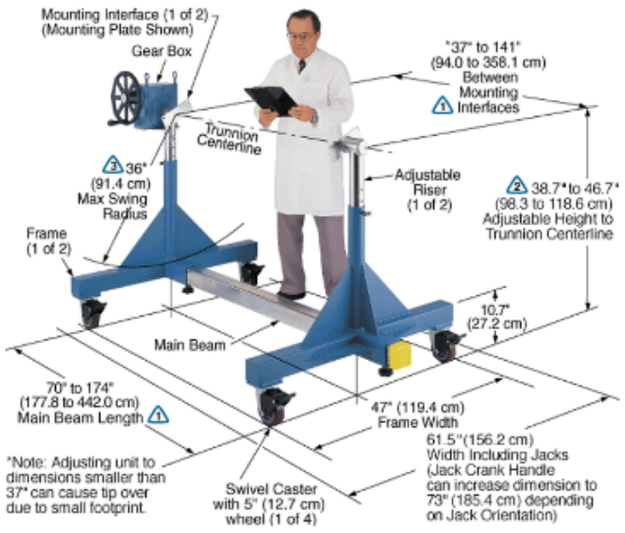
Max Torque: 5,400 in-lbs

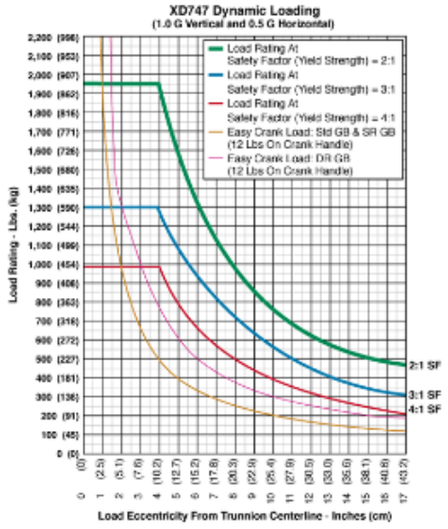
Easy Crank: 2,000 in-lbs

Off-the-shelf / 700 Series / XD747

XD747 Data Sheet

The Model XD747-P8-B052 shown below is typical and representative of the XD747 Models. For more information on specifying a holding fixture, see the 700 SERIES OPTIONS page and 700 SERIES CREATING A MODEL NUMBER pdf.





1 The maximum distance between mounting interfaces is directly related to the main beam length. Specify the distance between mounting interfaces to be at or slightly larger than the length of the part-to-be-handled. The fixture can be adjusted to accommodate smaller length parts, however, the main beam(s) extending from each end frame may be inconvenient. For more information see the 700 SERIES OPTIONS page and 700 SERIES CREATING A MODEL NUMBER pdf.

2 Addition of the optional SR or DR gearbox decreases the vertical riser adjustment from 8" to 6" and increases the minimum trunnion height from 38.7" to 40.7".

3 A smaller than standard swing radius may be recommended for some applications. See the "Technical Section" under "Holding Fixture Safety" on page 3 of 7 concerning "Unexpected Accident Loads" and the chart on page 4 of 7 referring to "Maximum Recommended Swing Radius"

Product Features:

- **Safety Factor:**3
- **Rated Load Capacity:**
  Dynamic, 0" eccentricity: 1,300 lbs. (590 kg.)
  Dynamic, 5" eccentricity: 1,080 lbs. (490 kg.)
- **Operating Temperature:**+32 to +104 °F (0 to +40 °C)
  Contact factory for special applications with extended operating temperatures.
- **Choice of Trunnion Interface/Mount/Clamp Options:**
  Angle Interface
  Mounting Plate Interface
- **Choice of Main Beam Length**
- **Main Beam Ball Lock Pins:**Reliably prevents End Frames from slipping on Main Beams
- **Gearbox:**60:1 ratio with 12" diameter crank
- **Casters:**5" diameter x 2" wide wheel with polyurethane tread, sealed swivel bearing and Tech-lock brake
- **Materials:**Steel construction
- **Finish:** Flotron Blue powder coat with selected parts zinc plated.

700 Series Standard Options:

Optional Main Beam Lengths (BXXX):

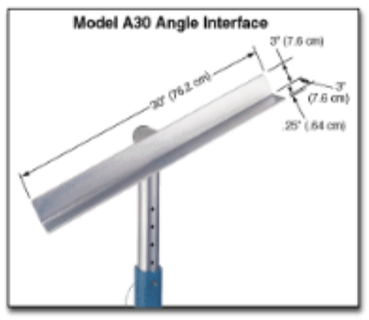
Main Beams may be ordered in any length between Trunnion Interface Mounts within the limits shown below. "XXX" = length in inches between trunnion interface mounts (1" increments).

MODEL	MIN	MAX
739	29"	141"
747	37"	141"
759	49"	141"
739DB	29"	154"
747DB	37"	154"
759DB	49"	154"

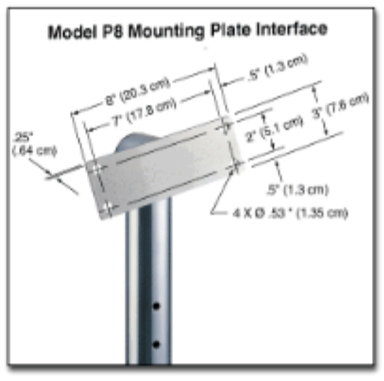
Lengths shorter than the MIN shown above can be dangerous due to tip over. Lengths longer than MAX shown above require a special beam. While the two End Frames can be adjusted toward each other to accommodate smaller length parts, excessively long beams with a small part will leave the Main Beams extending from each End Frame enough to be inconvenient. It therefore is desirable to order the Main Beam close to the size of the actual part-to-be-handled.

Optional Trunnion Interface/Mount/Clamp:

1. Angle Interface (A30) - The angle interface offers the most adaptability for customers. Either of the 3" perpendicular surfaces of the angle may be bolted or clamped to. The standard length is 30 inches with no bolt holes. The standard finish is clear zinc plate.



2. Mounting Plate Interface (P8) (Not available on SR or DR option. See P12/A30 options.) - The Part-to-be-handled can be easily bolted to this flange type interface. The standard size is 3" by 8" with a four-hole bolt pattern spaced at 7" by 2" centered on the plate. The four holes will accept up to ½" diameter bolts. The standard finish is clear zinc plate.



FLOTRON®

700 Series

Creating a model number

XD _ _ - _ _ - _ _ _ - _ _ - _ _ - _ _ - _ _ _ - _ _ - _ _ - _ _ - _ _ _ _ _ _ - _ _ _ - _ _ - _ _ _ _ - _ _ - _ _ - _ _ _

Model Type

(blank)-Standard finishes
C - - - - Clean Room finishes Except Hydraulic
N - - - - Electroless Nickel Plate

ESD Ground
(blank) - No ESD Ground
E - - - - Ground Lug and Drag Chain for use in EPA's

Lubricants:
(blank) - Standard lubricant
L1 - - - - Trunnions & caster swivel bearings lubricated with Krytox GPL 207
L2 - - - - Trunnions & caster swivel bearings lubricated with Braycote 601EF
NOTE:
"C" finish includes L1 Lubricants

Size
739 - 39" Wide frame
747 - 47" Wide frame
759 - 59" Wide frame

Style
(blank) - Single Main Beam
DB- - - -Double Main Beam

Forklift Tubes
(blank) - No Forklift Tubes
F1 - - - - Frame mounted Forklift Tubes (not compatible with XD739)

Proof Load Test
(blank) - No Proof Load Test
PLT - - - Standard Proof Load Test (includes deliverable report)

Caster
(blank) - Standard caster with brake
C1 - - - - Heavy duty caster with brake and swivel lock
C2 - - - - Standard caster with brake and conductive wheel
C3 - - - - Caster with elastomer wheel to improve rollability
C4 - - - - Spring loaded casters isolate shock and vibration

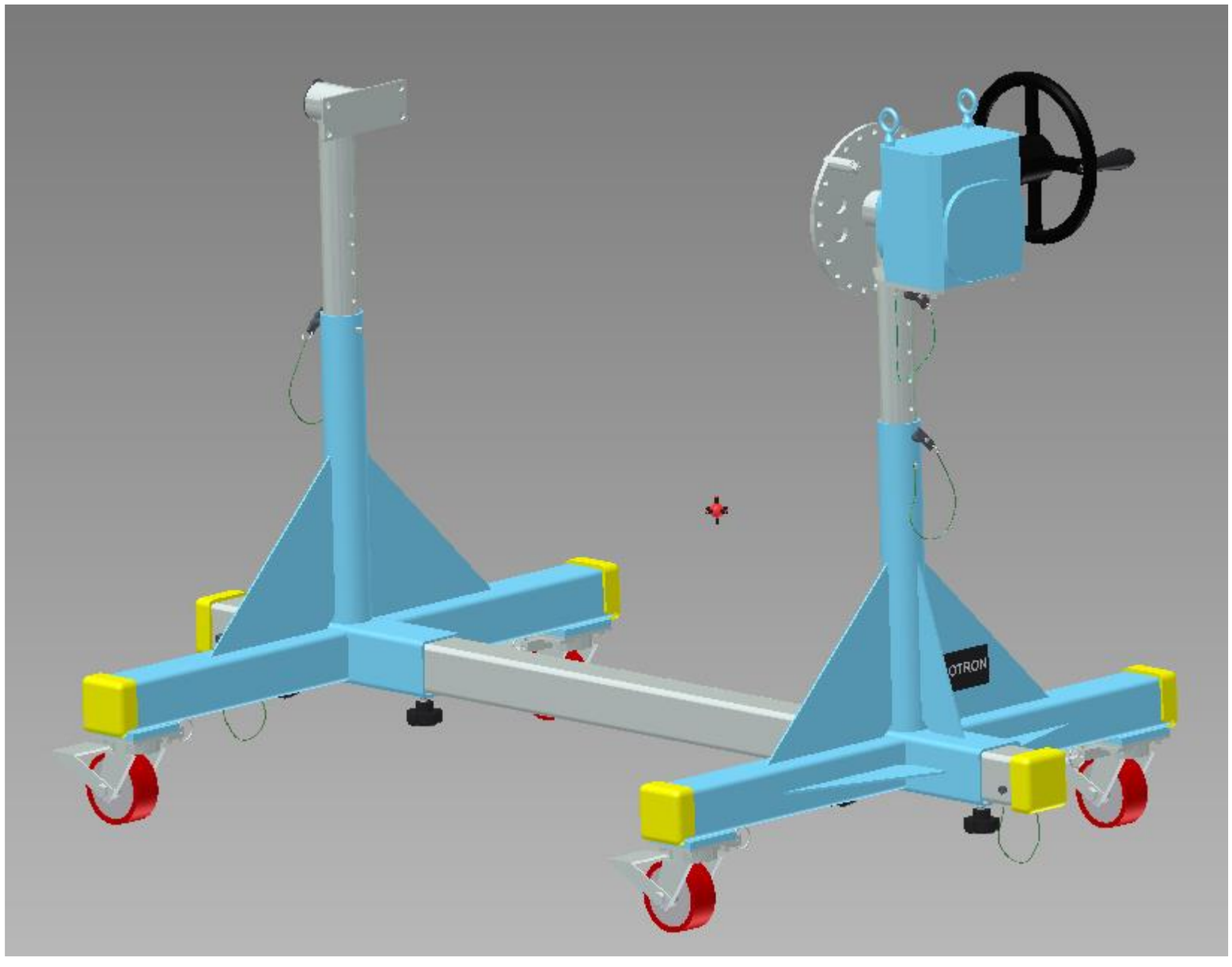
Towing Interface
(blank) - No Towing Interface
T1 - - - - Removable Towing Interface (attaches to main beam)

Main Beam
B"XXX"-Main Beam length where "XXX"= length in inches between trunnion interface mounts. (1" increments within the following range)

MODEL	MIN	MAX
739	30"	141"
747	37"	141"
759	49"	141"
739DB	30"	154"
747DB	37"	154"
759DB	49"	154

Sleeved Trunnion Bearings
(blank) - Standard trunnion bearings
B1 - - - - PTFE sleeved bushings in bearing housings

CAD Model (STEP file format or other)



2630 Progress St. Vista, California 92081 USA
www.flotron.com

700 Series Tronic Price List

Effective 1/01/2018

Standard XD Units:

	1-4 Units	5-9 Units	10-14 Units	
XD739-B____*	10,949 ea.	10,730 ea.	10,515 ea.	
XD747-B____*	11,156 ea.	10,933 ea.	10,714 ea.	For units of 15 or
XD759-B____*	11,377 ea.	11,149 ea.	10,926 ea.	more call factory
XD739DB-B____*	12,954 ea.	12,695 ea.	12,441 ea.	
XD747DB-B____*	13,160 ea.	12,896 ea.	12,638 ea.	
XD759DB-B____*	13,376 ea.	13,108 ea.	12,846 ea.	

Beam Price Information:

Specify beam length between clamps in inches - standard pricing includes up to 84"
For additional information see our webpage http://www.flotron.com/pdf/700number.PDF

For inside beam length greater than 84" but less than 141"	Price is per inch 1-4 Unit(s)	Price is per inch 5-9 Units	Price is per inch 10-14 Units	Unit Type
	17.72	16.50	15.20	Single Beam
	35.43	33.00	30.40	Double Beam (DB)

Additional Options:

Flotron offers a variety of configurations for its XD series units. Below is a list of some of the options available.

	1-4 Unit(s)	5-9 Units	10-14 Units
Finish:			
C Prefix for cleanroom finish	7,719	5,132	4,809
N Prefix for Electroless nickel plate	3,337	3,236	3,139
ESD Ground:			
E Prefix for ESD grounding features	92	90	89
Lubricants:			
L1: Trunnions & caster swivels lubed w/ Krytox GPL 207	853	827	803
L2: Trunnions & caster swivels lubed w/ Braycote 601EF	1,194	1,158	1,123
Forklift Tubes:			
F1: Forklift Tubes (frame mounted)	2,726	2,644	2,565
Hydraulic Lift:			
HYD: Hydraulic Lift Riser Addition	6,617	6,088	5,691
Frame Mounted Jacks:			
J0: Mtg Plates only for Jacks	373	362	351
J1 - J4: Frame Mounted Jacks (1 set of four)	1,841	1,786	1,733
J1H-J4H: Hex Drive, Frame Mounted Jacks (1 set of four)	2,161	2,097	2,034
Gearbox Options:			
LGB: Less Gearbox (Need Index Plate added)	(1,134)	(1,100)	(1,067)
SR: Single Reduction high capacity gearbox (P12 included)	7,071	6,505	6,081
DR: Double Reduction high capacity gearbox (P12 included)	8,805	8,100	7,572
P12: Plate Clamp (additive to P8 price)	988	909	850
Push Bar:			
P1: Gearbox Mounted Push Bar	1,224	1,187	1,152
Index Plate:			
IND15: 15° index plate	747	712	677
INDS15: 15° index plate w/ stops	844	807	771
Sleeved Trunnion Bearings:			
B1: PTFE bushings in bearing housings	981	952	923
Towing Interface:			
T1: Removable Towing Interface (attaches to main beam)	923	895	868
Caster Options:			
C1: Upgraded Caster with Swivel Locks additive	328	321	315
C2: Caster with Conductive Wheel	328	321	315
C3: Caster with Elastomer Wheel to improve rollabiltiy	550	534	517
C4: Spring Loaded Casters isolate shock & vibration	1,802	1,748	1,696
Proof Load Test:			
PLT: Standard Proof Load Test (includes deliverable report)	1,845	1,790	1,736

Notes: For modified or custom units Flotron will assign a special part number.
All prices are FOB Vista, CA USA
Above units have a shipping weight in excess of 450 lbs./ 205 kgs.

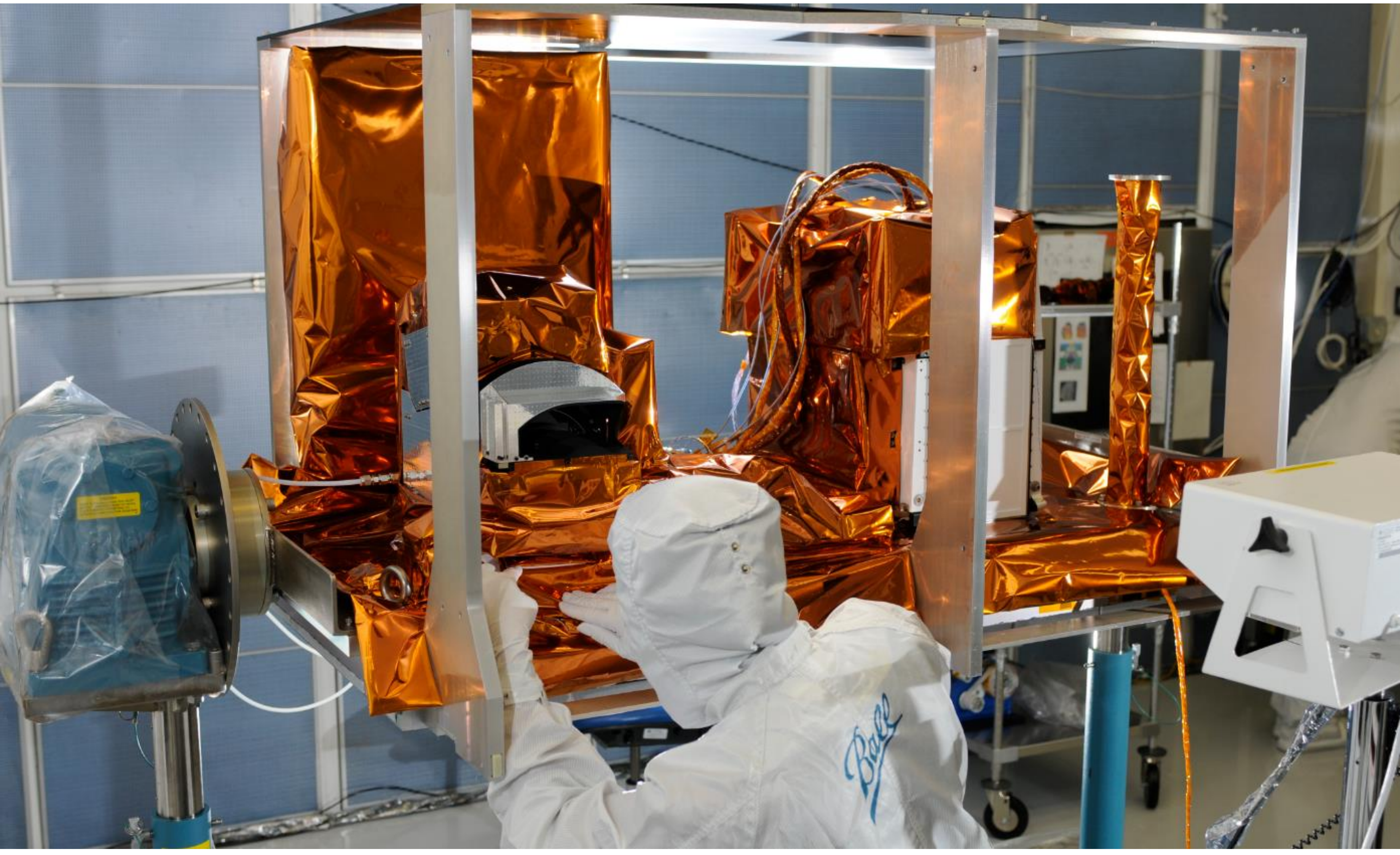
FLOTRON

Designer and Manufacturer of Rotation Fixtures

Off-the-shelf / 700 Series (Small Satellite AI&T Production Lines)

Flotron Rotation Fixture provides SNC technicians ergonomic access during AI&T of OG2 Satellites

Off-the-shelf / 700 Series (Instrument Assembly and Test)



Flotron Rotation Fixture provides BATC technicians ergonomic access during AI&T of the Ozone Mapping and Profiler Suite (OMPS)

FLOTRON

Designer and Manufacturer of Rotation Fixtures

Off-the-shelf / 700 Series (SMAP Radar Instrument Assembly and Test)

NASA Administrator Charles Bolden at JPL learns about the (SMAP) spacecraft's radar instrument assembly from Engineer, Wayne Lee.

FLOTRON®

Designer and Manufacturer of Rotation Fixtures

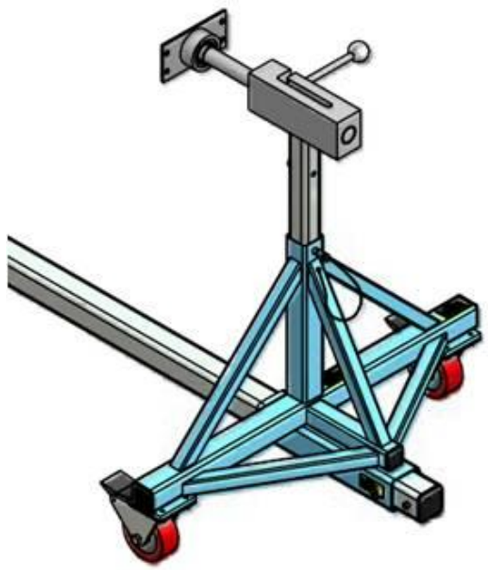
Off-the-shelf / 900 Series (Optical Assembly and Test)

Flotron Rotation Fixture supports six BATC beryllium mirror segments between a series of cryogenic tests.

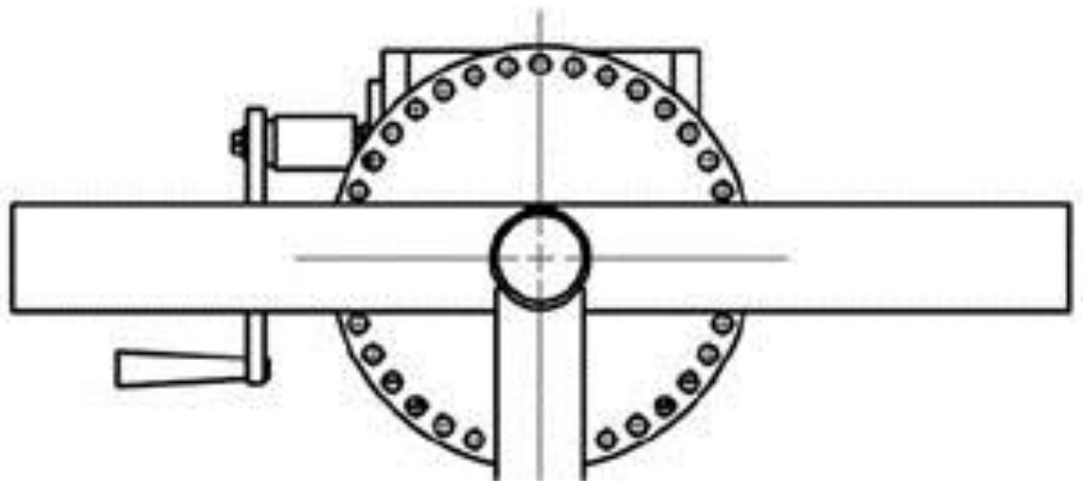
Defining Modified Standards:

- Customer requirements that are not fulfilled with Flotron's Off-the-Shelf product, simple modifications (examples below). NOTE: Some of these modifications are now Off-the-Shelf options.
  - Finishes
  - Lubricants
  - Casters
  - Push Bar
  - Towing Interface
  - Forklift Tubes
  - Proof Load
  - Drip Pan
  - Trunnion Bearings
  - Lock Rods

Modified Standard Rotation Fixtures

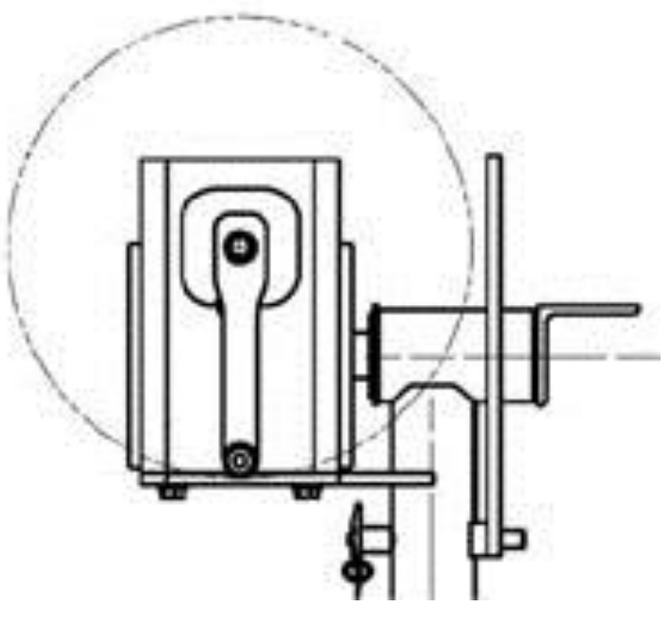


This axial slide feature provides a substantial amount of axial float for small loads.



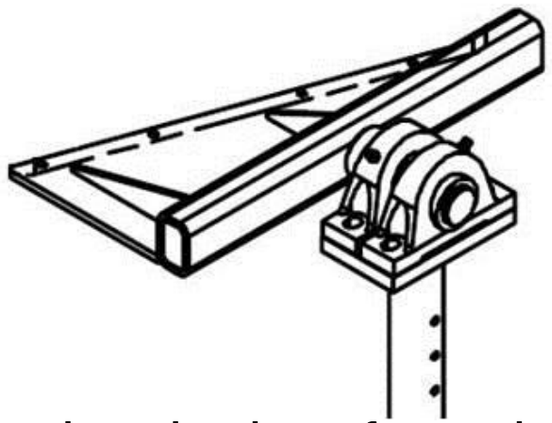
Sometimes 10° indexing of the index plate is preferred instead of 15°

Splitting the index plate and removing the gearbox eliminates line of site obstructions

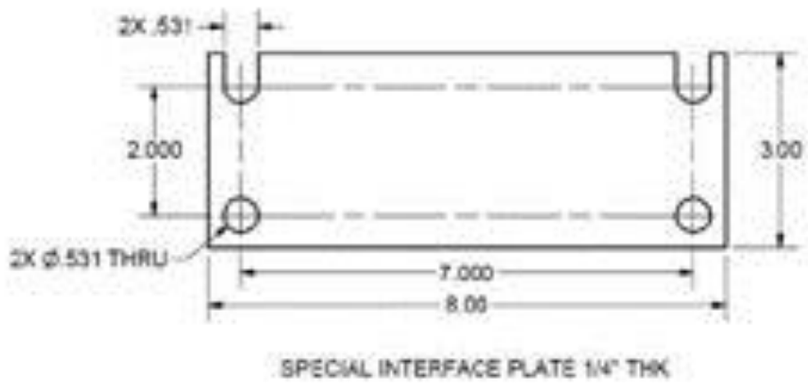


Sometimes a ratchet hand crank is preferred instead of the circular hand wheel

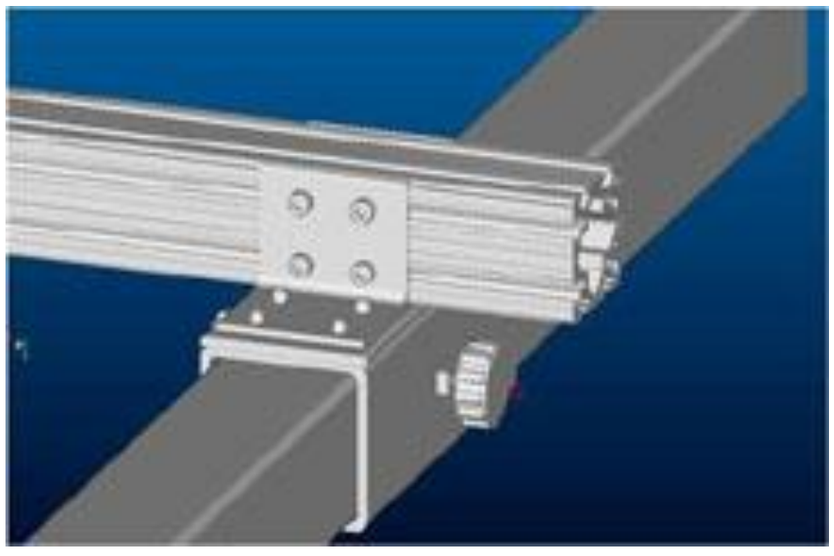
Modified Standard Rotation Fixtures



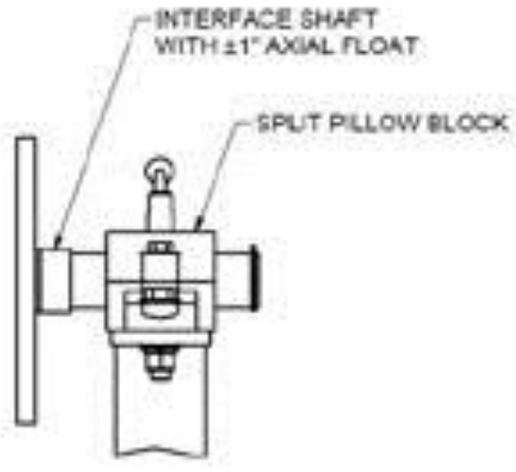
Capturing the interface shaft in dual pillow block bearings accommodates overhung loads



Slotting the top two holes of a standard Flotron P8 interface eases installation and removal

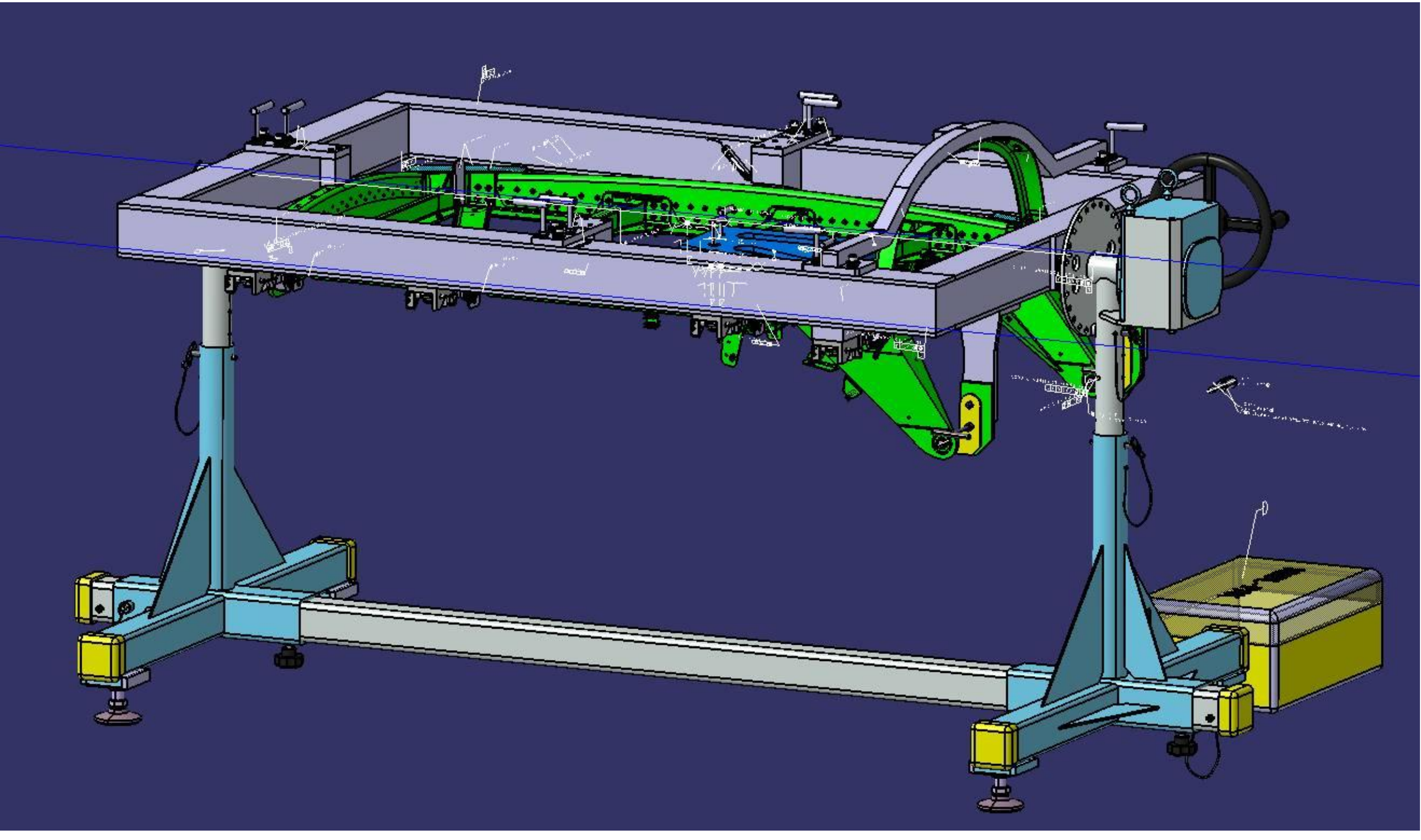


80/20 material can be incorporated into a 700 series main beam slide and used as a junction to a test box



Lengthening the interface shaft and capturing it with a pillow block bearing provides axial float that eases part removal and installation

Modified Standards / 700 Series



Supports assembly of machined stretch formed details.

Flotron Custom Solutions:

- Five Categories (Typically Customer Applications involve more than one category)
  - Engineered Lift Systems
  - Cantilevered Solutions
  - Multi-Axis Rotation
  - Precision Alignment
  - Large Swing Radius
- Custom Solution Process
  - Customer identifies a mover and shaker POC to engage Flotron. Flotron identifies a Project Manager.
  - An NDA is signed
  - If available, a SOW or product specification and any relevant payload and / or tooling geometry is shared, CAD and / or 2D Drawings
  - Flotron gathers the necessary functional requirements using an internal customer requirements capture form.
  - Flotron generates a proposal drawing and we send this to our customer.
  - There are typically several iterations of drawing revisions to effectively capture all of the functional and dimensional requirements.
  - In parallel, a pricing estimate is generated and a written proposal is sent to the customer for review.
  - The drawings is signed off by the relevant customer contacts.
  - Flotron finalizes the design and details the drawings for production.
  - Flotron’s Project Manager works to ensure that all requirements are effectively flowed through our organization, that the project is completed on time and within budget and coordinates the proof load and acceptance testing, associated non-destructive inspection and deliverable reports, if applicable.

Flotron Custom Solutions:

CUSTOM SOLUTIONS

For special requirements that cannot be resolved with an Off-the-Shelf or Modified Standard Flotron, our experienced team of sales engineers will work with you to design a Custom Solution.

Engineered Lift

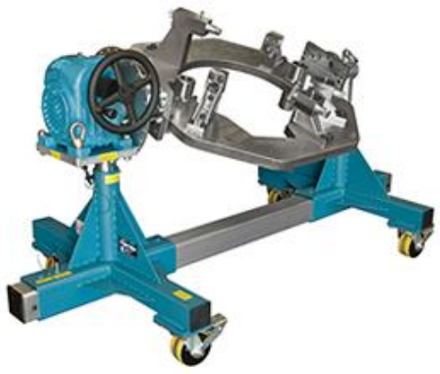
Cantilevered

Multi-Axis Rotate

Precision Alignment

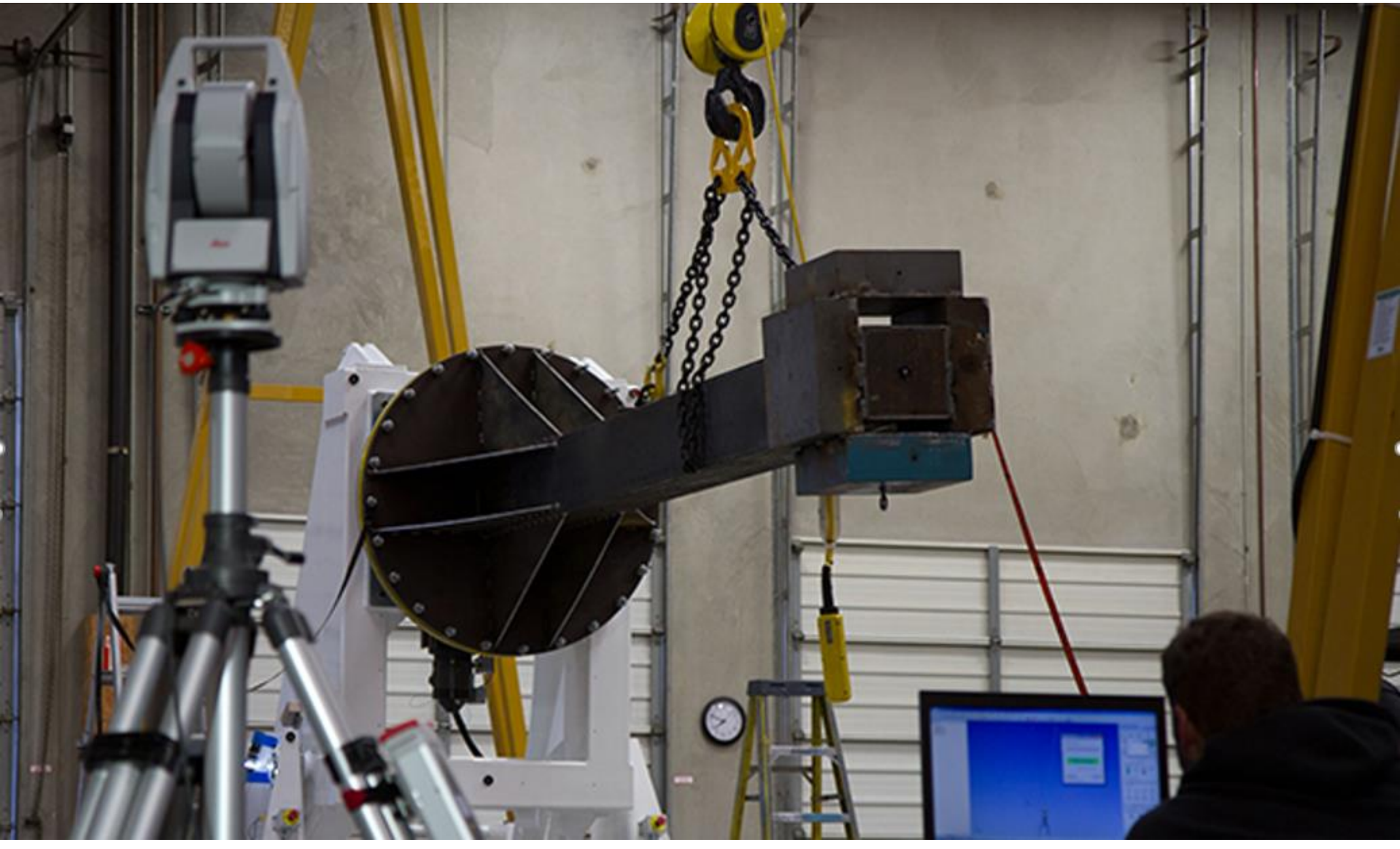
Large Swing

Payload Interfaces



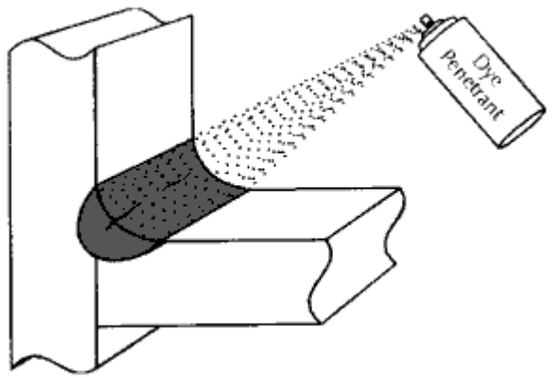
	Verification Matrix- SDRL_6	Test	Inspection	Mathematical Analysis	Audit	Design Validation Method
1	INTRODUCTION					
1.1	Scope					
	This document specifies the requirements for a second generation Mobile Two Axis Positioner (MTAP-2). The MTAP-2 will be used to carry a payload during movements within the Ball Aerospace & Technologies Corp. (BATC) facilities and launch site facilities in order to perform all the associated payload test requirements. The MTAP-2 will be able to rotate the payload from the vertical to horizontal position and about the payload Z-Axis (reference figure 1). The MTAP-2 with and without an attached payload must be capable of rolling into and integrating with the existing Shipping Container for shipment to and from the launch sites (reference figure 2). The MTAP-2 sitting inside the Shipping Container shall maintain the payload in a horizontal (<10 deg.) position.					
1.2	Requirements Weighting Factors					
	"Shall" designates the most important weighting level—mandatory. Any deviations from these mandatory requirements require the approval from BATC prior to implementation. "Shall" requirements appearing in sections 3, 4 and 5 require verification of compliance.					
[1.2A]	Verifiable requirements shall be identified with a number corresponding to the Verification Matrix and be noted [x.x.xX] as appropriate to the paragraph numbering.					
1.3	TBD/TBR					
	The term "To Be Determined (TBD)" applied to a missing requirement means that Ball Aerospace will determine the missing requirement. The term "To Be Resolved (TBR)" means that the requirement is subject to review for appropriateness by Ball Aerospace. Each instance of a TBD or TBR in this specification is parenthetically identified by either the acronym "TBD" or "TBR," respectively, followed by the identification number. For example "(TBD-001)."					
1.4	Figures					
	Figure 1 Pictorial of MTAP-2 and payload in the horizontal and Vertical Orientation Figure 2 MTAP-2 to Container Integration					
2.	APPLICABLE DOCUMENTS					
	The following documents and those referred to in the text of this specification, of the issue on the date of invitation for bids, form a part of this specification to the extent specified herein. In the event of conflict between this specification and any referenced document, this specification shall govern.					
2.1	Government Documents					
	AFSPCMAN91-710 RANGE SAFETY USER REQUIREMENTS MANUAL, VOLS. 3 AND 6					
2.2	Industry Documents					

Proof Load and Acceptance Testing

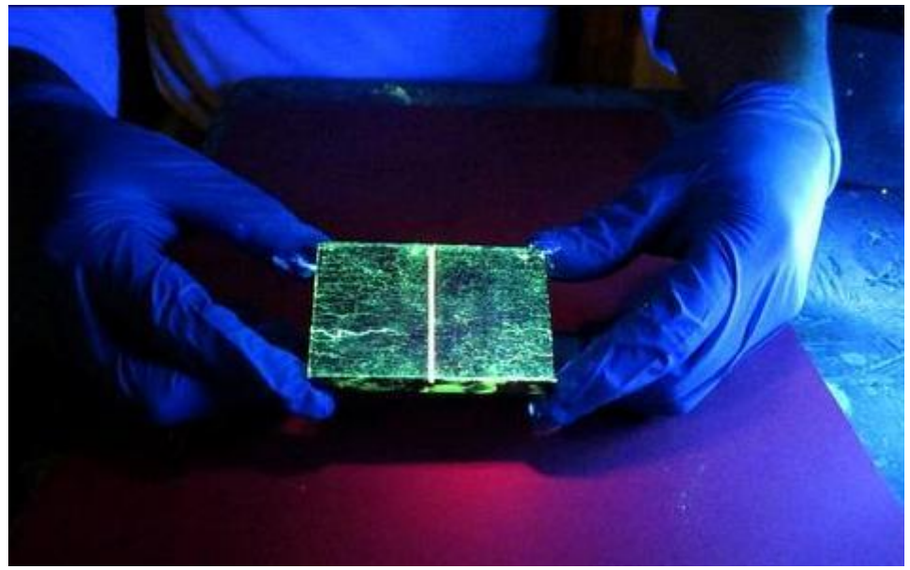


Non-Destructive Test Services

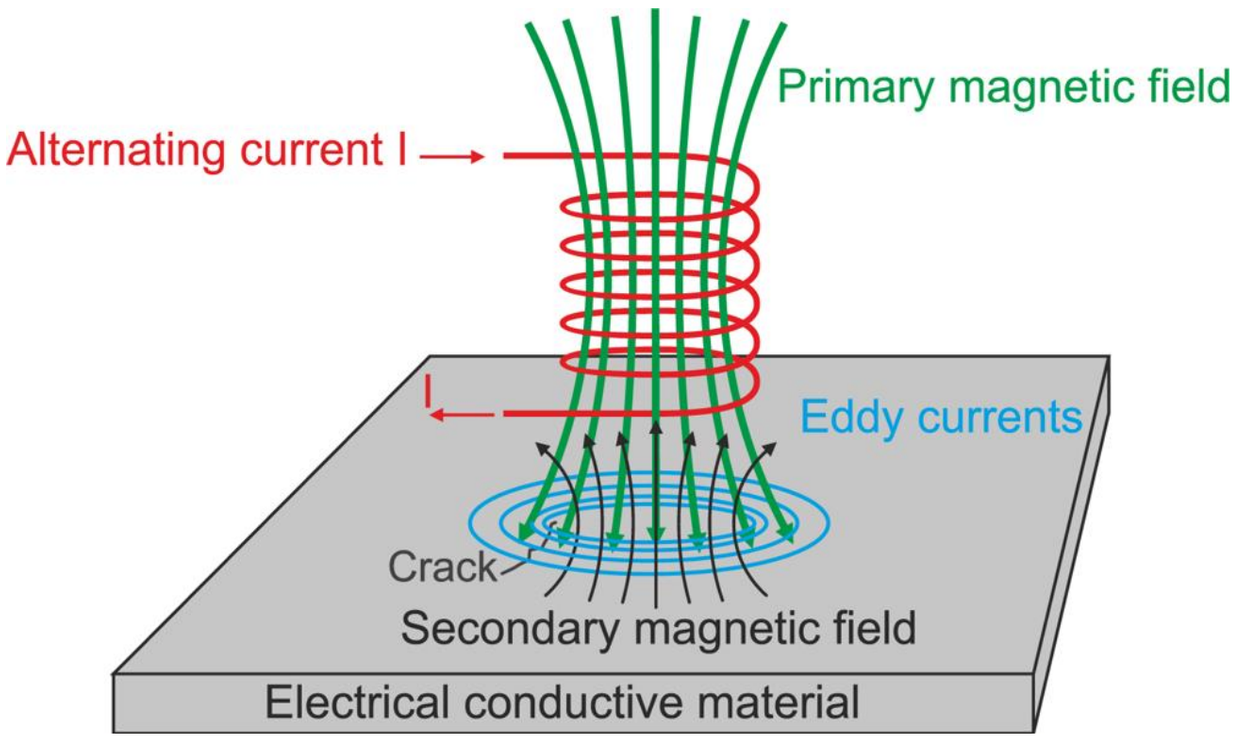
Liquid Penetrant Inspection



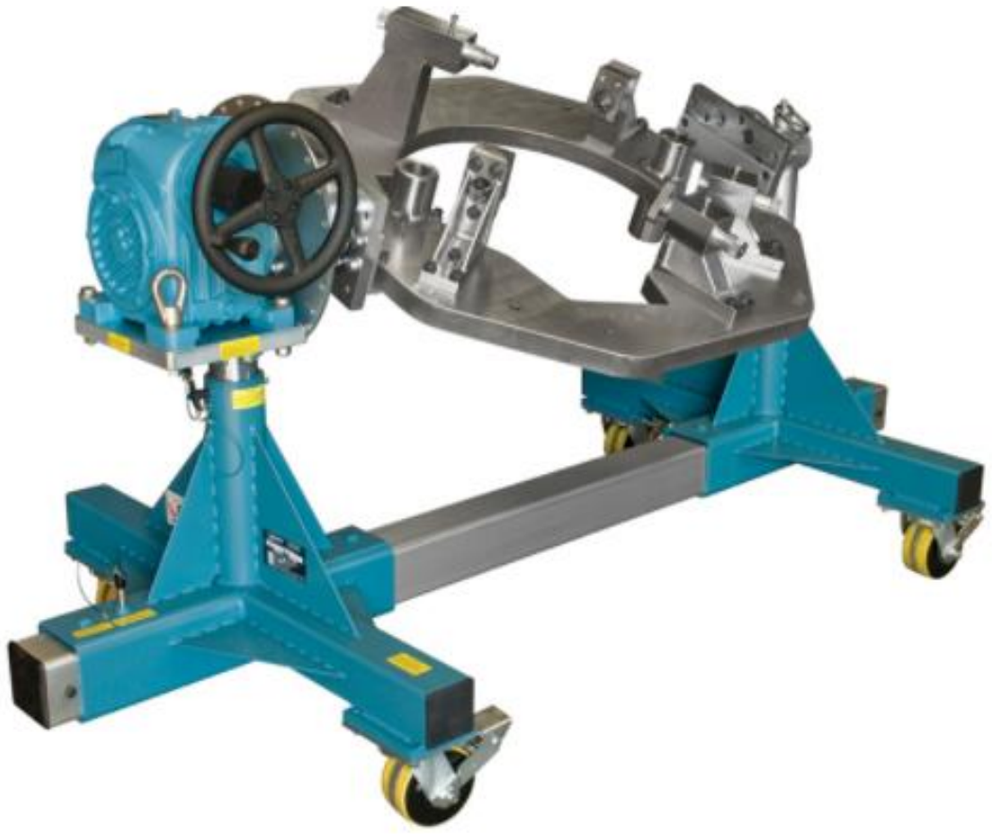
Fluorescent dye penetrant



Eddy Current Inspection



Custom Solutions / Payload interfaces



Turbopump Assembly Rotation Fixture

Manual Composite Operations Rotation Fixture

Custom Solutions/ Multi-Axis Rotate

Dual Axis Rotate and Precision Alignment

Dual Axis Motorized Rotate

Custom Solutions/ Engineered Lift

Asynchronous Lift

Synchronized Mechanical Lift

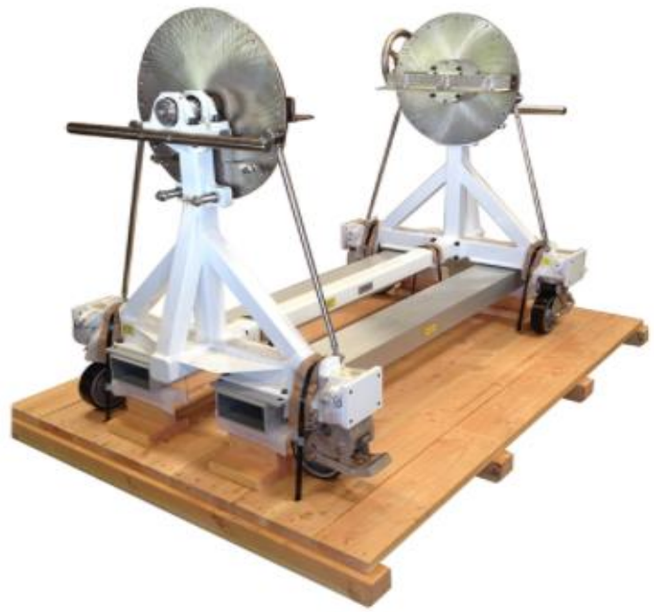
Custom Solutions/ Large Swing

Large Swing Radius with Mechanical Height Adjustment

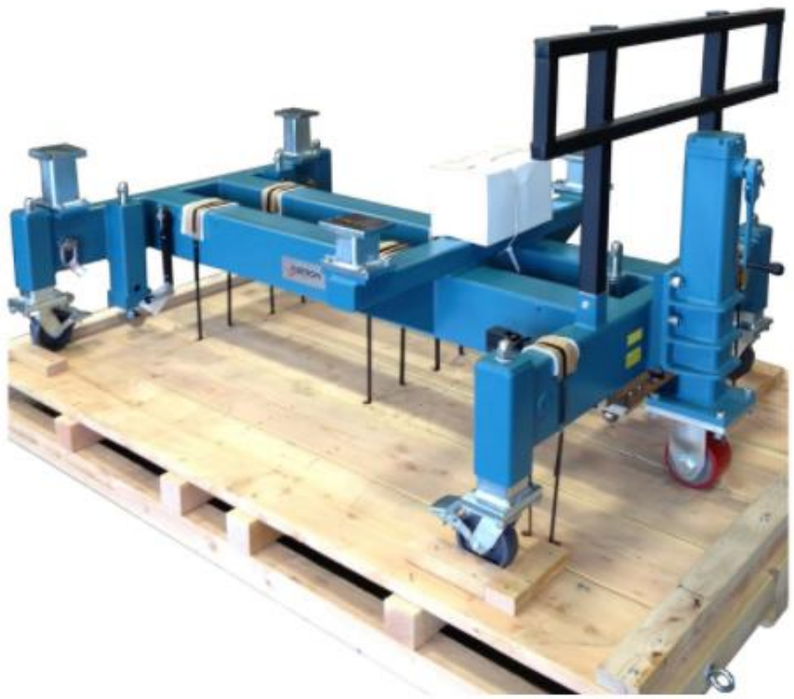
Large Swing Radius with 10,000 lbs Capacity

Custom Solutions/ Precision Alignment

Split Ring Rotation and Precision Alignment



Single Axis of Rotation for Precision Optical Alignment

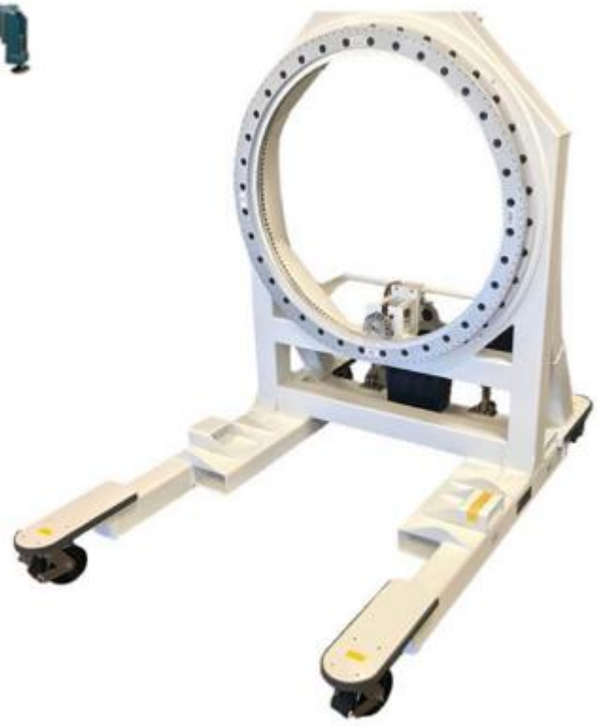


Modular Precision Alignment Base Fixture

Precision Alignment, Rotation, Translation and Height Adjustment

Custom Solutions/ Cantilevered

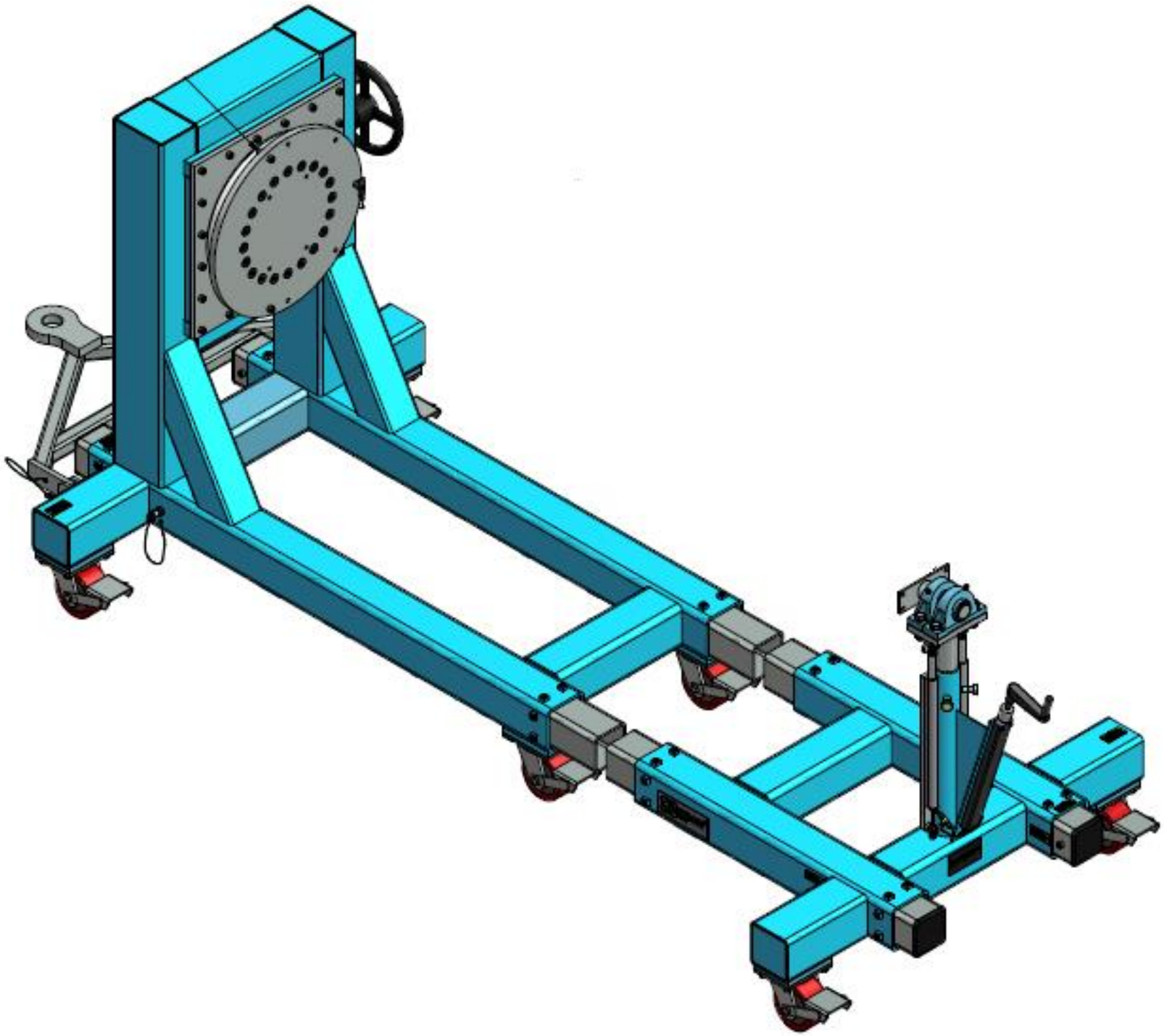
Cantilevered, Motorized Rotation and Height Adjustment



Cantilevered Satellite Integration Fixture

Cantilevered, Motorized Height Adjustment with Scissor Lift

Custom Solutions / Cantilevered & Engineering Lift

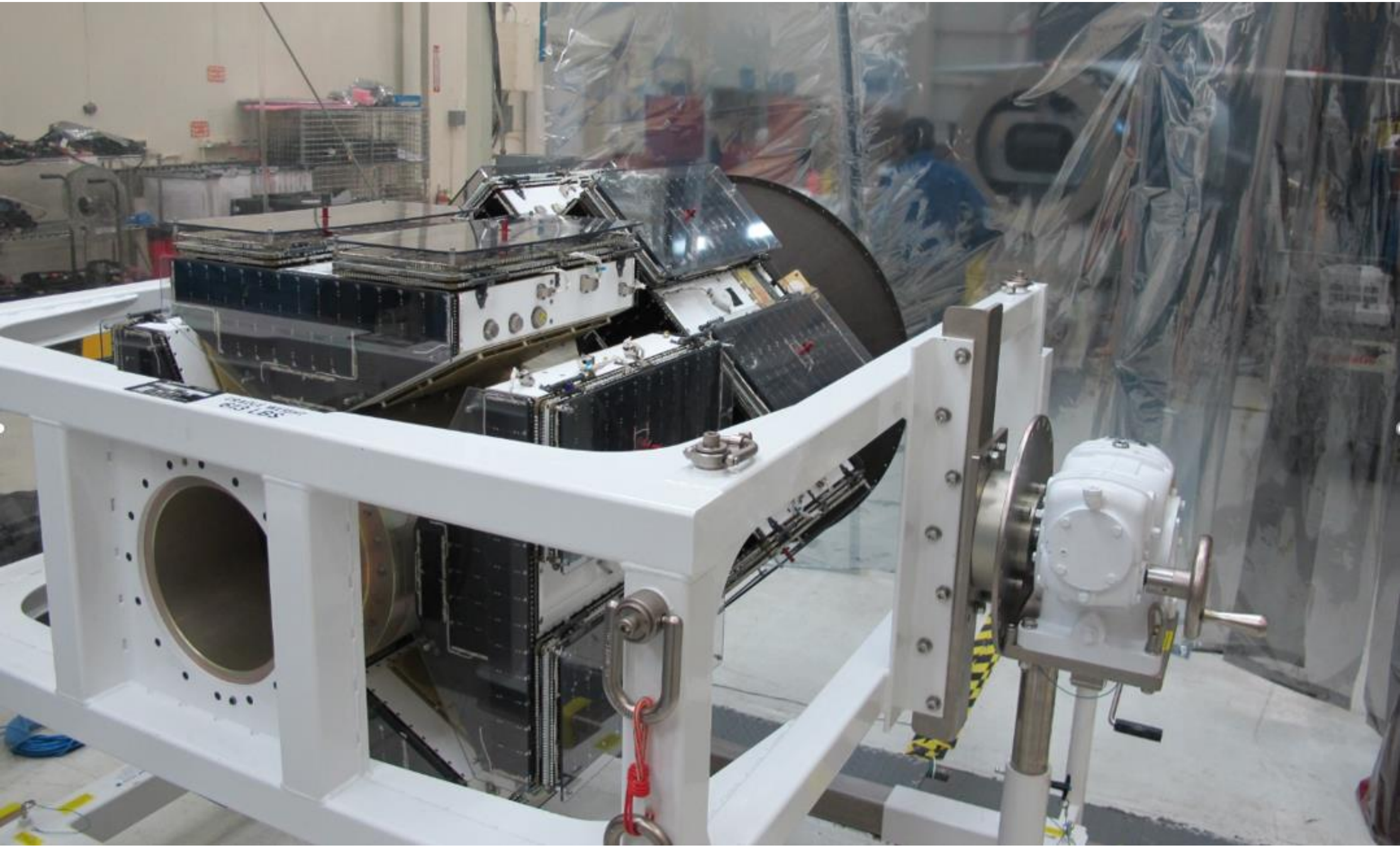


Supports composite structure in cantilevered configuration and tip of payload with height adjustment capability.

FLOTRON®

Designer and Manufacturer of Rotation Fixtures

Custom Solutions / Payload Interfaces (Small Sat Deployment Module AI&T)



Flotron Rotation Fixture supports AI&T of SNC Deployment Module and Eight SWRI Microsatellites

Custom Solutions / Cantilevered Satellite Integration fixture (Composite Structure AI&T)

Flotron Satellite Integration Fixture supporting a spacecraft structure for a scientific mission.

Custom Solutions / Payload Interfaces (8006-300/400 Composite Structure Assembly)

Flotron Rotation Fixture and Payload Interface Hardware Support NG JWST Composite Spacecraft Structure Assembly

Custom Solutions / Payload Interfaces (8006-300/400 Composite Structure Assembly)

Flotron Rotation Fixture and Payload Interface Hardware Support NG JWST Composite Spacecraft Structure Assembly

FLOTRON

Designer and Manufacturer of Rotation Fixtures

Custom Solutions / Multi-Axis Rotate (Mid-Size Satellite AI&T and Transport)

Flotron Satellite Positioner transports and Upends JPSS-1 NASA/NOAA next generation Weather Satellite.

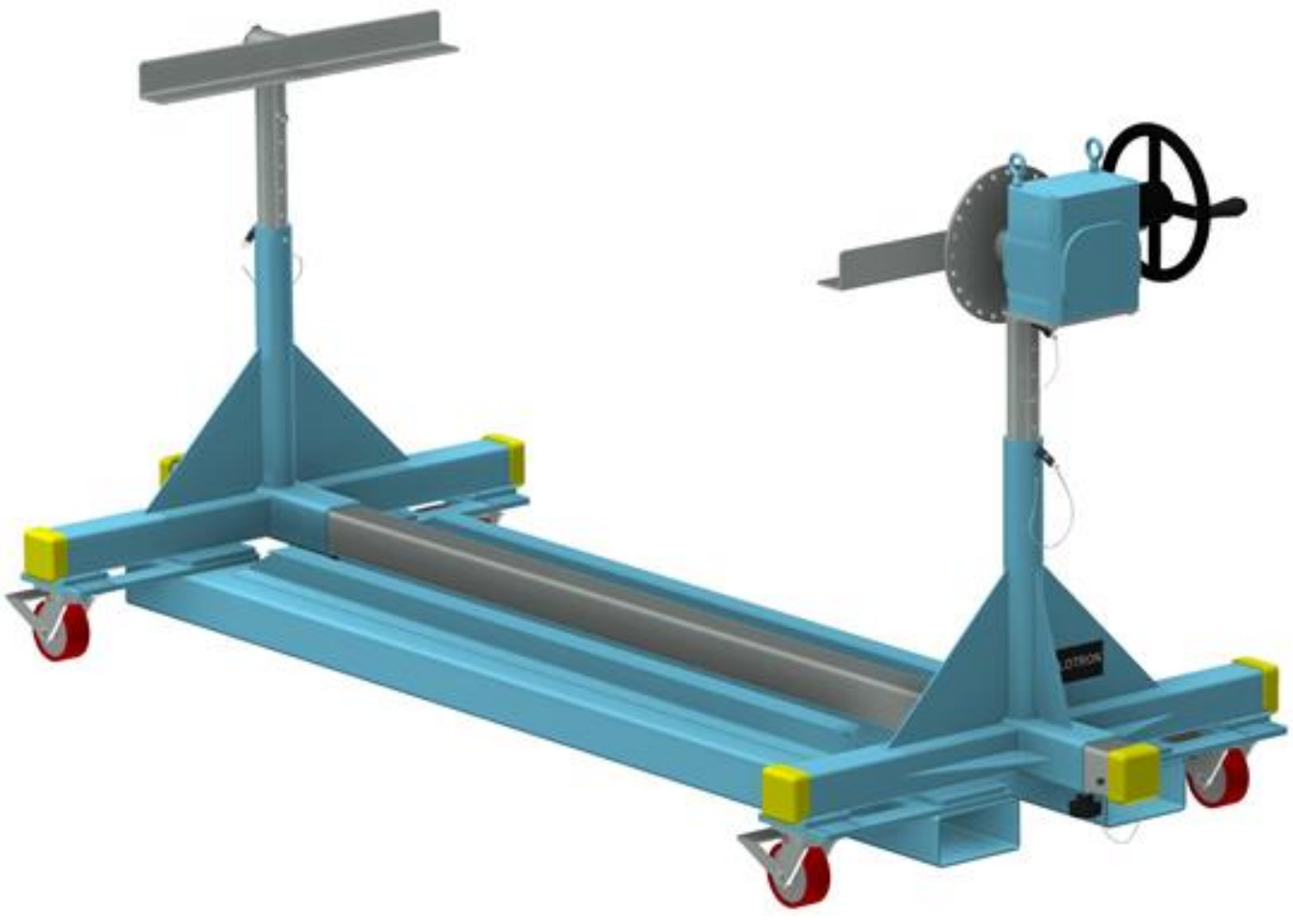
New Off-the-Shelf Options:

- Lubricants
- Forklift Tubes
- Push Bars
- Sleeved Trunnion Bearings
- Towing Interface
- Special Casters
- Proof Load Testing

New Off the Shelf Options

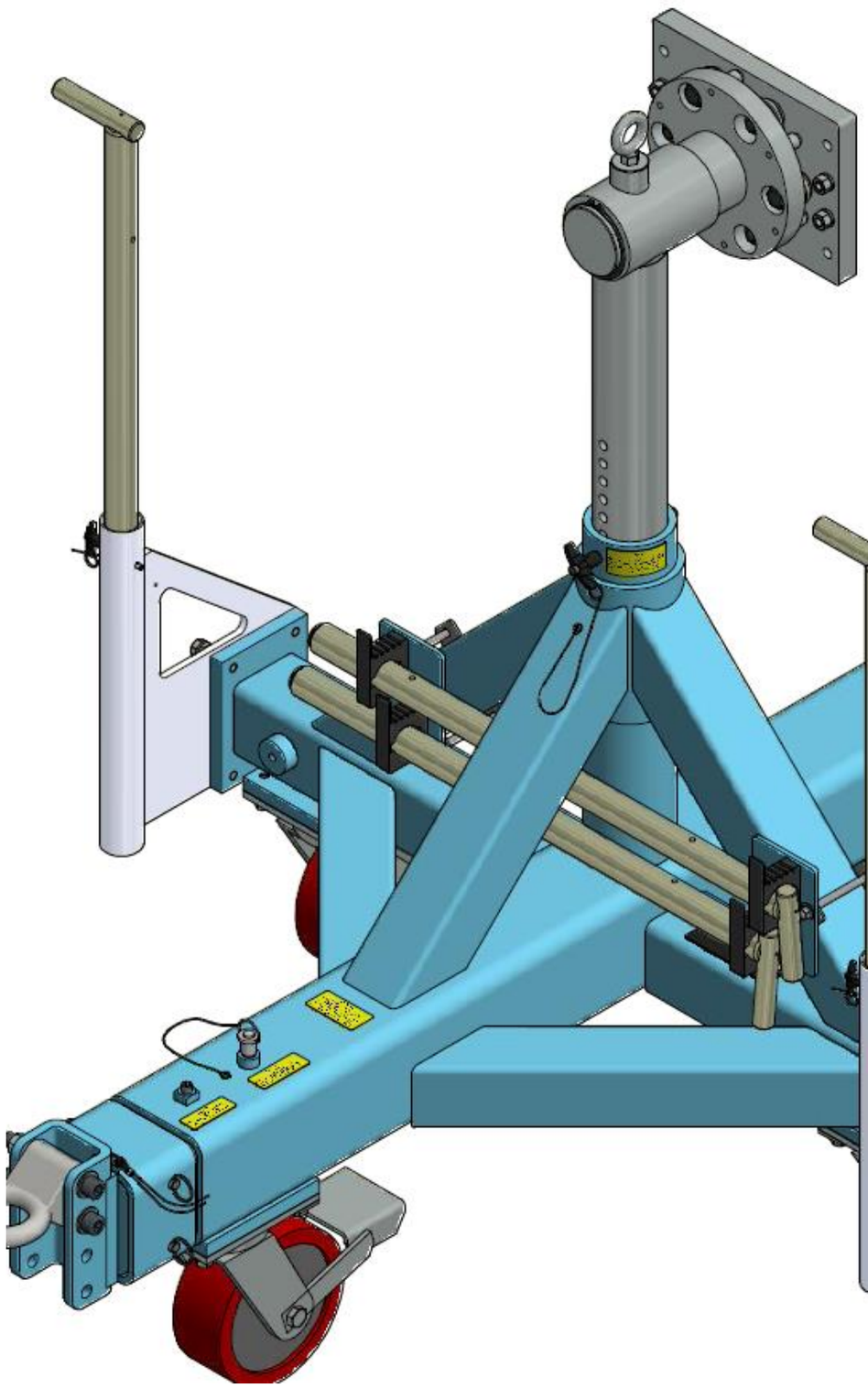
- Lubricant selection – Trunnion and Caster swivel components lubricated with Krytox GPL 207 or Braycote 601EF.

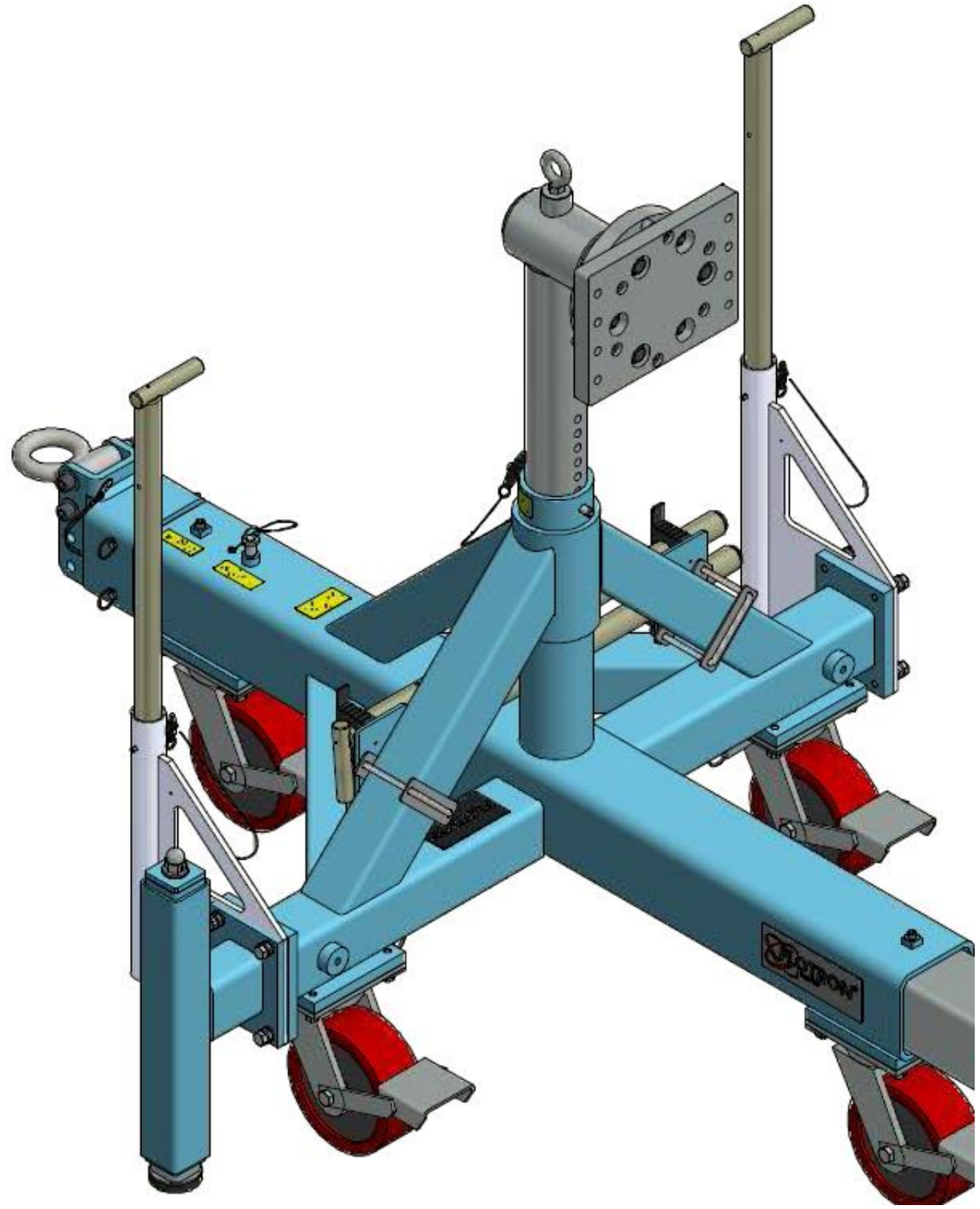
Forklift Tubes



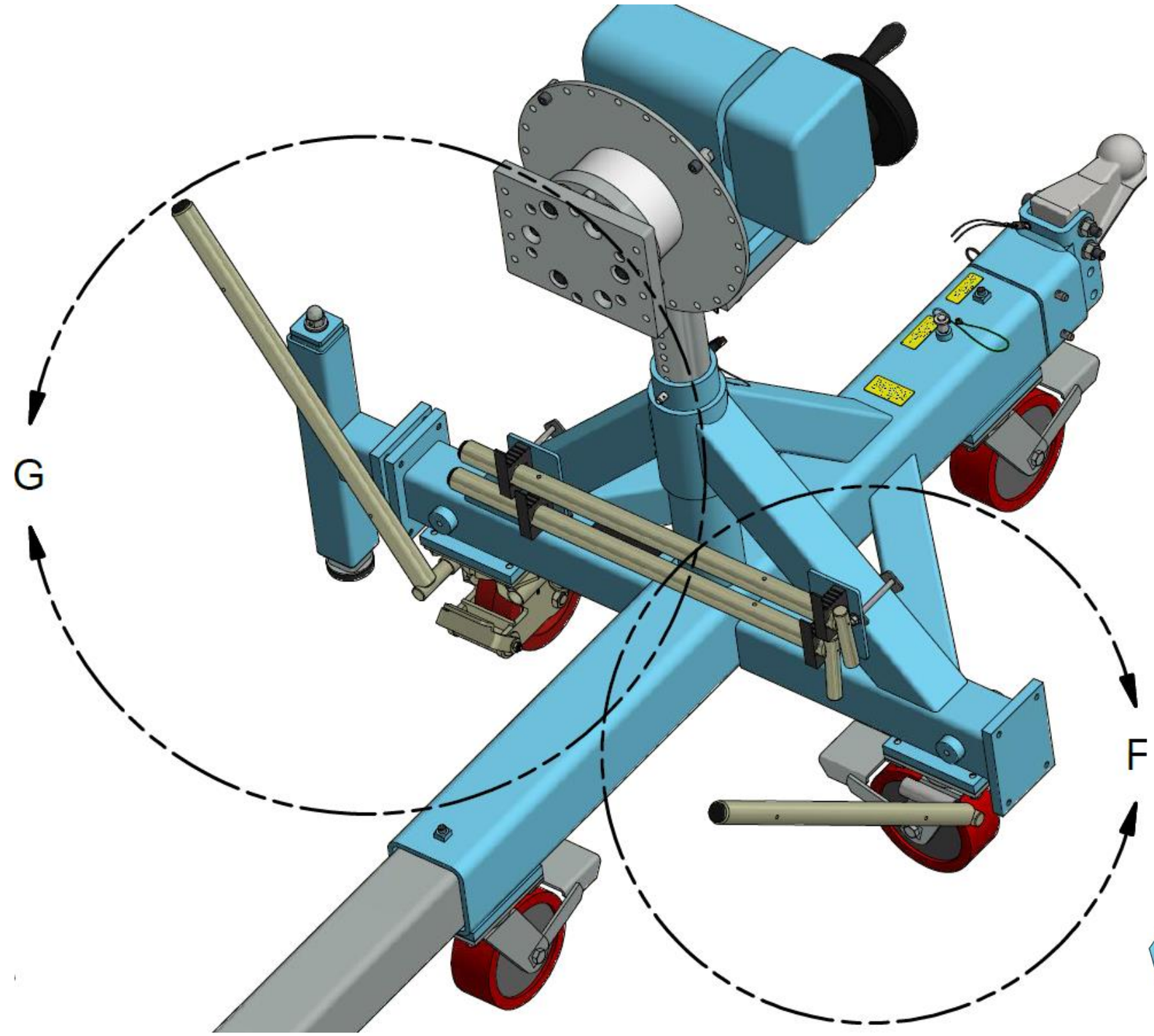
Push Handle

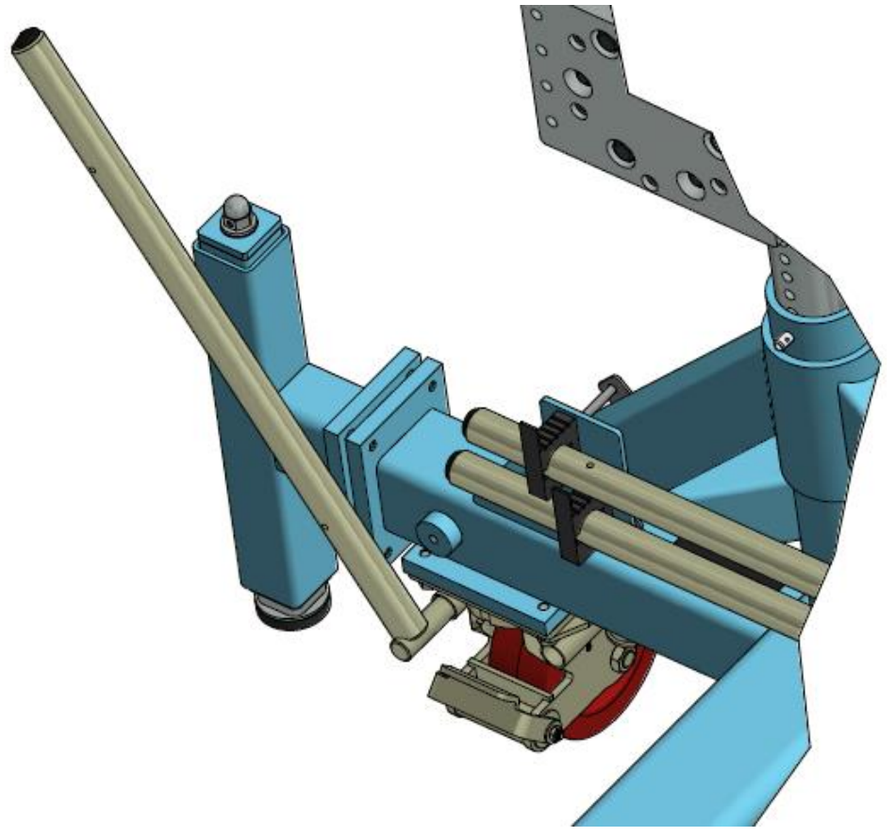
Push Bar and Stowage

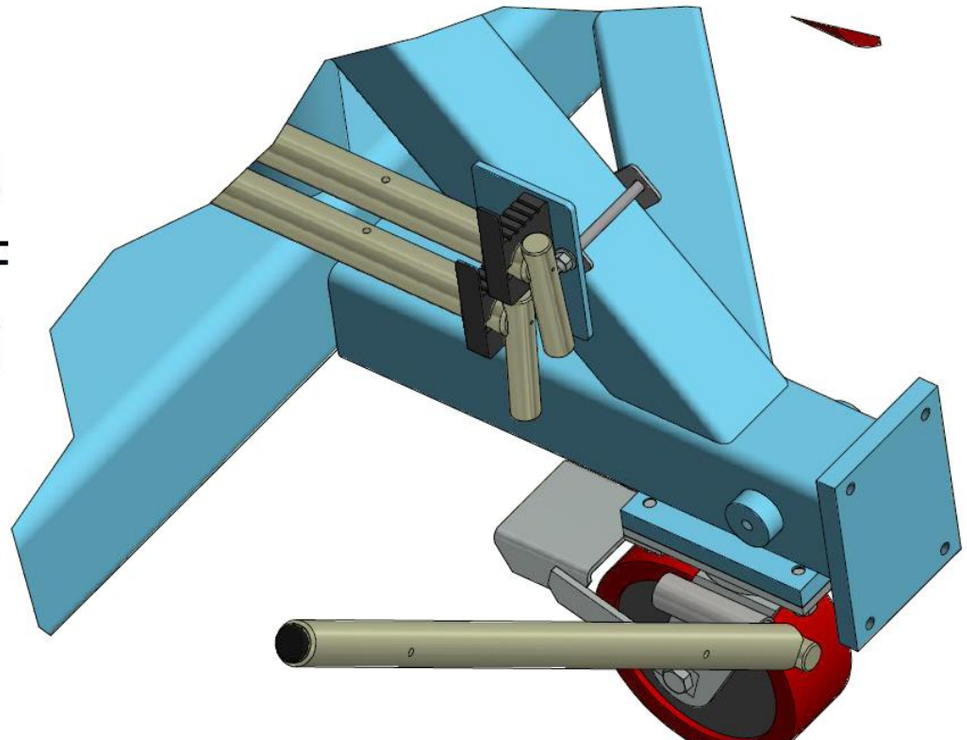




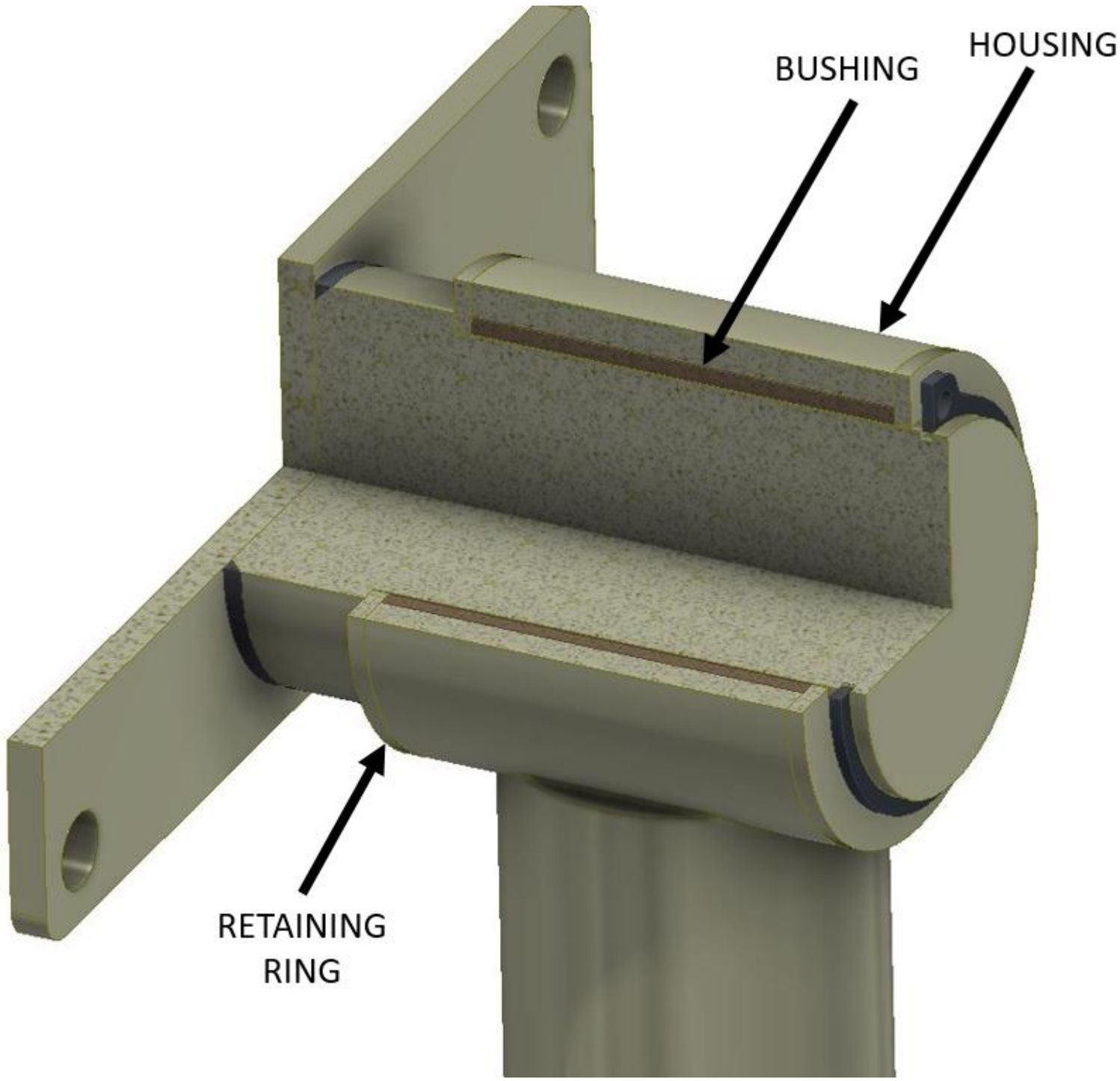
Steering Bar



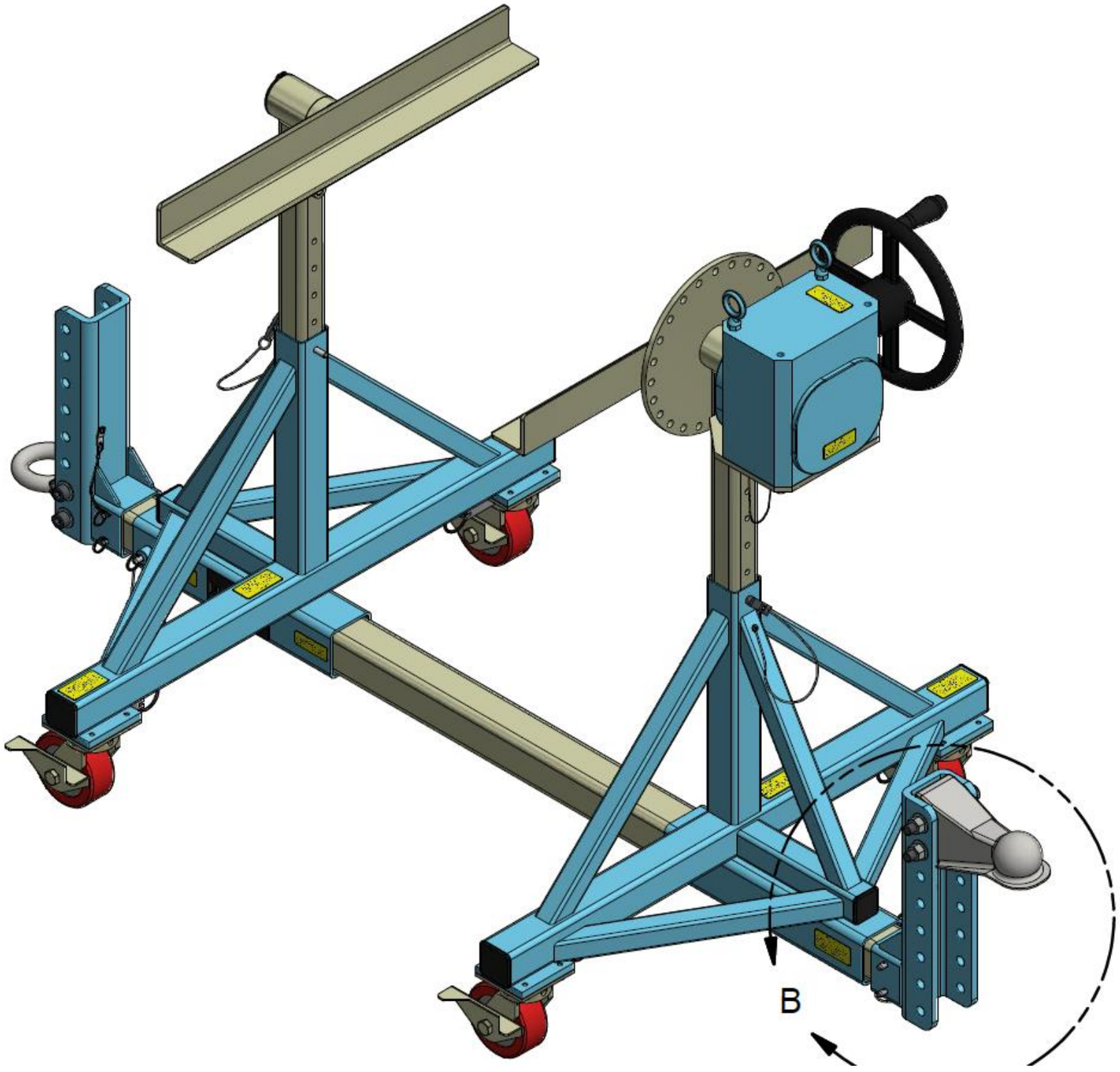


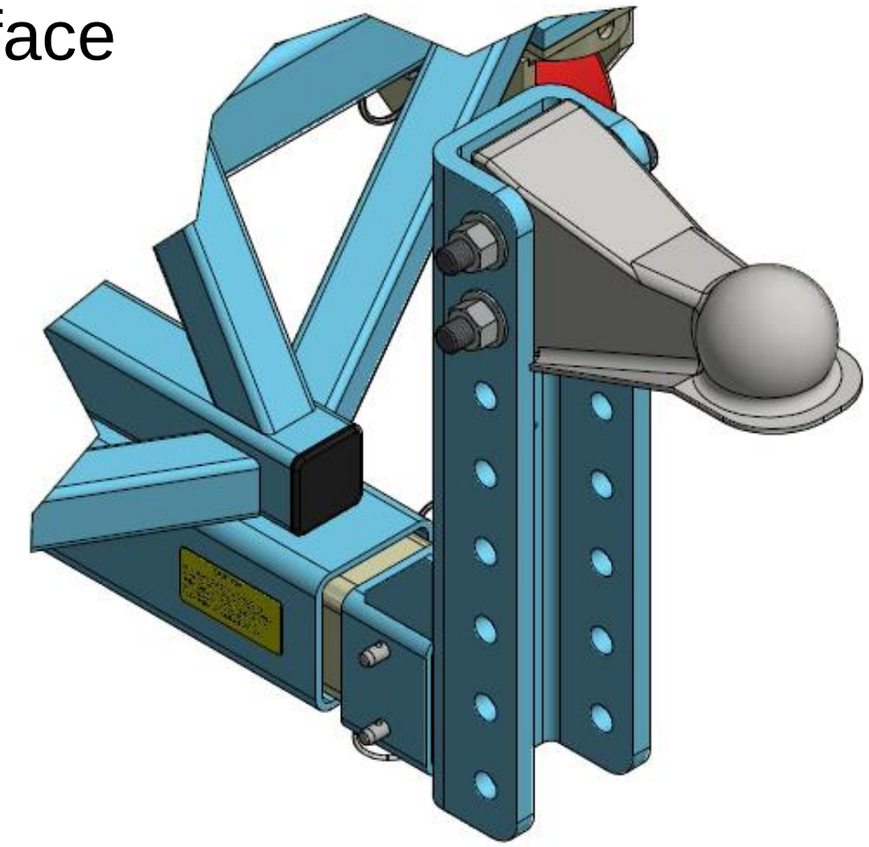


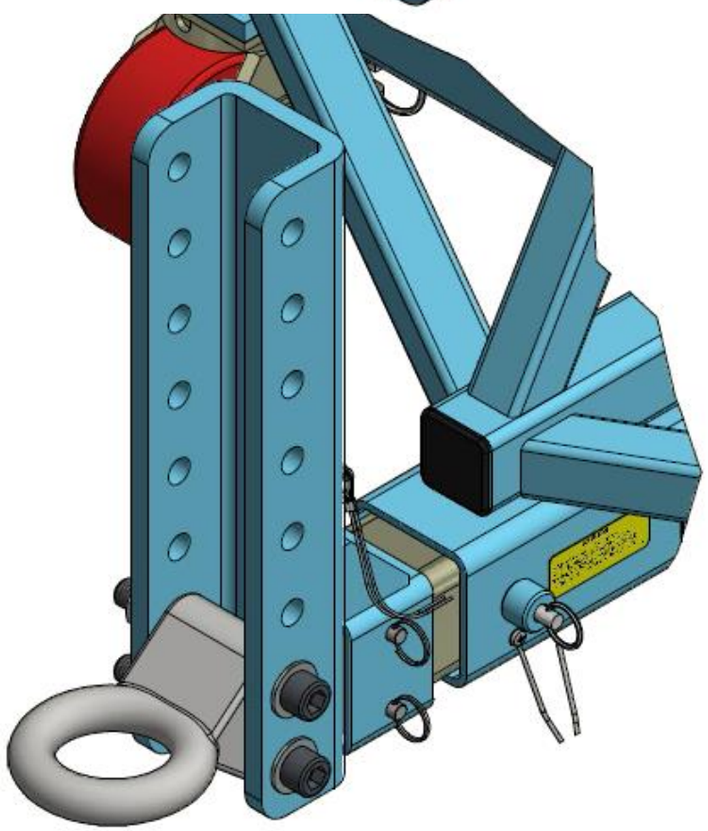
Sleeved Trunnion Bushing



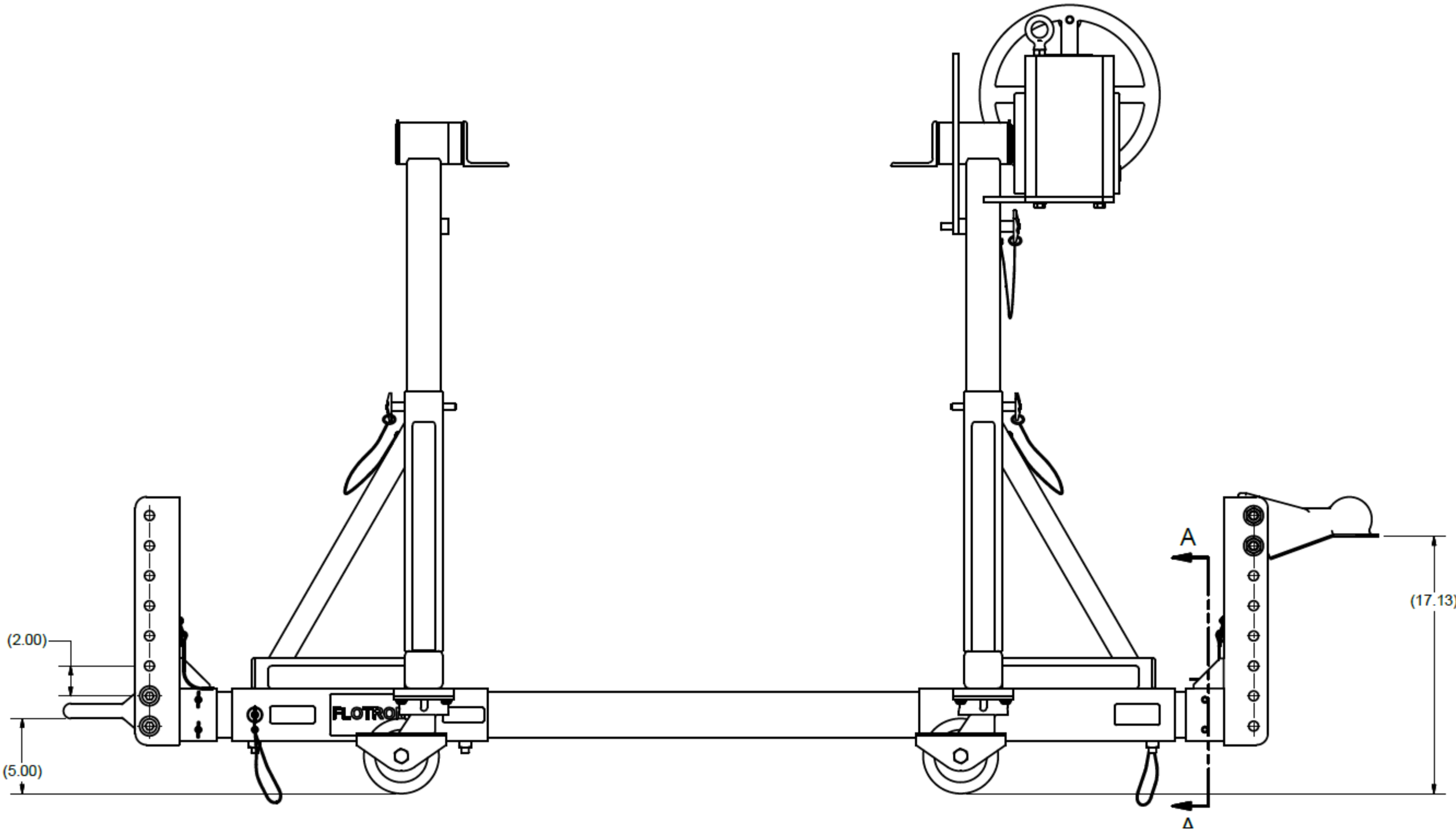
600 Series Towing interface



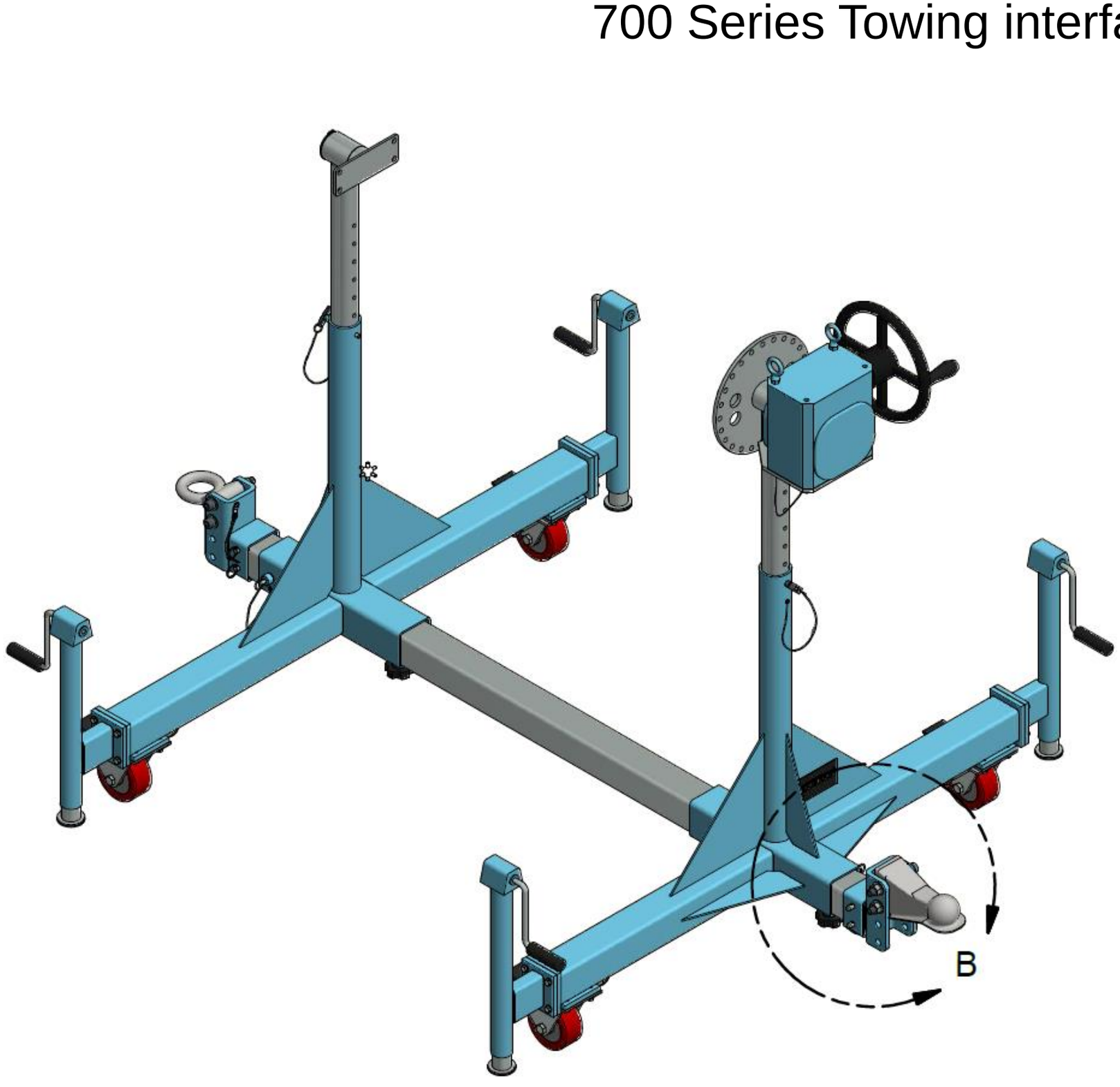


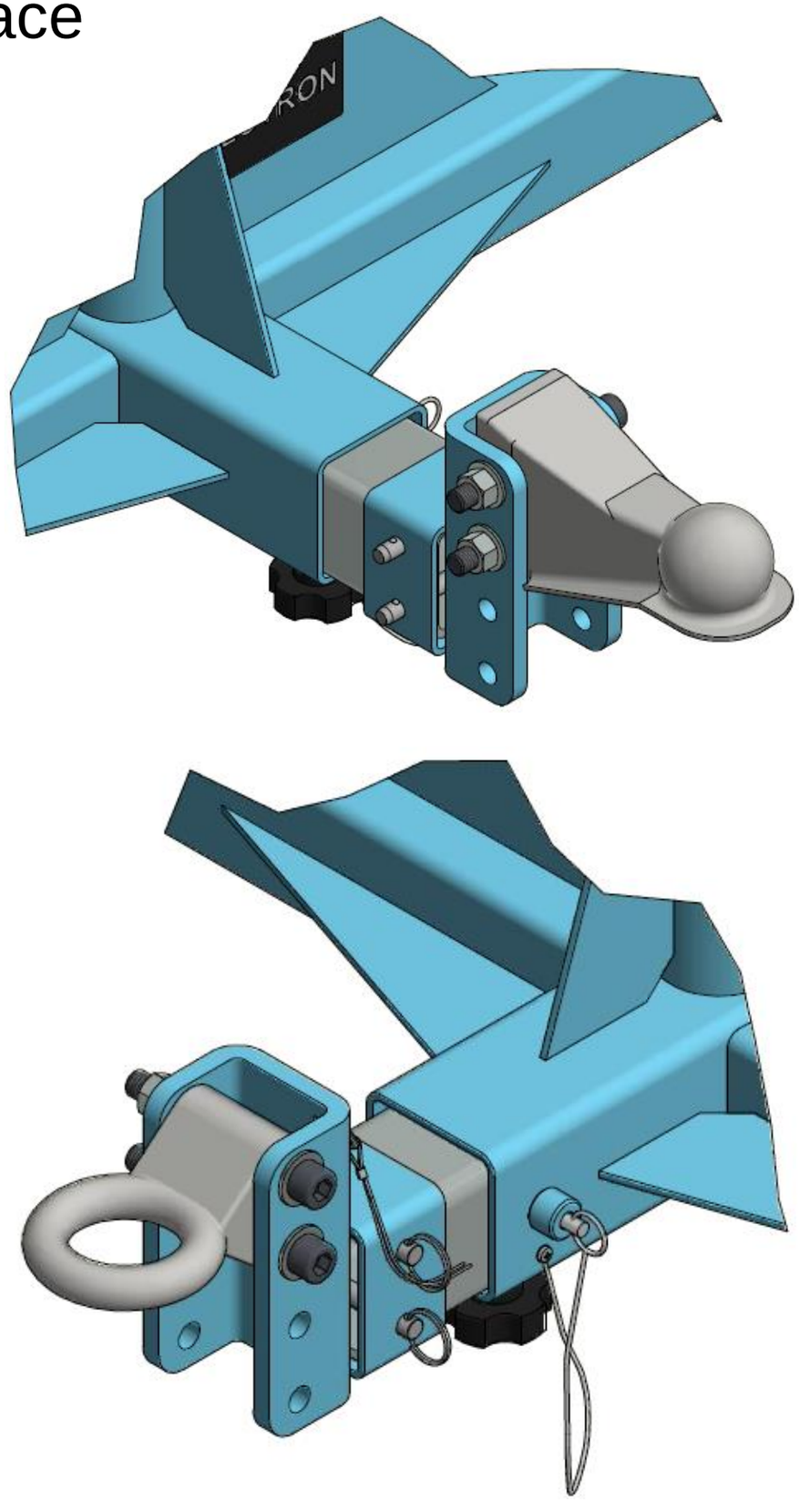


600 Series Towing interface

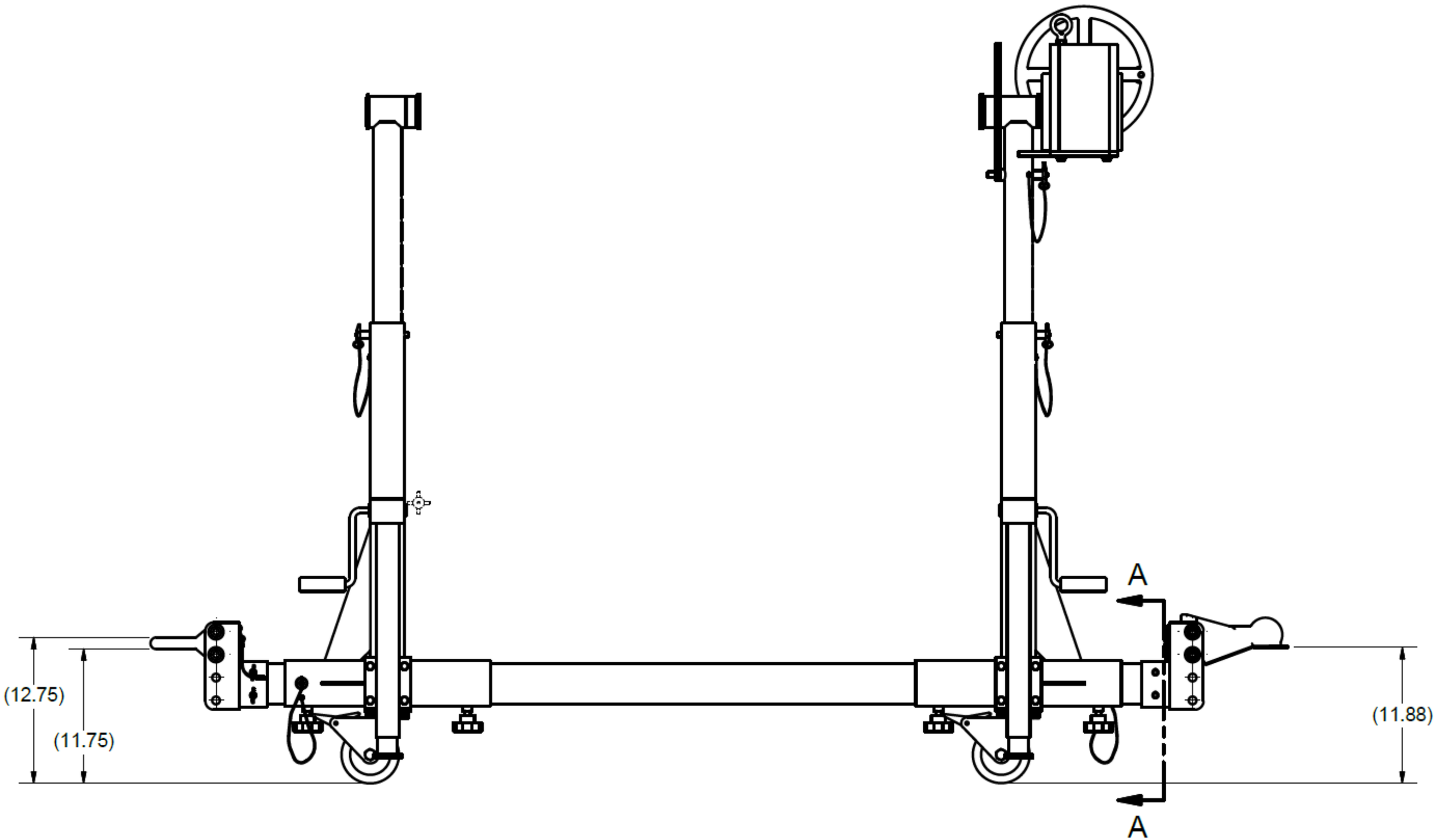


700 Series Towing interface

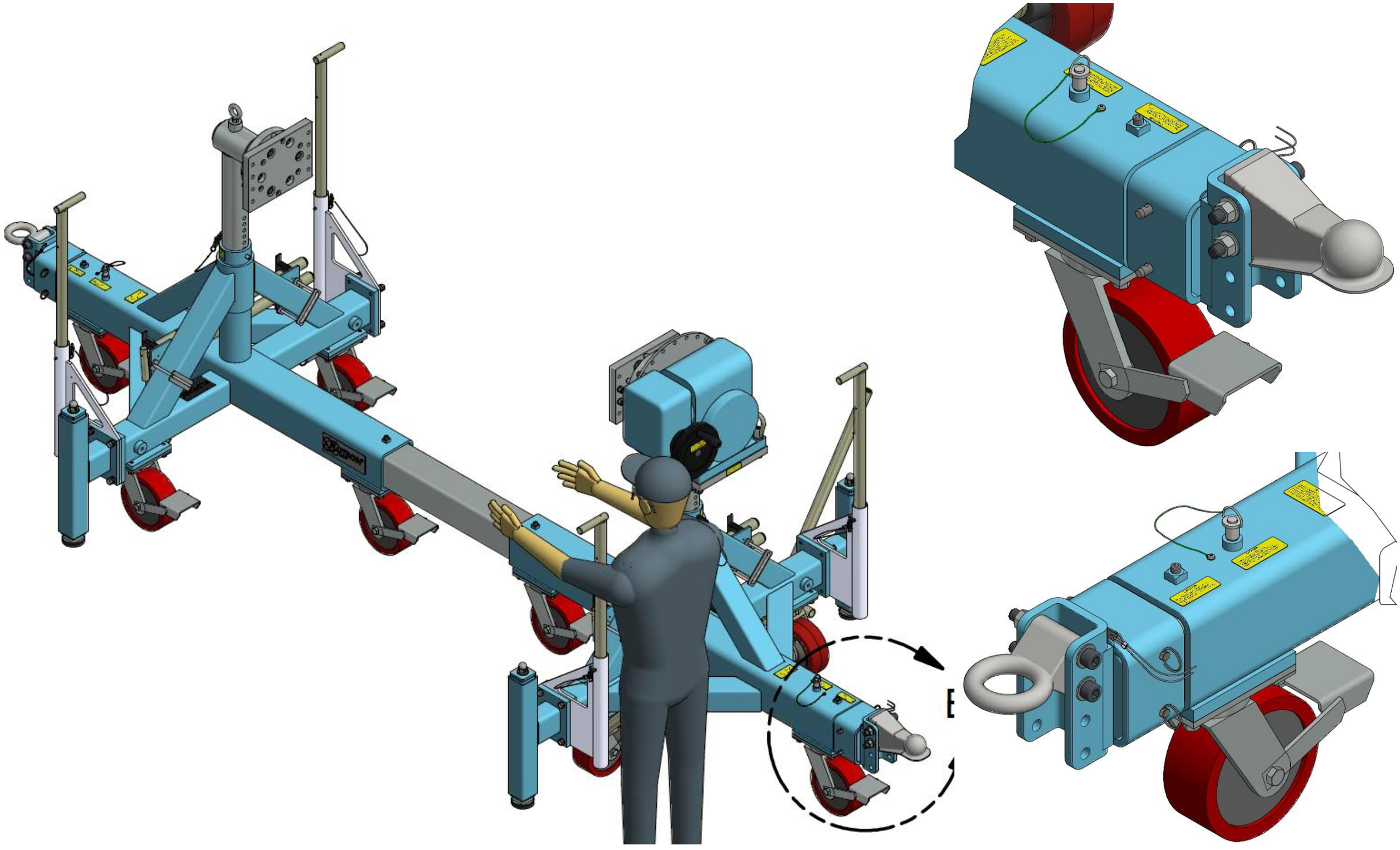




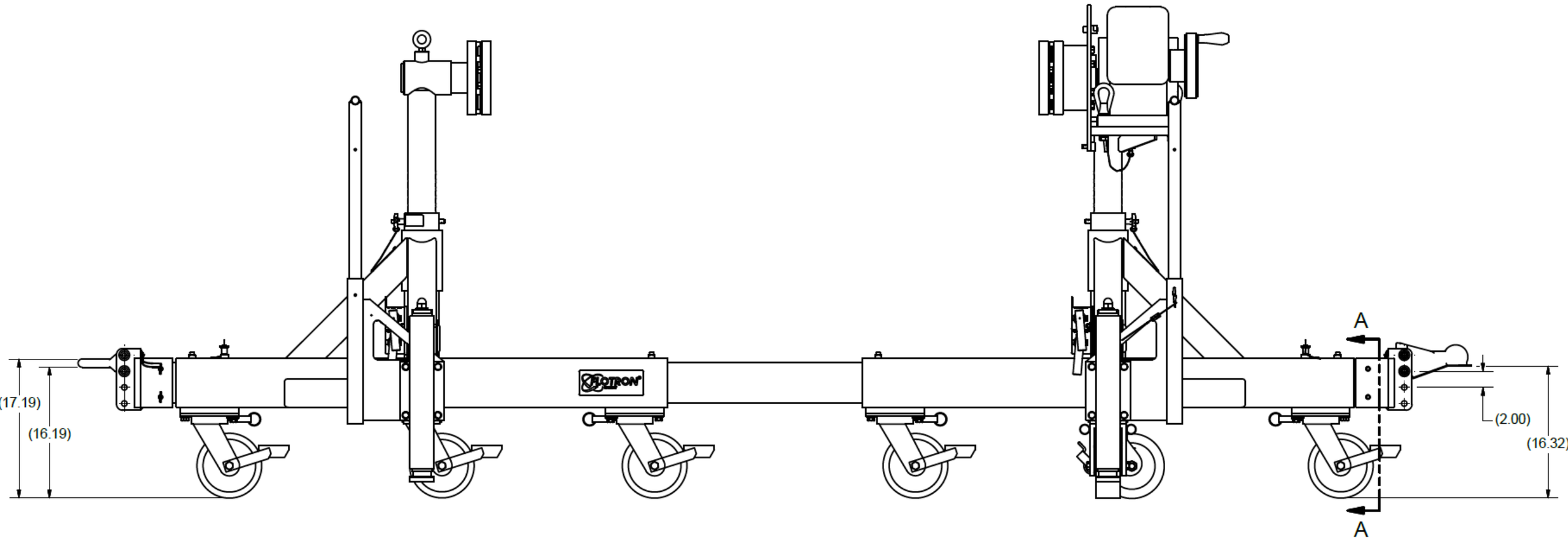
700 Series Towing interface



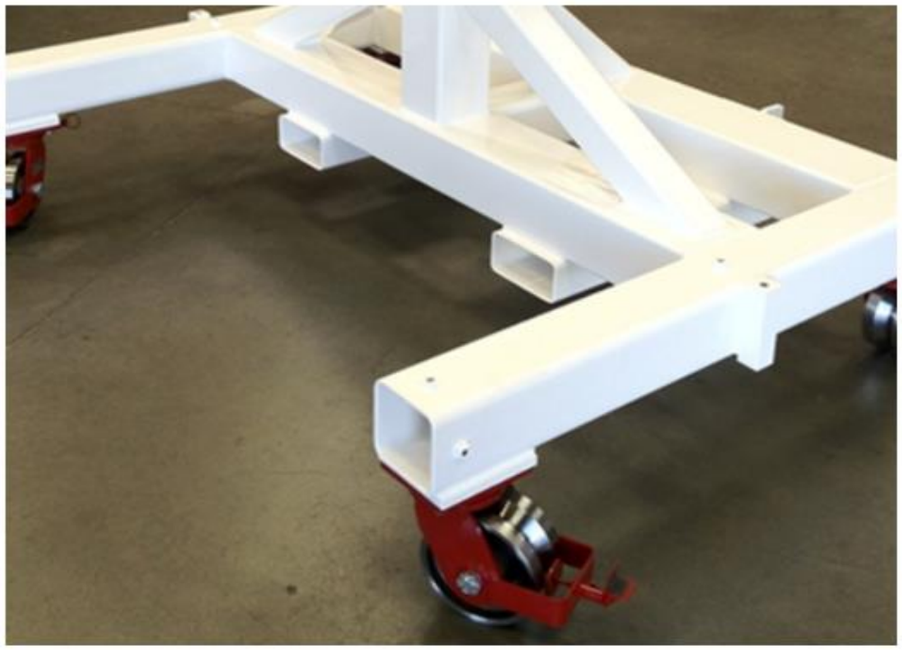
800 Series Towing interface



800 Series Towing interface



Special Casters



Spring loaded casters

V-Groove Casters

Dual wheel casters

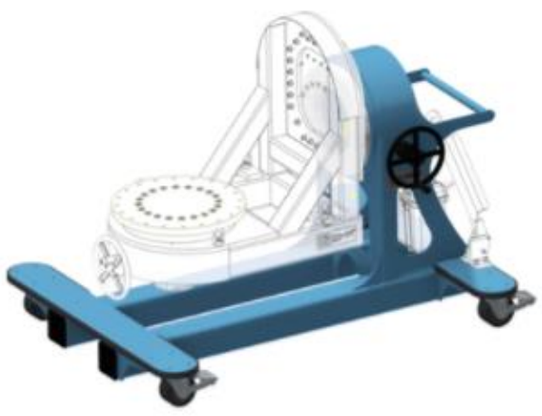
Hard Wheel Material Casters

New Products:

- CTL Series
- Mobile platform
- Spacecraft positioner

Off-the-shelf / Cantilevered Rotation Fixtures

CTL36



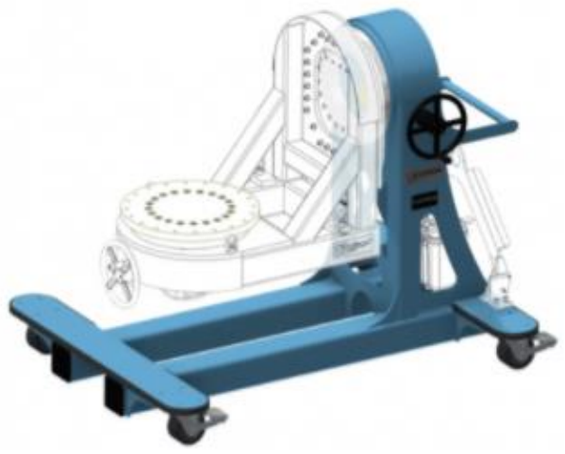
Load Rating: 3,000 lbs @ 30"

Swing Radius: 27.2”

Max Torque: 8,000 in-lbs

Easy Crank: 7,000 in-lbs

CTL48



Load Rating: 2,600 lbs @ 30"

Swing Radius: 39.2”

Max Torque: 8,000 in-lbs

Easy Crank: 7,000 in-lbs

CTL60

Load Rating: 2,200 lbs @ 30"

Swing Radius: 51.2”

Max Torque: 8,000 in-lbs

Easy Crank: 7,000 in-lbs

CTL-AH

Load Rating: 3,000 lbs @ 30”

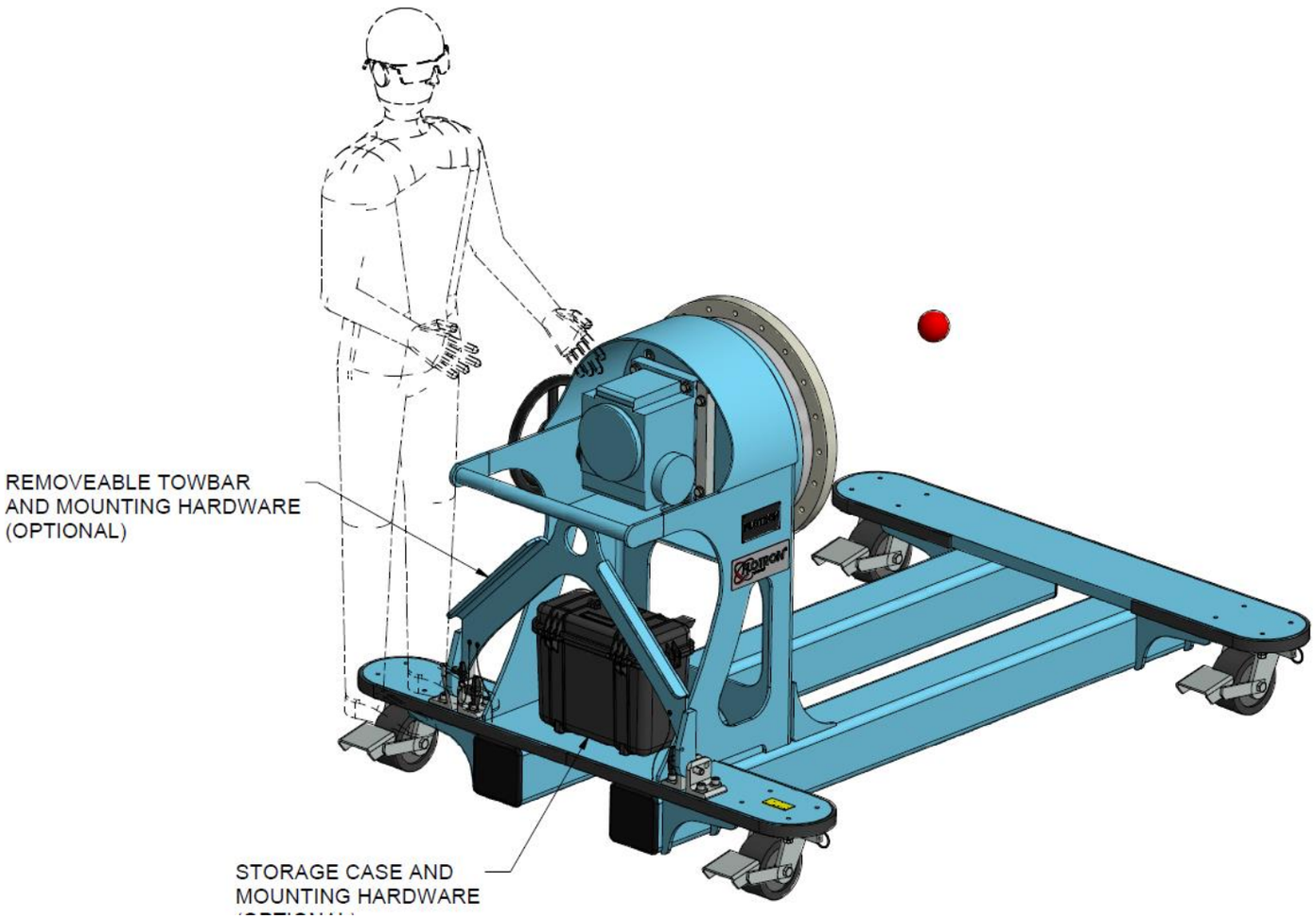
Swing Radius: 21” - 51”

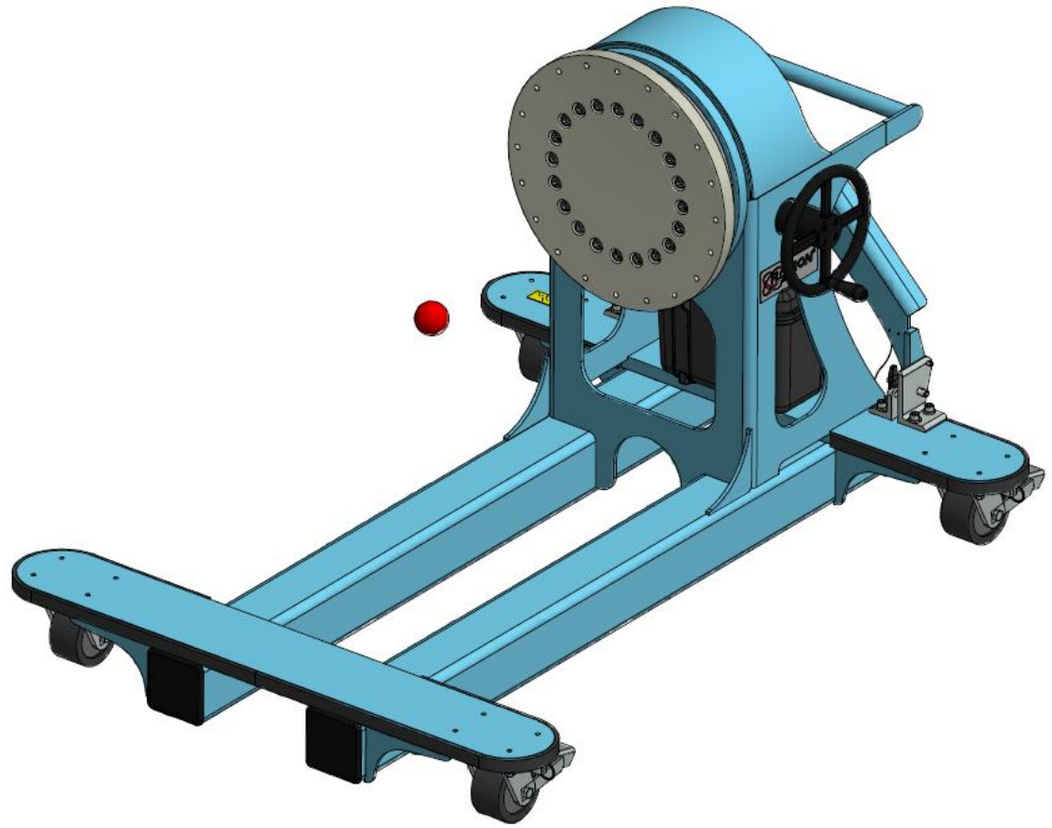
Max Torque: 8,000 in-lbs

Easy Crank: 7,000 in-lbs

Off-the-shelf / Cantilevered Rotation Fixtures

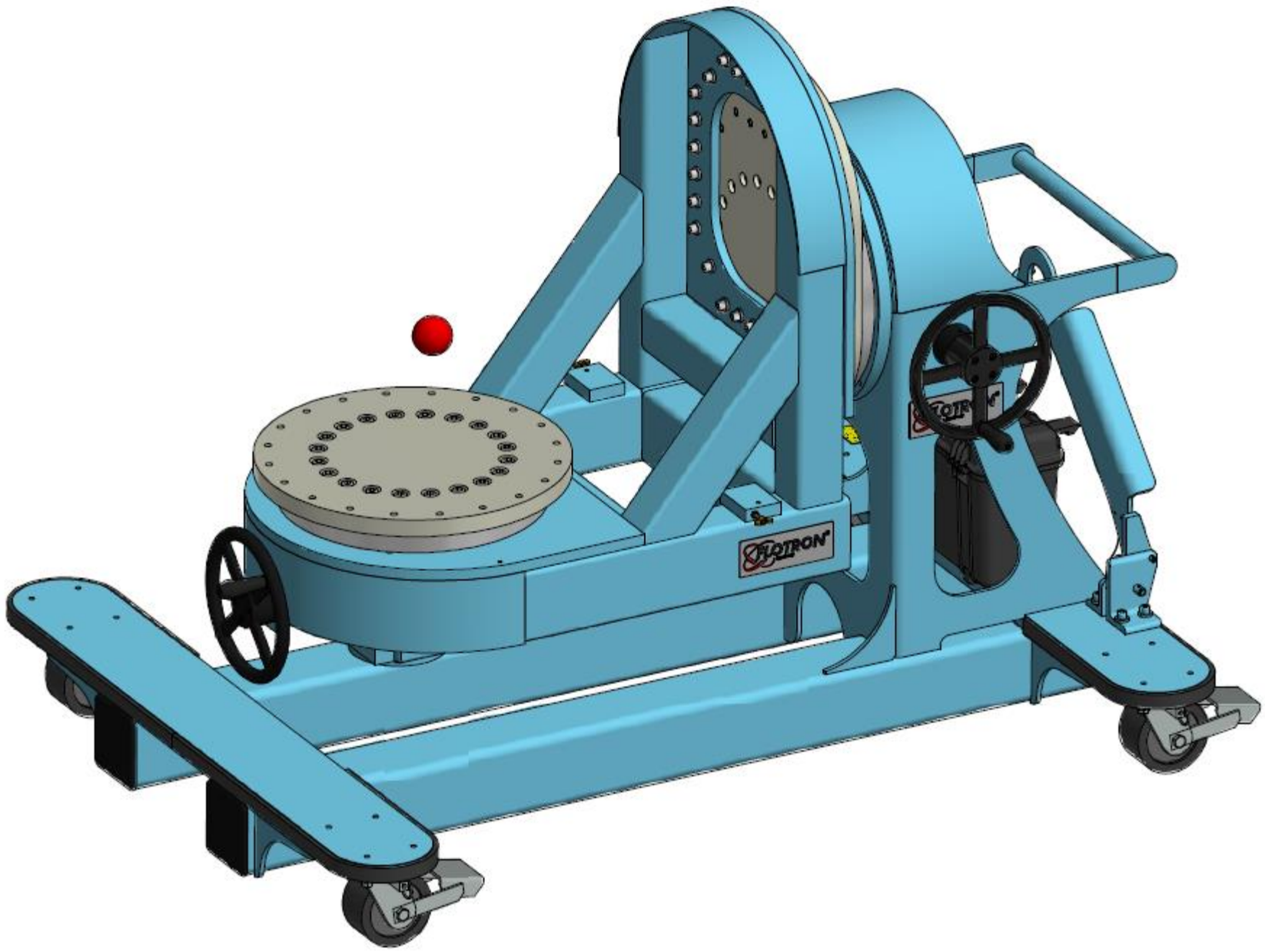
CTL36





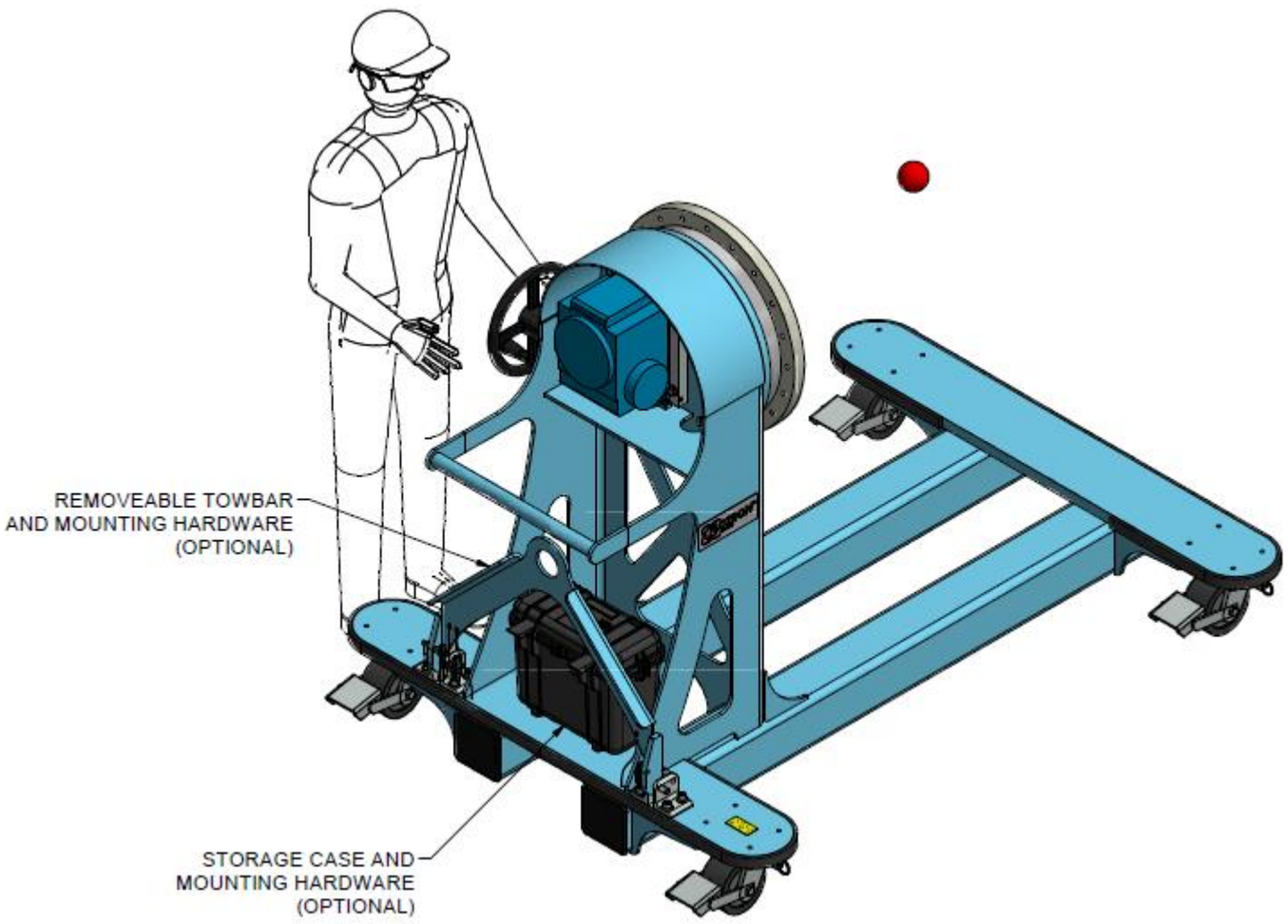
Off-the-shelf / Cantilevered Rotation Fixtures

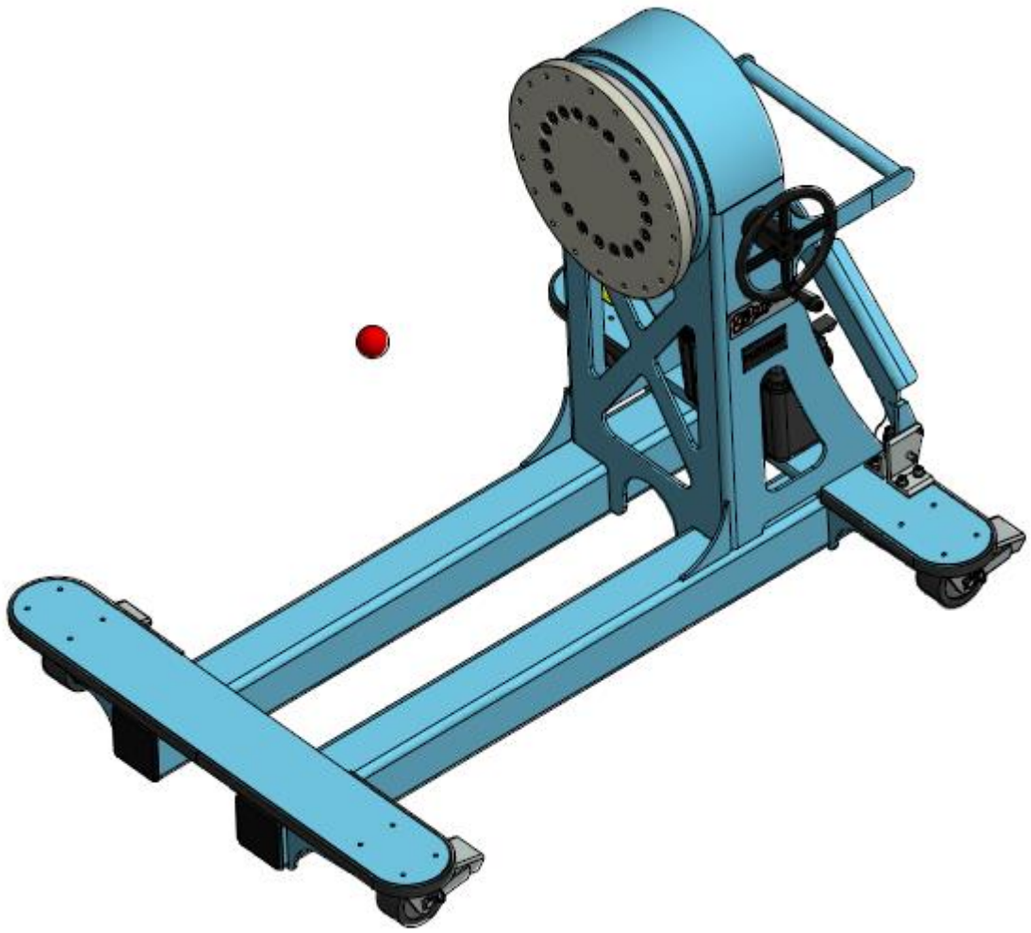
CTL36 Secondary Rotation Axis



Off-the-shelf / Cantilevered Rotation Fixtures

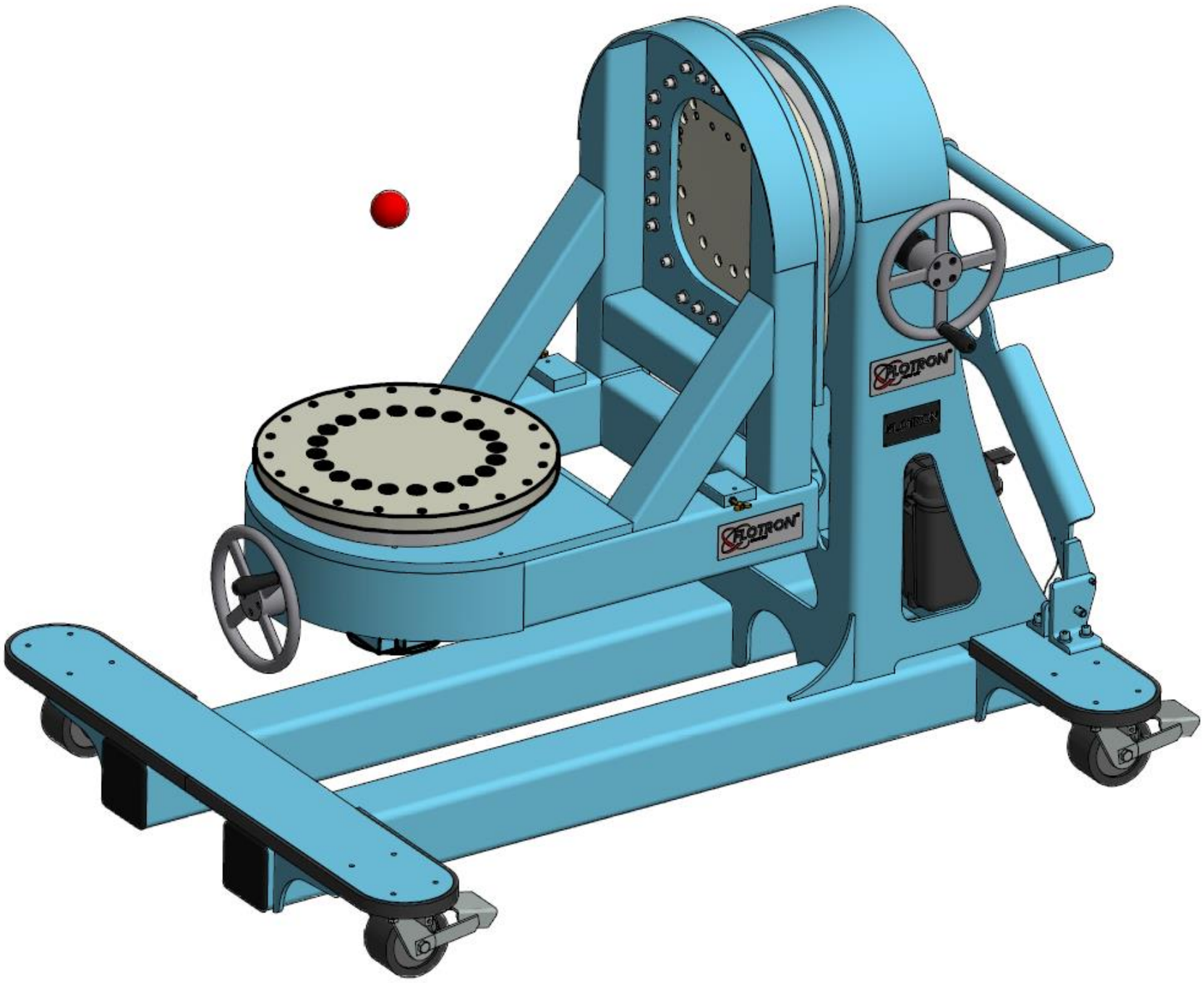
CTL48





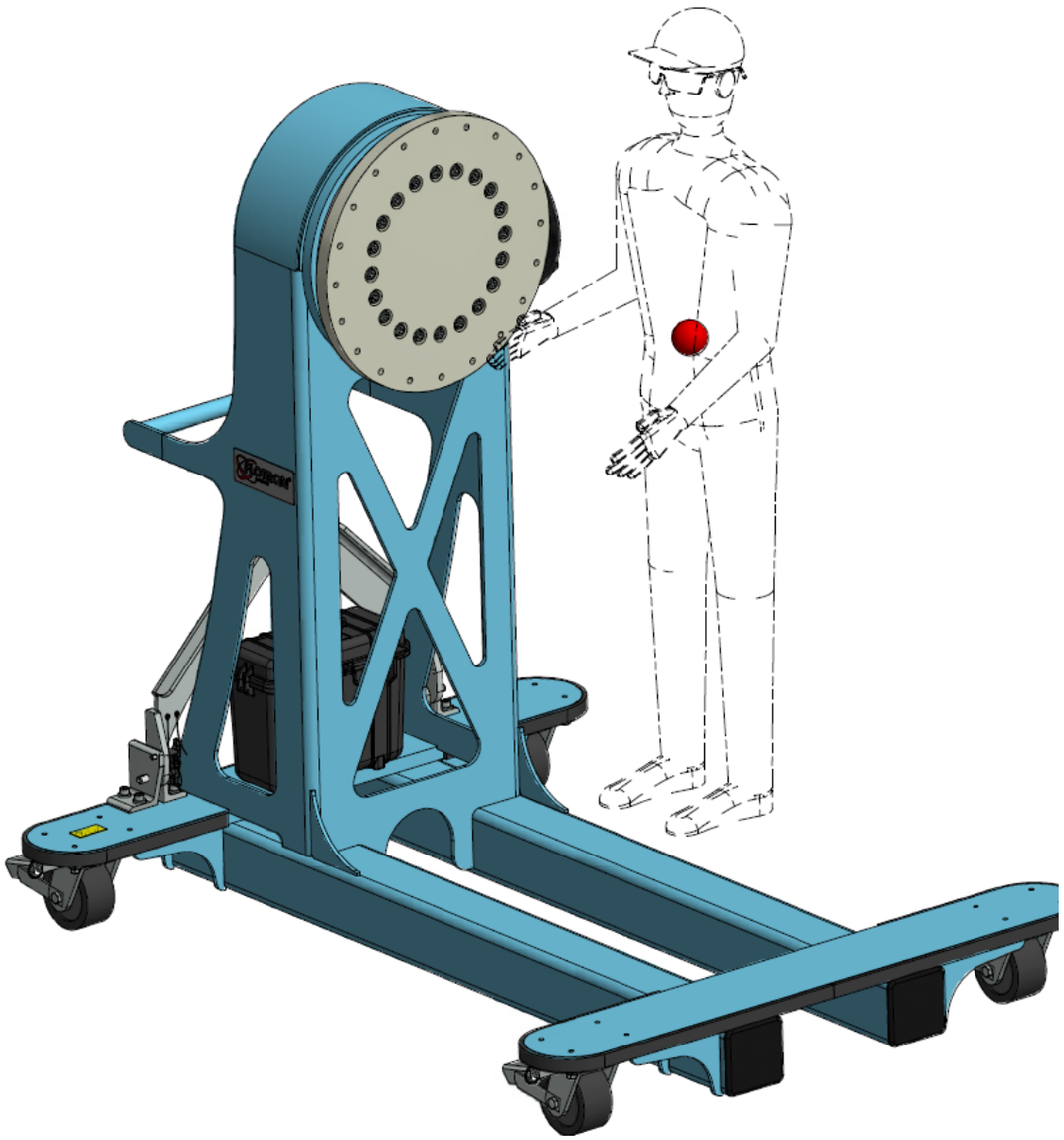
Off-the-shelf / Cantilevered Rotation Fixtures

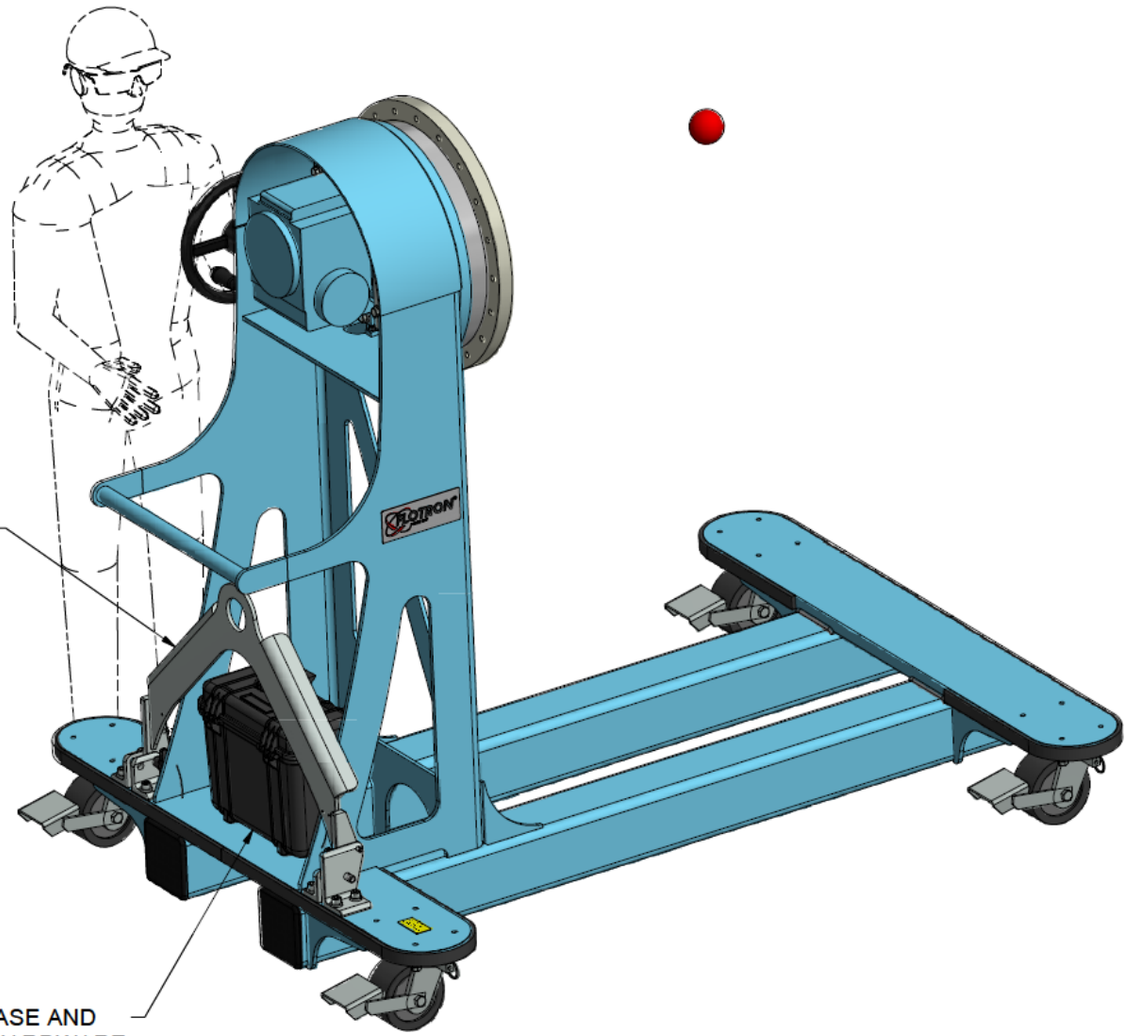
CTL48 Secondary Rotation Axis



Off-the-shelf / Cantilevered Rotation Fixtures

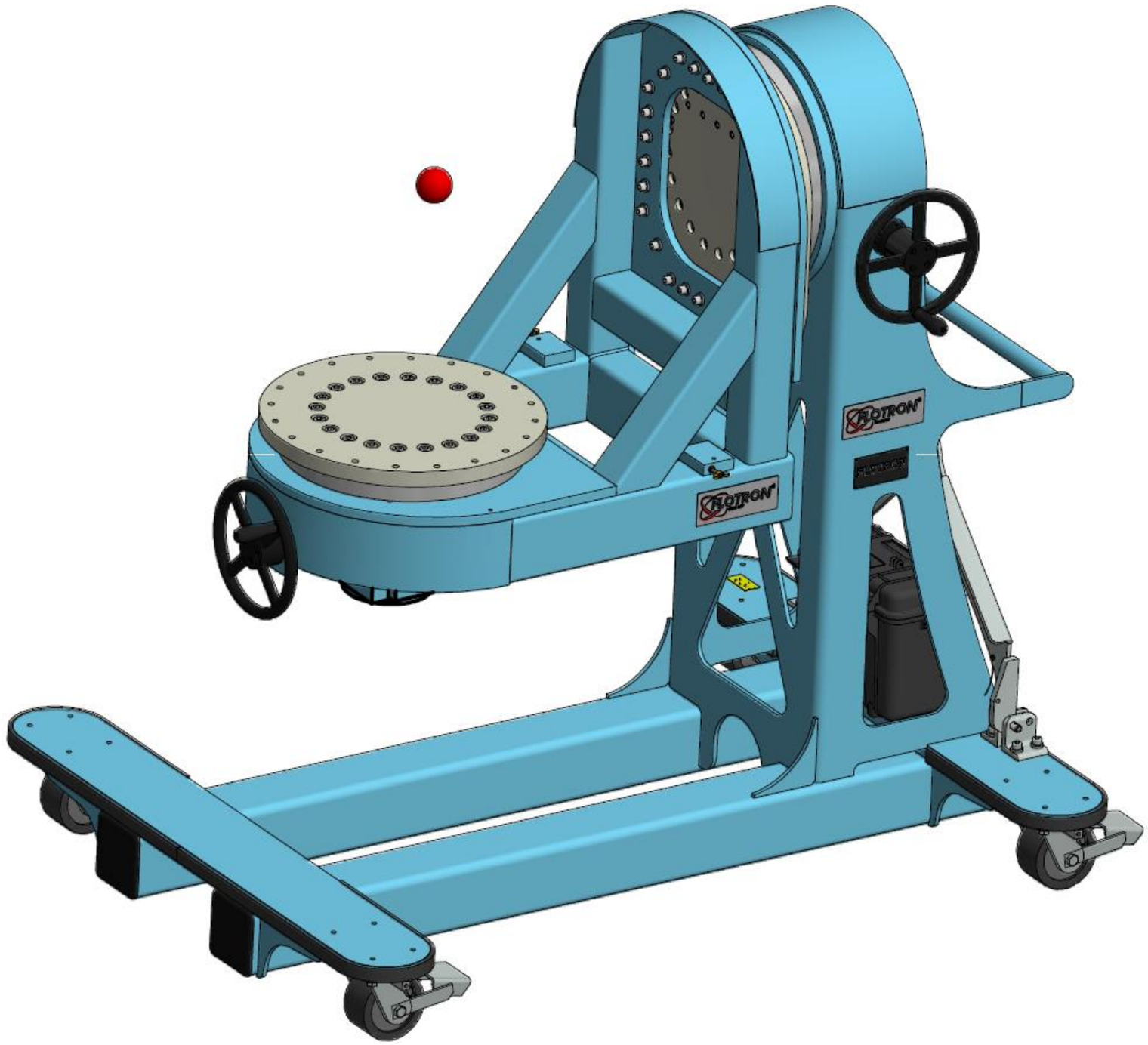
CTL60





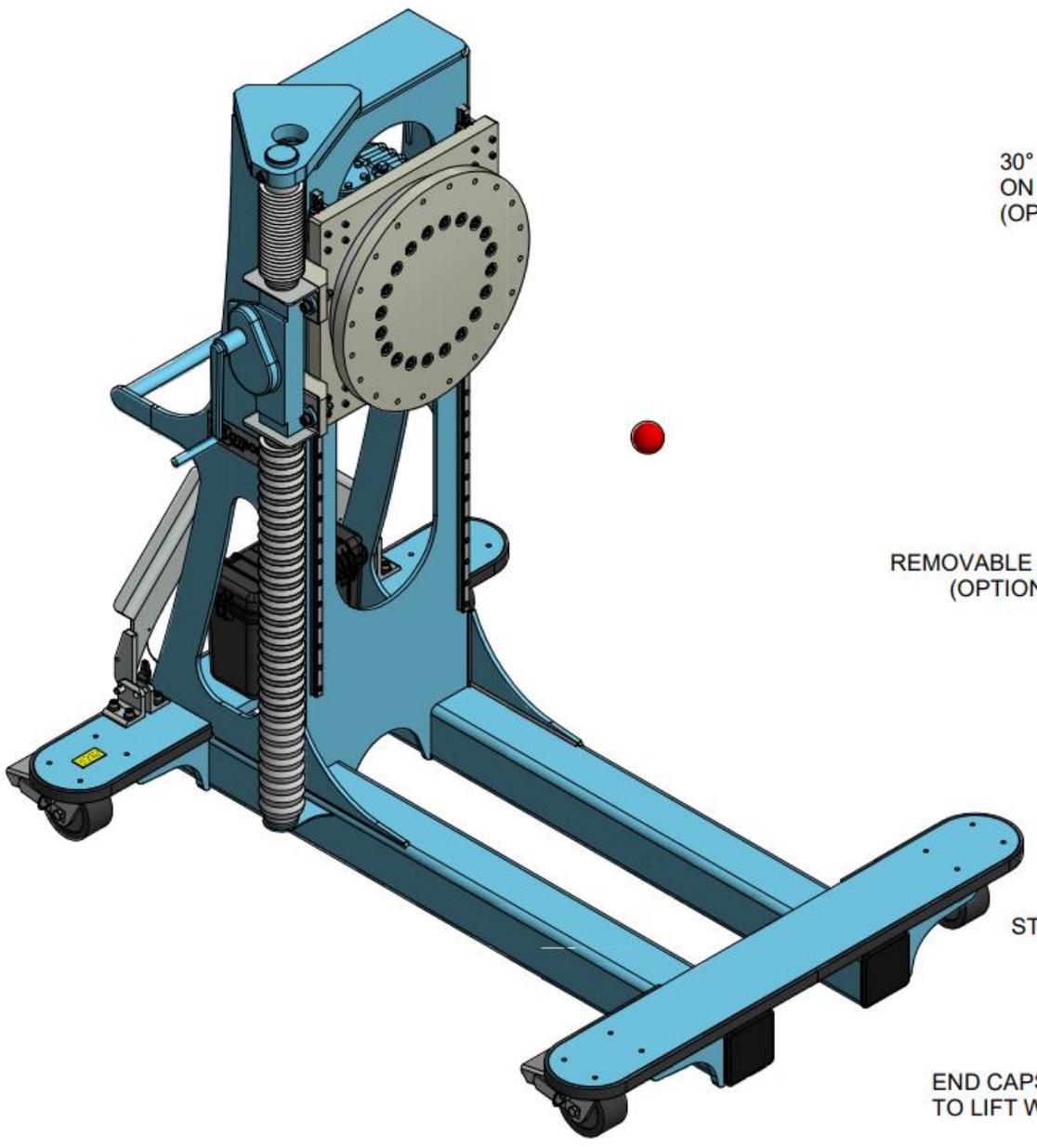
Off-the-shelf / Cantilevered Rotation Fixtures

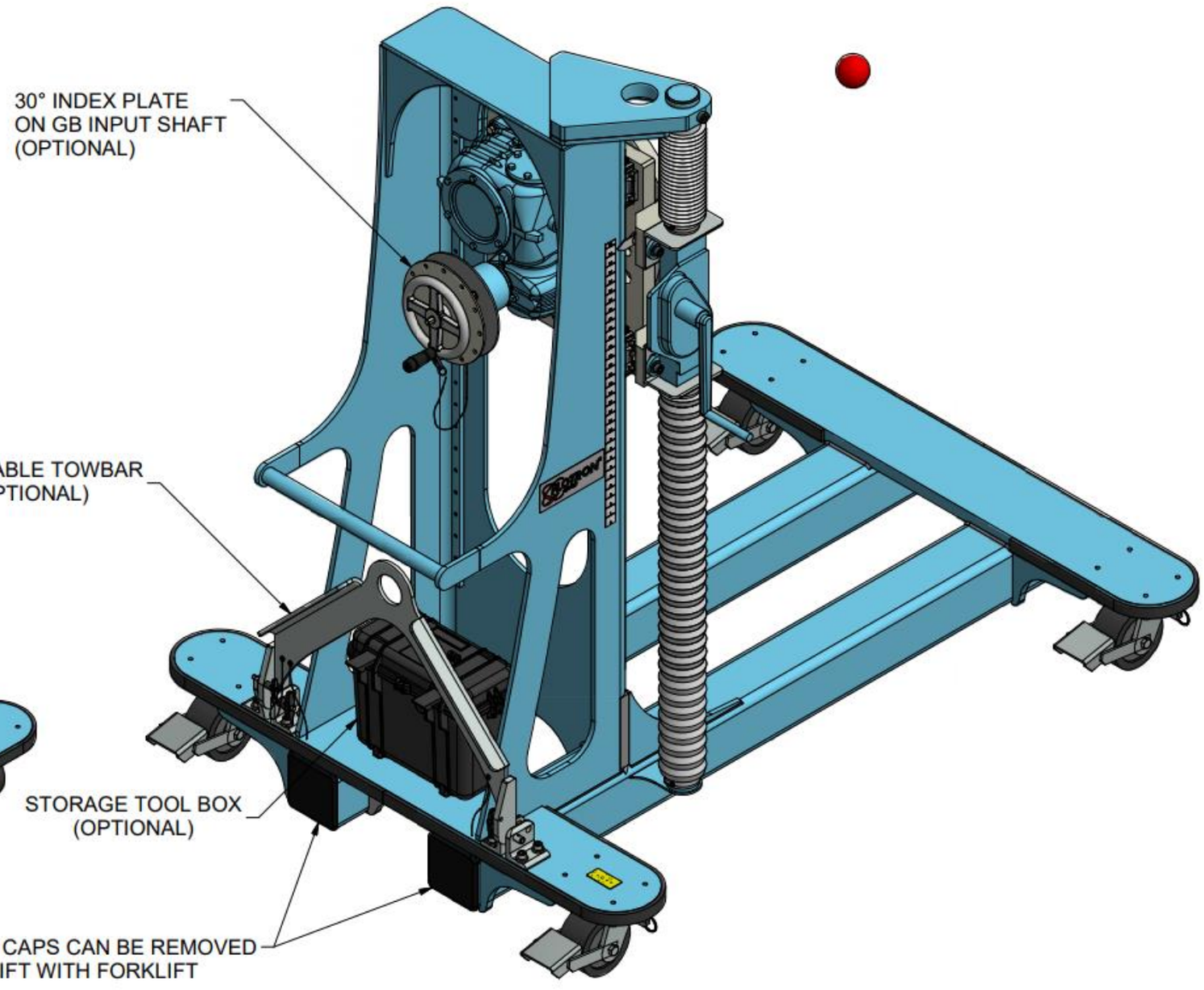
CTL60 Secondary Rotation Axis



Off-the-shelf / Cantilevered Rotation Fixtures

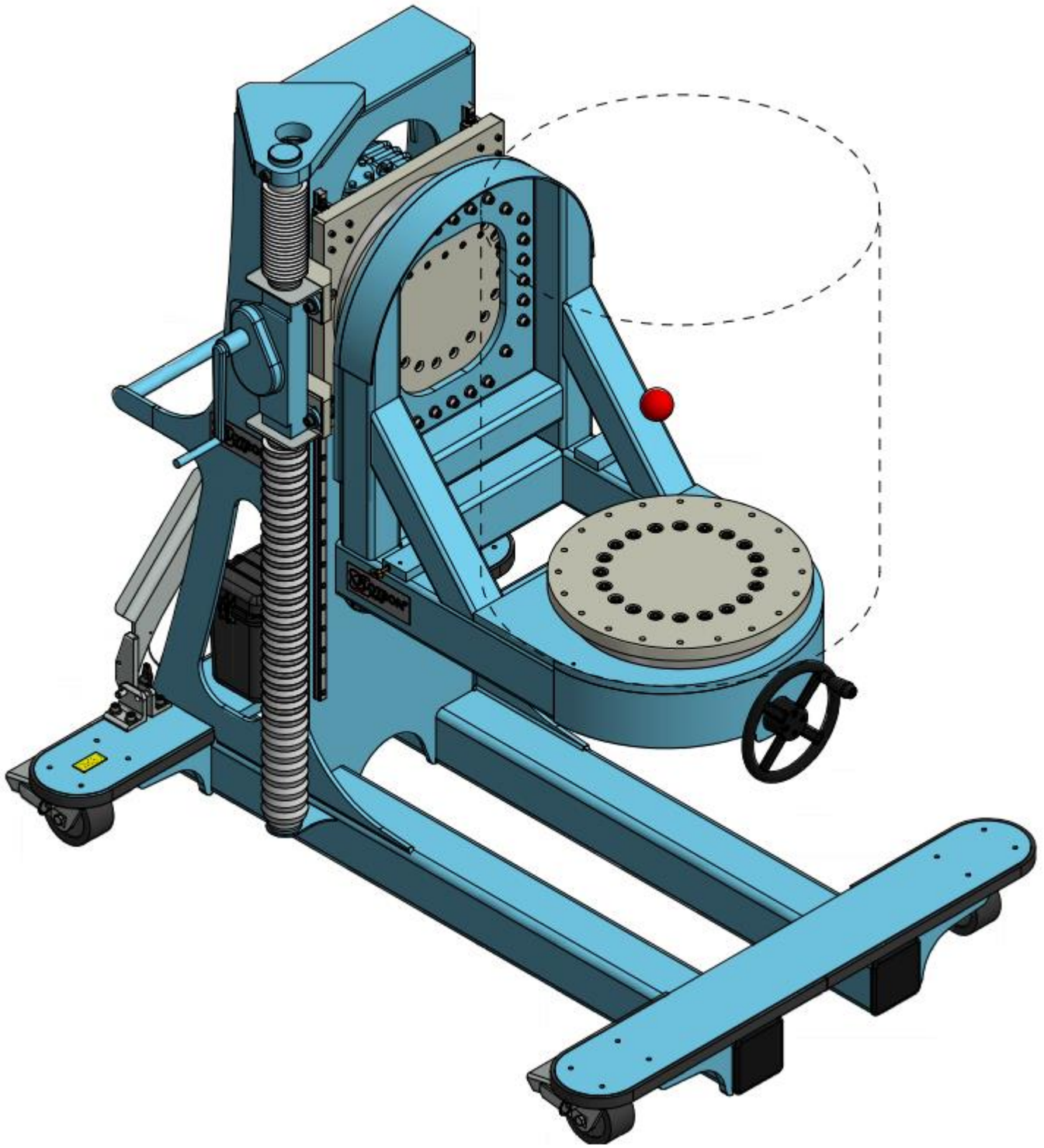
CTL-AH





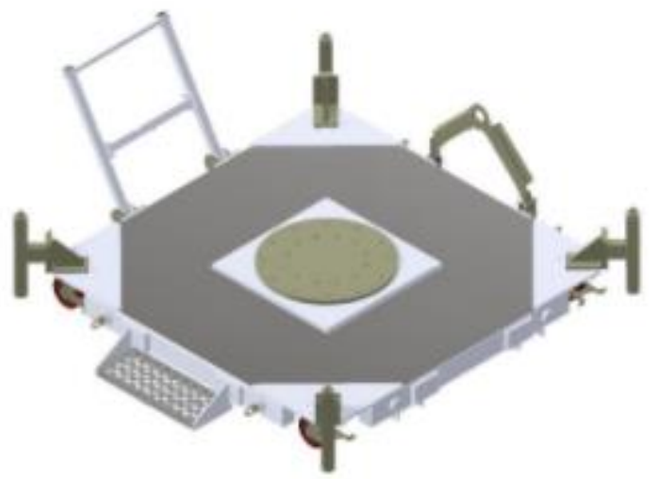
Off-the-shelf / Cantilevered Rotation Fixtures

CTL-AH Secondary Rotation Axis



Off-the-shelf / Mobile Satellite Platforms

SSMP



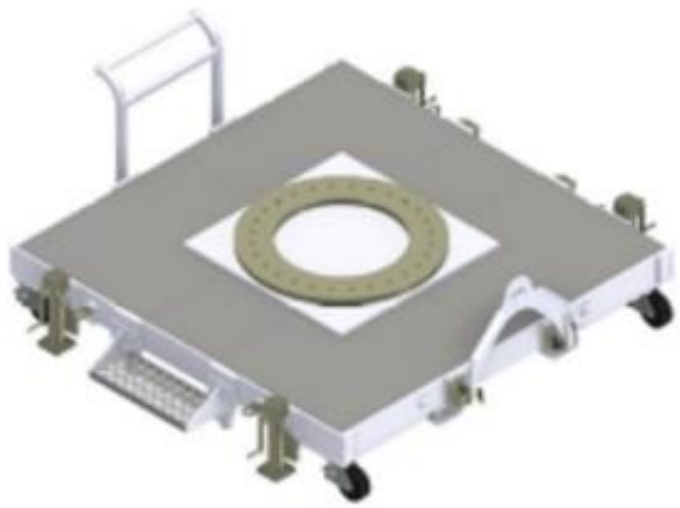
Load Rating: 2,000 lbs @ 100”

Swing Radius: 89”

Max Torque: N/A

Easy Crank: N/A

MSMP



Load Rating: 10,000 lbs @ 100”

Swing Radius: 100”

Max Torque: N/A

Easy Crank: N/A

Off-the-shelf / Mobile Satellite Platforms