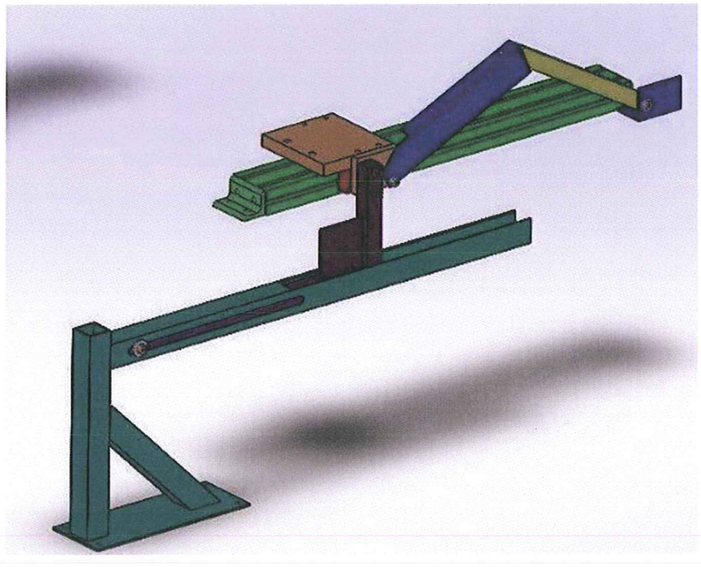
Fleetwood RV Folding Bed Project



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Sponsored By:

REV Group

Faztek

Purpose, Function & Description

Fleetwood RV currently has a flip-up bed that creates more cabinet storage when the motorhome is in transient. This flip-up bed has its own powered mechanism. In addition, the bed sets inside a slide-out box assembly that also has its own powered mechanism. This current design is not in all the motorhomes they build. The purpose of a new design is they want a lower cost design, so that the flip-up bed mechanism is mechanical driven by the powered slide-out box mechanism. Once this mechanism is implemented in all motorhomes, it will offer a greater amount of closet space. What is desired is a mechanism that will be powered by the current motor that slides the bed assembly out the side of the RV when parked.

Research

For this project, the first thing the team did was study the existing design used in the RVs. After observing the current method, the parts were looked at in the current design that the proposed design would replace. Calculations were done to determine the amount of force the design would put on the parts that are currently used and will be retained in the new design. It was then determined what parts of the design could be purchased and which parts would have to be custom manufactured. The Fleetwood custom shop was then asked to build a mock-up slider assembly for the testing of the new design. The prototype design was then integrated into the mock-up for testing.

Performance Specifications and Optional Specifications

Taking into account the weight of the bed, the distance that is must travel and the performance of the motor in current use, we must calculate the needed torque and stroke of the current slide mechanism that will be tied into to see if it offers what is desired to obtain the requested results. The new design must not hinder operation of the current slide mechanism and be able to be used on multiple units. Ideally, we can come up with a design that will not require much alteration of the current system along with not requiring much alteration to the current RV design. It would also be desired that we do not eliminate the under be storage currently available.

Design Calculations

Attached are 2 illustrations of the assembly that refers to the points the calculations are based on and 3 sheets of design calculations.

On the first page are the calculations for the force needed to move the bed into the upward position. According to the calculations, it will require a force of 1692 LBS to raise the bed and move the remaining slide out portion of the slider assembly. The motor running the slide out of the RV is rated at a maximum torque of 2000 in/LBS (see attached drawing # 1510000006 for power curve). The torque arm for the motor is 1.1296" giving the motor 1770 LBS of force. This indicates that the motor is adequate to operate our assembly.

The second page is a spreadsheet that shows how the force needed decreases as the angle of the bed increases. This was done to show the head of engineering the range of force needed if we increased the start angle of the bed.

The third page of calculations pertains to the floor post. These are to determine the size of the fastener used to attach the post to the floor and the amount of deflection when the force is applied. The fasteners, #14 self-drilling screws (.25"ø), used to attach the post to the floor have a shear strength of 1372 LBS (1). There are four screws per post to provide a total of 5488 total pounds of resistance to shear. The calculations indicate a load of only 810.72 LBS of force on each post. The amount of calculated deflection for each post is 0.286 "at the top of the post.

Design Analysis

The design of our portion of the project is complete and ready to be added to the existing bed assembly for testing. We are currently waiting on Fleetwood's prototype shop to finish with the existing bed assembly mock-up to test our design and determine if any modifications will be needed.

In the design, we approached a local manufacturer (Faztek) of machine guards and ask if they would like to be used as the basis of our design. This was to fulfill Fleetwood's desire for the majority of the parts to be purchased as off the shelf parts. In the event that Fleetwood decides that the design will be incorporated into their recreational vehicle (RV) line, they will not have to manufacture the majority of the parts. Faztek accepted our offer to sponsor a portion of the design and donated the parts requested in the hopes of having a successful design that will give them the opportunity to possible get a future contract with Fleetwood.

Assembly

The prototype of the sliding bed was completed on Saturday, April 2nd. The team started at 7 a.m. and completed assembly around 11 a.m. The initial testing of the prototype then commenced. The motor of the slide assembly had no issue with the force required to raise the head of the bed. Aside from one side of the prototype having a part that was not properly aligned and causing the binding of one of the sliding blocks, the bed raised effortlessly.

The issue that occurred, which is the focus of redesign is that the force of gravity isn't great enough to slide the head of the bed to the down position when the whole sliding assembly is retracted. Upon testing, it was discovered that at any angle the head is raised over 45° does not allow the bed to slide back down by the force of gravity.

It was then determined that a method using mechanical means to force the head of the bed back down was needed. Three methods, one using a spring, one using a gas strut, and one using the motion of the slider assembly were then discussed amongst the team. Upon presenting the 3 options to the engineering staff at Fleetwood, it was determined that spring would be a liability do to it wearing out and failing. It was then determined that the gas strut idea would be too costly given out budget. The Fleetwood fab shop is currently in possession of drawings for the design to use the motion of the slider assembly. The redesigned parts are to be fabricated and installed this week.

The updated prints for the new parts were fabricated over week of April 4th – 8th. The team met on April 8th to examine the new design and test it.

Testing Procedures

All testing will be performed by Fleetwood's proto shop. A mocked up slide-out bed on an actual ram system will simulate the movement. It will include 4,500 cycle of the tilt bed in the up and down position. This amount has been determined to stimulate usage of normal wear and tear by end user. In, addition we'll be also checking the amperage draw of the ram system in the up and down positions. This is necessary because the ram system has a maximum amp draw before the motor shuts off. See attached drawing from Power Gear section "OPERATION CONDITIONS"

Prints & Drawings

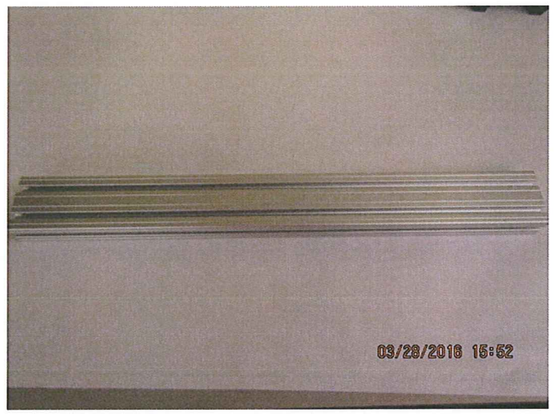
Attached are a print of the assembly we designed, the parts obtained from Faztek, the custom parts we designed, the bed ram motor and some illustrations of the assembly with the existing bed.

Photographs of Components:

Attached are photographs of each part of the design along with a photograph of the whole assembly.

Assembly

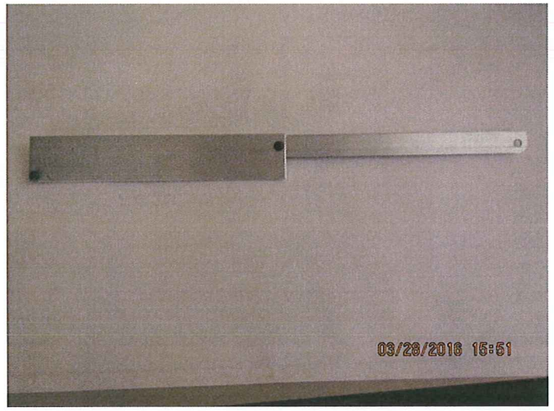
Corner Bracket



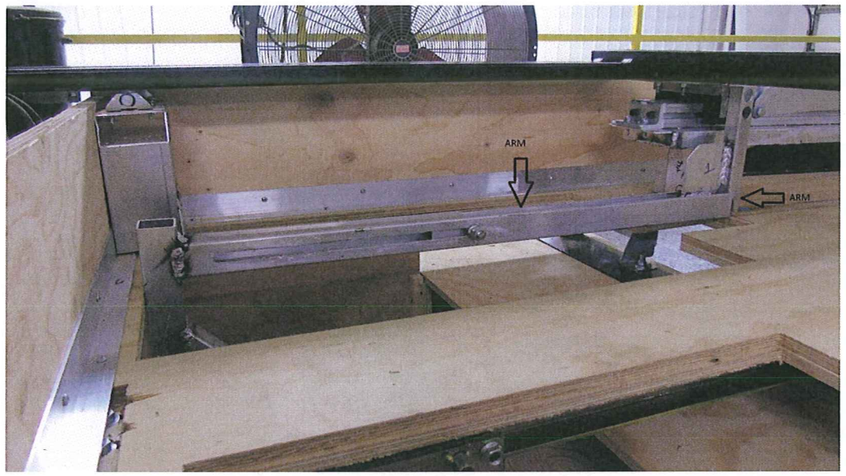
Slider Track

Slider

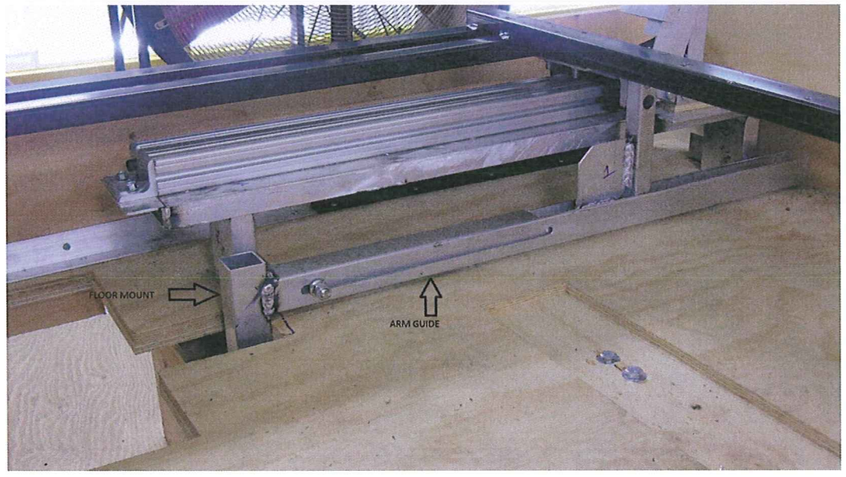
Top Plate



Link Assembly



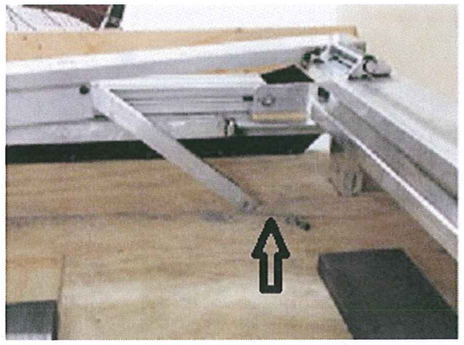
Arm Assembly



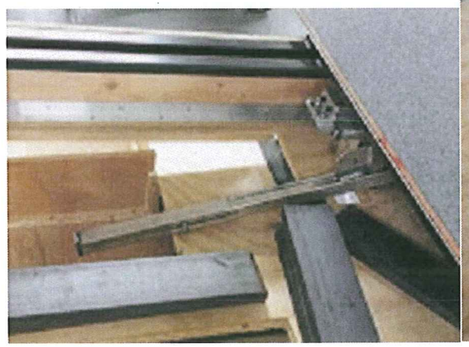
Floor Mount / Arm Guide Assembly

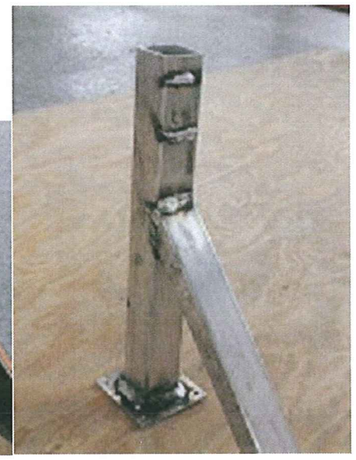
Testing

Testing of the assembly was started on April 11th. The assembly was cycled 900 times when failure occurred. The bolt connecting the two sliding links came out on one side of the assembly.



The result of the bolt coming out was the breaking of the tubes that guide the arms at the welds.





It was decided to replace all of the bolts used as pivot points were to be replaced with socket head shoulder bolts. The new bolts were installed and the broken parts re-welded and testing was resumed with the cycling count started over at zero.

The cycle test was completed on April 18, 2016. The assembly continued cycling past the 4500 cycle test and the testing was completed at 4900 cycles.

Budget

The current design the RV manufacturer installs has an approximate cost of $350.00 just for the motor and wiring. Fleetwood ask us to aim for a $220 budget which would be a savings of 37%.

The current team design includes:

The parts that were used from Faztek were quoted for a total of $162.76 per assembly with a 5-7% discount if ordered in bulk. (See attached Bill of Materials).

The price for the nuts, bolts and washers were obtained from McMaster Carr and came to a total of $21.85 per assembly.

The costs for the remaining parts were quoted by Whitley Welding and Fabrication per phone conversation. These parts came in at $210 per assembly.

The total cost of our assembly came to $386.47. This was $36.47 above budget. Given time to get quotes from other suppliers, the project could be feasible in the future.

Fleetwood Bed Folding Project budget Numbers

Part	Supplier	# Required	Price per Part	Qty. Discount	Total
Custom Corner	Faztek	2	$27.15	5%	$51.59
T-Slot	Faztek	2	$21.66	5%	$41.15
Linear Bearing	Faztek	2	$32.57	5%	$61.88
5/16-18 x 1" SHCS	McMaster-Carr	8	$0.21		$1.69
3/8 x 5/16 SHSS	McMaster-Carr	6	$2.27		$13.62
#14 Steel Drilling Screw	McMaster-Carr	10	$0.17		$1.69
Nylon Locknut	McMaster-Carr	6	$0.18		$1.10
3/8" UHMW Washer	McMaster-Carr	12	$0.31		$3.75
Link-2	Whitley Welding	2	$17.00		$34.00
Top Plate	Whitley Welding	2	$15.00		$30.00
Floor Post Guide Arm	Whitley Welding	2	$24.00		$48.00
Floor Post Mount	Whitley Welding	2	$32.00		$64.00
Link-1	Whitley Welding	2	$17.00		$34.00
				Grand Total	$386.47

Ownership

The results of this project will be the sole property of Fleetwood RV.

Conclusion

The design teams was tasked with replacing a two motor RV slider/bed lifter design and eliminate the motor that raised the head of the bed when the slider was retracted back into the RV for travel mode. The design parameters given by the commissioning company stated that we use no springs, chains, rack and pinions. A mechanical linkage was the only option presented.

When the design was done, failure was experience during testing. After changing out the bolts at the pivot points with shoulder bolts, the design completed the testing cycle. Actually, the design survived 4900 cycles, 400 over the testing specification of 4500 cycles.

When the budget numbers were received, the costs came in at $30-$50 **OVER** the cost of using two motors.

So, while the design was successful in function, it did not meet the desired budget.

Gantt Chart

See attached

Bibliography

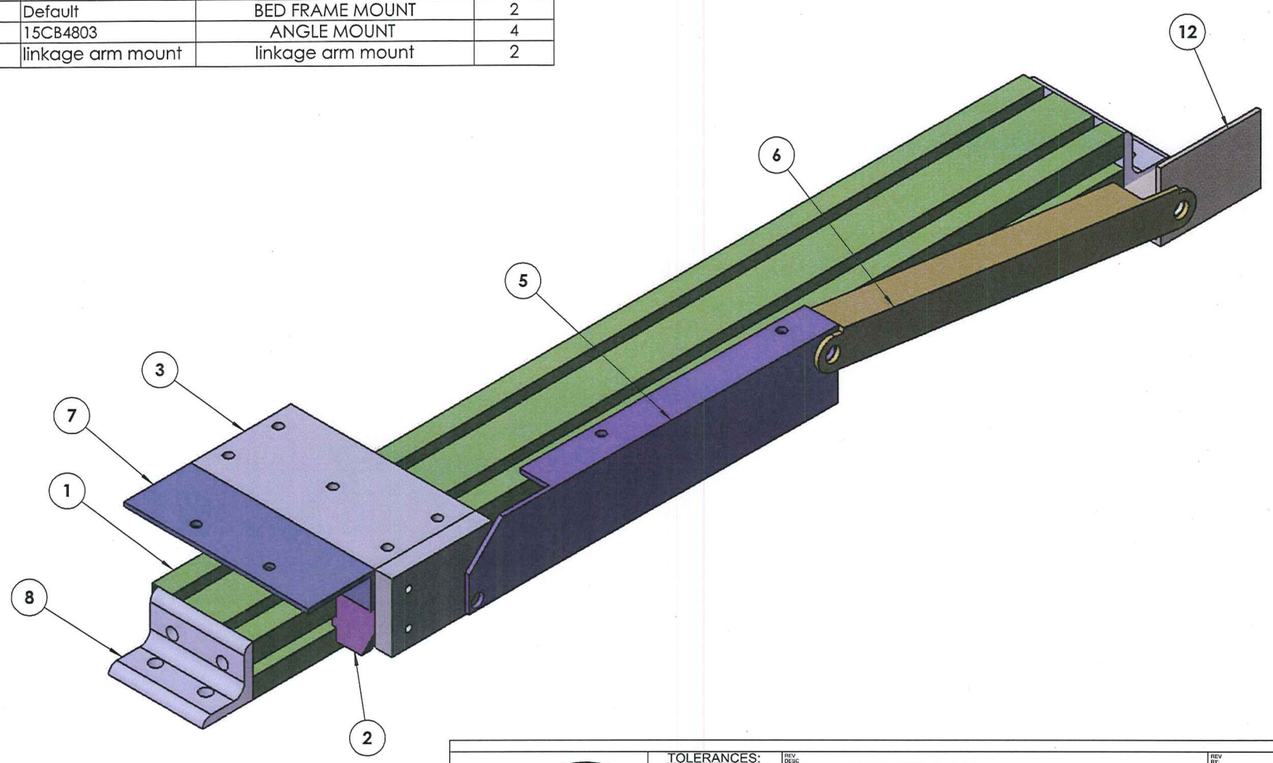
Vector Mechanics for Engineers, Statics and Dynamics, Fifth Edition, Ferdinand P. Beer and E. Russell Johnston, Jr.

Faztek Online Catalog: http://www.faztek.net/catalogs.html

McMasterCarr.com

(1) "Scrooscoop Fastener Co." http://www.scrooscoop.com/toppage1.htm, 4/24/2016

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	15EX1530	EXTRUSION	2
2	15LM8562	LINEAR BEAING SLIDER	2
3	15CM0917	TOP PLATE	2
5	LINK-1	LONG LINKAGE ARM	2
6	LINK-2	SHORT LINKAGE ARM	2
7	Default	BED FRAME MOUNT	2
8	15CB4803	ANGLE MOUNT	4
12	linkage arm mount	linkage arm mount	2



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3 PLACE +/- 0.005
4 PLACE +/- 0.001
ANGULAR +/- 0.05°
FRACTION +/- 1/64"

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SHEET: 1 OF 3
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D.O.P.
DATE: 4/20/16
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PART#: Slider Assembly

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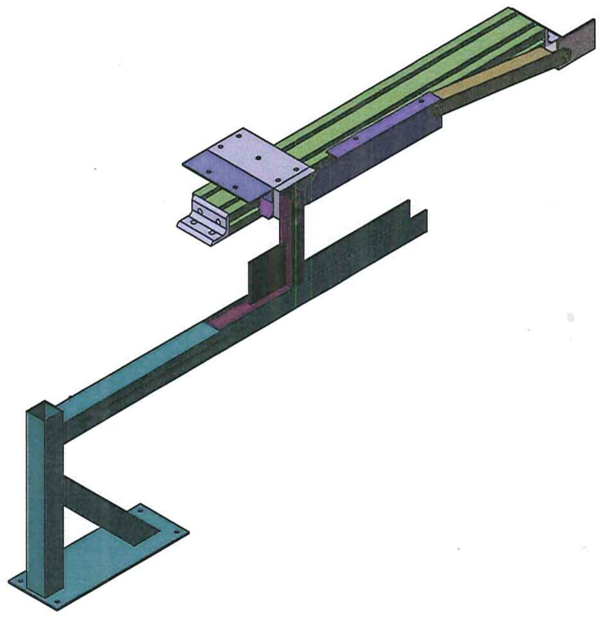

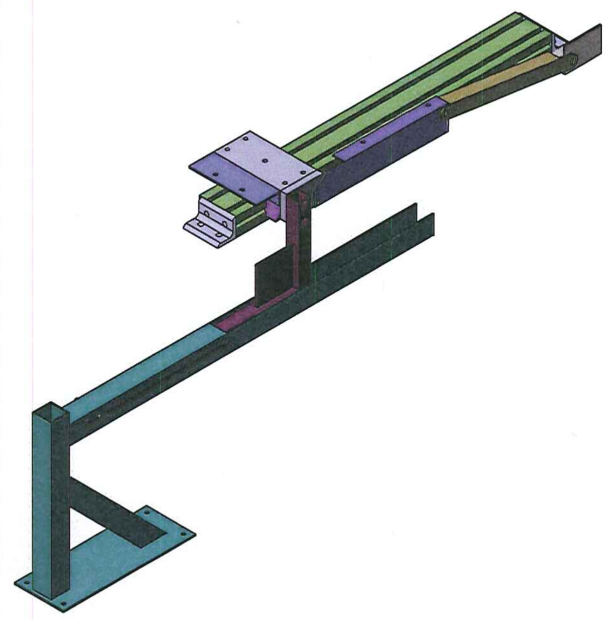

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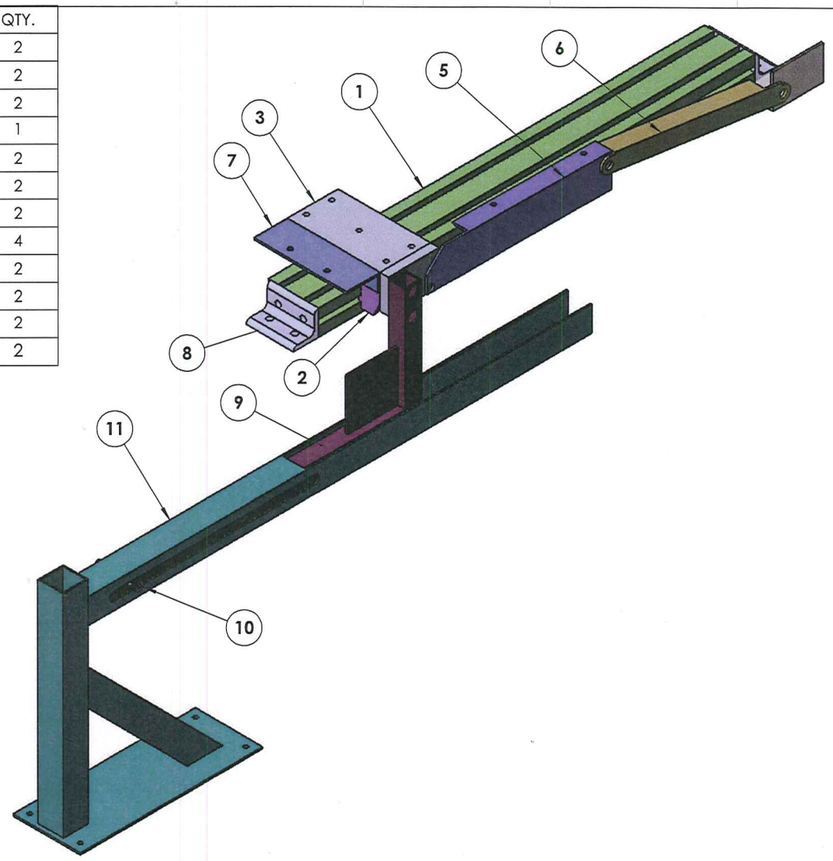
2	15LM8562	LINEAR BEAING SLIDER	2
3	15CM0917	TOP PLATE	2
4	Slider Assembly		1
5	LINK-1	LONG LINKAGE ARM	2
6	LINK-2	SHORT LINKAGE ARM	2
7	Default	BED FRAME MOUNT	2
8	15CB4803	ANGLE MOUNT	4
9	FLOOR POST-2	ARM GUIDE	2
10	91259A630	DRIVE PIN	2
11	Floor post_1	FLOOR POST GUIDE	2
12	linkage arm mount	linkage arm mount	2



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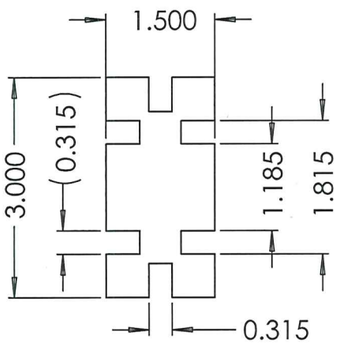

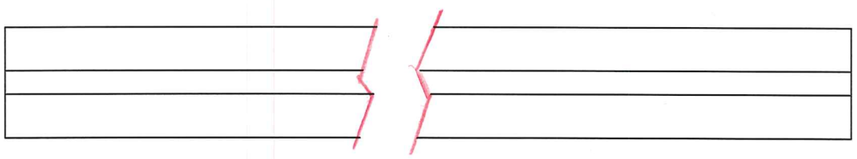

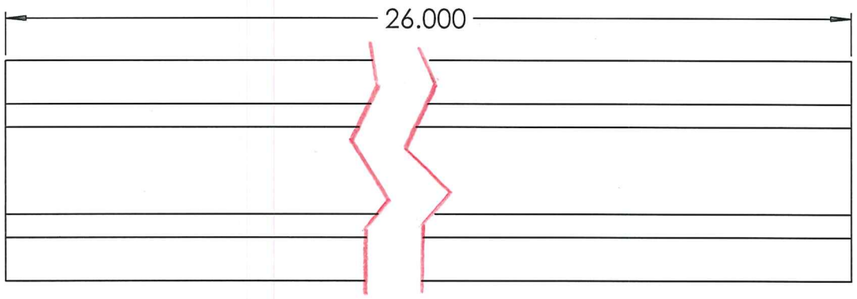

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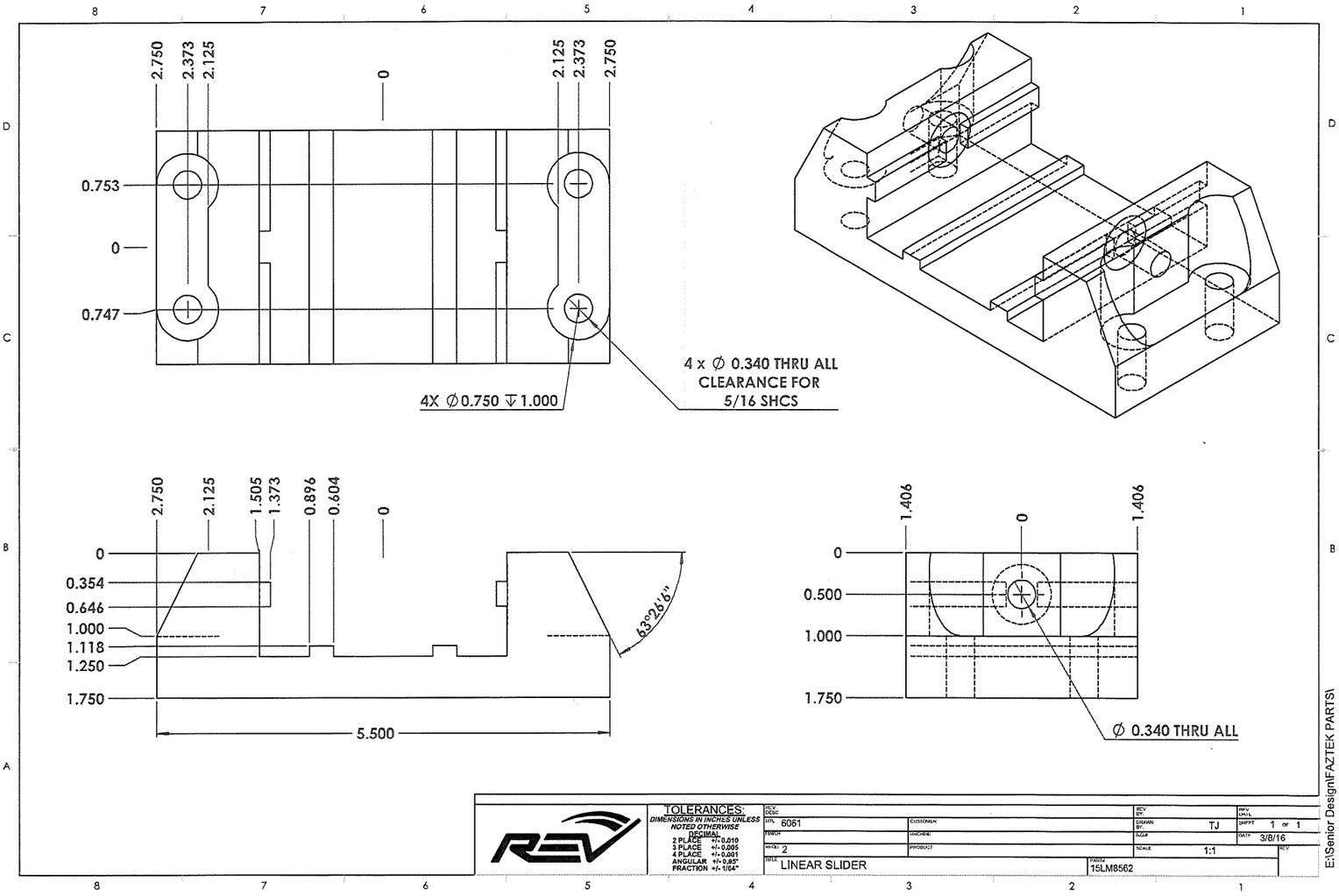

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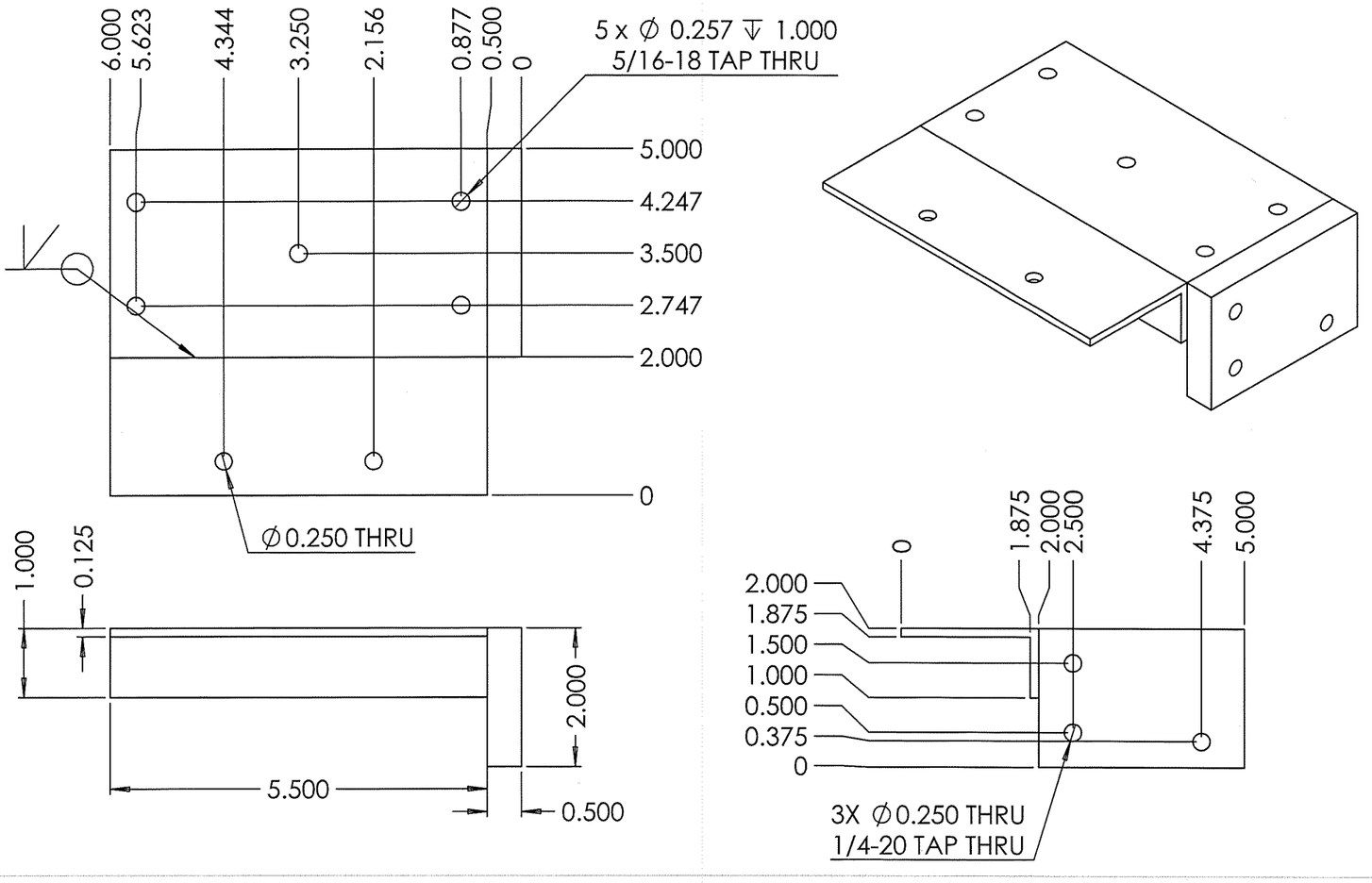

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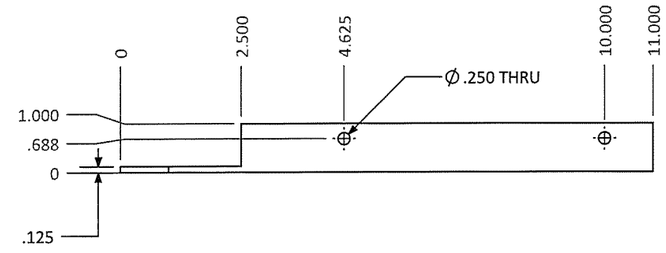

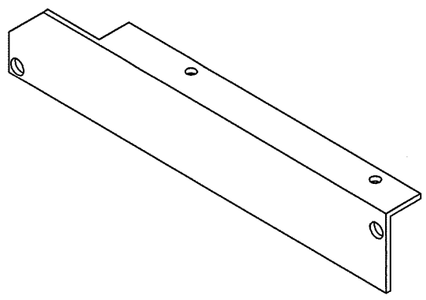

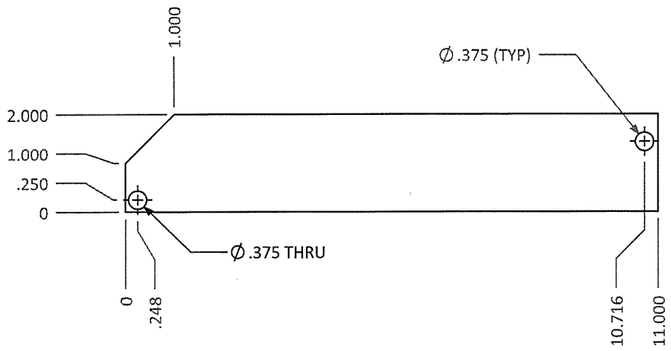

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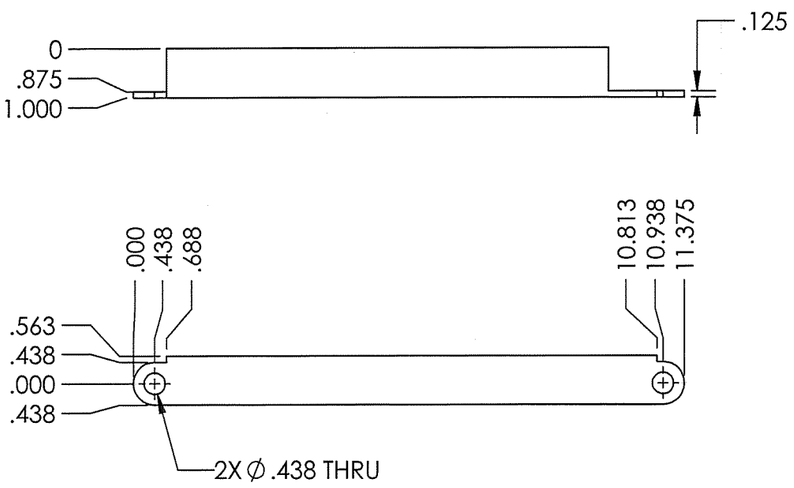

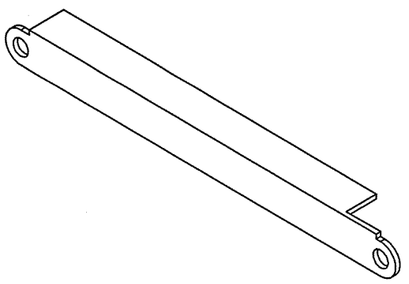

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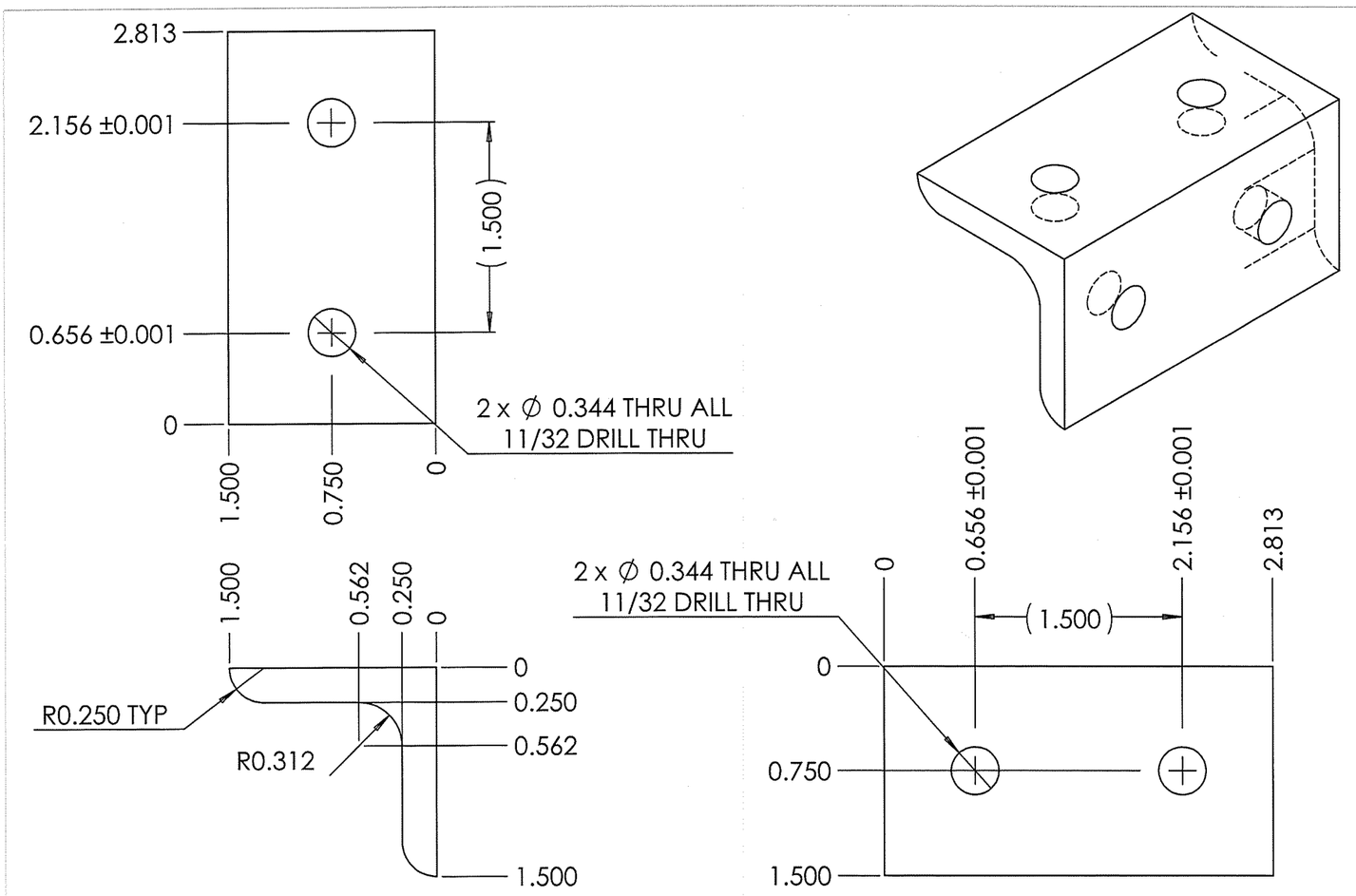

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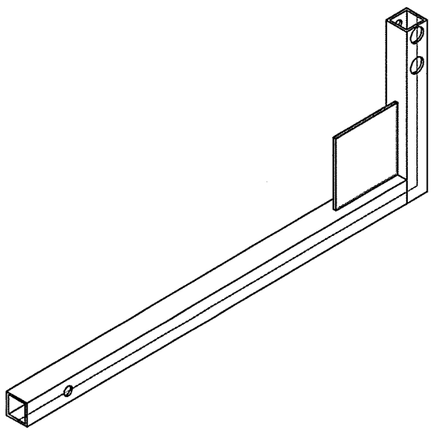

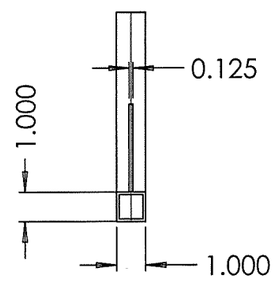

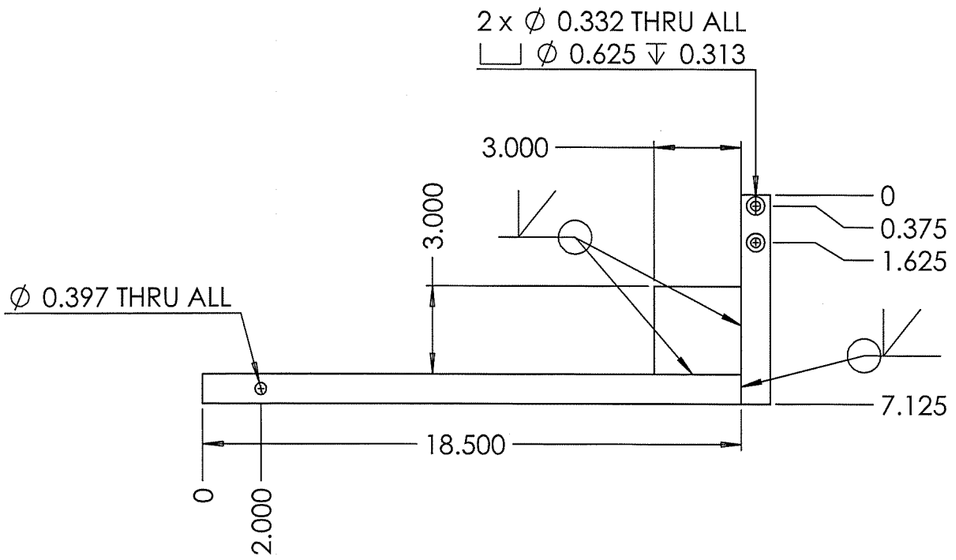

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		TITLE FLOOR POST GUIDE ARM		PART # Floor Post Guide Arm	

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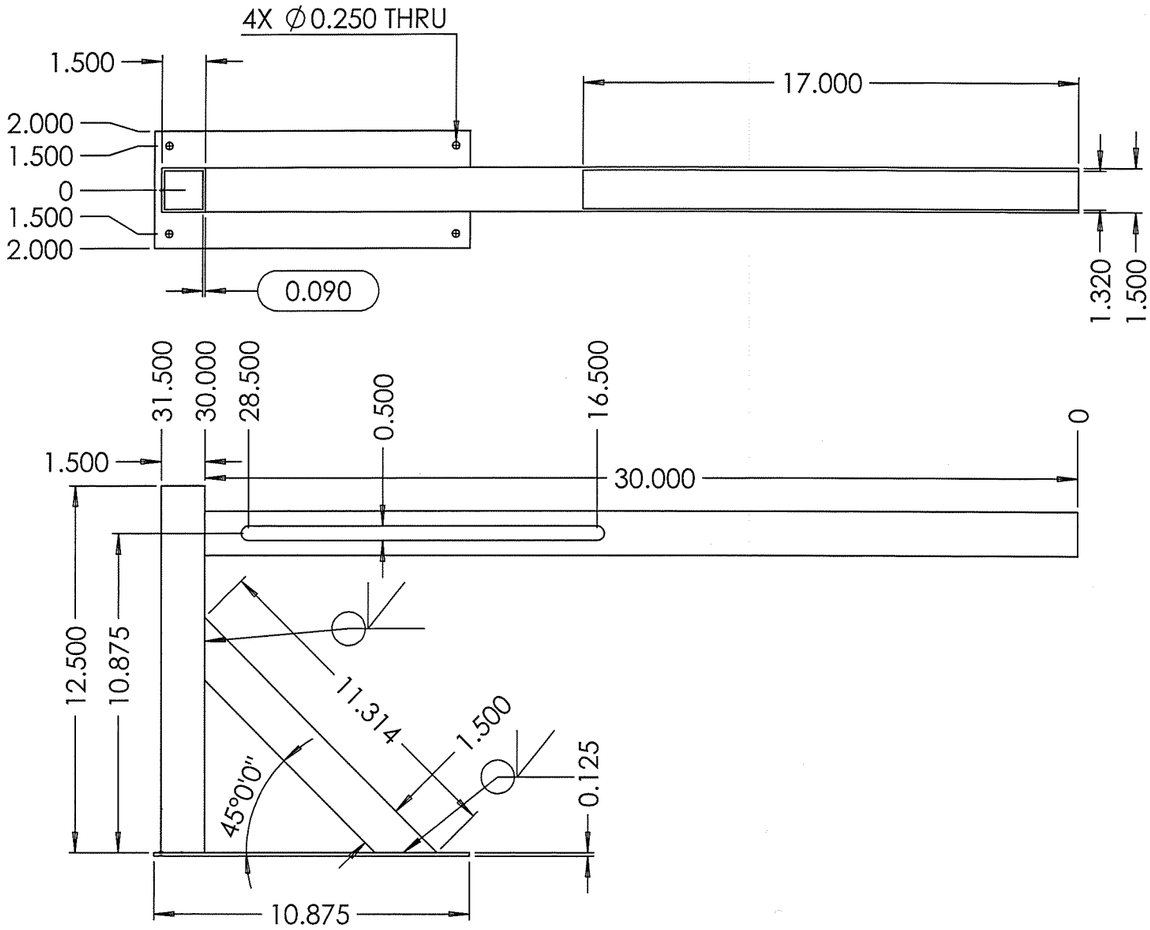
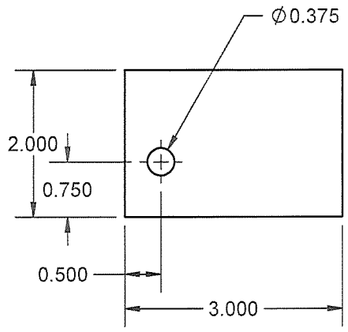
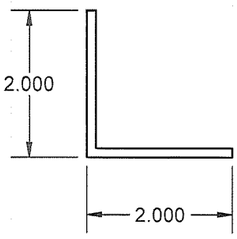


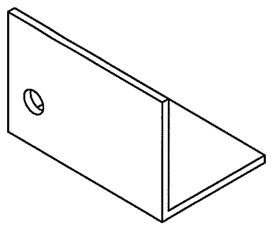
TOLERANCES: *DIMENSIONS IN INCHES UNLESS NOTED* DECIMAL 2 PLACE +/- 0.010, 3 PLACE +/- 0.005, 4 PLACE +/- 0.001, ANGULAR +/- 0.05°, FRACTION +/- 1/64"	MTL 6061 tube	CUSTOMER Fleetwood	DRAWN BY TJ	SHEET 1 OF 1
	FINISH	MACHINE	SCALE 1:1	DATE 4/20/16
	REQD 2	PRODUCT	S.O.#	REV
	TITLE FLOOR POST MOUNT		PART # Floor Post Mount	

E:\Senior Design\

ITEM NO.	DESCRIPTION	MATERIAL	QTY.
1	ANG- ALUM 2 x 2 x 1/8	6063-T5	1







Vehicles for life

NEXT ASSY	USED ON	
APPLICATION		

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL 6063-T5

FINISH -

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

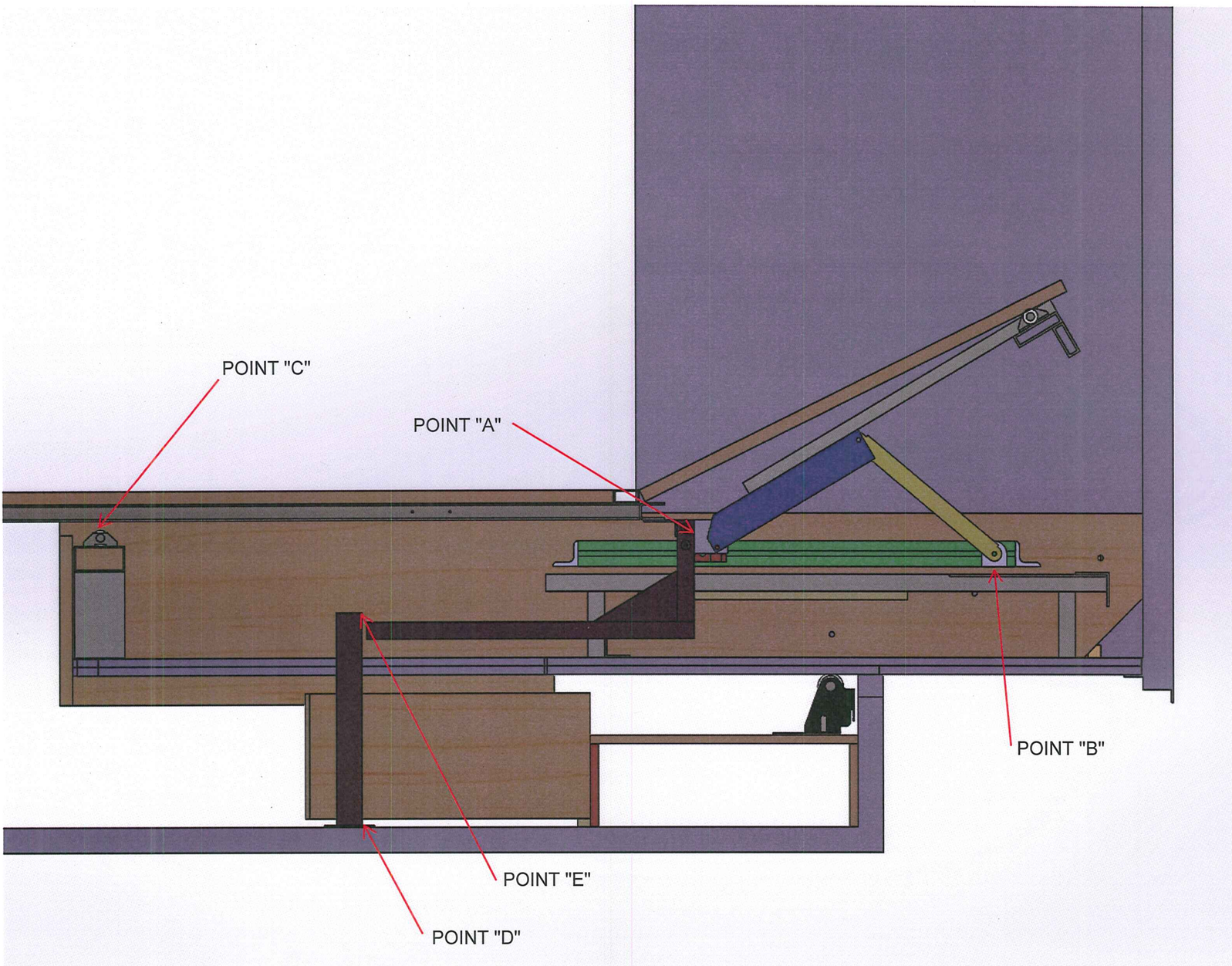
COMMENTS:

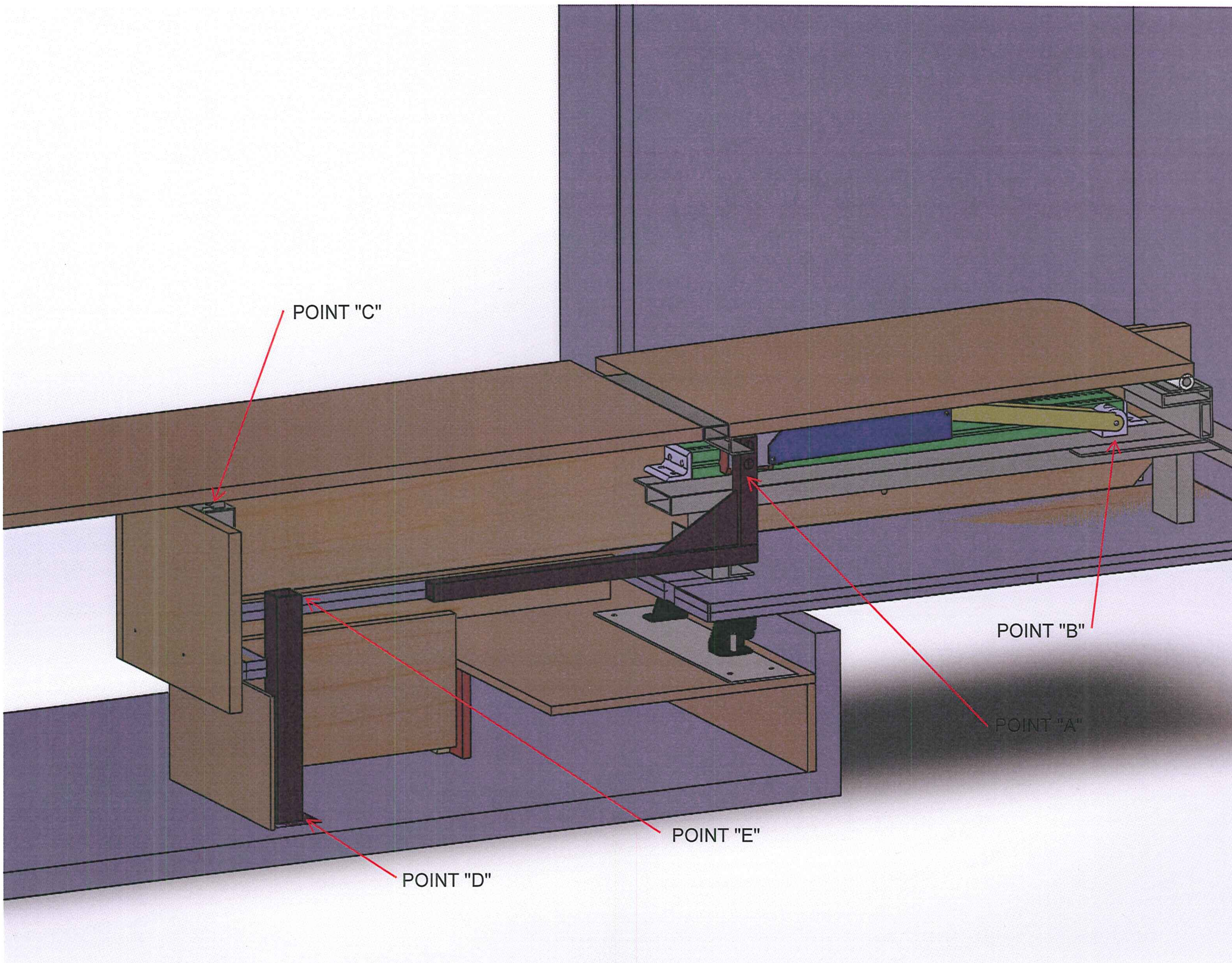
REV GROUP, INC.

TITLE: LINK ANGLE-2

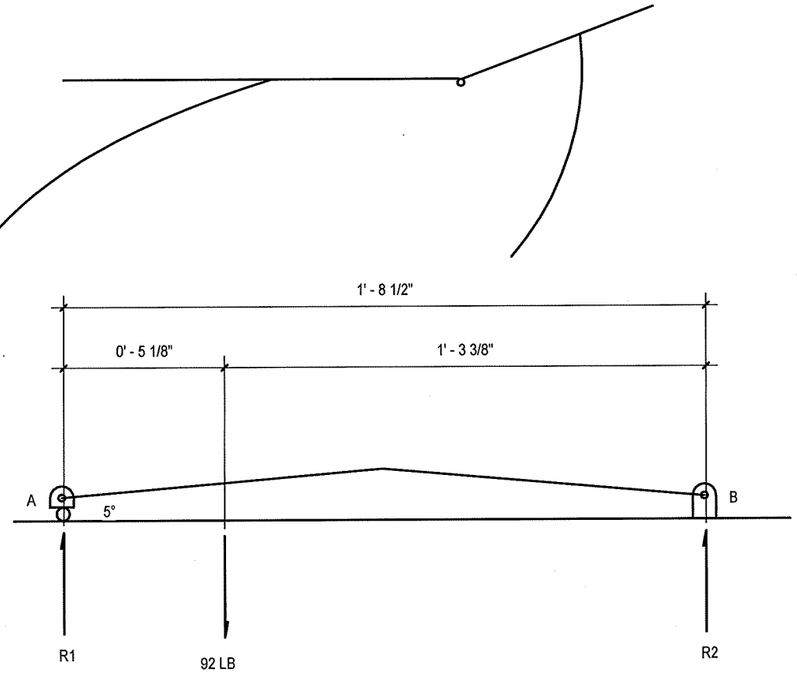
SIZE	DWG. NO.	REV
A	LINK_ANGLE-2	+

SCALE: 1:2 | WEIGHT: 0.14 | SHEET 1 OF 1

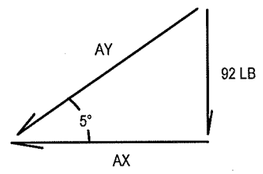

POINT "C"
POINT "A"
POINT "B"
POINT "E"
POINT "D"


POINT "C"
POINT "B"
POINT "A"
POINT "E"
POINT "D"

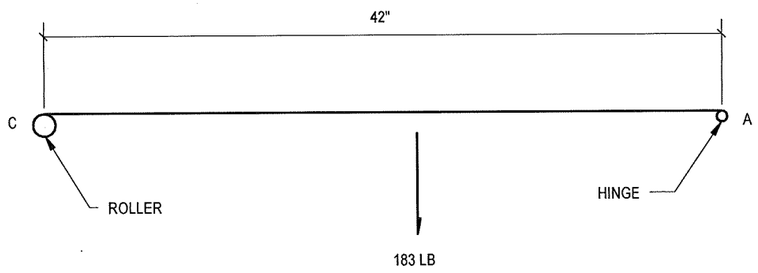
Calculations Sheet #1



{M(A) = 0 = (5.125*92) - (R2*20.5)
{M(A) = 0 = 471.5 - 20.5*R2
R2 = 471.5 / 20.5
R2 = 23 lb
R1 = 92 lb - 23 lb
R1 = 69 lb



TAN 5° = 92 lb / AX
AX = 92 lb / TAN 5°
AX = 1052 lb



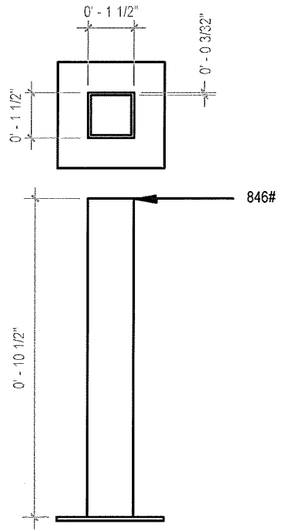
Total Force = (1052 LB + 183 LB + 175 LB{1}) * 1.2 (Friction Factor) = 1692 LB
Total Force / 2 (1692 LB / 2 = 846 LB) Represents (2) assemblies.
{1} = 175 LB is the additional weight from the slide out that motor has to move.

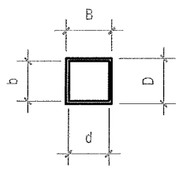
Calculations (Page 2)

Force to Raise Head of Bed From 5° to 25°

Degree	Radians	Tan	Weight (Lifted Portion)	Force	Friction	Weight (Remainder of Bed)	Total
5	0.0872	0.0874	92	1052	0.2	183	1482
6	0.1047	0.1051	92	876	0.2	183	1271
7	0.1221	0.1227	92	750	0.2	183	1119
8	0.1396	0.1405	92	655	0.2	183	1006
9	0.1570	0.1583	92	581	0.2	183	917
10	0.1744	0.1762	92	522	0.2	183	846
11	0.1919	0.1943	92	474	0.2	183	788
12	0.2093	0.2124	92	433	0.2	183	739
13	0.2268	0.2307	92	399	0.2	183	698
14	0.2442	0.2492	92	369	0.2	183	663
15	0.2617	0.2678	92	344	0.2	183	632
16	0.2791	0.2866	92	321	0.2	183	605
17	0.2966	0.3056	92	301	0.2	183	581
18	0.3140	0.3247	92	283	0.2	183	560
19	0.3314	0.3441	92	267	0.2	183	540
20	0.3489	0.3638	92	253	0.2	183	523
21	0.3663	0.3837	92	240	0.2	183	507
22	0.3838	0.4038	92	228	0.2	183	493
23	0.4012	0.4242	92	217	0.2	183	480
24	0.4187	0.4450	92	207	0.2	183	468
25	0.4361	0.4660	92	197	0.2	183	456

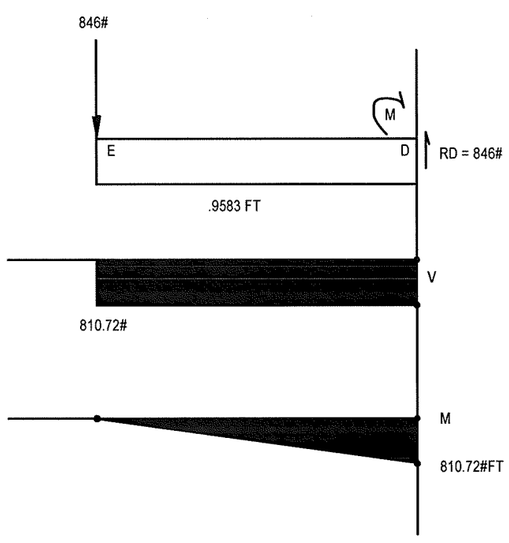
Calculations Sheet #3





I = (BD^3 - bd^3) / 12
I = (1.5"^4 - 1.32"^4) / 12
I = 2.02"^4 / 12
I = 0.16833"^4

MATERIAL: AL6063 T-5
E=10 X 10^6 PSI
I = 0.16833"^4



M(D) = 0.9583 FT X 846#
M(D) = 810.72#FT

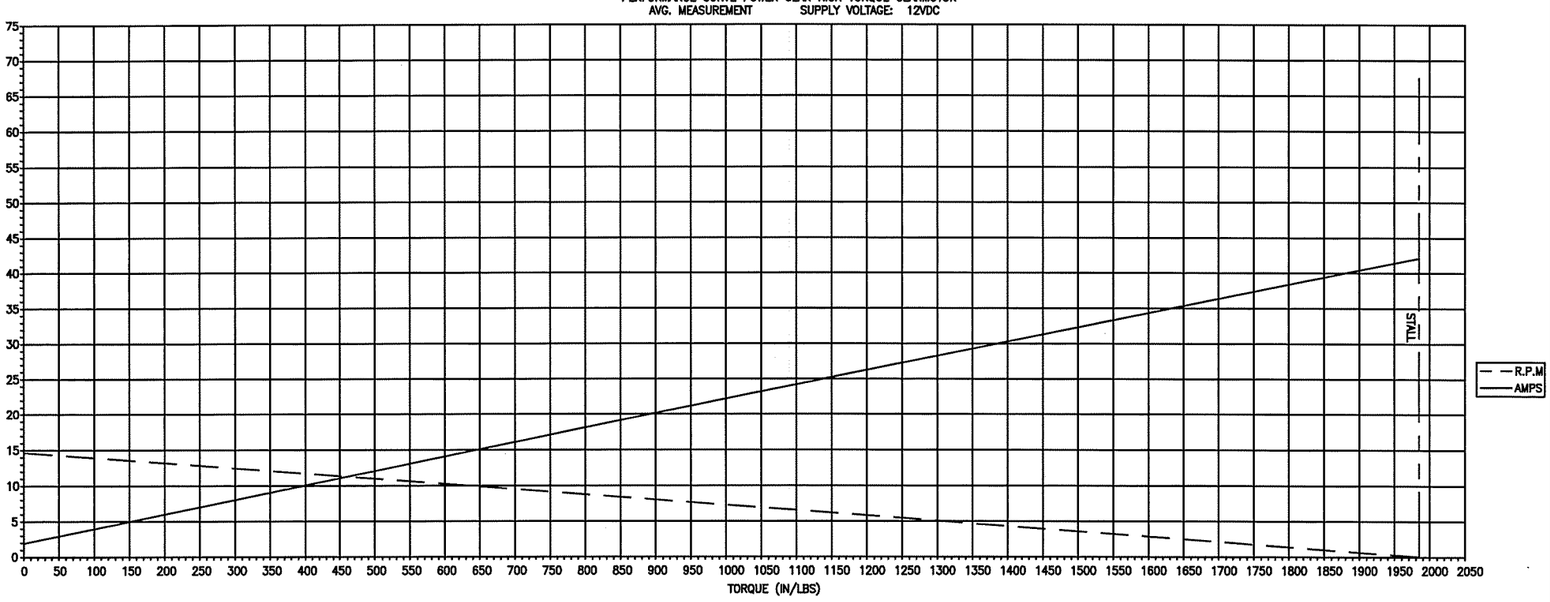
Reaction at A = 810.72 lb

Moments at A: Ma = -Fa = -810.72 lb * 11.5" = -9323.30" lb

Max Deflection @ Load: [(F * (a^3)) / (3 * E * I)] = [(810.72 LB * (11.5"^3)) / (3 * (10*10^6 psi) * 0.16833in^4)] = 0.244164"

Max Deflection @ end: [(F * (a^3)) / (3 * E * I)] * [(1 + 3*b) / (2 * a)] = [(810.72 LB * (11.5"^3)) / (3 * (10*10^6 psi) * 0.16833in^4)] * [(1 + 3*1") / (2 * 11.5")] = 0.286227"

PERFORMANCE CURVE POWER GEAR HIGH TORQUE GEARMOTOR
AVG. MEASUREMENT SUPPLY VOLTAGE: 12VDC



REV	DESCRIPTION	ECN	DATE	BY
0A	RELEASE TO PRODUCTION	7751	04/20/06	TLB
0B	UPDATED TEXT	09-0103	09-11-08	BAE

1217 E. SEVENTH STREET * MISHAWAKA, INDIANA 46544
FAX: (574) 255-5029 * PH: (574) 254-5285

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES.
TOLERANCES ARE:
DECIMALS ANGLES
.X±.06 ±1°
.XX±.03
.XXX±.010
BREAK ALL SHARP EDGES .005/.030
DO NOT SCALE DRAWING

TITLE: MOTOR MX2 DS W/O PIN W/CONN-B
PRODUCT
MATL PURCHASED
SCALE 1:3 | DRAWN DGW | DATE 02/17/06 | SHEET 2 OF 2
SIZE A | DWG NO. 1510000006 | REV. 0B

Current Order

About you

If you have ordered from this site before, we can retrieve your information.

User name or e-mail address

Password

LOG IN Cancel

Forgot your user name or password?

I am new to this website.

Products

Show line references

Purchase order (optional)

Line	Quantity	Product		Ships	Unit price	Total	Delete
1	1 pack	91251A563	Black-Oxide Alloy Steel Socket Head Cap Screw, 5/16"-18 Thread, 1" Length, packs of 50	Monday morning	$10.56 pack	10.56	
2	6 each	91259A176	Alloy Steel Shoulder Screw, 3/8" Diameter x 5/16" Long Shoulder, 5/16"-18 Thread Size	Monday morning	2.27 each	13.62	
3	1 pack	90064A620	Zinc-Plated Steel Drilling Screw for Metal, 1/4"-14 Thread, 1" Length, Drill Point #3, packs of 50	Monday morning	8.44 pack	8.44	
4	1 pack	97135A220	Grade 8 Steel Nylon-Insert Locknut, Zinc Yellow-Chromate Plated, 5/16"-18 Thread Size, packs of 20	Monday morning	3.68 pack	3.68	
5	1 pack	95649A241	UHMW Polyethylene Flat Washer, 3/8" Screw Size, 0.390" ID, 0.625" OD, packs of 25	Monday morning	7.81 pack	7.81	
6							

ADD | Paste products and quantities

Merchandise total $44.11

Special Instructions

PLACE ORDER

Quote#: 27994

Quote Date: 4/13/2016

Innovative Guarding & Safety Solutions

"Protect your assets....see the guys in the yellow hats"

Distributor: IPFW
Contact: BRENT RANSOM
Customer:
Revision: Orig
Date: 4/13/2016

Location:

Quoted By: LB

Total Sale Kit form (net cost): $ 162.76
Total Sale Assy form (net cost): $ -
Estimated Project Weight: #N/A

*** $50 minimum order**
*** The following quote is valid for 15 days**
*** All orders are subject to a handling fee whether shipped collect or prepaid**
*** Assemblies are placed on a skid, wrapped in cardboard, banded, and stretchwrapped. For crate costs, please contact us at 260.482.7544.**

Faz-timator V18.00											
Tag	Part Number	Qty	Length (")	Width (")	Part Description	Machining Description			Wt.	Price Each	Extended Price
3	15CM0941	2			57.50" Custom Corner Bracket			#N/A	#N/A	$ 27.15	$ 54.30
1	15EX1530	2	26.000		1.5" X 3" T-Slotted Extrusion	15MA9051	2	Tap Both Ends	10.3	$ 21.66	$ 43.32
2	15LM8562	2			Double Flange Linear Bearing - 3.0" Ext				0.5	$ 32.57	$ 65.14

Ph: 260.482.7544 - Fx: 260.482.7354
www.faztek.net
sales@faztek.net - design@faztek.net

Task	10-Jan		17-Jan		24-Jan		31-Jan		7-Feb		14-Feb		21-Feb		28-Feb		6-Mar		13-Mar		20-Mar		27-Mar		3-Apr		10-Apr		17-Apr		24-Apr	
Form Team																																
Select Project																																
Write Proposal																																
Initial Design																																
Write Report #1																																
Initial Calculations																																
Design Analysis																																
Revised Calculations																																
Parts Aquired																																
Mock-Up Ready																																
Build 3-D Model																																
Drawings																																
Photos of Components																																
Assembled Prototype																																
Testing & Re-Design																																
Diagrams & Eng. Drawings																																
Photo's Complete																																
Fabrication Procedure																																
Test Results																																
Costing																																
Conclusions																																
Presentation Rehearsal																																
Poster Design																																

Plan

Actual