August 4, 2020

U.S. Department of Transportation
Federal Highway Administration

1200 New Jersey Ave., SE
Washington, D.C. 20590

In Reply Refer To:
HSST-1/CC-152

Mr. Frederick Mauer
Gregory Industries
4100 13th Street, SW
Canton, OH. 44710

Dear Mr. Mauer:

On March 6, 2019, the Federal Highway Administration (FHWA) issued Letter CC-152 for the Gregory Industries Truck-Trailer Mounted Attenuator (TTMA) 200. On May 1, 2020, Gregory Industries submitted a second application for eligibility for an updated TTMA 200 which features heavier-duty spindles and electric braking system. This letter is in response to the May 1, 2020 request for FHWA to review the updated device for eligibility for reimbursement under the Federal-aid highway program. This FHWA letter of eligibility is assigned FHWA control number CC-152 and will supersede and replace the existing letter CC-152.

Decision

The following device is eligible within the length-of-need, with details provided in the form which is attached as an integral part of this letter:

- TTMA-200

Scope of this Letter

To be found eligible for Federal-aid funding, new roadside safety devices should meet the crash test and evaluation criteria contained in the American Association of State Highway and Transportation Officials'(AASHTO) Manual for Assessing Safety Hardware (MASH). However, the FHWA, the Department of Transportation, and the United States Government do not regulate the manufacture of roadside safety devices. Eligibility for reimbursement under the Federal-aid highway program does not establish approval, certification or endorsement of the device for any particular purpose or use.

This letter is not a determination by the FHWA, the Department of Transportation, or the United States Government that a vehicle crash involving the device will result in any particular outcome, nor is it a guarantee of the in-service performance of this device. Proper manufacturing, installation, and maintenance are required in order for this device to function as tested.

This finding of eligibility is limited to the crashworthiness of the system and does not cover other structural features, nor conformity with the Manual on Uniform Traffic Control Devices.

Eligibility for Reimbursement

Based solely on a review of crash test results and certifications submitted by the manufacturer, and the crash test laboratory, FHWA agrees that the device described herein meets the crash test and evaluation criteria of the AASHTO's MASH. Therefore, the device is eligible for reimbursement under the Federal-aid highway program if installed under the range of tested conditions.

Name of system: TTMA-200
Type of system: Truck-Trailer Mounted Attenuator
Test Level: MASH Test Level 3 (TL3)
Testing conducted by: Applus IDIADA KARCO Engineering, LLC.
Date of request: May 1, 2020

FHWA concurs with the recommendation of the accredited crash testing laboratory on the attached form.

Full Description of the Eligible Device

The device and supporting documentation, including reports of the crash tests or other testing done, videos of any crash testing, and/or drawings of the device, are described in the attached form.

Notice

This eligibility letter is issued for the subject device as tested. Modifications made to the device are not covered by this letter. Any modifications to this device should be submitted to the user (i.e., state DOT) as per their requirements.

You are expected to supply potential users with sufficient information on design, installation and maintenance requirements to ensure proper performance.

You are expected to certify to potential users that the hardware furnished has the same chemistry, mechanical properties, and geometry as that submitted for review, and that it will meet the test and evaluation criteria of AASHTO's MASH.

Issuance of this letter does not convey property rights of any sort or any exclusive privilege. This letter is based on the premise that information and reports submitted by you are accurate and correct. We reserve the right to modify or revoke this letter if: (1) there are any inaccuracies in the information submitted in support of your request for this letter, (2) the qualification testing was flawed, (3) in-service performance or other information reveals safety problems, (4) the system is significantly different from the version that was crash tested, or (5) any other information indicates that the letter was issued in error or otherwise does not reflect full and complete information about the crashworthiness of the system.

Standard Provisions

- To prevent misunderstanding by others, this letter of eligibility designated as FHWA control number CC-152 shall not be reproduced except in full. This letter and the test documentation upon which it is based are public information. All such letters and documentation may be reviewed upon request.

- This letter shall not be construed as authorization or consent by the FHWA to use, manufacture, or sell any patented system for which the applicant is not the patent holder.

- This FHWA eligibility letter is not an expression of any Agency view, position, or determination of validity, scope, or ownership of any intellectual property rights to a specific device or design. Further, this letter does not impute any distribution or licensing rights to the requester. This FHWA eligibility letter determination is made based solely on the crash-testing information submitted by the requester. The FHWA reserves the right to review and revoke an earlier eligibility determination after receipt of subsequent information related to crash testing.

Sincerely,

Michael S. Griffith

Michael S. Griffith
Director, Office of Safety Technologies
Office of Safety

Enclosures

Request for Federal Aid Reimbursement Eligibility of Highway Safety Hardware

Submitter	Date of Request:	May 01, 2020	◉ New ○ Resubmission
	Name:	Nick Injev	
	Company:	Applus IDIADA KARCOEngineering, LLC.	
	Address:	9270 Holly Road, Adelanto, CA 92301	
	Country:	United States of America	
	To:	Michael S. Griffith, Director FHWA, Office of Safety Technologies	

I request the following devices be considered eligible for reimbursement under the Federal-aid highway program.

Device & Testing Criterion - Enter from right to left starting with Test L ! - ! - ! ! - ! - !

System Type	Submission Type	Device Name / Variant	Testing Criterion	Test Level
'CC': Truck-Mounted Attenua	◉ Physical Crash Testing ○ Engineering Analysis	TTMA-200	AASHTO MASH	TL3

By submitting this request for review and evaluation by the Federal Highway Administration, I certify that the product(s) was (were) tested in conformity with the AASHTO Manual for Assessing Safety Hardware and that the evaluation results meet the appropriate evaluation criteria in the MASH.

Individual or Organization responsible for the product:

Contact Name:	Frederick Mauer	Same asSubmitter☐
Company Name:	Gregory Industries	Same asSubmitter☐
Address:	4100 13th Street SWCanton OH 44710	Same asSubmitter☐
Country:	United States of America	Same asSubmitter☐

Enter below all disclosures of financial interests as required by the FHWA `Federal-Aid Reimbursement Eligibility Process for Safety Hardware Devices' document.

Gregory Industries is the manufacturer and marketer of the TTMA-200.

Applus IDIADA KARCOEngineering, LLC (IDIADA KARCO) isan independent research and testing laboratory having no affiliation with any other entity. IDIADA KARCO isactively Involved In data acquisition and compliance/certification testing for a variety of government agenciesand equipment manufacturers. The principalsand staff of IDIADA KARCO have no past or present financial, contractual or organizational interest in any company or entity directly or indirectly related to the products that KARCO tests. If any financial interest should arise, other than receiving fees for testing, reporting, etc., with respect to any project, the company will provide, In writing, a full and immediate disclosure to the FHWA.

PRODUCT DESCRIPTION

Help

(•) New Hardware or Significant Modification ( ) Modification to Existing Hardware

The TTMA-200 is trailer attenuator designed to dissipate the kinetic energy of an impacting vehicle to reduce the severity of a crash. As the impact head and mandrel are pushed forward into the first tube, the tapered mandrel bursts the first tube at the corners into four (4) straps. The bursting of the first tube dissipates the kinetic energy of the impacting vehicle. The trailer attenuator hasa length of 23.6ft (7.2 m) with an optional hitch extension its total tested length was 24.9 ft. (7.6 m) and a max width of 8.0 ft. (2.4 m). The TTMA-200 is supported by a wheel and axle assembly and isattached to the support truck with a lunette ring.

All testing of the TTMA-200 was conducted with an optional 4.0 ft. x 8.0 ft. (1.2 m x 2.4 m) arrow board and arrow board frame that attached to the trailer frame assembly. The arrow board frame wasattached to the trailer frame assembly with two (2) 5/8" grade 5 boltsand six (6) 1/2" grade 5 bolts. The arrow board was secured to the arrow board frame with five (5) 3/8" grade 5 bolts. An optional 16.0 in. (406 mm) hitch extension bolted to the trailer frame assembly with four (4) 5/8" grade 5 bolts. The TTMA-200 lunette ring was inserted into astandard 8-ton pintle hitch mounted on the support truck at a height of 19.5 in. (495 mm). Complete detail of the assemblies can be found in the manufacturer's drawings.

Test Chronology and Design Modifications:
Tests 3-51, 52, and 53 were conducted from 07/23/18 through 07/26/18.
Test 3-50 was conducted on 03/11/20.
Throughout the series, the TTMA-200 was tested with some optional accessories, one being a light bar at the rear of the TMA. The mounting method of the optional light bar accessory was changed during the test series. Tests 3-52 and 3-53 were tested with the revised mounting method of the accessory. The new mounting method used four (4) pieces of 0.75 in. (19 mm) galvanized steel hanger strap to secure the light bar. Test 3-50 replaced the galvanized steel strap with astainless steel strap to add longevity to the attachment component. These changes had no impact on performance of the system.
Test 3-50 was run with a heavier duty spindle. This change added an additional 0.9 lbs (0.4 kg) per axle. In addition, Test 3-50 wasalso run using an optional electrically operate braking package to the axle. This change added an additional 8.1 lbs (3.7 kg) per axle. The total change in axle weight was 18 lbs (8.2 kg). Only Test 3-50 was performed with this modification to the axle because a 1100C vehicle is the most susceptible to seeing a change in occupant impact velocities and ridedown acceleration than the heavier 2270P vehicle used in Tests 3-51, 3-52, and 3-53. Therefore, Test 3-50 represents the worst case test for this design modification.
During Test 3-50, the occupant struck the dashboard at time 0.1016 s. Since the impact head engaged the axle push rods at 0.125 s, it can be concluded that the occupant impact velocity was not affected by this change.
The time of maximum ridedown acceleration occurred between times 0.1252 sand 0.1352 s. The maximum ridedown acceleration was -17.8 g's, which is well below the MASH allowable ridedown acceleration of 20 g's therefore this modification had a minimal effect on the performance of the TTMA-200.

CRASH TESTING

By signature below, the Engineer affiliated with the testing laboratory, agrees in support of this submission that all of the critical and relevant crash tests for this device listed above were conducted to meet the MASH test criteria. The Engineer has determined that no other crash testsare necessary to determine the device meets the MASH criteria.

Engineer Name:	Nick Injev	
Engineer Signature:	Nick Injev email=nick.injev@idiada.com,c=US Digitally signed by Nick Injev DN: cn=Nick Injev, o=Applus IDIADA KARCO, ou, Date: 2020.05.01 14:50:09 -07'00'	
Address:	9270 Holly Road, Adelanto, CA 92301	Same asSubmitter ☒
Country:	United States of America	Same asSubmitter ☒

A brief description of each crash test and its result: Help

Required Test Number	Narrative Description	Evaluation Results
3-50 (1100C)	IDIADA KARCO Test Number P40080-01. An 1100C test vehicle impacting the TTMA-200 at a nominal impact speed and angle of 62 mph and 0°, respectively. The primary intent of this test is to evaluate the impact performance of the TTMA-200 during small car impacts. The support vehicle was blocked against forward movement. The support vehicle wasalso placed in second gear with the parking brake engaged and the front wheels were centered with no steering angle. The test vehicle, 2015 KiaRio impacted the TTMA-200 at aspeed and angle of 61.64 mph (99.20 km/h) and 1.2°. The TTMA-200 brought the vehicle to a controlled stop. There was no penetration into the occupant compartment and the deformation limits were not exceeded. The Occupant Impact Velocities (OIV) in the longitudinal and lateral directions were 32.8 ft/s (10.0 m/s) and 1.0 ft/s (0.3 m/s), respectively. The Ridedown acceleration in the longitudinal and lateral directions were -17.8 g and -2.2 g, respectively. The TTMA-200 met all the requirements for MASH Test 3-50.	PASS

Required Test Number	Narrative Description	Evaluation Results
3-51 (2270P)	IDIADA KARCO Test Number P38076-01. An 2270P test vehicle impacting the TTMA-200 at a nominal impact speed and angle of 62 mph and 0°, respectively. The primary intent of this test is to evaluate the energy dissipation capacity of the TTMA-200, structural adequacy and occupant risk. The support vehicle was blocked against forward movement. The support vehicle wasalso placed in second gear with the parking brake engaged and the front wheels were centered with no steering angle. The test vehicle, 2012 RAM 1500 impacted the TTMA-200 at aspeed and angle of 64.11 mph (103.18 km/h) and 0.3°. The TTMA-200 brought the vehicle to a controlled stop. There was no penetration into the occupant compartment and the deformation limits were not exceeded. The Occupant Impact Velocities (OIV) in the longitudinal and lateral directions were 29.2 ft/s (8.9 m/s) and 0.7 ft/s (0.2 m/s), respectively. The Ridedown acceleration in the longitudinal and lateral directions were -14.9 g and -3.1 g, respectively. All the occupant risk values were below the preferred values in MASH. The TTMA-200 met all the requirements for MASH Test 3-51.	PASS
3-52 (2270P)	IDIADA KARCO Test Number P38078-01. An 2270P test vehicle impacting the TTMA-200 offset 1/3 the vehicles overall width at a nominal impact speed and angle of 62 mph and 0°, respectively. The primary intent of this test is to evaluate structural adequacy and occupant risk. The support vehicle was blocked against forward and lateral movement. The support vehicle wasalso placed in second gear with the parking brake engaged and the front wheels were centered with no steering angle. The test vehicle, 2013 RAM 1500 impacted the TTMA-200 at aspeed and angle of 62.99 mph (101.37 km/h) and 0.1°. The TTMA-200 brought the vehicle to a controlled stop. There was no penetration into the occupant compartment and the deformation limits were not exceeded. The Occupant Impact Velocities (OIV) in the longitudinal and lateral directions were 28.2 ft/s (8.6 m/s) and 2.0 ft/s (0.6 m/s), respectively. The Ridedown acceleration in the longitudinal and lateral directions were -16.4 g and 2.5 g, respectively. The TTMA-200 met all the requirements for MASH Test 3-52.	PASS

3-53 (2270P)	IDIADA KARCO Test Number P38075-02. An 2270P test vehicle impacting the TTMA-200 offset 1/4 the vehicles overall width at a nominal impact speed and angle of 62 mph and 10°, respectively. The primary intent of this test is to evaluate structural adequacy and occupant risk. The support truck weighed 10,337 lbs and was tested with the parking brake engaged, transmission placed in second gear and the front wheels centered with no steering angle. The test vehicle, 2012 RAM 1500 impacted the TTMA-200 at a speed and angle of 63.49 mph (102.18 km/h) and 10.1°. The TTMA-200 brought the vehicle to a controlled stop. There was no penetration into the occupant compartment and the deformation limits were not exceeded. The Occupant Impact Velocities (OIV) in the longitudinal and lateral directions were 26.6 ft/s (8.1 m/s) and 1.3 ft/s (0.4 m/s), respectively. The Ridedown acceleration in the longitudinal and lateral directions were -9.8 g and -4.0 g, respectively. The support vehicle had a maximum roll ahead measurement 34.8 ft. (10.6 m). The TTMA-200 met all the requirements for MASH Test 3-53.	PASS
3-54 (1500A)	Per MASH this test is optional	Non-Relevant Test, not conducted

Full Scale Crash Testing was done in compliance with MASH by the following accredited crash test laboratory (cite the laboratory's accreditation status as noted in the crash test reports.):

Laboratory Name:	Applus IDIADA KARCO Engineering, LLC.	
Laboratory Signature:	Nick Injev email=nick.injev@idiada.com, c=US Digitally signed by Nick Injev DN: cn=Nick Injev, o=Applus IDIADA KARCO, ou, Date: 2020.05.01 14:50:26 -07'00'	
Address:	9270 Holly Road, Adelanto, CA 92301	Same as Submitter ☒
Country:	United States of America	Same as Submitter ☒
Accreditation Certificate Number and Dates of current Accreditation period :	TL 371: July 1, 2019 - July 1, 2022	

Submitter Signature*: Nick Injev Digitally signed by Nick Injev DN: cn=Nick Injev, o=Applus IDIADA KARCO, ou, email=nick.injev@idiada.com, c=US Date: 2020.05.01 14:50:43 -07'00'

Submit Form

ATTACHMENTS

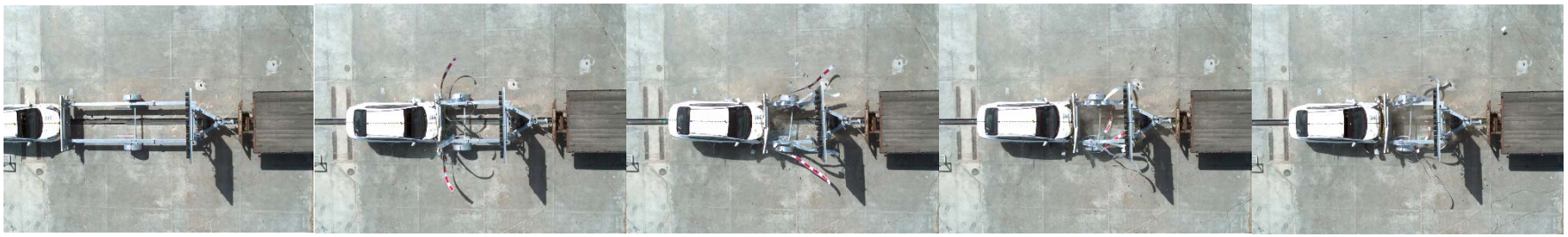
Attach to this form:

1) Additional disclosures of related financial interest as indicated above.
2) A copy of the full test report, video, and a Test Data Summary Sheet for each test conducted in support of this request.
3) A drawing or drawings of the device(s) that conform to the Task Force-13 Drawing Specifications [Hardware Guide Drawing Standards]. For proprietary products, a single isometric line drawing is usually acceptable to illustrate the product, with detailed specifications, intended use, and contact information provided on the reverse. Additional drawings (not in TF-13 format) showing details that are relevant to understanding the dimensions and performance of the device should also be submitted to facilitate our review.

FHWA Official Business Only:

Eligibility Letter		
Number	Date	Key Words

MASH 2016 Test 3-50 Summary



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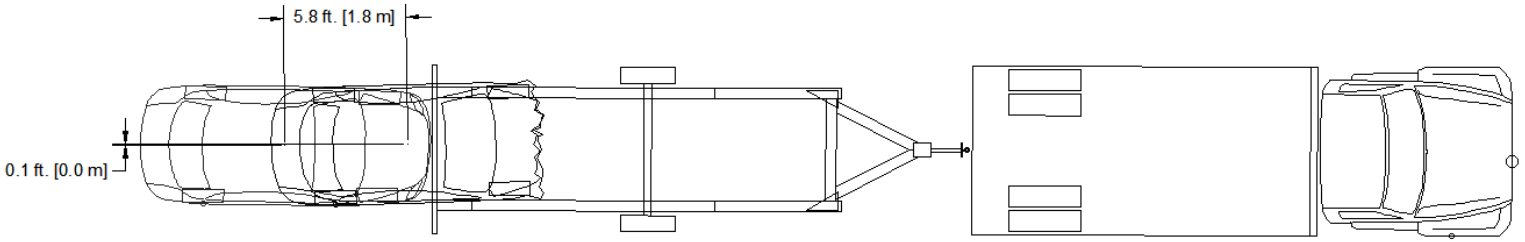


General Information

Test Agency	Applus IDIADA KARCO
Test No	P40080-01
Test Designation	3-50
Test Date	03/11/20

Test Article

Name / Model	TTMA-200
Type	Crash Cushion
Crash Cushion Length	24.9 ft. (7.6 m)
Road Surface	Smooth, clean concrete

Test Vehicle

Type / Designation	1100C
Year, Make, and Model	2015 Kia Rio
Curb Mass	2,559.5 lbs (1,161.0 kg)
Test Inertial Mass	2,462.5 lbs (1,117.0 kg)
Gross Static Mass	2,635.6 lbs (1,195.5 kg)

Impact Conditions

Impact Velocity	61.64 mph (99.20 km/h)
Impact Angle	1.2°
Location / Orientation	0.6 in (15 mm) left
Kinetic Energy	312.8 kip-ft (424.1 kJ)

Exit Conditions

Exit Velocity	N/A
Exit Angle	N/A
Final Vehicle Position	5.8 ft. (1.8 m) downstream 0.1 ft. (0 m) left
Support Truck Rollahead	0.0 ft (0 m)
Vehicle Snagging	None
Vehicle Pocketing	None
Vehicle Stability	Satisfactory
Maximum Roll Angle	-2.9 °
Maximum Pitch Angle	3.2 °
Maximum Yaw Angle	2.6 °

Occupant Risk

Longitudinal OIV	32.8 ft/s (10.0 m/s)
Lateral OIV	1.0 ft/s (0.3 m/s)
Longitudinal RA	-17.8 g
Lateral RA	-2.2 g
THIV	32.8 ft/s (10.0 m/s)
PHD	17.8 g
ASI	1.21

Test Article Deflections

Static	9.9 ft. (3.0 m)
Dynamic	10.7 ft. (3.3 m)
Working Width	N/A
Debris Field	N/A

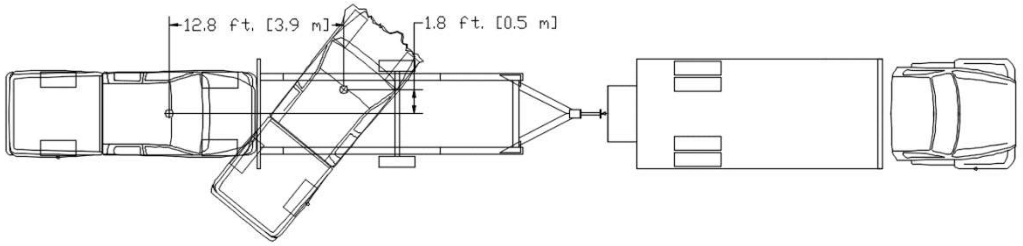
Vehicle Damage

Vehicle Damage Scale	12-FD-5
CDC	12FDEW3
Maximum Intrusion	0.1 in. (3 mm) at toe pan

Figure 4 Summary of Test 3-50

MASH 2016 Test 3-51 Summary

0.000 s 0.100 s 0.200 s 0.525 s 1.300 s



GENERAL INFORMATION

Test Agency	KARCO Engineering, LLC.
KARCO Test No	P38076-01
Test Designation	3-51
Test Date	07/25/18

TEST ARTICLE

Name / Model	TTMA-200
Type	Trailer Mounted Attenuator
Support Vehicle Length	25.0 ft. (7.6 m)
TMA Length	24.9 ft. (7.6 m)
Road Surface	Concrete
Support Vehicle Restraint	Blocked Against Roll Ahead

TEST VEHICLE

Type / Designation	2270P
Year, Make, and Model	2012 RAM 1500
Curb Mass	4,987.9 lbs (2,262.5 kg)
Test Inertial Mass	4,989.0 lbs (2,263.0 kg)
Gross Static Mass	4,989.0 lbs (2,263.0 kg)

Impact Conditions

Impact Velocity	64.11 mph (103.18 km/h)
Impact Angle	0.3°
Location / Orientation	1.0 in. (25 mm) Right of TMA CL
Kinetic Energy	685.5 kip-ft (929.4 kJ)

Exit Conditions

Exit Velocity	N/A
Exit Angle	N/A
Final Vehicle Position	12.8 ft. (3.9 m) Downstream 1.8 ft. (0.5 m) Left
Exit Box Criteria Met	N/A
Vehicle Snagging	None
Vehicle Pocketing	None
Vehicle Stability	Satisfactory
Maximum Roll Angle	-2.5 °
Maximum Pitch Angle	10.7 °
Maximum Yaw Angle	48.8 °

Occupant Risk

Longitudinal OIV	29.2 ft/s (8.9 m/s)
Lateral OIV	0.7 ft/s (0.2 m/s)
Longitudinal RA	-14.9 g
Lateral RA	-3.1 g
THIV	29.2 ft/s (8.9 m/s)
PHD	14.9 g
ASI	0.97

Test Article Deflections

Static	5.1 ft. (1.6 m)
Dynamic	10.8 ft. (3.3 m)
Working Width	17.8 ft. (5.4 m)
Debris Field	67.2 ft. (20.5 m) Downstream 4.0 ft. (1.2 m) Left

Vehicle Damage

Vehicle Damage Scale	12-FD-4
CDC	12FDEW2
Maximum Intrusion	Negligible

Figure 4 Summary of Test 3-51

MASH 2016 Test 3-52 Summary

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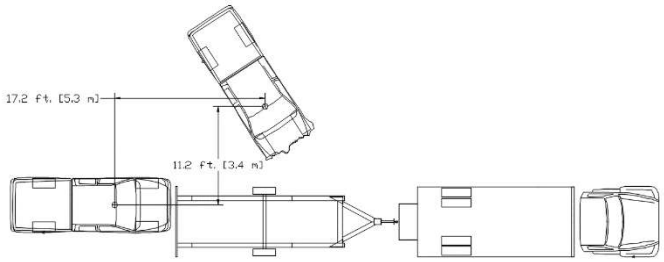


GENERAL INFORMATION

Test Agency	KARCO Engineering, LLC.
KARCO Test No.	P38078-01
Test Designation	3-52
Test Date	07/26/18

TEST ARTICLE

Name / Model	TTMA-200
Type	Trailer Mounted Attenuator
Support Vehicle Length	25.0 ft. (7.6 m)
TMA Length	24.9 ft. (7.6 m)
Road Surface	Concrete
Support Vehicle Restraint	Rigidly Blocked

TEST VEHICLE

Type / Designation	2270P
Year, Make, and Model	2013 RAM 1500
Curb Mass	4,990.1 lbs (2,263.5 kg)
Test Inertial Mass	5,009.9 lbs (2,272.5 kg)
Gross Static Mass	5,009.9 lbs (2,272.5 kg)

Impact Conditions

Impact Velocity	62.99 mph (101.37 km/h)
Impact Angle	0.1°
Location / Orientation	26.7 in. (678 mm) Left of TMA CL
Kinetic Energy	623.0 kip-ft (844.7 kJ)

Exit Conditions

Exit Velocity	N/A
Exit Angle	N/A
Final Vehicle Position	17.2 ft. (5.2 m) Downstream 11.2 ft. (3.4 m) Left
Exit Box Criteria Met	N/A
Vehicle Snagging	None
Vehicle Pocketing	None
Vehicle Stability	Satisfactory
Maximum Roll Angle	5.4 °
Maximum Pitch Angle	7.6 °
Maximum Yaw Angle	-68.2 °

Occupant Risk

Longitudinal OIV	28.2 ft/s (8.6 m/s)
Lateral OIV	2.0 ft/s (0.6 m/s)
Longitudinal RA	-16.4 g
Lateral RA	2.5 g
THIV	28.2 ft/s (8.6 m/s)
PHD	16.5 g
ASI	0.96

Test Article Deflections

Static	4.1 ft. (1.2 m)
Dynamic	11.1 ft. (3.4 m)
Working Width	16.4 ft. (5.0 m)
Debris Field	No Article Debris

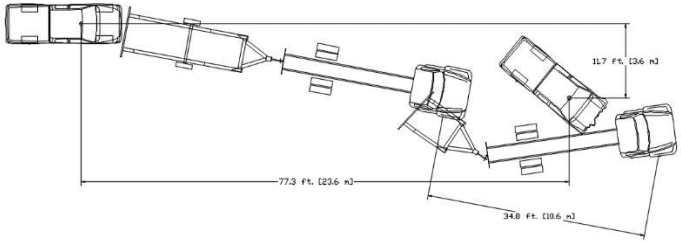
Vehicle Damage

Vehicle Damage Scale	12-FD-4
CDC	12FDEW3
Maximum Intrusion	0.2 in. (5 mm)

Figure 4 Summary of Test 3-52

MASH 2016 Test 3-53 Summary

0.000 s 0.100 s 0.200 s 0.425 s 0.625 s



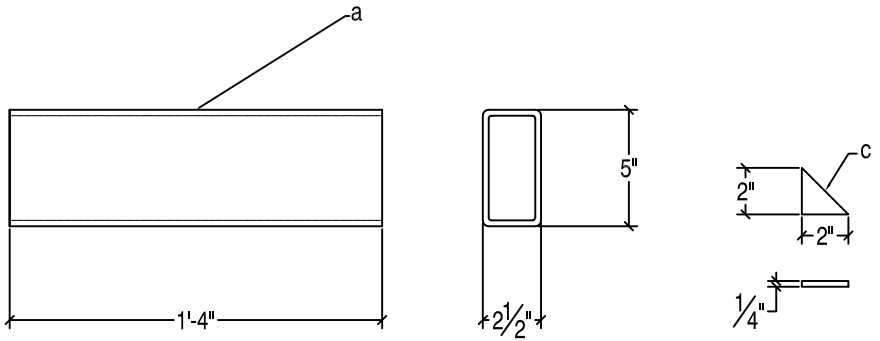
GENERAL INFORMATION	
Test Agency	KARCO Engineering, LLC.
KARCO Test No	P38075-02
Test Designation	3-53
Test Date	07/26/18
TEST ARTICLE	
Name / Model	TTMA-200
Type	Trailer Mounted Attenuator
Support Vehicle Length	25.0 ft. (7.6 m)
TMA Length	24.9 ft. (7.6 m)
Road Surface	Concrete
Support Vehicle Restraint	2nd gear, parking brakes engaged
TEST VEHICLE	
Type / Designation	2270P
Year, Make, and Model	2012 RAM 1500
Curb Mass	5,112.4 lbs (2,319.0 kg)
Test Inertial Mass	4,996.7 lbs (2,266.5 kg)
Gross Static Mass	4,996.7 lbs (2,266.5 kg)

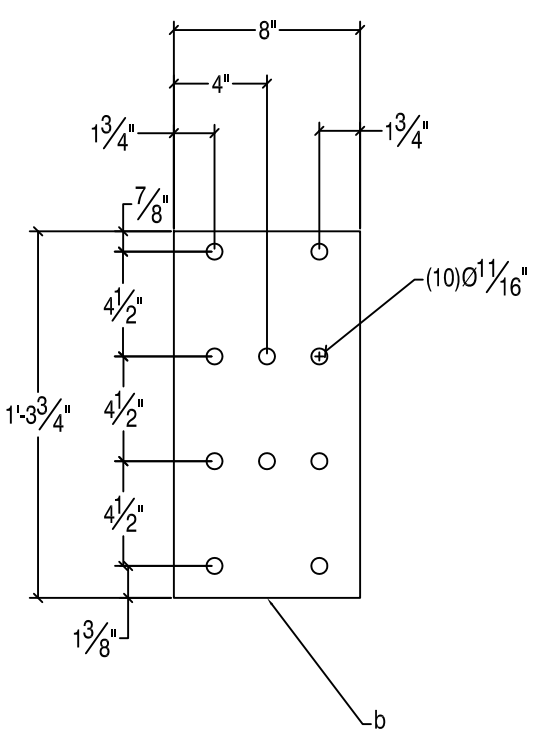
Impact Conditions	
Impact Velocity	63.49 mph (102.18 km/h)
Impact Angle	10.1°
Location / Orientation	Offset 500 mm
Kinetic Energy	673.3 kip-ft (912.9 kJ)
Exit Conditions	
Exit Velocity	21.6 mph (34.8 km/h)
Heading Angle	38.0°
Final Vehicle Position	77.3 ft. (23.6 m) Downstream 11.7 ft. (3.6 m) Right
Support Vehicle Roll Ahead	34.8 ft. (10.6 m)
Vehicle Snagging	None
Vehicle Pocketing	None
Vehicle Stability	Satisfactory
Maximum Roll Angle	-2.5 °
Maximum Pitch Angle	-8.5 °
Maximum Yaw Angle	-24.8 °

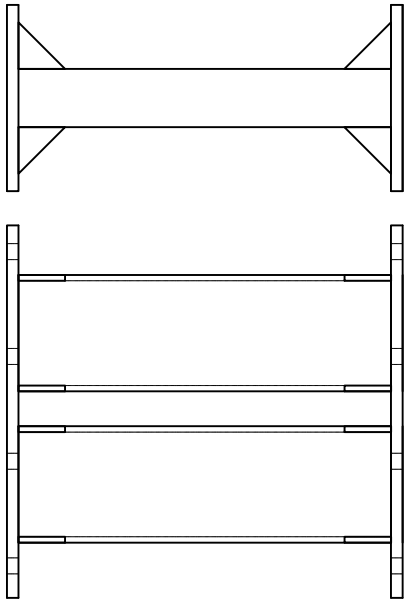
Occupant Risk	
Longitudinal OIV	26.6 ft/s (8.1 m/s)
Lateral OIV	1.3 ft/s (0.4 m/s)
Longitudinal RA	-9.8 g
Lateral RA	-4.0 g
THIV	26.6 ft/s (8.1 m/s)
PHD	10.6 g
ASI	0.84
Test Article Deflections	
Static	11.6 ft. (3.5 m)
Dynamic	11.6 ft. (3.5 m)
Working Width	23.4 ft. (7.1 m)
Debris Field	57.1 ft. (17.4 m) Downstream 13.0 ft. (4.0 m) Right
Vehicle Damage	
Vehicle Damage Scale	12-FR-4
CDC	12FZEW3
Maximum Intrusion	0.2 in. (5 mm)

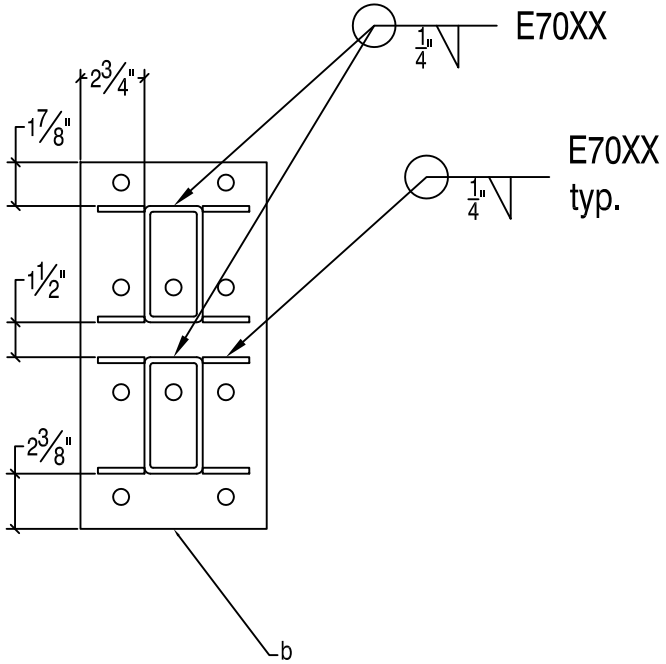
Figure 4 Summary of Test 3-53

ITEM	QTY	DESCRIPTION	MATERIAL
a	2	Extension Tube	5"x2.5"x3/16" A500 B
b	2	End Plate	1/2" A36
c	2	Gusset	1/4" A36









Gregory Industries, Inc.
4100 13th Street, SW
Canton, Ohio 44710
Phone: 330-477-4800x123

TTMA-100 & 200
16" Hitch Extension

Sheet: 1

Date: 12/14/10

Drawing Name: Hitch Extension STI MO

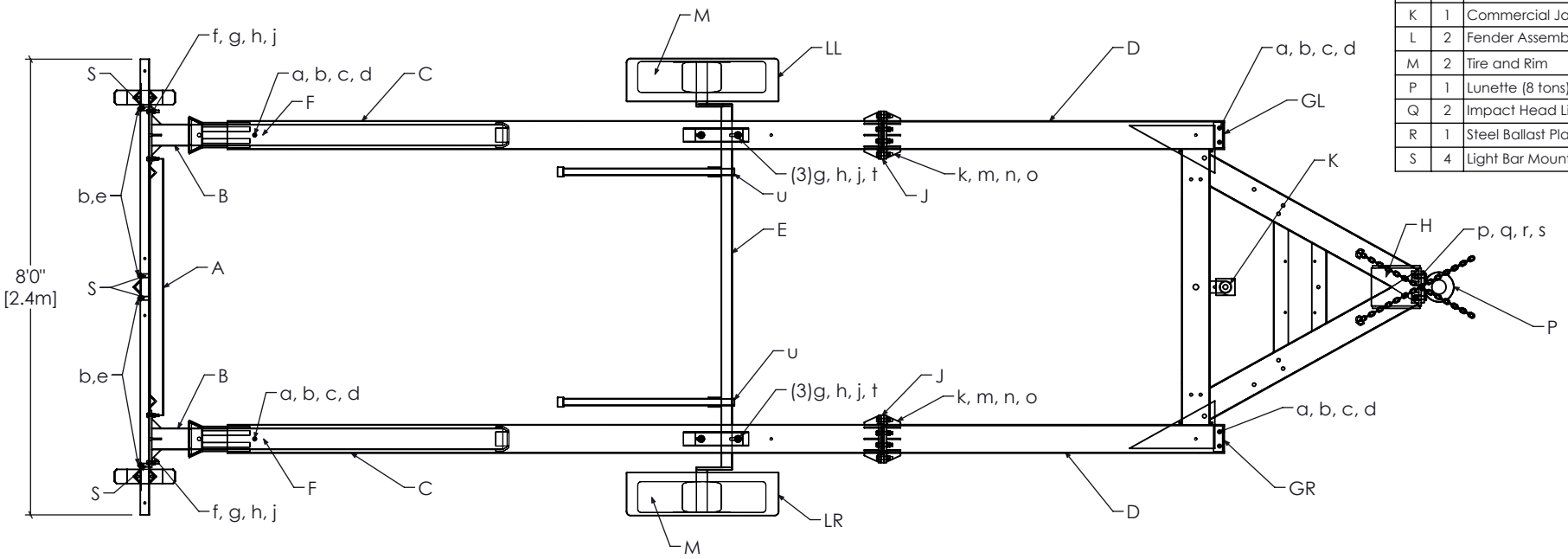
Scale: NONE

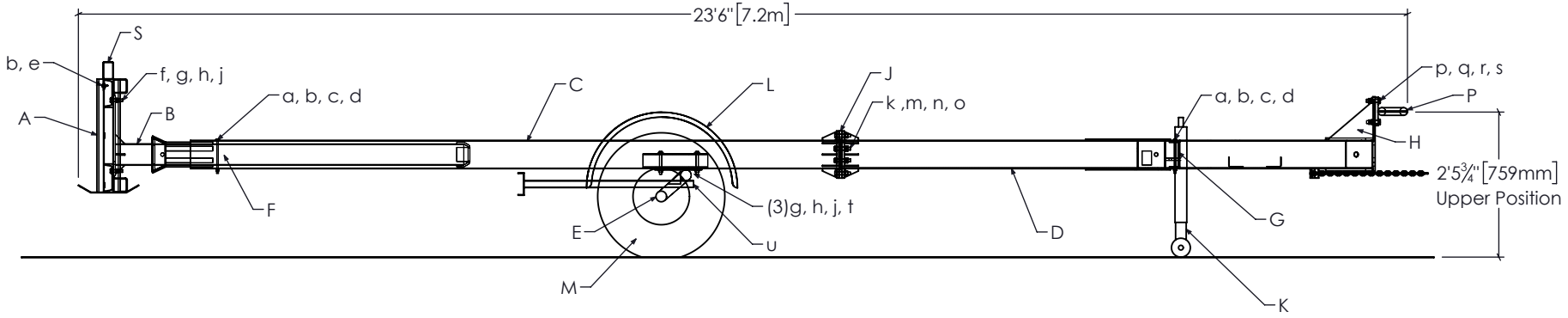
By: JRR

Rev: 1

ITEM	QTY	DESCRIPTION	ITEM	QTY	DESCRIPTION	ITEM	QTY	DESCRIPTION
a	6	5/16" x 7" Grd 5 Hex Bolt	h	12	1/2" Heavy Lock Washer	q	4	5/8" Washer
b	10	5/16" Washer	j	12	1/2" Grd 5 Hex Nut	r	4	5/8" Heavy Lock Washer
c	6	5/16" Heavy Lock Washer	k	16	9/16" x 3" Grd 5 Hex bolt	s	4	5/8" Grd 5 Hex Nut
d	6	5/16" Grd 5 Hex Nut	m	16	9/16" SAE Washer	t	4	1 1/2" Plastic Locking Plug
e	4	5/16" Tech Screws	n	16	9/16" Heavy Lock Washer	u	2	Square Tubing Plug
f	8	1/2" x 2.25" Grd 5 Hex Bolt	o	16	9/16" Grd 5 hex Nut			
g	20	1/2" Washer	p	4	5/8" x 2 1/2" Grd 5 Hex Bolt*			

ITEM	QTY	DESCRIPTION
A	1	Impact Head
B	2	Bursting Mandrel
C	2	First Tube
D	1	Trailer Frame
E	1	Axle Assembly
F	4	Plastic Guide Plates
G	2	End caps (R-right, L-left)
H	1	Hitch Assembly
J	8	Spacer
K	1	Commercial Jack
L	2	Fender Assembly (R-right, L-left)
M	2	Tire and Rim
P	1	Lunette (8 tons)
Q	2	Impact Head Lighting Package (Optional)
R	1	Steel Ballast Plate (Optional)
S	4	Light Bar Mounting Bracket





REV	DESCRIPTION	DATE
A	ADDED TOLERANCE AND FINISH DETAILS	06/21/2018
B	ADDED LIGHT BAR MOUNTING BRACKET, 5/16" TECH SCREW, AND 1/2" WASHERS	09/27/2018

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
SURFACE: HOT DIP GALVANIZED
TOLERANCE:
LINEAR: ±1/16"
BOLT HOLE: +1/16", -0"
ANGULAR: ±1°

Gregory Industries, Inc.
4100 13th Street, SW
Canton, Ohio 44710
Phone: 330-447-4800x123

TTMA-200

Assembly

Sheet: 100

Date: 9/27/2018

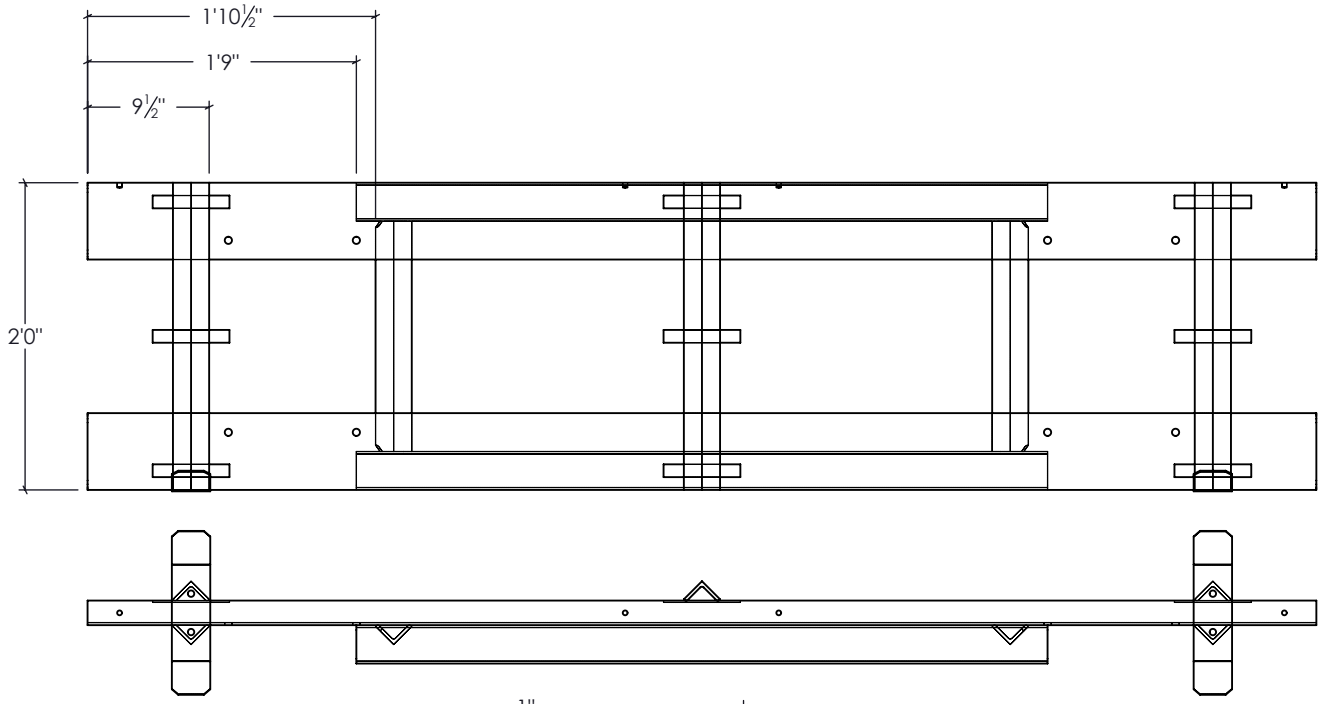
Drawing Name: TTMA-200

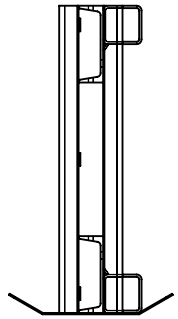
Scale: 1:35

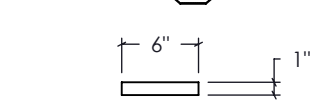
By: JMS

Rev: B

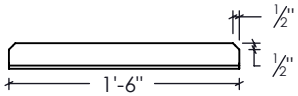
ITEM	QTY	DESCRIPTION
A	1	Impact Head
a1T	1	Front Plate - Top
a1B	1	Front Plate - Bottom
a2	5	Vertical Supports
a3	2	Vertical Supports
a4	2	Front Plate Stiffener
a5	9	Chevron Mounting Bracket
a6	2	Bumper Skid
S	4	Light Bar Strap



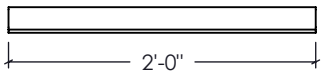




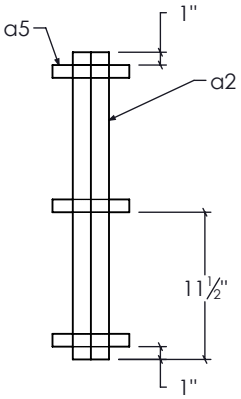
a5 - Chevron Mtg. Bracket

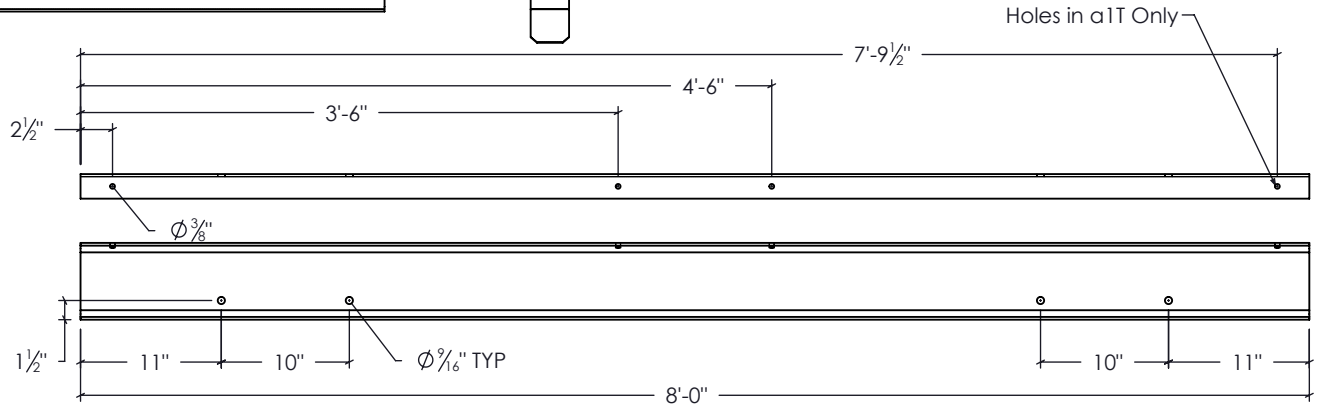


a3 - Vertical Support
2"x2"x1/4" Angle

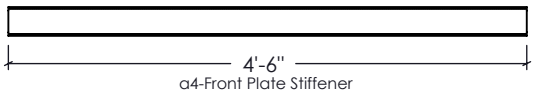


a2 - Vertical Support
2"x2"x1/4" Angle

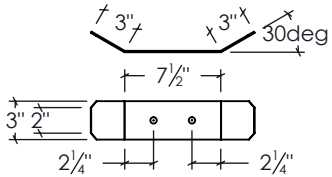




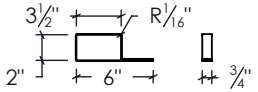
a1T & a1B- Front Plate
C6X8.2 Channel



a4-Front Plate Stiffener
3"x3"x3/16" Tube



a6- Bumper Skid
1/4" A36 Plate



S - Light Bar Strap

REV	DESCRIPTION	DATE
A	ADDED TOLERANCE AND FINISH DETAILS	06/21/2018
B	ADDED LIGHT BAR MOUNTING BRACKET	09/26/2018

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
SURFACE: HOT DIP GALVANIZED
TOLERANCE:
LINEAR: ±1/16"
BOLT HOLE: +1/16", -0"
ANGULAR: ±1°

Gregory
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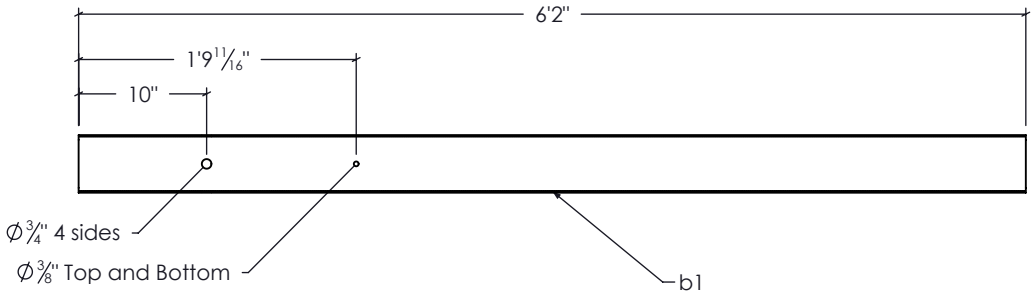
Canton, Ohio 44710
Phone: 330-447-4800x123

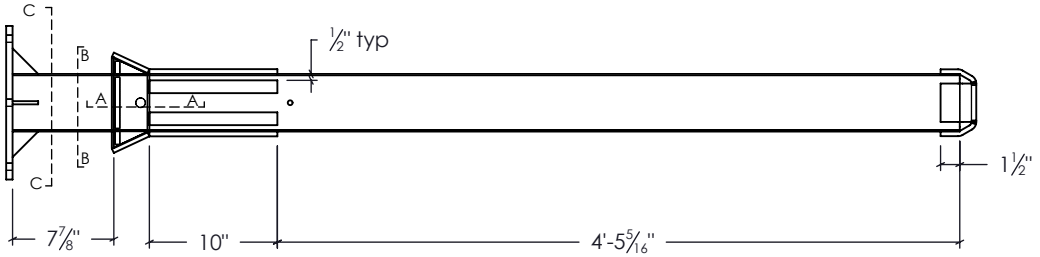
TTMA-200

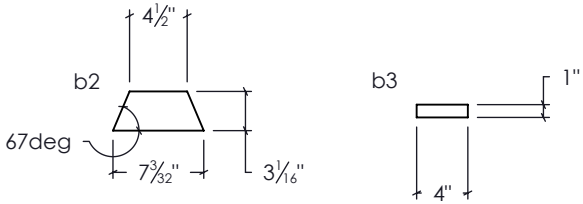
Impact Head Assembly

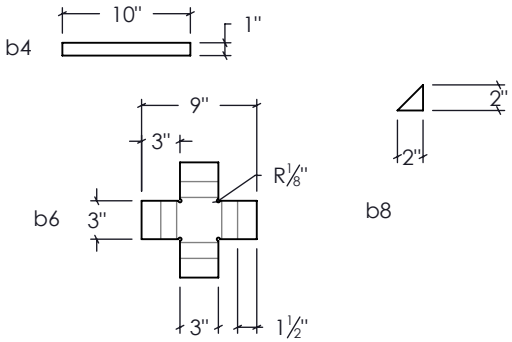
Sheet: 101
Date: 9/27/2018
Drawing Name: TTMA-200
Scale: 1:15
By: JMS
Rev: B

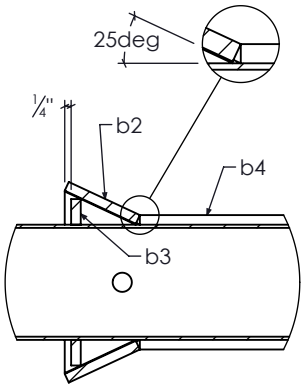
ITEM	QTY	DESCRIPTION
B	2	Bursting Mandrel
b1	2	Mandrel Tube
b2	8	Burster Plate
b3	8	Burster Support
b4	16	Guide Strap
b6	2	End Plate
b7	2	Mandrel End Plate
b8	8	Gusset Plate
F	4	Plastic Guide



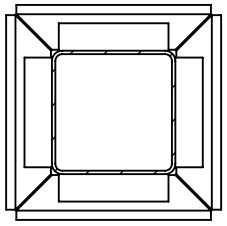




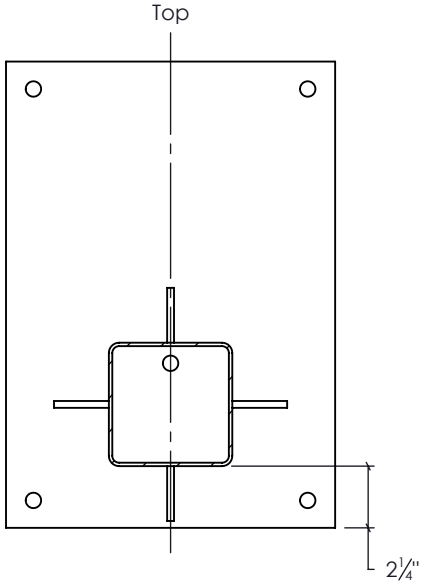




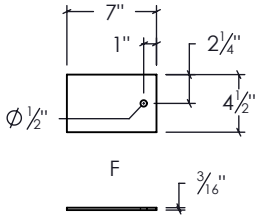
DETAIL "A-A"
Note: Positioning of b3 is critical to maintain the angle of the burster plate b2

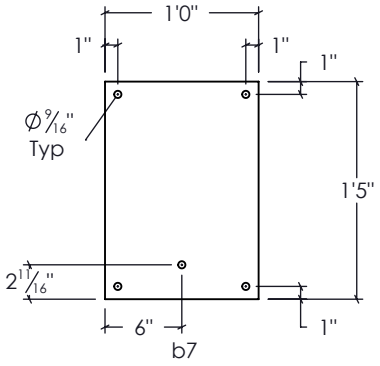


SECTION "B-"B
SCALE 1 : 7



SECTION "C-C"
Bottom





REV	DESCRIPTION	DATE
A	ADDED TOLERANCE AND FINISH DETAILS	06/21/2018

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
SURFACE: HOT DIP GALVANIZED
TOLERANCE:
LINEAR: ±1/16"
BOLT HOLE: +1/16", -0"
ANGULAR: ±1°

Gregory Industries, Inc.
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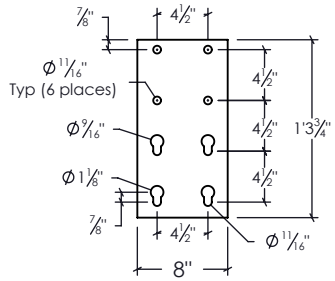
Canton, Ohio 44710
Phone: 330-447-4800x123

TTMA-200

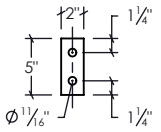
Mandrel Assembly

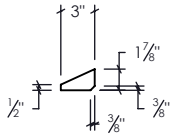
Sheet: 102
Date: 9/27/2018
Drawing Name: TTMA-200
Scale: 1:15
By: JMS
Rev: A

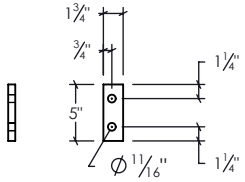
ITEM	QTY	DESCRIPTION
d1	2	Frame Tube
d2	4	Gusset Plate
d3	1	Cross Tube
d4	2	Hitch Tube
d5	1	Hitch Plate
d6	2	Hitch Support Plate
d7	2	Hitch Gusset
d8	8	Splice Plate (4 For Part C)
d9	24	Splice Gusset Plate (12 for Part C)
d10	8	Space

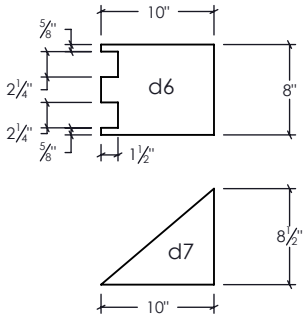


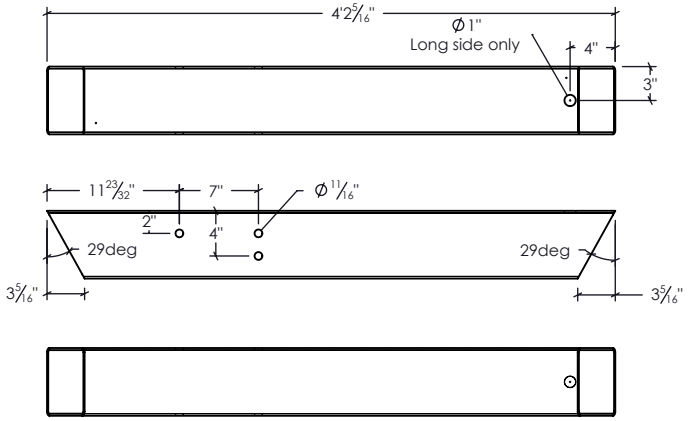
d5


d8

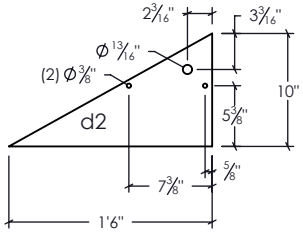

d9

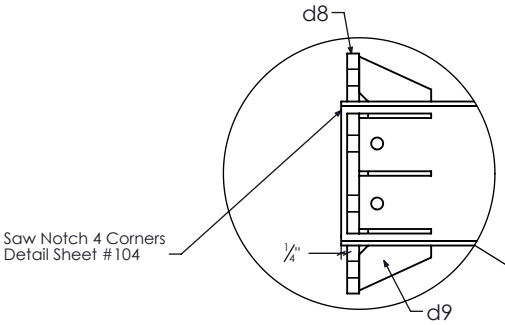

d10

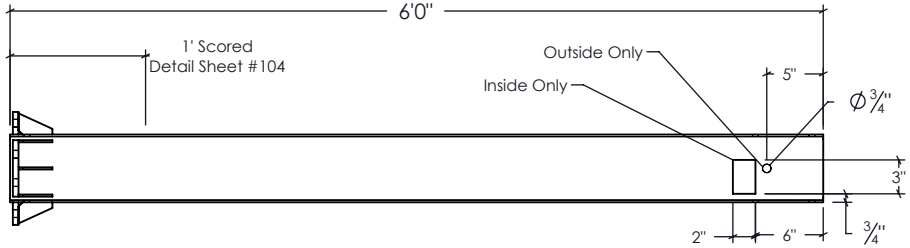


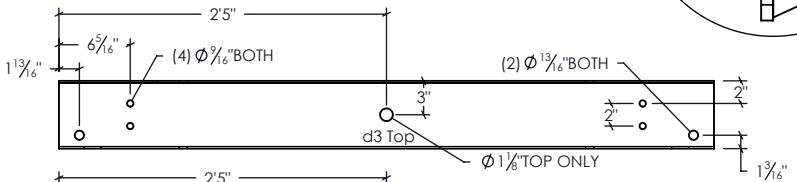


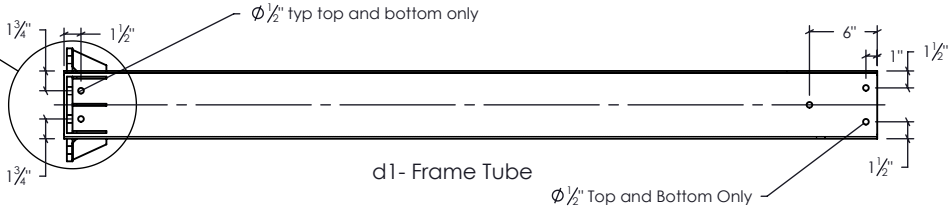
d4

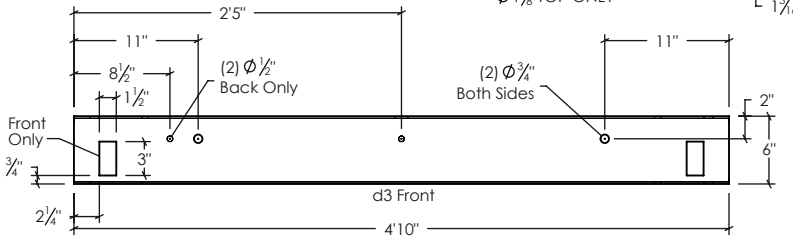












REV	DESCRIPTION	DATE
A	ADDED TOLERANCE AND FINISH DETAILS	06/21/2018

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
SURFACE: HOT DIP GALVANIZED
TOLERANCE:
LINEAR: ±1/16"
BOLT HOLE: +1/16", -0"
ANGULAR: ±1°

Gregory
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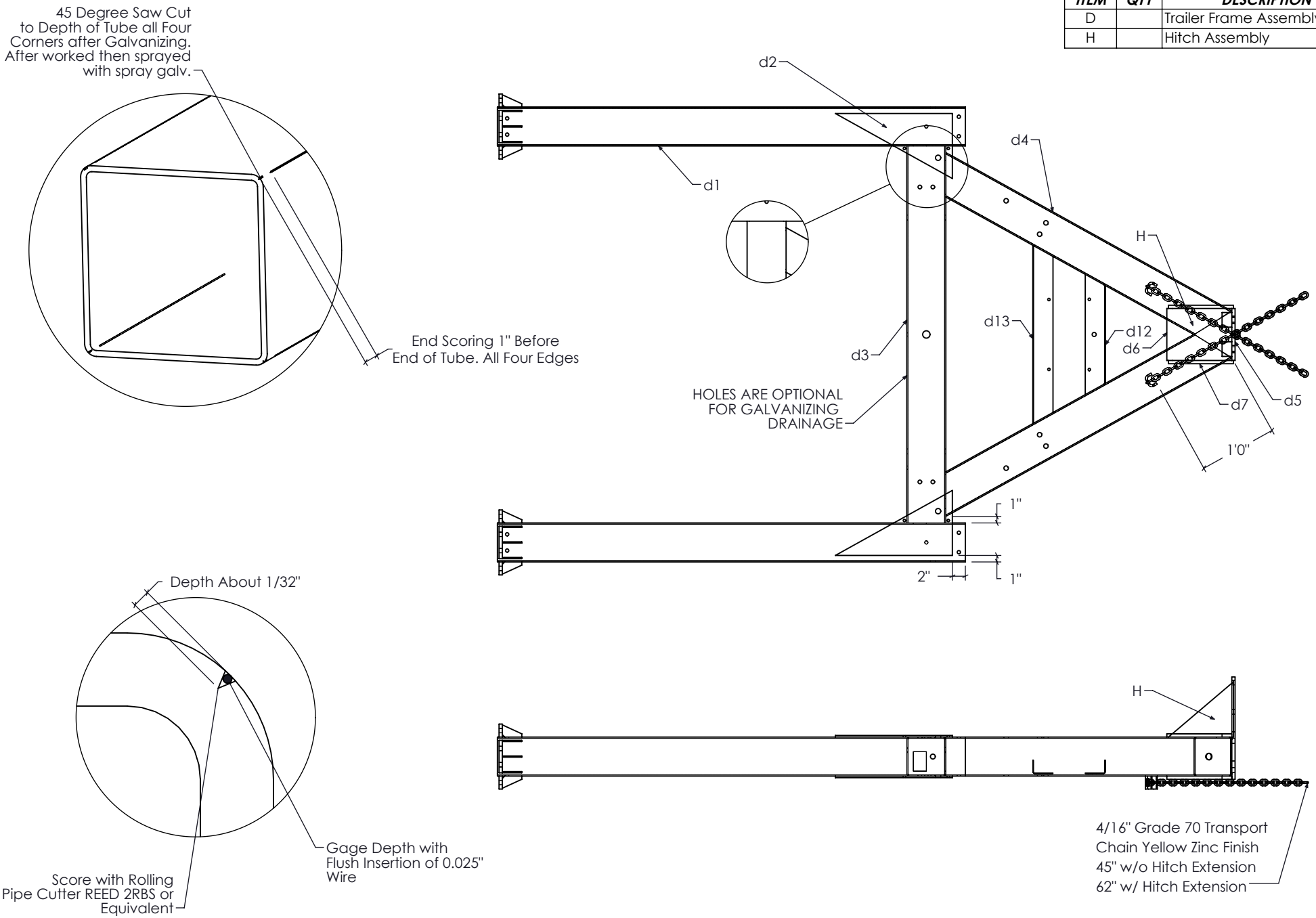
Canton, Ohio 44710
Phone: 330-447-4800x123

TTMA-200

Trailer Frame Parts

Drawing Name: TTMA-200
Scale: 1:17
Sheet: 103
Date: 9/27/2018
By: JMS
Rev: A

ITEM	QTY	DESCRIPTION
D		Trailer Frame Assembly
H		Hitch Assembly



REV	DESCRIPTION	DATE
A	ADDED TOLERANCE AND FINISH DETAILS	06/21/2018

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
SURFACE: HOT DIP GALVANIZED
TOLERANCE:
LINEAR: ±1/16"
BOLT HOLE: +1/16", -0"
ANGULAR: ±1°

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Canton, Ohio 44710
Phone: 330-447-4800x123

TTMA-200

Trailer Frame Assembly and Scoring Details

Sheet: 104

Date: 9/27/2018

Drawing Name: TTMA-200

Scale: 1:20

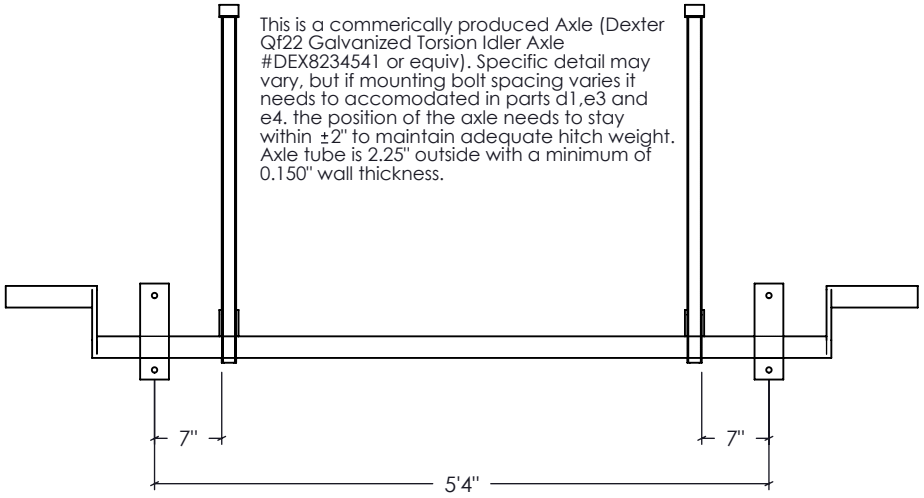
By: JMS

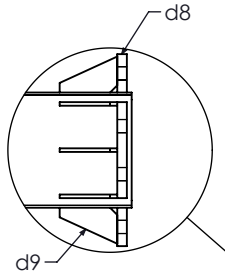
Rev: A

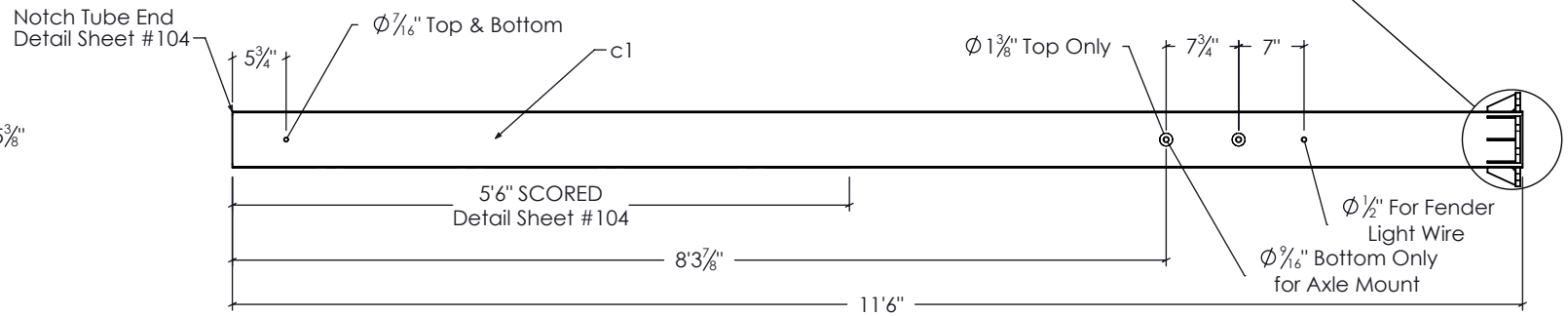
ITEM	QTY	DESCRIPTION
C	2	First Tube
c1	2	Bursting Tube
E	1	Axle Assembly
e4	2	Axle Shear Connector
e5	4	Shear Bolts
e6	2	Axle Push Tubes
e7	4	Gusset Plate
e8	2	End Plate
GR	1	PS End Tube Cover
GL	1	DS End Tube Covers

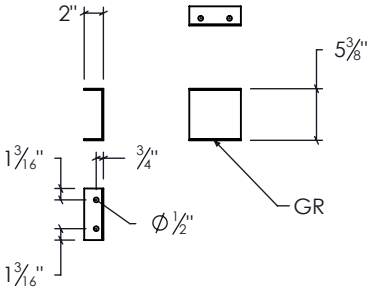
Note:

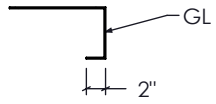
This is a commericallly produced Axle (Dexter Qf22 Galvanized Torsion Idler Axle #DEX8234541 or equiv). Specific detail may vary, but if mounting bolt spacing varies it needs to accomodated in parts d1,e3 and e4. the position of the axle needs to stay within ±2" to maintain adequate hitch weight. Axle tube is 2.25" outside with a minimum of 0.150" wall thickness.

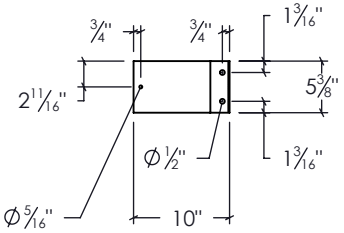


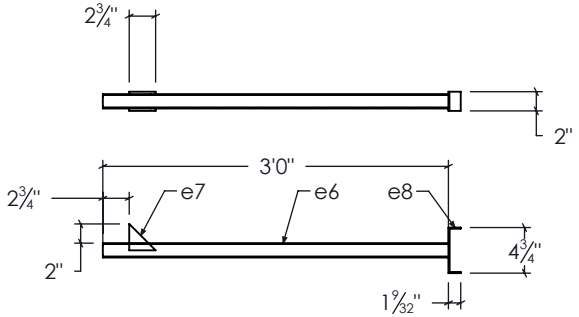


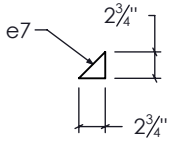


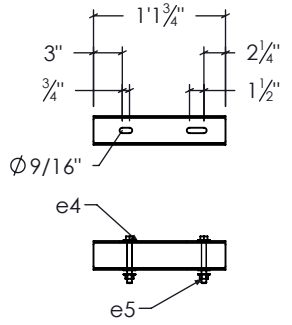












REV	DESCRIPTION	DATE
A	ADDED TOLERANCE AND FINISH DETAILS	06/21/2018

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
SURFACE: HOT DIP GALVANIZED
TOLERANCE:
LINEAR: ±1/16"
BOLT HOLE: +1/16", -0"
ANGULAR: ±1°

Gregory
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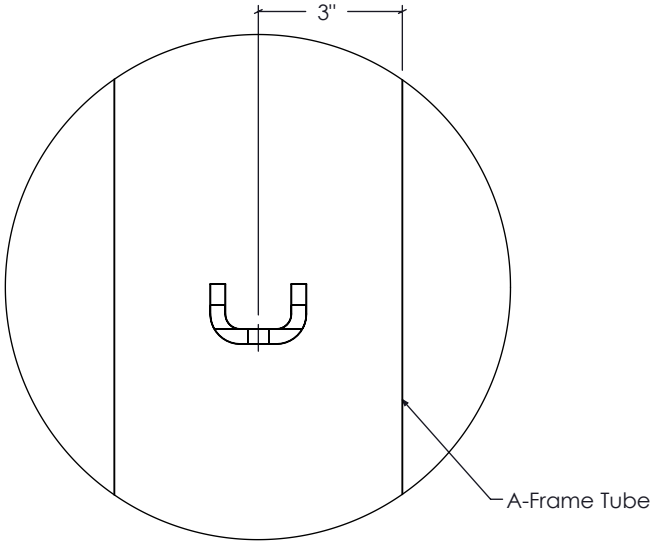
Phone: 330-447-4800x123

TTMA-200

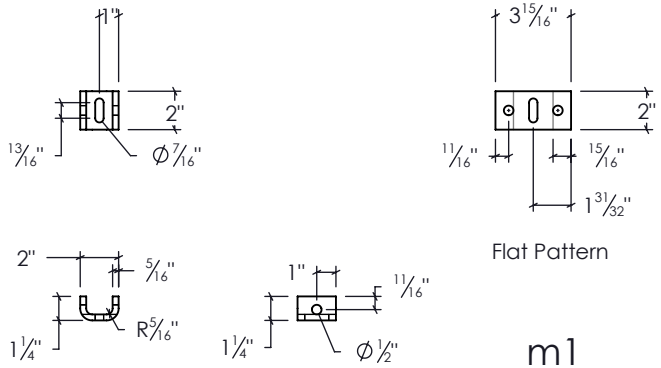
First Tube, Axle Assembly and Front End Covers

Sheet: 105
Date: 9/27/2018
Drawing Name: TTMA-200
Scale: 1:20
By: JMS
Rev: A

ITEM	QTY	DESCRIPTION
m1	2	Chain Bracket
m2	2	Retainer Rod
m3	2	Cotter Pin
d12	1	Front battery Mount - 18.5"x5"
d13	1	Rear Battery Mount 27.5" x 5"

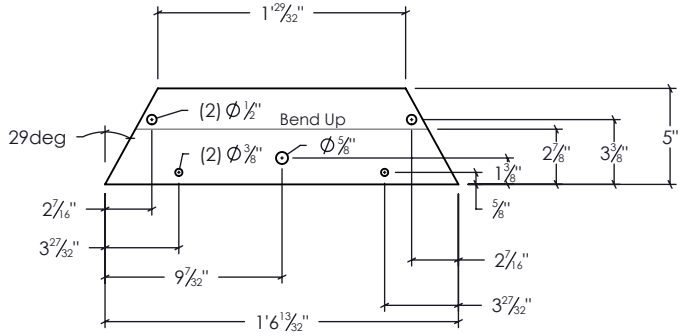


Chain Attachment Detail
NOT TO SCALE

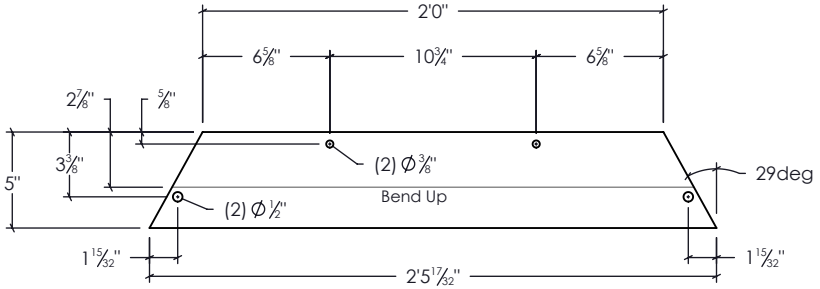


m1

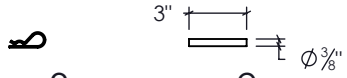
Bend Diagram



d12



d13



m3 m2

REV	DESCRIPTION	DATE
A	ADDED TOLERANCE AND FINISH DETAILS	06/21/2018

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
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TOLERANCE:
LINEAR: ±1/16"
BOLT HOLE: +1/16", -0"
ANGULAR: ±1°

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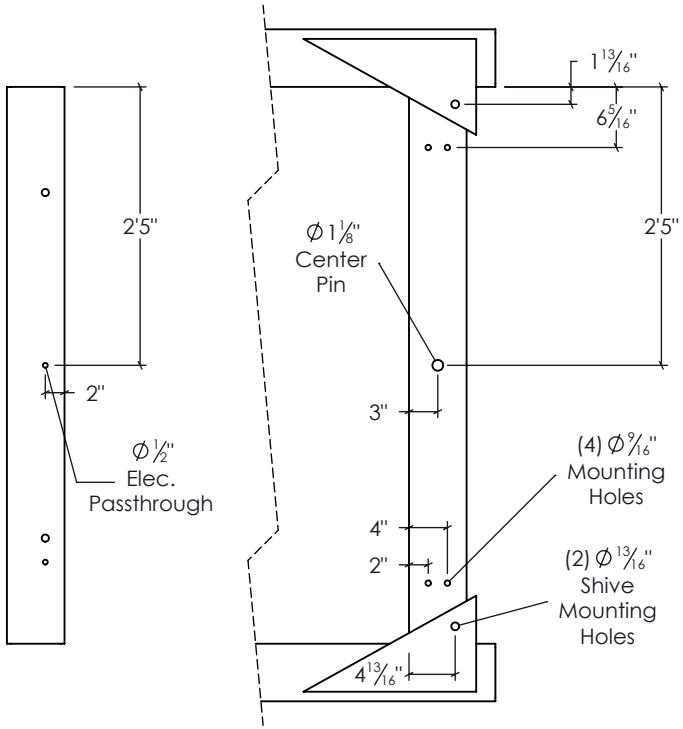
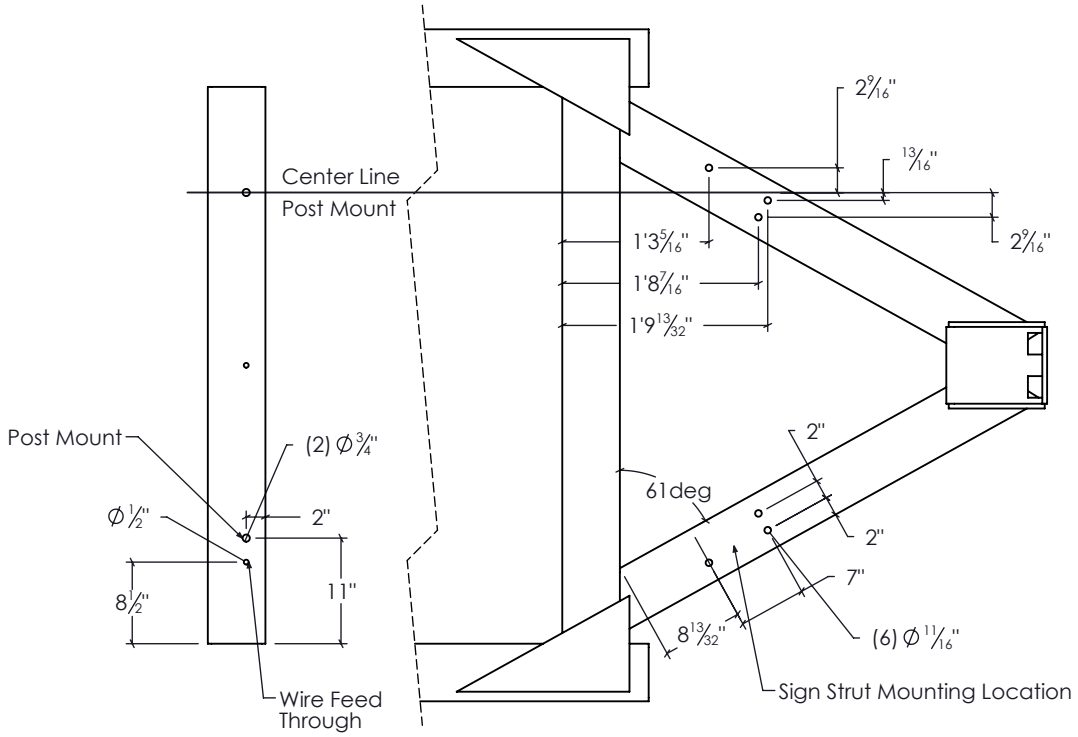
TTMA-200
Safety Chain Attachment Details

Sheet: 106
Date: 9/27/2018
Drawing Name: TTMA-200
Scale: 1:10
By: JMS
Rev: A



Optional Reverse Guidance Mounting Detail



Arrow Board Mounting Detail

REV	DESCRIPTION	DATE
A	ADDED TOLERANCE AND FINISH DETAILS	06/21/2018

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
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TOLERANCE:
LINEAR: ±1/16"
BOLT HOLE: +1/16", -0"
ANGULAR: ±1°

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TTMA-200

Arrow Board and Reverse Guidance Mounting Detail

Sheet: 107

Date: 9/27/2018

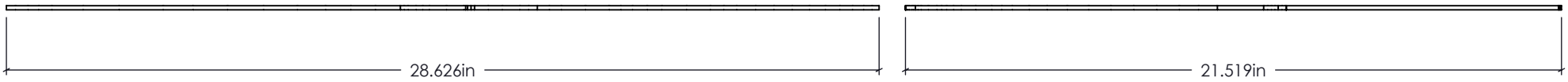
Drawing Name: TTMA-200

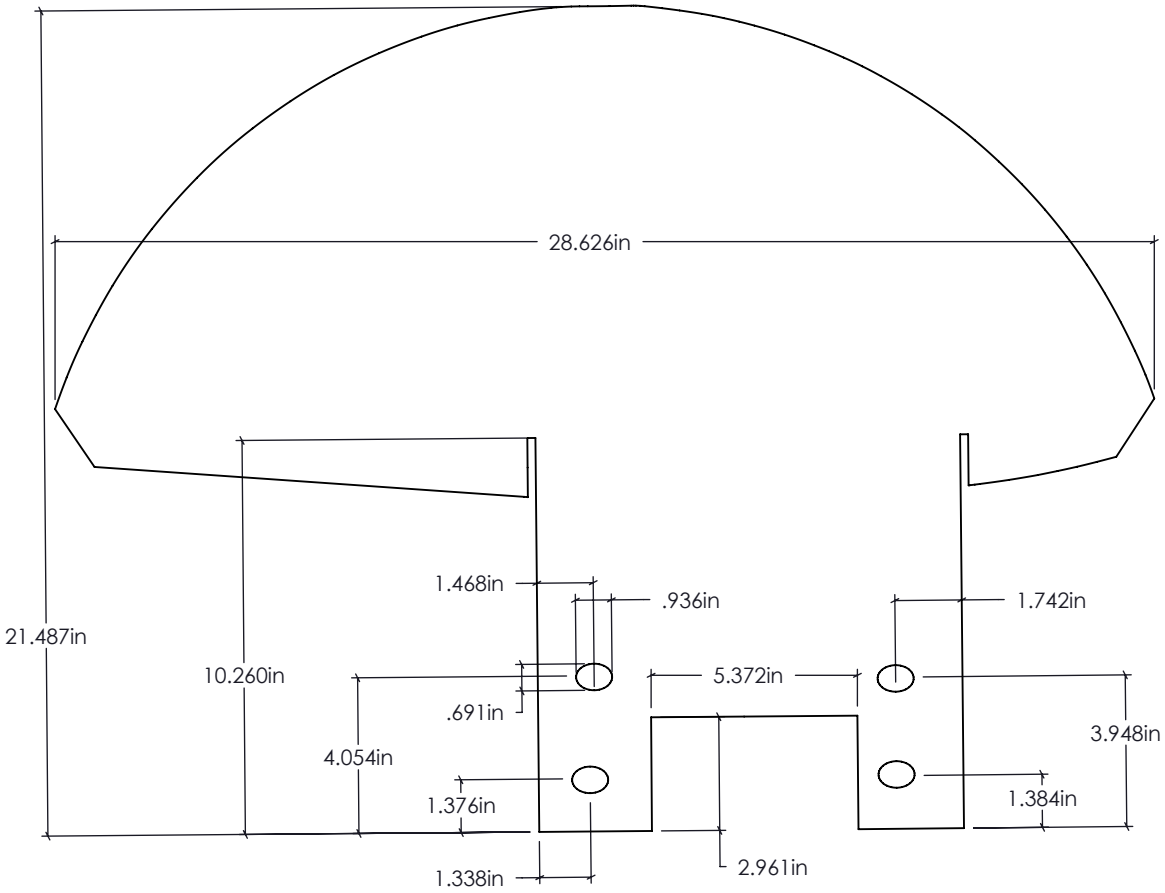
Scale: 1:20

By: JMS

Rev: A

ITEM	QTY	DESCRIPTION
L	2	Fender





REV	DESCRIPTION	DATE
A	ADDED TOLERANCE AND FINISH DETAILS	06/21/2018

UNLESS OTHERWISE SPECIFIED:
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TOLERANCE:
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BOLT HOLE: +1/16", -0"
ANGULAR: ±1°

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TTMA-200

Fender

Sheet: 108

Date: 9/27/2018

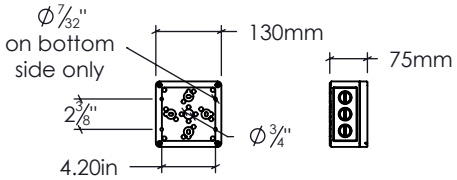
Drawing Name: TTMA-200

Scale: 1:5

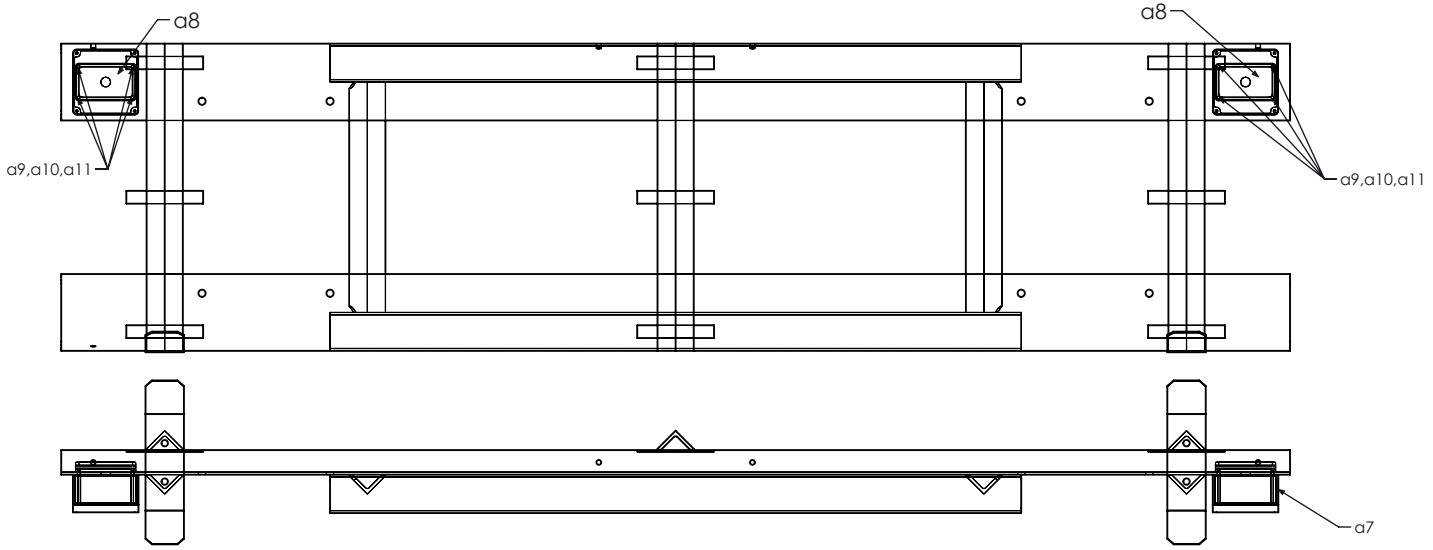
By: JMS

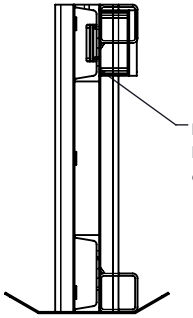
Rev: A

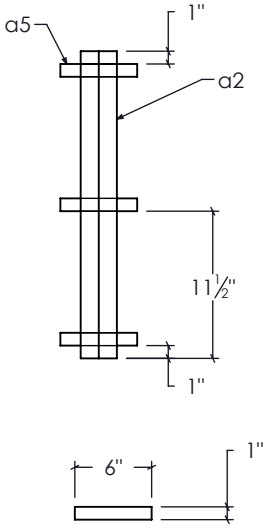
ITEM	QTY	DESCRIPTION
A	1	Impact Head
a1T	1	Front Plate - Top Lighting Package
a2	5	Vertical Supports
a5	9	Chevron Mounting Bracket
a7	2	Junction Box
a8	2	Whelen Linear Light Head or equiv
a9	8	Stainless Machine Screw
a10	8	Nylon Locknut
a11	8	Stainless Flat Washer



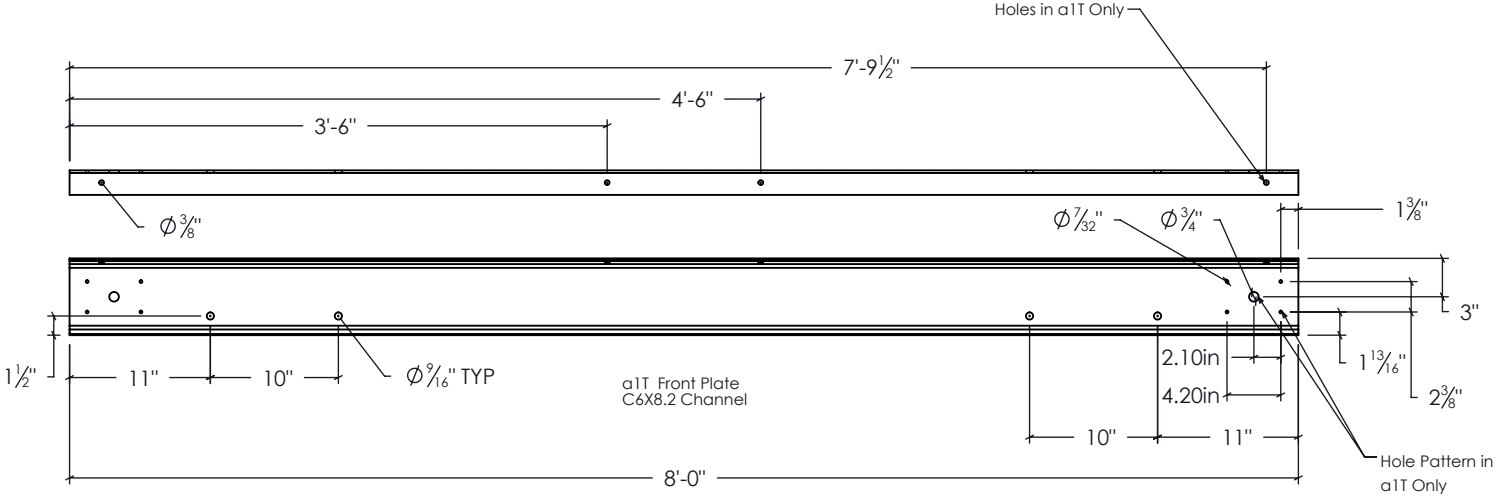
a7 - Junction Box
PolyCase SK-16-02
or equiv

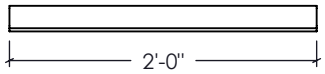






a5 - Chevron Mtg. Bracket





a2 - Vertical Support
2"x2"x1/4" Angle

REV	DESCRIPTION	DATE
A	ADDED TOLERANCE AND FINISH DETAILS	06/21/2018

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TOLERANCE:
LINEAR: ±1/16"
BOLT HOLE: +1/16", -0"
ANGULAR: ±1°

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TTMA-200

Impact Head Lighting Package (Optional)

Sheet: 109

Date: 9/27/2018

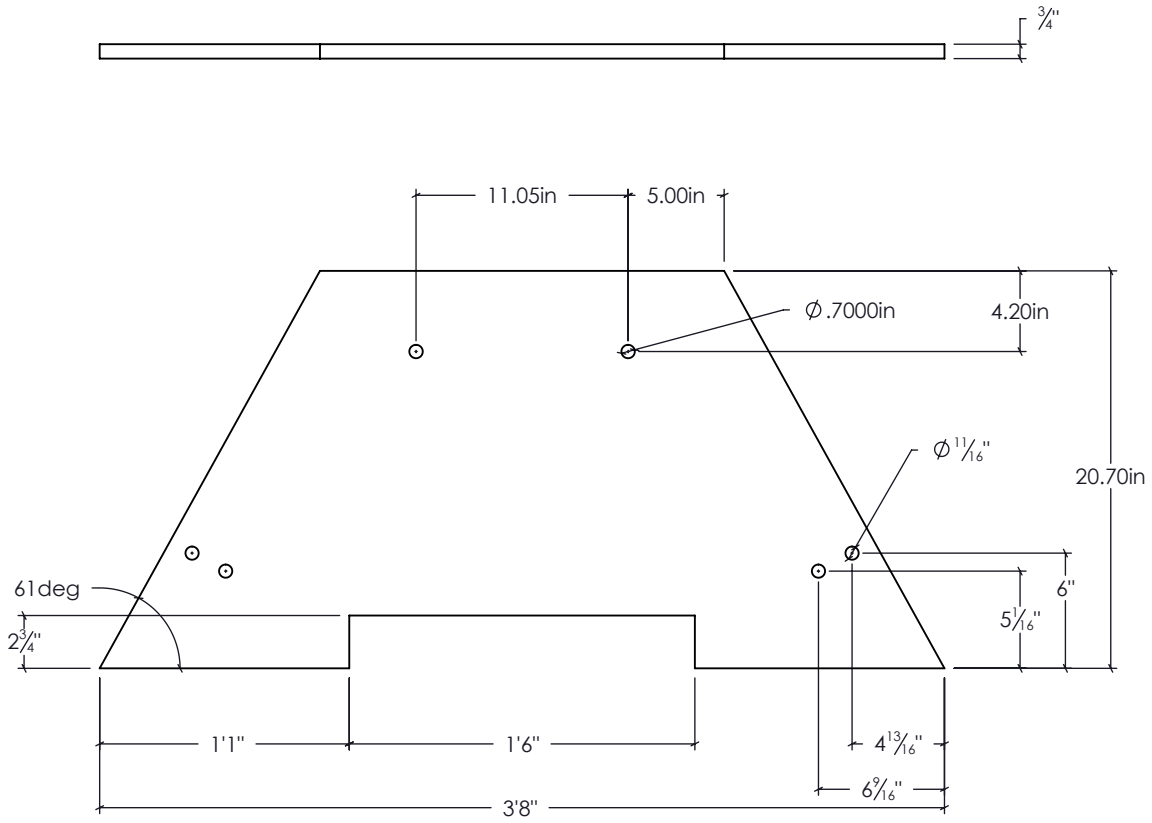
Drawing Name: TTMA-200

Scale: 1:15

By: JMS

Rev: A

ITEM	QTY	DESCRIPTION
R	2	Ballast Plate
r1	6	5/8" x 9" Grd 5 Hex Bolt
r2	12	5/8" Flat Washer
r3	6	5/8" Lock Washer
r4	6	5/8" Grd 5 Hex Nut



REV	DESCRIPTION	DATE
A	ADDED TOLERANCE AND FINISH DETAILS	06/21/2018

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
SURFACE: HOT DIP GALVANIZED
TOLERANCE:
LINEAR: ±1/16"
BOLT HOLE: +1/16", -0"
ANGULAR: ±1°

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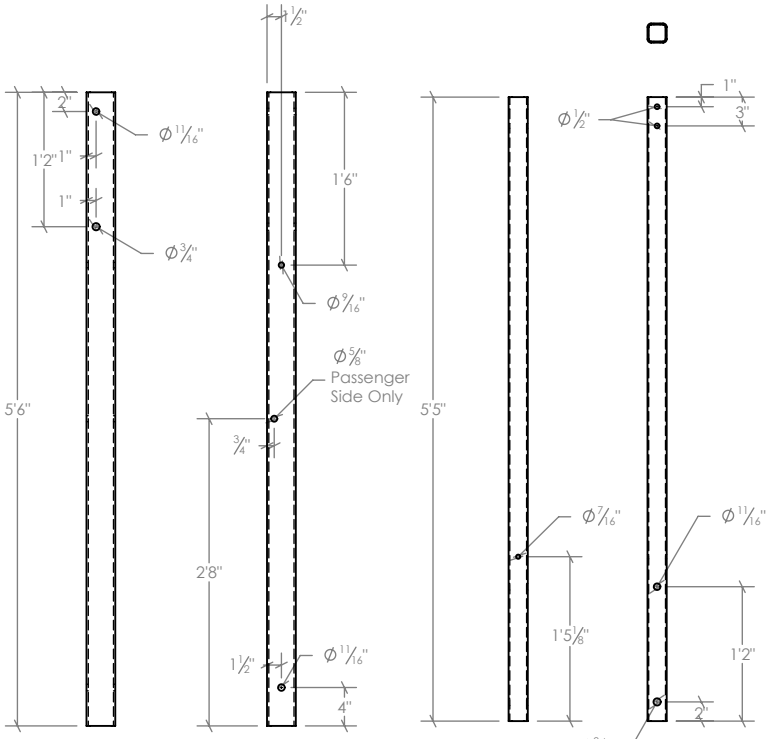
TTMA-200

Steel Ballast Plate (Optional)

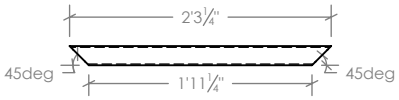
Sheet: 109
Date: 9/27/2018
Drawing Name: TTMA-200
Scale: 1:10
By: JMS
Rev: A

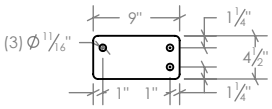
ITEM	QTY	DESCRIPTION	
a	2	Lower Sign Support Tube	
b	2	Upper Sign Support Tube	
c	2	Angled Strut	
d	2	Base Plate	
e	2	Angle Strut Sign	
f	2	Sign Leg	
g	1	Winch Mount	
h	4	Stop Plate	
j	1	Upper Sign Mount	
k	2	End Plate	
m	1	Cross Beam	
n	5	Sign Mounting Sleeve	
o	1	Tube Cap	
p	1	Cable Bracket	
q	1	Idler Bracket	

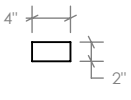


Part a

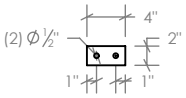
Part b





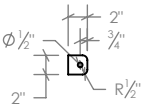


Part h

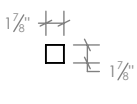


Part k

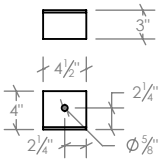
Part n



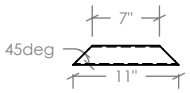
Part p

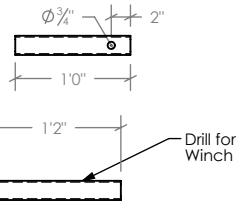


Part o

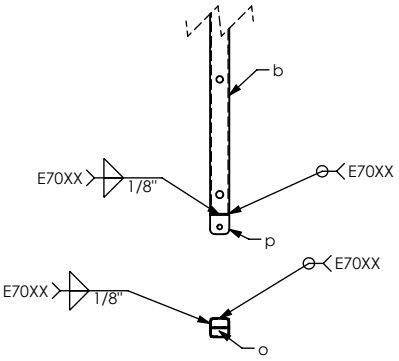


Part q

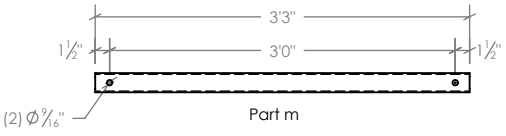




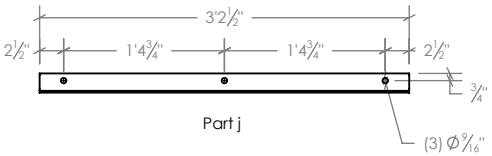
Part g



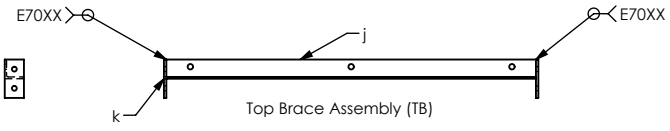
Upper Sign Tube Assembly
Passenger Side



Part m



Part j



Top Brace Assembly (TB)

REV	DESCRIPTION	DATE
A	ADDED TOLERANCES AND FINISH	06/22/2018

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
SUFACE: HOT DIP GALVANIZED
TOLERANCE:
LINEAR: ±1/16"
BOLT HOLE: +1/16", -0"
ANGULAR: ±1°

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Trailer TMA (TTMA-200)
Folding Sign Stand

Parts

Sheet: 100

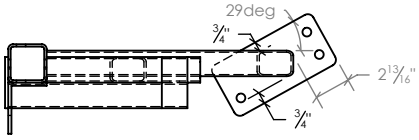
Date: 7/3/2018

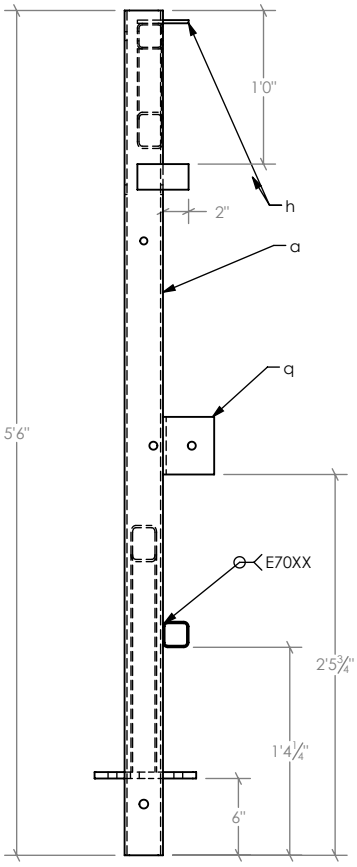
Drawing Name: TTMA-200

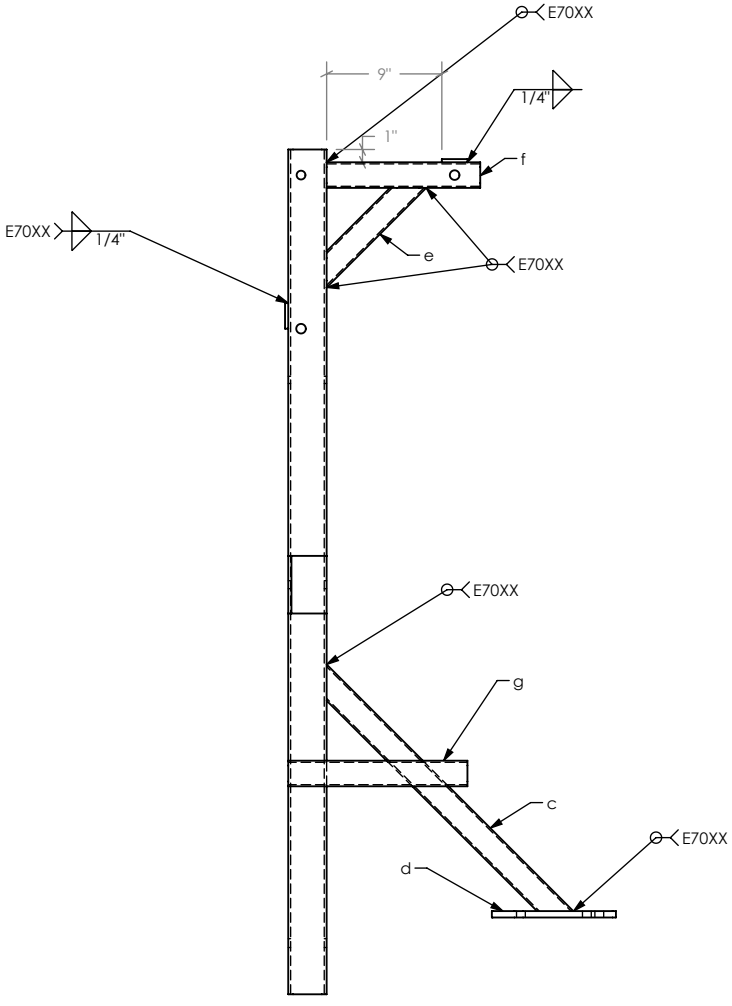
Scale: 1:20

By: JMS

Rev: A







REV	DESCRIPTION	DATE
A	ADDED TOLERANCES AND FINISH	06/22/2018

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BOLT HOLE: +1/16", -0"
ANGULAR: ±1°

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Trailer TMA (TTMA-200)
Folding Sign Stand

Passenger Side Assembly

Sheet: 101

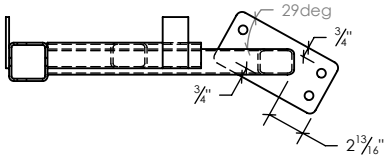
Date: 7/3/2018

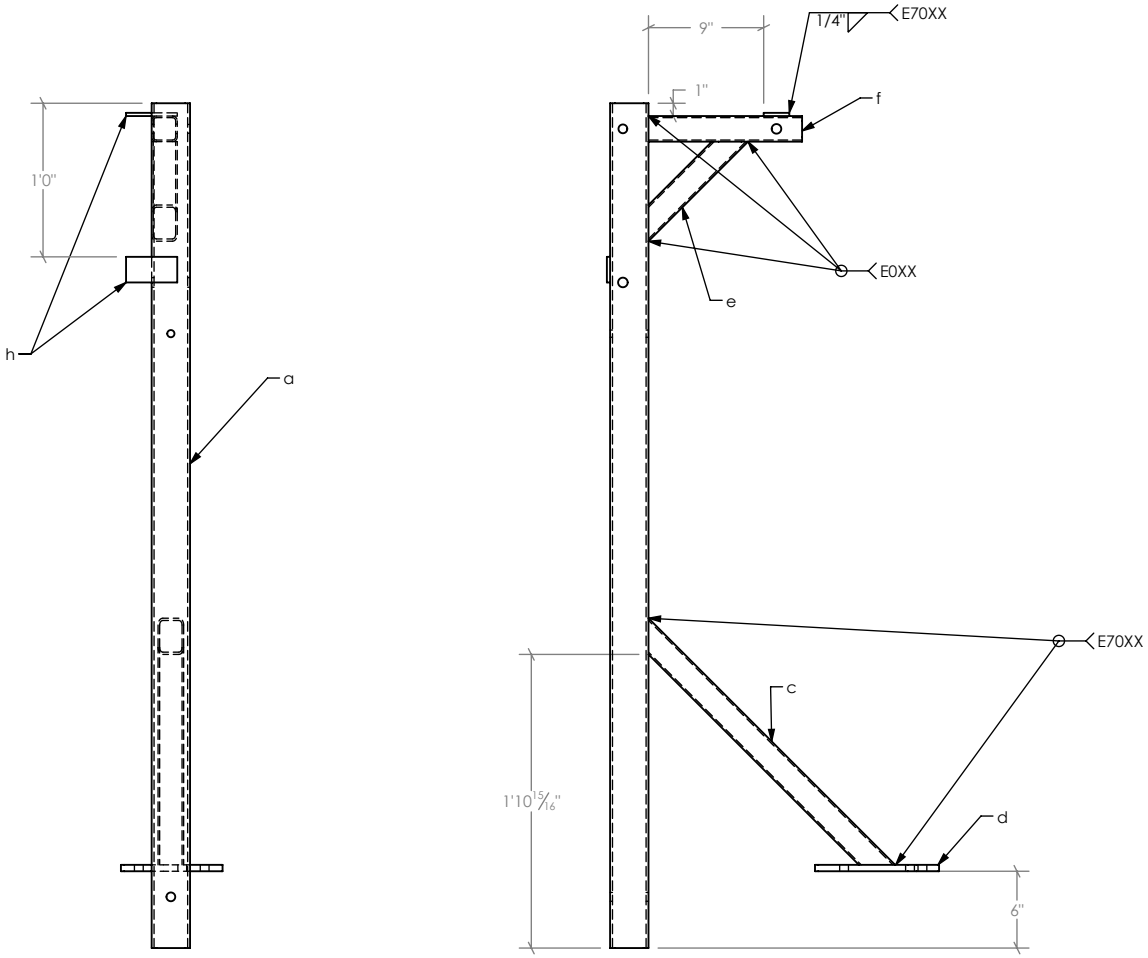
Drawing Name: TTMA-200

Scale: 1:15

By: JMS

Rev: A





REV	DESCRIPTION	DATE
A	ADDED TOLERANCES AND FINISH	06/22/2018

UNLESS OTHERWISE SPECIFIED:
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TOLERANCE:
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BOLT HOLE: +1/16", -0"
ANGULAR: ±1°

Gregory

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Trailer TMA (TTMA-200)
Folding Sign Stand

Driver Side Assembly

Sheet: 102

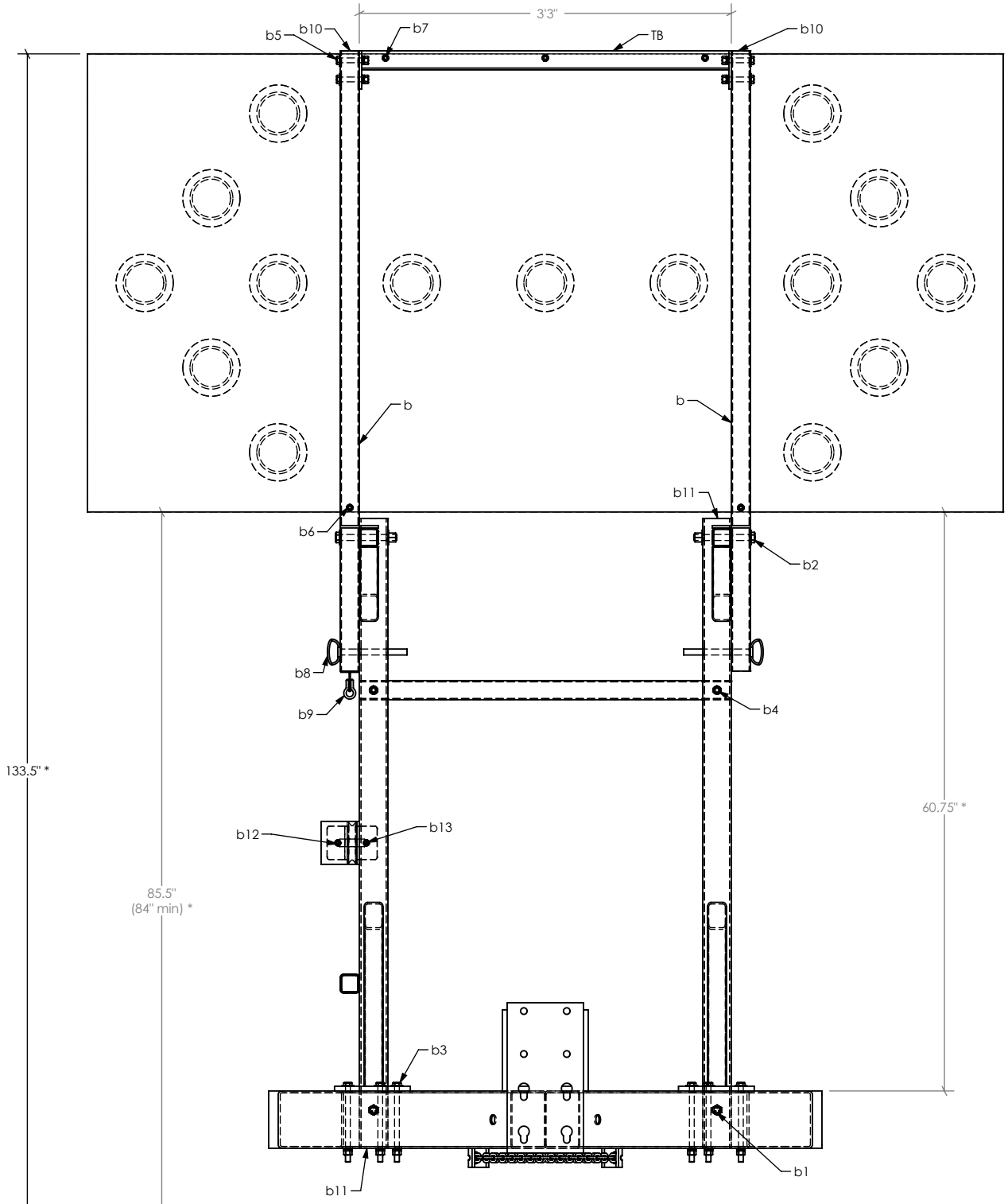
Date: 7/3/2018

Drawing Name: TTMA-200

Scale: 1:15

By: JMS

Rev: A



*Ground Height may vary slightly based on manufacturer of board.

REV	DESCRIPTION	DATE
A	ADDED TOLERANCES AND FINISH	06/22/2018

ITEM	QTY	DESCRIPTION
b1	4	5/8" x 10 1/2" Grade 5 w/ Washer, Nut and Lock Washer
b2	2	5/8" x 6" Grade 5 w/(2) Washers, Nylon Lock Nut
b3	6	1/2" X 8" Grade 5 w/Washer, Nut and Lock Washer
b4	2	1/2" X 6" Grade 5 w/Washer, Nut and Lock Washer
b5	4	1/2" x 3" Grade 5 w/Washer, Nut and Lock Washer
b6	2	3/8" x 6" Grade 5 w/Washer, Nut and Lock Washer
b7	3	3/8" x 4" Grade 5 w/Washer, Nut and Lock Washer
b8	2	5/8" x 7" Hitch Pin and Clip
b9	1	5/16" Screw Pin Anchor Shackle (CM)
b10	9	2"x2" Plastic End Cap
b11	4	3"x3" Plastic End Cap
b12	2	5/16" x 1" Grade 5 w/Washer, Nut and Lock Washer
b13	2	5/16" x 4" Grade 5 w/Washer, Nut and Lock Washer

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
SUFACE: HOT DIP GALVANIZED
TOLERANCE:
LINEAR: ±1/16"
BOLT HOLE: +1/16", -0"
ANGULAR: ±1°

Gregory Industries, Inc.
4100 13th Street, SW
Canton, Ohio 44710
Phone: 330-447-4800x123

Trailer TMA (TTMA-200)
Folding Sign Stand

Assembly Front View

Sheet: 103

Date: 7/3/2018

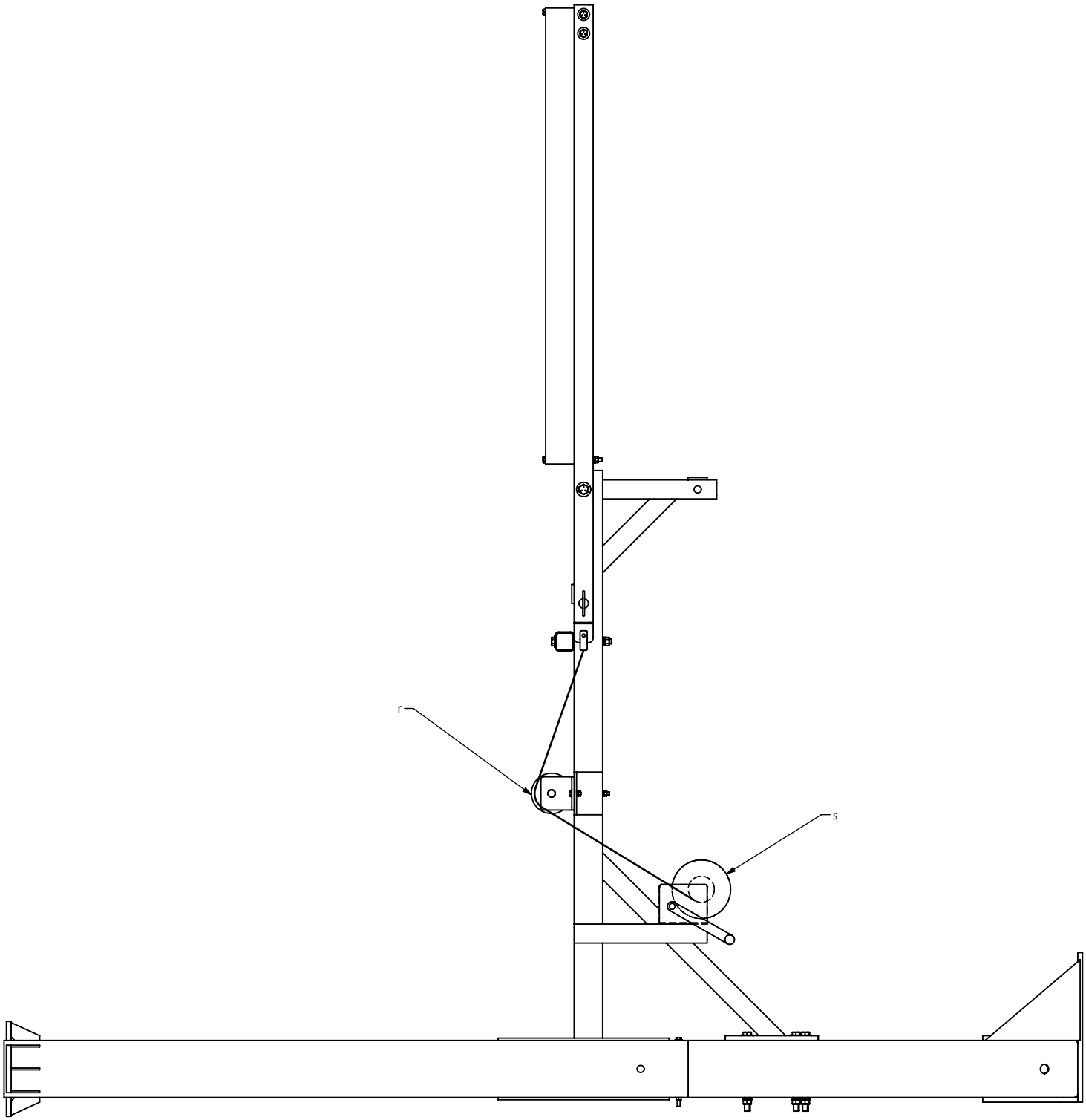
Drawing Name: TTMA-200

Scale: 1:16

By: JMS

Rev: A

ITEM	QTY	DESCRIPTION	MANUFACTURER
r	1	Pulley	ZORO Item #5RRR3 or equiv
s	1	Winch	DL Item # DLB1200A or equiv



REV	DESCRIPTION	DATE
A	ADDED TOLERANCES AND FINISH	06/22/2018

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
SUFACE: HOT DIP GALVANIZED
TOLERANCE:
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Trailer TMA (TTMA-200)
Folding Sign Stand

Assembly Side View

Sheet: 104

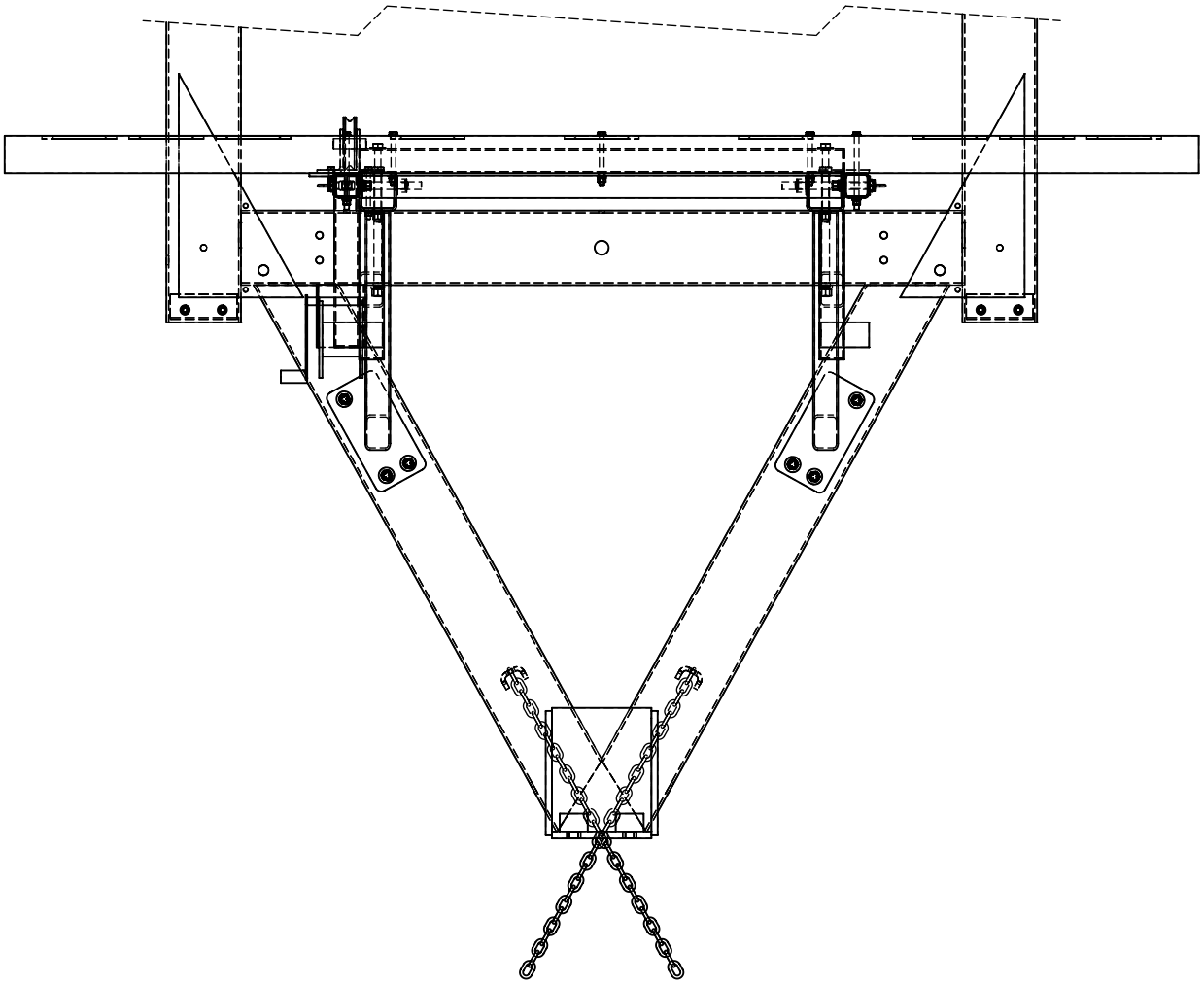
Date: 7/3/2018

Drawing Name: TTMA-200

Scale: 1:15

By: JMS

Rev: A



REV	DESCRIPTION	DATE
A	ADDED TOLERANCES AND FINISH	06/22/2018

UNLESS OTHERWISE SPECIFIED:
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Gregory

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Trailer TMA (TTMA-200)
Folding Sign Stand

Assembly Top View

Sheet: 105

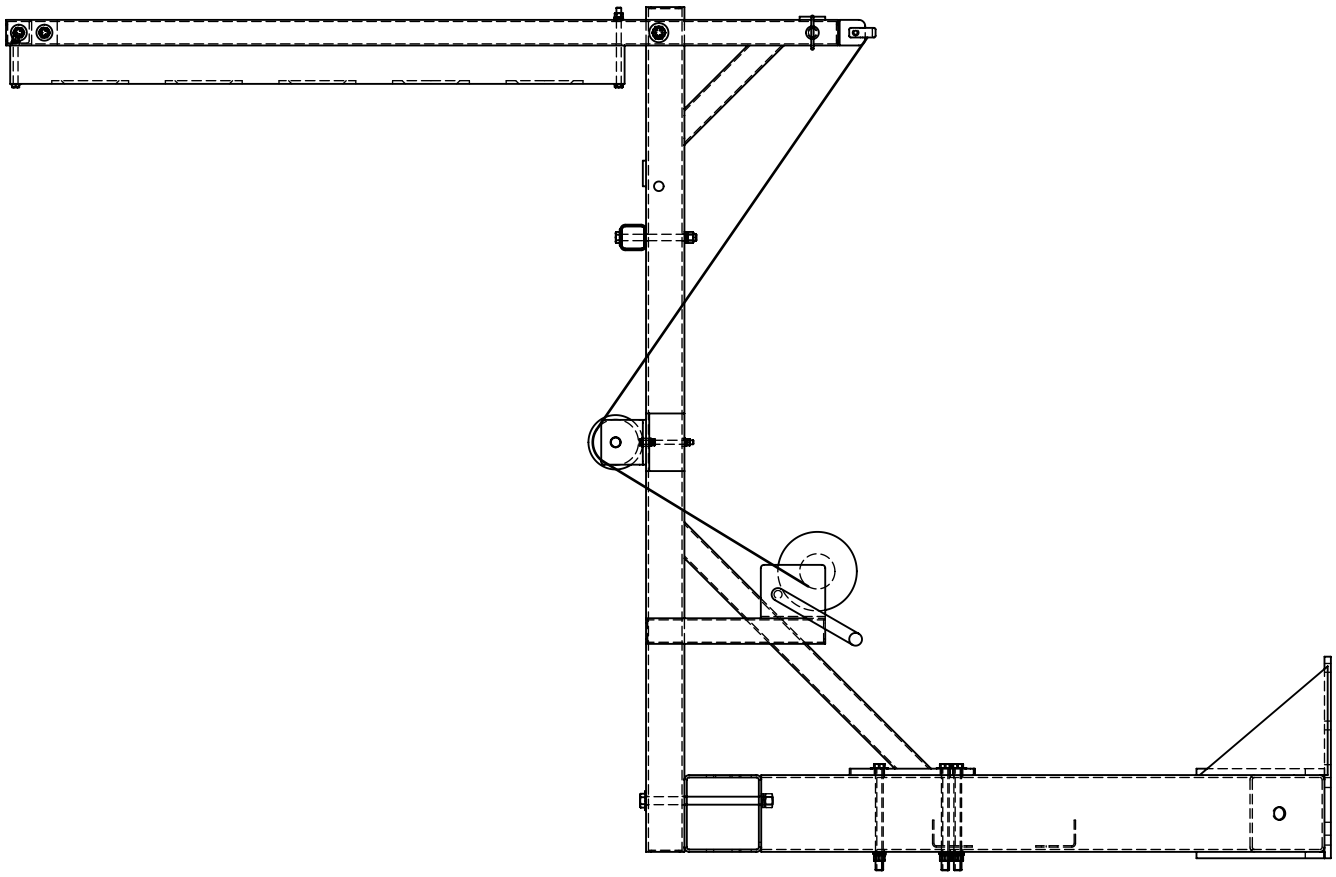
Date: 7/3/2018

Drawing Name: TTMA-200

Scale: 1:15

By: JMS

Rev: A



REV	DESCRIPTION	DATE
A	ADDED TOLERANCES AND FINISH	06/22/2018

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Trailer TMA (TTMA-200)
Folding Sign Stand

Folded Assembly Side View

Sheet: 106

Date: 7/3/2018

Drawing Name: TTMA-200

Scale: 1:15

By: JMS

Rev: A