



United States Department of Agriculture

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Agricultural Research Services

# Camera Inspection System for Plastic in Cotton Module Feeder

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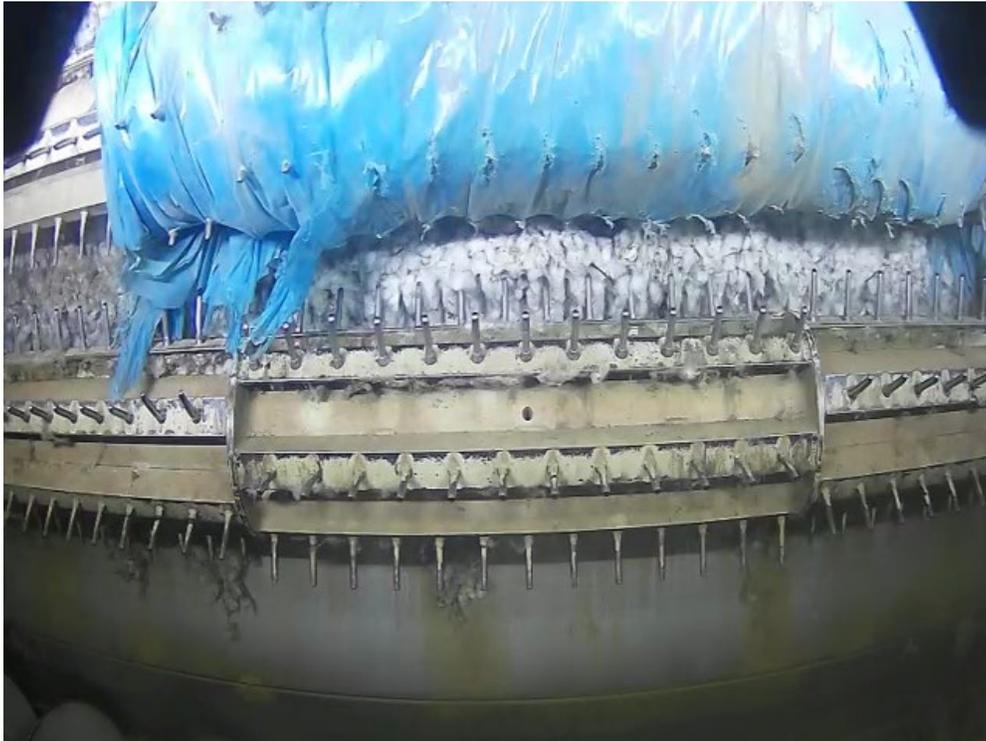
Lubbock Texas

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*Disclaimer* – The parts and equipment detailed in this technical note are what was utilized in the research. Reference of a product or trade name are listed for reference only and does not indicate a preference, or endorsement by the USDA-ARS over other compatible products or manufacturers. USDA is an equal opportunity employer.

## 1. Objective

This report details a simple low-cost module-feeder camera system that will allow ginner's a periodic real-time view of the module feeder's dispersing cylinder. In practice we've observed that when these systems are installed, the gin crews are much more respondent to keeping the cylinder's clean which in turn results in a significant reduction in number of plastic calls on bales from the USDA-AMS classing office. Figure 1 shows an example picture from one of camera inspection systems, taken at one of our commercial test gins.



**Figure 1:** Module feeder image capture by inspection system with plastic on dispersing cylinders.

## 2. System Overview

### 2.1 Option 1 Overview: Simple Module Feeder Camera System (covered in depth in this technical note).

The first option, is the simplest system that is comprised of:

- IP Camera/s,
- Mechanical camera housing with integral optical air-wash to help keep optics clear of dust and debris,
- Generic security camera viewing software provided by cotton gin. Available from 3<sup>rd</sup> party or normal security camera viewing software that ships with camera.

### 2.2 Option 2 Overview: Automatic Stand-Alone Module Feeder Camera System [To be released Q4 2020].

Option 2 augments Option 1, Simple System, by adding custom software that runs on a stand-alone PC. The software augments the system by enabling the system to interact with a PLC to automatically pause the module feed, thereby providing enough time to allow for the cotton to settle out of the air, enabling cameras after which the software automatically captures a clear picture of dispersing cylinders. When this development is finished, it will also include automatic detection of plastic on cylinders and

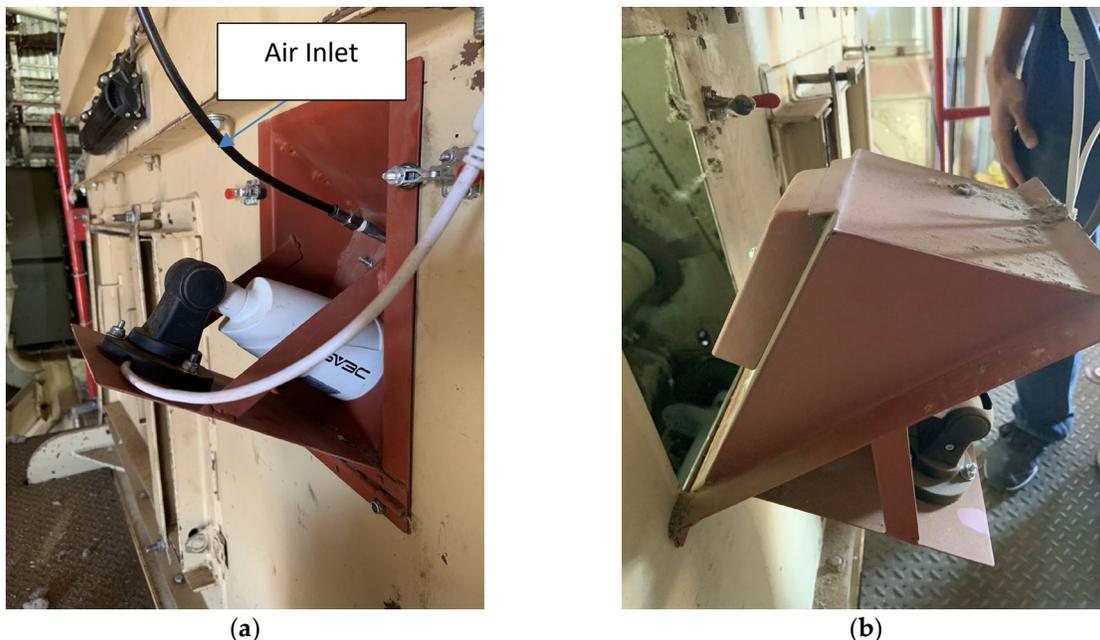
provide an external relay to trigger an alarm beacon to alert the gin crew of the presence of plastic on the cylinders.

### 3. Mechanical and Optical System Details

#### 3.1 Option 1 Details: Simple Module Feeder Camera System

The simple system is for the construction of a camera housing with integral air-wash, to keep the optics clean, to house ethernet IP cameras and suggestions as to suitable lights. This simplified system will use the cameras in their primary intended usage, i.e. in security camera viewing mode, and will depend upon the gin to provide or use the included software that comes with the cameras for viewing of the dispersing cylinders. This system provides a system that can be readily adopted by most gins with minimal technical expertise. The simplified version allows for inspection of module feeder rollers whenever the feed is stopped. Figure 1 shows an example image, taken during 2019 ginning season, from one of the cameras mounted on the back wall of a module feeder.

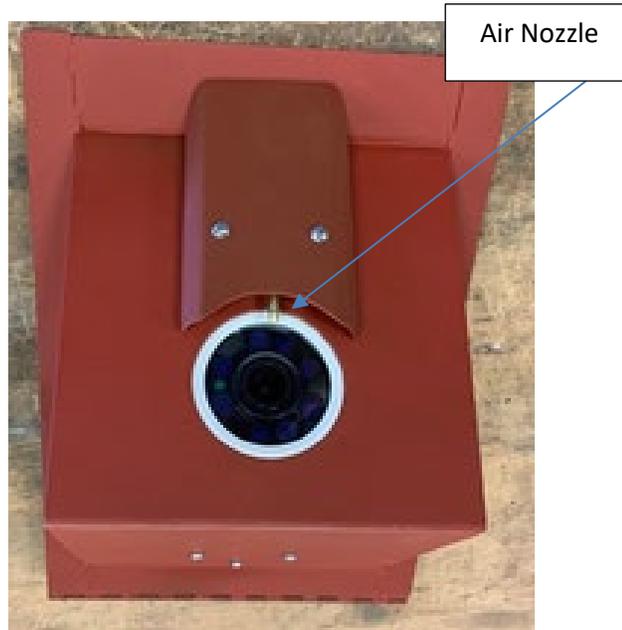
For this option, a custom housing design, with integral quick access for cleaning, is shown in Figure 2a?. The mechanical fabrication design files for this housing are provided in the drawings package that are included with this technical note as an attachment. Of note, to provide easy cleaning, is the hinge that allows access to camera for periodic cleaning of the optics. Figure 2b, shows the housing tipped out for easy access to optics for cleaning.



**Figure 2.** Second generation inspection camera and simplified housing, that relies on external lights. Figure 3a shows the camera housing mounted to the back side of module feeder and Figure 3b shows the housing as it's tipped back out of the module feeder, allowing easy access to the optics for cleaning. Of note is the

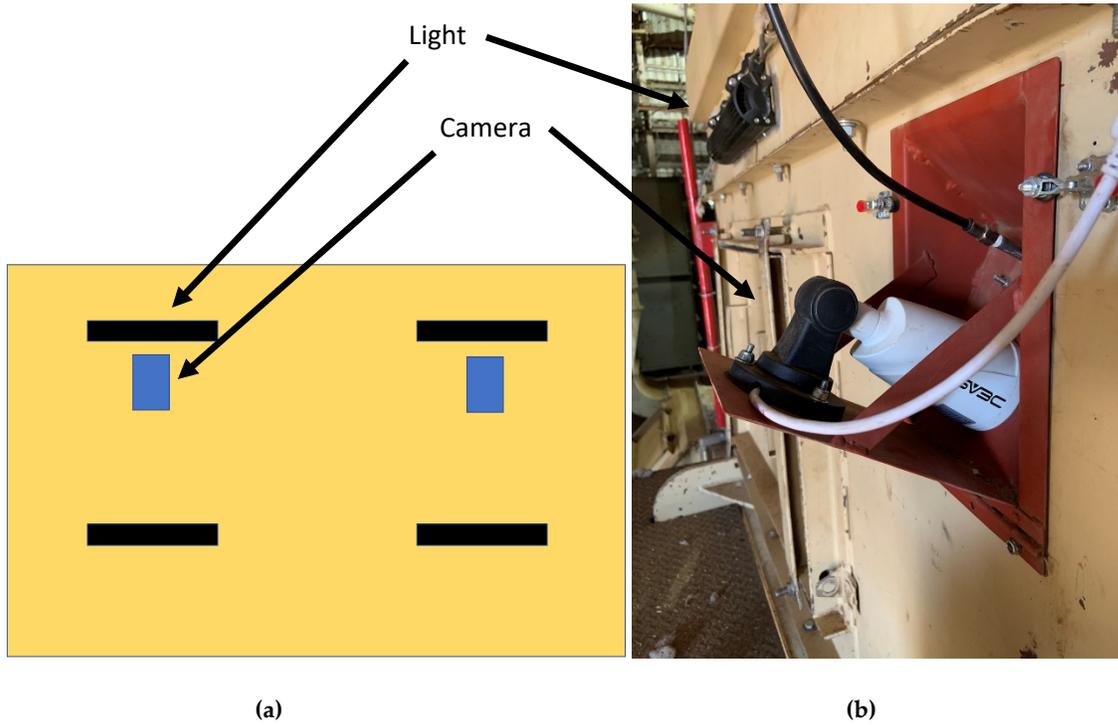
air-inlet tube, seen in Figure 2a, that directs air across the optics thereby providing an air-wash to help keep the optics clean.

The air wash nozzle's position is shown in Figure 3.



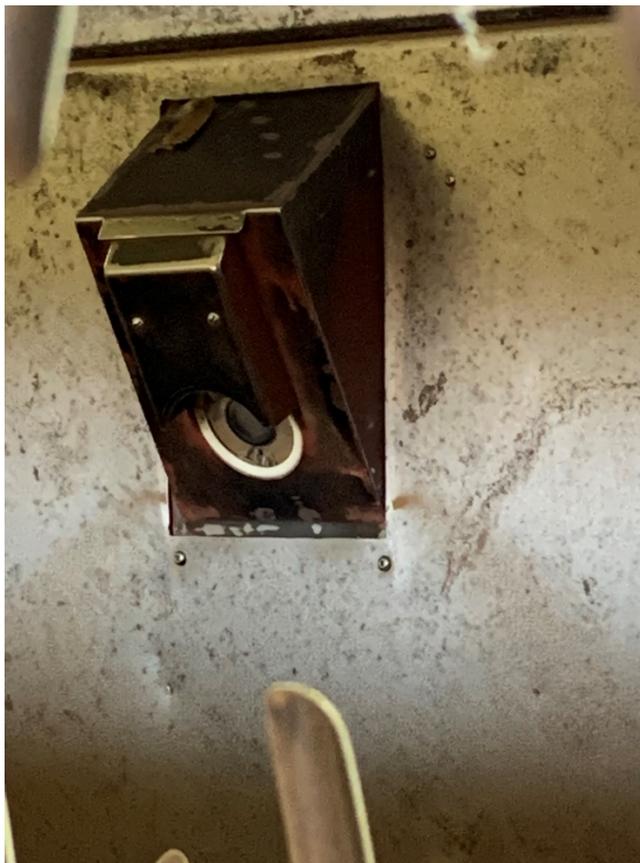
**Figure 3.** Shows the camera side of the air-inlet tube, back-side view is detailed in Figure 2a, that directs air across the optics thereby providing an air-wash to help keep the optics clean.

The recommended position of the camera housing and lights, on the back-wall of the module feeder, are shown in Figure 4. Another alternative camera light location to consider is the roof of the module feeder. As when placed on the back wall, well back from the cylinders, this location provides ideal protection from flying debris.



**Figure 4.** General placement (a), on back wall of module feeder, of camera inspection system components. Black boxes indicate placement of lights, blue boxes indicate placement of camera housings. Picture (b), shows how the camera and one of the lights were installed at a commercial gin.

Figure 5 shows the camera housing as seen from inside the module feeder. For many module feeders, two cameras will be required to enable viewing of entire module feeder dispersing cylinders. For a few of the smaller feeders, a single camera might be acceptable. Conversely, there might be a few module feeders with very close back walls, where the camera is mounted too close to view entire range from top to bottom cylinders, in which case 3 or 4 cameras might be necessary. Of importance is to note the sloping angle of the housing, which helps it shed cotton and debris. Along that same design paradigm, is the shroud covering the air-wash nozzle which helps to prevent cotton from hanging on the air nozzle. As the air-wash nozzle is pointed directly at the camera lens, it is important to provide filtration to pneumatic air supply to ensure a source of clean dry air to the air-wash system.



**Figure 5.** Camera housing as seen from inside the module feeder.

Of note is that for any one particular installation, the distance between the back wall to the dispersing cylinders will dictate required placement of the components. Best practice is to hook up the cameras and hold them on the inside, against the back wall, in approximate location and adjust until image coverage of dispersing cylinders is suitable. Depending upon the geometry of the particular module feeder, the angle that the housing positions the camera at may need to be adjusted before fabrication and/or may require more than one camera.

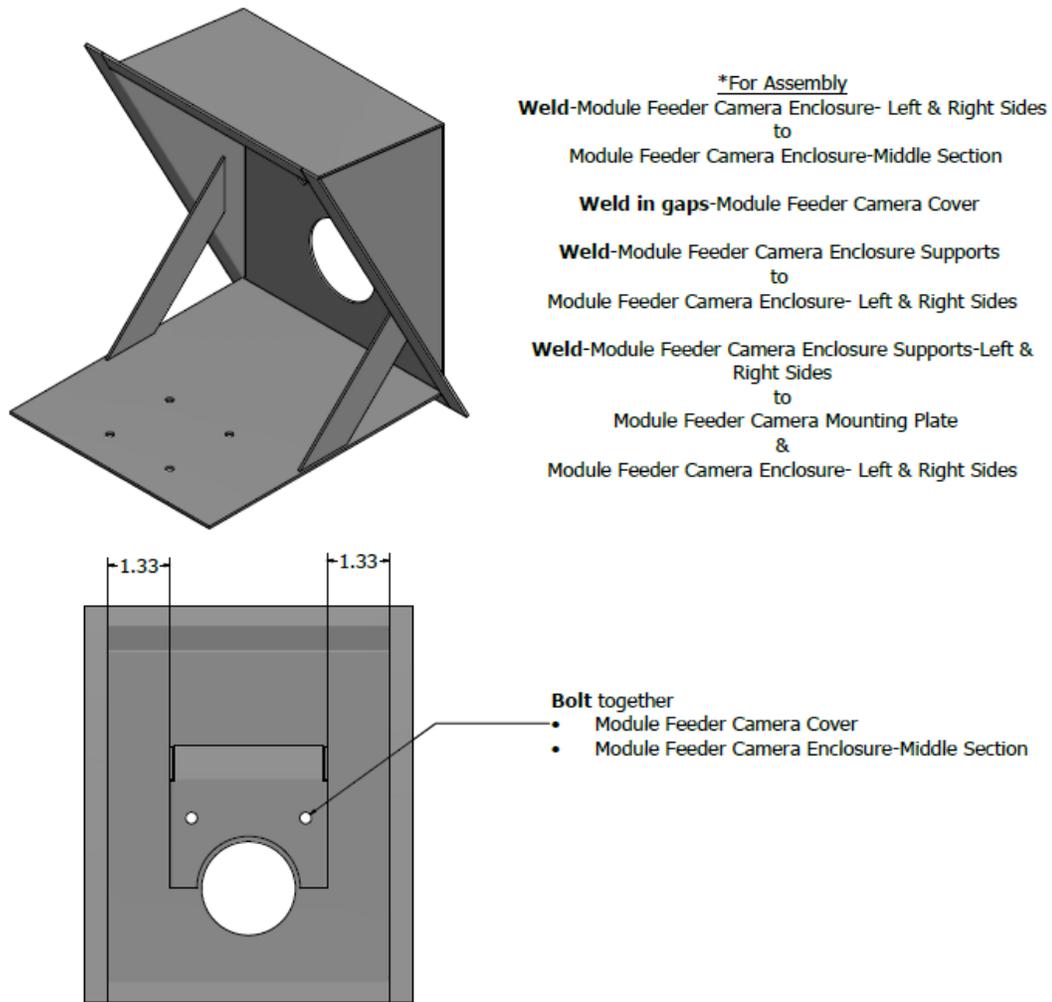
#### **6. Discussion: Impact of System on Plastic Contamination**

After monitoring the prototype system during the 2019 ginning season, it became apparent that the top camera required significantly less maintenance than the bottom camera. The top camera was also much less likely to be damaged by rocks and less likely to be covered up by mud. Our recommendation is to strive to avoid placing the cameras low. Of note however is that lights will likely still be needed on the lower section to provide enough light to illuminate the lower cylinders. Best practice is to hand-position lights and verify sufficient lighting in images before cutting in mounting holes for lights. Nominal light levels at surface of dispersing cylinders were from 500 – 1000 Lux.

When the system was put into practice in a commercial cotton gin, the gin enjoyed a significant drop in the number of plastic calls after installation, and diligent use of the system, in comparison to the prior

year when they had no inspection system. While only an observational single case study; it does suggest real benefits can be achieved when inspection systems are installed and used to rapidly identify when plastic gets onto the cotton module's dispersing cylinders and the gin crew expediently removes the plastic before it has a chance to shred the plastic and disperse it further into the gin.

**Mechanical Design Drawings (Figures 6 – 10)**



**Figure 6.** Design drawing of module feeder camera housing (units in inches).



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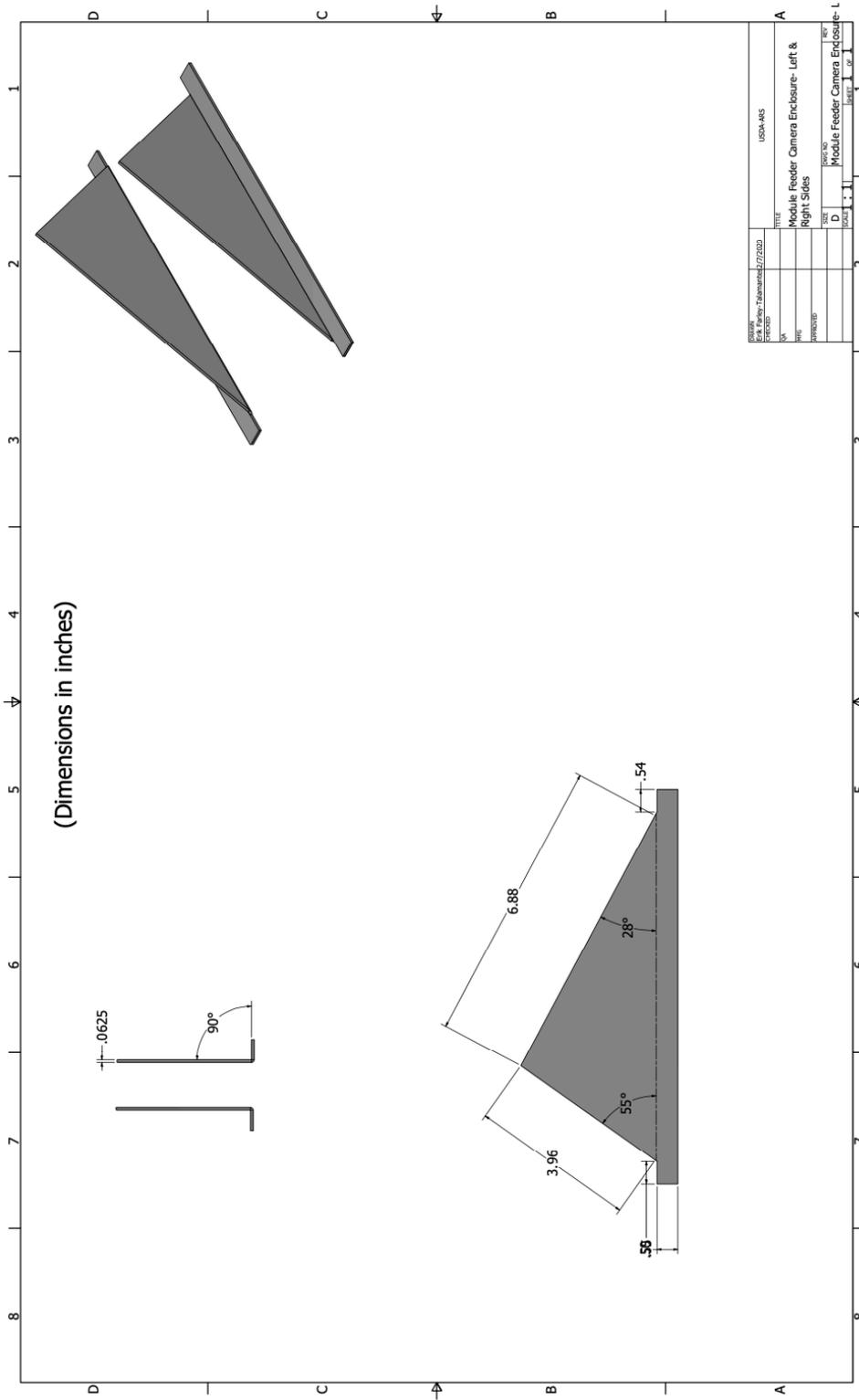


Figure 8. Module feeder camera housing support bracket (#1, 3 of assembly drawing).

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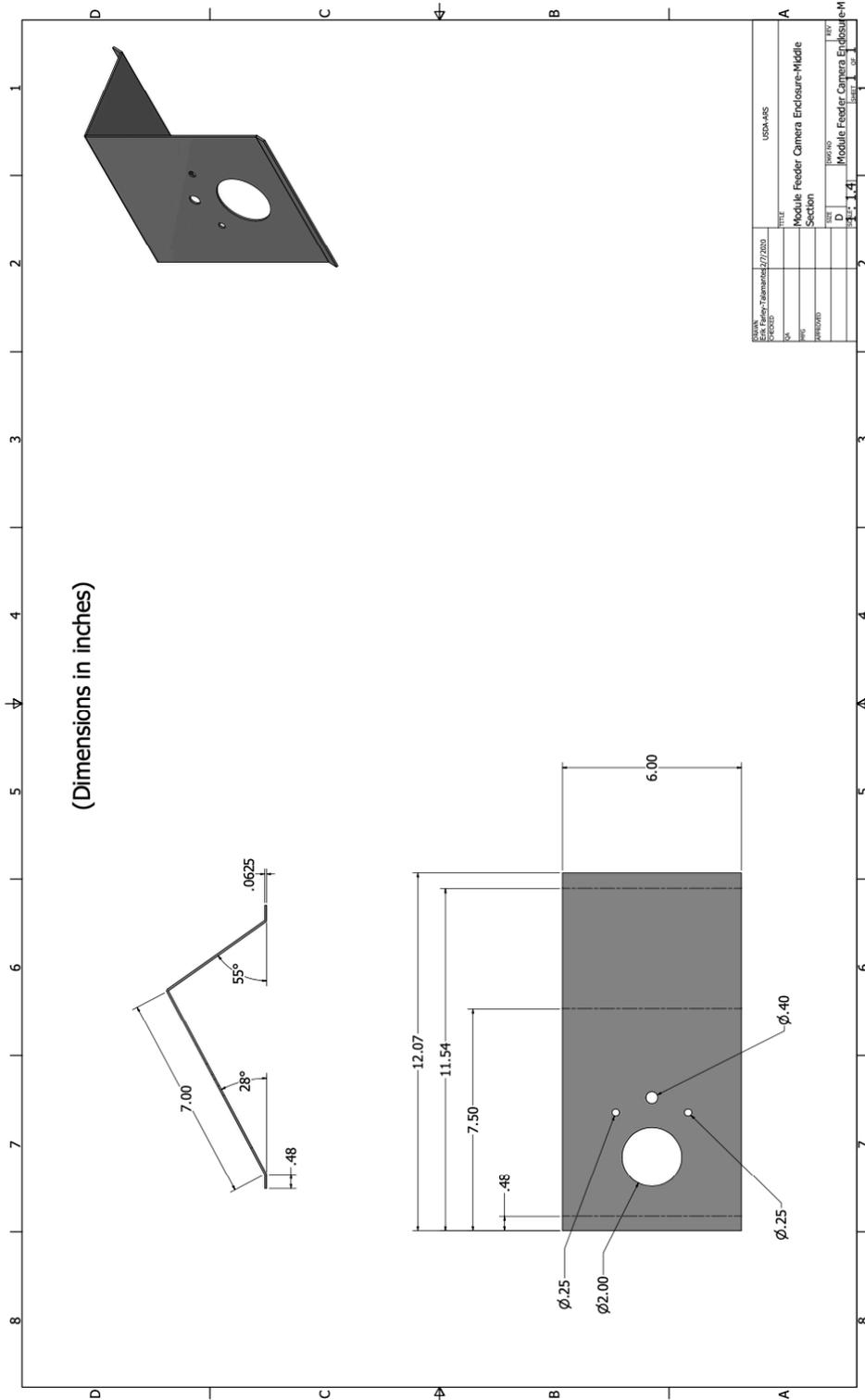


Figure 9. Module feeder camera housing middle section (#2 of assembly drawing).

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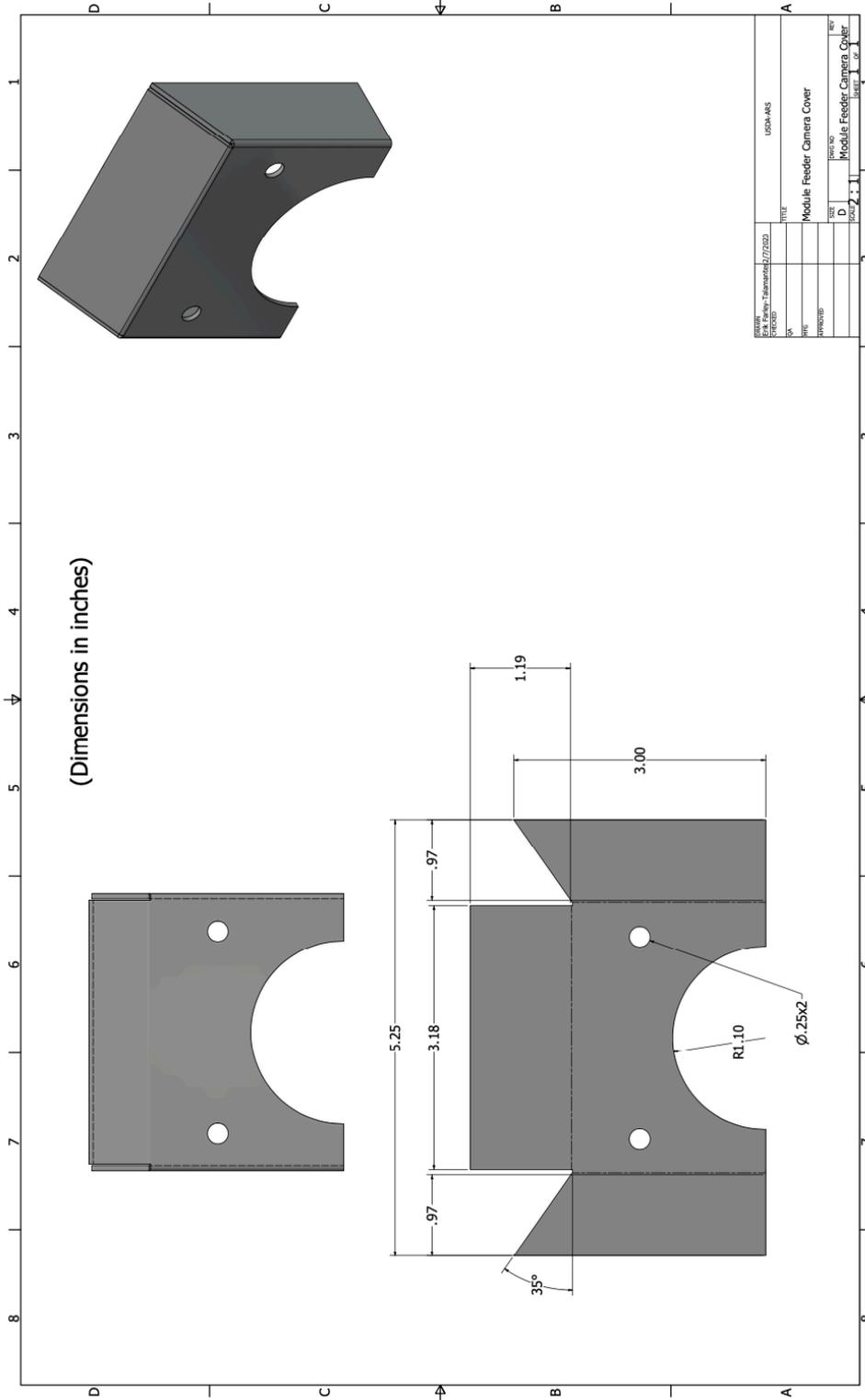


Figure 10. Module feeder camera housing air-wash tube protection cover (#4 of assembly drawing).

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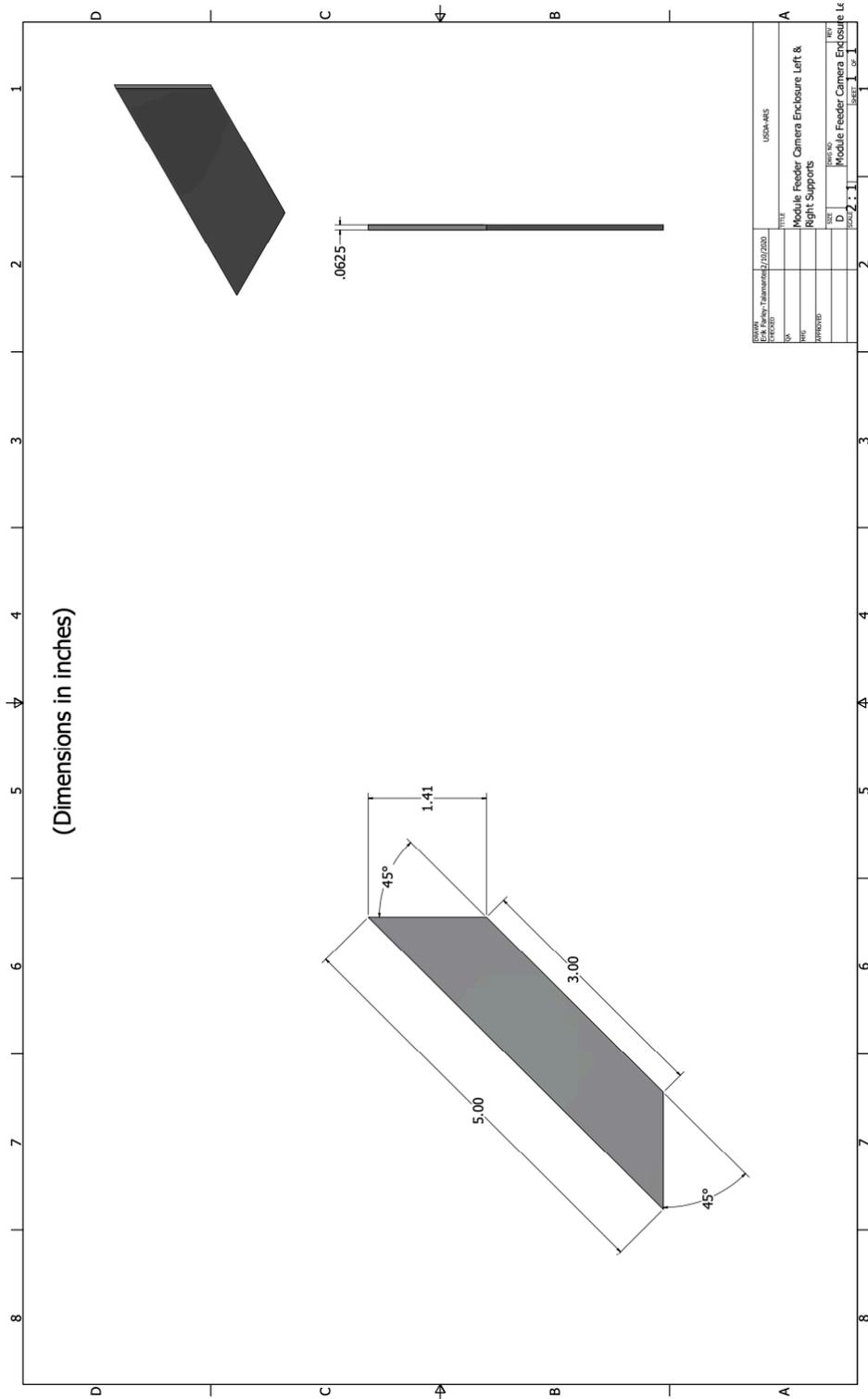


Figure 11. Module feeder camera housing enclosure support straps (#5 of assembly drawing; x2).

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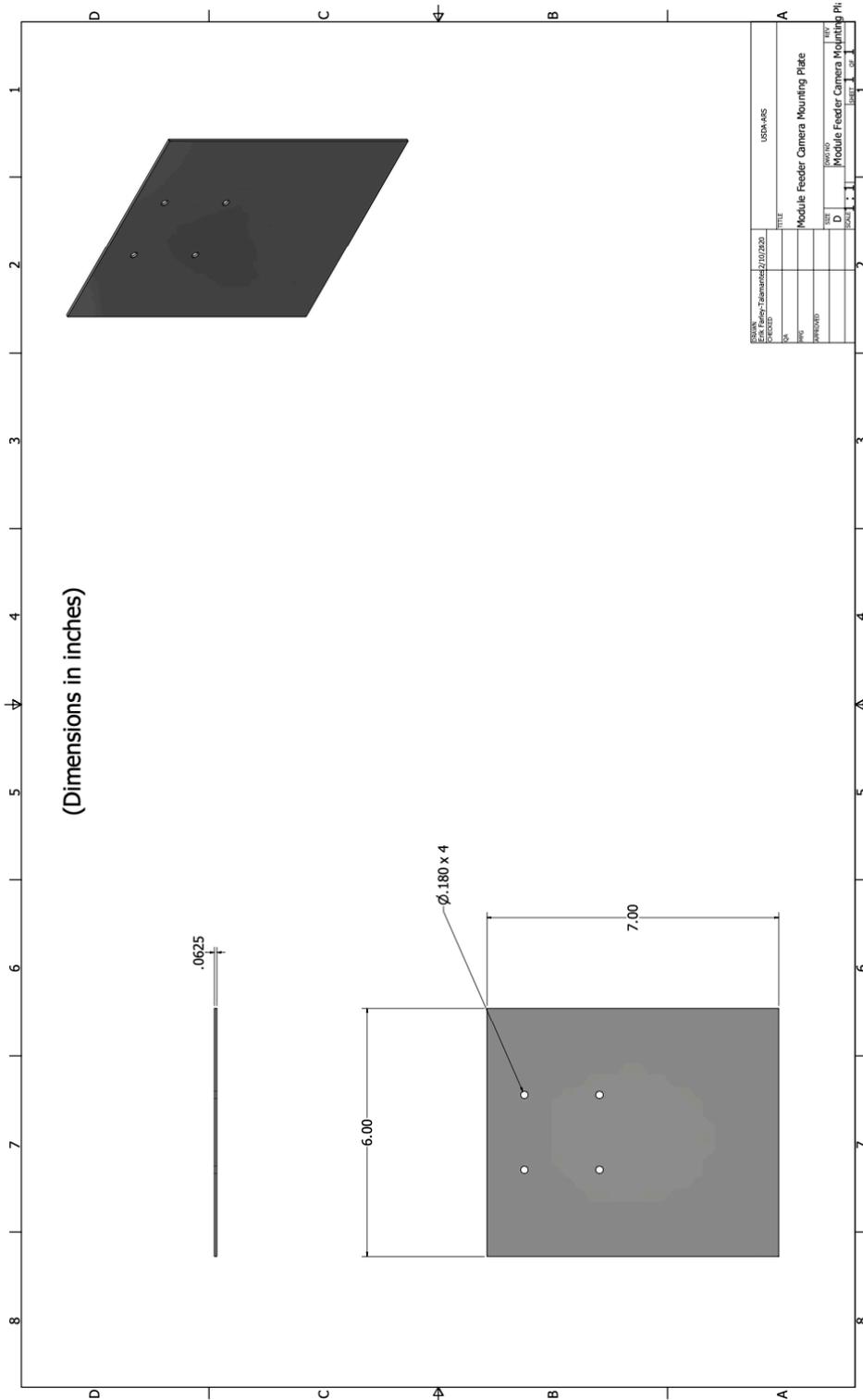


Figure 12. Module feeder camera mounting plate (#8 of assembly drawing).



**Module Feeder Parts List (Simplified-System) Note: Part Assembly Id #'s refer back to full assembly drawing detailed in Figure 7.**

Available from Amazon.com:

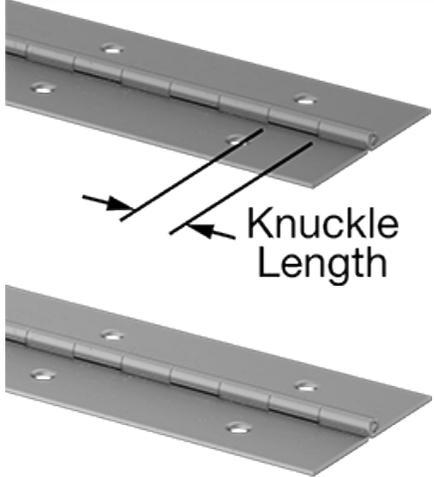
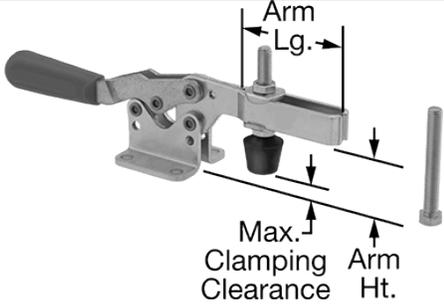
Part ID, Picture	Product Description	Price
 <p data-bbox="354 873 566 900">Part Assembly Id: 7</p>	<p data-bbox="743 680 1205 800">Dahua Lite 4MP IP Mini-Bullet IR 2.8mm Security Camera (N41BD22). Power from 12VDC power supply or via POE switch</p>	<p data-bbox="1279 726 1365 753">\$125.31</p>
	<p data-bbox="743 1100 1205 1220">LED Light Bar Nilight 20 Inch 126w LED Work Light Spot Flood Combo Led Bar Off Road Lights Driving Lights Led Fog Light Jeep Lights Boat Lighting.</p>	<p data-bbox="1260 1146 1390 1173">4 @ \$25.92</p>
	<p data-bbox="760 1541 1190 1629">Idealy 150W DC 12V Ip67 Waterproof LED Power Supply Driver Transformer Adapter for Lighting Strip with outdoor.</p>	<p data-bbox="1260 1556 1390 1619">4 @ \$33.99 (1 per light)</p>



From McMaster CARR:

Product Description	Product Link	Product ID	Price
 <p>Part Assembly Id: 14</p>	<p>Full-Cone spray nozzle  <a href="https://www.mcmaster.com/32885k131">https://www.mcmaster.com/32885k131</a></p>	32885K131	\$10.52 Each
 <p>Part Assembly Id: 9</p>	<p>Set Screw Shaft Collar  for 3/8" Diameter, Black-Oxide 1215  Carbon Steel  <a href="https://www.mcmaster.com/9414t8">https://www.mcmaster.com/9414t8</a></p>	9414T8	\$1.38 Each
Product Description	Product Link	Product ID	Price
 <p>Part Assembly Id: 12</p>	<p>Standard-Wall Steel Pipe Nipple  Threaded on Both Ends, 1/8 NPT, 2-  1/2" Long Compact Extreme-Pressure  Steel Pipe Fitting  90 Degree Elbow Connector, 1/8 NPTF  Female  <a href="https://www.mcmaster.com/50925k118">https://www.mcmaster.com/50925k118</a></p>	50925K118	1@ \$4.80
 <p>Part Assembly Id: 13</p>	<p>High-Pressure Brass Pipe Fitting  45 Degree Elbow Adapter, 1/8 NPT  Female x Male  <a href="https://www.mcmaster.com/50785k81">https://www.mcmaster.com/50785k81</a></p>	50785k81	1@ \$3.53

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 <p>Knuckle Length</p> <p>Part Assembly Id: 6</p>	<p>Piano Hinge with Holes Steel, 1-1/4" Overall Width, 0.245" Knuckle Diameter (cut to 6") <a href="https://www.mcmaster.com/1569a927-1569A391">https://www.mcmaster.com/1569a927-1569A391</a></p>	<p>1569A927</p>	<p>1@ \$2.65 @ 1 ft length</p>
 <p>Arm Lg.</p> <p>Max. Clamping Clearance</p> <p>Arm Ht.</p> <p>Mounted externally to assembly on module feeder to hold housing in place, (Figure 4b)</p>	<p>Low-Profile Hold-Down Toggle Clamp <a href="https://www.mcmaster.com/5128a62">https://www.mcmaster.com/5128a62</a></p>	<p>5128A62</p>	<p>\$10.07 Each x2</p>

Miscellaneous parts:

	<p>A UPS Battery Backup and Industrial Power Filter</p>	
	<p>Pneumatic Filter to provide Dry Clean Air to Optical Air-Wash Nozzle.</p>	