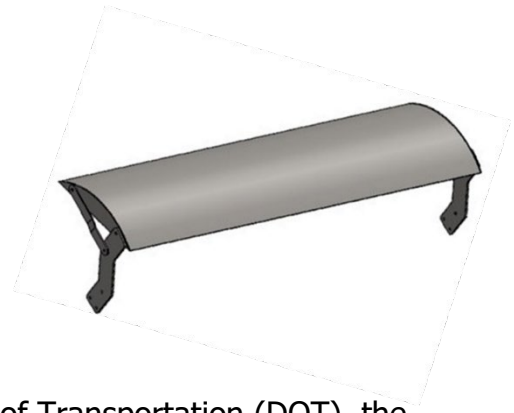


Air Foil Innovation

Overview

Introduced as a State Transportation Innovation Council (STIC) innovation through the STIC's Maintenance Technical Advisory Group, the Air Foil is an arched piece of metal or plastic that is mounted to the rear of a large dump truck.



Originally conceptualized by the Oregon Department of Transportation (DOT), the purpose of the Air Foil is to use the air passing over the top of the truck while it is moving and force it down the backside of the truck, reducing material buildup on the truck's tailgate, taillights, and spreader system. Use of the Air Foil minimizes the need for operators to frequently pull over and clean off the back of the truck and increases truck visibility for the travelling public during winter weather events.

Transportation Challenges Addressed

During winter maintenance operations, the lights and reflective material located on the back of dump trucks become covered with debris from the roadway, reducing truck visibility. The Air Foil eliminates the need for operators to pull off the road as frequently to clean the truck's tailgates, lights and spreader systems. It also creates a safer environment for the travelling public as it improves truck visibility.



Pilot Project Highlights

PennDOT Engineering District 10 (Armstrong, Butler, Clarion, Indiana and Jefferson counties) initiated the process by fabricating and comparing the weight, cost and durability of Air Foils made from steel versus plastic poly material. This was followed by piloting the Air Foil on district dump trucks during the 2022-23, 2023-24 and 2024-25 winter seasons.

During the pilot, the district compared the visibility of the warning lights and reflective material on the tailgates of trucks with and without the Air Foil and adjusted based on overall performance and feedback from operators. The Air Foil performed as predicted by keeping trucks cleaner, saving operators time and increasing truck visibility.

District 10 developed the specification and standard drawings for Air Foils and partnered with the Forest County State Correctional Institute (SCI Forest) to produce the Air Foil at a cost of approximately \$1,550 each, including materials and labor. The district also developed a process to order the Air Foil through SCI Forest.

Lessons Learned and Best Practices

When piloting the Air Foil, the below **challenges** were identified by District 10.

Would the air turbulence cause additional sight distance issues behind the vehicle?

During the pilot phase, District 10 determined this was not an issue; if anything, it assisted with better visibility.

Would the cold air being forced down the tailgate cause the materials in the spreader box to freeze as well as spreading or moisture issues?

No. For example, during the pilot phase, one of the winter weather events produced wet snow, followed by a sudden drop in temperatures to single digits. District 10 experienced no issues during this event.



Would operator buy-in and support be an issue?

Through the pilot phase, feedback from operators was positive, and they increasingly requested to use trucks outfitted with the Air Foil versus ones without the Air Foil. Operators noted that without the Air Foil, they typically had to exit the truck several times each shift to clean the truck's taillights and tailgates, but with the Air Foil, they could complete an entire shift without having to exit the truck.

Could a prototype be fabricated that adhered to PennDOT's Fleet Management Division (FMD) policies and satisfied safety concerns?

While FMD had some initial concerns with safety, District 10 worked directly with them to ensure adequate lighting and safety mechanisms were in place if the Air Foil failed.

Would use of the Air Foil ultimately yield the intended safety and/or cleanliness benefits?

During the pilot phase, it was noted that when using the Air Foil, it drastically increased visibility of the reflective tape during any type of snow event in comparison to trucks not equipped with the Air Foil.

Since PennDOT uses skid/salt and Oregon DOT uses sand, would use of the Air Foil still yield the similar results?

During the pilot phase, it was noted that regardless of whether 100% salt or a skid/salt mixture was used, it yielded the same results by keeping the rear of the trucks clean.

Material Selection and Installation Considerations

Oregon DOT uses a slide-in style of spreader where the entire unit slides in the bed of the truck, whereas PennDOT hangs the spreaders on the rear of the trucks. District 10 modified Oregon DOT’s original idea to develop an initial prototype. Since the mounting bracket is different from Oregon DOT’s original setup, the district initially repurposed the old-style brine tank brackets that hung on the tailgates. This allowed for the brackets to be repurposed into something useful and expedited the build process.



Steel Prototype

The first Air Foil prototype was built using steel. It took approximately 40 labor hours to fabricate and install the prototype. During the first winter weather event, District 10 noted the success of the Air Foil prototype and quickly worked to develop another prototype to test other materials, such as plastic, with the goal of reducing the weight of the Air Foil.

District 10 used the same build design as the steel prototype; however, they replaced the curved metal piece with plastic that is commonly used on the

front of the snowplows with the thought that old plow faces that needed replaced could be reused in the future. The downside with this approach was that the plastic cost significantly more than the steel, and concerns existed about the plastic cracking due to sun and temperature exposure.



Plastic Poly Prototype

| Material | Steel | Poly Plastic Material |
|----------------------------|-----------------------------------|---|
| Prototype Weight | 242 lbs. | 167 lbs. |
| Prototype Cost | \$2,299* | \$2,967* |
| Prototype Pros/Cons | No major long-term wear concerns. | Ability to recycle old plow faces. Long-term concerns with wear. |

*Cost of materials and labor for Armstrong County to fabricate the Air Foil.

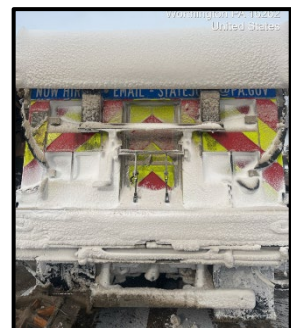
- Both prototypes were used during the pilot phase, which involved a significant amount of trial and error with mounting and finding the correct angle of the Air Foil.
- After piloting the Air Foil the first two winter seasons, District 10 worked with FMD and the Maintenance team to adjust the first two prototypes to something that could be easily implemented at a statewide level. District 10 also developed shop drawings (see pages 6-11) to ensure consistent fabrication of the Air Foil statewide as well as a guide for other areas to use. It took approximately 40 labor hours to draft, review and finalize the shop drawings.
- Through this process, the decision was made not to reuse the old brine tank brackets and instead use a more simplistic and lighter bracket made out of A36 Steel to mount the Air Foil to the tailgate. By doing this, District 10 was able to cut approximately 90 lbs. from the original design, making it safer to install and easier on the tailgate pivot points.
- The district partnered with SCI Forest County to fabricate Air Foils upon request and created an End User Procedure document for organizations interested in ordering Air Foils for their dump trucks. If PennDOT county maintenance organizations want to work with SCI Forest County to fabricate Air Foils, please work through the District Equipment Manager to coordinate.

Cost/Benefit Information

- By partnering with SCI Forest, District 10 reduced the cost of fabricating the Air Foil to approximately \$1,550, a reduction of approximately \$700 from the original steel prototype the district fabricated.
- Use of the Air Foil is not only safer for the travelling public through improved visibility of the trucks, but also safer for operators as it results in less time outside the truck, which could lead to slips, trips and falls.
- Reviewing crash data and reports from the past five years, District 10 noted that approximately half of the hit-from-behind crashes statewide during the winter months referenced that the public could not see the truck from behind. There is a potential with use of the Air Foil that hit-from-behind crashes could be reduced statewide.



1st Snow Event Testing Without Air Foil



1st Snow Event Testing With Air Foil



2nd Snow Event Testing Without Air Foil



2nd Snow Event Testing With Air Foil

Applicability Beyond PennDOT

This concept is also applicable to other transportation entities as well as local government organizations. Using its own experience, for example, PennDOT could educate and encourage local governments on the use of the Air Foil on their truck fleets (through training, marketing, etc.) and benefits of its use, including more efficient and safer winter maintenance operations for both operators and the travelling public.

Next Steps

Next steps include piloting a smaller version of the Air Foil to test whether it yields the same results and increases visibility of the light bar on top of the cabs. This pilot will be conducted in Winter 2025-26. For more information on deploying this innovation, email penndotstic@pa.gov.



NOTE:

- 1) Prime and paint PennDOT Yellow.
- 2) Use only Grade 8 Plated Hardware with Locknuts
- 3) Utilize certified welder.
- 4) Dry fit & Tack weld before final fitting and welding.
- 5) Ideal angle of the face of the foil with tailgate open and secured with chains or fabricated tailgate stop is to be 66–68 degree.
- 6) Radius all sharp edges
- 7) Material: A-36 Steel

TOLERANCES: (UNLESS NOTED)

.XX =±0.1
 .XXX =±0.01
 ANGLES =±2°
 FRACTIONS =±1/16"

DWG BY: MG

CHECKED BY:

FILE NO.

DATE: 9-24-2024

SCALE:

THE PENNSYLVANIA DEPARTMENT OF TRANSPORTATION

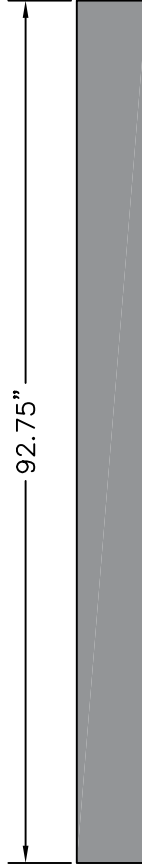
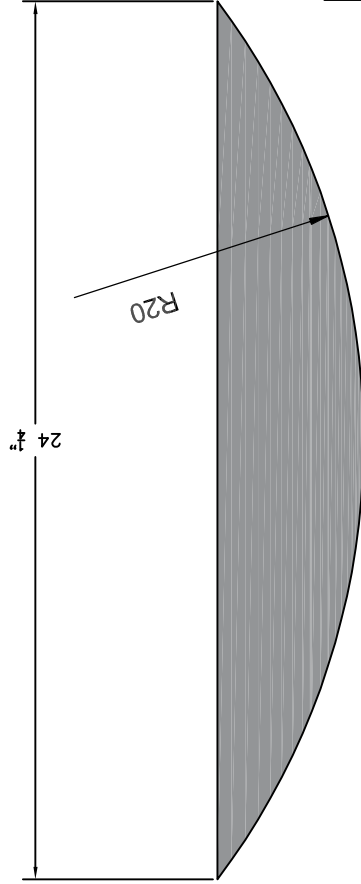


AIR FOIL

SHEET
1/6

DWG NO.

VERSION:
A



NOTE:

- 1) 1/8" steel
- 2) Geometry can be rolled or broken into 1 1/2" to 2" segments.

TOLERANCES: (UNLESS NOTED)

.XX = ±0.1

.XXX = ±0.01

ANGLES = ±2°

FRACTIONS = ±1/16"

DWG BY: MG

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THE PENNSYLVANIA DEPARTMENT OF TRANSPORTATION

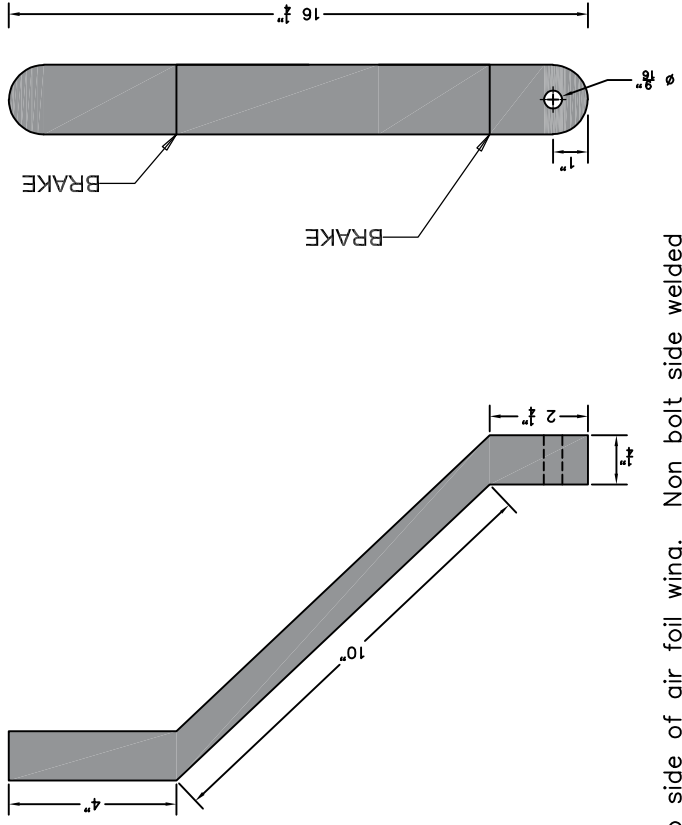


AIR FOIL
"WING"
WITH SIDE
PLATE

SHEET
2/6


DWG NO.

VERSION:
A



TOLERANCES: (UNLESS NOTED)
 .XX = ±0.01
 .XXX = ±0.001
 ANGLES = ±2°
 FRACTIONS = ±1/16"
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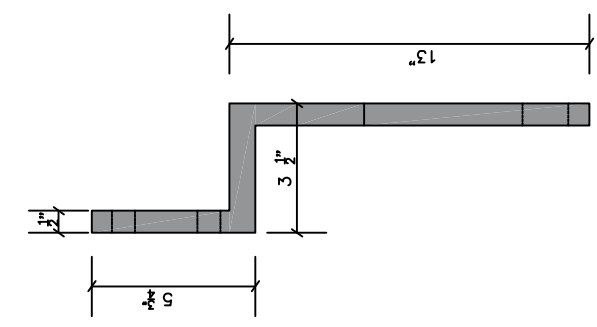
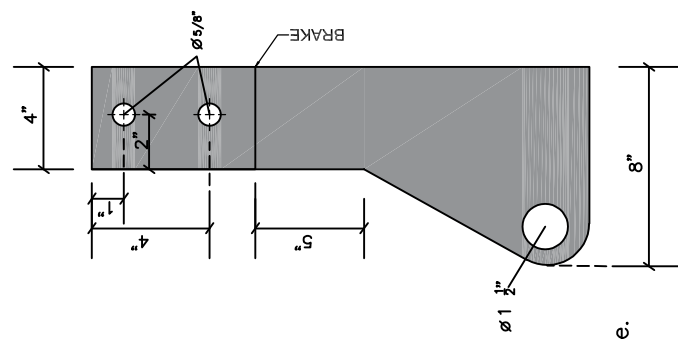
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ANGLE SUPPORT BRACKET

| | | |
|--------------|---------|---------------|
| SHEET 3/6 | DWG NO. | VERSION: A |
|--------------|---------|---------------|

NOTE:
 1) Utilize 1/4" Steel
 2) Hole side bolts to side of air foil wing. Non bolt side welded to side support bracket.

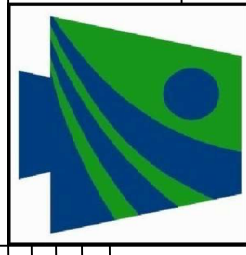


NOTE:

- 1) Utilize 1/2" Steel
- 2) 1 1/2" hole may need bushed depending on tailgate pin size.
- 3) Utilize Grade 8 bolts and lock nuts.
- 4) Mounts to air foil side and larger hole mounts to tailgate pins.

TOLERANCES: (UNLESS NOTED)
 .XX = ±0.01
 .XXX = ±0.001
 ANGLES = ±2°
 FRACTIONS = ±1/16"
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THE PENNSYLVANIA DEPARTMENT OF TRANSPORTATION

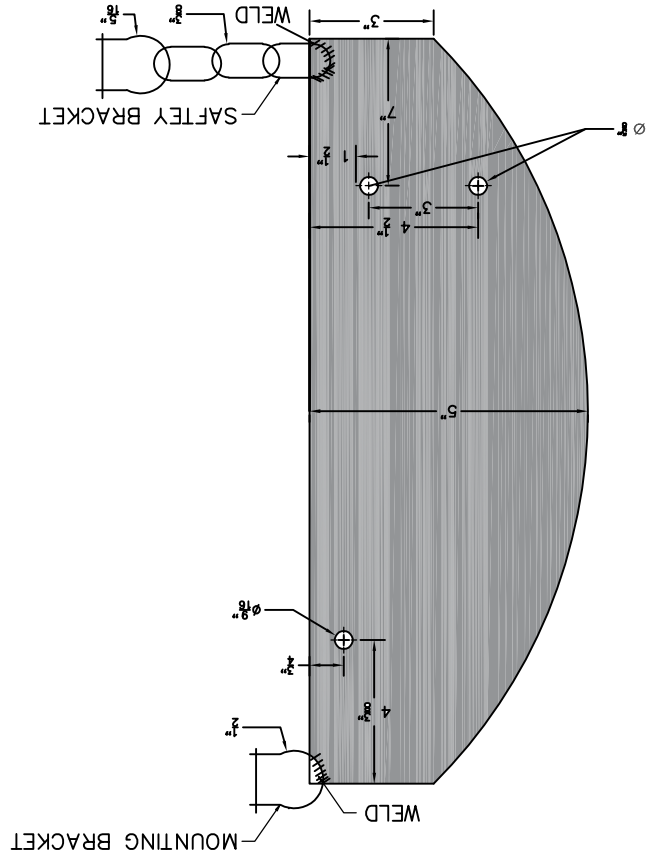


**SIDE
SUPPORT
BRACKET**

SHEET
 4/6

DWG NO.

VERSION:
A



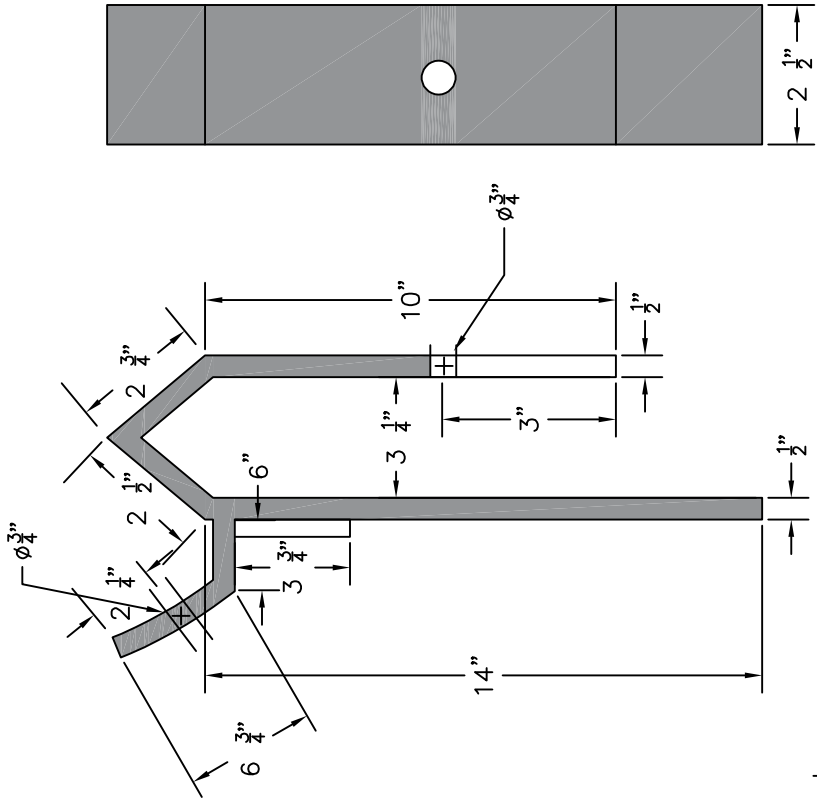
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| THE PENNSYLVANIA DEPARTMENT OF TRANSPORTATION | |
| TOLERANCES: (UNLESS NOTED) .XX = ±0.01 .XXX = ±0.001 ANGLES = ±2° FRACTIONS = ±1/16" | |
| DWG BY: MG | |
| CHECKED BY: | |
| FILE NO. | |
| DATE: 9-24-2024 | |
| SCALE: | |

- NOTE:**
- 1) Utilize 3/8" chain
 - 2) Use 1/2" Clevis for top mounting bracket.
 - 3) Use minimum 5/16" clevis for safety bracket.
 - 4) Chain length will vary depending on make/model.



**SIDE VIEW
AIR FOIL
WING**

| | | |
|--------------|---------|---------------|
| SHEET 5/6 | DWG NO. | VERSION: A |
|--------------|---------|---------------|



- NOTE:
- 1) Utilize 1/2" Steel
 - 2) Brake where applicable. Weld all other joints.

TOLERANCES: (UNLESS NOTED)

.XX = ±0.1

.XXX = ±0.01

ANGLES = ±2°

FRACTIONS = ±1/16"

DWG BY: MG

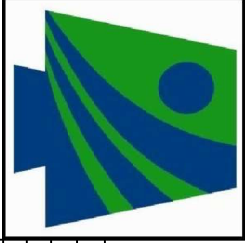
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FILE NO.

DATE: 9-24-2024

SCALE:

THE PENNSYLVANIA DEPARTMENT OF TRANSPORTATION



TAILGATE
SUPPORT

SHEET
6/6

DWG NO.

VERSION:
A