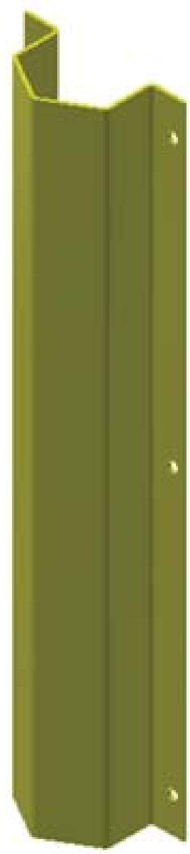
PIPE GUARDS

BPGWM Series



Passenger Car Crash Rating: 5 mph

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BEACON®

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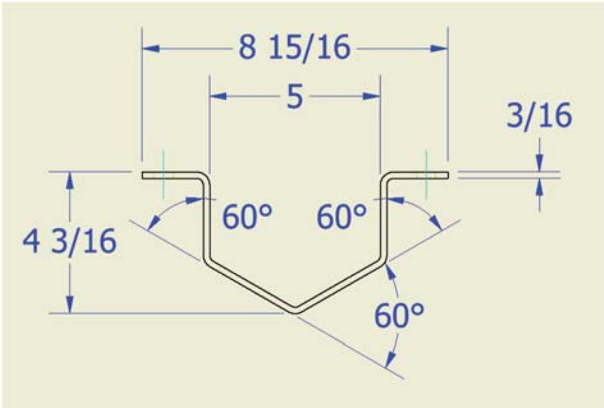
Background:

Pipe Guards are steel safety equipment used to protect vulnerable pipes from vehicular collisions. Beacon Industries used the BPGWM236 as a model number to determine the 5mph crash rating.

Methodology:

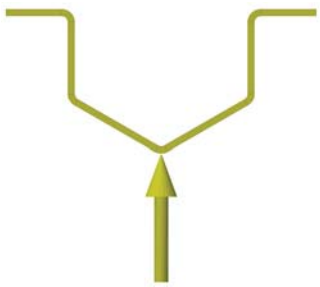
Autodesk Inventor's Finite Element Analysis (FEA) program computes the deflection of a part given the following variables: Part Geometry, Input force magnitude and direction, and Constraints on the part.

Inventor's Sheet Metal Application was used to model the BPGWM236. The material thickness was set to 3/16" and the bend radii were set to the programs default values. The dimensions of the Pipe Guard were based off of the standard Pipe Guard design.



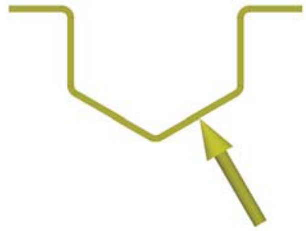
The study includes 4 different loading conditions. The 4 loading conditions were chosen based on worst case impact locations for each face.

Load condition 1 was a point load halfway between the top and bottom and directly on the front radius of the Pipe Guard, directed perpendicular to the centerline of the radius.



Load Condition 1

Load condition 2 was a point load halfway between the top and bottom and in the middle of the right side 60° face of the Pipe Guard, directed perpendicular to the 60° face.



Load Condition 2

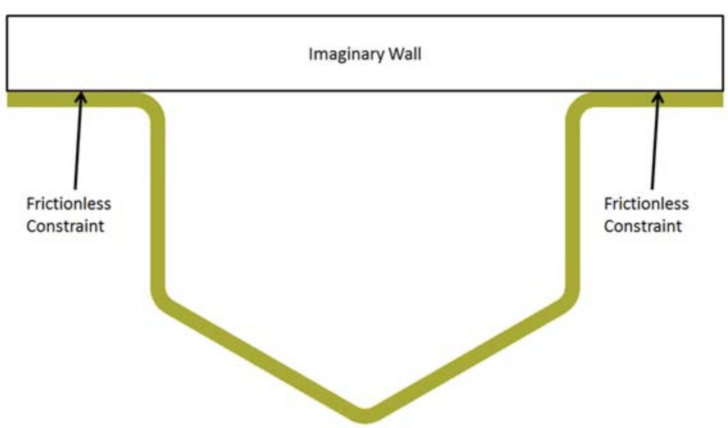
Load condition 3 was a point load halfway between the top and bottom and directly on the right side radius of the Pipe Guard, directed perpendicular to the centerline of the radius.

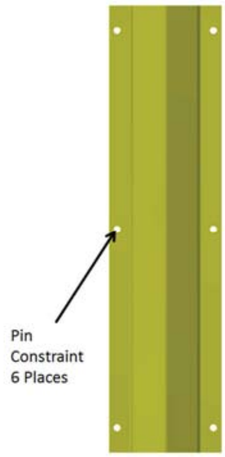
Load Condition 3

Load condition 4 was a point load halfway between the top and bottom and in the middle of the right side 90° face of the Pipe Guard, directed perpendicular to the 90° face.

Load Condition 4

The Pipe Guard was constrained as it would be under normal operation. The two flanges were held in place using a frictionless constraint, which put an imaginary wall behind the Pipe Guard. All 6 anchor holes were held in place using a Pin constraint, which simulates a bolt being placed in that location.





The magnitude of the force was determined using known physics equations combined with an iterative process within the FEA program.

According to Newton's second law of Motion:

Force = Mass x Acceleration

According to ASTM F2656-07, the standard mass of a small passenger car is ~2500 lb, therefore for this equation:

Mass = 2500 lbm or 77.702 lbf

The acceleration must be determined based on the known physics equation:

$$A = \frac{V_f^2 - V_i^2}{2 \times d}$$

Where:

A = Acceleration

V_f= Velocity Final = 0 mph = 0 ft/s

V_i= Velocity Initial = 5 mph = 7.333 ft/s

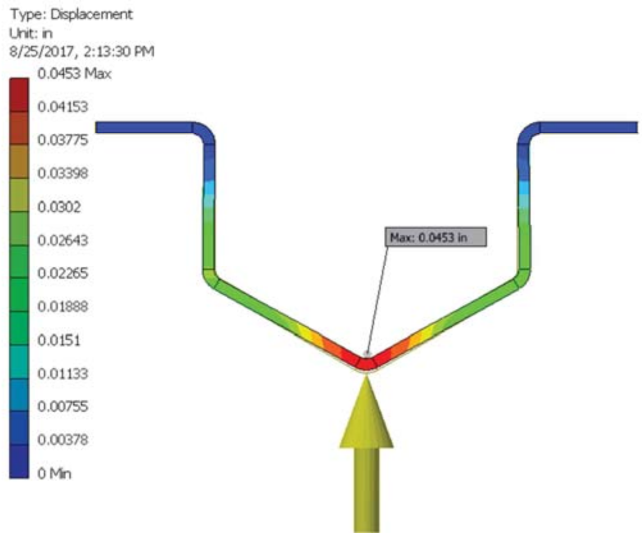
d = Distance traveled = deflection at location of force (as determined by FEA)

According to this equation, the acceleration and impact force increases as the deflection decreases.

According to real world physics, the deflection increases as the impact force increases.

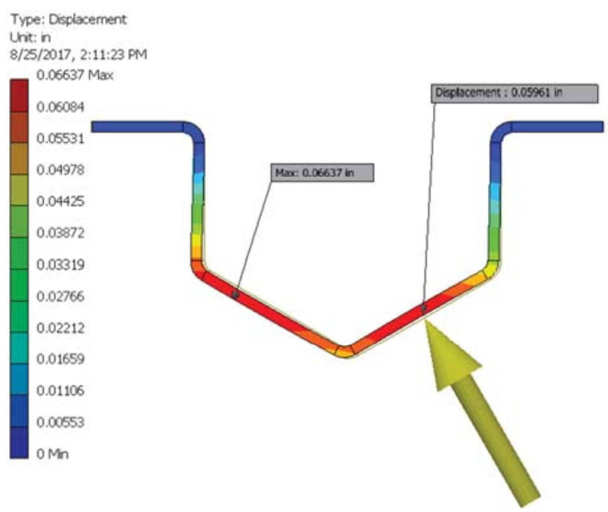
Therefore an iterative process was used to zero in on the point where the calculated force based on the FEA deflection was equal to the FEA input force.

This iterative process was repeated for each different load condition. The results are as follows:



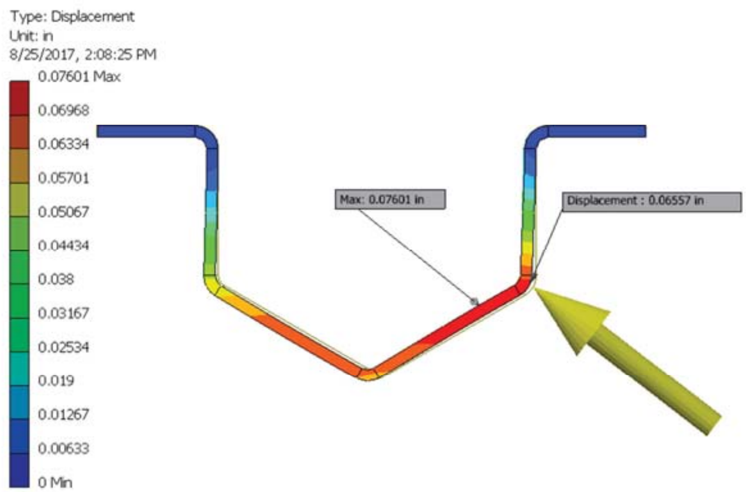
Results Load Condition 1

Deflection at load:	.0453 inches
Max Deflection:	.0453 inches
FEA input force:	46115 lbf
Calculated impact force based on deflection:	46122 lbf



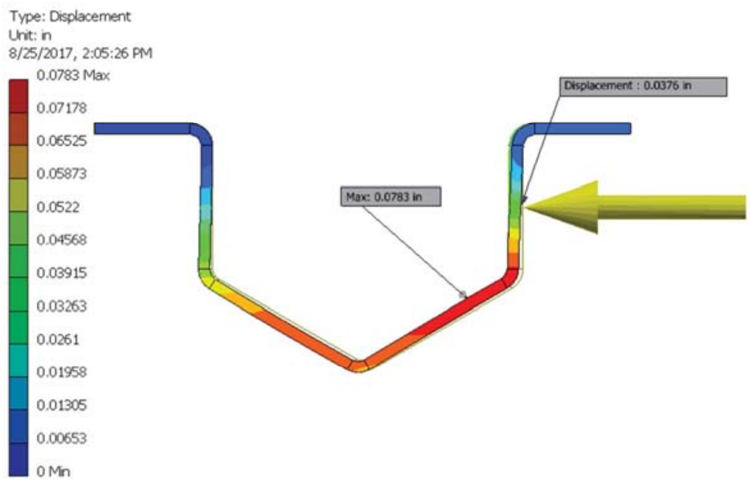
Results Load Condition 2

Deflection at load:	.05961 inches
Max Deflection:	.06637 inches
FEA input force:	35050 lbf
Calculated impact force based on deflection:	35050 lbf



Results Load Condition 3

Deflection at load:	.06557 inches
Max Deflection:	.07601 inches
FEA input force:	31875 lbf
Calculated impact force based on deflection:	31864 lbf



Results Load Condition 4

Deflection at load:	.0376 inches
Max Deflection:	.0783 inches
FEA input force:	55555 lbf
Calculated impact force based on deflection:	55567 lbf

Conclusion:

The under the worst case load condition given a 2500 lb car traveling 5 mph, the BPGWM236 only deflects .0783 inches, which is well under the 1-5/16 inch standard gap that this Pipe Guard has between the edge of the guard and the outside of the pipe. The BPGWM236 Pipe Guards can be rated for a 5 mph collision by a small passenger car.