II-VI

Variable Radius Mirrors (VRMs)

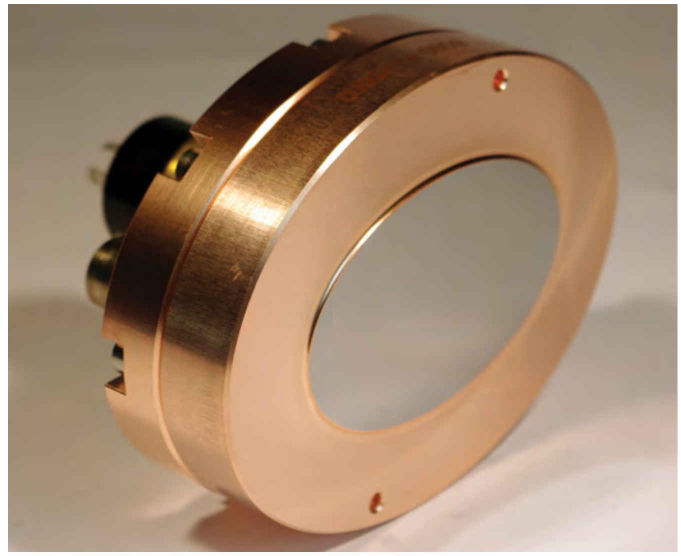
DYNAMICALLY CHANGE BEAM CHARACTERISTICS ON THE FLY

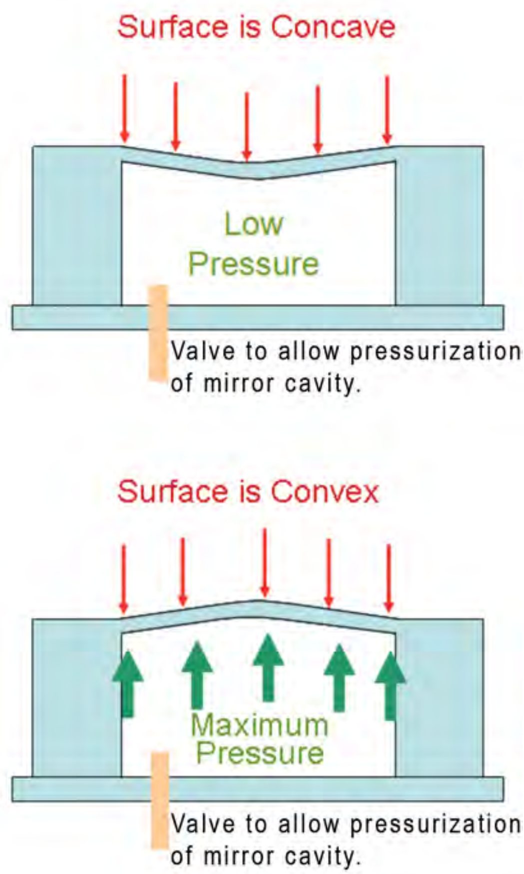
Variable Radius Mirrors (VRMs)

The II-VI Variable Radius Mirror (VRM) allows users to dynamically change their beam characteristics on the fly. By controlling the VRM's radius of curvature with water or air pressure, users can adjust the laser beam divergence.

VRM's allow focus depth adjustment during material piercing; this produces optimum process speed. It also allows flying optics systems manufacturers to compensate for focal length variations across the working table. This is especially important with large working tables, where beam divergence or beam diameter could be changing as the optical path moves across the work area.

VRM's can be manufactured in a large variety of configurations and can be custom designed for specific applications.





Features

- Adaptive surface allows control of beam divergence and focus spot size.
- II-VI's highest reflectivity MMR-A coating provides minimal power loss.
- Proven coating reliability for more than 1,000,000 cycles.
- Available in a variety of radius ranges.
- Mirrors can be used for either water or air pressurization to control radius.
- Pressure ranges up to 12 bar can be used (dependent upon desired radius).
- Available for use at near normal incidence and 45 degree angle of incidence.
- Available in a number of standard configurations.
- Mirrors can be custom designed to desired specifications.

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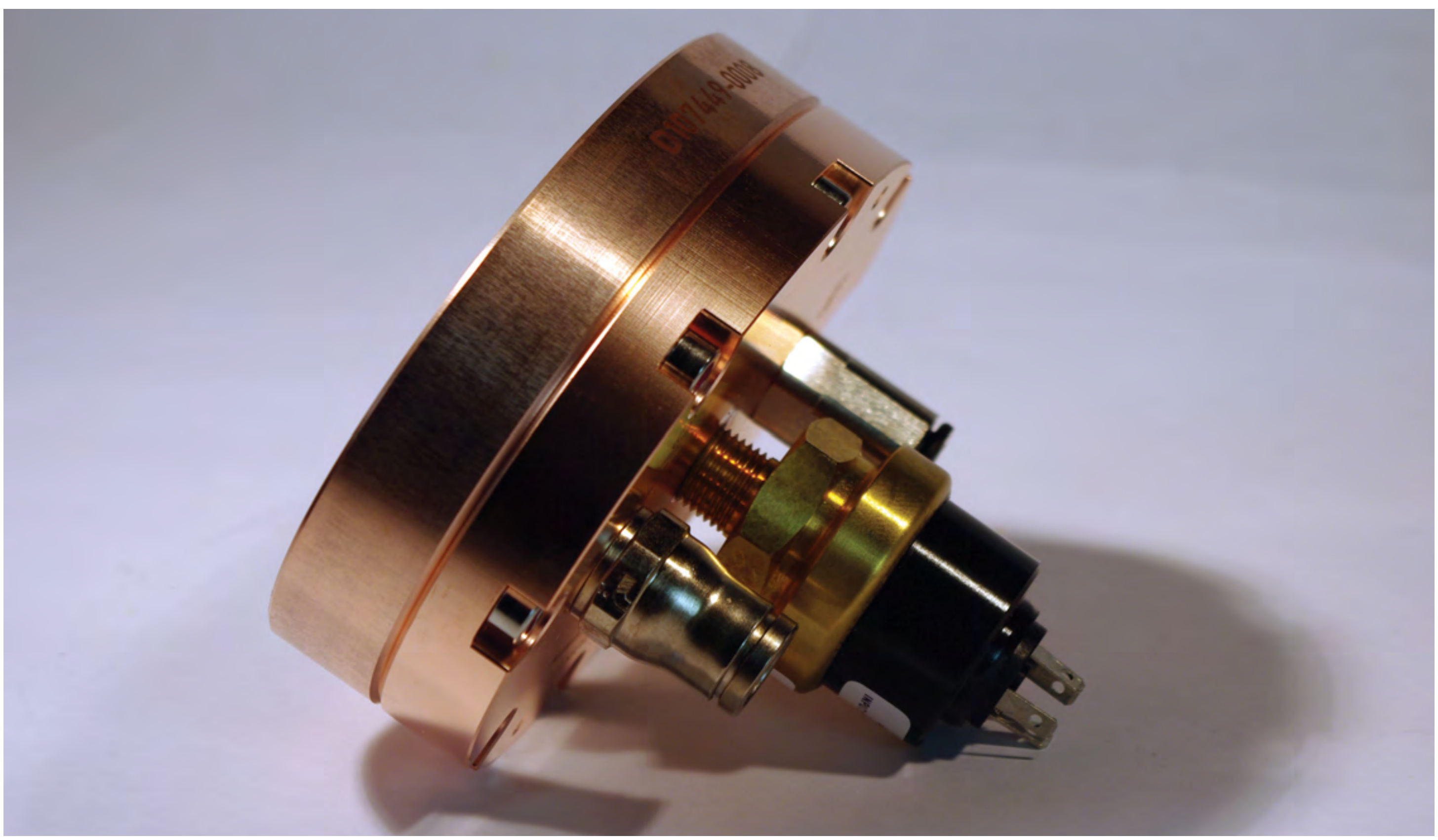
Specifications

Substrate:	Copper	
Standard Mirror Diameter	57.1mm	79.0mm
Usable Clear Aperture	35mm	50mm
Radius Range*	6 MCC - 6 MCX 3 MCC - PO PO - 3 MCX 1.2 MCX - 1.6 MCX	
Pressurization Method	Water	Air
Pressurization Range (bar)	3-12	0-12
Angle of Incidence	Near normal	45 degrees
Pointing Stability	≤ 30 arc seconds	
Reflectivity with MMR-A Type Coating	> 99.8% @ 10.6μm	

* Customized radius range available
M is meter, CC is concave, CX is convex, PO is plano



Variable Radius Mirrors (VRMs)

Applications

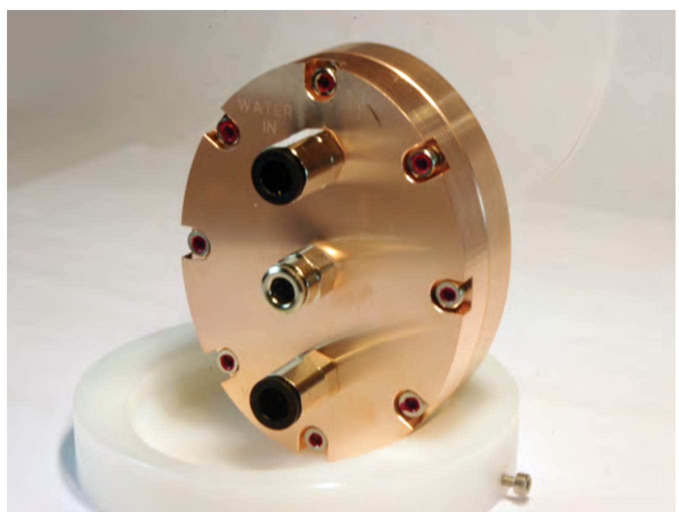
Overview

The evolution of laser cutting continues to drive the need for better control and simultaneous flexibility. The introduction of the variable radius mirrors affords the laser integrator both of these goals. Whether it's maintaining control of the divergence of the laser beam over the entire cutting area or it's adjusting the depth of focus of the lens; variable radius mirrors can bring a new dimension to the 2D or 3D laser cutting process.

Dynamic Beam Divergence Control

One challenge for the laser integrator has been maintaining consistent cutting quality at the work piece over the entire cutting area. A major cause of variation stems from the effect of divergence as a function of path length. For a flying optic system, the change in path length from one point on the cutting plane to another produces a corresponding change in the beam diameter. This can result in changes to the depth of focus and spot size.

Variable Radius Mirrors provide an elegant method for controlling this variation. Implementation of a VRM near the resonator can compensate for the changes in the path length. This enables the user better control of the lens focus over the entire cutting area. For even better control, a second VRM can be used further down stream to produce an autocollimator. The result is more consistent cutting results and a better end product.

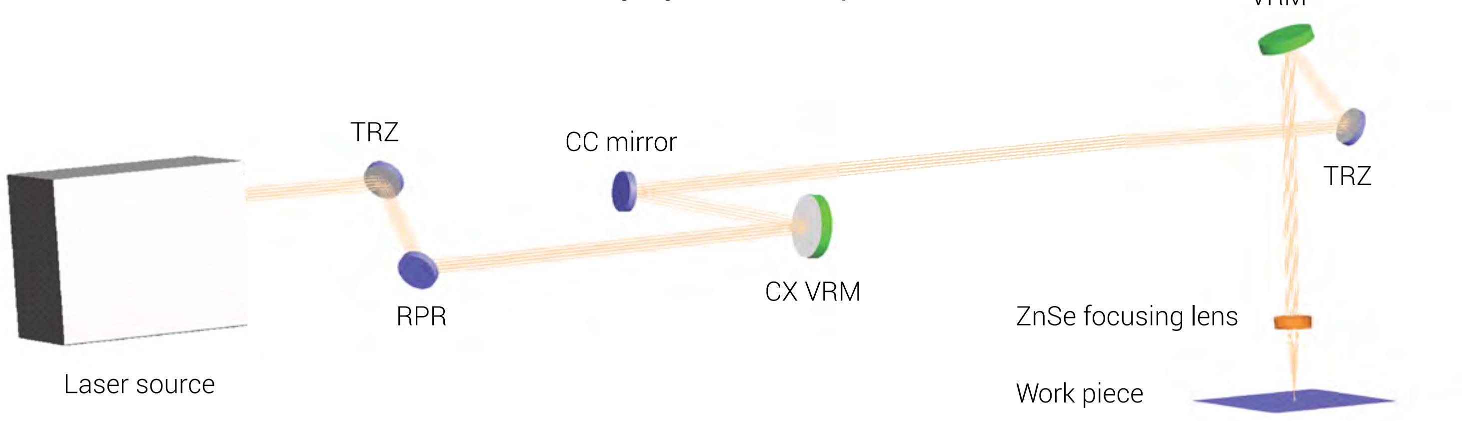


Dynamic Focal Length Adjustment

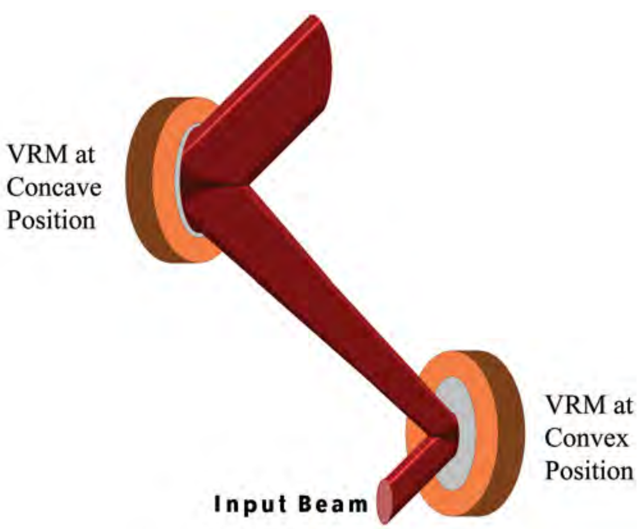
Another benefit afforded by the use of variable radius mirrors is the ability to dynamically adjust the focal length of the lens. Changing the divergence of the beam into the focusing lens causes a corresponding change in focal length. This greatly increases the flexibility of a system without changing the focusing lens. For example, the parameters of the system can be adjusted for cutting different thicknesses of material. This saves the downtime that would be necessary for changing the lens.

Variable Radius Mirrors (VRMs)

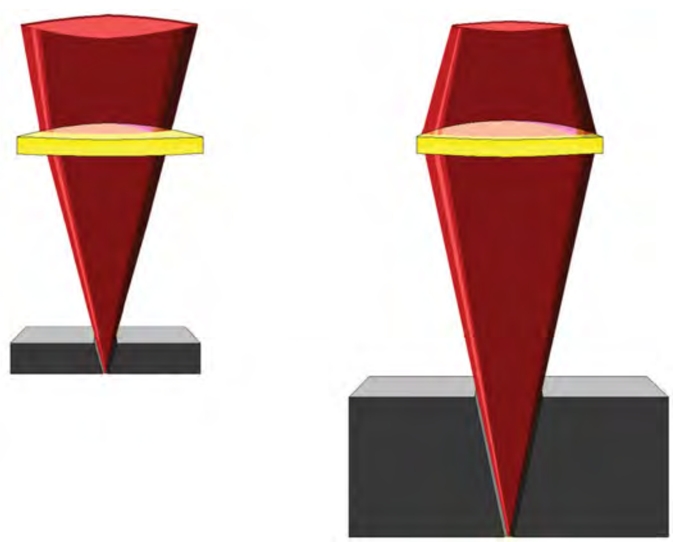
Beam Delivery System Example



Example of a Variable Collimator



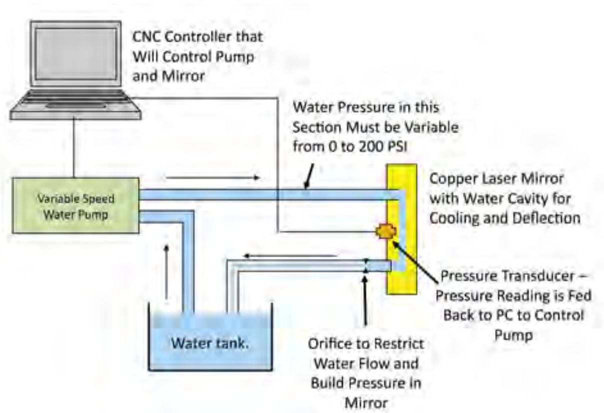
Example of a Dynamic Focus Adjustment



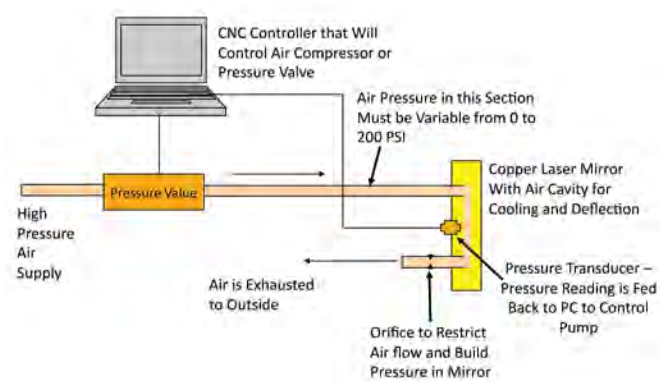
Variable Radius Mirrors (VRMs)

Designs

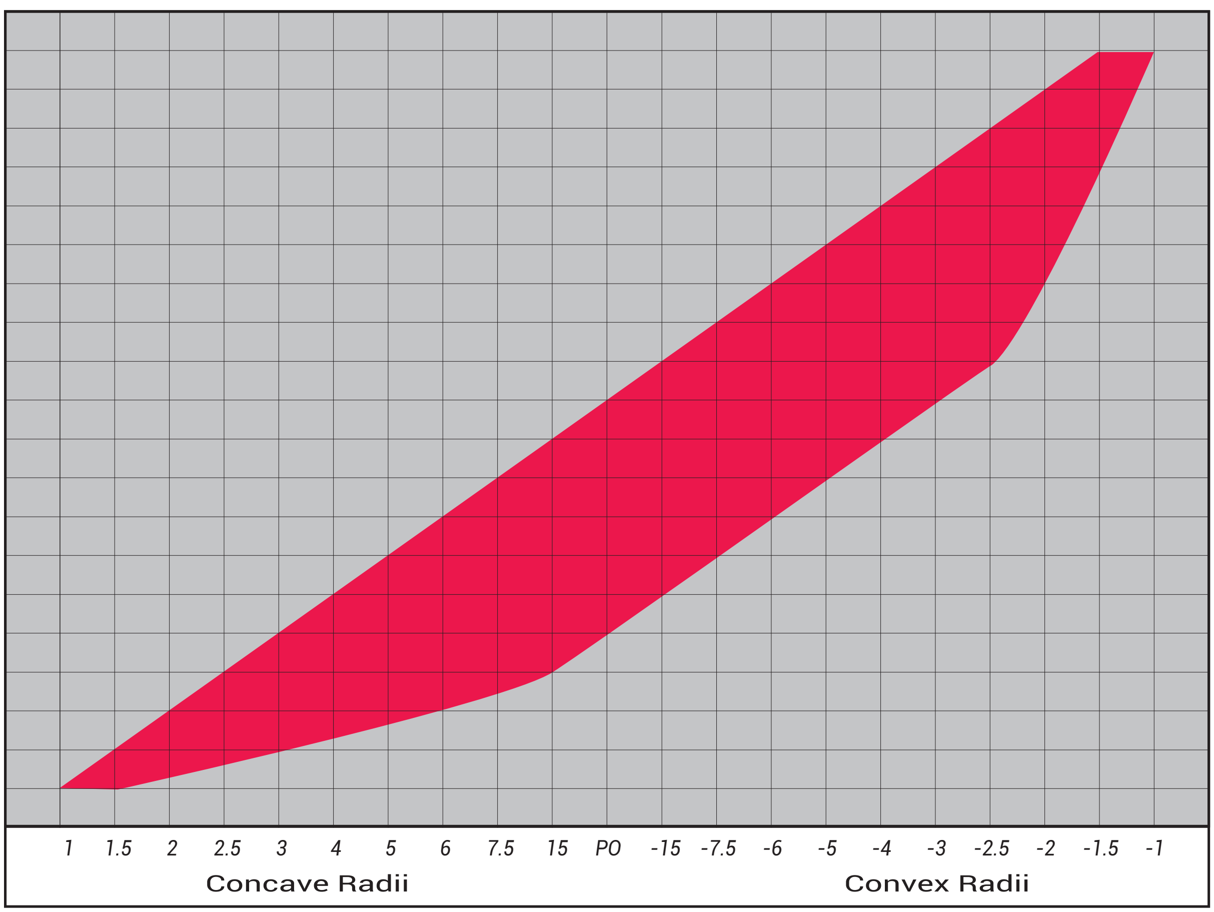
Example Water Cooling Method



Example Air Cooling Method



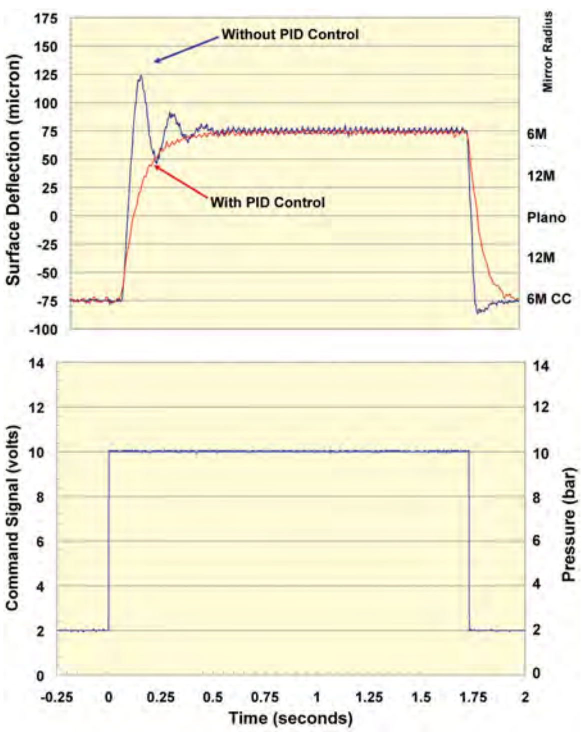
Example Radius Usage Range



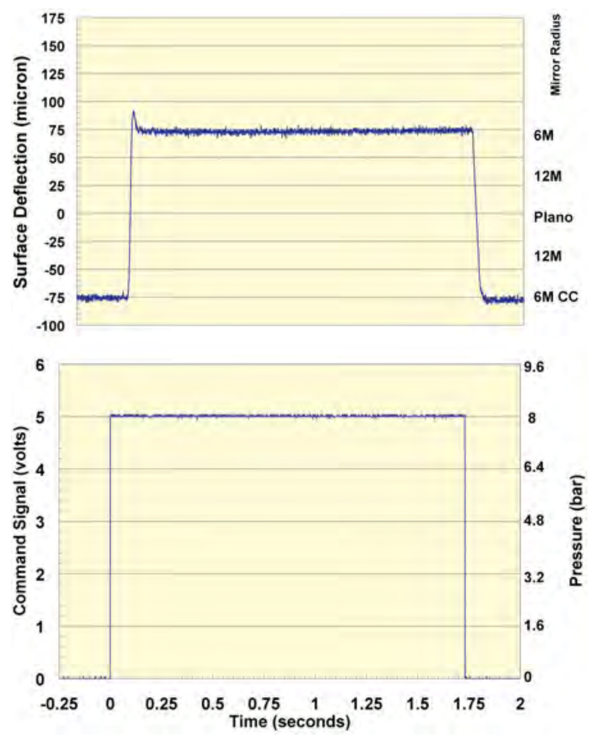
Variable Radius Mirrors (VRMs)

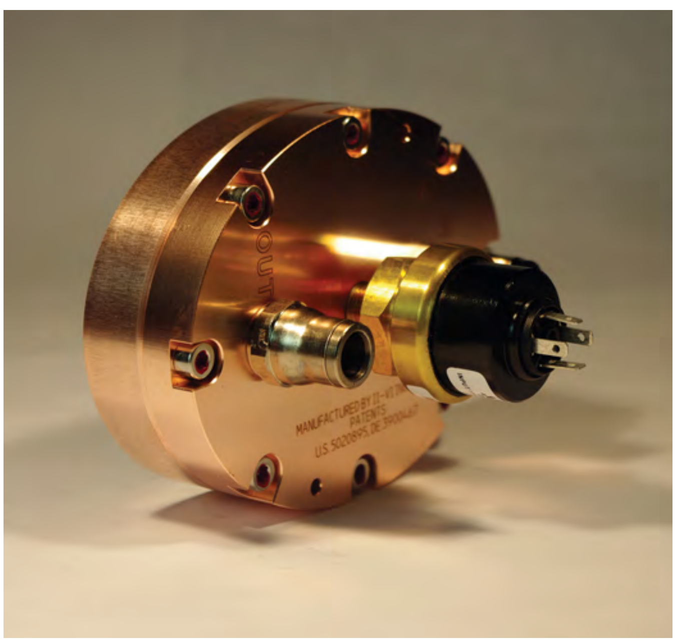
Designs

Typical Step Response for Water Pressurized VRM

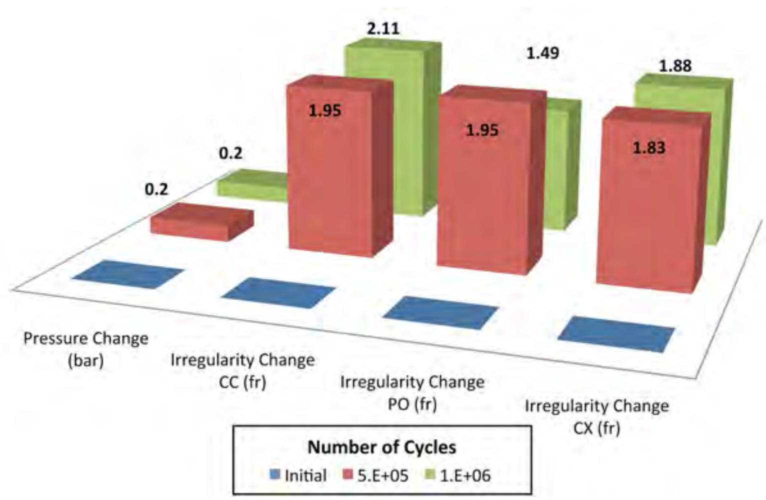


Typical Step Response for Air Pressurized VRM





Fatigue Data



Variable Radius Mirrors (VRMs)

Base Configurations

VRM-0-100001 — Page 9

- Near Normal Incidence
- Water Pressurized

VRM-45-100001 — Page 10

- 45 Degree AOI
- Water Pressurized

VRM-45-100002 — Page 11

- 45 Degree AOI
- Air Pressurized

VRM-45-400001 — Page 12

- 45 Degree AOI
- Water Pressurized

VRM-45-400002 — Page 13

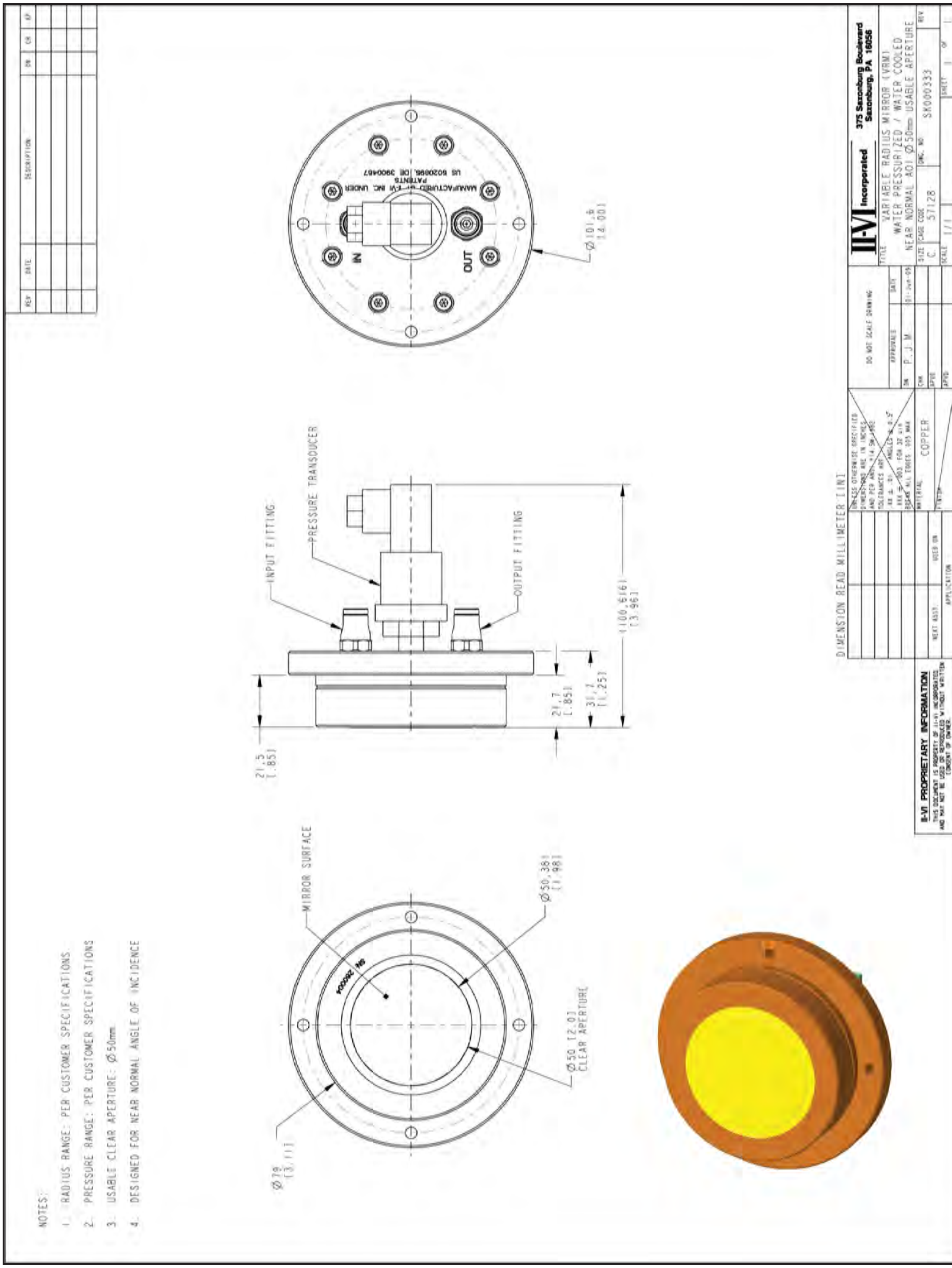
- 45 Degree AOI
- Air Pressurized

VRM-45-600001 — Page 14

- 45 Degree AOI
- Water Pressurized

VRM-45-600002 — Page 15

- 45 Degree AOI
- Air Pressurized



VRM-0-100001

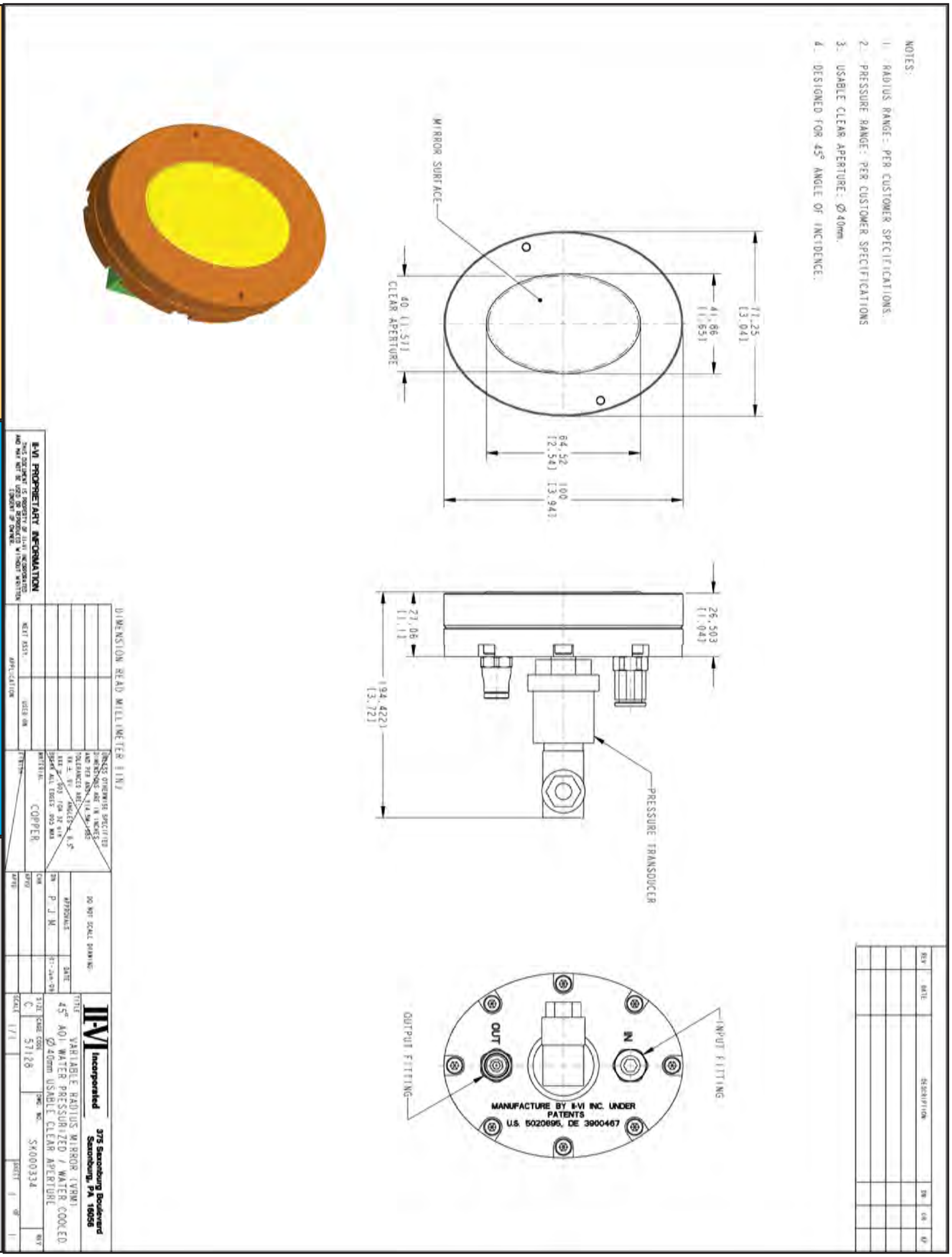
Water Pressurized

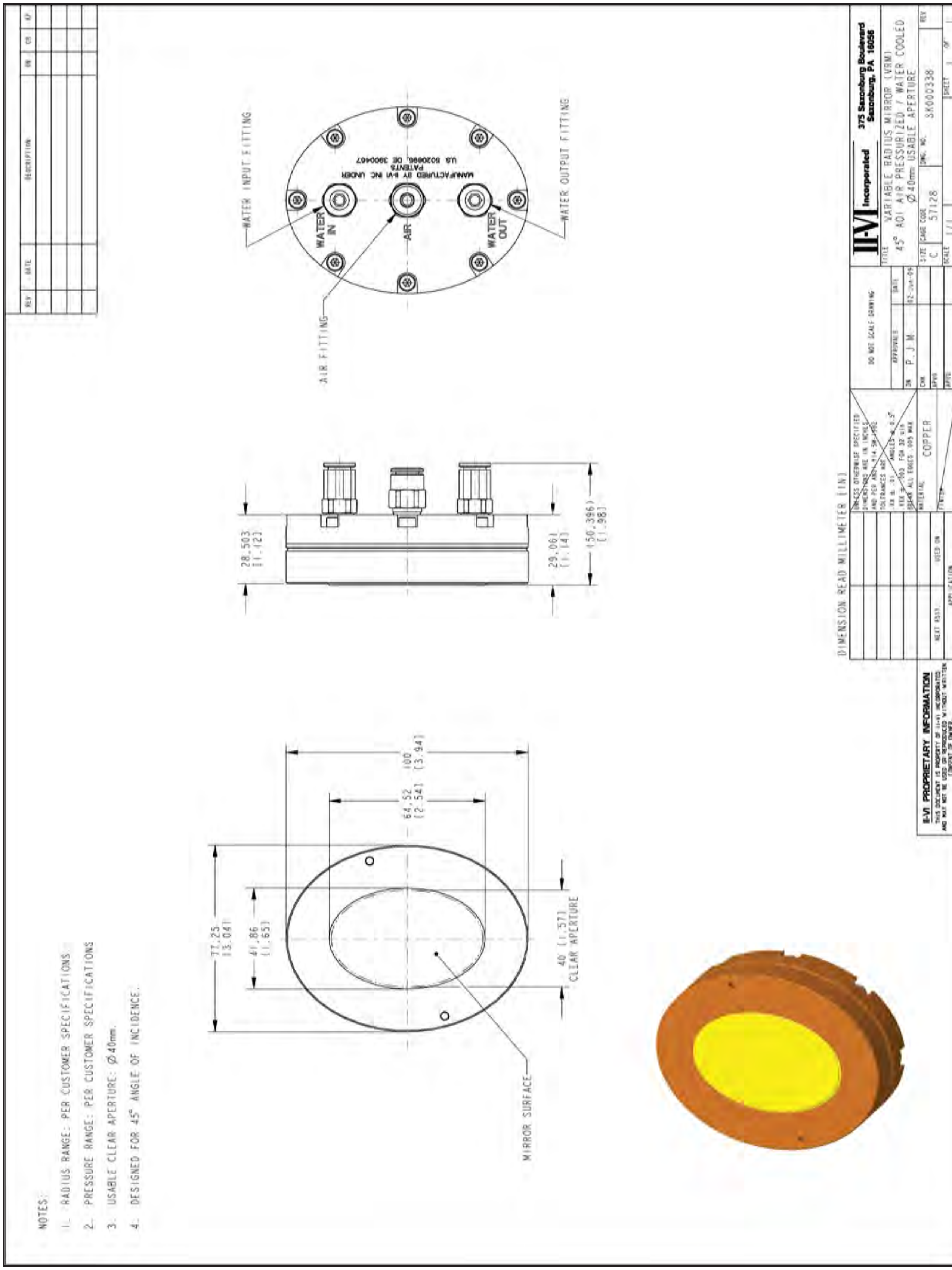
Near Normal Incidence

45 Degree AOI

Water Pressurized

VRM-45-100001





VRM-45-1000002

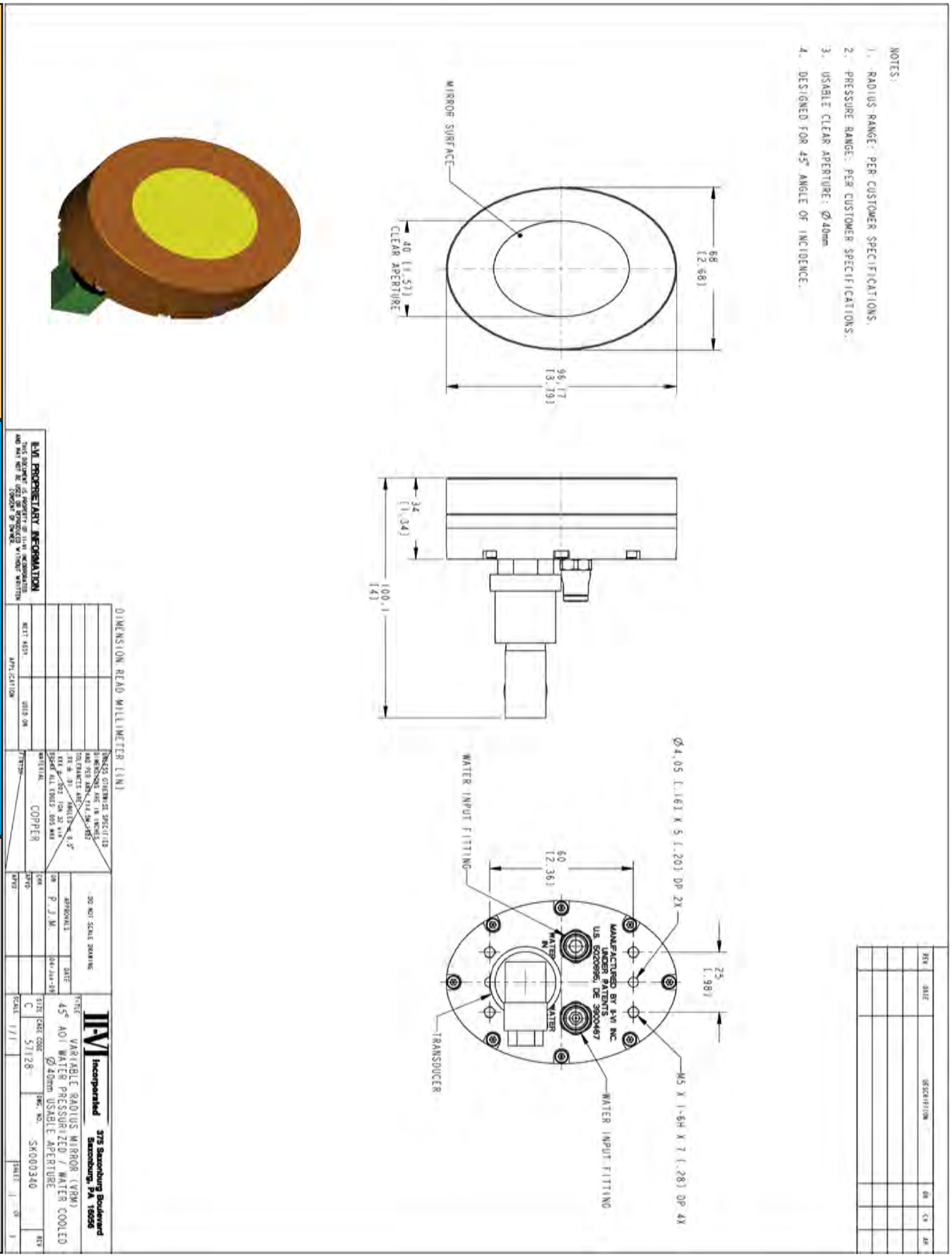
Air Pressurized

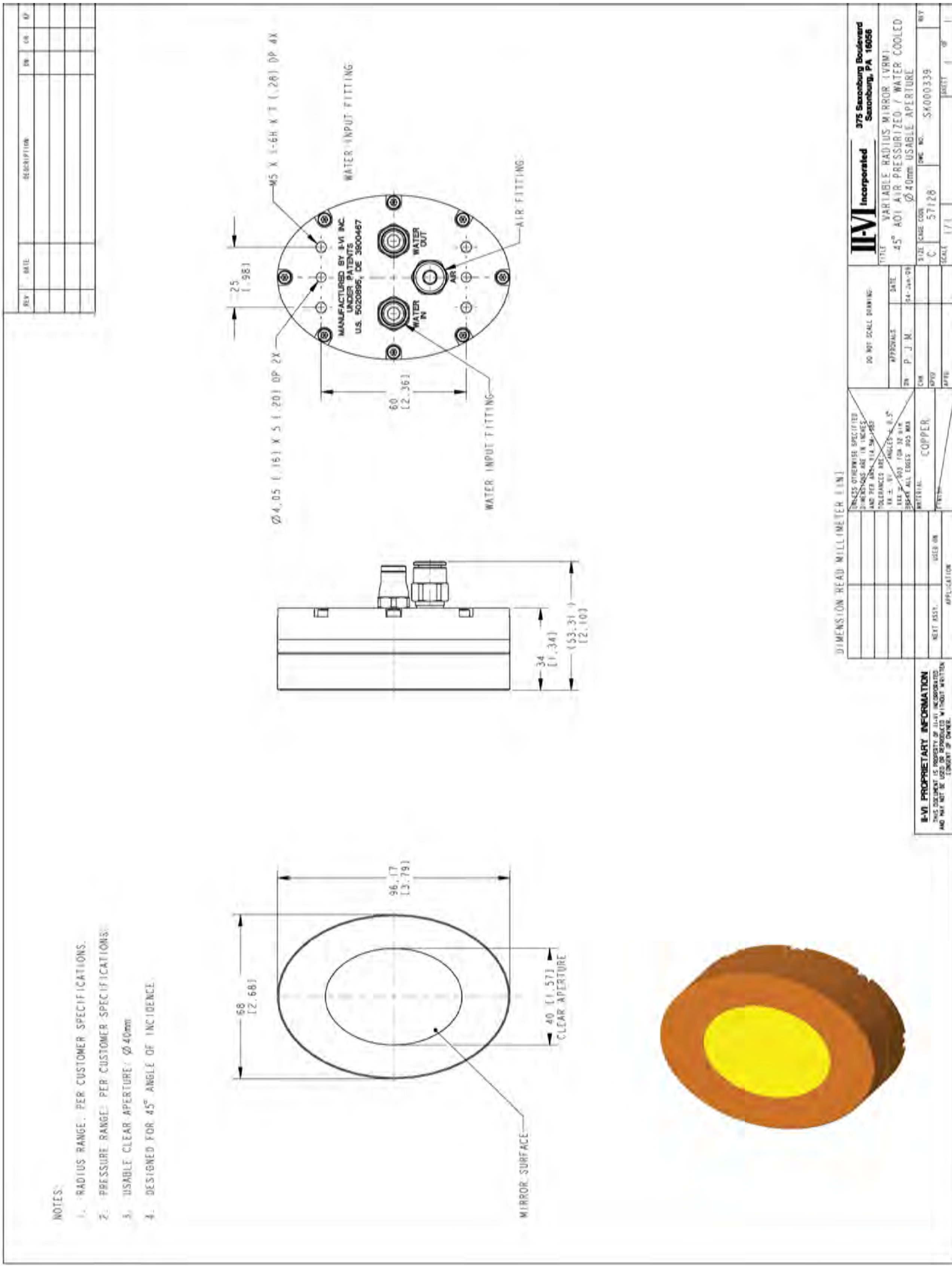
45 Degree AOI

45 Degree AOI

Water Pressurized

VRM-45-400001





45 Degree AOI

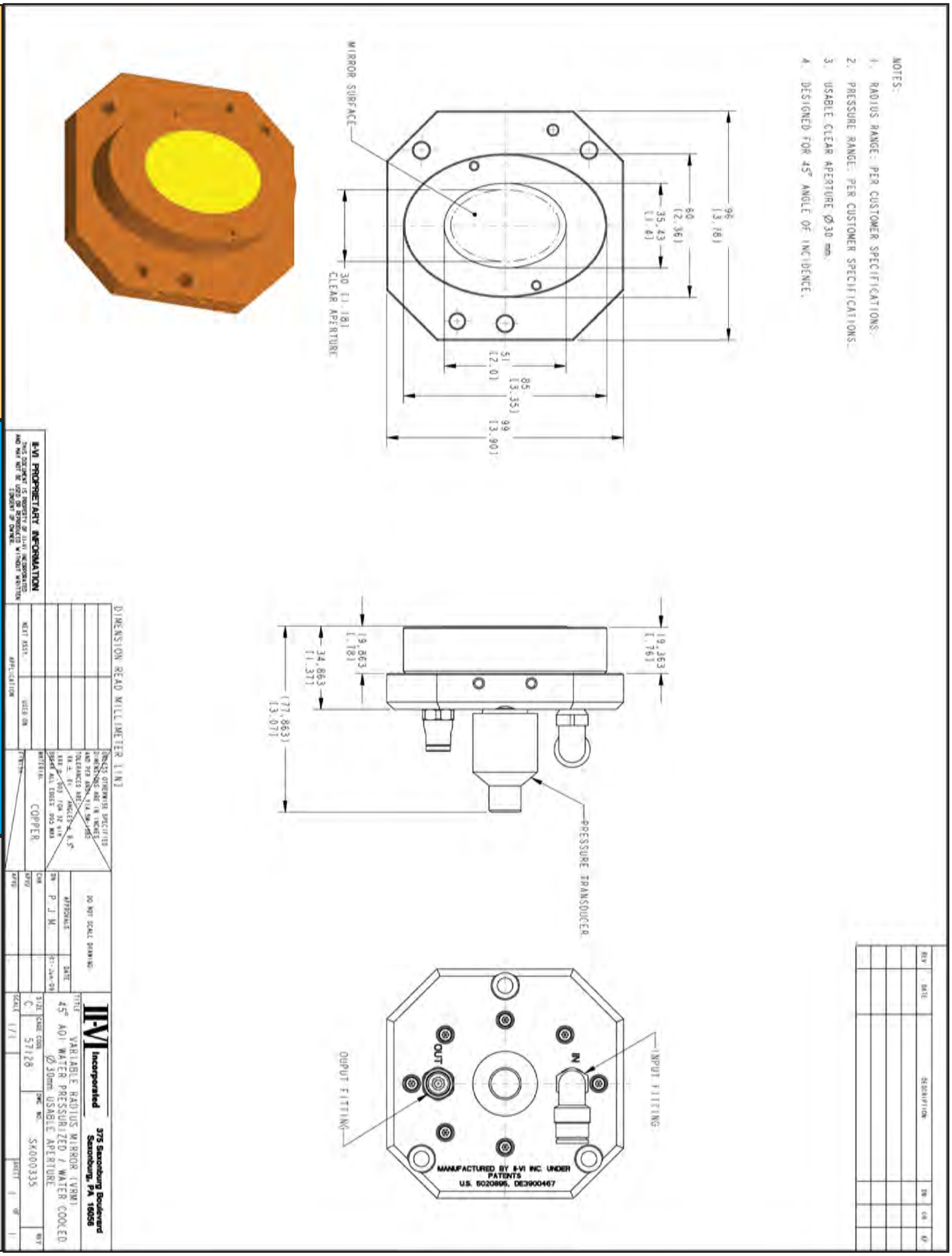
Air Pressurized

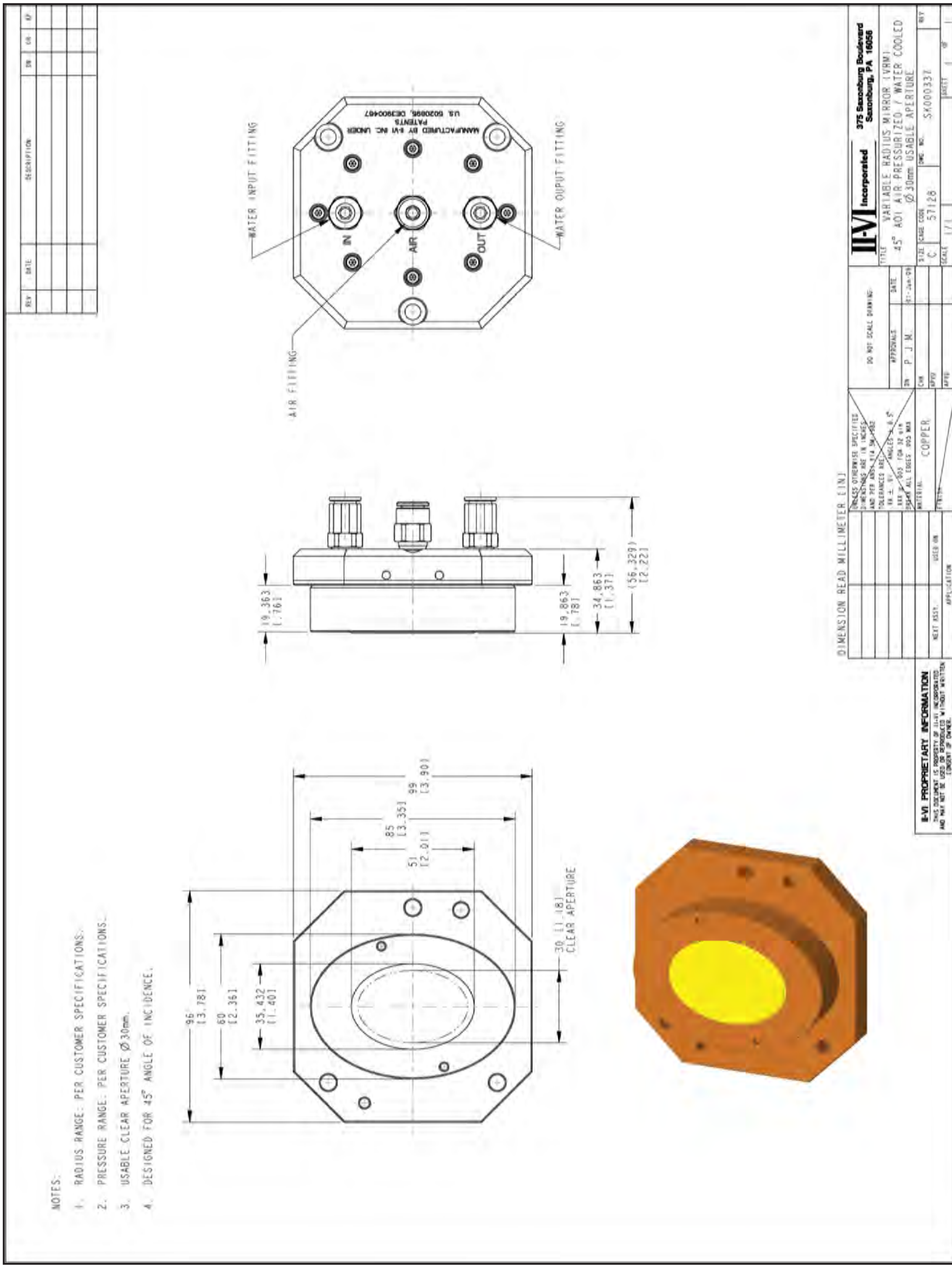
VRM-45-400002

45 Degree AOI

Water Pressurized

VRM-45-600001





VRM-45-600002

Air Pressurized

45 Degree AOI