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MECHANICAL DETAILS FOR CONSTRUCTION OF A DRY AEROSOL DEPOSITION CASE

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14. ABSTRACT

This document contains detailed design information for assembly of a Dry Aerosol Deposition Device (DADD). This report is further to technical report AFRL-RX-TY-TP-2008-4617, ADA492108 and technical report AFRL-RX-TY-TR-2008-4592, ADA502105; work unit DODT0056.

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1. SUMMARY

This document contains detailed design information for assembly of a Dry Aerosol Deposition Device (DADD). This report is further to technical paper AFRL-RX-TY-TP-2008-4617, ADA492108 and technical report AFRL-RX-TY-TR-2008-4592, ADA502105; work unit DODT0056.

2. INTRODUCTION

Growing threats of biological contamination of infrastructure and equipment led to the development of antimicrobial surfaces/coatings. Standard methods to test efficacy of such materials have applied microbial agents suspended in aqueous buffers. These surfaces, however, will likely be contaminated via aerosol exposure, so antimicrobial efficacy measurements using microbes deposited as aerosols will provide a more-representative test platform. A settling chamber is the most common method for depositing biological aerosols on surfaces, but it can impose limitations in respect to time and variability of sample loading. In prior work, a Dry Aerosol Deposition Device (DADD) was developed that uses impaction rather than settling to load surfaces with biological aerosols, providing a mechanism for rapid and highly reproducible loading of microorganisms onto surfaces. The DADD was tested with *Bacillus atrophaeus* spores and *Staphylococcus aureus* vegetative cells, deposited to glass coupons at concentrations exceeding 1×10^4 colony-forming units/cm^2. The average coefficient of variation (CV) for sample-to-sample loading within experiments was 13.6% for spores and 6.1% for *S. aureus* cells. The DADD provides a mechanism to load coupons with a highly reproducible challenge of microorganisms. Preliminary validation was performed on glass coupons, but the device can also be used with aluminum, concrete or fabric samples. The DADD was demonstrated to be a relatively simple and inexpensive device that can easily be contained within a 4-foot biological safety cabinet.[1]

3. DESCRIPTION

Technical details for operation, validation, and analysis of biological aerosols using the DADD are provided elsewhere.[1] Preliminary construction of the DADD was reported previously, but detailed fabrication instructions and mechanical drawings are expanded herein. The DADD device consists of six key components (Figure 1): (1) a Collison nebulizer (BGI, Inc. Waltham, MA), (2) a diffusion dryer (Air Techniques International, Owens Mills, MD), (3) an M20-3GF02N5EG5 diverter valve (GC Valves, Integrated Process Solutions, Kennesaw, GA), (4) a nozzle and (5) a dispensing system. All components are assembled on a support stand (6) and connected to a control system (not shown). Dimensions in all drawings are US inch series (Imperial Units). Materials used for the construction of components referenced by the included mechanical drawings were aluminum alloy unless specified on the individual drawing.

The Collison nebulizer (1) was modified by welding a stainless steel 3/8-in × 1/2-in National Pipe Thread (NPT) pipe bushing (SS-8-RB-6, Swagelok® Company) to the outlet pipe. This allowed use of a compression fitting (SS-810-7-8, Swagelok® Company) for connection to the diffusion dryer (Model 250, Air Techniques International (ATI)). The ATI diffusion dryer (Figure 2) uses plastic housing and end caps that are not suitable for steam sterilization. To achieve compatibility, new housing and end caps were fabricated from stainless steel and brass, respectively, to replace the original components (Figure 3 and Figure 4).

Parts List	
ITEM	PART NAME
1	Nebulizer
2	Dryer
3	Valve
4	Nozzle
5	Dispensing System
6	Support Stand

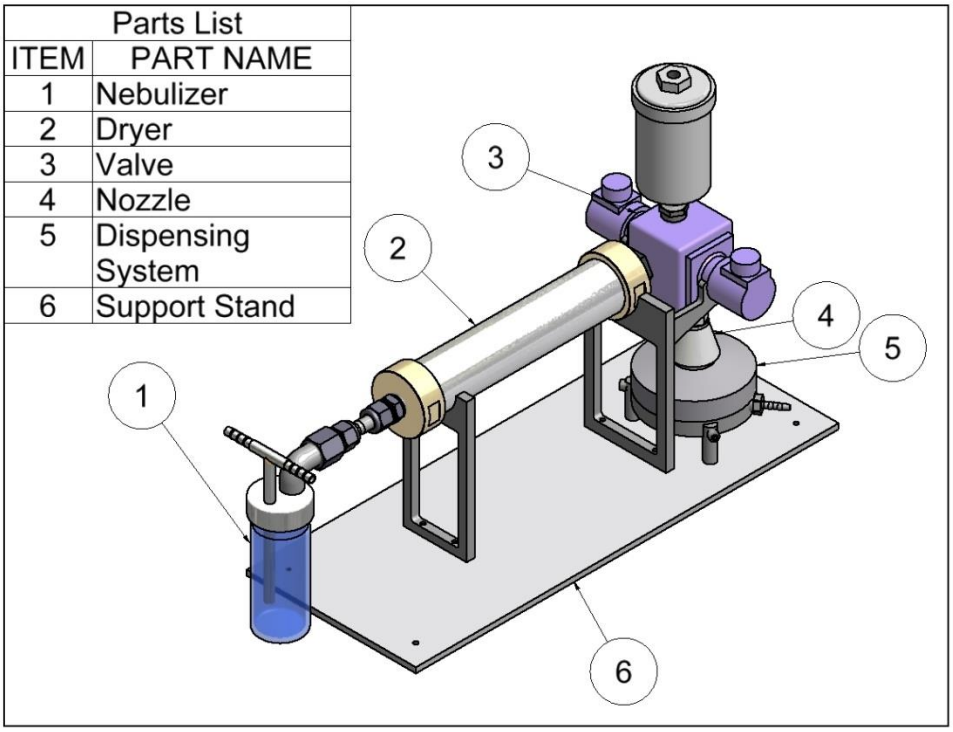

Figure 1. Key components of a DADD

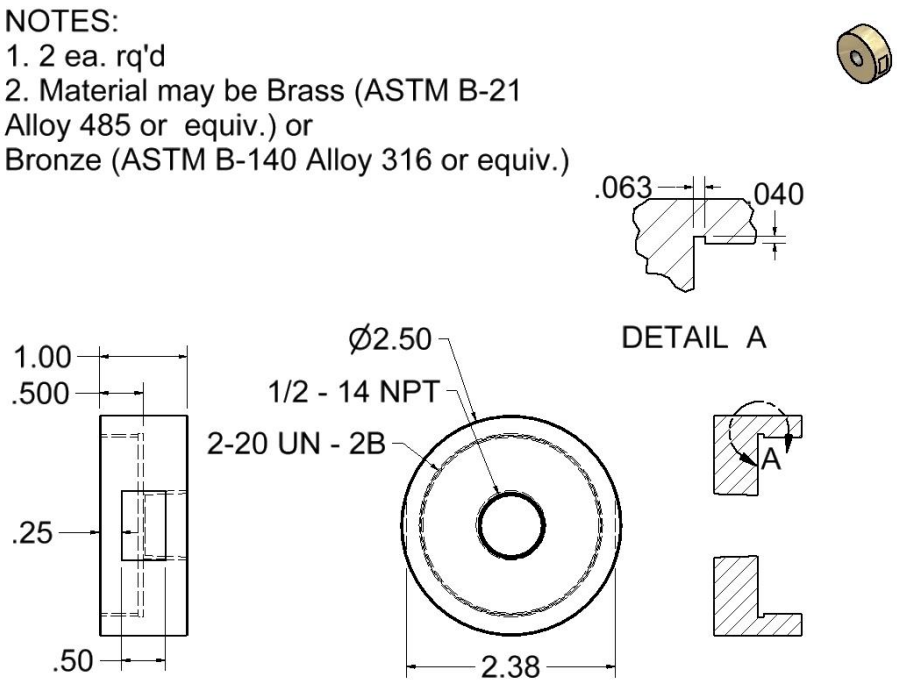

Figure 2. Mechanical drawing of replacement end cap; dimensions are given in inches

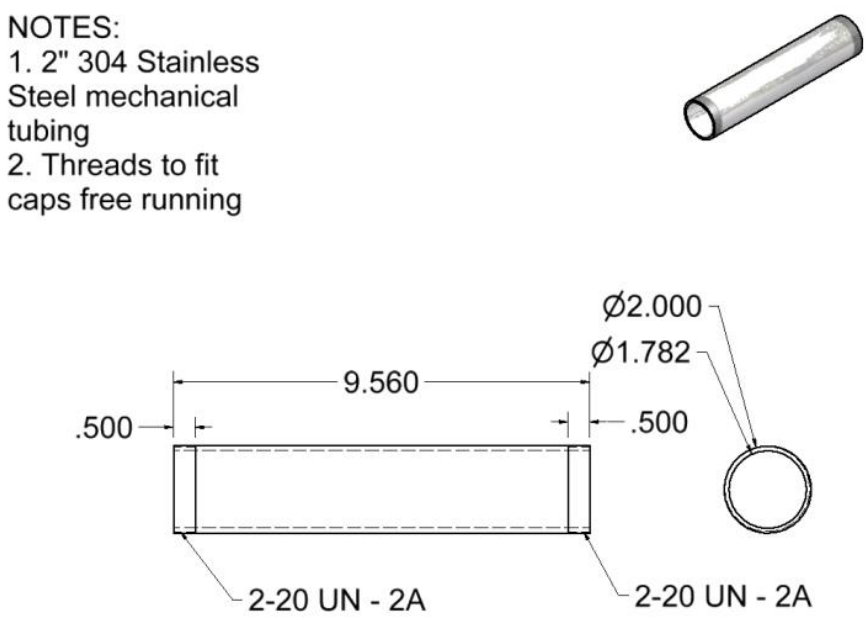

Figure 3. Mechanical drawing of replacement housing

Compression fittings (SS-810-1-8, Swagelok® Company) were used to connect the diffusion dryer to the nebulizer. A 1/2-in × 3/4-in NPT reducing pipe nipple (SS-12-HRN-8, Swagelok® Company) was used to connect the diffusion dryer to the inlet port of the diverter valve. The diverter valve was then attached to the diffusion dryer as described above.

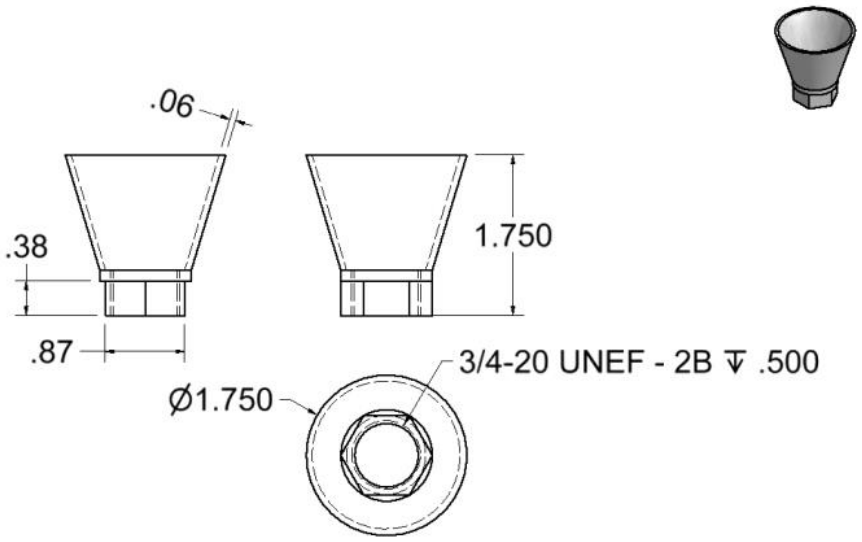

Figure 4. Mechanical drawing for nozzle (DADD component 4)

The normally open outlet of the diverter valve was positioned pointing upward and fitted with a HEPA filter (USA Numatics, Inc, Novi, MI) using a 1/2-in × 3/4-in NPT reducing pipe nipple (SS-12-HRN-8, Swagelok® Company). The normally closed outlet was positioned pointing downward and fitted with a nozzle fabricated from aluminum stock(Figure 4) and using a modified male connector (SS-810-1-12, Swagelok® Company). The modification consisted of simply boring the male connector through to a 0.500-in diameter.

A control unit (Figure 5) was constructed to control the duration and interval of the diverter valve actuation and the rotation of the dispensing system.

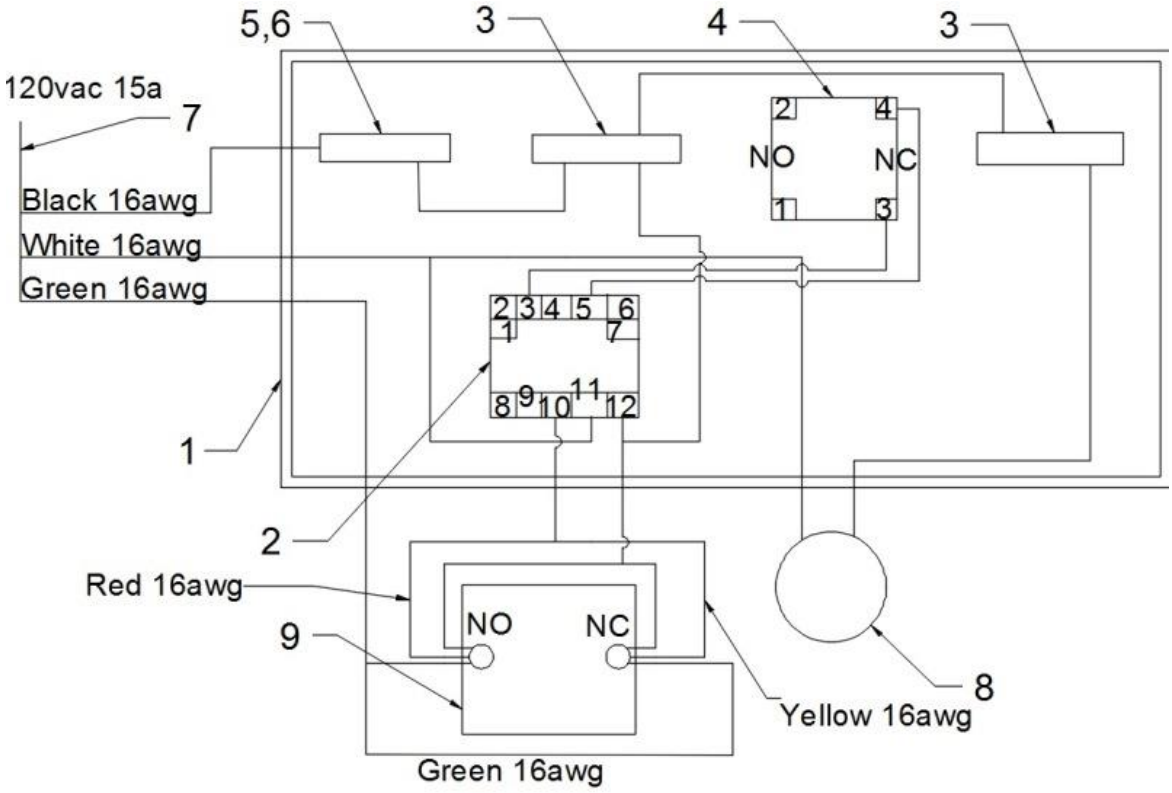

Figure 5. Schematic of control unit connection

Key: (1): Enclosure (Hubbell Wiegmann, Freeburg, IL, part # HW-100806CHSC), (2): Timer (Koyo Electronics, Tokyo, Japan, part # KT-V4S-D), (3): Switch (Hawkes Electronics, Wheeling, IL part #CA04J137207Q), (4) Switch (Baco Controls, Inc., Baldwinsville, NY part # unknown),(4.1) Contactor Kit (Baco Controls, Inc., Baldwinsville, NY part # unknown (5): circuit breaker (Schurter Inc. Santa Rosa, CApart # 4430.2309), (6): circuit breaker cover (Schurter Inc. Santa Rosa, CA part # 4430.013), (7): power cord (Electri Cord Mfg Co. Eagan, MN part # PCLT66609), The following not shown in drawing, but used to connect components, (8): cord grip (Seacon LLC, Centennial, CO part #69915K54), (9): GC Valve (GC Valves, Integrated Process Solutions, Kennesaw, GA), (10): heat shrink tubing (Insultab Inc, Woburn, MA part # HS-105-3/8 in), (11, 12, 13): power connectors, black, white and green respectively (Anderson Power Products, Sterling, MA part # 1395G1S, 1395G2S, 1395G3S)

The dispensing system is composed of a control switch contained in a controller box, a 20-rpm gear motor (Polyvolt North Haven, CT; part # J206 XMC-6032), and components described in the mechanical drawings (Figure 6–Figure 10).

Parts List	
ITEM	PART NAME
1	Impinger base
2	Turntable leg
3	Impinger turntable
4	Impinger drive hub
5	Petri dish and divider
6	1/4" X 1/4 NPT Hose barb
7	Bolt 1/4-20 x 3/8
8	Bolt 1/4 - 20 UNC - 1/4
9	Gearmotor

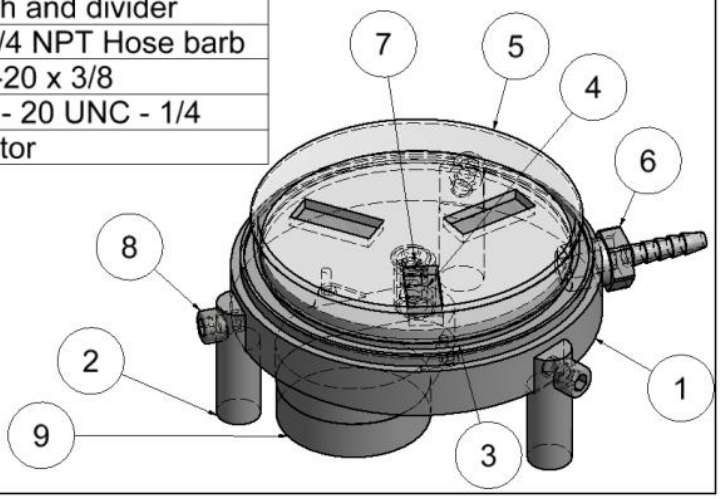

Figure 6. Mechanical drawing of dispensing system (DADD component 5)

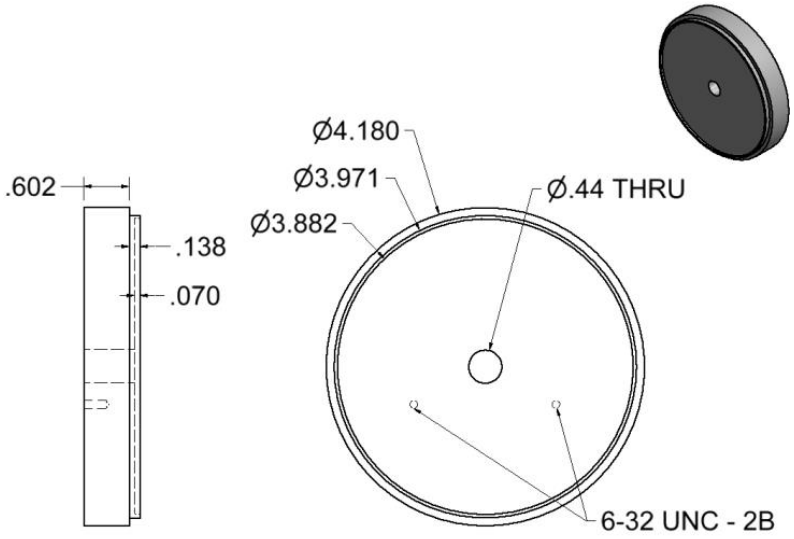

Figure 7. Mechanical drawing of dispensing system base

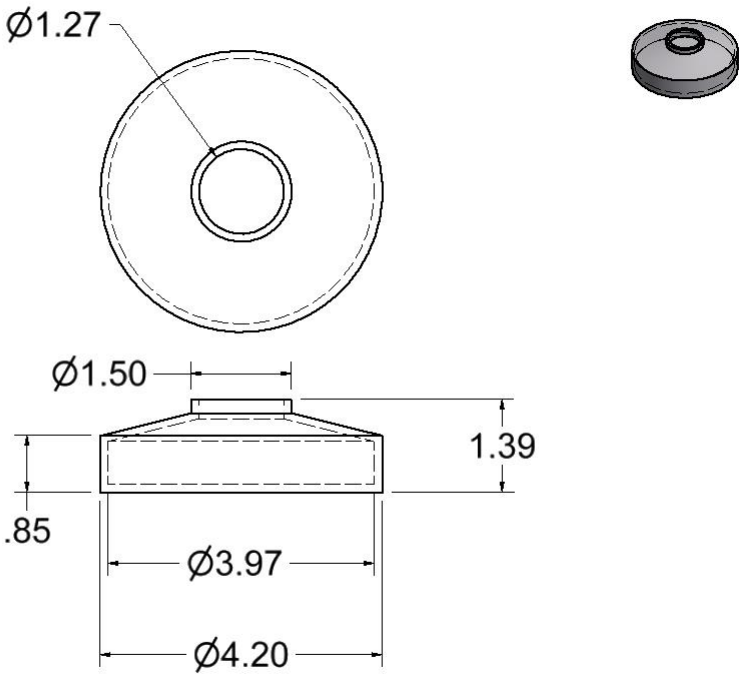

Figure 8. Mechanical drawing of Impinger top

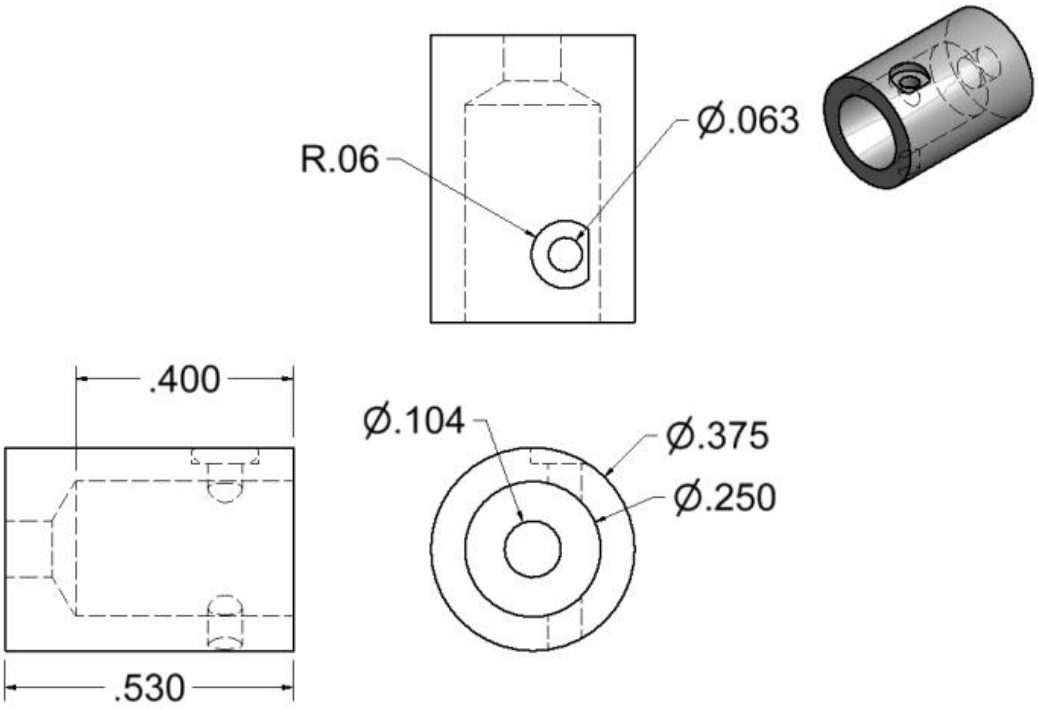

Figure 9. Mechanical drawing of motor drive hub

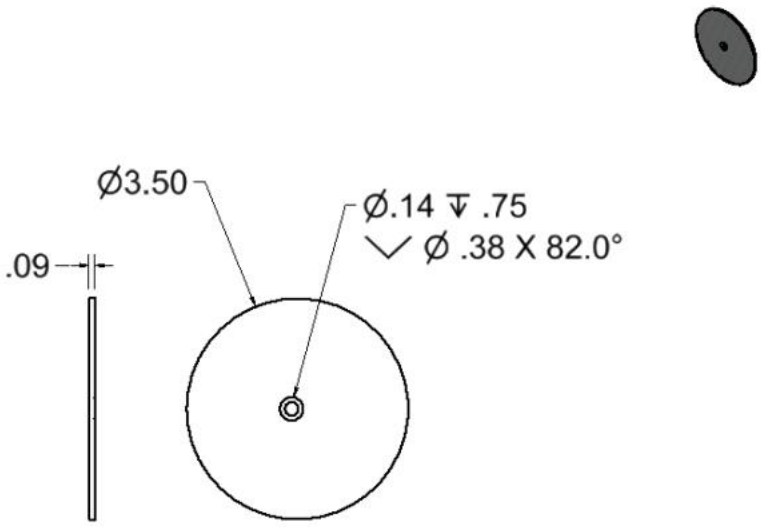

Figure 10. Mechanical drawing of dispensing system turntable

The support stand is composed of aluminum components described in the drawings (Figure 11–Figure 16).

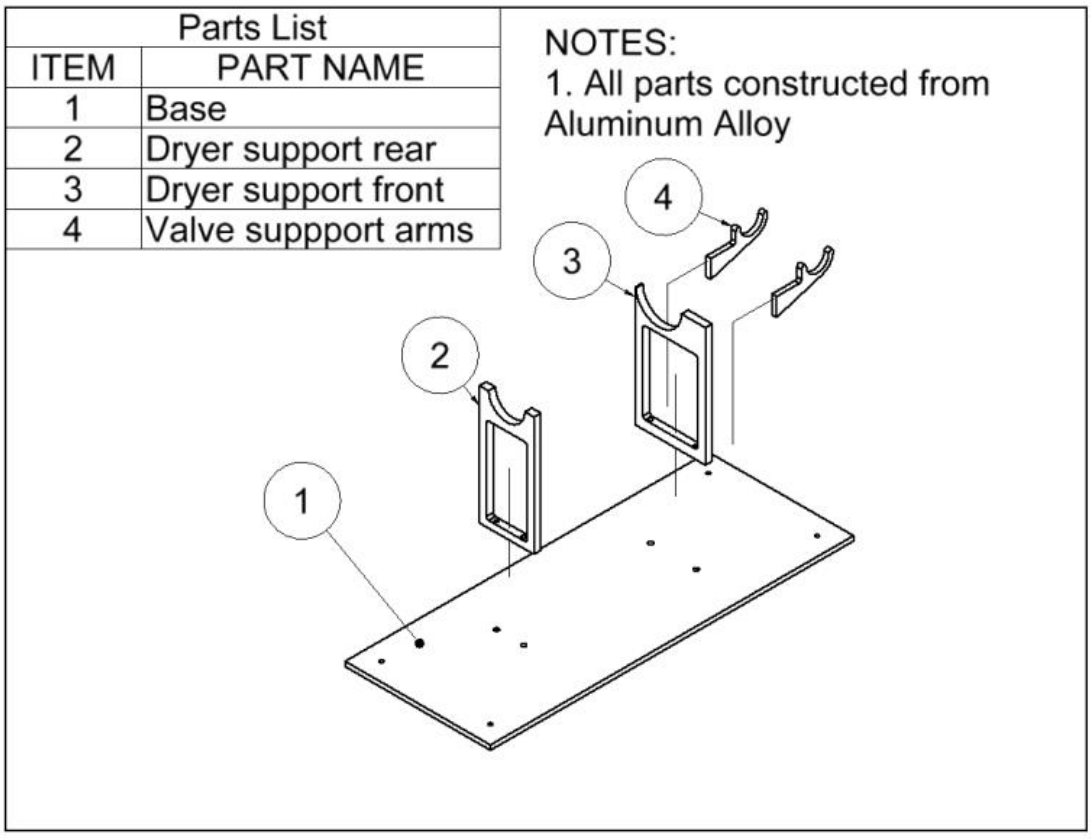

Figure 11. Support stand (DADD component 6): comprising base (1), dryer support rear (2), dryer support front (3), and valve support arms (4)

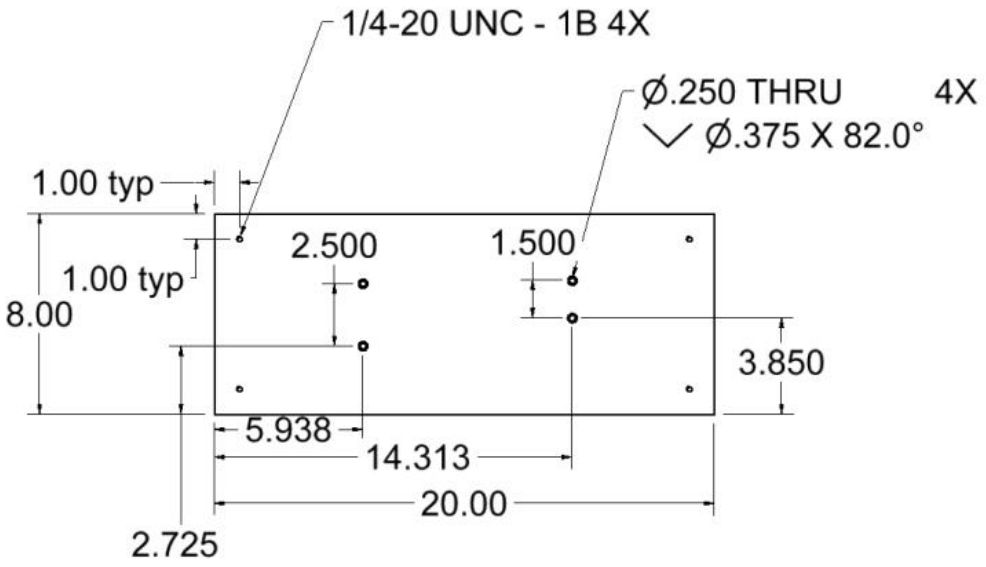

Figure 12. Mechanical drawing of support base (Support Stand Item1)

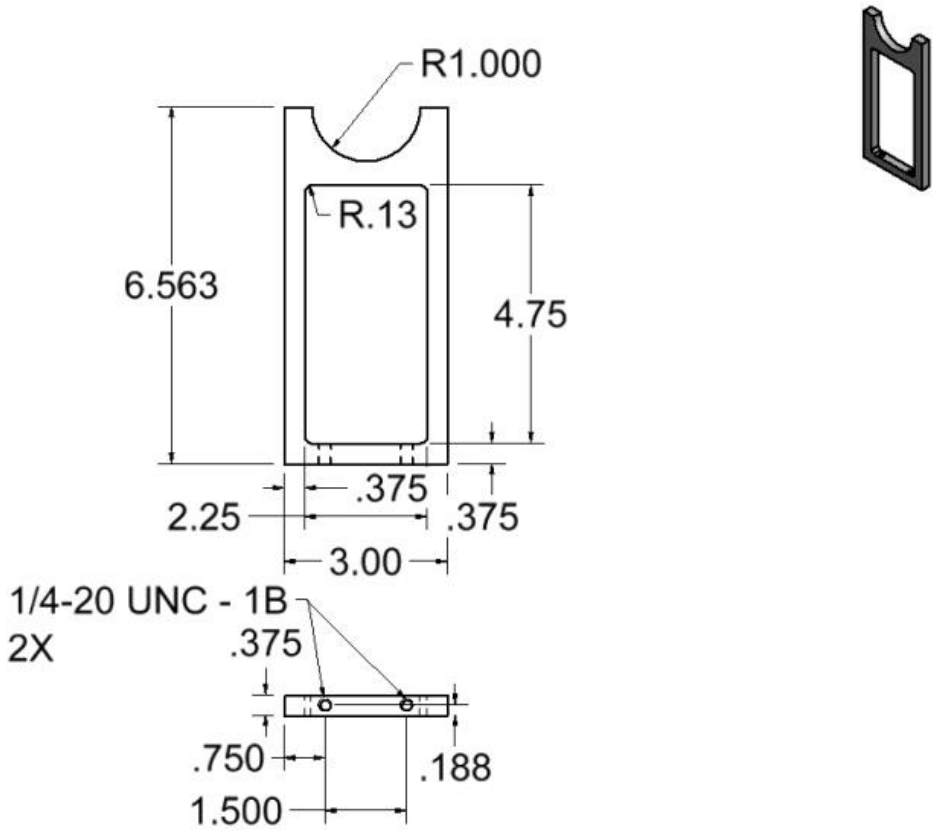

Figure 13. Mechanical drawing of dryer support rear (Support Stand Item 2)

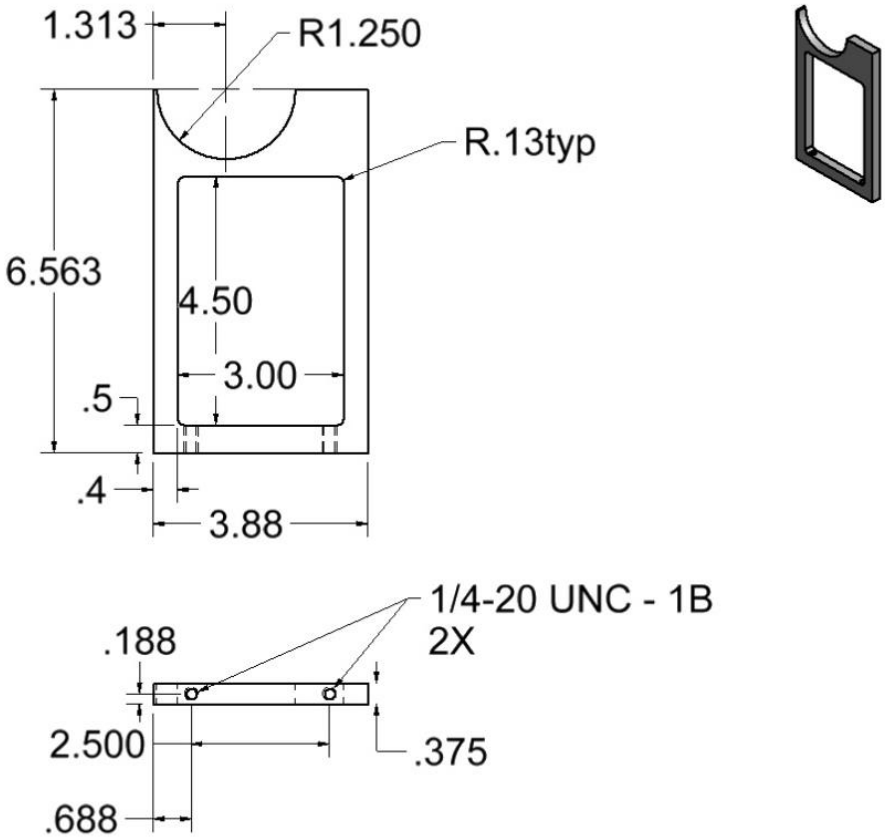

Figure 14. Mechanical drawing of dryer support front (Support Stand Item 3)

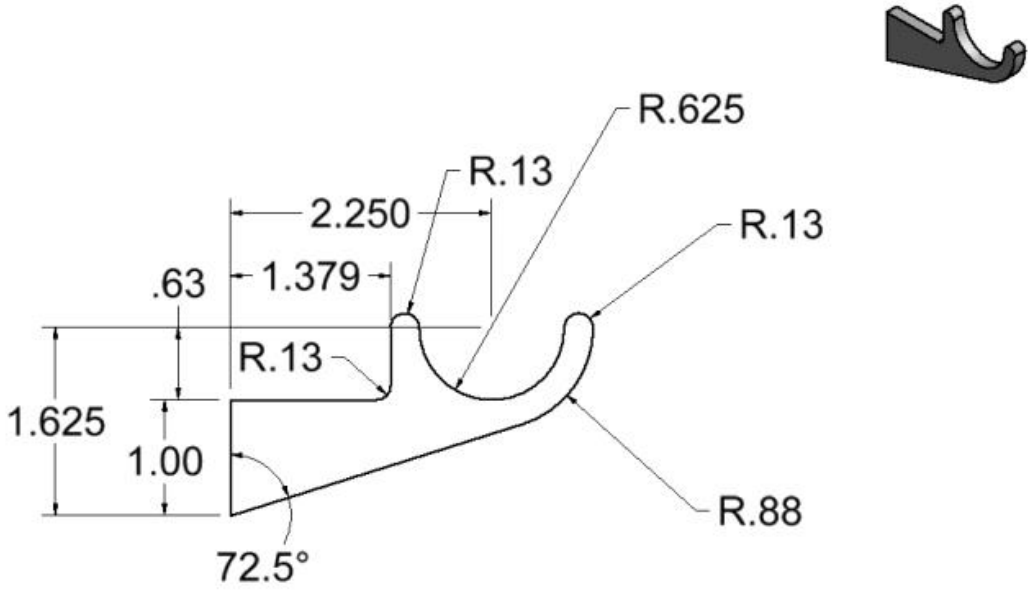

Figure 15. Mechanical drawing of valve support arm (Support Stand Item 4)

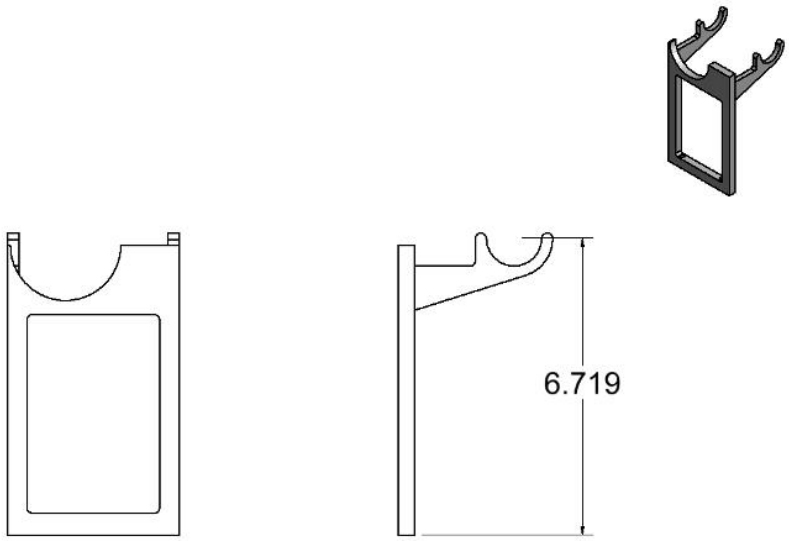

Figure 16. Mechanical drawing of support weldment (Support Stand Items 3 and 4)

4. REFERENCES

B.K. Heimbuch, K. Kinney, B. Nichols, J.D. Wander. The Dry Aerosol Deposition Device (DADD): An instrument for depositing microbial aerosols onto surfaces. *Journal of Microbiological Methods*, 78 (2009), 255–259