



# **AIR FORCE RESEARCH LABORATORY MATERIALS AND MANUFACTURING**

## **RAIN EROSION TEST APPARATUS**

### **Use Policies, Operating Procedures & Specimen Configurations**

Updated March 2019

University of Dayton Research Institute  
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Dayton, OH 45469-0054



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**1.0 GENERAL INFORMATION**

The AFRL Rain Erosion Test Facility (herein referred to as “erosion facility”) is a government-owned facility operated by the University of Dayton Research Institute (UDRI) to serve the international aerospace community. Access is provided for both military and commercial testing. Priority of testing can usually be determined on a first-come, first-serve basis, but on occasion this order must be broken for more immediate or emergency evaluations. Failure to comply with the direction of erosion facility personnel can result in cancellation of testing. For more information about the AFRL/UDRI rain erosion test apparatus, contact:

<b>Contractor Personnel University of Dayton Research Institute</b>	<b>AFRL Government Personnel</b>
UDRI Erosion Facilities ATTN: Ollie Scott 300 College Park Dayton, OH 45460-0054 Office: (937) 255-0197 Rain Rig: (937) 255-4289  <a href="mailto:Ollie.Scott.ctr@us.af.mil">Ollie.Scott.ctr@us.af.mil</a> <a href="mailto:Ollie.Scott@udri.udayton.edu">Ollie.Scott@udri.udayton.edu</a>	AFRL Rain Erosion Test Facility Coatings, Corrosion & Erosion Lab AFRL/RXSS (CCEL) ATTN: Matthew I. Hartshorne 2179 12th St, Building 652 Rm 59 Wright-Patterson AFB, Ohio 45433-7718 (937) 255-2532  <a href="mailto:matthew.hartshorne.1@us.af.mil">matthew.hartshorne.1@us.af.mil</a>

## **2.0 INTRODUCTION**

The phenomenon known as rain erosion, or the damage to materials caused by the impingement of raindrops at high speed, has long been a concern to the United States Air Force. The Air Force Research Laboratory (AFRL) at Wright-Patterson Air Force Base, Ohio, has conducted and sponsored research on rain erosion resistant materials since 1947.

In the course of rain erosion research over the years, the rotating arm apparatus has provided the best laboratory simulation of the environment for evaluating materials and investigating rain erosion mechanisms. Typically, in a rotating arm apparatus, test specimens are attached to the tip of a knife-edge propeller-like blade that is rotated horizontally at a specific velocity through a simulated rainfall. The results of rotating arm investigations have been correlated with actual flight test results, taking into consideration the relative ranking of the erosion resistance of materials and the mode of failure of these materials under the influence of raindrop impingement.

UDRI has been involved in rain erosion research and erosion-resistant material development since 1964. UDRI participated in the design, development, construction, and calibration of the present Rain Erosion Test Apparatus. Over the years, UDRI has conducted more than 140,000 evaluations, representing practically all rain erosion resistant aerospace systems developed over the past five decades.

The AFRL Rain Erosion Test Apparatus is capable of attaining constant velocities between 100 and 900 miles per hour, although current operations are limited to a maximum of 650 mph. The test specimens are exposed to a calibrated fixed rate of one inch per hour simulated rainfall. Raindrop impact is randomly distributed over the exposed surfaces of the test specimens. The test duration can be designated in specific increments (e.g., seconds, minutes or hours) or terminated at the operator's discretion when erosion damage is observed.

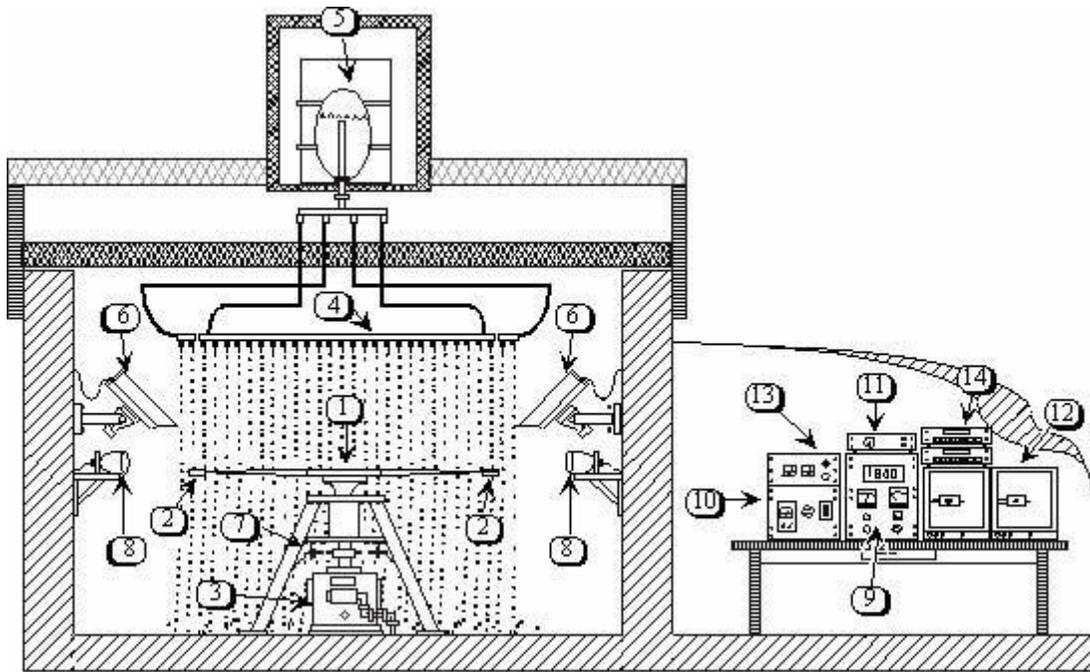
### **3.0 RAIN EROSION TEST APPARATUS**

The rotating arm apparatus consists of an eight foot diameter, double arm blade designed to produce high tip velocities with zero lift and low drag coefficient. Duplicate test specimens are mounted at the leading edge tip sections of the double rotating arm. The specimens can be rotated at variable velocities between 100 and 650 MPH.

The double arm blade is mounted horizontally on a vertical drive shaft (Figure 1). The simulated rainfall is produced by four curved manifold quadrants. Each manifold has 24 equally-spaced capillaries. De-ionized water is delivered to the four manifold quadrants simultaneously from a constant volume water storage tank. Temperature controlled water then fills the capillaries to produce raindrops.

Drop size and drop rate are controlled by the water temperature, capillary orifice diameter, and head pressure of the water storage tank. Raindrops from the simulation apparatus impact the test specimens throughout their entire annular path. Drop size and drop rate are approximately 1.8 to 2.2 mm and 6 to 7 drops per second, respectively. Calibration of the Rain Field is performed on a regular basis by UDRI personnel.

All functions of the apparatus are controlled and monitored from the remote control room. Instantaneous velocity readout is monitored by an integrating digital voltmeter. Variable speed operation is possible through the operator's manual control. Magnetic pickups and LED strobe lights provide stop motion viewing of the test specimens under actual test conditions. Closed-circuit color cameras and monitors allow the operator to visually observe the test specimens undergoing rain field exposure. Test studies are digitally recorded and available to the customer for later study.



**Figure 1: AFRL Rain Erosion Test Apparatus**

1. Double-Arm Blade	8. LED Strobe Lights For Stop-Motion Viewing
2. Mated Test Specimens	9. Variable Speed Readout And Control
3. Vertical Drive Gearbox And Shaft	10. Strobe Control
4. Curved-Manifold Quadrants	11. Remote Color Camera Controls
5. Water Storage Tank For Rain Simulation	12. Color Monitors For Specimen Viewing
6. Remote-Controlled Cameras	13. Rain Simulation Control
7. Magnetic Pickups For Firing Strobe Lights	14. Digital Video Recorder

#### 4.1 TYPES OF MATERIALS EVALUATED

The following is a list of typical materials submitted for rain erosion evaluation using the available configurations:

Composites	Coated metals
Coated composites	Ceramics
Plastics	Honeycomb constructions
Coated plastics	Bulk material constructions
Reinforced plastics	Glass materials
Metals	Optical materials

#### 4.2 Failure Analysis

Materials evaluated for rain erosion resistance are normally either bulk type or coated. Damage is evidenced by erosion loss or coating adhesion failure. Such terms as pitting, cratering, cracking, material loss or fracture, core-crushing, and delamination are used to describe the progressive performance of the materials. These evaluations are reported as a function of time in the test run. Failures near the specimen holder areas are usually taken as anomalies.

The rain erosion environment is more severe than many users initially realize. Often, the evaluation reports must use the phrase “pre-existing defect” to describe an early failure mode.

## 5.1 USE POLICIES

### 5.2 Scheduling

Due to the frequent, high demand usage of the erosion facility, prospective users are urged to schedule test dates well in advance. Scheduling is normally accomplished by calling UDRI at Wright-Patterson Air Force Base; Office: (937) 255-0197 Rain Rig: (937) 255-4289, or FAX (937) 255-0954.

Address US Postal correspondence to:

UDRI Erosion Facilities  
ATTN: Ollie Scott  
300 College Park  
Dayton, OH 45460-0054  
Office: (937) 255-0197  
Rain Rig: (937) 255-4289

[Ollie.Scott.ctr@us.af.mil](mailto:Ollie.Scott.ctr@us.af.mil)

[Ollie.Scott@udri.udayton.edu](mailto:Ollie.Scott@udri.udayton.edu)

**Note: Do not use this address to ship samples. See Section 5.4.1 for sample shipment requirements.**



**IMPORTANT!! SPECIAL ARRANGEMENTS MUST BE MADE FOR DOD CLASSIFIED TEST SPECIMENS. NOTIFY EROSION FACILITY PERONNEL WHEN SCHEDULING TEST DATES IF SPECIMENS ARE CLASSIFIED.**

#### 5.2.1 Payment Scheduling

Payment arrangements are substantially different for users with a U.S. Government sponsor than those without a sponsor. To avoid delays or cancellation of testing, it is recommended that payment scheduling be arranged as soon as possible after test scheduling.

#### 5.2.2 Users with a U.S. Government Sponsor

Users with a sponsor must contact the Financial Division of the Air Force Research Laboratory (AFRL/RXFM) at (937) 255-9765 to arrange payment conditions as soon as possible after scheduling test dates. This is often a time-consuming process, but payment conditions must be arranged before testing can take place. **Testing will be delayed or cancelled if payment conditions are not arranged.**

### 5.2.3 Users Without a U.S. Government Sponsor

Users without a U.S. Government sponsor operate on a purchase order basis with the University of Dayton Research Institute (UDRI). The user company must submit the signed “Test Description and Approval Form” (Appendix A) enclosed in the Formal Proposal from the UDRI office of Contracts and Grants; [937-229-2919] In addition to the signatures of the UDRI collaborator and an official from the user company, the form will lastly be signed by AFRL/RXS for completion.

The purpose of this form is to provide mutual assurance of safety, responsibility, and confidentiality of testing and test results. Suitable time must be allowed to obtain the signatures on this form, especially with the users’ company. **Any discussion or questions regarding this form should be raised as soon as possible after test scheduling. Testing may be delayed or cancelled if payment conditions are not arranged at least two weeks prior to the test date(s).**

### 5.2 Cancellation Policy

Users who cancel or postpone a scheduled test must contact UDRI **at least two weeks prior to the scheduled test date(s)**. Users who fail to make timely notification will be charged 20% of the scheduled test cost. Exceptions to this charge will be made in the event of inclement weather, personal emergency, or in the event that UDRI can schedule another user in the testing dates that had been reserved for the original user. In the event that UDRI must cancel testing because payment conditions have not been arranged or necessary documents have not been received, the same cancellation policy will apply.

### 5.3 Test Plan

All users must submit a detailed test plan to fully document, guide, and direct specific test needs. Before scheduling testing, the user should know the number of specimens, geometry, configuration, maximum run time(s), intermediate inspections (if required), and if the specimens are DOD classified or unclassified. See **Section 8.0** for various specimen and configuration options. See **Section 7.0** for Angle of Impact/Incidence definition.

Prospective users are encouraged to discuss their test plans thoroughly with erosion facility personnel well before the scheduled test date. In addition to technical matters, guidance can often be provided regarding the necessary paperwork.

The test plan must include an adequate specimen material description, required velocity and angular modes, order of testing, and a definition of test duration, e.g., to initial failure, to complete failure (substrate exposed), length of time, etc. See **Section 6.0** for a velocity conversion chart.

**The final test plan must be submitted to erosion facility personnel at least 3 days prior to the scheduled test date to allow sufficient time for review and clarification. The test plan serves as a basis for the evaluation sheet used by the erosion facility operator at the time of testing. If the test plan is late or not submitted, the testing may be delayed or cancelled.**

It is important to note that this whirling-arm facility is a double whirling arm and duplicate specimens must be run with each test. These specimens must be identical in configuration and within a weight differential of two grams.

**Material Safety Data Sheets (MSDS) or other statements of material non-toxicity must be supplied with the Test Plan.**

#### **5.4 Custom Specimen Configuration Fixturing**

In the event standard specimen configurations offered by the rain erosion facility do not meet the requirements of the user, it is possible to have custom specimen configuration fixtures designed and fabricated. The erosion facility personnel will work closely with the user in developing safe and effective specimen configuration tooling.

Due to centrifugal forces on the whirling arm blade during testing, the maximum combined mass of specimen and fixture is limited to 322grams  $\pm$ 2grams. The two fixtures must be identical, compact, and sufficiently robust to withstand wind and mechanical buffeting and high radial G-forces while holding the test specimen securely. The fixture must have a neutral flight profile and not produce lift.

The centerline of the specimen will be in the flight plane of the blade when mounted in the fixture on the blade. Flight cross sections should be no greater than 4 square inches although allowances may be made for tilted or airfoil specimens.

Specimen release during flight is unacceptable and will result in immediate test stoppage, removal of the fixtures, and a ban from any further use/testing.

Materials used to manufacture specimen fixtures depend on the expected useful testing lifetime. Fixtures are typically made from stainless steel, titanium alloy, or 2XXX or 7XXX series tempered aluminum or combinations of these.

#### **5.5 Specimen Description**

It is the policy of AFRL (Air Force Research Laboratory) to maintain a complete database of all rain erosion test results from the erosion facility. This data constitutes the history and progress of rain erosion resistant material development and is accessed only under a strict USAF need basis. Specimens to be tested must be accompanied by a description sufficient to allow the inclusion of the material and the results into the database. This description can be generic, but it must include at least the class of material(s) being evaluated, with some indication as to material treatment, coating thickness, etc. Specimen description is listed from the top down.

#### **Example:**

Polyurethane topcoat, light gray, 0.006” thickness / Polyurethane rain erosion coating, dark gray, 0.020” thickness / Epoxy primer, light green, 0.004” thickness / Chromate-free pretreatment / Aluminum Airfoil

### 5.5.1 Specimen Shipment

Specimens must be shipped no less than 7 days in advance of the scheduled test date to allow for dimensional checking. Because rain erosion test specimens range from the fragile to the rugged, packaging and shipping should be guided accordingly. Every effort will be made to maintain the integrity of test specimens, although rain erosion test conditions can compromise this goal. If there is any concern about specimen configurations, contact erosion facility personnel.

**Ship specimens via Fed Ex or UPS to:**

**ATTN: Ollie Scott / Cheryl Castro, UDRI  
AFRL/RXSS (CCEL), Erosion Facilities  
2700 D Street, Building 1661, Room C110  
Wright-Patterson AFB, OH 45433**



**IMPORTANT: The address above cannot be used for shipment of classified materials.**



**IMPORTANT: If test specimens are hand-carried to the erosion facility on the day of testing and do not fit the testing assembly, the test time will be abbreviated or canceled.**

### 5.5.2 Specimen Evaluation

The digital video recorder and stroboscopic lighting system provide continuous visibility of the specimens during testing and enable real-time evaluation. The specimens are also inspected under 10X magnification during any specified inspection and following testing. If required, post-test analysis services are available at an additional cost.

### 5.5.3 Specimen Return

After testing, all specimens and DVD's containing the files digitally recorded during testing will be returned via domestic UPS ground service. If a different shipper or expedited shipping service is required, the user must provide a UPS or FedEx shipping account number. International shipments are the responsibility of the user.

### 5.6 Data Submission

Following the test and evaluation sequence, an electronic copy (PDF) of the detailed test report is emailed to the user; a hard copy of the report is available upon request. All test results and all test specimens are handled on a strict proprietary basis. No endorsement of materials is intended either by the USAF or UDRI.

## **5.7 On-Site Visitors**

Users are welcome to witness the testing of their specimens. Due to facility size and safety restrictions, no more than three visitors at one time are allowed inside the control room. Prior notification is required and the visitors must contact the government personnel or contractor (see Section 1.0 General Information) a minimum of 5 business days prior to the test date to gain access to Wright-Patterson Air Force Base: The visitor access process and requirements change periodically, you will be advised of the current requirements at the time you contact government personnel.

**NOTE: Foreign National visitors may witness the testing of their specimens; however, the visit access process is different and requires a minimum of 4-8 weeks advance notice.**

## 6.0 VELOCITY CONVERSION

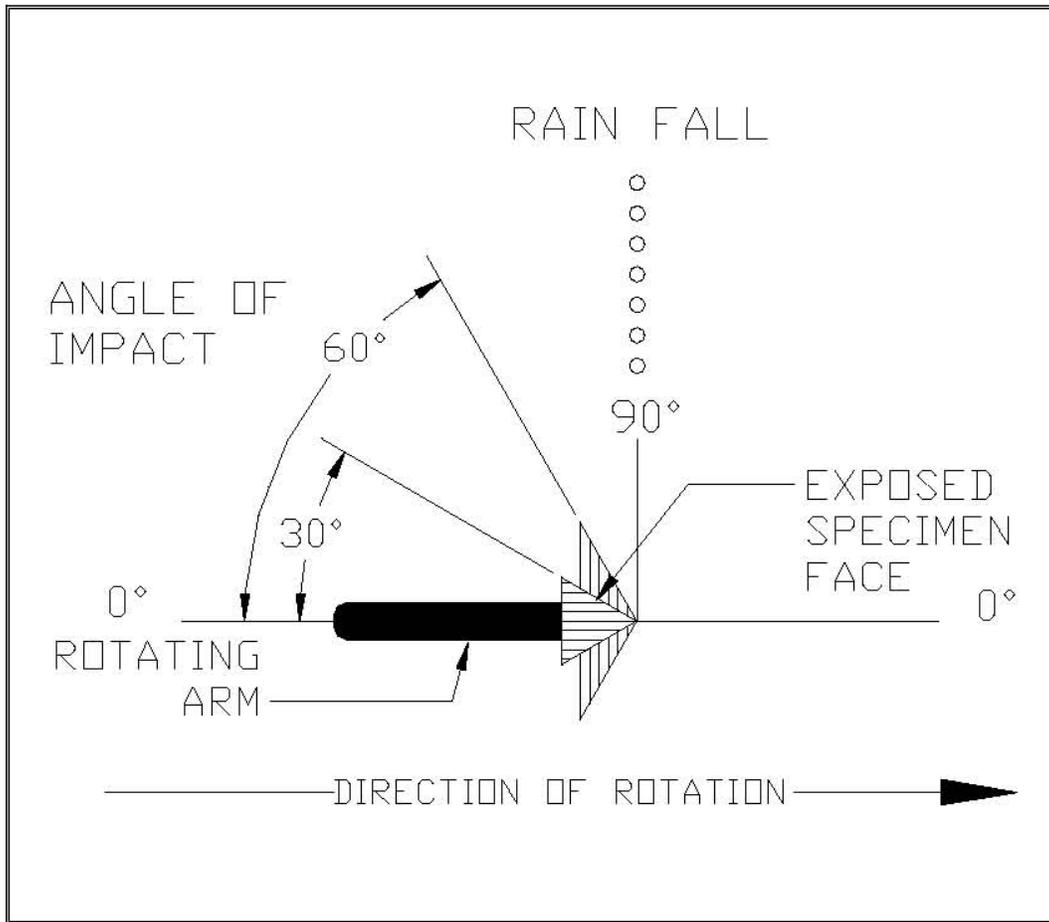
Table 1: Velocity Conversion Table

<u>MPH</u>	<u>RPM</u>	<u>MACH</u>	<u>KNOTS</u>	<u>FT/SEC</u>	<u>KM/HR</u>	<u>METERS/SEC</u>	<u>MPH</u>
100	365	0.13	87	147	161	45	100
110	402	0.15	95	161	177	49	110
120	438	0.16	104	176	193	54	120
130	475	0.17	113	191	209	58	130
140	511	0.19	122	205	225	63	140
150	548	0.20	130	220	241	67	150
160	584	0.21	139	235	257	72	160
170	621	0.23	148	249	274	76	170
180	657	0.24	156	264	290	80	180
190	694	0.25	165	279	306	85	190
200	730	0.27	174	293	322	89	200
210	767	0.28	182	308	338	94	210
220	803	0.29	191	323	354	98	220
230	840	0.31	200	337	370	103	230
240	876	0.32	208	352	386	107	240
250	913	0.33	217	367	402	112	250
260	949	0.35	226	381	418	116	260
270	986	0.36	234	396	434	121	270
280	1022	0.37	243	411	451	125	280
290	1059	0.39	252	425	467	130	290
300	1095	0.40	260	440	483	134	300
310	1132	0.41	269	455	499	139	310
320	1168	0.43	278	469	515	143	320
330	1205	0.44	286	484	531	148	330
340	1241	0.45	295	499	547	152	340
350	1278	0.47	304	513	563	156	350
360	1314	0.48	312	528	579	161	360
370	1351	0.49	321	543	595	165	370

Table 1 continued: Velocity Conversion Table

<u>MPH</u>	<u>RPM</u>	<u>MACH</u>	<u>KNOTS</u>	<u>FT/SEC</u>	<u>KM/HR</u>	<u>METERS/SEC</u>	<u>MPH</u>
410	1497	0.55	356	601	660	183	410
420	1533	0.56	365	616	676	188	420
430	1570	0.57	373	631	692	192	430
440	1606	0.59	382	645	708	197	440
450	1643	0.60	391	660	724	201	450
460	1679	0.61	399	675	740	206	460
470	1716	0.63	408	689	756	210	470
480	1752	0.64	417	704	772	215	480
490	1789	0.65	425	719	788	219	490
500	1825	0.67	434	734	805	224	500
510	1862	0.68	443	748	821	228	510
520	1898	0.69	451	763	837	232	520
530	1935	0.70	460	778	853	237	530
540	1971	0.72	469	792	869	241	540
550	2008	0.73	477	807	885	246	550
560	2044	0.74	486	822	901	250	560
570	2081	0.76	495	836	917	255	570
580	2117	0.77	503	851	933	259	580
590	2154	0.78	512	866	949	264	590
600	2190	0.80	521	880	965	268	600
610	2227	0.81	529	895	981	273	610
620	2263	0.82	538	910	998	277	620
630	2300	0.84	547	924	1014	282	630
640	2336	0.85	556	939	1030	286	640
650	2373	0.86	564	954	1046	291	650
660	2409	0.88	573	968	1062	295	660
670	2446	0.89	582	983	1078	299	670
680	2482	0.90	590	998	1094	304	680

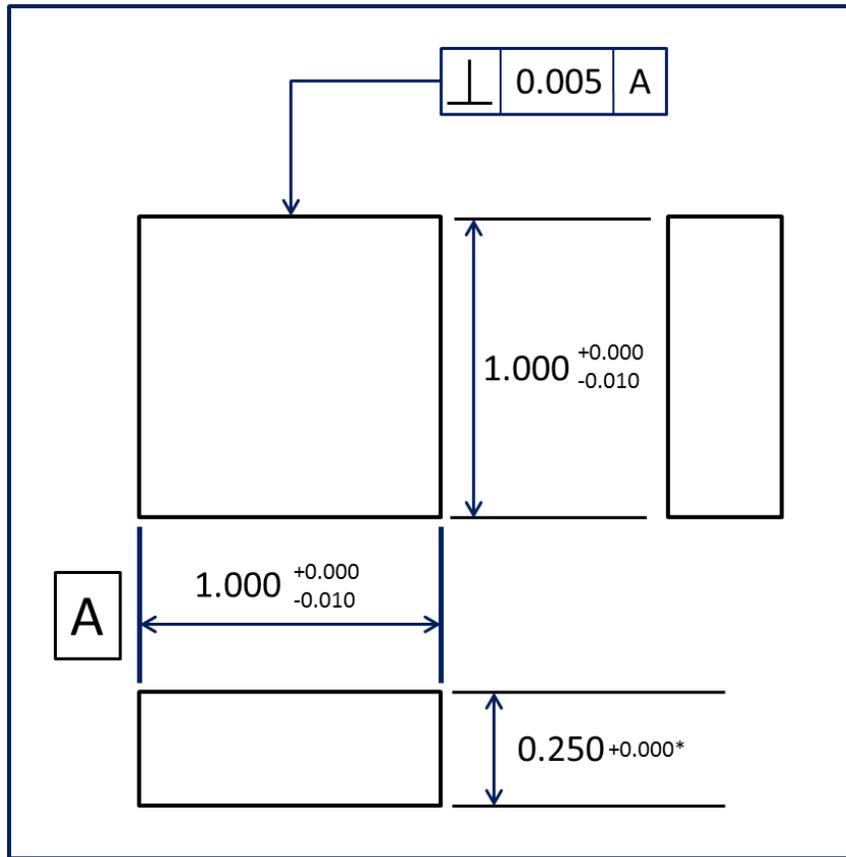
## 7.0 ANGLE OF IMPACT DEFINITION



*Figure 2: Angle of Impact*

## 8.1 SPECIMENS

### 8.2 Square Specimen: 30, 45 and 90°



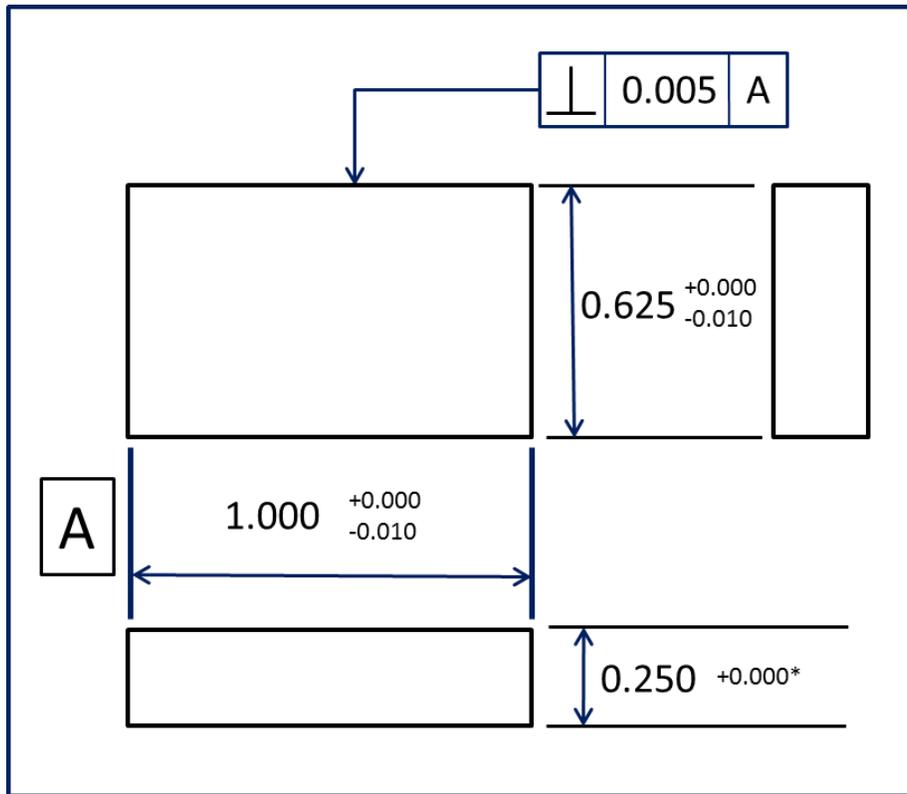
\*Specimens can be any thickness from 0.125 to a maximum of 0.250

*Figure 3: Square Specimen - 30°*

- All dimensions in inches
- Total dimensions include coating thickness, if any
- For specimens under 0.250 thickness, shims must be supplied for both specimens for a total mounting thickness of 0.250
- Pocket depth of specimen holder is .250 +0.005 -0.000

**NOTE: IR transmitting materials should be a minimum of 0.200**

## 8.3 Rectangular Specimen: 45°



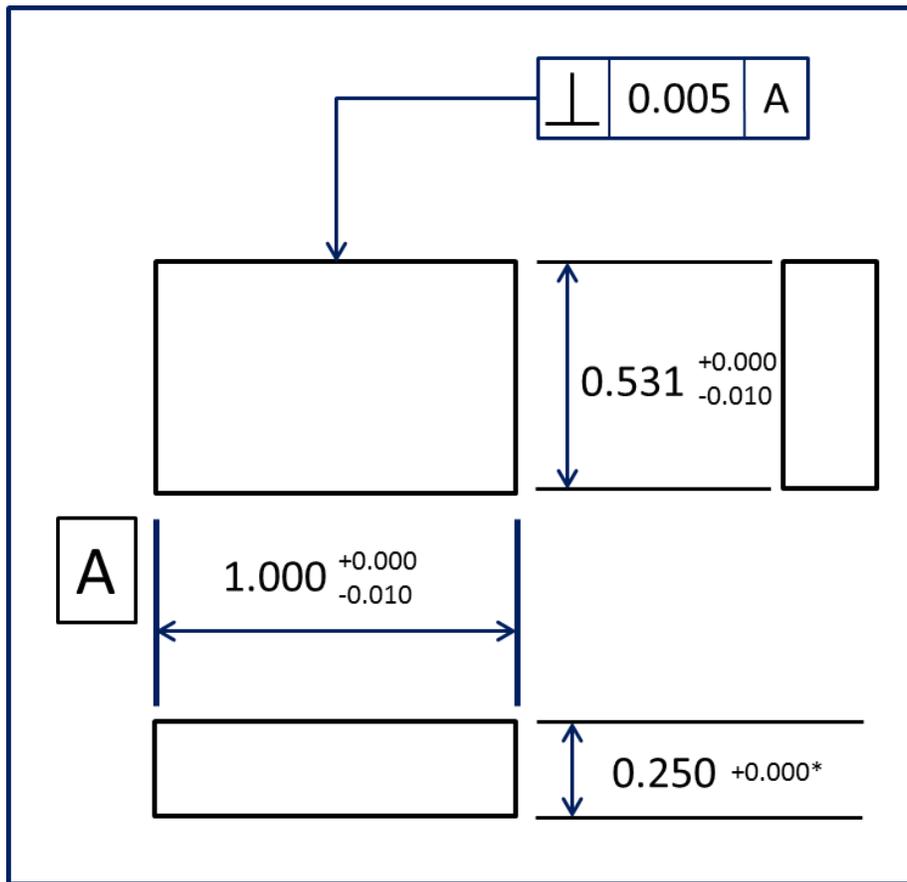
\*Specimens can be any thickness from 0.125 to a maximum of 0.250

*Figure 4: Rectangle Specimen - 45°*

- All dimensions in inches
- Total dimensions include coating thickness, if any
- For specimens under 0.250 thickness, shims must be supplied for both specimens for a total mounting thickness of 0.250
- Pocket depth of specimen holder is 0.250  $+0.005 -0.000$

**NOTE: IR transmitting materials should be a minimum of 0.200**

## 8.4 Rectangular Specimen: 60°



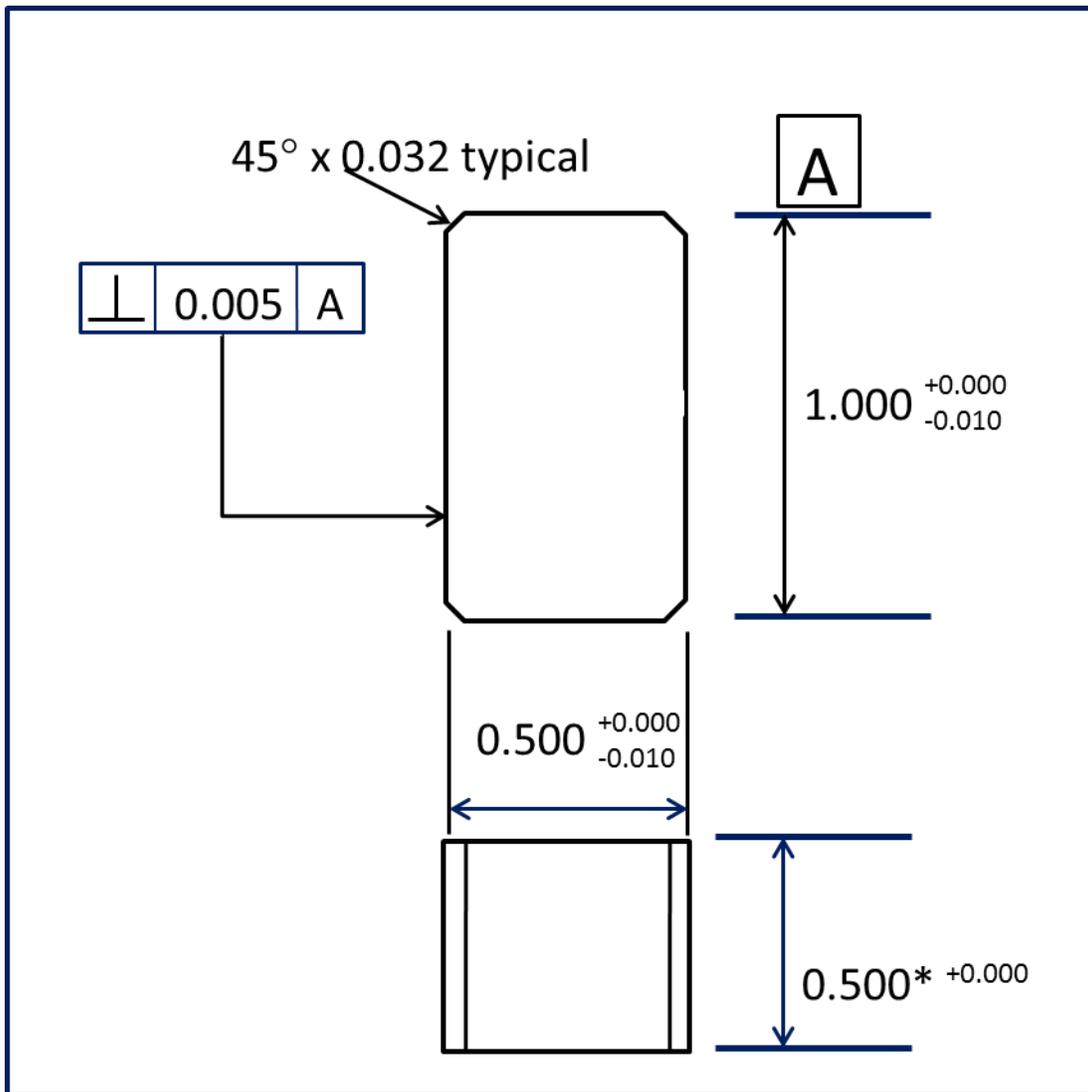
\*Specimens can be any thickness from 0.125 to a maximum of 0.250

*Figure 5: Rectangular Specimen - 60°*

- All dimensions in inches
- Total dimensions include coating thickness, if any
- For specimens under 0.250 thickness, shims must be supplied for both specimens for a total mounting thickness of 0.250
- Pocket depth of specimen holder is 0.250  $+0.005$   $-0.000$

**NOTE: IR transmitting materials should be a minimum of 0.200**

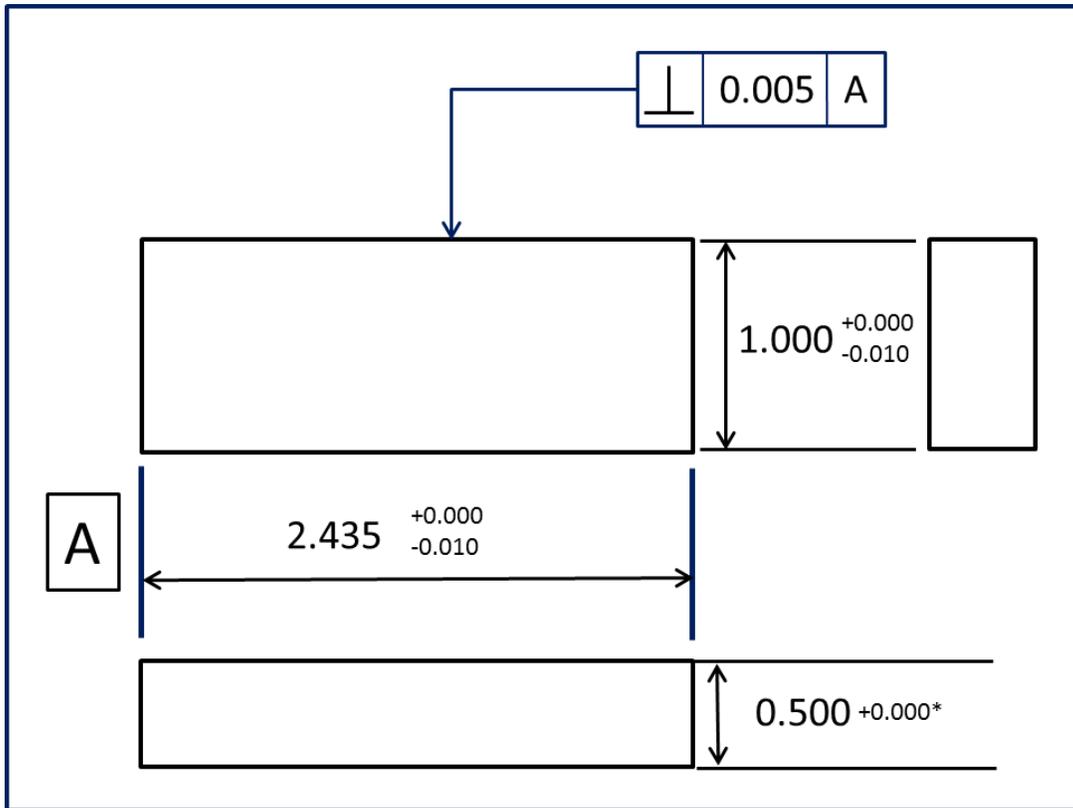
## 8.5 Rectangular Specimen: 90°



\*Specimens can be any thickness from 0.125 to a maximum of 0.500.

**Figure 6: Rectangular Specimen - 90° - Configuration 1**

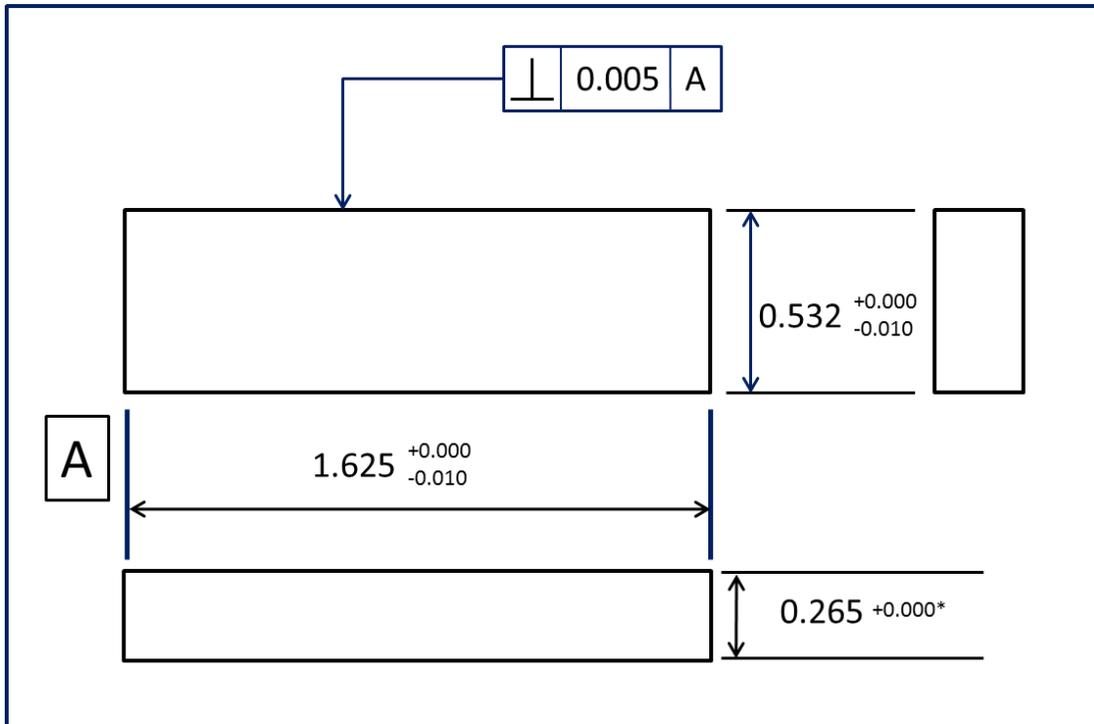
- All dimensions in inches
- Total dimensions include coating thickness, if any
- For specimens under 0.500 thickness, shims must be supplied for both specimens for a total mounting thickness of 0.500
- Pocket depth of specimen holder is 0.500 <sup>+0.005</sup> <sub>-0.000</sub>



\*Specimens can be any thickness from 0.125 to a maximum of 0.500

**Figure 7: Rectangular Specimen - 90° - Configuration 2**

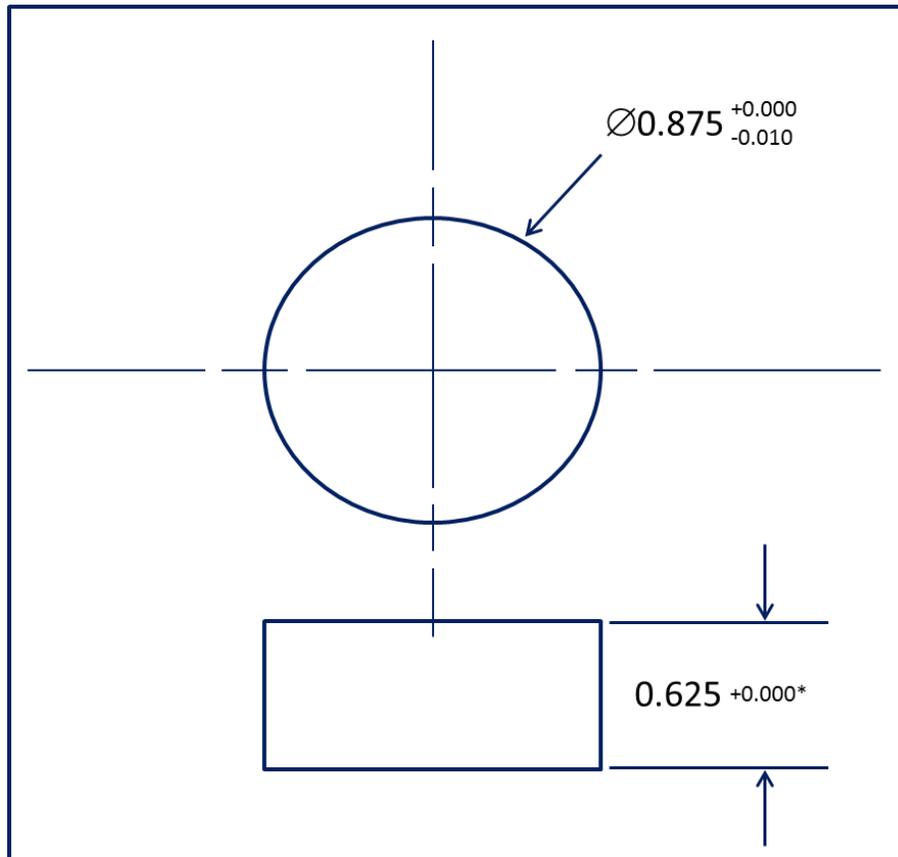
- All dimensions in inches
- Total dimensions include coating thickness, if any
- For specimens under 0.500 thickness, shims must be supplied for both specimens for a total mounting thickness of 0.500
- Maximum weight of specimen is 190 grams
- Maximum test velocity 500 mph.



\*Specimens can be any thickness from 0.125 to a maximum of 0.265

**Figure 8: Rectangular Specimen - 90° - Configuration 3**

- All dimensions in inches
- Total dimensions include coating thickness, if any
- For specimens under 0.265 thickness, shims must be supplied for both specimens for a total mounting thickness of 0.265
- Pocket depth of specimen holder is  $0.265$   $^{+0.000}_{-0.005}$

**8.6 Disc Specimen: 90°**

\*Specimens can be any thickness from 0.125 to a maximum of 0.625

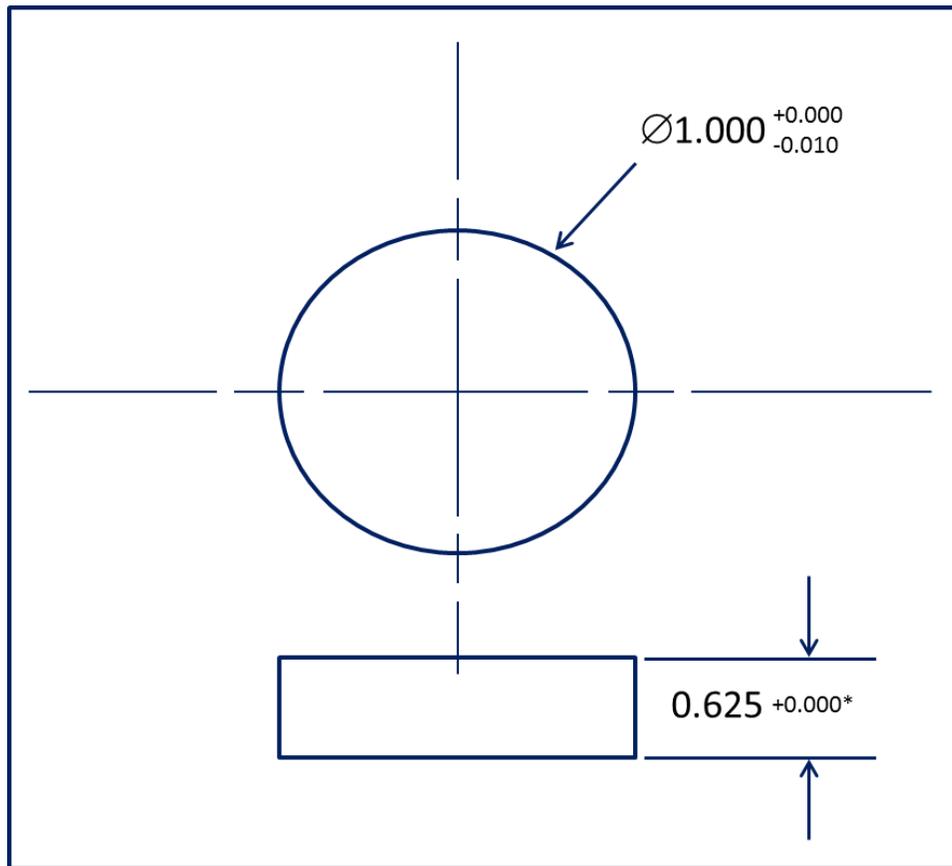
*Figure 9: Disc Specimen - 90° - Configuration 1*

All dimensions in inches

- Total dimensions include coating thickness, if any
- For specimens under 0.435 thickness, shims must be supplied for both specimens for a total mounting thickness of 0.435
- Pocket depth of specimen holder is  $0.435^{+0.000}_{-0.005}$
- For specimens over 0.435 thickness, shims are not required

**NOTE: IR transmitting materials should be a minimum of 0.200.**

## 8.6 Disc Specimen: 30, 35, 40, 45, 53, 60, 70, 80 and 90°



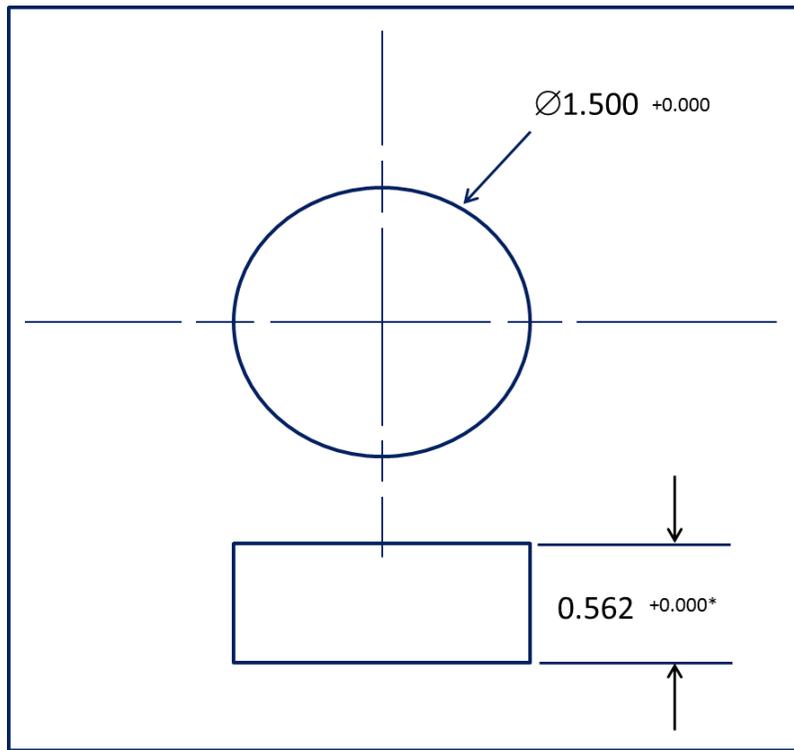
\*Specimens can be any thickness from 0.125 to a maximum of 0.625

*Figure 10: Round Specimen – Configuration 2*

- All dimensions in inches
- Total dimensions include coating thickness, if any
- For specimens under 0.435 thickness, shims must be supplied for both specimens for a total mounting thickness of 0.435
- Pocket depth of specimen holder is  $0.435 +0.000 -0.005$
- For specimens over 0.435 thickness, shims are not required

**NOTE: IR transmitting materials should be a minimum of 0.200.**

## 8.7 Disc Specimen: 45° and 90°



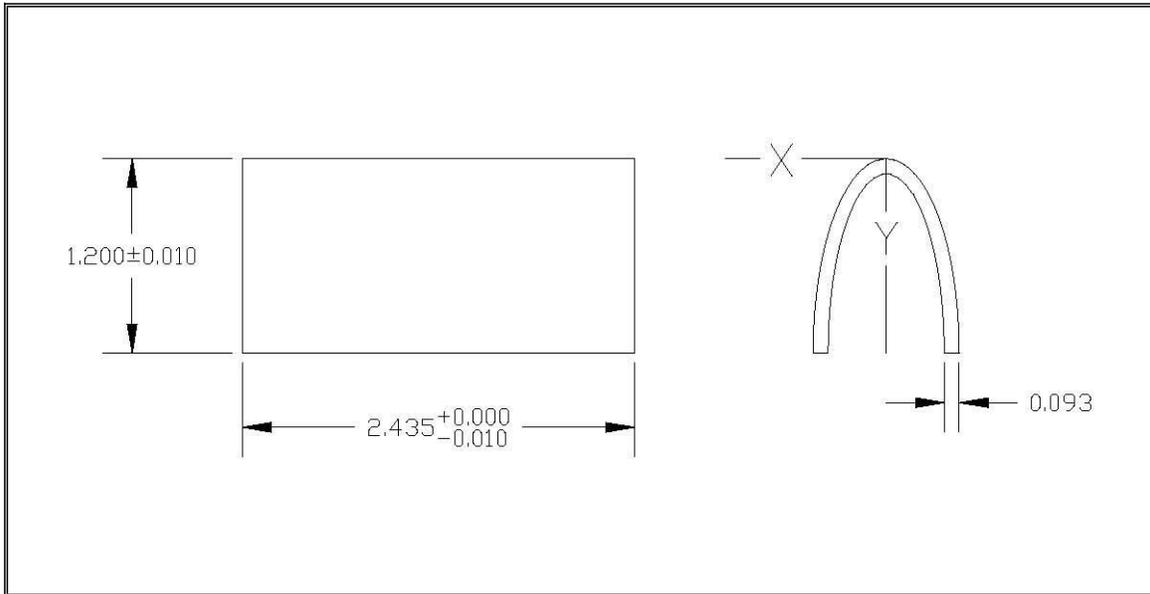
\*Specimens can be any thickness from 0.125 to a maximum of 0.562

*Figure 11: Disc Specimen - 45° and 90° – Configuration 3*

- All dimensions in inches
- Total dimensions include coating thickness, if any
- For specimens under 0.535 thickness, shims must be supplied for both specimens for a total mounting thickness of 0.535
- Pocket depth of specimen holder is  $0.535 \pm 0.005$
- For specimens over 0.535 thickness, shims are not required

**NOTE: IR transmitting materials should be a minimum of 0.200 Maximum weight of specimen is 130 grams.**

## 8.8 Leading Edge Airfoil Specimens



*Figure 12: Composite Leading Edge Airfoil Specimen – Configuration 1*

% Chord	(Y) Ordinate	(X) Abscissa
.00	.00	.000
1.25	.05	.112
2.50	.10	.172
5.00	.20	.250
7.50	.30	.304
10.00	.40	.344
15.00	.60	.400
20.00	.80	.432
25.00	1.00	.439
30.00	1.20	.454

- All dimensions in inches
- Maximum weight of the specimen is 200 grams

**NOTE: Coatings applied to this airfoil configuration average 0.010 – 0.020 inches in thickness, with a maximum thickness limited to 0.050 inches.**

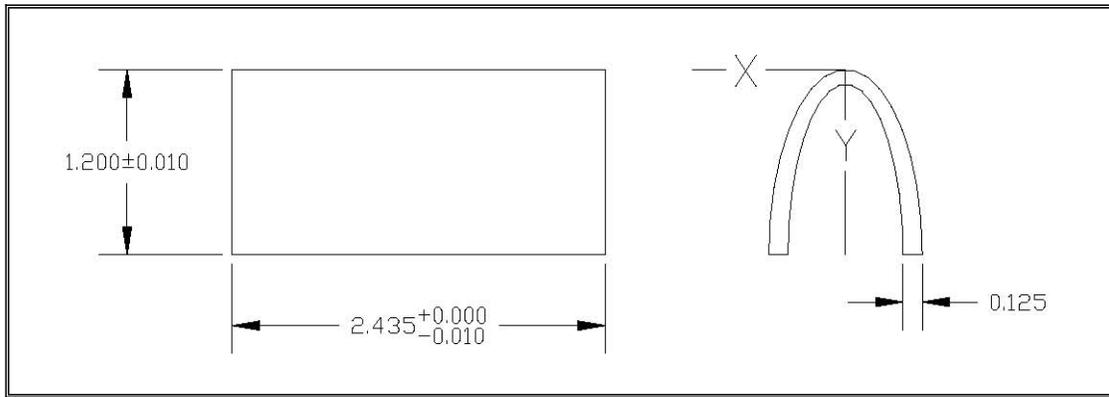


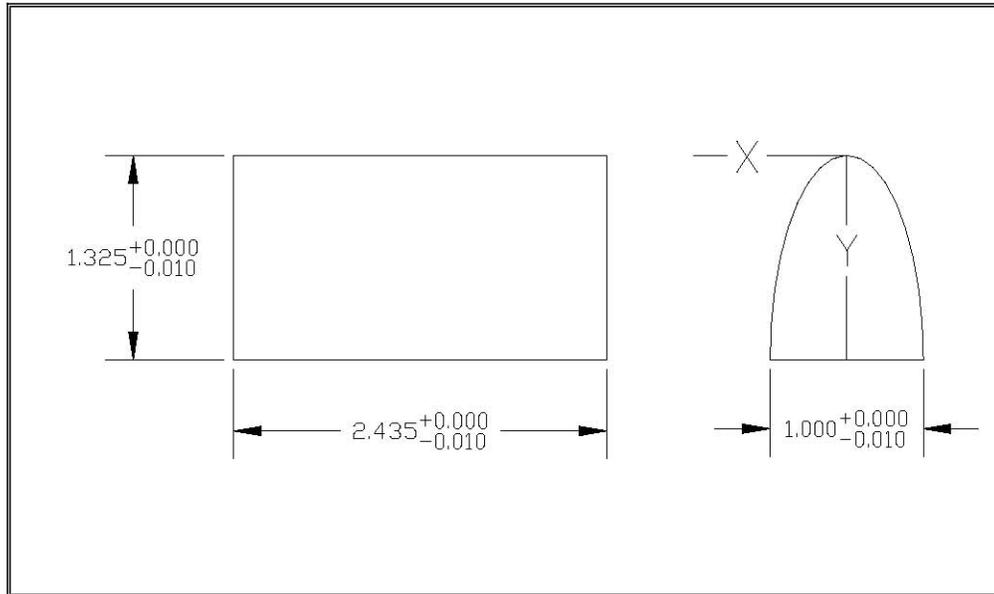
Figure 13: Leading Edge Airfoil Specimens – Configuration 2

% Chord	(Y) Ordinate	(X) Abscissa
.00	.00	.000
1.25	.05	.158
2.50	.10	.218
5.00	.20	.296
7.50	.30	.350
10.00	.40	.390
15.00	.60	.446
20.00	.80	.478
25.00	1.00	.485
30.00	1.20	.500

- All dimensions in inches
- Maximum weight of the specimen is 200 grams

**NOTE: Coatings applied to this airfoil configuration average 0.010 – 0.015 inches in thickness with a maximum thickness limited to 0.040 inches.**

### 8.9 Solid Airfoil Specimens



*Figure 14: Solid Airfoil Specimen – Configuration 1*

<b>% Chord</b>	<b>(Y) Ordinate</b>	<b>(X) Abscissa</b>
.00	.00	.000
1.25	.05	.158
2.50	.10	.218
5.00	.20	.296
7.50	.30	.350
10.00	.40	.390
15.00	.60	.446
20.00	.80	.478
25.00	1.00	.485
30.00	1.20	.500

- All dimensions in inches
- Total dimensions include coating thickness, if any
- Maximum weight of specimen is 123 grams

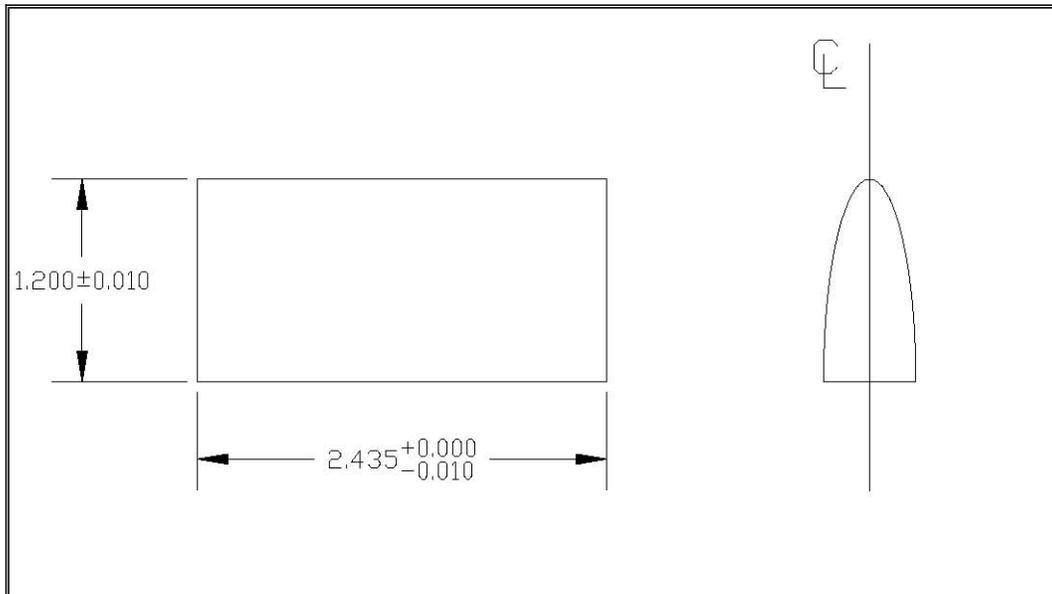
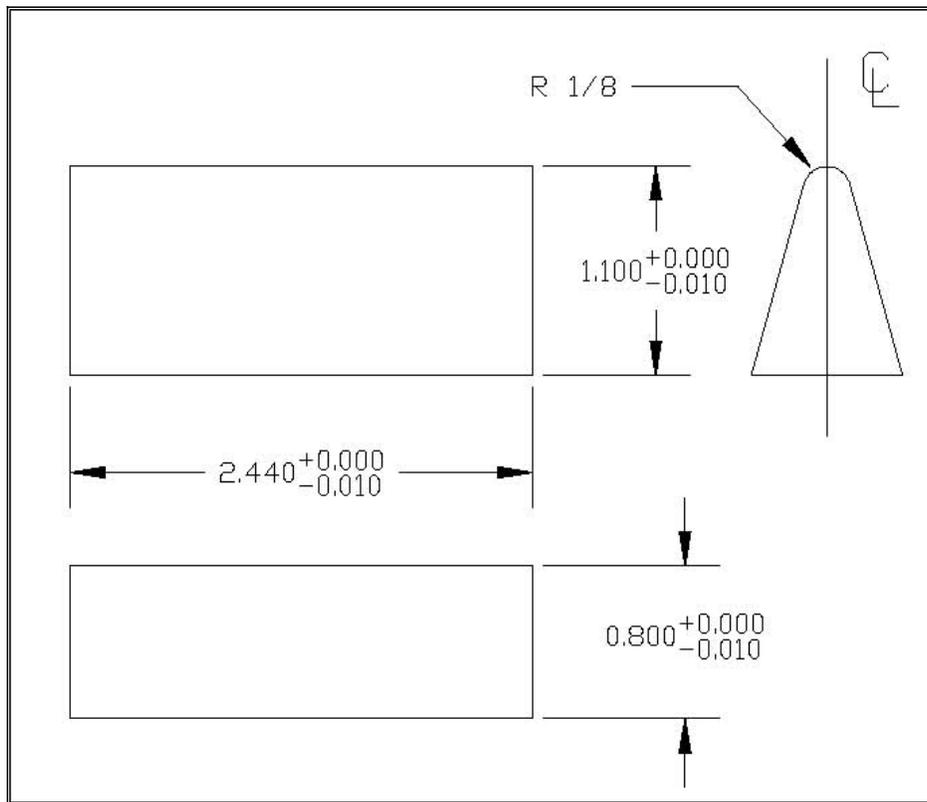


Figure 15: Solid Airfoil Specimen – Configuration 2

(X) Inches	(W) Abscissa
.000	.000
.050	.086
.100	.133
.200	.205
.300	.265
.400	.317
.500	.362
.600	.403
.700	.439
.800	.471
.900	.499
1.000	.524
1.200	.550

- All dimensions in inches
- (X) – chord length = .000 at leading edge
- (W) – total width of airfoil symmetrical about the centerline
- Maximum weight of the specimen is 200 grams



*Figure 16: Solid Airfoil Specimen – Configuration 3*

- All dimensions in inches
- Total dimensions include coating thickness, if any
- Maximum weight of specimen is 190 grams

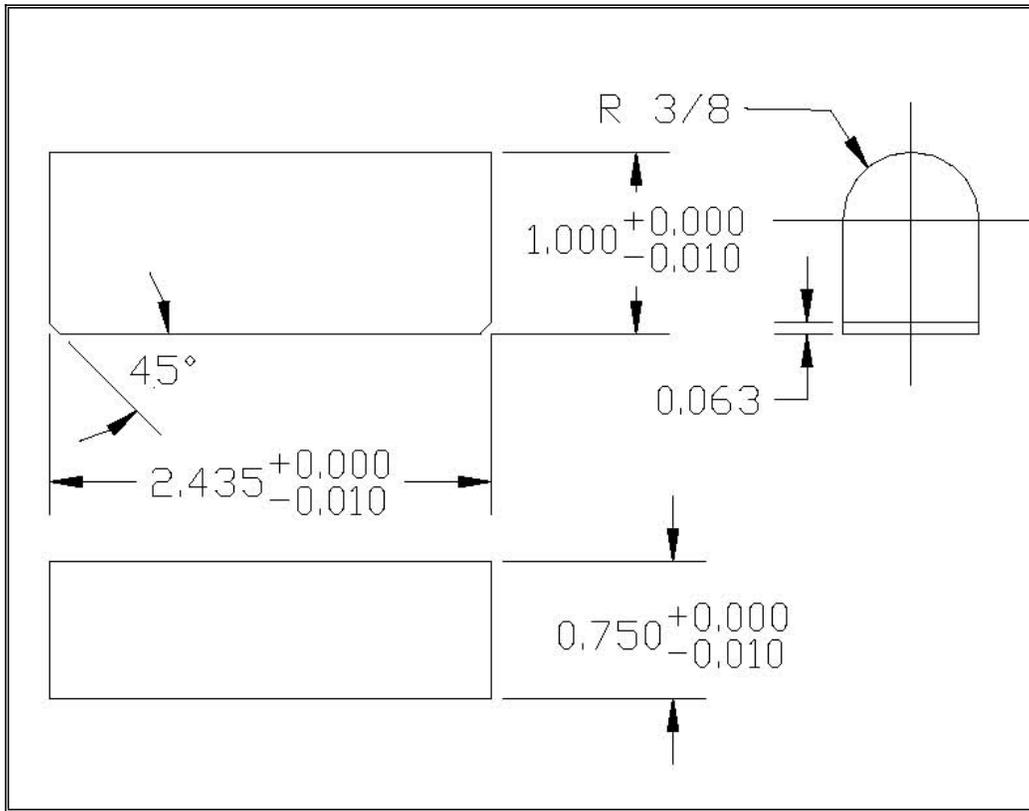


Figure 17: Solid Airfoil Specimen – Configuration 4

- All dimensions in inches
- Total dimensions include coating thickness, if any
- Maximum weight of specimen is 160 grams

**END OF GUIDE**