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NRL ARCH REFLECTIVITY TEST SETUP

TECHNICAL BULLETIN 101

The NRL Arch is a well-established, free-space measurement system for testing the absorbing efficiency of flat materials over broad frequency ranges. It was originally designed at the United States Naval Research Laboratory (NRL) in 1945 for measuring angular-dependent performance of broadband Radar Absorbing Materials (RAM). As its name suggests, the system is crafted of a physical arch equipped with one transmit and one receive antenna positioned along the arch at a constant distance from the material under test, which rests on a reflective metal plate below. The static distance of the material under test shall be large (30”-36”) such that the material is in the far field. The arch design allows for the movement of both antennas to any off-normal angle along the curve while maintaining constant spacing from test materials. Standard measurements of normal incidence are performed at the smallest off-normal angle at which antenna crosstalk does not alter measured values. An overview of the test setup is depicted in Figure 1, below.

LEGEND	
- - →	Incoming signal (P_0)
- - →	Detected signal (P_1)

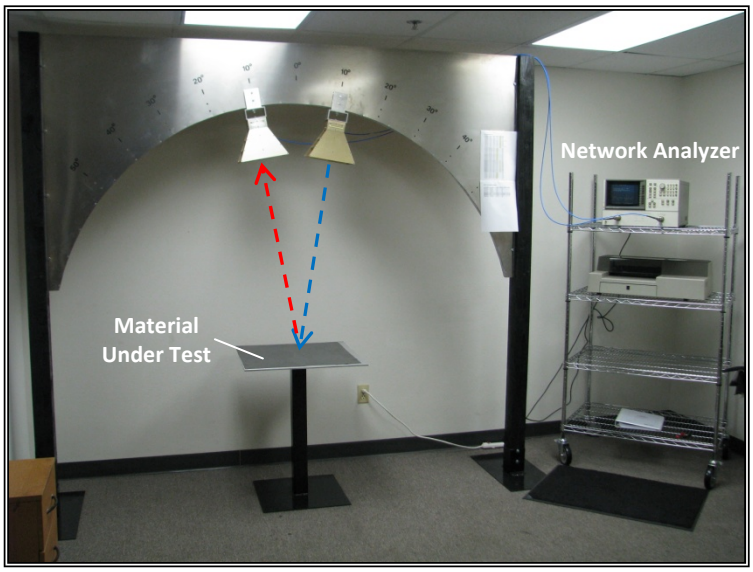

Figure 1. Overview of NRL Arch Reflectivity Test Setup

The transmit antenna is connected to a signal generator that sends microwave energy toward the target (either the reflective metal plate or material under test resting on the plate), and the receive antenna is attached to a signal detector that measures the remaining microwave energy after reflection. In most cases, a network analyzer functions as both the stimulus and detector of the microwave signal.

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Calibration to the reflective plate provides a baseline for perfect reflection, or zero absorption, in the system. Reflectivity is typically measured in decibels (dB), which relates the ratio of transmitted power to received power by the following equation:

$$dB = 10\log_{10}\left(\frac{P_1}{P_0}\right)$$

where P_1 is the received power and P_0 is the transmitted power. dB loss is plotted vs. frequency and the resulting curve shows the absorption efficiency of the material under test at every frequency within the specified range. A quick reference guide for the correlation between dB loss and absorption efficiency (in % power lost) is presented in Table 1, below.

QUICK REFERENCE GUIDE									
dB	**Absorption Efficiency**		**dB**	**Absorption Efficiency**		**dB**	**Absorption Efficiency**		**dB**	**Absorption Efficiency**
-1	20.57%		-11	92.06%		-21	99.21%		-31	99.92%
-2	36.90%		-12	93.69%		-22	99.37%		-32	99.94%
-3	49.88%		-13	94.99%		-23	99.50%		-33	99.95%
-4	60.19%		-14	96.02%		-24	99.60%		-34	99.96%
-5	68.38%		-15	96.84%		-25	99.68%		-35	99.97%
-6	74.88%		-16	97.49%		-26	99.75%		-36	99.97%
-7	80.05%		-17	98.00%		-27	99.80%		-37	99.98%
-8	84.15%		-18	98.42%		-28	99.84%		-38	99.98%
-9	87.41%		-19	98.74%		-29	99.87%		-39	99.99%
-10	90.00%		-20	99.00%		-30	99.90%		-40	99.99%

Table 1. Correlation between dB loss and Absorption Efficiency

MAST Technologies utilizes the NRL Arch reflectivity test set-up for the characterization and quality control of magnetic and dielectric absorbing materials. Currently MAST is able to test across the frequency range of 700 MHz to 20 GHz.