



## METALLURGICAL LABORATORY MARKING EVALUATION PROGRAM

Description	Evaluation of marking systems for durability
Problem	A test methodology was needed to evaluate the durability of various marking systems when exposed to UV, chemicals, or abrasion.
Approach	A quantitative system of evaluation was designed based on assessing the legibility of every alphanumeric in the marking as a function of test variables.
Conclusions	Using the method developed, marking system rankings can be used as a decision-making tool for application-dependent selection

Durability of various marking system/substrate combinations was evaluated by subjecting test coupons to three types of tests- (1) Solar Radiation IAW MIL-STD-810F, (2) Resistance to chemical exposure, and (3) Resistance to particulate abrasion. For all tests, 7 substrates were used, each with four marking systems. The substrates consisted of both square and round tubular sections approximately 12 inches in length.

### Substrates

Steel, Zinc Plated (Olive coloring)  
Steel, Cadmium Plated  
Stainless Steel  
Steel  
Aluminum, Clear Anodized  
Brass  
Aluminum, Black Anodized

### Marking Systems

Ink with Clear Overcoat  
Label  
Laser  
Thermark

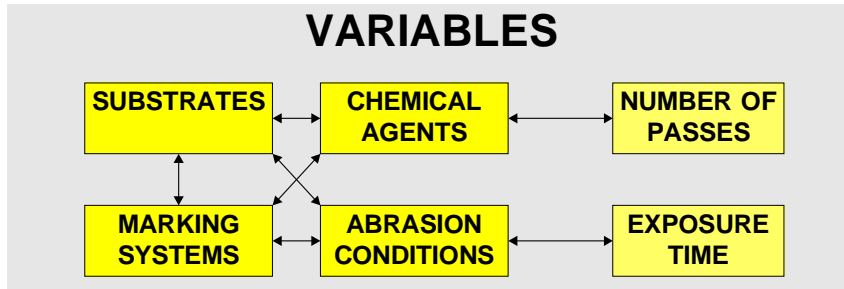
### Abrasion

Constant distance from nozzle  
Constant spray angle  
Constant air pressure  
Constant feed rate  
Number of passes - 2, 4, and 6



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The program was conducted as shown by the flow chart-



### EVALUATION TECHNIQUE

Each alphanumeric in the marking individually rated:

Rating 1.0 - Completely Legible

Rating 0.5 - Partially Legible

Rating 0.0 - Not Legible

The rating for each marking obtained from a sum of the alphanumeric ratings by defining two indices:

**Legibility Index - Absolute**

**Legibility Index - Normalized**

### SCOPE OF EVALUTION

Comparison of various systems in their initial state, as a function of exposure, and with respect to the rate of degradation.

Quantitative Data Generated:

**Chemical Resistance Testing - 81,144 Data Points**

**Abrasion Resistance Testing - 7,728 Data Points**

### DATA REDUCTION

Exclusion matrices constructed to specify conditions under which a marking system/substrate/exposure combination failed the pass criteria (Absolute Legibility Index of  $> 0.70$ )



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The two "Legibility Indices" (LIs) defined were: (1) "Absolute Legibility Index" or  $LI_A$  that represents the legibility of a marking at any given time and (2) "Normalized Legibility Index" or  $LI_N$  that represents the legibility of a marking with respect to its pre-test (initial) legibility. Thus,

$$LI_A = \frac{\sum_{i=1}^N L_R}{N}$$
$$LI_N = \frac{LI_A}{LI_I}$$

Where  $L_R$  is the legibility rating for each alphanumeric,  $N$  is the total number of alphanumerics in the marking and  $LI_I$  is the initial Legibility Index.

Using these indices, the data were reduced to construct matrices that depicted the combinations that did (Green shaded) and did not (Red shaded) meet the criteria  $LI_N \leq 0.700$  at 10,000 seconds of exposure. The matrices also include data on below-acceptance initial legibility (indicated by X).