SAE Aerospace
An SAE International Group

AEROSPACE RECOMMENDED PRACTICE

MAP 4053

Issued 10-31-89
Reaffirmed 2007-12

UNIFORM MEASUREMENT UNITS FOR LEAKAGE RATES

1. PURPOSE:

This MAP is intended to set forth standardized measurement units for the eventual replacement of the variety of fluid leakage rate measurement units now in use.

2. SCOPE:

Applications include specifications, reports, ratings, texts, etc., where fluid leakage rates are treated.

3. APPLICABLE DOCUMENTS:

SAE J916A - Rules for SAE Use of SI (Metric) Units

ANSI Z210.1 - Metric Practice Guide (American National Standard, 1973 American National Standards Institute -)
ASTM Document E380-72

4. SPECIFIC REQUIREMENTS:

This MAP recommends that units of mg/s (milligrams per second) be universally used for measurement of fluid leakage through containment barriers.

5. GENERAL NOTES:

Currently, leakage rates are treated in a wide variety of measurement units for reasons of practice or direct relation to instrumentation readout. There is a need for standardized terminology for expressing and comparing leakage rates. In SI (metric) terms, it would be logical to use mass/time units of kg/s (kilograms per second). However, this results in a very small number when applied to commonly used liquid and gaseous leakage rates. For example, helium leakage rates across precision valve seats or permeating through materials, are currently expressed as "atmospheric cm^3/s" in the E-10 to E-04 range. Using kg/s units, these would be in the range of E-13 to E-07. A higher range, as exemplified by allowable seat leakage for a current aircraft refuel shutoff valve is 60 cm^3/min. In kg/s terms, this would be E-04. Therefore, commonly used leakages fall within the range of E-12 to E-04. Such low numbers are relatively awkward to handle. A prefix raising the exponent by a multiple of six has been selected. This results in the term mg/s for uniform expression of leakage rates. Most practical leakages will fall within the range of E-06 to E+02.

In gas leakage rate measurement, volumetric units are commonly employed, relating directly to contemporary instrumentation. However, this requires reference to "standard" temperatures and pressures, which are not universally accepted. Conversion to mass/time units after measurement is relatively simple and avoid the need for knowledge of "standard" conditions.

Gas, liquid, and vapor leakage rates through barriers, components and systems vary widely in character and magnitude. An individual leakage may simultaneously involve liquid and gaseous states of one or a combination of fluids. One or more leakage principles may be acting (molecular, viscous). Again, mass/time units provide for logical measurement of each situation.

Use of this MAP does not imply necessity of change in existing calculation, control, or measurement of leakage rates; nor does it suggest any particular interval for leakage rate testing, since some instrumentation yields instantaneous readings while others may require measurement over some definite time interval. However, final leakage rates should be converted from the various original units in to the standard mg/s.

6. CLASSIFICATION:

A useful system for classifying the range of any fluid leakage rate is based on the SI notation decade exponent. For example:

SAE Standard Leakage Rate Class	Decade Range of Class mg/s	Typical Leakage Rate in the Class mg/s	
1	$10^1 \leq R < 10^2$	6.0	E+01
0	$10^0 \leq R < 10^1$	1.0	E+00
-1	$10^{-1} \leq R < 10^0$	2.5	E-01
-5	$10^{-5} \leq R < 10^{-4}$	9.9	E-05