Mass Standards Handbook — The Advantages of Troemner Alloy 8 Stainless Steel

In 2003, Henry Troemner LLC began manufacturing stainless steel weights using a new, unique, material specifically designed to meet the many demands required of precision weights. Precision weight requirements of consistent density, low magnetic properties, extremely smooth surface finishes, and hardness are not easily achieved. For example, softer stainless steels developed to obtain better surface finishes tend to have higher magnetic properties. Softer stainless steels, although easier to machine and polish, do not have the hardness of less machining friendly stainless steels and may wear more quickly and lose weight faster when in use. Henry Troemner LLC spent years researching and testing various stainless steels to characterize the optimal material used for making precision weights in order to specify a material that would be far superior to any other stainless steel being used. The result is Troemner Alloy 8 Stainless Steel, the finest commercially available stainless steel for high precision calibration weights and mass standards. Alloy 8 meets and exceeds all stainless steel material specifications that NBS (now NIST) specified when purchasing the original U.S. state laboratory mass standards over 35 years ago.

Troemner weights made from Alloy 8 Stainless Steel provide the customer the following benefits:

Low Magnetic Properties - The most important attribute of Troemner Alloy 8 is its extremely low magnetic properties. ASTM E617-97 Standard Specification for Laboratory Weights which covers classes 0, 1, 2, 3, 4, 5, 6 and 7 has specifications for maximum allowable susceptibility and magnetic field. See Table 12 below for these specifications.

Table 12 - Magnetic Properties

WEIGHT CLASS	VOLUME MAGNETIC SUSCEPTIBILITY (χ)	MAXIMUM MAGNETIC FIELD	
		µT	mG
0	0.01	2.0	20
1	0.03	4.0	40
2, 3, 4	0.05	6.0	60
T = Tesla G = Gauss			

OIML International recommendation R111 for Weight Classes E1, E2, F1, F2, M1, M2, M3 also has specifications for maximum allowable susceptibility and magnetic field.

See Table 13 and 14 on page 80 for these specifications.

The magnetic susceptibility specification for Troemner Alloy 8 is 0.005, which exceeds ASTM and OIML specifications for all classes.

Why are magnetic properties important? The magnetic field of the weight can react with the balances' magnetic fields causing calibration errors. Many of today's precision balances have weighing cells which are sensitive to magnetic field changes. If one moves a magnetized weight around a balance pan affecting the magnetic field of the weighing cell, the balance readings may change, introducing errors into the measurement.

Magnetic properties in stainless steel can be characterized in two ways. Magnetic susceptibility is a dimensionless measure that determines the ability of a material to respond to an external magnetic field. Magnetic field in a material can be measured once a material is magnetized. The higher the susceptibility for a material, the easier it is to become magnetized.

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Austenitic stainless steel has naturally low magnetic permeabilities. During the manufacturing process, cold working of the metal can change the grain structure of the material and increase its ability to be magnetized. This change in grain structure will be dependent upon the grade of stainless steel.

Once a weight exhibits susceptibility it can be magnetized when placed in a magnetic field. The amount of permanent magnetization will depend on the strength of the magnetic field and the susceptibility of the sample. The magnetic susceptibility of a sample can be reversed through stress relieving (annealing) of the sample. This process does not produce repeatable results and Troemner does not recommend it.

A weight that becomes magnetized can be "de-magnetized" by introducing the weight to an electrical magnetic field generated by a piece of equipment. By holding the weight with its field perpendicular to the field generated by the piece of equipment, you can reduce the magnetic field of the weight. However, this method is not recommended since the weight can become easily magnetized again if it is exposed to another magnetic field.

Alloy 8's composition has extremely low natural magnetic susceptibility. Troemner, Alloy 8 has been extensively tested for susceptibility before and after manufacturing using our NVLAP accredited calibration process. Extensive tests were also performed for permanent magnetism. Weights made of Alloy 8 were exposed to various magnetic fields and none of them became magnetized.

For more information on magnetic susceptibility, Troemner's NVLAP accredited measurement process, and information on a laboratory inter-comparison, there is a technical paper posted on Troemner's web site. Go to www.troemner.com, click on the literature library tab, then technical literature.

Consistent Density - Because it is a custom material, Troemner Alloy 8 is obtained from a single source, and is purchased in mill run quantities (40,000 pound minimum) to assure consistency in material density across different sizes of weights. Troemner reports a density of 8.03 g/cm^3 for Alloy 8 after testing several samples using its NVLAP accredited density calibration process. Density measurements across all diameters were within +/- 0.006 g/cm^3. This is important for weights that are subsequently recalibrated after the initial sale because the reported density is used to make buoyancy corrections during calibrations. Variations in material density can have an effect on the calibrated value assigned to weights. (Check your Certificate or Statement of Accuracy for the density of your weights.)

Surface Finish and Hardness - Troemner Alloy 8 is significantly harder than material used previously. The benefit to the user of a harder material is it is less susceptible to wear and scratches. A weight made of harder stainless steel is less likely to lose enough mass to carry it out of its adjusted tolerance.

A weight manufactured using Troemner Alloy 8 will have extremely low magnetic properties, consistent density, and the mirror-like, highly polished finish you have come to expect from Troemner in order to meet today's rigorous requirements.

Table 13 - Maximum Susceptibility, χ of OIML Weights

WEIGHT CLASS	E_1	E_2	F_1	F_2
Nominal value ≥ 100 g	0.01	0.03	0.07	0.21
Nominal value < 100 g	0.025	0.075	0.25	0.75
Nominal value ≤ 1 g	0.12	0.37	1.2	-

Table 14 - Maximum Permanent Magnetism, μ_0 M (μT), of OIML Weights

WEIGHT CLASS	E_1	E_2	F_1	F_2	M_1	M_2	M_3
Maximum Magnetism, μ_0 M (μT), of OIML weights	3	10	30	100	300	1000	3000

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