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Subject:	Allowable Bake Temperature for UHV Processing of Aluminum Alloys		
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As of E960022-v2 (we are now at v8), 6061-T6 is baked at 150C, but all other aluminum alloys are baked at 120C (section 12.4). Of course as a practical matter when combining aluminum, or if unsure of the alloys in the batch, the default should be 120C. Generally LIGO aluminum parts are comprised of 3 different aluminum alloys:

6061-T6

2024-T351

5083 (no temper called out on the aLIGO UK team drawings)¹

The effect on room temperature strength after elevated temperature exposure at 150C (302F) for 100 hr is taken from the R.C. Rice et. al., "Metallic Materials Properties Development and Standardization (MMPDS), Jan-2003, DOT/FAA/AR-MMPDS-01

Aluminum Alloy - Temper	% Tensile Ultimate Strength (Ftu)	% Tensile Yield Strength (Fty)	MMPDS Figure
2024-T351	96%	93%	3.2.3.1.1(e) & (f)
5052-H34	97%	100%	3.5.1.3.1(c) & (d)
5052-H38	99%	97%	3.5.1.5.1(c) & (d)
6061-T6	100%	100%	3.6.2.2.1(c) & (d)

Note that there is no degradation in strength for the 6061-T6 material. For 2024-T351 exposed to the LIGO-E960022 bake temperature of 120C, the degradation is to 99% of Ftu and 96% of Fty; The exposure to 150C is only an additional 3% reduction in strength.

¹ The aLIGO UK team had some aluminum parts which were rather weak (low yield strength) which they attributed to overheating in a bake. The 5000 series of wrought alloys are strengthened by cold working (not solution or age heat treating). However one can presumably remove the cold work temper by stress relief under an elevated temperature. Since the UK do not call out the temper, it is also possible that their problem was related to a machine shop using -O temper (instead of H112, H321 or H343). The UK re-designed a couple/few parts so that even with an -O temper the have sufficient strength.

I have not found data on the effect of exposure to elevated temperature on the room temperature strength of the 5083 alloy. For the 5052 alloy (another in the 5000 series), the reduction is no more than we are permitting for 2024. Consequently it is likely that the accidental baking to 150C of these 5083 quad suspension parts is OK. Baking 2024 and 6061 parts at 150C is generally OK.

It is best to restrict aluminum alloys other than 6061 to 120C, unless there are compelling reasons to bake at a higher temperature. An example of a compelling reason is baking the Magnet Assembly for the Penultimate Reaction Mass, [D070234-v2](#) (5083 alloy; without the magnets) at 145C, so that the adhesive (MasterBond EP30-2) is well outgassed.