Each cal is a list of set points in temperature and the corresponding voltage measured at that set point. My understanding is that the resistance corresponding to the calibration in the bath was applied at the connector for the temperature probe via a resistance box and the voltage was measured by the data system.

Questions:

1. What were the resistances set in the resistance box? The problem is that I suspect the input resistance values may be in error because of inadequate thermal control at the temperature head, and this would give departures increasing at low temperature. See the discussion below.

2. What does the 'Applied' column mean? Some of these are 0.2 different from the set points in some cases. Is the fit to these values or to the set points?

3. Was the temperature dependence of the A-D calibration handled right for these calibrations, and also for the processing of research flights? This was a time when all this was being sorted out. Appropriate temperature-dependent calibrations for the A-D are needed when the calibration is done (unless the temperature is 40C).

4. How should the resistance be reflected in voltage? The values in these calibrations are not consistent with the expected dependence of a PRT (with resistance varying approximately as 1+0.003982T_C) so there must be an offset in the measured voltage if that voltage is linearly related to the resistance. How does the pre-amp work?

Comments:

1. It would be better to work with the Callendar-Van Dusen equation, cited in the Goodrich Technical Report 5755 as follows:

$$\frac{R_T}{R_0} = 1 + \alpha \left[T - \delta \left(\frac{T}{100} - 1 \right) \left(\frac{T}{100} \right) - \beta \left(\frac{T}{100} - 1 \right) \left(\frac{T}{100} \right)^3 \right]$$

where R_T is the resistance at temperature$T$ (in degrees Celsius), R_0 is the resistance at temperature 0°C, $\alpha = 0.003925$, $\delta = 1.46$, and $\beta = 0.1$ for T>0 and 0.0 otherwise. This expands to the following power-law equation:

$$\frac{R_T}{R_0} = 1 + 0.0039823T - 5.7305 \times 10^{-7} T^2 \left\{ +3.925 \times 10^{-10} T^3 - 3.925 \times 10^{-12} T^4 \right\}$$

where the final term in brackets is only included for T>0. If the equation fit to the measured values for resistance vs temperature is inconsistent with this, especially at the low-T end, I'd suspect the bath control of uniform temperature and use a fit where this equation is matched to the values at higher temperature and extrapolated to low temperature. To pursue this, though, I need the resistance values, not the voltages, or else some way of finding the resistance values from the voltages. My hope is to determine the linear and quadratic terms from measurements near room temperature, which should be close to the values in the above equation, and then see if extrapolation to low temperature is consistent with the low-T calibration points. I suspect there will be deviations because of the difficulty in providing a good thermal sink in the baths at low temperature.

2. A new temperature scale was introduced in 1990 that affects measurements such as this. It goes by the name ITS-90 and is described in NIST Tech Note 1265. A somewhat incomplete study of this suggests that the differences it might introduce are $<0.1^\circ$C in the most extreme cases we will encounter, so I have not included these changes for now. At some time it may be worth considering more carefully how the redefinition of the temperature scale (which brings it more in line with the thermodynamic scale and so better for our purposes) might affect our measurements.