HW7.1

We know that the horizontal force will result in a downward component on the tube because of the angle of the guy wire. So we need to find out the load where the tube will buckle. First we find the Transition Slenderness Ratio = Sqrt(2Pi^2 E/ Sy) = 117.4. Next, what is the Slenderness Ratio of the tube? Its Area Moment of Inertia is 1.132 in^4 and its Area is 1.767 in^2, so the Radius of Gyration = Sqrt(I/A) = 0.80 in. The tube is pinned-pinned, so its effective length equals its length = 180 in. So the tube's Slenderness Ratio = 224.9. That's higher (more skinny) than the Transition SR, so we use the Euler equation.

The critical buckling load is then = Pi^2*E*I/Le^2 = 10,346 Lb.

By geometry, if the horizontal force is F, the vertical force is 15/6 F, so 15/6 F must be less than 10,346, or F must be less than 4138 Lb.

The FOS for a 3000 Lb load is just 4138 / 3000 = 1.38, because 4168 is the largest it could be before the tube buckled.

HW7.2

A. First we need to find out if the column is skinny or stubby, so we calculate the Transition Slenderness Ratio for the material = 116.7. Then calculate I and A to get a Radius of Gyration = 12.5mm. The effective length, Le = 2 x L because it is fixed-free end conditions, so Le = 4000mm. The Slenderness Ratio of this tube, Le/Rg = 320. This is above the Transition, so we use Euler and get 39.2 kN for the buckling load. The load for a FOS = 2 would be half that, or 19.6 kN.

B. If the tube has fixed-fixed end conditions, Le = 0.5 x L = 1000 mm, and now the Slenderness Ratio is 80, which is below the Transition, making it a stubby column, and we use the Johnson equation. We calculate the Critical Stress as 229.5 MPa and multiply by the area of the column to get a Critical Load of 450.6 kN.