**Helicopter Hover Ceiling – Multiple Regression**

**Introduction**

The ability of a helicopter to hover in mid-air is affected by the air’s density. The denser the air the easier it is for a helicopter to hover. Two primary factors that affect air density are altitude and temperature. Air is less dense at higher altitudes and warmer temperatures. The practical effect of this is that altitude and air temperature determine the maximum payload (weight) a given helicopter can safely carry.

Because of their unique ability to access remote locations helicopters are often used to fight forest fires. In addition to transporting people and equipment helicopters can carry large tanks of water to a fire and dump it. Since water is very heavy it’s important to know the limits of the total weight of the helicopter and payload (amount of water) that can be safely carried. This maximum total weight is referred to as the hover ceiling.

Forest fires, of course, occur at locations of varying altitudes and air temperature which means hover ceilings also vary greatly. Charts are prepared for specific models of helicopters that show hover ceilings for a range of altitudes and temperatures. Because of the relatively large number of variables and values the charts can be somewhat cumbersome to use. An example of a hover ceiling chart is shown below.****

**Project**

In 2003 the fire-fighting division of Montana’s Department of State Lands decided to convert their paper hover ceiling charts into mathematical formulas that could be loaded into a computer. Instead of finding the values on a chart the pilot could simply enter the altitude and temperature into the computer (or calculator) and it would calculate the hover ceiling (weight). The department hired a consultant to accomplish this task.

The procedure used by the consultant was to pull a sufficient amount data from the chart and use multiple regression to generate an equation that computes the hover ceiling from the input variables (altitude and temperature). The attached spreadsheet “Helicopter Hover Ceiling – Multiple Regression” shows the procedure.

**Update to 2016**

According to Chuck Brenton, head of the Department of State Lands fire-fighting unit, hover ceilings are still calculated using regression equations and computers. The helicopters and equations have been updated, however, since the initial equations were developed in 2003.