The Challenger Disaster

[The information given below is from the *Journal of the American Statistical Association* 84, pages 945-957, December, 1989. Available in the Math Library.]

On January 28, 1986 the space shuttle Challenger exploded. Seven astronauts died because two large rubber O-rings leaked during takeoff. These rings had lost their resiliency because of the low temperature at the time of the flight. The air temperature was about 0^o Celsius, and the temperature of the O-rings about 6 degrees below that.

On the night of January 27, 1986, the night before the space shuttle Challenger accident, there was a three-hour teleconference among people at Morton Thiokol (manufacturer of the solid rocket motor), Marshall Space Flight Center [NASA (National Aeronautics and Space Administration) center for motor design control], and Kennedy Space Center. The discussion focused on the forecast of a 31^o F temperature for launch time the next morning, and the effect of low temperature on O-ring performance. A data set, Figure 1 below, played an important role in the discussion. Each plotted point represents a shuttle flight that experienced thermal distress in the field-joint O-rings; the x axis shows the temperature at launch and the y axis shows the the damage index to the O-rings. The O-rings seal the field joints of the solid rocket motors, which boost the shuttle into orbit. Based on the U-shaped configuration of points it was concluded that there was no evidence from the historical data about a temperature effect.

Nevertheless, there was a debate on this issue, and some participants recommended that the launch be postponed until the temperature rose above 53^o F – the lowest temperature experienced in previous launches – because the corresponding flight had the highest number of distressed O-rings. Some participants believed, based on the physical evidence, that there was a tem perature effect on O-ring performance; for example, one of the par ticipants, Roger Boisjoly, stated: *temperature was indeed a discriminator*. In spite of this, the final recommendation of Morton Thiokol was to launch the Challenger on schedule. The recommendation transmitted to NASA stated that *Temperature data are not conclusive on predicting primary O-ring blowby.*

Data from previous 23 flights are given below

Temperature (C)	Damage Index
12	11
14	4
14	4
17	2
19	0
19	0
19	0
19	0
19	0
20	0
21	4
21	0
21	4
21	0
21	0
22	0
23	0
24	4
24	0
24	0
26	0
26	0
27	0

Fig 1: Damage Index of O-ring vs. Temperature

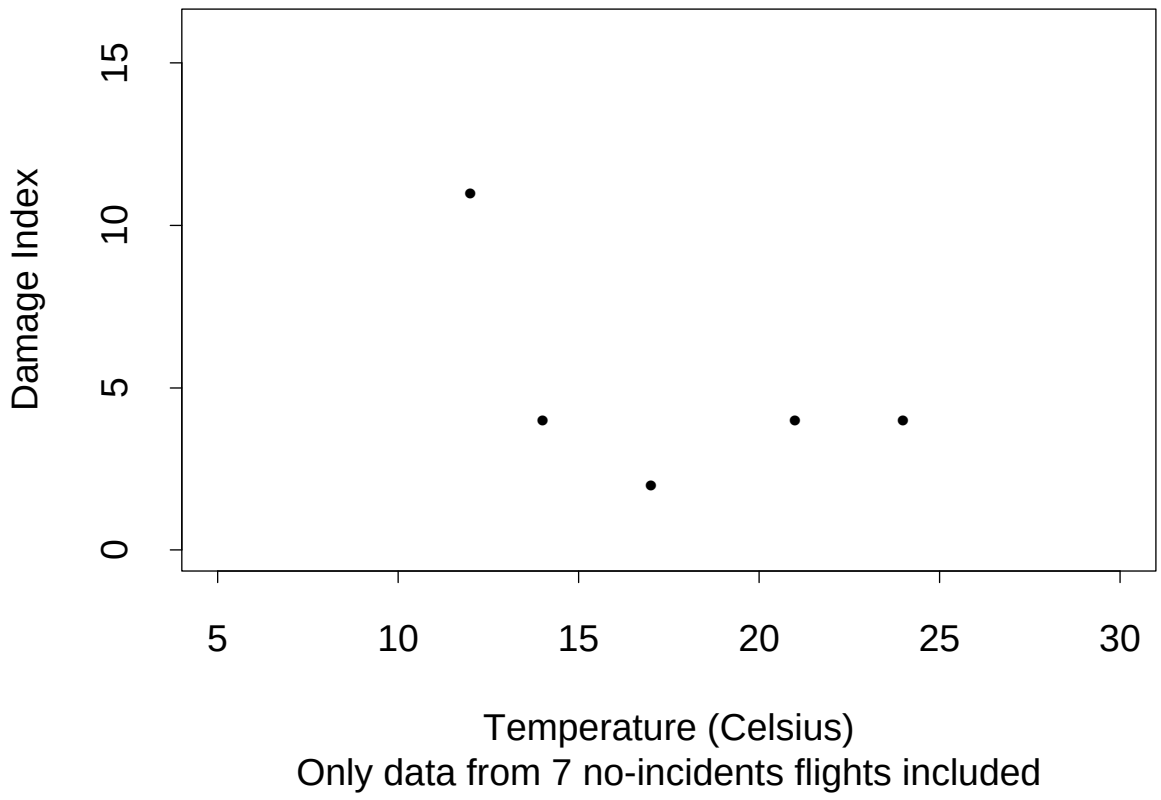

Fig 2: Damage Index of O-ring vs. Temperature