ADDENDUM TO FINAL REPORT

DETERMINATION OF A MODEL TO PREDICT
WINTER MAINTENANCE
PERSONNEL LEVELS

D. F. Haber, U. Limaye
Civil Engineering Department
University of Idaho

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Introduction:

As requested by the WINTER COMPLEMENT MAINTENANCE PERSONNAL ALLOCATION COMMITTEE, analysis of the sensitivity and updating the data base of the allocation model was carried out. The previous models allocating winter maintenance personnel were based on historical data from 1982 to 1987 (not including 1988 and 1989). The dependent variable of the model was defined as - "The average number of manhours expended per day for "Peak Storms" (ASH). Peak storms were defined as "Those days whose total road clearing manhours exceeded the mean plus one and half standard deviations. This cutoff level is arbitrary and could affect results of the model. In this study, the effect of this cutoff level on the model and on the personnel allocations was analyzed.

Data Sets

ASH can be extracted from two similar data sets. One is the cost dataset and the other is the maintenance dataset. Either data set should give the same results for manhours worked for winter storm activity. However, the cost data set contains additional information concerning costs for the activities. The previous model was constructed using the maintenance data set, but the cost model was constructed using the cost data set. A complete comparison was run between both data sets for all available winter maintenance data. This comparison showed exact agreement between the two sets except for a small number of observations. These differences are attributed to reporting error and did not affect any subsequent analysis.

Several other changes in the data set were made in this study. First, data from winters 1988 and 1989 were included, and secondly, storm manhours worked by special crews whose work areas may cross several standard foreman areas were

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also included in the updated data set. These special crew manhours especially affected the results for Districts 3 and 6.

Dependent Variable

The definition of ASH, "the storm days where the total road clearing manhours exceeded some specified cutoff value" were exactly the same for both analysis. However, this study used a variable parameter K for the cutoff factor whereas the previous analysis used K = 1.5 as stated above.

The actual cutoff level is determined by $\mu + K\delta$; where μ represents the average ASH over the winter season, δ the number of deviations and K the cutoff factor.

Five cutoff factors were selected K = 1.65, K = 1.5, K = 1.28, K = 1.04 and K = 0.84 (Table 1). If ASH is distributed normally, these various K's can determine the percentage of total storm days used to develop the complement. For instance, if K = 1.5, then only 6.7% of the days during a winter season were designated as "Peak Storm Days".

Table 2, 3 and 4 list the changes in cutoff levels with the change (from present levels) in winter complement. Table 2 uses historic values (REQH), Table 3 uses predicted values (REQP), and Table 4 uses only the 1989 values in the independent variables to produce statewide complement (REQC). Figure 1 graphically illustrates this linear trend between ASH and change in winter complement for the entire state and Figures 2 thru 7 illustrates this trend for each District.

Results: A linear trend was found between Cutoff Factor K and ASH both statewide and district wide. Almost all FA's also gave such a linear trend.

This linear trend indicates there is not an abrupt change in State or District Winter Compliments with different cutoff levels to determine storm hours. Once the cutoff level is chosen, state or district winter complements can be determined by the model.

The choice of the cutoff factor (K) is a management decision with higher cutoff levels indicating large complements and lower cutoff levels giving proportionally smaller compliments.

Given a specific cutoff level, District winter complement can be estimated. The District Complement values for K = 1.5 are somewhat higher than in the previous model before updating - TABLE 5 gives the comparison between models.

TABLE 1

Cutoff value	Symbol for ASH Obtained
μ + 1.65δ (5%)	ASH 1
μ + 1.5δ (6.7%)	ASH 2*
μ + 1.28δ (10%)	ASH 3
μ + 1.04δ (15%)	ASH 4
μ + 0.84δ (20%)	ASH 5

*Used for previous study

TABLE 2.

Dependent Variable	Change in Complement REQH (Statewide)
ASH 1 (K=1.65)	44
ASH 2 (K=1.5)	30
ASH 3 (K=1.28)	7
ASH 4 (K=1.04)	-19
ASH 5 (K=0.84)	-40

TABLE 3.

Dependent Variable	Change in Compelment REQP (Statewide)
ASH 1	45
ASH 2	30
ASH 3	7
ASH 4	-20
ASH 5	-40

TABLE 4.

Dependent Variable	Change in Complement REQC (Statewide)
ASH 1	51
ASH 2	35
ASH 3	13
ASH 4	-14
ASH 5	-35

TABLE 5.

Cutoff Factor K = 1.5

Previous Model		Updated Model	
District	Change in Complement	District	Change in Complement
1	+7	1	+8
2	-8	2	-5
3	-4	3	+5
4	+6	4	+6
5	+12	5	+15
6	+2	6	+6
	15		35

Change in complement for entire state
Vs.
Cutoff factor (K)
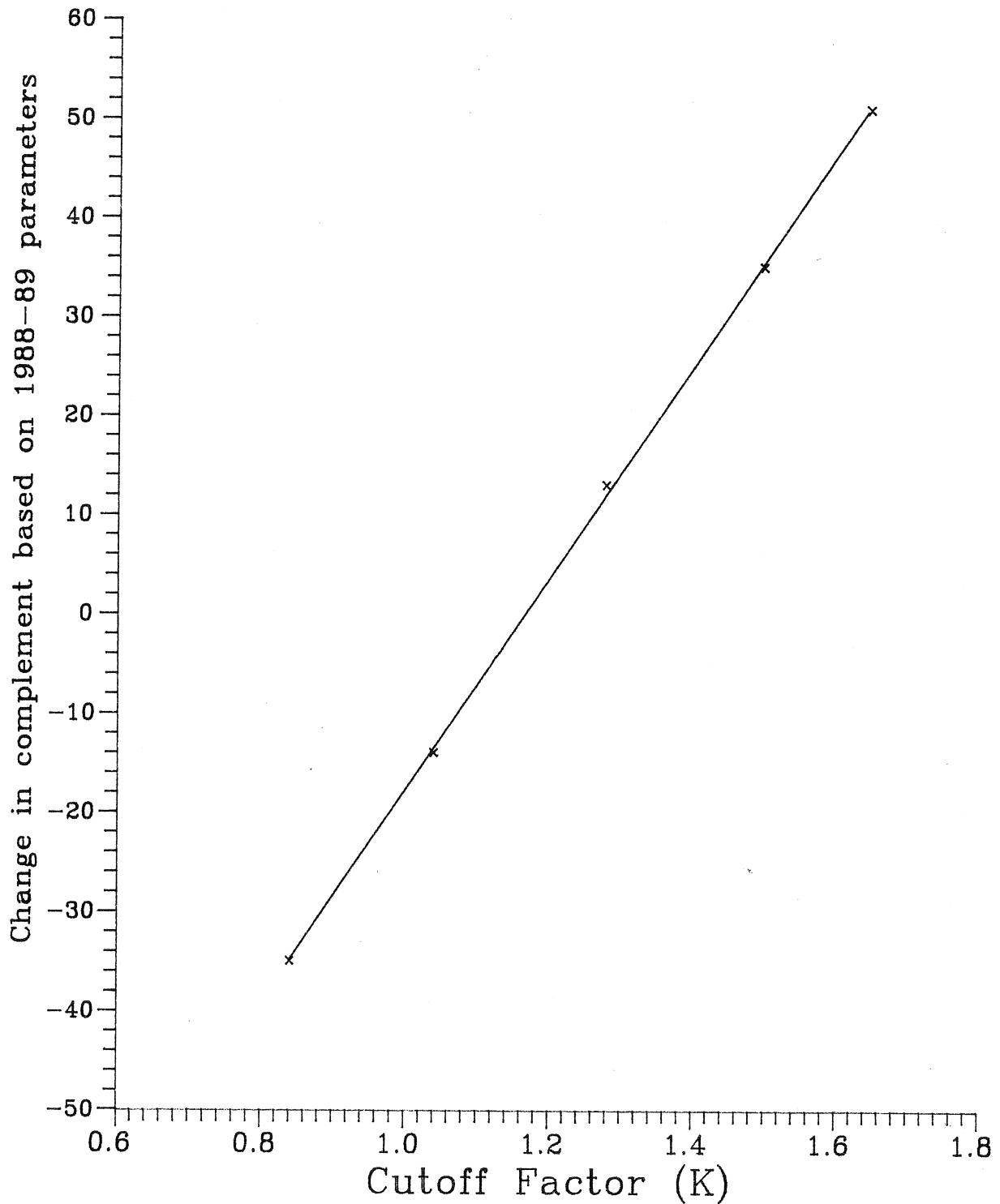
Figure 1

Change in complement Vs. Cutoff factor (K)
District 1
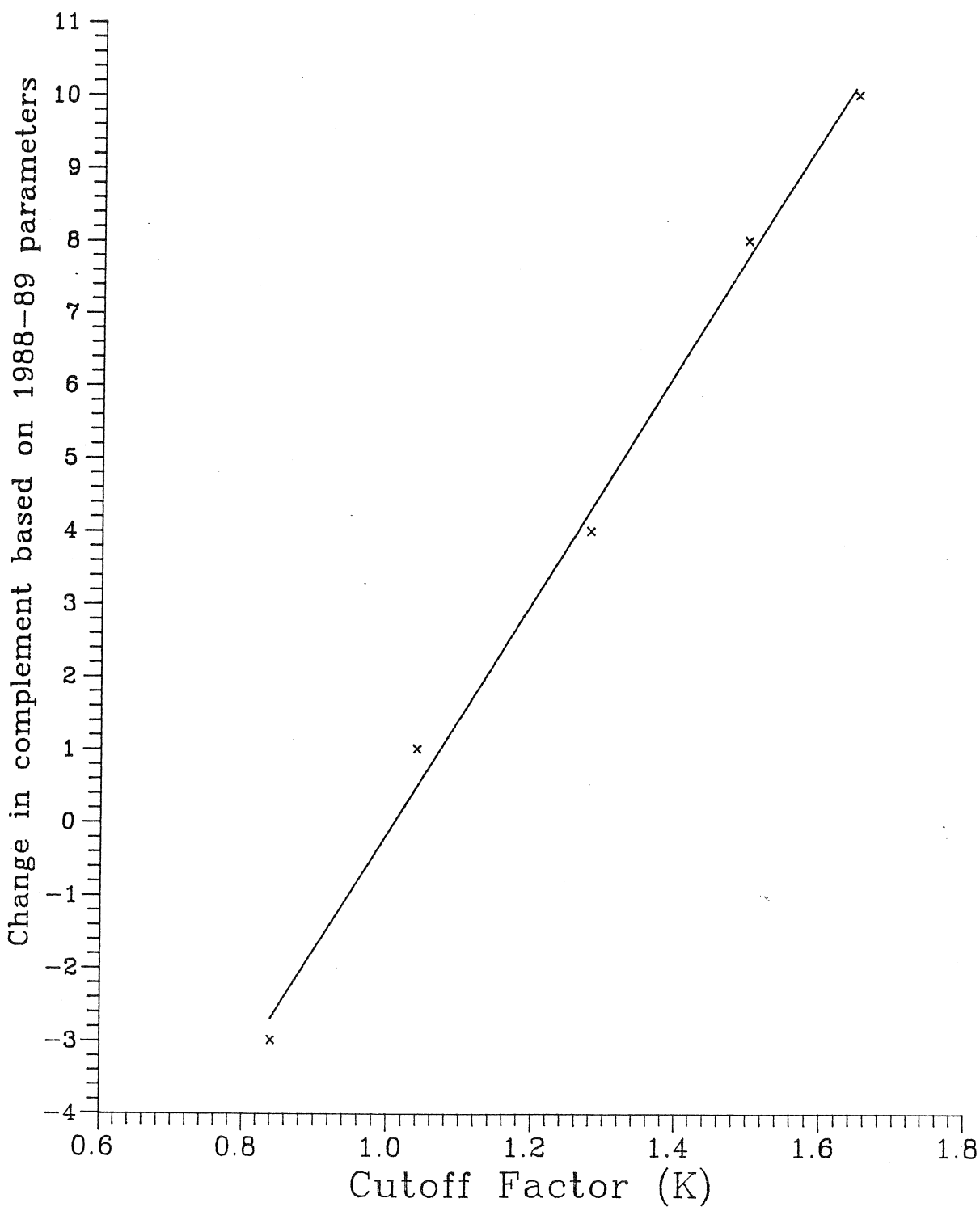
Figure 2.

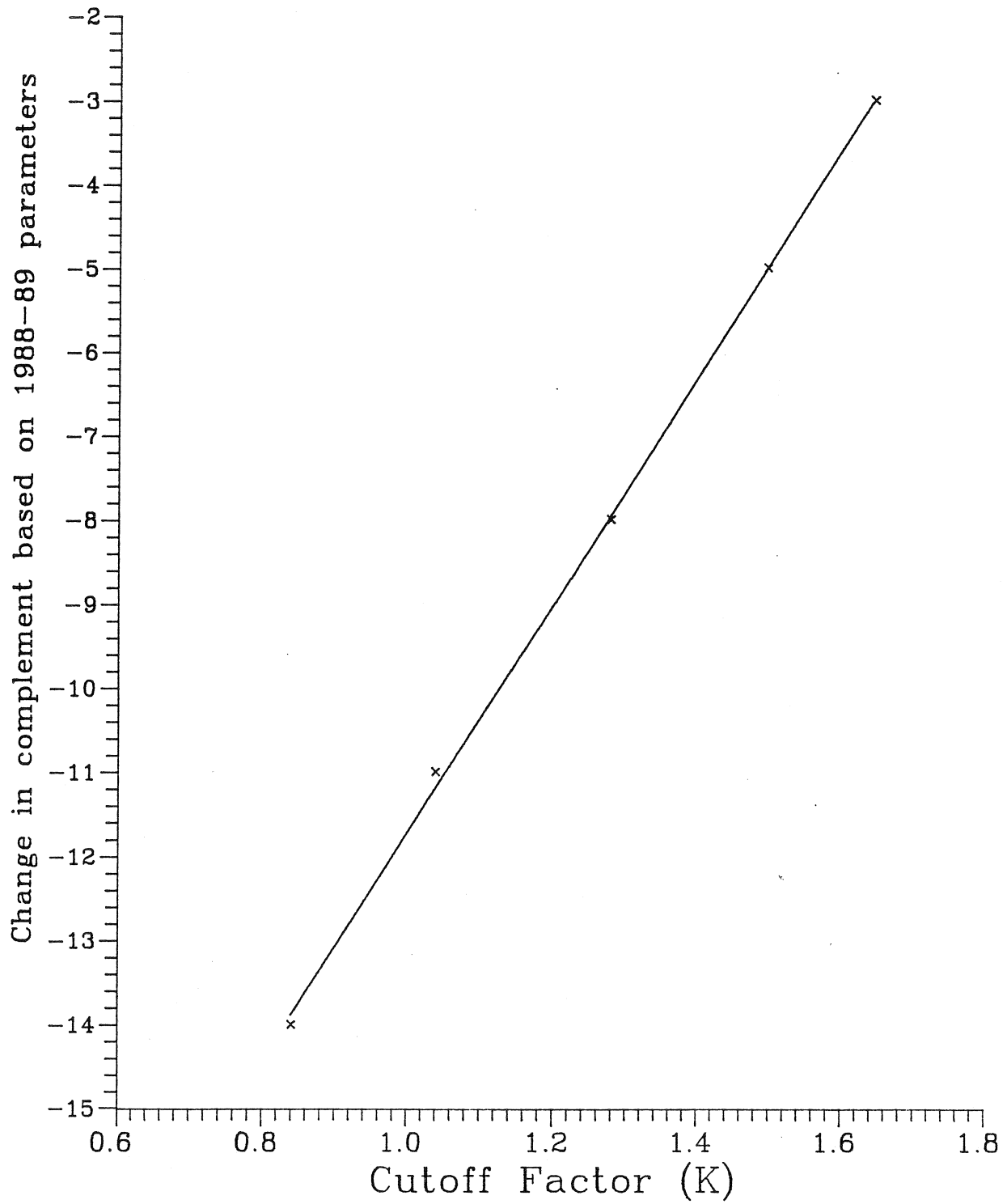# Change in complement Vs. Cutoff factor (K)
District 2

Figure 3

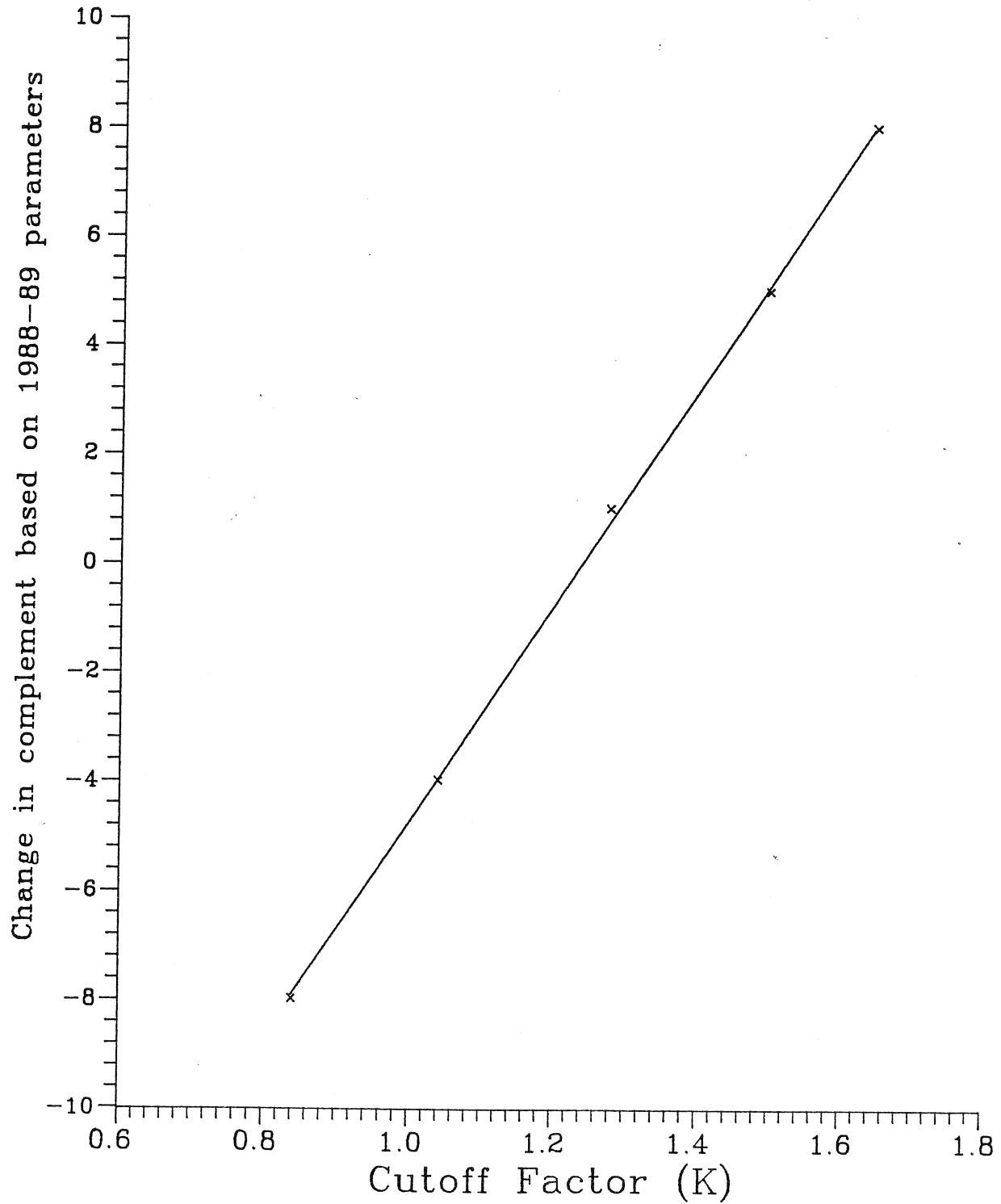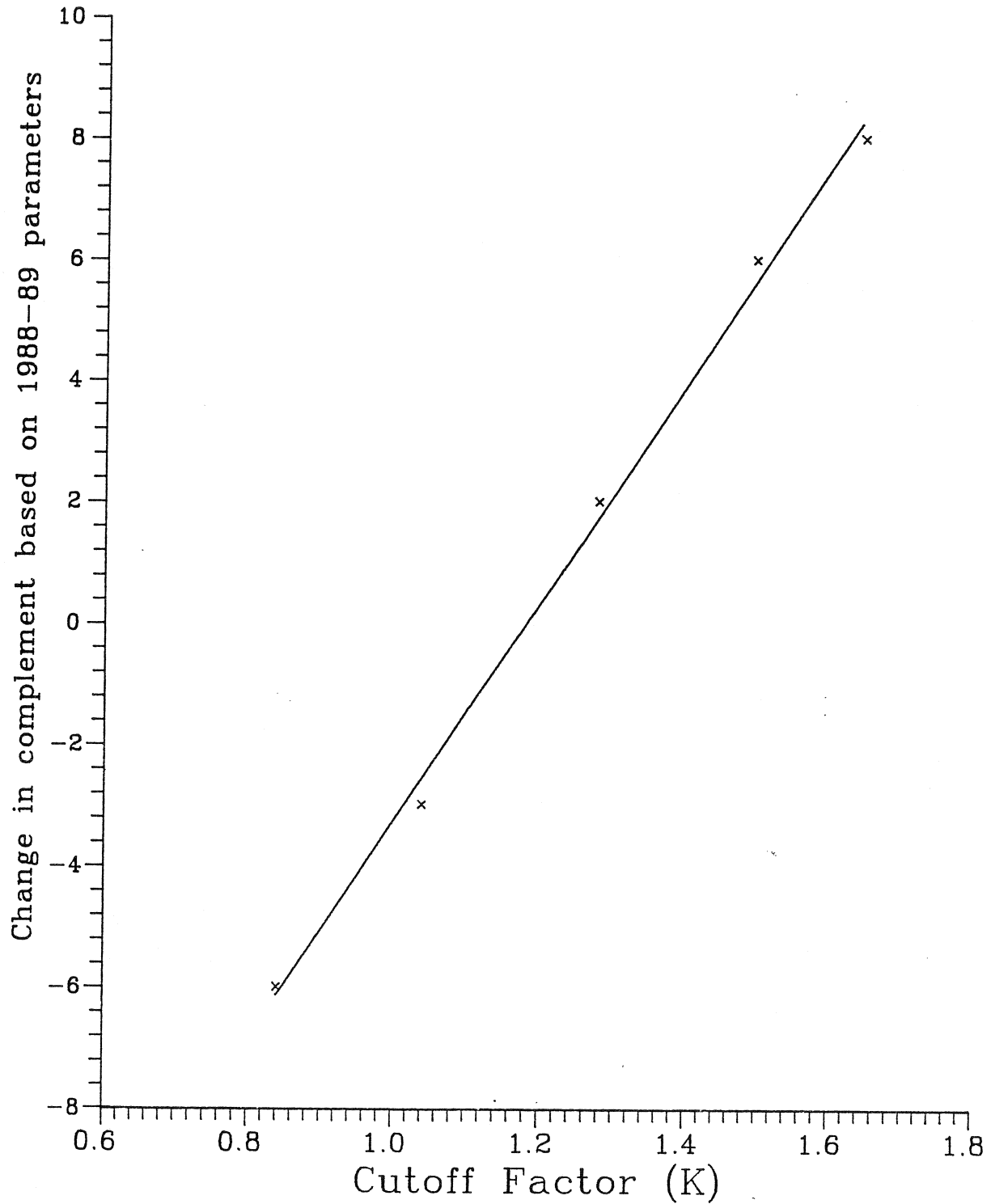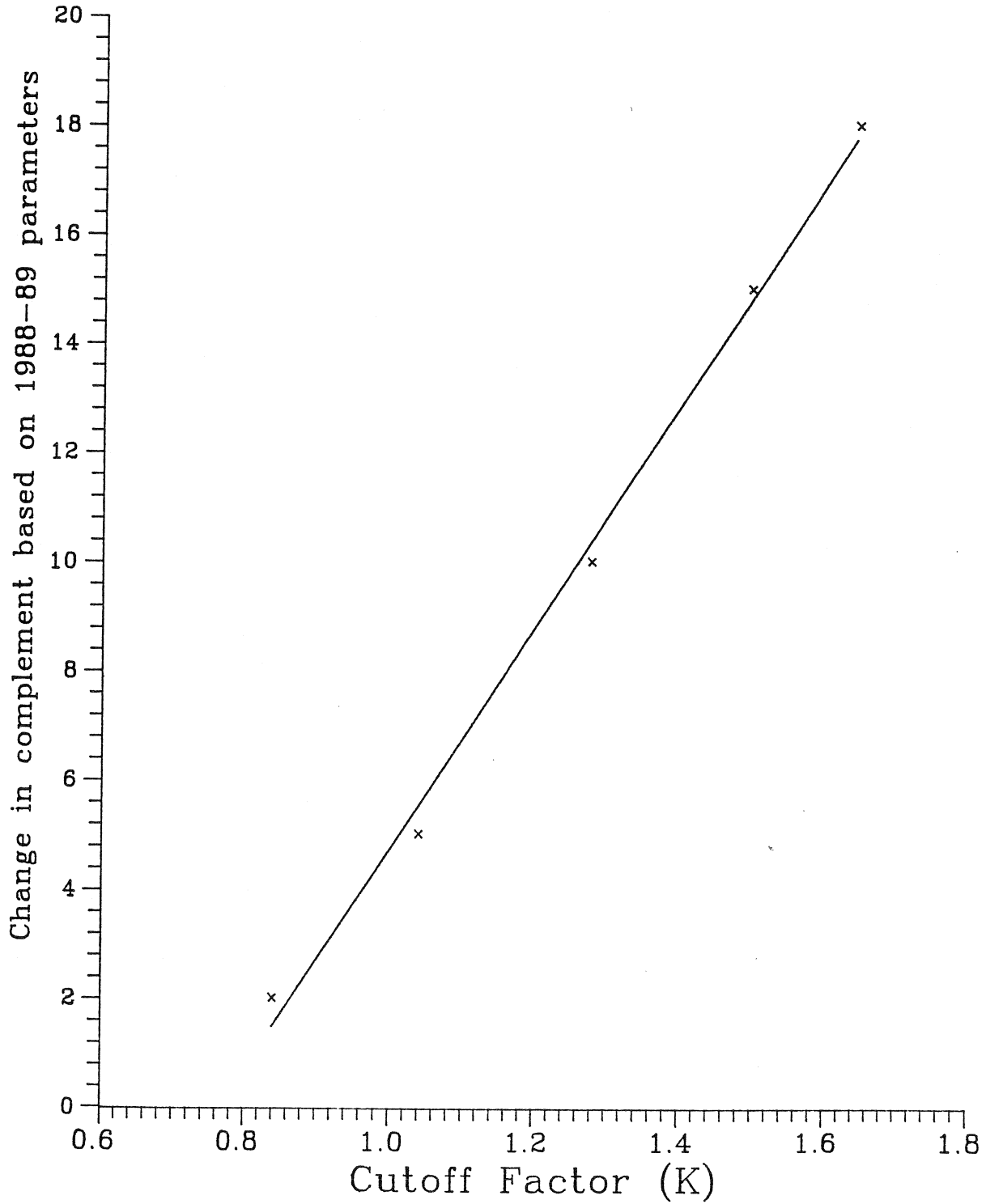# Change in complement Vs. Cutoff factor (K

District 3

Figure 4

Change in complement Vs. Cutoff factor (K)
District 4

Figure 5

Change in complement Vs. Cutoff factor (K)
District 5

Figure 6
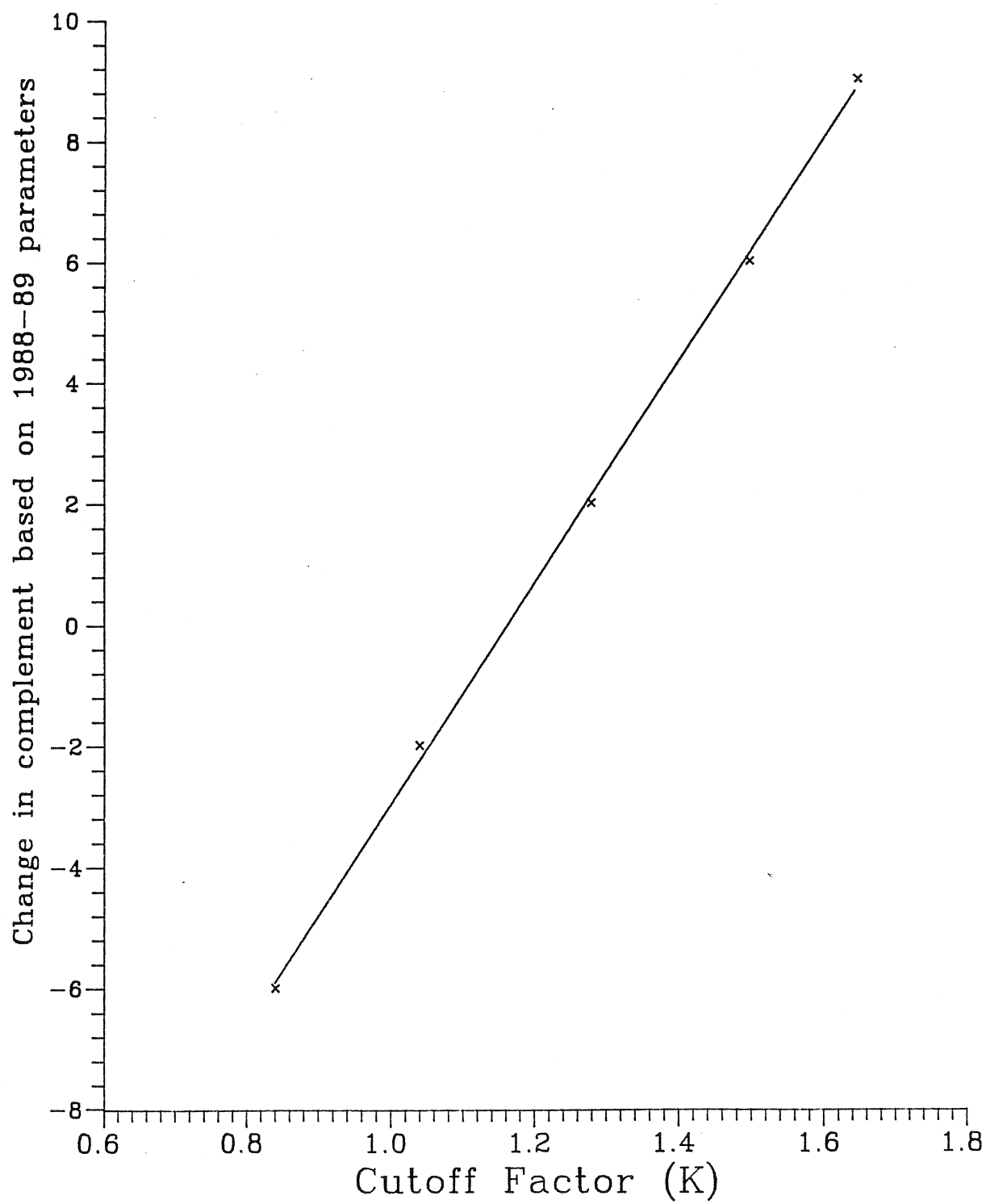
Change in complement Vs. Cutoff factor (K)
District 6

Figure 7