AM 65-5

# BIOMEDICAL SURVEY OF ATC FACILITIES

## 1. Incidence of Self-Reported Symptoms

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# BIOMEDICAL SURVEY OF ATC FACILITIES

## 1. Incidence of Self-Reported Symptoms

### I. Introduction.

Of the several factors that commonly characterize the work of the air traffic control specialist (ATCS) in the Federal Aviation Agency (FAA), shift rotation is afforded particular significance in opinions repeatedly expressed by ATCS's and by relevant studies reported in the scientific literature.[3] Accordingly, a survey was designed and conducted to evaluate the differential effects upon job-related health and well-being that might be attributable to the different shift-rotation schedules employed by various ATC facilities. Also evaluated, because of their occasional relationship to shift rotation, were the factors of time between shifts, which ranged generally from 8 hours or less to greater than 24 hours, exposure to ATC shift-rotation schedules (i.e., controller experience that, for the subject population studied, ranged from less than 18 months to more than 16 years), and chronological age.

Owing to the high volume of collected data, a single report would have been particularly unwieldy. Consequently, the decision was made to prepare several reports, each pertaining to one or two major indexes of information. This report, the first, has to do with a single index of information—the responses to a Symptom Check List that was completed by all subjects prior to and immediately following the work shift and that, for the most part, provides an indication of the nature and incidence of common symptoms induced by, or related to, everyday stress.

### II. Methods.

A. *Selection of Facilities.*—From the shift schedules obtained from the ATC facilities in eastern, southern, midwestern, and southwestern states and on the basis of traffic volume reported for fiscal year 1960,[1] six en route and six terminal (tower) facilities were selected to provide the subject population. In the case of shift-rotation schedules, the principal criterion consisted of rotation frequency; i.e., the number of days or weeks required for a complete rotation through Mid-Shift 1 (0000–0800), Day-Shift 2 (0800–1600), and Evening-Shift 3 (1600–0000). The underlying objective, of course, was to achieve the maximum range of such frequency.

A secondary criterion was prompted by the advantage likely to be provided by matching facilities on the basis of shift-rotation schedules. The advantage concerned would consist of the opportunity for comparison of facilities on the basis of other than shift rotation and, by permitting the possible disclosure of differential effects *not* attributable to shift rotation, would insure the refinement of any conclusions concerning shift rotation.

In the case of traffic load, only those en route facilities having a high traffic volume and only those terminal facilities having a high volume of instrument approaches were selected for consideration. With respect to the latter, the decision was based on the assumption that, in contrast to total traffic volume, volume of instrument approaches is the more valid measure of ATCS workload since this imposes a more complex and broader spread of work upon the operating positions. Additionally, the use of instrument approach volume as a criterion for selection was expected to enhance the validity of comparisons between towers and centers.

Identification and brief descriptions of the pertinent characteristics of the shift-rotation schedules of the facilities selected are given in Table 1. A more detailed description of these characteristics is provided by Appendix A.

As has been indicated, these characteristics served as one basis for the selection of facilities. Following the survey, the chiefs of the selected facilities were queried about any changes in their respective shift-rotation schedules that might have taken place. No significant changes were reported to have occurred.

TABLE 1

Shift Rotation Schedules

| Facility | Rotation Frequency | Successive Work Days | Rotation Pattern [a] | Days Off Change | Approx. % of Mids | Approx. % of Days | Approx. % of Evenings |
|---|---|---|---|---|---|---|---|
| Atlanta Center (ATL) | 3 Weeks | 5 | 1, 3, 2, 3, 2, 1, 3, 2, 3, 2, 2, 3, 2, 3, 2, 1. | Unsched. and Infreq. | Contr: 13<br>Asst. 9 | 43<br>46 | 43<br>46 |
| Boston Center (BOS) | 3 Weeks | 5 | 1, 3, 2, 3, 2, 1. | Every 6 Weeks | 16 | 42 | 42 |
| Cleveland Center (CLE) | 3 to 5 Weeks | 5 | 1, 3, I, 3, 2, 3, 2, 3, 2, 1.[b] | Every 5 Weeks | 15 | 37 | 48 |
| Ft. Worth Center (FTW) | 1 Week | 5 | 3, 3, 2, 2, 1.[c] | Every 4 Weeks | 10 | 50 | 40 |
| Indianapolis Center (IND) | 1 Week | 5 | 3, 3, 2, 2, 1.[d] | Every 8 Weeks | 6 | 47 | 47 |
| Kansas City Center (MKC) | 1 Week | 5 | 3, 3, 2, 2, 1.[e] | Every 4 Weeks | 10 | 45 | 45 |
| Atlanta Tower (ATL) | 3 Weeks | 5 | 1, 3, 2, 3, 2, 1. | Every 12 Weeks | 20 | 40 | 40 |
| Boston Tower (BOS) | 3 Weeks | 5 | 1, 3, 2, 3, 2, 1. | Every 10 Weeks | 20 | 40 | 40 |
| Buffalo Tower (BUF) | 3 Weeks | Alternating 5 & 6 | 1, 3, 2, 3, 2, 1. | Every 2 Weeks | 20 | 40 | 40 |
| Burlington Tower (BTV) | 1 Week | 5 | 3, 3, 2, 2, 1 | Every 4 Weeks | 20 | 40 | 40 |
| Milwaukee Tower (MKE) | 1 Week | 5 | 3, 3, 2, 2, 1.[f] | Every 4 Weeks | 10 | 45 | 45 |
| Philadelphia Tower (PHL) | 3 Weeks | 6 | 1, 3, 2, 3, 2, 1. | Every Week | 20 | 40 | 40 |

a—1-mid shift, 2-day shift, 3-evening shift.
b—I shift (Individual scheduling) : 1/3 worked the 1 shift while the remaining 2/3 worked the 2 or the 3 shift.
c—Every other week the final work day was spent on the 2 or the 3 shift.
d—The 1 shift was worked by only 1/3; the remaining 2/3 worked either the 2 or the 3 shift, or a shift between 1400 and 2200 hours.
e—About 10% worked 4 consecutive weeks on the 2 or 3 shift.
f Approximately 1/3 worked the same shift for one work week, changing shifts each week.

Finally, for the facilities concerned, the traffic characteristics during the fiscal year in which the survey was conducted have been extracted [2] and are given in Table 2.

B. *Development of the Data-Inventory Deck (DID).*—Because of the additional work imposed upon a working population by any survey and the follow-up surveys likely to occur, the attempt is usually made to achieve the greatest ratio of data to cost-in-time for the subjects. Therefore, it was decided to obtain a fairly complete, daily inventory of psychophysiological indexes relating to general health and well-being, job-induced stress, behavioral habits such as times and duration of sleep, and the use of commonly prescribed medications and their possible side effects. The indexes were then constructed and scaled in such a manner that the time required of the subject to complete the inventories would be minimal. These were next assembled into preshift and postshift inventories, and given a 1-week trial run at the Oklahoma City RAPCON facility. Immediately following this trial run, individual critiques were held with each trial subject who had been instructed to complete the preshift and postshift inventories each day. The purpose was to evaluate the comprehensibility of terminology, completeness of instructions, ease of completing the inventories, and to obtain whatever criticisms and suggestions that the subjects might have to offer. As a result of the interest and cooperation of these personnel, invaluable criticisms and sug-

TABLE 2

Enroute and Terminal Air Traffic Activity for Fiscal Year 1961

| Centers [a] | Aircraft Handled | | Departures | | Overs | |
|---|---|---|---|---|---|---|
| | Rank | Number | Rank | Number | Rank | Number |
| Indianapolis | 4 | 490,035 | 5 | 167,168 | 2 | 155,699 |
| Atlanta | 5 | 489,153 | 4 | 180,345 | 5 | 128,463 |
| Boston | 6 | 409,543 | 6 | 159,570 | 13 | 90,403 |
| Kansas City | 7 | 383,546 | 11 | 128,149 | 6 | 127,248 |
| Cleveland | 8 | 375,165 | 17 | 96,789 | 1 | 181,569 |
| Ft. Worth | 9 | 357,230 | 10 | 134,887 | 15 | 87,456 |

| Towers | Total Operations [b] | | Instrument Operations [b] | | Instrument Approaches [c] | |
|---|---|---|---|---|---|---|
| | Rank | Number | Rank | Number | Number | % of Total Operations |
| Atlanta | 19 | 216,172 | 6 | 134,285 | 11,932 | 5.51 |
| Boston | 25 | 187,228 | 17 | 93,997 | 10,848 | 5.79 |
| Buffalo | 116 | 95,148 | 47 | 42,188 | 10,032 | 10.54 |
| Philadelphia | 37 | 163,438 | 11 | 110,729 | 12,075 | 7.38 |
| Milwaukee | 51 | 152,673 | 42 | 46,252 | 6,952 | 4.55 |
| Burlington | 202 | 50,865 | 52 | 37,586 | 5,229 | 10.28 |

a—Enroute activity based on 37 facilities.
b—Total operations and instrument operations based on 240 facilities.
c—Instrument approaches based on 195 FAA approach control facilties.

gestions were obtained and were incorporated in the makeup of the indexes. With these revisions, the indexes were then printed on IBM cards that were bound into preshift and postshift booklets. A reproduction of the data-inventory deck comprises Appendix B.

The present study is concerned with responses to 19 symptoms elicited on card 3 (Appendix B) of the preshift booklet in reply to: "Check the items you have experienced since your last duty shift. If you haven't experienced any of them, check the item 'none'." The study is also concerned with the responses to 17 of the 19 symptoms elicited on the fourth card (card 8, Appendix B) of the postshift booklet in reply to: "Check the items you have experienced during the shift you have just completed. If you haven't experienced any of them, check the item 'none'." It was assumed that the two additional symptoms on the preshift card would not be experienced during a shift. These symptoms were insomnia and nightmares.

C. *Procurement of Subjects.*—Following the coordinative announcement of the survey by the Director, Bureau of Air Traffic Management (now called the Air Traffic Service), the chief of each selected facility was contacted directly for the purpose of making arrangements for a visit to his facility by the research team. Essentially, these arrangements consisted of assembling on a given scheduled day the evening watch teams and any other available assistant and journeymen controllers from 1500 to 1600 hours and the day watch teams from 1600 to 1700 hours. The attendance of only journeymen and assistant controllers actually engaged in air traffic control was requested and overtime pay for their attendance was authorized by the Air Traffic Service. Of course, limiting the briefings to the two sets of watch teams meant that something less than 100% of the ATCS personnel would be in attendance,

but it was assumed that out of those attending, the desired number of volunteers would be obtained. Another assumption was that no significant bias in the samples would result from confining the briefings to only the day and evening watch teams.

Upon the arrival of the research team at a facility, the chief and his available staff were briefed on the nature of the project and the potential benefits to his facility. Subsequently, in most instances, the research team was introduced by the facility chief or his assistant to the assembled personnel. Here, the purposes of the research were again described with emphasis being placed upon (1) the potential benefits to the Agency, the facility, and the controller group; (2) the dependence of the success of the research upon the cooperation of working assistant and journeymen controllers; (3) the dedication and perseverance that a subject must have in order to participate for the 90 days of the survey; and (4) the completely confidential nature of all personal information collected during the project.

Following this, all the duties to be assumed by the subjects were given, the use of the research material was described and illustrated with large replicas of the DID cards, and questions were solicited and answered. Finally, the request for volunteers was made.

Those who volunteered were asked to complete a short questionnaire indicating name, age, GS grade, time in grade, controller status (assistant, journeyman, senior, shift supervisor), number of years in each status level, and total amount of service with the CAA/FAA. The volunteers were then informed that the final selection of subjects would be made from the information on the questionnaire and that those selected would be notified and, on the following day, could obtain their initial packets of previously mailed research materials from the office of the chief. They were also informed that a Summary Instruction Sheet (Appendix C) describing the use of the materials was in the first packet and that additional materials would be mailed to each subject at his home address.

In all, 792 ATCS's were briefed. Of these, 432 (55%) volunteered. The numbers of those briefed and of those who volunteered are given in Table 3.

Since the number and the nature of volunteers for the project could not be predicted in advance and independent decisions had to be made for each facility during the day it was visited, only general considerations for subject selection could be specified. These were that both assistant and journeymen controllers would be selected and that for each type of controller group an attempt would be made to obtain a variety of age and experience combinations.

Within this framework, the subjects were selected from among those who volunteered at each

TABLE 3

Numbers of ATCS Personnel Briefed and Volunteering by Facility

| Facility | Date Briefed | Number Briefed | Number Volunteered | Percent Volunteered |
|---|---|---|---|---|
| Centers: | | | | |
| Fort Worth | 3/ 9/61 | 90 | 54 | 60 0 |
| Kansas City | 3/13/61 | 100 | 60 | 60.0 |
| Indianapolis | 3/15/61 | 155 | 79 | 51.0 |
| Cleve'and | 3/16/61 | 100 | 46 | 46.0 |
| Boston | 3/20/61 | * | 35 | * |
| Atlanta | 3/23/61 | 140 | 57 | 40.7 |
| Towers: | | | | |
| Milwaukee | 3/14/61 | 25 | 20 | 80.0 |
| Buffalo | 3/17/61 | 15 | 15 | 100.0 |
| Burlington | 3/18/61 | 27 | 19 | 70.4 |
| Boston | 3/20/61 | * | 13 | * |
| Philadelphia | 3/21/61 | 26 | 19 | 73.1 |
| Atlanta | 3/22/61 | 30 | 15 | 50.0 |

* A total of 84 center and tower personnel met together for the Boston briefings. For the combined groups, the percentage of volunteers was 47.6.

facility. The names of those selected were then given to the chief of the facility who, in turn, notified the personnel concerned on the same or following day. In most cases, the requirement of filling out the data-inventory deck for 90 consecutive days was begun by the subjects on the day of their next work shift. On days off, only one card (see Temperature Card, Appendix B) had to be completed. This was a card that, in addition to periodic oral temperature readings, required entries pertaining to sleep, medication, etc. The numbers of those assistant and journeymen controllers who volunteered and of those who were selected are given in Table 4 for each facility.

D. *Characteristics of Subjects.*—A total of 300 subjects was selected. Of these, 292 began the 90-day survey, 273 continued for 30 days, 250 continued for 60 days, and 209 finished. Inspection of "drop-outs" by facility is provided by Table 5.

TABLE 4

Distributions of Assistant and Journeyman ATCS Selected and Not Selected From Volunteers in Each Facility

| | Centers | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ft. Worth | | Kansas City | | Indianapolis | | Cleveland | | Boston | | Atlanta | |
| | Sel. | Not Sel. | Sel. | Not Sel. | Sel. | Not Sel. | Sel. | Not Sel. | Sel. | Not Sel. | Sel. | Not Sel. |
| Assistant | 13 | 2 | 12 | 3 | 11 | 5 | 7 | 0 | 6 | 0 | 14 | 6 |
| Journeyman | 22 | 17 | 23 | 22 | 24 | 39 | 28 | 11 | 29 | 0 | 21 | 16 |

| | Towers | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Milwaukee | | Buffalo | | Burlington | | Boston | | Philadelphia | | Atlanta | |
| | Sel. | Not Sel. | Sel. | Not Sel. | Sel. | Not Sel. | Sel. | Not Sel. | Sel. | Not Sel. | Sel. | Not Sel. |
| Assistant | 2 | 0 | 5 | 0 | 3 | 0 | 6 | 0 | 4 | 0 | 1 | 0 |
| Journeyman | 13 | 5 | 10 | 0 | 12 | 4 | 7 | 0 | 14 | 1 | 14 | 0 |

TABLE 5

Drop-Outs

| Facility | Number of Subjects | At End of First 30 Days | | At End of First 60 Days | | At End of Survey | |
|---|---|---|---|---|---|---|---|
| | | Cumulative | | Cumulative | | Cumulative | |
| | | N | % | N | % | N | % |
| FTW Cen | 35 | 2 | 5.7 | 3 | 8.6 | 13 | 37.1 |
| MKC Cen | 35 | 2 | 5.7 | 4 | 11.4 | 5 | 14.3 |
| CLE Cen | 35 | 6 | 17.1 | 8 | 22.9 | 15 | 42.9 |
| IND Cen | 35 | 5 | 14.3 | 12 | 34.3 | 15 | 42.9 |
| BOS Cen | 35 | 4 | 11.4 | 10 | 28.6 | 16 | 45.7 |
| ATL Cen | 35 | 4 | 11.4 | 6 | 17.1 | 14. | 40.0 |
| BUF Twr | 15 | 0 | 0.0 | 1 | 6.7 | 1 | 6.7 |
| MKE Twr | 15 | 0 | 0 0 | 0 | 0.0 | 1 | 6.7 |
| PHL Twr | 18 | 0 | 0.0 | 0 | 0.0 | 2 | 11.1 |
| BTV Twr | 15 | 0 | 0.0 | 1 | 6.7 | 2 | 13.3 |
| BOS Twr | 12 | 1 | 8.3 | 1 | 8.3 | 1 | 8.3 |
| ATL Twr | 15 | 3 | 20.0 | 4 | 26.7 | 6 | 40.0 |
| Total | 300 | 27 | 9.0 | 50 | 16.7 | 91 | 30.3 |

## III. Results.

The design of the survey and consequent analyses of the data permitted appraisal of the significance of what are termed "main effects" and their interactions. Again, because of the volume of data, only those "main effects" that reveal the differences attributable to *facilities* (shift-rotation frequency) and to *time between shifts* will be reported. Information pertaining to the interactions is available in the appendixes.

A. *Symptom Type and Incidence.*—To determine the relative frequency with which each symptom was reported, the reports of each symptom made by all subjects and for all reporting days were totaled and the representative percentages computed. These are presented in Figure 1 for symptoms reported immediately prior to and after the work shift. As might be expected, the highest rates of incidence occur in the case of those symptoms most likely to be judged as being stress induced or related. The most notable exception seen is that of "aching or burning eyes," which was included in the checklist because of its possible relevance to the requirements of the work performed by controllers. To present the rates of incidence of each symptom for *each* facility, Figures D1 through D12 were prepared (Appendix D).

B. *Facilities.*—Of the several methods for appraising the differences in incidence of symptoms between the different facilities, percentage of symptom days provides an economical basis of comparison. Figure 2 presents, for the preshift reports, these percentages; i.e., the percent of the total reporting days for which the subjects of the facility reported one or more symptoms. In the case of the centers, the percentages of symptom days reported for the Ft. Worth (53.9), Kansas City (56.4), and Indianapolis (56.5) Centers are lower than for the Cleveland Center (60.9) and substantially lower than for the Boston (66.1) and Atlanta (66.4) Centers. The interesting aspect of this finding is that the Ft. Worth, Kansas City, and Indianapolis Centers are also characterized by the highest rate of shift-rotation frequency, whereas the Cleveland, Boston, and Atlanta Centers rotated through the three work shifts at a much lower rate of frequency (Table 1).

A gross exception to this finding and, additionally, far greater variance, exists for towers. Here, Burlington (69.1), which is characterized

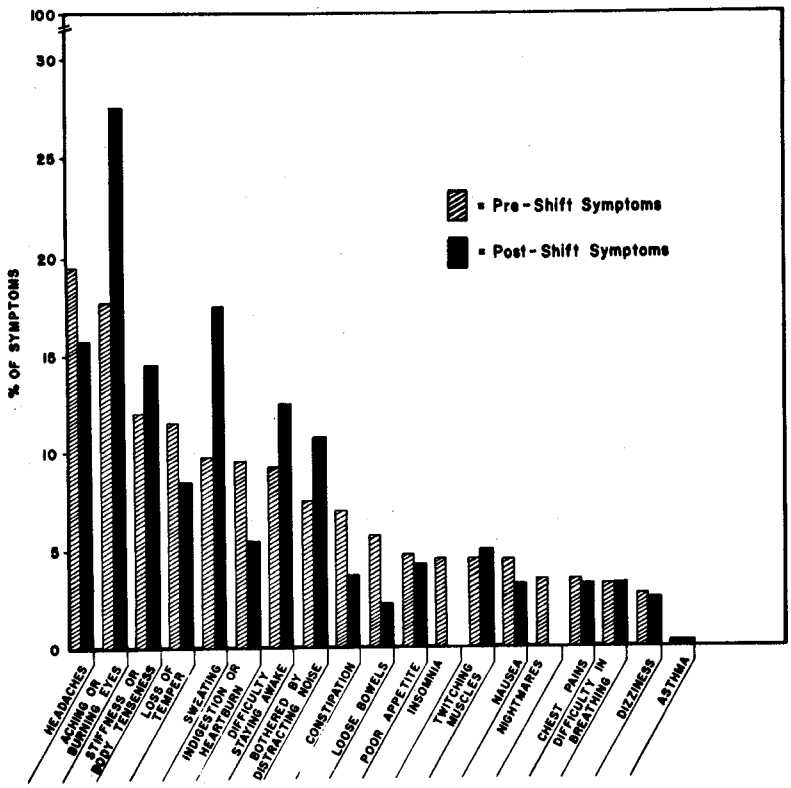


FIGURE 1. Percent of Symptoms—Preshift and Postshift.

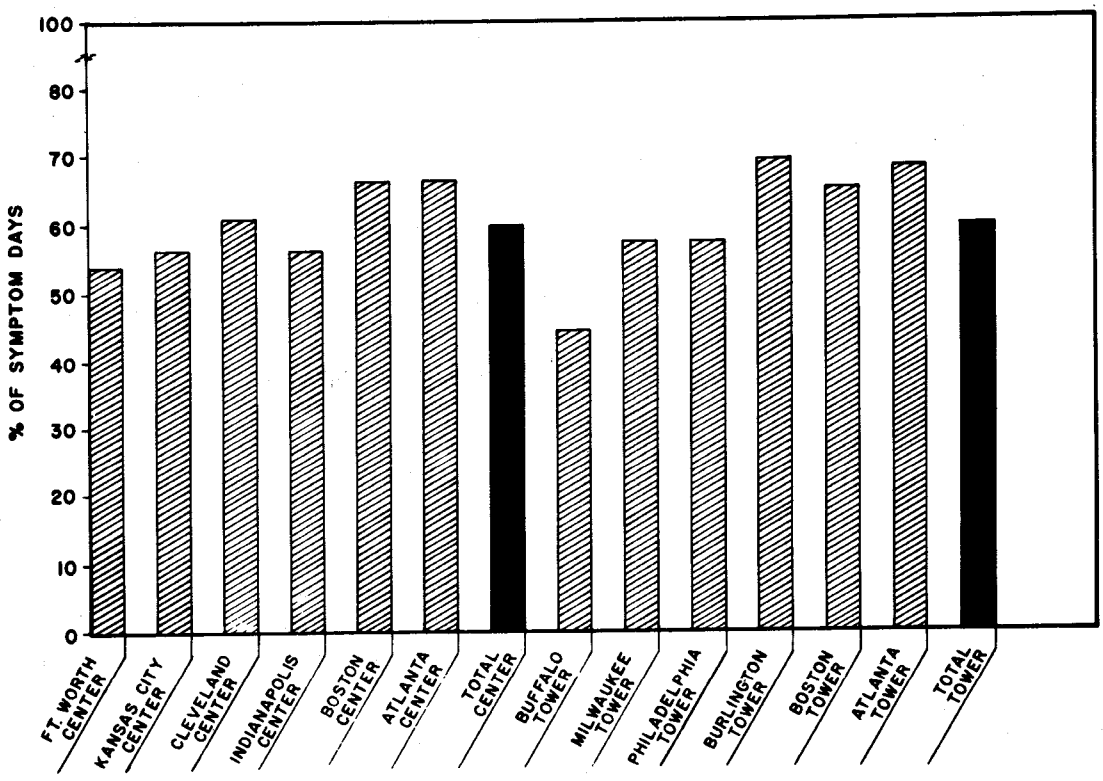


FIGURE 2. Percent of Symptom Days by Facility—Preshift.

by a high rate of shift-rotation frequency, has the highest incidence of symptom days reported and is closely followed by the Boston (65.0) and Atlanta (67.9) Towers, which have a much lower rate of shift-rotation frequency. At the other extreme, we find Buffalo (44.4), which rotates through the three work shifts at a low rate of frequency. Milwaukee (57.5) and Philadelphia (57.5), which fall in the midrange, are characterized, respectively, by a high and low rate of shift-rotation frequency.

Finally, in comparing percentage of symptom days for all centers (total center, 59.9%) against percentage of symptom days for all towers (total tower, 59.5%), very little difference is seen.

Equally interesting comparisons are provided by Figure 3, which presents the percentages of symptom days reported postshift. First, with the exception of Atlanta Center (−0.8%), all other centers evidence an increase in percentage of symptom days reported. Second, the greatest increase occurs at the Ft. Worth Center (+10.5%), which had the lowest preshift percentage, but then the next greatest increase appears in the case of the Boston Center (+8.0%), which had close to the highest preshift percentage. Third, and in contrast, the towers on the whole did not exhibit any increase in percentage of postshift symptom days reported. Individually, the three facilities, Buffalo (−2.4%), Milwaukee (−0.6%), and Philadelphia (−10.0%), which had the lowest preshift percentages, show slight to appreciable decrease in their respective percentages, while the remaining three facilities, Burlington (+0.5%), Boston (+6.3%), and Atlanta (+6.4%), which had the highest percentages, show slight to appreciable increase in percentage of symptom days.

From the foregoing, it may be concluded that, by itself, the rate of frequency with which personnel are rotated through the three work shifts, whether it be within a period of 1 week or within a period of several weeks, does not account in any convincing manner for the differences in the incidence of symptoms characterizing the different facilities.

C. *Time Between Shifts.*—The isolation of this factor for study was occasioned by the generally expressed interest in the effects of the "quick-turn-around"; i.e., working a shift after having had 8 hours or less of off-duty time since the last work shift. Consequently, the amount of time between successive shifts was obtained for each subject and for each reporting (work) day, and these periods of time were categorized as shown by Figure 4. Then, for each category of time, there was computed the percentage of days on which one or more symptoms were reported by the subjects who, also, had reported for work after having had, for example, 8 hours or less of off-duty time since their last work shift.

Figure 4, which presents both preshift and postshift reports, shows that the highest incidence of symptom days reported prior to the work shift occurs when the period of time since the last shift was 8 hours or less and, somewhat surprisingly, that the next highest incidence occurs when the period of time between shifts was greater than 24 hours. In the case of the postshift reports, we would expect and, indeed, do find that the greatest increase in the incidence of symptom days occurs for the quick-turn-around category.

The conclusion to be drawn from these data is obvious: The quick-turn-around does engender the highest incidence of symptom reports.

To present in more detail the interactions between time between shifts and facility, the graphs contained in Appendix E were compiled. Using the graphs, one can study the incidence of symptoms attributable to each of the categories of time between successive shifts for each of the different facilities and type of facility.

## IV. Discussion.

It was predicted that those facilities that rotated their personnel through the three basic work shifts most frequently would show the highest incidence of reported symptoms. The prediction was not confirmed; thus, it may be concluded that on the basis of the data reported and for the different shift schedules involved, no given schedule possesses a comparative advantage.

Such a conclusion, however, cannot be regarded as final because analyses of the remaining data may yield findings at variance with what has been reported thus far; of course, such subsequent findings may be of a confirmatory nature.

At any rate, if one can assume on the basis of the reported findings that shift-rotation fre-

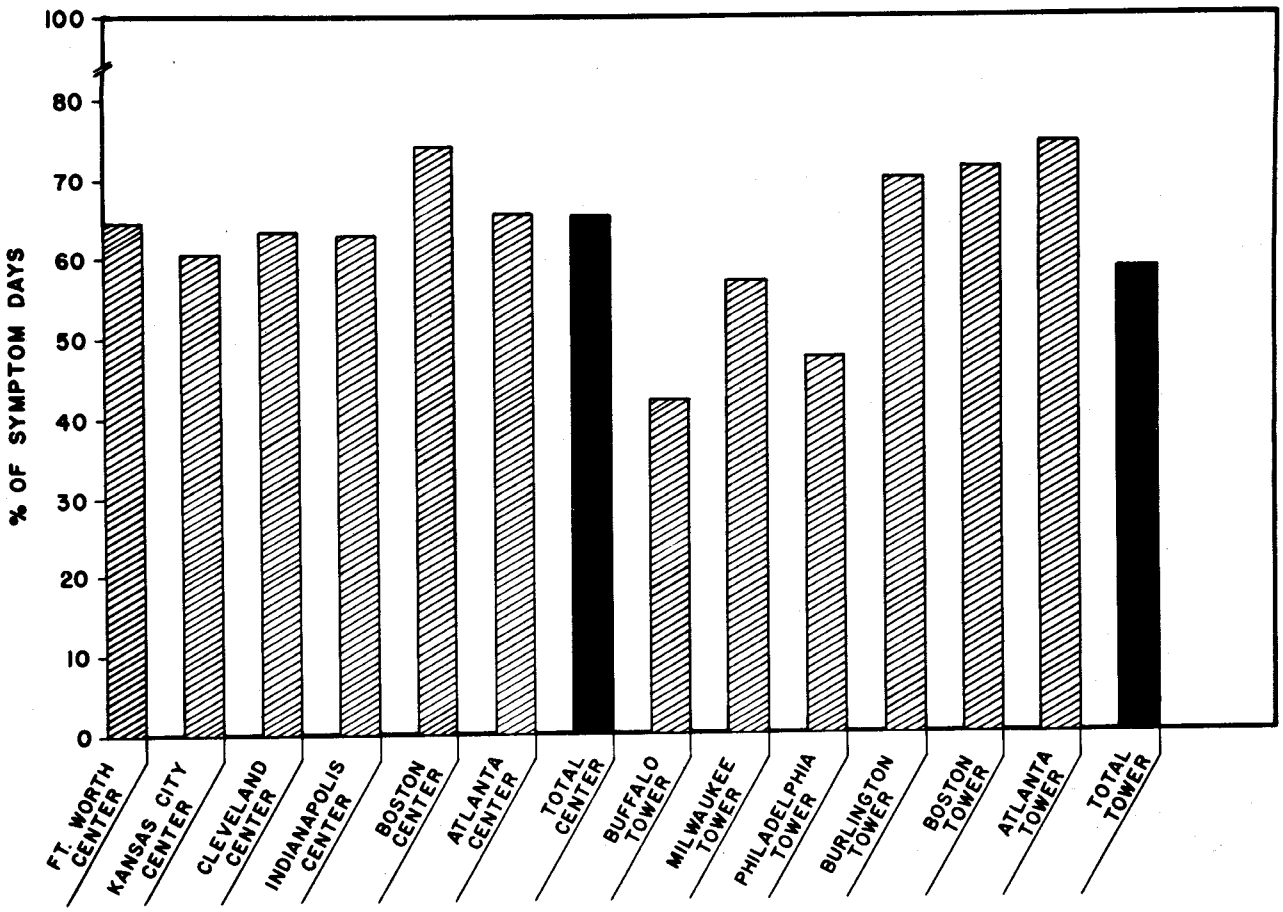


FIGURE 3. Percent of Symptom Days by Facility—Postshift.

quency contributes little or nothing to the incidence of symptoms for the different facilities, then he is compelled to search for other explanations.

As will be reported at a later date, experience was substantially and positively related to the incidence of the symptoms concerned. One possibility, therefore, is that an unknown bias in the selection of subjects at each or some of the facilities might have been largely responsible for the differences noted between them. For example, the variations between the Buffalo and Burlington facilities might be attributable to a preponderance of subjects of short-term experience having been selected at Buffalo and a preponderance of subjects of long-term experience having been selected at Burlington. The data, it is true, reveal that the experience level for the centers is lower than for the towers, but no systematic difference in experience can be found for centers alone or for towers alone. Experience, then, does not seem to account for the differences between facilities.

Let us consider next time between shifts and the general finding that 8 hours or less between shifts produced the highest incidence of reported symptoms. Here, one asumption might be that the shift-rotation schedule (or facility) generating the greatest frequency of quick-turn-arounds would be effecting the highest symptom incidence. Inspection of the data for the individual facilities reveals this assumption to be extremely limited and, therefore, of doubtful validity, in that it is confirmed in the case of Burlington and clearly contraindicated in the case of Kansas City.

Another explanation, although not of general applicability, is one involving the scheduling of days off. The Buffalo and Philadelphia Towers, which showed the lowest incidence of reported symptoms (Figures 2 and 3), are also character-

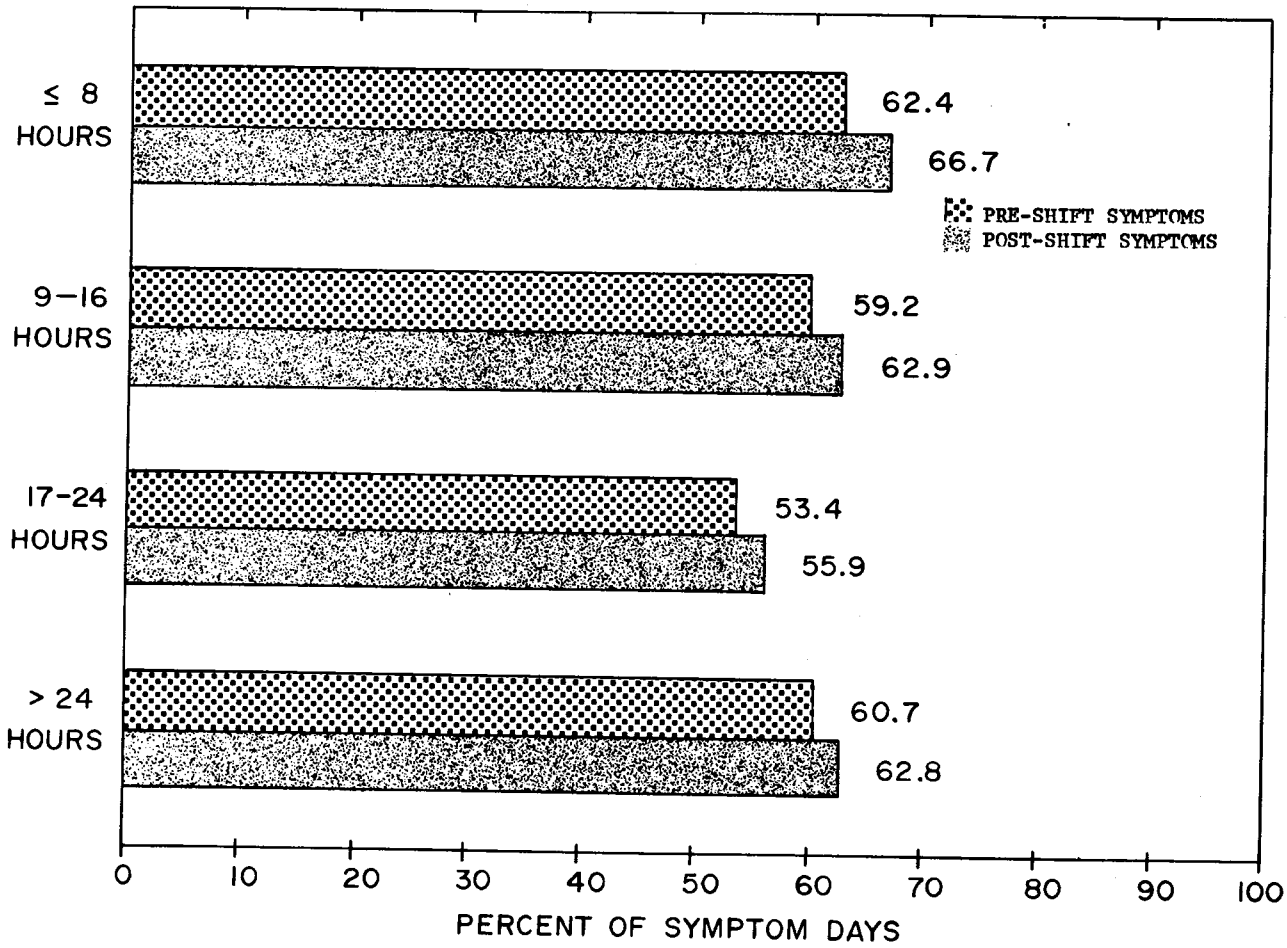


FIGURE 4. Percent of Symptom Days by Time Between Shifts.

ized by the highest rate of frequency with which days off were systematically changed (Table 1). Briefly, the effect of this is twofold: At the Buffalo and Philadelphia Towers, the ATCS receives periods of 3 and 4 consecutive days off more frequently than does the ATCS at the other facilities and, also more frequently, either one or both of the weekend days are included in his period of days off. This could be of some significance since in our culture so much of the family and social activities tend to be oriented around the weekend. Possibly, then, the more frequent opportunity to enjoy a normal off-duty life may have a mitigative effect upon the symptoms concerned, their causes, or both.

Finally, one additional aspect of the data raises some intriguing, but presently unanswerable, questions. If in Table 3 the three centers and three towers having the largest ratio of volunteers to number briefed are identified and if their symptom percentages in Figures 2 and 3 are examined, we find that among the centers the three having the highest volunteer percentages also have the three lowest preshift symptom percentages. Similarly, among the towers the three high-volunteer-rate towers have the lowest preshift symptom percentages. With the exception of the Fort Worth and Cleveland Centers, the same statistically significant relationship between volunteer percentage and symptom percentage is found with postshift symptoms. Comparison of the symptom percentages with the data inTable 5, which indicates the percentages of individuals remaining in the study, showed similar trends.

These relationships between the incidence of symptoms and volunteer and participation percentages suggest that variables other than shift-rotation schedules and air-traffic-volume physical facilities account for the differences in reported symptoms.

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## APPENDIX A

## ATLANTA CENTER (ATL)

RANKINGS—Among the 36 enroute traffic control centers, 4th in total aircraft handled, 4th in departures and arrivals, and 6th in over-flights.

GENERAL SCHEDULE—

Controllers

| *Shifts* | *Hours* | *Consecutive Work Days* |
|---|---|---|
| 1 | 0000–0800 | 5 |
| 3 | 1600–0000 | 5 |
| 2 | 0800–1600 | 5 |
| 3 | 1600–0000 | 5 |
| 2 | 0800–1600 | 5 |
| 1 | 0000–0800 | 5 |
| 3 | 1600–0000 | 5 |
| 2 | 0800–1600 | 5 |
| 3 | 1600–0000 | 5 |
| 2 | 0800–1600 | 5 |
| 2 or 3 | 0800–1600 or 1600–0000 | 5 |
| 3 | 1600–0000 | 5 |
| 2 | 0800–1600 | 5 |
| 3 | 1600–0000 | 5 |
| 2 | 0800–1600 | 5 |
| 1 | 0000–0800 | 5 |

Assistant Controllers

| | | |
|---|---|---|
| 1 | 0000–0800 | 5 |
| 3 | 1600–0000 | 5 |
| 2 | 0800–1600 | 5 |
| 3 | 1600–0000 | 5 |
| 2 | 0800–1600 | 5 |
| 3 | 1600–0000 | 5 |
| 2 | 0800–1600 | 5 |
| 3 or 2 | 1600–0000 or 0800–1600 | 5 |
| 2 or 3 | 0800–1600 or 1600–0000 | 5 |
| 2 | 0800–1600 | 5 |
| 1 | 0000–0800 | 5 |

## CLEVELAND CENTER (CLE)

RANKINGS—10th in total aircraft handled, 17th in departures and arrivals, and 1st in over-flights.

GENERAL SCHEDULE—

| *Shifts* | *Hours* | *Consecutive Work Days* |
|---|---|---|
| 1 | 0000–0800 | 5 |
| 3 | 1500–2300 | 5 |
| * | ** | 5 |
| 3 | 1600–0000 | 5 |
| 2 | 0700–1500 | 5 |
| 3 | 1600–0000 | 5 |
| 2 | 0800–1600 | 5 |
| 3 | 1500–2300 | 5 |
| 2 | 0800–1600 *** | 5 |
| 1 | 0000–0800 | 5 |

SPECIFIC CHARACTERISTICS—*During 1 of every 10 weeks, the team was broken up and the members were individually scheduled to work for a period of 5 consecutive days one of the following shifts: **0000–0800, 1600–0000, 0900–1700, or 1700–0100. ***For the first day of this work week, the shift was 0700–1500.

DAYS OFF—Changed every 5 weeks, moving 1 day backwards, as shown in the following example:

| | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S |
|---|---|---|---|---|---|---|
| AA | X X O O X X X | X X O O X X X | X O O X X X X | X O O X X X X | X O O X X X X | X O O X X X X |
| BB | X O O X X X X | X O O X X X X | X O O X X X X | O O X X X X X | O O X X X X X | O O X X X X X |
| CC | O O X X X X X | O O X X X X X | O O X X X X X | O X X X X X O | O X X X X X O | O X X X X X O |

AA—Controller whose days off changed from Tuesday & Wednesday to Monday & Tuesday
BB—Controller whose days off changed from Monday & Tuesday to Sunday & Monday
CC—Controller whose days off changed from Sunday & Monday to Sunday & Saturday
X—Assignment to one of the work shifts in use at the facility
O—Day off

PERCENTAGE OF MIDS—Approximately 13%

## FORT WORTH (FTW)

RANKINGS—11th in the total aircraft handled, 11th in departures and arrivals, and 13th in overflights.

GENERAL SCHEDULE—

| *Shifts* | *Hours* | *Consecutive Work Days* |
|---|---|---|
| 3 | 1600–0000 | 5 |
| 3 | 1500–2300 | 1 |
| 2 | 0800–1600 | 1 |
| 2 | 0700–1500 | 1 |
| *1 | 0000–0800 | 1 |

SPECIFIC CHARACTERISTICS—*Each team was placed in a category called "Extra" every other week on its final work day and for this work day the members of this team were assigned to any one of the following shifts: 0800–1600, 1000–1800, or 1400–2200.

DAYS OFF—Changed every 4 weeks, moving 1 day backwards, as shown in the following example:

| | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S |
|---|---|---|---|---|---|---|
| AA | X X O O X X X | X X O O X X X | X O O X X X X | X O O X X X X | X O O X X X X | X O O X X X X |
| BB | X O O X X X X | X O O X X X X | X O O X X X X | O O X X X X X | O O X X X X X | O O X X X X X |
| CC | O O X X X X X | O O X X X X X | O O X X X X X | O X X X X X O | O X X X X X O | O X X X X X O |

AA—Controller whose days off changed from Tuesday & Wednesday to Monday & Tuesday
BB—Controller whose days off changed from Monday & Tuesday to Sunday & Monday
CC—Controller whose days off changed from Sunday & Monday to Sunday & Saturday
X—Assignment to one of the work shifts in use at the facility
O—Day off

PERCENTAGE OF MIDS—Approximately 10 %

## INDIANAPOLIS CENTER (IND)

RANKINGS—5th in the total aircraft handled, 6th in departures and arrivals, and 4th in over-flights.

GENERAL SCHEDULE—

| *Shifts* | *Hours* | *Consecutive Work Days* |
|---|---|---|
| 3 | 1600–0000 | 1 |
| 3 | 1600–0000 | 1 |
| 2 | 0800–1600 | 1 |
| 2 | 0800–1600 | 1 |
| *1 | 0000–0800 | 1 |

SPECIFIC CHARACTERISTICS—*Shift 1 was worked by only one-third (approx) of the personnel for an 8-week rotated period. The remaining two-thirds worked either the 2, 3, or J shift. This latter shift was occasioned by a daily briefing held every day between 1400–1600 hours. Each individual attended the briefing once a work week and to permit attendance, he was assigned to work a 1400–2200 shift work day of the week.

DAYS OFF—Changed every 8 weeks, moving 1 day backwards, as shown in the following example:

| | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S |
|---|---|---|---|---|---|---|
| AA | X X O O X X X | X X O O X X X | X O O X X X X | X O O X X X X | X O O X X X X | X O O X X X X |
| BB | X O O X X X X | X O O X X X X | X O O X X X X | O O X X X X X | O O X X X X X | O O X X X X X |
| CC | O O X X X X X | O O X X X X X | O O X X X X X | O X X X X X O | O X X X X X O | O X X X X X O |

AA—Controller whose days off changed from Tuesday & Wednesday to Monday & Tuesday
BB—Controller whose days off changed from Monday & Tuesday to Sunday & Monday
CC—Controller whose days off changed from Sunday & Monday to Sunday & Saturday
X—Assignment to one of the work shifts in use at the facility
O—Day off

PERCENTAGE OF MIDS—Less than 10%

## KANSAS CITY CENTER (MKC)

RANKINGS—8th in the total number of aircraft handled, 10th in departures and arrivals, and 7th in over-flights.

GENERAL SCHEDULE—

| *Shifts* | *Hours* | *Consecutive Work Days* |
|---|---|---|
| 3 | 1600–0000 | 1 |
| 3 | 1600–0000 | 1 |
| 2 | 0800–1600 | 1 |
| 2 | 0800–1600 | 1 |
| 1 | 0000–0800 | 1 |

SPECIFIC CHARACTERISTICS—With one exception, approximately 80% of personnel worked Shift 1 for a 4 week rotated period while the remaining 20% worked a 1200–2000 shift. The exception was a shift schedule which consisted of 4 consecutive weeks of either Shift 2 or 3 and which was rotated through all crews (8).

DAYS OFF—Changed every 4 weeks, moving 1 day backwards, as shown in the following example:

| | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S |
|---|---|---|---|---|---|---|
| AA------- | X X O O X X X | X X O O X X X | X O O X X X X | X O O X X X X | X O O X X X X | X O O X X X X |
| BB------- | X O O X X X X | X O O X X X X | X O O X X X X | O O X X X X X | O O X X X X X | O O X X X X X |
| CC------- | O O X X X X X | O O X X X X X | O O X X X X X | O X X X X X O | O X X X X X O | O X X X X X O |

AA—Controller whose days off changed from Tuesday & Wednesday to Monday & Tuesday
BB—Controller whose days off changed from Monday & Tuesday to Sunday & Monday
CC—Controller whose days off changed from Sunday & Monday to Sunday & Saturday
X—Assignment to one of the work shifts in use at the facility
O—Day off

PERCENTAGE OF MIDS—Less than 10%

## ATLANTA TOWER (ATL)

RANKINGS—Among the 226 terminal ATC facilites, 21st in total operations, 7th in instrument operations, and 17th in instrument approaches.

GENERAL SCHEDULE—

| *Shifts* | *Hours* | *Consecutive Work Days* |
|---|---|---|
| 1 | 0000–0800 | 5 |
| 3 | 1600–0000 | 5 |
| 2 | 0800–1600 | 5 |
| 3 | 1600–0000 | 5 |
| 2 | 0800–1600 | 5 |
| 1 | 0000–0800 | 5 |

SPECIFIC CHARACTERISTICS—No significant exceptions.

DAYS OFF—Changed every 12 weeks, moving 1 day backwards, as shown in the following example:

| | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S |
|---|---|---|---|---|---|---|
| AA | X X O O X X X | X X O O X X X | X O O X X X X | X O O X X X X | X O O X X X X | X O O X X X X |
| BB | X O O X X X X | X O O X X X X | X O O X X X X | O O X X X X X | O O X X X X X | O O X X X X X |
| CC | O O X X X X X | O O X X X X X | O O X X X X X | O X X X X X O | O X X X X X O | O X X X X X O |

AA—Controller whose days off changed from Tuesday & Wednesday to Monday & Tuesday
BB—Controller whose days off changed from Monday & Tuesday to Sunday & Monday
CC—Controller whose days off changed from Sunday & Monday to Sunday & Saturday
X—Assignment to one of the work shifts in use at the facility
O—Day off

PERCENTAGE OF MIDS—20%

## BOSTON TOWER (BOS)

RANKINGS—29th in total operations, 14th in instrument operations, and 11th in instrument approaches.

GENERAL SCHEDULE—

| *Shifts* | *Hours* | *Consecutive Work Days* |
|---|---|---|
| 1 | 0000–0800 | 5 |
| 3 | 1600–0000 | 5 |
| 2 | 0800–1600 | 5 |
| 3 | 1600–0000 | 5 |
| 2 | 0800–1600 | 5 |
| 1 | 0000–0800 | 5 |

SPECIFIC CHARACTERISTICS—No significant exceptions.

DAYS OFF—Changed every 10 weeks, moving 1 day backwards, as shown in the following example:

| | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S |
|---|---|---|---|---|---|---|
| AA | X X O O X X X | X X O O X X X | X O O X X X X | X O O X X X X | X O O X X X X | X O O X X X X |
| BB | X O O X X X X | X O O X X X X | X O O X X X X | O O X X X X X | O O X X X X X | Q O X X X X X |
| CC | O O X X X X X | O O X X X X X | O O X X X X X | O X X X X X O | O X X X X X O | O X X X X X O |

AA—Controller whose days off changed from Tuesday & Wednesday to Monday & Tuesday
BB—Controller whose days off changed from Monday & Tuesday to Sunday & Monday
CC—Controller whose days off changed from Sunday & Monday to Sunday & Saturday
X—Assignment to one of the work shifts in use at the facility
O—Day off

PERCENTAGE OF MIDS—20%

## BUFFALO TOWER (BUF)

RANKINGS—129th in total operations, 37th in instrument operations, and 30th in instrument approaches.

GENERAL SCHEDULE—

| *Shifts* | *Hours* | *Consecutive Work Days* |
|---|---|---|
| 1 | 0000–0800 | 5 or 6 days—alternating |
| 3 | 1600–0000 | 5 or 6 days—alternating |
| 2 | 0800–1600 | 5 or 6 days—alternating |
| 3 | 1600–0000 | 5 or 6 days—alternating |
| 2 | 0800–1600 | 5 or 6 days—alternating |
| 1 | 0000–0800 | 5 or 6 days—alternating |

SPECIFIC CHARACTERISTICS—Exceptions to the above occurred when Sunday or Saturday was a day off. At those times personnel worked 5 days on, 2 off. That occurred for 4 consecutive weeks, followed by 10 consecutive weeks given in the general schedule.

DAYS OFF—Changed every 2 weeks, moving 1 day forward. That is to say, days off changed from Tuesday & Wednesday to Wednesday & Thursday. Exceptions occurred when Sunday or Saturday was a day off, which occurred for 5 consecutive weeks.

| T F S | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S | S M T |
|---|---|---|---|---|---|---|
| O O X | X X X X X O O | O X X X X X O | O X X X X X O | X X X X X O O | O O X X X X X | O O X |

PERCENTAGE OF MIDS—20%

## BURLINGTON COMBINED STATION/TOWER (BTV)

RANKINGS—169th in total operations, 54th in instrument operations, and 29th in instrument approaches.

GENERAL SCHEDULE—

Controllers

| *Shifts* | *Hours* | *Consecutive Work Days* |
|---|---|---|
| 1 | 1600–0000 | 1 |
| 3 | 1600–0000 | 1 |
| 2 | 0800–1600 | 1 |
| 2 | 0800–1600 | 1 |
| 1 | 0000–0800 | 1 |

Assistant Controllers

| | | |
|---|---|---|
| 3 | 1600–0000 | 5 |
| 2 | 0800–1600 | 5 |

SPECIFIC CHARACTERISTICS—No significant exceptions.

DAYS OFF—Changed every 4 weeks, moving 1 day backwards, as shown in the following example:

| | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S |
|---|---|---|---|---|---|---|
| AA | X X O O X X X | X X O O X X X | X O O X X X X | X O O X X X X | X O O X X X X | X O O X X X X |
| BB | X O O X X X X | X O O X X X X | X O O X X X X | O O X X X X X | O O X X X X X | O O X X X X X |
| CC | O O X X X X X | O O X X X X X | O O X X X X X | O X X X X X O | O X X X X X O | O X X X X X O |

AA—Controller whose days off changed from Tuesday & Wednesday to Monday & Tuesday
BB—Controller whose days off changed from Monday & Tuesday to Sunday & Monday
CC—Controller whose days off changed from Sunday & Monday to Sunday & Saturday
X—Assignment to one of the work shifts in use at the facility
O—Day off

PERCENTAGE OF MIDS—Controllers: 20%
Assistant Controllers: 0

## MILWAUKEE TOWER (MKE)

RANKINGS—53rd in total operations, 33rd in instrument operations, and 25th in instrument approaches.

GENERAL SCHEDULE—Primary Group

| *Shifts* | *Hours* | *Consecutive Work Days* |
|---|---|---|
| 3 | 1500–2300 | 1 |
| 3 | 1600–0000 | 1 |
| 2 | 0700–1500 | 1 |
| 2 | 0800–1600 | 1 |
| 1 | 0000–0800 | 1 |

SPECIFIC SCHEDULE—Secondary Group

| | | | | | | |
|---|---|---|---|---|---|---|
| S | 2 | 0 | 0 | 2 | 3 | 3 |
| M | 0 | 3 | 2 | 2 | 0 | 3 |
| T | 1 | 3 | 2 | 0 | 2 | 0 |
| W | 1 | 3 | 2 | 0 | 2 | 0 |
| T | 1 | 3 | 2 | 3 | 2 | 2 |
| F | 1 | 3 | 0 | 3 | 0 | 2 |
| S | 0 | 0 | 2 | 3 | 3 | 2 |

SPECIFIC CHARACTERISTICS—40% of those in the primary group worked Shift 2 the final day of the work week; all personnel in the primary group rotated through that assignment.

DAYS OFF—Within the primary group days off changed every 4 weeks, moving 1 day forward, as shown in the following eeample:

| S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S |
|---|---|---|---|---|---|
| X X O O X X X | X X O O X X X | X X O O X X X | X X X O O X X | X X X O O X X | X X X O O X X |

X—Assignment to one of the work shifts in use at the facility

O—Day off

Within the secondary group days off are shown in the specific schedule, indicated by the figure "0"

PERCENTAGE OF MIDS—14%

## PHILADELPHIA TOWER (PHL)

RANKINGS—51st in total operations, 15th in instrument operations, and 18th in instrument approaches.

GENERAL SCHEDULE—

| *Shifts* | *Hours* | *Consecutive Work Days* |
|---|---|---|
| 1 | 0000–0800 | 6* |
| 3 | 1600–0000 | 6 |
| 2 | 0800–1600 | 6 |
| 3 | 1600–0000 | 6 |
| 2 | 0800–1600 | 6 |
| 1 | 0000–0800 | 6 |

SPECIFIC CHARACTERISTICS—*Exceptions occurred as a consequence of the forward rotation of days off. When days off were Sunday and Saturday of a given calendar week, personnel worked 5 consecutive days (Monday through Friday).

DAYS OFF—Changed every week, moving 1 day forward, as shown in the following example:

| S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S | S M T W T F S |
|---|---|---|---|---|---|
| X X X O O X X | X X X X O O X | X X X X X O O | O X X X X X O | O O X X X X X | X O O X X X X |

X—Assignment to one of the work shifts in use at the facility
O—Day off

PERCENTAGE OF MIDS—20%

# APPENDIX B

## DATA-INVENTORY DECK

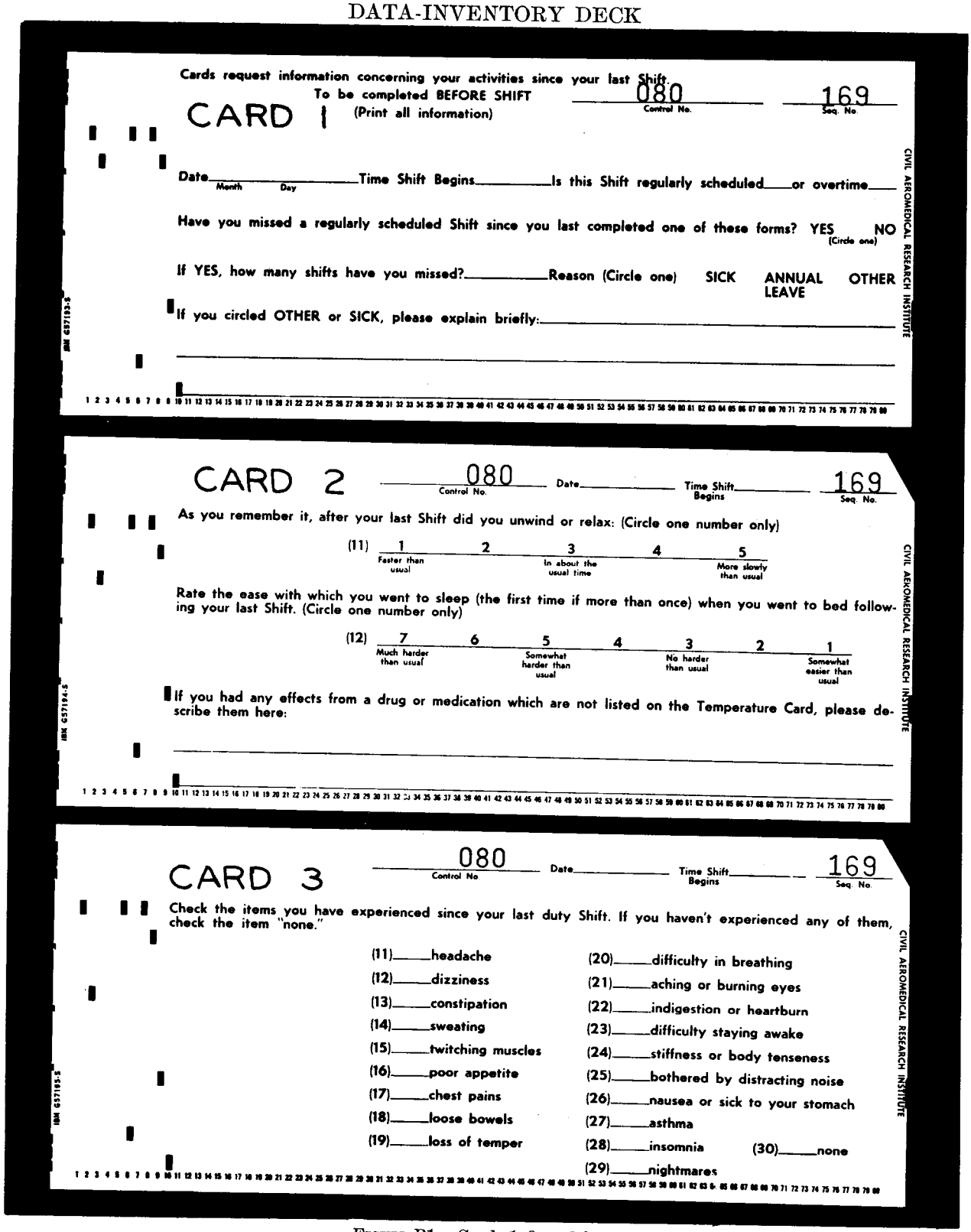
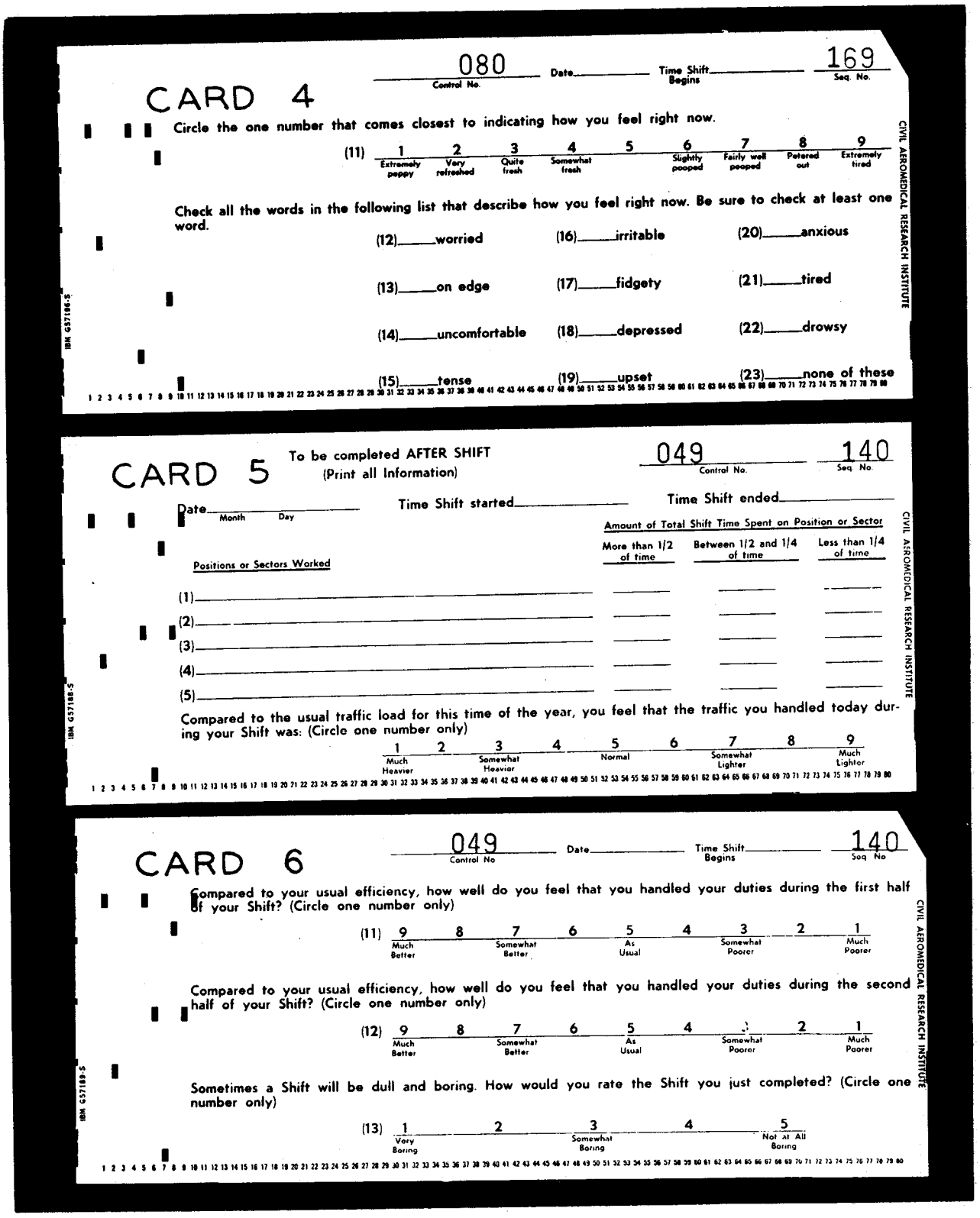



FIGURE B1.—Cards 1, 2, and 3.



CARD 4

080 Control No. Date Time Shift Begins 169 Seq. No.

Circle the one number that comes closest to indicating how you feel right now.

(11) 1 Extremely peppy; 2 Very refreshed; 3 Quite fresh; 4 Somewhat fresh; 5; 6 Slightly pooped; 7 Fairly well pooped; 8 Petered out; 9 Extremely tired

Check all the words in the following list that describe how you feel right now. Be sure to check at least one word.

(12)____worried (16)____irritable (20)____anxious

(13)____on edge (17)____fidgety (21)____tired

(14)____uncomfortable (18)____depressed (22)____drowsy

(15)____tense (19)____upset (23)____none of these

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CARD 5

To be completed AFTER SHIFT (Print all Information)

049 Control No. 140 Seq. No.

Date____ Month Day Time Shift started____ Time Shift ended____

| Positions or Sectors Worked | Amount of Total Shift Time Spent on Position or Sector: More than 1/2 of time | Between 1/2 and 1/4 of time | Less than 1/4 of time |
|---|---|---|---|
| (1)____ | | | |
| (2)____ | | | |
| (3)____ | | | |
| (4)____ | | | |
| (5)____ | | | |

Compared to the usual traffic load for this time of the year, you feel that the traffic you handled today during your Shift was: (Circle one number only)

1 Much Heavier; 2; 3 Somewhat Heavier; 4; 5 Normal; 6; 7 Somewhat Lighter; 8; 9 Much Lighter

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IBM G57188-S

CARD 6

049 Control No Date Time Shift Begins 140 Seq No

Compared to your usual efficiency, how well do you feel that you handled your duties during the first half of your Shift? (Circle one number only)

(11) 9 Much Better; 8; 7 Somewhat Better; 6; 5 As Usual; 4; 3 Somewhat Poorer; 2; 1 Much Poorer

Compared to your usual efficiency, how well do you feel that you handled your duties during the second half of your Shift? (Circle one number only)

(12) 9 Much Better; 8; 7 Somewhat Better; 6; 5 As Usual; 4; 3 Somewhat Poorer; 2; 1 Much Poorer

Sometimes a Shift will be dull and boring. How would you rate the Shift you just completed? (Circle one number only)

(13) 1 Very Boring; 2; 3 Somewhat Boring; 4; 5 Not at All Boring

CIVIL AEROMEDICAL RESEARCH INSTITUTE

IBM G57189-S

FIGURE B2.—Cards 4, 5, and 6.

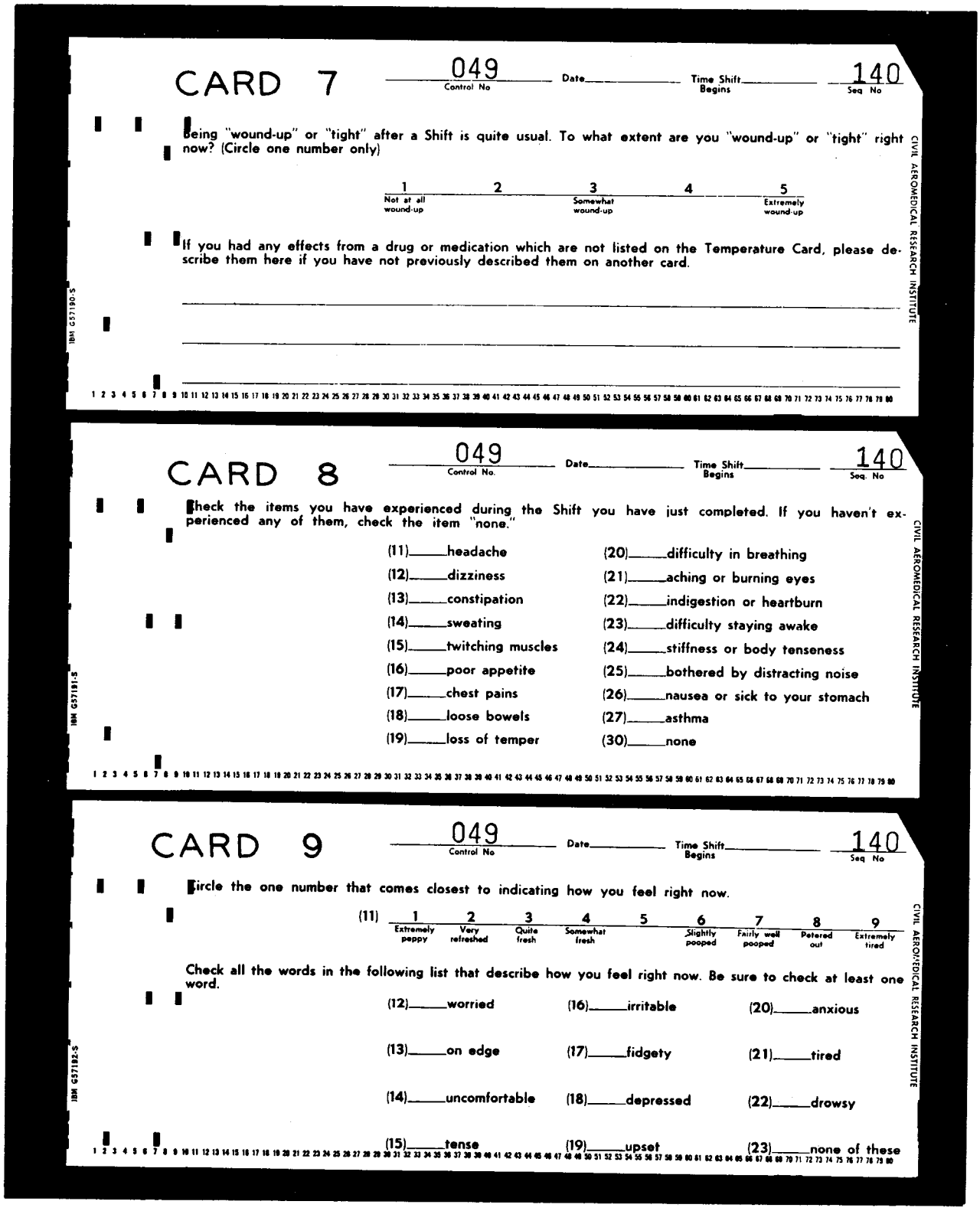


FIGURE B3.—Cards 7, 8, and 9.

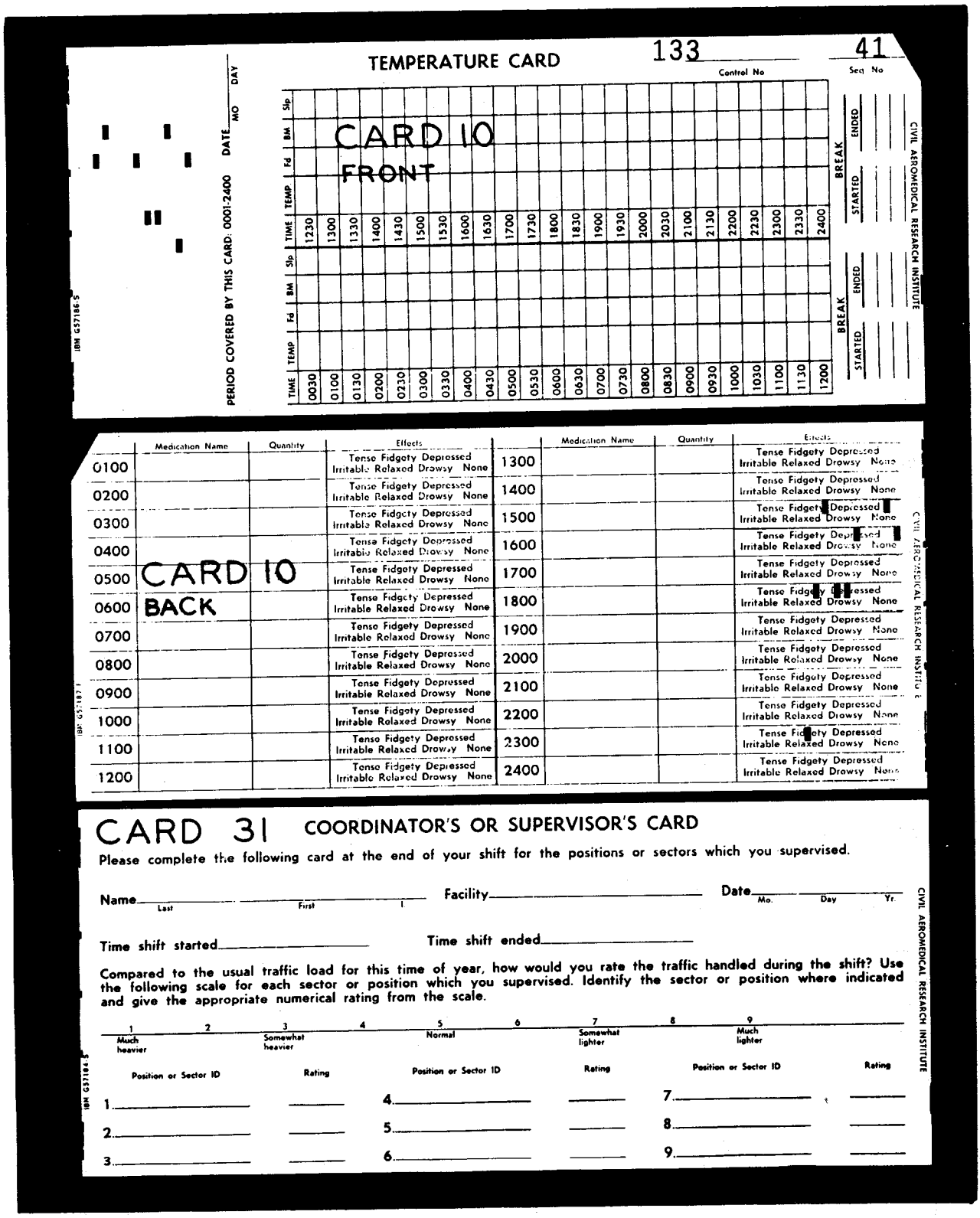


FIGURE B4.—Cards 10 (Front and Back) and 31.

APPENDIX C

*Civil Aeromedical Research Institute*

**FEDERAL AVIATION AGENCY**
**P.O. BOX 1082**
**OKLAHOMA CITY, OKLAHOMA**

## GENERAL INSTRUCTIONS

This study is being conducted to obtain information on the physiological and psychological effects of shift, or watch, rotation. To obtain the data for the evaluation of the effects, you are being asked to complete short questionnaires before and after each shift and to keep a record of your temperature, meals, sleep, and bowel movements. This information will be sent directly to the Civil Aeromedical Research Institute and will never be seen by anyone in your facility.

UNDER NO CIRCUMSTANCES WILL YOUR ANSWERS BECOME A PART OF YOUR PERSONNEL FILE OR IN ANY WAY AFFECT YOUR STATUS IN AIR TRAFFIC CONTROL WORK! THEY WILL BE KEPT IN THE FILES OF THE CIVIL AEROMEDICAL RESEARCH INSTITUTE AND BE USED FOR RESEARCH PURPOSES ONLY.

**BEFORE SHIFT BOOKLET:** These booklets are to be completed **at your facility** before the start of every shift. When you have answered all the questions, put the booklet in the attached envelope, seal it, and give it to the Watch Supervisor or Coordinator for mailing.

A control number has been printed at the top of each card in the booklet. This number has been assigned to you for the duration of the study and will be printed on all the forms which you complete. Whenever you complete a booklet or card, check the control number to be sure that it is yours. If it is not your number, cross it out and write in your number.

Whenever a time is requested, report it in terms of 24-hour local time - - not Greenwich Mean Time (Zebra Time).

**AFTER SHIFT BOOKLET:** This is similar to the Before Shift Booklet and should be completed at your facility immediately after coming off shift. When you have answered the questions, seal it in the attached envelope, and give it to the Watch Supervisor or Coordinator for mailing.

**WORD LISTS:** There are two word lists with each Before and After Shift Booklet. Using the word list that does **not** have a green stripe at the top, read each word and write down the first word that comes to your mind after reading it. It doesn't make any difference what this word is--write it down. Go through the list of words as rapidly as you can before you start either a Before or After Shift Booklet. Then put the word list in the envelope and complete the booklet. When you have finished the booklet, read each word on the word list with the green stripe at the top and write down the first word that comes to your mind. Since this is the same list of words that you read before completing the booklet, try to give the same response word that you gave the first time; but if the first word that comes to mind is not the same as the word that you gave the first time, it doesn't make any difference--write down the new word.

Please do not look back at the first word list at any time to see what you wrote down. This is one of the most important parts of the study but it will be of no value if you look back at the first word list.

When you have finished the word list with the green stripe at the top, put it in the envelope with the booklet and the other word list, seal the envelope, and give it to the Watch Supervisor or Coordinator for mailing.

**NUMBERING OF ENVELOPES AND BOOKLETS:** A number is printed in the upper left-hand corner of the envelope attached to each booklet and in the upper right-hand corner of each booklet. All odd numbers (1, 3, 5, etc.) are for Before Shift Booklets and forms; all even numbers (2, 4, 6, etc.) are for After Shift Booklets and forms. Since we are interested in the effects of shift patterns over time, it is essential that the booklets be completed in order. That is, you should start with the booklet having 1 on the envelope and booklet before the shift; after the shift the booklet with 2 on the envelope and booklet should be completed; before the next shift the booklet with the envelope marked 3 should be completed, and so on. Always start a shift with a booklet having an odd number on the envelope and booklet, follow it with the next even numbered envelope and booklet, and continue throughout the study always keeping the numbers in order.

# APPENDIX D

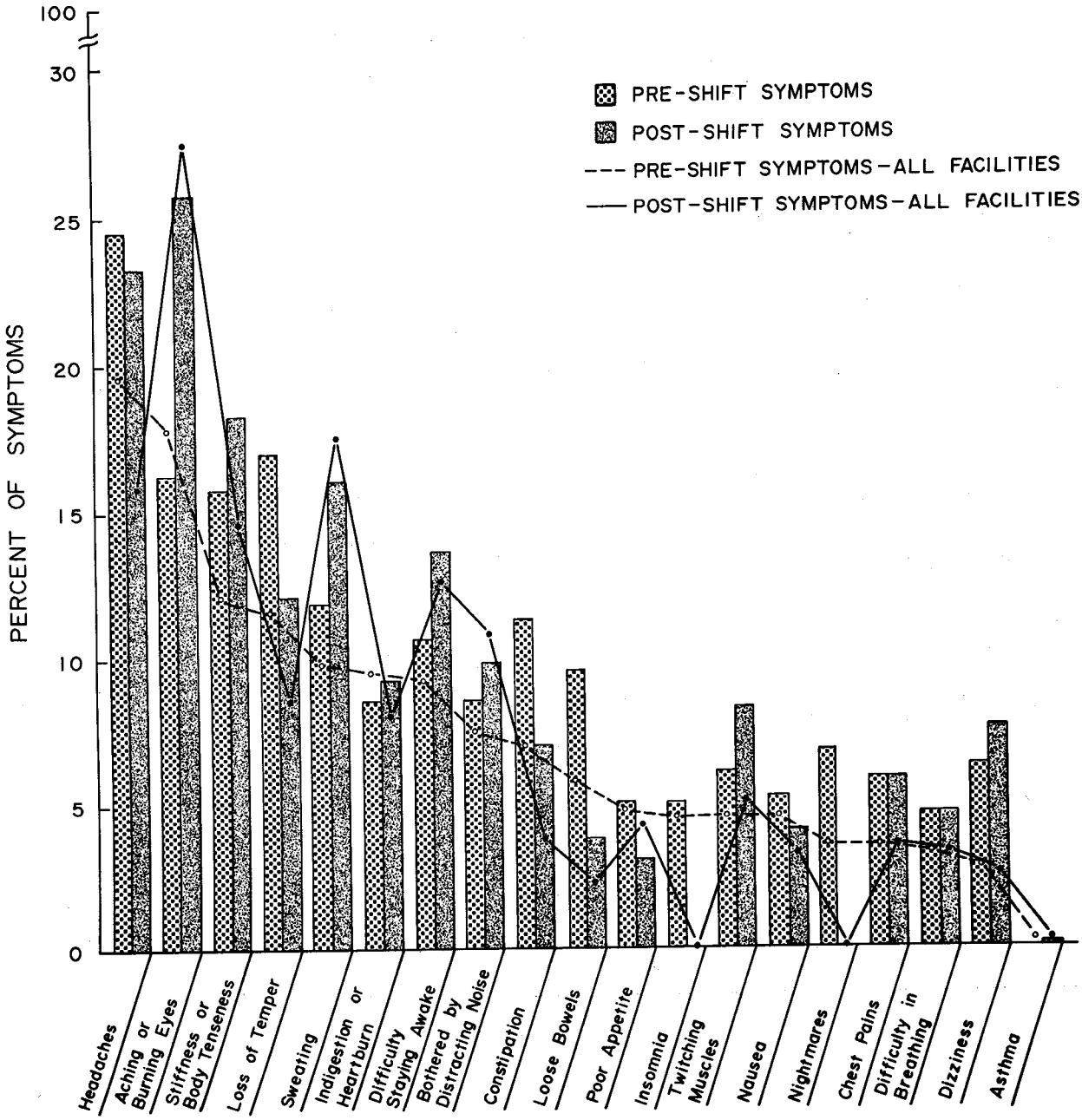


FIGURE D1.—Percentage of Symptoms—Preshift and Postshift (Atlanta Center).

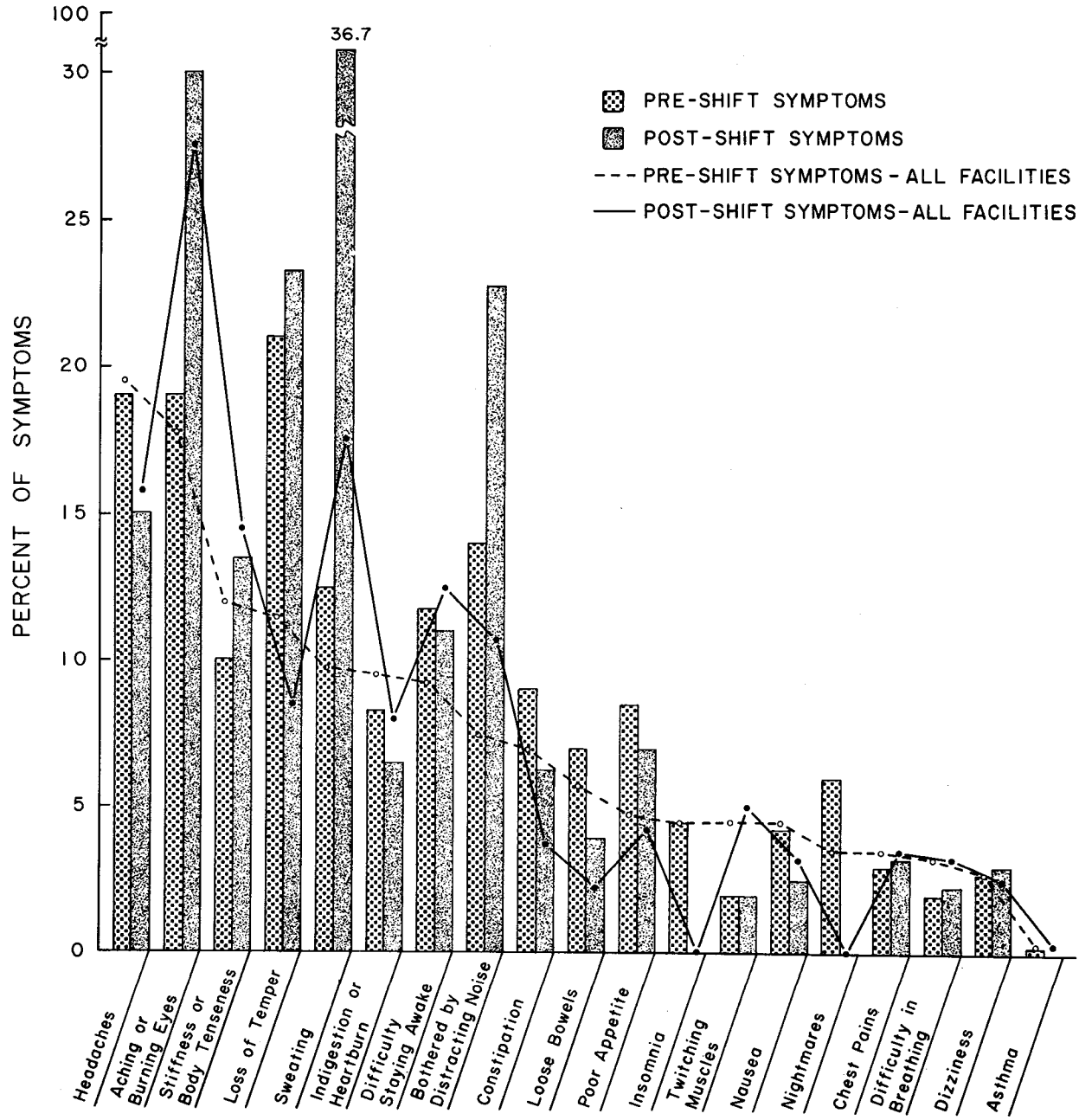


FIGURE D2.—Percentage of Symptoms—Preshift and Postshift (Boston Center).

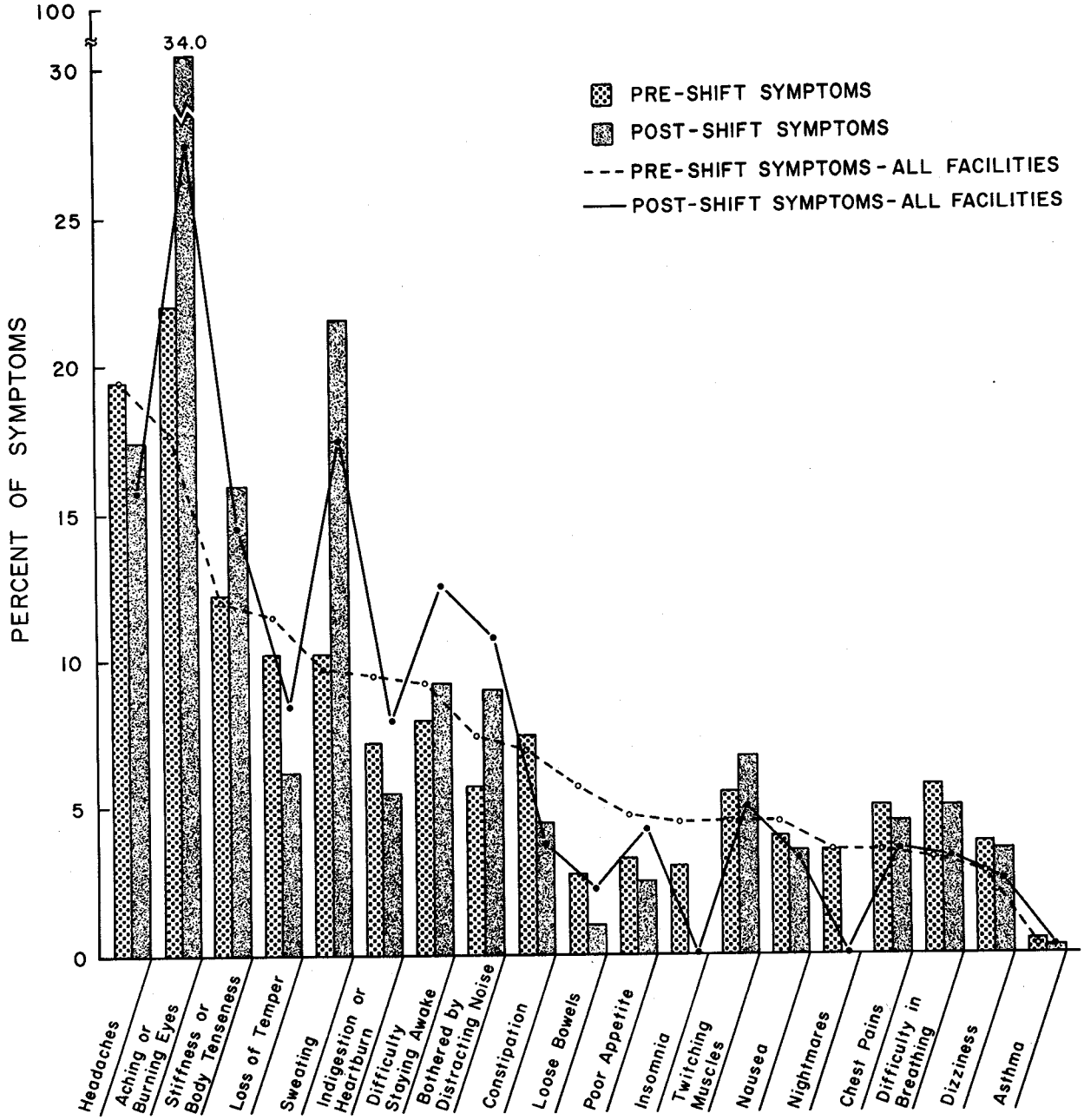


FIGURE D5.—Percentage of Symptoms—Preshift and Postshift (Indianapolis Center)

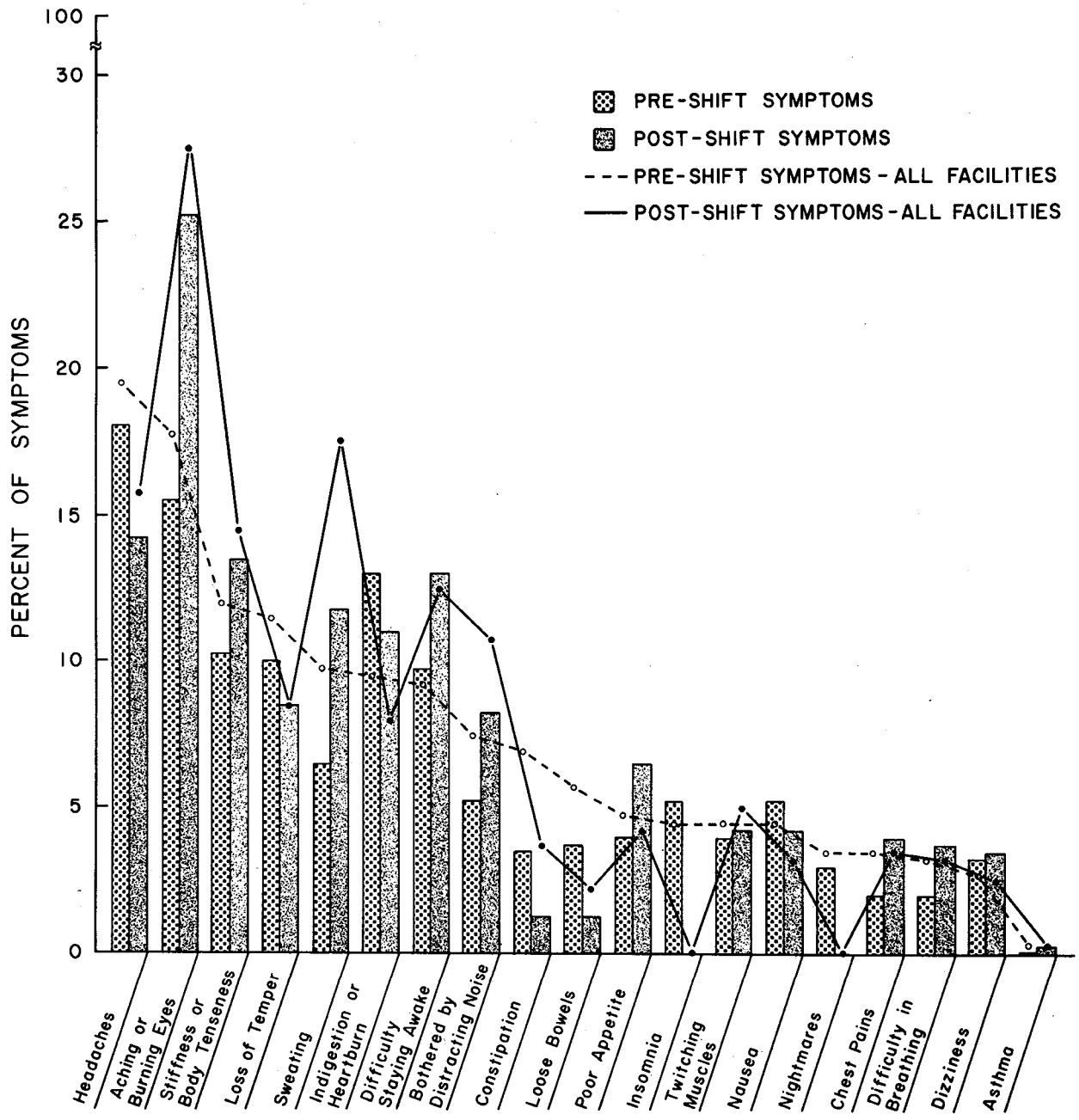


FIGURE D6.—Percentage of Symptoms—Preshift and Postshift (Kansas City Center)

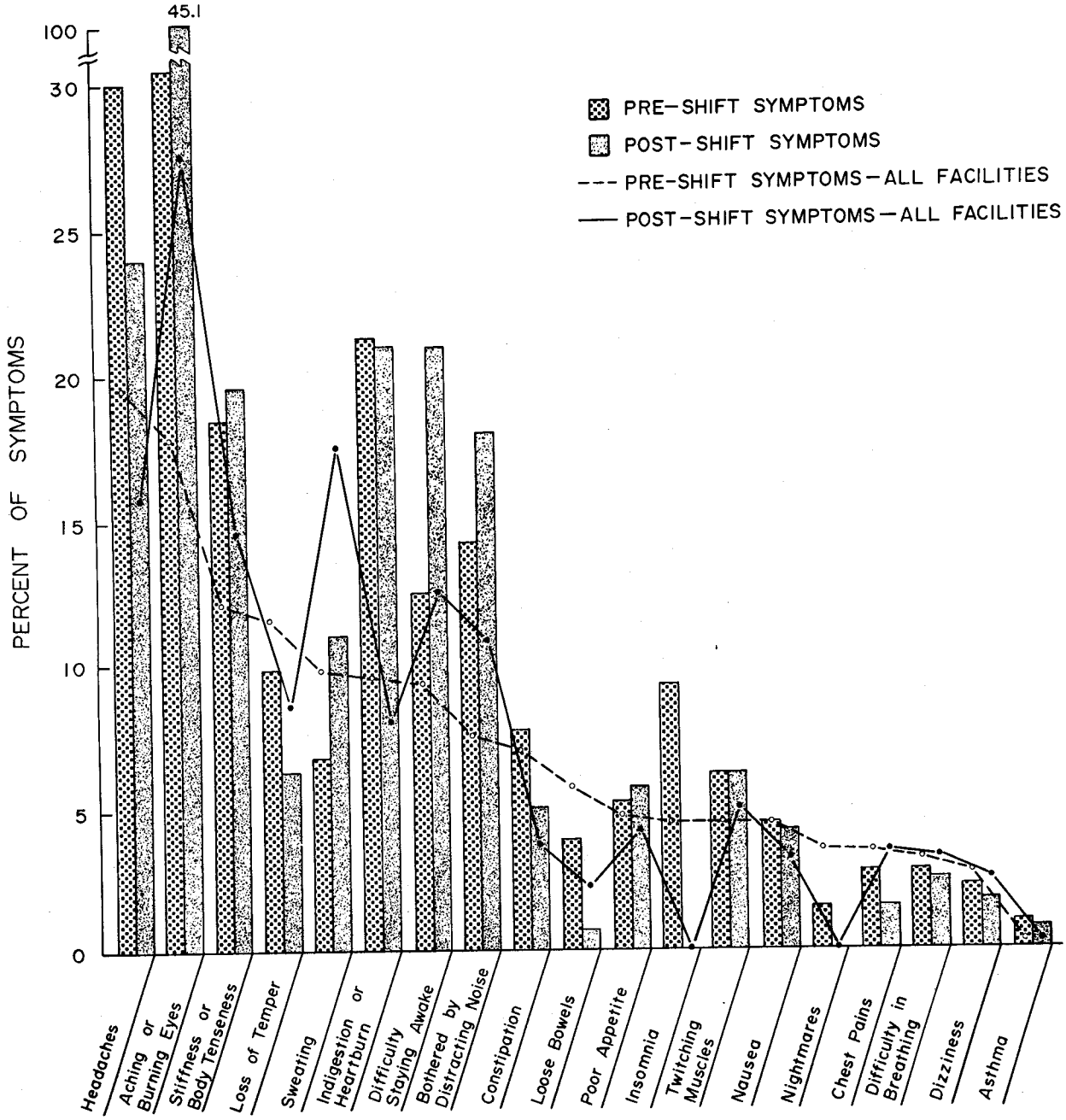


FIGURE D7.—Percentage of Symptoms—Preshift and Postshift (Atlanta Tower).

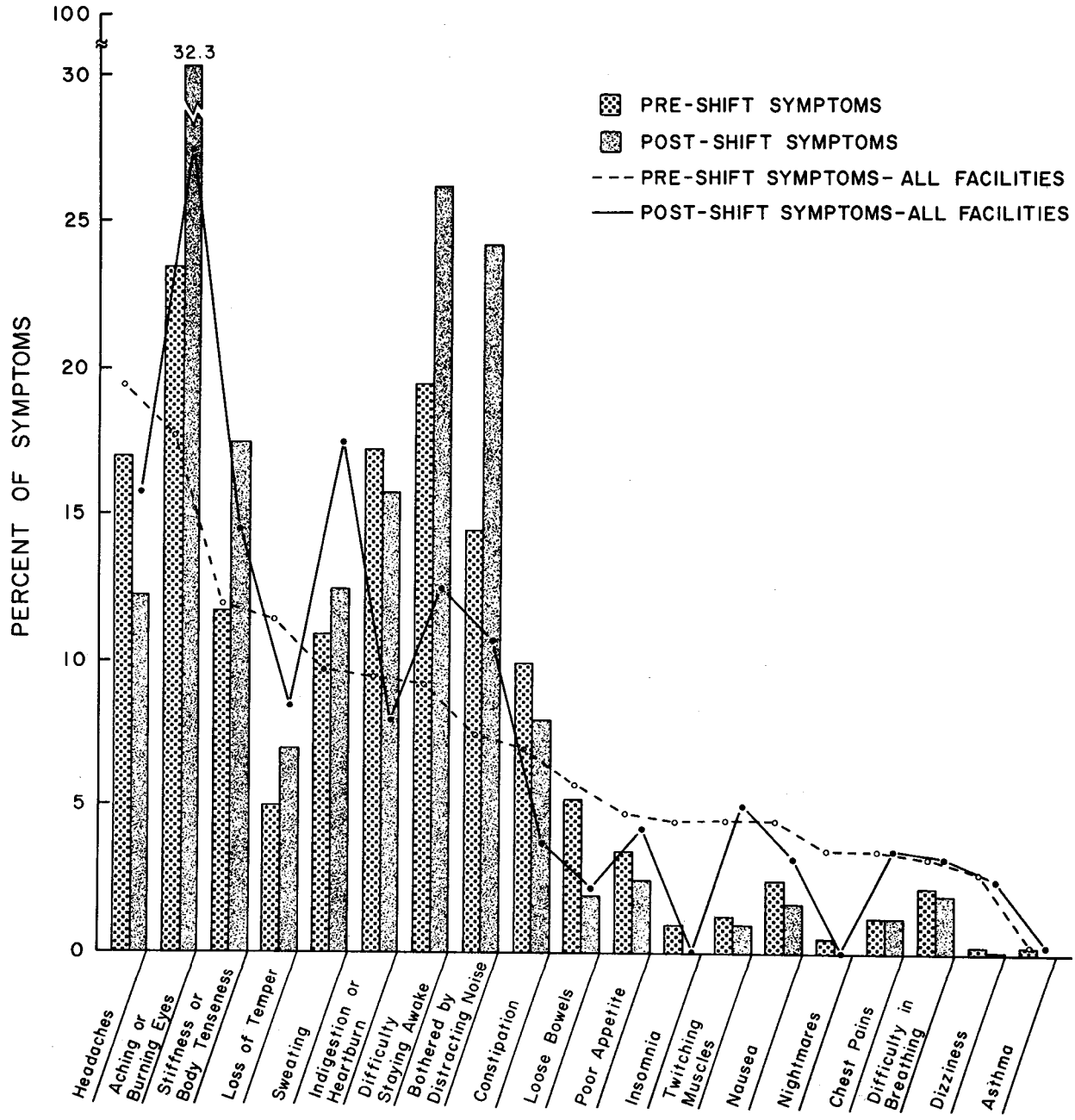


FIGURE D8.—Percentage of Symptoms—Preshift and Postshift (Boston Tower).

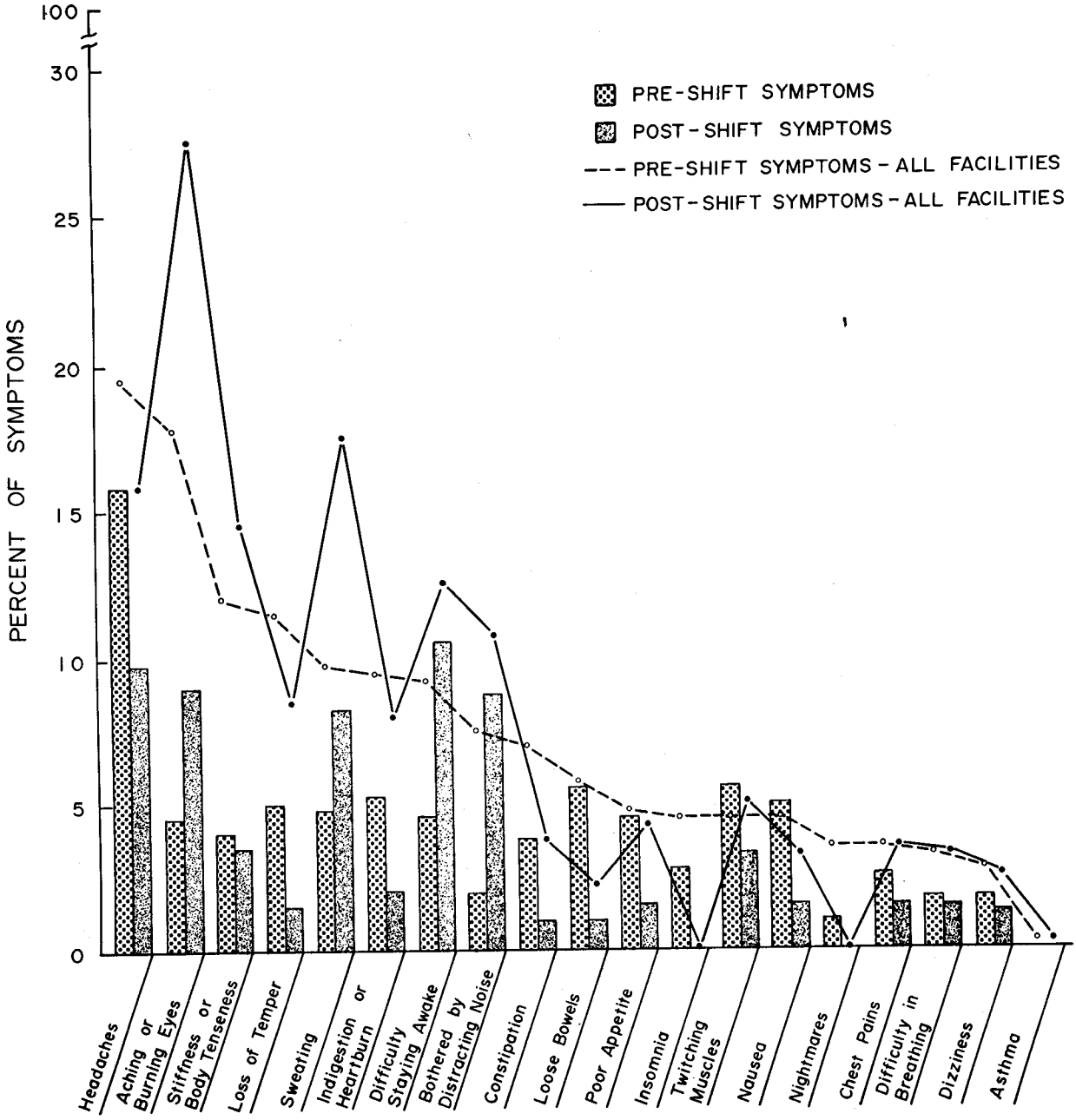


FIGURE D9.—Percentage of Symptoms—Preshift and Postshift (Buffalo Tower).

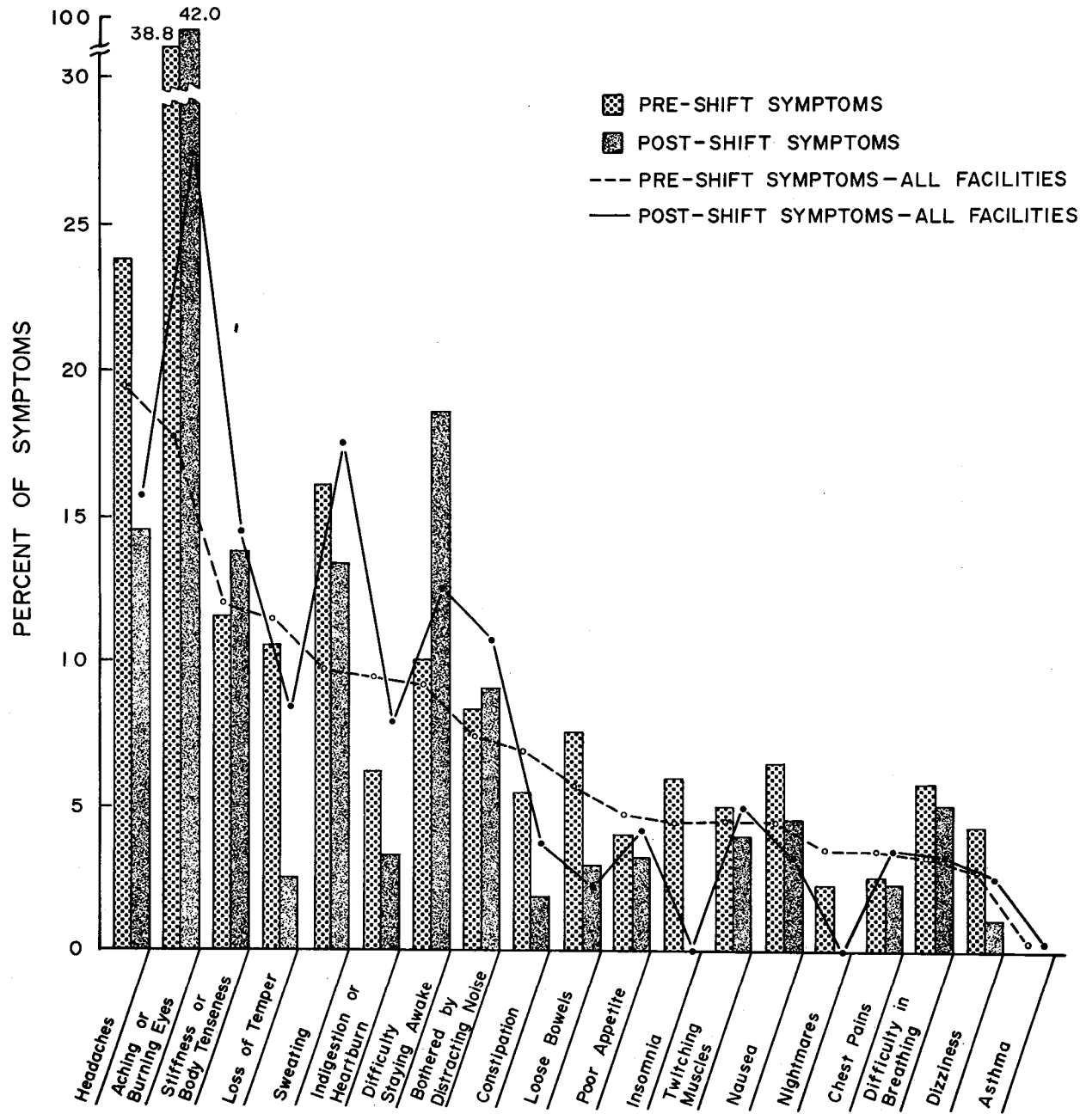


FIGURE D10.—Percentage of Symptoms—Preshift and Postshift (Burlington Tower).

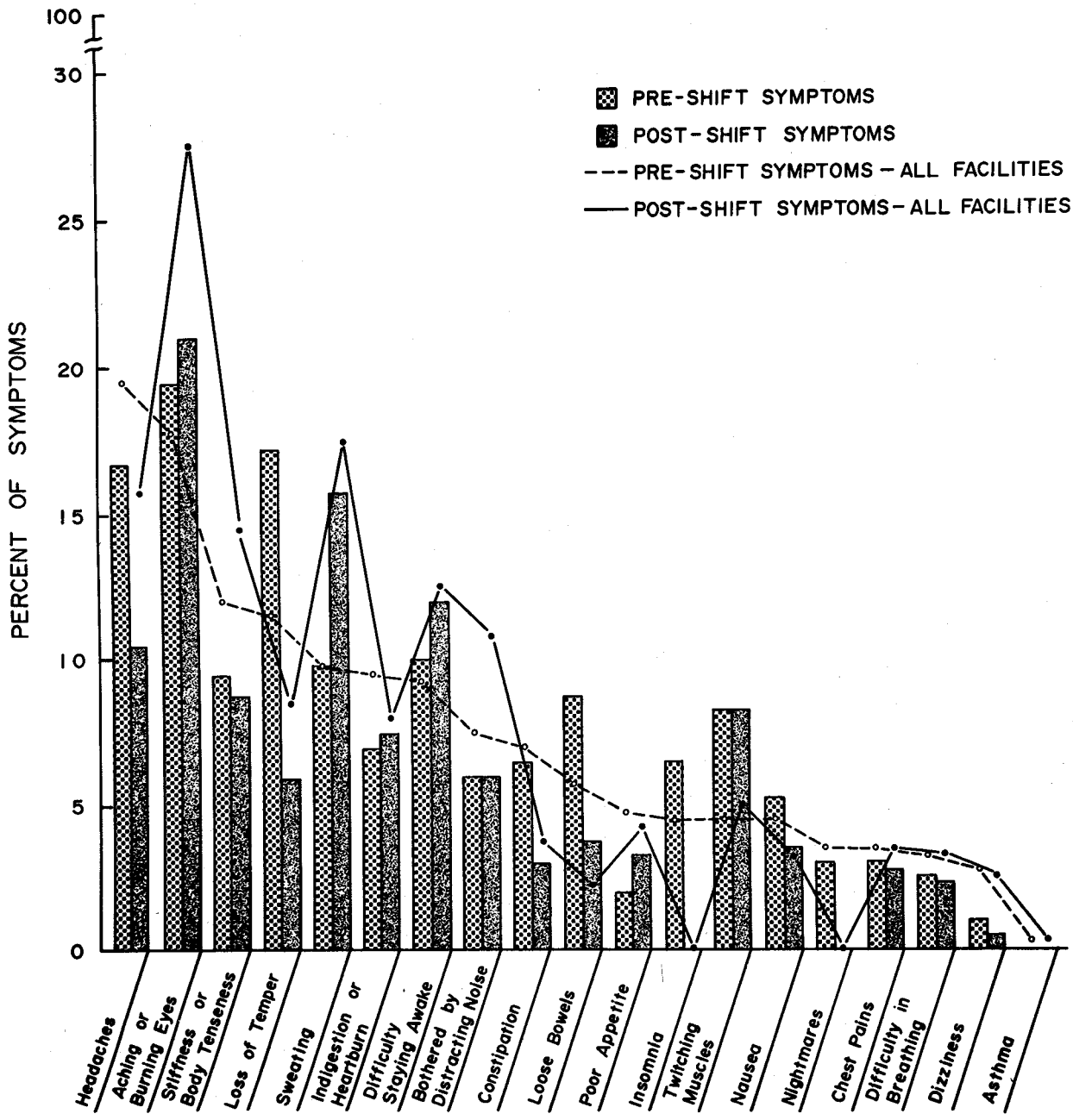


FIGURE D11.—Percentage of Symptoms—Preshift and Postshift (Milwaukee Tower).

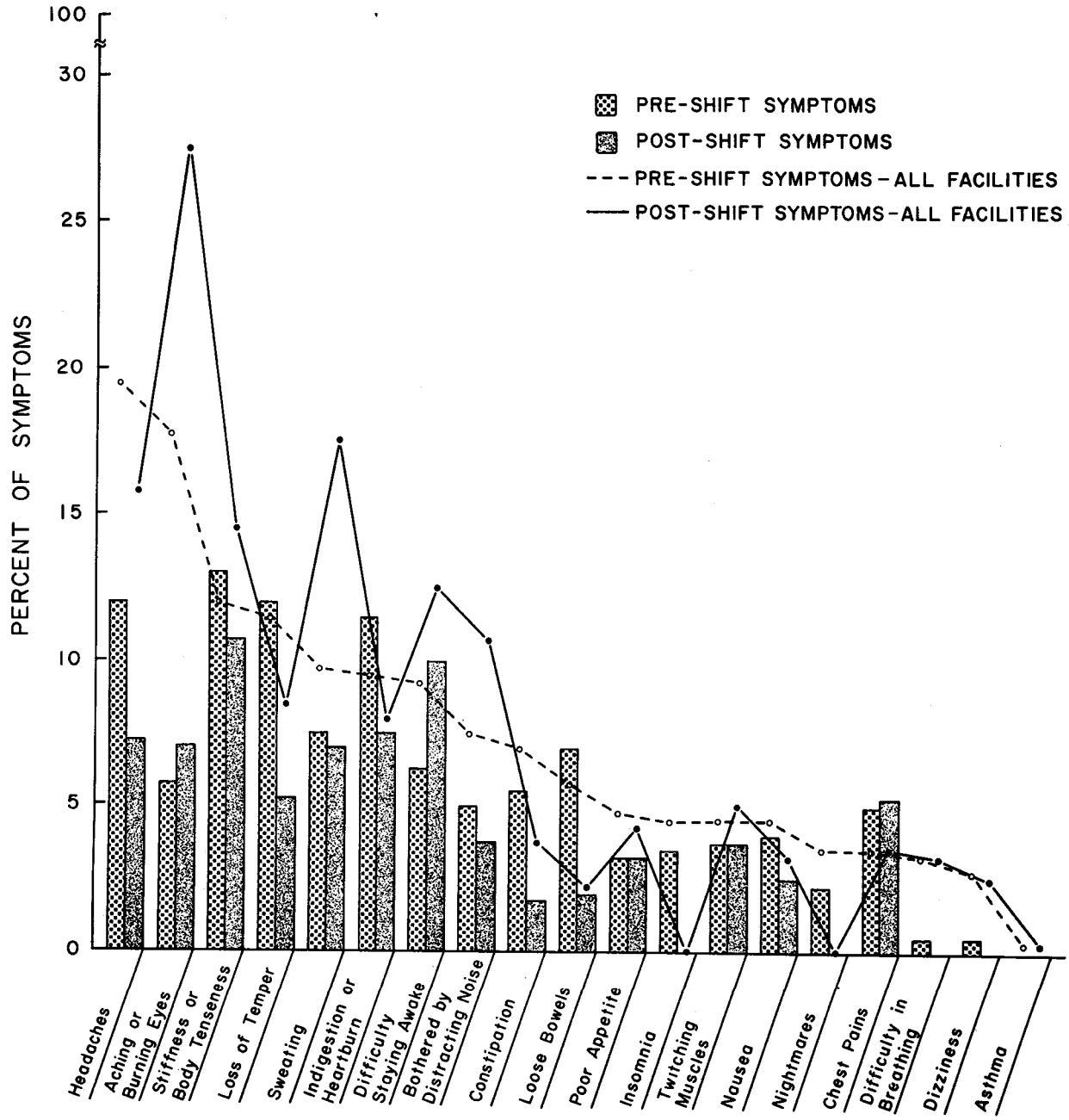


FIGURE D12.—Percentage of Symptoms—Preshift and Postshift (Philadelphia Tower).

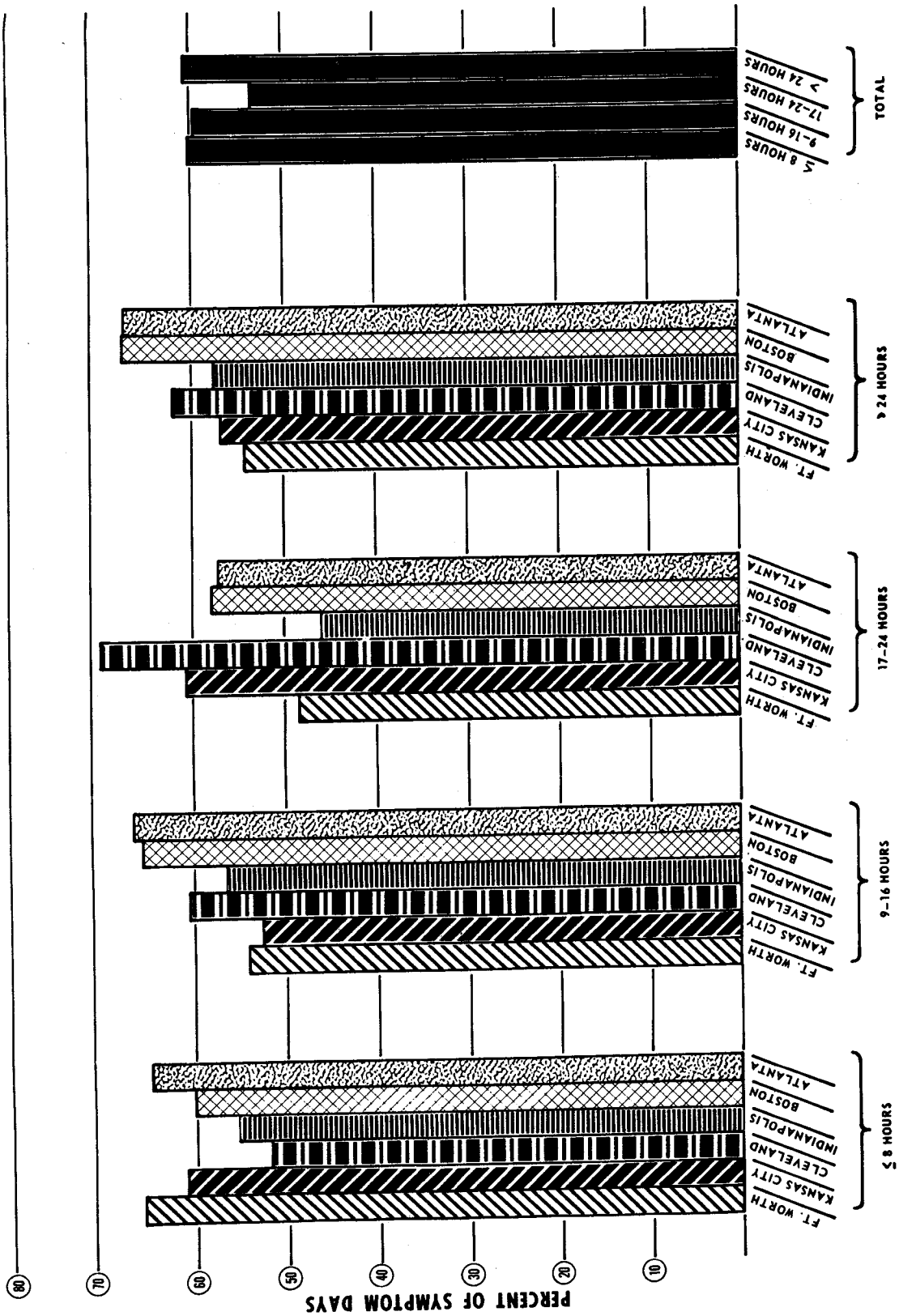


FIGURE E1.—Time Between Shifts by Centers—Preshift.

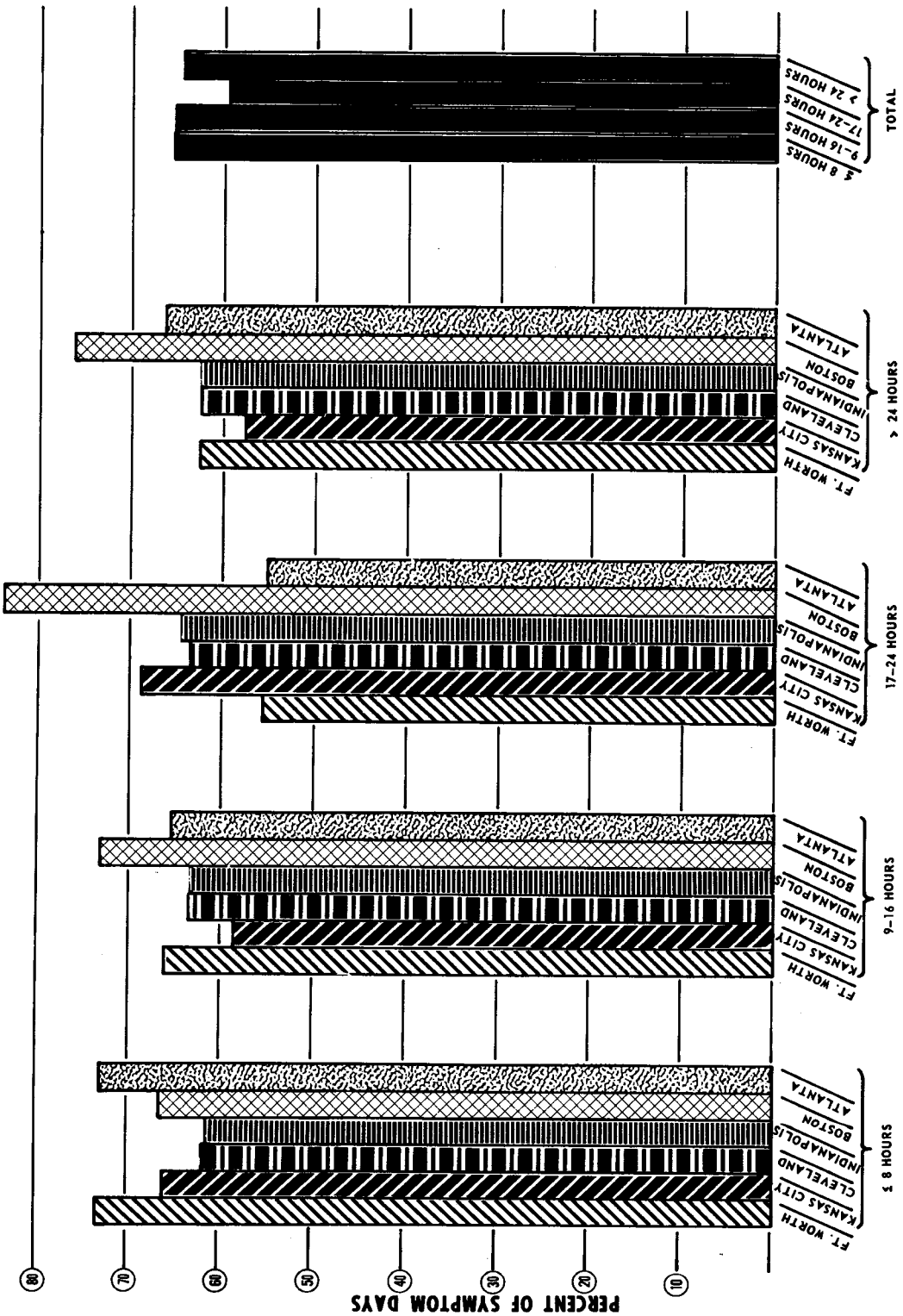


FIGURE E2.—Time Between Shifts by Centers—Postshift.

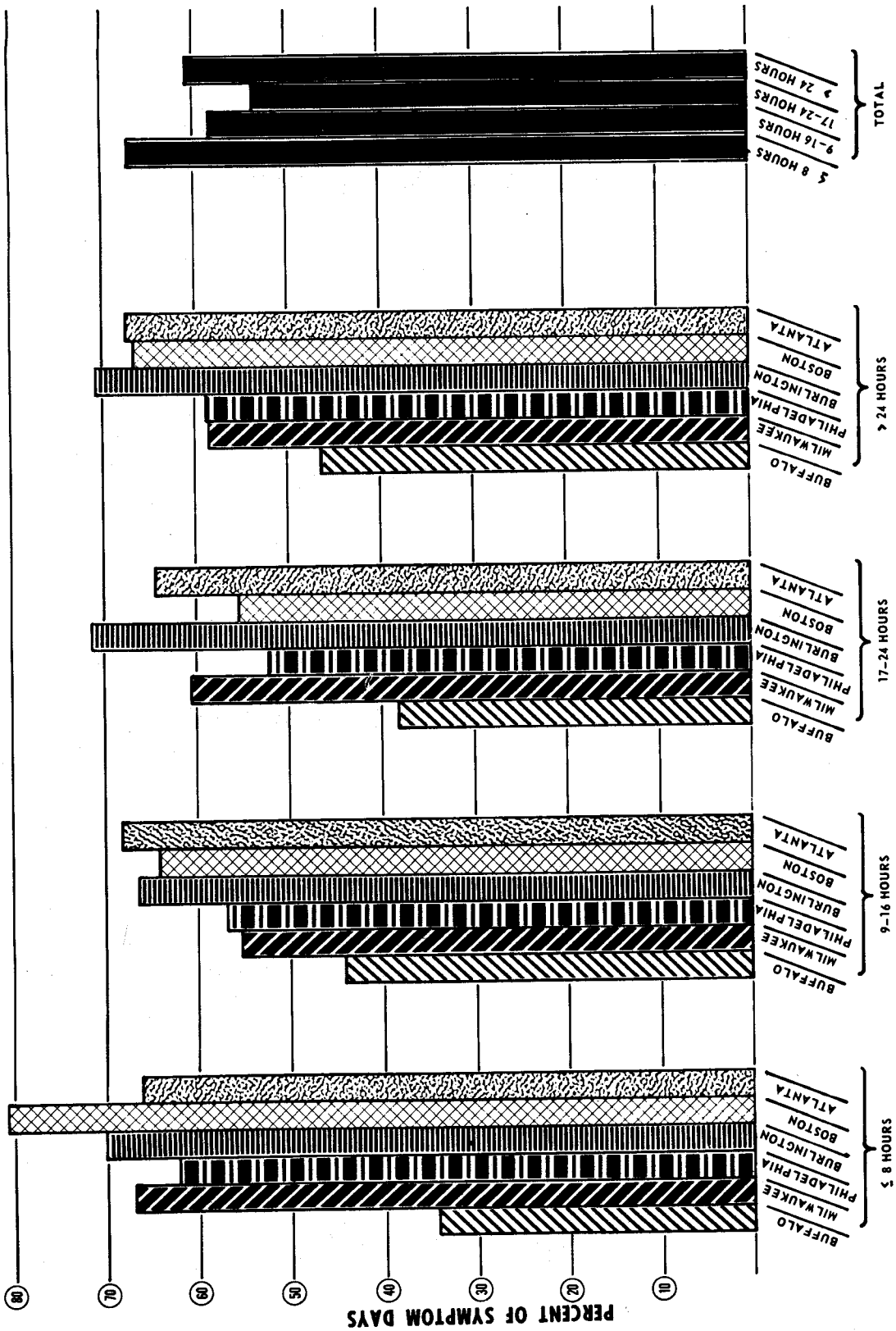


FIGURE E3.—Time Between Shifts by Towers—Preshift.

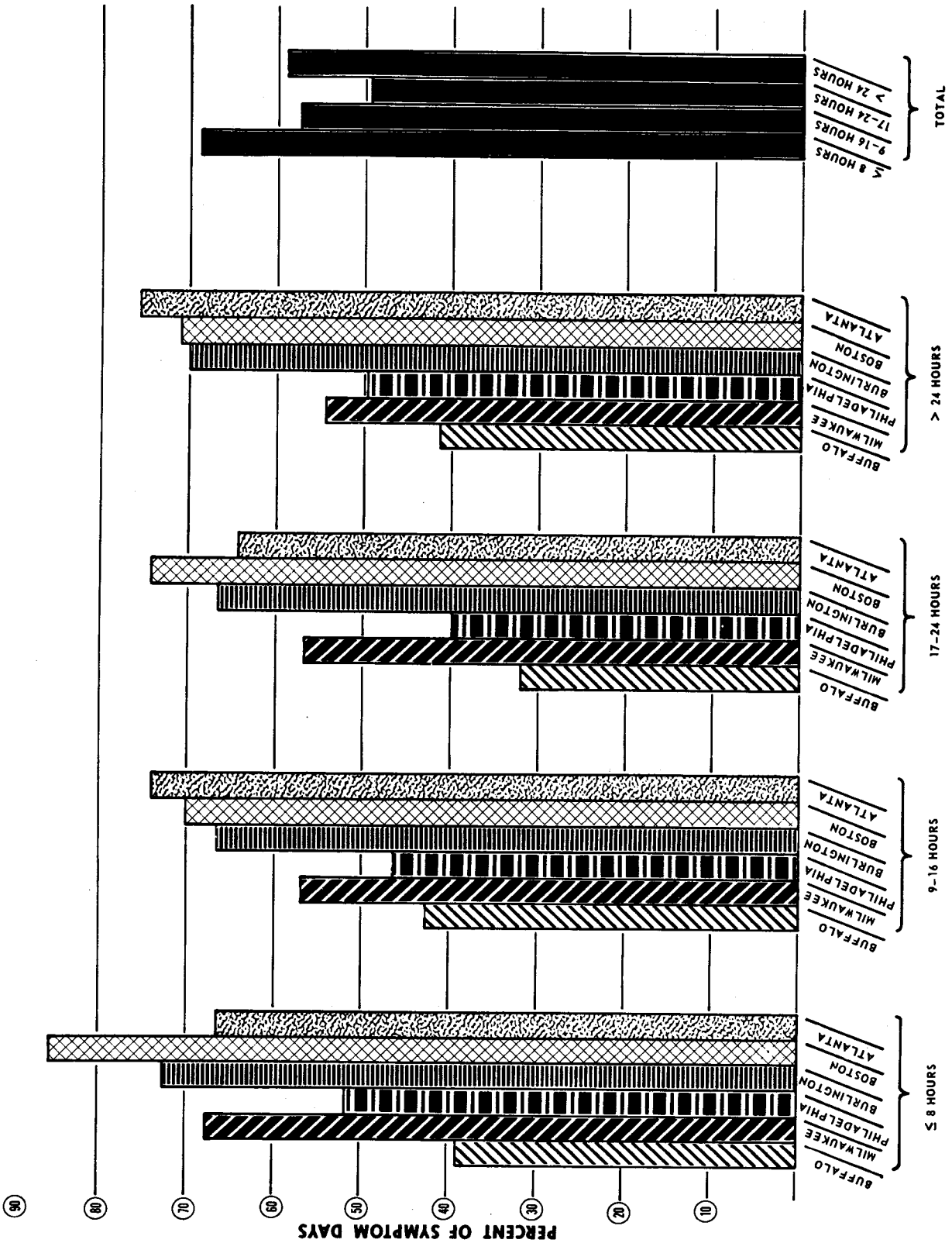


FIGURE E4.—Time Between Shifts by Towers—Postshift.

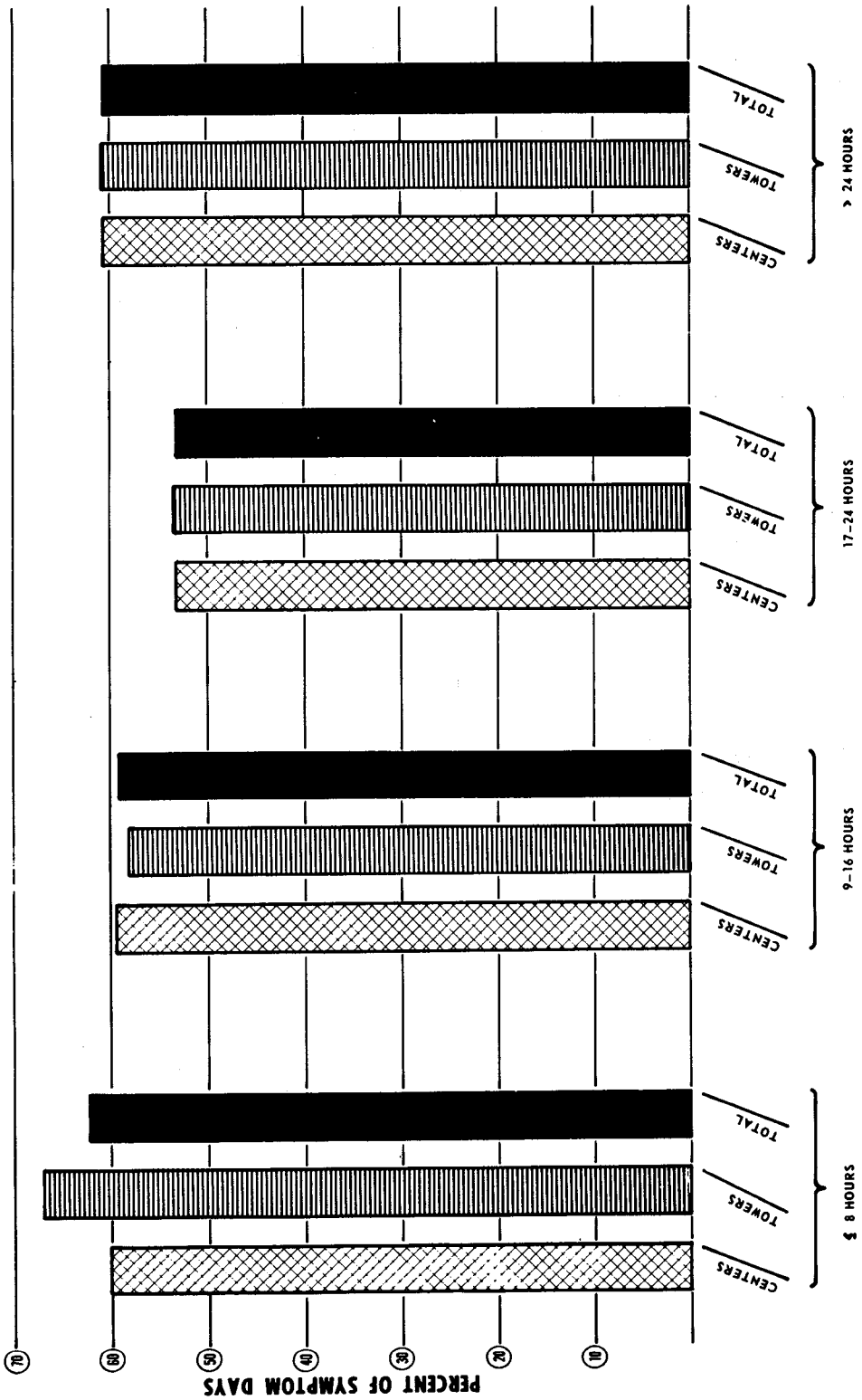


FIGURE E5.—Time Between Shifts by Type of Facility—Preshift.

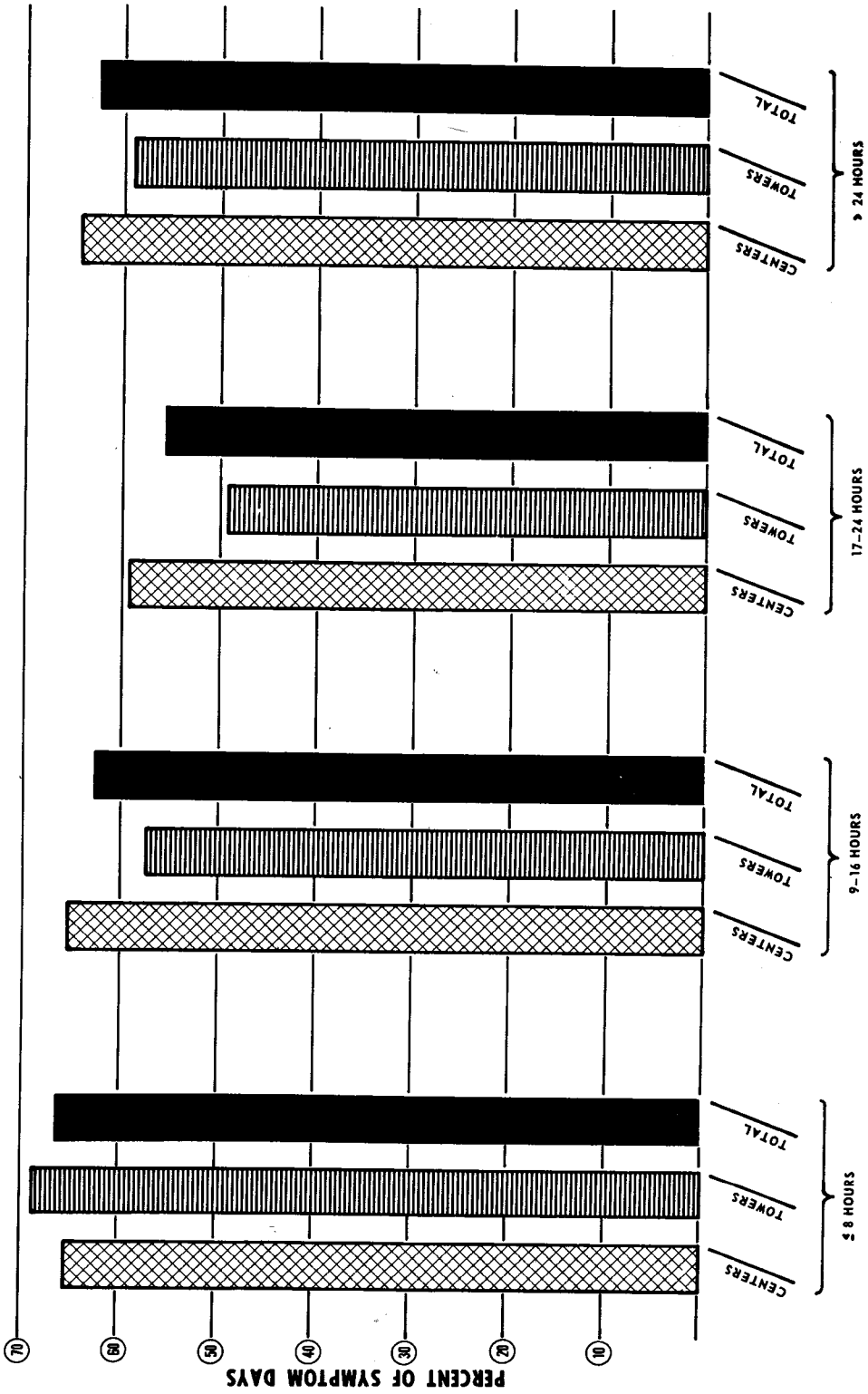


FIGURE E6.—Time Between Shifts by Type of Facility—Postshift.