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ANALYSIS OF FLIGHT SERVICE STATION CONSOLIDATION AND SECTORIZATION--PHASE II: LAS VEGAS, TONOPAH, ELY, AND NEEDLES FLIGHT SERVICE STATIONS

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ABSTRACT

This project was conducted in response to requests by AAT-1 and ATF-4 for information relative to Flight Service Station modernization. This Phase II report provides data collected at facilities within the Western Region. The purpose of the study is to examine the potential benefits of consolidation of flight service station facilities. In addition, an alternative method of geographic sectorization of the preflight briefing function is discussed. Results indicate that potential increases in preflight service level can be achieved through consolidation. However, the potential benefits of sectorization are not as apparent.

ANALYSIS OF FLIGHT SERVICE STATION CONSOLIDATION AND SECTORIZATION-- PHASE II: LAS VEGAS, TONOPAH, ELY, AND NEEDLES FLIGHT SERVICE STATIONS

This letter report was authored by John J. Maloney and James D. Talotta, ANA-250, and under NPD 13-251, Subprogram 131-402, Project Number 131-402-254, Flight Service Station Consolidation/Sectorization Study. The report is the second in a series of three to be presented on the subject. This document presents results of activity data collected at several facilities relating to possible productivity improvements if existing Federal Aviation Administration (FAA), Flight Service Stations (FSS's) are consolidated.

BACKGROUND

The present network of FSS's consists of 290 facilities widely dispersed throughout the continental United States. The FAA is undertaking an automation program of the existing FSS network. Included in the automation plan is the possibility of reducing the number of FSS facilities through relocation and consolidation into a smaller number of facilities.

This report is a response to requests from ATF-4 and AAT-1 to determine what, if any, productivity increases may be expected from consolidation. Another endeavor of the report is to consider the possible manner in which the pre-flight weather briefing function may be divided into sectors based on the distribution of briefing request.

The study has been divided into three geographically diverse areas: A Phase I Letter Report (NA-77-63-LR) has been published on data collected at three Virginia FSS's. ("Analysis of Flight Service Stations Consolidation and Sectionization Phase I: Charlottesville, Richmond and Washington Flight Service Stations" by John J. Maloney, ANA-250, December 1977.) This Phase II report provides information on four facilities three of which, Las Vegas (LAS), Tonopah (TPH), and Ely (ELY) are located in Nevada, and fourth facility, Needles (EED) in California. A Phase III report will be issued describing data collected at three facilities in Indiana.

PURPOSE

The objective of the study is to determine through quantifiable performance measures, if there is to be expected an improvement in FSS productivity through consolidation. These measures include the response time to incoming calls, current utilization of personnel, and estimated required staffing. An additional objective is to determine the desirability and feasibility of sectorization of incoming calls based on geographic distribution.

APPROACH

A total of nine data collectors, primarily air traffic control specialists, from the National Aviation Facilities Experimental Center (NAFEC) were divided into teams and assigned to each of the facilities. Data were simultaneously collected by each of the teams on a predefined schedule. A total of 48 hours of work activity were monitored with all hours of the day covered. This presented an around the clock sample of facility workload. The study focused on the primary operational duties common to FSS's; namely, preflight, in-flight, and flight data. Activity relating to the in-flight and flight data positions was recorded manually on moving paper chart (kymograph) recorder using descriptive work activity codes. In-person preflight transactions were recorded and included in the sample. Telephone activity for the preflight position was recorded on a telephone traffic computer. This traffic computer made a permanent recording of the activity for analysis. The team members were also responsible for determining the number of specialists on duty at the facility and the number of specialists available to perform activities. These observations were made on a cue at approximately 5-minute intervals. Also available were historical activity records including flight plan forms and pilot briefing logs obtained from each facility after the normal 15-day retention period.

The activity level during the sample period was compared with Fiscal Year 1977 data for the same locations. Using a Student's t test of significance at the 95-percent confidence level, it was found that the sample days did not differ significantly from the base year. Additionally, the activity level during the sample represented activity at the 55th percentile level in comparison to the base year data. For each facility the percentile day observations were the following: LAS 61st percentile, TPH 54th percentile, ELY 81st percentile, and EED 24th percentile. This activity level was expressed in flight services, a derived measure computed from two times the number of flight plans filed, plus two times the number of pilot briefings provided, added to the number of aircraft contacted. The sample period selected represented normal activity levels for these facilities.

RESULTS - Preflight

The preflight position was examined in detail during the data collection. Three of the facilities, EED, TPH, and ELY FSS's, had one qualified journeyman specialist on duty during the period. TPH and EED FSS's did have an additional trainee on duty primarily for the day shift; however, this individual was not included as part of the staff unless qualified to work a position without direct supervision. The basic preflight staffing for each of the facilities is depicted in table 1.

TABLE 1. PREFLIGHT STAFFING

FACILITY	SHIFT SCHEDULE		
	Day	Evening	Midnight
EED	1	1	1
ELY	1	1	-*
TPH	1	1	1
LAS	3	2	2
Totals	6	5	4

*ELY FSS closed 2100-0530 (local)

The trainees, if included, could enlarge the EED and TPH daytime staffing by one additional specialist. At the EED, ELY, and TPH FSS's the preflight staff may be considered as a number less than one because at these facilities the specialist is occupied with a variety of collateral duties.

Thus by excluding trainees and considering other activities at these facilities the results demonstrate a conservative measure of the effects of consolidation. In a later section this actual observed staff will be compared with estimates of required preflight staff for the consolidated facility.

To demonstrate the current activity level for each of these facilities, the number of flight plans and pilot briefings provided divided by the actual observed number of preflight specialists is presented in table 2 over various time periods.

TABLE 2. NUMBER OF FLIGHT PLANS FILED AND PILOT BRIEFINGS PROVIDED PER SPECIALIST PER HOUR

FACILITY	SHIFT SCHEDULE		
	Day	Evening	Midnight
EED	3.2	1.2	1.2
ELY	3.0	1.5	—
TPH	2.4	.7	1.5
LAS	5.8	7.6	3.7

This table demonstrates that, on a per-specialist basis, LAS FSS is providing more services than the other three facilities. An interesting anomaly occurs during the evening shift when large numbers of military flight plans are processed causing the evening activity to be heavier than the daytime activity at LAS. For operational purposes the daylight hours may be considered the most active period in terms of demand on the system. The primary point of the table is the current difference in productivity level for these facilities.

Another indicator of preflight workload is a measure of specialist utilization (table 3). Utilization is the ratio of actual pilot-to-specialist conversation time in minutes to the total number of man-minutes available if the specialist had been occupied continuously.

TABLE 3. PREFLIGHT SPECIALIST UTILIZATION*

FACILITY	SHIFT SCHEDULE		
	Day	Evening	Midnight
EED	.11	.02	.03
ELY	.03	.02	--
TPH	.10	.04	.04
LAS	.21	.12	.07

$$*\text{utilization} = \frac{\text{total preflight connect time (min)}}{\text{No. of preflight specialists available} \times 60 \text{ (min)}}$$

Table 3 demonstrates again the differences between these facilities in a precise fashion; namely, the actual briefing time of preflight specialists.

The figures represent averages accumulated during the sample; however, individual hourly activity for these facilities may be considerably higher, depending on demand. The primary point is the difference, on a per-specialist basis, between the existing facilities. This has a strong influence on the potential effect of consolidation.

The final indicators of activity level and the quality of service provided to the calling pilot are congestion measures collected during the sample. These measures basically consist of waiting times for calling pilots. These waiting times may be expressed as averages over all callers, or, more significantly, averaged over only those calls which in fact experienced delays. For example, if 90 percent of callers are answered without delay, then the average delay of all calls is minimal, but a caller in the remaining 10 percent group is interested in the delay which he or she experiences rather than all others. The average delay of all calls for each of the facilities by times of day is given in table 4.

TABLE 4. AVERAGE OBSERVED PREFLIGHT WAITING TIME (SEC)

FACILITY	SHIFT SCHEDULE		
	Day	Evening	Midnight
EED	11.8	7.6	5.3
ELY	18.0	5.3	--
TPH	13.7	6.9	8.4
LAS	6.0	7.6	8.7

The generally rapid overall response time indicates the high caliber of service provided by these facilities. Only during daylight hours does service deteriorate somewhat at the smaller facilities. This is primarily due to the infringement of other collateral duties on the specialist.

The more potent indicator of service level is the average actual delay of calls which do in fact experience delays. In table 5, the large number of calls answered immediately does not dilute the actual delay time.

TABLE 5. AVERAGE DELAY OF CALLS EXPERIENCING DELAYS (SEC)
(A delayed call is defined as a call experiencing a delay of 10 sec or longer)

FACILITY	SHIFT SCHEDULE		
	Day	Evening	Midnight
EED	26.0	17.0	0.0
ELY	139.0	10.0	--
TPH	70.4	19.0	12.0
LAS	19.5	14.3	15.2

Considering Tables 3 and 5 jointly, it is interesting to compare conceptually the difference between a single specialist facility such as ELY with LAS, a facility in which specialists are dedicated solely to a single operational position. At ELY one might expect other duties such as weather observations, in-flight activity, or flight data to infringe on a specialist's availability to provide preflight service and thus create a high utilization figure. In fact, average preflight utilization at ELY FSS is considerably lower than LAS FSS during daylight hours. The primary reason is the greater demand for service in the LAS area. However, it is also reasonable to expect long delays as collateral duties infringe on a specialist's ability to answer the telephone promptly. This effect is demonstrated in Table 5 with large average

delays at ELY versus LAS FSS. Although, in this case, the sample size is small with four delayed calls, the figures indicate that those callers who call while a specialist is engaged in collateral duties experience longer delays than calling a busier facility with specialists dedicated solely to preflight. Effectively, this indicates that a smaller facility with minimum demand for service provides for a lower overall utilization of personnel while simultaneously providing a lower service level for calling pilots. A similar but not as dramatic effect is apparent at EED and TPH FSSs.

It is of note to look at a small facility with specialists moving from position to position, responsible for a variety of tasks, and consider these specialists to be "busier" than specialists at a large facility seated at a position exhibiting little movement. Certainly, specialists at a small facility consider themselves "busier." From observation of the facilities and data in Tables 3 and 5, it appears much of the routine movement in a small facility does little to contribute to productivity.

The mathematical model used in analysis may describe activity at the various facilities in an exact fashion. The term "traffic intensity" is defined as the average number of busy preflight specialists per hour. In addition, the likelihood of delay or the amount of delay may be described in terms of probabilities. These figures indicate the chance of delay for a calling pilot and the predicted delay of the call. Table 6 gives the traffic intensity for the facilities over various time intervals.

TABLE 6. PREFLIGHT POSITION TRAFFIC INTENSITY

FACILITY	SHIFT SCHEDULE		
	Day	Evening	Midnight
EED	.09	.02	.02
ELY	.03	.02	--
TPH	.08	.03	.04
LAS	.46	.20	.11

traffic intensity = No. of transactions/hr x mean connect time (min) x 1 hr/60 min

Table 6 is another indicator of the difference in activity level between the facilities as well as the very low activity level during the evening and midnight hours at the smaller facilities.

Consolidation of facilities represents a pooling of specialists from various facilities to provide a larger nucleus of available specialists with which

to meet anticipated demand. Conceptually, this represents an equitable distribution of workload across the specialists. Additionally, because of the random nature in which pilots call these facilities, a consolidated facility should be able to provide a better service level to the flying public in terms of a decreased likelihood of delay or reduced waiting times. The queuing model is used to generate a probability of a busy system for separate facilities as well as a similar probability for a hypothetical consolidated facility (table 7).

TABLE 7. PROBABILITIES OF A BUSY SYSTEM

FACILITY	SHIFT SCHEDULE		
	Day	Evening	Midnight
EED	.08	.08	.02
ELY	.03	.02	--
TPH	.08	.03	.04
LAS	.08	.08	.05
"CONSOLIDATED"	.01	.00	.00

Table 7 predicts that the pooling of available specialists at various facilities will reduce the chance of encountering a busy system given the present demand for service at the separate facilities; i.e., the consolidation of facilities will result in improved service for the calling pilot.

A graphic example (figure 1) of the result of consolidation is the presentation of data for the most busy hour observed during the data collection. The actual transactions are plotted on a time line scale for the separate facilities. These transactions are then merged to depict the results if all calls had been answered in a single facility.

The chart demonstrates the relative lack of preflight activity at the three smaller facilities. At LAS FSS, although only two specialists were assigned preflight, four calls were answered during a brief period. The first and second calls were answered by preflight specialists. A preflight specialist put one call in a hold status to answer the third, and the assistant chief assisted by answering the fourth. The merged or consolidated facility indicates that from four to five specialists were available to provide service at the separate facilities. The actual demand could have been serviced with three specialists with only a brief period in which four specialists would have been required. In effect, consolidation of these specialists provides a buffer of capacity to meet short term demand fluctuations.

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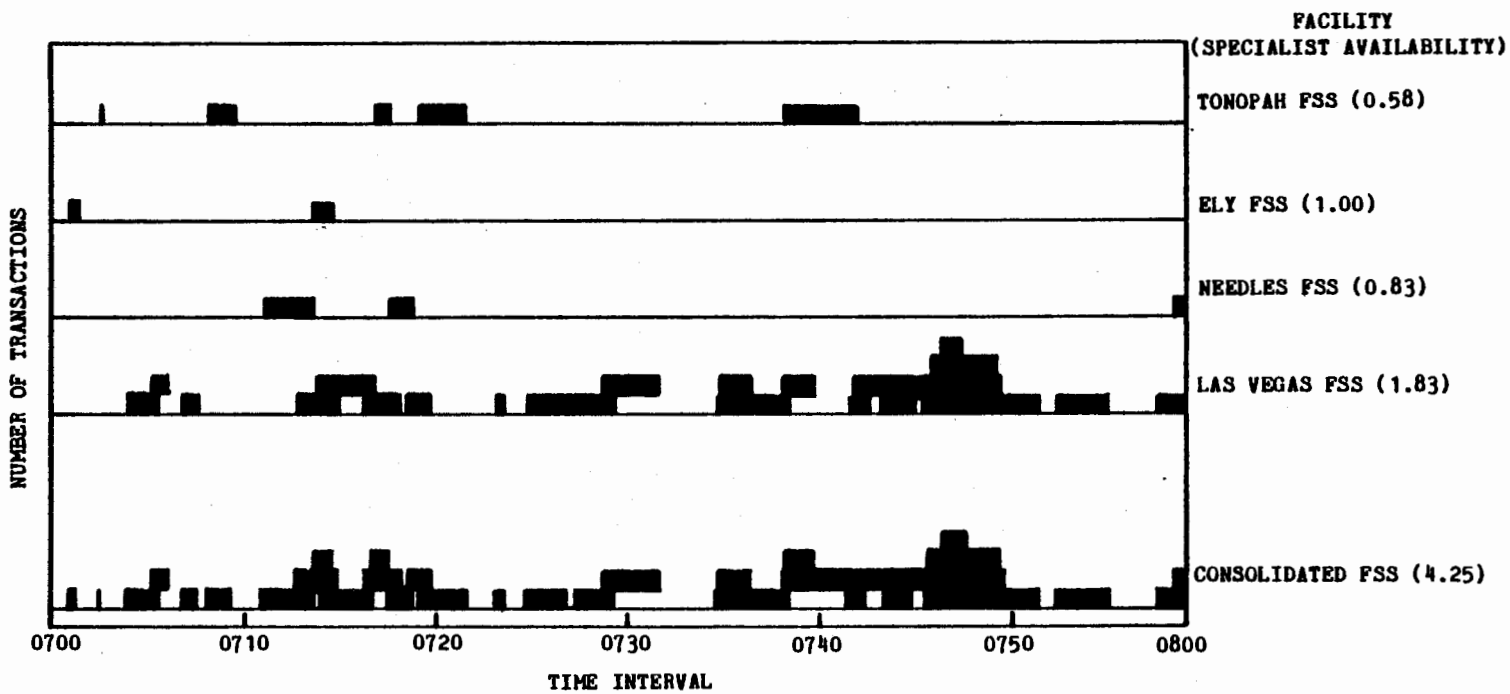

FIGURE 1. PREFLIGHT BRIEFING TRANSACTIONS DURING MOST ACTIVE OBSERVED HOUR (0700-0800, 8/4/77)

The final results of the analysis indicate that during evening and midnight watches, there is sufficient preflight staff on duty at LAS FSS to satisfy the current relatively low demand for service. The available manpower thus freed from these shifts could be more fully utilized during daylight hours. Thus, a larger staff is available to meet the greater demand fluctuations which occur during the daytime period.

RESULTS - Flight Data and Preflight

Information pertinent to the flight data and in-flight operational positions was classified into common work activity codes. Table 8 describes work categories collected during sampling.

TABLE 8. WORK ACTIVITY CODES

1. On frequency communication with an aircraft
2. Writing on various forms such as logging incoming contacts or copying a message, etc. (except flight plans)
3. Filing of forms (flight progress strips, flight plans, etc.) into bins, cabinets, or files
4. Typing on keyboard (typewritten only)
5. Looking at reference data or manuals such as charts, location identifier manual, etc. (within the context of another work activity)
6. Copying flight plans
7. Searching for information such as flight plan forms, flight progress strips, manuals, etc. (within the context of another work activity)
8. Scheduled or unscheduled broadcasts (Sigmets, Airmets, Notams, Pireps, etc.)
9. Pilot briefing on radio, telephone or in person (does not include copying flight plans)
10. Communication outside of the facility (with other FSS's, center, tower, military base operations, etc.)
11. Communication with others within the facility (work related)
12. Handling of Service B teletype messages — as opposed to Service A weather information
13. Movement about the facility such as walking to teletype, wall charts, or filing cabinet (within another work related activity)
14. Waiting time for a pilot within the facility awaiting service
15. Navigational aid monitor duties

During actual operations many of these activities occur simultaneously and in a regular order. For example, a typical in-flight contact begins with activity 1 and is followed by activity 2. Other activities such as 6 or 9 will occur and the transaction will terminate with activity 1. To reduce the volume of data, these activities have been compressed into task events. Basically, a task event is any period during which one or more activities were occurring continuously. A task event represents a working situation versus a no-work period. The results are presented in three elements; the number of task events per hour, the average duration of the task event, and the percentage of utilization of the specialist; i.e., the ratio of working time to total time available.

Table 9 describes the activity levels for the flight data and in-flight positions in terms of task events.

TABLE 9. AVERAGE HOURLY TASK EVENTS

FACILITY	SHIFT SCHEDULES		
	Day	Evening	Midnight
Flight Data Position			
EED	4.4	1.0	1.2
ELY	4.1	2.1	--
TPH	3.4	1.7	1.2
LAS	17.6	8.2	2.6
In-Flight Position			
EED	13.8	6.6	2.6
ELY	11.1	6.6	--
TPH	13.6	6.8	3.6
LAS	20.6	6.2	2.4

The figures indicate the flight data position is more active at LAS FSS than the other facilities. The primary reason is the large volume of military activity generated by Nellis AFB. In contrast, the other facilities experienced only limited military activity.

Of the four facilities, only LAS assigns a specialist full time to the flight data position. Specialists at the remaining facilities share this activity with other duties. In addition, during daylight hours LAS FSS has an individual dedicated solely to teletype. This position is staffed by other than an air traffic control specialist (ATCS). This position and associated work activity were not included in any sample to keep data consistent across facilities. The findings indicate that the flight data workload distributed across several facilities may be serviced with the existing staff at LAS during evening and midnight periods. During daylight periods LAS should handle the combined operation without a change in existing staffing except for periods when the peak hours of several facilities happen to coincide. Analysis of the peak hour activity (table 10) indicates highest utilization figures during the evening period when large numbers of flight plans are handled in a short time period. This type of activity could be distributed over several hours because it is not time critical.

TABLE 10. PEAK HOUR OBSERVED UTILIZATION

Flight Data Position

FACILITY	SHIFT SCHEDULE		
	Day	Evening	Midnight
EED	.23	.03	.05
ELY	.23	.04	—
TPH	.19	.04	.04
LAS	.54	.90	.09

$$\text{utilization} = \frac{\text{No. of task events x avg. duration per event (min)}}{\text{No. of specialists available x 60 (min)}}$$

In situations approaching peak utilization an additional specialist would be required. In a consolidated facility additional staff would be available to meet these varying demand situations.

Comparing the in-flight position across facilities demonstrates a reasonable distribution of workload. Although LAS does exhibit a somewhat larger increase in task events than the other facilities during daylight hours, the average number of task events per hour is similar. To evaluate the potential service capacity of an in-flight specialist, the peak hour utilization figures were computed for each of the facilities. Table 11 demonstrates the demand which may be placed on a consolidated facility if peak hours were to coincide.

TABLE 11. PEAK HOUR OBSERVED UTILIZATION

In-Flight Position

FACILITY	SHIFT SCHEDULE		
	Day	Evening	Midnight
EED	.76	.40	.26
ELY	.63	.15	—
TPH	.54	.09	.07
LAS	.52	.15	.11

$$\text{utilization} = \frac{\text{No. of task events x avg. duration (min)}}{\text{No. of specialists available x 60 (min)}}$$

The results in table 11 indicate that for brief high demand periods the single specialists on duty with many collateral duties may indeed be busier than a specialist dedicated solely to the in-flight position of the LAS FSS. However, considering the relatively low peak-hour evening and night figures, it is reasonable to expect the single specialist at LAS to handle the current demand. During daylight hours two specialists would be required to handle the in-flight activity for a consolidated facility.

In summary, based on timings and task event analysis it appears that one specialist at the LAS FSS could handle flight data activities for a consolidated facility except during unusually busy periods when a second specialist would be required. Similarly, the consolidated in-flight operation may be handled during evening and night hours with a single specialist. During daylight hours, two specialists would be required. Finally, based on queuing analysis the preflight position, with current available staffing, should provide improved service in terms of reduced waiting times and chance of a busy system. Further manpower, freed by this change in assignments, may be more effectively utilized to meet changing demand situations.

SECTORIZATION

Pilot briefing data for the most active and least active observed days of data collection were plotted (figures 2 and 3). On both days, a heavy concentration of flights to southern California was noted. The Los Angeles basin was the area for which most pilots requested briefings from LAS FSS. Blending this pilot briefing activity with the concept of sectorization, then a possible approach to sectorization in the Las Vegas area along the 36° latitude and 114° longitude could provide both a practical and an equitable distribution of workload (figure 4).

A three-sector configuration could thus be considered along the following lines: an eastern sector covering the largest geographical area with predominately long-range briefings (36 percent of workload), a more centralized northwest sector covering the area from central California to Idaho and, Las Vegas local briefings (30 percent of workload), and finally, a very specialized southwest sector covering flights primarily to the Los Angeles basin (34 percent of workload).

All specialists in the facility would be checked out in one of the three sectors prior to working the preflight position. These specialists would, during busy periods, answer calls incoming to other positions (as they do now) but, if free, they would be the first line of service to calls within their sector. They would thus become experts within their primary area, familiar with special flying problems and anomalies typical of their geographic region.

During slower periods, this three-sector configuration can be reduced to two, eliminating the northwest sector, with the eastern sector absorbing the Las Vegas local briefing workload and the southwest sector taking the long-distance calls. In effect, this would result in an eastern and western sector configuration divided along the 114° longitudinal axis.

Another possible benefit of a sectorized FSS may be realized in reduced training time prior to checkout at the preflight position. This would be achieved by reducing the volume of information a specialist would need to know prior to becoming operational at a briefing position. Additionally, it would be logical to initially check out specialists in areas wherein their major experience lies; namely, the EED specialists on the Southwest Sector (where Needles is presently located) and the TPH and ELY specialists on the Northwest Sector (sector encompassing these facilities).

In summary, if sectorization is to be considered, then the degree of consolidation will influence the necessity and extent of sectorization; specifically, the larger the geographic area of consolidation, the greater the need to consider sectorization. For example, specialists at LAS FSS in fact already operationally brief to areas far in excess of specialists at ELY, TPH, or EED FSS's. Therefore, sectorization is not considered necessary, considering the limited scope of the consolidation effort discussed here. The benefits of sectorization may become more evident with large-scale FSS consolidation encompassing several states. Thus, the fewer the eventual number of FSS's, the greater the potential benefits in utilizing the concept of sectorization in reduced training time, greater in-depth knowledge of the area, and increased fluency in providing weather services.

For further information regarding the work involved, the NAFEC Program Manager, Hugh Milligan, may be contacted at (609) 641-8200, extension 3385, or FTS 346-3385.

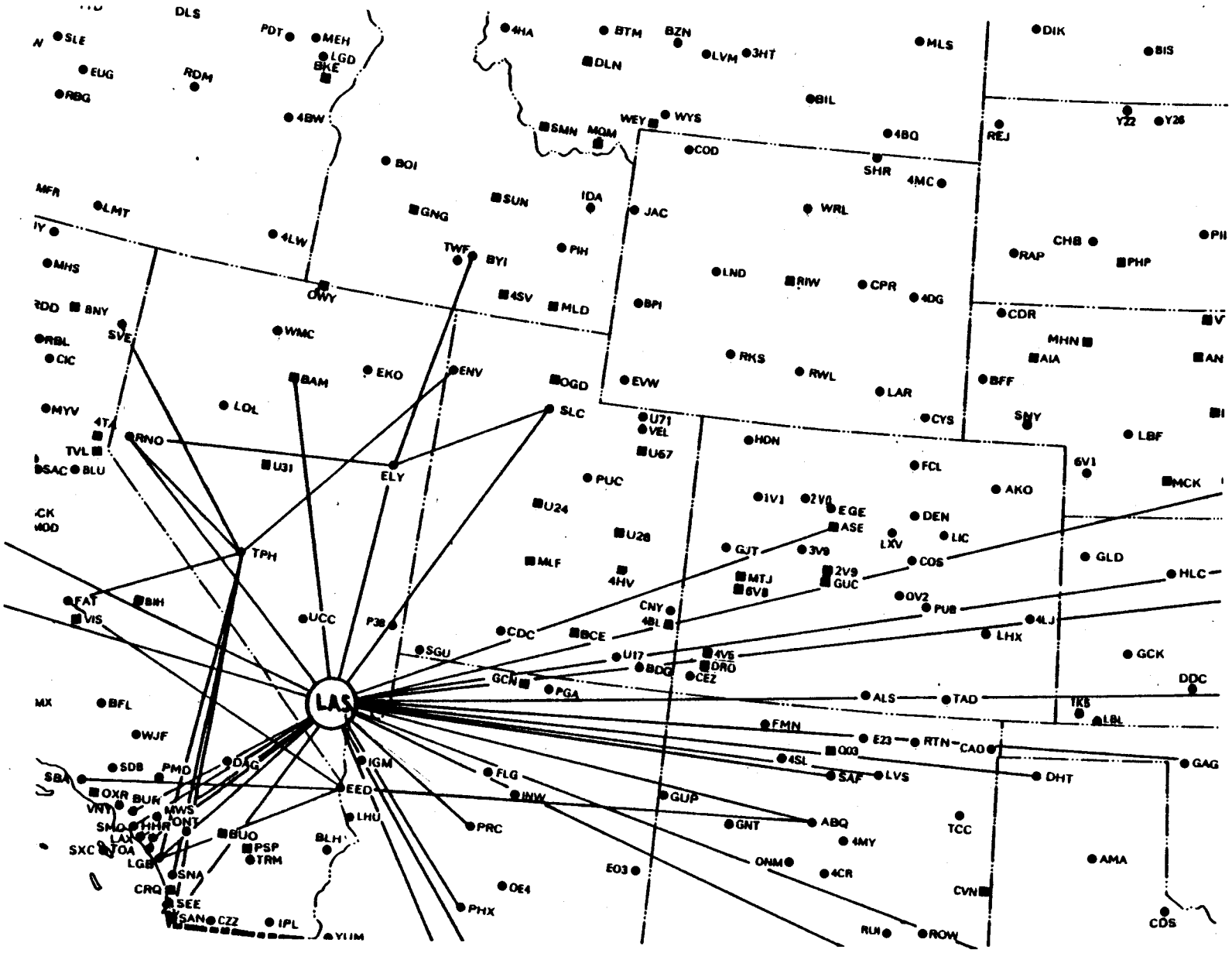

FIGURE 2. REPRESENTATIVE PLOT OF BRIEFING REQUESTS BY FACILITIES - LAS VEGAS (LAS), TONOPAH (TPH), ELY (ELY), AND NEEDLES (EED) - LEAST ACTIVE OBSERVED DAY (7/27/77)

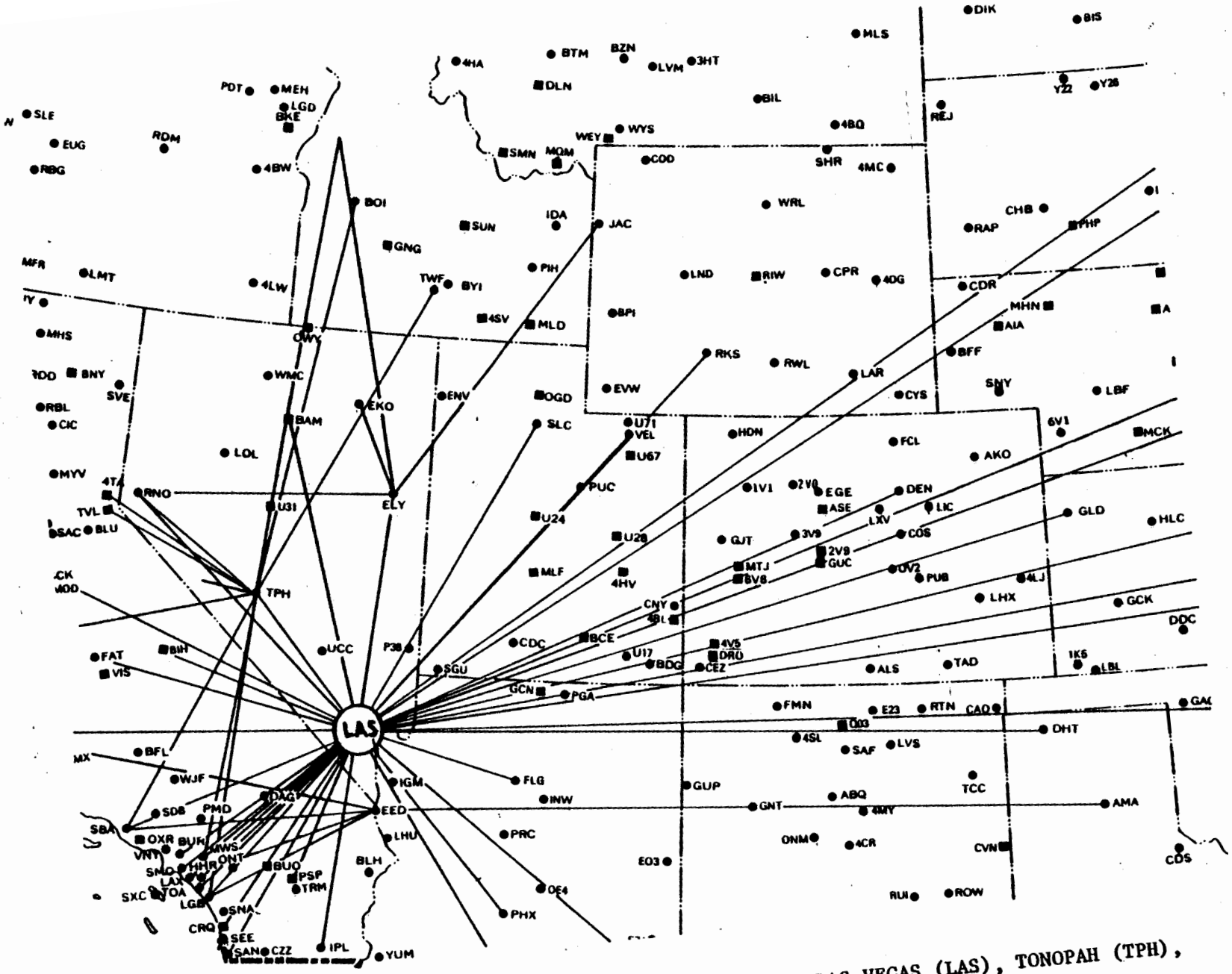

FIGURE 3. REPRESENTATIVE PLOT OF BRIEFING REQUESTS BY FACILITIES - LAS VEGAS (LAS), TONOPAH (TPH), ELY (ELY), AND NEEDLES (EED) - MOST ACTIVE OBSERVED DAY (8/4/77)

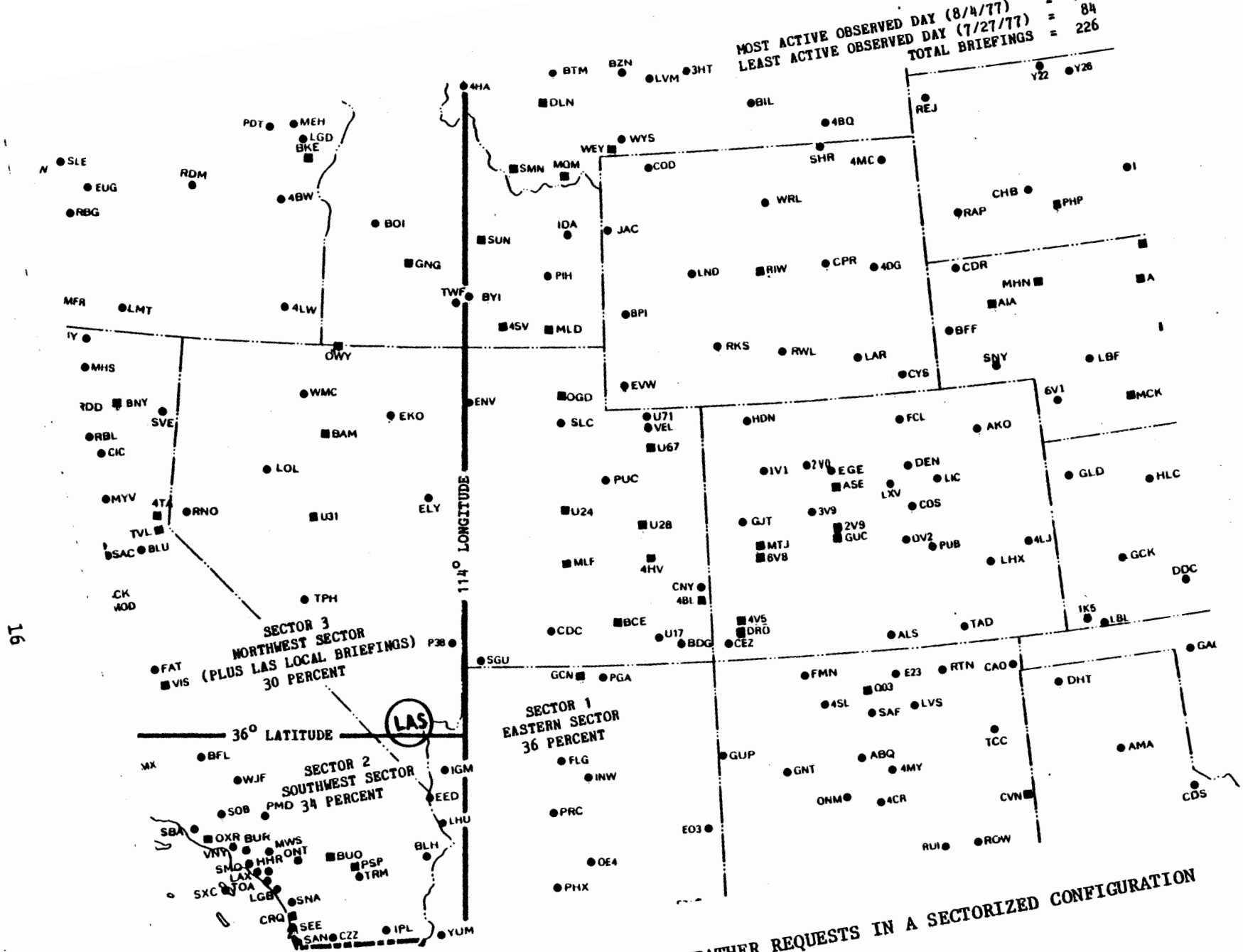

FIGURE 4. PERCENTAGE DISTRIBUTION OF PREFLIGHT WEATHER REQUESTS IN A SECTORIZED CONFIGURATION

CONCLUSIONS

1. LAS FSS is providing more service per specialist than either EED, ELY, or TPH Flight Service Stations.

2. With incoming calls randomly distributed, consolidation should yield an increase in preflight capacity.

3. Consolidated flight data workload may be handled with a single specialist except during brief active periods in which a second specialist would be required.

4. During daylight hours two inflight specialist would be required at a consolidated facility. For the remaining hours activity could be handled with a single specialist.

5. Considering the limited scope of consolidation envisioned and the fact that LAS FSS preflight specialists currently provide service to a larger geographic area than the other facilities, sectorization of preflight activity is not considered beneficial.

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