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STUDY OF NOISE IN AIR ROUTE TRAFFIC CONTROL CENTER, FLIGHT SERVICE STATION, AIR TRAFFIC CONTROL TOWER, AND REMOTE FACILITIES

IIT RESEARCH INSTITUTE

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STUDY OF NOISE IN AIR ROUTE TRAFFIC CONTROL CENTER, FLIGHT SERVICE STATION, AIR TRAFFIC CONTROL TOWER AND REMOTE FACILITIES

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16. Abstract

This report describes various methods of reducing noise in several FAA Air Traffic Control and Navigational Facilities that exceed the facility noise criteria recommended in a previous report. Noise control procedures for each facility under consideration are described as well as the reasons for selecting specific noise reduction methods.

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STUDY OF NOISE IN AIR ROUTE TRAFFIC CONTROL CENTER (ARTCC), FLIGHT SERVICE STATION (FSS), AIR TRAFFIC CONTROL TOWER (ATCT) AND REMOTE FACILITIES

1. INTRODUCTION

This report describes the results of a study to recommend noise reduction techniques for implementation in several Federal Aviation Administration (FAA) facilities. In an interim report* to the FAA, noise criteria were established for a wide range of facilities in which the criteria were based on the single number dBA scale. For most FAA facilities it was found that the measured noise levels met the criteria. However, certain areas had noise levels in excess of the criteria. The purpose of this report is to consider the techniques of noise control as a means of reducing the excess noise levels. Specifically, those facilities where noise reduction is required include:

- Air Traffic Controller Rooms
- Auxiliary Power Generators
- Remote Facilities (VORTAC's)
- Operational Rooms (noisy equipment, e.g., printers)

The noise criteria for each facility were based on permissible noise levels (in dBA) that allow FAA personnel to perform their work tasks without undue hearing loss, interference, discomfort or annoyance. The methods of noise control are discussed for those facilities or areas where noise suppression is required.

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* Semmelink, A. and Clinch, J. M., "Noise Standard Report - Study of Noise in Air Route Traffic Control Center (ARTCC), Flight Service Station (FSS), Air Traffic Control Tower (ATCT) and Remote Facilities," Report FAA-RD-72-47, IIT Research Institute, December 13, 1971.

2. TECHNICAL DISCUSSION

2.1 Background

The noise criteria that have been developed for the FAA facilities involved a combination of empirical field evaluations (noise surveys, interviews, etc.) and the use of existing data for reliable voice communication in the presence of noise. The environmental noise may consist of voice interference, communication and equipment noise whose levels depend on the type of facility, location and mode of operations. Classification of the sites is by type:

- Air Route Traffic Control Center
- Flight Service Station
- Air Traffic Control Tower
- Remote Facilities

Further categorization of component areas was made to distinguish between job categories such as administrative, maintenance and operations. Areas were also divided into two categories: critical and noncritical areas. A critical area such as, for example, an air traffic control room would necessitate certain minimum noise levels for satisfactory mission achievement, while noncritical areas, such as general maintenance, have less critical requirements.

The sites investigated with the exception of the Oberlin, Ohio, ARTCC were all located in the Chicago area (Tables I and II). The noise criteria for each site (see appendix) show the measured and maximum acceptable level for a given area or location within the site. It may be seen that, in most cases, the measured noise levels are in compliance with the specified noise criteria. Consequently, the technical discussion is limited to those areas which indicate noise levels in excess of the established criteria.

Table I

SITES AND COMPONENT AREAS SURVEYED

1. Air Route Traffic Control Center
   a. Administration Wing
      Offices; Training Room; Conference Room
   b. Operations and Automation Wing
      Controller Area; Computer Area; Equipment Area; Medical Clinic
   c. Cafeteria
   d. Engine Generator Building

2. Flight Service Station
   a. Offices
   b. Operations Area
   c. Equipment Area

3. Air Traffic Control Tower
   a. Administration Area
      Offices; Training Room; Conference Room
   b. Operations Area
      Cab; Terminal Radar Approach Control Room
   c. Equipment Area

4. Remote Facilities
   a. Remote Transmitter/Receiver (RT/R)
   b. Remote Center Air/Ground (RCAG)
   c. VHF Omnirange with Tactical Air Navigation (VORTAC)
   d. VHF Omnirange (VOR)
   e. Instrument Landing System (ILS)
   f. Airport Surveillance Radar (ASR)
   g. Air Route Surveillance (ARSR)
   h. Automatic Data Interchange System (ADIS) (BDIS)
   i. Engine-Generator
   j. Microwave Link Repeater (RML)

Table II

SITES SURVEYED AND THEIR LOCATION

Facility	Location
ARTCC	Aurora, Illinois
FSS	DuPage Airport, Illinois
ATCT	O'Hare Intl. Airport, Chicago
	Midway Airport, Chicago
	Meigs Field, Chicago
	DuPage Airport, Illinois
Remote Facilities:	
RT/R	O'Hare Intl. Airport, Chicago
	DuPage Airport, Illinois
RCAG	O'Hare Intl. Airport, Chicago
VORTAC	O'Hare Intl. Airport, Chicago
	Joliet, Illinois
VOR	Libertyville, Illinois
ILS	O'Hare Intl. Airport, Chicago
	Midway Airport, Chicago
ASR	O'Hare Intl. Airport, Chicago
	Midway Airport, Chicago
ARSR	McCook, Illinois
ADIS/BDIS	DuPage, Illinois
Engine Generator	All Remote Stations. Largest in area is 550 KVA at Aurora, Illinois
RML	LaGrange, Illinois

2.2 Facilities/Areas for Noise Control Implementation

2.2.1 ARTCC Controllers Room

The ARTCC controllers room being a critical area has been shown in the noise standard report by IITRI to be subject to higher noise levels than the criteria demand.

It was determined that although equipment noise contributed to the overall noise, the major source of interference with communications activity, as measured by the frequency of message repeats and difficulty in handling traffic load, was voice interference from adjacent operators. Controllers independently coped with this problem through the selective use of speakers and headsets in various combinations as a function of work load and noise level. During busy traffic periods headsets were elected in preference to speakers as a means of individual noise control.

Noise data taken in the controllers room at Aurora were obtained prior to any "soundproofing" of the room and equipment. A visit to the Oberlin ARTCC, which had been architecturally modified for maximum comfort and noise control, was arranged with a view to determine whether the environmental noise was reduced below the Aurora levels. The controllers room at Oberlin has a similar layout to the Aurora center thus comparison between the noise levels at the two facilities was considered valid.

In contrast to the Aurora site, the walls of the Oberlin controllers room were lined with 3-in.-thick Acoustic Wood Fibered insulation panels. The ceiling was also dropped about 2 ft to facilitate the panels. The equipment consoles were modified to accommodate a closed plenum chamber behind each row of consoles to improve the cooling characteristics of the room and equipment. All individual cooling fans were removed from the console equipment and precooled air is passed from ceiling air vents in the room. This rework was undertaken to provide not only a more comfortable environment but to cool the equipment racks by the passage of air through openings in the base of the consoles into the plenums. The plenums were equipped with an overhead ducting system to exhaust heated air from the room. The floors of the room were fully-carpeted with short pile Acrylan carpet for comfort and noise suppression.

Measurements of the noise levels (in dBA) in the Oberlin control room are compared with the unmodified Aurora site. Because noise data were not available for the Oberlin site prior to soundproofing, comparisons between the Aurora and Oberlin control rooms should only serve as a guideline. These data are shown for comparison purposes in Table III.

Table III

CONTROLLERS SECTION ARTCC (AURORA AND OBERLIN)
COMPARISON OF NOISE LEVELS
AT SIMILAR POSITIONS IN CONTROL ROOM

Position	Aurora dBA	Oberlin dBA
1	67-79	64-72
2	66-75	68-74
3	62-71	68-73
4	64-71	66-72
5	66-76	64-74
6	68-73	63-71

Interviews with Oberlin controllers indicated that the room was less noisy due to the soundproofing. However the above noise data suggest that there was little difference in noise levels between the Aurora and Oberlin control rooms. The phrase a "calmer atmosphere" was the majority opinion at Oberlin which suggests a psychological benefit. However, the observer noted there was less noise reverberation in the Oberlin controller work areas, than at Aurora possibly because the carpet tended to muffle speech from opposite consoles across the aisles. It appears that the use of carpeting attenuates sound incident on the floor area. However, direct airborne sound is unaffected by the carpet. Other modifications such as paneling the room walls and ceiling with acoustic tiles was felt to be too remote from the major noise sources, e.g., speakers and communication areas, to affect the noise levels at the operator stations. No sound insulation had been applied to the consoles at Oberlin or no attempt was made to regulate the speaker volume to an acceptable level for receiving communications.

The upper limits of the noise levels in the controller rooms mainly arise from the loudspeakers, raised voices and teleprinters (intermittent). The ambient levels without these noise sources is generally between 64 to 68 dBA, the lower limit being an acceptable value defined in the noise criteria. One solution to the speech interference from adjacent operator stations would be to install acoustic booths or wall partitions between each sector to absorb the direct path sound. Unfortunately this would be impractical due to the nature of air traffic operations because each controller requires not only person-to-person communication but also physical mobility between adjacent sectors. Thus a "booth type" partition would be an undesirable countermeasure for noise control.

Several alternative methods of noise reduction may, however, be feasible. First, a reduction in reverberation noise by soundproofing the face of the consoles with suitable sound absorbing material. Second, the use of specially designed speaker enclosures for controllers. These countermeasures are discussed in the recommendations (Section 3).

2.3 Auxiliary Power Generators

Each FAA facility and remote station has its own independent power generator which can be used in the event of an emergency (e.g., power failure). Field surveys at the generator sites listed in the noise standard report indicated that the noise levels exceeded the 90 dBA limit for an 8 hour exposure given in the Walsh-Healey criteria. Table IV shows the Walsh-Healey regulation for permissible noise exposure* criteria.

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* When the daily noise exposure is composed of two or more periods of exposure to different noise levels, their combined effect is accumulative. If the sum of the fractions,

$$\frac{C_1}{T_1} + \frac{C_2}{T_2} + \ldots. + \frac{C_n}{T_n}$$

exceeds unity, then the mixed exposure should be considered to exceed the limit value. C indicates the total time of exposure at a specified noise level and T is the total time of exposure permitted at that level.

Table IV

WALSH-HEALEY NOISE CRITERIA

Duration Per Day Hours	Sound Level dBA	Duration Per Day Hours	Sound Level dBA
8	90	1 1/2	102
6	92	1	105
4	95	1/2	110
3	97	1/4 or less	115
2	100		

A permissible average level for an 8 hour exposure would be 80 dBA as defined in the noise standard report. However, since each generator is exercised only about 1 hour per month, it would seem that only in the event of a prolonged power shutdown would the generators be required to supply electricity to the facility. Exposure of generator noise to personnel inside the generator building and from the intake and exhaust duct outside the building also need to be considered for generator usage over a prolonged period.

While methods are available for soundproofing engine generators by constructing special enclosures and lining the intake and exhaust ducts with insulation material such a countermeasure is obviously uneconomical for application since they operate only on a standby basis. A more practical solution for noise reduction would be for operating and maintenance personnel to wear ear protectors during the engine running time. It is recommended that wearing fitted earplugs be made mandatory for FAA personnel exposed to generator noise. Special earplugs that permit the wearers to communicate in the presence of high noise levels are available for this purpose (see Section 3).

2.4 Noisy Equipment

The noise data obtained from field surveys on this program indicated that noisy equipment such as teleprinters, speakers and office typewriters were, in most cases, in excess of the established noise criteria.

2.4.1 Teleprinters

Being of an intermittent nature the use of printers in ATC areas and the FSS's does not represent a continuous noise exposure problem. Measurements at the FSS's at DuPage Airport, Illinois showed that in proximity to the teletype machines (with closed covers) the noise levels exceeded the criteria by as much as 10 dBA. Reduction of noise in the pilot briefing room, for example, may be possible by moving the teletype equipment rack further away from the communications area. The use of mobile wall partitions to act as a sound barrier between the noisy equipment and communication areas could also reduce the noise exposure levels. However, should this be impractical due to operational procedures, as indicated from interviewing the maintenance engineer at DuPage Airport, an alternative would be to isolate the noise by designing sound insulation covers for the teletype machines.

A plexiglas front cover for reading the output type encased in an aluminum frame containing styrofoam packing inside the frame and the machine mounted on felt pads might be one solution. In this way, the printer impact and tracking noise would be attenuated by the cover and the vibration-induced noise from the table support reduced by the felt pads. The extent of the noise reduction to be expected from such a countermeasure cannot be determined prior to installation. However, it is felt that a meaningful noise reduction would be obtainable.

2.4.2 Speakers and Headsets

It has been found that the major source of interference with communication activity in air traffic control areas as measured by frequency of repeated messages and reports of difficulty in handling traffic loads were intrusions of other operators voices. Under these conditions controllers elect their own method of noise control through the use of speakers and headsets. During low air traffic density periods, the speakers provided the prime means of monitoring communications. However, during busy periods the voice interference problems caused operators to switch to headsets since they provided a less distracting and more reliable means of communication.

Although the noise criteria for ATCT and ARTCC controller areas recommended in the noise standard report will provide an environment in which reliable communications can be achieved, alternative solutions regarding a reduction in voice interference and speaker communications may be more desirable. Future designs can be employed which will provide control over the voice interference by adjacent operators or provide control facilities which require fewer person-to-person messages or which may be conducted over shorter distances. This latter control would permit voice communication at much reduced volume and thereby reduced noise level. The disadvantage of this procedure is that although adjacent messages may not interfere with a controller's ability to hear his respondent, the information may become integrated with meaningful messages. This can either lead to incorrect recall or a decrease in the ability to recall information. This effect has not been demonstrated empirically in the field but has been repeatedly confirmed in the laboratory.

In most ATC areas the most annoying speakers to controllers are those where a disquieting "squeal" or tonal noise is present in the broadcast message. Elimination of this annoyance would therefore be a desirable feature. Differences in speaker volume between various transmitting centers also produce an interference problem to controllers. Consequently, regulation of the speaker volume to a level that is less annoying to controllers while still permitting messages to be understood would be a recommended countermeasure for noise control.

In ARTCC controller rooms, the speakers are generally located beneath the overhead panels of the consoles near the radarscope operator. The sound energy radiated from the speakers is transmitted in all directions. The use of acoustic absorbing materials for lining the exposed metal surfaces of the consoles will tend to absorb sound waves reflected from these surfaces. On the other hand, the use of individual acoustic booths or partitions to reduce the transmission and reverberation has been ruled out on the grounds of practical considerations. However, the design of a chair or chair-console combination where a controller is positioned to receive and transmit information via speakers and microphones integrated into the chair frame, while permitting the required mobility, should be considered.

Noise cancelling features for both transmission and receiving may be incorporated into the chair by delaying one signal with respect to the other. This has been shown to increase the perceived signal-to-noise ratio without changing the signal intensities. For example, noise cancellation may be possible by having two speakers integrated into the chair close to the controller's ear and delaying the input signal to one speaker by 180 deg with respect to the other. Such a system using ear level chair speakers has been demonstrated by the FAA* for pilot use in small aircraft.

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* Tobias, J. V., "Auditory Processing for Speech Intelligibility Improvement," Aerospace Medicine, p 728, July 1970.

2.4.3 Office Machines

Office machines such as typewriters, telephones, etc., do not represent a critical noise problem, although isolation of such equipment would be an advantage. Office spaces provided with mobile wall partitions to isolate such machine noise from outside personnel could be one method of noise control. However, the practice of placing typewriters on felt pads should be a standard procedure. The structure supporting a typewriter is often a lightweight flexible table which when excited into vibration by typewriter motion can efficiently radiate noise into the office space. A definite reduction in noise level should be obtained, particularly at lower frequencies (less than 1000 Hz), if several felt pads are placed under the metal feet of a typewriter supported by a typical office table.

3. CONCLUSIONS AND RECOMMENDATIONS

The results of noise surveys of the various FAA facilities described in the previous noise standard report were used to determine whether the environmental noise level interfered with work activity, the type of noise associated with interference and the acceptable noise levels for the nature of the work being performed by FAA personnel. In general, the measured noise levels for a given environment were found acceptable in that compliance with the recommended noise criteria was established. However, methods to reduce the noise in a given area where the measured noise level exceeds the criteria need to be considered. The procedures that are recommended to meet the noise level goals given in the criteria in the case of excessive noise are discussed below. The noise criteria are listed in the appendix.

3.1 ARTCC Controller Rooms

The rework modifications that have been carried out at the Oberlin ARTCC control room were found satisfactory because the Oberlin controllers found the working environment more pleasant and "less noisy". Comparison with the unmodified Aurora center control room noise levels was not significant since no noise data were available prior to the soundproofing at Oberlin. Consequently, the type of soundproofing (walls and floors) that has been undertaken at Oberlin is a recommended countermeasure.

3.1.1 Headsets

The use of headsets by controllers as a means of individual noise reduction is recommended during busy air traffic periods. This permits the controller to reduce the background noise and eliminate the speech interference problem arising from other communications in the control room. One lightweight headset that reduces the background noise all the time (between pauses and when the user is speaking) is the Venture I headset manufactured by Northern Electric. This headset employs a small transmitter housed in a noise cancelling enclosure instead of a conventional voice activated switch and thereby increases the signal-to-noise ratio by reducing the background noise. In this way the annoyance of repeats missed because of background noise interference is eliminated. The cost of the headset depends on the quantity and the extension cord length required for air traffic operations.

3.1.2 Carpeting

The use of low pile carpet of the type used at the Oberlin center in the aisles and walkways between consoles, which tends to muffle sound emanating from opposite sectors, is recommended.

3.1.3 Acoustic Liners (Consoles)

All exposed metal surfaces on the control room consoles should be coated with special sound insulation liners. A foam insulation material (Blachford Acoustic Liner 50) having a beige colored perforated surface fabric in front of the foam rubber and a pressure sensitive adhesive for affixing it to metal surfaces is available for this purpose. The 0.5-in.-thick foam of the liner attenuates the middle to upper frequencies (1000 to 5000 Hz) in the speech frequency range by sound absorption. Thus sound arising from communication noise sources and normally reflected from the hard surfaces of the consoles can be suppressed by the application of these acoustic liners. Table V lists the approximate cost per sq ft of material.

Table V

COST VERSUS AREA FOR RECOMMENDED ACOUSTIC LINING MATERIAL

Area ft^2	Cost per ft^2
Under 200	$1.16
225 - 500	1.02
525 - 2000	0.80
2025 - 5000	0.75

3.2 Power Generators

As discussed in Section 2, the use of custom fitted molded earplugs by FAA personnel working near a generator in operation should be made mandatory.

3.2.1 Earplugs

A wide variety of earplugs are available commercially to seal the ear passage from undesirable generator noise. A recent review* of the effectiveness of earplugs indicates most earplugs will attenuate noise by an average of 30 dB. Consequently almost all earplugs have excellent attenuation characteristics if the earplug is properly fitted and well sealed in the users ear passage. However, wearability factors such as ease of insertion and removal durability, ease of cleaning and comfort are of prime importance in selecting an earplug. For this reason it is recommended that Peacekeeper earplugs manufactured by General Electric which can be individually custom fitted to a users ear canal be employed by the FAA.

Fitting the Peacekeeper is fast, easy and comfortable. The ear canal is cleaned and examined. A nontoxic, nonallergenic silicone rubber mold is shaped to a tapered cone and inserted into the ear canal. The mold takes about 15 minutes to set while the person being fitted is requested not to move his jaw for the setting period. For easy insertion and removal, handles are inserted on the outer surface with special color codes for each ear. The mold is then dipped into a finish coating, covering over pore and hair marks. The whole process takes about 20 minutes for each person being fitted.

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* Flugrath, J. M., et al., "The Effectiveness of Earplugs" Sound and Vibration, May 1972.

The Peacekeeper ear protector gives an attenuation of 30 dB in the frequency range of 250 to 2000 Hz with further reduction at higher frequencies. This attenuation permits the wearer to receive verbal messages and the ability to communicate in a high noise environment. The Peacekeeper earplugs are presently being used by workers in industry and government in work areas that are exposed to high noise levels in order to comply with the Walsh-Healey laws.

In addition to personnel in power generator facilities, it is recommended that maintenance personnel working in other high noise areas such as air conditioning plant facilities (e.g., near the absorption machines at Aurora ARTCC) be made to wear these earplugs to minimize the possibility of hearing loss. Typically, the cost of a pair of Peacekeeper earplugs, depending on the quantity required, varies from $4.00 to $6.00.

3.3 VOR/VORTAC Facilities

The noise measured in the equipment rooms of the VORTAC sites at O'Hare Airport, Joliet and Libertyville exceeded the maximum permissible level of 75 dBA by about 3 dBA. A more serious problem was in the Libertyville VOR equipment room, where noise levels of 80 dBA were measured in front of the RTB-2 equipment. This excessive noise originated from the blowers supplying cooling air to Klystron tubes in the equipment cabinet. It has been suggested in an internal FAA report* that by reducing the fan blower speeds cooling the Klystron tubes and cabinet a marked noise reduction is obtainable. However, this can have an adverse effect on the life of the Klystron since considerable heat is generated in the anode and the sufficient cooling air is required to dissipate this heat. Otherwise the effect of reduced cooling will be to elevate the operating temperatures.

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* Story, P. H., "Report on Reducing the Noise Level at a VORTAC," FAA Albuquerque, New Mexico, March 1970.

The above suggestion of reducing the fan blower speeds and thereby reduce the noise levels seems satisfactory provided the decreased airflow supply does not result in elevating the Klystron temperature to a point which causes eventual equipment failure or malfunction. In the above-mentioned study it was reported that by reducing the Klystron blower speed in the RTB-2 equipment by 50 percent (3600 to 1800 rpm) and reducing the cabinet blower speed from 1800 to 1200 rpm, the noise levels decreased from 86 to 74 dBA. Other measurements before and after the fan speed modifications in the above VORTAC equipment area indicated noise reductions ranging from 7 to 10 dBA depending on whether the receiver-transmitter or power supply cabinet doors were opened or closed.

In the present series of noise measurements at the Illinois VORTAC sites the worst case was at the RTB-2 Ground Beacon at Libertyville where 5 dBA was the minimum noise reduction necessary to comply with the recommended noise criteria. It is suggested therefore that the blower controlling the Klystron tube cooling be modified or replaced to reduce its speed by about 33 percent instead of the 50 percent reduction originally specified in the above-mentioned FAA report.

Fan noise is related to many variables such as type of fan (centrifugal, propeller, etc.) number of blades, blade size, etc., as well as the blade frequency and speed.

For axial flow fans, empirical results indicate that the sound intensity is approximately proportional to the sixth power of the fan speed.* We may then write

$$I \propto N^6$$

The sound intensity in dB is defined as

$$IL = 10 \log \frac{I}{I_o}$$

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* Priede, T., "Origins of Automotive Vehicle Noise," J. Sound and Vibration 15(1), 8 March 1971.

where I_o is a reference intensity equal to 10^{-12} watts/meter.
A change in intensity level (ΔIL) can be computed from the equation

$$\Delta IL = 1D \log \frac{I_2}{I_1}$$

where I_1 and I_2 are the two values of sound intensity.

Based on the sixth power sound intensity versus fan speed relationship, Table VI indicates the typical fan noise reductions. (The change in sound intensity level (ΔIL) is equivalent to the change in sound pressure level).

Table VI

TYPICAL FAN NOISE REDUCTIONS

Fan Speed, rpm (where N = Original Speed)	$\frac{I}{I_n}$	Noise Reduction, dB
0.9N	0.532	2.7
0.8N	0.262	5.8
0.75N	0.178	7.5
0.67N	0.0905	10.4
0.5N	$1.56 \times 1D^{-2}$	18
0.1N	10^{-6}	60

A 33 percent fan speed reduction, which is a reasonable change, would then lower the fan noise about 10 dB. Conservatively, such a speed reduction would produce at least a 6 dBA noise reduction and would comply with the noise standards for the VORTAC facilities.

In summary, it is recommended that modifications be made at VORTAC sites to lower the equipment cooling fan speeds by about 33 percent in order to reduce the noise levels by at least 6 dBA.

3.4 Noisy Equipment

Consideration of equipment noise mainly from teletype machines, computer printers and other office equipment reveals the necessity of having an enclosure around the machines. In most cases, as for example, teletype machines, the item is furnished with a protective cover. However, it is recommended that each machine be equipped with not only a cover to attenuate the printer impact and carriage tracking noise but also be supplied with a felt or rubber base pad for mounting the machine on the working surface. In this way, vibration-induced noise when the machine is operating will be reduced. The extent of the reduction is difficult to determine since the method of base mounting the machine on a pad will depend on the type of working surface and proximity of the operating personnel.

APPENDIX

RECOMMENDED NOISE CRITERIA FOR FAA FACILITIES

The table shown, reproduced from the noise standard report, summarizes the results obtained from noise surveys and indicates the recommended noise levels as a single number criteria in dBA for each facility, area and location. The noise criteria list the maximum acceptable (upper limit) and desirable levels (lower limit) within the range shown in the table. Measured values of the overall noise in dBA are listed in the right-hand column.

RECOMMENDED NOISE CRITERIA

Noise Criteria dBA		Measured
	O'HARE FIELD	
	ASR 7 New Radar	
80*	Inside Generator Room	106-107 dBA
	Outside Generator Room (Exhaust Side)	88 dBA
	ASR 4 Old Radar	
65-75	Center of Room	67 dBA
	Behind Equipment Rack	70 dBA
	End of Runway 14 R River Grove Localizer	
80*	Engine Generator Room	103 dBA
	Outside Engine Generator Room (Exhaust Side)	88 dBA
65-75	Localizer Equipment Room	75 dBA
	14 R ALS	
80*	Engine Generator Room	108 dBA
	Outside Engine Generator Room (Vent Fan Side)	88 dBA
	14 R Glide Slope Facility	
65-75	Center of Room	67 dBA
	Behind Equipment Racks (Vent Fans)	73 dBA
	Glide Slope	
80*	Inside Generator Room	104 dBA
	Outside Generator Room (Exhaust End)	94 dBA
65-75	Inside Equipment Room	70 dBA
	RT/R	
80*	Inside Generator Room	101 dBA
	Outside Generator Bldg (Exhaust End)	85 dBA
65-75	Center of Equipment Room	66 dBA
	Behind Equipment Racks	69 dBA

* Refers to upper limiting noise level for 8 hour exposure.

Noise Criteria dBA		Measured
	ATCT Cab	
50-60	Cab (Center)	62-66 dBA
80*	Generator Room Control Tower (Diesel Eng.)	100 dBA
65-75	Radar Room Below Cab	72-74 dBA
65-75	Mechanics Equipment Room (Basement)	74-83 dBA
	RCAG	
80*	Inside Generator Room	93 dBA
	Outside Generator Room	78 dBA
65-75	Center of Equipment Room	72 dBA
	Behind Equipment Racks	75 dBA
	VORTAC	
80*	Inside Generator Room	91 dBA
	Outside Generator Room (Generator Exhaust and Blower Noise)	77 dBA
65-75	Center of Room	78 dBA
	Behind Equipment Rack	74 dBA
	MIDWAY AIRPORT	
	South Terminal Bldg	
45-55	Manager's Office	47 dBA
45-55	Main Office	45-60 dBA
45-55	Asst. Mgr. Office	44-52 dBA
55-65	Outside Main Office (Hall)	65-80 dBA
	ATCT	
50-60	Cab (Center)	62 dBA
55-65	Stairwell Next to Ready Room	53-61 dBA
45-55	IFR Room	54 dBA
	(with Speech Intercom)	72 dBA
45-55	ATCT Chief's Office	48 dBA
45-55	Maintenance Supervisor's Office	53 dBA
55-65	Equipment Room	
	Bay 2, Rack B	67 dBA
	Video Mapper	62 dBA
	East Side of Room	55 dBA
	Between Back Side of Com. Air and Front Side of Radar	61 dBA

Noise Criteria dBA		Measured
	Localizer No. 1	
65-75	Center of Room	67 dBA
80*	Engine Generator Shed (Engine Running)	100 dBA
	ASR Site	
65-75	Building (Middle of Room)	76 dBA
	(with 3-Phase Blower Motor On)	83 dBA
	Engine Generator Shed (Engine Running)	93 dBA
	6 ft Outside Trailer Exhaust	74 dBA
	Outside Ambient	71 dBA
	Transmitter No. 2	
65-75	(Blower On)	77 dBA
	(Blower Off)	66 dBA
	Glide Path Building	
65-75	Operating	69 dBA
80*	Engine Generator Trailer (Engine Running)	98 dBA
	6 ft Outside Trailer Exhaust	77 dBA
	Outside in Front of Inlet	78 dBA
	Outside by Cooling Fan	86 dBA

ARTCC - AURORA

Basement

Noise Criteria dBA	Radar Room - Ext.	Measured
60-65	NRKM (Below A/C Duct)	69 dBA
	G-22 (Tape Transport)	66 dBA
	G-12	64 dBA
	G-13	64 dBA
	H-12	64 dBA
	H-13	64 dBA
	H-3	64 dBA
	G-3	64 dBA
	E-8	65 dBA
	F-8	65 dBA
	F-24	67 dBA
	D-13	64-65 dBA
	A-10	65-67 dBA
	B-10	65-67 dBA
	A-22 (Rear)	71 dBA
	A-21 (Rear)	71 dBA
	C-19	67 dBA
	C-18	67 dBA

Noise Criteria dBA		Measured
55-65	Supervisor's Desk	65 dBA
	First Floor	
	<u>Kitchen and Cafeteria</u> (rework underway)	
	Threshold of Serving Room (12 noon)	70-76 dBA
45-55	Cafeteria (11:45 - 12:00 noon)	64-80 dBA
	Cafeteria (Nominal)	70 dBA
	Cafeteria (Near Entrance)	70 dBA
	Outside Entrance to Cafeteria	54-70 dBA
	<u>Locker Room</u>	
55-65	Midsection of Locker Room (Intercom On)	74 dBA
	Midsection of Locker Room (Background Noise)	47 dBA
	Basement	
	<u>Telco Room</u>	
55-65	File 106-11 (Switching Gear)	61-69 dBA
	FB 107-1 (Beneath A/C Unit)	59-63 dBA
	104-11 (Clicking Area)	62-69 dBA
	101-10 (Ambient)	57 dBA
	101-10 (Clicking Area)	70 dBA
	103-11 (Ambient)	58 dBA
	103-11 (Clicking Area)	72 dBA
	001-3 (Behind Record Files)	66 dBA
	PBX	71-78 dBA
	<u>Electronic Equipment Room (Radar)</u>	
55-65	In Desk and Monitoring Area	69 dBA
65-75	In Remaining Areas:	
	CHI Scan Conversion No. 2 (rear) (Overhead Fan)	75 dBA
	LAG Scan Conversion No. 8 (rear) (No Overhead Fan)	72-75 dBA
	Horicon System (A/C On)	72 dBA
	Horicon System (A/C Off)	70 dBA
	OMA Scan Conversion (front)	73 dBA
	OMA - ARSR Radarscope	71 dBA
	Between WBR ARSR & WBR Scan Conv. (rear)	73-74 dBA
	HOR ARSR (front)	72 dBA
	Near Stairway No. 3	70 dBA

Noise Criteria dBA		Measured
	WBR RML (rear) (Under Air Handling Unit)	71 dBA
	HOR RML (rear) (Power Supply, High Frequency)	71 dBA
	Between LAG Beacon (front) LAG ARSR (front) (Fan Duct)	73 dBA
	<u>Air Conditioning Room</u>	
80*	Center of Room (near Absorption Machine)	83 dBA
	Remaining Area	81 dBA
65-75	At Work Station	75 dBA
	<u>Second Floor</u>	
40-45	Medical Room (212A)	47-52 dBA
45-55	Medical Asst. (carpet) (with typewriter)	66 dBA
45-55	Office (211A) (Blower On)	50 dBA
40-45	Personnel Office (211)	47 dBA
40-45	Defense Readiness (210) (4 people)	48 dBA
45-55	Defense Readiness (210) (with Typewriter)	66 DBA
40-45	ARTC Computer Tn'g (206)	45 dBA
45-55	Hallway Next to ARTC Comp. Tn'g	46 dBA
45-55	Hallway Next to ARTC Comp. Tn'g (Voices)	57 dBA
40-45	ARTC Radar Tn'g (202A)	46 dBA
40-45	ARTC Radar Tn'g and Manual Control Tn'g (202)	44 dBA (50 dBA Max)
45-55	Hallway Near Entrance to Room 202	50 dBA
40-45	Office (201)	47 dBA
45-55	Office (201) (Voices)	54 dBA
45-55	Classroom (201A)	45 dBA
45-55	Classroom (201A) (Voices)	58 dBA
45-55	Classroom (201A) (Typewriter)	70 dBA
40-45	Ready Room (203) (No Carpet)	47 dBA
40-45	Adjoining Room (No Carpet)	44 dBA
45-55	Adjoining Room (No Carpet) (Voices)	52 dBA
45-55	Corridor (Near Xerox Machine)	54 dBA
55-65	Corridor (Near Xerox) (Machine Operating)	68 dBA
45-55	Area Next to Stairwell	50 dBA
45-55	Area Next to Stairwell (Voices)	60 dBA
45-55	Stair No. 2	53-60 dBA

Noise Criteria dBA		Measured
45-55	Stairwell Landing (Stair No. 2)	53 dBA
45-55	Corridor to Observation Deck (215)	51 dBA
55-65	Corridor to Observation Deck (Voices)	66 dBA
55-65	Observation Deck (Open Partition)	71-73 dBA
55-65	Cartographer (216)	63-65 dBA
	Controllers Section (rework underway)	
55-65	Between B4 and C4	67 dBA
55-65	Between B18 and C18	67-70 dBA
55-65	Between B33 and C33	65-69 dBA
55-65	Between A33 and B33	62-71 dBA
55-65	Between A13 and B18	66-75 dBA
55-65	Between A4 and B4	67-79 dBA
55-65	Between C4 and D4	68-73 dBA
55-65	Between C18 and D18	66-76 dBA
55-65	Between C33 and D33	64-71 dBA
	Computer Section (rework underway)	
65-75	In Front of High Speed Printer (IBM 1403)	70-76 dBA
65-75	Computer Floor Control Console	66-78 dBA
80-85	IBM 1403 with Cover Open	90 dBA
65-75	IBM 7251 Storage Element	69 dBA
65-75	In Font of Four Teletype Machines	70 dBA
65-75	Between Two Rows of IBM 7289-II Peripheral Adapter Modules	70 dBA
	Generator Bldg.	
80*	Center of Room Between Two Engines Running Underload	108 dBA
	12 ft West Side of Bldg.	83 dBA
	12 ft South Side of Bldg.	74 dBA
	12 ft East Side of Bldg.	84 dBA
	ARSR - McCOOK RADAR SITE	
	Engine Generator Room	
80*	(Engine Running)	102 dBA
	(Exhaust Fan Background)	82 dBA
	Equipment Room	
65-75	Southwest Corner	71 dBA
	West Central	72 dBA
	Northwest	73 dBA

Noise Criteria dBA		Measured
	Southeast Corner	72 dBA
	Middle	72 dBA
	North (Blower Noise from Vent. in Corner)	74 dBA
	Blower Side of Relay Racks	76 dBA
	<u>North Room</u>	
55-65	Center of Room	63 dBA
	East Side	62 dBA
	West Side	59 dBA
	<u>Mobile Trailer</u>	
45-55	Office Space (Chief's)	62 dBA
	Near A/C Outlet	60 dBA
	East End of Trailer	54 dBA

FSS - DuPAGE AIRPORT

Noise Criteria dBA		Measured
	<u>Administration Bldg.</u>	
55-65	ADIS/BDIS Operations Room (Teletype Machines and H/L Connectors)	70-74 dBA
45-55	Pilot Briefing Room (Center of Rooms)	60 dBA
55-65	Pilot Briefing Room (Teletype Covers Open) (Front of TTY Mach.)	74 dBA
45-55	Pilot Briefing Room (Teletype Covers Closed) (Front of TTY Mach.)	68 dBA
	<u>ATCT</u>	
50-60	Cab	46-65 dBA
55-65	Communication Equipment Room (70 dBA due to Exhaust Fan)	66-70 dBA
45-55	Tower Chief's Office (Air Conditioning On)	51 dBA
	<u>Remote Transmitter Site</u>	
65-75	Remote Transmitter Site	74 dBA
	(Fan Vent in Operation)	83 dBA

Noise Criteria dBA		Measured
	RML SITE LaGRANGE (Microwave Link Repeater)	
55-65	Equipment Room	62 dBA
	(at Air Conditioner)	67 dBA
	(due to Loudspeaker)	80 dBA
80*	Generator Room	93 dBA
	Outside Generator Room (Exhaust Side)	78 dBA
	VORTAC SITE JOLIET	
65-75	Equipment Room (78 dBA caused by Cooling Blower in Equipment Racks)	74-78 dBA
80*	Inside Generator Room	93 dBA
	Outside Generator Room (Exhaust Side)	88 dBA
	VORTAC SITE LIBERYVILLE (Northbrook)	
65-75	Equipment Room Center of Room	76 dBA
	Near Two Racks (Noise caused by blower) (Rho-Theta Equip. Ground Beacon Model RT B-2)	80 dBA
80*	Generator Room	98 dBA
	Outside Generator Room	82 dBA

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