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Environmental Impact Analysis Process



REVISED DRAFT
ENVIRONMENTAL IMPACT STATEMENT
FLIGHT OPERATIONS IN THE SELLS AIRSPACE
OVERLYING THE TOHONO O'ODHAM INDIAN
RESERVATION & ORGAN PIPE CACTUS NATIONAL
MONUMENT SOUTHERN ARIZONA

DEPARTMENT OF THE AIR FORCE
TACTICAL AIR COMMAND

90 08 17 197



DEPARTMENT OF THE AIR FORCE

WASHINGTON, D.C. 20330 -1000

June 6, 1986

OFFICE OF THE ASSISTANT SECRETARY

TO: ALL INTERESTED GOVERNMENT AGENCIES, PUBLIC GROUPS, AND INDIVIDUALS

Attached for your review and comment is the Revised Draft Environmental Impact Statement (EIS) for Flight Operations in the Sells Airspace Overlying the Tohono O'Odham Indian Reservation and Organ Pipe Cactus National Monument in Southern Arizona.

This Revised Draft Environmental Impact Statement evaluates the impacts of supersonic flight operations in the Sells Military Operations Area/Air Traffic Control Assigned Airspace (ATCAA) as part of the review of the existing supersonic waiver to conduct supersonic flight operations below 30,000 feet mean sea level. This document also discusses current and future Air Force and Air National Guard aircrew training in the airspace over the Tohono O'Odham Indian Reservation and Organ Pipe Cactus National Monument in Southern Arizona.

There will be a sixty day review and public comment period for the Revised Draft EIS which ends on August 12, 1986. A public hearing will be scheduled in the near future. It will be held in the vicinity of the Sells Airspace during the public comment period. The exact time and place will be announced as soon as final arrangements are completed. Those agencies and individuals who desire to provide written comments may do so by submitting them to the U.S. Air Force by August 12, 1986. Written comments or questions on the Revised Draft EIS should be directed to:

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HQ TAC/DEEV
Langley AFB, VA 23665-5001
ATTN: Captain Ed Taylor
Telephone (804) 764-4430

Sincerely,

GARY D. VEST

Deputy for Environment, Safety and Occupational Health

Deputy Assistant Secretary of the Air Force
(Installations, Environment and Safety)

1 Attachment
Revised Draft EIS

COVER SHEET

A. Responsible Agency: United States Air Force

B. Action: Continued flight operations in the Sells Airspace overlying the Tohono O'Odham Indian Reservation and Organ Pipe Cactus National Monument, Southern Arizona.

C. Responsible Individual: Capt Edwin Taylor, HQ TAC/DEEV, Langley AFB, VA 23665, Telephone (804) 764-4430.

D. Designation: Revised Draft Environmental Impact Statement (RDEIS).

E. Abstract: This statement evaluates the impacts of supersonic flight operations in the Sells Military Operations Area (MOA)/Air Traffic Control Assigned Airspace (ATCAA) as part of the review of the existing supersonic waiver to conduct supersonic flight operations below 30,000 feet MSL.

This document also discusses current and future Air Force and Air National Guard (ANG) aircrew training in the airspace over the Tohono O'Odham Indian Reservation and Organ Pipe Cactus National Monument in Southern Arizona. Training conducted includes low altitude flights conducted at subsonic speeds along military training routes and in low altitude tactical navigation areas beneath the SELLS airspace, and high altitude flights conducted at subsonic and supersonic speeds. In calendar year 1985, 41,138 sorties were flown in and beneath the Sells Airspace. Of these, 18,903 were low altitude sorties and 22,235 were high altitude sorties, of which 5120 of the high altitude sorties may have included supersonic flight. By 1990, the sortie rates would increase to 46,700 sorties. Of these, about 24,000 would be low altitude sorties and 22,700 would be high altitude sorties of which 3953 may include supersonic flight.

The primary environmental concern of supersonic flight operations is the effects of sonic booms on human health and annoyance, wildlife, structures, cultural resources and recreational activities. It is projected that an individual underneath the airspace would hear an average of less than one boom per day, and would be unlikely to hear three or more booms per day. Sonic boom overpressures would range from 1 to 5 psf, with the average carpet boom being 2 to 3 psf. Infrequent focus booms could occur in the area.

Each environmental attribute was analyzed to a depth sufficient to determine if the potential impact would be significant. The local populace perceives significant impacts on lifestyle due to noise. No significant impacts were identified on socio-economics or health effects. The potential long term health effects of loud noise is a debatable issue, though some researchers believe there is a link between loud noise and ill-health. However, this is contrary to the consensus of the scientific community at this time.

F. Public Comment Period: Comment period on the Revised Draft EIS ends on 12 August 1986. Comments must be received by 12 August 1986. Notice of the hearing will appear in local newspapers.

G. DATE MADE AVAILABLE TO PUBLIC: JUN 6 1986

SUMMARY SHEET

1. Type of Statement: Revised Draft Environmental Impact Statement
2. Type of Action: Administrative

Continued flight operations in the Sells Airspace Overlying the Tohono O'odham Indian Reservation and Organ Pipe Cactus National Monument, Southern Arizona.

3. Description of Action: This statement evaluates the impacts of supersonic flight operations in the Sells Military Operations Area (MOA)/Air Traffic Control Assigned Airspace (ATCAA) as part of a review of the existing Air Force supersonic waiver to conduct supersonic flight operations below 30,000 feet MSL.

This statement also discusses current and future Air Force and Air National Guard (ANG) aircrew training in the airspace over the Tohono O'odham Indian Reservation and Organ Pipe Cactus National Monument in southern Arizona. Training in this airspace, is conducted primarily by Air Force and ANG units stationed at Luke AFB and Williams AFB near Phoenix, Arizona, and at Davis-Monthan AFB and Tucson International Airport near Tucson, Arizona. Other users of the airspace include ANG units from other states during winter months; USAF aircraft from Nellis AFB, Nevada, and Holloman AFB, New Mexico; and Navy and Marine Corps aircraft from Marine Corps Air Station (MCAS) Yuma, Arizona; MCAS El Toro, California; Naval Air Station Miramar, California, and various carriers of the Pacific Fleet. The airspace is regularly used for exercises that may be attended by participants from any unit or base in the United States.

Training conducted beneath the Sells Airspace includes low altitude flights conducted at subsonic speeds along military training route corridors and in low altitude tactical navigation areas. However, these low altitude training flights are approved by the Air Force after coordination with the FAA, other adjacent airfields and the state clearinghouses. While these routes must be evaluated for potential environmental impacts, they are approved as separate actions. Training in the Sells Airspace include low altitude flights conducted at subsonic speeds, and high altitude flights conducted at subsonic and supersonic speeds. In calendar year (CY) 1985, 41,138 sorties were flown by military aircraft in and beneath the Sells Airspace. Of these, 18,903 were low altitude sorties (including flights on MTRs and LATN areas) and 22,235 were high altitude sorties, of which 5120 were in the categories that may include supersonic flight. By 1990, the sortie rate is projected to increase to 46,702. Of these about 24,000 would be low altitude sorties, and 22,700 would be high altitude sorties of which 3953 may include supersonic flight.

4. Summary of Environmental Impacts: The environmental impacts are a result of the aircraft flying greater than the speed of sound, and flying low level at subsonic speeds. Currently, the Sells Airspace is used primarily by Air Force and Air National Guard units in southern Arizona for flight training at subsonic speeds, and supersonic speeds above 10,000 feet mean sea level (MSL) to 30,000 ft MSL and higher. The impacts are air pollutants, low level jet noise and sonic booms.

The Arizona State Department of Health Services has reported air quality within the Sells Airspace to be in compliance with federal and state ambient air quality standards with the exception of total suspended particulates (TSP), sulfur oxides and carbon monoxide. Calculations of aircraft contributed pollutants compared to observed pollutant loading indicate minimal impact from these operations. Air quality is not expected to change substantially due to projected increases in aircraft operations.

The primary impact of concern for local residents is the effects of low level training flights and sonic booms on people, domestic animals, wildlife, archaeological sites and structures. The subsonic noise impact beneath the Sells Airspace results primarily from low level training flights flown along Military Training Routes (MTRs) and in low altitude tactical navigation (LATN) areas. The number of sorties flown on MTRs in 1985 was 5323 sorties, about 22 per day. This is expected to increase to about 8900 sorties per year (about 40 per day) by 1990. The number of LATN sorties flown in 1985 was about 14,400 sorties, about 64 per flying day. This is projected to remain constant through 1990. This level of low altitude activity would produce no quantifiable change in day-night average sound level (DNL) for nearby communities due to designated avoidance areas around these communities.

The impact of subsonic noise would be greatest in those remote areas where several MTR segments coincide. A worst case estimate of current noise levels in these areas, assuming all aircraft pass over the same spot on the ground in a 24 hour period, results in a DNL of 61 dB. This is expected to increase to a DNL of 67 dB under the segments by 1990. However, a more realistic case is that of 25% of flights pass over the same spot on the ground in a 24 hour period. This results in a current DNL of 55dB, and a projected 1990 DNL of 61 dB. At these levels no hearing or health effects are expected.

For the effects of sonic booms, the Air Force conducted an extensive literature review, conducted special tests and developed a sonic boom model to assess the magnitude of impacts to the various environmental attributes. The sonic boom model proposed from analysis of F-15 operations conducted at the Oceana MOA (W-72 off the coast of North Carolina), and air combat maneuvering instrumentation (ACMI) data from the Luke Range indicate the average duration of a supersonic event was about 15 seconds. The number of supersonic events per sortie averaged 2.7 with thirty percent of these producing a sonic boom that hit the ground, or 0.8 booms per sortie. The Luke Range study showed the average carpet boom (the boom pattern produced by straight level flight) would impact about 51 square miles. The study also showed supersonic flight operations occur within an elliptical area of about 1865 square miles for the 1.0 cutoff ellipse. Statistical analysis of the Oceana and Luke Range data indicate the average carpet boom will range between two to four pounds overpressure per square foot (greater than eleven pounds per square foot is generally required to cause structural damage). The probability of a six pound per square foot boom occurring is about one in 1,000 chances. It is projected that an individual underneath the airspace would hear an average of less than one boom per day and would be very unlikely to hear three or more booms per day.

Maneuvering operations such as longitudinal accelerations, pushovers, and turns can cause focusing of the sonic wave at a fixed location. As indicated these focus booms impact at a fixed location and do not follow the aircraft

flight track. The pressure increase can vary from two to five (Thery, 1972; Maglieri, Carlson, McLeod, 1971) times the overpressure level of the carpet boom at the location of focus; however, atmospheric conditions reduce the possibility of such increase from two to four times. Often atmospheric turbulence will cause a de-focusing effect that dissipates the boom completely (Galloway, 1982). A most important point about focus booms is that the peak pressure decays much more rapidly than that of a carpet boom and thus, the positive impulse is much lower (contains less energy) than a carpet boom of the same overpressure. Galloway (1982) has provided generalized algorithms for evaluating the spatial effects of focus booms. Statistical analysis of this data shows the chance of any one location receiving a focus boom from linear acceleration and pushover maneuvers is one in about 3,300 and for a turn maneuver the probability is one in 5,000 chances. The probability of a superfocus boom is one in about 16,700 chances. Daley (1982) has also investigated the spatial effect of a focus boom by using the National Oceanic and Atmospheric Administration's Splash sonic boom model. The model showed that the focus zone exceeding nominal carpet boom levels was a band about 16 feet wide paralleling the curved flight track. At the point where the overpressure is twice the nominal carpet boom overpressure, the width reduces to about three feet. Applying this data to Sells would show the probability of a focus boom impacting any one spot where the overpressure is equal to nominal carpet to be about one chance in 8500; for overpressures two times or more greater than nominal, the probability reduces to one in 42,500 chances. Thus it can be seen that for higher magnification factors, the spatial effect and probability of the boom hitting any given location gets extremely small.

There are three categories of concern in terms of sonic booms impact to people: potential for hearing loss, annoyance, and non-auditory ill-health. The long term day-night "C" weighted noise level currently associated with the maneuvering ellipse indicates a spatial average of 60 decibels. This is expected to decrease to 59 dB by 1990. From an energy average standpoint, a focus or superbomb adds less than 0.01 decibels to these values and consequently is not significant in terms of day-night average noise levels. This data, along with the fact that tests conducted where the overpressures ranged between 50 to 144 psf did not show any permanent hearing loss, leads the Air Force to the conclusion that booms in the range anticipated at the Sells airspace would not cause any hearing loss, either from routine operations or from a focus boom.

Annoyance factors suggested by CHABA (1982) coupled with EPA (1974) and HUD (1980) recommended noise level guidelines indicated that about 10% of all residents beneath the airspace would be highly annoyed due to the cumulative noise levels of 62dB DNL.

No definitive stance on physiological ill-health can be made at this time. There is little doubt that noise including sonic booms acts as a stressor, but it is not known with any degree of certainty whether prolonged exposure results in cumulative pathology. Some research has been conducted to determine the link between noise and ill-health; however, many of these studies are questioned by the scientific community. CHABA (1981) was requested by OSHA and EPA to consider research that might be performed to examine the effects on human health from long-term noise exposure for industrial workers and the general population, respectively. CHABA's conclusion was that auditory effects were fairly well defined, however, in

light of the data reviewed on non-auditory effects it would be prudent to obtain more critical research. While these considerations are primarily for general audible and industrial impact noises, it is stressed that specific data on sonic booms is also needed. EPA (1974) indicates that due to the frequency range of sonic booms they may not be as harmful as other higher frequency impact sounds.

Researchers like Kryter (1980) and Broadbent (1980) indicate that if ill-health can result from noise, the vehicle probably is due to psychological stress factors. If this is the connection and if one accepts the social surveys that predict annoyance as a factor of noise levels, then one would conclude that a very low percent if any of the exposed people beneath the Sells airspace would develop non-auditory ill-health conditions.

Public commenters to other environmental impact statements addressing supersonic flight urged the Air Force to provide a "worst-case" analysis of potential health impacts caused by sonic booms. However, specific predictions of such impacts are not possible. Additional years of research are needed to scientifically determine causal connections or to realistically predict generalized health effects based upon noise. Nevertheless, it has been suggested that there are links between noise and problems such as hypertension, cardiovascular changes, increased neurologic and gastrointestinal disturbances, changes in the course of pregnancy, and changes in hormone levels and other chemical balances. These effects are exemplary of conditions associated with stress. While such effects have been suggested, no method is available to predict either any specific reaction or the proportion of the community which could be affected. Although such effects cannot be dismissed, prevailing scientific opinion supports the expectation that the predicted noise exposure would not cause the effects speculated on above.

It is recognized future research may provide a better understanding of the relationship between noise and non-auditory ill-health; however, in the interim decisions must be based on that data supported by the scientific community.

Sonic boom effects on domestic animals and wildlife have been evaluated. Species of concern in the Sells Airspace are horses, cattle, goats, swine and sheep. Review of available literature, information obtained on species response to sonic booms in other areas and special studies conducted for coordination under the Endangered Species Act indicate supersonic flight in the Sells Airspace has not significantly impacted domestic animals or wildlife in the area.

Bighorn sheep on the Luke and Nellis AF Ranges have been exposed to sonic booms for a number of years. No noticeable effects in the population age structure, longevity or reproductive success has been found for the sheep on the Luke and Nellis AF Ranges (McQuivey, 1978).

Domestic animals such as cattle, horses, sheep and poultry show very little behavioral effect from exposure to sonic booms (Cottureau, 1972; Fletcher and Busnell, 1978; Hinshaw and others, 1970; Nixon and others, 1968; ICAO, 1970). Available literature and special studies reviewed support the fact that animals and wildlife can and do flourish in the presence of military aircraft operations, both subsonic and supersonic. Fletcher (1968) concludes

if aircraft noise has an adverse impact, areas around large airports would be devoid of wildlife. This is also true for military operations areas and it should be noted that noise levels in MOAs are normally less than that at busy commercial airports and military airfields with jet activity.

The Air Force in conjunction with the Texas Historic Preservation Commission, and the Texas Bureau of Economic Geology conducted tests to evaluate the significance of supersonic flight on archaeological sites within the Valentine MOA. The test did not indicate a significant impact would occur. Applying this data along with data obtained in tests in Railroad Valley, Nevada, the Air Force concludes cultural resources in Sells MOA would not be significantly impacted.

Damage to structures should be limited and would primarily involve claims for window breakage. At the anticipated overpressure levels, the probability of glass breakage is about two-tenths of one percent. NASA's review of structural responses indicated overpressures less than about 11 pounds per square foot should not cause structural damage (Clarkson and Mayes, 1972). A 1977 evaluation on an adobe house in southern Arizona indicated the structure reacted similarly to conventional style structures. Therefore, other than window breakage, structural damage may be limited to the probability that one in 16,700 super booms could have an associated focus region where the focused portion would hit a structure. Due to the sparsity of structures in the area, the chance of a structure being hit by such a boom is limited; however, it is possible.

The potential for sonic boom impact on the local economy has been evaluated and determined not to be significant. The evaluation included a review of population, employment, personal income, commercial activities, housing, tourism, ranching, farming, and mining. In no case did any of the area's economic attributes indicate sonic booms have resulted in a significant impact.

In conclusion, the Air Force does not foresee significant impacts from current or future supersonic activity to human health, the local economy, or the other topics investigated, such as endangered species. The local populace clearly perceives significant impacts to such factors as their quiet, rural lifestyle and their health. A number of people are anticipated to remain "highly annoyed" as operations continue.

5. Alternatives Considered:

- a. No action.
- b. Low-Altitude Flying Training:
 - (1) Fly routes established by other bases.
 - (2) Reroute existing military training routes.
 - (3) Raise minimum altitude on military training routes.
 - (4) Discontinue low-level navigation flying.
 - (5) Develop additional routes.

c. Sells Airspace Supersonic Training:

- (1) Transfer supersonic training to other MOAs/ATCAAs.
- (2) Transfer supersonic training to other MOAs and restricted areas.
- (3) Raise supersonic training floor.
- (4) Discontinue supersonic training.
- (5) Establish a new training area for supersonic activity.

6. Actions Taken and Proposed to Reduce or Mitigate Impact:

a. Actions taken:

(1) No flights permitted below 3,000 AGL feet unless on a military training route or in a low altitude tactical navigation area. Supersonic flights are restricted to daylight hours, and other operations are generally conducted during daylight hours.

(2) Additional supersonic training areas, such as the Gladden Airspace, have been identified and are being used as much as possible. Supersonic functional flight checks have been prohibited in the Sells Airspace since July 25, 1977.

(3) A pilot briefing program has been developed to ensure all units are reminded of flight restrictions in the Sells Airspace and sensitive areas on the Tohono O'Odham reservation.

(4) Avoidance areas for low level flight operations have been established to minimize impact on populated areas.

(5) Increased use has been made of flight simulators to reduce flight operations.

(6) Constant review of the adequacy of the flight simulator program as a substitute for some flight operations.

b. Actions proposed:

(1) Assign a single point of contact the sole responsibility for dealing with all problems that may arise from the use of airspace over the Tohono O'Odham Reservation and the Organ Pipe Cactus National Monument.

(2) In cooperation with the Tohono O'Odham Tribal Council and the Tribal Chairman, institute a continuing program of visitations at the tribal and district levels to improve communications, complete claims forms, receive complaints, explain military operations in the airspace, and generally deal with such problems as may arise.

7. Comments Requested: The following agencies were contacted regarding this proposal:

- a. Federal Aviation Administration
- b. Department of Health, Education, and Welfare
- c. U.S. Department of the Interior, U.S. Fish and Wildlife Service
- d. Arizona Game and Fish Department
- e. Bureau of Indian Affairs, Department of the Interior, Tohono O'Odham Agency
- f. Tohono O'Odham Tribe of Arizona
- g. National Park Service, Organ Pipe Cactus National Monument
- h. National Park Service, Western Region
- i. Arizona State Historic Preservation Office
- j. Arizona State Museum

8. Other Factors: The Tohono O'Odham Tribal Council filed a petition in May 1975 with the FAA requesting FAA exercise their administrative power and prohibit all low altitude and supersonic military flight activity over the reservation. The primary complaint was noise from low altitude overflights and sonic booms. Another letter in March 1977 protested in strong terms the establishment of the Sells Low Military Operations Area (MOA) which overlies almost the entire Tohono O'Odham Reservation. This letter was directed to FAA when the "Notice of Intent" was published.

9. The revised draft environmental statement on the Sells Airspace was made available to the Environmental Protection Agency and the public on _____

10. Copies of the Revised Draft Environmental Impact Statement (RDEIS) are being provided to the following libraries and clearinghouses for the convenience of citizens in the local communities who wish to review the RDEIS:

LIBRARIES

Tucson Main Public Library
200 S. 6th Avenue
Tucson, AZ 85701

Phoenix Public Library
12 E. McDowell Road
Phoenix, AZ 85004

CLEARINGHOUSES

Department of Economic Planning and Development
State of Arizona
1624 West Adams St.
Phoenix, AZ 85007

Maricopa Association of Governments
1820 West Washington Street
Phoenix, AZ 85007

PIMA Association of Governments
405 Transamerica Building
Tucson, AZ 85701

In addition, copies of the RDEIS have been provided for review and comment to governmental agencies and to the Tohono O'odham Tribal Council. Any persons wishing to comment on this RDEIS may obtain copies by writing to the public affairs offices at the following Air Force Bases:

PUBLIC AFFAIRS OFFICES

Public Affairs Office
832nd Air Division
Luke AFB, AZ 85309

Public Affairs Office
830th Air Division
Davis-Monthan AFB, AZ 85707

Public Affairs Office
Headquarters Tactical Air Command
Langley AFB, VA 23061

Public Affairs Office
30th Fighter Wing
Wurtsmith AFB, MI 48899

PREFACE

This document has been prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), the Council on Environmental Quality (CEQ) regulations, Department of Defense Directive 6050.1, and Air Force Regulation 19-2. Because in 1979 the Draft Environmental Impact Statement (EIS) was prepared and distributed to the public and other federal, state, and local agencies for comment using the report format recommended in the then current CEQ guidelines, that format has also been retained for this revised document.

In the 1979 Draft EIS the Indian tribe beneath the Sells airspace was called the Papago Indian tribe. In early 1986, the Papago Indians changed their name and are now recognized as the Tohono O'Odham Indian tribe. Efforts have been made in this document to give proper reference to the Tohono O'Odham Indians. However, there may be occasional oversights, or occasions where references to Papago are retained to maintain continuity with the 1979 Draft EIS and previous correspondence with the Papago Tribe.

The Draft EIS was circulated for comment in February 1979. A public hearing was held on March 27, 1979, in the Village of Santa Rosa on the Tohono O'Odham Indian Reservation, Arizona. The transcript of this hearing and letters of comment from federal and state agencies, other interested organizations, and individuals formed the basis for revision of this document. Particular emphasis has been placed on a further survey of Tohono O'Odham concerns. The document also presents information on changes to routes, types, and levels of flying activities since the Draft EIS was filed. Many of these changes were made in response to Tohono O'Odham complaints.

The conclusions and recommendations contained in this document are based on surveys, background studies, analyses, and additional coordination incorporating substantive comments received as well as operational considerations.

This document was prepared under the supervision of the Deputy Chief of Staff, Engineering and Services, Headquarters Tactical Air Command, Langley AFB, Virginia. Personnel at Headquarters 12th Air Force, Luke, Williams, and Davis-Monthan Air Force Bases and the Arizona Air National Guard assisted in providing details of flying training activities and public information and coordinating procedures.

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LIST OF ABBREVIATIONS AND ACRONYMS

ACM	- Air Combat Maneuvers
ACT	- Air Combat Training
AD	- Air Division
AFB	- Air Force Base
AFM	- Air Force Manual
AFR	- Air Force Regulation
AGL	- Above Ground Level
ANG	- Air National Guard
ATC	- Air Training Command/Air Traffic Control
ATCAA	- Air Traffic Control Assigned Airspace
CDNL	- C-weighted Day-Night Sound Level
CEQ	- Council on Environmental Quality
CHABA	- Committee on Hearing, Biomechanics, and Bioacoustics
CSEL	- C-weighted Sound Equivalent Level
CY	- Calendar Year
dB	- Decibels
dBA	- Decibels, A-weighted
DCM	- Defensive Combat Maneuvering
DEIS	- Draft Environmental Impact Statement
DNL	- Day-Night Average Sound Level
EIS	- Environmental Impact Statement
EPA	- Environmental Protection Agency
FAA	- Federal Aviation Administration
FEIS	- Final Environmental Impact Statement
FLIP	- Department of Defense Flight Information Publications
FSS	- Flight Service Station
FY	- Fiscal year
HUD	- Department of Housing and Urban Development
IFR	- Instrument Flight Rules
LANTIRN	- Low Altitude Navigation and Targeting Infrared for Night
LATN	- Low Altitude Tactical Navigation
LATR	- Low Altitude Tactical Route
m	- Meters
MOA	- Military Operations Area
MSL	- Above Mean Sea Level
MTR	- Military Training Route
NAAQS	- National Ambient Air Quality Standard
NCC	- National Climatic Center
NEPA	- National Environmental Policy Act of 1969
NGB	- National Guard Bureau
NM	- Nautical Mile
NOAA	- National Oceanic and Atmospheric Administration
NPS	- National Park Service
OPCNM	- Organ Pipe Cactus National Monument
OSHA	- Occupational Safety and Health Administration
PSF	- Pounds per square foot
SA/SAT	- Surface Attack/Surface Attack Tactics
SHPO	- State Historic Preservation Officer
SON	- Sonora
TAC	- Tactical Air Command
TACP	- Tactical Air Control Parties
TASS	- Tactical Air Support Squadron
TFG	- Tactical Fighter Group

LIST OF ABBREVIATIONS AND ACRONYMS -- Continued

TFTS	- Tactical Fighter Training Squadron
TFW	- Tactical Fighter Wing
TSP	- Total Suspended Particulates
TTW	- Tactical Training Wing
USFWS	- U.S. Fish and Wildlife Service
VFR	- Visual Flight Rules
VORTAC	- VHF Omnidirectional Range/Tactical Air Navigation System
VR	- Visual Route

DEFINITIONS OF TERMS

The definitions below are not necessarily full technical definitions. Most technical terms are fully defined in the text or appendixes.

ACMI (Air Combat Maneuvering Instrumentation) -- A data collection system for recording the movement of an aircraft that combines information from the aircraft itself and from outside sources.

Avian -- Of or pertaining to birds.

Carpet boom -- The normal sonic boom cause by an aircraft.

CDNL (C-weighted Day-Night Sound Level) -- A value used in noise analysis for measuring impulsive sound over a 24-hour period. Roughly, this is a weighted average of CSELs with greater weight given to sounds that occur at night.

Consonance -- Harmony; agreement; congruity.

CSEL (C-weighted Sound Equivalent Level) -- The average sound exposure level of a sound event that accumulates over a period of time (a sonic boom; a gunshot) measured from beginning to end.

Culminating -- Reaching the highest point or the end of a series of events or actions.

dB (decibel) -- A unit for measuring the relative loudness of sounds; approximately the smallest degree of difference of loudness ordinarily detectable by the human ear.

Ephemeral -- Short-lived; transitory. A thunderstorm is an ephemeral rain.

Focus boom -- An intensified sonic boom that occurs when two or more shock waves arrive at the same place at about the same time. See Appendix B.

Gamut -- The entire range or extent of anything.

Mach Number -- A number representing the ratio of the speed of a body to the speed of sound in the surrounding atmosphere. Supersonic speeds are represented by Mach numbers of 1.0 or higher.

MOA (Military Operations Area) -- An airspace assignment of defined vertical and horizontal dimensions established to segregate certain military activities.

Nautical Mile -- 6,076 feet (1.15 statute miles).

Nocturnal -- Active at night.

Nominal Rectilinear -- Approximately rectangular, referring to the shape of a carpet boom on the ground.

Optimum -- The best or most favorable.

Petroglyph -- A figure or design pecked, scraped, or cut into rock.

Pushover -- A maneuver in which the nose of an aircraft is moved up or down while the aircraft continues moving in the same geographic direction -- for example, changing from a climb to level flight or from level flight to a dive.

Secondary Boom -- A sonic boom caused by something other than the nose of an aircraft reaching supersonic speed. A secondary boom might be caused by refraction of the initial boom or by some part of the aircraft (e.g., a wingtip) reaching supersonic speed at a slightly different time than the nose. See Appendix B.

Sonic Boom -- A sharp impulsive noise (like a rifle shot) caused when an aircraft reaches the speed of sound. The initial boom is caused when the nose of the aircraft reaches the speed of sound.

Sortie -- From takeoff to full-stop landing for a single aircraft.

Spatial -- Of space; as used here, it refers to any vertical or horizontal limits affected by an action, activity, or object.

Statute Mile -- 5,280 feet; the common mile.

Super Boom -- An intensified focus boom sometimes caused by abrupt or "tight" aircraft maneuvers. See Appendix B.

1.0 PROJECT DESCRIPTION

1.1 GENERAL

This environmental statement evaluates the impact on the natural and human environment existing in southern Arizona as a result of military flight operations within the Sells Airspace. The Sells Airspace primarily overlies the Tohono O'Odham Indian Reservation. Figure 1.1-1 shows the general location of the Sells Airspace, the Tohono O'Odham Reservation, and the Organ Pipe Cactus National Monument. This statement discusses both supersonic flight operations conducted above 10,000 feet above mean sea level (MSL), and subsonic flight operations conducted primarily below 10,000 feet MSL.

1.2 PURPOSE

The purpose of this document is to evaluate the impacts of supersonic flight operations in the Sells Military Operations Area (MOA)/Air Traffic Control Assigned Airspace (ATCAA) as part of a review of the existing supersonic waiver to conduct supersonic activity below 30,000 feet MSL.

This document also discusses current and future Air Force and Air National Guard (ANG), and other military aircrew training in the airspace over the Tohono O'Odham Indian Reservation and Organ Pipe Cactus National Monument in southern Arizona. Military Training Routes (MTRs) and low altitude tactical navigation (LATN) areas beneath the Sells Airspace are also included in this document in order to evaluate the overall effect of related flying activities. However, these low altitude training routes are approved separately by the Air Force after coordination with the FAA, other adjacent airfields, and the state single point of contact. While these areas must be evaluated for potential environmental impacts, they are considered actions separate from the designation of MOAs, ATCAAs or the processing of supersonic waivers.

1.2.1 USAF SUPERSONIC POLICY

U.S. Air Force policy is to conduct supersonic operations where possible over open water areas (above 10,000 feet). Supersonic flight over land is normally conducted above flight level (FL) 300 (30,000 ft MSL).

Under present procedures, if mission requirements dictate deviation from the above supersonic flight criteria, a waiver request is forwarded to Headquarters USAF for consideration. Periodic review of the supersonic waiver must include a review of the past activity, an analysis of any effects of the activity, and a detailed review of the proposed future activity. This procedure provides a continuing analysis of USAF supersonic activity. If a waiver is issued, it specifies some length of time for periodic review.



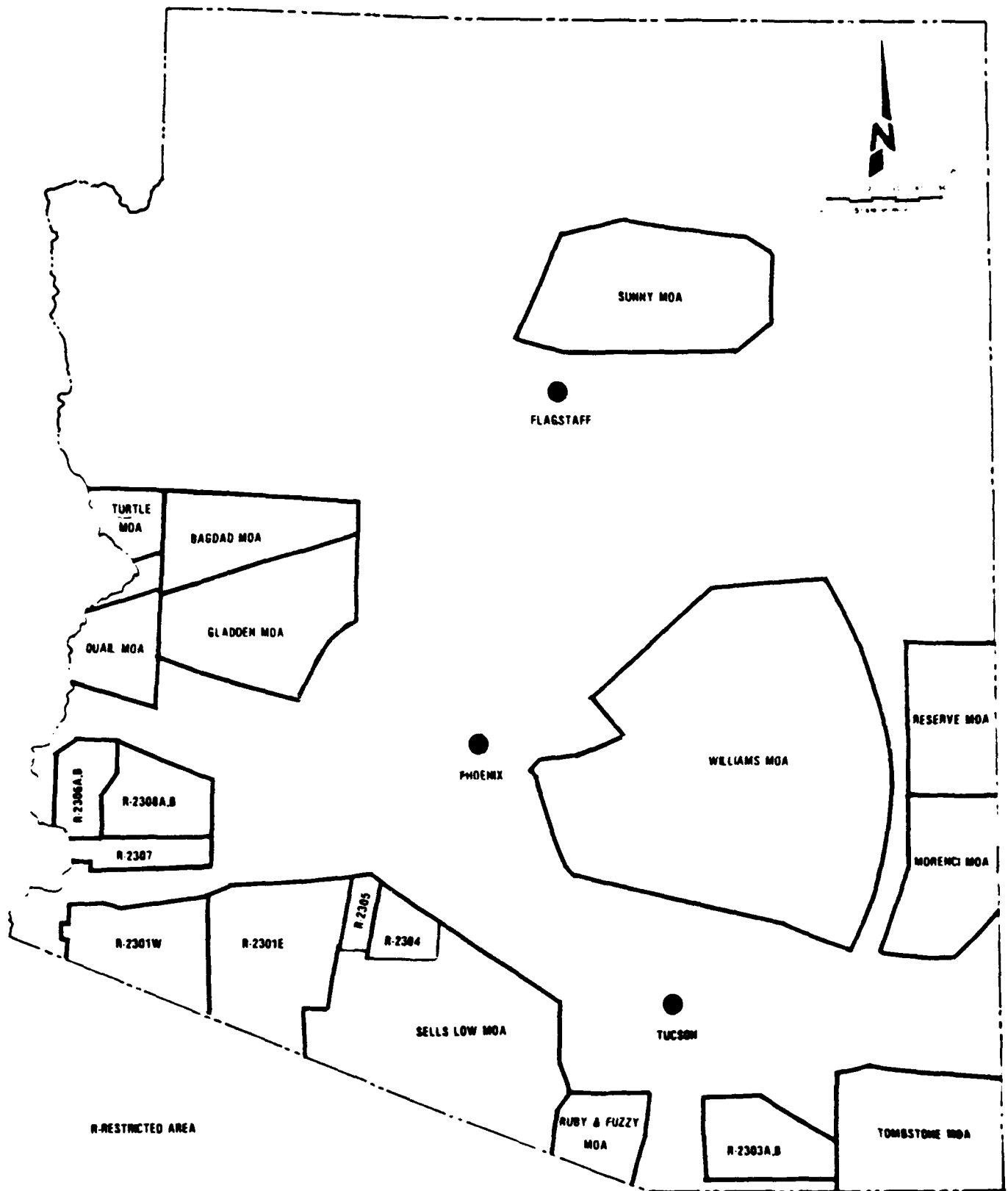


FIGURE 1.1-2. FLYING AREAS IN THE VICINITY OF THE SELLS AIRSPACE

1.2.2 DESIGNATION OF THE SELLS AIRSPACE

The charted Sells Airspace is designated by non-rulemaking airspace action IAW FAA Handbook 7400.2. The Sells airspace includes airspace above the Tohono O'Odham Indian Reservation and other adjacent areas from an altitude of 3000 feet AGL to 51000 feet MSL (FL-510). A detailed description of the boundaries and stratification of the Sells Airspace with geographical coordinates is contained in Appendix G.

MOAs and ATCAAs are designated for the purpose of providing air traffic separation between specific flight activities. Information on the Air Force activity taking place within the Sells Airspace is normally made available to the FAA a minimum 16 hours in advance of all sorties flown. Current information on real time use of the airspace is available upon request to all civilian visual flight rules (VFR) air traffic transiting the airspace, by contacting an FAA Flight Service Station (FSS) or Albuquerque Center on their appropriate frequencies.

The Air Force assumes responsibility for safe separation between participating military aircraft in the Sells MOA airspace. Civilian VFR traffic penetrating the Sells Airspace operates on a "see and avoid" concept. Military flying operations conducted below 18,000 feet MSL are normally on IFR (Instrument Flight Rules) flight plans but are generally not under the positive control of Albuquerque Center while in the MOAs. Aircraft operating along MTRs or in the LATN area beneath the Sells Airspace normally operate under visual flight rules (VFR).

1.2.2 HISTORY OF SELLS AIRSPACE

1.2.2.1 The Tohono O'Odham and the Sells Reservation

The ancestors of many of the modern Tohono O'Odham came under the jurisdiction of the United States as a result of the Gadsden Purchase (1853). Others moved into the United States from Mexico later. The incoming Anglo-Americans were the first to make a consistent terminological distinction between the Pima (Pimans who lived along the Gila River) and the Tohono O'Odham (all other Pimans). Tohono O'Odham-Anglo relations were friendly and Tohono O'Odham military units were a major factor in defending south-central Arizona against the Apache. A result of this cooperation is that reservations were not established for the Tohono O'Odham while the Anglo and Hispanic populations were still small. Finally, reservations were established at San Xavier in 1874 and at Gila Bend in 1882. These reservations included an estimated 10 percent of the Tohono O'Odham.

The government considered the rest of Tohono O'Odham land open for settlement by non-Indians. Creation of what is now the Sells Reservation began in 1911 and continued intermittently until 1940. The largest land addition was in 1918. The Sells reservation presently encompasses 4,435 square miles.

The Indian Reorganization Act of 1934, which encouraged the formation of tribal governments, is the basis for the Tohono O'Odham tribal government. The Act was accepted by the Tohono O'Odham in a referendum in 1934. A constitution and bylaws were ratified by the Tohono O'Odham in 1936 and approved by the Secretary of the Interior in 1937.

1.2.2.2 Organ Pipe Cactus National Monument

The Organ Pipe Cactus National Monument (OPCM) comprises 330,874 acres (133,901 hectares) and lies in extreme southern Arizona adjacent to the international boundary with Mexico. It is bounded on the west by the Cabeza Prieta National Wildlife Refuge, on the east by the Tohono O'odham Indian Reservation, and on the north by public lands administered by the Bureau of Land Management. The monument is under the western portion of the Sells Airspace.

The Organ Pipe Cactus National Monument was established by Presidential Proclamation in 1937 to perpetuate for future generations a representative sample of the Sonoran Desert, its overall scenery, indigenous plants characterized by saguaro-paloverde association, the distinctive organ pipe cactus, desert wildlife species, and the historic resources associated with man's presence and life within the monument area.

On November 10, 1978, 312,600 acres (95 percent) of the Organ Pipe Cactus National Monument was designated Wilderness Area. This designation requires the National Park Service to manage and preserve this area in the manner specified by the Wilderness Act of 1964 and the National Park Service wilderness use and management policies.

The monument is one of only 28 natural sites within the United States officially designated as a unit of UNESCO's (United Nations Economic, Scientific, and Cultural Organization) worldwide "Man and the Biosphere" Reserve System. This system for the conservation and preservation of unique natural areas has the sanction and support of the State Department and many international bodies.

1.2.2.3 Military Aircraft Operations in the Sells Airspace

Use of the airspace over the Tohono O'odham Indian Reservation and Organ Pipe Cactus National Monument for significant amounts of military air activity began in the early 1940s. Many of the existing civil and military airports in southern Arizona began as World War II airfields. U.S. Air Force (and Army Air Corps/Air National Guard) training has been conducted continuously in the area since that time, though there have been fluctuations in the volume and density of use.

The Air Force has been permitted by the FAA to conduct training in the airspace above the Tohono O'odham Indian Reservation and the Organ Pipe Cactus National Monument since 1951. Before 1975, the military was virtually free to operate without restriction below 18,000 feet MSL. Normally, the military designated their training areas in airspace clear of federal airways and in a location as free as possible of nonparticipating aircraft. The Sells Airspace met these criteria and was considered an optimum training area. In 1975, the MOA program was established. The Sells 1 MOA was established in September 1975, and the Sells Low MOA was established in September 1977.

Air Force policy since 1971 has been to integrate the maximum practicable amount of air combat training into the FAA Air Traffic Control System under IFR. To avoid the possibility of mid-air collisions with civil and commercial aviation, the Air Force performs all air combat training in either special use airspace or air traffic control assigned airspace off the airways. Use of the Sells Airspace is in consonance with this policy.

1.2.2.4 USAF-Tohono O'Odham Relations

In February 1974 the Tohono O'Odham began submitting a series of claims and complaints about sonic boom damage and low-level flights. On May 14, 1975, the Legal Counsel for the Tohono O'Odham requested that the FAA issue a rule or order prohibiting use of the airspace over the reservation for low-level navigation training by military aircraft and any training activity by military aircraft that produces sonic booms. This petition to the FAA resulted in a series of meetings and actions to resolve the controversy. A Draft Environmental Impact Statement (EIS) was filed and released for public comment in February 1979. A public hearing was held on the Draft EIS at the reservation on March 27, 1979.

Since the filing of the Draft EIS and as a result of comments at the public hearings and other meetings, several changes in MTRs were made (see Table 2.4.1). Also, more areas were designated as low altitude avoidance areas.

A public affairs program was established to maintain dialogue between the USAF and the Tohono O'Odham Indian Tribe after the Santa Rosa meeting in 1979. This program gradually became inactive, partly because of staff changes in both the USAF and the Tohono O'Odham Tribe and partly because no complaints were received from either the Tohono O'Odham Tribe or individual Tohono O'Odham Indians.

There was a USAF committee to improve relationships between the USAF and the Tohono O'Odham at Luke AFB and the members were aware of the potential for friction and problems, but no effective communications have ever been established between the committee and the Tohono O'Odham Tribe, primarily because of differences in organization and perspective between the two groups. Previous efforts, such as sending a van to the Tohono O'Odham Reservation to perform minor repairs and serve as a public information contact, have been ignored or rejected by the Tohono O'Odham, although it is not always clear whether the rejection was an official act of the Tohono O'Odham Tribe or the response of a tribal employee.

Damage caused by sonic booms is recoverable from the Air Force. The Air Force accepts claims for damage caused by sonic booms and reimburses the claimant for repairs and/or replacement of the damaged item.

Reimbursement may include compensation for personal injury resulting from sonic booms, although the evidence of this type of injury has been extremely small. Claims offices are located at Davis-Monthan, Williams, and Luke AFBs. Davis-Monthan AFB exercises claims jurisdiction for damage claims arising from flight operations in the Sells Airspace.

The claims system has suffered from the same communications problems as the public affairs program. After the Santa Rosa meeting in 1979, Papago Legal Services helped individual Indians with claims forms, and USAF personnel visited Sells every 6 months to help claimants fill out forms. Copies of the forms were available at the tribal offices or at Davis-Monthan AFB, and assistance in completing forms was also available at Davis-Monthan AFB. The USAF had expected that information on the claims system would reach the Papago population through the Santa Rosa meeting and through articles in the tribal newspaper, the Papago Runner, but this was not the case. Many Tohono O'Odham

who know that reimbursement for damages was available did not know how to file, and many Tohono O'Odham in remote areas were not aware that claims could be made.

Through time, the system deteriorated. Papago Legal Services stopped helping with forms because of the press of other duties. The number of claims, which had never been large, dropped off to the point that the USAF visits to Sells stopped. Attempts were made to re-establish the visits but a series of scheduling problems have prevented this. By early 1983, essentially the only claims that were submitted were from the Papago Housing Authority for damages to tribal/government housing.

Claims are made on Standard Form 95, the General Services Administration form used for all damage, injury, or death claims against the government. The complexity and verification requirements of the form probably have made it seem more trouble than it was worth to file a minor claim. In fact, the claims office at Davis-Monthan AFB is willing to accept collect telephone calls, take minor claims over the telephone, and will reimburse amounts up to \$100 for claims that seem reasonable without requiring any further action from the claimant (other kinds of claims still require that standard procedures be followed), but it appears most Tohono O'Odham are not aware of this.

The USAF, after consultation with the Tohono O'Odham Tribe and Organ Pipe Cactus National Monument (OPCNM), has established avoidance areas and regulations for various kinds of training flights and briefs pilots on these each time they fly in the Sells Airspace. However, inadvertent violations sometimes occur. Some alleged violations are not actually violations. Avoidance areas are not marked on the ground and the precise limits of those areas probably are not known to anyone on the reservation or at OPCNM. A final problem is that most people cannot accurately estimate the distance to and elevation of aircraft, so that aircraft often are perceived as being nearer and lower than they actually are.

Disruption of the activities of groups of people have been minimized, but disruption of livestock roundups by subsonic and supersonic jet overflights continues to occur. Under existing conditions, there is no effective way of preventing disruptions caused by single overflights because roundups occur at various times and places on the reservation and the USAF and ANG and other military users have no means of finding out when and where they will occur. Repeated overflights of the same activity by the same aircraft ("buzzing"), which have been reported by the Tohono O'Odham, are a violation of USAF and FAA regulations.

1.3 NEED FOR SPECIAL USE AIRSPACE

The performance and optimum flight characteristics of U.S. military fighter aircraft have improved dramatically over the past several years. Aircraft such as the F-15 and F-16 have capabilities far in excess of previous weapons systems including the F-4 and F-104. Supersonic flight training is essential if aircrews are to realize the full potential and purpose for which these aircraft were designed and procured.

Combat experience has demonstrated that the effectiveness and survival of aircrews exposed to sophisticated anti-aircraft weapons systems and enemy

fighter interceptors are directly affected by the type, quality, and amount of previous training. The aircrew flight training programs used by the Air Force have been developed after a careful analysis of previous experience, known and postulated enemy tactics, and the performance of the aircraft employed by potential adversaries. Flight training programs are designed to provide aircrews with the most realistic combat training possible while under peacetime constraints.

1.3.1 FLIGHT SAFETY REQUIREMENTS

Federal Aviation Regulations require that aircraft operating below 10,000 feet MSL maintain an airspeed of less than 250 knots indicated airspeed unless either the minimum safe airspeed for any particular operation is greater, in which case the aircraft may be operated at the minimum safe speed, or the aircraft are flown within airspace designed and approved for higher speeds (MTRs, MOAs, etc). Because of their performance characteristics, military aircraft such as the F-15 and F-16 cannot maintain flight through many of the training maneuvers at speeds less than 250 knots. Additionally, the FAA recognizes the need for military aircraft to train in special use airspace and thus reduce the potential for mid-air collisions with civil aircraft.

With the large number of modern USAF aircraft and aircrews required for national defense, the limited airspace acceptable for tactical fighter training in the United States is in constant demand and heavily scheduled. Historically, the Air Force has concentrated initial qualification tactical aircrew training in the southwestern United States because of excellent weather conditions for flight training. Table 1.3-1 shows the percent of initial U.S. Air Force and Air National Guard combat aircrew training conducted at bases in Arizona.

TABLE 1.3-1
PERCENT OF INITIAL COMBAT AIRCREW QUALIFICATION
TRAINING CONDUCTED AT ARIZONA AIR FORCE BASES (CY 1985)

	F-15	F-16	OA-37	F-5	A-7	A-10
LUKE AFB	72.5%	43%	-	-	-	-
WILLIAMS AFB	-	-	-	100%	-	-
DAVIS-MONTHAN AFB	-	-	100%	-	-	100%
TUCSON INTL AIRPORT AIR NATIONAL GUARD	-	50% ^a	-	-	100%	-

a. Scheduled to begin in FY 1988.

b. Luke AFB, Williams AFB, and Davis-Monthan AFB are active units.

1.4 CURRENT AIR FORCE TACTICAL TRAINING OPERATIONS

The Air Force conducts two basic categories of flight training for tactical fighter aircrews: initial qualification training and continuation flying training. Initial qualification training qualifies pilots and weapons systems operators (pilots and navigators) in the basic skills required to fly combat in a specific fighter aircraft. This training, conducted by the Tactical Air Command (TAC), is subsequent and in addition to the basic flying training programs conducted by the Air Training Command (ATC), when the individual is awarded the military aeronautical rating of Pilot or Navigator. Continuation flying training is designed to develop and sustain a high level of aircrew proficiency in all facets of tactical operations. It normally begins after the pilot or navigator graduates from the initial qualification course and upon assignment to an operational flying unit.

Both initial and continuation tactical flying training include the following types of training:

- Transition -- To train qualified pilots with the characteristics of new tactical aircraft (transitioning from the F-4 to F-15).
- Formation -- Two or more aircraft flying together to provide mutual support.
- Instrument -- Flight conducted using navigation and altitude instruments aboard the aircraft.
- Aerial Refueling -- Airborne refueling of fighter-type aircraft to extend the combat range of the fighter.
- Low Altitude Training -- Navigation along an approved MTR by means of geographical reference from one point to another at low altitude.
- Low Altitude Tactical Navigation -- Tactical training for support of ground forces involving visual navigation within a general area rather than along a MTR.
- Air-to-Surface Gunnery -- Firing of aircraft armaments against specified targets on the ground (also called surface attack training, SAT). This training is not conducted in the Sells Airspace.
- Air Combat Training (ACT) -- This consists of (a) basic flight maneuvers (BFM), performing maneuvers to become familiar with aircraft performance capabilities; (b) air combat maneuvering (ACM), airborne maneuvering against another aircraft simulating an air engagement at both supersonic and subsonic air speeds; and (c) defensive combat maneuvers (DCM), maneuvers designed to avoid intercepting aircraft and air-to-air and surface-to-air missiles.
- Air Intercept Training -- Airborne target acquisition using primarily radar acquisition, either on the aircraft or ground-based, generally culminating in an ACM engagement.

- Functional Check Flights -- Test flights by especially qualified pilots to evaluate aircraft performance after major maintenance before release for normal use.
- Low Altitude Threat Awareness Training (LATAT)

1.5 CRITERIA FOR SELECTION OF SPECIAL USE AIRSPACE

Selection and use of airspace for these events are governed by a number of Air Force regulations that are in consonance with FAA Rules and Regulations. In general, flight training is conducted in identified areas selected by the USAF and approved by the FAA. The airspace identified for flight training should meet the following basic requirements:

- Be close to base -- Distance for optimum training value depends on the mission and type of aircraft. The goal is to provide maximum training time for the least fuel spent in transit.
- Be sparsely populated -- So that aircraft operations will have the least possible effect on people.
- Have limited commercial airline and IFR routes -- To avoid conflicts in scheduling and constant rerouting problems.
- Be controlled by a single scheduler -- Best safety factor and optimum utilization is obtained by controlled scheduling.
- Have primary user(s) with scheduling priority.
- Have minimum flight delays enroute, entering, or leaving the area -- Saves fuel and prevents excessive maneuvering in positive control areas.
- Fit mission size -- Varies with mission and aircraft type.
- Avoid noise-sensitive areas if possible -- These areas include hospitals, schools, national parks, national monuments, scenic waterways, high use recreational areas, etc.

The training most severely restricted by these considerations is supersonic flight. Air Force tactical supersonic flight over land areas below 30,000 feet MSL is presently authorized in only twelve areas in the continental United States. These are located in the vicinity of White Sands, NM; Reserve, NM; Valentine, TX (Holloman AFB); Bullion Mountains, CA; Panamint Valley, CA (George AFB); Pioche, Nevada (Tactical Fighter Weapons Center, Nellis AFB); Gladden, AZ; Sells, AZ; Luke Ranges, AZ (Luke AFB); Utah Test and Training Range, UT (Hill AFB); Eglin Corridor, FL (Eglin AFB); and the Edwards Complex, CA (Edwards AFB). All are areas of comparatively sparse population.

2.0 AIR FORCE FLYING ACTIVITIES IN SELLS AIRSPACE AND THE AFFECTED ENVIRONMENT

2.1 GENERAL

This chapter describes the Air Force tactical training missions conducted in and beneath the Sells Airspace, the types of training conducted, the types of aircraft flown, the level of activity or use by each type of aircraft, and the concept of operations in the Sells Airspace. This section also characterizes the land areas (site locations) and describes the existing conditions of the human environment underlying the Sells Airspace.

2.2 TACTICAL TRAINING MISSIONS IN SOUTHERN ARIZONA

The following sections describe military installations that require military operations areas (MOAs) and gunnery ranges to accomplish their missions. There are not any gunnery ranges located beneath the Sells MOAs.

2.2.1 LUKE AFB, ARIZONA

The headquarters is now the 832nd Air Division (AD), whose mission is to train qualified aircrews in the operation of fighter aircraft and use of their weapon systems. The 58th Tactical Training Wing (TTW) currently provides training in the F-16 fighter and the 405th TTW provides training to F-15 aircrews. The F-15 and F-16 training in the Sells Airspace is conducted primarily above 10,000 feet above mean sea level (MSL) although much training in both aircraft is accomplished on MTRs beneath the Sells Airspace. Active Air Force use of the F-4 at Luke AFB was terminated in the fall of 1982. An Air Force Reserve squadron will begin F-16 operations in the late 1980's. Both F-15 and F-16 aircraft are capable of supersonic flight.

2.2.2 WILLIAMS AFB, ARIZONA

The 425th Tactical Fighter Training Squadron (TFTS), assigned to the 405th TTW and based at Williams AFB provides training in the F-5 aircraft to foreign military pilots under the Military Assistance Program and instructor upgrade training for USAF pilots. F-5 aircrew training is conducted primarily above 10,000 feet MSL; although, some low-altitude navigation training is done below 10,000 feet MSL. The F-5 aircraft occasionally flies supersonic above 10,000 feet MSL.

2.2.3 DAVIS-MONTHAN AFB, ARIZONA

The headquarters is now the 836th AD, whose mission is to train aircrews in the operation of fighter aircraft and the use of their weapon systems. The 355th TTW currently provides combat crew training in the subsonic A-10 for aircrews of the U.S. military forces.

The 23rd Tactical Air Support Squadron (TASS) provides airborne forward air controllers and personnel for Tactical Air Control Parties (TACP) capable of air strike control and liaison in direct support of ground forces.

The 23rd TASS formerly flew propeller driven O-2 and OV-10 aircraft, but now flies the OA-37 aircraft. Over 99% of OA-37 training is conducted below 10,000 feet MSL.

2.2.4 TUCSON INTERNATIONAL AIRPORT, ARIZONA

The 162nd Tactical Fighter Group (TFG), Arizona Air National Guard (ANG), provides combat aircrew training for ANG and USAF aircrew in the operation of the A-7. In the late 1980's the 162nd TFG will add F-16 combat aircrew training.

2.2.5 OTHER MISSIONS

2.2.5.1 Operation Snowbird

During the winter months, the 162nd TFG (Tucson IAP) and the 832nd AD (Luke AFB) host ANG/AFRES fighter units deployed to southern Arizona for additional training. These units from northern states deploy as squadrons of about 16 aircraft to Arizona for 1 to 3-week periods of concentrated tactical training. The visiting ANG units fly out of ANG facilities at Davis-Monthan AFB, and Luke AFB. This training is mainly confined to the air-to-ground ranges located at the Luke Air Force Range (Restricted Area R-2301/4/5) but includes some low altitude navigation and air maneuvering in Sells Airspace. ANG units fly a variety of aircraft including the F-4 (Luke AFB), A-7 (Davis-Monthan AFB), and A-10 (Davis-Monthan AFB).

2.2.5.2 Other Military Services

The Sells Airspace is used on a limited but more or less regular basis by aircraft from many units. These include, but may not be limited to, aircraft from Nellis AFB, Nevada; Holloman AFB, New Mexico; and Navy and Marine aircraft from Marine Corps Air Station (MCAS) Yuma, Arizona; MCAS El Toro, California; Naval Air Station (NAS) Miramar; and various carriers of the Pacific Fleet. Additionally, the airspace is regularly used for exercises, and participants may be from virtually any military unit/base in the United States. Amount of participation may range from 15 to 20 sorties to as many as 100 or more sorties per day, and the exercises may last from one to five days. Much of this use results from routing aircraft to and from the three tactical ranges within Restricted Areas R-2301E and R-2304 (Figure 1.1-2).

2.3 TYPES OF OPERATIONS IN SELLS AIRSPACE

The following sections describe the major flight operations that occur in and beneath the Sells Airspace over the Tohono O'Odham Reservation.

2.3.1 HIGH ALTITUDE TRAINING

2.3.1.1 Transition Training

This training, provided for qualified pilots, serves as a transition from one type of aircraft to another (such as F-4 to F-15). Transition training is the first phase of tactical training and provides the pilot with basic skills and knowledge of the operation and handling characteristics of the aircraft. High altitude transition training is conducted at subsonic airspeeds at altitudes from 10,000 feet to 33,000 feet MSL. Transition training is conducted in the Sells Airspace shown in Figure 2.3-1.

2.3.1.2 Formation Training

After transition training, pilots progress to the formation training phase. Here they develop the skills necessary to fly and maneuver their aircraft in close proximity with other aircraft. This training is conducted at subsonic airspeeds at altitudes from 10,000 feet MSL to 51,000 feet MSL. Formation training is conducted in the Sells Airspace shown in Figure 2.3-1.

2.3.1.3 Air Combat Maneuvering Training

In this phase of training pilots begin to develop their tactical skills. Air maneuvering is a comprehensive phase that runs the gamut from basic maneuvers, through air combat tactics, and radar directed intercepts that culminate in three-dimensional air-to-air engagements. During these air-to-air combat engagements, opposing pilots maneuver by maintaining visual contact with the opposing aircraft. This training, conducted at altitudes from 10,000 feet to 51,000 feet MSL, includes supersonic flight. Air combat maneuvering is conducted in the Sells Airspace shown in Figure 2.3-1.

2.3.1.4 Air Intercept Training

In this phase of training pilots develop skills in use of airborne radar systems. Using long-range detection radar, the pilots track potential targets and learn how to direct their aircraft and engage other high-speed targets, ensuring effective weapons delivery. Frequently a combination of ground and airborne radar is used to direct the aircraft to the intercept. While the intercepting aircraft flies to engage the opposing aircraft and gain a tactical advantage, this training differs from air combat maneuvering in that the intercepting aircraft may never have visual contact with the opposing aircraft. Friend or foe identification is frequently determined by electronic systems. Air intercept training is conducted from 10,000 feet MSL to 51,000 feet MSL at subsonic and supersonic speeds in the same airspace areas used for air combat maneuvering (see Figure 2.3-1).

2.3.2 LOW ALTITUDE TRAINING

2.3.2.1 Low Altitude Training on Military Training Routes

The low altitude training is accomplished by high performance tactical aircraft such as the A-7, A-10, F-4, F-5, F-15, F-16, and OA-37 along predetermined and designated Military Training Routes (MTRs). At this time, all MTRs beneath the Sells Airspace are Visual Routes (VRs). These routes are corridors from 2 NM to 10 NM in width.

Low altitude training provides the pilot with experience in navigation by means of visual reference from one geographic point to another along a corridor at low altitude. Operating close to the ground, the pilot can penetrate a hostile environment and arrive at a target without being detected by radar. Low altitude missions are subsonic, generally flown between 100 and 1,500 feet above ground level (AGL) on approved MTRs and are planned to terminate with the delivery of practice ordnance (munitions) at the Luke Air Force Range. These routes are coordinated with the Federal Aviation Administration (FAA) and approved as separate actions by major Air Command headquarters. These routes are published in the Department of Defense Flight Information Publications (FLIP) for distribution to interested aviation

personnel. The segments of those approved routes that cross the Tohono O'odham Reservation and the Organ Pipe Cactus National Monument are shown in Figure 2.3-2 (map lines mark route centers) and described in Appendix H. Avoidance areas are shown in Figure 2.3-3. Criteria for selecting routes is contained in FAA Handbook 7610.4 and in Tactical Air Command Regulation 55-34.

These routes are flown at altitudes described in FLIP, between 240 and 480 knots by one or more aircraft. Aircraft using the routes include the F-5, F-4, A-10, A-7, F-15, and F-16. Although most MTRs are charted and flown as low as 100 feet AGL, many aircrew members, such as those in upgrade training and other training courses, are restricted to a 500-foot AGL minimum altitude. Aircrews from Luke AFB are restricted to a minimum of 500 feet AGL while on a route that traverses the Tohono O'odham Reservation. When operational training requirements dictate and the aircrew is qualified, some aircraft will operate as low as 100 feet AGL on these routes. Currently, only the A-7 operates as low as 100 feet AGL and in excess of 250 knots on MTRs beneath the Sells Airspace. A-10 and OA-37 aircraft also operate as low as 300 feet but normally below 250 knots and outside of MTR corridors. The maximum of 250 knots below 10,000 feet is an FAA airspace restriction also placed on civilian aircraft.

2.3.2.2 Low Altitude Tactical Navigation (LATN)

This low altitude training is performed beneath the Sells airspace by slower, more maneuverable aircraft and differs from low altitude training on MTRs in that those slower aircraft do not follow MTRs. However, aircraft must avoid designated areas. This training is performed by A-10 and OA-37 aircraft while enroute to and from the Luke Air Force Range. The purpose of LATN is to prepare pilots for close air support of friendly ground forces in a medium/high threat environment and differs from low altitude training on MTRs in that the pilot has greater latitude in planning his entry/exit route to a target area. The pilot must be able to navigate at very low altitudes, using terrain features as necessary to prevent or reduce detection and interdiction by the enemy. The A-10 and OA-37 role in close air support missions must respond to changing battlefield conditions. Thus, the pilot can expect to be assigned new targets while airborne and must be able to plan and fly entry/exit routes to the target area tailored to the tactical situation. Training to develop these skills cannot be confined to established MTRs but requires wider areas. LATN missions will be flown in flights of two or more aircraft at airspeeds below 250 nautical miles per hour and at altitudes ranging from 300 to 1,000 feet AGL. Minimum altitude restrictions contained in Air Force Regulation (AFR) 60-16 are as follows:

a. "... pilots will not fly aircraft over congested areas such as a city, town, or settlement, or open air assembly of persons except at an altitude that insures at least 1,000 feet above the highest obstacle within a horizontal radius of 2,000 feet of the aircraft."

b. "... do not operate aircraft closer than 500 feet to any persons, vessel, vehicle, or structure."

Noise-sensitive areas can be avoided by the A-10, OV-10, and OA-37 aircraft because of their slower speed and excellent turning performance. Use of a wide area allows compliance with AFR 60-16 restrictions and avoidance of

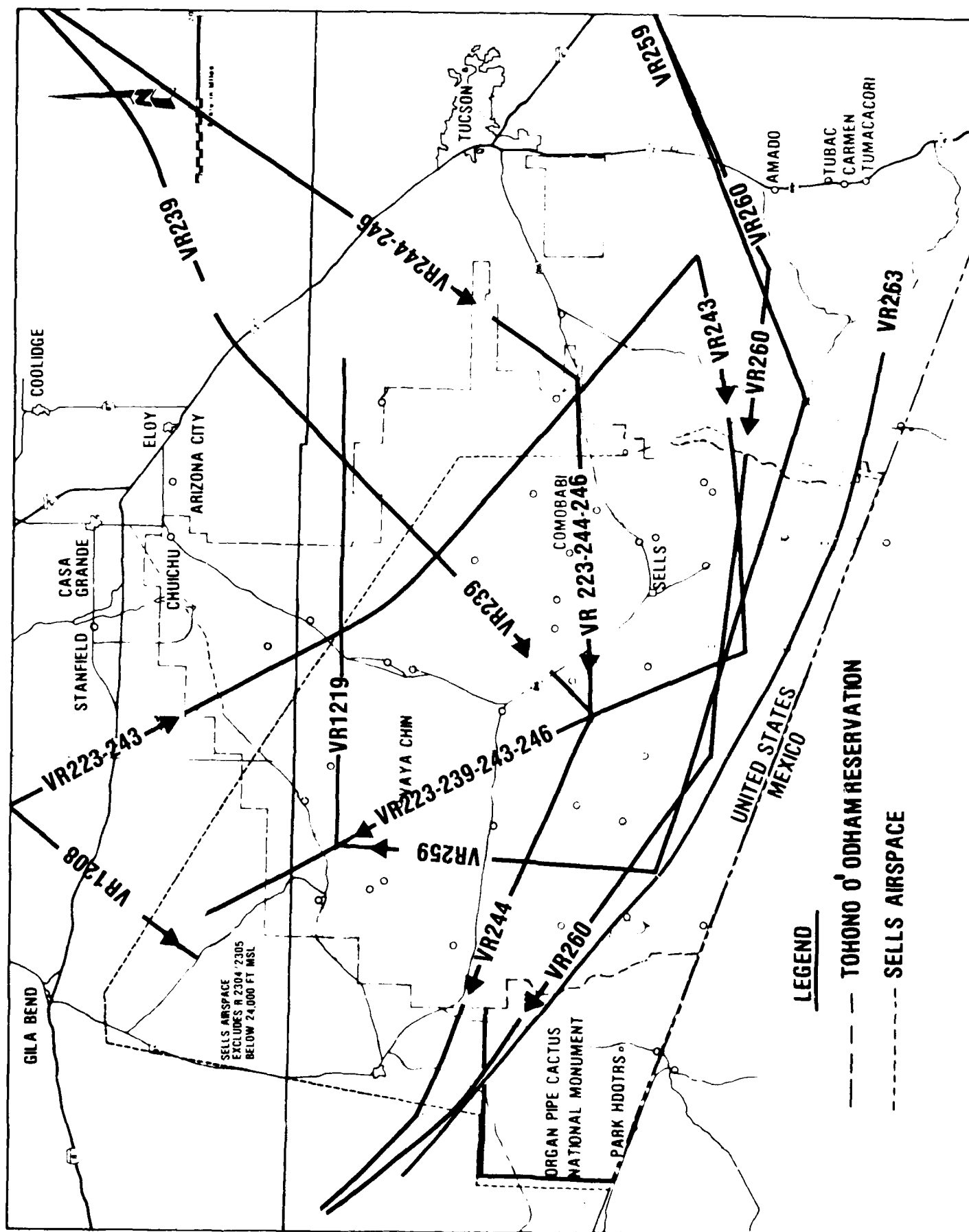


FIGURE 2.3-2. MILITARY TRAINING ROUTES IN THE SELLS AIRSPACE

sensitive areas without degrading the realism of LATN training. The areas used for LATN training and avoidance areas are shown in Figure 2.3-3.

2.3.3 FUNCTIONAL CHECK FLIGHTS

Certain types of major aircraft repair and maintenance require an aircraft to be test flown by a qualified pilot before its release for normal use. Prior to 1977 the Sells Airspace had been used for functional check flights at high altitude that were conducted at subsonic and supersonic airspeeds. Effective July 25, 1977, supersonic functional check flights in the Sells Airspace were prohibited. However, subsonic check flights are still flown in the same area as the air combat maneuvering (Figure 2.3-1).

2.4 TRAINING ACTIVITY IN SELLS AIRSPACE

This section describes the aircraft which are major users of the Sells Airspace and the level of training activity (number of sorties flown) for each aircraft.

2.4.1 DESCRIPTION OF AIRCRAFT

The A-10 is an aircraft designed specifically for close air support missions. It offers a unique combination of large payload, long loiter, and wide combat radius to ensure operational flexibility. It is equipped to defeat a whole array of targets, including tanks, encountered when supporting ground forces. The A-10 is a twin-engine, nonafterburning subsonic aircraft with a wingspan of 57 feet 6 inches, a length of 53 feet 4 inches, and a height of 14 feet 8 inches.

The A-7 is a single-engine, nonafterburning subsonic tactical fighter. With a wingspan of 38 feet 9 inches, a length of 46 feet 1-1/2 inches, and a height of 16 feet 3/4 inches, the A-7 is an outstanding weapon system for close air support roles.

The F-4 is an all-weather multirole fighter capable of achieving air superiority and performing close support and interdiction missions. It is a supersonic twin-engine afterburning aircraft, with a wingspan of 38 feet 7-1/2 inches, a length of 63 feet, and height of 16 feet 5-1/2 inches.

The F-5 is a twin-engine highly maneuverable air-superiority fighter used by allied foreign countries. This afterburning supersonic tactical fighter is capable of carrying two 20-millimeter (mm) cannons and several missiles, or bombs. The F-5 is used for training pilots in air combat maneuvering and is used to train pilots of user countries. It has a wingspan of 26 feet 8 inches, a length of 47 feet 4-3/4 inches, and is 13 feet 4 inches in height.

The F-15 is a twin-engine turbofan afterburning multi-role fighter that has replaced the air-superiority role of the F-4, and will progressively replace the air to ground role. It is a high altitude supersonic fighter capable of operating at low altitudes. It has a wingspan of 42 feet 9-3/4 inches, a length of 63 feet 9 inches, and a height of 18 feet 5-1/2 inches.

The F-16 is a highly maneuverable air-superiority air-to-ground tactical fighter. It has a single afterburning turbofan engine and is capable of supersonic flight. The F-16 generally carries one 20-mm multibarrel cannon and air-to-air or air-to-surface missiles and bombs, and has a wingspan of 32 feet 10 inches, a length of 49 feet 6 inches, and a height of 16 feet 8 inches.

The OA-37 is a twin-engine nonafterburning turbojet used for forward air control duty in support of ground forces. This subsonic aircraft has replaced the O-2s and OV-10s. The OA-37 has a span of 35 feet 10-1/2 inches, length of 28 feet 3-1/4 inches, and height of 8 feet 10-1/2 inches.

2.4.2 CURRENT ACTIVITIES

The amount or level of flying training activity in and beneath the Sells Airspace is shown in Table 2.4-2. This table shows the number of sorties flown for each aircraft for calendar year 1985 and beyond. Totals of sorties flown are also shown.

A "sortie" consists of a single aircraft flight. The length of time for a sortie will vary from a low of 45 minutes to a high of 2-1/2 hours depending on aircraft type, configuration, air-to-air refueling, mission requirements, etc. The amount of time actually spent in or beneath the Sells Airspace during one sortie will vary from 10 minutes on a high-speed, low altitude navigation mission to 40 minutes on a high altitude intercept mission. The average time is 20 minutes per sortie. Low altitude navigation sorties will normally pass through or beneath the Sells Airspace once if flown from a base in the Phoenix area, or twice if flown from a base in the Tucson area. Other types of sorties will maneuver in the assigned airspace for the scheduled time, flying over the same points several times.

The Sells Airspace is normally activated between the hours of 7:00 a.m. and 7:00 p.m. local time with occasional periods scheduled until 10:30 p.m. for night training. Scheduling of the Sells Airspace is controlled by the 832nd AD, Luke AFB. MTRs beneath the airspace are scheduled separately.

Some of the training sorties flown by certain types of aircraft shown in Table 2.4-2 were flown along MTRs. A breakdown of the type of aircraft using specific routes and the corresponding 1985 sortie rates are shown in Table 2.4-1.

2.4.3 FUTURE ACTIVITIES

The number and type of sorties scheduled to be flown in and beneath the Sells Airspace are shown in Table 2.4-2. These include sorties flown on MTRs and in LATN areas beneath the Sells Airspace, and sorties flown in the Sells Airspace. National Guard and Air Force Reserve units are projected to add the F-16 aircraft to their inventory in the late 1980's, however visiting ANG units are expected to continue use of the F-4 for the near future.

MTRs will continue to be used to provide low altitude training for Tactical Air Command aircrews. The existing MTRs shown in Figure 2.3-2 will continue to be used. Visual Route (VR) 263, scheduled by the Tucson Air National Guard (ANG) will begin operation in 1988, and will be used by A-7, A-10, OA-37 and F-16 aircraft.

TABLE 2.4-1
TRAINING ROUTE SORTIE RATES FOR CY 1985
MILITARY TRAINING ROUTES

Type Aircraft	VR 223	VR 239	VR 243	VR 244	VR 246	VR 259	VR 260	VR 1219	Total Sorties
A-4	6	28	4	7	1	-	-	-	46
A-6	-	2	-	-	-	-	-	-	2
A-7	56	12	6	62	5	450	729	2	1322
A-10	4	55	-	4	-	300	486	-	849
F-111	-	1	-	-	-	-	-	4	5
AV-8	-	6	2	-	-	-	-	-	8
F-4/RF-4	14	17	30	16	4	-	-	-	81
F-5	33	12	18	144	76	-	-	4	287
F-15	135	4	6	4	-	-	-	-	149
F-16	2123	87	221	80	-	-	-	12	2523
T-38	-	20	4	6	-	-	-	-	30
Other	-	2	9	3	1	-	-	6	21
Total Sorties	2371	246	300	326	87	750	1215	28	5323

Notes:

1. The following MTRs shown in Draft EIS have been discontinued: VR 242, VR 257, VR 258, VR 267, VR 268, VR 293, IR 240.
2. VR 1219 was approved in 1984.
3. VR 263 scheduled to begin operation in 1988.

TABLE 2.4-2
 EXPECTED UTILIZATION -- SELLS AIRSPACE: FUTURE
 CY ESTIMATES

Unit/Aircraft	1985	1986	1987	1988	1989	1990
425 TFS/F-5	5000(100)-----					5000(100)
405 TTW/F-15	9606(3202)	7945(2648)	7945(2648)	7945(1848)	7945(1048)	7945(648)
58 TTW/F-16	6795(1818)	6855(1818)	8028(2121)	9080(2424)	9080(2424)	9080(2424)
302 SOS/F-16	-	1100(300)	1985(606)-----			1985(606)
162 TFG/F-16	-	207(19)	2092(122)	3002(175)-----		3002(175)
162 TFG/A-7	3608	3597	3571	3561-----		3561
355 TTW/A-10	10364-----					10364
602 AIRCW/OA-37	4065-----					4065
Others	1700-----					1700
Total	41138(5120)	40833(4885)	44750(5597)	46702(5153)	46702(4353)	46702(3953)

Note:

1. Figures in () are supersonic sorties.

The base altitude of MTRs scheduled by Luke AFB currently 500 feet AGL is projected to be lowered to 100 feet AGL where feasible, though much activity will take place at 300 feet AGL to accommodate training by aircrews flying with the LANTIRN system. Most of the MTRs shown in Figure 2.3-2 were reviewed by the Tohono O'odham, and changes made to lessen the impact on individuals living under the airspace. Similar coordination is expected for any future changes to these MTRs.

LATN is expected to continue at approximately 14,000 sorties per year. The areas shown in Figure 2.3-3 currently being avoided by aircraft flying LATN will continue to be briefed as areas to avoid. Additional areas to be avoided will be considered as necessary.

Supersonic activity down to 10,000 feet MSL will continue, though at a reduced level. The introduction of the F-15E at Luke AFB, and the subsequent decrease in F-15A/B aircraft will cause a decrease in the level of supersonic activity over the Sells Airspace since the F-15E will fly more air to ground missions rather than air to air missions which involve supersonic flight. Table 2.4-2 shows the projected decrease.

2.5 OPERATIONAL CONCEPT FOR SELLS AIRSPACE

The following section describes the composition of the Sells Airspace and its operational uses.

2.5.1 MILITARY TRAINING CONDUCTED ABOVE 3,000 FEET

Federal Aviation Administration Handbook 7610.4, Special Military Operations, requires air combat maneuvering to be conducted in special use airspace or MTRs when maneuvering occurs below 10,000 feet MSL at speeds exceeding 250 knots. Therefore, the Sells Airspace is designated as a special use airspace in order to provide sufficient airspace to conduct military aircrew training essential to the national defense. Figure 2.5-1 illustrates the extent of the Sells special use airspace and shows horizontal limits of the various areas described below. Figure 2.5-2 illustrates the vertical zones.

2.5.1.1 Military Operations Area (MOA)

Those portions of the Sells Airspace below 18,000 feet MSL are called Sells Military Operations Areas (Sells MOAs). Its purpose is to reduce the potential for mid-air collisions by charting the airspace so nearby FAA Flight Service Stations (FSS) and other interested aviation personnel are aware of the military training being conducted in the area.

The Sells Low MOA airspace is established from 3,000 feet above ground level (AGL) to 10,000 feet MSL. The airspace is necessary to permit existing and future USAF required flight operations in the Sells Airspace and to enhance flight safety of the entire aviation community operating in or through the area. The flight operations in the Sells Low MOA consist primarily of ingress/egress to the Luke Air Force Range.

The Sells 1 MOA is that airspace between 10,000 feet MSL and 18,000 feet MSL. This airspace is available for formation, transition and instrument training, functional flight checks, and air combat maneuvering. Some air intercept training is also conducted in the Sells 1 MOA. Some portions of the flights in this airspace maybe supersonic.

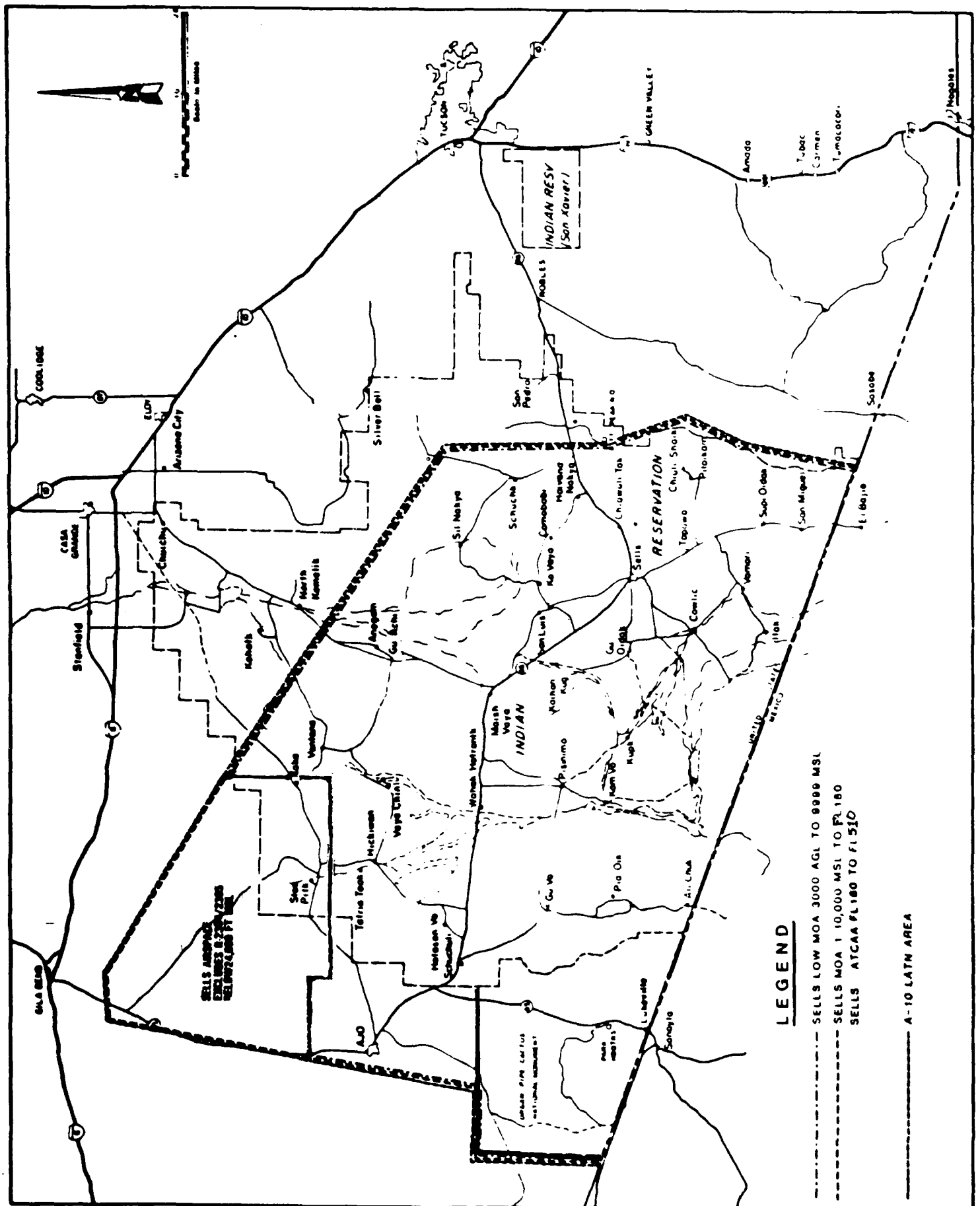


FIGURE 2.6-1. Sells MOAs and ATCAAs

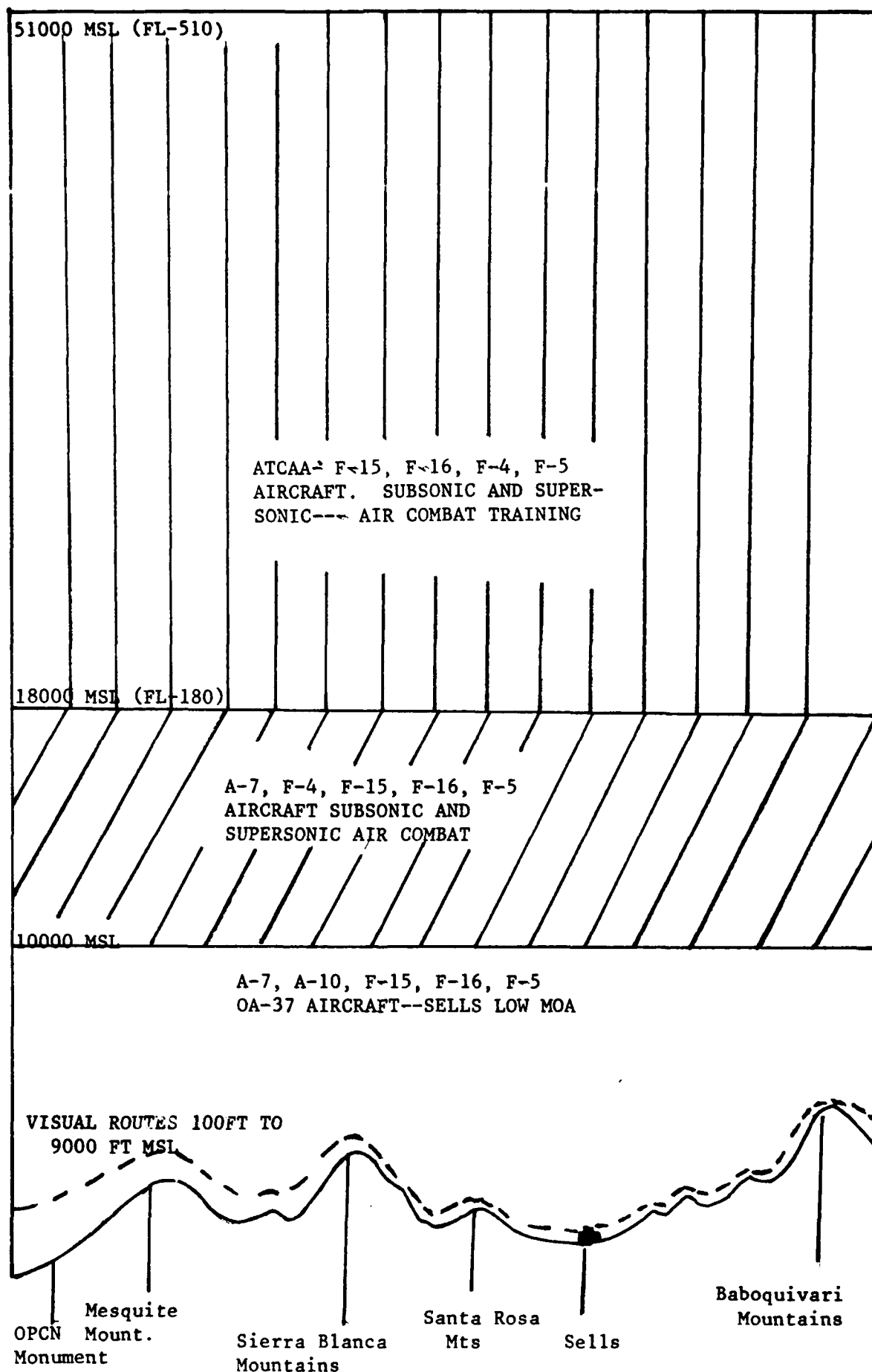


FIGURE 2.5-2. Vertical Zones Within The Sells Airspace
2-14

2.5.1.2 Air Traffic Control Assigned Airspace (ATCAAs)

The Sells Airspace above 18,000 feet MSL except for R-2304/2305 is composed of the Sells ATCAA. This airspace is used primarily for air combat maneuvering and air intercept training. Most of the supersonic flying activity takes place in this airspace. Figure 2.5-2 is a cross-sectional illustration of the various levels (altitudes) of airspace and their identifying names.

2.5.2 MILITARY TRAINING CONDUCTED BELOW 3,000 FEET AGL

The two types of training conducted below 3,000 feet are subsonic flights on MTRs and LATN. MTRs are developed by individual Air Force bases, coordinated with FAA, approved by major Air Command headquarters, and published in FLIP to accommodate low-level training flight operations for all military aircraft overflying the Tohono O'Odham Reservation and the Organ Pipe Cactus National Monument below 3,000 feet AGL at speeds above 250 knots. This procedure reduces the flexibility and/or responsiveness in establishing and/or adjusting MTRs to avoid newly identified noise/time-sensitive areas. Because the administrative procedure to select, coordinate, and obtain approval is lengthy, care and restraint are exercised when making route segment changes.

Since LATN is conducted at airspeeds less than 250 knots, there is no requirement to publish a formal route area. These low-level operations are expected to continue over the Tohono O'Odham Reservation and the Organ Pipe Cactus National Monument for the foreseeable future. Air Force policy requires consultation with any potentially affected communities in the selection of MTRs. While LATN areas do not require publication or a formal route, discussions between the Air Force and Tohono O'Odham Tribal Representatives have identified noise-sensitive areas that are to be avoided.

2.5.3 OTHER AIRSPACE USERS

While the presently established Sells Airspace is used primarily by USAF/ANG units to conduct various phases of flight training, the airspace is available to civil aviation. Commercial airlines formerly operated approximately one flight per day each way between Tucson VORTAC and Puerto Penasco, Mexico. Sufficient airspace between 30,000 feet MSL and 37,000 feet MSL was made available by Albuquerque Air Traffic Control Center, in coordination with the 832nd AD, to permit safe passage of an occasional commercial airliner and private jet aircraft as necessary. Airspace between 100 feet and 12,500 feet AGL is occasionally made available for customs officials operating out of Tucson, AZ.

Small airports are located at Ajo, Pisinimo, and Sells, and air traffic is generally small in volume and consists of light general aviation aircraft. Provisions have also been made to permit general aviation traffic to transit R-2305 at 500 feet AGL on a non-interference with military use basis. These aircraft use the Sells Airspace below 18,000 feet MSL. Designation of a MOA does not prevent civilian aircraft operating on a visual flight rules (VFR) clearance from flying through or in the MOA even when military activity is being conducted therein, but the volume and nature of military use tends to discourage civilian use. Civilian aircraft operating on an instrument flight rules (IFR) clearance may be cleared through/into a MOA if FAA Air Traffic Control can provide IFR separation from other aircraft.

The airspace management function of the 832nd AD has not received any complaints pertaining to use of the Sells Airspace by civilian aircraft and is not aware of any problems arising from such use.

2.6 EXISTING LAND AREA CHARACTERISTICS BENEATH THE SELLS AIRSPACE

This section describes the land resources and the socioeconomic conditions of the area beneath the Sells Airspace as it currently exists. Because flying training has been conducted in the Sells Airspace since early in World War II, actual environmental baseline conditions (conditions of the environment prior to the action) cannot be established. Supersonic activity by jet fighters training in the Sells Airspace began in about 1955.

The following sections characterize other components of the existing environment and present impacts on the environment because of current use of the Sells Airspace.

2.6.1 LOCATION

The Sells Airspace overlies portions of three southern Arizona counties: Maricopa, Pinal, and Pima. Encompassing 7,100 square miles (statute), the bulk of the land mass under the Sells airspace is in western Pima County, extending south from a point within the Tohono O'Odham Reservation west of Tucson to the U.S. border beginning at the eastern boundary of the Tohono O'Odham Reservation and continuing westward to the Organ Pipe Cactus National Monument. Portions of the airspace flank the main Tohono O'Odham Indian Reservation to the west. Of the 4,435 square miles included in the main reservation, approximately 80 percent lies within the boundaries of the Sells Airspace. About 80 percent of the reservation's land is also within Pima County, while the reservation accounts for approximately 50 percent of the county's land area. This area includes the principal city in the reservation, Sells, the Organ Pipe Cactus National Monument, and the Kitt Peak National Observatory.

Figure 1.1-1 depicts the Sells Airspace, the Tohono O'Odham Reservation, the Organ Pipe Cactus National Monument, and those portions of Maricopa, Pinal, and Pima counties underlying the airspace. The two smaller and separate land areas that are a part of the Tohono O'Odham Reservation -- San Xavier, southwest of Tucson, and Gila Bend, north of the town of Gila Bend -- are not located under the Sells Airspace.

2.6.2 THE NATURAL ENVIRONMENT

2.6.2.1 Topography

The land under the Sells Airspace is in the Sonoran Desert at the southern edge of the Basin and Range province. The area is characterized by small, generally north-south trending mountain ranges separated by broad, semiarid valleys. The valley floors are formed by overlapping alluvial fans spreading from the mountains. Drainage is to the Rio Sonoyta to the south or to the Gila River to the north. Elevations range from slightly less than 1,000 feet MSL near the southwest corner of the Organ Pipe Cactus National Monument to 7,730 feet MSL at Baboquivari Peak on the eastern boundary of the Tohono O'Odham Reservation.

2.6.2.2 Climatology

The nearest first-order weather station to the Sells Airspace is Tucson International Airport. The area weather is predominantly warm and dry. The majority of precipitation falls in July, August, and September. Snowfall is very sparse, averaging less than 1 inch per year. Heavy fog (less than 1/4 mile visibility) occurs less than 1 day per year. Winds predominantly blow from the south through the east-southeast, and wind speed generally averages 8 miles per hour for the year. A shallow nocturnal surface-based inversion forms in the evening and usually disappears by early afternoon. Climatology is discussed in more detail in Appendix A.

2.6.2.3 Air Quality

Determining the effect of USAF/ANG use of the Sells Airspace on air quality differs from the normal EIS procedure because aircraft emissions have been present since before modern air quality monitoring began. In this case, aircraft emissions were calculated and compared to the total background concentrations of pollutants (which included those from the aircraft). A detailed description of the methods used and the results of the calculations are included in Appendix A. Most of the concentrations of pollutants are considerably below the federal and state primary and secondary standards for air pollutants. Exceptions are sulfur dioxide (two violations of the 3-hour standard at Ajo in 1980), total suspended particulates (TSP) (three violations of the 24-hour standard at Casa Grande and three at Stanfield in 1981) and Carbon Monoxide. The Ajo area has been designated a nonattainment area (that is, air quality worse than the ambient standards) for TSP and sulfur dioxide. Pima County has been designated a nonattainment area for carbon monoxide (localized around Tucson).

The impact of current aircraft operations in the Sells Airspace on the ambient air quality is minor. A detailed discussion of air quality is contained in Appendix A.

2.6.2.4 Noise Impacts of Current Activities

2.6.2.4.1 Subsonic Noise Impact

The subsonic noise impact beneath the Sells Airspace results primarily from low level training conducted along Military Training Routes (MTR) and in low altitude tactical navigation (LATN) areas. Table 2.4-1 shows the level of current MTR activity and Figure 2.3-2 shows the location of the MTRs. In calendar year 1985, 5323 low level sorties (22 sorties/day) were flown on MTRs crossing beneath the Sells Airspace. Based on the sortie rates and the type of aircraft operating along these routes, the noise levels where VR 223, 239, 243 and 246 coincide, or where VR 223, 244 and 246 coincide, are expected to generate the greatest noise impact to established communities. However, due to the established avoidance procedures, the nearest communities are from two to three miles from either of the segments, and at that distance no environmental impacts are anticipated to established communities.

Currently, the greatest subsonic impact occurs in the remote areas directly beneath the MTRs and away from the established communities. Table 2.6-1 shows the dispersal of low level sorties over the MTRs, and the resulting noise

levels expressed in DNL. The DNL values were calculated for the F-16 aircraft at 500 feet AGL since the F-16 is the predominant user of the MTRs scheduled by Luke AFB, and 500 feet AGL is the base altitude of the MTRs. The analysis represents the worst case since it assumes each sortie passes over the same spot on the ground during the 24 hour period. It is considered highly unlikely that every sortie on a MTR would pass over the same spot since MTRs beneath the Sells Airspace are from two to ten miles wide. A statistical analysis of the probable dispersion of sorties over the width of the MTRs indicate that 25% is a more reasonable assumption, though it is still considered a conservative approach. Therefore also provided in Table 2.6-1 are DNL values representing the case where 25% of all sorties pass over the same spot on the ground during the 24 hour period. For VRs 259/260 scheduled by Davis-Monthan AFB, the DNL were taken from the Environmental Assessment for the Beddown of F-16 Aircraft by the Tucson ANG (ANG, 1985). Though DNL values for rural areas generally range from 30 to 40 DNL, jet aircraft have operated in the Sells Airspace since the 1940's. The values in Table 2.6-1 are representative of noise levels underneath the MTRs and away from the established communities. However it is clear from the table that the noise levels from current operations do not approach the threshold for concern for potential hearing loss.

TABLE 2.6-1

Sortie Rates and DNL Values For The Sells Airspace
Military Training Routes (CY1985)

VR	No. of SORTIES	No. of #SORTIES/DAY	DNL ¹ (dB)	DNL ² (dB)
223	2371	11.0	61	55
239	246	1.0	-	-
243	300	1.0	-	-
244	326	1.0	-	-
246	87	0.4	-	-
1219	28	0.1	-	-
259	750	3.0	55	53
260	1215	5.0	57	54
263 ⁵	-	-	-	-
223 ³	2774	12.0	61	55
223 ⁴	3004	13.0	61	55

1. DNL calculated for F-16 at 500 feet AGL (100% of sorties passing over same spot on the ground).

2. Represents DNL for 25% of sorties passing over same point on the ground

3. Where VRs 223, 244 and 246 coincide.

4. Where VRs 223, 239, 243 and 246 coincide.

5. VR 263 scheduled to begin operation in 1988

6. The "-" represents case where too few sorties occur daily to calculate a DNL.

2.6.2.4.2 Supersonic Noise Impacts

Before discussing sonic boom impacts, a summary of the sonic boom phenomenon and characteristics specific to the Sells Airspace is provided. The reader who desires a more indepth review of this is referred to Appendix B. When aircraft exceed the speed of sound (Mach 1) a sonic boom is produced. The boom is an instantaneous sound similar to a thunder clap. Noise levels can vary considerably, depending on the aircraft size, speed, and distance to the observer. The maximum overpressure occurs directly beneath the aircraft and decreases as the lateral distance from the flight track increases. This basic travelling boom is called a carpet boom.

An important consideration in the assessment of the effects of sonic booms is that not all booms created are heard at ground level. Sonic shock waves or rays are created when an object is travelling at a rate greater than the speed of sound. The speed of sound at any altitude is a function of the temperature; decrease in temperature results in a decrease of sound speed, and vice versa. Under standard atmospheric conditions, the air temperature decreases with increases in altitude (for example, when the sea level temperature is 59°F, the temperature at an altitude of 30,000 feet has dropped to -49°F). Thus, there is a corresponding decrease in sound speed with increasing altitudes. This temperature gradient helps to bend the sound waves in an upward direction. At low supersonic speed the sonic shock wave will not penetrate below altitudes at which the local speed of sound is greater than the speed of the aircraft. Therefore, the shock waves are refracted back to higher altitudes if the plane moves subsonically with respect to the speed of sound at ground level, even though its speed is greater than the speed of sound at its operating altitude. For example, at 30,000 feet altitude, an aircraft's flight Mach number would have to exceed 1.13 before the boom would be heard on the ground (see Figure 3a in Appendix B-3). The heights and Mach number produced during F-15 combat maneuvering operations are such that less than one boom out of every three produced is likely to be heard at ground level. The other two of the three booms are refracted upward and are not heard at the ground. This same phenomenon, "cutoff", also acts to limit the width of sonic booms which reach ground level.

Elaborate procedures exist for calculating the pressure-time signature of sonic booms based on the specific shape and aerodynamics of the flight vehicle. An empirical procedure (Carlson 1978) has been developed for situations where peak overpressure is the feature of interest. The method allows determination of on-track and off-track overpressures for aircraft in level flight or in climbing and descending flight paths. The method uses basic aircraft operating conditions such as Mach number, altitude, weight and flight path angle. Comparisons with measured sonic boom overpressures and duration have shown that Carlson's predictive procedure is very accurate when atmospheric conditions are favorable for sound propagation. In nonstandard atmospheres (where there are winds and temperature deviations from the standard lapse rate which tend to distort the shock wave), the results are generally an overestimate and are thus considered to be the upper bound of the overpressure possible for the modeled conditions. The Carlson (1978) procedure is used in this analysis because it has been demonstrated to be sufficiently accurate in predicting overpressures in carpet booms, the predominate type expected in the Sells Airspace and the one that has the largest spatial affect. Additionally, supersonic flight in the Sells

Airspace predominately occurs during moderate climbs, descents and turns as well as level flight. These operations are satisfactorily handled by the Carlson procedure. Tight turns, pushovers, dives and acceleration maneuvers can generate waveforms that overlap (focus) at a fixed location. These waveforms (focused booms) are not sufficiently accommodated by the Carlson procedure; however, their environmental consequences and contribution to spatial affect type analysis will be covered later.

To assess the probable significance of supersonic operations in a MOA, flight parameters should be modeled so overpressures and long term noise levels can be predicted. During air combat maneuvering operations an aircraft's altitude, speed and duration of supersonic flight varies during the training mission; on an individual basis, the ground track appears random. Modeling these conditions requires real time acquisition of the aircraft's position, speed and acceleration. The Department of Defense has installed instrumentation that will provide the needed data at selected MOA's and ranges. The instrumentation (Air Combat Maneuvering Instrumentation) systems provide a video tape of the complete mission including display of all vital data for each aircraft. While the ACMI system is primarily for pilot debriefings, it is ideal for obtaining operational data to evaluate (model) operational conditions.

An ACMI system was used in a study conducted at the Oceana MOA (W-72 off the coast of North Carolina) where the F-15 based at Langley AFB conducted training operations similar to those being conducted in the Sells Airspace. Researchers used the result of the Oceana study to develop a model of the parameters of Air Force supersonic flight operations. Further study of the type conducted in Oceana was performed in the ACMI range in the Luke Air Force Range near the western edge of the Sells Airspace. The operations flown in the Luke Range as part of this study were flown by the same pilots flying similar operations as those flown in the Sells airspace. The results of the Luke Range Supersonic study agreed favorably with the Oceana study, and are used to define the extent of supersonic operations in this analysis. By using the supersonic flight track data from the Luke Range ACMI, and the procedures developed in the Oceana study, the impact of the supersonic operations in the eastern and western sections of the Sells Airspace was determined. Data obtained through the Luke Range ACMI and the number of sorties expected to be flown in each half of the Sells Airspace were used for calculating C-Weighted Day-Night Average Sound Levels (CDNL).

TABLE 2.6-2

Distribution of Oceana Test Sonic Boom
Overpressures Adjusted For Sells Airspace Flying and Ground Altitudes

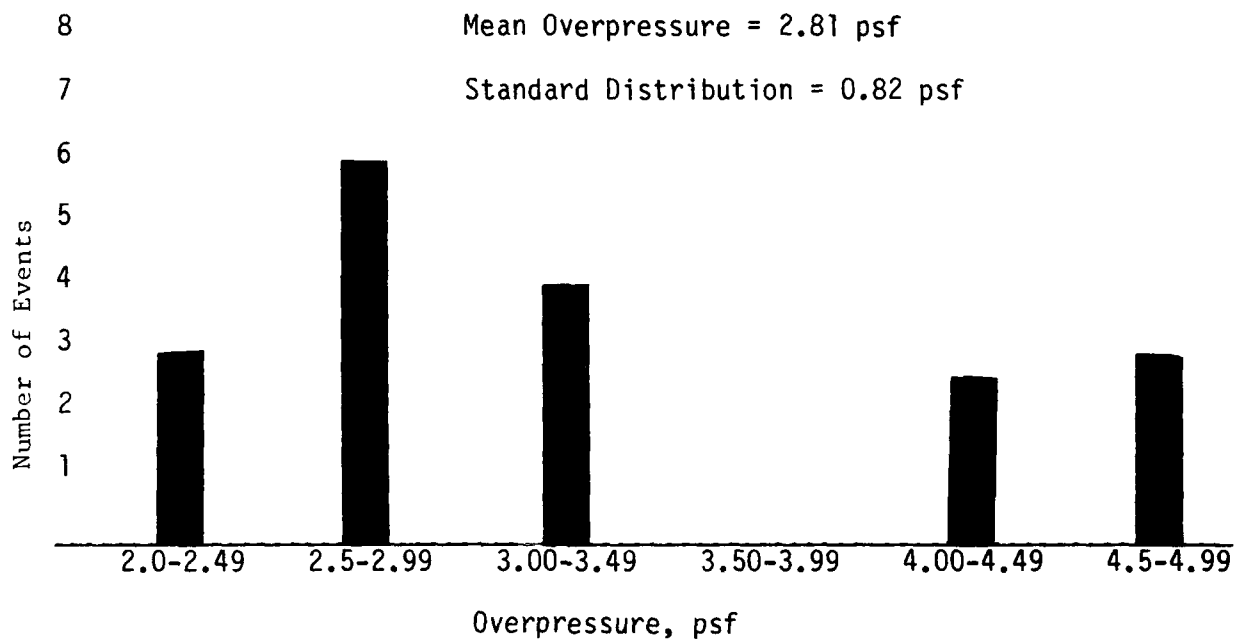


TABLE 2.6-3

Expected Sells Airspace
Carpet Boom Overpressures
East and West Ellipses

Overpressure (psf)	Expected % of Booms Exceeding Overpressure
1	99
2	92
3	62
4	21
5	3
6	0.1 (1 in 1,000)

Note: These values are based on maximum aircraft speeds. Average overpressures for any supersonic flight would be 5 to 10% less.

A statistical analysis of Oceana data provides some insight into the expected frequencies and intensities of sonic booms for the Sells Airspace. The number of events per overpressure that occurred in Oceana can be normalized to Sells conditions by making a nominal 2,500 foot altitude correction. These data are presented in Table 2.6-2. The mean overpressure value for the 18 normalized events is 3.27 pounds per square foot (psf) with a standard deviation of 0.88 psf. Assuming a normal distribution for the data, the relative occurrence of different boom strengths can be evaluated. Table 2.6-3 provides this estimate and also clearly demonstrates that the average sonic boom will be in the 2 to 4 pounds per square foot carpet boom range; the statistics also indicate that only one in 1,000 will exceed 6 pounds per square foot. The data in these tables represent a worst case analysis because for each Oceana supersonic event, the lowest altitude and highest Mach number that occurred during the event were recorded as the data points for the event.

Results of analyzing 21 Oceana sorties show the average time an aircraft spent in the MOA was 20 minutes. During this time the 21 aircraft went supersonic 56 times, or 2.7 times per sortie. Of these 56 events 18 were at a Mach number above cutoff. This equates to about 30 percent of the supersonic events producing a sonic boom that would hit the ground, or 0.8 booms per sortie. The average time for the supersonic events was 15 seconds. Thus, during about one percent of the time the aircraft is within the MOA it is, on the average, propagating a boom.

Based upon the sortie rates for the F-5, F-15, and F-16 aircraft that perform supersonic flight during ACM and intercepts, the rates for boom generation determined during the Oceana study may be applied to supersonic activities in the Sells Airspace. Table 2.4-2 provide calendar year (CY) 1985 supersonic sorties rates.

Total annual combined F-5, F-15, and F-16 sorties where supersonic flight is expected to occur is 5120 sorties. On a daily basis this equates to 22 sorties per day when the generation of sonic booms is expected. Using the Oceana average of 0.8 booms per sortie that would hit the ground, 18 booms per day would be expected to impact the ground under the Sells Airspace. Since the Sells Airspace is often operationally divided into two areas, each area is expected to receive an average of nine (9) booms per day that would impact the ground.

Although the entire Sells airspace is used for supersonic flight, the Luke Air Force Range ACMI data indicates that air combat maneuvering operations are expected to be conducted in an area of roughly elliptical shape that is 36 miles wide and 48 miles long. This area would contain approximately 95+ percent of the supersonic flights conducted in either half of the airspace. These data indicate that the average area of coverage for booms that reached the ground was 51 square miles (HQ TAC 1983).

From about the 0.8 cutoff distance the sonic boom pressure wave decays rapidly as the lateral distance approaches cutoff. Thus, considering the randomness of the flight tracks, if a sonic boom were generated at the edge of the supersonic maneuvering ellipse, half of the effect of the boom would be outside the ellipse. Therefore, two more ellipses are the 0.8 (56 CDNL) and 1.0 (46 CDNL) cutoff points for any given sonic boom occurring along the edge of the supersonic maneuvering ellipse.

These latter ellipses have dimensions of 41.7 x 53.7 and 43.1 x 55.1 miles, respectively. The area covered by the 0.8 cutoff ellipse is 1,759 square miles and about 1,865 square miles for the 1.0 cutoff ellipse (HQ TAC, 1983).

Based on the terrain, training requirements and location of towns and villages under the Sells Airspace, Figure 2.6-1 is illustrative of one probable orientation of the supersonic maneuvering ellipses and the accompanying 0.8 and 1.0 cutoff ellipses. The reader should note the entire Sells Airspace is used for supersonic operations.

As with any area where supersonic operations are conducted, the residents are concerned with the number of booms expected to occur as well as the range of overpressures. Past experience indicates individuals living within a MOA, on average, will hear no more than two to three sonic booms per day. Statistical analysis of the Oceana MOA data generally supports this conclusion.

The two supersonic maneuvering ellipses depicted in Figure 2.6-1 would be expected to receive nine (9) sonic booms each per day. One ellipse is shown in the eastern half of the Sells Airspace (Areas C and D) and the other in the western half (Areas A and B). Supersonic operations are approximately equally split between the eastern and western sections. The primary entry points are located in the northern portions of Areas A and C and in the southern portions of Areas B and D, yielding a north-south orientation to the major axes of the ellipses. The western section also has entry points near the eastern and western boundaries of Areas A and B. The supersonic flight track data used to define the supersonic maneuvering ellipses were obtained from actual operations conducted near the western edge of the Sells Airspace. The ellipses shown adequately account for the supersonic operations in the Sells Airspace.

To determine the probability of an observer hearing a sonic boom at any point on the ground and beneath the supersonic maneuvering ellipses, a statistical method is used based upon a binomial distribution.

Assuming a binomial distribution in which all events are independent and randomly distributed and only two outcomes are possible (boom or no boom), the probability of any given number of booms hitting the ground is given by:

$$P(y) = \frac{n!}{(y!)(n-y)!} (p)^y (1-p)^{n-y}$$

where $P(y)$ = the probability of y number of booms hitting the ground,

n = number of booms

p = probability of a boom hitting the ground,

y = number of booms hitting the ground.

From a spatial point of view, the probability of a boom hitting the ground on any one trial is equal to the area of the boom divided by the area of the maneuvering ellipse (51 sq mi/1,357 sq mi = 0.0376, which is the average probability across the maneuvering ellipse). The number of trials are taken as 9 booms per day. Analysis of Figure 5 in Appendix B-3 shows the probability of an aircraft being supersonic at the center of the maneuvering ellipse is about two times greater than the mean probability; the value for the edge of the ellipse is

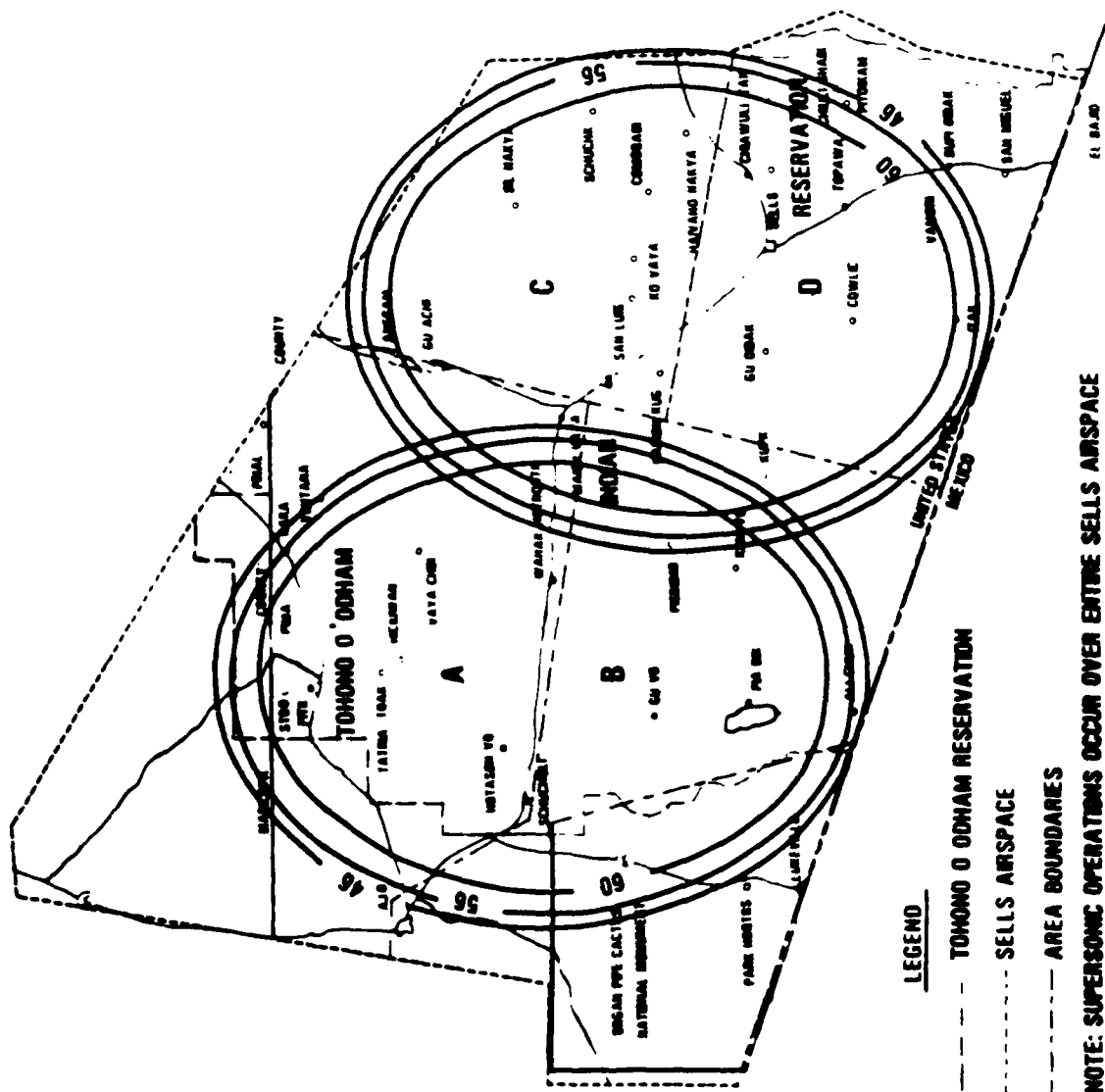


FIGURE 2.6-1 PREDICTED C-WEIGHTED DAY-NIGHT AVERAGE SOUND LEVELS FOR TYPICAL SUPERSONIC OPERATIONS (dB) (1985)

conservatively taken to be one-half the mean probability. Table 2.6-4 provides the statistical review of the probability of hearing different numbers of booms for the maneuvering ellipse edge and center as well as the ellipse average.

The mean number of booms expected to be heard is the number of booms times the probabilities of hearing a boom (0.0376 for ellipse average, 0.075 for ellipse center and 0.019 for the ellipse edge). These values are tabulated in Table 2.6-5 along with the probabilities of hearing no booms and hearing three or more booms on any given day. The ellipse average is less than one boom per day. Likewise, those individuals living on the edge of the maneuvering ellipse would expect to hear less than one boom per day (on any given day they have a 86 percent chance of not hearing a boom at all).

In addition to the data collected in the Oceana study, tests were conducted by the Air Force in June 1978 in the Valentine MOA at the request of state agencies and area residents. The results were consistent with those of the Oceana study. A summary of these test operations is provided in Appendix B.

Some supersonic maneuvering operations may produce a focus boom. The phenomenon can occur when shock waves from an aircraft in supersonic flight converge on the same point in space at the same time. The point of convergence can occur either on the ground or at some point in the atmosphere.

Maneuvers that can produce such an effect are longitudinal acceleration, as long as the aircraft is at an altitude and Mach number combination that is above cutoff; pushover from a climb, as long as the curvature of the flight path is sufficient; and constant speed turns, as long as the rate of change in heading is great enough. Obviously, combinations of these maneuvers also can produce focusing of the boom. Typically these booms affect a relatively small area (on the order of much less than one square mile) and occur at a geographically fixed location relative to the flight track. Within the focus zone two or more secondary booms may occur, but the magnitudes are substantially lower than those of carpet booms for the same Mach numbers. Although pressure increases of two to five times that of normal carpet booms have been measured (Thery and others 1972; Maglieri and others 1972), and one study (Wanner and others 1972) measured up to nine times the nominal carpet, a highly stable atmosphere must exist for these events to occur. More generally, atmospheric turbulence and wind shear reduce the possibility of such increases to values of two to four times the normal overpressure. Often atmospheric turbulence will cause a defocusing effect that dissipates the boom completely (Galloway 1982). A most important point is that the peak pressure of a focus boom decays much more rapidly than in a carpet boom and thus, the positive impulse is much lower (contains less energy) than a carpet boom of the same overpressure (Galloway 1982).

As previously indicated, Carlson's procedure for calculating carpet boom overpressures is not suitable for calculating focus boom overpressures. Procedures are available; however, to determine overpressure values as well as predict the location of the boom if real-time weather and accurate flight data are available. Galloway (1982) has suggested a generalized procedure for use in environmental analysis since precise flight data and weather information cannot be reliably estimated.

TABLE 2.6-4

Probability of a Carpet Boom Occurrence at a Given Location

Number of Booms "N"	% Probability ^a of Hearing "N" Booms in Maneuvering Ellipse			% Probability ^a of Hearing "N" or More Booms in Maneuvering Ellipse		
	Average	Center	Edge	Average	Center	Edge
0	73.6	53.6	85.7	100.00	100.00	100.00
1	23.0	34.4	13.3	26.4	45.9	14.6
2	3.1	9.8	0.98	3.1	11.5	0.94
3	0.25	1.5	0.04	0.26	1.7	0.04
4	0.01	0.15	--	0.01	0.16	--
5	--	0.01	--	--	0.01	--
6	--	--	--	--	--	--

a. Per ellipse

b. Due to rounding, sum of numbers do not equal 100.00 in all cases.

TABLE 2.6-5
Summary of Carpet Boom Probabilities

Location	Chance of Hearing No Booms	Chance of Hearing 3 or More Booms
Ellipse Center	53.6%	1.66%
Ellipse Average	73.6%	0.26%
Ellipse Edge	85.7%	0.04%

TABLE 2.6-6
Probability of a Focus Boom Zone Occurring at a Given Location

Type Maneuver	Focus Zone	Super Focus Zone
Acceleration/Pushover	0.0003	--
Turns	0.0002	0.00006

Note: Where overpressure exceeds that from rectilinear flight conditions.

General characteristics of focus booms can be used to develop statistical models (Galloway 1982):

Two cases can be examined by treating longitudinal acceleration and pushovers as one situation, and constant speed turns and turn entries as a second situation.

Consider longitudinal acceleration and pushovers first. As an airplane accelerates from subsonic to cutoff Mach number, no boom reaches the ground. As the airplane passes through the Mach number for cutoff at the airplane's flight altitude, the incident and ground-reflected shock waves combine to produce a pressure rise. The pressure rise in excess of the overpressure for a normal N-wave at that Mach number and altitude can occur within a short distance along the flight path, on the order of 300 feet or less wide, spreading laterally as a thin crescent shape area which decreases in width until it disappears at the lateral cutoff distance. (Lateral cutoff distance is approximately 1.5 times airplane height above ground.) The location of the focal zone is fixed geographically by the airplane's flight path, and does not move along the ground as in the case of carpet booms. Beyond this "focus" boom zone, as the airplane flight progresses, a normal N-wave is produced as a carpet boom. It is accompanied by one or more secondary booms, with magnitudes approximately equal to the carpet boom at the focus zone, decaying rapidly with distance along the flight path. The secondary booms occur slightly delayed in time, so that a ground observer hears two (or more) booms in rapid succession.

Pushover maneuvers provide a similar crescent shaped focus zone. In this case the crescent shaped zone is reversed in direction. Statistically, for impact analysis purpose, the two maneuvers can be considered the same phenomenon.

Supersonic turns produce focus effects if the rate-of-change of airplane heading exceeds a value determined by airplane Mach number and altitude. In practice, military maneuver altitudes, Mach numbers and bank angles are of a magnitude that could result in a focusing effect. These booms will not reach the ground unless the Mach number and altitude exceed cutoff conditions for rectilinear flight. For a constant rate turn, the focal line is fixed on the ground, located on a circular arc having the same origin as the airplane's turn, with a radius equal to or slightly less than that of the airplane's flight path. No booms reaches the ground inside the focus radius.

A focus zone, approximately 300 feet wide, or less, around the focal arc, has the same pressure rise above nominal boom overpressure for rectilinear flight, at the same Mach number and altitude, as discussed above for longitudinal acceleration. Outside the focal zone primary N-waves are produced with overpressures lower than those for rectilinear flight, decaying in magnitude with increasing distance in a similar manner as N-waves decay in magnitude at points lateral to the flight path in rectilinear flight.

As in the case of longitudinal acceleration, secondary N-wave booms of reduced magnitude are produced at points outside the airplane turn

radius. Again, these booms decay rapidly in magnitude as distance outside the turn increases.

Under optimum weather conditions for stable sound propagation, a super focus condition can exist when an airplane starts a turn from a rectilinear flight path. This effect can cause a pressure rise of up to nine times the nominal rectilinear flight overpressure if the atmosphere is extremely stable. According to Galloway (1982), "This 'super boom' is confined, however, to a circular zone whose radius is approximately 300 feet or less". While the location can be estimated by theory, the real atmosphere makes it difficult to locate the point on the ground. Over ninety supersonic flights were flown at the White Sands Missile Range in an attempt to locate the focus region. Several multiple booms were picked up, but no superbooms were found (Wiggins 1969).

Galloway (1982) continues with the following explanation:

"The maximum area within the focus zone can be estimated, for longitudinal acceleration (and pushovers), as approximately 450 times the height of the airplane in feet. Thus at 15,000 feet, the focus zone does not exceed 0.25 square miles. The region of this zone where the peak overpressure exceeds the level flight overpressure at the same Mach numbers is less than one-quarter of this area or less than 0.06 square miles. For constant rate turns the total area is 300 times the arc length, or approximately 0.28 square miles for an airplane making a 90 degree turn with a radius of 2.7 nautical miles (NM).

Daley (1982) has analyzed the Oceana data and found the average turn radius was 2.7 NM with a 55 degree curvilinear path length per sortie.

Continuing with Galloway (1982):

Again the area of pressure exceeding rectilinear flight is approximately one-quarter of the total or less than 0.07 square mile. From Wanner the area of a possible super focus boom is less than 0.01 square miles. Excess overpressures are most likely to not exceed 2 to 4 times the steady state overpressure in the most intense part of these focal zones.

This is to say that the nominal overpressure being magnified is the level associated with the carpet at the focus distance from the flight track centerline. For turn maneuvers where the focus zone may be offset from the flight track by a few miles, the carpet overpressure will be a fraction of the centerline overpressure and consequently, focusing will involve the fractional value rather than the centerline value.

Statistical analysis of these generalized estimates is provided in Table 2.6-6. While the values are considered to be very conservative, they show the probability of a given point in the airspace being within the zone of focus from a rectilinear acceleration or pushover is 0.03 percent or one chance in about 3,300 chances, and one in 5,000 for a turn maneuver. The probability for the superfocus zone is one in about 16,700 chances. The point of excessive overpressure is considered to be a much smaller area within the focus zones and consequently should have a small probability of occurring at any given point.

Daley (1982) has investigated the spatial effect of the focus zone where the overpressure was twice that for rectilinear flight. The National Oceanic and Atmospheric Administration's (NOAA) splash sonic boom model was used to demonstrate overpressure and spatial effects of an F-105 aircraft making a circular pylon turn maneuver. While the analysis was for a different type aircraft, the flight geometry is within that which could occur in the Sells Airspace, and the results are valuable in understanding the probable width of focus. The model showed that the focus zone exceeding nominal carpet was a band about 16 feet wide paralleling the curved flight track. This data indicate such a maneuver would generate a focus zone of about 0.02 square miles. The probability of a single focus boom of this type impacting any single point in the maneuvering area with an overpressure greater than the maximum expected for rectilinear flight is 0.00012 or one in about 8,500 chances. At the point where the overpressure is twice the nominal carpet boom overpressure, the width decreases to about 3 feet wide. The probability of the 2x region hitting any given point in the maneuvering area is one in about 42,500 chances, or about a third of the probability for the focus boom impacting a given point.

From an energy average standpoint, a focus or superboom adds less than 0.01 decibel to the space/time average C-Weighted Sound Equivalent Level (CSEL) of the carpet booms and does not result in a significant change to the long term average C-Weighted Day-Night Average Sound Level (CDNL) value for the ellipses. It is recognized that a superfocused boom could impact a structure in the maneuvering area; however, the probability of this occurring where the overpressure is great enough to cause damage is very small.

2.6.2.5 Plants and Animals

2.6.2.5.1 Vegetation

The vegetation of the project area is characteristic of the Arizona Upland of the Lower Sonoran Life-zone (McGinnies 1981). The vegetation in the Arizona Upland is relatively homogeneous, with variations correlated with soils types, and slope gradient and orientation. Important plant species include creosote, foothill paloverde, mesquite, ironwood, and ocotillo. Cacti are numerous, the most conspicuous ones being saguaro, barrel cactus, organ pipe cactus, and a wide variety of prickly pears and chollas. Perennial grasses are locally abundant; both winter and summer ephemerals carpet the ground in favorable seasons.

Yucca, cholla cactus, saguaro cactus, blue paloverde, and honey mesquite all are protected under the Arizona Native Plant Law (Ariz. Rev. Stat., Chapter 7, Article 1, Sec. 3-901).

Aircraft operations in the Sells airspace do not involve ground disturbances, except for the case of an emergency and/or crash landing.

2.6.2.5.2 Aquatic Resources

Aquatic habitats within the project area are limited to ephemeral streams and ponds that develop following infrequent rain and spring-fed habitats. Consequently, aquatic resources within the project area are relatively uncommon.

Because of the scarcity of surface water resources in the project area and the nature of the aircraft operations, no significant impacts on aquatic resources are anticipated.

2.6.2.5.3 Terrestrial Animal Life

Animal life in the project area includes a wide range of domesticated and wild species. Domestic species include cattle, horses, goats, sheep, swine, cats, and dogs (see Appendix K).

A total of 5 species of amphibians, 43 reptiles, 48 mammals, and over 250 bird species have been recorded in the Organ Pipe Cactus National Monument, which occupies the southwestern portion of the project area (National Park Service 1978a,b).

The more common species include various species of lizards and snakes, jackrabbits, cottontails, squirrels, gophers, mice, rats, coyote, fox, badger, skunk, bobcat, mountain lion, and mule deer. The large variety of bird species observed in the area reflects the wide variety of habitats found in the Sonoran Desert and the location of the area in the migration route of numerous species (see Appendix K).

Sensitive species that occur or may occur within the area include the Gila monster (Heloderma suspectum), classified as threatened by the state of Arizona, and the desert tortoise (Gopherus agassizii) which is a candidate for listing as a federally protected species. In addition, the Sonoran pronghorn (Antilocapra americana sonoriensis) the peregrine falcon (Falco peregrinus) and the gray wolf (Canis lupus baileyi) are federally listed endangered species known to occur within the project area.

2.6.3 SOCIOECONOMIC RESOURCES OF PIMA COUNTY AND PAPAGO RESERVATION

County-wide information was used to assess the economic characteristics of the Sells Airspace for several reasons: (1) the large geographic area and sparse population of the study area; (2) the fact that subcounty data were unavailable for time-series analysis; and (3) the fact that almost the entire airspace is within Pima County (outside the immediate Tucson area) and overlies the largest, albeit small, settlements in the county.

Information for the socioeconomic conditions in the region (Pima County) was taken from a 1980 U.S. Air Force study entitled Economic Impact Study, Valentine and Morenci Military Operations Areas Final Report, prepared by Headquarters Tactical Air Command in cooperation with contract consultants. In addition information concerning the Tohono O'Odham Reservation was taken from the Bureau of Indian Affairs (BIA) "Labor Force Estimates" and "Information Profiles of Indian Reservation in Arizona, Nevada and Utah" for the years indicated.

2.6.3.1 Villages and Communities

Some 149 separate and distinct locations on the main Tohono O'Odham Reservation have been identified as settlements. Of the 149 settlements, only about one-third are currently inhabited. Sells, in addition to being the largest community, is the center of all reservation activities. Its population is about 2,800, the population of the entire reservation is about 9500 people.

Public facilities on the reservation include a post office, a public high school and elementary school, a US Public Health Service 50-bed hospital at Sells and a health center at Santa Rosa, a municipal center and a tribal arts and crafts shop.

2.6.3.2 Population

The population of Pima County grew about 66 percent between 1970 and 1980, from 351,667 to 531,443 people. No appreciable net change has occurred in the 20 percent share that Pima County's population represented of the statewide total for Arizona since 1960. However, Pima County accounted for as much as 25 percent of the state population in 1970.

An important factor in the analysis of Pima County is that the entire county is considered as the Tucson metropolitan area (standard metropolitan statistical area). Tucson itself accounts for approximately two-thirds of the county's population, with the "urbanized" area containing between 80 and 85 percent of the people.

Total population estimates for the Tohono O'Odham Reservation indicate erratic growth patterns. Population estimates for the reservation are 9537 on the reservation, and 1770 Indians off the reservation (BIA, 1983). There has been a net increase of 2801 residents affiliated with the reservation between 1971 and 1983 (Table 2.6-7). This is a 29 percent increase.

2.6.3.3 Employment

The civilian labor force in Pima County increased by 48 percent (from 126,000 to approximately 187,100) from 1970 to 1979. Pima County has maintained a relatively constant proportion of about 18 percent of the state's labor force. The labor force growth rate from 1970 to 1978 was 43 percent, an 8-year period when population in the county grew about 33 percent, an indication of an increased number of households with more than one wage earner and an increasing size of the working age population. Employment grew from 121,800 to 178,200 between 1970 and 1979, a 46 percent increase. Combined with a labor force increase of 48 percent over the 9 years, this has meant a rise in the unemployment rate from 3.3 percent to 5.8 percent by 1980. Pima County's unemployment rate has consistently remained below that of the state as a whole.

Employment information for residents of the Tohono O'Odham Reservation indicates consistent growth of employed people from 1971 to 1984. The Bureau of Indian Affairs, "Labor Force Estimates" (BIA, 1985), indicates 7217 residents of the Tohono O'Odham Reservation were available for employment. Of this total, 4840 were employed, and 2377 were unemployed for a 33 percent unemployment rate. The unemployment rate among Indians is of significant importance since the rate reached a peak of 36 percent in 1975 but was never below 24 percent during the 1970s.

Nevertheless, significant employment gains were registered during the 1970s. Forty three percent more residents of the reservation were employed in 1978 as in 1971. This is an average annual growth rate of approximately 6.2 percent. The labor force grew by a total of 4235 through 1984 (Table 2.6-8).

TABLE 2.6-7
Population, 1971-1983
Tohono O'Odham Indian Reservation

	On Year Reservation	Adjacent to Reservation	Total
1983	9,537	1,770	11,307
1978	8,321	1,669	9,990
1977	8,885	1,657	10,542
1975	8,390	1,608	9,998
1973	7,703	1,456	9,159
1972	7,073	2,736	9,809
1971	6,736	2,606	9,342

Source: "Report of Labor Force," (Papago) Tohono O'Odham Agency. Annual for years indicated.

Reprinted from Economic Impact Study, Valentine and Morenci Military Operations Areas, Final Report, HQS TAC/DEEV, U.S. Air Force, May, 1980.

Source: "Information Profiles of Indian Reservations in Arizona, Nevada and Utah, 1983.

TABLE 2.6-8
Labor Force and Employment, 1971-1984
Tohono O'Odham Indian Reservation

Year	Labor Force		Employment	Unemployment Rate
	Number	% of Pop.		
1984	7,217	75.7	4,840	33.0%
1983	5,009	52.5	3,448	31.0%
1981	5,009	52.5	3,448	31.0%
1978	4,424	53.2	3,229	27.0%
1977	4,748	53.4	3,086	35.0%
1975	4,563	54.4	2,920	36.0%
1973	3,449	44.8	2,432	29.5%
1972	3,122	44.1	2,324	25.6%
1971	2,982	44.3	2,256	24.3%

Source: "Report of Labor Force," (Papago) Tohono O'Odham Agency, BIA. Annual for years indicated.

Reprinted from Economic Impact Study, Valentine and Morenci Military Operations Areas, Final Report, HQS TAC/DEEV, U.S. Air Force. May, 1980.

Source: "Information Profiles of Indian Reservations in Arizona, Nevada and Utah, for 1981 and 1983.

2.6.3.4 Personal Income

Total cash income to individuals and tribe in 1983 was about \$17,498,000 with wage employment accounting for approximately \$13,500,000 of the total. Wages for federal employment comprised roughly 43% of the wage income. Self employed earnings totaled \$1,400,000 with practically all from livestock sales. For comparison, total income to the tribe and individuals in 1978 was \$12,900,000. This represents an increase of 26% since 1978 (BIA, 1983).

Average per capita tribal income in 1983 from earned sources was \$1835, in 1980 the total was \$1259. Earned sources exclude tribal income from such items as mineral deposit bonuses or welfare payments. Though earned sources were expected to increase appreciably the next few years, total unearned income from mineral activity was expected to increase only slightly during the same period due to copper price stagnation (BIA, 1983).

2.6.3.5 Commercial Activities

Commercial activities on the Tohono O'Odham Reservation include six general mercantile stores, five auto service stations, one cafe and two snack restaurants. Noranda and Newport Mining companies both have copper mining leases on the reservation. The Tohono O'Odham Tribe owns 70 percent interest in Phillips Petroleum ammonium nitrate processing plant on the reservation. The tribe has organized its own utility authority for commercial sale and distribution of electric power and water on the reservation.

2.6.3.6 Housing

In 1983 there were 2470 housing units on the Tohono O'Odham Reservation. Of these, 85 percent (2100) are below minimum national standards. At least 60 percent (1500 units) lack either electricity or flush toilets or both. At least 35 percent (850 units) are badly deteriorated structurally and is an immediate threat to the health and safety of the occupants. Department of Housing and Urban Development (HUD) and the Tohono O'Odham Housing Authority are concentrating on construction of new low-rent "turn key" type houses to improve conditions for the Tohono O'Odham people (BIA, 1983).

2.6.3.7 Tourism and Recreation

Information regarding the Organ Pipe Cactus National Monument is included in a separate section at the end of this chapter.

Growth in visits to Tumacacori National Monument east of the Tohono O'Odham Reservation has been consistent, rising from about 54,000 in 1960 to 76,600 in 1978. 1979 showed a drop to 59,000, a decrease similar in magnitude to Organ Pipe Cactus National Monument. Both sites are characterized by growth patterns similar to other National Park Service sites within the Southwest (Table 2.6-9).

Another national attraction is the Kitt Peak National Observatory, operated by the Association of Universities for Research in Astronomy, Incorporated. Since its opening to the public in 1964, annual attendance figures have steadily climbed from approximately 44,000 to almost 104,000 in 1979.

TABLE 2.6-9
Visits to Developed Tourist Sites, 1960 to 1979
Pima County, Arizona

Year	National Monuments		Kitt Peak National Observatory
	Tumacacori	Organ Pipe Cactus	
1979	59,000	134,000	103,933
1978	76,600	150,300	90,692
1977	74,000	139,800	75,435
1976	80,300	130,700	75,830
1975	78,700	139,200	82,102
1974	71,000	105,000	62,260
1973	78,200	89,400	65,922
1972	68,400	86,600 ^a	52,846
1971	68,700	366,900	48,254
1970	63,700	415,400	47,314
1969	60,000	333,000	57,441
1968	63,000	347,800	52,842
1967	49,500	340,700	52,953
1966	50,500	293,400	49,133
1965	56,100	362,800	43,837
1964	55,600	324,700	--
1963	54,400	329,800	--
1962	55,200	294,100	--
1961	56,300	252,100	--
1960	53,800	262,100	--

Source: U.S. Department of the Interior
National Park Service, Washington D.C.
Organ Pipe Cactus National Monument
Kitt Peak National Observatory
Pima County, Arizona.

Note: National Monument visitor counts rounded to nearest 100.

^aBeginning in 1972, the National Park Service changed counting procedures at Organ Pipe. Accurately comparing figures with past years is not possible. See text for further explanation.

Tohono O'Odham lands contain many other areas of tourist interest. Major tourist interests are: Tohono O'Odham Rodeo and Fair, hunting and camping. A fact book on the Tohono O'Odham Tribe is reprinted as Appendix I. It contains more detailed information on the Tohono O'Odham Reservation, its people and its economy.

Tourism and travel expenditure data have been collected on a countywise basis in Arizona since 1976. During the 4 years through 1979, expenditures by travelers in Pima County have risen nearly 90 percent, and the county has improved its share of Arizona's travel dollars from 22.7 percent to 23.8 percent. This may be due, in large part, to Tucson's general growth and attractions, though it is impossible to extract Tucson data from total county information.

2.6.3.8 Ranching

Most of the land on the Tohono O'Odham Reservation is used as rangeland for raising cattle. Water development and maintenance projects on the reservation are being continued to support the cattle industry and eliminate some of the losses suffered each year through drought. The tribe also owns a herd of registered Hereford cattle that it maintains on special pastureland. This herd is under expert management and is being used to improve the quality of both the tribal herd and privately owned cattle. In 1983, livestock sales amounted to about \$1,400,000. In 1970, sales of livestock accounted for \$975,000. The 1970 to 1983 increase of \$425,000 represents a 43.5 percent gain. However, receipts from livestock sales accounted for only 8 percent of total tribal income in 1983, a decrease from 23 percent in 1970. Ranching is apparently becoming of less importance to the reservation economy.

2.6.3.9 Farming

Farming on the Tohono O'Odham Reservation is experiencing a resurgence. An agricultural cooperative was organized in February 1971 at San Xavier District where the water table is relatively shallow and a system of electrically powered wells has been installed by the Bureau of Indian Affairs. In 1983, some 5600 acres of land was in developed irrigation. Additional agricultural enterprises are being planned or placed in operation on other parts of the reservation (Chuichu, Cockleburrr, Jackrabbit, and Tohono O'Odham Farms). The U.S. Army Corps of Engineers have completed a new 2-1/4 mile-long earth dam and reservoir in the Vaiva Vo area that is designed to control flood runoff in the Santa Rosa Wash. Eventually water in the reservoir will irrigate thousands of acres of good soil in the northern section of the main reservation.

2.6.3.10 Mining

In recent years, mining has been of increasing economic importance to the Tohono O'Odham Tribe. Copper is being mined at several locations on the reservation and produces revenue for the tribe as well as employment for the Tohono O'Odham people. The Noranda and Newmont Mining Companies have each discovered rich deposits of high grade copper ore in the northern part of the reservation and are now preparing to mine this ore.

2.6.4 TOHONO O'ODHAM ATTITUDES

The Tohono O'Odham believe that Air Force training seriously affects their ability to carry on their customary culture, religion, and social life. They are opposed to any flights audible and visible from their homelands.

Also it is the position of the Tohono O'Odham Tribe that the USAF/ANG has abused the airspace overlying the Tohono O'Odham Indian Reservation and should cease its overflights. The Tohono O'Odham feel the peace and serenity of the reservation have been shattered by repeated sonic booms from aircraft flying at supersonic speeds within the Sells Airspace. In addition, reservation inhabitants report being repeatedly shaken by the sudden appearance of very low-flying Air Force A-10 and Air National Guard A-7 subsonic aircraft that, according to the Tohono O'Odham, are intentionally bent on harassing reservation communities, vehicles, cattle herds, and individuals at every opportunity. Specific instances of aircraft harassment were aired thoroughly during the course of the 1979 Santa Rosa meeting.

The Tohono O'Odham view the establishment of the Sells MOAs and ATCAAs and accompanying Air Force/Air National Guard flying training missions as showing indifference to the feelings of the Tohono O'Odham concerning their land and life-style. The fact that they perceive relatively little change in military flight operations within the Sells Airspace since the 1979 Santa Rosa meeting leads the Tohono O'Odham to believe that the military will carry on its training missions as always in spite of complaints registered by the tribe.

In spite of prolonged exposure to jet aircraft movements within the Sells Airspace, the Tohono O'Odham still have difficulty identifying the kinds of aircraft sighted over reservation land and remain confused as to why they are there at all, and why they continue to cause damage and frighten people. Those Tohono O'Odham who attended the 1979 Santa Rosa meeting heard the Air Force's explanations and were briefed in terms of the kinds of training missions flown. Those who did not attend had to rely on others for the information. Given the remoteness, isolation, and poor communication over much of the Tohono O'Odham Reservation, it is understandable why current information of both tribal and nontribal sources frequently fails to reach the people.

The Tohono O'Odham feel that they were never consulted over the use of the Sells Airspace and that their opinion would be disregarded were it not in agreement with the ultimate goals of the military. Many Tohono O'Odham understand and appreciate the need for realistic training environments in terms of the priorities of national defense; they prefer, however that the flights be conducted outside of reservation airspace.

2.6.5 AREA EAST OF TOHONO O'ODHAM INDIAN RESERVATION

This area, formerly a part of the Sells Airspace, overlies the broad Altar Valley. It has been deleted from the Sells Airspace. From 100 feet AGL to 10,000 feet MSL, this area is now the Fuzzy MOA. From 10,000 feet MSL to 18,000 feet, it is the Ruby 1 MOA. It is bordered on the east by the Tumacacori Mountains and on the west by the Baboquivari Mountains. Keystone Peak in the Sierrita Mountains lies just

north of the area. The area is to the east of the Sells Tohono O'Odham Indian Reservation and southeast of the Kitt Peak Observatory.

2.6.6 ORGAN PIPE CACTUS NATIONAL MONUMENT

The National Park Service (NPS) has been concerned about the intrusion of low-level flights over the monument since the advent of the first A-10 in the spring of 1976 and their gradual buildup to current levels. Lowering of the 1,000-foot AGL floor to 300 feet and the increased use of the monument as an area for these training flights have also contributed to the concerns of the National Park Service regarding its management responsibilities of the monument's natural environment. Visitors and campers at the monument are reported to resent flight operations and to express that resentment to the National Park Service. There have been allegations by NPS employees that military aircraft have flown over avoidance areas at low altitudes. Representatives of the National Park Service have attended most meetings held at Sells and have voiced their concern. They have intermittently maintained aircraft disturbance logs, initiated meetings with the various air bases to determine the origin of the disturbances, submitted formal letters of protest regarding the inclusion of the monument in the Sells Low MOA, and requested that the general public become better informed as to the impacts that military aircraft operations will have on the monument. They also have requested that public meetings about the action be held in other places around the state.

Aircraft disturbances logs maintained by the National Park Service reported 14 overflights considered disruptive during a 21-day period between May 25, 1983, and June 13, 1983. The time of these flights was reported to range from 7:30 a.m. to 5:11 p.m. The USAF was not informed of these overflights. Seven written complaints objecting to overflights were received by the monument superintendent from April 1981 through March 1983. These complaints were not forwarded to the Air Force for consideration or action.

The areas most heavily used by visitors and for which complaints are most frequent are:

- o Organ Pipe Cactus Monument headquarters
- o Ajo Range and area in vicinity of Ajo Mountain Drive
- o The center of the monument in the vicinity of the Puerto Blanco Drive.
- o State Highway 85 in the monument
- o Vicinity of Bates Well

Current USAF training activities over the Organ Pipe Cactus National Monument consist of the following:

- o Air combat maneuvering is permitted above 10,000 feet MSL. Pilots are directed to direct supersonic flights away from the monument.
- o Two military training routes cross or come near the northeastern boundary of the monument.

- o Low altitude tactical navigation training flights are permitted anywhere over the monument, except that aircraft must not fly lower than 3,000 feet above ground level over the headquarters and campground area and around Mt. Ajo. Civilian aircraft can operate in this area under visual flight rules without any special restrictions.

The National Park Service agrees that those training operations appear to reflect due consideration and concern for the monument values and resources; however, they are concerned that some pilots do not comply with avoidance restrictions and that there is no single office where complaints may be filed.

Because the visitation count methodology for Organ Pipe Cactus changed in 1972, long-term visitation growth trends are impossible to accurately determine. Prior to 1972, counts were made of all vehicles entering a road headed for Organ Pipe Cactus Monument. However, that road also led to other roads, so not all such vehicles entered the monument site. Beginning in 1972, counts were made only of vehicles actually entering the grounds of the monument. All vehicle counts are multiplied by an average persons per car factor (which varies from year to year) to determine the number of people visiting.

Growth trends in the two periods can be analyzed, however, for Organ Pipe Cactus National Monument. Prior to 1972, annual visits grew from 262,000 in 1960 to 366,900 in 1971, a 40 percent rise. Visitation reached its peak in 1970 at 415,400. Between 1972 and 1979, visits to the monument grew from 86,600 to 134,000, a 55 percent increase. Peak attendance in this period was in 1978, when 150,300 visits were recorded. Results of the two counting methods indicate a fairly consistent growth pattern. Visitor counts since 1979 have continued to show an increase with a peak in 1981 of over 165,000 visitors. In the first 5 months of 1983, 141,400 visitors were reported, an increase of 42 percent for the year to date.

2.6.7 HISTORIC AND PREHISTORIC CULTURAL RESOURCES

2.6.7.1 Cultural Resource Sites

The files of the Arizona State Museum contain site records on 571 cultural resource sites that are on or appear to be on land under the Sells Airspace. A listing and brief description of each of these sites is included in Appendix J. All of the sites except one, Mount Baboquivari (AZ DD:2:21), a sacred mountain, are artifacts or assemblages of artifacts (i.e., material products of human behavior). Some are single component sites (i.e., they were used or occupied only once), but many show evidence of repeated use through time.

Of the recorded sites, 419 are prehistoric, 6 are of unknown date, and 178 sites or components are historic. Sites or components that were identified as definitely Tohono O'odham were considered historic; possible Tohono O'odham sites were considered prehistoric. Differences in numbers of sites in different districts probably reflect the amount of survey work done rather than site frequency. Site distribution is as follows:

Organ Pipe Cactus National Monument

Prehistoric: 98

Historic: 19

Unknown: 2

Organ Pipe Cactus National Monument and Gu Vo District

(on the fence line)

Prehistoric: 19

Historic: 15

Gu Vo District

Prehistoric: 49

Historic: 5

Unknown: 1

Baboquivari District

Prehistoric: 35

Historic: 11

Chukut Kuk District

Prehistoric: 10

Historic: 11

Sells District

Prehistoric: 40

Historic: 36

Schuk Toak District

Prehistoric: 17

Historic: 10

Sif Oidak District

Prehistoric: 125

Historic: 44

Pisinimo District

Historic: 2

Gu Achi District

Prehistoric: 7

Historic: 8

Hickiwan District

Prehistoric: 18

Historic: 13

Unknown: 2

Private or Possibly Private

Prehistoric: 1

Historic: 2

Unknown: 2

City of Ajo

Historic: 2

2.6.7.2 National Register Sites

Based on Arizona State Museum files, the following sites are listed on the National Register of Historic Places:

Ventana Cave, AZ Z:12:4; Hickiwan District; cave (Early Man to modern)

Growler Mine Area, AZ Z:13:48; OPCNM; mine complex

Bull Pasture, AZ Z:14:86, OPCNM; water hole, military camp

La Victoria Mine, America Mine, SON C:1:14, OPCNM; mine complex w/standing structures

El Camino del Diablo, SON C:1:15; OPCNM,; trail

Milton Mine, SON C:1:16; OPCNM; mining complex w/standing structures
Gachado Well and Line Camp, SON C:1:17; OPCNM; habitation, corral, well
w/standing structures

2.6.7.3 Other Sites With Standing Structures

The following sites are not on the National Register of Historic Places, but have standing structures:

AZ AA:5:97; Sif Oidak District; ramada; Tohono O'Odham

AZ AA:13:1; Schuk Toak District; mine camp and trading post; Anglo

AZ DD:2:41; Baboquivari District; petroglyphs; Hohokam, Tohono O'Odham

AZ DD:5:3; Chukut Kuk; adobe house; Tohono O'Odham

SON C:4:3; Sells District; sahuaro camp; Tohono O'Odham

3.0 RELATIONSHIP OF EXISTING AND PROPOSED ACTIONS TO LAND USE PLANS AND POLICIES

3.1 LAND BENEATH SELLS AIRSPACE

3.1.1 TOHONO O'ODHAM INDIAN RESERVATION

Most of the open expanse of land used by the Tohono O'Odham Indians is range land with each square mile producing forage for less than three head of livestock. Efforts to improve the land are continuing with reseeding and development of water resources.

Agricultural development has begun and will be expanded in the northern part of the Tohono O'Odham Reservation. Much of the area affected by new agricultural developments lies outside the boundaries of the Sells Airspace.

3.1.2 ORGAN PIPE CACTUS NATIONAL MONUMENT

The Organ Pipe Cactus National Monument was established to perpetuate a representative sample of the Sonoran Desert. Attractions at the monument include scenery, plants, wildlife, and historic and prehistoric cultural resources. Camping and picnic facilities are limited. Visitation in the peak attendance year (1981) was 91 percent higher than in 1972.

3.2 AIRSPACE ABOVE THE TOHONO O'ODHAM INDIAN RESERVATION AND ORGAN PIPE CACTUS NATIONAL MONUMENT

No special procedures or operating limitations are or will be placed on civil aircraft operating under visual flight rules in the Sells MOAs. However, the presence of military aircraft in the airspace increases the risks to civilian aircraft operating in the area. For that reason, special use airspace such as MOAs/ATCAAs were developed to enhance pilots safety by identifying boundaries of training areas and activities.

4.0 PROBABLE IMPACT OF THE CURRENT AND PROPOSED ACTIONS ON THE ENVIRONMENT

4.1 GENERAL

The impact of flight operations in and beneath the Sells Airspace generate both direct and indirect impacts. The direct impacts are those that can be quantified such as air quality and noise levels. The indirect effects of flight operations include subjective evaluations of the effects on wildlife, historical and archeological sites, threatened and endangered species present in the area, and movement of other air traffic through the area.

4.2 AIR QUALITY

The Arizona State Department of Health Services has reported air quality within the Sells Airspace to be in compliance with federal and state ambient air quality standards with the exception of total suspended particulates (TSP), sulfur oxides and carbon monoxide. A small northwest corner of the airspace (Ajo) is within a TSP non-attainment area (area where air quality is worse than ambient standards). Pima County is a non-attainment area for carbon monoxide. Calculations of aircraft contributed concentrations to observed pollutant loading in Appendix A indicate minimal impact. The high TSP levels are probably due to smelting activities and naturally occurring windblown dust from desert exposed area; the contribution from aircraft exhaust to TSP concentrations is minimal.

All other gaseous pollutant levels are quite low in the airspace. Considering the altitude of most flights and the temporary nature and small amount of aircraft exhaust emissions, utilization of this airspace will not significantly affect the ambient air quality of the region.

4.3 NOISE IMPACTS

4.3.1 GENERAL CONSIDERATIONS FOR THE SELLS AIRSPACE

Noise in the Sells Airspace results from aircraft operations conducted at subsonic and supersonic speeds. Aircraft in the area will be subsonic during most of the flight, but may accelerate to supersonic speed when conducting air combat training maneuvering operations above 10,000 feet mean sea level (MSL).

4.3.2 SUBSONIC NOISE IMPACT

4.3.2.1 Subsonic Noise Impact on People

The subsonic noise impact beneath the Sells MOA results primarily from low-level training flights conducted along Military Training Routes (MTR) and in Low Altitude Tactical Navigation (LATN) areas. Figure 2.3-2 shows the location of the routes and Table 4.3-1 provide future sortie rates (CY 1990) along MTRs, and corresponding noise levels expressed in DNL. As noted in Chapter 2, established communities are avoided by airspace users, and should not be impacted by low level flight operations. DNL values are used to predict annoyance. The DNL value is equivalent to a LEQ value when there are only daytime noise events present. The LEQ value can be used to predict health effects. The term DNL is an equivalent sound level averaged over a twenty-four hour period with a ten decibel penalty added to any sound that occurs at night (between 10:00 pm and 7:00 am).

The area of greatest impact will continue to be the areas directly beneath the MTRs, but away from established communities. As indicated by comparing Table 4.3-1 to Table 2.6-1, the DNL for these areas will increase from four to six dB over existing levels. This is due to a projected increase in sortie rates and a change in base altitude from 500 feet AGL to 300 feet AGL by Luke AFB based aircraft. The base altitude of MTRs scheduled by Davis-Monthan AFB will remain at current levels. As in Chapter 2, the DNL is calculated using F-16 aircraft at 300 feet AGL since the F-16 is the predominant user of the MTRs scheduled by Luke AFB. The DNL of 67dB where several MTR segments coincide represents the absolute worst case where every sortie passes over the same spot on the ground during a 24 hour period. Table 4.3-1 also shows the DNL for the more reasonable case of 25% of all sorties passing over the same spot on the ground (a conservative estimate). The DNL of 61dB means 9% of all people beneath the MTRs would be highly annoyed. The four to six dB increase in noise levels would be noticeable by persons living under the MTRs, however, these areas are so sparsely populated that the actual number of affected individuals would be small.

The noise levels projected for the areas beneath the MTRs (61dB) are well below the criteria set by EPA for potential hearing loss, though the projected increase in noise levels are expected to increase the level of annoyance of campers, recreationists and hunters visiting the rural areas beneath the Sells Airspace. Especially annoying will be flyovers by low flying aircraft. A typical case is a F-16 aircraft at intermediate power and 300 feet AGL. A peak noise level of 103 dB(A) would result, lasting from 1 to 3 seconds. Similarly impacted would be visitors to the Organ Pipe Cactus National Monument (OPCNM). The impact would be reduced in areas frequented by the majority of visitors due to avoidance procedures in effect over the monument. Individuals in the more remote areas would remain annoyed by low flying aircraft due to LATN activity, projected to continue at about 14,000 sorties per year, and increased use of MTRs. However, the increased use of the MTRs over the OPCNM will result in no appreciable increase in the noise environment.

4.3.2.2 Subsonic Noise Impact on Animals

Domestic animals under the Sells Airspace include cattle, horses, goats, sheep swine, dogs and cats. Appendix K lists wildlife inhabiting the area under the airspace. Review of available literature, information obtained on species response to low level flight indicate that low-level subsonic flight in the Sells airspace should not significantly impact domestic or wildlife species in the area.

Though many long term effects and responses remain to be studied, there are numerous examples of wildlife populations that live in apparent harmony with long term exposure to low level jet overflights. Animals on the Luke and Nellis Air Force Ranges have been exposed to low level jet aircraft noise for over 25 years with no apparent effects. US Fish and Wildlife Service records show the age structure and population count of bighorn sheep on the Nellis Air Force Range have not significantly changed (McQuivey, 1978). On the Luke Range, falcons nest in low level corridors where jets frequently pass very close to the surface (Ellis, 1981). Cattle grazing in close proximity to target complexes on the Avon Park Air Force Range show no behavioral response while jet aircraft make low level target passes.

While reported observations and studies regarding the effects of low level jet flight on wildlife and domestic animals are not conclusive, the preponderance

TABLE 4.3-1

Future Sortie Rates and DNL Values for the Sells Airspace
Military Training Routes (CY 1990)

VR	No. of SORTIES	No. of SORTIES/DAY	DNL ¹ (dB)	DNL ² (dB)
223	4531	20.0	66	60
239	401	2.0	56	54
243	765	3.4	58	53
244	687	3.0	58	53
246	188	1.0	-	51
1219	42	0.2	-	-
259	858	4.0	57	54
260	858	4.0	57	54
263	600	3.0	56	53
223 ³	5406	24.0	67	61
223 ⁴	5807	26.0	67	61

1. DNL calculated for F-16 at 300 feet AGL.
2. Represents DNL for 25% of sorties passing over same point on the ground.
3. Where VRs 223, 244 and 246 coincide.
4. Where VRs 223, 239, 243 and 246 coincide.
5. The "-" represents case where too few daily sorties occur to calculate DNL.

of information to date indicate that wildlife and farm animals do not suffer major long term adverse effects from low level subsonic jet overflight.

4.3.3 SUPERSONIC NOISE IMPACTS

Chapter 2 presented a summary of the sonic boom phenomenon and characteristics specific to the Sells Airspace. The reader who desires a more indepth review of this is referred to Appendix B.

Currently, combined sorties by F-5, F-15 and F-16 aircraft where supersonic flight would be expected is 5120 sorties. This equates to 18 sonic booms per day using the Oceana average of 0.8 booms per sorties. Since the Sells airspace is often divided into two operational areas, each area would be expected to receive nine (9) sonic booms per day. An individual living under the airspace would expect to hear one or less boom per day at this level of activity.

The total annual combined F-5, F-15 and F-16 sorties (shown in Table 2.4-2) where supersonic flight would be expected to occur based on future sortie rates is expected to increase each year between 1985 and 1988, then decline in 1989 and 1990. The sortie rates would then remain stable. The combined sortie rates where supersonic flight may occur would reach 3953 in 1990. On a daily basis this would equate to 18 sorties per day when the generation of sonic booms would be expected. Using the Oceana MOA average of 0.8 booms hitting ground, 14 sonic booms per day would be expected to impact the ground under the Sells airspace. Since Sells is often operationally divided into two areas, each area would receive 7 sonic booms per day that would hit the ground.

As stated previously in Chapter 2, air combat maneuvering operations are conducted in an area of roughly elliptical shape, 36 miles wide by 48 miles long. This area contains 95+ percent of supersonic flights conducted in either half of the airspace, though the entire Sells airspace is available for supersonic flight. The 0.8 and 1.0 cutoff ellipses have dimensions of 41.7 x 53.7 and 43.1 x 55.1 miles respectively. Based on terrain, training requirements and location of towns and villages under the Sells airspace, Figure 4.3-1 is illustrative of one probable orientation of the ellipses and the corresponding CDNL for these ellipses (CDNL is the C-weighted day-night sound average for impulse sounds). The two supersonic maneuvering ellipses depicted in Figure 4.3-1 are projected to receive seven sonic booms per day on a long term basis.

As noted before, in areas where supersonic operations are conducted, the residents are concerned with the number of booms expected to occur as well as the range of overpressures. To determine the probability of an observer hearing a sonic boom at any point on the ground beneath the supersonic maneuvering ellipses, a statistical method is used based upon a binomial distribution.

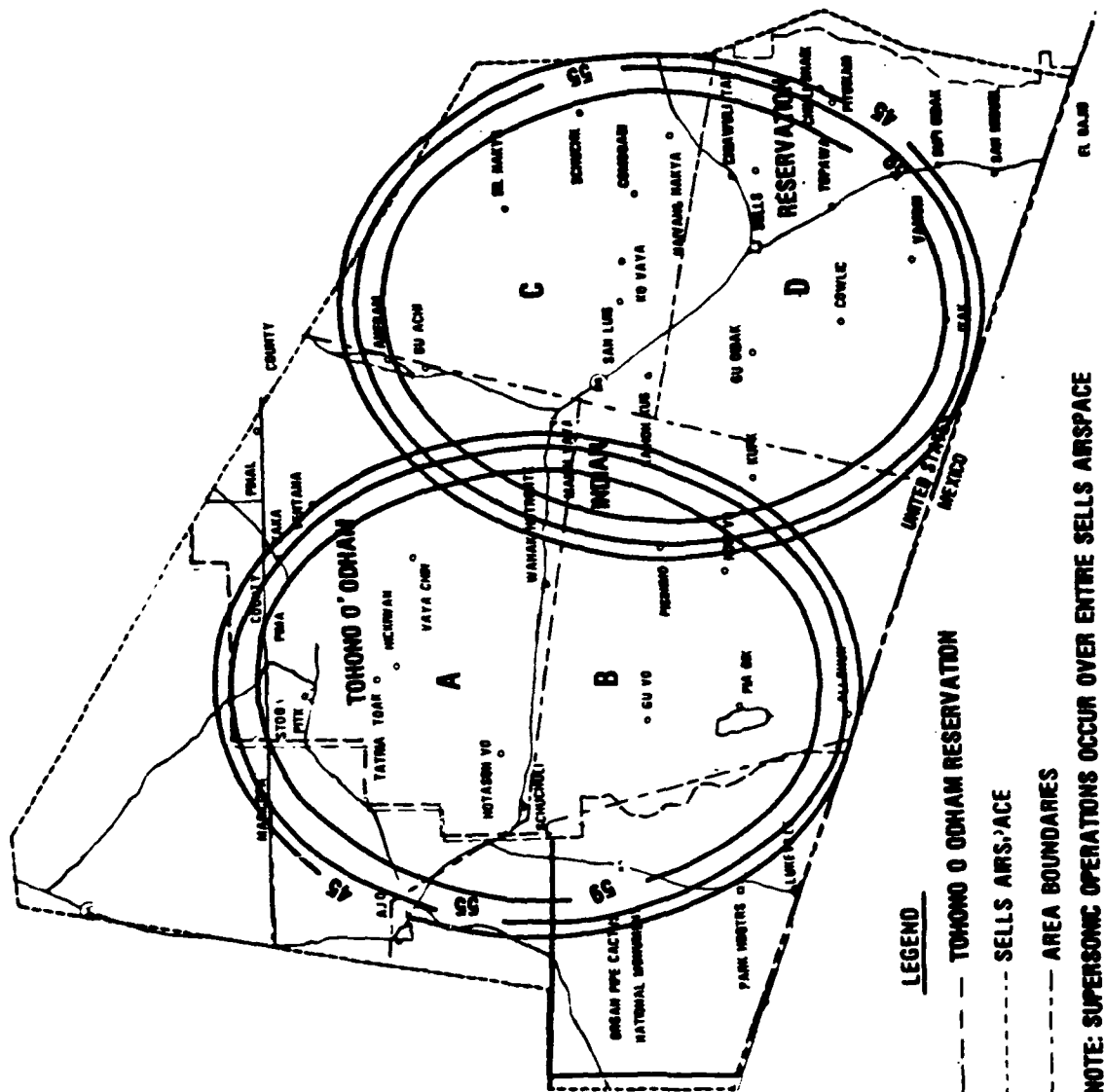


FIGURE 4.3-1 PREDICTED C-WEIGHTED DAY-NIGHT AVERAGE SOUND LEVELS FOR TYPICAL SUPERSONIC OPERATIONS (dB) (1990)

Assuming a binomial distribution in which all events are independent and randomly distributed and only two outcomes are possible (boom or no boom), the probability of any given number of booms hitting the ground is given by:

$$P(y) = \frac{n!}{(y!)(n-y)!} (p)^y (1-p)^{n-y}$$

where $P(y)$ = the probability of y number of booms hitting the ground,

n = number of booms

p = probability of a boom hitting the ground,

y = number of booms hitting the ground.

From a spatial point of view, the probability of a boom hitting the ground on any one trial is equal to the area of the boom divided by the area of the maneuvering ellipse (51 sq mi/1,357 sq mi = 0.0376, which is the average probability across the maneuvering ellipse). The number of trials are taken as 7 booms per day. Analysis of Figure 5 in Appendix B-3 shows the probability of an aircraft being supersonic at the center of the maneuvering ellipse is about two times greater than the mean probability; the value for the edge of the ellipse is conservatively taken to be one-half the mean probability. Table 4.3-2 provides the statistical review of the probability of hearing different numbers of booms for the maneuvering ellipse edge and center as well as the ellipse average.

The mean number of booms expected to be heard is the number of booms times the probabilities of hearing a boom (0.0376 for ellipse average, 0.075 for ellipse center and 0.019 for the ellipse edge). These values are tabulated in Table 4.3-3 along with the probabilities of hearing no booms and hearing three or more booms on any given day. The ellipse average is expected to be one or less boom per day. Likewise, those individuals living on the edge of the maneuvering ellipse could expect to hear less than one boom per day and on any given day they have a 87 percent chance of not hearing a boom at all.

Some supersonic maneuvering operations may produce a focus boom. The phenomenon can occur when shock waves from an aircraft in supersonic flight converge on the same point in space at the same time. The point of convergence can occur either on the ground or at some point in the atmosphere.

Maneuvers that can produce such an effect are longitudinal acceleration, as long as the aircraft is at an altitude and Mach number combination that is above cutoff; pushover from a climb, as long as the curvature of the flight path is sufficient; and constant speed turns, as long as the rate of change in heading is great enough. Obviously, combinations of these maneuvers also can produce focusing of the boom. Typically these booms affect a relatively small area (on the order of much less than one square mile) and occur at a geographically fixed location relative to the flight track. Within the focus zone two or more secondary booms may occur, but the magnitudes are substantially lower than those of carpet booms for the same Mach numbers.

TABLE 4.3-2

Probability of a Carpet Boom Occurrence at a Given Location

Number of Booms "N"	% Probability ^a of Hearing "N" Booms in Maneuvering Ellipse			% Probability ^a of Hearing "N" or More Booms in Maneuvering Ellipse		
	Average	Center	Edge	Average	Center	Edge
0	76.5	57.9	87.4	100.00	100.00	100.00
1	20.9	32.9	11.9	23.5	42.1	12.6
2	2.4	8.0	0.69	2.6	9.2	0.7
3	0.16	1.0	0.02	0.2	1.2	0.01
4	0.00	0.8	0.00	0.04	0.2	0.0
5	--	0.0	--	0.03	0.1	---
6	--	--	--	--	--	---

a. Per ellipse

b. Due to rounding, sum of numbers do not equal 100.00 in all cases.

TABLE 4.3-3
Summary of Carpet Boom Probabilities

Location	Chance of Hearing No Booms	Chance of Hearing 3 or More Booms
Ellipse Center	57.9%	1.2%
Ellipse Average	76.5%	0.2%
Ellipse Edge	87.4%	0.01%

TABLE 4.3-4
Probability of a Focus Boom Zone Occurring at a Given Location

Type Maneuver	Focus Zone	Super Focus Zone
Acceleration/Pushover	0.0003	--
Turns	0.0002	0.00006

Note: Where overpressure exceeds that from rectilinear flight conditions.

Sonic booms and their effects have been studied by the Air Force, Federal Aviation Agency, and National Aeronautics and Space Administration. The following pages contains a review of the literature in this area and discusses several tests conducted to determine sonic boom effects on people, animals, and structures.

4.3.4 SONIC BOOM IMPACTS ON PEOPLE

Noise is commonly defined as unwanted sound. It is one of the biological stressors associated with everyday life. Noise can be annoying, invoking anger and frustration; it can disrupt communication and individual thoughts and affect performance capability (EPA 1974). Loud noises can cause temporary and permanent hearing loss. In recent years many articles have been published that indicate a possible link between noise and physiological ill-health. Some studies have reported a greater prevalence of hypertension and other cardiovascular changes among workers exposed to high noise levels as compared to workers in quieter environments. Other studies have linked excessive noise exposure in industry with increased neurologic and gastrointestinal disturbances.

Sonic booms may be an irritant to outdoor recreationists, particularly those engaged in hunting, camping and hiking. The degree of personal irritation experienced by individuals participating in recreational activities is difficult to assess with accuracy. Some experiments have shown a tendency for sonic boom exposure to degrade the performance of certain visual, steering and tracking tasks, while others have shown no effect on performance (Runyan and Kane 1973b). Sonic booms have also been reported to interrupt work, rest, school, and other day-to-day activities. The actual acoustic masking effect of the boom is negligible because its duration is only a fraction of a second and most of the energy is in the lower frequency ranges.

The attention given to the sonic boom immediately after its occurrence, conversation and comments about it, the possible disruption of a group activity such as a classroom or a clinical activity, actually are extended interruptions either with or without startle. It may take several minutes after the interruption before order is restored in the case of groups of individuals. The response may be largely dependent upon the individual subjects and the nature of the sound source. Sonic booms in the Sells Airspace should be within the range of 2 to 4 psf. Other typical noises (impact) in this range are pile-driving operations, metal-beating and drop-forging, detonating toy caps and firecrackers, and firing hand guns. While these impact noises may irritate, startle and awake people, a high degree of behavioral habituation is normally seen in humans when the exposure is repeated (EPA 1974).

The startle response has been investigated by R. Rylander (Committee on Hearing, Bioacoustics, and Biomechanics (CHABA) 1981) where a group of volunteers were exposed to 5 to 12 booms with overpressures ranging from 1.2 to 12.8 psf. The presence of startle reactions was assessed by using a hand-steadiness test, recordings of heart beat frequency and a tracking test. The results show startle reactions could be characterized by an increase in gross muscular movements immediately after the boom and a slight increase in the heart beat frequency and muscular contractions in the arm and back. Changes were momentary and disappeared within a few seconds after exposure.

It should be noted that the average increase in heart beat frequency was about 2 beats per minute. When the subjects were exposed to noise from a pistol shot, the heart rate increased an average of nine beats per minute. The test also shows a tendency to habituation after about 10 sonic boom exposures.

There have been several studies conducted on the effects of loud noises and sonic booms on people; however, the Committee on Hearing, Bioacoustics, and Biomechanics (CHABA) provides their consensus on the published data (CHABA 1981). CHABA was asked by the National Institute for Occupational Safety and Health (the research arm of the Occupational Safety and Health Administration (OSHA)) and the Environmental Protection Agency (EPA) to consider research that might be performed to examine the effects on human health from long-term noise exposure for industrial workers and the general population, respectively. The primary question was whether those noise standards established to safeguard hearing are sufficient also to protect against health disorders other than hearing defects. CHABA's conclusion was: "Evidence from available research reports is suggestive, but it does not provide definitive answers to the question of health effects, other than to the auditory system, of long-term exposure to noise. It seems prudent, therefore, in the absence of adequate knowledge as to whether or not noise can produce effects upon health other than damage to the auditory system, either directly or mediated through stress, that insofar as feasible, an attempt should be made to obtain more critical evidence" (CHABA 1981). CHABA reported that many of the available foreign studies could be criticized on methodological basis (studies were not adequately controlled for other known risk factors). Studies in the United States primarily concentrated on cardiovascular response to noise, and the results have been contradictory. CHABA recommended guidelines for future research on the subject.

There are some scientists who believe the link between noise and ill-health is well defined. Worthington's article, "The Potential Health Effects of Sonic Booms on Human Population", (see Appendix B for complete article) stresses that data he has reviewed are "indicative of possible effect" that sonic booms can cause hearing loss and other ill-health conditions.

As EPA (1974) points out, a number of factors must be considered in predicting the effect of impulse noise on people. While the peak sound pressure level, duration and rise time are useful in characterizing an impulse noise, the number of and time interval between impulses and audiometric frequency must be considered along with an individual's susceptibility to inner ear damage, orientation of the ear with respect to the noise, action of acoustic reflex and additive conditions of other continuous noises in order to assess effects on people.

Data discussed previously and in Appendix B indicate that on average a person in the MOA should hear no more than one boom a day. The energy of these sonic booms is primarily in the 5 through 100 Hertz (Hz) range (considerably below that of gunfire and most industrial noise). Tests conducted in 1968 at Tonapah, Nevada, showed sonic booms with overpressures ranging from 50 psf to 144 psf did not cause direct injury to the exposed people. Subjects exposed to simulated air bag noises at peak levels as high as 80 psf showed that small

temporary changes in hearing were mainly caused by the high frequency noise and not the low frequencies as found in sonic booms (Sommer and Nixon 1973). Thus the Air Force does not consider the level of overpressures or frequency of sonic booms and focus booms in the Sells Airspace to be significant with respect to possible or permanent hearing loss.

CHABA (1982) has evaluated the hazard of prenatal noise exposure and reports: "There is no conclusive evidence of detrimental effects of high-intensity external sound in higher mammals. Tones of 100-120dB (decibels) at the mother's abdominal surface are attenuated by the mother's body and the tissue and fluids surrounding the fetus by approximately: 20-25 dB for single frequencies from 50 to 200 Hz; 25-30 dB at 500 Hz; 40 dB at 1000 Hz; 50 dB at 2000 Hz; and 70 dB or more at 4000 Hz and higher frequencies. Internal background noise levels of 70-85 dB SPL have been measured in the vicinity of the fetal head; the background noise is probably generated by the mother's circulatory system."

In respect to other potential ill-health effects, Kryter (1980), in summary of his review and tutorial paper on physiological effects on noise states, "...it is more likely that noise related general ill-health effects are due to the psychological annoyance from the noise interfering with normal everyday behavior, than it is from the noise eliciting, because of its intensity, reflexive response in the autonomic or other physiological systems of the body. The psychological stresses may cause a physiological stress reaction that could result in impaired health."

Broadbent's (1980) review and tutorial paper (which is a companion report to Kryter's) indicates increasing levels of noise increases annoyance with a resultant probable increase in the general arousal or excitability of the nervous system. There are many psychological factors which cause differences in human response to the same level of sound energy.

The Environmental Protection Agency (EPA), Department of Housing and Urban Development (HUD) and the Occupational Safety and Health Administration (OSHA) have adopted levels for protection of people. EPA and HUD defined levels are for protection of hearing loss and limiting the degree of annoyance. The OSHA regulations on noise are for protection from hearing loss in the industrial environment and do not apply in this case.

The procedure used by the EPA (1980) and HUD (n.d.) to assess the impact of sonic boom exposures on people relates the long-term average C-weighted day-night sound level (CDNL) produced by booms to the number of people that would be highly annoyed by the booms (Figure 4.3-2). This procedure was developed by the National Research Council of the National Academy of Sciences through its Committee on Hearing, Bioacoustics, and Biomechanics (CHABA 1977; 1982). The procedure is based upon results from several laboratory studies and social surveys. One social survey was conducted in Oklahoma City where the residents were exposed to eight sonic booms each day for six months. During the course of this test, they were asked, on three separate occasions to assess their reactions to the sonic booms. Another social survey was conducted near an Army base where civilian residents were exposed daily to the noise from large artillery practice firings. Laboratory tests were designed to explore peoples' ability to judge the relative annoyance of sonic booms and subsonic jet aircraft flyovers.

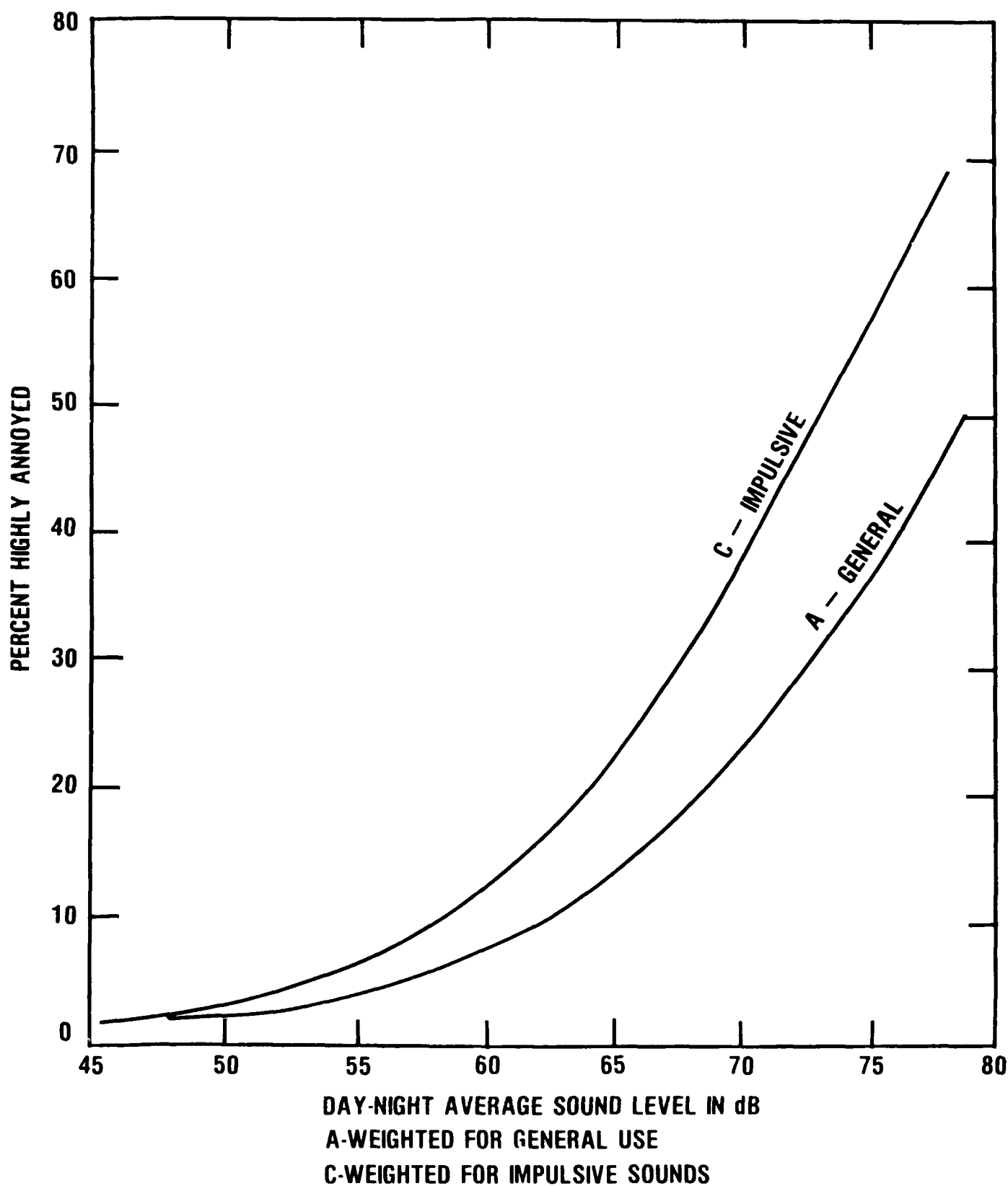


FIGURE 4.3-2 RECOMMENDED RELATIONSHIPS FOR PREDICTING COMMUNITY RESPONSE TO HIGH-ENERGY IMPULSIVE SOUNDS AND TO OTHER SOUNDS

The number of people that would be highly annoyed by sonic booms is a function of the CDNL produced by the booms. The CDNL's for the Sells airspace are shown in Figure 4.3-1. Based on the anticipated noise levels for the operational area, it is expected about 11% of the residents beneath the maneuvering ellipses would be highly annoyed and may complain about the noise. Persons residing within the supersonic maneuvering ellipses would be expected to hear one or less booms per day, and persons residing outside the maneuvering ellipses would be expected to hear less than one boom per day. At the indicated noise levels, no hearing loss is expected to occur as a result of the sonic booms.

4.3.5 CUMULATIVE IMPACTS OF SUBSONIC AND SUPERSONIC NOISE

Before proceeding further with the discussion of sonic boom impacts, it is important to determine the cumulative impact of the subsonic and supersonic noise on people beneath the Sells Airspace. The projected subsonic activity would result in a DNL of 67dB (absolute worst case) in the area where several MTRs coincide. The projected supersonic activity would produce an overlying CDNL under the maneuvering ellipses of 59dB. The cumulative noise level resulting from the combined subsonic and supersonic activity in the airspace is a worst case cumulative DNL of 68dB (20% highly annoyed), or a cumulative DNL for the 25% overflight case of 62dB (10% highly annoyed).

It is recognized future research may provide a better understanding of the relationship between noise and physiological ill-health; however, in the interim decisions must be based on that data supported by the scientific community. If the social surveys adequately predict the level of annoyance and accepting Kryter's (1980) position, then it could be concluded that if other physiological effects occur they should be generally limited to that segment of the population predicted to be annoyed. In this respect, 10% of the people living under the airspace are projected to be highly annoyed.

The above discussion shows that scientific uncertainty exists regarding health effects of long-term exposure to noise. Additional years of research are needed to scientifically determine casual connections or realistically predict generalized health effects based upon noise. The Air Force is conducting research which should help answer some of the existing questions, but the ultimate answers will depend on the accumulated learning of many research programs. In addition, while the analysis used conservative techniques to predict noise exposure levels, there are no generally accepted techniques for predicting worst case long term health impacts from noise exposure.

4.3.6 SONIC BOOM EFFECT ON ANIMALS

Domestic animals inhabiting the Sells Airspace include cattle, horses, goats, swine, sheep, dogs and cats. Wild animals known to live in the area include jackrabbits, cottontails, squirrels, gophers, mice, rats, coyote, peccary,

gila monsters, desert tortoises, fox, badger, coati, skunk, bobcat, mountain lion, white-tailed deer, and mule deer. Numerous bird species may reside in or transit the area. Appendix K list wildlife species known to live in the area. Review of available literature, information obtained on species response to sonic booms in other areas, and special studies conducted for coordination under the Endangered Species Act indicate supersonic flight in the Sells Airspace should not significantly impact domestic or wildlife species in the area.

Domestic animals such as cattle, horses, sheep and poultry show very little behavioral effects from exposure to sonic booms (Cottureau 1972; Fletcher and Busnel 1978; Hinshaw and others 1970; Nixon and others 1968; International Civil Aviation Organization (ICAO) 1970). Investigations of sonic boom effects on farm animals (horses, beef cattle, turkeys, broilers, sheep, dairy cattle and pheasants) at Edwards AFB during 1966 show, except for avian species, the behavioral reactions were considered minimal. "Occasional jumping, galloping, bellowing and random movement were among the effects noted. The responses of the large farm animal in these tests were judged to be in the range of normal activity in comparison with animals observed under controlled conditions. The poultry observed showed more response than the large animals, especially in the early stages of the test. Occasional flying, running, crowding and cowering were noted" (Fletcher and Busnel 1978). Hinshaw and others (1970) reports that hens exposed to four booms per day tended to run to shelter after the first boom, but later booms had less effect.

Pigs, both in the open and in buildings, showed a transient tendency to be quiet. Other scientists' review (ICAO 1970) of the Edwards AFB study indicate the range of sonic boom overpressures was 1.7 to 3psf. This study indicated that large farm animals sometimes reacted to the boom with spontaneous behavior (occasional galloping of horses, bellowing of dairy cattle, increased activity of beef cattle), but that similar behavior was equally prevalent among boom-free farm animals in a different state. Poultry showed mild reactions to the booms in most cases, but in less than 10 percent of the cases chickens reacted with crowding, cowering, or pandemonium. There was said to be no measurable effect of these reactions on egg production, milk production, and food consumptions (ICAO 1970). It was observed that more severe reactions resulted from low level subsonic flights, motorcycles, paper blown by the wind and other startling effects (ICAO 1970). Nixon and others (1968) and Fletcher and Busnel (1978) largely confirm the above observations for horses and cattle and cattle and sheep, respectively. Hinshaw and others (1970) also states horses, cattle and sheep show brief periods of startle, but soon return to normal activity. Response to repeated booms show some degree of habituation, less effect. Fletcher and Busnel (1978) states cattle are generally described as briefly stopping their current activity or moving several steps and orientating toward the direction of the sound. Horses have been reported to show a more violent reaction than other grazing species. A few have been reported as showing muscular tremors, galloping and jumping. There is a possibility that horses confined in buildings may show an exaggerated response as a result of being alarmed. Sheep have been described as temporarily stopping feeding, grazing, running or ruminating in response to sonic booms. There appears to be no report of panic, injury or impaired reproduction (Fletcher and Busnel 1978).

Observations reported by the U.S. Fish and Wildlife Service (USFWS) personnel regarding responses of bighorn sheep on the Luke Air Force Range, Arizona, to

sonic booms indicate minimal impacts or disturbance to the sheep (Yuma 1979). These observations are listed in Appendix B. Desert bighorn sheep on the Nellis AF range, Nevada, have been exposed to sonic booms since 1955. During this period there has been no significant change in the sheep population's age structure, longevity, or reproduction success. The population has been maintained around 1,500 sheep since 1947 by harvesting (trophy hunts) and removing sheep to establish herds in other parts of Nevada. About 40 percent of the state's sheep population is on the Nellis AF Range and it is the largest in population (McQuivey 1978).

Avian species will occasionally run, fly or crowd when exposed to sonic booms. In a field and laboratory study (Teer and Truett 1973) mourning doves, mockingbirds, cardinals, lark sparrows, and quail were exposed to sonic booms or simulated boom overpressures to discover if booms were adversely affecting reproduction. Some differences in various phases of reproduction success were found between the control and test groups; however, none of the comparisons indicated the differences were caused by other than natural environmental factors. The laboratory test involved 7,425 incubated bird eggs which were carried through to hatching. Chicks hatched from these eggs were carried through to twelve weeks of age. Pressures of 2, 4 and 5.5 psf were delivered to the incubated eggs at three frequencies each day for 18 days. According to Teer and Truett (1973), results of these test showed that the pressures had no effects on hatching success, growth rates, or mortality.

A study conducted by Ellis (1981) under cooperative agreement between the US Fish and Wildlife Service and the Air Force for consultation on the peregrine falcon involved data gathering at twenty-four breeding sites of ten raptorial birds in an effort to record responses to low level subsonic jets and mid- and high-altitude sonic booms. The study concluded that, "while the birds were often noticeably alarmed by the subject stimuli, the negative responses were brief and never productivity limiting. In general, the birds were incredibly tolerant of stimulus loads which would likely be unacceptable to humans." Ellis further states, "significantly, birds of prey of several genera commonly nest in the supersonic military operations areas in southern Arizona. In addition, raptor eyries are frequently found at locations where low level jet traffic naturally concentrates." USFWS review of the Ellis study concluded that jet aircraft flights under 5,000 feet AGL and mid- to high-altitude (higher than 5,000 feet AGL) supersonic flight activity is not likely to jeopardize the continued existence of the peregrine falcon. Raptors studied by Ellis (1981) responded more to the sight of aircraft than to the sounds of aircraft. Small nestlings did not respond to sight or sound. Large nestlings were alerted by aircraft greater than 300 meters (m) away and alarmed by aircraft closer than 100m. Adults were alerted and alarmed by aircraft at distances closer than 300 m. In no cases were eggs or nestlings dragged or kicked from nests by alarmed adults.

Cottureau of National Veterinary School of Lyon, France reports in all the studies concerning sonic booms, whether real or simulated, the authors came to the same general conclusions: Sonic booms and subsonic flight noise has very little effect on animal behavior. As Cottureau (1972) says, "Chronic direct effects on wild animals have not been investigated but no significant effects of this kind are presently foreseen."

An FAA study (Runyan and Kane 1973a; 1973b) arrived at the following conclusions:

1. Animal damage claims are only a very small fraction of the total damage claims that have been submitted to the Air Force.
2. The behavioral reactions of farm animals to sonic booms are, for the most part, minimal.
3. All experimental evidence to date indicates that the exposure of chicken eggs to sonic booms does not affect their hatchability.
4. Sonic booms do not appear to pose a threat to fish or fish eggs.
5. Knowledge concerning the effects of sonic booms on wildlife is limited, but it appears that sonic booms do not pose a significant threat.

In summary, the available literature and special studies reviewed support the facts that animals and wildlife can and do flourish in the presence of military aircraft operations, both subsonic and supersonic. Fletcher and Busnel (1978) recognized this by pointing out that if aircraft noise were aversive to wild animals, areas around large airports would be devoid of wildlife. This would also be true for military operation areas. At Nellis and other Air Force ranges where low level and supersonic flights are being conducted animals and wildlife have been exposed to sonic booms for over 25 years with no apparent significant effect. It is thus concluded that while some individual animals may show an adverse response, as a whole they should not be significantly impacted by the low level subsonic and mid- and high-level supersonic operations within the Sells Airspace.

4.3.7 SONIC BOOM EFFECTS ON STRUCTURES

Based on available literature, projected overpressures and past experience in other supersonic MOA's, structures in the Sells Airspace should not be significantly affected. Three large scale tests account for the bulk of recorded data available in describing structural response to sonic boom overpressure. The most intensive test was conducted at White Sands Missile Range, New Mexico, where 21 structures of various design and construction were instrumented and then exposed to more than 1,500 sonic booms with overpressures as high as 20 psf (Slutsky 1975). Except for glass, no damage was detected for overpressures up to 5 psf, nor was there evidence of any cumulative damage effects after a series of 860 successive flights at about 5 psf. The only evidence of damage at the conclusion of the tests, other than glass breakage, was three bricks that had loosened beneath a window ledge.

The results of the three large-scale sonic boom structural tests and several other tests were analyzed by NASA. In their conclusion, they make the following statement (Clarkson and Mayes 1972):

The extensive series of overflight tests have provided valuable data on the order of magnitude of responses to be expected. These tests show that building structures in good repair should not be damaged at boom overpressures less than about 11 psf. However, it is recognized that

considerable loading variability occurs, owing to atmospheric effects, and that the residual strength of structures varies according to usage and natural causes. Thus, there is a small probability that some damage will be produced by the intensities expected to be produced by supersonic aircraft.

One additional investigation is worthy of mention. In 1977 an adobe house on the Tohono O'Odham Reservation was instrumented and evaluated while supersonic training was taking place overhead (USAF 1979). The conclusion of the evaluation was that the adobe structure reacted similar to a conventional structure. Based on this evaluation, there should be no difference in the probability of damage to an adobe structure than a conventional structure.

Given the low Mach numbers and high altitudes of the proposed supersonic operations in the Sells Airspace, the probability of a structure being hit by a 6 psf carpet boom is less than one in 1,000 chances, for an 11 psf carpet boom the probability is beyond eight standard deviations of the mean boom strength and is considered to be below any level of significance. For focus booms greater than twice the nominal carpet boom pressure, the probability of a structure being hit is less than the range of one in 3,400 chances; a superboom is less than one in 16,700 chances. With this low probability and the fact that the positive peak of a focus boom has less impulse than a carpet boom signature generated from the same altitude and Mach number, the chance of causing structural damage is very small.

By far, the largest percentage of sonic boom damage claims stems from broken or cracked glass. All of the tests conducted in the United States have confirmed that glass damage is the most prevalent damage caused by sonic booms (Hershey and Higgins 1973). Because the microstructure of glass is amorphous rather than crystalline, the practical design strength of glass is dependent on the surface scratch condition. Glass that has been sandblasted, scratched, or nicked will not exhibit the same strength as a properly installed relatively new pane of glass.

In addition to the variation due to surface scratch condition, there are also variations with loading geometry, loading rate, atmospheric moisture content, and composition. Glass also exhibits a property known as "static fatigue" in that it is weaker for loads of longer duration. Thus, for sonic boom loading, which has a duration of the order of 0.1 seconds, the strength of glass will be roughly twice that obtained in typical laboratory assessments. By using a data base of unpublished static results provided by Libbey-Owens-Ford Company, a statistical analysis was performed to determine the probability of glass breakage for various overpressures. If all flight paths are considered equally likely -- that is, the aircraft could approach from any direction, then the probability of breakage for good glass at various nominal overpressures is as follows (Hershey and Higgins 1973):

<u>Overpressures</u>	<u>Probability of Breakage</u>
1 psf	.000001*
2 psf	.000023

*1 pane in 1,000,000 panes

If the aircraft were to approach from head-on or perpendicular to the plane of the window, the probability would increase somewhat, as follows:

<u>Overpressures</u>	<u>Probability of Breakage</u>
1 psf	.000023
2 psf	.000075
3 psf	.000300
4 psf	.001200
5 psf	.002300
6 psf	.004000

Note that for the overpressures previously discussed, around 5 psf, the probability of breakage is about two-tenths of one percent. Over a long period of time a few windows can be expected to be broken or cracked as a result of sonic booms. The Air Force has established procedures to recover the costs of damage resulting from sonic booms. While broken or cracked windows may be an inconvenience to the individual, the damages are recoverable from the Air Force.

4.3.8 SONIC BOOM EFFECTS ON TERRAIN AND SEISMIC ACTIVITY

Several studies have been performed to study the magnitude of seismic effects resulting from sonic booms (Slutsky 1975). Appendix B provides two such studies; one was conducted within the Valentine MOA area, the other was conducted at Railroad Valley, NV, both of which have soil characteristics similar to those of the Sells Airspace area. The Valentine test showed the peak verticle particle velocity to range between 0.009 and 0.012 inches per second. The Railroad Valley test results were of the same magnitude. These levels of ground motion are considerably below that allowed in the strictest blast codes (Dade County n.d.) (1 in/sec.). Considering the small level of movement, there should be no significant impact on the terrain or seismic activity in the Sells Airspace area. A study by Goforth and McDonald (1968) concluded that the static deformation that occurs at the surface is unlikely to build up sufficiently to constitute a menace to structures. As a part of the analysis, the peak particle velocities produced by the sonic booms were shown to be well below damage thresholds accepted by the United States Bureau of Mines and other agencies. The peak particle velocities recorded at a depth of 44 feet were attenuated by a factor of 75 relative to those recorded at the surface.

There has been some concern that supersonic flights over mountainous areas could cause avalanches under certain conditions. In 1967, the National Park Service attributed damage to two National Park areas caused by falling earth and rock immediately after a sonic boom (National Bureau of Standards 1971). The only test in the United States to study the possibility of avalanches was conducted in the Star Mountain area near Leadville, Colorado (Slutsky 1975). Eighteen supersonic runs were conducted with overpressures ranging from 1.5 to 5.2 psf. No avalanche was observed as a direct result of a sonic boom. Forest Service personnel rated the avalanche hazard as low during the test period and considered the test as inconclusive; therefore, the potential for sonic booms triggering avalanches remains largely unknown.

4.3.9 HISTORICAL/ARCHAEOLOGICAL SITES

Known cultural resource sites in the project area are listed in Appendix J. Both the Arizona State Historic Preservation Officer (SHPO) and the Arizona State Museum were queried for opinions about the possible impact of sonic boom overpressures on archaeological sites. The office of the SHPO responded that they were not aware of any specific studies dealing with the impact of sonic booms on historic properties and did not know how to evaluate the impact. Their concern was that short- and long-term effects of sonic booms not adversely affect the historic buildings, structures, and standing ruins in the Sells Airspace. The Arizona State Museum replied that the data were not sufficient to support an informed opinion.

For purposes of evaluating the effects of sonic boom overpressures on cultural resource sites, the sites can be divided into four categories: open sites without standing structures, open sites with standing structures, caves and rock shelters, and petroglyphs on boulders or rock faces.

Open sites without standing structures consist of artifacts on and in the ground and the arrangement of the artifacts in relation to each other and to other site features (soil layers, packed living surfaces, etc.). In most sites, particularly in sandy soils, the artifacts that remain are those that resist oxidation and decay (pottery, stone, glass, nonferrous metals). Within the context of sonic boom overpressures, such objects are not fragile and are not likely to be damaged as a result of sonic booms.

Standing historic structures are as susceptible to damage by sonic boom overpressures as any other structures of similar condition (see Section 4.3.7).

Studies on the impact of sonic boom overpressures on caves and petroglyphs were performed in west Texas in response to public comments on the Valentine MOA EIS. These studies indicated that there would normally be no effect from sonic boom overpressures, but that in extreme cases there might be spalling of surface rock layers that were already in an unstable state from natural erosive mechanisms (USAF 1983). If such spalling did occur where there were petroglyphs, the petroglyphs would be damaged. Spalling of cave or rock shelter roofs would not damage buried archeological remains in caves unless the collapsing rocks penetrated the cave floor and disturbed artifact content.

4.4 ACCIDENT HAZARD

4.4.1 HAZARD FROM CRASHES

The potential impact area is about three million acres. Between April 1, 1968, and April 30, 1986, there have been a total of 12 accidents involving 14 aircraft. The impact areas for these aircraft are illustrated in Figure 4.4-1. Aircraft involved were (1) F-104; (2) F-104; (3) F-4; (4) F-5; (5 and 6) one F-4 and one T-38 mid-air collision; (7) F-100; (8) F-4; (9 and 10) two F-5s. Not shown on the map are crashes that occurred since February 1986, which involved one F-15 and one F-5 aircraft on 7 March 1986 and 6 Feb 1986 respectively. There have been no civilian deaths or injuries.

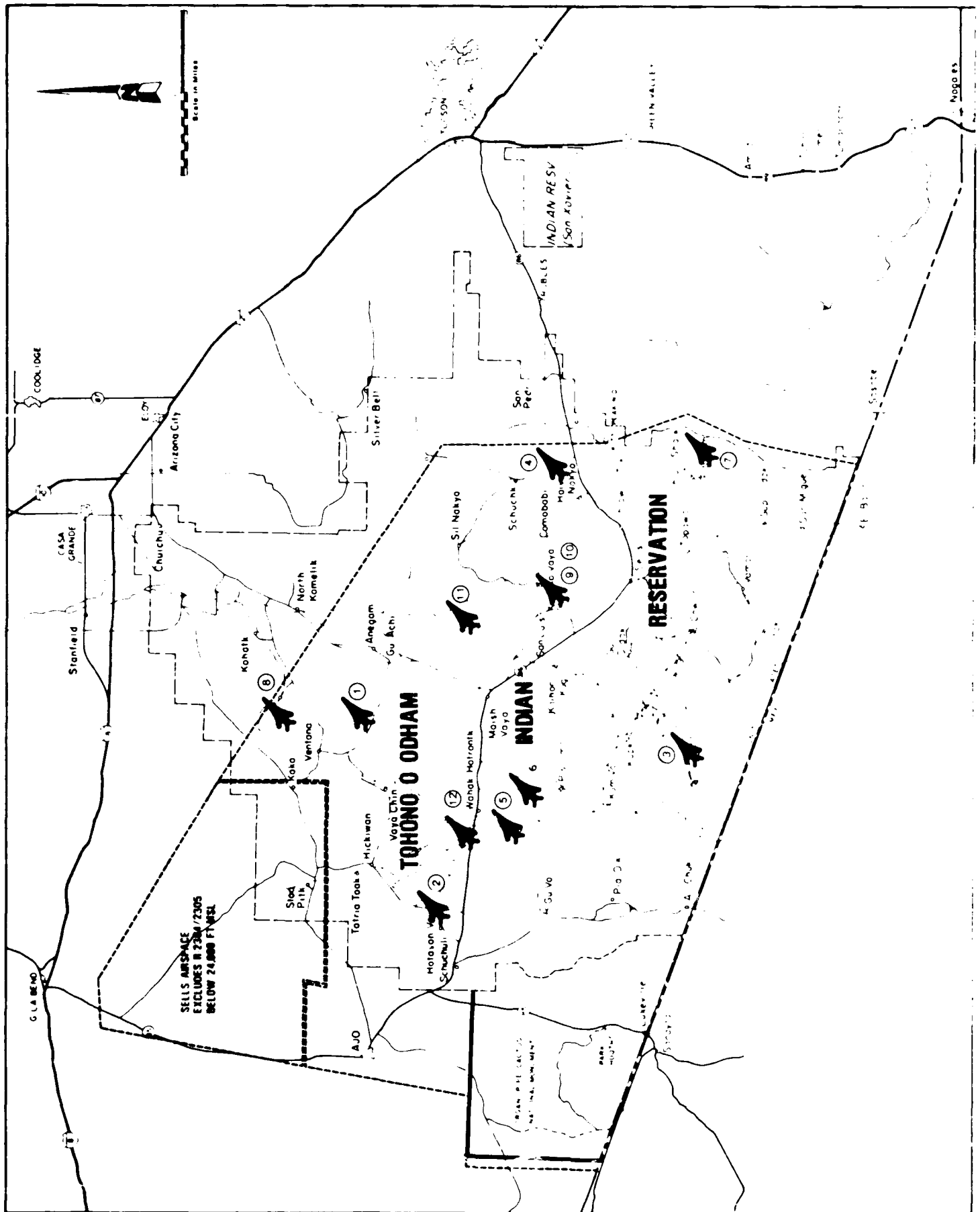


FIGURE 4.4-1 Location of Impact Areas of Crashes

4.4.2 HAZARD FROM ORDNANCE

F-5, F-16, A-7, A-10, and OA-37 aircraft carry inert ordnance (military weapons and ammunition) on some missions through the Sells Airspace enroute to military ranges. Aircraft based in the Tucson area (A-7, A-10, OA-37) carry ordnance on approximately 90 percent of their missions flown in the Sells Airspace. The routes involved are low-level training routes and LATN routes. Aircraft based in the Phoenix area (F-5, F-16) carry ordnance on less than 10 percent of their missions flown in the Sells Airspace, primarily on low-level training routes. F-15 aircraft do not normally carry ordnance in the Sells Airspace.

Inert ordnance carried by the aircraft consists of inert dummy bombs, light spotting charges, and 20 millimeter (mm) ball ammunition. The inert bombs are bomb cases filled with concrete, vermiculite, or some other filler. The spotting charges are smoke bombs with about the explosive capacity of a cherry bomb. The 20 mm ammunition is nonexplosive -- essentially large (.79-cal) rifle cartridges. In the event of a crash, none of the munitions carried by aircraft is of the type that would increase the danger to bystanders above that caused by the crashing aircraft itself.

4.5 IMPACT ON OTHER AIRSPACE USERS

Private aircraft are not prohibited from use of the airspace. Civilian aircraft operating on a Visual Flight Rules (VFR) clearance may fly through or in a MOA even when military activity is being conducted. Civilian aircraft operating on an Instrument Flight Rules (IFR) clearance may be cleared through or into a MOA if FAA Air Traffic Control can provide IFR separation from other aircraft.

All aircraft, military and civilian, are under the control of the FAA in Air Traffic Control Assigned Airspace areas (ATCAAs) above 18,000 feet MSL.

Although military use of the Sells airspace creates no special hazards for other aircraft, the existence of the MOA may discourage civilian use of the Sells Airspace.

4.6 IMPACT ON PLANTS AND ANIMALS

4.6.1 PLANTS

Aircraft operations in the Sells Airspace will have no impact on plants on the ground below. In the event that an aircraft crashes, plants will be damaged or destroyed.

There are no plants in the project area that are listed by the federal government as "threatened" or "endangered." Yucca, blue paloverde, honey mesquite, and most species of cactus are protected under the Arizona Native Plant Law (Ariz. Rev. Stat., Chapter 7, Article 1, Sec. 3-901).

Damage or destruction of plants as a result of aircraft accidents will occur but is not considered a significant impact.

4.6.2 ANIMALS

The effects of noise on animal populations are considered in Section 4.3.6 and are not included in this section.

The effects of aircraft operations on ranching are considered in Section 4.7.3.

There is no evidence that aircraft operations in the Sells Airspace will have any negative effect on terrestrial animals below the airspace. In the event of an accident, there may be minor negative effects on animal populations represented at the crash site.

The effects of aircraft operations on birds are likely to be greater. Potential impacts include disturbance of or collisions with birds in flight and disturbance of nesting birds around cliffs. The birds most likely to be disturbed in flight are buzzards, various raptors, and waterfowl. The nature of the training missions and the type of aircraft used for low-level training (primarily A-7s, F-16s, OA-37s, F-4s and A-10s) will tend to minimize both disturbance and the danger of collision. The area of greatest danger to and from waterfowl is around the Santa Rosa Wash impoundment near Vaiva Vo, an area where air traffic is light.

Evidence collected by Ellis (1981) on the effects of aircraft operations at the level used in the Sells Airspace on eight species of raptors suggests that such operations do not disturb the nesting cycle or cause birds to fail to return to an eyrie in succeeding years.

4.7 ECONOMIC IMPACT

4.7.1 GENERAL ECONOMIC CONDITIONS ON THE TOHONO O'ODHAM RESERVATION

There is no evidence that military operations in the Sells Airspace have had any significant direct economic impact, positive or negative, on the Tohono O'Odham Reservation. Secondary or diffuse impact on the residents of the reservation is positive to the extent that military installations contribute to the general economy and job market in the Phoenix and Tucson areas, and to the extent that residents of the Tohono O'Odham Reservation seek employment in those areas.

4.7.2 GENERAL ECONOMIC CONDITIONS RELATING TO ORGAN PIPE CACTUS NATIONAL MONUMENT

Businesses around the Organ Pipe Cactus National Monument are affected by the amount of visitation at the monument. Though it is not possible to determine the effects, if any, of military operations in the Sells Airspace on visitation at the monument, the continuing upward trend of visitation at the monument indicates that no substantial negative impact on businesses around OPCNM exists due to aircraft operations in the Sells Airspace.

4.7.3 IMPACT ON RANCHING

The effects of military aircraft operations in the Sells Airspace on ranching differ from the effects of those operations on the domesticated animals involved. If a herd of cattle scatters in response to a low-flying aircraft,

that is not an economic impact, but if the herd has been gathered in a roundup and must be reassembled, that is an economic impact. The Tohono O'Odham Council, Tohono O'Odham Legal Services, and individual Tohono O'Odham Indians have complained of roundups being disrupted by low-flying aircraft. In the past, there has been no effective, consistent means of notifying airspace users of planned roundups. The disruption of roundups and the additional work required to reassemble, do impact ranching on the Tohono O'Odham reservation.

4.7.4 IMPACTS ON FARMING

Aside from possible effects of noise on domesticated animals (discussed in Section 4.3.6) military aircraft operations in the Sells Airspace should have no other impact on farming.

4.7.5 IMPACTS ON MINING

Military aircraft operations in the Sells Airspace will have no effect on mining (see Section 4.3.8 for seismic effects of sonic boom overpressures).

5.0 ALTERNATIVES TO FLIGHT OPERATIONS IN THE SELLS AIRSPACE

5.1 GENERAL

The following is a discussion of alternatives to flight operations in the Sells Airspace overlying the Tohono O'Odham Indian Reservation, the Organ Pipe Cactus National Monument, and other public lands in Pima County. In addition to the "no action" alternative, the discussion also presents alternatives to the two major sources of noise that impact the land area beneath the Sells Airspace -- low-level subsonic flights and sonic boom noise produced by aircraft flying above 10,000 feet mean sea level (MSL).

5.2 NO ACTION ALTERNATIVE

Under the "no action" alternative all supersonic flight operations the Sells Airspace would cease. However, because supersonic training must be continued to maintain combat capability, the training sorties scheduled in the Sells Airspace would have to be conducted in other existing designated special use airspace. Other Special Use Airspace (SUA) within acceptable range is already scheduled to the point of saturation for the same missions out of the same bases and could not accommodate the addition of training sorties presently using the Sells Airspace. The impact on all users would be major, i.e. curtailment of training, lengthening of training programs, reduction of training effectiveness, and/or reduction of military pilots trained. In the case of the F-5 aircraft based at Williams AFB, restrictions on the use of Sells Airspace would have even a more serious impact. No other available Special Use Airspace is within range of the F-5. While the Bagdad/Gladden MOAs are within range they are already fully used and the F-5 would be required to fly excessive distances to those SUA due to the complexities of transiting the Phoenix area airway/arrival/departure routings. The reasons that supersonic aircrew training cannot be discontinued are explained in other sections within this chapter. Figure 1.1-2 shows some of the existing restricted airspace areas, and other MOAs/ATCAAs (military operations areas/Air Traffic Control Assigned airspace areas) that would have to accommodate the training sorties currently conducted in the Sells Airspace.

The adverse environmental effects of the supersonic training flight operations would be eliminated from those areas beneath the Sells Airspace but would be transferred to other areas. The environmental effects in any other MOA would depend on local conditions. Because of the increase in flight operations from current use levels (assuming that the increased training sorties could be accommodated), the perceived effects of noise and intrusion at the new location would be greater.

Supersonic flight training operations are already being conducted at other MOAs/ ATCAAs within the acceptable training range. The supersonic operations

currently conducted within the Sells Airspace could not be accommodated within any existing MOA/ATCAA shown in Figure 1.1-2 without seriously degrading training value. Other restricted airspace areas in southern Arizona are saturated and are not available for supersonic training operations.

Other alternatives that could achieve training objectives and reduce the environmental effects are changes in the levels of flight activity of the various types of training conducted. These alternatives are discussed in subsequent sections.

5.3 ALTERNATIVES TO LOW ALTITUDE TRAINING

5.3.1 FLY ROUTES ESTABLISHED BY OTHER BASES

This alternative would reduce the noise/annoyance factor to the inhabitants of the area beneath the Sells Airspace by spreading the low-level flights over a greater number of routes. The ability to accomplish this alternative is limited by the number of other routes available, the amount of traffic already using the route, the purpose of the training mission, and the distance from where the flight originates and terminates.

Total training sorties are held to a minimum by combining low-level navigation with air-to-ground bombing or gunnery events. This procedure has decreased costs and increased the realism of aircrew training. Units at Davis-Monthan AFB, Tucson International Airport, and Luke AFB combine low-level navigation with air-to-ground attack training into one aircrew training sortie in the A-10, A-7, F-4, and F-16. To a lesser degree, F-4 and F-16 air-to-ground range sorties are also conducted independently of low-level routes to maximize their training time on the ranges. The primary range for air-to-ground sorties is R-2301E, R-2304 and R-2305 located just west and north of the Sells Airspace.

Figure 1.1-2 shows the MOAs, ATCAAs, and Restricted Areas in the Luke AFB, Davis-Monthan AFB, and Sells Airspace area. The most obvious route to the R-2301E range for Davis-Monthan AFB, Tucson-based Air National Guard (ANG) aircraft, and, to some extent, Luke AFB aircraft is on routes that cross the Sells Airspace. (See Figure 2.3-2 for military training routes in southern Arizona.)

If the operations were merely transferred to routes, not transiting the Sells airspace, established by other bases the physical effects resulting from use of MTRs in the Sells Airspace would just be transferred to other locations. The environmental impacts of those effects would depend on local conditions.

5.3.2 REROUTE EXISTING MILITARY TRAINING ROUTES

In 1979, when the Draft EIS was published, 15 MTRs (14 visual routes and 1 instrument route) crossed the Sells Airspace. Since then, seven routes have been deleted to minimize impact on the Tohono O'odham Reservation and Organ Pipe Cactus National Monument. Rerouting existing MTRs within the Sells Airspace would have the effect of reestablishing zones of impact that have been abandoned.

5.3.3 RAISE MINIMUM ALTITUDE ON MILITARY TRAINING ROUTES

Raising the minimum altitude of military training routes to 2,000 feet or higher reduces the perceived noise level to individuals and wildlife on the ground; for example, A-7 single event sound level at 500 feet is 94.2 decibels (dB), and A-7 single event sound level at 2,000 feet is 84.3 dB. However, raising MTR altitude in this manner would preclude effective low-level training for aircrews.

5.3.4 DISCONTINUE LOW-LEVEL NAVIGATION FLYING

U.S. military tactical fighter forces must be prepared to execute air-to-ground attack missions. Aircrews must penetrate increasingly sophisticated and extensive enemy defensive systems to reach their targets. To improve their chances of reaching combat targets, they fly at high speed and/or very low altitudes -- below the detection level of enemy radars. This type of flight requires extensive aircrew training and practice since significant geographical references or checkpoints are visible for only a few seconds at high speed and very low altitudes. Aircrews must acquire and identify these checkpoints, correlate them with a map to determine their position while avoiding the ground or other obstacles, and maintain or correct their direction and airspeed to achieve ingress to the target. Preplanned, single line, high-speed, low-level ingress to a target will continue to be used in the foreseeable future for tactical aircraft.

With the advent of the A-10 ground attack fighter, the single line concept of low-level navigation has been greatly modified. The A-10 is employed in search and destroy missions that range over a relatively wide area to locate and attack enemy ground forces, most often in close proximity to friendly ground units. The A-10 flies at relatively low airspeeds and very low altitudes, avoiding all identifiable signs of the enemy and using terrain masking to avoid radar or visual detection enroute to the target area. Development of the skills to exploit the capabilities of the A-10 requires extensive training and practice. Areas that provide the pilot freedom of route selection must be used to train A-10 pilots in low-level navigation. Elimination of low-level navigation, whether it be on a military training route or in an area for low altitude tactical navigation, would be detrimental to the combat readiness of tactical air forces and greatly impair national security defense capability. Aircrews would be denied the opportunity to train in a realistic environment.

5.3.5 DEVELOP ADDITIONAL ROUTES

Developing additional routes in southern Arizona is not a viable alternative. Although not evident by the maps (only the route centerline is depicted), each military training route is 2 to 10 miles wide. Existing routes, airports and heavily populated areas cover almost the entire land area of southern Arizona. So there is limited airspace available outside the area underlying the Sells Airspace in which to locate additional routes. Further, existing MTRs under the Sells Airspace were developed and designed to provide training as well as a suitable means of transiting the Sells Airspace to reach the restricted areas west of the Sells Airspace. Therefore, units from Luke and Davis-Monthan AFBs are able to get as much training as possible from each sortie. Developing additional routes in the limited airspace outside the

Sells Airspace to avoid transiting that area would reduce the quality of training, would increase fuel consumption and would not serve any useful training requirement.

5.4 ALTERNATIVES TO SUPERSONIC TRAINING

5.4.1 TRANSFER SUPERSONIC TRAINING TO OTHER MOAs/ATCAAs

The location of densely populated areas, numerous civil airways, established restricted areas, and other MOAs/ATCAAs in southern Arizona have limited the identification and use of most other airspace areas for supersonic operations. The Gladden ATCAA, located northwest of Luke AFB, approved for supersonic operations in November of 1977, is already fully loaded with training activities/missions and is not capable of absorbing additional flights.

Use of the Gladden Airspace for additional supersonic training flights would create unacceptable delays in, and loss of, training activities as a result of an overcrowded airspace area. Overcrowding increases the potential for mid-air collisions.

In June 1985 FAA revealed additional Federal Airways proposed in Arizona some of which will impact adversely upon military SUA. If the proposed airways are approved the Gladden MOA/ATCAAs will be reduced in size and the YUMA Army Proving Ground (YPG) Restricted Areas (R-2306 A/B/C, R-2307, and R-2308 A/B) will not only be reduced in size but will have an east/west airway imposed through the center of the SUA. These actions will effectively render the YPG area unusable for military flight training activities and would further hamper operations in the Gladden SUA.

5.4.2 TRANSFER SUPERSONIC TRAINING TO OTHER MOAs AND/OR RESTRICTED AREAS

Other areas that have been evaluated to determine if they can accommodate supersonic training include the Williams MOAs, R-2301 E/W, R-2303 A/B at Fort Huachuca, and the YPG Restricted Areas R-2306/7/8. The Williams MOAs have not been approved for supersonic operations, are used extensively for student pilot training, and are the only acceptable airspace area close enough to Williams AFB to accommodate this type of training. R-2303 is unsatisfactory for supersonic training because the airspace is too small in size horizontally and vertically, and is too distant from Luke and Williams AFB..

R-2301E and the Yuma Army Restricted Areas R-2306/8 are of minimally acceptable size to handle supersonic training activities. Several problems are evident, however. The primary mission of the Army areas is to provide Army ground-to-ground ordnance testing. Commingling of air combat training over ground-to-ground ordnance testing is not an acceptable alternative due to the fundamental safety problems involved. A base altitude of 16,000 feet MSL would be required to separate the two activities. This would reduce the vertical envelope necessary for realistic air maneuvering by one-third. With inexperienced aircrews, the possible penetration of the base altitude is increased and would increase the flight safety hazard. As indicated in paragraph 5.4.1 the proposed imposition of a new airway along the northern boundary of R-2306/8 and another airway through the center of this airspace will force current military flight training operations from this airspace.

This will impose additional burdens on the few remaining SUA in Arizona.

Supersonic air maneuvering sorties are presently scheduled in the air-to-air gunnery range, R-2301E, when that range is not scheduled for its primary mission. Although these ranges were already heavily scheduled, additional supersonic activity is scheduled to reduce noise and aircraft congestion in Sells Airspace. A concerted effort has been made to increase utilization of R-2301E for supersonic air maneuvering training to the maximum extent practical to further reduce noise impact on the land area beneath Sells Airspace. The use of this airspace and that contained above the Yuma Proving Ground has absorbed approximately 20 percent of the supersonic training presently scheduled by the 832nd Air Division. Other possible training areas suitable for supersonic operations, located outside the state of Arizona, are beyond a reasonable distance (100 miles) of those units that utilize the Sells Airspace.

5.4.3 RAISE SUPERSONIC TRAINING FLOOR

Raising the supersonic training floor would degrade the training capability and increase safety hazards without materially reducing sonic boom impacts. Training capability would be reduced because pilots would be required to spend more time concentrating on staying within a restricted training zone and less time concentrating on practicing the skills required for successful air-to-air combat. Introduction of this additional arbitrary element would degrade realistic tactics training by teaching student pilots to fly in a different manner than they would in actual combat.

Accidents hazards would be increased because of two factors; the same number of aircraft would occupy a smaller volume of space, and pilots would be required to look inside the cockpit more often to check altitudes when they should be looking outside to see other aircraft.

Raising the supersonic training floor would be a negligible factor in reducing sonic boom noise and overpressures. Under the conditions where the sonic boom under an F-15 flying at 10,000 feet MSL would be 142 dB, the noise from the same aircraft at 15,000 feet MSL would be 140 dB. Overpressure would be reduced from 5 pounds per square foot (psf) to 4.5 psf.

5.4.4 DISCONTINUE SUPERSONIC TRAINING

A-7 and A-10 air combat training would not be affected since these aircraft do not require training at supersonic speeds. Elimination of supersonic training in the F-4, F-5, F-15, and F-16 would be detrimental to the combat capability of tactical air forces and thus to national security, since student aircrews would be denied the training necessary for the successful completion of assigned aerial combat tasks.

5.4.5 ESTABLISH A NEW TRAINING AREA FOR SUPERSONIC ACTIVITY

Population density, civil airways, restricted areas, and MOA/ATCAAs conflict with the establishment of an additional supersonic training area within 100 nautical miles of Luke AFB. Other training areas located outside Arizona would be beyond reasonable distance of the units utilizing the airspace. Even now, 832nd Air Division (AD) pilots operating in the Sells

Airspace expend 50 percent of their flight time in transit. Increased distances to other areas would necessarily result in a further reduction in productive mission training time and increased fuel consumption, causing increased fuel cost.

6.0 PROBABLE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED SHOULD FLIGHT OPERATIONS CONTINUE

6.1 AIR QUALITY

Air pollutants contained in engine exhaust deposited within the Sells Airspace will continue. Concentrations of pollutants are considerably below and are projected to remain below the federal and state primary and secondary standards except around Ajo, which is within a designated nonattainment area for total suspended particulates (TSP) and sulfur dioxide, and in Pima County, which is a designated nonattainment area for total suspended particulates (TSP) and sulfur dioxide.

6.2 NOISE

Current projected subsonic and supersonic jet operations in the Sells Airspace will continue to create a noise impact on the environment beneath the airspace. Tohono O'odham Indians opposing military flight operations have expressed concern regarding the potential adverse impact frequent sonic booms and low level flight may have on both the human and wildlife population of the area. Although the noise may be annoying to some individuals, the projected levels are not of a magnitude where hearing loss would be expected. There is data that suggest a link between noise and non-auditory physiological effects; however, much of this data is questioned on methodological grounds. If it is possible that noise causes non-auditory health effects, it is probable that these effects would be mediated through psychological behavioral patterns due to annoyance stresses. About 9500 people live within the area underlying the Sells Airspace. Most of these are exposed to the noise effects (sonic booms) of supersonic flight operations. Supersonic operations are conducted throughout the airspace, but are predicted to occur generally in two maneuvering areas that would experience about 7 sonic booms per day each. One in eight (about 900 people) people are expected to be highly annoyed due to supersonic flight operations by 1990. The noise level from sonic booms in the highest exposure area has a C-weighted day-night average sound level of 59dB.

Low intensity noise is expected along all designated low altitude training routes and LATN areas away from population centers and designated avoidance areas as a result of low altitude tactical training. Noise is projected to increase in the areas beneath the MTRs due to a projected increase in the low altitude activity along the routes, though supersonic flight activity is projected to drop by 1990 with a corresponding drop in noise levels, and LATN activity and its associated noise is projected to remain at current levels.

6.3 ACCIDENTS

The possibility of an aircraft accident injuring humans, or damaging buildings does exist. Twelve accidents have occurred in the Sells Airspace between 1968 and early 1986, with no civilian deaths or injury or private property damage.

Inert ordnance is carried by some aircraft using the Sells Airspace on their way to bombing and gunnery ranges. The potential for injury or damage from these armaments is extremely low, since they consist of inert dummy bombs, light spotting changes and 20 millimeter ball ammunition.

6.4 ACTIONS TAKEN OR PROPOSED TO MITIGATE THE ADVERSE ENVIRONMENTAL IMPACTS

6.4.1 ACCOMPLISHED ACTIONS

6.4.1.1 Raised Base Altitude

The original Sells Low MOA proposal was to establish a base altitude of 100 feet above ground level; however, it was modified, at the insistence of the Tohono O'odham Tribes to establish a base altitude of 3,000 feet above ground level (AGL). This action raised the minimum altitude for aircraft transiting the area to the Luke AFB Range from 1,500 feet to 3,000 feet and above for (1) aircraft transiting the Sells Airspace to the Luke AFB Range (2) aircraft flying medium altitude visual/radar navigation routes, and (3) aircraft flying routes designed for reduced weight flights.

6.4.1.2 Reduced Supersonic Sorties

Supersonic functional flight checks have been prohibited in the Sells Airspace since July 25, 1977. This reduced the number of sonic booms by about 2 percent. F-15 aircraft remain subsonic until within 17-20 nautical miles (NM) of each other, reducing the area over which sonic booms can occur by about 60 percent.

6.4.1.3 Pilot Briefing Programs

An improved pilot briefing program has been developed to ensure that all units using the Sells Airspace are reminded prior to each flight of restrictions and sensitive areas underlying the Sells Airspace. Each squadron briefing room contains a map depicting the exact location of designated noise-sensitive areas. Pilots interviewed at Davis-Monthan AFB and Tucson IAP as part of this study were aware of the presence of the avoidance areas.

6.4.1.4 Daylight/Alternate Scheduling

Air Combat Training (ACT), which produces sonic booms and associated overpressures, is limited to daylight hours and is now also scheduled in R-2301E, the Gladden Airspace, R-2304, and R-2305 when these areas are available. ACT is scheduled in the Sells Airspace only when Range R-2301E is being fully utilized and no other airspace is available.

6.4.1.5 Public Affairs Program

Public affairs efforts have included a formal public affairs program, a committee to improve relationships between the USAF and the Tohono O'odham, and private voluntary efforts by USAF personnel at Luke AFB and ANG personnel at Tucson IAP. Until recently, the official programs were dormant. The private programs continue to operate, especially the efforts from Luke AFB, which are more formal and oriented toward specific goals.

6.4.2 PROPOSED AIR FORCE ACTIONS

6.4.2.1 Tohono O'Odham Concerns

In order to provide a more unified approach to the various problems discussed earlier in the document, the USAF, working in cooperation with the Tohono O'Odham Tribal Council and the Chairman of the Tribal Council, will attempt to implement the following system:

1. To avoid diffusion of effort and to keep lines of communication as uncluttered as possible, the USAF should assign a single point of contact (SPC) the responsibility for dealing with problems arising from the continued use of the Sells airspace over the Tohono O'Odham Reservation.

2. In cooperation with the Tohono O'Odham Tribal Council and the Tribal Chairman, the SPC will institute a continuing program of visitations at the tribal and district levels to improve communications, complete claims forms, receive complaints, explain military operations in the airspace, and generally deal with such problems as may arise.

6.4.2.2 Organ Pipe Cactus National Monument Concerns

The USAF regards continued use of the mountain and valley terrain of the Organ Pipe Cactus National Monument (OPCNM) as very important in training pilots for low-level operations. Avoidance areas have been established to minimize impact on concentrations of visitors to the monument.

The USAF/ANG will increase emphasis in pilot briefings on the importance of avoiding these areas. The single point of contact (SPC) will be responsible for all problems that may arise from aircraft operations over OPCNM. The SPC will cooperate with the monument supervisor in enforcing avoidance of designated areas and in discussing other procedures for minimizing impact on the monument and its visitors.

6.4.2.3 Additional Potential Mitigating Actions

6.4.2.3.1 Flight Simulators

Flight simulators are used to provide some training to aircrews that previously was performed by actual flight instructions. Flight simulators are used to the maximum extent possible, but their use is technologically limited by the current state of the art. However, this program is under constant review, and it may be possible to transfer some future flight activity to the simulators.

7.0 RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF THE ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

At present, there is no indication that the use of Sells Airspace will have any effect on the long-term productivity or use of natural and physical resources located on the reservation.

The expected impacts will be on the human environment. Minor damage to structures is anticipated. Continuing operations probably will serve as an irritant to residents of the Tohono O'Odham Reservation and monument employees and visitors at Organ Pipe Cactus National Monument (OPCNM).

Use of the Sells Airspace probably will not hinder development on the Tohono O'Odham Reservation or the OPCM. Urban development on the Tohono O'Odham Reservation may be as objectionable to the Tohono O'Odham as present USAF operations.

USAF operations in the Sells Airspace will have no permanent effect and will not foreclose any future options. Impact will cease the moment aircraft operations cease.

8.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

There are no known irreversible or irretrievable commitments associated with the use of the airspace because national defense priorities would require similar training to be conducted elsewhere. The following resources are considered irretrievable; however, they would be so even if the training were conducted elsewhere.

8.1 FUEL

The expenditure of aircraft fuel is not renewable. As more efficient engines are developed, fuel consumption will decrease. Such trends are expected to continue. Newer Air Force aircraft such as the F-15 and A-10 use less fuel than older aircraft such as the F-4 and F-100.

8.2 AIRCRAFT AND AIRCREW MEMBERS

The loss of aircraft and aircrew members due to accidents is an irretrievable commitment of physical and human resources. It is doubtful if transferring the flying activity to another area would change this commitment of resources except possibly to increase the accident rate if a more crowded area is used.

8.3 LAND

The land area impacted by aircraft accidents including flora and fauna in the immediate crash area is irretrievable. Desert environments are extremely slow in recovering, and the visible impact will remain for decades.

9.0 OTHER CONSIDERATIONS

9.1 NATIONAL DEFENSE

Vital, realistic aircrew training in aerial combat tactics and low altitude navigation is achieved within the Sells Airspace. This training provides each student aircrew with the level of proficiency required prior to assignment to an operational unit. The skill levels thus attained are developed further by programs of continuation training, conducted by the operational unit. Realistic tactical flying training is the keystone to ensure the readiness and survival of tactical fighters, forward air controllers, and reconnaissance aircrews and is essential to the mission of the Air Force and national defense. The quantity, quality, and realism of aircrew training determines, in principal measure, the probability of success and survival in combat. Airspace in which to conduct this training is vital to the maintenance of combat ready tactical air forces available for deployment on a worldwide basis.

Aircrew training through the use of flight simulators is used to minimize the number of aircraft sorties required for aircrew training. Reduction of aircrew sorties in lieu of flight simulator missions cannot be done until it has been conclusively proven that training tradeoffs in the simulator can be quantified. In the development of flight training programs, maximum use of flight simulators is required to supplement aircraft sortie training in maintaining aircrew proficiency skills.

The Instructional Systems Development (ISD) concept is applied to conduct aircrew training. ISD includes a continual review of flying programs to ensure that aircrew proficiency is maintained while optimizing monetary savings through reduced aircrew sorties. Instructional Systems Development and simulator training cannot replace actual experience in flying the aircraft; therefore, these methods of training are not acceptable to fully replace actual flying experience.

10.0 DETAILS OF ANY UNRESOLVED CONTROVERSY

10.1 TOHONO O'ODHAM ACTIONS

The Tohono O'Odham Indians have protested the use of the airspace over their reservation for Air Force training activity since at least 1974. Indian protests to the FAA in 1977 led to a negotiated settlement and the establishment of the Sells Low MOA with a floor of 3,000 feet, rather than the 100 feet originally intended. Meetings between the Air Force and the Tohono O'Odham Tribe began in 1975. The Tribe and representatives of the Air Force met monthly from July 1977 to May 1978, and extensive coordination was made during that period. These meetings were suspended in 1978, and similar meetings have been held only sporadically since. The Air Force has responded after situations of particularly severe sonic booms, and in some areas disciplinary actions have been taken against pilots who violated restrictions specified in para 6.4.1 above. The Air Force desires to resume periodic meetings and expand their scope.

10.2 ORGAN PIPE CACTUS NATIONAL MONUMENT

While recognizing and appreciating efforts by the Air Force to minimize impact on the Organ Pipe Cactus National Monument (OPCNM), the National Park Service has opposed and continues to oppose inclusion of the OPCNM in the Sells MOA.

11.0 CONSULTATION AND COORDINATION

During the preparation of the environmental impact statement, the Air Force contacted state and local offices, interested groups, and other federal agencies concerning continued low level and supersonic flight in the Sells Airspace. Communications ranged from formal written comments to informal personal contacts.

Federally mandated consultation has been conducted with the USFWS and the Arizona State Historic Preservation Office for endangered species and archaeological concerns, respectively.

Section 7 of the Endangered Species Act of 1973 requires federal agencies to consult with USFWS if a proposed action may have an effect on a listed endangered or threatened species. The Air Force initiated Section 7 consultation with the USFWS in February 1979 regarding the effects of sonic booms on the Peregrine Falcon. In order to develop sufficient information for making a biological opinion, the USFWS and the Air Force jointly conducted a two year field study on the responses of raptorial birds to sonic booms and low level jet aircraft overflights. Results of this study show in no case are nestling death or eyrie abandonment indicated. The USFWS concurred in this finding. In June 1978 and again in January 1980, the Air Force initiated formal Section 7 consultation with the USFWS regarding the effects of Air Force activities on the Sonoran pronghorn. After review of endangered species files and information provided by the Sonoran Pronghorn Recovery Team, the USFWS determined that Air Force activities are unlikely to jeopardize the continued existence of the Sonoran pronghorn, and therefore the Air Force believes no additional coordination is required. After similar consultation concerning the gray wolf, the USFWS concluded that Air Force operations are unlikely to jeopardize the continued existence of the gray wolf. The Air Force continues to review operations in respect to endangered species and to coordinate with the USFWS on mitigation efforts.

Title 36 CFR 800 requires federal agencies to identify properties listed or eligible for listing on the National Register of Historic Places that are located within the area of the action's environmental impact and that may be affected by the action. The Arizona State Historic Preservation Office, based on the Arizona State Museum files provided the location of several National Register sites within the Sells Airspace (see Section 2.6.7.2). Appendix B provides a review of sonic boom effects on archaeological sites in the Valentine MOA. As a worst case analysis, the maximum expected ground motion from a sonic boom is about 0.08 inches per second. At this level of motion it is not expected that a sonic boom would trigger any more deterioration than would be expected by natural processes.

A public hearing on the DEIS was held on March 27, 1979 in the village of Santa Rosa, Tohono O'odham Indian Reservation Arizona. The purpose of the hearing was to obtain comments and any additional information from the residents and other interested parties. In most cases, responses to questions raised were answered at the public hearing. Many of the questions asked led to revision in the text of the statement that clarified many of the issues raised.

The major issues discussed at the public hearing and brought out in letters received during and after the public comment period included in some form the following:

1. Health effects, both acute and chronic, on individuals beneath the flight activity.
2. Resolution of damage claims submitted to the Air Force as a result of supersonic flight activity.
3. Effects of sonic booms on structures in the area.
4. Analysis of all viable alternatives to the continuing action.

Each of these areas of concern is discussed in various portions of the text. Some of the questions raised led to additional studies and review of additional material. Responses to each of the questions above can be found in the sections indicated below:

Question 1: Section 4.3.3, Section 4.3.4, Appendix B

Question 2: Section 1.2.2.4

Question 3: Section 4.3.7, Appendix B

Question 4: Sections 5.0 through 5.5

Questions raised during and after the public comment period by federal, state and local agencies are included in Appendix C. These letters were used in scoping the significant issues discussed in this document.

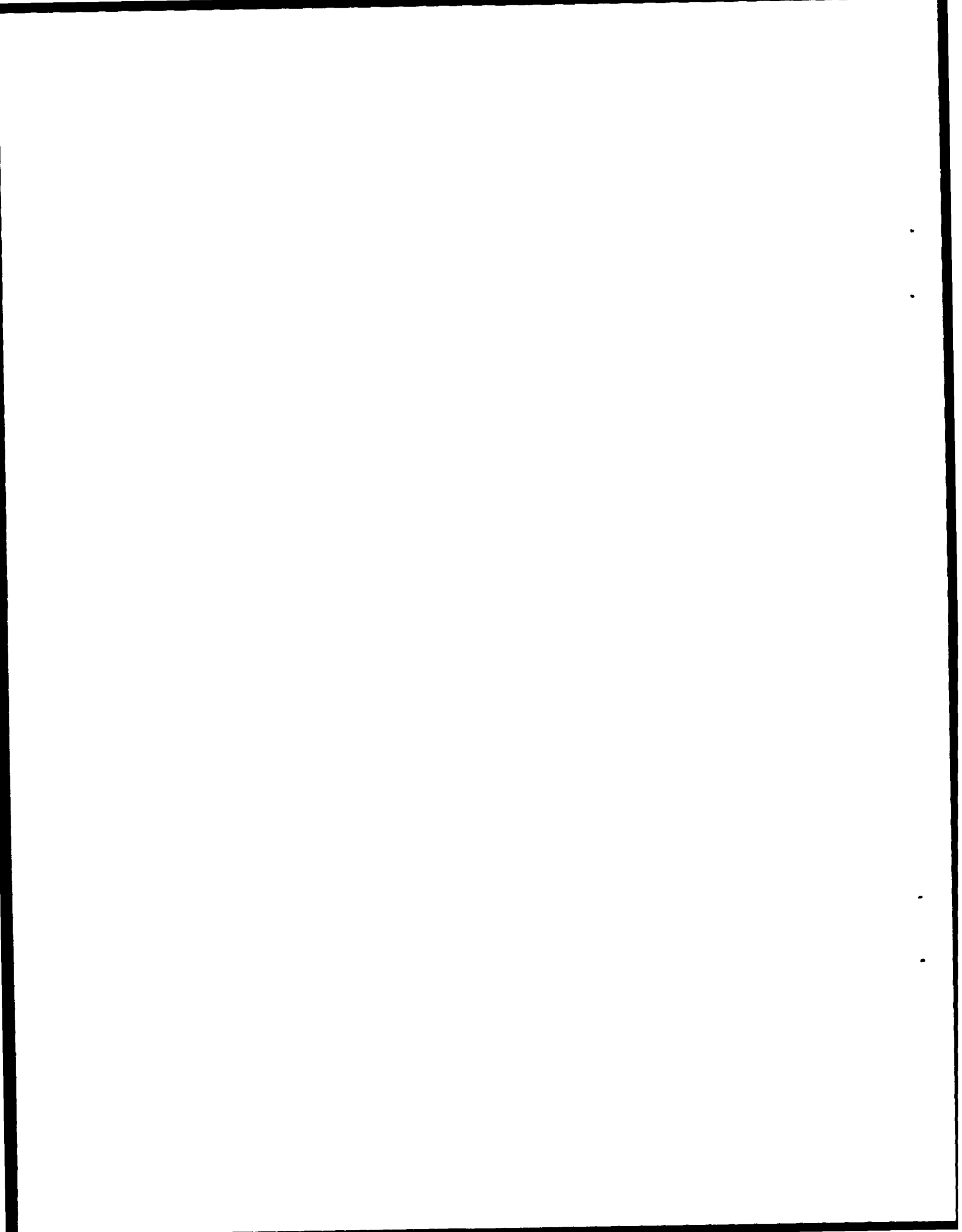
A report prepared by Richard D. Worthington, Ph.D is published in Appendix B. It represents an opposing view on impacts of sonic booms on people based on an extensive literature review of data on general audible and impact noises. While the report is very pessimistic compared to the position adopted by the National Research Council's Committee on Hearing, Bioacoustics, and Biomechanics (CHABA, 1981), the Air Force feels some points raised by Worthington have merit while others must be questioned. Immediately behind Worthington's report is the Air Force's rebuttal followed by Worthington's comments on the rebuttal.

REFERENCES

- Broadbent, D. E. 1980. Noise in relation to annoyance, performance, and mental health. Journal of the Acoustical Society of America 68(1).
- Bureau of Indian Affairs (BIA). 1981. "Information Profiles of Indian Reservations in Arizona, Nevada and Utah"., pp49-52. Phoenix Area Office Bureau of Indian Affairs.
- . 1983. "Information Profiles of Indian Reservation in Arizona, Nevada, and Utah"., pp66-70. Phoenix Area Office, Bureau of Indian Affairs.
- . 1985. "Indian Service Population and Labor Force Estimates"., p16. Washington D.C. Office, Bureau of Indian Affairs.
- Carlson, Harry W. 1978. Simplified Sonic Boom Prediction. NASA Technical Paper 1122.
- Clarkson, B. L., and Mayes, W. M. 1972. Sonic boom-induced building structure responses including damage. Journal of the Acoustical Society of America 51:742-757.
- Committee on Hearing, Bioacoustics and Biomechanics (CHABA). 1977. Guidelines for preparing environmental impact statements on noise. Assembly of Behavioral and Social Sciences, The National Research Council, National Academy of Sciences.
- . 1981. The effects on human health from long-term exposures to noise. Assembly of Behavioral and Social Sciences, The National Research Council, National Academy of Sciences.
- . 1982. Prenatal effects of exposure to high-level noise. Assembly of Behavioral and Social Sciences, The National Research Council, National Academy of Sciences.
- Cottureau, P. 1972. Sonic boom exposure effects: effects on animals. Journal of Sound Vibration 20(4):531-534.
- Dade County, Florida. n.d. Section 13-12, Particle Velocity and Amplitude. Building Code.
- Daley, P. S., LTC. 1982. "National Oceanic and Atmospheric Administration (NOAA) Estimates of Focus Boom Geometry and Magnitude." Letter, SAF/MIQ, Pentagon, Washington, D.C. 27 September 1982.
- Department of Housing and Urban Development (HUD). n.d. Environmental Criteria and Standards. 24 CFR Part 51.
- Ellis, D. H. 1981. Responses of raptorial birds to low level military jets and sonic booms. Institute for Raptor Studies, Oracle, Arizona.
- Environmental Protection Agency. 1974. Information on levels of environmental noise requisite to protect public health and welfare with an adequate margin of safety. EPA 550/9-74-004.

- . 1980. Guidelines for noise impact analysis -- draft version. Office of Air, Noise, and Radiation, USEPA.
- Fletcher, J. L., and Busnel, R. G., eds. 1978. Effects of noise on wildlife. Academic Press.
- Galloway, W. J. 1982. Sonic boom impact analysis research recommendations. BBN Report 4952, Bolt Beranek and Newman, Inc.
- Goforth, T. T., and McDonald, J. A. 1968. Seismic effects of sonic booms. NASA CR-1137.
- Headquarters Tactical Air Command. 1983. Unpublished Data on Sonic Boom Investigations at Luke AFB, Arizona. HQ TAC/DEEV, Langley AFB, Virginia.
- Hershey, R. L., and Higgins, T. H., eds. 1973. Statistical prediction model for glass breakage from nominal sonic booms. Federal Aviation Administration Report FAA-RD-73-79.
- Hinshaw, W. R.; Bell, W. B.; Ladson, T. A.; McNeil, E. C. E.; and Taylor, J. P. 1970. An annotated bibliography on animal response to sonic booms and other loud sounds. Washington, D.C.
- International Civil Aviation Organization (ICAO). 1970. Sonic Boom Effects on the Animal Kingdom. Sonic Boom Panel, Montreal, 12-21 October 1970.
- Kryter, K. D. 1980. Physiological acoustics and health. Journal of the Acoustical Society of America 68(1).
- Maglieri, D. J.; Huckel, V.; and Henderson, H. 1972. Sonic boom measurements for SR-71 aircraft operation at MACH numbers to 3.0 and altitudes to 24,384 meters. NASA Technical Memorandum D-6823.
- McGinnies, W. G. 1981. Discovering the desert. University of Arizona Press.
- McQuivey, R. P. 1978. The desert bighorn sheep of Nevada. Nevada Department of Game and Fish Biological Bulletin 6.
- National Guard Bureau (NGB). 1981. Environmental assessment, southern Arizona Auxiliary Airfield. Air Directorate.
- National Bureau of Standards with Environmental Protection Agency. 1971. The effects of sonic boom and similar impulsive noise on structures.
- National Park Service (NPS). 1978a. Checklist of mammals, amphibians, and reptiles. Organ Pipe Cactus National Monument.
- . 1978b. Checklist of birds. Organ Pipe Cactus National Monument.
- Nixon, C. W.; Hille, H. K.; Sommer, H. C.; and Guild, E. 1968. Sonic booms resulting from extremely low altitude supersonic flight: measurements and observations on houses, livestock and people. Aerospace Medical Research Laboratories, Wright-Patterson Air Force Base, Report AMRL-TR-68-52.

- Runyan, I. J., and Kane, E. J. 1973a. Sonic boom literature survey. Federal Aviation Administration Report FAA-RD-73-129-1 (State of the Art, Vol I).
- 1973b. Sonic boom literature survey. Federal Aviation Administration Report FAA-RD-73-129-2 (Capsule Summaries, Vol. II).
- Slutsky, S. 1975. Survey of sonic boom phenomena for the non-specialist. Federal Aviation Administration Report FAA-RD-75-68.
- Sommer, H. C., and Nixon, C. W. 1973. Primary components of simulated air bag noise and their relative effects on human hearing. Aerospace Medical Research Laboratories, Wright-Patterson Air Force Base, DOT/USAF Study AMRL-TR-73-52.
- Teer, J., and Truett, J. C. 1973. Studies of the effects of sonic boom on birds. Federal Aviation Administration Report FAA-RD-73-148.
- Thery, C.; Wanner, J.; Vallee, J.; and Vivier, C. 1972. Theoretical and experimental studies of the focus of sonic boom. Journal of the Acoustical Society of America 52(1):13-32.
- U.S. Air Force (USAF). 1979. Draft environmental impact statement, flight operations in the Sells Airspace overlying the Papago Indian Reservation, southern Arizona. Headquarters Tactical Air Command.
- 1980. Economic impact study, Valentine & Morenci Military Operations Areas, final report. A report prepared by Team Four, Inc. (Envirodyne Engineers, Inc.) for Headquarters TAC/DEEV.
- 1983. Revised draft, environmental impact statement, supersonic flight operations in the Valentine Military Operations Area. Tactical Air Command, Holloman Air Force Base.
- Wanner, J. L.; Vallee, J.; Vivier, C.; and Thery, C. 1972. Theoretical and experimental studies of the focus of sonic booms. Journal of the Acoustical Society of America 52.
- Wiggins, J. H. Jr. 1969. Effects of sonic boom. J. H. Wiggins Company, Palos Verdes Estates, California.
- YUMA. 1979. U.S. Fish and Wildlife Letter of Observations on Bighorn Sheep. Yuma, Arizona: Gene Cook, Environmental Engineering, 58th TTW, CES/DEEVE, Luke Air Force Base, June 6, 1979.



APPENDIX A
Climate and Air Quality

CLIMATE AND AIR QUALITY

CLIMATOLOGY OF ARIZONA

The following material was extracted from Climate of the States, Volume 2 -- Western States (U.S. Department of Commerce 1974).

Arizona exhibits a wide range of climates because of its variation in elevations, ranging from low deserts to very high mountain peaks. In the mountains that run diagonally from southeast to northwest, precipitation (rain plus melted snow) averages between 25 and 30 inches annually. Temperatures often drop below zero when cold air masses from Canada invade. Snowfall can exceed 100 inches in the higher elevations.

The deserts, on the other hand, receive as little as 3 or 4 inches of precipitation per year. The plateau country in the northeast receives about 10 inches per year. Temperatures climb up to 120 degrees in the desert areas during the summer months.

Precipitation throughout Arizona is governed to a great extent by elevation and season. During winter (November through March), Pacific storm systems march across the state. They bring heavy snows to the higher mountains and spotty rains in the southern deserts. Summer rainfall is heavier as moisture from the Gulf of Mexico is transported into the state between early July and mid-September.

Thunderstorms result from heating of the ground and lifting of the moisture over the mountain ranges. Thus, the heaviest rainfall in the state is found in the mountainous regions of the central and southeast. These storms are sometimes accompanied by strong winds and blowing dust prior to rainfall; hail or tornadoes, however, are very rare. Thunderstorms range from less than 5 days per year in the southwestern deserts to over 70 days per year in the eastern mountains.

The average number of days per year with measurable precipitation varies from 72 at Flagstaff, to 34 at Phoenix, 50 at Tucson, 53 at Winslow, and 15 at Yuma. A large part of Arizona is semiarid with prolonged periods of no precipitation. The air is generally clear and dry during April, May, and June. Clouds and high humidities are observed during July and August as well as December through February.

Temperatures vary widely in the state depending on elevation. The mean annual temperature ranges from 45 degrees in the higher northern mountains to 75 degrees in the southwestern deserts. Great extremes are found between day and night temperatures throughout the state. The daily range between maximum and minimum temperatures approaches 50 to 60 degrees during the drier portions of the year.

The length of the growing season varies tremendously over Arizona. In higher terrain, the growing season can be as little as 3 months. The

southern deserts, on the other hand, sometimes go 2 to 3 years without experiencing a freeze.

winds in Arizona are generally light and variable. Speeds generally average less than 10 miles per hour. Direction is highly dependent on local topography. In the mountains, upslope/downslope patterns are observed while winds are channeled through valley floors. In the southern deserts, southwesterly winds prevail throughout the year.

CLIMATOLOGY OF SOUTHERNMOST ARIZONA

SURFACE

For the area of the Sells Airspace, only two stations had climatological data available: Tucson and Douglas Smelter, Arizona (U.S. Department of Commerce 1975 and 1980). Data from these two stations suggest that the climate over the area is characterized by a long, hot season beginning in April and ending in October. Maximum temperatures above 90 degrees are the rule from May through September. Temperatures over 100 degrees averaged 41 days per year at Tucson from 1951 to 1975. The diurnal temperature range is large, averaging 30 degrees although it may exceed 40 degrees. The average growing season at Tucson approximates 250 days.

The distribution of precipitation through the years is such that 50 percent of the annual amount falls between July and September and a secondary maximum from December through March provides over 20 percent of the annual total. Flash flooding can occur with heavy thunderstorms. Snow is observed infrequently at lower elevations but does occur in the surrounding mountains during the winter months.

Relative humidity varies diurnally as does the temperature. From the first of the year, the humidity decreases until July and then increases during the thunderstorm season. It then decreases until it begins to climb in late November.

This area of Arizona receives more sunshine than any other section of the United States. Cloudless days are common, and the average cloudiness, much of it being very thin cirriform clouds, is low.

Surface winds are light with no important seasonal variations in velocity or direction. Wind velocities and directions are influenced greatly by the surrounding mountains as well as by the general slope of the terrain. With weak pressure gradients, local winds in the area tend to be from the southeast during the night and early morning, veering to the northwest during the day.

While dust and haze are frequently visible, their effect on the general clarity of the atmosphere is not great. Visibility values are normally high, and fog is extremely rare.

UPPER AIR

The National Climatic Center (NCC) at Asheville, North Carolina, was contacted to obtain any inversion data that had been compiled in the study area. NCC has the most comprehensive meteorological and climatological data base in the country. It collects both National Weather Service and military airport data. Only one data set, Inversion Study for Tucson, Arizona, was available (National Climatic Center (NCC) 1981; U.S. Environmental Protection Agency (EPA) 1975). This study was performed over a 1-year period from June 1956 to May 1957. Tables A-1 through A-4 were prepared to summarize the frequency of occurrence and height of inversions for the local times of 2:00 and 8:00 a.m. and 2:00 and 8:00 p.m. at Tucson during the 1956-1957 period. From these tables, it is evident that a shallow nocturnal surface-based inversion formed in the evening and disappeared usually by early afternoon. Thus, pollutant trapping may be expected at night; however, rapid mixing of the pollutants would probably occur during the daylight hours.

Table A-5 was prepared from mixing heights (Holzworth 1972) to illustrate climatological mean mixing heights for the seasons and an annual mean, both morning and afternoon observations. Data in Table A-5 would confirm the earlier observation of a shallow inversion in the morning followed by a deep mixing layer in the afternoon.

These data are assumed to represent the vertical structure of the atmosphere in the project area. These are the only such data available.

CLIMATOLOGY: SELLS AIRSPACE

The nearest first-order weather station to the Sells Airspace is Tucson International Airport. Table A-6 shows the climatological normals, means, and extremes of temperature, rainfall, snowfall, and winds recorded at Tucson from 1941 to 1970 (U.S. Department of Commerce 1980). From Table A-6 the area weather is warm and very dry. The majority of precipitation falls in July, August, and September. Snowfall is very sparse, averaging less than 1 inch per year. Heavy fog (less than 1/4 mile visibility) occurs less than 1 day per year.

Wind speed and direction, especially important parameters in diffusion of air pollutants, were recorded from 1967 to 1971 at the Tucson IAP (U.S. Department of Commerce 1973). These data were plotted into a wind rose and are displayed in Figure A-1. Winds predominantly blow from the south through the east-southeast, and wind speed generally averages 8 miles per hour for the year.

Another measure of dispersion potential is atmospheric turbulence, the rate of exchange of momentum and heat. Stability is directly related to the degree of turbulence. Stability data were collected at Tucson concurrently with the above-mentioned wind data (U.S. Department of Commerce 1973). Table A-7 shows percentage of occurrence of stability classes at Tucson for the 5-year period. In general, stability class A

TABLE A-1

Percentage Frequency of Occurrence of Inversion
at Tucson, Arizona

Height of Inversion (meters)	Surface	Base of Inversion (meters)										Total
		1-100	101-250	251-500	501-750	751-1,000	1,001-1,500	1,501-2,000	2,001-2,500	2,501-3,000		
1-100	7.6	--	0.6	0.5	--	--	0.3	--	--	--	--	9.0
101-250	46.0	--	0.8	--	0.3	--	--	0.6	--	0.6	0.6	48.3
251-500	23.8	--	0.3	0.3	--	--	--	--	--	0.5	0.5	24.9
501-750	4.1	--	--	--	--	--	--	--	0.3	--	--	4.4
751-1,000	0.8	--	--	--	--	--	--	--	--	--	--	0.8
1,001-1,500	0.3	--	--	--	--	--	--	--	--	--	--	0.3
>1,500	0.6	--	--	--	--	--	--	--	--	--	--	0.6
Total No Inversions	83.2	--	1.7	0.8	0.3	--	0.3	0.6	0.3	1.1	1.1	88.3
												11.7
												100.0

Source: U.S. Environmental Protection Agency 1975

Note: Time -- 2:00 a.m. MST

TABLE A-2
Percentage Frequency of Occurrence of Inversions
at Tucson, Arizona

Height of Inversion (meters)	Base of Inversion (meters)										Total
	Surface	1-100	101-250	251-500	501-750	751-1,000	1,001-1,500	1,501-2,000	2,001-2,500	2,501-3,000	
1-100	2.7	0.3	1.2	1.1	--	--	--	--	0.3	--	5.6
101-250	25.4	3.2	2.5	0.6	0.5	--	0.3	0.6	0.9	0.3	34.3
251-500	20.7	1.2	0.5	0.5	0.6	--	0.5	--	1.0	0.3	25.3
501-750	4.8	--	--	--	--	0.3	--	--	--	--	5.1
751-1,000	1.4	--	--	--	--	--	--	--	--	--	1.4
1,001-1,500	0.6	--	--	--	--	--	--	--	--	--	0.6
1,500	0.3	--	--	--	--	--	0.3	--	--	--	0.6
Total	55.9	4.7	4.2	2.2	1.1	0.3	1.1	0.6	2.2	0.6	72.9
No Inversions											27.1
											100.0

Source: U.S. Environmental Protection Agency 1975.

Note: Time -- 8:00 a.m. MST.

TABLE A-3
Percentage Frequency of Occurrence of Inversions
at Tucson, Arizona

Height of Inversion (meters)	Base of Inversion (meters)										
	Surface	1-100	101-250	251-500	501-750	751-1,000	1,001-1,500	1,501-2,000	2,001-2,500	2,501-3,000	Total
1-100	--	--	--	--	--	--	0.6	0.8	0.9	--	2.3
101-250	0.6	--	--	0.3	0.9	--	1.1	2.0	1.4	2.2	8.5
251-500	--	--	0.3	--	0.5	0.3	1.4	0.9	1.7	2.0	7.1
501-750	--	--	--	--	--	--	0.3	--	0.2	--	0.5
751-1,000	--	--	--	--	--	0.3	--	0.2	--	--	0.5
1,001-1,500	--	--	--	--	--	--	--	--	--	--	--
1,500	--	--	--	--	--	--	--	--	--	--	--
Total No Inversions	0.6	--	0.3	0.3	1.4	0.6	3.4	3.9	4.2	4.2	18.9
											81.1
											100.0

Source: U.S. Environmental Protection Agency 1975.

Note: Time -- 2:00 p.m. MST.

TABLE A-4
Percentage Frequency of Occurrence of Inversions
at Tucson, Arizona

Height of Inversion (meters)	Base of Inversion (meters)										Total
	Surface	1-100	101-250	251-500	501-750	751-1,000	1,001-1,500	1,501-2,000	2,001-2,500	2,501-3,000	
1-100	15.0	--	1.7	--	--	--	0.3	--	--	0.6	17.6
101-250	28.4	--	--	0.3	--	0.6	0.3	--	1.0	1.7	32.3
251-500	4.5	--	--	0.5	--	0.2	--	--	0.3	1.4	6.9
501-750	--	--	0.2	--	--	--	0.5	--	0.3	0.2	1.2
751-1,000	--	--	--	--	--	--	--	--	0.3	--	0.3
1,001-1,500	--	--	--	--	--	--	--	--	--	--	--
1,500	--	--	--	--	--	--	--	--	--	--	--
Total	47.9	--	1.9	0.8	--	1.1	--	--	1.9	3.9	58.3
No Inversions											41.7
											100.0

Source: U.S. Environmental Protection Agency 1975.

Note: Time -- 8:00 p.m. MST.

TABLE A-5
Summary of Southern Arizona
Mixing Heights

Season	Time of Day	Mean Mixing Height (meters)
Winter	Morning	250
Spring	Morning	300
Summer	Morning	350
Autumn	Morning	250
Annual	Morning	300
Winter	Afternoon	1,400
Spring	Afternoon	2,800
Summer	Afternoon	3,200
Autumn	Afternoon	2,200
Annual	Afternoon	2,400

Source: Holzworth 1972.

Table A-6

Normals, Means, And Extremes Tucson, Arizona

Month	Temperature °F				Normal Degree days Base 65 °F	Precipitation in inches												Relative humidity pct.				Wind						Mean number of days						Average station pressure mb.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
	Extremes					Water equivalent						Snow, ice pellets		Relative humidity pct.				Fastest mile			Sunrise to sunset			Precipitation			Thunderstorms	Heavy fog, visibility ½ mile or less	90° and above (d)	Temperatures °F Max. 32° and above Min. 32° and below °F and below	2555 feet mvt.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
	Daily maximum	Minimum	Monthly	Record highest		Record lowest	Year	Maximum	Year	Minimum	Year	Maximum	Year	Maximum in 24 hrs.	Year	Hour	Hour	Hour	Hour	Mean speed m.p.h.	Prevailing direction	Speed m.p.h.	Direction	Year	Pct. of possible sunshine	Mean sky cover, tenths.						Clear	Partly cloudy		Cloudy																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
																																				Normal	Maximum monthly	Year	Maximum	Year	Hour	Hour	Hour	Hour	m.p.h.	Direction																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
63.5	38.2	50.9	87.1	1953	16.1	1946	0.77	1946	4.7	1949	4.7	1946	0.77	1946	40	40	35	15	32	32	1962	33	39	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40

Means and extremes above are from existing and comparable exposures. Annual extremes have been exceeded at other sites in the locality as follows: Highest temperature 112 in June 1902; lowest temperature 6 in January 1913.

(a) Length of record, years, through the current year unless otherwise noted, based on January data.
(b) 70° and above at Alaskan stations.
* Less than one half.
† Trace.

NORMALS - Based on record for the 1941-1970 period.
DATE OF AN EXTREME - The most recent in cases of multiple occurrence.
PREVAILING WIND DIRECTION - Record through 1963.
WIND DIRECTION - Numerals indicate tens of degrees clockwise from true north. 00 indicates calm.
FASTEST MILE WIND - Speed is fastest observed 1-minute value when the direction is in tens of degrees.

Reprinted from: U. S. Department of Commerce, 1980.
Local Climatological Data, Annual Summary With Comparative Data.
Asheville, North Carolina.

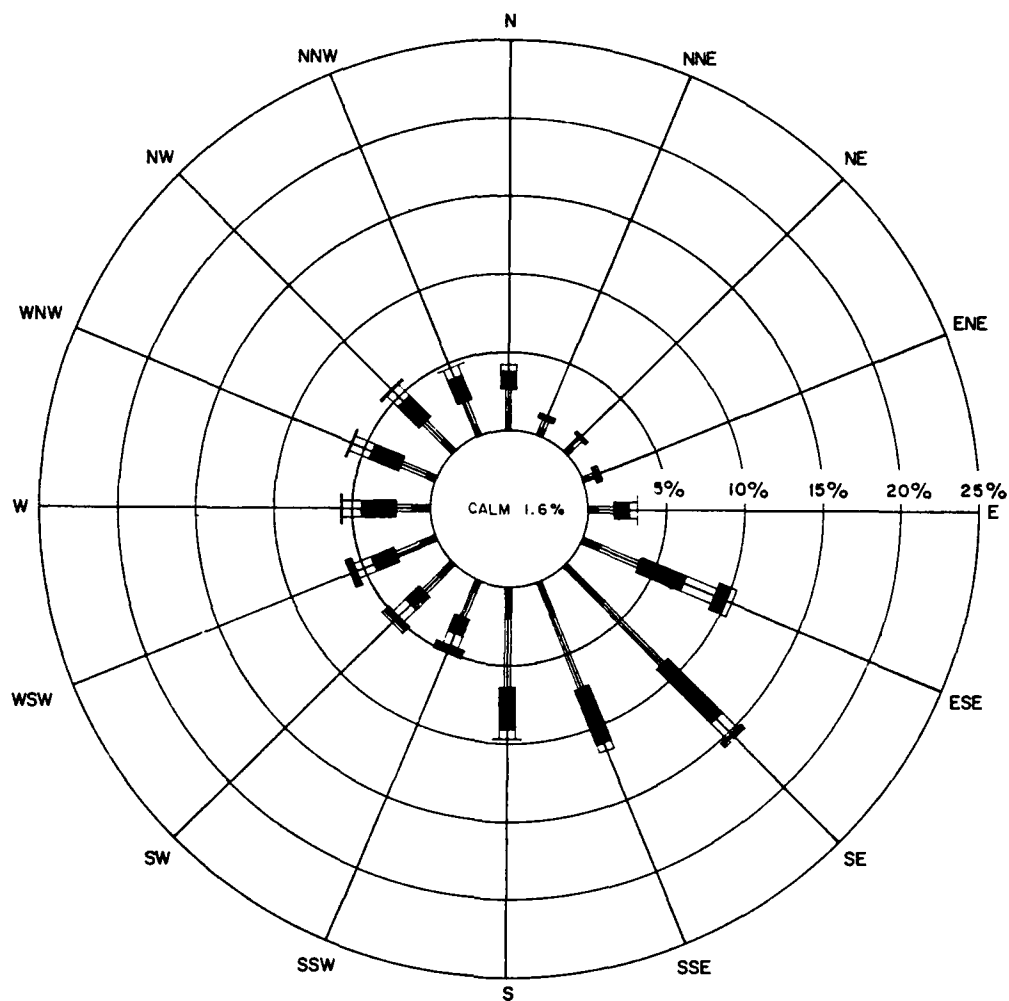


Figure A-1 Wind Rose for Tucson, Arizona

TABLE A-7

Percentage of Occurrence of Stability
Classes at Tucson, Arizona (1967-1971)

Stability Class	National Climatic Center Definition	Frequency of Occurrence (percent)
A	Extremely unstable	2.6
B	Unstable	8.8
C	Slightly unstable	13.8
D	Neutral	33.0
E	Slightly stable	41.8
F	Stable to extremely stable	a

Source: U.S. Department of Commerce 1973.

^aCombined with class E stability.

indicates a rapid rate of dispersion, while stability class F indicates a slow rate of dispersion.

AIR QUALITY ANALYSIS

EXISTING CONDITIONS

Background air quality usually implies the existing ambient level of air pollutants before the impact of the proposed action is reflected. In the case of this analysis, however, the background air quality already reflects the impact of flying activities since the air pollutant concentrations of 1980-1982 probably include pollutant concentrations from flying activities depending on distance from the flight to the air sampler, the meteorology in the area of the flight, etc. The Sells Airspace has been utilized since 1941-1942.

To develop an evaluation of background air quality, it is necessary to choose an existing air monitoring station that is representative of the Sells Airspace. For this purpose, the 1980-1982 air quality data for Arizona reports were consulted (Arizona Department of Health Services (ADHS) 1980-1982). In these publications, 1980-1982 air pollution concentrations are presented for all criteria pollutants at air monitoring stations throughout the state of Arizona. Table A-8 provides the appropriate background air monitoring station locations and the 1980-1982 air quality data for these stations near the Sells Airspace. Since the airspace overlies a large area, these eight sites were chosen so as to depict the air quality near the boundaries (on the east, north, and west; none available to the south).

The federal (EPA) and state of Arizona air quality standards are presented in Table A-9. The EPA primary standards define levels of air quality which are necessary, with an adequate margin of safety, to protect the public health. EPA secondary standards define air quality levels which protect the public welfare from any known or anticipated adverse effects of a pollutant.

Comparing Table A-8 to Table A-9 reveals that most of the "background" air pollutant concentrations are considerably below the primary and/or secondary standard for the various pollutants. The exceptions have been violations of annual and 24-hour total suspended particulate (TSP) standards at Casa Grande during 1980 and 1981 and at Stanfield during 1981. Violations of 3-hour sulfur dioxide (SO₂) standards have occurred at Ajo in Pima County. In fact, the northwest corner of the airspace is within a TSP nonattainment area (area where air quality is worse than ambient standards). The remainder of the airspace is within an attainment area for all other pollutants (an area where air quality is at least meeting the standards). Although lead concentrations are not given in Table A-8, the observed concentrations during 1980-1982 were far below the lead standard at all Arizona monitoring stations.

The Ajo nonattainment area is a result of copper smelter activities and naturally occurring windblown dust from desert exposed areas. The

TABLE A-8
"Background" Air Pollutant Concentrations
in Sells Airspace Area

Background Air Pollutant Monitoring Station Location	Air Pollutant Concentration									
	Ozone		Carbon Monoxide (CO)		Nitrogen Dioxide (NO2)		Total Suspended Particulates (TSP)		Sulfur Dioxide (SO2)	
	Year	1-hour ^a	1-hour ^b	8-hour ^b	Annual ^c	Annual ^c	Annual ^c	24-hour ^{c,d}	Annual ^c	24-hour ^c
Maricopa, 6.5 miles N.W. of town, Pinal County	1980	.05	3	1	10 ^e	55	153	NA ^f	NA	NA
	1981	NA	3	1	7	54	142	2	49	17
	1982	NA	NA	NA	7 ^e	54 ^e	94	3 ^e	90	32
Casa Grande, Pinal County	1980	NA	NA	NA	NA	105	256	NA	NA	NA
	1981	NA	NA	NA	NA	93	276 ^g	NA	NA	NA
Casa Grande, Indian Hwy 6, operated by Noranda, Pinal County	1981	NA	NA	NA	NA	24 ^e	70	NA	NA	NA
	1982	NA	NA	NA	NA	31	61	NA	NA	NA
Stanfield, Pinal County	1980	NA	NA	NA	NA	65 ^e	192	NA	NA	NA
	1981	NA	NA	NA	NA	103	309 ⁱ	NA	NA	NA
	1982	NA	NA	NA	NA	74	215	NA	NA	NA
Ajo, Camelback Mountain site, operated by Phelps-Dodge, Pima County	1980	NA	NA	NA	NA	32	176	13	2,148 ^h	283
	1981	NA	NA	NA	NA	31	111	18	943	293
	1982	NA	NA	NA	NA	17	89	7 ^e	1,153	252
Green Valley, 245 N. Esperanza Pima County	1980	NA	NA	NA	NA	39	70	NA	NA	NA
	1981	NA	NA	NA	NA	46	83	NA	NA	NA
	1982	NA	NA	NA	NA	33	91	NA	NA	NA
Green Valley, 2 miles N. of townsite, operated by Phelps-Dodge, Pima County	1980	NA	NA	NA	NA	49	110	1	160	34
	1981	NA	NA	NA	NA	48	93	1	260	40
	1982	NA	NA	NA	NA	40	83	0	0	0
Organ Pipe, Pima County	1980	NA	NA	NA	NA	36 ^e	63	NA	NA	NA
	1981	NA	NA	NA	NA	34	76	NA	NA	NA
	1982	NA	NA	NA	NA	24	76	NA	NA	NA

Source: Arizona Department of Health Services 1980-1982.

^aConcentrations in parts per million, second highest concentration.

^bConcentrations in milligrams per cubic meter, second highest concentration.

^cConcentrations in micrograms per cubic meter.

^dSecond highest concentration.

^eAnnual mean based on a limited number of samples.

^fNA = not available.

^gThere were three (3) violations of the 24-hour standard in 1981.

^hThere were two (2) violations of the 3-hour standard in 1980.

ⁱThere were three (3) violations of the 24-hour standard in 1981.

TABLE A-9
Federal and Arizona State
Ambient Air Quality Standards

Pollutant	Averaging Time	State and Federal Standards	
		Primary	Secondary
Carbon monoxide	1-hour	40	40
	8-hour	10	10
Nitrogen dioxide	Annual	100	100
Ozone	1-hour (daily max)	.12	.12
Particulates	24-hour	260	150
	Annual (geom. mean)	75	60
Sulfur dioxide	3-hour	--	1,300
	24-hour	365	--
	Annual	80	--
Lead	Calendar quarter	1.5	1.5

Source: Arizona Department of Health Services 1980.

Note: Units are micrograms/m³ except for carbon monoxide that has units of milligrams/m³ and ozone that has units of ppm. Reference conditions are 25 degrees C and 760 mm Hg.

Standards are not to be exceeded more than once per year except:

1. In the case of ozone, the number of exceedance days is not to be more than 1.0 per year based on a 3-year running average.
2. In the case of lead, never to be exceeded.

violations of the TSP standards at Casa Grande and Stanfield are probably for the same reasons. The SO₂ violations that occurred in 1980 at Ajo Camelback Mountain are due to copper smelter emission sources nearby.

In summary, the existing air quality within the Sells Airspace is generally very good with the exceptions noted before. ADHS has noted a general improvement in the state's air quality during 1982, and the TSP and SO₂ concentrations at Casa Grande, Stanfield, and Ajo also demonstrated corresponding improvement during 1982 (ADHS 1982). One speculative reason for this improvement might be that a decrease in emissions has occurred because of decreased industrial production (particularly at the copper smelters). The next section quantifies the contribution of aircraft emissions to the reported "background" pollution concentrations presented in Table A-8.

QUANTIFICATION OF IMPACT OF AIRCRAFT FLIGHTS ON AMBIENT AIR QUALITY IN THE SELLS AIRSPACE

The final step in the air quality analysis involves the quantification of air pollution concentrations resulting from the aircraft exhaust pollution emissions over the Sells Airspace. These aircraft-contributed concentrations can then be compared to the background concentrations developed in the previous section and to the air quality standards (National Ambient Air Quality Standards (NAAQS)); in this manner, the relative severity of the impacts may be established.

The estimate of air pollution concentrations from aircraft emissions requires a three-step analysis:

1. Emissions from the various aircraft passing through the Sells Airspace must be quantified. The amount of emissions, in turn, determines the quantity of pollution released into the atmosphere and can thus be dispersed.
2. A dispersion analysis must be performed which determines resulting air pollution concentrations from the aircraft emissions. The dispersion analysis indicates the atmosphere's ability to transport and dilute the air pollution emissions.
3. Resulting model-predicted aircraft air pollution concentrations are compared to background air quality levels and to the air pollution standards (NAAQS) to estimate the severity of the impact on ambient air quality in the Sells Airspace.

First, aircraft emissions are estimated using emission factors and flight operational data. Equation 1 illustrates this concept:

$$\text{Total aircraft emissions} = \text{Emission factor} \times \text{Number of sorties} \quad \text{eq (1)}$$

Table A-10 provides emission factors in terms of emissions by engine type, fuel burned, and operational mode (Sears 1978; Scott and Naugle

TABLE A-10
Aircraft Emission Factor
(by Engine Type)

Aircraft Type	Common Aircraft Name	Engine Type	Operating Mode	Emission Factor (lb/1,000 lb of fuel)				Part ^a
				CO	HC	SOX	NOX	
A-4	Skyhawk	J65-W20	Intermed. Approach	7.72	0.03	1.0	7.55	--
				14.30	0.13	1.0	7.97	--
A-6	Intruder	J52	Intermed. Approach	4.40	--	1.0	9.45	--
				10.87	0.23	1.0	6.49	--
A-7	Corsair 2	TF41-A-2	Approach	10.20	2.2	1.0	6.8	0.36
			Intermed.	3.70	0.4	1.0	12.0	0.52
			Military	1.80	0.2	1.0	21.0	0.67
A-10	--	TF34	Approach	8.30	0.6	1.0	5.8	0.02
			Intermed.	4.30	0.2	1.0	7.5	0.01
			Military	2.30	0.1	1.0	10.0	0.05
F-4,104	Phantom	J79-6E-10	Approach	9.40	1.1	1.0	4.8	1.8
			Intermed.	4.60	0.3	1.0	5.6	2.8
			Military	2.20	0.2	1.0	8.9	2.2
			Afterburner	4.00	0.01	1.0	3.1	0.15
F-5	Freedom Fighter	J85-6E-5	Approach	73.6	6.4	1.0	2.3	0.011
			Intermed.	43.0	3.5	1.0	2.3	0.011
			Military	29.0	0.8	1.0	2.6	0.018
			Afterburner	26.0	0.07	1.0	2.0	0.008
F-8	Crusader	J57	Approach	3.30	0.97	1.0	9.07	--
			Intermed.	1.78	0.65	1.0	11.16	1.43
			Afterburner	32.24	0.47	1.0	4.26	--
F-15,16	Eagle	F-100, P-100	Approach	5.80	1.9	1.0	6.7	0.27
			Intermed.	1.60	0.1	1.0	9.8	0.47
			Military	0.90	0.1	1.0	27.0	0.34
			Afterburner	4.00	0.01	1.0	3.1	0.15
FB-111A	--	TF30-P-7	Approach	11.5	3.2	1.0	6.1	0.12
			Intermed.	1.2	0.2	1.0	14.0	0.44
			Military	0.8	0.1	1.0	20.0	0.35
			Afterburner	4.0	0.01	1.0	3.1	0.15
F-111F	--	TF30-100	Approach	9.9	2.7	1.0	6.3	0.08
			Intermed.	0.7	0.1	1.0	20.0	0.32
			Military	0.7	0.1	1.0	28.0	0.24
			Afterburner	4.0	0.01	1.0	3.1	0.15
O-2	--	--	Approach	945.9	70.6	1.0	5.5	55.0
			Intermed.	972.0	17.4	1.0	6.6	40.0
			Military	1,030.0	22.5	1.0	5.3	20.0

Sources: Sears 1978; Scott and Naugle 1978.

^aPart: particulates.

1978). Table A-11, in turn, gives emission factors in terms of number of sorties by aircraft type and operational mode. Table A-12 combines the operational data (number of sorties and modes) with the emission factors in Table A-11 to produce the estimated aircraft emissions. In addition, the number of sorties for each aircraft type is broken into the type of flight (i.e., transition, low altitude, etc.); the power settings for the mode of operation were assumed as follows:

- o Air Combat Maneuvers -- Intermediate

- o Low Altitude -- Intermediate

The operational data in Table A-12 give the annual number of sorties by aircraft type projected for the future usage of the Sells Airspace; these data best represent conditions in the Sells Airspace now and in the future.

The next step of the analysis is to perform dispersion modeling calculations. An unventilated box model is used, with all pollutants emitted within the box assumed to be homogeneously mixed and nonreactive. Two box models were used:

1. One to simulate low-level flights (below 1,500' AGL) only
2. One to simulate all flights (below 45,000' AGL) within the Airspace

The horizontal dimensions of the Sells Airspace are 110 miles by 48 miles.

For low-level flights, the size of the box is computed as follows:

$$\begin{aligned}\text{Box size} &= 48 \text{ miles} \times 114 \text{ miles} \times 0.28 \text{ miles} = 1,532 \text{ cubic miles} = \\ &6.39 \times 10^{12} \text{ cubic meters}\end{aligned}$$

Table A-13 provides the annual average calculated air pollution concentrations due to low-level flights for each air pollutant.

For all flights, the size of the unventilated box is computed as follows:

TABLE A-11
Aircraft Emission Factors
(by Number of Sorties)

Aircraft Type	Average Fuel Burned (lbs) per Sells Airspace sortie	Operating Mode	Emission Factor (lb per sortie)				
			CO	HC	SOX	NOX	PART ^a
A-4	1,582	Intermed. Approach	12.21	0.05	1.58	11.94	--
			22.62	0.21	1.58	12.61	--
A-6	3,605 (both engines)	Intermed. Approach	32.43	--	7.37	69.65	--
			80.11	1.70	7.37	47.83	--
A-7	4,800	Approach	48.96	10.56	4.8	32.64	1.73
		Intermed.	17.76	1.92	4.8	57.60	2.50
		Military	8.64	0.96	4.8	100.80	3.22
A-10	2,800	Approach	23.24	1.68	2.8	16.24	0.056
		Intermed.	12.04	0.56	2.8	21.00	0.028
		Military	6.44	0.28	2.8	28.00	0.140
F-4	8,000	Approach	75.2	8.80	8.0	38.40	14.40
		Intermed.	36.8	2.40	8.0	44.80	22.40
		Military	17.6	1.60	8.0	71.20	17.60
		Afterburner	32.0	0.08	8.0	24.80	1.20
F-5	2,600	Approach	191.4	16.6	2.6	6.0	0.03
		Intermed.	111.8	9.1	2.6	6.0	0.03
		Military	75.4	2.1	2.6	6.8	0.05
		Afterburner	67.6	0.2	2.6	5.2	0.02
F-8	3,520 (13,240- afterburner)	Approach	11.62	3.41	3.5	31.9	--
		Intermed.	6.27	2.29	3.5	39.3	5.0
		Afterburner	426.86	6.22	13.2	56.4	--
F-15	9,480	Approach	55.0	18.0	9.5	63.5	2.56
		Intermed.	15.2	9.5	9.5	92.9	4.46
		Military	8.5	9.5	9.5	256.0	3.22
		Afterburner	37.9	1.0	9.5	29.4	1.42
F-16	3,250	Approach	18.9	6.2	3.3	21.8	0.9
		Intermed.	5.2	3.3	3.3	31.8	1.5
		Military	2.9	3.3	3.3	87.8	1.1
		Afterburner	13.0	0.3	3.3	10.1	0.5
F-104	3,500	Approach	32.9	3.9	3.5	16.8	6.3
		Intermed.	16.1	1.1	3.5	19.6	9.8
		Military	7.7	0.7	3.5	31.2	7.7
		Afterburner	14.0	0.04	3.5	10.9	0.5
FB-111A	12,770 afterburner	Afterburner	51.1	0.13	12.8	39.6	1.9
F-111F	17,960 afterburner	Afterburner	71.8	0.18	18.0	55.7	2.7
O-2	525	Approach	23.6	1.8	.03	0.14	1.4
		Intermed.	24.3	0.4	.03	0.17	1.0
		Military	25.8	0.6	.03	0.13	0.5

Sources: Sears 1978; Scott and Naugle 1978.

^aPART: particulates.

TABLE A-12

Aircraft Emission Estimates

Aircraft Type	Type of Maneuver	No of Sorties	Calculated Annual Aircraft Emissions (lbs/yr)				
			CO	HC	SOX	NOX	PART
F-5	Low Altitude	287	32107	2614	747	1723	8
	Air Combat	4713	526913	42888	12254	28278	141
	Subtotal	5000	559020	45502	13001	30001	149
F-15	Low Altitude	1949	22625	18516	18516	181062	8692
	Air Combat	5996	91139	56962	56962	557028	26742
	Subtotal	7945	113764	75478	75478	738090	35434
F-16	Low Altitude	5148	26770	16988	16988	163706	7722
	Air Combat	8919	46379	29432	29432	283624	13378
	Subtotal	14067	73149	46420	46420	447330	21100
A-10	Low Altitude	10364	124782	5803	29019	217644	290
A-7	Low Altitude	1322	23479	2539	6345	76146	3305
	Air Combat	2239	39765	4299	10747	128966	5596
	Subtotal	3561	63244	6838	17092	205112	8901
OA-37	Low Altitude	4065	42843	17398	13414	36178	284
OTHERS	Low Altitude	193	7102	463	1544	8646	4323
	Air Combat	1507	55458	3617	12056	67514	33757
	Subtotal	1700	62560	4080	13600	76160	38080
TOTALS	Low Altitude	23328	279708	64321	86573	685105	24624
	Air Combat	23374	759654	137198	121451	1065410	79614
	Total	46702	1039362	201519	208024	1750515	104238

TABLE A-13
Calculated Air Pollutant
Concentrations
Resulting From Low Level Flights Only

Pollutant Type	Total Emissions (Milligrams)	Box Size (cubic meters)	Calculated Annual Pollutant Concentration ^a (milligrams/cubic meter)
CO ^b	1.27×10^{11}	6.39×10^{12}	0.020
HC ^b	2.92×10^{10}	6.39×10^{12}	0.005 (5.0) ^c
SOX ^b	3.93×10^{10}	6.39×10^{12}	0.006 (6.0) ^c
NOX ^b	3.11×10^{11}	6.39×10^{12}	0.049
PART ^b	1.12×10^{10}	6.39×10^{12}	0.002 (2.0) ^c

^aCalculated concentration = $\frac{\text{Total emissions}}{\text{Box size}}$

^bCO: Carbon monoxide; HC: Hydrocarbons;
SOX: Sulfur oxides; NOX: Nitrogen oxides;
PART: particulates

^cLower number in parentheses is concentration in micrograms per cubic meter.

Box size = 48 miles x 114 miles x 8.52 miles = 46,621 cubic miles =

194.4 x 10¹² cubic meters

Table A-14 gives the annual average calculated air pollution concentrations from all flights within Sells Airspace. Comparing Table A-13 to Table A-14 reveals that low-level flights cause higher pollution concentrations near ground level than all flights combined spread over a larger volume.

The final step of the analysis is to compare the aircraft-contributed concentrations to background levels and ambient air quality standards; Table A-15 provides these comparisons. It should be noted that these comparisons are very conservative for the following reasons:

- o No atmospheric ventilation is allowed beyond the airspace over the span of an entire year.
- o Conversions of annual aircraft calculated concentrations to shorter terms (i.e., 1-hour, 8-hour, 3-hour, etc.) are done very conservatively.
- o The "worst" case is assumed by comparing low-level flight calculated concentrations rather than all flights over a larger volume.

As shown in Table A-15, aircraft concentrations do not approach ambient air quality standards but apparently can contribute significantly to the background air quality of the region. Based on these calculations, the impact on the ambient air quality over the Sells Airspace is minor.

DIFFERENCES BETWEEN THE PRESENT APPROACH AND THE APPROACH USED IN THE DRAFT EIS OF 1979

The following techniques were used in the present air quality analysis that differed from the original approach in the draft EIS of 1979:

- o An analysis of background air quality is included herein; it was not in the draft EIS.
- o Updated emission factors developed in 1978 are used to compute emissions from the aircraft.
- o Updated operational data (number of sorties by aircraft type and operating mode) have been utilized in the present analysis.
- o Two box models are used instead of the one in the draft EIS. The additional box model accounts for the impact of low-level flights solely and the results are more conservative than those of the analysis in the 1979 draft.

TABLE A-14
Calculated Air Pollutant
Concentrations
Resulting From All Flights

Pollutant Type	Total Emissions (Milligrams)	Box Size (cubic meters)	Calculated Annual Pollutant Concentration ^a (milligrams/cubic meter)
CO ^b	4.74×10^{11}	194.4×10^{12}	0.002
HC ^b	9.14×10^{10}	194.4×10^{12}	0.0005 (0.5) ^c
SOX ^b	9.44×10^{10}	194.4×10^{12}	0.0005 (0.5) ^c
NOX ^b	7.94×10^{11}	194.4×10^{12}	0.004 (4.0) ^c
PART ^b	4.73×10^{10}	194.4×10^{12}	0.0002 (0.2) ^c

^aCalculated concentration = $\frac{\text{Total emissions}}{\text{Box size}}$

^bCO: Carbon monoxide; HC: Hydrocarbons;
SOX: Sulfur oxides; NOX: Nitrogen oxides;
PART: particulates

^cNumber in parentheses indicates concentration in micrograms per cubic meter.

TABLE A-15

Comparison of Aircraft Operations
Concentrations of Ambient Air Quality
Standards and Background Levels

Pollutant	Averaging Time	Concentrations (ug/m3)		Lowest Background by Sells MOA	Calculated Concentrations from Aircraft Ops.
		NAAQS	Arizona		
CO	1-hour	40 ^a	40 ^a	3 ^a	0.5 ^{a,b}
	8-hour	10 ^a	10 ^a	1 ^a	0.3 ^{a,c}
HC	3-hour	160	160	NA	100.0 ^d
NOX	Annual	100	100	7	6.0
PART	24-hour	260	150	61	14.0 ^e
	Annual	75	60	17	2.0
SOX	3-hour	--	1,300	49	120.0 ^d
	24-hour	365	365	17	42.0 ^e
	Annual	80	80	1	6.0

^aConcentrations given in milligrams per cubic meter.

^bTo convert "annual" calculated aircraft concentrations to obtain 1-hour estimate, the annual values in Table A-13 were multiplied by 25; this is very conservative.

^cTo convert "annual" calculated aircraft concentrations to obtain 8-hour estimate, the annual values in Table A-13 were multiplied by 15; this is very conservative.

^dTo convert "annual" calculated aircraft concentrations to obtain 3-hour estimate, the annual values in Table A-13 were multiplied by 20; this is very conservative.

^eTo convert "annual" calculated aircraft concentrations to obtain 24-hour estimate, the annual values in Table A-13 were multiplied by 7; this is very conservative.

- o Annual concentrations of certain pollutants are converted to short-term concentrations so that a comparison could be established between aircraft concentrations and ambient air quality standards and background levels.

REFERENCES

- Arizona Department of Health Services. 1980-1982. Air quality control for Arizona, annual reports. Phoenix, Arizona.
- Holzworth, G. 1972. Mixing heights, windspeeds, and potential for urban air pollution throughout the contiguous United States. Research Triangle Park, North Carolina: U.S. Environmental Protection Agency.
- National Climatic Center. 1981. Telephone communication to determine availability of surface and upper air data in southern Arizona, August 31, 1981.
- Scott, H. A., and Naugle, D. F. 1978. Aircraft air pollution emission estimation techniques - ACEE. Tyndall Air Force Base, Florida.
- Sears, D. R. 1978. Air pollutant emission factors for military and civil aircraft. Huntsville, Alabama.
- U.S. Department of Commerce. 1973. Monthly, seasonal, and annual wind distribution by Pasquill stability class (5). Asheville, North Carolina: National Climatic Center.
- 1974. Climate of the states, Volume 2 -- Western states. Port Washington, New York.
- 1975. Climate of Douglas Smelter, Arizona. Asheville, North Carolina: National Climatic Center.
- 1975. Inversion study of Tucson, Arizona. Asheville, North Carolina: National Climatic Center.
- 1980. Local climatological data, annual summary with comparative data, 1980, Tucson, Arizona. Asheville, North Carolina: National Climatic Center.
- U.S. Environmental Protection Agency. 1975. Inversion study of Tucson, Arizona. Asheville, North Carolina: National Climatic Center.

APPENDIX B-1

**SONIC BOOM
CHARACTERISTICS**

SUPERSONIC AIRCRAFT AND SONIC BOOMS

PREFACE:

Introduction of advanced aircraft such as the F-15 and F-16, designed to operate at supersonic speeds in combat, has created a need for conducting realistic training at these speeds. One result of supersonic flight is the creation of a wave of compressed air in front of the aircraft. This is heard, and felt, as a sudden loud impulse noise and is called a "sonic boom." The purpose of this paper is to discuss causes and types of sonic booms, and their potential environmental and physiological effects.

SCOPE:

Sounds are atmospheric disturbances detected by the human ear through changes in air pressure on the ear drum. These pressure changes are extremely small and are propagated through the air at the speed of sound -- about 760 miles per hour at "standard" sea level temperature of 59°F.

A sonic boom may be defined as an acoustic phenomenon we hear when an object exceeds the speed of sound. When the speed of an aircraft is faster than the speed of sound, the air in front of the aircraft is compressed, forming a shockwave. An individual actually hears the change in pressure when air molecules are first compressed and then returned to a more normal state. The pressure differential across the shock wave is relatively large (larger than that produced by speech pressure changes) and is very sudden. As a result the human ear perceives the rapid change in pressure as an impulsive type sound very much like the crack of a whip or a rifle shot.

With the spectacular rise in the maximum speed of military aircraft in the last three decades and the need to adequately train and maintain military pilot proficiency, sonic booms are an increasing phenomenon in various parts of the United States. Because a sonic boom manifests itself as sound to the human ear, we tend to forget that it is actually a sudden change in pressure that may have an effect on people, structures, animals, and wildlife. The most important effects are obviously those that man experiences; however, we must also be concerned with effects in other areas as well.

Since the late 1940s when aircraft first broke the so-called "sound barrier", studies and experiments have been conducted primarily to determine the effects of sonic booms on people. During the fifties and sixties as sonic booms became more prevalent in the United States, studies were expanded to include the effect on structures.

Studies have also been made to determine the effects of sonic booms on domestic animals, livestock, and more recently on wildlife. The discussion which follows will summarize the background and the latest available information for sonic booms.

BACKGROUND OF SONIC BOOM THEORY:

The movement of bodies at speeds greater than the speed of sound has been studied for well over 200 years. Forces produced by gunnery projectiles were determined at speeds up to Mach 2 (twice the speed of sound) as long ago as 1742. Ernst Mach, a professor of physics in Vienna, published papers as early as 1887 encompassing both mathematical and experimental studies of supersonic flow. Studies by Prandtl (1907), Meyer (1908), and Ackeret (1925) were precursors to the virtual explosive rate of progress in the study of supersonic flow during the thirties, forties, and fifties. From 1959 to 1964, after aircraft routinely achieved supersonic flight, a great deal of experimental work was done in wind tunnels and in flight tests to investigate the validity of the basic theories previously developed.

Sonic booms may sound the same to the human ear; however, as early as 1947 Hayes^X derived a mathematical model subsequently called the "Supersonic Area Rule" which demonstrated that each aircraft or supersonic projectile generated its own particular pressure source which was dependent on the area cross-sections cut out by the Mach wave. Figure 1 is a simplified drawing of the pressure wave generated by a body in supersonic flight. The pressure signature is referred to as an N-wave because of the characteristic shape of the signal as recorded on electronic monitoring devices. In 1952, Whitham^X enlarged on the crosssection idea and developed a formulation which combined the individual pressure sources making it possible to calculate the pressure field of real aircraft configurations. These calculations only considered the volume effect of the supersonic bodies as contributing to the distant disturbance field. Subsequent work by Busemann in 1955, Walkden in 1958, and Morris in 1960 considered the lift distribution created by the fuselage and wings.^X The end result of all these later investigations was to show that at low altitude, the lift effects were relatively unimportant but for large airplanes at high altitudes the lift effects became dominant.

Other factors such as atmospheric variations also have an effect on the magnitude of sonic boom overpressure^Y. Atmospheric pressure and temperature, like the speed of sound vary with altitude. In the early development of sonic boom calculations there was no detailed analytical method that would account for atmospheric variations. It was assumed that flight was in a homogeneous atmosphere. Today, however, there is extensive information available to help determine atmospheric effects on sonic booms.

In 1964, H. W. Carlson of NASA and the Boeing Company developed digital computer methods and programs to calculate a realistic source distribution that could be applied to computation of the distant pressure field. The distant pressure field or far field is the pressure normally heard by an individual as the sonic boom sound or noise. The far field pressure (ΔP) can be calculated using a simplified formula developed by Carlson and Maglieri of NASA^W. The simplified method is explained in detail at the end of this discussion and some representative overpressures calculated.

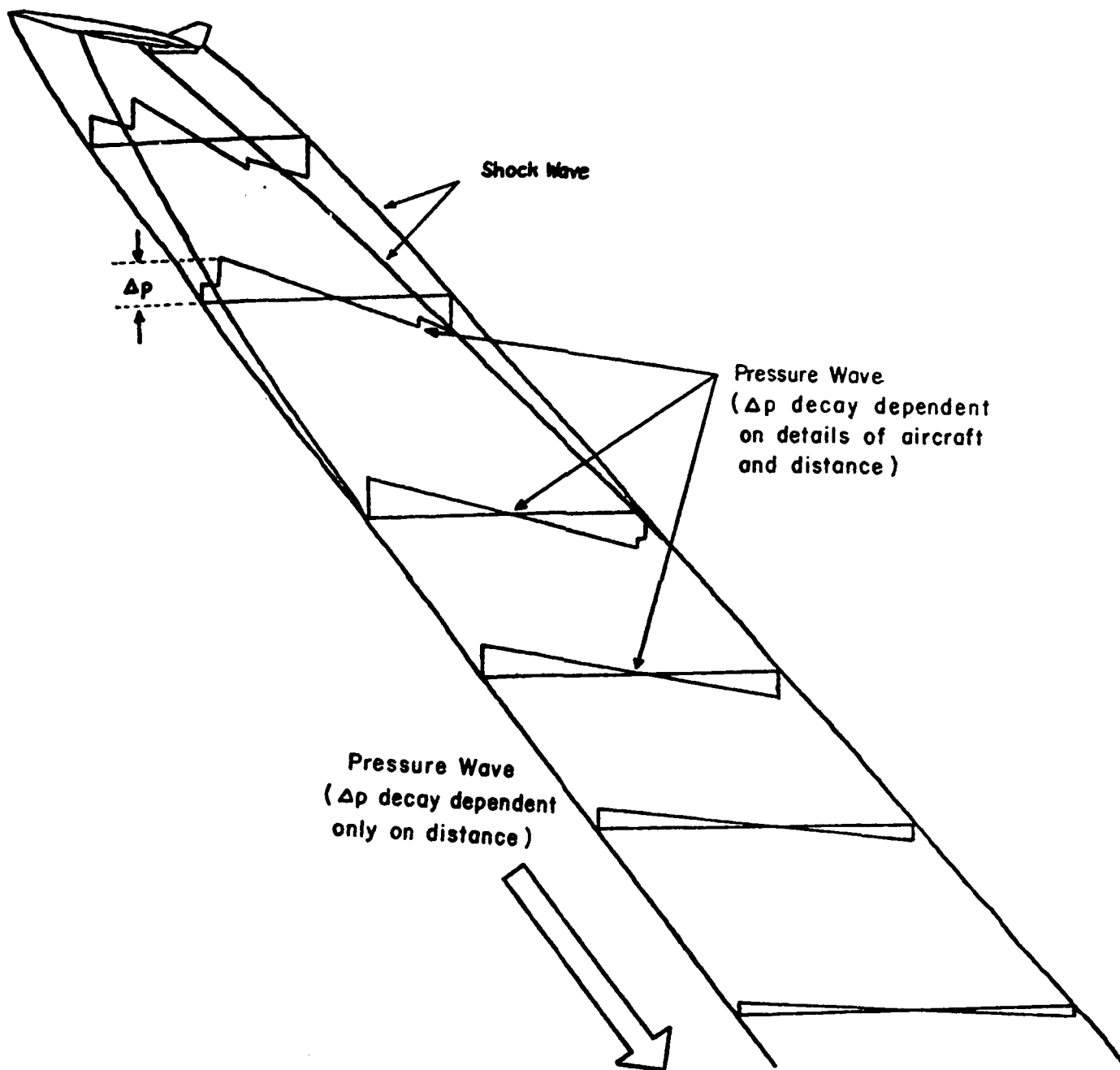


FIGURE I
SIMPLIFIED SONIC BOOM DIAGRAM SHOWING "N-WAVE"

SONIC BOOM CHARACTERISTICS:

Straight and Level Flight: A supersonic aircraft in straight and level flight produces a sonic boom pattern on the ground which can be likened to a moving carpet. An important consideration in the assessment of the effects of sonic booms is that not all booms created are heard at ground level. The atmospheric air temperature decreases with height above ground. This temperature gradient acts to bend the sound waves of a sonic boom upward. Depending upon the aircraft height and Mach number, the paths of many sonic booms are bent upward sufficiently that the boom never reaches ground level. The heights and Mach numbers produced during F-15 combat maneuvering are such that less than one boom out of every three produced is likely to be heard at ground level. This same phenomenon (cutoff) also acts to limit the width of those sonic booms that do reach ground level. The average carpet boom produced during F-15 combat maneuvering operations is between 9 and 10 miles in width (4.5 to 5 miles wide on either side of the aircraft flight track).

The intensity of the sound and overpressure at ground level is largely dependent upon the aircraft's altitude and airspeed. Peak overpressures occurs directly under the centerline of the aircraft, diminishing at the edge of the carpet to approximately 0.5 to 1.0 pounds per square foot. Figure 2a is a depiction of a "carpet" boom. Occasionally, multiple overpressures occur in the same area. These are produced by shock waves emitted from the front and rear of an aircraft and are sometimes recognized as two closely spaced booms of similar intensity.

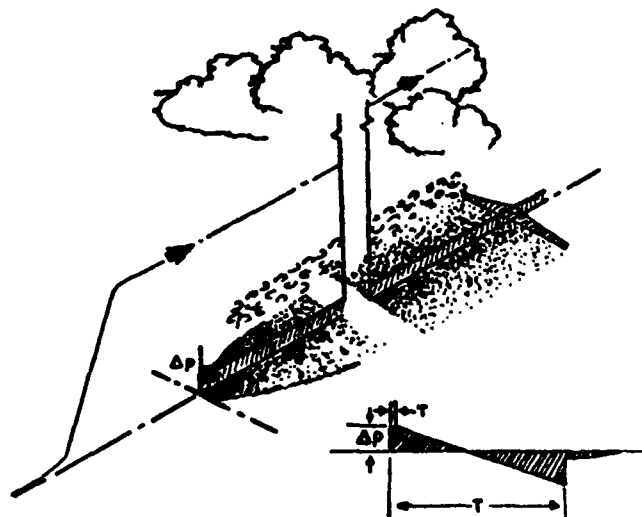


Figure 2a - Sonic Boom Ground-Pressure Patterns — "Carpet Boom"

Maneuvering Flight: The majority of supersonic flight for fighter type aircraft is directly associated with air combat maneuvering training. However, aircraft are normally supersonic only about one percent of the time while conducting air combat maneuvering. Airspace requirements for a normal engagement of two aircraft is usually represented as a vertical cylinder of airspace with a diameter of approximately 8 - 10 nautical miles. (See Figure 2b.) While the aircraft are within this cylinder they are not generally supersonic. (This diameter represents the approximate distance one can see another fighter aircraft with the naked eye.) Each engagement (dog-fight) may last from two to four minutes, with the supersonic portion of the flight occurring when one aircraft breaks away from the fight and the second or chase aircraft accelerates to supersonic speed in order to get close enough to fire (simulated) a missile. At this point, the battle is terminated and the aircraft reposition for the next engagement. This repositioning process may take from three to five minutes and are conducted at

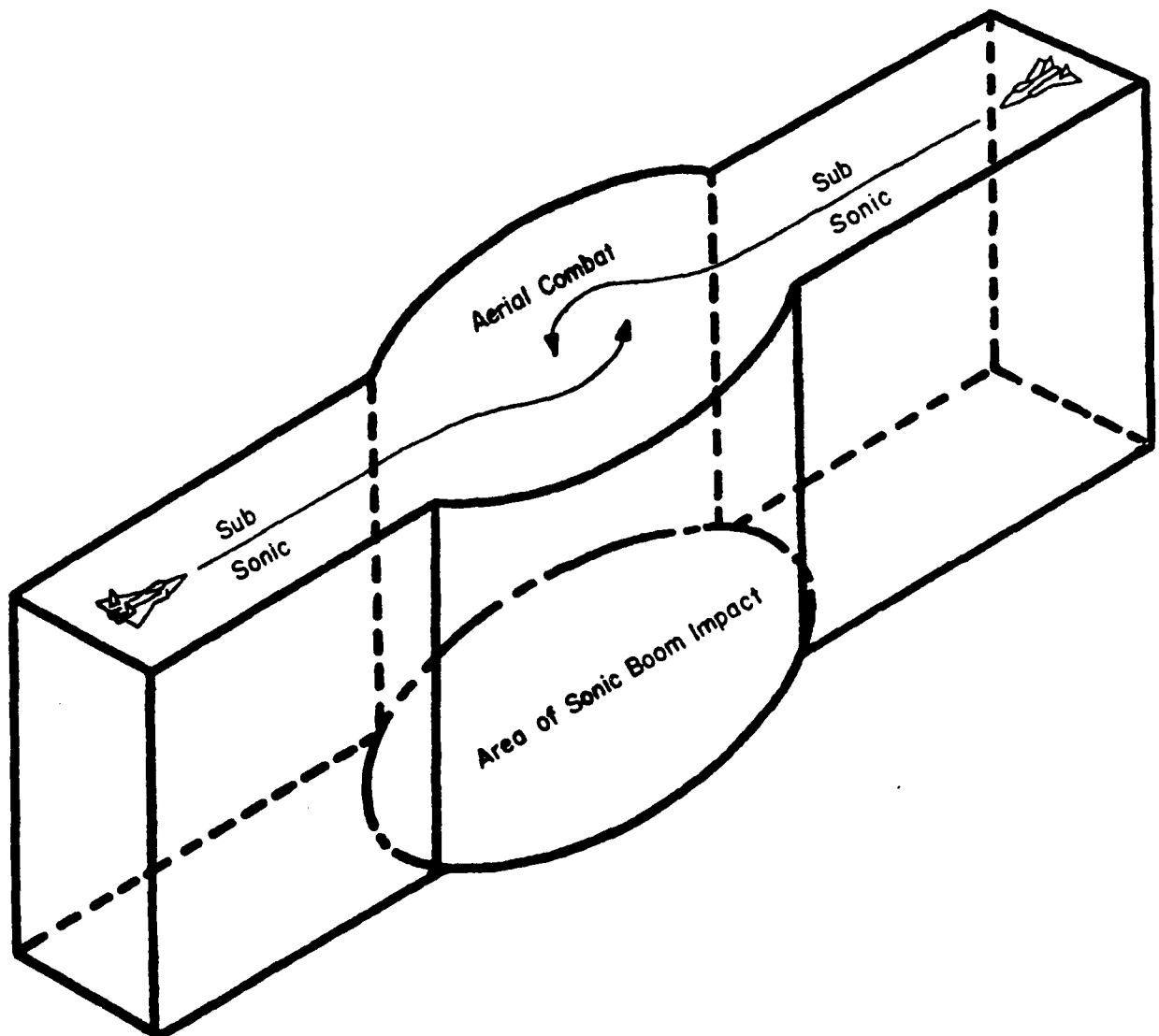


Figure 2b Air-To-Air Maneuvering Area Showing Sonic Boom Impact Area

subsonic speeds. Two to three individual engagements may take place during a single training period and involve either two or, at a maximum, four aircraft. Since the supersonic portion of the battle occurs primarily during break away and chase, the type of sonic boom generated are carpet booms. There is a possibility that one in two sonic booms will be a super or focus boom; these booms can occur during rapid acceleration, tight turns, and pushover operations with a small curvature or arc of the flight track.

FOCUS BOOMS:

Intensified booms can result from various airplane maneuvers which result in pressure buildups at ground level above the pressure created by the aircraft in steady rectilinear flight. In general, the total ground area receiving such sonic booms is substantially reduced from that impacted by "carpet" booms. While the area of these "focus" booms is small (approximately 300 feet wide and limited in length) when compared to the "carpet" boom, the intensity and overpressures may be higher than a "carpet" boom by a factor of 2 to 5. Duration does not vary significantly. The "focus" boom will only affect a fixed area on the ground, i.e., the boom does not move along the surface with the aircraft as does a "carpet" boom. In each maneuver, pressure buildups occur in the localized regions suggested by the shaded areas shown in the sketches in Figure 2c. Illustrated are three types of maneuvers which could result in pressure buildups at ground level (a longitudinal acceleration, a 90° turn, and a pushover maneuver). The effects can be minimized by reducing acceleration and turn rates. The turn focus does not always reach the ground if a large radius turn is used. The pushover focus does not always reach the ground if a small curvature of the flight path is used. Pull-up maneuvers and deceleration do not produce a focus boom.

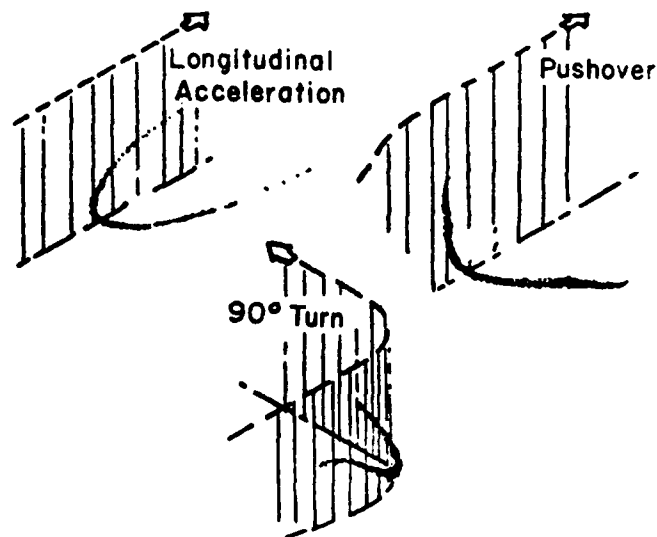


Figure 2c Areas on the Ground Exposed to Focused Sonic Booms
Resulting From Three Different Aircraft Maneuvers

HUMAN RESPONSE:

Of the many field studies conducted to better understand community response to sonic booms, the three most extensive were conducted over St. Louis, Oklahoma City, and Edwards Air Force Base.

St. Louis, Missouri^A -- During the early 1960's, St. Louis was exposed to sonic booms over a seven-month period. A total of 76 flights of supersonic aircraft were made (with several aircraft per flight), producing over-pressures up to 3 pounds per square foot (psf). After the flights a random sampling of residents revealed the following:

- About 90% experienced some interference with speech, activities, etc.
- About 35% were annoyed.
- Less than 10% contemplated complaint action.
- A fraction of 1% actually filed a formal complaint.
- The number of formal complaints was proportional to the number of supersonic missions, i.e., as missions progressed, formal complaints increased.
- A large portion of formal complaints mentioned building damage.
- No adverse physiological effects were noted.

Oklahoma City, Oklahoma^B -- Slightly more than 1250 sonic booms were generated over Oklahoma City during the spring and summer of 1964. The average weekly intensity of over-pressure was increased from 1.13 psf to 1.60 psf over the period of the test. Over-pressures during the test ranged from 0 to 3.5 psf. Almost 3000 adults, representing a cross-section of local residents, were interviewed three times during the six-month test. Based on responses to various questions asked during the interviews, the group was divided into those considered "favorably disposed toward aviation" and those classified as "unfavorable" similar to those found in St. Louis test. There were exception, however, as indicated below:

- About 3% of the "favorable" group felt like complaining about the booms and less than 2% actually did, while 37% of the "hostile" group felt like complaining and 12% did.
- At end of the test, 73% of the total group felt they could learn to live with eight booms per day indefinitely.
- Reactions of urban and rural residents to sonic booms were essentially the same.

- Persons who filed formal complaints with the FAA were much more intensely annoyed and hostile toward the supersonic aircraft than were non-complainers. These individuals reported 3 to 4 times more sonic boom interference, four times more annoyance, 6 to 9 times more desire to complain and 3 times more damage by booms. They placed less importance on aviation in general, the necessity of supersonic travel or the necessity of local booms. Complainers were more often middle-aged females with older children and smaller families. They generally had more education and income and more often had ties with the aviation industry. About 40%, however, felt they could learn to live with eight sonic booms per day.

Edwards AFB, California^C -- In 1967, residents from the base and two nearby communities occupied indoor and outdoor test sites and reported their psychological reactions to sonic boom over-pressures in the range of 1.5 to 3.0 psf. Test results were as follows:

- Those indoors reacted to an over-pressure of 1.69 psf as unacceptable in the following proportion: 50% of the residents from the two communities, 27% of the residents from the base.

- Those outdoors reacted to an over-pressure of 1.69 psf as unacceptable: 59% from the two communities; 33% from the base.

- Including all tests, outdoor listeners found booms slightly less acceptable than indoor listeners. Additionally, reaction of outdoor listeners was more consistent.

- Age and sex were not statistically significant parameters in the rating and sonic boom repetitions did not increase acceptability.

Physiological effects of sonic booms have been studied in several countries and over a variety of human conditions.

In Russia^D, tests were conducted to determine the effect on brain and heart potential, blood chemistry, arterial pressure, auditory acuity and visual response delay. Results showed that sonic boom intensities of up to 1.72 psf cause very slight shifts in these human functions. These shifts did not exceed the normal range of fluctuation and returned to normal in one to two minutes.

The University of Toronto Institute for Aerospace Studies^E exposed individuals to 25 sonic booms per minute for two minutes at over-pressure of 2, 4 and 8 psf. Results showed that boom of up to 8 psf had no detrimental effect on human hearing or heart rate, but that over-pressure of 4 psf would be considered unacceptable to most people. Impacts of over-pressure greater than 8 psf were not examined.

The Committee on Hearing, Bioacoustics and Biomechanics of the National Academy of Science, National Research Council^F, published damage risks criteria recommending limits to peak impulsive noise levels as a function of impulse duration for a nominal exposure of 100 impulses per day. For impulse noises, such as the noise from a sonic boom, the limit is 140 db which equates to approximately 4.17 psf booms. This criteria is designed to protect individuals from experiencing a permanent threshold shift in hearing over a long term (20 years) period.

Tests have been conducted to determine the effect of sonic booms on sleep, task performance, loudness annoyance and startle acceptability and many other areas^V. The Sonic Boom Literature Survey encapsulates 92 investigations in the human response to sonic booms. The following general conclusions can be drawn from these tests:

- The most frequently reported complaint in regard to sonic booms is house rattles and vibrations.
- Booms of similar intensity are slightly less acceptable to listeners outdoors.
- In all tests conducted thus far there has been no evidence direct personal injury resulting from sonic booms.
- On the basis of experimental evidence to date, an acceptable sonic boom over-pressure compatible with undisturbed sleep cannot be given.
- Some experiments have shown a tendency for sonic boom exposure to degrade the performance of certain visual and motor tasks, while other tests have shown no effect of performance. The response is dependent upon the individual subject and the sonic boom over-pressure.

At the request of the U.S. Environmental Protection Agency the Committee on Hearing, Bioacoustics and Biomechanics (CHABA) of the National Academy of Science has reviewed the available data on human response to sonic booms and has recommended a procedure for assessing the impact of sonic booms and other high-energy acoustical impulses on residential living. This procedure relates percent of a population that would be expected to be highly annoyed by the sonic boom environment to the C-weighted day-night average sound level (abbreviated as CDNL) in decibels. This measure is the long term average of the C-weighted sound levels accumulated over a 24 hour period, with a 10 decibel penalty to events that occur after 10:00 p.m. and before 7:00 a.m. The C-weighting is a standardized frequency response found on sound level measuring equipment. The C-weighting puts more emphasis on the sounds of low frequencies than the A-weighting used for more common sounds such as traffic noise or subsonic airplane noise.

The CDNL for sonic boom exposures can be calculated from the expression:

$$L_{CDn} = \overline{L_{CE}} + 10 \log_{10} (N_d + 10 N_n) - 49.4$$

where L_{CE} is the logarithmic average of the C-weighted sound exposure level of individual booms, N_d is the number of events that occur between 7:00 a.m. and 10:00 p.m., N_n is the number that occur from 10:00 p.m. until 7:00 a.m., and 49.4 is ten times the logarithm of the number of seconds in a 24 hour day, relative to a one second reference period. An equation to calculate C-weighted sound exposure levels for the F-15 is given later in this appendix.

The relation between CDNL and the percent of a population that, on average, would be highly annoyed is:

<u>CDNL</u>	<u>Percent Highly Annoyed</u>
50	3
55	6
60	12
65	23
70	39

STRUCTURAL RESPONSES:

Following are general observations from 100 investigations of structural response to sonic booms.

- The largest percentage of sonic boom damage claims has been for glass damage. Plaster damage is second.

- The direction of boom propagation in relation to the orientation of a structure is very important.

- Sonic booms with over-pressure of 3 psf to 5 psf can cause minor damage to plaster on wood lath, old gypsum board and bathroom tile, new stucco, and suspended ceilings already damaged.

- A supersonic flight which produces 1 psf over-pressure can be expected to break 68 per million exposed glass panes. Breakage will occur almost entirely in already cracked windows. Breakage rate of new glass properly installed should be about 1 pane per million.

- Seismic effects resulting from sonic booms are well below structural damage thresholds.

Three large scale tests account for the bulk of recorded data available in describing structural response to sonic boom over-pressure. These include the Oklahoma City and Edwards AFB tests mentioned previously and a test conducted at White Sands in 1965.

Oklahoma City, Oklahoma^G -- Eleven typical types of residential structures were instrumented and exposed to eight sonic booms per day at over-pressures of zero to 3.5 psf. The test program consisted of 26 weeks of eight daily controlled sonic booms having intensities in the range 0 - 3.5 psf (median peak over-pressure of 1.2 psf) followed by thirteen weeks of observation and inspection of the structures to determine the normal rate of deterioration as compared to the rate of deterioration found during the 26 week sonic boom period. The major conclusions reached as a result of this investigation were as follows:

- There was no conclusive evidence of significant damage to the test houses. However, there was a significant increase in the occurrence of minor paint cracking over nail heads and in corners in two of the test houses during the sonic boom period, suggesting that sonic booms accelerated this minor deterioration.

- Measured deflection of window glass in the test houses was not sufficient to cause damage.

- Maximum free ground over-pressure alone is of little value in making structural response calculations since the shape and duration of the pressure wave acting on the structure, plus the natural frequency of the structural element must be taken into consideration.

- For a given aircraft producing N-waves of constant length, the impulse of the wave (positive area under the pressure-time plot) can be more closely correlated with some structural responses than can over-pressure. However, impulses from one aircraft should not be directly compared with impulses produced by a dissimilar aircraft for purposes of structural response.

Edwards AFB, California^H -- Typical wood frame houses, as well as long span steel frame industrial buildings, were instrumented and subjected to over-pressures of two and three psf. Booms with durations of 0.1 second (fighter aircraft) and 0.2 second (bomber aircraft) were produced to determine wall displacement (flexing). The measured plate response of three gypsum board/wood stud/wood siding walls and one large plate glass window, and the measured racking response of two typical wood frame houses, one one-story and one two-story, were analyzed in detail and compared with the response predicted using boom signatures. The following were the most significant findings of this study:

- Sonic booms from large aircraft such as the XB-70 affect a greater range of structural elements (those elements with natural frequencies below 5 cps) than sonic booms from smaller aircraft such as the B-58 and F-104.

- Peak plate displacements of three typical walls in the two test houses were less than 0.034 inches for sonic boom over-pressures of approximately 2 psf. Racking displacements were extremely small at the roof lines of the two test houses (.005" and .0018") for sonic booms on the order of 2 psf.

- Structural response could be adequately predicted using peak over-pressures and Dynamic Amplification Factor (DAF) spectra calculated from free-field signatures.

- No sonic boom damage was observed in test structures prior to or after the test flights.

- Since the condition of the glass panes at Edwards AFB was determined prior to the test program, the number of damaged panes caused by booms from test missions should be an indicator of glass damage to be expected from supersonic flights generating peak over-pressures of 2-3 psf. The rate was one damaged pane per 7.9 million boom-pane exposures. This rate was 27 percent of the rate for buildings in communities adjacent to Edwards which were not condition surveyed prior to test missions.

- Fifty-eight percent of all incidents of damage for which complaints were received were listed as possibly caused by sonic booms generated by test program flights. Of these valid incidents, 80 percent were for glass, 5.5 percent for plaster or stucco, and 14.5 percent for bric-a-brac or other fallen object damage.

White Sands, New Mexico^I -- Twenty-one structures were instrumented and exposed to 1500 booms with over-pressures up to 20 psf. Insight was gained into large and small building reactions to sonic booms. No damage was detected for over-pressure up to 5 psf, nor was there any evidence of cumulative damage effects after a series of 850 successive flights producing 5 psf. One boom of about 40 psf was generated accidentally. The structural test area included 21 buildings varying in design, construction, and age. The following are the most significant conclusions reached as a result of this study.

- The direction of boom pressure propagation in relation to the orientation of a structure or structural element is very important to its reaction. For example, booms traveling directly into a window cause the window to react more violently than do booms traveling away from the window.

- The peak pressure recorded on an exterior wall surface is influenced by the wall rigidity. The stiffer the wall, the higher the pressure.

- Reflecting surfaces such as billboards or houses placed beyond 15 feet from an external house wall do not significantly modify the peak boom pressure applied to the wall. Depending on orientation of the wall and the reflecting surface with respect to the aircraft flight direction, an increase in peak pressure can be expected when the reflecting surface is closer than 15 feet from the wall.

- Motion of the frame holding a window does not significantly influence the response of large windows framed by stud walls.

- The average transmissibility of large windows (8' x 10'), defined as the ratio of peak inside to peak outside pressure, can vary between 0.5 (boom wave directed into window) and 1.0 (boom wave directed away from window).

- The transmissibility of a room appears to be governed more by the size of the window walling the room than by room volume.

- Booms cause exterior walls to move more than interior walls in the minimum damage index level for walls in small houses, such as those used in this test. Bellows distortion may govern wall damage for larger houses, but the associated minimum damage index level for the larger houses could be larger than that observed in these tests.

- To study the cumulative effects of repeated sonic booms, 680 successive flights at a scheduled overpressure of 5.0 psf were generated during one period of the study. No damage to previously undamaged material was identified during the period.

- Bricks on the sill below a picture window in one of the test houses were cracked by the accidental sonic boom. This was apparently caused by the window flexing outward after being pushed inward by the boom over-pressure (the glass was not damaged).

The results of the three large scale sonic boom structural tests and several other tests were analyzed by NASA. In their conclusion they make the following statement: AA

The extensive series of overflight tests have provided valuable data on the order of magnitude of responses to be expected. These tests show that building structures in good repair should not be damaged at boom overpressures less than about 11 lb/ft². However, it is recognized that considerable loading variability occurs, owing to atmospheric effects, and that the residual strength of structures varies according to usage and natural causes. Thus, there is a small probability that some damage will be produced by the intensities expected to be produced by supersonic aircraft.

One additional investigation is worthy of mention. In 1977 an adobe house in southern Arizona was instrumented and evaluated while supersonic training was taking place overhead. BB The conclusion of the evaluation was that the adobe structure reacted similar to a conventional style structure. Based on this analysis, there should be no difference in the probability of damage to an adobe structure or a conventional structure.

EFFECTS ON TERRAIN AND SEISMIC ACTIVITY

Several studies have been performed to study the magnitude of seismic effects resulting from sonic booms. K One study by Goforth and McDonald concluded that the static deformation that occurs at the surface is unlikely to build up sufficiently to

constitute a menace to structures. As a part of the analysis, the peak particle velocity was determined for various geological formations. The damage potential of the peak particle velocities produced by the sonic booms is well below damage thresholds accepted by the United States Bureau of Mines and other agencies. The peak particle velocities recorded at a depth of 44 feet were attenuated by a factor of 75 relative to those recorded at the surface. The maximum ground particle velocity is of the order of 0.1 millimeters per second for each psf of sonic boom overpressure.X

There has been some concern that supersonic flights over mountainous areas could cause avalanches under certain conditions.CC In 1967, damage in two National Parks was attributed to falling earth and rock. In both incidents, the falling earth and rock were preceded by sonic booms. The only test in the United States to study the possibility of avalanches was conducted in the Star Mountain area near Leadville, Colorado.X Eighteen supersonic runs were studied with overpressures ranging from 1.5 to 5.2 psf. No avalanche was observed as a direct result of a sonic boom. Forest Service personnel rated the avalanche hazard as low during the test period and considered the test as inconclusive; therefore, the potential for sonic booms triggering avalanches remains largely unknown.

STATISTICAL STUDIES OF DAMAGE

Data was gathered from the Oklahoma City and St. Louis tests as well as a test in Chicago to determine the number of complaints and damage claims submitted by the public.X Data also was used to verify damage claims and dollar value of claims paid. Most claims involved broken glass and cracked plaster in more poorly constructed and maintained homes. Injury claims to people or animals were very few and of an indirect type, such as injury resulting from falling objects, broken glass or self injury due to startle.

From 1956 to 1970, the amount of money claims for structural damage was \$30.6 million while the amount paid was \$1.7 million. For the years up to and including 1968, 65% of all paid claims were for glass and 18% were for plaster damage.

By far, the largest percentage of sonic boom damage claims stems from broken or cracked glass damage. All of the tests conducted in the United States have confirmed that glass damage is the most prevalent damage caused by sonic booms.J Because the microstructure of glass is amorphous rather than crystalline, the practical design strength of glass is a surface condition property rather than a constant material property. What this indicates is that the strength of the glass is dependent on the surface scratch condition. Glass that has been sandblasted, scratched or nicked will not exhibit the same strength as a properly installed, relatively new pane of glass.

In addition to the variation due to surface scratch condition, there are also variations with loading geometry, loading rate,

atmospheric moisture content, and composition. Glass also exhibits a property known as "static fatigue" in that it is weaker for loads of longer duration. Thus for sonic boom loading, which has the duration of the order of 0.1 sec, the strength of glass will be roughly twice that obtained in typical laboratory assessments. By using a data base of unpublished static test results provided by Libbey-Owens-Ford Company, a statistical analysis was performed to determine the probability of glass breakage for various over-pressures. If all flight paths are considered equally likely; that is, the aircraft could approach from any direction, then the probability of breakage for good glass at various nominal overpressures is shown below.^J

<u>Overpressures</u>	<u>Probability of Breakage</u>
1 psf	.000001*
2 psf	.000023

*1 pane in 1,000,000 panes

If the aircraft were to approach from head-on or perpendicular to the plane of the window, the probability would increase somewhat, as shown below:

<u>Overpressures</u>	<u>Probability of Breakage</u>
1 psf	.000023
2 psf	.000075
4 psf	.001200
20 psf	.105000
40 psf	.323000

ANIMAL RESPONSE:

Controlled investigations of animal response to sonic boom began in 1965 with study of the effect of hatchability of chicken eggs. It was resumed in 1967 when the response of farm animals to sonic booms was studied as part of the Edwards Air Force Base sonic boom experiments. Subsequent studies were concerned with the response of cattle and horses to extremely intense booms (80 to 144 psf), with effects on fish, reindeer, mink and fish eggs.

The following are general conclusions drawn from investigations of animal response to sonic booms:

- The animal damage claims are a small fraction of total sonic boom damage claims submitted to the Air Force.

- Reactions of farm animals to sonic booms are minimal.

- Evidence indicates that exposure of mink to sonic booms does not affect reproduction.

- Sonic booms do not affect the hatchability of chicken eggs nor do they affect fish or fish eggs.

- Although knowledge concerning the effects of sonic booms on wildlife is limited, all evidence to date indicates that animals, under most circumstances, are unaffected. Sonic booms may, under extreme and unusual circumstances (booms in excess of 100 psf) adversely affect wildlife, as in the case of the Sooty Tern incident (discussed latter).

Individual wild, domestic or pet animals exhibit different reactions to sonic booms according to the species involved, whether the animal is alone, and some cases whether there has been previous exposure. Common reactions are moving, raising the head, stampeding, jumping and running. Avian species may run, fly or crowd. Animal reactions vary from boom to boom and are similar to low-level subsonic flights, helicopters, barking dogs, blowing paper and sudden noises. The responses are either unrecognizable or consist of an apparent alerting accompanied by trotting off a short distance. Damage claims have been submitted by farmers and livestock breeders concerning loss resulting from sonic booms. Primary complaints have been that the productivity of animals was adversely affected and that panic and injury often resulted from the startle reaction. From Air Force claims records between 1961 and 1970, \$900,000 in animal claims were made and \$128,000 in damages awarded. The largest amounts were connected with mink production (\$610,000 in claims and \$100,000 in damages paid) with claims for chickens and horses following.^L

Several experiments have been conducted to investigate the physiological animal response to sonic booms. Studies under various tests were: Effect on hatchability of chicken eggs; cattle and horse response; effects of intense booms (80 to 144 psf) on fish; reindeer; mink; and fish eggs. In other studies no significant responses or production changes were found for pheasants, chickens, turkeys, sheep, dairy and beef cattle or horses.^M Bell reported that between 1961 and 1970, claims submitted to the Air Force for chickens, horses, and cattle totalled \$144,000 but only \$21,500 was actually awarded in damages.^L

Mink Reactions: Two extensive investigations of mink response to sonic booms, ranging in over-pressure from 0.5 psf to 2.0 psf in one test^N and 3.6 psf to 6.6 psf in the second test^O, found that no adverse reproduction for behavior resulted from the booms.

Chickens: Two tests were conducted to investigate sonic booms effects on hatchability of chicken eggs. One study carried out in Texas in 1965^P exposed a total of 3,415 hatching eggs to 30 booms per day over a 21 day period. Over-pressures ranged from 0.75 psf to almost 6 psf. No deviations in the hatch rate were found in this test. A second test conducted in France in 1972^Q exposed hatching eggs to six booms per day. The hatched chicks from these eggs were all normal.

Fish: Testing of fish eggs and guppy reaction to sonic booms was conducted in the early 1970s. Trout and salmon were reared from egg stage to maturity in the usual manner except for exposure to sonic booms in the range of 1 psf to 4 psf^R. No abnormal increase in mortality rate was noted. Guppies were exposed to shock waves of 550 psf (in the air)^S. The fish detected the passage of the shock wave and reacted momentarily, however, no adverse effects were noted in observations during two months subsequent to the shock wave exposure.

Reindeer: A study of reindeer reaction^T to sonic booms revealed that at low levels of over-pressure (0.3 psf to 0.5 psf) the animals react with temporary muscle contraction and minimal or undetectable interruption of activities. Higher levels of over-pressure (up to 10.5 psf) caused the reindeer to raise their heads, look around and sniff but never produced a reaction strong enough to bring resting animals to their feet. Panic movements were not observed, but neither was adaption to startle noted.

One well documented incident reveals that supersonic over-pressures may have affected a wild bird reproduction rate.^U During 1969 in a Sooty Tern breeding colony of a Florida key, the birth rate of young terns was 1.3% of the expected rate. Possible causes including weather, predation, food shortage, over-dense vegetation in the colony, pesticides, and disturbance by man were investigated and discounted. Three very intense sonic booms between May 4 and May 11 may have caused embryo damage due to egg abandonment or physical damage to uncovered eggs. (Over-pressures of 100 psf or more have been generated by aircraft flying supersonically within 60 feet of the ground.) Birth rates in preceding and succeeding years were normal.

Bighorn Sheep: Correspondence from US Fish and Wildlife Service personnel managing the Cabeza Prieta Wildlife Refuge, Arizona, listed observations of bighorn reactions to sonic booms.^{EE} The observations were reported as follows:

9/13/78. Plomosa mtns. 1 ewe, 1 yearling 3 class II rams, 2 class, III rams. Activity - all animals bedded down (sonic boom) animals stayed in position, standing but frozen, then entire band

ran about 20 yards upslope, huddled, alert, stayed in this position for about 15 minutes then moved uphill towards new shaded area.

1/3/79. Plomosa Mtns. 6 ewes, 2 yrlds. Activity - feeding, (sonic boom) no visible reaction.

May 1979. New Water Mtns. 2 ewes, 2 lambs. Activity - bedded down (sonic boom) sheep twisted their heads and stared in several directions, none of the animals rose.

3/21/79. Kofa Mtns. 3 rams. Activity - walking up hillside (sonic boom) sheep stopped, looked around and continued walking up hillside.

3/22/79. Kofa Mtns. 13 rams. Activity - part of band bedded down, part standing around (sonic boom) bedded sheep jumped to their feet, standing sheep bolted about five yards, in about 5 minutes sheep began to feed and bed down again.

SONIC BOOM CALCULATIONS:

A simplified method for calculating the sonic boom characteristics for various aircraft shapes has been developed. The sonic boom over-pressure and signature duration may be predicted for the entire affected ground area for aircraft in level flight or in moderate climbing or descending flight paths. The procedures for calculation of the predicted sonic boom by the simplified method involves three basic steps: determination of an aircraft shape factor, evaluation of atmosphere propagation factors, and calculation of signature shock strength and duration.

The effects of flight-path curvature and aircraft acceleration are not considered in using the simplified method. The method is further restricted to a standard atmosphere without wind. These limitations, however, do not appear to affect the general applicability of this method for normal variations from the standard atmosphere and for moderate flight-path curvature and aircraft acceleration. A variety of correlations of predicted and measured sonic boom data for aircraft and spacecraft has served to demonstrate the applicability of the simplified method.

The simplified method is illustrated in Figure 3 where:

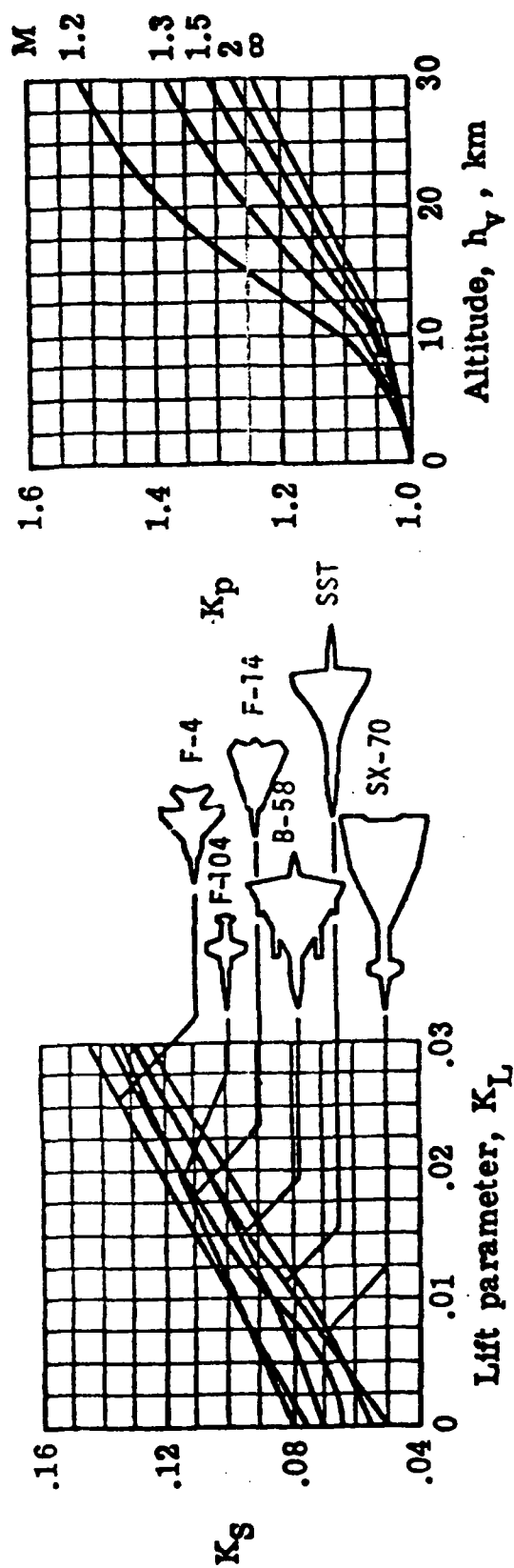
Δp = Maximum over-pressure expected

K_L = Lift parameter

P_v = Atmosphere pressure at aircraft altitude

P_g = Atmospheric pressure at the ground

K_s = Shape factor



- (1) Enter lift parameter K_L

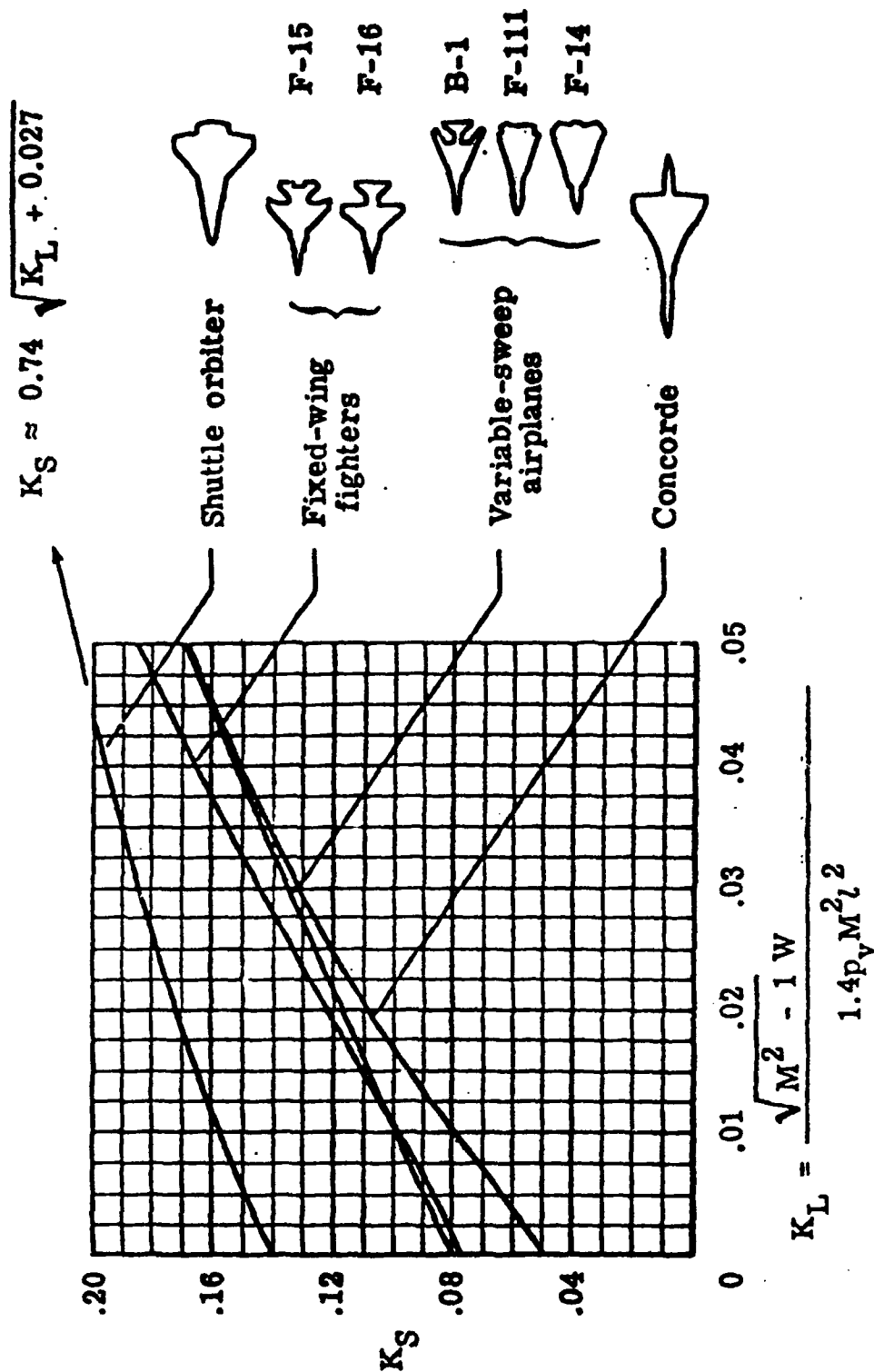
$$K_L = \frac{\sqrt{M^2 - 1} \cdot W}{1.4 p_V M^2 \gamma^2}$$

Select shape factor K_S
- (2) Enter altitude h_V and
 Mach number M
 Read pressure amplification
 factor K_P

- (3) Calculate bow-shock overpressure

$$\Delta p_{\max} = 2 K_P K_S \sqrt{p_V p_g} (M^2 - 1)^{1/8} h^{-3/4} \gamma^{3/4}$$

Figure 3 - Super-simplified sonic-boom prediction method for on-track bow-shock overpressure of conventional airplanes in level flight.



(b) Contemporary aircraft.

Figure 3 - Concluded.

K_p = Pressure amplification factor

M = Mach number

W = Weight

l = Length of aircraft

h = Height of aircraft above ground

Several cases were chosen for study representing the range of altitudes in which training aircraft would be conducting air combat maneuvering. Since ACM type training is the major source of sonic booms, supersonic activity involving primarily the F-4, F-15, and F-16 was selected. For each aircraft, boom strengths were calculated for altitudes ranging from 15,000 to 30,000 feet mean sea level. The calculations were made for the aircraft in steady rectilinear flight (constant speed, straight and level flight). Table 1 illustrates the overpressures of sonic booms for various altitudes. Table 2 shows the extent (width) of sonic booms at various airspeeds and altitudes and provides the intensity of the boom at cutoff.

Boom Duration:

The N-wave duration (Δt) can be estimated by the relationship:

$$\Delta t = \frac{4.8(M)(r)^{0.25}(l)^{0.75}K_S}{1.4(\sqrt{M^2-1})^{0.75}(a_h)}$$

where:

M = Aircraft Mach Number

r = Slant Range distance from aircraft to observer

l = Aircraft Reference Length

K_S = Aircraft Shape Factor

a_h = Speed of Sound at Aircraft Altitude

Sonic Boom Cutoff:

The temperature gradient in a standard atmosphere refracts sonic booms upwards. Booms caused by aircraft at low Mach numbers, depending on aircraft height, h , above ground, will not propagate to the ground. The Mach number below which this occurs, and above which will result in boom reaching the ground, is called cutoff Mach number, and is symbolized as M_C . The cutoff Mach number is approximately given by:

TABLE I
SONIC BOOM INTENSITY* DIRECTLY UNDER FLIGHT TRACK

Aircraft	F-4				F-15				F-16			
Aircraft Altitudes (ft) MSL	15000	20000	25000	30000	15000	20000	25000	30000	15000	20000	25000	30000
Pressure at Altitude (P_v)	1194.3	972.5	785.3	628.4	1194.3	972.5	785.3	628.4	1194.3	972.5	785.3	628.4
Aircraft Weight (W)	36,100 lb				40,000 lb				23,500 lb			
Aircraft Length (Z)	58.0 ft				64.0 ft				47.5 ft			
Shape Factor (K_s) M=1.1	0.080	0.082	0.084	0.086	0.080	0.081	0.083	0.085	0.080	0.082	0.084	0.086
(K_s) M=1.4	0.082	0.084	0.087	0.090	0.082	0.084	0.086	0.088	0.082	0.084	0.087	0.090
Pressure Factor (K_p) M=1.1	1.03	1.05	1.07	1.11	1.03	1.05	1.07	1.11	1.03	1.05	1.07	1.11
(K_p) M=1.4	1.02	1.03	1.04	1.05	1.02	1.03	1.04	1.05	1.02	1.03	1.04	1.05
Normal Ground Pressure @ 5000 ft	1760.8 PSF				1760.8 PSF				1760.8 PSF			
@ 6000 ft	1695.9 PSF				1695.9 PSF				1695.9 PSF			
ΔP (psf) @ MACH 1.1 5000 ft	3.92	2.73	2.07	1.66	4.23	2.90	2.20	1.77	3.38	2.35	1.78	1.42
6000 ft	4.17	2.82	2.11	1.68	4.49	3.00	2.24	1.79	3.59	2.43	1.82	1.45
ΔP (psf) @ MACH 1.4 5000 ft	4.82	3.32	2.51	1.99	5.19	3.57	2.67	2.09	4.15	2.86	2.16	1.71
6000 ft	5.12	3.42	2.56	2.01	5.51	3.69	2.73	2.11	4.41	2.94	2.20	1.73

*Aircraft in steady rectilinear flight.

TABLE 2
SONIC BOOM CUTOFF DISTANCE AND INTENSITY AT CUTOFF

ACFT	F-15			
Altitude (FT) MSL	15,000	30,000	15,000	30,000
MACH Number	1.1M			
Ground Altitude (FT) MSL	5,000 ft		6,000 ft	
Cutoff Distance (ft)	23,500	*	21,200	4,500
Slant Range (FT) r	25,540		23,030	24,420
Shape Factor (K_S)	0.080		0.080	0.084
Pressure Factor	1.03		1.03	1.11
ΔP at Cutoff (psf)	0.85		0.88	0.55
Width of Audible Boom (Miles)	8.9		8.0	1.7

* No boom at ground level ($M < M_C$)

$$M_c = e^{4.033 \times 10^{-6} h}$$

when $h < 35,300$ feet. M_c is equal to 1.153 when h is between 35,300 and 51,000 feet. A similar process works to limit the distance a sonic boom will propagate to the side of a flight path, where again cutoff occurs. This distance, $d_{y,c}$, in feet, may

be calculated from:

$$d_{y,c} = h \frac{(1+M_c)}{M} \left(\frac{M^2 - M_c^2}{M_c^2 - 1} \right)^{0.5}$$

where h is height of the aircraft in feet, and M is the aircraft Mach number.

C-weighted Sound Exposure Level

The C-weighted sound exposure level, CSEL, used to calculate C-weighted day-night average sound level for sonic booms caused by F-15 aircraft is given approximately by:

$$\overline{L_{CE}} = 180 + 10 \log_{10} \delta_v \delta_g + 2.5 \log_{10} (M^2 - 1) - 15 \log_{10} r$$

where:

δ_v = the ratio of atmospheric pressure of aircraft height to sea level pressure

δ_g = the ratio of atmospheric pressure at an observer's ground elevation to sea level pressure

M = the aircraft Mach number

r = the slant distance from aircraft to the observer

As an example, the C-weighted sound exposure level for an aircraft at 21,000 feet, flying at Mach 1.15, directly underneath the flight path at an observer elevation of 6,000 feet is 111.6 decibels.

OCEANA MOA STUDY - DEVELOPMENT OF SONIC BOOM MODEL

Air combat training with F-15 aircraft takes place within the geographic boundaries of an airspace defined as a Military Operating Area (MOA). In order to obtain full mission capability during such operations F-15 aircraft will achieve supersonic speeds (in excess of Mach 1.0), thus producing sonic booms. In order to assess the significance of such supersonic flight operations on people at ground level who may hear sonic booms it

is necessary to examine a number of features of sonic boom production during F-15 air combat maneuvering training, such as:

- the geographical region within the MOA where supersonic flight occurs and the distribution of flight paths utilized,
- the height distribution of aircraft when operating supersonically,
- the Mach number distribution of supersonic flights,
- durations of supersonic flight, and
- the influence of cutoff Mach number on limiting sonic booms that actually reach ground level.

Knowledge of the above information permits calculation of C-weighted day-night average sound level at ground areas that would be affected by F-15 air combat maneuvering operations. C-weighted day-night average sound level (CDNL) is a measure of environmental noise produced by impulsive sounds, such as sonic booms, that has been found to correlate well with average human responses to impulsive noise. It is the acoustical measure recommended by the National Research Council and the Environmental Protection Agency for assessing the environmental effects of impulsive noise.

The availability of instrumentation systems within some MOA's for real-time acquisition of position, velocity, and acceleration data from individual aircraft engaged in training provides the capability to obtain information necessary to define the operational parameters required to compute CDNL. Training operations at Oceana are recorded from time aircraft enter the MOA until they depart the area. The recorded data are available for playback at Langley AFB for post flight analysis by aircrew members. A wide variety of data are available for individual aircraft, or data from one aircraft relative to another. Of interest in this analysis are the data relating to horizontal and vertical projections of flight trajectories. Mach numbers, duration of supersonic flight, and maneuvers performed while supersonic. These data are available simultaneously on a series of visual displays. For example, the horizontal projection of flight trajectories (flight track) can be presented on one display, while simultaneously the heights, Mach numbers, and other data for the different aircraft involved in the exercise can be displayed numerically, as a function of time, on an adjacent display.

Personnel from the Environmental Planning Division of Headquarters Tactical Air Command have analyzed the recorded data from 21 sorties of F-15 aircraft engaged in air combat maneuvering in the Oceana MOA. The average duration of sorties was approximately 20 minutes while the aircraft were within the MOA. During this time the 21 aircraft were supersonic 56 times, or 2.7 times per sortie.

Of these 56 events, 18 were at Mach numbers above cutoff, or 0.8 per sortie. The distribution of Mach numbers greater than or equal to M1.0 and altitudes at which they occurred is plotted in Figure 3a, along with the cutoff Mach number function. Figures 3b and c provides histograms of the altitude and Mach numbers.

As the first step in constructing a model for F-15 sonic boom calculations the data on Figure 3a were analyzed to obtain a height and Mach number that could be used to calculate an energy mean C-weighted sound exposure level (CSEL) that would be representative of the entire distribution of flights. The lowest flight altitudes generate the highest boom levels, that is boom levels are inversely proportional to height. For this distribution the root-mean-square of the reciprocal of heights was calculated, for those booms above M_c , then its reciprocal used to represent the logarithmic mean height. (The single apparently anomalous flight at M1.5 at 42,000 feet was not used, so as not to bias the rms height upward.) The rms height thus calculated was 15,140 feet.

The Mach number distribution (above M_c) was examined to define an appropriate Mach number for CSEL computations. The arithmetic mean Mach number for all 18 booms was 1.128, with a standard deviation of 0.095. Excluding the Mach 1.5 flight, the arithmetic mean was 1.106, with a standard deviation of 0.020. In order to obtain an energy mean CSEL, the variation of CSEL with Mach number must be considered. The energy mean Mach number with all 18 booms is 1.114, while exclusion of the Mach 1.5 flight yields an energy mean Mach number of 1.106, yielding a 0.1 decibel difference between the two cases. The 1.106 energy mean Mach number was used in this analysis.

Utilizing these values, the energy mean CSEL for F-15 air combat maneuvering operations, directly below the aircraft, for a ground elevation of sea level, corresponding to an aircraft height of 15,140 feet and Mach number of 1.106, because:

$$\overline{L_{CE}} = 113.2 \text{ decibels}$$

For any other ground elevation or aircraft height, the $\overline{L_{CE}}$ algorithm must be modified appropriately to:

$$\overline{L_{CE}} = 115.7 + 10 \log_{10} \Delta_v + 10 \log_{10} \Delta_g$$

The above calculations gives a CSEL value at a single point directly below the flight path. Points to the side of the flight path, up to cutoff, will have decreasing sound exposure levels as the distance from the flight path increases. In addition, the extent of exposed areas along the flight path will depend on how long the aircraft remains supersonic.

Along the flight path, directly underneath, the boom will travel a distance equal to the aircraft speed times the duration of supersonic flight. Examination of the Oceana MOA data indicates that duration varied from approximately 6 to 24 seconds, with 15

MACH EVENTS VS. ALTITUDE HISTOGRAM

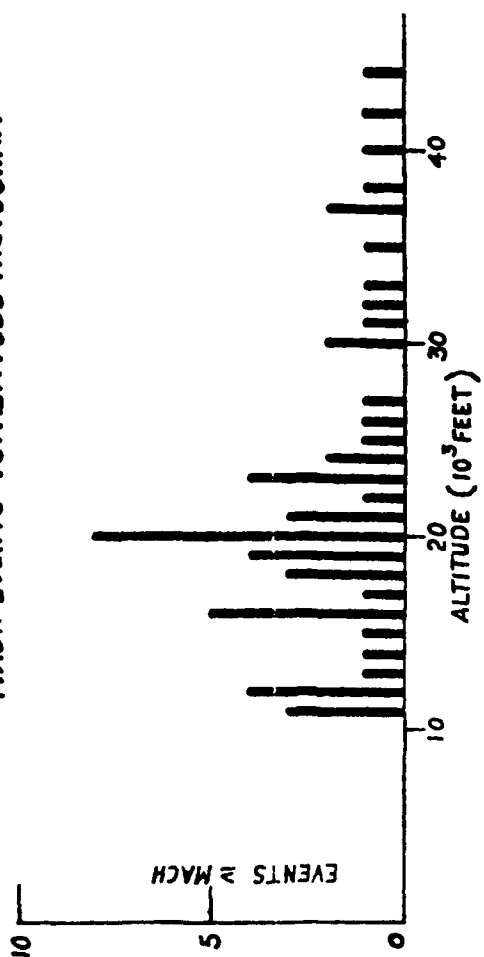


Figure 3b

MACH NUMBER HISTOGRAM

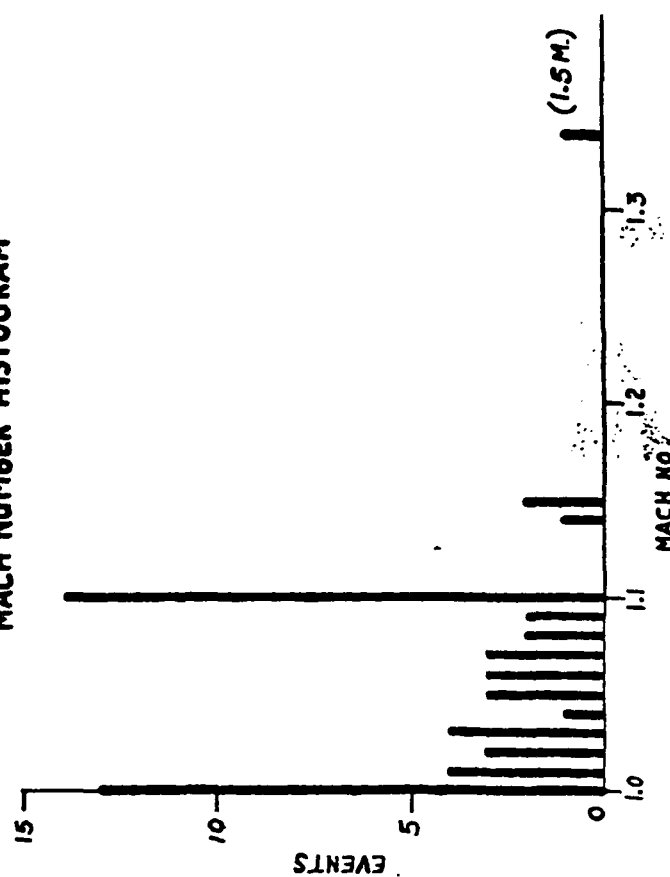


Figure 3c

MACH EVENTS VS. ALTITUDE PROFILE

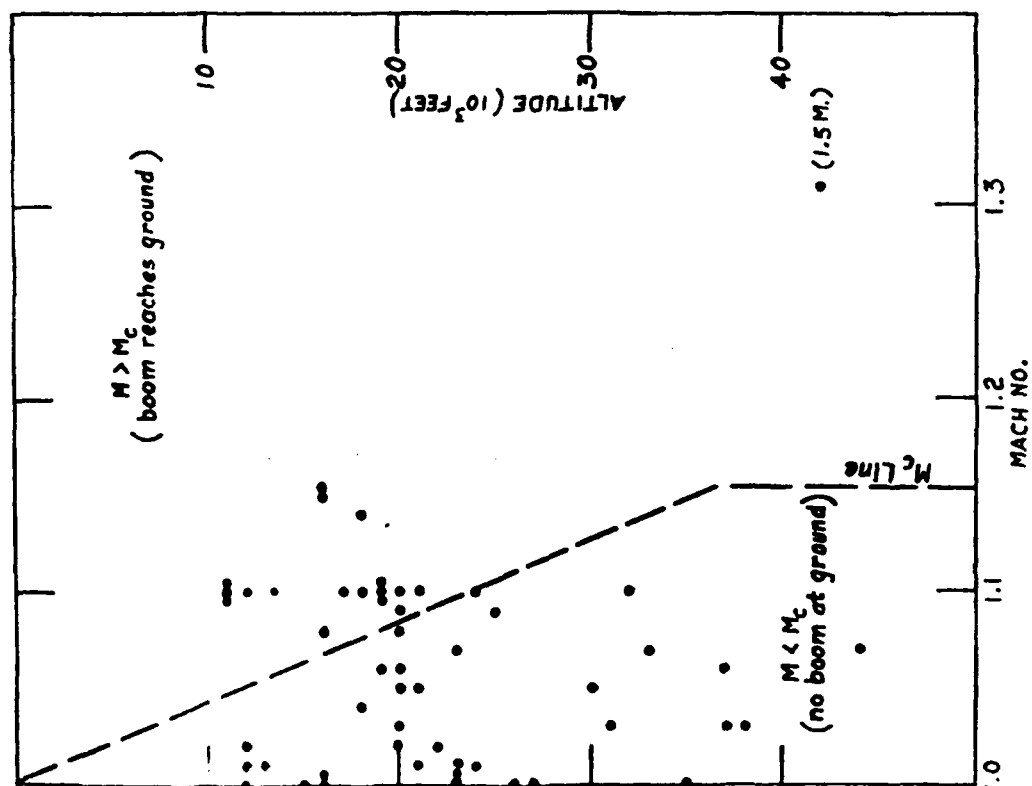


Figure 3a

seconds as an average. At Mach 1.1, the distance traveled in 15 seconds, at 15,000 feet altitude, is approximately 17,500 feet.

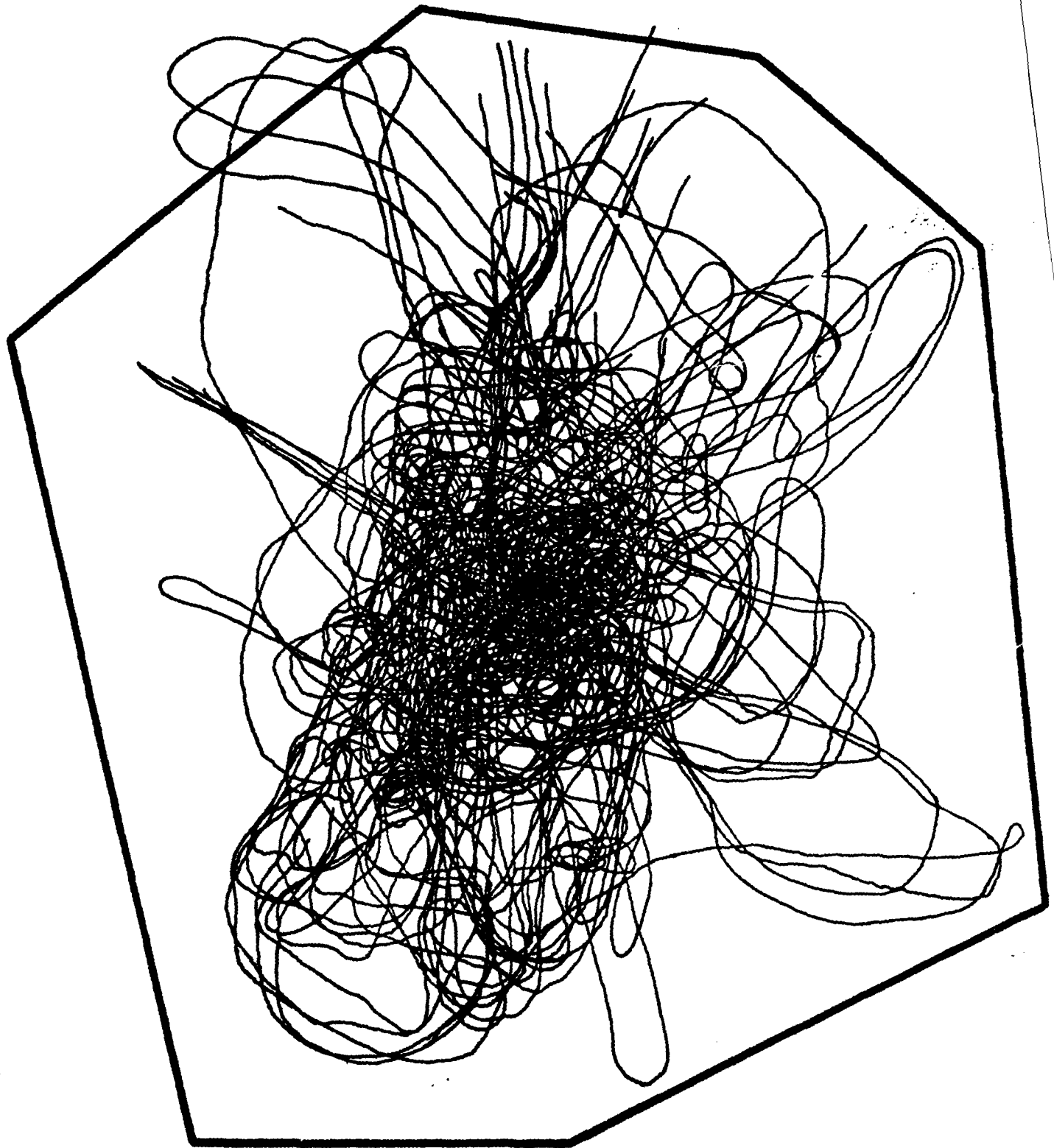
The distance to the side of the flight path at which cutoff takes place can be calculated from the $d_{y,c}$ formula previously discussed. With a height of 15,140 feet, and an average Mach number of 1.106, the cutoff Mach number is 1.06, resulting in a lateral distance to cutoff, $d_{y,c}$, of 27,500 feet, on either side of the flight path.

Directly underneath the flight path the CSEL remains constant. The CSEL to the side of the flight path decreases by 15 times the logarithm of the ratio of slant distance to aircraft height above ground, up to a lateral distance where this ratio is approximately 0.8. The sonic boom wave disintegrates rapidly into a rather ragged sine wave of much lower pressure as the lateral distance approaches cutoff. The CSEL is assumed to decrease by 10 additional decibels as the ratio of slant distance to $d_{y,c}$ increases from 0.8 to 1.0. The boom CSEL is considered negligible at greater lateral distances. With aircraft height of 15,140 feet, and a lateral cutoff distance of 27,500 feet, the CSEL at 0.8 of lateral cutoff, or 22,000 feet, is 3.7 decibels lower than directly beneath the flight path, and approximately 14 decibels lower at 27,500 feet.

The CSEL along the boom carpet, directly under the aircraft, is constant. The space average CSEL over the boom area is the energy mean average sound level from 0.8 times the lateral cutoff distance on one side of the boom width to the sound level overhead. This space average value is 1.4 decibels below the overhead level for the Oceana data. The space average CSEL per boom is thus $113.2 - 1.4 = 111.8$ decibels over an area with dimensions of 17,500 feet along the flight track (3.3 miles), 22,000 feet to each side (4.2 miles), for a total area of 28 square miles.

In the above analysis it was found that the area exposed to a boom that propagated to the ground was 28 square miles, and that this happened, on average, 0.8 times per sortie. The long term average sound level at points on the ground is determined by the average CSEL per event, the average number of events per day, and the probability that the point on the ground will be within the boom carpet area of 28 square miles while aircraft are within the MOA, which is typically more than 1,000 square miles in area.

The Oceana MOA analyses provide data from which to make the necessary computations. Traces of the aircraft flight tracks show that, except for entry and exit of the MOA, maneuvers are concentrated in an area roughly of an elliptical shape. (See Figure 4 which provides a composite of all flight tracks in the Oceana Study.) The origin of the ellipse is at a geographical location that is midway between two navigational reference points, approximately 40 miles apart, the major axis of the ellipse being along this line.



Oceana MOA Study Composite Flight Tracks

Figure 4

B-1-29

For F-15 maneuvers, the aspect ratio of the ellipse surrounding the maneuvering area is approximately 1.7:1, or 20 miles wide by 34 miles long, covering approximately 534 square miles. Within this area, supersonic flight is contained within a smaller ellipse, with the same origin and principal axes as the larger, having an aspect ratio of 1.5:1, with dimensions of approximately 12 miles wide by 18 miles long, enclosing an area of approximately 170 square miles. Figure 5 provides a composite of all supersonic events for each aircraft's flight track. Also shown are the supersonic, 0.8, and 1.0 Mach cutoff ellipses.

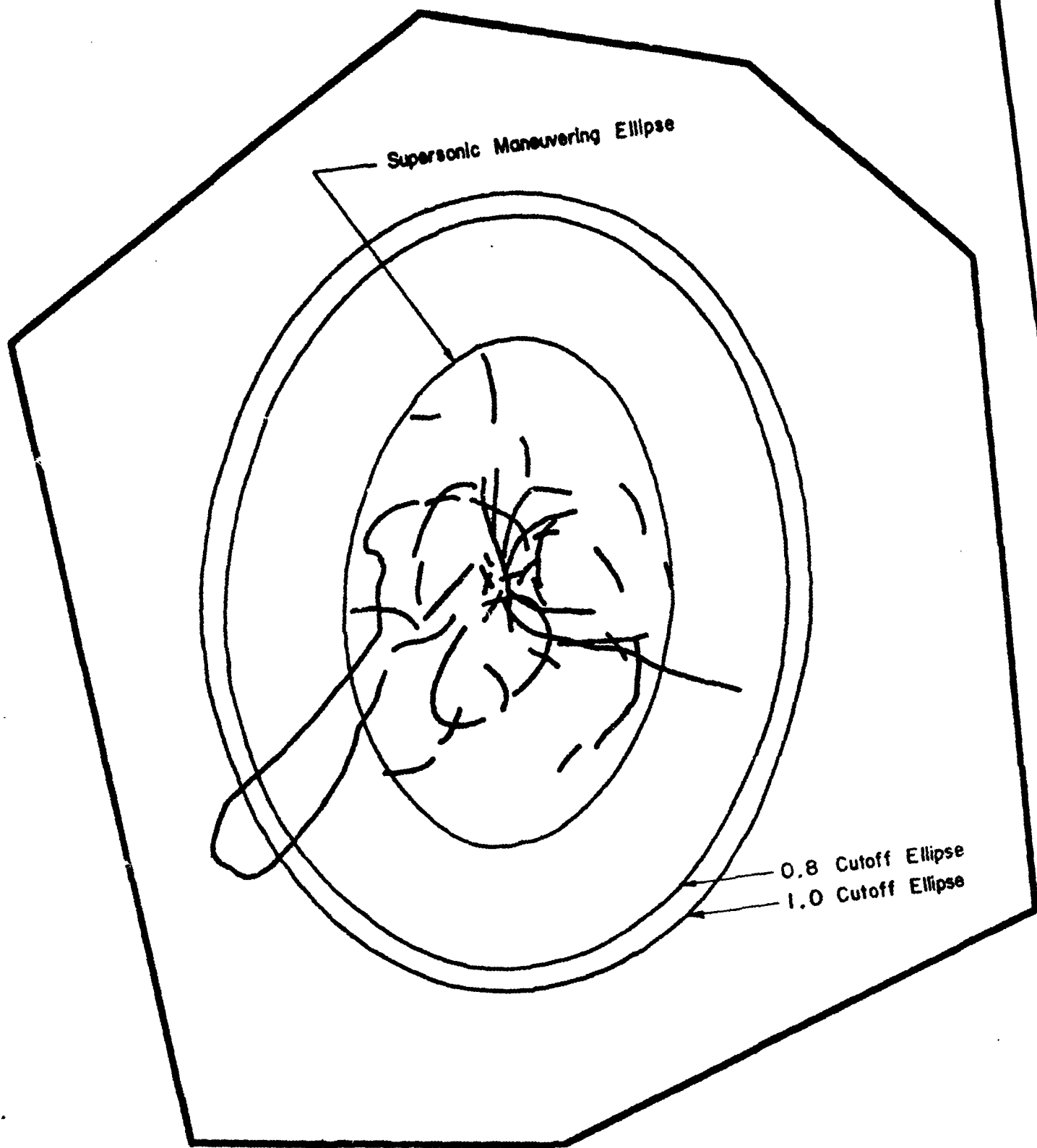
Traces of the flight tracks show that an aircraft can be at any location within the ellipses during a sortie. On average, the F-15 makes 0.8 propagating booms per sortie, of 15 seconds duration, during a 20 minute sortie. That is, during 0.010 of the time the aircraft is within the supersonic maneuvering area it is, on average, causing a propagating boom. The randomness of the flight tracks within the supersonic area, and the low probability of occurrence lead to a first order assumption that the probability of a boom being experienced on the ground is a random process having a Poisson distribution function. The expected rate of boom production, and resultant CSEL are as described above; the geographical location of the aircraft when causing a boom is equally probable at any point within the supersonic maneuvering area.

The above assumptions lead to the computation that the space average CSEL per boom within the supersonic maneuvering ellipse is the space average CSEL per boom, reduced by 10 times the logarithm of the ratio of the area per boom to the area of the supersonic maneuvering area,

$$\overline{L_{CE}} = 111.8 - 10 \log_{10} \frac{170}{28} = 104.0 \text{ decibels.}$$

Since the flights are assumed to occur anywhere within the supersonic maneuvering area, including along its periphery, a larger area outside this boundary will be exposed to somewhat lower sound levels, out to 0.8 times the cutoff distance, or 4.2 miles to the side of the flight track. This defines an outer ellipse with dimensions of 20.4 miles total width by 26.4 miles length (423 square miles) with a long term average CSEL of $104.0 - 3.7 = 100.3$ decibels along the boundary. A third ellipse, corresponding to the cutoff boundary, has dimensions of 22.4 miles in width and 28.4 miles in length (500 square miles), with a boundary CSEL of 90.9 decibels. With these computations, the C-weighted day-night average sound level can be computed for the cumulative effect of operations. For 15 sorties per day, 5 days per week, 52 weeks per year, with 0.8 booms per sortie, the long term average number of daily operations is:

$$15 \times \frac{5}{7} \times 0.8 = 8.6$$



Oceana MOA Study Composite Supersonic Flight Tracks

Figure 5

B-1-31

The space average CDNL within the supersonic maneuvering area having dimensions of 12 by 18 miles is:

$$\overline{L_{CDN}} = 104.0 + 10 \log_{10} 8.6 - 49.4 = 63.9 \text{ decibels.}$$

The ellipse at 0.8 times cutoff distance, 20.4 miles wide by 26.4 miles long, has a CDNL of $63.9 - 3.7 = 60.2$ decibels. The outer ellipse, defining the outer cutoff boundary, 22.4 miles wide by 28.4 miles long, has a CDNL of 50.0 decibels.

The elliptical areas, and the CDNL values across the ellipses, can be displayed as CDNL contours for overlay on topographic charts.

All of the above computations have been based upon booms caused during unaccelerated flight conditions. Rapid acceleration in level flight, pushovers from a climb attitude, or sharp turns, can cause a very localized "focus boom." Typically, such booms expose of the order of one-quarter square mile in area, at a fixed location, i.e., not moving with the aircraft as in a normal "carpet" boom. A focus boom may have a pressure rise of two to four times that of a normal boom. In order to consider the possible effect of focus booms on CDNL, the effect of increased overpressure on calculation of CSEL, the probability of occurrence of a focus boom, and the area of the focus boom are required. The CSEL of a focusboom will increase over the CSEL of a normal boom by 10 times the logarithm of the square of the increase in overpressure. With a factor of four increase in overpressure the CSEL will increase by 12 decibels.

Determining the probability of a focus boom occurring, per aircraft sortie, is not readily possible from existing data. Review of the Oceana data for 56 supersonic events did not allow determination of which were likely to cause focus booms. In the Valentine test of June 1978, pilots reported 205 supersonic events, of which 18 caused booms reported by residents. One of these was possibly a focus boom. With lack of any other data, in this analysis it is assumed that one boom in 20 reaching the ground will be a focus boom.

The space average CSEL for a focus boom can be estimated as the logarithmic space average CSEL from a normal boom, plus the contribution of a focus boom of 12 decibel higher CSEL in a localized area. The ratio of area of a focus boom, one square mile, to a normal boom area, 28 square miles, is the spatial probability of affecting the normal boom carpet area. The space/time average sound level of a focus boom relative to a normal boom, , is thus:

$$\Delta = 12 + 10 \log_{10} \frac{1}{20} + 10 \log_{10} \frac{1}{28}$$

$$\Delta = - 15.5 \text{ decibels.}$$

Addition of the focus boom space/time average CSEL to a normal boom adds 0.1 decibel to the space/time average CSEL of the

original normal boom. Since the assumed probability that any given boom will be a focus boom is probably excessively high, the CDNL on a long term basis should not be affected by the occasional occurrence of a focus boom.

All computations in this study are based on ground at sea level and flight altitude of 15,140 feet. For higher ground elevations and flight altitudes, appropriate adjustments in the equations are required. In general, it can be expected that as ground elevation increases, average flight altitudes will also increase proportionately. (For example, in the F-15 test operations conducted at Valentine MOA in June 1978, the ground elevation was between 6,000 and 8,000 feet, and average aircraft height when supersonic was approximately 22,000 feet, or the same height above terrain as at Oceana.)

Making the altitude corrections to evaluate potential noise levels where the ground level is 6,000 feet MSL and the aircraft at 22,000 feet MSL results in the supersonic ellipse having a space average of:

$$\overline{L_{Cdn}} = (63.9 + 2.5) - 3.6 - 1.0 = 61.8 \text{ decibels}$$

Similarly, the CDNL for the ellipse at 0.8 cutoff becomes 58.3 decibels, while the ellipse at cutoff becomes 47.9 decibels.

REFERENCES

- A. RESULTS OF USAF-NASA-FAA FLIGHT TEST PROGRAM TO STUDY COMMUNITY RESPONSE TO SONIC BOOM IN THE ST. LOUIS AREA
Charles W. Nixon and Harvey H. Hubbard
NASA TN D-2705, 1965
- B. COMMUNITY RESPONSE TO SONIC BOOMS IN THE OKLAHOMA CITY AREA:
VOL II DATA ON COMMUNITY REACTIONS AND INTERPRETATIONS
Paul N. Borsky
Aerospace Medical Research Laboratories, Wright Patterson Air Force Base, Ohio, AMRL-TR-65-37, Vol II, Oct 65
- C. PSYCHOLOGICAL EXPERIMENTS OF SONIC BOOMS
K.D. Kryter, P.J. Johnson and J.R. Young
Sonic Boom Experiments at Edwards Air Force Base, .
Interim Report, July 18, 1967, Annex B
- D. THE INFLUENCE OF IMPULSE NOISE CREATED BY MODERN AIRPLANES ON THE HUMAN ORGANISM
A.V. Chapek, B.M. Mirzoyev and V.N. Somonov
Joint Publications Research Service: 38,272, October 1976
- E. INITIAL CALIBRATION AND PHYSIOLOGICAL RESPONSE DATA FOR THE TRAVELLING WAVE SONIC BOOM SIMULATOR
Richard Carothers
Institute for Aerospace Studies, University of Toronto,
UTIAS Technical Note No. 180, August 1972
- F. PROPOSED DAMAGE RISK CRITERION FOR IMPULSE NOISE (GUNFIRE) "REPORT OF WORKING GROUP 57, NAS-NRC COMMITTEE ON HEARING" BIOACOUSTICS AND BIOMECHANICS (CHABA)
W. Dixon Ward
Chairman, Washington, D.C.: Office of Naval Research
pp 499-500
- G. FINAL REPORT STRUCTURAL RESPONSE TO SONIC BOOMS
Office of Deputy Administrator for SST DEV., F.A.A.
Washington, D.C., SST 65-1, Vol 1 AD 610822, February 1965
- H. RESPONSE OF STRUCTURES TO SONIC BOOMS PRODUCED BY XB-70, B-58 and F-104 AIRCRAFT
J.A. Blume, R.L. Sharpe, G. Kost and J. Proulx
- I. STRUCTURAL REACTION PROGRAM NATIONAL SONIC BOOM STUDY PROJECT
John A. Blume and Associates Research Div., SST Dev., F.A.A.,
Report No. SST 65-15, Vol 1, April 1965

- J. STATISTICAL PREDICTION MODEL FOR GLASS BREAKAGE FROM NOMINAL SONIC BOOM LOADS
K.L. Hershey and T.H. Higgins
Report FAA-RDD-73-79, January 1973
- K. SEISMIC EFFECTS OF SONIC BOOMS
T.T. Goforth and J.A. McDonald
NASA CR-1137, 1968
- L. ANIMAL RESPONSE TO SONIC BOOMS
Wilson B. Bell
Sonic Boom Symposium, The Journal of the Acoustical Society of America, Vol 51, No 2 (Part 3), February 1972, pp 758-765
- M. SONIC BOOMS RESULTING FROM EXTREMELY LOW ALTITUDE SUPERSONIC FLIGHT: MEASUREMENTS AND OBSERVATIONS ON HOUSES, LIVESTOCK AND PEOPLE
C.W. Nixon, H.K. Hille, H.C. Sommer and E. Guild
Aerospace Medical Research Laboratories, Wright Patterson Air Force Base, Ohio, Report No. AMRL-TR-68-52, October 1968
- N. THE EFFECTS OF SIMULATED SONIC BOOMS ON REPRODUCTION AND BEHAVIOR OF FARM RAISED MINK
H.F. Travis, G.U. Richardson, J.R. Menear and James Bond
U.S. Department of Agriculture/Agricultural Research Service
ARS 44-200, June 1968
- O. AN INTERDISCIPLINARY STUDY OF THE EFFECTS OF REAL AND SIMULATED SONIC BOOMS ON FARM RAISED MINK (MUSTELA VISON)
Hugh F. Travis, James Bond, K.L. Wilson, J.R. Leekly, J.K. Menear, C.R. Curran, F.R. Robinson, W.E. Brewer, G.A. Huttenhauer and J.B. Henson
Federal Aviation Administration, Report No. FAA-EQ 72-2, Aug 72
- P. EFFECT OF SONIC BOOMS ON THE HATCHABILITY OF CHICKEN EGGS
J.M. Heinemann and E.F. BeBroeq, Jr.
Regional Environmental Health Laboratory, Kelly Air Force Base, Texas, Report SST 65-12, February 1965
- Q. SONIC BOOM EXPOSURE EFFECTS: EFFECTS ON ANIMALS
P. Cottereau
The Journal of Sound Vibration, Vol 20, No. 4, 1972, pp 531-534
- R. EFFECT OF SONIC BOOM ON FISH
R.R. Ruckes
FAA Report FAA-RD-73-29, February 1973
- S. SONIC BOOM EFFECT ON FISH - OBSERVATIONS
M.E. Wilkins
Unpublished Paper, NASA Ames Research Center
Moffett Field, California 1971

- T. EXPERIMENTS OF THE EFFECTS OF SONIC BOOM EXPOSURE ON HUMANS
R. Rylander, S. Sorenson, K. Berglund and C. Brodin
Sonic Boom Symposium, The Journal of the Acoustical Society of America, Vol 51, No 2, (Part 3), February 1972, pp 790-798
- U. MASS HATCHING FAILURE OF DRY TORTUGAS SOOTY TERNS
S.B. Robertson, Jr.
Fourteenth International Ornithological Congress, Holland, 1970
- V. SONIC BOOM LITERATURE SURVEY, VOL 1 STATE OF THE ART
Larry J. Runyan and Edward J. Kane
Report No. FAA RD-73-129-1, September 1973
- W. SIMPLIFIED SONIC BOOM PREDICTION
Harry W. Carlson
NASA Technical Paper 1122, March 1978
- X. SURVEY OF SONIC BOOM PHENOMENA FOR THE NON-SPECIALIST
Simon Slutsky
Report No. FAA-RD-75-68, February 1975
- Y. SONIC BOOM, A REVIEW OF CURRENT KNOWLEDGE AND DEVELOPMENTS
The Boeing Company, Supersonic Transport Branch
Boeing Document D6A10598-1, January 1967
- Z. PROCEEDINGS AT THE SECOND SONIC BOOM SYMPOSIUM
H.S. Ribner, H.H. Hubbard, Editors
Sponsored by the Acoustical Society of America
Houston, Texas, November 3, 1970
- AA. SONIC-BOOM-INDUCED BUILDING STRUCTURE RESPONSES INCLUDING DAMAGE
Clarkson, Brian L. and William H. Mayes
J. Acoust. Soc. America Vol. 51, Feb 1972, pp. 742-757
- BB. DRAFT ENVIRONMENTAL IMPACT STATEMENT FLIGHT OPERATIONS IN THE SELLS
AIRSPACE OVERLYING THE PAPAGO INDIAN RESERVATION, SOUTHERN ARIZONA
Department of the Air Force
Headquarters Tactical Air Command, Langley AFB, VA, Feb 1979
- CC. THE EFFECTS OF SONIC BOOM AND SIMILAR IMPULSIVE NOISE ON STRUCTURES
National Bureau of Standards with Environmental Protection Agency,
December 1971
- DD. EFFECTS ON NOISE ON WILDLIFE
John L. Fletcher and R.G. Busnel
Academic Press, New York 1978
- EE. YUMA, U.S. FWS LETTER OF OBSERVATIONS ON BIGHORN SHEEP.
Gene Cook, Environmental Engineering
58th, CES/DEEVE, Luke AFB, Yuma, Arizona. June 6, 1979.

SUMMARY OF THE JUNE 1978
REPORT OF SUPERSONIC TEST OPERATIONS
IN THE
VALENTINE MOA/ATCAAA

SUMMARY OF THE JUNE 1978 TEST OF SUPERSONIC F-15 FLIGHT OPERATIONS
IN THE VAN HORN AREA*

At the request of the Texas State Budget and Planning Office, Parks and Wildlife Department, General Land Office and several area residents, the 49th Tactical Fighter Wing conducted a test of supersonic flight operations in the Van Horn area for sixteen days during June of 1978. Test operations were conducted Monday through Thursdays for four weeks beginning 5 June 1978 through 29 June 1978 for a total of sixteen test days. The test objective was to assess, via public response, the impact of supersonic flight operations upon the environment beneath and near the proposed area.

In coordination with Headquarters Tactical Air Command environmental personnel, the 49th TFW developed an area resident questionnaire (Atch 1) to correlate perceived sonic booms and effects with sonic booms reported by pilots during the test. To provide the questionnaires to area residents at centralized distribution points, 1000 questionnaires were sent to the Valentine School Superintendent's Office in Valentine, Texas, and 1000 more were sent to the Airport Manager's Office in Marfa, Texas. Additional questionnaires were requested by a resident of the Davis- Mountain Resort Community located 15 miles east of Valentine along the eastern boundary of the area. One hundred copies were subsequently sent for centralized distribution to this area. To inform area residents that the test would be performed during the month of June, a press release was sent to radio station KVLB in Alpine, Texas, the Alpine Avalanche newspaper in Alpine, Texas, and the Big Bend Sentinel in Marfa, Texas on May 26, 1978. The release included a request for local feedback on test effects and told area residents how to obtain copies of the test questionnaires.

49TH TFW OPERATIONAL TEST GUIDELINES: During the test, the 49th TFW scheduled every available air combat training sortie to the proposed area without degrading the accomplishment of other training requirements such as electronic countermeasure, dissimilar air combat and low altitude training requirements which require specialized areas for accomplishment. Night flying was not scheduled to the area since no night supersonic training is proposed. Flight size to the maximum extent possible was limited to three aircraft, to optimize each pilot's data collection accuracy. If larger flight sizes had been flown, the pilot's cockpit workload would have been more demanding and could have contributed to errors in his recording the locations and times of sonic boom occurrences.

Pilots were instructed to thoroughly orient themselves on their first flight to the area by locating visual landmarks to stay within the area and to avoid supersonic flight within five nautical miles of Valentine. Except for the above restriction on Valentine, pilots were allowed to work anywhere within the area between 12,500 feet mean sea level (6,000 to 8,000 feet above the

*Subsequent to conducting the supersonic test, the name of the MOA was changed from Van Horn to Valentine since the latter town is within the boundary of the area.

ground) and 52,000 feet above mean sea level. The 12,500 foot minimum altitude was used for this test so that data could be acquired on sonic booms generated below the proposed 15,000 feet mean sea level minimum altitude. On every flight to the area, even if no supersonic flight was accomplished, each pilot was required to fill out a supersonic pilot data sheet (Atch 2). Information from each pilot data sheet was consolidated for test data summaries and used for correlating by time, aircraft flight parameters associated with ground perceived sonic booms and effects reported by area resident questionnaires. The location and direction of flight from each pilot data sheet reporting supersonic flight was plotted on area maps to depict daily test operations. Also for each test day, the area resident locations reporting sonic booms were annotated. If the time of the ground perceived sonic boom was included on the questionnaire, then a correlation between the pilot reported boom with the ground reported boom could be made.

Figure 1 depicts the cumulative total of every pilot reported sonic boom location during the test, the number of people reporting and number of booms reported from each area resident location. The majority of the booms occurred in the northern half of the area. The pilots conducted more training in this area because it is closer to Holloman. A total of 146 sorties were flown to the area during 16 test days. 205 Sonic booms were reported by pilots during the test. 24 Questionnaires from four area locations reported a total of 18 different sonic booms. 32 People from the four locations reportedly heard sonic booms during the test (Figure 1).

TEST DATA SUMMARY: The following data summarizes all local sorties flown from Holloman during the 16 test days from 5 Jun 78 to 29 Jun 78 as compared to the number of sorties flown to the Van Horn area.

Total local sorties from Holloman - 394

Total sorties flown to Van Horn - 146

Percentage of total sorties flown to Van Horn - 37%

Total local air combat training sorties (supersonic dog fight type missions) - 279

Total air combat training sorties to Van Horn - 146

Percentage of total air combat sorties flown to the Van Horn area - 54%

Average sorties to the area per test day - 9

Total daily sorties to Van Horn ranged from zero on 29 Jun to a high of 20 on 20 Jun.

TEST TOTALS

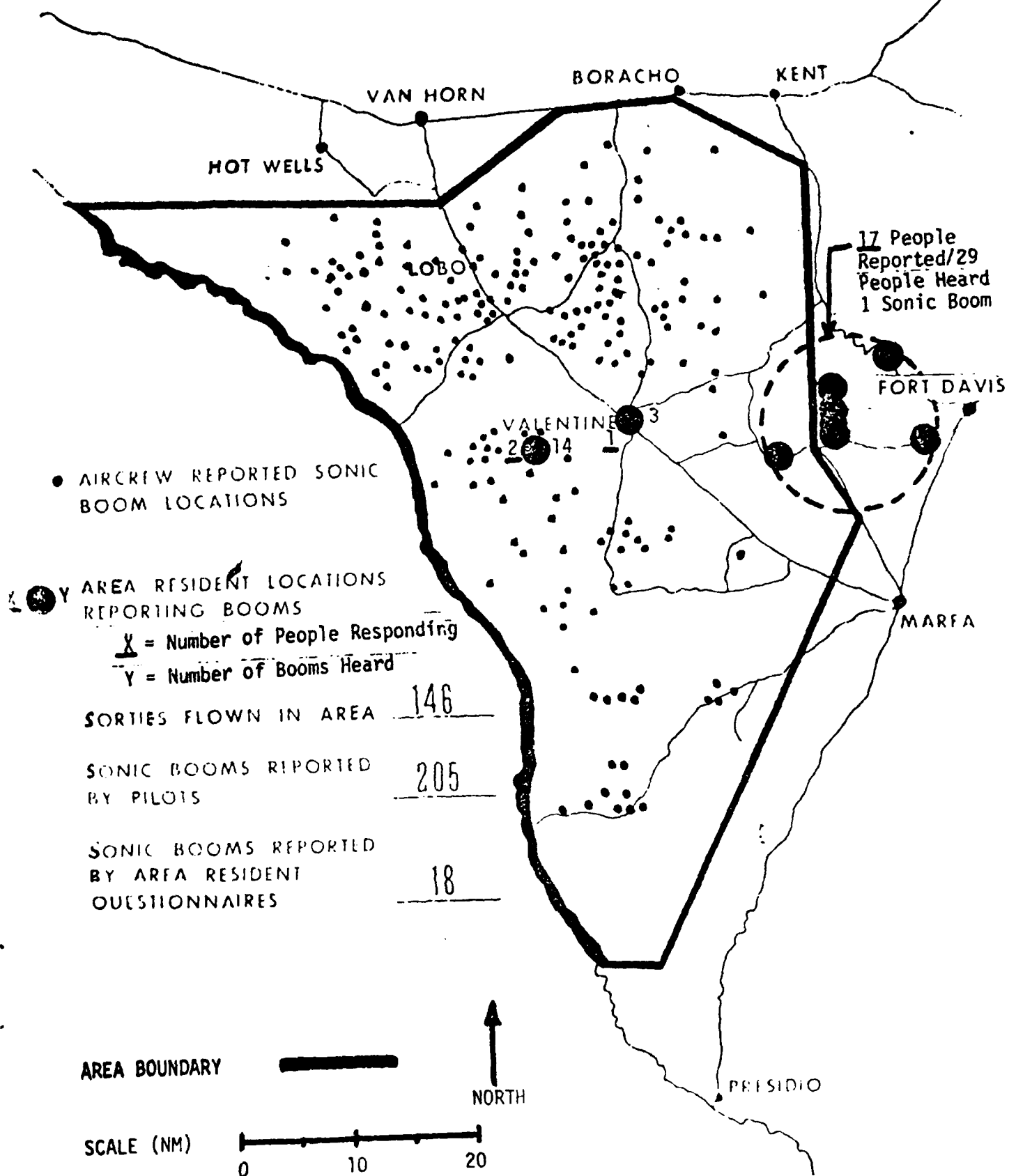


Figure 1

The remaining 11 of the air combat training sorties flown from Holloman could not be scheduled to the test area due to mission qualification training requirements for low altitude airspace and military radar support available only within the White Sands Missile Range areas. In addition, 22 sorties required diversion to other areas due to adverse weather on departure to or within the test area. The total number of sorties flown to the area during the test was primarily limited by two factors. First, the 49th TFW had not received its full complement of 72 aircraft. Second, for the entire 16 test days, twelve of the aircraft assigned to Holloman were deployed to Eglin AFB, Florida, to participate in the Weapons Systems Evaluation Program (WSEP).

The following is a summary of the sonic booms reported by pilots during the test.

Total sonic booms reported by pilots - 205*

Average number of pilot reported sonic booms per test day - 12.8

Average number of resident reported sonic booms per test day - 1.13

Average number of pilot reported sonic booms per sortie to the area - 1.40

Average number of resident reported sonic booms per sortie to the area - .12

Average mean sea level altitude of boom occurrences - 22,877 feet

Lowest mean sea level altitude of boom occurrences - 12,500 feet

Median mean sea level altitude of boom occurrences - 22,000 feet

Average supersonic speed reported by pilots - 1.11 Mach

Average calculated overpressure at reported ground points - 0.5 to 2.0 psf.

Average calculated sound level at reported ground points - 102 db CSEL.

Maximum supersonic speed reported during the test - 1.45 Mach

Maximum calculated ground overpressure resulting from test operations - 3.65 psf

*Based on the Mach number and altitude distribution of the Van horn test which are almost identical to the Oceana data, approximately 30% of the 205 events could have been expected to be observable at ground level.

Maximum calculated sound decibel level resulting from test operations - 109 dB CSEL

Boom activity ranged from one on June 5, 78 to a daily high of 32 on June 20, 78.

Altitudes of the sonic booms ranged from the base of the area, 12,500 feet MSL, to 47,000 feet MSL. Thirty-four booms (or 16.5% of the total number of pilot reported booms) were generated between 12,500 feet and 15,000 feet. The relatively low booms per sortie figure of 1.40 can be attributed to two factors. First, the pilots were unfamiliar with the area during the early stages of the test, resulting in conservative flight tactics until accustomed to visual landmarks for staying within the area. Second, due to the distance of the Van Horn area from Holloman (150 miles), fuel consumed during transit to and from reduced available fuel for training while in the area. This decreased amount of fuel resulted in shorter area training periods and consequently fewer sonic booms per sortie as compared to F-15 flight operations to nearby White Sands Missile Range areas.

AREA RESIDENT RESPONSE: Twenty-four area resident questionnaires were received by the 49th TFW in response to the test. Two questionnaires were submitted by a resident from the town of Valentine listing three different booms. Five were from the residents ten miles west of Valentine reporting 14 different booms. Seventeen questionnaires were submitted listing a total of 29 people located along the eastern area border referencing the one sonic boom at about 1:10 pm on June 22. A total of eighteen different sonic booms were reported by area residents. This total, as a percentage of the total pilot reported booms, equates to 9%. The 49th TFW realizes that area residents may have perceived a much larger percentage of the sonic booms than were reported via the questionnaires. The 9% figure can possibly be attributed to one of the following reasons. Some area residents may have:

- a. Observed no significant impact resulting from the sonic boom activity.
- b. Been apathetic toward the test outcome or whether supersonic activities were conducted.
- c. May have felt the effects were acceptable per their understanding of the Air Force needs for realistic training; or
- d. Unaware of the test period or did not obtain the distributed questionnaires.

POST TEST ACTIONS: On June 30, 78 a press release was made to radio station KVLB in Alpine, the Alpine Avalanche Newspaper in Alpine, the Big Bend Sentinel Newspaper in Marfa and the Van Horn Advocate in Van Horn, Texas. The release requested all comments and questionnaires be forwarded to Holloman by July 24 for inclusion in the test report. In addition, a public meeting to discuss test results was announced. In coordination with area residents and

Air Force personnel, the meeting to discuss test results and solicit further area resident comments was set for August 3 at the Valentine school. The meeting was attended by Air Force representatives from the 49th TFW, Holloman Staff Judge Advocate, Holloman Office of Information, 12th Air Force, Headquarters Tactical Air Command, Headquarters USAF Legislative Liaison and Headquarters USAF Southwest FAA Region. Representatives from the district offices of Congressman Richard White and Senator John Tower were present. A representative from Congressman Robert Krueger's office was scheduled to attend but was subsequently diverted to the flood disaster area near San Antonio, Texas.

Approximately 140 area residents and interested parties were in attendance. The meeting was well organized by the protest committee and attended by the local news media, including the Houston NBC affiliate. Questions asked were pertinent and, in most cases, germane to the discussion.

As part of the area residents' presentation, 35 mm slides were shown depicting damages to an adobe home and water tank allegedly caused by a sonic boom on June 22 at 1:10 pm at the McKinney residence. Mrs. K. W. Hollen, stated that her adobe house, located 20 miles east of the area boundary, had been significantly damaged by the effects of sonic booms occurring in the vicinity during the past two years. She alleged no damage to her house from test area operations, however. To determine the validity of both claims, a structural engineer qualified to assess supersonic damage, from Cannon AFB, New Mexico, and a legal claims representative from Holloman, were sent to the area on August 14, 1978. The claims representative personally instructed both parties on how to fill out the required forms and where to submit them. The engineer's evaluation of the McKinney residence concluded that "The cause of the damage is a combination of natural forces acting upon the structural and obsolete construction practices." No evaluation was made of the alleged broken water tank since the engineer was not aware of this reported damage prior to the visit. In addition, the residents failed to mention the water tank damage to the engineer during the investigation. The engineer's evaluation of the Hollen claim concluded: "The primary cause of the damage is not due to sonic boom but to lack of proper maintenance and obsolete construction methods which have contributed to the present deteriorated condition of the building." However, a sonic boom of 5.6 psf overpressure could cause unstable plaster to fall and damage to bric-a-brac. The area has experienced several sonic booms in the past and a sonic boom of 5.6 psf overpressure is not unreasonable.

To date, only one of the above two alleged damage claims has been submitted to Air Force personnel. Mrs. K. W. Hollen filed a claim for sonic boom damages to her adobe residence located 20 miles east of the area boundary in the amount of \$7,148. No test sonic booms are alleged to have resulted in this damage claim. Mrs. Hollen's claim is presently being reviewed at Headquarters USAF. The McKinney residence which alleged specific structural damage as a result of a test sonic boom, has yet to submit a claim.

against the Air Force. Subsequent to the August 3 Valentine meeting, on September 22, an additional claim which alleged property damage as a result of test sonic booms was received by 49th TFW personnel. Mr. Darrell York, who resides 20 miles northeast of Valentine, alleged that test sonic booms (no specific occurrence) caused a 700 foot deep, uncased well to cave in and destroy the pump located at the 400 foot level. Mr. York submitted a claim for damages in the amount of \$1,916.58. Payment of the claim was denied based upon the lack of proof of liability on the Government's part. Mr. York was advised that an appeal of this decision could be made but no response has been received.

TEST CONCLUSIONS:

a. From an operational viewpoint, the proposed area can effectively accommodate the unique airspace requirements associated with realistically employing the F-15.

b. The number of sonic booms per sortie can be expected to be about 2.0-2.5. Approximately one-third or less of these would be expected to hit the ground.

c. No report was received indicating any window breakage resulting from test operations.

d. Based on area resident comments, the lack of test physical damage and previous USAF operational experience, of the two primary environmental effects associated with sonic boom activity (noise and overpressure), noise had the most impact upon the environment. The intensity of the noise and overpressure effects resulting from supersonic operations in this area have been reduced by restricting aircraft to relatively high altitudes greater than 8,000-10,000 feet above the ground environment. For example, the highest airspeed reported during the test was 1.45 Mach at an altitude of 19,000 feet mean sea level. Although this boom was not reported by area residents, a ground location directly beneath this sonic boom occurrence would have received an overpressure of 3.65 pounds per square foot with a decibel reading of 111 dB CSEL. For comparison purposes, an M-14 30.06 caliber rifle heard from a distance of 150 feet would produce a decibel level of 110 dB CSEL.

e. Boom overpressures on the ground were calculated by Air Force environmental engineers to average 0.5 to 2 psf, with some reaching 3.65 psf.

f. There was no impact on the McDonald Observatory operation by the test flights. Personnel at the McDonald Observatory were provided a daily flight schedule of times when aircraft would be in the area during the test. With this information, they were prepared to observe if any flights affected their operation. 49th TFW personnel discussed the flight operations with the observatory director prior to the test. He indicated he was satisfied that a negligible effect would occur. On Aug 1, 78 the director

stated that observatory personnel saw one small contrail and heard one minor boom which they considered too insignificant to report. He said the flight operations had no impact on observatory functions.

g. Based upon inquiries, local area residents desire additional information on the long-term effects of proposed supersonic activity, in particular on human beings, adobe structures and animals. Such information will be presented in the Environmental Impact Statement.

h. Even though area resident questionnaire response to the test was minimal, there remains opposition to the proposal from some residents beneath and adjacent to the area.

i. It is desirable to obtain information regarding the effects of sonic boom activity on the peregrine falcon. Dr. Hunt, the Research Director for the Chihuahuan Desert Research Institute, indicated his willingness to cooperate with USAF in this effort.

SUMMARY: The 49th TFW has attempted to minimize the environmental impact of supersonic operations upon the proposed area by revision of the eastern area boundary, placing a no-supersonic area within five miles of Valentine and restricting flight operations to a relatively high altitude (8,000 to 10,000 feet) above the ground. Although these actions did result in a loss of potential training airspace, test results indicate that established area restrictions allowed realistic F-15 training while effectively decreasing the intensity of ground perceived noise and overpressure effects. Noise appears to be the primary impact resulting from the sonic boom activity. Test results show, however, that only a fraction of the total booms generated will impact upon any one location beneath or adjacent to the area. This is due to the large size of the area, the sparse population and the dependence of ground perception upon the aircraft maneuvering altitude when the boom is generated. Projected future utilization of the area is estimated to be 300 sorties per month of about fifteen sorties per day during a normal five-day work week. Based on the booms per sortie test rate of 1.40, 21 booms would be generated per day. As pilot familiarity with the area increases, the booms per sortie average could be expected to increase to approximately 2.0-2.5. In this case, up to 37 booms per day would occur; however, only 12 booms per day are expected to reach ground level.

Although only 9 percent of the total booms were reported by residents during the supersonic flight operations in the area, there remains organized opposition toward the proposal from some area residents and concerned citizens. The noise effects from sonic boom activity upon this area's traditional atmosphere of peace and tranquility have been and will continue to be the major point of opposition.

SONIC BOOM OCCURRENCE QUESTIONNAIRE

1. Date/Time of Sonic Boom Occurrence _____

2. Your Location at Time of Occurrence _____

3. Reaction at Time of Occurrence _____

4. Other Information Pertinent to Test _____

5. Name and Address _____

VAN HORN SUPERSONIC DATA

This questionnaire must be filled out for every sonic boom occurrence. The data required is important and must be as accurate as possible. Every sortie that is flown in the Van horn test area must have this sheet filled out even if no sonic booms were generated. Plot the location of the boom by number on the attached map.

SONIC BOOM DATA

1. CALL SIGN/DATE/PILOT'S NAME _____ / _____ / _____

2. TIME OF ENTRY TO VAN HORN MOA _____ EXIT _____

3. TIME AND ALTITUDE OF EACH SONIC BOOM

1.	_____ / _____
2.	_____ / _____
3.	_____ / _____
4.	_____ / _____
5.	_____ / _____
6.	_____ / _____

4. LOCATION OF EACH SONIC BOOM

1.	_____ N _____ W
2.	_____ N _____ W
3.	_____ N _____ W
4.	_____ N _____ W
5.	_____ N _____ W
6.	_____ N _____ W

5. FLIGHT ATTITUDE DURING EACH SONIC BOOM (I.E., STRAIGHT AND LEVEL, DIVE, CLIMB)

1.	_____
2.	_____
3.	_____
4.	_____
5.	_____
6.	_____

6. MAXIMUM MACH NUMBER DURING EACH OCCURRENCE

1.	_____
2.	_____
3.	_____
4.	_____
5.	_____
6.	_____

APPENDIX B-3

SONIC BOOM EFFECT
ON ARCHEOLOGICAL SITES

VALENTINE MOA

AFGL Technical Memorandum No. 50

Seismo-Acoustic Effects of Sonic Booms
on Archeological Sites,
Valentine Military Operations Area

By

James C. Battis
20 July 1981

Distribution of this document is limited. Other requests for this document may be addressed to AFGL/LWH, Hanscom AFB, MA 01731

PREFACE

The AFGL Technical Memorandum Series is intended to make results of the AFGL, in-house scientific efforts rapidly available to specific groups and individuals known to have an immediate interest in the results obtained. Where appropriate, final results for the permanent record will be published later in the AFGL In-House Technical Report (TR) Series for wide distribution, including DTIC. A Technical Memorandum may not be referenced in the open literature; however, results presented therein may be referenced as "private communication" with the written consent of the originating office.

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ABBREVIATIONS AND UNITS

AFGL/LWH - Applied Crustal Physics Branch
Air Force Geophysics Laboratory

AGL - Above Ground Level

cm - centimeters (10^{-2} meters, 0.394 inches)

HQ TAC/DEEV - Environmental Planning Division,
Headquarters, Tactical Air Command

kg/m² - kilograms per square meter - (4.882 pounds per square foot)

km - kilometers (10^3 meters, 0.540 nautical miles)

ln - natural logarithm

m - meters (3,281 feet)

μ - microns (10^{-6} meter, 3.94×10^{-5} inches)

m_b - bodywave magnitude

M_L - local magnitude

MOA - Military Operations Area

MSL - Mean Sea Level

nm - nautical miles (1.151 statute miles)

psf - pounds per square foot

TBEG - Texas Bureau of Economic Geology

TSHPO - Texas State Historical Preservation Office

1. INTRODUCTION

During the period 16 to 18 July 1981 AFGL/LWH participated in a field program designed to study the effects of sonic booms on significant archeological sites located within the Valentine, Texas MOA. This effort was in response to a request from HQ TAC/DEEV to assist in the environmental impact assessment being conducted as part of the process required to redesignate the Valentine MOA from subsonic to supersonic operations. In addition to personnel from LWH and DEEV, the Texas State Historical Preservation Office (TSHPO) and Texas Bureau of Economic Geology (TBEG) participated in the field program.

This investigation was primarily directed at the determination of potential damage to rock shelter and petroglyph sites which might be caused by sonic booms. The rock shelters consist of caves located in hard rock formations such as cliffs which form canyon walls and mountain slopes. Pictographs are often found on the rock surfaces of these caves. Petroglyphs can be found on any hard rock surface including rock outcrops and free standing boulders. While other possible archeological sites were not explicitly considered, the data provided in this paper covers a wide range of the geologic settings found in the Valentine MOA and can be used for estimation of seismo-acoustic effects of sonic booms at other possible sites.

During this study, seismic and acoustic sensors were used to record the effects of sonic booms at locations similar to significant archeologic sites within the Valentine MOA. Based on these records, estimates are made of peak ground velocities at the archeological sites which would result from supersonic operations over the Valentine MOA. These levels of

motion are compared to other, more common sources of seismic motions.

In addition, a similar sonic boom test was performed in Railroad Valley, Nevada and the results of this test are discussed in terms of the implications for damage to historic artifacts within the Valentine MOA.

2. SEISMO-ACOUSTIC EFFECTS OF SONIC BOOMS

Under most conditions, the ground surface responds nearly as a rigid body to acoustic waves propagating through the atmosphere. The incident pressure wave is reflected off the surface without phase change. This is a consequence of the large density contrast between air and ground. The incident and reflected pressures are of equal amplitude.

In reality, the atmosphere and ground are not completely decoupled and a low level of ground motion is induced by acoustic waves. The amplitude of the induced motion will be larger in soils than in hard rock. Under certain limited conditions the induced ground motion can become much larger than usual. These amplified seismic waves, known as air-coupled surface waves, can be generated when the shallow ground structure consists of a thin, low velocity layer over a layer of much higher velocity.¹ If the velocity of the surface layer approaches the speed of sound in air, the seismic wave travels with the acoustic wave and the amplitude of the seismic motion is re-inforced or amplified. Alluvial basins, such as found in the Valentine MOA, typically have velocity structures which support air-coupled surface waves.

3. FIELD STUDIES

Acoustic and seismic measurements of sonic booms and the induced ground motions were conducted at two locations in the Valentine MOA. These sites were chosen for topographic and geologic similarity to significant archeological sites identified by TSHPO. The actual test locations were suggested by a geologist from TBEG and accepted with the concurrence of the other participating offices. A brief description of each site is given in the following sections.

3.1 Rock Shelter Site

The first site occupied was located in the Van Horn Mountains at approximately $30^{\circ} 48.7'N$ and $104^{\circ} 51.4'W$. The general area contained at least five caves or rock shelters of natural origin in competent rhyolitic rock. The caves were located in a north to northwest facing cliff at an elevation of 1525m MSL (5000 ft MSL). The caves at this site showed evidence of human habitation including pictographs.

The geologic setting of this site precluded the generation of significant air-coupled seismic waves as would be expected in a site located on the floor of an alluvial basin. However, topographic amplification of the acoustic or seismic waves inside the rock shelters as compared to outside the caves was considered a possible effect. To examine this problem, acoustic pressure transducers and vertical seismometers were deployed at two locations. One system was installed on a cave floor and the other on a rock outcrop about 50m (164 ft) from the instrumented cave. The second location was considered to be free of any topographic effects and thus representative of the free-field acoustic and seismic motions. As the pictographs were drawn on the rock

walls of the shelters, both seismometers were placed on hard rock. The use of only vertical seismometers is justified by the fact that vertical ground motion is generally the largest of the three components of motion produced by sonic booms.

3.2 Boulder Field Site

The second site examined in this effort was selected for its similarity to the geology of the Lobos Canyon petroglyph site. The test locale consisted of boulders and outcrops of Cox sandstone situated on an alluvial fan at the western base of the Van Horn Mountains. This site was at an elevation of approximately 1300m MSL (4265 ft). The coordinates of the site were 30° 50'N and 104° 54'W.

At this site the primary concern was the efficiency of coupling between ground motion induced in the soil of the alluvial fan and the rock outcrops and boulders. Instrumentation at this location included one pressure transducer, a vertical seismometer and a horizontal seismometer with its axis oriented along the north-south direction. These instruments were deployed on a outcrop in the boulder field.

Though most Lobos Canyon petroglyphs are on boulders, petroglyphs on rock outcrops are threatened more than those on boulders by damage from the seismo-acoustic effects of sonic booms. Motion in boulders and outcrops of rock on the alluvial fan can be generated in two ways. First, the acoustic wave hitting the boulder or outcrop surface directly will develop motions within the rock. The amplitude of this motion is not expected to be appreciably different in boulders and outcrops. Second, ground motions generated in the alluvium can be transmitted to the boulder or outcrop. In the case of boulders whose base is slightly buried in

the alluvium, the boulder will respond as a rigid body to motions of the frequencies expected in this problem. In other words, the boulder will respond like a cork floating on ocean waves. With no vibrations occurring internally to the boulder, the potential for damage is extremely small. For outcrops, however, the seismic motion can be transmitted into the rock and thus a higher potential for damage exists. The response of a large outcrop to the seismo-acoustic motions produced by sonic booms should represent the upper limit of boulder response.

3.3 Supersonic Overflights

Overall, ten supersonic flights were made over the two locations just described. Six flights occurred while the rock shelter site was occupied and four flights were conducted over the boulder field site. All passes were made by F-15 aircraft flying at Mach 1.1 and at altitudes of 4570 and 6100m MSL (15000 and 20000 ft). For an F-15 aircraft flying at the specified altitudes and speed, the peak over-pressures expected to be observed ranged from 14.2 to 20.7 kg/m² (2.9 to 4.2psf).²

Of the ten sonic booms generated only two were audibly or instrumentally detected at the ground level. It is assumed that the sonic booms generated in the remaining eight overflights were refracted back into the atmosphere without reaching the ground. This phenomena is the result of atmospheric conditions, such as the temperature gradient between the aircraft operating altitudes and ground level.

4. DATA ANALYSIS

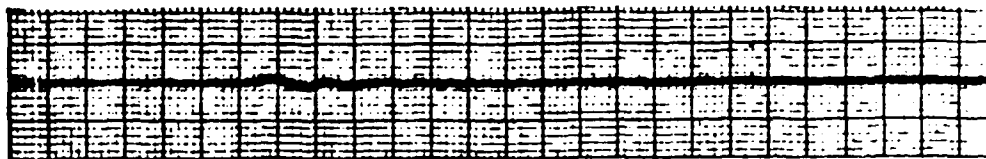
4.1 Rock Shelter Site

In Figure 1, the seismic and acoustic records of the one sonic boom observed at the rock shelter site are shown. Pressure transducers in both

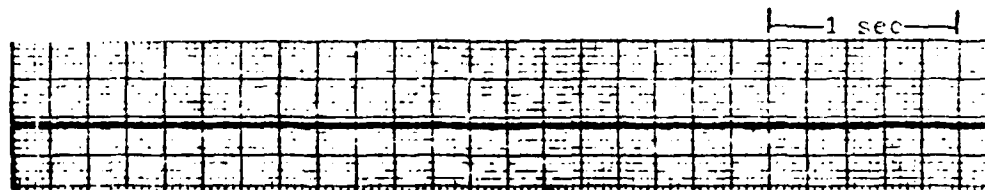


Seismic - Vertical

Acoustic

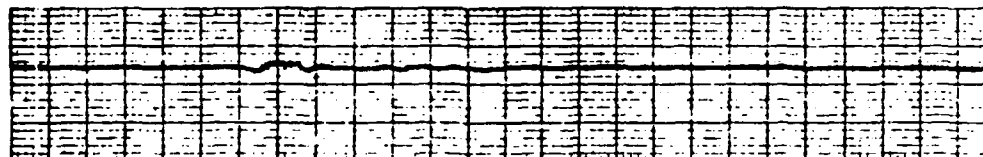


Cave Site



Seismic - Vertical

Acoustic



Free-Field Site

Figure 1 - Seismic and Acoustic Records of a Sonic Boom at the Rock Shelter Site.

the free-field and the cave recorded an acoustic N-wave having a duration of 0.32 sec and peak over-pressure of 0.503 kg/m^2 (0.103 psf). The sonic boom was produced on an east to west pass over the site with the aircraft at 6100m MSL (20000ft). This flight path is parallel to the cave mouth.

As the expected over-pressures were much higher than those actually observed, the seismic instrument gains were set relatively low. This resulted in no detectable ground motion at the free-field site and barely discernible motion on the cave instrument. The low amplitude motions at the cave prevent the accurate evaluation of the frequency of this signal, although a lower limit of 25hz can be estimated. Using a conservative estimate of 50hz, the acoustically induced ground velocity is $4.5 \mu/\text{sec}$ ($1.8 \times 10^{-4} \text{ in/sec}$). If the frequency is 25hz then the velocity is $2.5 \mu/\text{sec}$ ($9.7 \times 10^{-5} \text{ in/sec}$). The variation in amplitude results from the frequency dependence of the instrument response. The signal arrives in several packets over a time window of 0.48 sec.

The lack of detectable seismic motion at the free-field site is not unexpected. The velocity recorded at the cave is very close to the detection threshold of the instrument system as deployed. If either the instrument response was lower or the instrument-ground coupling was poorer at the free-field site than at the cave site, no motion would be recorded even though the actual ground motions at each site were identical. In fact, the free-field site appeared to have poorer coupling between the ground and the seismometer than at the cave site.

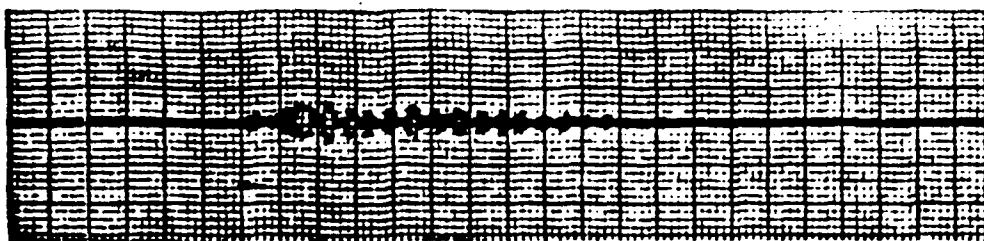
4.2 Boulder Field Site

The N-wave recorded at the Boulder Field site was very similar

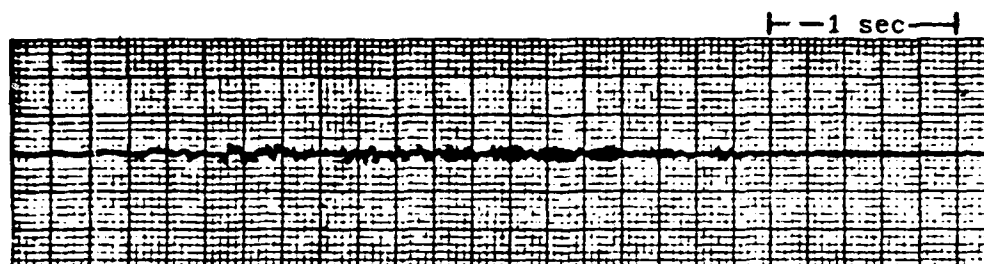
to that recorded at the rock shelter. A peak over-pressure of 0.601 kg/m^2 (0.123 psf) with N-wave duration of 0.32 sec was recorded. The acoustic and seismic traces of this event are shown in Figure 2. This sonic boom was also recorded from an east to west overpass at an altitude of 6100 m MSL (20000 ft).

The peak velocity of the North-South oriented horizontal seismometer was found to be $5.7 \mu / \text{sec}$ ($2.2 \times 10^{-4} \text{ in/sec}$). At a frequency of 30 Hz . It should be noted that this motion is not the maximum trace displacement due to instrument response effects. Actually, it occurs in one of the late arriving packets of energy. The peak vertical velocity occurs approximately 0.5 sec into the record and has an amplitude of $7.5 \mu / \text{sec}$ ($2.9 \times 10^{-4} \text{ in/sec}$). The frequency of the vertical motion is uniform throughout most of the record and is 30 Hz . Vertical signal duration is 3.48 seconds .

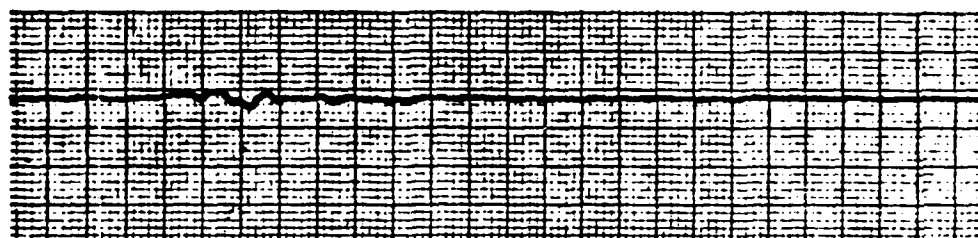
The dominant signal on the vertical seismometer is an air-coupled acoustic wave with an interference pattern typical of multipathing. Physical constraints require that the air-coupled surface wave was generated in the alluvial material and not in the rock outcrop. Its appearance on a record made at a hard rock site indicates coupling between the alluvial material and the outcrop. The 30 Hz frequency is higher than normally expected for the dominant frequency of the air-coupled wave. Values in the range of 10 to 20 Hz are more common in alluvial basins. (Henry Ossing, pers. com.) The higher frequency can be explained in either of two ways. First, the geologic layering in the alluvial fan cannot support the lower frequencies. Second, the lower frequency waves were generated in the alluvium but were not efficiently transmitted to the rock



Seismic - Vertical



Seismic - N-S Horizontal



Acoustic

Figure 2 - Seismic and Acoustic Records of a Sonic Boom at the Boulder Field Site.

outcrop. Given the available data, one explanation cannot be shown to be superior to the other.

As stated above, the vertical record exhibits an interference pattern characteristic of multipathing. Multipathing is the condition where almost identical seismic signals arrive at the seismometer along two or more different paths with a small time delay between arrivals. The cause of multipathing is likely to be local geologic irregularities. This phenomenon causes amplitude modulation of the signal with time. The effect is that the reported peak velocity is actually larger than if a signal transmitted along a single path had been recorded.

4.3 Acoustic Admittances

Acoustic admittance is defined as the ratio of peak velocity to peak over-pressure at specified frequencies. If $Y(f)$, is the admittance, $V_{\max}(f)$ is the peak velocity and $P_{\max}(f)$, the over-pressure at a specified frequency, then:

$$Y(f) = V_{\max}(f) / P_{\max}(f) \quad (1)$$

Under linear elastic assumptions, the admittance at any frequency is a fixed ratio of induced ground motion to input over-pressure. Strictly, it is also a function of the angle at which the sonic boom hits the ground. For sonic booms in the range 2.4 to 24.4 kg/m² (0.5 to 5.0psf) the linear response of ground motion to over-pressure has been empirically demonstrated.³ Acoustic admittance is typically calculated as the spectral ratio of the seismic and acoustic signals.

Due to the limitations of the available data a modified admittance value is calculated for the two sites investigated. In this case, the absolute peak over-pressure is used in place of $P_{\max}(f)$. As the relative

spectral characteristics of the N-wave are uniform for a given aircraft, this modification is not significant as long as the use of this value is restricted to the specific aircraft or one producing a spectrally similar N-wave.

For the rock shelter site the calculated admittance is $8.9(\mu / \text{sec})/(\text{kg}/\text{m}^2)$ ($1.7 \times 10^{-3} (\text{in}/\text{sec})/\text{psf}$) at 50hz. A value of $12.5(\mu / \text{sec})/(\text{kg}/\text{m}^2)$ ($2.4 \times 10^{-3} (\text{in}/\text{sec})/\text{psf}$) at 30hz was found at the boulder site. These values are comparable to an admittance of $15.4 (\mu / \text{sec})/(\text{kg}/\text{m}^2)$ ($3.0 \times 10^{-3} (\text{in}/\text{sec})/\text{psf}$) found as a typical value for hard rock.³

5. EVALUATION OF RESULTS

5.1 Acoustic Effects

The peak over-pressure for carpet booms generated during supersonic operations over the Valentine MOA is calculated to be $25.3 \text{ kg}/\text{m}^2$ (5.2 psf).² In a sonic boom this pressure is applied impulsively to the ground. To fracture most rocks much higher levels of pressure must be applied continuously to failure. Laboratory measurements of the crushing strengths of rocks at low confining pressures and normal temperatures show a wide variability depending on the actual rock type and condition.⁴ A value of $1.0 \times 10^5 \text{ kg}/\text{m}^2$ ($2.1 \times 10^4 \text{ psf}$) is a conservative lower limit. More typical values are between 10 and 200 times this pressure. In any case, this lower limit is 4000 times the over-pressure generated by a sonic boom. In addition, rock, as with most other material, can withstand higher stresses applied impulsively rather than continuously.

From the comparison of the sonic boom over-pressure and crushing strengths of rock it is apparent that even a worst case sonic boom, specifically a focus boom, will not produce pressure pulses sufficient to

to produce damage to archeological sites of the type considered in this report. Only in the extreme case of highly deteriorated and rotten rock formations would it be conceivable that the acoustic shock of a sonic boom could trigger any type of damage. At all archeological sites visited during this study, the rocks appeared sufficiently competent to withstand these over-pressures.

5.2 Blasting Codes

Strict blasting codes typically limit the peak vector sum ground velocity to less than $2.6 \times 10^4 \mu$ /sec (1.0in/sec) at the structure closest to the blasting point and not owned by the company doing the blasting.⁵ (The vector sum velocity is defined as the square root of the sum of the squares of the velocities in the three components of motion). This value is approximately one-half the ground velocity at which the potential for damage to buildings exists.⁶ The complex structural response of buildings makes them more sensitive to motion than rock is likely to be.

Supersonic operations over the Valentine MOA are expected to generate carpet booms with over-pressures below 25.3 kg/m^2 (5.2psf).² Using this value and the admittances calculated in Section 3.3, peak vertical ground velocities can be evaluated for the two sites which were studied. At the rock shelter site the maximum velocity is expected to be 225μ /sec (8.8×10^{-3} in/sec) and 316μ /sec (1.2×10^{-2} in/sec) at the boulder field site. Use of these vertical amplitudes as the motion levels in all three components of motion is a conservative assumption as vertical motion is generally the highest amplitude of the three components. A conservative estimate of the peak vector sum velocity at each site is found to be 390μ /sec (1.5×10^{-2} in/sec) and 547μ /sec (2.1×10^{-2} in/sec), respectively.

These values are less than 2.5% of the ground velocity limits used in blasting codes.

At these levels of motion, competent rock will be unaffected by the transmission of seismic waves. The predicted velocity levels are unlikely to initiate either fracture or spalling in rocks. However, it is possible that in rocks where natural, meteorological action has initiated these erosive mechanisms the sonic boom induced motion could accelerate the processes to some small degree. In other words, a sonic boom might trigger the final separation of one rock surface from another. For this to happen the natural processes of erosion, working over a long period of time, would be required to develop a highly unstable condition in which the sonic boom provides the last, destabilizing force. Without the sonic boom, however, the natural forces would, in a relatively short time, have produced the same end effect.

5.3 Earthquake Motions

The Valentine MOA includes the seismically active Marfa Basin.⁷ The epicenter of what is believed to be the largest earthquake in Texas during historic times had an epicenter approximately 14 km (7.5nm) northwest of the town of Valentine. This earthquake occurred on 16 August 1931. Estimates of the magnitude of this event range between 5.6 and 5.9_{m_b} and 6.4_{M_L}. Between 1977 and 1980 numerous events with magnitudes up to 2.6_{M_L} were recorded instrumentally within the Valentine MOA. The epicenters of these events are also shown in Figure 3. On 1 August 1975 a poorly located earthquake of magnitude 4.8_M was felt in Valentine.

The location of the 16 August 1931 earthquake places it within 110 km (60nm) of any point within the Valentine MOA. Using a strong

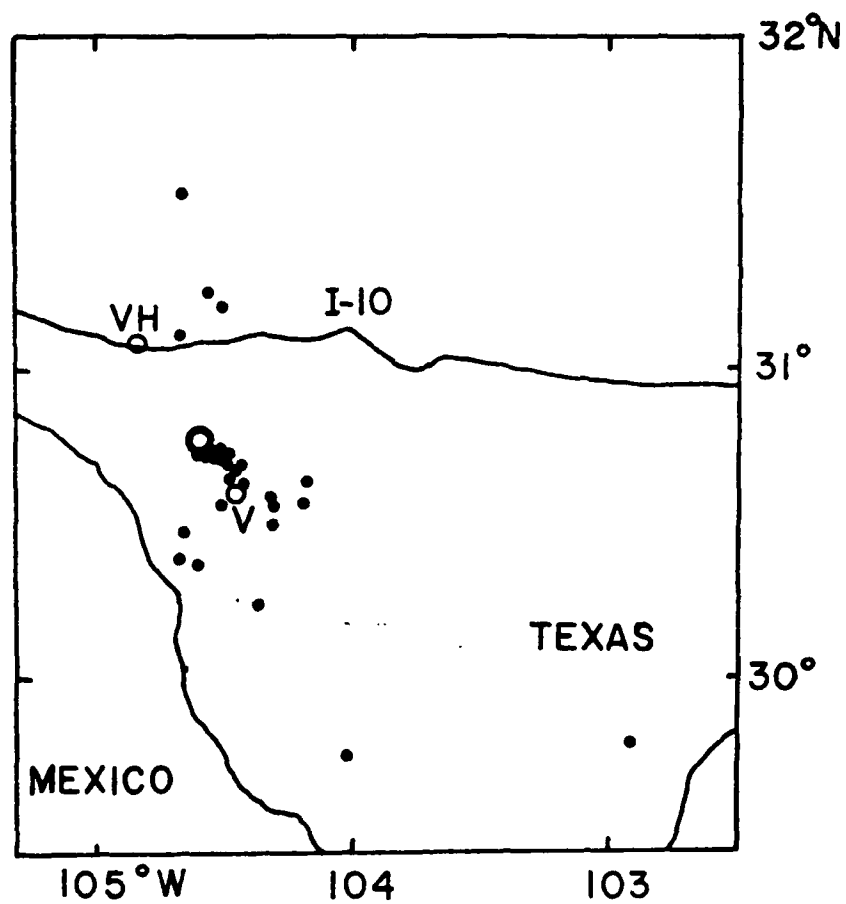


Figure 3 - Earthquake epicenters located near the Valentine MOA. Open circles represent the towns of Van Horn (VH) and Valentine (V). Bold open circle is the epicenter of the Texas Earthquake of August 1931.

ground motion attenuation function of the form:

$$\ln v_g = 1.73 + 0.921M_L - 1.20 \ln (R + 25) \quad (2)$$

estimates of the peak velocities from this earthquake can be made.⁸ In this equation v_g is the site velocity in cm/sec, M_L is magnitude and R is the epicentral distance in kilometers. Using a local magnitude of 5.8 M_L , equivalent to 5.6 m_b , the ground velocity from this event is found to be $3.3 \times 10^4 \mu$ /sec (1.3 in/sec) anywhere within the Valentine MOA. This value is 100 times the value estimated for sonic boom induced ground velocities. At a closer range, 50km, the ground motion is $6.6 \times 10^4 \mu$ /sec (2.6 in/sec) or 200 times the value of the induced motions.

The estimation of peak velocities from low magnitude, local earthquakes is a difficult problem. However, accelerograms have been made at Bear Valley, California for events of 3.0 and 3.2 M_L at distances of 2 to 10 km (1.1 to 5.4 nm).⁹ A peak velocity of $1.0 \times 10^4 \mu$ /sec (0.4 in/sec) was recorded at 2 km (1.1 nm) for the 3.0 M_L event, and $7.2 \times 10^3 \mu$ /sec (0.3 in/sec) at 5km (2.7nm) and $2.3 \times 10^3 \mu$ /sec (8.9×10^{-2} in/sec) at 10 km(5.4nm) . The smallest of these values is approximately four times the velocity produced by a maximum sonic boom over-pressure.

The ratio of energies for a 3.2 M_L earthquake to a 2.0 M_L events is 15. Velocity is related to energy as the square root of the energy or in this case ratio of four. Thus, a 2.0 M_L earthquake occurring within 10km of an archeological site can be expected to generate ground motions comparable to those caused by sonic booms. Events of this magnitude, or larger, have been reported in the Valentine MOA, though the frequency of occurrence of an event of this magnitude is uncertain.

5.4 Railroad Valley Sonic Boom Tests

On 19 June 1981, AFGL/LWH and TAC conducted a test in Railroad Valley, Nevada similar to that conducted in the Valentine MOA. In this test five sonic booms were produced by an F-111 flying at Mach 1.1 and altitudes of 3050 and 4000m AGL (10000 and 13000ft). Sonic booms having over-pressures of 4.1 to 18.2 kg/m² (0.8 to 3.7 psf) were recorded at ground level by seismic and acoustic arrays located on the alluvial floor of the valley (Francis Crowley, pers. com.)

Acoustic admittances calculated for Railroad Valley are representative of the admittances for soil in alluvial basins. Rock materials, as at the archeological sites, can be expected to have lower admittance values. Thus, the admittances found for Railroad Valley can be considered upper limiting values for the areas of interest in the Valentine MOA.

Admittances, calculated in the same manner as used in Section 3.3, were found to range from 12.3 to 46.9(μ /sec)/(kg/m²) (2.4×10^{-3} to 9.0×10^{-3} (in/sec)/psf) for Railroad Valley. The variation appears to be azimuth dependent and suggests a high variability in the shallow structure near the recording array. These values are from 0.98 to 5.3 times the admittances calculated at the Valentine sites.

Using the maximum admittance found in Railroad Valley and 25.3 kg/m² (5.19 psf), the maximum over-pressure from carpet booms in the Valentine MOA, an upper limit velocity can be found for the archeological sites. This value is $1.2 \times 10^3 \mu$ /sec (4.7×10^{-2} in/sec) or approximately four times the level predicted on the basis of actual measurements. As in Section 4, using this value as the amplitude in the three directions of motion, the vector sum velocity is found to be $2.1 \times 10^3 \mu$ /sec

(8.1×10^{-2} in/sec). This value is still only 8% of the strict blasting code limit. The vertical velocity is approximately one-half of the velocity generated by the $3.2M_L$ earthquake in Bear Valley at an epicenter distance of 10km (5.4nm). The conclusions stated in Section 5.2 concerning the effects on rocks of low velocity seismic motions are believed to apply at these amplitude levels also.

6. CONCLUSIONS

Seismo-acoustic recordings of sonic booms were made at two sites in the Valentine MOA. Each location was selected as representative of a class of significant archeological sites found within the MOA. These studies indicate that sonic booms are unlikely to cause damage to the archeological finds. The expected motions are, at worst 8% of the limits set by strict blasting codes and comparable to velocities which could be produced by local earthquakes which occur in Valentine area. At all sites visited during this study the rocks appeared to be sufficiently competent to withstand the acoustic and seismic motions generated by sonic booms. As a worst case scenario, it is concluded that a sonic boom might trigger the spalling of surface rock layers which are already in an unstable state due to natural erosive mechanisms. In this case, however, the natural processes would be expected to complete the spalling process over a short time.

References

1. Haskell, N. (1951) A note on air-coupled surface waves, Bull. Seism. Soc. Amer., 41, p. 295-300.
2. Draft Environmental Impact Statement, Supersonic Flight Operations in the Valentine Military Operations Area. (1979), Dept. of the Air Force, Holloman AFB, New Mexico.
3. Goforth, T., and McDonald, J (1968) Seismic Effects of Sonic Booms, NASA Report No. CR-1137, Teledyne Geotech, Garland Texas.
4. Handin, J. (1966) Strength and Ductility, in Handbook of Physical Constants, S. Clark, Jr., ed., The Geol. Soc. Amer., New York, NY.
5. Dade County, Florida Code, Section 13-12.
6. Ortaid, L. (1972) Blasting operations in the urban environment, Assoc. Engin. Geol., 9, p. 27-46
7. Dumas, D., Dorman, H., and Lathan, C. (1980) A reevaluation of the August 16, 1931 Texas earthquake, Bull. Seism. Soc. Amer., 70, p. 1171-1180.
8. McGuire, R., (1974), Seismic Structural Response Risk Analysis Incorporating Peak Response Regressions on Earthquakes Magnitude and Distance, Dept. Civil Eng. Research Report No. R47-51, Mass. Inst. Tech., Cambridge, MA.
9. Turnbull, L., Sun, D., Battis, J., and Ringdal, F., Source Studies in the Near-and Far-Field, Semi-Annual Technical Report No. ALEX(02)-TR-75-02-PART A, Texas Instruments Inc., Dallas, Texas.

APPENDIX B-4

**THE POTENTIAL HEALTH EFFECTS OF SONIC BOOMS
ON HUMAN POPULATIONS**

BY

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WITH AIR FORCE CRITIQUE AND WORTHINGTON'S REBUTTAL

**THE POTENTIAL HEALTH EFFECTS OF SONIC BOOMS
ON HUMAN POPULATIONS**

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THE POTENTIAL HEALTH EFFECTS OF SONIC BOOMS
ON HUMAN POPULATIONS

This report has been prepared to present a summary of some of the important research completed to date that describes the effects of "noise" on human health. Noise is most often defined as "unwanted sound"; however, it has recently been redefined as "audible sound which is harmful to human health" (Welch, 1971). Health is defined by the World Health Organization as "a state of complete physical, mental and social well being," not merely as "the absence of disease or infirmity."

Sounds take many forms, most of which are not harmful. Variation of sounds is found in frequencies, loudness, and duration. The sonic boom is one form of sound that is best described as being of short duration (perhaps 0.2 second), broad-banded (most of the frequencies are between 50-1,000 cycles per second) and loud (readings can approach 120 decibels). Most of the research completed to date has not been conducted using sounds of the sonic boom type. This is not that important, however, as I will review several important studies that clearly show that loud sounds of whatever frequency within the range of human hearing (approx. 50-20,000 cycles per second) and of whatever duration (short pulsed or continuous) bring on the same general class of effects within the human body. All of the literature that deals with the effects of loud sounds (>90dB) on the bodies of man or experimental animals is relevant. While many of the studies do not prove conclusively that the particular effect occurs in man, they "raise a red flag" that serves to alert responsible persons to the fact that no population should be exposed to the intensity of sonic boom testing proposed by the Air Force for the population in the area of Valentine, Texas, until more research is completed.

SCOPE OF THE PROPOSED TEST.

The Air Force will provide details of the exact scope of the proposed testing in its Environmental Impact Statement. In general, the population of the Valentine area will receive up to 150 sonic booms per day with a "nominal" overpressure of about 2 lbs. per square foot (PSF) for an indefinite period of time (probably for a number of years).

I would like to direct attention to the subject of "nominal overpressures". Nominal overpressures are extremely misleading. In the testimony given by Environmental Specialist Jerome B. Carr, Ph.D., of the Lowell Technological Institute to the Environmental Protection Agency at the Hearings on the Physiological Effects of Sound he pointed out the following:

The important thing to realize is that no matter how low they design this average or nominal value there will always be some high overpressure waves somewhere along any individual flight path, and these overpressure values will be capable of producing physical damage. . . . (Carr, 1971)

What Dr. Carr is saying is that every time a plane flies over, the "nominal" overpressure will be exceeded within a narrow portion of the area affected by the boom. When a given area receives a number of booms, it is a matter of probability as to how many will exceed the nominal level. If only 5% of the booms (one in twenty) fall in the above "nominal" category, then with 100 booms per day five will be above "nominal" and within a zone of higher pressures that could cause damage.

Dr. Carr continued in his testimony before the EPA to raise another point:

Now, there is another thing that the FAA tends to play down and that is the occurrence of what is called superbooms. Superbooms are sonic booms that produce an overpressure value 4 times or up to 4 times as large as nominal value. So, in other words, whenever a supersonic plane maneuvers or turns or changes altitude - does anything like this - it produces a superboom on the ground, a crescent shaped area about one square mile, and the value will lie up here (indicating) clearly within the damage portion of the curve. (Carr, 1971)

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It is obvious that if the F-15 is to be tested it will have to turn, change altitude, and maneuver constantly within the test area, and that will affect large areas with high intensity superbooms.

Dr. Carr continued with a point I also want to make:

The fact is that we have voluminary evidence that suggest that the sonic boom will cause physiological damage to the hearing system and because of this research is definitely needed before we can release the supersonic planes for overland flight. (Carr, 1971)

The projected "nominal" overpressures are not likely to cause hearing loss, but superbooms and overpressures that exceed "nominal" (nominal being close to 2 PSF) pose a threat to the health of man in the form of potential hearing loss. Studies in which rodents were exposed to simulated sonic booms have confirmed that ear damage can occur (Majeau-Chargois, et. al., 1970). The remainder of this report will be concerned with other effects on health for which even "nominal" overpressures are dangerous.

EQUIVALENCE AND RELEVANCE OF PUBLISHED RESEARCH.

I indicated in the introductory section that the sounds used in the various experimental designs differ in frequencies, intensities, and durations. Jansen has been a leader in investigating the effects of loud noise on man and animals. His own research has involved case studies of humans exposed to continuous loud noise as well as experimental animals exposed to continuous and pulse-type noises of various intensities and durations. In an important review article he summarizes:

. . . it is clear that the relations between high sound levels and their psychophysiological influences are quite unequivocal. There are reactions that may be judged to endanger human well-being and health. It is obvious too, that single events whose intensities exceed established limits are as important as equivalent continuous sound levels. . . . Summarizing, it may be concluded that noise stimuli beyond the critical curve limit for normal vegetative reaction [see below] is 99 dB(A) at maximum, and that between 90 dB(A) and 100 dB(A), a general hazard to human health must be considered. (Jansen, 1973)

It should be pointed out that "nominal" sonic booms have a loudness of at least 105 dB which means that on the log-scale decibel curve the sonic boom is 10 times louder than the threshold for effects on human health that Jansen describes.

The importance of the work by Jansen (1973) is that it equates the single event pulse-type and continuous sound exposures. It means, for example, that case studies of populations of workmen employed in factories where they are exposed to a continuous high level of noise cannot be dismissed as "irrelevant" to a situation in which people are exposed to the loud pulses of sonic booms. Jansen has shown that similarities in the responses of the human body to loud noises of all types exist. While a study of factory workers is probably not exactly equivalent to the possible effects of sonic booms on people, the information can be used as indicative of possible effects since the stress responses of the body involve the same mechanisms (see below).

PHYSIOLOGICAL EFFECTS OF SOUND ON MAN

ANATOMICAL CONSIDERATION.

Before attempting to describe the effects of sound on man it is important to understand just how vibrations in the air can excite the nervous system of man as well as the endocrine system. I will not attempt to describe the workings of the ear beyond saying that the structures of the ear transform vibrations of the air into the electrical energy of nerve impulses traveling to the brain. The "interpretation" of these impulses by the brain constitutes what we know as sound.

The issue of importance is what happens to the impulses entering the brain that have come from the ears. Many authors have commented on the various pathways the nerve impulse takes within the brain (Welch, 1971; Kryter, 1970).

The interpretation of vibrations in the air (i.e. hearing) is an important part of the survival of man in his environment and is the basis of communication. It is not surprising to find that nerve impulses arriving in the brain from the ears are relayed to many other areas.

It has been generally known for many years that man and other animals exhibit what Selye first described as a "general adaptation syndrome". Any of a variety of stressors including loud sounds can activate this "nonspecific response of the body to any demand made upon it; a stereotyped, phylogenetically old adaptation pattern primarily preparing the organism for physical activity, e.g. fight or flight" (Carlestan, 1973). As Carlestan (1973) and many others have pointed out, the activation of this system is involuntary (i.e. beyond our conscious control), and although adaptive, the repeated activation of this system constitutes a kind of demand on the resources of the body that leads to health problems. Not only is the activation of the system beyond our control, but many studies have proven that an individual cannot habituate (i.e. become adjusted) to the stimuli that trigger the response.

Briefly, the mechanism is one in which impulses from the auditory nerves are routed through the brain stem up to the higher centers (auditory cortex) where interpretation (sound) is registered. These impulses pass through the reticular formation on the way to the higher centers where they play a role in arousal. From the reticular formation they can pass to the hypothalamus where nerve impulses and release of releasing factors can activate the master endocrine gland in the body, the pituitary gland. It is here that disturbances in hormonal levels can occur. Impulses can also be relayed out from the brain over sympathetic nerves from the brain and spinal cord. The responses brought about by the effects of loud sounds (weaker sounds do not excite the system) or other stressors which are beyond our conscious control are called the "vegetative responses". These responses occur even when an individual is asleep

when subjected to a loud sound. Furthermore, as stated above an individual cannot completely adapt to the stressors that stimulate the activation of this automatic sequence of body responses (Welch, 1973).

THE VEGETATIVE RESPONSES.

The responses that occur when an individual is subjected to a loud sound (greater than 90 dB; pulsed or continuous) are the following (Jansen, 1973; Rosen, 1970; Dougherty, 1971):

- Dilation of pupils
- Moderate decrease in stroke volume of heart
- Change in heart rate
- Decrease in skin temperature
- Vasoconstriction of peripheral blood vessels
- Inhibition of gastro-intestinal peristaltic activity (i.e. decrease in rate of stomach churning, etc)
- Inhibition of secretion of gastric juices and saliva
- Increase in release of adrenalin and noradrenalin
- Increase in production of steroids
- Increase in cortical blood volume
- Increase in perspiration

This is only a partial list of effects of sudden loud noise on the body. These responses are adaptive as they prepare the body for exceptional activity. Today, however, the need for exceptional muscular activity is greatly reduced and the system is activated much too often which creates imbalances within the body that lead to health problems.

HUMAN CASE STUDIES OF THE HEALTH EFFECTS OF CHRONIC NOISE EXPOSURE

Jansen (1973) has shown that similar effects within the body are elicited by loud noise whether it is of a pulse type or of a continuous nature. All of the following studies are relevant in that they clearly indicate that human health deteriorates when individuals are exposed to loud noise for long periods of time (years).

Cohen (1973). Cohen compared 500 factory workers exposed to 95 dB or higher noise for 5 years or longer with 500 factory workers employed in quieter factories and found significant differences in the health records for the following:

respiratory disturbances
non-specific allergenic disturbances
musculoskeletal disturbances
cardiovascular disturbances
gastrointestinal disturbances

The high noise group had more accidents, absences from work, and health problems.

Sakamoto (1959). This investigator reported that more than 50% of the inhabitants living close to an airport complained of various types of somatic distress.

Mjasnikow (1970); Andriukin (1961); Shatalov, et al. (1962); Ratner (1963).

These case studies of workers from noisy factories revealed an increased incidence of hypertension. Control groups from quiet factories did not show the higher levels.

Jerkova and Kremarova (1965); Anidrukovich (1965); Strakhov (1966); Dumkina (1970). These case studies report increased incidence of "nervous complaints" in workers habitually exposed to high noise levels.

Abey-Wickrama (1969, 1970); Herridge and Low-Beer (1973). These investigators report a correlation between living near an airport in England and an increased number of admissions to psychiatric hospitals. These findings were challenged (Chowns, 1970); however, the Herridge and Low-Beer (1973) study is a follow-up that reports the same trend.

Tarentola, et al. (1968). This investigator reported that 65% of the factory workers he surveyed who were exposed to noise and vibration for many years had gastrointestinal lesions.

Hunter (1971). He observed an increase in physiological responses and a decrease in performance in dyslexic children compared to normal children

in an area near the San Diego Airport. This study indicates that some people are more vulnerable to the effects of noise than others.

Hausmann (1973). In a review of the literature of noise effects on mental health he says "There are signs that a clear relationship between noise and mental health will be found when sufficient interest develops in the communities of mental health workers and those in the fields related to psychophysiology of audition."

EPA (U.S. Environmental Protection Agency) Report to the President and Congress on Noise (1971). The EPA suggests that there is some evidence of higher incidence of cardiovascular disease, equilibrium disorders and ear-nose-and-throat disorders among workers exposed to high levels of noise.

Jansen (1959). This investigator studied 1400 workers from a variety of jobs who received high levels of noise and found significant differences in incidence of altered cardiac responses.

Connell (1972). This investigator studied woodsmen in Sweden who use noisy motor saws. He found that after work their fingers would turn blue, then white. He considered this evidence of vasospastic disease caused when the small vessels in the hands constrict and cut off the blood supply. Vibration clearly is a factor here along with the sound. Sonic booms also produce whole body vibration which interacts with the sound.

Bell (1966). Bell conducted a neurological study of Italian weavers working in a noisy factory. He found their reflexes to be hyperactive. In some cases the workers EEG's showed a diffuse desynchronization similar to that occurring in the psychoneurosis of personality disturbance.

THE EXPERIMENTAL EVIDENCE FOR THE EFFECTS OF LOUD SOUNDS ON HEALTH

In this section I will present a summary of the experimental studies that

have recorded the effects I have indicated below. When possible I have indicated the type of experimental animal utilized. This listing of experimental studies is far from complete. The literature is quite extensive and scattered making it difficult to locate. All of these studies have in common the fact that some form of loud sound was utilized in the experimental design.

CARDIOVASCULAR CHANGES

<u>Peripheral vasoconstriction</u>	MAN	(Lehman and Tamm, 1956; Jansen, 1964, 1973; Jansen and Rey, 1962; Kryter, 1973)
<u>Increased heart rate</u>	MAN	(Kryter, 1973; Collins and Iampietro, 1973, they used simulated sonic booms)
	HUMAN FETUS	(Bernard and Sontag, 1947)
<u>Heart enlargement</u>	RAT AND RABBIT	(Cerber and Anderson, 1967)
<u>Hypertension</u>	?	(Smirk, 1949)
	RAT	(Rosencrans, et al., 1966, used other stressors in combination)
	RAT	(Hudak and Bukley, 1961)
CHANGES IN BASAL SKIN RESISTANCE	MAN	(Collins and Iampietro, 1973, they used simulated sonic booms)

CHANGES IN HORMONE SECRETION

<u>Increase in adrenalin and nor-adrenalin</u>	MAN	(Levi, 1966; Arguelles, et al., 1970)
	RAT	(Horio et al., 1972; Rosen- crans, et al., 1966)
	MICE	(Jensen and Rasmussen, 1970)
<u>Increase in corticosterones</u>	RAT	(Henkin and Knigge, 1963; Rosencrans, et al., 1966)
<u>Increase in the weights of adrenal glands</u>	RAT	(Sackler, et al., 1959, 1960; Sackler and Weltman, 1963; Jurtshuk, et al., 1951; Miline and Kochak, 1952)
	MICE	(Anthony and Ackerman, 1955)
	GUINEAPIG	(Anthony, et al., 1959)
<u>Decrease in thyroid hormone secretion</u>	GUINEAPIG	(Brown-Grant and Perthes, 1960)
	RABBIT	(Brown-Grant, et al., 1954; Harris, 1955)

<u>Degenerative changes in the thyroid gland</u>	RAT	(Milne, 1952)
<u>Increase in ACTH secretion</u>	GUINEAPIG	(Brown-Grant and Perthes, 1960)
	RABBIT	(Brown-Grant, et al., 1954; Harris, 1955; Arvay, 1960)
CHANGES IN WATER AND ELECTROLYTE BALANCE	RAT	(Lockett, 1970; Ogle and Lockett, 1968)
REDUCTION IN STOMACH CONTRACTIONS	MAN	(Smith and Laird, 1930)
BLOOD SUGAR LEVEL CHANGES	?	(Ashbel, 1956)
CHANGES THAT INVOLVE RESISTANCE TO DISEASE		
<u>Leukopenis followed by leukocytosis</u>	MICE RAT	(Jensen and Rasmussen, 1970) (Johns, 1967)
<u>Decrease in thymus weights</u>	RAT	(Sockler, et al., 1960; Sockler and Weltman, 1963)
<u>Increased incidence of tumor growth</u>	MICE	(Jensen and Rasmussen, 1970)
<u>Interference of inflammatory and interferon responses</u>	MICE	(Jensen and Rasmussen, 1970)
BEHAVIORAL CHANGES		
<u>Changes in EEG's</u>	FETAL GUINEAPIG MAN	(Scibetta and Rosen, 1969) (Strakhov, 1962; Collins and Iampietro, 1973, they used simulated sonic booms)
<u>Interference with normal circadian rhythms</u>	RAT	(Horio, et al., 1972)
<u>Increase in emotionality</u>	RAT	(Hale, 1953)
<u>Other changes in behavior</u>	RAT	(Sockler and Weltman, 1963; Morra, 1969; Thompson and Sontag, 1956)
EFFECTS ON REPRODUCTION AND DEVELOPMENT		
<u>Abnormal spermatogenesis</u>	RAT	(Milne, 1954)
<u>Decrease in fertility of females</u>	RAT	(Sockler, et al., 1959; Sockler and Weltman, 1963; Sockler, et al., 1960; Arvay, 1970)

<u>Infertility</u>	RAT	(Zondek and Tamari, 1964)
<u>Decrease in ovarian and uterus weights</u>	RAT	(Tamari, 1970; Sockler, <u>et al</u> 1959, 1960; Sockler and Weltman, 1963)
<u>Persistert estrus</u>	RAT AND RABBIT	(Zondek and Tamari, 1960; Hagino, 1968; Tamari, 1970)
<u>Reduced litter size</u>	RAT	(Gerber, 1966)
<u>Smaller fetuses</u>	RAT AND RABBIT RAT	(Gerber and Anderson, 1967) (Ward, <u>et al.</u> , 1970)
<u>Resorption of litters</u>	RAT MICE	(Gerber, 1977) (Ward, <u>et al.</u> , 1970)
<u>Developmental abnormalities</u>	RAT MICE	(Gerber, 1966) (Peters and Strassburg, 1968, more cleft palate; Ward, <u>et al.</u> , 1970, cranial and limb defects)
<u>Catecholamines are teratogenic i. e. cause birth defects</u>	?	(Gerber, 1969)
<u>Release of oxytocin</u>	? RAT	(The Sciences, 1970) (Lockett, 1970, used thunderclaps)

A REVIEW OF POSSIBLE EFFECTS ON HUMAN REPRODUCTION AND DEVELOPMENT

In the preceeding section I summarized the literature that pertains to the effects of sound on the reproduction and development of experimental animals. These studies clearly indicate that loud sounds in the environment of these animals in some way become translated into highly disruptive effects on the normal pattern of reproduction and development. These studies also suggest that the normal pattern of reproduction and fetal development in man may also be adversely affected.

Sontag and his associates have produced a series of studies that have proven that the human fetus can hear loud airborne sounds in the last months of

development (Sontag and Wallace, 1935; Bernard and Sontag, 1947; Thompson and Sontag, 1956). Not only is the fetus capable of hearing, but he is also capable of registering a startle response like that of the adult. Other changes in the physiology of the fetus have been monitored in response to loud sounds (Sontag, 1970).

A number of investigators have reported changes in the behavior of experimental animals (rats) that were exposed in the fetal state to loud sounds (Hale, 1953; Thompson and Sontag, 1956; Sockler and Weltman, 1963; Morra, 1969). The behavioral changes observed involved changes in emotionality (increased rates of urination and defecation), decrease in locomotor and bodily activity, and decreased performance in maze-learning ability. In one particularly illuminating study conducted by Sontag (1963, 1970) the statistical relationship between quick movement or activity during the human fetal period (responses such as can be induced by loud sounds) was correlated to patterns of behavior as a young child. He found increased social apprehension among the children that exhibited more activity as a fetus as judged by hesitation to join groups, anxiety in the face of peer aggression, reluctance to enter nursery school car, etc. These studies suggest that should a human fetus be subjected to repeated startle responses by sonic booms their later behavior will be affected.

The work of Gerber (1969) is of special interest in that it suggests that high levels of catecholamines (adrenalin and noradrenalin) are teratogenic (i. e. cause birth defects). Developmental abnormalities in rats and mice exposed to audiogenic stress (loud sounds) have been reported (Gerber, 1966; Peters and Strassburg, 1968; Ward, et al., 1970) and include an increased incidence of cleft palate as well as other cranial and limb defects. The level of circulating catecholamines in humans exposed to sonic booms will be higher than normal and will remain high as long as the testing is conducted as the body

response that releases these substances never completely habituates to the continuous presence of the stressor. This risk to human fetal development is completely unknown.

The work of Lockett (1970) is of great interest in that he reports the release of oxytocin in rats exposed to thunderclaps. The thunderclap is similar to a sonic boom in being a pulsed sound but differs in being of longer duration and in having most of the energy in lower frequency ranges. Oxytocin is the hormone that is involved in the initiation of the birth process as it stimulates uterine contractions and it also plays a role in lactation. What is not presently known is whether sonic booms will cause the release of oxytocin in the human pregnant female. If it does, the risk of a miscarriage is greatly enhanced.

A final study will be referenced here as it pertains to normal human growth, development, and reproduction. Bennholdt-Thomsen (1938) described "urbanization trauma" or "civilization damage" which pertains to the accelerated and increased life-rhythm accompanying city-life. He compared the onset of menses in young girls raised in the city environment with that for young girls raised in quiet rural areas. He found that menses started earlier in girls raised in the city. He also found that it started earlier in young girls pursuing intellectual professions as opposed to those not pursuing such professions. He found these trends were also correlated with increased population density. He reported that with increase in density the average newborn weights were greater as well as average heights. He attributed this to increase in stimulation in the denser city environment where individuals received more stimuli in the form of noise, light, social contact, etc. He postulated that these stimuli led to the changes in life-rhythms that he observed. Some authorities have explained some of these trends with other hypotheses such as dietary changes. Neverthe-

less, the increased stimulation of individuals living in urban environments appears to be a reasonable hypothesis to explain the early appearance of first menses. Substantiating work has come from other investigators who have reported that audiogenic stress disrupts the normal biorhythms of experimental animals (Zondek and Tamari, 1960; Hagino, 1968; Tamari, 1970; Horio, et al., 1972). The role of loud sound in affecting more subtle changes in human biorhythms is still unknown.

SUMMARY

Loud sounds (>90dB) within the range of human hearing whether they are pulsed or continuous activate the sympathetic part of the autonomic nervous system. The activation of this system is adaptive in that it prepares the body for exceptional activity. The responses of the body to sympathetic stimulation involve almost every system and part of the body and include changes in blood flow, heart action, blood sugar levels, fluid and electrolyte balance, hormone levels, etc. Health problems are created in some individuals when this system is repeatedly stimulated. Complete habituation to persistent stimuli never takes place in anyone.

The available evidence is now of such a magnitude that the only conclusion that can be drawn is that the health of some individuals will be adversely affected should sonic boom testing be conducted over the population of Valentine, Texas and vicinity. It is not possible to predict what the specific effects on a given individual might be or even what proportion of the population will experience adverse reactions. Some of the possible effects that cannot be dismissed on the basis of current knowledge are especially frightening. These include the potential effects on the fetus such as birth defects, miscarriage, and changes in normal child behavior. Other possible effects on all people include

loss of hearing, effects on mental health, effects on the circulatory system such as hypertension, digestive system problems, etc. In view of the current knowledge of the adverse effects of loud sounds on health it is morally and ethically wrong for a governmental agency knowingly to subject a human population to this form of increased stress. The testing of the F-15 fighter plane should not be conducted over any populated area.

BIBLIOGRAPHY

- Abey-Wickrama, I., et al. 1969. Mental-hospital admissions and aircraft noise. LANCET 1969:1275-1277.
- Andriukin, A. A. 1961. Influence of sound stimulation on the development of hypertension. Clinical and Experimental results. COR VASSA 3:285-293.
- Andrukovich, A. I. 1965. Effects of industrial noise in winding and weaving factories on the arterial pressure in operators of the machines. GIG. TR. ZABOL. 9:39-42.
- Anthony, A. and E. Ackerman. 1955. Effects of noise on blood eosinophil levels and adrenals of mice. J. ACOUST. SOC. AMER. 27:1144-1149.
- Anthony, A., et al. 1959. Noise stress in laboratory rodents. I. Behavioral and endocrine responses of mice, rats, and guinea pigs. J. ACOUST. SOC. AMER. 31:1430-1437.
- Arguelles, A. E., et al. 1970. Endocrine and metabolic effects of noise in normal, hypertensive and psychotic subjects. IN: Physiological Effects of Noise. Welch, B. L. and A. S. Welch, eds. New York: Plenum Press, 43-56.
- Arvay, A. 1970. Effects of noise during pregnancy upon foetal viability and development. IN: Physiological Effects of Noise. Welch, B. L. and A. S. Welch, eds. New York: Plenum Press, 91-115.
- Ashbel, Z. Z. 1956. Effects of ultrasound and high frequency noise in blood sugar level. Transl. into Engl. from GIGIENA TRUDA I PROFESSIONAL'NYE ZABOLEVANIYA, MOSCOW 2:(JPRS-36252).
- Bell, A. 1966. Noise: An occupational hazard and a public nuisance. Public Health Paper No. 30. Geneva: World Health Organization.
- Bennholdt-Thomsen, C. 1938. Über die Acceleration der Entwicklung der heutigen Jugend. KLINISCHE WOCHENSCHRIFT (BERLIN) 17:865-870.
- Bernard, J. and L. W. Sontag. 1947. Fetal reactivity to fetal stimulation: a preliminary report. J. GENETIC PSYCHOLOGY 70:205-210.
- Brown-Grant, K. and G. Perthes. 1960. The response of the thyroid gland of the guineapig to stress. J. PHYSIOL. (LONDON) 151:40-50.
- Brown-Grant, K., et al. 1954. The effect of emotional and physical stress on thyroid activity in the rabbit. J. PHYSIOL. (LONDON) 126:29-40.
- Bugliarello, G., et al. 1976. The Impact of Noise Pollution. A Socio-Technological Introduction. New York: Pergamon Press Inc. xviii-461.
- Carlestam, G., et al. 1973. Stress and disease in response to exposure to noise - a review. IN: Proc. Int. Congress on Noise as a Public Health Hazard, Dubrovnik, Yugoslavia, 1973. U. S. Env. Protection Agency, Washington, D. C. 479-486.
- Carr, J. B. 1971. Statement of Jerome B. Carr, Ph. D., Environmental Specialist, Lowell Technological Institute Research Foundation, Lowell, Mass. IN: Public Hearings on Noise Abatement and Psychological Effects. U. S. Env. Protection Agency, Washington, D. C. 131-134.
- Chowns, R. H. 1970. Mental-hospital admissions and aircraft noise. LANCET 1970:467.
- Cohen, A. 1973. Industrial noise and medical absence and accident record data on exposed workers. IN: Proc. Int. Congress on Noise as a Public Health Hazard, Dubrovnik, Yugoslavia, 1973. U. S. Env. Protection Agency, Washington, D. C. 441-453.

- Collins, W. E. and P. F. Iampietro. 1973. Effects on sleep of hourly presentation of simulated sonic booms (50N/M²). IN: Proc. Int. Congress on Noise as a Public Health Hazard, Dubrovnik, Yugoslavia, 1973. U. S. Env. Protection Agency, Washington, D. C. 541-558.
- Connell, J. 1972. The biological effects of noise. Paper given at Annual Meeting of the British Assoc. for Advancement of Science. May 9, 1972. (Summary in Bugliarello, et al. 1976).
- Dougherty, J. 1971. Statement of Dr. John Dougherty, School of Public Health, Harvard University, Cambridge Mass. IN: Public Hearings on Noise Abatement and Control. Vol. VII. Physiological and Psychological Effects. U. S. Env. Protection Agency, Washington, D. C. 169-170.
- Dumkina, G. Z. 1970. Some clinico-physiological investigations made in workers exposed to the effects of stable noise. IN: Physiological Effects of Noise. Welch, B. L. and A. S. Welch, eds. New York: Plenum Press, 346 +.
- E. P. A. (U. S. Environmental Protection Agency). Report to the President and Congress on Noise. Washington, D. C., December, 1971.
- Gerber, W. F. 1966. Developmental effects of chronic maternal audiovisual stress on the rat fetus. J. EMBRYOL. EXP. MORPH. 16:1-16.
- _____. 1969. Comparative teratogenicity of isoproterenol and trypan blue in fetal hamster. PROC. SOC. EXP. BIOL. MED. 130:1168-1170.
- _____. 1970. Cardiovascular effects of chronic intermittent noise stress. IN: Physiological Effects of Noise. Welch, B. L. and A. S. Welch, eds. New York: Plenum Press, 85-90.
- _____. and T. A. Anderson. 1967. Cardiac hypertrophy due to audiogenic stress in rats, Rattus norvegicus albinus, and rabbit, Lepus cuniculus. COMP. BIOCHEM. PHYSIOL. 21:573-578.
- Hagino, N. 1968. (No title). JAP. J. PHYSIOL. 18:350 +.
- Hale, E. B. 1953. WADC Technical Report 53-282. Wright Air Development Center, Ohio.
- Harris, G. W. 1955. Neural Control of the Pituitary Gland. London: Arnold.
- Hausman, W. 1973. Noise and mental health - an overview. IN: Proc. Int. Congress on Noise as a Public Health Hazard, Dubrovnik, Yugoslavia, 1973. U. S. Env. Protection Agency, Washington, D. C. 593-598.
- Henkin, R. I. and K. M. Knigge. 1963. Effects of sound on the hypothalamic-pituitary-adrenal axis. AMER. J. PHYSIOL. 204:710-714.
- Herridge, C. F. and L. Low-Beer. 1973. Observations of the effects of aircraft noise near Heathrow Airport on mental health. IN: Proc. Int. Congress on Noise as a Public Health Hazard, Dubrovnik, Yugoslavia, 1973. U. S. Env. Protection Agency, Washington, D. C. 599-607.
- Horio, K., et al. 1972. Adrenocortical response to noise exposure. Reprinted from: Joint Meeting of Int. Societies for Hygiene, Preventive and Social Medicine. Oct. 29-Nov. 1.
- Hudak, W. J. and J. P. Buckley. 1961. Production of hypertensive rats by experimental stress. J. PHARMACEUTICAL SCI. 50:263-264.
- Hunter, E. J. 1971. Autonomic responses to aircraft noise in dyslexic children. PSYCHOLOGY IN THE SCHOOLS 8:362-367.
- Jansen, G. 1959. Zur Entstehung Vegetativer Funktionsstörungen durch Lärmenwirkung. ARCHIV. GEWERBEPATH. U. GEWERBEHYG. 17:238-261.
- _____. et al. 1964. Vegetative reactions to auditory stimuli: comparative studies of subjects in Dartmund, Germany, and the Mabaan tribe in the Sudan. TRANS. AMER. ACAD. OPTH. AND OTOLARYNGOLOGY 68:445-455.
- _____. 1970. Relation between temporary threshold shift and peripheral circulatory effects of sound. IN: Physiological Effects of Noise. Welch, B. L. and A. S. Welch, eds., New York: Plenum Press, 67-74.

- _____. 1973. Non-Auditory effects of noise. Physiological and psychological reactions in man. IN: Proc. Int. Congress on Noise as a Public Health Hazard, Dubrovnik, Yugoslavia, 1973. U. S. Env. Protection Agency, Washington, D. C. 431-439.
- _____ and P. Rey. 1962. Der Einfluss der Bandbreite eines Gerausches auf die Strake vegetativer Reaktionen. INT. Z. FUR ANGEWANDE PHYSIOLOGIE -- EINSCHLIESSLICH ARBEITSPHYSIOLOGIE (BERLIN) 19:209-217.
- Jensen, M. M. and A. F. Rasmussen, Jr. 1970. Audiogenic stress and susceptibility to infection. IN: Physiological Effects of Noise. Welch, B. L. and A. S. Welch, eds. New York: Plenum Press, 7-20.
- Jerkova, H. and B. Kremarova. 1965. Observations on the effects of noise on the general health of workers in large engineering factories; attempt at evaluation. PRACOVNI LEKORSTOR (PRAGUE) 17:147-148.
- Johns, M. W. 1967. (No title). J. PATH. BACT. 93:681 +.
- Jurtshuk, P., et al. 1951. Biochemical responses of rats to auditory stress. SCIENCE 129:1424-1425.
- Kryter, K. D. 1970. The Effects of Noise on Man. New York: Academic Press.
- _____. 1973. Some laboratory tests of heart rate and blood volume in noise. IN: Proc. Int. Congress on Noise as a Public Health Hazard, Dubrovnik, Yugoslavia, 1973. U. S. Env. Protection Agency, Washington, D. C. 487-497.
- Lehmen, G. and J. Tamm. 1956. Über Veränderungen der Kreislaufdynamik des ruhenden Menschen unter Einwirkung von Geräuschen. INT. Z. FUR ANGEWANDE PHYSIOLOGIE EINSCHLIESSLICH ARBEITSPHYSIOLOGIE (BERLIN) 16:217-227.
- Levi, L. 1966. Life stress and urinary excretion of adrenaline and noradrenaline. IN: Prevention of Ischemic Heart Disease. Raab, W., ed.
- Lockett, M. F. 1970. Effects of sound on endocrine function and electrolyte excretion. IN: Physiological Effects of Noise. Welch, B. L. and A. S. Welch, eds. New York: Plenum Press, 21-41.
- Majeau-Chargois, D. A., et al. 1970. Sonic boom effects on the organ of Corti. LARYNGOSCOPE 80(4):620-630.
- Milne, R. 1952. (No title). COMPT. REND. L'ASSOC. ANAT. 39:649 +.
- _____. 1954. (No title). COMPT. REND. L'ASSOC. ANAT. 40:179 +.
- _____ and D. Kochak. 1951. (No title). COMPT. REND. L'ASSOC. ANAT. 38:692-703.
- Mjasnikow, A. L. 1970. IN: The Pathogenesis of Essential Hypertension. Proceedings of the Prague Symposium, 153-162.
- Mora, M. 1969. (No title). J. GENET. PSYCHOL. 114:77 +.
- Ogle, C. W. and M. F. Lockett. 1968. The urinary changes induced in rats by high pitched sound (20 kcyc./sec.). J. ENDOCRINOL. 42:253-260.
- Peters, S. and M. Strassburg. 1968. (No title). DEUTSCHE ZAHNARTZTLICH Z. 23:843.
- Ratner, M. V., et al. 1963. Thesen des Berichtes der allunionswissenschaftlichen Tagung über methodische Probleme der Lärmwirkung auf den Organismus. INST. FUR ARBEITSHYGIENE UND BERUFSKRANKHEITEN, AMW, UdSSR.
- Rosecrans, J. A., et al. 1966. The production of hypertension in male albino rats subjected to experimental stress. BIOCHEM. PHARMACOLOGY 15:1707-1708.
- Rosen, S. 1970. Noise, hearing and cardiovascular function. IN: Physiological Effects of Noise. Welch, B. L. and A. S. Welch, eds. New York: Plenum Press, 765-776.
- Sakamoto, H. 1959. Endocrine dysfunction in noisy environment. Report II. MIE MEDICAL JOURNAL 9:59-74.
- Shatalov, N. N., et al. 1962. On the state of the cardiovascular system under conditions of exposure to continuous noise. Report T-411-R, N65-15577. Defense Research Board, Toronto, Canada.

- Smirk, F. R. 1949. Pathogenesis of essential hypertension. BRITISH MEDICAL JOURNAL 1:791-799.
- Smith, E. L. and D. A. Laird. 1930. The loudness of auditory stimuli which affect stomach contractions in healthy human beings. J. ACOUSTICAL SOC. AMER. 94:n.p.
- Sockler, A. M. and A. S. Weltman. 1963. Psychophysiologie neuropharmacologie et biochemie de la crise audigene. IN: Colloq. Inst. Centre Nat. de la Recherche Scientifique, No. 112. Gif-sur-Yvette. 255-288.
- _____, et al. 1959. Endocrine changes due to auditory stress. ACTA ENDOCRINOLOGICA 31:405-418.
- _____, et al. 1960. Endocrine aspects of auditory stress. AEROSPACE MED. 31:749 +.
- Sontag, L. W. 1963. Somatopsychics of personality and body function. VITA HUMANA 6:1-10.
- _____. 1970. Effects of noise during pregnancy upon foetal and subsequent adult behavior. IN: Physiological Effects of Noise. Welch, B. L. and A. S. Welch, eds. New York: Plenum Press, 131-141.
- _____ and R. F. Wallace. 1935. The movement response of the human fetus to sound stimuli. CHILD DEVELOPMENT 6:253-258.
- Strakhov, A. B. 1962. Electroencephalographic changes under prolonged action of noise. Translated from: BYULLETIN EKSPERIMENTAL'NOY BIOLOGII I MEDITSINY 7 (OTS Report 11615).
- _____. 1966. Some questions of the mechanism of the action of noise on an organism. Report N67-11646. Joint Publications Research Service, Washington, D. C.
- Tamari, I. 1970. Audiogenic stimulation and reproductive function. IN: Physiological Effects of Noise. Welch, B. L. and A. S. Welch, eds. New York: Plenum Press, 117-130.
- Tarantola, A., et al. 1968. Syndrome dispectica in lavoratori esposti a vibrazioni ed elevata rumorosita. LAVORO UMANO (NAPLES) 20:245-265.
- The Sciences. 1970. Shattered sleep. THE SCIENCES May, 1970:10.
- Thompson, W. D. and L. W. Sontag. 1956. Behavioral effects in the offspring of rats subjected to audiogenic seizure during the gestational period. J. COMP. PHYSIOL. PSYCH. 49:454-456.
- Ward, C. O., et al. 1970. Teratogenic effects of audiogenic stress in albino mice. J. PHARM. SCI. 59:1661-1662.
- Welch, B. L. 1970. IN: Physiological Effects of Noise. Welch, B. L. and A. S. Welch, eds. New York: Plenum Press, 5-6.
- _____. 1971. Statement of Bruce L. Welch, Ph.D., School of Medicine, The Johns Hopkins University, Baltimore, Md. IN: Public Hearings on Noise Abatement and Control. Vol. VII. Physiological and Psychological Effects. U. S. Env. Protection Agency, Washington, D. C. 238-270.
- Zondek, B. and I. Tamari. 1960. Effects of audiogenic stimulation on genital functions and reproduction. AMER. J. OBSTET. GYNEC. 80:1041-1048.
- _____. Effects of auditory stimulation on reproduction. IV. Experiments on deaf rats. PROC. SOC. EXP. BIOL. MED. 116:636-637.
- _____. 1964. Infertility induced by auditory stimuli prior to mating. ACTA ENDOCRINOL. 90:227-234.

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REPLY TO
ATTN OF: BBA

6 February 1979

SUBJECT Evaluation of Sonic Boom Health Effects Report

TO TAC/DEEV (Wm A. Duffy)
Langley AFB VA 23665

1. The report on "The Potential Health Effects of Sonic Booms on Human Populations" by Richard D. Worthington that was submitted to our office with your 10 January letter request has been reviewed. Lt Col Dan Johnson was asked to review the report and provide comments to me for incorporation into our response to TAC/DEEV. His review and comments, directed to the Worthington report and the question of physiological effects of noise, are so thoroughly treated that his comments are being forward to you as our response to your request (atch 1).

2. The general situation of sonic boom exposures of the human population has not changed markedly over the years. Whenever sonic booms occur over populated areas some complaints to the responsible party are expected. In addition, damage to window glass, plaster, and the like as well as possible breakage of bric-a-brac type items will occur. The tolerance of the exposed population to these events will be influenced by the extent and nature of the public information about the booms prior to and during the program. The manner in which any damage to property by the booms is recognized and equitably compensated in an expedient way is likewise very important. Delayed investigations of minor claims, large amounts of documentation required from the damaged party and slow responses to remedy the situation and make compensation are believed to be major contributors to reduced tolerance of sonic booms. Negative reaction and more widespread damage to property may be expected to increase with significant growth in the intensity and/or frequency of sonic booms.

3. The receptor most sensitive to impulse noise in man is the human auditory mechanism, and especially the eardrum membrane. Rupture of the eardrum membrane has occurred in response to intense impulsive sounds such as heavy weapons fire, explosions and blasting, and the like, however there is no confirmed instance known to us of human eardrum rupture caused by sonic boom. As mentioned by Lt Col Johnson, this includes some of our own personnel who have experienced several sonic booms at levels of 100 to 144 pounds per square foot with no discomfort or adverse effect on their hearing mechanisms. In spite of the extensive literature cited and interpreted by Dr. Worthington and in view of the rather extensive experience of the USAF, NASA and the FAA during the

National Supersonic Transport Program, there is no evidence known to us of direct physiological injury due to exposure to sonic booms. Indirect injury has been reported to result from individuals struck by objects falling due to the sonic boom, and the like, and the possibility of this type of injury does exist.

4. To be scientifically objective, it must be recognized that whether sonic booms (and loud noise) produce adverse health effects on man involving his cardiovascular system, endocrine system, hypertension and the like, is still an open question. These "indirect" effects in humans can be activated by so many different stimulus factors (both external and internal to the individual), including basic emotions, that it has not been possible to establish unambiguous causal relationships between the various noises and their purported effects.

5. It is hoped that this information is useful to you. If there are questions please contact Lt Col Johnson or the undersigned at autovon 785-4244/3607.

Charles W. Nixon

CHARLES W. NIXON, Ph.D.
Chief, Biological Acoustics Branch
Biodynamics and Bioengineering Division

3 Atchs

1. Sonic Boom Comments
2. Guidelines for Preparing EIS on Noise
3. Report #550/9-74-004

COMMENTS ON "THE POTENTIAL HEALTH EFFECTS OF SONIC BOOMS ON HUMAN POPULATIONS" BY R. WORTHINGTON

1. General: This is a rather difficult paper on which to comment. In some areas the author is clearly wrong and specific comments to this effect are given below. On the one hand he overstates some of the effects of sonic booms in some cases and on the other, he ignores hard quantifiable effects of sonic booms that are known. In some parts of his paper he makes statements that are difficult to dispute. He discusses some nonauditory effects of sound that do occur. The difficulty arises in assessing the importance of such effects on humans and their health. As Dr. Worthington clearly shows, there are numerous reports that claim rather dire effects from noise. How reasonable these claims are has been summarized by others such as Dr. Kryter¹ and Dr. Cohen.² The state of the art may be best summarized in the EPA Criteria Document on Noise.³ Its conclusion on nonauditory noise states

"Noise can elicit many different physiological responses. However, no clear evidence exists indicating that the continued activation of these responses leads to irreversible changes and permanent health effects. Sound of sufficient intensity can cause pain to the auditory systems. Except for those persons with poorly designed hearing aids, such intense exposures should not normally be encountered in the nonoccupational environment. Noise can also effect the equilibrium of man, but the scarce data available indicates that the intensities required must be quite high or similar to the intensities that produce pain."⁴

The most recent assessment of the current state of knowledge and its use in this field is contained in the Second Edition, Handbook of Noise Control (1979) in the introductory paragraph of a chapter on Physiological Effects of Noise by Dr. William Burns, Emeritus Professor of Physiology, Charing Cross Hospital Medical School, University of London, England.

Introduction

This chapter discusses the physiological reactions of the human body to noise; the effects on the hearing mechanism and psychological effects are described in Chaps. 8 and 16, respectively. Knowledge in this field has not kept pace with advances in knowledge of the relation between noise and hearing. Studies of physiological effects contain difficulties of observation and interpretation. Where human laboratory studies are used, projection to real life situations may be misleading. Studies on lower mammals may be complicated by significant species differences compared with humans; and the

effects of magnitude of the stimulus in animal experiments, compared with that conceivably sustained in real life in human exposure, must be considered. In field studies of real human situations, adequately controlled conditions may be unattainable, so that results deriving from some other factor in the total environment of the subjects may be incorrectly attributed to noise. All of these considerations enjoin caution in the acceptance of conclusions of any study in this field.

While this does not say that there will not be any problems with noise exposure, it does indicate that in spite of the extensive literature conclusive cause and effects relationships of noise have not been established and that hearing is still probably the most sensitive indicator of physiological damage.⁵ So part of the problem of assessing the effects of sonic booms in the Valentine area is to explore the expected impact of sonic booms on hearing. Fortunately, as will be shown in the specific comments later on, the effect of sonic booms on hearing is expected to be completely negligible.

2. Specific Comments:

a. Worthington states that sonic booms are broad banded (most frequencies are between 50-1000 cycles per second) and loud (readings can approach 120 decibels). This is one indication that Dr. Worthington is somewhat off the mark. First, while it is true that sonic booms are broad banded, most of the energy lies in the 20 Hz to 100 Hz range. This is important because as will be mentioned in a later comment, these frequencies do not directly affect humans as much as they affect houses in which humans live. These low frequencies couple into the structure of a house and will cause "house rattles." These low frequencies also mean that the A-weighted level, or dBA, will be considerable less. In fact a sonic boom with an unweighted peak level of 120 dB will have an A-weighted sound exposure level of 78 to 85 dB. A standard sound level meter on slow response would read somewhere between 75 to 82 dB for this boom of 120 decibel peak.³ Note that these levels are even below the A-weighted level of 99 dB quoted by Jansen 1973, (see bottom of page II of Worthington's paper). This again emphasizes that the non-auditory effects of the sonic booms should not be considered a problem. Numerous activities and events, such as shutting car doors, shouts, loud talking, barking dogs, etc., will cause similar A-weighted levels and are certainly expected to be as important as the direct audible effects of the sonic booms, even those 10 decibels to 15 decibels or so higher. This is of some importance since the peak pressures of nominal booms will range from 115 dB (about .25 psf) to 133 dB (approx 2 psf). The 120 dB that Worthington cites is probably slightly low. This leads into the next comment.

b. Worthington states that up to 150 sonic booms will occur per day with a nominal overpressure of about 2 lbs per square foot (PSF). First, it should be emphasized that 150 booms per day is too high an estimate of what any one location on the ground will receive. Personnel from our laboratory have visited areas that have similar activities to what is expected for the Valentine area. In such areas only 1 or 2 sonic booms per day were perceived. Discussions with the residents of the area verified that this was a reasonable average. Yet the aircraft were predicted to have gone supersonic far more often. The inconsistency, of course, comes from the fact that when an aircraft goes supersonic in a large area, only part of that area may be impacted by a sonic boom. The amount of area impacted depends somewhat on altitude, but mostly on the time the aircraft stays supersonic and the kind of maneuvering involved. For instance, a single sustained supersonic level flight could impact a far greater land area than 100 short time supersonic bursts of speed - even assuming each supersonic burst covers a different geographic area. In summary, it is important that the effects of sonic booms be assessed by predicting, or measuring, the expected number of booms per day that will be received by any one individual or any one land area. This average number of booms should be roughly predicted in the Impact Statement. However, we would be surprised if on the average more than a few booms a day occurred at any one location.

c. Worthington quotes Carr about the problem of superbooms.

It is quite true that the type of maneuvering expected in the Valentine area will cause some focusing of the sonic booms. However, two considerations should be kept in mind. First, the greatest peak pressure of a sonic boom from level flight is directly beneath the aircraft. The sonic boom pressure decreases as the lateral distance from the aircraft increases. Since the predicted nominal boom is that boom right under the aircraft, only those areas directly under the aircraft will receive the nominal boom. The expected peak pressure can be increased by as much as a factor of four, but when this happens it is more often than not an amplification of a boom that is less than the nominal boom. The focusing of a sonic boom from a supersonic turn is a good example. The second consideration is that generally the more the boom is amplified, the less area will be affected. Thus the greater the superboom the less likely such a boom will occur at any one land area.

Again referring to our experience with similar areas, perhaps only one or two superbooms will occur per year at any one location. These few booms, nevertheless, will result in one of the two clearly identifiable impacts that will occur from supersonic flight in the Valentine area (the other impact, annoyance from house rattles, will be discussed later). It is reasonably certain that on occasion some windows will be broken and some plaster or drywall cracks will occur. Major structural damage is very unlikely to occur, but minor damage cannot ever be ruled out.

Speaking only as an individual, if I were living in the Valentine area, I could easily accept the proposed supersonic overflights provided if a window is broken, I could get it replaced without a hassle. By no hassle, I mean that I can make one call and get the first commercially available service to replace the window. If I would have to file a written claim and wait until an investigator saw the window, this would be unacceptable. In other words, if the Air Force is not reasonable in how they handle minor damage to structures, then I would campaign vigorously to prevent them using the area in which I lived for supersonic maneuvers.

The comment was made that superbooms are liable to cause hearing loss. This is clearly wrong for occasional superbooms of even 40 psf, much, less superbooms from 4 psf to possibly 10 psf that are likely to occur in the subject area. People from our laboratory have been exposed to sonic booms as high as 144 psf without adverse effects. Research on 100 subjects exposed to rapid air bag inflations that were accompanied by intense impulse (which are reasonably similar to sonic booms) showed only a very small amount of temporary change in hearing that quickly recovered. Subjects exposed to simulated air bag noises at peak levels as high as 166 dB (80 psf) showed that small temporary changes in hearing were mainly caused by the high frequency noise and not the low frequencies as found in sonic booms. Even use of the CHABA criteria for impulse noise, which doesn't consider the ameliorating fact that the sonic boom is largely composed of low frequency energy, would allow one boom per day at 152 dB (18 psf). In essence, we are sure that even the occasional superboom expected for the Valentine area is safe with respect to hearing damage.

c. Worthington cites numerous research articles which indicate the Physiological Effects of Sound On Man. This is an area that has been debated for many years and will probably never be resolved to everyone's satisfaction. Kryter has recently made detailed and objective surveys of the literature and it is appropriate to state the conclusions. In work supported by the U.S. EPA, Kryter concludes:

In spite of the very large gaps in our knowledge and the existence of some apparently conflicting research results, the following conclusions are put forth, with, of course, the usual admonition that more research is needed before they can be accepted with great confidence.

1. There is no likely damage risk to a person from the possible unconditioned stress responses to noise that are mediated by the autonomic system.

2. Noise may often be concomitant with danger and adverse social-environmental factors that are more important than the noise itself as a cause of apparent greater incidences of various physical and psychological disease and accidents in industry.

3. Autonomic system stress responses could conceivably be a contributing factor to ill health in some persons as the result of noise in their living environment directly interfering with auditory communications and sleep, and, thereby, creating the feelings of annoyance and anger that serve as the direct cause of the stress responses.

4. It would appear that controlling meaningless noise to levels that permit auditory communication and sleep behavior adequate for a given work or living environment would obviate that occurrence of any extraauditory responses in the body of a stressful nature.

The problem, as I see it, with most non-auditory research, is that clear cause and effect relationships have not been found. For instance, there are some studies that have shown that blood pressure of workers in noisy industries are higher than the blood pressures in the general populations. What such studies have not shown is that the noise is the cause of the high blood pressure. The high blood pressure could just as well be due to vibration, dust, the danger of moving machinery, etc., or some combination of these. The problem is that noise is a by-product of those kinds of jobs that probably do cause more stress. With respect to noise induced hearing loss, we know by experience that one extremely loud noise can cause a permanent change in hearing ability. We can further verify such changes in animals by looking at damaged hair cells of the inner ear. We have no similar data for blood pressure. Thus we can only make a conjecture that there might be a cause and effect relation. Such a relation could be shown if we could find two groups of people identical in all ways except for noise exposure. Unfortunately, such a situation has not been found. Until such proof is forthcoming, such possible effects must be ignored in the planning or decision making process. If we do not ignore these conjectures, then the question is not whether or not a few sonic booms in the Valentine area are a problem, but the question is should we have an industrialized civilization at all. We know enough about typical noise doses of Americans to realize that a few sonic booms would be only a very small contribution to the average person's total noise exposure. (See for instance, Schori, 1978).¹²

With this in mind, let us use the only knowledge of sonic booms that can be quantified. It is known that the number of people who report that they are highly annoyed does increase with increased sound pressure level of the booms. A study was conducted in Oklahoma City in which 8 booms per day occurred every day for a period of six months.¹³ Different peak levels were used during different times and the population was also questioned at different times. It is clear that exposure to sonic booms can reach an unacceptable level. The residents were asked a variety of questions concerning why they were annoyed. In virtually every case, if they were annoyed by sleep disturbance, startle, speech interference, etc., they also reported that they were annoyed by "house rattles." Thus, "house rattles" appears to be the most sensitive effect of sonic booms. Further discussion of this effect can be found in such reports as those by Schomer.¹⁴ Recent guidelines for such high energy impulses have been provided to the EPA by a National Research Council Committee on Hearing, Bioacoustics and Biomechanics (CHABA).¹⁵ Pertinent parts of these guidelines are attached. If for planning purposes the impact of the sonic booms is to be kept equivalent to a general noise exposure of an L_{dn} of 65 dB, 8 booms per day greater

than 2 psf would be unacceptable. Other unacceptable exposures to residential dwellers would be 16 booms at 1.4 psf or 4 booms at 2.8 psf. By converting the peak pressures to C-weighted Sound Exposure Levels, combinations of sonic booms at different levels can be assessed. Observation of these guidelines will insure that the Valentine area will be impacted no worse than any other area impacted with a new noise source. Besides the DOD, HUD also is planning to use a limit for new housing of an L_{dn} of 65 dB.¹⁶

From our visit to other areas, it is believed that this limit will be met since the operations between different MOA's are similar. A more detailed assessment should be included in the EIS.

3. Conclusions:

Prof Worthington shows concern about the sonic boom exposure expected in the Valentine area. We agree that there is some basis for concern, but not for the reasons stated. Occasionally light damage from booms can be expected to occur. Annoyance, largely due to house rattles, will occur. This annoyance can be quantified and an acceptable exposure defined. This should be done.



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REFERENCES

1. Kryter, K. D., "Extraauditory Effects of Noise," Effects of Noise on Hearing, Donald Henderson et al (ed.), New York: Raven Press, pp. 531-546, 1976.
2. Statement of Dr. A. Cohen, Hearings before the Subcommittee on Government Regulation of the Select Committee on Small Business, pp. 62-63, July 23, 24, 25, 1975.
3. Young, Robert W., "Average Sound Level Including Sonic Booms," Acoustical Society of America Meeting, Paper 116, 6 November 1975.
4. Public Health and Welfare Criteria for Noise, EPA Document 550/9-73-002, July 27, 1973, pp. 7-20.
5. "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," EPA Document 550/9-74-004, Appendix E, pp E-81, E-82, March 1974.
6. Visit by Dr. C. W. Nixon and Lt Col D. Johnson to the Sells MOA, Oct 1977.
7. For model predicting window breakage, see:

"Guidelines for Preparing Environmental Impact Statements on Noise," CHABA, Working Group 69, National Academy of Sciences, Wash. D.C., 1977, pp. VI-22.

or

Hershey et al, "Application of the Response Probability Density Function Technique to Predicting the Probability of Sonic-Boom Glass Breakage," J. Acoust. Soc. Am. (55), 100-1017, May 1974.
8. Nixon, C. W., Hille H., H. C. Sommer and E. Guild, "Sonic Booms Resulting from Extremely Low-altitude Supersonic Flight: Measurements and Observations on Houses, Livestock and People," AMRL-TR-68-52, Oct 1968.
9. Nixon, C. W., Human Auditory Response to an Air Bag Inflation Noise. Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio 45433, prepared for the Department of Transportation under Contract No. P. O. 9-1-1151, 7 March 1969.
10. Sommer, H. C. and C. W. Nixon, "Primary Components of Simulated Air Bag Noise and Their Relative Effects on Human Hearing," AMRL, WPAFB, Ohio. DOT/USAF Study, AMRL-TR-73-52, November 1973.

11. CHABA (Ward, et al 1968), "Proposed Damage-Risk Criterion for Impulse (Gunfire)," (U). Report of Working Group 57, NAS-NRC Committee on Hearing, Bioacoustics, and Biomechanics (CHABA), W. Dixon Ward, Chairman, Washington, D.C.: Office of Naval Research.
12. Schori, T. R. and McGatha, E. A., "A Real-World Assessment of Noise Exposure," Sound and Vibration (12) 24-30, Sep 1978.
13. Borsky, Paul N. (1965): Community Reactions to Sonic Booms in the Oklahoma City Area, AMRL-TR-65-37, Vol II. See especially pages 104-112.
14. Schomer, P. D., "Growth Function for Human Response to Large-Amplitude Impulse Noise," J. Acoustical Society of America, (64) 1627-1632, Dec 1978.
15. "Guidelines for Preparing Environmental Impact Statements on Noise" Op. Cit. pp. VI-12 to VI-13 and V-1 to V-3.
16. "Environmental Criteria and Standards," Federal Register, Vol. 43, No. 249-Wednesday, Dec 27, 1978.

RESPONSE TO DR. CHARLES W. NIXON AND LT. COL. DANIEL L. JOHNSON'S
CRITIQUES OF "POTENTIAL HEALTH EFFECTS OF SONIC BOOMS
ON HUMAN POPULATIONS" BY RICHARD D. WORTHINGTON

The central thesis of my report on the potential health effects of sonic booms is that this type of loud impulse noise constitutes a stressor that will lead to the deterioration of the health of some individuals that are exposed for a period of years. Nothing in the critiques of my report by Dr. C. W. Nixon and Lt. Col. D. L. Johnson can disprove that contention. In fact, the volume of information on adverse effects of loud noise on human health is now so extensive that the stand taken by Nixon and Johnson represents "the clutching at straws." Clearly, the Air Force is not willing to take responsibility for the health and welfare of individuals in the proposed operations areas for to acknowledge that human health might be affected is to open a "can of worms" in terms of the legal ramifications that are involved.

In the following paragraphs I will address some of the questions that Nixon and Johnson raised concerning my report. In a few cases I was wrong, but most of their own comments are inaccurate or misleading.

CRITIQUE BY DR. C. W. NIXON

Section 1 is a historical statement of no relevance to the content of my report. Section 2 concerns property damage which I did not address.

Section 3. Concerning the possible loss of hearing from exposure to sonic booms I would have to say that I agree with Dr. Nixon (and Lt. Col. Johnson) in that the literature (available data) does not indicate that sonic booms are likely to cause hearing loss. If I had found solid evidence, I would have presented it. I do not believe that the final word is in, however. I did find

one study which reports that sonic booms cause hair cell damage in rodents (direct physiological damage). I raised concern in my health effects report only about focus booms (super booms) having the potential to damage hair cells. The accepted exposure limits to continuous noise of the intensity of the focus booms that could occur with some regularity in the proposed operations areas are measured in seconds. I do not agree with the contention (he references no study to back up his claim) of Johnson that only a few focus booms will be heard by an individual in the area in the course of a year for reasons that I will elaborate upon below. However, using the phrase in Dr. Nixon's report "to be scientifically objective," the effects, if any, of continuous exposure (for years) to periodic focus booms on human hearing is not known.

Section 4.

To be scientifically objective, it must be recognized that whether sonic booms (and loud noise) produce adverse health effects on man involving his cardiovascular system, endocrine system, hypertension and the like, is still an open question. These 'indirect' effects in humans can be activated by so many different stimulus factors (both external and internal to the individual including basic emotions, that it has not been possible to establish unambiguous causal relationships between the various noises and their purported effects.

I would urge all readers of this report to study this paragraph from Dr. Nixon's report to try and determine just what he is saying. Is he saying that although some researchers have shown a link between loud noise and adverse health effects, until that relationship is firmly proven and unambiguous to all concerned, the Air Force will continue to expose unwilling people to loud noise and assume no responsibility for the consequences? Is he not also saying that because the same physiological mechanisms are activated by many factors including emotions that it is all right to add sonic booms? What exactly is Dr. Nixon saying?

I submit that Dr. Nixon is clearly aware of the many studies that indicate

loud noise causes adverse health effects through repeated activation of the stress response. I also submit that he is "clutching at straws" to keep from admitting that the causal mechanisms have already been shown to be clear and unambiguous. Perhaps the courts will have to decide when results are "unambiguous." I believe that the case can be made now.

RESPONSE TO LT. COL. JOHNSON

Section 1. I would like to focus on the first quotation referenced by Johnson. Most of the quotation is irrelevant but the first two sentences could be misleading to the untrained.

Noise can elicit many different physiological responses. However, no clear evidence exists indicating that continued activation of these responses leads to irreversible changes and permanent health effects.

Please note the words "irreversible" and "permanent" in the quotation. If hypertension results from continuous exposure to loud noise (such has been demonstrated in humans and experimental animals!) that would not be counted in the above quotation because it need not be "permanent" as it can be successfully treated (i.e. reversed). If an individual develops gastrointestinal lesions from exposure to loud noise as has been demonstrated in workers in certain industries, it would also not count as a "permanent" and "irreversible" health effect. Hypertension is a non-permanent (potentially at least) and reversible health problem that causes large numbers of deaths in this country each year. I submit that the first quotation submitted by Johnson is irrelevant to the thesis I have advanced in my health effects report. I also challenge the contention that irreversible and permanent health damage does not occur with exposure to loud noise. The evidence is presented in my health effects paper in connection with the reproduction and later behavior of laboratory animals. This literature is completely overlooked in the noise effects surveys

I have seen. Birth defects, miscarriages (through release of oxytocin), and behavioral disturbances are likely to be permanent and irreversible!

The second quotation, that from Dr. Burns, is correct. I agree that "caution" must be used in accepting conclusions from research studies concerning effects of noise exposure on human and animal health. In view of the many studies we presently have that indicate adverse health effects from continuous exposure, what about exercising the same caution in regards to exposing individuals in the future? It is possible to pick on almost any study and say that such and such was not adequately controlled. However, we have an added consideration here. Many studies have now been completed that show that man is adversely affected by exposure to loud noise for long periods of time. These studies cut across different industries, cultures, and environments, but all have in common the exposure of individuals to loud noise. Many of the studies have been carefully controlled. The common thread is loud noise. One can clutch at straws and say "to be scientifically objective" something is wrong with each study. This is clearly an unreasonable approach. To add one more bit of recent evidence to the controversy, I cite a recent summary article from Parade (Dec. 2, 1979):

Noise and blood pressure. Continued exposure to loud noise not only impairs hearing, it can also raise blood pressure. So contends the Federal Health Agency of West Berlin, whose findings are being studied by the World Health Organization.

Research scientists in West Berlin monitored workers in a bottling plant where the average noise decibel level was 95. After several days of wearing ear covers, their blood pressures went down. Once the ear covers were removed, their blood pressures rose.

According to the study, continued exposure to high noise levels can cause not only high blood pressure but eventually some heart damage.

This type of controlled study completely takes the rug out from under the authorities Nixon and Johnson reference with their contentions that other environmental factors have not been controlled and screened out. In

this study the workers continued to work in the same environment. Noise exposure was controlled by wearing ear covers. It is clear that the noise was the factor responsible for the elevation of blood pressure.

I might point out that I have already referenced in my health effects report the studies that have shown that impulse noise is just as bad as continuous noise in causing the responses that impair health. I will also point out that the sonic booms projected for the operations areas are many times louder than the 95db background noise in the factory in West Germany.

The final remarks in Section 1 regarding hearing as the most sensitive indicator of physiological damage is misleading and simply not true. Chronic auditory stress is the most important health consideration.

Section 2, Specific Comments, A. I was completely aware of the energy distribution of sonic booms when I wrote my report and I can see here that Johnson is guessing that the threshold levels established by Jansen for initiating the physiological responses might not be exceeded by the nominal sonic booms that would be experienced in the operations areas. This question can be resolved by simply asking if any studies show that sonic booms initiate a true startle response? If such is the case, then the physiological mechanisms would be activated that would cause the stress responses that could lead to the deterioration of health with long-term exposure.

In an important FAA sanctioned study by Thackray, Rylander, and Touchstone (1973, FAA-AM-73-11) it was clearly established that sonic booms trigger a true startle response in female subjects. They estimated that outdoor booms of about 50N/m^2 (= about 1 PSF) was close to the threshold for producing startle responses in some of the subjects inside the frame test building. They also found that a marked jump in the percentage of individuals experiencing startle effects occurs when the overpressures reach 150-180N/m² outdoors (only

40-46N/m² inside the frame test building). They did not determine what levels outside would initiate startle responses in individuals who were exposed outside or what the threshold levels might be for males. They also reported that no habituation was possible to the louder booms. I have two or three other references that I can supply on request that have shown no habituation is possible to sonic booms.

Section 2, B. I must admit that I am partly in error in regards to the scope of the proposed testing; however, Johnson's estimates are almost certainly in error and are not supported by factual surveys. He predicts that an individual will experience no more than a few booms per day. Now that I know the exact scope of the proposed testing I predict that some individuals will hear 20-40 booms per day on some days with an average of close to 15. If the use in either proposed area is doubled, the average will double. . Who is correct?

In order to determine the exposure level one must know several parameters and then conduct an appropriate survey. First, one must know the distribution of the population in the operations area. Second, one would need a saturation map showing the density of booms as a function of surface area as an operations area would not be uniformly utilized. With these two facts one could then design a sampling procedure and analysis that would provide a true picture of what individuals are experiencing. Johnson has given us his opinion that some people will hear an average of two booms per day, but it is possible that others living near the areas of greatest use within the operations areas will hear most of the booms every day. In the absence of a valid survey, the potential exposure of some people to every boom generated must be considered. If this project is approved, then the exposure of individuals to 40 booms/day or 80/day, if the use were to be doubled in either area, would be within the proposal limits. We know very little about annoyance from such saturation booming as the Oklahoma City test only subjected individuals to about eight per day. I will elaborate

on this point below.

Section 2, C (pp. 3-4). Regarding the frequency of focus booms I can only say that I completely disagree with the estimates given by Johnson for the same reason outlined above.

Section 2, C (pp. 4-5). In this section Johnson quotes conclusions drawn by Kryter. These conclusions deserve comment.

Kryter clearly acknowledges that a stress response does occur in the human in response to loud noise (point 3). He does not appear to be aware of studies that contradict some of his conclusions. For example, his conclusion that "there is no likely damage risk to a person from possible unconditioned stress response to noise" is certainly challenged (but not yet positively refuted) by studies that have shown that the high levels of circulating catecholamines released during stress can cause birth defects in experimental animals and by many other studies that have demonstrated disruption of normal gestation in rats subjected to stress. Should any of these effects also occur in humans I would consider that to be damage from the stress response. I might add that the recent study from West Germany has linked the high blood pressure caused by exposure to factory noise to heart damage.

Kryter's second point that environmental factors associated with noise might be more important than the noise itself causing physical and psychological disease is true in some cases but is not the best explanation for the variety of studies we have today. Studies such as the West Germany study referenced above and other controlled studies I have reviewed in my health effects report show that it is the noise that is causing the deterioration of health in some exposed individuals.

In Kryter's third point he acknowledges that "autonomic system stress responses could conceivably be a contributing factor to ill health in some persons as a result of noise in their living environment" He tries to

equate this with disruption of communication and sleep which further aggravates the condition. I do not think that anyone will deny that well-rested people can better handle stress, but all of the studies of workers from noisy industries deal with people who presumably go home to quieter home environments after work. I suspect that Kryter is thinking in terms of those studies that concern populations living within noisy environments, such as those who live near airports. In those cases I can see that he has a point as rest would be disturbed, but the many studies concerning exposure to loud noise at work do not support his conclusion.

Johnson's comments in the first paragraph of page five again raise the issue of demonstrating clear cause and effect relationships between exposure to loud noise and health problems. He demonstrates here that he is not familiar with the literature (see my health effects report for references). In the case of blood pressure, for example, blood pressure changes have been monitored in humans in the laboratory in response to loud noise. We also know what intensity of noise is required to produce the automatic and involuntary increase in blood pressure. Studies have shown that individuals working in noisy factories have elevated blood pressures compared to individuals working in quieter factories. Now it has recently been shown that individuals who start wearing ear protectors to reduce the perceived noise experience a reduction in blood pressure while they are still at work in the same environment with the same machines, dust, vibrations, anxieties, and whatever. The issue is now very clear and the attempts by Johnson and the Air Force to play down these studies is not justified.

In the last paragraph on page five Johnson raises the issue of annoyance. This subject was not covered in my health effects paper, but I will make some comments on this problem. Johnson tries to play up the importance of "house rattle" as the most sensitive effect of sonic booms. I have already cited a study that has confirmed that many people experience a true startle response to

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sonic booms. Every human being who can read this report has been startled at one time or another. This is always a very unpleasant and truly annoying experience. The issue is not about the few people who elected to equate the annoyance to "house rattle" which is something that perhaps they better understood among the few choices on the questionnaires rather than the true physiological response to being startled. There is absolutely no question about the fact that sonic booms are annoying to many individuals because they startle those individuals. There is also the fact that many individuals in the Oklahoma City survey found the experience completely unacceptable.

As for guidelines to reduce the annoyance, one can refer to a number of documents that have something to say. It is important to realize, however, that the Air Force has not conducted the proper studies that will adequately describe the impact of the proposed project on the human population. The opinions of Johnson are not adequate. I have indicated in a previous section what would be required to demonstrate impact. Anything less than that would be inadequate. We must assume that some individuals will hear every boom (full proposed impact) until the Air Force conducts the appropriate unbiased surveys in some operations area.

In the EPA report "Information on levels of environmental noise requisite to protect public health and welfare with an adequate margin of safety" (1974) it was concluded:

Thus, the peak over-pressure of a sonic boom that occurs during the day should be no more than 35.91 pascals if the population is not to be annoyed or the general health and welfare adversely affected. (Note: 1 PSF=47.88 pascals).

This document also points out that for eight booms per day the level should be less than 12.45 pascals.

In another important study by B. O. Lundberg (1969), "Acceptable nominal sonic boom overpressures in SST operation," IN: Proceedings of the conference,

noise as a public health hazard, W. D. Ward and J. E. Fricke, eds., pp. 276-297, the following conclusions were reached:

1. Supersonic overland operation of the SST would impose, all over the world, a worse than airport-like environment over numerous recreational and residential areas. To permit this would be an unthinkable atrocity.
2. For the SST boom to be acceptable over land, its nominal intensity must be reduced from the currently anticipated level of 2.0 PSF at initial cruise to the order of 0.2 PSF if the SST is believed to be greatly needed and economic and about 0.1 PSF, or even less, if SST operation will be generally regarded as unwanted and uneconomic, i.e., must be subsidized to be kept alive.

Lundberg based his analysis on the responses and data from the very Oklahoma City study that Johnson referenced.

Section 3. It is quite right that I am concerned about the effects of sonic booms on the health of residents in the proposed operations areas. Johnson should be concerned and for the same reasons. It is the civilized society that takes what it has learned and applies that knowledge for constructive purposes. To ignore the volumes of data that are now available concerning the effects of loud noise on health is unethical. The Air Force must abort its plans to test the F-15 over populated areas, or it must accept responsibility for the health and welfare of the individuals that are to be exposed.

A CONCLUDING ANALOGY

I would like to conclude my response to the critiques with a simple analogy that I think might clarify the issues. Let us assume that the sonic boom is a drug alleged to have some healing property and that the Air Force is seeking permission to use it on humans. The potential side effects as determined from studies of laboratory animals and some human studies are the following: hypertension, heart damage, gastrointestinal lesions, endocrine

disturbances, increased incidence of birth defects, psychological disturbances, abnormal spermatogenesis, decreased fertility, and disturbances of normal body rhythms. What would be the chance that the FDA would sanction the use of such a drug on humans? I think the answer is obvious.

The U. S. government has made some monumental errors regarding exposing human populations to health-damaging factors in the past. One such example that has been in the news recently concerns atomic fallout over a small western town near the test site. The individuals in that community have suffered from an extremely high incidence of cancer. Perhaps at the time that the testing was done little was known about the long-term consequences to the radiation exposure. In the present case the Air Force wants to expose humans to excessive loud noise pollution without the consent of the individuals involved. We also know what the expected health consequences of such a premeditated act will be on the population. Yet the Air Force has made little effort to find a less populated site or to assume any responsibility for the consequences of the act. The legal consequences are likely to set precedents because the Air Force knows before the testing starts that studies have shown that the health of individuals is likely to be affected. To forge ahead with the untenable position held by the Air Force that cause and effect relationships have not been adequately proven is irresponsible.

Richard D. Worthington
Associate Professor
Department of Biological Sciences
The University of Texas at El Paso

APPENDIX C

Controversy Surrounding Sells
Flying Activity

APPENDIX C-1

Newspaper Articles

APPENDIX C-2

Correspondence

Arizona Daily Sun-8/11/75

Papagos Petition Over Sonic Boom

SELLS (AP) — Legal officials of the Papago Indian tribe have filed a petition with the Federal Aviation Administration concerning sonic booms by Air Force jets over the reservation.

James J. Prucell, a lawyer in the Papago Legal Services office here, said there has been a "sizeable number" of complaints from most of the tribe's 15 major villages in the last two years on sonic booms and other aircraft noises.

He said statements detailing some minor injuries, property damage, frightened children and general disturbances have been filed.

Officials at Luke Air Force Base near Phoenix and Davis-Monthan Air Force base at Tucson confirmed that their jets regularly fly over the Papago reservation, west of Tucson.

Luke officials said supersonic flights and low level flights are made over the reservation as part of routine training missions. Davis-Monthan officials said most reservation flights are low-level.

"It has gotten to the point where my children stop and look at the windows whenever a sonic boom occurs," said Marvin Garcia, who lives in Little Tucson village, about 10 miles east of here.

Garcia said he regularly replaces windows broken by sonic booms and his house has two large cracks in walls because of the booms.

Similar damage has been reported by others on the reservation.

The Papago Runner

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THE PAPAGO INDIAN RESERVATION, APRIL 1977

VOL. 1 NO. 3

Compensation Available For Sonic Boom Damage

If your home has received damage that you attribute to sonic booms, you can receive compensation from the U.S. Air Force.

According to military officials, persons wishing to file a compensation claim can do so by writing a letter to the Staff Judge Advocate, Davis-Monthan AFB, Tucson, AZ., 85707, indicating that damage has been suffered because of a sonic boom. A self-explanatory claims kit will be mailed to you.

Capt. Michael Heenan, information officer at Luke AFB near Glendale, said all a person has to do is specify where he lives, what happened, the time and date the sonic boom and the

damage occurred. This information will be matched with a log of supersonic activities kept by the Air Force.

Compensation for broken windows is routine. However, if other damage is involved, such as structural damage to walls, floors and ceilings, investigators will likely visit the damage site to make a determination as to whether a sonic boom could have caused the damage.

If the investigators attribute the cause to a sonic boom, and the time and date of the sonic boom correspond with the Air Force's supersonic activities log, the claim will be paid, Air Force officials said.

DISPATCH, August 14 & 15, 1975

Papagos Voice Concern Over Loud Sonic Booms

SELLS (AP) — Legal officials of the Papago Indian tribe have filed a petition with the Federal Aviation Administration concerning sonic booms by Air Force jets over the reservation.

James J. Pruce, a lawyer in the Papago Legal Services office here, said there has been a

"sizeable number" of complaints from most of the tribe's 15 major villages in the last two years on sonic booms and other aircraft noises.

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PAPAGOS

Continued from page 1

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Garcia said he regularly replaces windows broken by sonic booms and his house has two large cracks in walls because of the booms.

Similar damage has been reported by others on the reservation.

ARIZONA DAILY STAR

Sonic Booms Again

The Papago Indian tribe has filed a petition with the Federal Aviation Administration concerning complaints over damage resulting from jet sonic booms. The Papago complaints are not the first; Tucson residents also have registered protests and claims over damage.

What is extra irritating concerning the Papagos is the admission by both Luke Air Force Base near Phoenix and Davis-Monthan Air Force Base that supersonic and low-level flights are made over the reservation as part of routine training missions. This must be interpreted as meaning the U.S. Air Force considers the reservation as a training area for its jets

and that would indicate little consideration for the residents of the reservation. The Air Force, of course, will quickly counter that it does have regard for the reservation Indians.

The Air Force can best prove its intentions by answering directly to the complaint of only one Papago reservation Indian, Marvin Garcia, who said he regularly has to replace broken windows and also has two large cracks in the walls of his home at Little Tucson village. But the complaints from the reservation are widespread and the Air Force should reconsider its "routine" of supersonic and low level flights over the Papago villages.

Raymond Dandy

RECEIVED AUG 18 1975

Sonic booms anger Papagos

ARIZONA DAILY STAR, 5/30/77

Air Force reviewing over-reservation flights

By JUDY DONOVAN
The Arizona Daily Star

The Air Force is reviewing its practice of flying jets at low levels and supersonic speeds over the Papago Indian Reservation.

But apparently little can be done to end the training missions that the Papagos say have cracked walls, shattered windows, stampeded cattle and terrified children. The damage was detailed in an Arizona Daily Star special supplement April 24.

The Dept. of the Air Force has issued a reply saying it has "no current plans to change or discontinue either low-level or high-level supersonic flight training."

However, the Air Force said it is reviewing its operations to see whether there are

alternatives that would reduce sonic booms or other aircraft noise over the reservation.

Earlier this year the Air Force asked the Federal Aviation Administration to formally chart the reservation as a low-level flight area for planes from Luke AFB near Phoenix and from Davis-Monthan AFB. The FAA has proposed, in turn, that the charting be done.

But the Papagos passed a tribal resolution protesting the move. The resolution calls the proposed charting another attempt by white society to deprive Indians of the "quiet enjoyment of some of their last remaining rights and assets."

A public hearing may result.

The tribe will have another chance to oppose training operations when the Air Force renews its application soon to contin-

ue military operations at the Gila Bend Guntery Range. The range is near the northwestern boundary of the reservation and jets use it to make flights over reservation lands.

Five Papagos and tribal attorney William Strickland met with Air Force officials at the Pentagon in Washington on April 21 to explain the tribe's resolution.

"We pointed out to them that they never came and asked the tribe for permission or made any agreement with us to fly over the reservation," said Ed Kisto, a tribal council member from Baboquivan District. "I told them that if they're going to train over the reservation then I guess we can come and wander around Luke."

Strickland said he sees no solution. "They showed us where all the other

sparsely populated areas were taken up planes from other Air Force bases," said.

In the Air Force reply, Col. William Taylor said it may seem a simple process: restrict aircraft from flying over the reservation, but flight patterns are determined by many factors.

"We must consider, for instance, a wide variety of aircraft involved, each with its own flight and noise characteristics," he said. "We must also consider local topography, other air traffic and more densely populated areas."

U.S. Rep. Morris K. Udall, D-Ariz., notified the FAA of the Papago opposition and has asked it to look into the complaint and to compare them with Air Force requirements.

Supersonic flights moved

Air Force to cut Papago 'buzzing'

By EDWARD J. SYLVESTER
The Arizona Daily Star

The Air Force will sharply reduce its low-level flights over the Papago Indian Reservation and move to cut back the sonic booms that have been a chronic cause of damage and injury there.

Col. Robert E. Blake, deputy commander for most training operations at Luke AFB, has already ordered jets under his command to maintain minimum altitudes of 2,000 feet over populated areas and has moved some supersonic flights out of the reservation airspace.

Tribal officials reported, and the Air Force confirmed, that Blake will hold monthly meetings with the Papagos to discuss problems, and that after the first meeting on July 28 he made these flight changes.

Periodically for more than 20 years the tribe has complained to the Air Force that its low-level training flights have stampeded cattle, terrified children and damaged schools across the 240,000-acre reservation west of Tucson.

Until now, tribal leaders say, they have received no cooperation from the Air Force in solving the problem. But tribal chairman Paul Williams and other Papago representatives say the July 28 meeting started a complete change in attitude by the Air Force.

During a tour of the reservation that day, Air Force officials saw damage reportedly caused by sonic booms and heard eyewitness accounts of cattle stampeded and schools "bumped" during low-level flights.

Windows have been shattered and walls cracked at some schools, and several years ago a jet crashed near the large Santa Rosa Boarding School.

At San Simon school, just as an officer was explaining that low-level flights over schools were forbidden even under current regulations, four jets buzzed the building, according to a tribal spokesman.

"Now that the Air Force has seen and heard some of these things firsthand, I think we've gone a long way toward improving the situation," said Mark Ulmer of Papago

Legal Services, who was authorized by Williams to release results of the meeting.

Some of the damages attributed to jets and a record of the nerve-jarring sonic booms over the reservation were reported as part of the Arizona Daily Star section on the Papagos published in April.

One of those incidents involved Joseph Angas of Hickman, whose home was seriously damaged by a sonic boom several years ago. Ulmer said the Air Force had agreed to pay for repairs to Angas's home.

The Air Force feels that it must keep using portions of the reservation for training flights, according to Paul Sewell, information officer for Luke.

"But we're very much interested in easing whatever impact these flights have on people living there," Sewell said. He said that Blake, who commands six of Luke's eight tactical jet squadrons, has been designated as the Air Force contact with the Papagos, and that Blake personally would attend all the monthly meetings.

Until now, jets entering the Gila Bend range have been permitted to fly at 1,500 feet along certain air corridors. Blake raised that minimum to 2,000 feet over populated areas, Sewell said.

Sonic booms, for the time being, will remain. But some supersonic testing will be moved west of the reservation, he said.

Ariz. Daily Star 8/9/77

ARIZONA DAILY STAR
8/9/77

12/20/82

Tucson Citizen

Papagos consider legal action against Air Force

By The Associated Press

SELLS — The Air Force is guilty of repeated violations of rules governing the Sells Military Operating Area in south-central Arizona, a Papago tribal official says.

Vice Chairman Francisco Jose Jr. said yesterday he had met with other tribal leaders to discuss legal recourse against the Air Force after jet-fighter exercises were conducted Dec. 10.

Sonic booms from low-flying jets broke windows and cracked walls

in houses on the reservation, tribal officials said.

"Some of the statements we heard were that the planes weren't much more than telephone-pole high," Jose said. "We also heard they flew directly over the village of Vaya Chin despite the fact that the villages were circled on their maps."

An agreement between the Papago Tribe and the Air Force stipulates that jets should not fly below 3,000 feet and should stay within flight corridors that avoid villages on the reservation.

Sunday, August 1, 1982

Papagos say Air Force ignores pact

Indians critical of noisy jets,
claim planes out of control

By Anne Outberg
Republic Staff

Papago Indians are complaining about Tuesday's crash of two Air Force jets over the reservation, protesting the noise of low-flying jets and expressing their fears that someone will be injured in a crash.

The F-5 jets crashed on the reservation Tuesday afternoon, killing one pilot, Capt. Larry Dowell, and injuring two others, Capt. Albert Phillips and Lt. Abdul R. al-Sharhi.

The pilots were performing fighter maneuvers when the accident occurred.

The jets were from the 425th Tactical Fighter Training Squadron at Williams Air Force Base, part of the parent organization of Luke Air Force Base's 405th Tactical Training Wing.

"What really concerns me is the planes were out of control," Papago Vice Chairman Enos Francisco said after Tuesday's crash.

The Air Force hasn't kept the agreements made

at public hearings in 1977 and 1979, when it agreed that pilots wouldn't fly below certain altitudes or fly over populated areas, Francisco said.

Lt. Col. James Reinhard, a Luke spokesman, said, "Our current flight routes, including low-level routes, were agreed with" at the public hearings.

Since then, Reinhard said, the Air Force has added no new routes.

He said the Federal Aviation Administration has authorized military flights over the reservation as part of the Sells Military Operating Area, which includes a region from southwest of Tucson to the borders of California and Mexico.

Sonic booms caused by low-flying aircraft have "really scared the daylight out of me sometimes," Francisco said. Children and elderly people are affected even more by the loud noise, he added.

The noise has broken windows and cracked walls of the Indians' adobe houses, according to Francisco.

The Papago Tribe has made no direct complaints to the Air Force since Tuesday's crash. Francisco said the Tribal Council will address the issue at its meeting Thursday and Friday.

Sunday, August 1, 1982

Papagos say Air Force ignores agreements, jets are out of control

By Anne Osberg

Republic Staff

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The pilots were performing fighter maneuvers when the accident occurred. The jets were from the 425th Tactical Fighter Training Squadron at Williams Air Force Base, part of the parent organization of Luke Air Force Base's 406th Tactical Training Wing.

"What really concerns me is the planes were out of control," Papago Vice Chairman Enos Francisco said of Tuesday's crash.

He said he thought the Air Force should have reported the crash to the reservation.

The Air Force hasn't kept the agreements made at public hearings in 1977 and 1979, when it agreed that pilots wouldn't fly below certain altitudes or fly over populated areas, Francisco said.

"Apparently, they're breaking their own policies," he said.

Lt. Col. James Reinhard, a Luke spokesman, said, "Our current flight routes, including low-level routes, were agreed with" at the public hearings.

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The noise has broken windows and cracked walls of the Indians' adobe houses, according to Francisco.

It seems like the Air Force is harassing people and "goes out of their way to scare people," he said.

One of the Papago villages was having a meeting, Francisco said, and nobody could hear anything because planes were flying so low. He said pilots also fly low over traffic and follow vehicles.

"They're not following their agreements. They seem to think they can do anything," Francisco said.

He said there has been no effort on the part of the Air Force to understand the Indians' position.

"They should go someplace else and do their training," Francisco said.

The Air Force is sensitive to the concerns of the Papagos, Reinhard said, but added, "We have to train in a realistic manner."

Reinhard said the chance of anyone on the Papago Indian Reservation getting hurt is the same as that of a building in downtown Phoenix being hit by a Boeing 747.

The Papago Tribe has made no direct complaints to the Air Force since Tuesday's crash. Francisco said the Tribal Council will address the issue at its meeting Thursday and Friday.

Vaya Chin Is Badly Shaken By Sonic Boom, Low Flying Jets

by Donna Jones

In one home a woman ran from room to room crying as the walls of her house shook and a television screen burst.

Another woman dove under a truck when she saw the planes. But the truck began vibrating so badly it moved, she says.

When Henry Ramon heard the sonic boom he was in his pickup truck five or six miles away from Vaya Chin and didn't think much of the noise.

But in his village, windows burst, walls shook, plaster cracked, and people ran for cover, some thinking a plane was about to crash, as three Air National Guard jets flew over Vaya Chin, some say just 300 feet above the ground.

Although the village is accustomed to low flying military planes and sonic booms, Ramon, who is a tribal council representative, said the Dec. 10 incident, which happened around 9:30 a.m., was like nothing before. Most village residents were terrified, he said.

"The people still aren't out of shock. It seems as if someone died. They're so quiet. It seems like they're going through a period of mourning," Ramon said of his neighbors.

In addition to reportedly damaging homes, the planes almost seriously injured a child and may have damaged the hearing of some residents.

Ramon said. A two-year-old child was moved from near a window just before it shattered, he said.

Many village residents experienced a temporary hearing loss, he said. One woman lost her hearing for two days and last week was still experiencing ringing in her ears, he said. Fluid and pus have been running out of the ears of one child since the incident, he said.

What is most unnerving to villagers is that they feel it could happen again at any time, Ramon said.

According to Papago Legal Services attorney John Harris, walls in at least four homes were damaged by the sonic boom. At least 11 homes, three of which were HUD homes built two years ago, reported damaged windows, he said.

According to Harris, exterior plaster on the homes was cracked, but they may also have some structural damage underneath, he said. He said some walls looked warped and nails in support beams for the roofs looked twisted.

A structural engineer brought into the village by the Air National Guard said structural damage to walls couldn't have been done by the aircraft, Harris said.

The legal services office is helping residents file claims with

the Air National Guard for damages, he said.

Commander John Hartnett, head of the guard's 162nd Tactical Group, said Air National Guard A-7 jets were participating in exercises over Vaya Chin during the time the sonic boom occurred.

He said, however, that it was not an A-7 that could have caused the damage attributed to the sonic boom because A-7s aren't capable of supersonic speed.

Though it is unlikely Air National Guard jets caused the damage, Hartnett said. "We felt very badly about the whole thing. I had sent a group of people to talk, look and investigate as much as they could."

Hartnett said the jets were participating in exercises with the Air Force, Navy and Marines.

He said he has not been able to substantiate it, but the sonic boom may have been caused by another military jet flying above the A-7s.

Harris said. "They're making the task of placing liability like finding a pea in a shell game. They're making it very difficult to nail down who was responsible."

Harris called the Air National Guard's explanation of what

Continued On Page 8

DECEMBER 21, 1983

Sonic Boom, Low Flying Jets Damage, Distress Vaya Chin

Continued From Page 1

caused the sonic boom a "self-serving hypothesis."

"The odds of that happening are astronomical. It sounds pretty far fetched, but it's difficult to refute the hypothesis," he said.

Although the guard isn't assuming responsibility, they did pass out damage claim forms at a village meeting, Harris said.

Since the physical damage doesn't coincide with their theory of what happened, they'll probably reject most of the claims, Harris said.

A \$2,500 limit was placed on each claim and that may not cover all the damage in some cases, Harris said.

Hartnett said "The claims that are legitimate, and the Air Force tends to be liberal (in their judgement), will be compensated."

He said the Air Force, not the Air National Guard, is the body that will actually be deciding on the claims and making compensation.

Harris said the tribe is now looking for its own experts to refute the Air National Guard's theory.

Ramon also said he didn't believe the theory. "We don't buy that. These people were there. They saw the plane throttle up and that's when the boom came," he said.

The district's other tribal council representative, Delma Garcia, said the Air Force and Air National Guard aren't living up to agreements made with the

tribe in 1979 during public hearings held on the reservation.

According to Harris the Air Force at that time made no formal agreements, but did acknowledge certain limitations it placed on itself.

Air Force officials said supersonic aircraft would fly no lower than 3,000 feet above populated areas, and that subsonic planes would fly at least 500 feet above and around any person in the desert, he said.

"My feeling is it's frustrating they're not doing what they said they were going to do. You could say it's one of a long list of broken promises," Garcia said.

Ramon said he would bring a resolution before the tribal council to ensure that the tribe seeks compensation for the people of Vaya Chin and that it address the overall problem of military aircraft flying over the reservation.

Vice chairman Francisco Jose said, "We can and will try to get sanctions against the Air Force."

He said the tribe will first follow the claims process and investigate the incident. But he said one option may be to take legal action against those responsible.

Hartnett said he is aware of problems reservation residents have had with the Air Force in the past, but for the Air National Guard, this is a first.

"This is the first incident that we have had in my memory," he said. The guard has had a wing stationed in Tucson since 1956, Hartnett said.

Social worker claims jets' sonic boom blasts windows on reservation

By PATRISIA GONZALES
and PAT BRENNAN
Citizen Staff Writers

Windows imploded and walls shook when supersonic jets made a sweep last Saturday over a village on the Papago Indian Reservation, according to a social worker who says he saw the damage.

Meanwhile, a spokesman for the Arizona Air National Guard, who said the planes probably had been participating in an exercise involving Air Force, Marine and Navy planes over the area, said the incident is being investigated.

John Harris, who works with the Papago Legal Services Bureau in Sells, 60 miles west of Tucson, said windows in six or seven houses imploded after a sonic boom Saturday morning. He said that a sleeping 2-year-old child had been moved away from a window, moments before it burst.

A spokesman at Air National Guard headquarters near Tucson International Airport, who declined to identify himself, said last night that the training missions were flown Saturday and Sunday morning. He said F-16 fighter jets from Luke Air Force Base near Phoenix, as well as F-4 and F-18 jets, participated in the exercise.

Navy planes from the Naval Air Station in Lemoore, Calif.; Marine aircraft from El Toro, Calif., and AWACS aircraft from Tinker Air Force Base in Oklahoma also participated in the weekend exercise, the spokesman said. He said no Davis-Monthan Air Force Base crews participated.

Harris said one woman claimed that her car was moved several feet by the vibration of the sonic boom, and that another woman told him that she drove under her truck for protection.

Harris said he did not witness either incident, but said he did see broken windows and cracks in the walls of houses, some of which were built with a grant from the U.S. Housing and Urban Development Department, less than three years ago.

Rattling windows also were reported Saturday morning on the West, East and North sides of Tucson. One resident said the shaking lasted for 10 or 15 seconds.

Harris said one villager estimated that the planes flew as low as 200 feet above the ground. He said some reservation residents complained of a painful ringing in their ears and temporary deafness.

"They (the jets) are a randomly predictable form of harassment out here," said Harris, who lives in Sells. The village he said was damaged, in the northwestern portion of the reservation west of Tucson, is called Vaya Chin, and includes about 30 homes, Harris said.

The unidentified spokesman said that if any damage had been done, it was not the result of Air Guard jets, because the Guard used no supersonic aircraft. He said jets would have been flying in the area at around 9:30 a.m. Saturday.

Members of the Papago tribal council were not available for comment last night. Harris said tribal officials were preparing a statement for release today.

The Arizona Republic

• Saturday, January 7, 1984

Papagos want flights over reservation to stop

Republic Staff / Associated Press

SELLS — The Papago Tribal Council unanimously has adopted a resolution calling for an end to Air Force flights over the reservation and making the problem a top priority for legal representatives of the tribe.

A sonic boom last month shattered windows and cracked walls in the village of Vaya Chin, 60 miles southwest of Casa Grande.

Officials at the Sells Indian

Hospital said about 15 residents of Vaya Chin have been to the hospital, complaining of pain and ringing in their ears since the sonic boom occurred.

John Harris, who represents Papago Legal Services Inc. on the reservation, said he has about 12 claims of damage against the Air Force on file in his office.

Harris said one man was back-packing in the mountains near

Vaya Chin on Dec. 10 and signed an affidavit this week affirming that supersonic aircraft flew over the village that day.

"He said that the planes definitely were not A-7s," Harris said. "He said they could have possibly been F-14s or F-15s. He and all the villagers said three planes flew over the village and the third plane caused the sonic boom."

Arizona Air National Guard officials said no supersonic aircraft

were used during the maneuvers.

The boom occurred during a combined exercise of planes belonging to the Arizona Air National Guard, the Navy, the Marines and Luke Air Force Base, Air Guard officials have said.

Officials at Luke said in a prepared statement Thursday that they are keeping in contact with tribal officials and will arrange to meet with them soon.

Papago Tribal Council seeks to halt military overflights, sonic booms

By Ernie Heitsley
The Arizona Daily Star

Spurred by complaints of recent sonic booms over a remote Papago Indian village, the Tribal Council has voted to have the Air Force stop its flights over the huge reservation.

The council unanimously passed a resolution seeking legal ways of ending the overflights Thursday, a tribal spokeswoman said.

Papagos in the tiny village of Vaya Chin who were harmed or whose property was damaged by the sonic booms on Dec. 10 and 11 are being asked to register their complaints with Papago Legal Services Inc., tribal legislative aide Elida Manuel said yesterday.

Vaya Chin, in the Hickman District in the northwestern corner of the sparsely populated, 2.8 million-acre reservation, is about 50 miles west of Tucson.

The damage apparently was done by one or more of about 40 aircraft used in a two-day military exercise involving the Air National Guard in Tucson, the Navy, the Marines, and Luke Air Force Base near Phoenix.

Manuel said villagers reported planes flying as low as 100 feet, and some said the noise of aircraft breaking the sound barrier left their ears ringing.

Col. John M. Hartnett, commander of the 162nd Tactical Fighter Group, has said that National Guard planes cannot fly at supersonic speeds.

But a spokeswoman for Hartnett said yesterday that supersonic aircraft — F-4s, F-15s, F-16s and F-18s — were used by other groups in the exercise.

She quoted Hartnett as having said after the incident that there was evidence of sonic booms having occurred.

Manuel said all supersonic flights must be made above 10,000 feet. The Air Force agreed in 1979 that no flights over the reservation, regardless of speed, would be made below 1,000 feet, she said.

She said that since the 1940s, the area has been referred to as the "Sells Military Operations Area," and that some Papagos have objected to it.

Hartnett said through Public Information Officer Kathryn Talalas, "We have sent a team to the village. We have made the Papago people aware of the procedures to file for claims. We also made an offer to Francisco José (vice chairman of the Papago Tribe) to mitigate immediate damage, and he turned us down."

"We continue to assist the affected Papago people with their mitigation of damage through well-established Air Force procedures," he said.

José could not be reached yesterday for comment.

A Davis-Monthan Air Force Base spokeswoman said base personnel have tried to contact tribal representatives about the possible claims, but no one has responded.

She said Davis-Monthan will handle any claims, although none of its aircraft was involved in the exercise.

Manuel said military flights over the reservation should be stopped at least until an environmental impact statement on effects of supersonic flights on people and livestock is finished.

A hearing, in preparation for an environmental impact statement, was held on the reservation in 1979, and two drafts have been prepared for the Air Force by the Benham Corp. of Oklahoma City.

Manuel said she believes that in light of the recent booms, the tribe is entitled to a new hearing.

Papagos join with New Mexico county in fight against Air Force sonic booms

The Associated Press

Officials in New Mexico's Catron County and representatives of Arizona's Papago Indian Tribe are discussing ways to fight the U.S. Air Force's plans for supersonic flights in their areas.

Catron County Commission Chairman David Vachar said he and other officials met with members of the Papago Tribal Council last week to exchange information in their mutual battles with the Air Force over the sonic boom issue.

Vachar said the problem is not limited to Catron County or the Papago Indian Reservation but affects populations in several states.

Papago Tribal Vice Chairman Francisco Jose Jr. said Wednesday his tribe also is sharing information

with concerned groups in Nevada and Utah. And he said the tribe is considering lobbying efforts at the state and national levels to prevent the flights.

Gov. Tony Amodeo has told Catron County officials he would support the Air Force plan to conduct supersonic training flights over the county. The Air Force plans to fly about 300 missions a month, which would generate about 800 sonic booms over the area.

The Air Force has not issued its final environmental impact statement on the effects of sonic booms.

But Catron County officials have said a draft of the statement is "seriously flawed" and have called for a redraft of the impact statement. They also have threatened to take the Air Force to court if flights are approved.

APPENDIX C-2

CORRESPONDENCE

NOTE:

Correspondence on pages C-2-2 through C-2-41 was included in the Draft Environmental Impact Statement (DEIS).

Correspondence on pages C-2-42 through C-2-72 was received after the Draft EIS was issued.

Correspondence on pages C-2-73 through C-2-115 was received after March 1, 1983.



LAW OFFICES OF
PAPAGO LEGAL SERVICES

POST OFFICE BOX 244
TULSA, ARIZONA 74104
TELEPHONE (918) 243-4400
TELETYPE (918) 243-4400

May 14, 1975

LARRY GARCIA
Assistant Attorney General
Papago Indian Reservation
Tucson, Arizona

ARNDT FENDEL
Assistant Attorney General
Papago Indian Reservation
Tucson, Arizona

Mr. Robert Stanton
Regional Director
FAA Western Region
P.O. Box 94007
Worldway Postal Center
Los Angeles, California 90009

Dear Mr. Stanton:

This office represents a number of individuals resident upon the Papago Indian Reservation. The Papago Reservation, as you may know, is located in southern Arizona. It includes three separate parcels of land known as the Sells Reservation, the San Xavier and the Gila Bend Reservations, which are depicted on the enclosed map. The Sells Reservation is the largest of the three. It was set apart for the benefit of the Papago Tribe by the Executive Order of President Woodrow Wilson dated January 14, 1916 and February 1, 1917. The San Xavier and Gila Bend Reservations were established by the Executive Order of July 1, 1874 and December 12, 1882. Our clients are all Papago Indians whose homes are located in various Reservation villages. These individuals and their predecessors have traditionally lived very quiet, serene lives in the Sonoran Desert. Many of the old ways of life have been carried forward to present times. Even today Papagos depend in good part upon hunting for their food. Most of their names are built with materials which the desert provides. Their surroundings remain, with one notable exception, set apart for their benefit and use. The Papago Reservation is occupied by more than eight thousand people living in approximately seventy villages distributed evenly across the Reservation.

I stated above that, with one exception, the letter and spirit of the above-mentioned Executive Order have been respected. It is that exception which is the subject matter of this letter.

It is an undisputed fact that Luke Air Force Base in Glendale, Arizona and Davis-Monthan Air Force Base in Tucson, Arizona, as well as other military bases engage in fighter jet training in the air space above the Papago Reservation in what is known as the "Sells Operational Area". This Area is depicted in the map herein enclosed. The training conducted in it is, to the best of our knowledge, of two types: 1. air-to-air combat and 2. low level navigation. The outline of the "Sells Operational Area"

C-2-2

Page 2

was provided us by the Information Office of Luke Air Force Base. You will notice that the Area encompasses nearly the entire territory of the Papago Reservation and that the Reservation occupies at least two-thirds of the Operational Area. Sells, I might add, is the largest village of the Papago Reservation, housing the Tribal Government and Bureau of Indian Affairs offices as well as the Indian Health Service Hospital.

Into the Sells Operational Area come daily and hourly flights of military jets performing the above-mentioned maneuvers, the conduct of which has created an intolerable situation for many Papago people. While engaged in air-to-air training these jets produce severe sonic booms. When navigating at low altitudes they frequently pass over or near villages, subjecting the people below to very loud engine noise. The impact of noise from aircraft flying at supersonic speeds and at low altitudes is sufficiently unreasonable, indeed, outrageous, but the damage produced by military aircraft is not limited to the destruction of the Papagos' auditory environment. It extends in the most harsh and devastating manner to their shelter. The shattering of windows and the cracking of walls, floors and ceilings are unrelenting experiences for these people, in their homes, schools and churches. As I said above, the materials for most of these structures (saguaro wood and sun-baked adobe bricks) are supplied from the desert. Almost without exception, all such buildings have been built by the people themselves. Prior to the advent of military fighter jet training over the Reservation, these structures stood solidly and served their intended purposes well. Structures built of more modern materials have likewise suffered damage in the years since the said military jet training began.

It is our belief that this training activity is unlawful.

First, it jeopardizes "persons and property on the ground", which the Administrator is authorized and directed under 49 USC § 1348(c), to protect. We believe that this section imposes a duty on the Administrator with respect to all people in the United States and their property, but it is our further position that the Administrator, as an officer of the United States, is charged with responsibility for fulfilling the trust obligations of the United States to the Papago Tribe and its members, in so far as that responsibility falls within the scope of his duties. To this extent his duty to protect the persons and property of Papago Indians on the Papago Reservation must be carried out with the highest degree of diligence, care, skill and loyalty. Through his failure to restrict the above-described training in the airspace above the Papago Reservation, the Administrator has neglected the trust responsibility which he shares with other officers of the United States.

Secondly, it violates the letter and intent of the Executive Order of 1874, 1882, 1916 and 1917, which set apart the land which comprises the Papago Reservation for the benefit of the Papago Indians. It is inconsistent for the United States to dedicate a territory as a homeland for a native people and thereafter to use that territory for jet fighter training which substantially interferes with that people's way of life. The said training activity constitutes an actual taking of the beneficial use of this land. As stated above, simply living where they do has become quite difficult for Papago people affected by the training. In the most real sense their lands are being taken from them for the purpose of providing the United States Air Force with a training area.

Thirdly, the conduct of the said training activity constitutes a breach by the United States Air Force of the trust responsibility of the United States for protecting Indian people, their lands and resources. In the context of modern society, the environment in which the majority of Papago people dwell is perhaps their greatest resource. In the past it has been the medium in which they have been able to dwell.

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clients could follow, the possibility of their obtaining relief thereby is so slight that it is practically non-existent, owing to the fact that proposals relating to issues such as I have described here are not customarily entertained by the FAA.

This letter is written on Mr. Hink's advice. Its purpose is to elicit your official opinion whether or not Subpart D or any other FAA rule or regulation does in fact provide our clients with an effective procedure in this matter. They are, of course, required to exhaust all administrative remedies before bringing their cause before a judicial tribunal. They are not, however, bound to pursue procedures in which there is no real likelihood of obtaining the relief which they seek.

Specifically, our clients seek a rule or order of the FAA prohibiting the use of airspace over the Papago Reservation for low-level navigation training by military aircraft and any training activity by military aircraft which produces sonic booms.

Because of the seriousness of the interference which our clients are suffering we wish to act as expeditiously as possible in this matter. Since a petition to the FAA would consume valuable time we are very reluctant to go forward with the Subpart D procedure if what Mr. Hink indicated is, in fact, correct. I therefore ask you to either confirm Mr. Hink's opinion that the pursuit of this administrative remedy would be a futile exercise on our clients' parts, or advise us otherwise. If it is your opinion that FAA procedures would not be futile you may regard this letter as our proposal to your office for a rule or order prohibiting military aircraft from engaging in low-level navigation training and in training which produces sonic booms in the airspace above the Papago Reservation. Accordingly, this letter is filed with you in triplicate as required by § 11.63 (a) of Subpart D.

Mr. Hink indicated to us that we could expect a speedy reply to this letter. Due to the gravity of the problem and our clients' sincere desire for a solution, that we would be very much appreciated.

Yours truly,

James J. Purcell
James J. Purcell

Copies of the foregoing were mailed on the 15th day of May, 1975 to the following:

Chairman, The Papago Tribe
P.O. Box 837
Sells, AZ 85634

Mr. William Strickland
Attorney for the Papago Tribe
Suite 802
Transamerica Bldg.
Tucson, AZ 85701

JNP/mj

Mr. Stanley K. Mathew, Secretary
United States Department of the Interior
1981 Constitution Avenue N.W.
Washington, D.C. 20242

C-2-5

build and maintain their, take their livelihood from domestic and wild animals and raise their children. The interference occasioned by the training of jet aircraft pilots has severely hampered Papago Indians in these pursuits.

Our clients' remedy by way of sonic boom damage claims is far from adequate to alleviate the interference to their lives and property by the said training.

It is the desire of this office to pursue every available remedy on behalf of our clients. We are thus prepared to follow any administrative procedure through which there is some prospect of obtaining an order prohibiting the above-described training over the Papago Reservation. In this respect we observe that under 72 Stat. 749, Section 307 (a), 49 USC § 1348 (a) the Administrator of the Federal Aviation Administration has the authority and responsibility to formulate policy with respect to the use of navigable airspace in the United States and to assign the use of navigable airspace under such terms, conditions, and limitations as he may deem necessary. We note further, as stated above, that under 49 USC § 1348 (c), the Administrator is authorized and directed

"...to prescribe air traffic rules and regulations governing the flight of aircraft, for the navigation, protection, and identification of aircraft (and) for the protection of persons and property on the ground...."

It appears to us, then, that the United States Air Force and other armed services, in making use of the airspace above the Papago Reservation, are subject to the authority of the Administrator, and that, should the Administrator deem it necessary, he is empowered to restrict those agencies from so using portions of the navigable airspace.

Our research has led us to 14 CFR Subchapter B, Part 11, Subpart D, §§ 11.61 et seq. § 11.61 states that

- "(a) This subpart establishes procedures for initiating, processing, issuing and publishing rules and orders issued under section 307 (a) of the Federal Aviation Act of 1958 (49 USC 1348(a)), including...
- ... (2) Assignments of segments of parts of the navigable airspace for special use purposes, such as restricted areas, military climb corridors, and experimental flight test areas; and
- (3) Special rules or orders relating to the assignment or use of navigable airspace.

§ 11.75 provides that

- "(a) Any interested person may petition to revoke or modify any rule or order covered by this subpart."

§ 11.63 states that all proposals for rules and orders must be filed in writing with the Director, who is defined in § 11.61 (c) as "the Associate Administrator for Programs, the Director, Air Traffic Service (or any person to whom he has delegated his authority in the matter concerned), or a Regional Director..."

In the belief that Subpart D provided a procedure through which our clients might obtain relief, we contacted your office on April 1 and April 2, 1975 and spoke with the Assistant Regional Director, Mr. Hink. During our discussion Mr. Hink advised us that, although Subpart D does set forth a technical procedure which our

C-2-4

RESOLUTION OF THE PAPAGO COUNCIL

RES. NO. 14-75

WHEREAS, it is reported to the Papago Council that military aircraft engaged in supersonic and low altitude flights over Nickman District have seriously infringed upon the rights of Papago Indians to peacefully inhabit the District as follows:

1. Noise produced by military aircraft has destroyed the tranquillity in which the people of the Nickman District have traditionally lived.
2. Military aircraft have, on repeated occasions, passed extremely close to the ground near homes, churches, school buildings and motor vehicles with the apparent intent to use them as objectives, causing the persons therein great fear.
3. Noise from military aircraft flying at supersonic speeds and at low altitudes has caused severe and recurring anxiety in infants, young children and elderly persons in the Nickman District.
4. The physical shock produced by military aircraft flying at supersonic speeds over the Nickman District has damaged and partially destroyed homes, churches and school buildings located there.
5. Noise produced by military aircraft is believed by some persons to have frightened game animals away from customary hunting areas of the Nickman District.

and

It is further reported to this council that the Papago Legal Services represents several individual persons and families in the Nickman District with respect to this matter and that these persons have authorized Legal Services to take such legal action as is necessary to bring an end to the said overflights, and that Papago Legal Services intends to take such action and

WHEREAS, this council believes that the efforts of Legal Services in this regard would be greatly assisted by the participation of the Papago Tribe, through its attorney William E. Strickland; and

WHEREAS, Papago Legal Services has expressed its desire and willingness to work together with the said William E. Strickland in pursuit of an

PAGE TWO
RES. NO. 14-75
THE PAPAGO COUNCIL

administrative and/or judicial remedy to this problem; and

WHEREAS, the Nickman District councilmen have requested that William E. Strickland also represent the Nickman District, and any other district of the Papago Reservation requesting such representation; and

WHEREAS, this Council finds that to prosecute this matter adequately the said William E. Strickland and Papago Legal Services will require the services of certain experts, that payment for reasonable and necessary expert services would be beyond the means of the various districts and of individual clients of Legal Services, and that the cost of such services could reasonably be expected to total FIVE THOUSAND DOLLARS (\$5,000.00).

NOW, THEREFORE, BE IT RESOLVED THAT the said William E. Strickland is hereby authorized and requested to represent the Papago Tribe, Nickman District which requests his representation, in an effort to bring about a cessation of supersonic and low-level military aircraft overflights of the Papago Reservation and to take, in conjunction with Papago Legal Services, such administrative and/or judicial action as he and Papago Legal Services may deem necessary or appropriate in this regard; and

BE IT FURTHER RESOLVED, that a fund of FIVE THOUSAND DOLLARS (\$5,000.00) is hereby appropriated and authorized to be expended in payment for such expert services as the said William E. Strickland deems reasonable and necessary to the prosecution of such administrative and/or judicial action; provided that no portion of this fund shall be so expended except upon presentation of a bill for services endorsed by the said William E. Strickland or his authorized agent; provided further, that in the event the said sum is not promptly available for such use, it shall be made available hereafter by the Treasurer of the Papago Tribe when the monies in the Tribal Treasury are increased either by revenue or credit.

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OFFICE TIME
8:30 AM - 4:30 PM
THE PAPAGO COUNCIL

1 The foregoing Resolution was duly enacted by the Papago Council on the 7th day
2 of April, 1975, at a meeting at which a quorum was present with a vote of 18
3 for, 1 against, 1 not voting and 2 absent, pursuant to authority vested in the
4 Papago Council by Article V, Section 2(b) and (c) of the Constitution and By-
5 laws of the Papago Tribe of Arizona ratified by the Tribe on December 12, 1936,
6 and approved by the Secretary of the Interior on January 6, 1937, (48 Stat: 904)
7 pursuant to Section 16 of the Act of June 18, 1934. Said Resolution is effect-
8 tive as of the date of its approval by the Superintendent of the Papago Agency
9 and is ~~now~~ subject to review by the Secretary of the Interior.

THE PAPAGO COUNCIL

Joseph M. Dubois
Joseph M. Dubois, Chairman

ATTEST:

William R. Garcia
William R. Garcia, Secretary

Joseph M. Dubois
Joseph M. Dubois, Chairman
APPROVED: April 9, 1975
Superintendent, Papago Agency



C-2-8



THE PAPAGO TRIBE OF ARIZONA
P. O. Box 877 • Tempe, Arizona 85281
Tel. Arizona 9604

Mr. Don M. Davis, Chief
Airspace and Procedures Branch
Air Traffic Division
Federal Aviation Administration
Department of Transportation
P.O. Box 92007, World Way Postal Center
Los Angeles, California 90009

March 29, 1977

RE: Airspace Case
77-4E-9-NR

Dear Sir:

On behalf of the Papago Tribal Council and of the 10,000 people they represent who reside on the Papago Indian Reservation located in South Central Arizona and which lies with in and comprises nearly all of the proposed Sells Low Military Operations Area (77-4E-9-NR) I wish to go on record as protesting in the strongest of terms the proposed MOA.

Attached to this letter you will find resolutions letters and petitions from various community groups and individuals protesting this proposed action and documenting the serious effects of the present military use on the life and well being of our communities.

We have are aware of the past and present combat training use of this air- space by the military. Their indiscriminate utilization, has long disrupted and threatened our various villages. Despite frequent protests to both military and FAA officials the abuse of our villages and people has continued and increased

These are not simply occasional inconveniences to a few scattered people. To the contrary, the proposed MOA encompasses an area containing more than 16,000 people in over 50 separate villages. Ten of these villages contain a population in excess of 250 persons, three in excess of 1,000 persons; and two, Sells and Ajo, have populations of 3,100 and 5,800 respectively.

The area contains two hospitals, two medical clinics, six normal schools and seven pre-schools. It has an active and growing livestock economy, two major mines, one international scientific installation, and one major medical scientific project. Student population in the area averages more than 2500 persons. Salaried work force is at least 5,500 and has grown by nearly 2,000 jobs in the past six years. General population has increased by at least 1,000 persons in the same time period.

C-2-9

In summary, the area in question has a large and rapidly growing population and a substantial and even more rapidly growing economy. It is not an uninhabited desert area. The proposed MOA would expose this area to serious disruption by military activities.

This area has ample experience with military flight operations. In the past three years we have experienced a rapid growth in both the severity and the frequency of disruptions due to flight operations. The bulk of the activity is reported as due to training flight operations out of the Luke Air Force Base.

Frequency of disruptive activity varies, apparently in accord with the training schedule of Luke and other nearby bases. It is safe to generalize, however, that throughout the year major disruptions occur at least once daily in the overall area. The normal frequency, however, is much higher. As an example, major sonic booms occurred in the Sells community on the average of at least twice per day during the December, January, February months. Sonic and subsonic disruptions occur in the Sells (G. Achi) area at least times per day and increase in frequency in the villages west of Santa Rosa. Major disruptions are experienced daily in practically all of the villages. Disruptions in proximity to Kitt Peak National Observatory reached such a status in 1978 that a high level meeting was held with FMA and military officials to try to negotiate a decrease in activity in that immediate area.

The scattered character and relatively unapologetic nature of the reservation population precludes detailed area-wide activity records. However, recent log books maintained at the Santa Rosa and San Simon boarding schools indicate an average of three disruptions daily. Older records compiled by the Sells Legal Services Office indicated an average of ten incidents per day recent observations in Sells showed an average two sonic booms per day. (copies attached) The serious effects of this military activity are wide ranging and varied. Due to the heavy low level flight activity they encompass both sonic and subsonic activity. Major effects may be divided into six categories, specifically:

1. **Physical Structural Damage:** Normally caused by severe sonic booms this includes glass breakage, cracking of stucco, separation cracks in internal walls, cracking of adobe bearing walls, and cracking of concrete floor slabs. The damage is most severe in dwelling structures, where sonic effects are exacerbated by the traditional adobe materials and the poor repair of many units (approximately 85% of dwelling units are of traditional adobe construction). Some damage has been reported recently in non-residential, especially school buildings. A few incidents have resulted in minor cuts to occupants from breaking glass. Other structural effects are severe enough to threaten the health and safety of occupants forced to continue living in the dwellings. Most such damage occurs in isolated villages to poor families and rarely results in claims filed against Air Force.
2. **Physical Disruptions:** The high level of sonic activity causes frequent disruption of scientific work and equipment at both the Sells IRS Hospital and at the Kitt Peak Observatory. Administrators at both installations have labeled the sonic and subsonic activity as a major inconvenience. Detailed comment from the Sells Hospital Director is attached.

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3. **Noise Disruption:** Caused by both sonic and subsonic activity, with the low level subsonic being the most serious due to the longer duration. The problem extends through out the reservation, but is perhaps most severe in the western section. The situation is made worse by multi-plane flights making multiple passes. Noise is an especially serious problem at the Santa Rosa and San Simon Boarding Schools (student population 550) and at the Santa Rosa Medical Clinic.
4. **Economic Disruption:** Live Stock: Basically a result of the intense noise disruption. The low flying planes and the booms cause a variety of negative reactions in cattle and in horses. There are direct reports of animals being spooked and chased off by the plane noise. Such incidents, besides obvious physical dangers, can and have resulted in the loss of an entire day's round up work for two or three men. Other, long range, effects, e.g. feeding patterns, etc., are not easily documented but are certainly not helpful.
5. **Personal Injury:** Various cases of direct personal injury due to flight operations have been reported. These include: cuts from glass broken by the sonic booms; cuts and other injuries due to structured damage; injuries caused by runaway animals spooked by booms or low flying planes; and autistic reactions in children to loud noises which appear related to sonic booms.
6. **Community Disaster Danger:** Flight activities over the reservation include not only single plane, low level activity but also dog fights and other combat maneuvers. The potential for collision and resulting crashes in occupied areas is very real. Twice with in the past three and one half years there have been mid-air collisions over the reservations. Three of the four planes crashed on the reservation with in short distances of large villages. In one of the collisions the planes bracketed the village of Hickman, population 220, crashing with in 3/4 miles of that village.

In summary, the proposed MOA is an area of substantial and growing population and economic activity. There are definite documented reports of a large range and economic activity. There are definite documented reports of a large range and high number of problems created by the existing military flight activities. The level and frequency of these problems has been increasing during the past several years. Beyond any question the proposed MOA has a serious influence on the environmental and the life of the people living with in the area.

We suggest that the frequency and seriousness of the present effects are totally unacceptable. This is especially hard to understand due to the ready availability of the Yuma Gannery Range beginning just west of the proposed MOA which is already set aside for military operations and is totally unoccupied. This space forms an immediately available and feasible alternative to the proposed reservation-based MOA.

Speaking on behalf of the 10,000 reservation people living in this area and of the area than 10 separate communities we strongly urge your reversal of the proposed MOA action. We also urge the relocation of existing authority for

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Mr. Don M. Davis, Chief
Page 4

military operations over this area. Finally, we insist that there are ample grounds in the various complaints now on file to demand the research and publication of a full environmental impact statement prior to establishment of the MOA.

Respectfully,

Carl W. Williams
Carl W. Williams, Chairman
The Papago Council

La



Public Health Service
Indian Health Administration
Office of Research and Development

Sells Indian Hospital
P.O. Box 548
Sells, Arizona 85634
March 29, 1977

Don M. Davis
Chief, Airspace and Procedures Branch
Air Traffic Division
Federal Aviation Administration
P.O. Box 92007
World Way Postal Center
Los Angeles, California 90009

Dear Mr. Davis:

In response to your memo of February, 1977 announcing the proposed Sells Low Military Operations Area (MOA), I am writing to bring to your attention some factors of which you should be aware before making a final decision.

The Sells Service Unit is the Indian Health Service administrative structure which provides health care for the 10,000 Papago Indian people living on the Papago Reservation in southwestern Arizona. As I'm sure you are aware, the proposed Sells MOA encompasses almost the entire reservation area. In providing health care for the Indian people of this area, we operate the Sells Indian Hospital, a 40-bed institution in the town of Sells; the Santa Rosa Health Center, a fixed outpatient clinic in the village of Santa Rosa; and the Mobile Health Unit (MHU), a mobile van equipped with complex tele-communications equipment which provides services to four Papago villages in their western districts.

In the context of our health system, I view the proposed low MOA as being extremely harmful to our health care delivery. I come to this conclusion for the following reasons:

- 1) At all of our facilities, we are treating patients with a variety of medical conditions, many of which are serious in nature. Our staff of physicians, paraprofessionals, and nurses treat patients who require a safe and quiet hospital atmosphere. In addition, the procedures and medical techniques we use are sometimes delicate in nature. As I understand the proposed MOA, I can envision a disruption of this hospital atmosphere on occasion because of low-flying aircraft and sonic turbulence. I am assuming that

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MR. DON M. DAVIS
March 29, 1977
Page 2

other similar MOA's do not operate around hospital facilities because of their adverse effect on a quiet environment, delicate medical procedures and medical instrumentation.

2) At the Sells Service Unit, we operate a complex system of space-age telecommunications called STAPAMC. This multi-million dollar venture is a combined project of NASA, Lockheed Missile & Space, Co., Indian Health Service, and the Papago Indian Nation. The system utilizes much of the equipment and communications learned here are programs and some of the experimental techniques learned here are slated to be used in the Space Shuttle Program. The system has telecommunications equipment at Sells Hospital, at the Santa Rosa Clinic, and at the Mobile Health Unit. In addition, there is a complex micro-wave antenna operation on Quijota Peak west of Sells that serves as the relay station for our system. Much of the electronic equipment, as you can imagine, is complex and very delicate in nature. We transmit color and black & white TV images, voice, computer data, and telemetry via a serious of micro-wave antennas. I have been advised by technical personnel that operate STAPAMC that the proposed MOA could have an adverse effect on the delicate instruments. In addition, there is the concern that low flying aircraft could severely interrupt the system by flying through the geometric path between our antennas.

3) Finally, in the village of Sells there is a small airstrip that is used by five Federal agencies on a regular basis. We use this airstrip frequently for air-evacuation of serious emergencies that must be immediately triaged to hospitals in Phoenix and Tucson. Air ambulance evacuation is a regular part of our program with flights on a daily basis. The proposed low MOA would potentially constitute an extremely hazardous condition, for these relatively slow aircraft descending into or climbing out of Sells airstrip area.

I would strongly urge your consideration of these factors as you evaluate the proposed low MOA. From the perspective of our health care delivery system -- its Indian patients, staff, equipment and services -- the potential harmful effect of the low MOA would be great.

Respectfully,

Timothy T. Fleming, M.D.
Timothy T. Fleming, M.D.
Director
Sells Service Unit

cc: E. S. Rabreau, M.D.
Director, ORD

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March 30, 1977

Mr. Don M. Davis, Chief
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Air Traffic Division
Federal Aviation Administration
Department of Transportation
P.O. Box 92007, World Way Postal Center
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RE: Airspace Case
77-ME-9-WR
(Sells MOA)

Dear Mr. Davis:

I. Introduction

This letter protesting establishment of the Sells Low Military Operations Area (hereinafter Sells MOA), is written on behalf of numerous Papago Indians who have registered complaints with Papago Legal Services regarding subsonic military flights over the reservation.

The objections which Papago Legal Services wishes to raise on behalf of its clients can be divided into two categories. The first category concerns consistent failures on the part of the United States Air Force (hereinafter USAF) and on the part of the Federal Aviation Administration (hereinafter FAA) to comply with important procedural requirements of the National Environmental Policy Act of 1969, 42 U.S.C.A. §4321 et. seq. (1970).

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The second category of objections concerns an apparent failure on the part of the USAF and the FAA to fulfill their substantive obligations to the Papago people regarding subsonic military overflights in reservation airspace.

II. Non-conformities with the procedural requirements of NEPA.

The National Environmental Policy Act (hereinafter NEPA) requires that all agencies of the federal government "include in every recommendation or report on...major federal actions significantly affecting the quality of the human environment a detailed statement by the responsible official on...the environmental impact of the proposed action." 42 USCA §4332(2)(C)(1)(1970). In the typical case this requirement is satisfied in a two step process. First, the responsible agency prepares a threshold environmental statement to determine whether the proposal is a "major federal action significantly affecting the quality of the human environment" within the meaning of NEPA. See generally, Comment, Threshold Determinations by Federal Agencies Under the National Environmental Policy Act of 1969, 1973 Wash. U.L.Q. 235 (1973). If this statement properly concludes that no significant environmental effects will result, the proposed project is permitted to proceed without further delay. However, if there is a threshold finding of significant environmental impact, the second step of the NEPA compliance process, preparation of a comprehensive Environmental Impact Statement, must be undertaken. See 42 USCA §4332(2)(C)(1970).

With the understanding that it constituted the USAF's attempts to comply with NEPA, I have studied a document (revised in December of 1976)

entitled "Formal Environmental Assessment, Flight Operations and Low Altitude Training in The Sells Airspace Over the Papago Indian Reservation." Unfortunately, nowhere does this document state whether it is intended to be a threshold assessment or a final environmental impact statement. This uncertainty forms the basis of my first objection to establishment of the Sells MDA.

Even a casual reading of NEPA will disclose that prior to agency action the environmental study must be clearly labelled as either a threshold or final environmental impact statement. In the absence of clear labelling, the agency proposing a particular action, in this case the FAA, could wrongly conclude that the statement is final and proceed without full consideration of environmental impacts, all in violation of the express language of NEPA. See, 42 USCA §4332 (1970). Thus, any FAA action, however tentative, to establish the Sells MDA is unlawful until the USAF identifies the nature of its environment assessment.

Because of the ambiguous nature of the Sells MDA assessment, I have prepared two sets of comments. Discussed first are those which apply whether the document is a threshold or final environmental assessment. Thereafter, comments are discussed which apply only if the document is a final environmental impact statement.

A. Threshold or final environmental assessment comments.

It is my opinion that the following discussions of environmental impacts in the Sells MDA assessment are, as a matter of law, inadequate:

- (1) Noise. The effects of subsonic flight noise are inadequately discussed at pages 18 to 34 of the Sells MDA assessment. For example, the assessment states that "noise generated by aircraft engaged in air-to-air intercept training, formation training and transition

training is at such a level that it is unlikely to...evolve strong community action." (18) Where is the data to support this conclusion? That is no evidence that a poll of community reaction to overflights has even been conducted in the villages. On the other hand, there is ample evidence, in the case files of this office and in the numerous comments which the FIA has received regarding its proposed establishment of the Sells MDA, that even an informal poll would reveal intense resentment among the villagers. The assessment's assertion that the overflights are unlikely to evoke strong community reaction is a bald conclusion, unsupported by any outside research. At the very outset, the assessment runs afoul of the rule, as stated in Hanly v. Mitchell, 460 F.2d 640, 647 (2d Cir. 1972), that the agency drafting an environmental statement "must affirmatively develop a reviewable environmental record in lieu of limiting itself to perfunctory conclusions with regard to a project's probable environmental impact." (emphasis added)

Numerous additional examples of inadequate discussion of the noise factor may be enumerated. First, the approximate maximum sound pressure levels for various villages as shown in Table 4.3 (at page 25) require a more thorough discussion. How were these estimates made? What assurance do the villagers have that the pilots, many of whom are presumably inexperienced, will be able to maintain the distances from the villages assumed by the approximations? Failure to address these questions renders Table 4.3 and its accompanying text conclusory and, therefore, inadequate.

Second, the discussion of the effect of noise on performance and work efficiency (32) is also inadequate. No authorities or references are

given for the assertions in this portion of the assessment. No attention is given the special problems that will be experienced by persons having hearing disorders; nor is there any discussion of the impact that noise induced stress will have upon the many diabetics who live on the reservation. The final and most glaring inadequacy of this portion of the assessment is that it is apparently based upon studies using non-Indian human subjects. Because it fails to take into account unique physiological, psychological, social, and cultural factors which may make the Papago people specially sensitive to over-flight clamor, the Sells MDA assessment could seriously underestimate the effect of noise on performance and work efficiency.

Third, the discussion of the effect of jet noise on animal populations is also inadequate. (33) For example, the few studies supporting the conclusions of this part are not based upon observations of Sonoran wildlife; instead, they are based upon studies of laboratory animals (chinchillas, rats) whose physiology may be entirely different from that of Sonoran fauna. It is common knowledge that the Sonoran jack-rabbit has adapted to the intense summer heat of this region by developing large ears to disperse body heat into the atmosphere. Will sound levels which are tolerable for the chinchilla and the rat destroy the jackrabbit's hearing because of the special adaptation of his ears? In its present inadequate form, the Sells MDA assessment sheds no light whatsoever on this question. There are other serious shortcomings. The assessment does not discuss the effect of jet noise on birds' eggs; it fails to mention the danger of collision with/harassment of birds in flight; it makes the wholly unsupported assertion that "it is quite likely that there has been adaptation and accommodation to (noise) on

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the part of the natural environment" (34) when, in fact, it is equally likely that the natural environment is undergoing a continuous process of degradation which has never been measured. These are serious inadequacies which can only be corrected by a continuing, comprehensive environmental study of the area and its unique wildlife. It is precisely such a study that NEPA requires prior to establishment of the Sells MDA. See, 42 USCA §4332(2)(C)(1970).

(2) Accident hazard. The accident hazards associated with the Sells MDA are discussed at page 37 of the assessment, where the USAF concedes that there have been 8 serious accidents since 1966. In view of this significant accident hazard, it would seem that, at the very least, there should be an effort to route flight paths away from the larger villages. Yet, incredibly, there is no evidence that even this simple safeguard has been implemented.

(3) Historical/Archaeological. The discussion of impacts upon historical/archaeological resources (37) is deficient because it is not based upon a study of the short and long term effects of over-flight noise on fragile adobe ruins and pottery artifacts. In the absence of such a study, the conclusion that "it is unlikely continued activity in the Sells airspace will damage the archaeological sites identified based on their physical construction and makeup and the lack of any indications of damage from previous operations" is unsupported and, hence, inadequate as a matter of law. Hanly v. Mitchell, 460 F.2d 640, 647 (2d Cir. 1972).

The preceding paragraphs have detailed why the discussion of environmental effects found in the Sells MDA assessment is inadequate. But this is only one half of the criticism. The other half is that several important environmental impacts are omitted altogether. For example, it is clear that NEPA requires discussion of cultural, social, and psychological impacts. See, e.g., Tierrepante Community Council vs. Richardson, 4 Envir. L. Rep. 20309 (S.D.Cal. 1973); Civic Improvement Committee v. Volpe, 2 Envir. L. Rep. 20170 (W.D.N.C. 1972), aff'd per curiam, 459 F.2d 957 (1972); McClean Gardens Residents Association v. National Capital Planning Commission, 2 Envir. L. Rep. 20659 (D.D.C. 1972); Brotherhood Blocks Association of Sunset Park v. Secretary of Housing and Urban Development, 3 Envir. L. Rep. 20351 (E.D.N.Y. 1973). Yet, in the Sells MDA assessment there is no study of, indeed there is not even mention of, cultural, social, and psychological effects. The human environment of the Papagos is a distinct cultural, social and psychological entity. To consider this aspect of the environment a negligible omission in direct violation of NEPA's mandate to "assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings." 42 USCA §4331(b)(2)(1970).

The assessment fails to discuss at least two additional environmental impacts. First, there is no discussion of the effect of subsonic noise upon the fragile adobe structures used universally by Papagos for housing and storage. Since this office has several cases documenting threats to the health and safety of Papagos whose homes were severely damaged by jet noise, it would seem that some discussion in this regard is appropriate. Second, there is no discussion of the effect overflights have on the reservation's livestock industry. What are the effects on the health and reproductive capacity of livestock? Do the noise disturbances make livestock management more difficult and, if so, what are the increased costs

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to the Papago cattlemen? These questions strike at the very heart of the Papago way of life, but the Sells MDA assessment leaves them unanswered. B. Comments which apply if the document is determined to be a final environmental impact statement.

If the assessment is intended to be a final impact statement, it is unacceptable because it fails to adequately discuss alternatives. See, 42 USCA §4332(2)(C)(1)(1970). The analysis of alternatives at pages 38 through 41 of the assessment is inadequate for several reasons.

First, the assessment states that a considerable number of Arizona's low level training routes traverse reservation airspace because "four of the seven Gila Bend Gunnery Range air-to-ground gunnery range entry corridors lie East-West from the Sells area to the range complex." (40) By implication, alternative range entry corridors which would not require use of reservation airspace are unsuitable because of "high density airways to the north of the Gila Bend Gunnery Range." (40) This simplistic rationale has forced me to conclude that the USAF has not taken seriously its statutory duty to consider alternative flight paths. In the first place, the assessment concedes that three of the seven Gila Bend Gunnery Range entry corridors could be used without traversing reservation airspace, but fails to explain why these additional corridors were not utilized to reduce intrusions above the reservation. It is not enough to state, without any explanation whatsoever, that high density airways to the north preclude use of alternative entry corridors to the gunnery range. (40) Presumably, the training flights already cross high density airways to reach reservation airspace; why can they not also cross the airways to the north

of the gunnery range? Moreover, the MDA assessment makes it clear that the training flights are travelling at extremely low altitudes; this factor would appear to provide the best possible protection against interference with high density airways, wherever they are located. In sum, there is a vast area of sparsely inhabited land to the north of the reservation, yet the MDA assessment provides no clue as to why it is not used for approaches to the Gila Bend Gunnery Range.

The second criticism of the discussion of alternatives stems from the statement that the Sells area is "the most direct route between Tucson and the Gila Bend Gunnery Range." (4) This is, of course, true. But the very purpose of the training missions, as explained in the MDA assessment, is to fly an indirect route which will train the pilots in low level navigation. (39) Numerous indirect routes which would reduce or eliminate intrusion into reservation airspace are available: (a) from Tucson to Picacho Peak, across the reservation at the village of Cockleburrt, and on to the gunnery range through the Saucedo and Sand Tank mountain ranges; (b) from Tucson to Oracle Junction, northwest along Highway 80-89 to Black Mountain, west from Black Mountain to the Maricopa and Gila Bend Mountains and, from these mountains, onto the gunnery range. The MDA assessment fails to even mention these or other possible alternatives.

The discussion of alternatives can also be criticized because it concludes that the "Tucson International Airport based unit uses the (Sells) area extensively due to its proximity to the airport." (40) In fact, there are other air spaces which are not discussed even though they are much closer to Tucson International Airport than is the Papago

Indian Reservation. (For example, the Sells MOA assessment could have at least mentioned the possibility of routing some of the training flights over the Altar Valley, or over the Saluarcita-Continental-Patagonia-Elgin loop.) The statement that "the F-5 unit at Williams uses no other area since it provides the only available airspace within practical range of the F-5 aircraft" (40) is open to a similar criticism because it fails to take into account the airspace above the Tortilla Mountains, Black Mountain, the Picacho Mountains, the Saucedo Mountains, the Sand Tank Mountains, and the Maricopa Mountains. All of these areas constitute a basin and range province which is identical to the Papago Reservation and is much closer to Williams Air Force Base; nevertheless, none of them received even the slightest mention in the Sells MOA assessment's discussion of alternatives.

A second basis for finding that the Sells MOA is insufficient as a final environmental impact statement is that no public hearings were held prior to compilation of the text. I am certain that public hearings would have brought to the attention of the USAF and the FAA many of the criticisms which are raised in this letter. The Council on Environmental Quality has made it quite clear that in cases such as this public hearings should be held prior to compilation of the impact statement and, more importantly, prior to any official action on the proposal being considered. See, Council on Environmental Quality, Preparation of EIS Guidelines, 38 Fed. Reg. 20550 (1973). It would seem, then, that formal approval of the Sells MOA must be delayed until public hearings can be held and the impact assessment can be revised to reflect input from the

affected communities.

III. Failure to fulfill substantive obligations to the Papago people.

There are at least five substantive obligations to the Papago people which will be breached if the Sells MOA is established in its present form. Three of these have already been brought to the attention of the FAA in a letter written on May 14, 1975 by Mr. James Purcell, Esq. of this office; they are repeated below verbatim:

First, it jeopardizes "persons and property on the ground", which the Administrator is authorized and directed under 49 USC §1348(c), to protect. We believe that this section imposes a duty on the Administrator with respect to all people in the United States and their property, but it is our further position that the Administrator, as an officer of the United States, is charged with responsibility for fulfilling the trust obligations of the United States to the Papago Tribe and its members, in so far as that responsibility falls within the scope of his duties. To this extent his duty to protect the persons and property of Papago Indians on the Papago Reservation must be carried out with the highest degree of diligence, care, skill and loyalty. Through his failure to restrict the above-described training in the airspace above the Papago Reservation, the Administrator has neglected the trust responsibility which he shares with other officers of the United States.

Secondly, it violates the letter and intent of the Executive Orders of 1874, 1882, 1916 and 1917, which set apart the land

which comprises the Papago Reservation for the benefit of the Papago Indians. It is inconsistent for the United States to dedicate a territory as a homeland for a native people and thereafter to use that territory for jet fighter training which substantially interferes with that people's way of life. The said training activity constitutes an actual taking of the beneficial use of this land. As stated above, simply living where they do has become quite difficult for Papago people affected by the training. In the most real sense their lands are being taken from them for the purpose of providing the United States Air Force with a training area.

Thirdly, the conduct of the said training activity constitutes a breach by the United States Air Force of the trust responsibility of the United States for protecting Indian people, their lands and resources. In the context of modern society, the environment in which the majority of Papago people dwell is perhaps their greatest resource. In the past it has been the medium in which they have been able to dwell, build and maintain shelter, take their livelihood from domestic and wild animals and raise their children. The interference occasioned by the training of jet aircraft pilots has severely hampered Papago Indians in these pursuits.

The final two substantive obligations flow from the National Environmental Policy Act of 1969. Under NEPA, the actual decision (sometimes called the "substantive" decision) to proceed with a project or undertaking can be reversed by a court of law if the agency's "actual balance" of costs and benefits that was struck was arbitrary or clearly gave

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insufficient weight to environmental values." Calvert Cliffs Coordinating Committee vs. Atomic Energy Commission, 449 F.2d 1109, 1115 (D.C. Cir. 1971); Environmental Defense Fund vs. Corps of Engineers, 470 F.2d 289, 298 (8th Cir. 1972). It is my position that any decision to establish the proposed Sells MDA in its present form will, as a substantive matter, give insufficient weight to environmental values and, hence, be subject to judicial reversal. A second substantive objection under NEPA is that the proposal for a Sells MDA fails to mitigate the environmental impacts of subsonic training flights over the reservation. Though the duty to mitigate some and possibly all of the environmental impacts arising from a proposed project is clear, Sierra Club v. Froehike, 359 F.Supp. 1289 (D.C.Tex. 1973), there is no evidence that the USAF or the FAA has attempted to reduce the effects of subsonic training over the reservation. The USAF and FAA have not adequately considered the possibility of alternative routes (see page 7 to 9 of this letter); nor have they considered the possibility of eliminating training flights on those days when important religious festivals and ceremonies are held. Numerous other ways to mitigate impact are undoubtedly available. The failure to undertake these and other mitigation efforts precludes establishment of the Sells MDA in its present form as a matter of substantive law. Sierra Club v. Froehike, *supra*.

IV. Summary

This letter has outlined numerous procedural and substantive considerations which, in my opinion, prohibit as a matter of law establishment of the Sells MDA in its present form. It is my hope that these comments provide the basis for constructive dialog between the Papago people, their representatives, the USAF, and the FAA. In particular, it is my fervent

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hope that after public hearings, the Sells MDA assessment will be rewritten to adequately discuss all environmental impacts, alternatives, and mitigation options. After this is accomplished, I am confident that the Sells MDA can be established in a modified form which protects the interests of the USAF in a strong national defense and, at the same time, vindicates the legal rights of the Papago people.

Sincerely,

PAPAGO LEGAL SERVICES

Mark Ulmer
Mark Ulmer



KITT PEAK NATIONAL OBSERVATORY

Operated by The
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University of Wisconsin
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March 30, 1977

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Mr. Don M. Davis
Chief, Airspace & Procedures Branch
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Post Office Box 92007
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Dear Mr. Davis:

We have recently seen a copy of the Federal Aviation Administration notice, dated February 1, 1977, addressed to All Interested Persons, concerning Establishment of the Sells Low Military Operations Area (MOA), Arizona, Airspace Case No. 77-NE-9-WR.

As you no doubt are aware, Kitt Peak National Observatory, a National Center of the National Science Foundation, is located on the eastern edge of the region to be affected by the proposed MOA. We are alarmed at the prospect of increased air traffic and low-level flights which the MOA implies.

It is true that the majority of the problems which the Observatory experiences with aircraft interference, such as sonic booms and condensation trails, result from supersonic and high altitude flights; however, the prospect of possibly increased subsonic air traffic at altitudes as low as 100 feet above ground level is far from reassuring. Our concerns are primarily that increased air traffic in the neighborhood of the Observatory at an altitude below 10,000 feet may interfere with our sensitive observations. As you know, we have active daytime observing programs of the sun, stars and planets.

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With the establishment and charting of a MOA, it is our understanding that potential users of the area would be provided with information about the area through both charts and briefings. Presumably this information could include notification of the location of the Kitt Peak National Observatory and advice to avoid the specific area by at least five miles in all directions. At five miles, airplanes in the low MOA would be less than 7° above our level and should have no adverse impact upon our observations. This suggestion has the support of the National Science Foundation.

We appreciate this opportunity to comment on the proposed establishment of a Military Operations Area and trust that you will carefully review our considerations when deciding upon final action in this matter. Since your visit to our facility on June 23, 1976, and our discussions at that time with representatives of the Air Force, communications of occasional problems with sonic booms and contrails have been greatly facilitated. We are appreciative of the efforts of the Air Force and the FAA to keep supersonic activities away from Kitt Peak, and trust you will continue to keep our concerns in mind when any military aircraft activity is planned in our area.

April 10th 1882

**David O. La Conte, Acting Director
Office of Administrative Services**

C-2-30

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Cecil Williams (Papago), Col. Robert E. Blake (AF), Major John E. Black (AF), Ervin Buchauer (FAA), Maj. Burr Campbell (AF), Maj. Jim Conner (AF-FAA), Ed Custer (FAA), Richard Domeo (Kitt Peak), Tim Fleming (M.D., Papago), Lt. Col. Jerry Foose (AF-FAA), Susan Forney (Kitt Peak), Chris Helms, Col. Phillip Howell (AF), Jim Kattzing (Kitt Peak), Jon Kosakoff (Papago), Ray G. Martinez (Conan Pipe), Sandra Pharo (Papago), Charles E. Ricketts (FAA), Capt. Jay Rowland (AF), Paul M. Sewell (AF), William E. Strickland (Papago), Lt. Col. John M. Varnum (AF), Capt. Fasnat (AF), Lt. Col. Stringer (AF).

FR: **William, Papago Legal Services**

SUBJ: Sells Low MOA

DATE: September 8, 1977

i.

At the close of our August 30, 1977 meeting, three proposals regarding the Seil Low MOA were under discussion. The first proposal, which resembles the original FAA proposal circulated in February of this year, floors the Seil's Low MOA at 100 feet. Under this proposal, the FAA would approve the MOA's exterior boundaries and its 100 foot floor, leaving the rest of the MOA to work out the details of flight operations within the MOA. Thus,

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after FAA approval of the general dimensions of the MOA, the Air Force, the Papago Tribe, and interested parties other than the FAA would mutually develop a memorandum of agreement to insure that subsonic training activities avoid sensitive areas on the ground. Then, the Air Force would promulgate directives to advise its pilots of the terms of the memorandum of agreement. Pilots violating the directives would be subject to Air Force discipline.

The second proposal floors the MOA at 3,000 feet and contemplates that the FAA will approve and chart routes below that altitude to accommodate the Air Force's low level training requirements. Under this proposal, routes below 3,000 feet would be mutually developed by all interested parties and thereafter presented to the FAA for final approval and charting. Additionally, protective cones ranging in diameter from 3 to 5 miles and extending from ground level up to 10,000 feet MSL (the ceiling of the Sells Low MOA) would be mutually developed where possible to block all training activity above certain sensitive areas. These protective cones would be approved and charted by the FAA if feasible.

The third proposal would establish a MOA with a discontinuous floor. Above sensitive areas the MOA would be floored at, for example, 3,000 feet; where ground conditions permitted, however, the MOA would be floored at a much lower altitude, perhaps 100 feet. It was generally agreed at the August 30 meeting that this proposal was too complicated and would take too long to implement. Therefore, it is not considered further.

II.

After extensive review, it is the opinion of Papago Tribal Chairman Cecil Williams, William Strickland (general counsel for the Papago Tribe), and Sandra Pharo and Mark Ulmer (attorneys from Papago Legal Services representing numerous individual Papagos) that the second proposal described (3,000 feet floor with mutually developed low level routes charted by the FAA) is the minimum acceptable point of compromise. This conclusion is based upon the conviction that a Sells Low MOA floored at fewer than 3,000 feet and lacking FAA charted low level routes would (1) violate the FAA's statutory obligation to protect "persons and property on the ground," 49 U.S.C. §1348(c), (2) violate the trust responsibilities of the Air Force, the FAA, and the Department of Interior towards the Papago people, (3) violate the letter and intent of the Executive Orders establishing the Papago Indian reservation, (4) violate the procedural and substantive obligations created by the National Environmental Policy Act of 1969, and (5) would otherwise be unlawful.

Our acceptance of the second proposal is expressly conditioned upon continued good faith efforts on the part of the Air Force and the FAA to (a) develop mutually acceptable low level corridors below the 3,000 foot floor of the Sells Low MOA, (b) develop alternatives which will significantly reduce the volume of low level training flights above the reservation (e.g., expand the Gila Range and reroute some flights around the northern horn of the reservation; utilize other airspace adjacent to the Gila Range for alternative entry corridors; all other feasible alternatives), and (c) substantially reduce the number and impact of sonic

booms over the reservation. By stating our acceptance conditionally, we do not imply mistrust of those with whom we are presently dealing. To the contrary, thus far the Air Force and FAA representatives have inspired confidence in their goodwill.

Under the second proposal, the Papago people and their representatives will do everything possible to assure that subsonic training continues without interruption on January 1, 1978 when, pursuant to FAA regulation, low level flights in excess of 250 knots are restricted to charted MOAs or published routes.

The second proposal requires that low level routes below the MOA's 3,000 foot floor must be mutually developed by the interested parties and submitted to the FAA for approval and charting. Our starting point is that low level routes which are drafted without extensive input from the Papago people are unacceptable over the long term. We recognize, however, that presently there is no time for extensive public input because routes must be submitted to the FAA's cartographer well in advance of January 1, 1978. We propose, therefore, a two stage process for developing mutually acceptable routes. During the first stage, the interested parties will develop interim routes as quickly as possible based on readily available maps, population statistics, and known information regarding culturally sensitive areas. These interim routes will be submitted to the FAA as quickly as possible for immediate charting. In the second stage, Papago Legal Services, under the supervision of the Papago Tribe, will conduct extensive field work in the affected districts to define and locate sensitive areas which were not taken into account when the interim routes were developed. Thereafter, the

interested parties will assemble for the purpose of modifying the interim routes in light of the new information. The revised routes will then be presented to the FAA for approval and charting.

The field work to be conducted by Papago Legal Services under the second stage will tax the program's limited budget. For this reason, we request that, if possible, the Air Force or the FAA provide Papago Legal Services with sufficient funds to accomplish this important work. Papago Legal Services will prepare a project proposal, including an adequate project monitoring system, if a funding source can be located.

Conditioned upon the continued good faith of the Air Force and the FAA during stage two, we will stipulate that the environmental impact statement prepared for the Sells Low MOA satisfies the National Environmental Policy Act's requirements with respect to the interim routes. This stipulation is made in recognition of the importance that uninterrupted low level training has for national security.

III.

It is my understanding that a 3,000 foot MOA presents special problems for the A-10 and, perhaps, the A-7, because the combat mission of these planes is to provide close support for troops engaged in fighting on the ground. This mission requires that the planes fly a more or less random low altitude holding pattern in the vicinity of combat zones so that they can respond instantaneously to calls for ground support while avoiding detection by enemy radar. Thus, to effectively train A-10 and A-7 pilots, the planes must be permitted to roam within large areas at low altitudes and, unlike the F-4 or F-15, cannot be restricted to

narrow, predetermined routes. Additionally, A-10 and A-7 training flights must be conducted in the vicinity of a gunnery range where ground support maneuvers (ordnance delivery, etc.) can be rehearsed.

I am unsure how the 3,000 foot Sells Low MOA can best accommodate these special requirements of the A-10 and A-7. It would seem possible to designate a 100 foot MOA floor in an area where impacts upon sensitive ground locations would be minimal. We stand ready to cooperate with the appropriate agencies to accommodate the special needs of the A-10 and A-7, provided that an eventual solution respects sensitive ground locations.

One final point regarding the A-10 and, perhaps, the A-7. There is some chance that the Department of Defense will determine that training missions for these planes may be flown at speeds below 250 knots. If this determination is made, the PMA regulation requiring low level flights in excess of 250 knots to remain within charted or MOA airspace would not apply to some A-10 and A-7 activity. We view this possibility with mixed feelings.

On the one hand, such a development could alleviate the reservation's air traffic problem inasmuch as a significant amount of uncharted or non-MOA airspace outside of the reservation's boundaries would become available for A-10 and A-7 training missions. For this reason, we would like to have an assurance that new airspace eventually made available to the A-10 and A-7 will be exploited by the Air Force to relieve traffic over the reservation.

On the other hand, we fear that because they are able to fly at

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speeds below 250 knots, the A-10s and A-7s will normalize the reservation in total disregard of the 3,000 foot MOA and its companion charted low level routes. We find little comfort in the assurance that regardless of their speed these aircraft would have to remain at least 500 feet away from persons and property on the ground. Therefore, the points of compromise outlined in this memorandum are presented on the assumption that special problems raised by the slow flight capabilities of the A-10 and A-7 will be resolved at an appropriate point in the negotiations.

IV.

If the proposals contained in this memorandum are for any reason unacceptable, please contact me immediately.

C-2-37



PAPAGO LEGAL SERVICES

LAW OFFICES OF
PAPAGO LEGAL SERVICES
P.O. BOX 144
SALLA ARIZONA 85073
TELEPHONE (602) 842-0000

BARBARA S. PALMER
MAUREN WALSH
JENNIFER

10 June, 1977

Robert O. Buffington
State Director
Bureau of Land Management
Department of the Interior
2400 Valley Bank Center
Phoenix, Arizona 85073

Re: Application No. A 9973 for the withdrawal of lands from settlement, sale
location or entry; date of filing April 11, 1977.

Dear Mr. Buffington:

On April 11, 1977, the United States Army Corps of Engineers, on behalf of the Department of Defense, filed with your office an application to withdraw lands for the Luke-Williams Air Force Range. Thereafter, your office, in an amended announcement finalized on May 24, 1977, gave notice to the public that comments regarding the proposed withdrawal would be considered if received within the following thirty days. This letter is written in response to that announcement on behalf of numerous Papago Indians who have registered complaints with my office regarding subsonic military training flights over their reservation.

BACKGROUND

For many years, the United States Air Force (hereinafter USAF) has used the air space above the Papago Indian Reservation for subsonic military training flights which terminated in ordnance delivery at various sites within the Luke-Williams Air Force Range. Until recently, this practice was unchallenged even though it seriously disrupted the Papago way of life. Then, on May 14, 1975, Mr. James Purcell, Esq. of this office filed a formal complaint with the Federal Aviation Administration (hereinafter FAA) stating that the overflights (a) violated the FAA's obligation under 49 U.S.C. 1348 (c) to protect persons and property on the ground, (b) violated the letter and intent of the Executive Order of 1974, 1982, and 1977, which set apart the Papago Reservation for the benefit of the Papago Indians, and (c) breached the trust responsibility of the

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United States toward the Papago people and their trust lands. (Pertinent portions of Mr. Purcell's letter are excerpted at pages 11 through 12 of the enclosure.) The FAA has taken this complaint under advisement, but has yet to undertake any formal action.

Less than one year after Mr. Purcell's letter, the FAA, on behalf of the Air Force, announced a proposal to establish a Salls Low Military Operation Area (hereinafter Salls MDA) in the air space above the Papago Reservation. The purpose of the Salls MDA, as explained in a document drafted by the USAF in December of 1976 and entitled "Normal Environment Assessment, Flight Operations and Low Altitude Training in the Salls Airspace Over the Papago Indian Reservation", is to formalize existing subsonic training flight patterns above the reservation which terminate in ordnance delivery at the Luke-Williams Air Force Range. In response to the Salls MDA proposal, I wrote a lengthy letter on March 30, 1977 to Mr. Don H. Davis, Chief of the FAA's Airspace and Procedures Branch, setting forth my reasons why the proposal should be disapproved. Six of these reasons were based upon the National Environmental Policy Act of 1969 and are as follows: (1) The USAF improperly failed to designate whether its environmental assessment for the Salls MDA was a threshold or final environmental impact statement, (2) the environmental assessment failed to adequately discuss environmental impacts, (3) the environmental assessment failed to adequately discuss alternatives, (4) on-reservation formalization of existing flight patterns would violate the FAA's substantive duty to balance the environmental costs of the proposal against its benefits, and (6) the USAF had breached its substantive duty to mitigate the environmental impacts of the proposal. In addition to these NEPA arguments, I repeated the three arguments made by Mr. Purcell in his May 14, 1975 letter to the FAA. (A copy of my March 30, 1977 letter to Mr. Davis is enclosed and is incorporated herein by reference.) As with Mr. Purcell's letter, the FAA has taken my comments under advisement; final action on the proposed Salls MDA is not expected until the end of this year.

Needless to say, neither Mr. Purcell's letter nor my letter has resulted in any significant reduction in the frequency of training flights over the reservation. The tragic pattern of previous year - disruption of the ecology of traditional Papago hunting grounds, harassment of villagers, dislocation of the Papago livestock industry, degradation of ancient festivals and rituals, desecration of the desert's solitude which is so basic to the Papago ethic - continues unabated. I am writing to demand that every effort be made to reverse this tragic pattern of neglect when the application for withdrawal of the Luke-Williams Air Force Range is considered by your office.

DISCUSSION

The USAF's primary justification for establishment of the Salls MDA is that simulated ordnance delivery at the Luke-Williams Air Force Range is a vital part of its military flight training program. The air space above the Papago Reservation, so the Air Force's argument runs, is the only available area for routing subsonic flights to terminate at the range. See, USAF, Normal Environment Assessment, Flight Operations and Low Altitude Training in the Salls Airspace Over the Papago Indian Reservation 30-41 (October 1976).

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Assuming agreements that the Air Force's position in this regard has some validity, the central question becomes, Can the existing gunnery range be modified to create additional entry corridors which do not require exclusive use of reservation airspace for flight approach and ordnance delivery? I believe that this question can be answered in the affirmative, and I further believe that the Bureau of Land Management, together with the Department of Defense and the PMA, is under a legal obligation to insure that lands are withdrawn for the Luke-Williams Air Force Range in such a way that alternative entry corridors can be established.

The strongest evidence that it is possible to modify the gunnery range to create alternative entry corridors lies in the Defense Department's request that a large area of land (called "Area C" in the Bureau of Land Management's announcements) presently without the boundaries of the range be set aside as a safety buffer zone. If land is available for a buffer zone, it seems likely that land could be found for the establishment of alternative entry corridors. The vast tracts of BLM controlled land in the vicinity of the gunnery range confirm this conclusion.

The law is clear that the BLM, the Department of Defense, and the PMA share a responsibility to protect the natural and human environments of the Papago Indian reservation by providing for alternative entry corridors in any eventual withdrawal of lands for the Luke-Williams Air Force Range. This responsibility arises under the various legal authorities cited in the Purcell letter of May 14, 1975 and in my letter of March 30, 1977, and requires at least the following specific action:

- (1) The applicant for withdrawal of gunnery range lands must prepare a full environmental impact statement which discusses all possible environmental impacts on the Papago Reservation;
- (2) The applicant for withdrawal of gunnery range lands must prepare a full environmental impact statement which discusses all possible alternatives and justifies the chosen alternative;
- (3) Public hearings must be held at convenient places on the Papago Indian Reservation prior to compilation of the impact statement and prior to any official action on the proposed withdrawal. Translators must be provided at these public hearings and a separate hearing must be held in each quadrant of the main reservation.
- (4) The applicant and the BLM must consult with the PMA prior to compilation of the impact statement and prior to final action. The PMA must comment to the applicant and the BLM prior to compilation of the impact statement and prior to final action. See 42 U.S.C.A. (2)(c)(1970) ("...the responsible Federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved".)
- (5) The applicant, together with BLM, must mitigate the environmental impact of the withdrawal on the Papago Indian Reservation.
- (6) Final action by the BLM must strike a fair balance between the benefits of the proposed withdrawal and the environmental costs to be borne by the Papago Reservation;

C-2-40

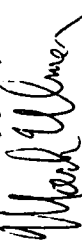
- (7) BLM must provide for alternative entry corridors which do not require exclusive use of reservation air space for flight approach and ordnance delivery;

Accordingly, I request that the above actions, as well as any other actions required by law, be undertaken as part of the withdrawal of range lands.

CONCLUSION

The Defense Department's request for withdrawal of the Luke-Williams Air Force Range lands is a rare opportunity for the United States government to fulfill its promise of a homeland for the Papago people. Logically and morally I believe the Bureau of Land Management, the Department of Defense, and the Federal Aviation Administration are obligated to guarantee that the opportunity is not wasted. It is my hope that all interested parties join in a cooperative effort to that end.

Sincerely yours,


Mark Ulmer
PAPAGO LEGAL SERVICES

MJ:lr
Enclosure 1
cc:

- Cecil Williams
Chairman
Papago Tribe of Arizona
Sells, Arizona 85634
- Morris K. Udall
U.S. House of Representatives
Washington, D.C. 20515
- Strickland & Altaffer
802 Transamerica Building
Tucson, Arizona 85701
- Mr. Don M. Davis
Airspace and Procedures Branch
Air Traffic Division
Federal Aviation Administration
Department of Transportation
Los Angeles, California 90009
- Major Pruitt
c/o Captain Rowland
58th CSO/JA
Luke AFB
Phoenix, Arizona 85309

C-2-41



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGIONIX
215 Fremont Street
San Francisco, Ca 94105

Project #D-JAF-K52003-AZ

Carlos Sterr, Ph.D.
Deputy for Environment and Safety
Office of the Assistant Secretary
Department of the Air Force
Washington, D.C. 20330

Dear Dr. Stern:

The Environmental Protection Agency has received and reviewed the draft environmental statement for the FLIGHT OPERATIONS IN THE SEL'S AIRSPACE OVERLYING THE PAPAGO INDIAN RESERVATION, SOUTHERN ARIZONA.

EPA's comments on the draft environmental statement have been classified as Category 10-2. Definitions of the categories are provided on the enclosure. The classification and the date of EPA's comments will be published in the Federal Register in accordance with our responsibility to inform the public of our views on proposed Federal actions under Section 309 of the Clean Air Act. Our procedure is to categorize our comments on both the environmental consequence of the proposed action and the adequacy of the environmental statement.

EPA appreciates the opportunity to comment on this draft environmental statement and requests three copies of the final environmental statement when available.

If you have any questions regarding our comments, please contact Betty Jankus, EIS Coordinator, at (415)556-6695.

Sincerely,

Paul De Falco, Jr.
Regional Administrator

Enclosure

Noise Comments

1. (DEIS, page 42)

The Draft EIS states the the Single Event Levels (SEL's) created by aircraft passing over the Papago Indian Reservation range from 101 dBA for F-104 aircraft to 106 dBA for F-4 aircraft (as measured at the 500' overflight). The Draft EIS also states that the number of these "Low Level Sorties" averages about 10,000 a year. The Final EIS should describe the length of time, the number of passes, and the number of transition trips required to complete a sortie. In addition, all possible mitigation to avoid or minimize the negative noise related impacts should be discussed.

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WESTERN REGION
P. O. BOX 10001, BIRMINGHAM, ALABAMA 35209
LOS ANGELES 447-7000



April 4, 1979

Dr. Carlos Stern, Ph.D.
Deputy for Environment and Safety
Department of the Air Force
Office of the Assistant Secretary
Washington, D. C. 20330

Dear Dr. Stern:

As requested, we have now completed the review of your draft environmental impact statement regarding "Flight Operations in the Sells Airspace Overlaying the Papago Indian Reservation, Southern Arizona."

Our review findings indicate that we have no comments of any substance to offer in regards to this proposed plan.

We appreciate the courtesy extended in bringing this matter to our attention.

Sincerely,

W. BRUCE CHAMBERS
Regional Planning Officer



DEPARTMENT OF THE TREASURY
WASHINGTON, D.C. 20220

April 10, 1979

Gentlemen:

Thank you for forwarding a copy of the draft environmental impact statement for "Flight Operations in the Sells Airspace Overlaying the Papago Indian Reservation, Southern Arizona".

This Department, on the basis of a review by the U.S. Customs Service, has no comment on the draft statement.

Sincerely,

Anthony J. DiSilvestre
Assistant Director (Environmental Programs)
Office of Administrative Programs

Department of the Air Force
Office of the Assistant Secretary
(SAF/MIQ)
Washington, D.C. 20330

cc: Mr. Casagrande

Brennan Harvey
Box 795
Tupowa, Arizona
55639
4/16/79

Mr. President Carter:

I am a Papago Indian from the Sells reservation in Arizona. I am writing to inform you on a meeting we had here on the reservation on March 27th 1979 with the Air Force, about sonic booms and low flying aircrafts.

There was many testimonies about the planes disturbing our peace and ruining our property, by planes flying about 30 feet right over our villages, and their sonic booms breaking our windows and cracking our adobe houses.

The Air Force have a Environmental Impact Analysis Process that they also presented. But in looking over it what they say is not true. Such has keeping away from villages and flying above 100 feet. This is a statement which they have in their book; pilots will not fly aircraft over congested areas such as a city, town, or settlement, or open air assembly of persons except at an altitude that insures at least 1000 feet above the highest obstacle within a horizontal radius of 2000 feet of the aircraft... do not operate aircraft closer than 500 feet to any person, vessel, vehicle, or structure. I personally have seen them go over our village at about 30 feet above the ground. I also was with our work crew one time when we went out to chop wood and two aircrafts circled and dove right at us over the top of our truck three of four times at about 40 feet. Now can you honestly call this Air Force Training?

I honestly believe that we Indians have a constitutional right has American Citizens for our peace and freedom from this kind of treatment from the Air Force, by them destroying our property, and disturbing our peace!

Sincerely
Brennan Harvey

Mr. John Stinson
Secretary of the Air Force
Washington, D. C. 20330
Dear Secretary Stinson:

I am writing to urge you to do all in your power to do away with the Air Force's in the Sells Air Force over the Papago Indian reservation here in Arizona.

It has been reported that the many sonic booms and several disturbances caused by these practice flights are harmful to the people, animals and general environment underneath. I have been told that the people, at least some of them, are suffering severe psychological problems, in addition to having some of their windows and adobe walls crack.

The disturbances caused by these Air Force flights is not only inhumane, but also is, I believe, unconstitutional, depriving the Papago people of their constitutional rights.

Please stop these flights.

Sincerely yours,

Ray C. Hester (Ray C. Hester)

Ray C. Hester
President Carter
Congressman Chelli
Senator De Concini
Senator Coleman



UNITED STATES
DEPARTMENT OF THE INTERIOR

OFFICE OF THE SECRETARY
PACIFIC SOUTHWEST REGION

BOX 30008 • 450 GOLDEN GATE AVENUE
SAN FRANCISCO, CALIFORNIA 94118
(415) 398-2200

ER-79/154

March 30, 1979

Dr. Carlos Stern
Deputy for Environment & Safety
U.S. Air Force
Washington, D.C. 20330

Dear Dr. Stern:

The Department of the Interior has received and reviewed the Draft Environmental Impact Statement by the U.S. Air Force for Flight Operations in the Sells Airspace Overlaying the Papago Indian Reservation, Pima, Pinal and Yuma Counties, Arizona.

We have a number of concerns both with the adequacy of this document, and with the safety and environmental consequences of the proposed project.

The detailed comments below focus largely on the noise and safety impacts of low flying aircraft in this airspace, particularly on the use and enjoyment of the Organ Pipe Cactus National Monument and the Papago Indian Reservation.

The Draft Environmental Impact Statement as prepared by the U.S. Air Force is inadequate, in our opinion. Outlined below are the major reasons:

1. The Draft Statement fails to properly address the serious impacts imposed upon the Organ Pipe Cactus National Monument. The Monument has been in existence as a unit of the National Park System since 1937. As a large natural area of the system it was expressly created to be enjoyed by all the citizens of the United States as near a natural environment as possible, free from all excessive man-made intrusions. Excessive, extremely low altitude jet aircraft maneuvering and the imposition of sonic booms seriously negate appropriate public use of the park to the point of being unacceptable by the visiting public and the National Park Service.

RECEIVED	
Western Regional Office	
APR 2 1979	
By: [Signature]	Special Director
For: [Signature]	Deputy Regional Dir.
By: [Signature]	Regional Dir.
By: [Signature]	Administrative
By: [Signature]	Legal
By: [Signature]	Public Affairs
By: [Signature]	Records

2. The Draft Statement fails to recognize the fact that Organ Pipe Cactus National Monument has an added protected status as a unit of the National Wilderness Preservation System. The National Wilderness Preservation System, as mandated by Congress, calls for agencies administering areas included within the system to be responsible for preserving the wilderness character of the areas designated. The National Park Service feels that to concur in the Air Force proposals for flying military training routes (Item 2.1.4) and the low altitude tactical navigation maneuvering (Item 2.1.5) would be totally contrary to that Congressional mandate.
3. The Draft Statement fails to recognize the fact that the Monument is one of only 28 natural sites within the entire United States officially designated a unit of UNESCO's (United Nations Economic, Social and Cultural Organization) Worldwide "Man and the Biosphere" Reserve System. This system of unique natural conservation preservation areas has the sanction and official support of many federal agencies and departments at the national decision-making level in Washington, D.C. The type of excessive intrusion on the Monument stated by this Air Force flight operations proposal is incompatible with the UNESCO designation.
4. The Draft Statement fails to mention or even respond to the fact that the National Park Service has officially objected from the outset to the attempt to include the Monument in this proposal. The official objection of the National Park Service was expressly stated in two written letters dated March 9, 1977 and September 30, 1977 (copies enclosed) and the same position was repeatedly stated for the record by NPS representatives attending various meetings on this proposal at Sells, Arizona. The Draft Statement totally omits inclusion of the two official letters of protest in the appropriate sections of the Draft Statement and makes no reference to the supporting position maintained by NPS representatives throughout the various meetings held at Sells, Arizona. The Air Force has a significant state of unresolved controversy existing with the National Park Service and a large percentage of objecting public visitors to the Monument (150,271 total visitors in FY 1978) which it neglects to even mention in its Draft statement, particularly in Section 10.0 on page 55.
5. The Draft Statement and preparatory public hearing process failed to give adequate public opportunity for comment. Under the National Environmental Policy Act (NEPA) of 1969, proposed projects or activities of a highly controversial nature, like the Sells Military Operational Area over Organ Pipe Cactus National Monument, are expected to be fully presented to a broad spectrum of the public by means of meetings or hearing where the public at large can be fully informed of the extent and consequences of the

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proposal and have ample opportunity for expression of their personal feelings about it. It is our contention that the extent of the proposed intrusion on Organ Pipe Cactus National Monument, if fully known to the public at large, by means of well-publicized public forums held in Tucson, Phoenix, Flagstaff, and other appropriate locations, would surface considerable public opposition to the inclusion of Organ Pipe Cactus National Monument in the proposed Sells Military Operational Area.

The several items mentioned above highlight our opposition to this Air Force proposal as it is presently constituted. We must strongly protest the inclusion of Organ Pipe Cactus National Monument within the Sells Military Operational Area. Military training flights, as they are currently occurring and as proposed for official FAA sanction under the Air Force proposal for the Sells Military Operational Area, excessively compromise the intent of the proclamation establishing the Monument, its operation under the NPS Establishment Act of 1916, the National Wilderness Preservation Act, the Park's UNESCO status, and some environmental protection aspects of the National Environmental Policy Act of 1969, as it applies to Organ Pipe Cactus National Monument.

In addition to adverse impacts on the Monument, there are also noise problems over the Papago Reservation. You state on page 31 of the Draft Environment Impact Statement, Sec. 3.2 Airspace Above the Papago Reservation: "No special procedures or operating limitations are or will be placed on VFR civil aircraft operating in the Sells MOA S."

There have been several Air Force planes that collided and crashed on the Papago Reservation and several near-misses with civil aircraft. The BIA has aircraft flying into Sells for cattle counting by airplane and the USPHS uses aircraft to transport patients in and out. Civilian pilots are increasingly apprehensive about the increased military traffic from ground level to above 30,000 feet.

On page 36, second paragraph stating "no direct personal injury suffered...." is incorrect. An elderly lady has suffered slight lacerations and contusion from falling plaster in her bathroom, and public school windows have been broken in classrooms. The Papago people are cattleman and stockraisers and work their cattle on horseshack, thus creating a strong potential of injury from being thrown from startled horses due to sonic booms and associated aircraft noise.

On page 55 is stated: "Supersonic functional flight checks have been prohibited in the Sells Airspace since 25 July 1977." This is not the case. Sonic booms occur several times weekly and a sonic boom at 0700, February 28, 1979, caused a mule to stampe at the cattle complex endangering lives of children.

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Because of the strong negative impacts this project will have on both the Papago people and the Organ Pipe Cactus National Monument, the Department of the Interior requests that careful consideration be given to holding additional public hearings on the DEIS and working closely with the National Park Service and the Papago Indian Agency to modify this project to mitigate its severe environmental and safety impacts.

If you have any questions about these comments, please contact me directly.

Sincerely,

Patricia Sanderson

Patricia Sanderson Port
Regional Environmental Officer

Enclosure

cc: Director, OEPF (w/copy incoming)
Commissioner, Bureau of Indian Affairs
Director, Heritage, Conservation and Recreation Service
Director, National Park Service
Director, Fish and Wildlife Service
Director, Geological Survey
Director, Bureau of Land Management
Commissioner, Bureau of Reclamation
Area Dir., BIA AZ
Reg. Dir., HCRS
Reg. Dir., FWS Albuquerque
Reg. Dir., NPS
Asst. Dir., GS
Reg. Dir., BLM AZ
Reg. Dir., BR NV

C-2-51

2

Office of the Secretary
 Maricopa Agency of Government
 1820 W. Washington Street
 Phoenix, AZ 85007

State Application (Similar 3A)
 MAR 13, 1979
 AZ No. 79-80-0C

Arizona State Clearinghouse
 1700 West Washington Street, Room 505
 Phoenix, Arizona 85007

Public Safety
 Indian Affairs
 Game & Fish
 Ag. & Hort.
 Civil Rights
 Center for Public Affairs
 U of A College of Medicine
 U of A College of Agriculture
 OEPAD: P. Pokorski
 J. Rich

Region I
 Region II
 Region IV
 Region V

is project is referred to you for review and comment. Please evaluate as to:

- (1) the program's effect upon the plans and programs of your agency
- (2) the importance of its contribution to State and/or statewide goals and objectives
- (3) its accord with any applicable law, order or regulation with which you are familiar
- (4) additional considerations

use return THIS FORM AND ONE XEROX COPY to the clearinghouse no later than 17 working days from the date noted above.

- ☐ No comment on this project
- ☐ Proposal is supported as written
- ☐ Comments as indicated below

Comments (Use additional sheets if necessary)

IT IS REQUESTED THAT ISSUES RELATED TO THE STATE GOVERNMENT BE ADDRESSED IN THE FUTURE STATEMENT. THE STATE GOVERNMENT IS REQUESTED TO CLARIFY THE

Dr. Jane's Becker
 Center for Public Affairs
 Arizona State University
 Tempe, Arizona 85281

State Application (Similar 3A)
 MAR 13, 1979
 AZ No. 79-80-0015

Arizona State Clearinghouse
 1700 West Washington Street, Room 505
 Phoenix, Arizona 85007

Public Safety
 Indian Affairs
 Game & Fish
 Ag. & Hort.
 Civil Rights
 Center for Public Affairs
 U of A College of Medicine
 U of A College of Agriculture
 OEPAD: P. Pokorski
 J. Rich

Region I
 Region II
 Region IV
 Region V

project is referred to you for review and comment. Please evaluate as to:

- (1) the program's effect upon the plans and programs of your agency
- (2) the importance of its contribution to State and/or statewide goals and objectives
- (3) its accord with any applicable law, order or regulation with which you are familiar
- (4) additional considerations

return THIS FORM AND ONE XEROX COPY to the clearinghouse no later than 17 working days from the date noted above.

- ☐ No comment on this project
- ☐ Proposal is supported as written
- ☒ Comments as indicated below

Comments (Use additional sheets if necessary)

Potential use of the airspace over the Papago Reservation is an alternative for accomplishment of some objectives by the USAP and ARD. Appropriate considerations with the Papago would be essential in establishing the particular or use of this particular alternative.

3-76-79

A-1

FORM TO BE COMPLETED BY REVIEWING AGENCY

Mr. John Blackburn, Exec. Dir.
Central Arizona Association
of Governments
P.O. Box JJ (1810 Main St.)
Florence, AZ 85232

State Application Identifier (SAI)

MAR 13, 1979 Date AZ No. 79-80-0015

Public Safety
Indian Affairs
Game & Fish
Ag. & Hort.
Civil Rights
Center for Public Affairs
U of A College of Medicine
U of A College of Agriculture
OEPAD: P. Pokorski
J. Rich

From: Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

Region I
Region II
Region IV
Region V

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Please return **THIS FORM AND ONE XEROX COPY** to the clearinghouse no later than 17 working days from the date noted above.
Please contact the clearinghouse if you need further information or additional time for review.

- ☒ No comment on this project
☐ Personal is supported as written
☐ Comments as indicated below

Comments: (Use additional sheets if necessary)

Reviewer's Signature

C-2-56

Date

FORM TO BE COMPLETED BY REVIEWING AGENCY

Mr. James R. Carter, Director
Agriculture & Horticulture Dept.
421 Capitol Annex West
Phoenix, Arizona 85007

State Application Identifier (SAI)

MAR 13, 1979 Date AZ No. 79-80-0015

Public Safety
Indian Affairs
Game & Fish
Ag. & Hort.
Civil Rights
Center for Public Affairs
U of A College of Medicine
U of A College of Agriculture
OEPAD: P. Pokorski
J. Rich

From: Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

Region I
Region II
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Region V

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- ☒ No comment on this project
☐ Personal is supported as written
☐ Comments as indicated below

Comments: (Use additional sheets if necessary)

Reviewer's Signature

C-2-57

Date 3/15/79

B-1

FORM TO BE COMPLETED BY REVIEWING AGENCY

Dr. Suzanne Dundoy, Director
Department of Health Services
1740 West Adams Street
Phoenix, Arizona 85007

State Application Form (SAL)
MAR 13, 1979
SAL No. 79-80-0015

Public Safety
Indian Affairs
Game & Fish
Ag. & Hort.
Civil Rights
Center for Public Affairs
U of A College of Medicine
U of A College of Agriculture
OEPAD: P. Pokorski
J. Rich

Health
Parks
Land
AORCC

Arizona State Clearinghouse
1740 West Washington Street, Room 505
Phoenix, Arizona 85007

Region I
Region II
Region IV
Region V

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- (4) additional considerations

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No comment on this project
Proposal is supported as written
Comments as indicated below

Comments: (Use additional sheets if necessary)

C-2-58

Mr. Robert Jantzen, Director
Game and Fish Dept.
2222 W. Greenway
Phoenix, Arizona 85023

State Application Form (SAL)
MAR 13, 1979
SAL No. 79-80-0015

From: Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

Public Safety
Indian Affairs
Game & Fish
Ag. & Hort.
Civil Rights
Center for Public Affairs
U of A College of Medicine
U of A College of Agriculture
OEPAD: P. Pokorski
J. Rich

Health
Parks
Land
AORCC

Region I
Region II
Region IV
Region V

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- (2) the importance of its contribution to State and/or statewide goals and objectives
- (3) its accord with any applicable law, order or regulation with which you are familiar
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No comment on this project
Proposal is supported as written
Comments as indicated below

Comments: (Use additional sheets if necessary)

Scientific knowledge of the potential effects of low-level flights on wildlife has not changed significantly since our letter of December 4, 1974 which was appended in the present draft EIS. We therefore reiterate those statements made in that correspondence and have no other specific comments.

C-2-59

Signature: Richard D. Stuckman

Ms. Dorothy Hall, St. Historic
Preservation Officer
At. State Parks Board
1688 W. Adams, Room 109
Phoenix, Arizona 85007

State Application Identifier (SAI)

79-80-0015

MAR 13, 1979

State

AZ

No.

79-80-0015

Public Safety

Indian Affairs

Game & Fish

Ag. & Hort.

Civil Rights

Center for Public Affairs

U of A College of Medicine

U of A College of Agriculture

OEPAID: P. Pokorski

J. Rich

Health

Parks

Land

AORCC

Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

Region I
Region II
Region IV
Region V

This project is referred to you for review and comment. Please evaluate as to:

- (1) the program's effect upon the plans and programs of your agency
- (2) the importance of its contribution to State and/or area-wide goals and objectives
- (3) its accord with any applicable law, order or regulation with which you are familiar
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- ☐ No comment on this project
☐ Proposal is supported as written
☐ Comments as indicated below

Comments: (Use additional sheets if necessary)

THIS PROGRAM WILL HAVE NO DIRECT EFFECT
ON CULTURAL RESOURCES.

State Application Identifier (SAI)

79-80-0015

MAR 13, 1979

State

AZ

No.

79-80-0015

Public Safety

Indian Affairs

Game & Fish

Ag. & Hort.

Civil Rights

Center for Public Affairs

U of A College of Medicine

U of A College of Agriculture

OEPAID: P. Pokorski

J. Rich

Health

Parks

Land

AORCC

Dr. Louis Kettel, Dean
University of Arizona
College of Medicine
Arizona Medical Center
- Tucson, Arizona 85724

Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

Region I
Region II
Region IV
Region V

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- (1) the program's effect upon the plans and programs of your agency
- (2) the importance of its contribution to State and/or area-wide goals and objectives
- (3) its accord with any applicable law, order or regulation with which you are familiar
- (4) additional considerations

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Please contact the clearinghouse if you need further information or additional time for review.

- ☐ No comment on this project
☐ Proposal is supported as written
☐ Comments as indicated below

Comments: (Use additional sheets if necessary)

FORM TO BE COMPLETED BY REVIEWING AGENCY

John M. Little, Acting Comm.
State Land Department
1624 West Adams, 4th fl.
Phoenix, AZ 85007
ATTN: Jeff Yeager

State Application Identifier (SAI)

MAR 13, 1979 AZ No. 79-80-0015

Public Safety
Indian Affairs
Game & Fish
Aq. & Hort.
Civil Rights
Center for Public Affairs
U of A College of Medicine
U of A College of Agriculture
OEFAD: P. Pokorski
J. Rich

Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

Region I
Region II
Region IV
Region V

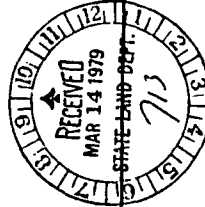
This project is referred to you for review and comment. Please evaluate as to:

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- (3) its accord with any applicable law, order or regulation with which you are familiar
- (4) additional considerations

Return THIS FORM AND ONE XEROX COPY to the clearinghouse no later than 17 working days from the date noted above.
Please indicate the date by which you need further information or additional time for review.

- ☒ No comment on this project
☐ Proposal is supported as written
☐ Comments as indicated below

Comments: (Use additional sheets if necessary)



C-2-62

FORM TO BE COMPLETED BY REVIEWING AGENCY

Michael A. Rammer's Director
Arizona State Parks
1688 W. Adams Room 109
Phoenix, Arizona 85007

State Application Identifier (SAI)

MAR 13, 1979 AZ No. 79-80-0015

Public Safety
Indian Affairs
Game & Fish
Aq. & Hort.
Civil Rights
Center for Public Affairs
U of A College of Medicine
U of A College of Agriculture
OEFAD: P. Pokorski
J. Rich

Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

Region I
Region II
Region IV
Region V

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- (2) the importance of its contribution to State and/or areawide goals and objectives
- (3) its accord with any applicable law, order or regulation with which you are familiar
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Please indicate the date by which you need further information or additional time for review.

- ☒ No comment on this project
☐ Proposal is supported as written
☐ Comments as indicated below

Comments: (Use additional sheets if necessary)

C-2-63

Reviewer's Signature: *AWM*

11-Mar-79

המחברת מודה לפרופ' ד"ר יעקב גורן על עזרתו במחקר.

Public Safety Health

Public Safety
Indian Affairs
Game and Fish
Mining
Civil Rights
Health
Parks
Land
AORCC

Region I
Region II
Region IV
Region V

- 1. the program's effect upon the plans and programs of your agency
- 2. the importance of its contribution to State and/or area; goals and objectives
- 3. its accord with any applicable law, order or regulation with which you are familiar
- 4. additional considerations

THIS FORM AND ONE XEROX COPY to its clearance no later than 17 working days from the date noted above, and the clearences if you need further information or additional time for review.

1. **Содержание:** Описание предмета, его назначения, особенностей конструкции, материалов, используемых при изготовлении.

Remarks (Use additional sheets if necessary)

From: Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

APR 13, 1979

Public Safety
Indian Affairs
Game & Fish
Agriculture
Civil Rights
Center for Public Affairs
U of A College of Medicine
U of A College of Agriculture
DEPAD: J. Pokorski
J. Rich

Region I
Region II
Region IV
Region V

- 1) the program's effect upon the plans and programs of your agency
- 2) the importance of its contribution to State and/or nationwide goals and objectives
- 3) in accord with any applicable law, order or regulation with which you are functioning
- 4) additional considerations

Please return THIS FORM AND ONE XEROX COPY to the classroom no later than 17 working days from the date noted above. Please contact the classroom(s) if you need further information or additional time for review.

☒ No comment on this project
☐ Proposal is supported as written
☐ Comments as indicated below

(A) $\frac{1}{x^2} = x^{-2}$

Peggy Pokorski
DEPAD
1700 W. Washington, Rm. 505
Phoenix, AZ

NO. 13, 1979 Date AZ No. 79-80-0015

State Application Number (SAD)

Public Safety
Indian Affairs
Game & Fish
Ag. & Hort.
Civil Rights
Center for Public Affairs
U of A College of Medicine
U of A College of Agriculture
DEPAW: P. Pokorski
J. Rich

From Arizona State Clearinghouse
1700 West Washington Street, Room 505
Phoenix, Arizona 85007

Region I
Region II
Region IV
Region V

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☐ Project is supported as written
☐ Comments as indicated below

Comments: (Use additional sheets if necessary)

Handwritten notes:
I appear to be that the sonic booms are caused by the aircraft flying over the area. The aircraft are flying at a low altitude and the booms are caused by the aircraft flying over the area. The aircraft are flying at a low altitude and the booms are caused by the aircraft flying over the area.

"It appears that the sonic booms (?) caused (cause?) some damage in (on?) the area. At least communications between the Air Force & Tribe have started & hopefully will resolve any potential problems."
Transcribed by S. Bussey, 4/10/84

C-2-66



LAW OFFICES OF PAPAGO LEGAL SERVICES, INC.

POST OFFICE BOX 146
SELLER, ARIZONA 85004
TELEPHONE (602) 932-0030

Community Legal Services
903 N. 2nd St.
Phoenix, Arizona 85004
258-3434
(Effective August 20, 1979)

August 14, 1979

355 CSG/JAD
Davis Mountain Air Force Base, Arizona 85207

58 CSG/JAD
Luke Air Force Base, Arizona 85309

Dear DMABD/LAFB:

This letter is to confirm in writing my telephone complaint of August 13, 1979.

At approximately 7:40 a.m., a massive, thunderous, explosive boom shook Sells. In a little over a year living in Sells, this was the worst sonic boom I have ever heard. Upon walking into my office at Papago Legal Services this morning, I was immediately confronted with complaints about broken windows. Assuming that the individuals would follow through on these complaints, the appropriate claim forms were processed and sent to you.

At 8:00 a.m. this same day, I heard very loud noises from the flying aircraft. When I looked out the living room window of my home, which is situated in the middle of Sells, I observed a large force jet flying directly over my home at an estimated altitude of 300 feet. With the noise that naturally would accompany such an occurrence, the aircraft had short-back wings, was light in color, and had a large fuel tank or simulated missile hanging below it. At first, because of the aircraft's incredibly low altitude, I suspected that the pilot was in trouble and a crash was imminent, but since the jet continued on a level path, this suspicion was not the case.

C-2-67

12

Letter to Davis, Honolulu, Hawaii, dated August 14, 1976

Immediately after this incident, I called the base. Major (phonetic spelling) of Davis, Honolulu, Air Force Base, who informed me that she had checked with Luke Air Force Base and that F-15 jet aircraft had been in the area at the time I reported.

At my office, I later received a call from Bob Chapman, Deputy Chief of the information office at Luke Air Force Base. He also informed me that F-15 jet aircraft had been in the base's area at the time of my reported incident, but informed me that the flight commander stated that at no time did the aircraft fly below 10,000 feet AGL. I again gave my description of the aircraft to Mr. Chapman. I am familiar with the configuration of the following aircraft, which can therefore be eliminated: A-7; F-5 (same as F-33); F-100. In elimination these aircraft, and noting that the aircraft was not camouflaged, Mr. Chapman indicated to me that the aircraft was probably an F-1 or F-2. Mr. Chapman promised me that a further investigation would be made and I would receive a response. I wish to make it very clear that my report of this aircraft is an unclassified report and not based on second hand information. While the altitude of altitude can of course only be that of a layman, I feel that the aircraft was at least below 500 feet, which is an obvious violation of the 3,000 foot floor on the HNM, with charter low level routes that obviously are not over Sells. If the aircraft in question was indeed an F-15, there is then a direct conflict between my testimony and that of the division commander.

Later in the day I received a phone call from Major Roy Campbell, Luke Air Force Base. With his customary discretion, Major Campbell informed me that his informal investigation indicated that the aircraft in question was probably an A-10 operating out of Luke Air Force Base on a low altitude training and navigation mission. Major Campbell also confirmed that there were three F-15s in the Sells area at the time of the earlier sonic boom. Major Campbell promised at that time that further investigation would be made and a written report sent to the Legal Services for office records.

I cannot give an exact identification of the aircraft in question, even though I can provide a general description. However, if the Air Force provided the line drawings or photographs that were requested, this difficulty might not arise. On August 23, 1976, I received the line drawings or photographs from paragraph 10. There, on May 23, 1976, I spoke with Major (phonetic spelling), and we discussed a then telephone communication indicated that the photographs will be sent to us shortly.

Letter to Davis, Honolulu, Hawaii, dated August 14, 1976

I would also like to take this opportunity to file a letter of commendation for an incident on Thursday, August 9, 1976. At this time, I am certain that the incident was on the road between Sells and Guilfoyle when a F-15 jet aircraft (two in front, two in back) flew directly over my car as I was travelling toward Quiltoia. The aircraft flew from my left to my right, and were approximately between 11:20 a.m. and noon. The aircraft was very close and disturbing one, occurred as I was travelling north toward the road on the road between Quiltoia and Casa Grande, just north of Santa Fe boarding school. At that time, approximately 12:00 p.m., two F-15 aircraft appeared from my right travelling in a general direction toward the road. One of the A-10 aircraft, the one in front (which I assume would be the student pilot), peeled off and flew directly toward my car and directly over it. The other aircraft banked behind a hill and was in sight. In both of these instances, the aircraft involved were flying at an approximate altitude of 100 feet AGL.

The August 13 incident was a clear violation of the 3,000 foot floor MDA floor, as well as a violation of what I understand to be the Federal Aviation Administration regulation that aircraft are not to be within 500 feet of persons or property on the ground. The August 13 incidents, while involving A-10 aircraft which are not subject to the 3,000 foot floor, would also appear to be improper in terms of both speed, regulations and general reasonableness. Since it is my understanding that the A-10 is a close-support aircraft, intended for attack against tanks and tanks on the ground (the A-10 Does it Better, Air Force Magazine, July, 1976), I cannot help but suspect that my car was not a target. The highway was a simulated tank used at least in the second incident. I am receiving training in the A-10. Since the A-10 is a slow low flying aircraft known for its maneuverability, where the pilot attacking a target could knock it up with your eyeballs. Air Force Magazine, July, 1976, would seem that the aircraft involved in the above described incidents would have avoided an automobile on the road at least to a greater extent than occurred.

It is particularly ironic that these incidents have occurred in the Air Force is still waiting for a response from the Air Force regarding the draft environmental impact statement hearing held on August 27, 1976 at Santa Rosa Boarding School. But this does illustrate the need for the appropriate governmental agencies to take an alternative action concerning the use of the Papoon Indian Reservation as a military training area. I am confident that these incidents will be fully investigated by the Air Force and the problem of Air Force overflights on this system through aviation in general will be appreciated.

H-1

Enclosure
Letter to Davis Monthan Air Force Base and Luke Air Force Base
August 14, 1979

Sincerely,

PAPAGO LEGAL SERVICES, INC.

Mark Caldwell

Mark Caldwell
Attorney at Law

cc: Dr. Carlos Stern
Deputy for Environment and Safety
Department of the Air Force
Washington, D.C. 20330

Colonel Jeff W. Smith
Head of USAF Representatives,
CEIS Hearing of 3/27/79
12 AF/Asst. Dir. Operational Plans
Bergstrom AFB, Texas 78743

1. Col. Raymond Boucher)
Maj. Fred Kuhn) Luke AFB (encl.)
Maj. Bert Campbell)

Maj. Frank Barrett)
Maj. Jay Miller)
Capt. James Beggerly) Davis Monthan AFB (encl.)
Capt. Charles King)

Office of Rep. Morris K. Udall
300 North Main Avenue
Tucson, Arizona 85701
Attn: Art Chapa

Director, Western Region
Federal Aviation Administration
Post Office Box 92007
Worldway Postal Center
Los Angeles, California 90009

Richard T. Christman
Superintendent, Papago Agency
Bureau of Indian Affairs,
Department of the Interior
Sells, Arizona 85634

Max Norris, Chairperson
Luos Francisco, Vice Chairperson
Papago Tribe of Arizona
Post Office Box 837
Sells, Arizona 85634

Mark Ulmer
Acting Director
Papago Legal Services, Inc.

C-2-71

C-2-70

13 August 1979

Mr. Mark Caldwell
Navajo Legal Services
P.O. Box 246
Sells, AZ 85634

Dear Mr. Caldwell:

In reference to your telephone call of 11 August 1979 you declared a sonic boom occurred at 7:40 a.m. and a low level overflight of the Sells area at 8:00 a.m. Our investigation has revealed that most possibly the sonic boom was caused by three Luke based F-15 aircraft who did fly super-sonic at 20,000' at approximately that time in the Sells Airspace. They were engaged, as usual, in dissimilar air combat training maneuvers. If there was any damage caused by that activity please notify the Legal Office at Davis-Monthan Air Force Base for claims jurisdiction.

The investigation of the overflight of the same day indicated that Luke based aircraft were not on any of the military training routes at that time. There were some A-10 aircraft in the Sells area during this time period but did not fly near the Sells area, as far as we can tell. Your comments also indicated that this type aircraft appeared to be a "large, white, swept wing fighter". In checking our flight records, we discovered that a flight of two U.S. Marine Corps A-4 aircraft were flying a training mission on VR-243 from 7:35 a.m. to 8:05 a.m.

The A-4 aircraft would match your description. Contact with Marine Corps Captain Turner, the Assistant Operations Officer for VMF 102 indicated that there were indeed two A-4s from his squadron near the Sells town at the time in question. Discussion with the pilots indicated that they did see the city and that they thought they avoided it to the south. Their altitude was 500' above the ground. They have been rebriefed by Captain Turner and the sensitive flying areas have been reemphasized. Both Captain Turner and myself apologize for the apparent error and request that you keep us posted as to any such occurrence in the future.

Thank you for your cooperation.

Sincerely,

LEONARD W. CATTILL, Lt Colonel, USAF
Chief, Information Division

Conrad and wife w/TA 1929

Atch 3



ARIZONA STATE PARKS

1600 WEST ADAMS STREET
PHOENIX, ARIZONA 85007
TELEPHONE 862-255-4174

BRUCE BABBITT
GOVERNOR

STATE PARKS
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DJANE MILLER
CHAIRMAN
SEDONA

PRISCILLA ROBINSON
VICE CHAIRMAN
TUCSON

OWEN ROBINSON
SECRETARY
TUMA

REESE G. WOODLING
TUCSON

A.C. WILLIAMS
PRESCOTT

ELIZABETH A. DRAKE
PARADISE VALLEY

ROBERT K. LANE
STATE LAND COMMISSIONER

MICHAEL A. RAMMERS
DIRECTOR

ROLAND H. BHANER
DEPUTY DIRECTOR

February 23, 1984

Mr. Stanley D. Bussey
Project Manager
The Benham Group
1200 N.W. 63rd Street
P.O. Box 20400
Oklahoma City, OK 73156

Re: USAF Operations
Sells Airspace
Environmental Impact Statement
USAF

Dear Stan:

Regarding your request for information and comment on this study as it relates to possible impacts by the Air Force's flight activities on significant historic and archaeological properties, I have the following comments:

1. I understand from our recent telephone conversation that you now have a current list of all the National Register properties that are located in the study area.
2. While there may be additional National Register-eligible standing buildings, structures, or ruins in the study area, we are not aware of any specific properties that should be included.

3. Regarding the impact of sonic boom flights on historic properties, I am not aware of any specific studies that have dealt with this problem and am not sure how to evaluate it. I hope your research has turned up an approach to assess this situation. Our concern, of course, is that the short-and-long term effects of sonic boom flights do not adversely affect the historic buildings, structures, and standing ruins in the Sells Airspace.

Please keep us informed of the progress of your study and, when possible, provide us an opportunity to comment on the draft report.

Sincerely,

Frank B. Fryman

Frank B. Fryman
Archaeologist & Compliance Coordinator

for Donna J. Schober
State Historic Preservation Officer



ARIZONA STATE MUSEUM
THE UNIVERSITY OF ARIZONA
TUCSON, ARIZONA 85721

June 10, 1983

Dr. Stanley D. Bussey
The Benham Group
Post Office Box 20400
Oklahoma City OK 73156

Dear Stan:

Your letter of May 26th to Paul Fish requesting information on sites within the Arizona State Museum Site Survey File for the Sells Indian Reservation area, and the Organ Pipe Cactus National Monument, along with accompanying data has been received.

This request has been passed on to me for handling, and I must admit I nearly forgot about it, but not quite. If I am reading the map as I should, we have 444 sites in the overall project area, with 200 of these being in Organ Pipe. I do not think there are less than the 444 sites, and I suspect that there might be more since the map was not quite detailed enough for me to be exact in translating it to our quadrangle system. I do not know which of these sites are known to you already, but I have appended a list of site numbers that are involved.

For what I have done so far, there is no charge. If you want site, plottings, and Xerox copies of involved sites, then there will be a charge of five cents a page for Xeroxing, plus \$8.50 an hour for my time on the project. If you want site plottings, please send copies of the involved USGS quadrangle maps with project boundary marked thereon.

To be quite fair, I have not the faintest idea of the impact on cultural resources as created by sonic booms of various intensities. If anything there would be ground settling and some movement of artifacts. I just do not feel competent to comment within this area.

Please do let me know if you need anything else with regards to your project. Feel free to call (602/621-4011) if time is still a factor, as I will be able to proceed immediately with data gathering.

Sincerely,
Sharon F. Urban
Sharon F. Urban (Mlee)
Public Archaeologist

Encl. (1)
SFD

K-1

SELLS AREA SITES

AZ Y:16:9, 10
 Z:6:1-7
 Z:7:6-11
 Z:8:1-6 (+)
 Z:9:1, 3, 5-9
 Z:10:1-3
 Z:11:1-5
 Z:12:1-15
 Z:13:1-50
 Z:14:1-90
 Z:15:1-2
 Z:16:1-19
 AA:9:1
 AA:13:1-21
 AA:14: Possible
 SON B:4:1-8
 C:1:1-16
 C:2:1-42
 C:3:1-7
 C:4:1-6
 AZ DD:1:1-58
 DD:2:1-40
 DD:5:1-14
 DD:6:1-19



United States Department of the Interior

NATIONAL PARK SERVICE

WESTERN REGION
 450 GOLDEN GATE AVENUE BOX 38063
 SAN FRANCISCO, CALIFORNIA 94102

IN REPLY REFER TO:

L7617 (WR-RPE)

January 31, 1984

Dr. Stanley D. Bussey
 Benham Group
 9400 N. Broadway
 P.O. Box 20400
 Oklahoma City, Oklahoma 73156

Dear Dr. Bussey:

This is in response to your request to the National Park Service for comments on the Environmental Impact Statement for the Sells Airspace over Organ Pipe Cactus National Monument.

Due to the short response time (two weeks) in your letter of January 19, 1984, we are forwarding copies of Superintendent Smith's letters of June 13, 1983 and June 23, 1983.

As military overflights of Organ Pipe Cactus National Monument continue to be a problem for visitors as well as employees, the Final Environmental Impact Statement for U.S.A.F. operations in the Sells Airspace over Organ Pipe Cactus National Monument should address this problem.

We appreciate the opportunity to comment on this document.

Sincerely,

W. Howard H. Chapman
 for Howard H. Chapman
 Regional Director, Western Region

Enclosures



United States Department of the Interior

NATIONAL PARK SERVICE
ORGAN PIPE CACTUS NATIONAL MONUMENT

IN REPLY REFER TO

RON L. E. BROWN
NATIONAL PARK SERVICE

W4618
XL7619

June 13, 1983

Memorandum

To: Regional Director, Western Region
Attention: Ron Replogle, Environmental Specialist

Through: General Superintendent, Southern Arizona Group

From: Superintendent, Organ Pipe Cactus National Monument

Subject: Comments on Draft Environmental Impact Statement
U.S.A.F. Flight Operations in Sells Airspace

Enclosed is a copy of a letter from Stanley D. Bussey of the Beahm Group, Inc., in which he asks certain questions and provides information pertaining to USAF flight operations in or near Organ Pipe Cactus National Monument. Also enclosed with Mr. Bussey's letter is a copy of the unofficial Draft Environmental Impact Statement on Flight Operations in the Sells Airspace overlying the Papago Indian Reservation.

As you know, military overflight of Organ Pipe Cactus National Monument continues to be a substantial disruptive vexation and is a source of considerable resentment on the part of visitors toward the National Park Service, as well as the military and in the part of employees toward the military.

Some of the observations make it difficult to believe the aircraft are not intentionally attempting to provoke problems, such as flying over the campground and employee residences at 7:00 A.M. on a Sunday morning.

We do appreciate the opportunity to provide input to the Environmental Impact Statement process. Our comments in response to Mr. Bussey's questions are as follows:

1. Any information about the monument that you believe should be included in the description (p. 31).

Please add:

On October 26, 1976, Organ Pipe Cactus National Monument was designated an International Biosphere Reserve under the United Nations Educational,

2

Scientific and Cultural Organization (UNESCO). On November 10, 1978, the U.S. Congress designated 312,600 acres as Organ Pipe Wilderness. Wilderness status covers 95% of the monument. (We feel the above is a minimal addition. The previous submission by former Superintendent Martinez is preferred and enclosed.)

2. We would appreciate visitor counts, if they are easily available, for all years since 1970.

1970 - 415,400	1977 - 139,816
1971 - 366,924*	1978 - 150,300
1972 - 86,627*	1979 - 134,010
1973 - 89,356	1980 - 150,687
1974 - 105,048	1981 - 165,154
1975 - 139,200	1982 - 154,310
1976 - 130,739	1983 - 141,397 as of 5/31/83 (42% increase for year to date)

*The method of recording/counting visitation was revised effective 1/1/72.

3. We would appreciate copies of any correspondence that you may have had with the USAF since March, 1979.

- a. 3/30/79 - Letter to Dr. Carlos Stem from Patricia S. Port, NPS
- b. 5/16/79 - Letter to Captain William A. Gauntt from Superintendent Ray G. Martinez, Jr.
- c. 4/1/80 - Letter to Honorable Morris K. Udall from Art Johnson
- d. 4/15/80 - Letter to Director William Whalen from Morris K. Udall
- e. 5/1/80 - Letter to Honorable Morris K. Udall from Deputy Director Ira J. Hutchison
- f. 9/8/80 - Memo to State Director, BLM, Phoenix from Acting Associate Regional Director, Resource Management, Western Region, National Park Service

8. Written complaint to the Superintendent:

4/1/81 - Robert L. Prodeman
3/3/83 - Dennis R. Brownridge
3/8/83 - Lora Anderson
3/8/83 - Mitchell Wyss

C-2-77

C-2-78

3/24/83 - Carlyn Jorvis

3/24/83 - Thomas Jorvis

3/30/83 - Edward Norvalis

4. What areas of the monument are most heavily used by visitors? In which of these areas are complaints about overflights most frequent?

- Monument headquarters
- Ajo Mountains and area in vicinity of the Ajo Mountain Drive
- Vicinity of the Puerto Blanco Drive, i.e., center of the monument
- State Highway 85 in the monument
- Vicinity of Bates Well

5. During our telephone conversation of 5/25/83, you mentioned that overflights of the headquarters and campground did occur. If you have maintained notes or logs on dates and time of overflights, we would appreciate copies.

As we stated in response to written visitor complaints, this practice was dropped when it became apparent the USAF was non-responsive. Since our conversation with Mr. Bussey on 5/25/83, we have noted the following incidents:

Time	Date	Sighting	Dir. of Travel
1:55 p.m.	5/25/83	Milton Mine area	SW/NW
5:11 p.m.	5/27/83	Headquarters	SW→NE
9:50 a.m.	5/28/83	Alamo Canyon	E→W
10:40 a.m.	5/28/83	Ajo Mtn. just north of Alamo Canyon	W→E
11:30 a.m.	5/28/83	South of Alamo Canyon	W→E
12:00 p.m.	5/28/83	Alamo Canyon	SW→NE
11:13 p.m.	6/02/83	Headquarters	W→E
11:50 a.m.	6/03/83	Martinez Mine/Twin Peaks	NN→SE
8:13 a.m.	6/08/83	Headquarters	N→S→N
8:37 a.m.	6/08/83	Martinez Mine area over Twin Peaks	S→NW
7:30 a.m.	6/9/83	Directly over Copper Mtn.	

C-2-70

Time	Date	Sighting	Dir. of Travel
11:35 a.m.	6/09/83	East side Copper Mtn.	E→W
9:10 a.m.	6/12/83	Route 85, Milepost 72	E→W, SW
7:40 a.m.	6/13/83	Route 85, Milepost 72	E→W, SW

6. To the extent that you can assess the situation, have problems with overflights increased, decreased or remained the same since 1977?

Nearly all of our staff has turned over since 1977, however, those few employees that were here in 1977 and are still with us today indicate that the problem continues to grow but is quite sporadic. Visitors have provided photographic documentation of their source of complaint. There may be a tendency to become more provocative, i.e.; apparently with intent to antagonize and infuriate persons on the ground.

This past winter when the campground was occupied by 800-1000 visitors, two aircraft passed directly overhead of the campground and employee residences at elevations less than 800 feet above the ground at approximately 7:00 a.m. on a Sunday morning. This loud and highly irritating noise appeared to be totally without defense and with malice of premeditation to harass park visitors and employees. On another occasion, a volunteer was nearly blown off the road by a low flying aircraft approaching from the rear of his vehicle. Also, we received a verbal complaint from the administrator of the Sierra del Pinacate National Park in Mexico relating similar incidents by American aircraft causing disturbance in Mexico.

In Mr. Bussey's letter of 5/26/83, he lists current USAF operations over Organ Pipe Cactus National Monument as follows:

- Air combat maneuvering is permitted above 10,000 ft. MSL. Pilots are directed to aim sonic booms away from the monument.
- Two military training routes cross or come near the northern boundary of the monument.
- Low altitude tactical navigation training flights are permitted anywhere over the monument, except that aircraft must stay above 3000 feet above ground level over the headquarters and campground area. Civilian aircraft can operate in this area under visual flight rules without any special restrictions.

While these statements appear to reflect due consideration and concern for values and resources to be preserved in the monument, without compliance and/or enforcement they are not worth the paper they are written on.

We feel a major criticism of the Draft document is that it tends to reflect an impression that the impact to the monument is slight in degree, infrequent in occurrence and the impact is only a small insignificant area when compared to the total.

C-2-80



United States Department of the Interior

NATIONAL PARK SERVICE
ORGAN PIPE CACTUS NATIONAL MONUMENT

WASHINGTON, D.C.
20540

IN REPLY REFER TO:

14618

June 23, 1983

5

A brief statement dated April 18, 1979 is enclosed for record and use. In addition, we appreciate the opportunity to address this problem and solicited assistance in finding a resolution before more serious incidents record loss of life and resources.

Harold J. Smith

Harold J. Smith

1983

Area Superintendent, Southern Arizona Group

Memorandum

To: All Employees & VLPs

From: Superintendent, Organ Pipe Cactus NM

Subject: Reporting observations of low flying aircraft

As a result of recent verbal and written communications with the military and their civilian consultants, there appears to be an opportunity to reduce and hopefully eliminate low flying aircraft from portions of the monument.

Aircraft observed other than within the two following circumstances should be reported to the Superintendent or designee so that the military can take appropriate action to prevent recurrence.

- 1) Over 500 feet above the ground within 5 miles of a line crossing the northeast corner of the monument or essentially within the perimeter of the Kuakatch Wash.

- 2) Over 3000 feet above the ground anywhere in the monument except the area covered in item (1).

If observations are made between 8:00 a.m. and 4:30 p.m., Monday through Friday, please report them immediately. During all other hours and weekends, record the data so that we can inform the military at our first opportunity. The information needed is:

Aircraft type	Time	Date	Location	Direction	Est. altitude
Special attention to the tail and/or engine configuration will assist in identifying the type of aircraft, i.e.; twin tails, twin engines, camouflage paint or any unique characteristics will help.					

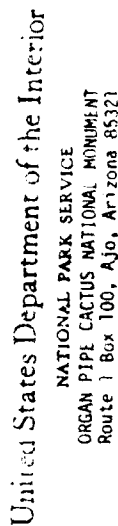
Thanks much for your assistance in resolving this problem.

Harold J. Smith

Harold J. Smith

Enclosures

C-7-8



WE ASK YOU TO:

W46
FXL7617

18 May 1979

Captain William A. Gauntt
H. Q. TAC/DEEV
Langley AFB, Virginia 23665

Dear Captain Gauntt:

Enclosed is a copy of the Environmental Impact Statement for the Sells Low MOA. I have marked up portions where additions or corrections might be considered.

I have also enclosed a minimum of information covering the Organ Pipe Cactus National Monument which the public should be aware of when considering this document. You may want to reward it from the Air Force point of view but we feel the basic data is pertinent to the subject and should be included in your Environmental Impact Statement.

If you have any questions or if I can be of any assistance please don't hesitate to let me know.

Sincerely yours,

Ray G. Martinez, Jr.
Superintendent

[illegible]

C-2-84

ORGAN PIPE CACTUS NATIONAL MONUMENT

The Organ Pipe Cactus National Monument is comprised of 330,834 acres (133,901 hectares) and lies in extreme southern Arizona adjacent to the international boundary with Mexico. It is bounded on the west by the Cabeza Prieta National Wildlife Range, on the east by the Pajarito Indian Reservation and on the north by public lands administered by the Bureau of Land Management. The Monument is proposed for inclusion in the Sells Airspace and must therefore be considered along with, but separate from the Papago reservation in this assessment process.

The Organ Pipe Cactus National Monument was established by Presidential Proclamation (No. 2232--April 12, 1937--50 Stat. 1827) to perpetuate for future generations a representative sample of the Sonoran Desert, its overall scenery, indigenous plants characterized by the saguaro-palo verde association, the distinctive organ pipe cactus, desert wildlife species, and the historic resources associated with man's presence and life within the Monument area.

The above purpose is based on the following relevant portion of the Proclamation establishing Organ Pipe Cactus National Monument:

"Whereas certain public lands in the State of Arizona contain historic landmarks, and have situated thereon various objects of historic and scientific interest; and whereas it appears that it would be in the public interest to reserve such lands as a National Monument, to be known as the Organ Pipe Cactus National Monument

Furthermore, in the Act of August 25, 1916 Congress established within the Department of the Interior, the National Park Service in order to provide for administration of such areas as Organ Pipe Cactus National Monument. The Act states that:

The service thus established shall promote and regulate the use of the Federal areas known as national parks, monuments and reservations... by such means and measures as conform to the fundamental purpose of the said parks, monuments and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.

In addition 312,000 acres of the Organ Pipe Cactus National Monument was officially designated wilderness on November 10, 1978 by Act of the 95th Congress. This designation as mandated by Congress requires the National Park Service to manage and preserve this wilderness area in the manner called for by the National Wilderness Act of 1964 and the National Park Service Wilderness use and management policies (neither of which may lower the standards called for by the Act of August 25, 1916 or the statutory authority under which the area was created).

This statement also recognizes the fact that the Monument is one of only 28 natural sites within the entire United States officially designated as a unit of UNESCO's (United Nations Economic, Scientific, and Cultural Organization) worldwide "Man and the Biosphere" Reserve System. This system for the conservation and preservation of unique natural areas has the sanction and support of the State Department and many international bodies.

The National Park Service is also required to protect certain sites and/or facilities which have been nominated and designated as significant historic resources to be placed on the National Register of Historic Places. This requirement comes from the National Historic Preservation Act of 1966, (80 Stat. 915, 16 U.S.C. 470) and Executive Order 11593 dated May 13, 1971. To date five sites within Organ Pipe Cactus National Monument are presently listed and 4 others are presently being considered.

Impacts Past and Present on the Organ Pipe Cactus National Monument by Military Operations

Prior to early 1976 the Monument was overflown by military aircraft at altitudes of 1000 feet and above. Established routes over the monument consisted of only one located in and over the extreme northeast corner of the Monument. In April of 1976 the A-10 was introduced and tested at Davis-Monthan Air Force Base. Initially only two of the planes were located at this base. However, by the fall of 1976 6 of the A-10s were being flown out of this location. The A-10s are designed to be capable of low speed and low altitude maneuvering and depends on the extreme low altitude for its own protection. With this in mind the Air Force lowered the altitude ceiling from 1000' to as low as 100' above the ground to allow for training of pilots in the A-10 aircraft. Consequently, the Air Force began using the entire monument to conduct these low level training exercises. At the present time (July 1979) there are 10 A-10s in operation out of Davis-Monthan and with the phase out of the A-7 aircraft it is estimated by 1981 that there will be 12 A-10s training out of this air base.

Details of Any Possible Consequences

The National Park Service has become increasingly concerned about the

Intrusion of low level flights over the Monument since the advent of the first A-10 in the spring of 1976 and their gradual build up from 2 aircraft in 1976 to 70 in 1979. Lowering of the 1000 foot AGL ceiling to 100 feet and the increased use of the Monument's 516 square miles as a prime area for these training purposes has also contributed to the concerns of the National Park Service regarding its management responsibilities of the Monument's natural environment.

National Park Service Actions

The National Park Service has expressed their concern over this increased activity in various ways. Representatives of the National Park Service have attended most sessions held at Sells and have voiced their concern. They have maintained aircraft disturbance logs, initiated meetings with the various air bases to determine the origin of the disturbances, they have submitted formal letters of protest regarding the inclusion of the Monument in the Sells Low Military Operations Area and have requested that the general public become better informed as to the impacts that this operation plan will have on the Monument.

National Park Service officials have taken the position that to include the Organ Pipe Cactus National Monument in the Sells Low Military Operations area, subjecting it to the low level flights required to train pilots in the A-10 must be considered as compromising the intent and integrity of the Monument as it was established. Furthermore, to subject the Monument and particularly the monument visitor to this type of intrusion would adversely affect the experience of those who come to the area for its natural values.

Summary of Letters from National Park Service and Department of the Interior In Appendix K



UNITED STATES DEPARTMENT OF THE INTERIOR

OFFICE OF THE SECRETARY

PACIFIC SOUTHWEST REGION
BOX 38088 • 450 COLLEGE AVENUE
SAN FRANCISCO, CALIFORNIA 94122
(415) 396-APR04 1979

ER-79/154

March 30, 1979

Dr. Carlos Stern
Deputy for Environment & Safety
U.S. Air Force
Washington, D.C. 20330

Dear Dr. Stern:

★*1

The Department of the Interior has received and reviewed the Draft Environmental Impact Statement by the U.S. Air Force for Flight Operations in the Sells Airspace Overlying the Papago Indian Reservation, Pima, Pinal and Yuma Counties, Arizona.

We have a number of concerns both with the adequacy of this document, and with the safety and environmental consequences of the proposed project.

The detailed comments below focus largely on the noise and safety impacts of low flying aircraft in this airspace, particularly on the use and enjoyment of the Organ Pipe Cactus National Monument and the Papago Indian Reservation.

The Draft Environmental Impact Statement as prepared by the U.S. Air Force is inadequate, in our opinion. Outlined below are the major reasons:

1. The Draft Statement fails to properly address the serious impacts imposed upon the Organ Pipe Cactus National Monument. The Monument has been in existence as a unit of the National Park System since 1937. As a large natural area of the system it was expressly created to be enjoyed by all the citizens of the United States in as near a natural environment as possible, free from all excessive man-made intrusions. Excessive, extremely low altitude, jet aircraft maneuvering and the imposition of sonic booms seriously negate appropriate public use of the park to the point of being unacceptable by the visiting public and the National Park Service.

RECEIVED	
Western Regional Office	
APR 2 1979	
Region: Director	
Dep. Regional Dir	
Operations Eval	
Administration	
Outreach	
Res. Mgmt. Plan	
ECO	
Public Affairs	
Action Taken	

2. The Draft Statement fails to recognize the fact that Organ Pipe Cactus National Monument has an added protected status as a unit of the National Wilderness Preservation System. The National Wilderness Preservation System, as mandated by Congress, calls for agencies administering areas included within the system to be responsible for preserving the wilderness character of the areas designated. The National Park Service feels that to concur in the Air Force proposals for flying military training routes (Item 2.1.4) and the low altitude tactical navigation maneuvering (Item 2.1.5) would be totally contrary to that congressional mandate.

3. The Draft Statement fails to recognize the fact that the Monument is one of only 28 natural sites within the entire United States officially designated as a unit of UNESCO's (United Nations Economic, Social and Cultural Organization) Worldwide "Man and the Biosphere" Reserve System. This system of unique natural conservation/preservation areas has the sanction and official support of many federal agencies and departments at the national decision-making level in Washington, D.C. The type of excessive intrusion on the Monument stated by this Air Force flight operations proposal is incompatible with the UNESCO designation.

4. The Draft Statement fails to mention or even respond to the fact that the National Park Service has officially objected from the outset to the attempt to include the Monument in this proposal. The official objection of the National Park Service was expressly stated in two written letters dated March 9, 1977 and September 30, 1977 (copies enclosed) and the same position was repeatedly stated for the record by NPS representatives attending various meetings on this proposal at Sells, Arizona. The Draft Statement totally omits inclusion of the two official letters of protest in the appropriate sections of the Draft Statement and makes no reference to the supporting position maintained by NPS representatives throughout the various meetings held at Sells, Arizona. The Air Force has a significant state of unresolved controversy existing with the National Park Service and a large percentage of objecting public visitors to the Monument (150,271 total visitors in CY 1978) which it neglects to even mention in its Draft statement, particularly in Section 10.0 on page 59.

5. The Draft Statement and preparatory public hearing process failed to give adequate public opportunity for comment. Under the National Environmental Policy Act (NEPA) of 1969, proposed projects or activities of a highly controversial nature, like the Sells Military Operational Area over Organ Pipe Cactus National Monument, are expected to be fully presented to a broad spectrum of the public by means of meetings or hearing where the public at large can be fully informed of the extent and consequences of the

proposal and have ample opportunity for expression of their personal feelings about it. It is our contention that the extent of the proposed intrusion on Organ Pipe Cactus National Monument, if fully known to the public at large, by means of well-publicized public forums held in Tucson, Phoenix, Flagstaff, and other appropriate locations, would surface considerable public opposition to the inclusion of Organ Pipe Cactus National Monument in the proposed Sells Military Operational Area.

The several items mentioned above highlight our opposition to this Air Force proposal as it is presently constituted. We must strongly protest the inclusion of Organ Pipe Cactus National Monument within the Sells Military Operational Area. Military training flights, as they are currently occurring and as proposed for official FAA sanction under the Air Force proposal for the Sells Military Operational Area, excessively compromise the intent of the proclamation establishing the Monument, its operation under the NPS Establishment Act of 1916, the National Wilderness Preservation Act, the Park's UNESCO status, and some environmental protection aspects of the National Environmental Policy Act of 1969, as it applies to Organ Pipe Cactus National Monument.

In addition to adverse impacts on the Monument, there are also noise problems over the Papago Reservation. You state on page 31 of the Draft Environment Impact Statement, Sec. 3.2 Airspace Above the Papago Reservation: "No special procedures or operating limitations are or will be placed on VFR civil aircraft operating in the Sells MDA's."

There have been several Air Force planes that collided and crashed on the Papago Reservation and several near-misses with civil aircraft. The BIA has aircraft flying into Sells for cattle counting by airplane and the USFWS uses aircraft to transport patients in and out. Civilian pilots are increasingly apprehensive about the increased military traffic from ground level to above 30,000 feet.

On page 36, second paragraph stating "no direct personal injury suffered...." is incorrect. An elderly lady has suffered slight lacerations and contusion from falling plaster in her bathroom, and public school windows have been broken in classrooms. The Papago people are cattlemen and stockraisers and work their cattle on horseback, thus creating a strong potential of injury from being thrown from startled horses due to sonic booms and associated aircraft noise.

On page 55 is stated: "Supersonic functional flight checks have been prohibited in the Sells Airspace since 25 July 1977." This is not the case. Sonic booms occur several times weekly and a sonic boom at 0700, February 28, 1979, caused a mule stampede at the cattle complex endangering lives of children.

Because of the strong negative impacts this project will have on both the Papago people and the Organ Pipe Cactus National Monument, the Department of the Interior requests that careful consideration be given to holding additional public hearings on the DEIS and working closely with the National Park Service and the Papago Indian Agency to modify this project to mitigate its severe environmental and safety impacts.

If you have any questions about these comments, please contact me directly.

Sincerely,

Patricia Sanderson Port

Patricia Sanderson Port
Regional Environmental Officer

Enclosure

- cc: Director, OEPB (w/copy incoming)
Commissioner, Bureau of Indian Affairs
Director, Heritage, Conservation and Recreation Service
Director, National Park Service
Director, Fish and Wildlife Service
Director, Geological Survey
Director, Bureau of Land Management
Commissioner, Bureau of Reclamation
Area Dir., SIA AZ
Reg. Dir., BC2S
Reg. Dir., FWS Albuquerque
Reg. Dir., NPS
Asst. Dir., GS
Reg. Dir., BLM AZ
Reg. Dir., BR NY

COPIES FOR FILE
(OPTIONAL)

RECEIVED
Organ Pipe Cactus, N.M.
MAY 30 1980

A3615(WR)OV

Honorable Morris K. Udall
House of Representatives
Washington, D.C. 20515

Dear Mr. Udall:

Thank you for your letter on behalf of Mr. Art Johnson, of the National Park Service, concerning military aircraft flights over Organ Pipe Cactus National Monument.

As you know, the Federal Aviation Administration has the authority and responsibility to establish Military Operations Areas, and the airspace over Organ Pipe Cactus National Monument is a part of the Sella area. Over the past several years, a number of meetings have been held in southern Arizona concerning training flights of military aircraft, and it is our understanding that portions of the Papago Indian Reservation have been excluded from the MOA because of the effects of low-flying aircraft on the villages in that area. Although the National Park Service has protested the inclusion of Organ Pipe Cactus National Monument, the U.S. Air Force has been using that airspace for training flights from a time before a designated wilderness was established. Requests by the National Park Service to keep training flights at altitudes above 3,000 feet have not been successful. Although military agencies have made an effort to avoid specific ground sites of a sensitive nature, it is their position that few large areas of a sparsely populated nature are available over which to conduct their training flights.

We hope that this information will be helpful.

Sincerely yours,

(Signed) _____
Director

cc: Western Regional Director (2) w/c of inc.
001-Reading File
160)
500)
190)
FBI:ward:med:5/8/80
Retyped:med:5/12/80

MORRIS K. UDALL
In District of Arizona
1000 EAST WASHINGTON AVENUE
TUCSON, ARIZONA 85719

CONGRESS OF THE UNITED STATES
HOUSE OF REPRESENTATIVES
WASHINGTON, D.C. 20515

COMMITTEE ON
INTERIOR AND RELATED AFFAIRS
CHAIRMAN

POST OFFICE AND CIVIL SERVICE

April 15, 1980

Mr. William Whalen
Director, National Park Service
Department of the Interior
Washington, D.C. 20240

Dear Bill:

Attached is a letter from a constituent regarding the annoying practice of military jets roaring through the airspace above Organ Pipe National Monument. I think he makes some excellent points.

I understand that your staff is working informally with the Federal Aviation Administration to identify areas disturbed by jet noise and to explore ways the problem can be corrected.

I believe this is an important matter, and urge you to hasten its resolution. Please keep me informed on the progress of these discussions.

Sincerely,

M. K. Udall
Morris K. Udall

attachment

twex

THIS STATIONERY PRINTED ON PAPER MADE WITH RECYCLED FIBERS

APR 1 1980

APR 1 1980

March 27, 1980

Morris Udall
Member of Congress

Dear Mo:

I would like to relate to you two instances which were disturbing to me during my recent visit to Organ Pipe Cactus National Monument in southern Arizona. I was there March 23-26. The first of these were the numerous low flying, double-tailed, military jets which I seen at least three pairs a day, flying through the Monument. The second instance occurred on March 25 when I seen a group of military fighter jets doing maneuvers at high altitudes directly overhead. Their maneuvers were accompanied by an extremely loud sonic boom.

These were very disturbing, and surprising, because I do a lot of camping and hiking in wilderness areas. I look at these areas as a place to escape the noise of town living and obviously I do not expect or want to see jets in a wilderness.

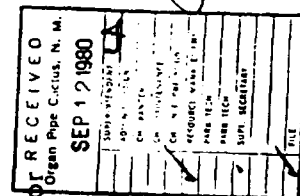
I made an official complaint to the Monument administration and they were very helpful and informative. They told me that although they agree with me that jets should not be allowed to maneuver over the Monument, they can not do anything about it because the Wilderness Act does not specifically ban aircraft. It is my contention that the gist of the Wilderness Act is to set aside certain areas of land to be untrammeled by man and left in its primitive character. The administration basically agreed with my ~~best~~ feelings about wilderness and it's incompatibility with jet maneuvers; but despite many similar complaints they were still waiting for a final decision on this problem, from Washington.

What is the current status of this decision process, if any? Is there anyone else I should write to? If at all possible, I urge you to quicken the final decision and try to get aircraft maneuvering banned from Wilderness.

Thank you very much for your time and representation.

Art Johnston
Box 1646
Bisbee, AZ 85803

C-2-98



NATIONAL PARK SERVICE

WESTERN REGION:

430 GOLDEN GATE AVENUE, BOX 36063
SAN FRANCISCO, CALIFORNIA 94117

IN REPLY REFER TO:
L7619 - 8LM
X (46)
(WR) REQ

September 8, 1980

Shiela - X-ref.
MS. X-ref.
to W-46 aft.
dist-house

Memorandum

To: State Director, Bureau of Land Management, Phoenix, Arizona

From: Associate Regional Director, Resource Management and Planning
Atlanta

Subject: Review of draft environmental impact statement, for continued use of public lands at the Luke Air Force Range, Arizona

We have reviewed the subject document and offer the following comments:

1. Page 1, paragraph 4: Reference is made to low-level overflights, sonic booms and towed-target debris as they relate to the Cabeza Prieta proposed wilderness. These same problems apply to the 312,600-acre existing wilderness with Organ Pipe National Monument and also detract from the monument's visual resources. During the preceding year, park employees, assisted by student volunteers, removed seven of the aerial dart tow targets described on Page 56 from within our wilderness zone, and we have documented frequent low-level over-flights and sonic booms. Suggest you include reference to Organ Pipe wilderness.
2. Page 36, paragraph 2: No burros are known to occur within the lands administered as Organ Pipe Cactus National Monument. The last burros were removed in early 1978.
3. Page 67, paragraph 6: See subparagraph 1, above.
4. Page 72, paragraph 5: We suggest also that an effort be made to prevent darts and other ordinance from being dropped within the Monument.
5. Page 95 (terms), Public Land: The definition should not be limited to lands administered by the Bureau of Land Management. All land management by local, state, and Federal governments are considered "Public Land".

Since we feel that the subject proposal has a direct influence on the area under our management, we appreciate the opportunity to comment on the draft document.

bc:
Superintendent, Organ Pipe
DOI, RZO, San Francisco
WASO (135)
General Superintendent, Southern

मार्ग, सिद्धि

Year of
The

• • •

Route 1, Box 100, A10, AZ 85521

51675

April 8, 1981

Mr. Robert L. Prockman
3219 Lin-Tai Road
St. Louis, MO 63125

Dear Mr. Prodemmi:

In response to your April 1, 1981 complaint regarding low-flying aircraft over Oregon Pipe Octopus National Monument, I offer the following information which I hope will answer some of your questions.

Organ Pipe Cactus National Monument is located directly south and east of the United States Air Force gunnery ranges. In the past, meetings have been held with all involved agencies regarding overflights. The wilderness and visitor use areas (headquarters) are considered restricted areas, and overflights at low altitudes will not occur at any time. This restriction is constantly monitored by the Air Force.

Documentation is made on each verified overflight violation and reported to the Air Force. To date, the reports would seem to have had little effect in halting the overflight violations.

We can assure you that we will continue to do everything possible to restrict this type of activity over Organ Pipe Cactus National Monument.

I hope your visit to this area of the National Park system was not entirely unimpaired by the aircraft flights and that you will pay us a return visit.

Sincerely,

William F. Wallace
Superintendent

20

A3615

March 10, 1983

Mr. Dennis R. Brownridge
1651 Old Pueblo Dr.
Tucson, Arizona 85745

Dear Mr. Brownridge:

It was kind of you to take the time to share with us your experience and impressions of Organ Pipe Cactus National Monument.

The Federal Aviation Administration has the authority and responsibility to establish Military Operations Areas, and the airspace over Organ Pipe Cactus National Monument is a part of the Sells MDA. Over the past several years, a number of meetings have been held in southern Arizona concerning training flights of military aircraft, and it is our understanding that portions of the Papago Indian Reservation have been excluded from the MDA because of the effects of low-flying aircraft on the village of that area. Although the National Park Service has protested the inclusion of Organ Pipe Cactus National Monument, the U.S. Air Force has been using that airspace for training flights from a time before a designated wilderness was established. Requests by the National Park Service to keep training flights at altitudes above 3,000 feet have not been successful. Although military agencies have made an effort to avoid specific ground sites of a sensitive nature, it is their position that few large areas of a sparsely populated nature are available over which to conduct their training flights.

For several years, documentation of each flight was reported to the U.S. Air Force. After a period of time, it became obvious this was a waste of time and the practice was dropped. Our records indicate various attempts by the Washington office of the National Park Service to reduce or eliminate this overflight practice.

At this location, we are not aware of testimony before Congress regarding this problem.

Once again, thank you for taking the time to comment and for your concern in the management of Organ Pipe Cactus National Monument.

Sincerely yours,

Harold J. Smith
Superintendent
HJSMITH:ss 3/10/83

C-2-98

4/1/81
No April Fool

complaint

The last 4 days, once, twice, or three
a day, many looking aircraft have passed
me, not at all the ground. -- this use covered
by the National Park Service charter, to "preserve
for future generations"? A reply would be
appreciated.

Robert R. Fendeman

Robert R. Fendeman

3219 LINTEL Rd.

St. Louis, Mo. 63125

C-2-97

W-1

March 3, 1983

Superintendent
Organ Pipe Cactus National Monument
Route 1, box 100
Ajo, AZ 8521

Dear Sir:

On a recent visit to OPCNM I was astounded to witness military jet fighter-bombers deliberately practicing in several portions of the Monument. Each day of my visit, I was terrorized by these shrieking warplanes as they dodged through the Ajo Range at Saguaro-top levels, sometimes hundreds of feet below me.

This is of course a totally inappropriate use of a natural region supposedly held in public trust. Since the military already owns some 5700 square miles of Southern Arizona alone--a vast area nearly twice the size of the Grand Canyon, Organ Pipe, and every other national park or monument, state, regional, and county park in Arizona put together, it would hardly seem necessary for them to joyride frivolously in our parks as well. I found it most embarrassing to explain this activity to some foreign visitors I encountered, who were dumbfounded at the seeming arrogance and lack of respect of our military toward what the visitors rightly regarded as part of our national treasure.

I realize that the military has enormous political power and is difficult to control in any event, and the pilots know, of course, that it is impossible for their planes to be identified at such high speed. However, I would very much appreciate it if you could tell me:

- How long this sort of intensive abuse of the Monument has been taking place, and
- Precisely what formal action OPCNM has taken to try and abate it, in the form of protests thru NPS or DOI channels, testimony before congress, or negotiations with the Air Force.

Thank you for your assistance.

Sincerely,

Dennis R. Brownridge
Dennis R. Brownridge
1651 Old Pueblo Dr.
Tucson, AZ 85745
(602) 624-2589

C-2-99

A3615

March 15, 1983

Ms. Lora Anderson
9282 Stanford Lane
Durham, California 95938

Dear Ms. Anderson:

It was kind of you to take the time to share with us your experience and impressions of Organ Pipe Cactus National Monument.

The Federal Aviation Administration has the authority and responsibility to establish Military Operations Areas, and the airspace over Organ Pipe Cactus National Monument is a part of the Salis MDA. Over the past several years, a number of meetings have been held in Southern Arizona concerning training flights of military aircraft, and it is our understanding that portions of the Papago Indian Reservation have been excluded from the MDA because of the effects of low-flying aircraft on the villages of that area. Although the National Park Service has protested the inclusion of Organ Pipe Cactus National Monument, the U.S. Air Force has been using that airspace for training flights from a time before a designated wilderness was established. Requests by the National Park Service to keep training flights at altitudes above 3,000 feet have not been successful. Although military agencies have made an effort to avoid specific ground sites of a sensitive nature, it is their position that few large areas of a sparsely populated nature are available over which to conduct their training flights.

For several years, documentation of each flight was reported to the U.S. Air Force. After a period of time, it became obvious this was a waste of time and the practice was dropped. Our records indicate various attempts by the Washington office of the National Park Service to reduce or eliminate this overflight practice.

Once again, thank you for taking the time to comment and for your concern in the management of Organ Pipe Cactus National Monument.

Sincerely yours,

Harold J. Smith
Superintendent
HJSMITH:ss 3/15/83

C-2-100

2/82

VISITOR COMMENTS

Date 2/8/82

Superintendent
Organ Pipe Cactus National Monument
Route 1, Box 100
Ajo, AZ 85321

Dear Superintendent:

I wish to make the following comments about services and/or conditions that I observed at Organ Pipe Cactus National Monument during my recent visit:

I would compliment you on the excellent management and foresight concerning the primitive area. It is one of the best I have observed in my travels in the national parks.

I would however encourage you to do whatever in your power you can to get rid of the low flying military aircraft. It is an insult to the beauty of Organ Pipes and detracts significantly from the experience of the park visitor. The Armstrong area was visited five times by low flying aircraft on Sunday, Monday, March 7th. Thank you for your efforts.

Signature Lore Anderson
Printed Name LORE ANDERSON
Printed Name 9282 Stanford Lane
Printed Street or P.O. Box Durham N.C. 27608
Printed City, State, ZIP Code

C-2-101

A3615

March 15, 1983

Mr. Mitchell Wyss
9282 Stanford Lane
Durham, California 95928

Dear Mr. Wyss

It was kind of you to take the time to share with us your experience and impressions of Organ Pipe Cactus National Monument.

The Federal Aviation Administration has the authority and responsibility to establish Military Operations Areas, and the airspace over Organ Pipe Cactus National Monument is a part of the Salls MOA. Over the past several years, a number of meetings have been held in southern Arizona concerning training flights of military aircraft, and it is our understanding that portions of the Papago Indian Reservation have been excluded from the MOA because of the effects of low-flying aircraft on the villages of that area. Although the National Park Service has protected the inclusion of Organ Pipe Cactus National Monument, the U.S. Air Force has been using that airspace for training flights from a time before a designated wilderness was established. Requests by the National Park Service to keep training flights at altitudes above 3,000 feet have not been successful. Although military agencies have made an effort to avoid specific ground sites of a sensitive nature, the available information to conduct their training flights.

For several years, documentation of each flight was reported to the U.S. Air Force. After a period of time, it became obvious this was a waste of time and the practice was dropped. Our records indicate various attempts by the Washington office of the National Park Service to reduce or eliminate this overflight practice.

Once again, thank you for taking the time to comment and for your concern in the management of Organ Pipe Cactus National Monument.

Sincerely yours,

Harold J. Smith
Superintendent
HJSMITH:ss 3/15/83

C-2-102

VISITOR COMMENTS

CU

Date 3/8/83

Superintendent
Organ Pipe Cactus National Monument
Route 1, Box 100
Ajo, AZ 85321

Dear Superintendent:

I wish to make the following comments about services and/or conditions that I observed at Organ Pipe Cactus National Monument during my recent visit:

The management of the park proper has been excellent during my stay.

However I believe that there is a problem with the Air Force jets flying so low over the National Monument. It presents an extreme in noise pollution and can be considered dangerous to park visitation.

Yesterday I watched as the performers manuever over the park and felt that there should be a minimum Altitude and they should adhere to

Signature M. J. Smith
Printed Name M. J. Smith
Printed Street or P.O. Box Durham, NC 27603
Printed City, State, ZIP Code

A3613

March 28, 1983

Ms. Carolyn Jervis
60 Barranca Road
Los Alamos, New Mexico 87544

Dear Ms. Jervis:

It was kind of you to take the time to share with us your experience and impressions of Organ Pipe Cactus National Monument.

The Federal Aviation Administration has the authority and responsibility to establish Military Operations Areas, and the airspace over Organ Pipe Cactus National Monument is a part of the Santa Rita MDA. Over the past several years, a number of meetings have been held in southern Arizona concerning training flights of military aircraft, and it is our understanding that portions of the Papago Indian Reservation have been excluded from the MDA because of the effects of low-flying aircraft on the villages of that area. Although the National Park Service has protected the inclusion of Organ Pipe Cactus National Monument, the U.S. Air Force has been using that airspace for training flights from a time before a designated wilderness was established. Requests by the National Park Service to keep training flights at altitudes above 3,000 feet have not been successful. Although military agencies have made an effort to avoid specific ground sites of a sensitive nature, it is their position that few large areas of a sparsely populated nature are available over which to conduct their training flights.

For several years, documentation of each flight was reported to the U.S. Air Force. After a period of time, it became obvious this was a waste of time and the practice was dropped. Our records indicate various attempts by the Washington office of the National Park Service to reduce or eliminate this overflight practice.

Once again, thank you for taking the time to comment and for your concern in the management of Organ Pipe Cactus National Monument.

Sincerely yours,

Harold J. Smith
Superintendent

HJSMT:ee 3/28/83

VISITOR COMMENTS

Date March 24, 1982

Superintendent
Organ Pipe Cactus National Monument
Route 1, Box 100
Ajo, AZ 85321

Dear Superintendent:

I wish to make the following comments about services and/or conditions that I observed at Organ Pipe Cactus National Monument during my recent visit:

We have spent several days camping & hiking at Organ Pipe and have been continually disturbed by the low level airplane flights and the noise both of the airplanes themselves and the sudden loud rumbles of their artillery. Especially when camping at Alamo Canyon and hiking in wilderness areas this overwhelming intrusion of the presence of man is very disturbing. I hope you can persuade the Air Force to cease low flights over the monument.

Carolyn Jervis
Signature CAROLYN JERVIS
Printed Name
60 Barranca Rd
Printed Street or P.O. Box
Los Alamos NM 87544
Printed City, State, ZIP Code

A3619

March 28, 1983

Mr. Thomas Jervis
60 Barranca Road
Los Alamos, New Mexico 87544
D

Dear Mr. Jervis:

It was kind of you to take the time to share with us your experience and impressions of Organ Pipe Cactus National Monument.

The Federal Aviation Administration has the authority and responsibility to establish Military Operations Areas, and the airspace over Organ Pipe Cactus National Monument is a part of the Sello MDA. Over the past several years, a number of meetings have been held in southern Arizona concerning training flights of military aircraft, and it is our understanding that portions of the Papago Indian Reservation have been excluded from the MDA because of the effects of low-flying aircraft on the villages of that area. Although the National Park Service has protested the inclusion of Organ Pipe Cactus National Monument, the U.S. Air Force has been using that airspace for training flights from a time before a designated wilderness was established. Requests by the National Park Service to keep training flights at altitudes above 3,000 feet have not been successful. Although military agencies have been an effort to avoid specific ground sites of a sensitive nature, it is their position that few large areas of sparsely populated nature are available over which to conduct their training flights.

For several years, documentation of each flight was reported to the U.S. Air Force. After a period of time, it became obvious this was a waste of time and the practice was dropped. Our records indicate various attempts by the Washington office of the National Park Service to reduce or eliminate this overflight practice.

Once again, thank you for taking the time to comment and for your concern in the management of Organ Pipe Cactus National Monument.

Sincerely yours,

Harold J. Smith
HJS:HTS 3/28/83

VISITOR COMMENTS

Superintendent
Organ Pipe Cactus National Monument
Route 1, Box 100
Ajo, AZ 85321

Dear Superintendent:

I wish to make the following comments about services and/or conditions that I observed at Organ Pipe Cactus National Monument during my recent visit:

Frequent flight of aircraft at low elevations over densely populated areas of the Monument, i.e. the campground/HQ area and the Blanco Canyon area, are inaccessibility safety grounds and detract from the wilderness character of the Monument.

25

Date March 24, 1983

13615

April 1, 1983

Mr. Edward Morvalais
4455 Willow Run
Beavercreek, Ohio 45430

Dear Mr. Morvalais:

It was kind of you to take the time to share with us your experience and impressions of Organ Pipe Cactus National Monument.

The Federal Aviation Administration has the authority and responsibility to establish Military Operations Areas, and the airspace over Organ Pipe Cactus National Monument is a part of the Sells MDA. Over the past several years, a number of meetings have been held in southern Arizona concerning training flights of military aircraft, and it is our understanding that portions of the Papago Indian Reservation have been excluded from the MDA because of the effects of low-flying aircraft on the villages of that area. Although the National Park Service has protested the inclusion of Organ Pipe Cactus National Monument, the U.S. Air Force has been using that airspace for training flights from a time before a designated wilderness was established. Requests by the National Park Service to keep training flights at altitudes above 3,000 feet have not been successful. Although military agencies have made an effort to avoid specific ground sites of a sensitive nature, it is their position that few large areas of a sparsely populated nature are available over which to conduct their training flights.

For several years, documentation of each flight was reported to the U.S. Air Force. After a period of time, it became obvious this was a waste of time and the practice was dropped. Our records indicate various attempts by the Washington Office of the National Park Service to reduce or eliminate this overflight practice.

Once again, thank you for taking the time to comment and for your concern in the management of Organ Pipe Cactus National Monument.

Sincerely yours,

Harold J. Smith
Superintendent

HJSMT:as 4/1/83

1/82

VISITOR COMMENTS

Date 30 Mar 82

Superintendent
Organ Pipe Cactus National Monument
Route 1, Box 100
Ajo, AZ 85321

Dear Superintendent:

I wish to make the following comments about services and/or conditions that I observed at Organ Pipe Cactus National Monument during my recent visit:

Since the Air Force has hundreds of square miles on bombing ranges to the west, I see no reason why military aircraft need to overfly the monument at low altitudes. I observed two A-10s flying at less than 500 ft over the ground at the Eltes Canyon picnic sites. Numerous aircraft were overflying the Alamo Canyon area at low altitudes.

Edward Norvais
Signature
Edward Norvais
Printed Name
4455 West Hill/low Ray
Printed Street or P.O. Box
Revere, MA 01901
Printed City, State, ZIP Code

C-2-109

prepared and used
at the meeting in
Phoenix on
April 19, 1979.

BRIEFING STATEMENT

AREA: ORGAN PIPE CACTUS NATIONAL MONUMENT

ISSUE: AIRCRAFT DISTURBANCES

BACKGROUND:

Disturbances caused by aircraft within Organ Pipe Cactus National Monument is a continuing problem. The conflict over this seemingly incompatible use of Monument lands is forcing the NPS to assume a more active role in an effort to halt these disturbances.

Military overflights of the Monument appear to have been occurring for many years. Military hardware (low targets, old shell casings and at least one aircraft crash) testify to this past use. With increased visitor use has come increased awareness and increasing numbers of visitor complaints. Park visitors object to the sound of sonic booms and visual impact of low flying aircraft after driving hundreds of miles to get away from the sights and sounds of civilization in an area included in the National Wilderness System.

During the winter season the largest percentage of park users are retired couples who come to the park in self-contained recreational vehicles. These people frequently have medical problems such as hearing impairments which require hearing aids. The sudden appearance of a low flying aircraft when it is least expected (such as one that approaches from behind a visitor who is driving down the highway) has startled more than one older citizen at Organ Pipe. The sonic booms can be particularly annoying to one fitted for such a hearing device.

The aircraft disturbances logged for 1979 from January 1 through April 6, totals 22. This figure includes sonic booms (if severe) and low level flights. Because of serious manpower shortages (staffing) at this time only a small percentage of the total number of disturbances are logged as it is known that overflights at low levels are occurring almost on a daily basis. Of those logged 8 are sonic booms recorded at the Visitor Center Headquarters area and 3 are sonic booms logged at other locations within the park. The remaining 11 disturbances are low level flights. Of these one consisted of an A-10 aircraft over Quitobaquito Pond, a small natural spring and pond that is also a popular visitor attraction, 4 incidents

C-2-110

of A-10 flights over or near the campground (aircraft usually in pairs) one reported from Bull Pasture in the Ajo Mountains, one instance of 4 A-10's that circled the Visitor Center Headquarters area three times, 3 instances of other A-10 low level flights at various locations and the remaining incident is an unidentified jet aircraft at higher elevations. The NPS has been endeavoring to mitigate the effects of these disturbances by ongoing contacts with various Air Force representatives namely:

- 1) A letter from NPS Western Regional Director, Howard Chapman to Mr. Don Davis, Chief Airspace and procedures, FAA, voicing NPS objections to the Sells MDA, dated March 9, 1977. See letter written to Regional Director Chapman by J. T. Abercrombie, Commander, U.S. Navy Supporting the NPS position and stating:

"I am aware that National Parks and Monuments have been set aside by Congress as outdoor museums, and that the National Park Service considers low flying aircraft incompatible with the objective. As you know, this office supports that concept and believes that military training routes and areas can be adjusted to aid in preserving the pristine atmosphere of Parks, without unacceptable mission derogation."

- 2) A letter from Organ Pipe Cactus N. M. Superintendent Martinez to the State Director BLM objecting to the airspace withdrawal on the basis of low level flights and other aircraft noise, dated June 6, 1977.
- 3) The attendance of Superintendent Martinez at a meeting in Sells, Arizona, August 30, 1977 to resolve conflicts between agencies concerning the Sells MDA.
- 4) The request for and attendance at a meeting at Luke AFB by two NPS representatives from Organ Pipe concerning how aircraft disturbances might be mitigated on February 27, 1979.
- 5) A similar meeting requested and attended by NPS representatives at Williams AFB, February 27, 1979.
- 6) A letter to Dr. Stern, Deputy for Environment and Safety, USAF, from Patricia Port, Regional Environmental Officer, Western Region, NPS summarizing NPS

objections to the Draft Environmental Impact Statement by the U.S. Air Force for flight operations in the Sells Airspace based on negative impacts imposed on this unit of the National Park System by air operations.

J. T. Abercrombie
/ 04/18/79



UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
Organ Pipe Cactus National Monument

March 20, 1959

Memorandum

To: Superintendent
From: Chief Ranger
Subject: Crash of Air Force Jet Fighter

The following events are recorded as a matter of record in connection with the subject accident:

March 20, 1959

2:00 P.M. (approximately) A sharp explosive blast was heard and felt in the Visitor Center where I was working at my desk. The shock was not unlike the occasional blast waves we experience from the mine operations in Ajo and no undue concern was caused although we in the office remarked upon it.

2:15 P.M. A distinctly audible thud was sensed in the Visitor Center followed immediately by a violent explosion in the vicinity. Within several minutes a radio report from the U.S. Customs House in Lukeville to the Sheriff's office in Ajo was monitored. It indicated that an aircraft had barely cleared the Port of Entry and had crashed within the Monument but the actual location of the crash scene was not apparent to us. Administrative Assistant Jack Hay and I were preparing to leave the office to investigate when a radio report on monument frequency was received from Laborer Henry Gray, collecting campground trash, indicated the scene south of his position.

2:18 P.M. Administrative Assistant Hay and I proceeded toward Lukeville for about 3 miles when we observed smoke from the apparent crash scene several hundred yards to the west of the highway. We parked the car and hiked to that point which proved to be about 400 yards from Highway 85. A large burned area of vegetation was located along with several small pieces of aircraft. A swath of vegetation with considerable damage extended north westward indicating the course of the craft. At this time Hay and I, having no other knowledge, had to assume that a pilot and possibly other persons were in the plane at the time of the crash. We instigated an exploratory sweep search along the route of damage. Small pieces of aircraft were found strewn along a 200 foot path for a distance approaching a mile.

Tow Target with tow harness, one of 3 known to exist within the Monument.

Location: T 145, R 8N, Sec. 23 NE 1/4 200 yds. South of NPS rt. 038, 0.4 miles East of the Palo Verde Camp.

Few intact plane parts were observed. It, of course, became immediately evident that no survivors would be found in this area.

3:00 P.M. (approximately) A large Air Force helicopter passed over the scene and continued in a southeasterly direction to Mexico. We assumed that the pilot had been able to bail out. Ray and I returned to the point of impact; located Ranger Ugolini and reported to headquarters via patrol radio. We received the information that the pilot had been picked up by helicopter.

3:15 P.M. Helicopter landed at scene of impact. Captain Haight (So?) informed us that they were from Tila Bend; the crashed plane was from Luke Field; the pilot (only occupant) was present. The pilot appeared to have only a superficial face scratch. Haight requested that we (including Deputy Sheriff Vaughn of Ajo who had arrived shortly prior) protect the scene until the arrival of air police. He stated that they would be in by sundown. We assured him that we would do so.

3:30 P.M. Ray and Henry Gray returned to headquarters. Ranger Ugolini and I remained at the scene. By this time curious persons, Americans and Mexicans, began to arrive. Our plans were radioed to headquarters.

3:45 P.M. (approximately) Deputy Sheriff Vaughn returned to Ajo.

5:00 P.M. Ranger Ugolini departed for headquarters.

5:15 P.M. Ranger Burns reported at the scene.

6:00 P.M. Air Force helicopter returned from Tila Bend with military police. Captain in charge and I made a cursory inspection of the scene. The captain informed us that the plane was a P 100 (jet fighter); that investigative personnel would be in on March 28; and that a reconnaissance unit would clean up on March 30 or 31.

6:30 P.M. Helicopter departed leaving two or three air police at scene. They expected the others to arrive by truck with supplies.

6:45 P.M. Ranger Burns and I left scene to return to headquarters.

6:55 P.M. Burns and I arrived at headquarters. Met emergency party of air police at Visitor Center.

John T. Ugolini
Chief Ranger

APPENDIX D

Comments From
National & State
Fish and Wildlife
Authorities



UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
Division of Wildlife Services
2721 N. Central, Suite 704
Phoenix, Arizona 85004

December 17, 1974

Mr. Glenn L. Hebert,
Deputy Base Civil Engineer
Department of the Air Force
Hqtrs. 58th Combat Support Group (TAC)
Luke Air Force Base, Arizona 85309

Dear Sir:

After reviewing the maps of your training route it appears that there are several factors to consider as far as the effects of these flights on wildlife within the flight patterns.

1. Bird - Aircraft collisions.
2. Harrassment of birds in flight.
3. Harrassment of nesting birds under the flight routes.
4. Harrassment of terrestrial mammals under your flight routes.

These impacts vary with the time of year and habitat types over which you fly.

Daylight, high speed, low level flights have a much greater chance of collision with birds than identical night flights.

During the summer months (April-October) buzzards would be encountered soaring throughout the flight routes. During the winter months Golden Eagles would be encountered throughout Arizona. Both of these species have flight patterns which may put them within the 500 ft. level of your flights. Smaller, less common raptors would also be encountered in the same areas. Any flights over water impoundments or free flowing water during the fall, winter and spring months are likely to encounter waterfowl.

The exact effects of almost daily low level flights over nesting birds is not well known, however, other similar types of harrassment have caused birds to interrupt their nesting cycle. Effect on terrestrial mammals is not well known either. It may very well cause some of these species to abandon very limited critical habitats such as riparian areas along water courses if these habitats were directly under your flight routes.



D-2

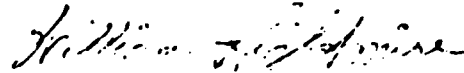
Save Energy and You Serve America!

Atch 3

I feel that the flights should be designed to minimize flying over water impoundments, flowing rivers, and riparian areas. This is especially critical on the Salt and Verde Rivers where the endangered Southern bald Eagle nests and inhabits for most of the year.

Thank you for the opportunity to make these comments. If you need any further information please feel free to call on us.

Sincerely yours,



William W. Rightmire,
State Supervisor

WILLIAM E. EVANS, Chairman, Flagstaff
ROBERT E. SPILLMAN, Phoenix
WILLIAM H. BEEBE, Prescott
CHARLES F. ROBERTS, G.D., Globe
DANIEL F. ROBERTS, JR., Yuma

WILLIAM E. EVANS

WILLIAM H. BEEBE

WILLIAM E. EVANS



ARIZONA GAME & FISH DEPARTMENT

2222 West Greenway Road Phoenix, Arizona 85023 942-9000

December 4, 1974

Mr. Glenn L. Hebert
Deputy Base Civil Engineer
Dept. of the Air Force
Headquarters 58th Combat Support Group
Luke Air Force Base, Arizona 85309

Dear Mr. Hebert:

In response to your inquiry of 29 November, we have made a search of existing data on the effects of aircraft noise on wildlife. Unfortunately, we find no reference to studies having been conducted previously. Comments submitted herein will therefore lack substantiative evidence to support our opinions on the impact of this stimuli.

As the routes you have defined are currently in use, we can assume that any stresses upon animal life have already been created. Therefore, further usage should not lower the existing tolerance threshold beyond the present condition.

Obviously the mechanism of stimulus effected by aircraft noise in the 90 decibel range is the phono-receptor. Initially, aircraft activities of this type contributed a new environmental condition for species in the contact areas. Subsequently, at the onset of flights, animal reaction was presumably one of fear in response to the sound stimuli. However, through the mechanism of the habitation learning process, affected wildlife should now be adapted to the sound as no subsequent effects were experienced in the form of physical harm. Therefore, at this time, wildlife should theoretically disregard the sound stimuli and not be affected by present or future flights.

Regretably, we must state that little or no factual data exists on the topic of aircraft flight effects on wildlife, and our opinions are based

Mr. Glenn L. Hebert

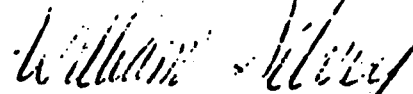
-2-

December 4, 1974

on a theoretical interpretation of animal behavior. However, we trust this information will be of assistance in your assessment of the flight patterns. If we can be of further aid, please contact us at any time.

Sincerely,

Robert A. Jantzen, Director



By: William Silvey, Specialist
Planning and Evaluation Branch

WS/cs



UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE



Ecological Services
2934 W. Fairmount Avenue
Phoenix, Arizona 85017

2-21-83-I-46

November 21, 1983

Mr. Stanley D. Bussey
The Benham Group
P. O. Box 20400
Oklahoma City, Oklahoma 73156

Dear Mr. Bussey:

This is in response to your letter of November 10, 1983 concerning the USAF operations in the Sells Airspace over the Papago Indian Reservoir, and Organ Pipe National Monument, Maricopa and Pima Counties, Arizona.

This project was addressed in a formal Section 7 consultation dated August 30, 1979. In that consultation, the effects of the proposed action were evaluated for the Sonoran pronghorn antelope (Antilocapra americana sonoriensis), gray wolf (Canis lupus baileyi) and peregrine falcon (Falco peregrinus). At that time, it was determined that the proposed action would not jeopardize the continued existence of any of these species. Provided that there have been no substantial changes in the proposed project since the 1979 consultation, the conclusions reached in that consultation are still valid.

We have reviewed the project area delineated in your letter of November 10, 1983 and find there are no other endangered or threatened species in the project area that would be affected by your proposed action.

If we may be of any further assistance please contact this office at (602) 241-2493.

Sincerely yours,

Field Supervisor

cc: Director, Arizona Game and Fish Department, Phoenix, Arizona
Regional Director, (SE, AHR), Fish and Wildlife Service, Albuquerque,
New Mexico

BRUCE BABBITT, Governor

RECEIVED

AUG 11 1983

THE BENHAM GROUP

ARIZONA GAME & FISH DEPARTMENT

2222 West Greenway Road Phoenix, Arizona 85023 942-3000



Director
BUD BRISTOW

Deputy Director
ROGER J. GRUENEWALD

August 4, 1983

Mr Gary W. Hunt
The Benham Group
P.O. Box 20400
Oklahoma City, OK 73156

Dear Mr. Hunt:

The concerns of the Arizona Game and Fish Department remain essentially the same as those stated in our December 7, 1974 letter. Additionally, low level overflights elicit an escape or flight response from many species of wildlife. Dr. David Ellis has conducted research on the impact of low level aircraft to nesting raptors. His work was conducted on contract from the U.S. Air Force. Information from Dr. Ellis' studies should be included in the Final Environmental Impact Statement. The title of a 1980 report by Dr. Ellis is "Responses of Raptorial Birds to Low Level Military Jets and Sonic Booms".

Thank you for the opportunity to review and update our response.

Sincerely,

Bud Bristow, Director

Vashti C. Supplee
Habitat Evaluation Specialist
Tucson Regional Office

VCS/br

CC: Planning and Evaluation Branch

APPENDIX F

USAF Policy on Air Combat
Training and Intercept Operations
in Air Traffic Control Assigned
Airspace

C O P Y

R 181734Z FEB 75

FROM TAC LANGLEY AFB VA/DOXBA

SUBJECT: AIR COMBAT TRAINING (ACT) AIRSPACE POLICY.

THE FOLLOWING CSAF/XOOFSA 130017Z FEB 75 IS RETRANSMITTED
FOR YOUR INFORMATION AND APPROPRIATE ACTION. QUOTE
REFERENCE DOD/FAA JOINT REVIEW (GROUP JRG) ACTIONS

1. AFR 55-24/FAA HANDBOOK 7610.4B DEFINES AIR COMBAT TRAINING (ACT) AS FLIGHT INVOLVING BASIC FLIGHT MANEUVERS (BFM) AIR COMBAT MANEUVERS (ACM); OR DEFENSIVE COMBAT MANEUVERS (DCM) SINGLY OR IN COORDINATION, AS AN ITEM TREATED BY THE JRG, IT HAS BEEN ESTABLISHED THAT THE FLIGHT CHARACTERISTICS OF ACT ARE AEROBATIC MANEUVERS UNDER FAR 91.71, AS SUCH, ACT MUST BE PERFORMED CLEAR OF FEDERAL AIRWAYS AND CONTROL ZONES. IN ADDITION AFR 60-16, PARA 5-15, REQUIRES THAT IT NOT BE DONE IN POSITIVE CONTROL AREAS EXCEPT BY SPECIAL AGREEMENT WITH FAA.
2. AS A RESULT OF A MID-AIR COLLISION IN OCTOBER 1974, BETWEEN AN F106 AND A CIVIL AIRCRAFT, THE NATIONAL TRANSPORTATION SAFETY BOARD RECOMMENDED THAT CERTAIN MILITARY TRAINING OPERATIONS BE CONFINED TO RESTRICTED AIRSPACE. AN IN-DEPTH STUDY OF THIS RECOMMENDATION REVEALS THAT IT WOULD BE UNDULY RESTRICTIVE ON THE CIVIL AVIATION COMMUNITY BECAUSE OF THE VOLUME OF ADDITIONAL RESTRICTED AIRSPACE THAT WOULD BE REQUIRED. THE AIR FORCE OPERATIONAL POLICY SINCE 1971 HAS BEEN TO INTEGRATE THE MAXIMUM PRACTICABLE AMOUNT OF FLIGHT TIME INTO THE AIR TRAFFIC CONTROL SYSTEM UNDER INSTRUMENT FLIGHT RULES. IN CONSONANCE WITH THIS, THE AIR FORCE IS PROPOSING TO THE JRG THAT ALL ACT BE PERFORMED IN EITHER SPECIAL USE AIRSPACE OR AIR TRAFFIC CONTROL ASSIGNED AIRSPACE OFF AIRWAYS.
3. IT IS RECOGNIZED THAT THERE ARE AREAS OF THE CONUS WHERE THERE IS INSUFFICIENT OFF-AIRWAY AIRSPACE TO ACCOMMODATE ACT IN AIR TRAFFIC CONTROL ASSIGNED AIRSPACE. THE AIR FORCE HAS ADVISED THE JRG THAT IT WILL INITIATE AIRSPACE ACTIONS AS REQUIRED TO ACQUIRE SUFFICIENT AIRSPACE TO PERMIT ACT WITHIN ATC ASSIGNED AIRSPACE OFF AIRWAYS. IN THIS MANNER IT IS HOPED THAT MAXIMUM COLLISION AVOIDANCE ADVANTAGE CAN BE ATTAINED THROUGH AIR TRAFFIC CONTROL SERVICES RATHER THAN THROUGH THE DESIGNATION OF SPECIAL USE AIRSPACE AND RESTRICTION OF NON-PARTICIPATING AIR TRAFFIC.
4. REQUEST EACH ACTION ADDRESSEE INITIATE THE REQUIRED AIRSPACE ACTIONS IAW AFM 55-2, TO PROVIDE THE ABSOLUTE MINIMUM OFF-AIRWAY AIRSPACE REQUIRED TO PERFORM ACT IN AIR TRAFFIC CONTROL ASSIGNED AIRSPACE CLEAR OF AIRWAYS. IF SUFFICIENT AND APPROPRIATE AIRSPACE IS NOT NOW AVAILABLE, REFER TO SECTION B, PAGES 26 AND 27 OF FAA HANDBOOK 7610.4, SPECIAL MILITARY OPERATIONS AND PART 5 OF FAA HANDBOOK 7400.2, PROCEDURES FOR HANDLING AIRSPACE MATTERS, HQ USAF ACTION OFFICER REMAINS LT COL H. S. RUSSELL, AUTOVON 2257411.

C O P Y

R 272337Z Nov 74

FM CSAF Wash DC/XOO

SUBJECT: INTERCEPT OPERATIONS IN ATC ASSIGNED AIRSPACE.

1. THE OPERATIONAL ASPECTS OF ATC ASSIGNED AIRSPACE FOR INTERCEPT TRAINING MISSIONS HAVE BEEN REVIEWED AND THE FOLLOWING POLICY AND GUIDELINES HAVE BEEN JOINTLY AGREED UPON BETWEEN THE FAA AND HEAD-QUARTERS USAF.

A. FAA AND MILITARY AIR TRAFFIC CONTROL (ATC) PERSONNEL AND MILITARY TACTICAL/WEAPONS CONTROLLERS CONDUCTING INTERCEPT TRAINING OPERATIONS SHALL REVIEW FAA HANDBOOK 7610.4B/AFR 55-24, SPECIFICALLY CHAPTERS 3, 5, 9, 11, 12, 13, 14 AND 16. NOTE: SECTION 4 OF CHAPTER 12 IS CANCELLED FOR THE USAF.

B. INTERCEPT OPERATIONS SHALL BE CONDUCTED IN ATC ASSIGNED AIRSPACE AS COVERED BY LETTERS OF AGREEMENT. OPERATIONS OUTSIDE OF POSITIVE CONTROL AREA (PCA) CAN BE CONDUCTED EITHER WITHIN ATC ASSIGNED AIRSPACE OR WITHIN CURRENTLY DESIGNATED RESTRICTED/WARNING AREAS DURING PUBLISHED HOURS OF OPERATION: GIVE FIRST PREFERENCE TO THE USE OF RESTRICTED/WARNING AREAS AS OUTLINED ABOVE TO THE EXTENT FEASIBLE. ATC ASSIGNED AIRSPACE IS DEFINED UNDER DEFINITIONS IN FAA HANDBOOK 7610.4B/AFR 55-24.

C. FLIGHTS TO AND FROM SUCH AREAS SHALL BE ON AN IFR CLEARANCE UNDER THE CONTROL OF EITHER AN FAA OR MILITARY AIR TRAFFIC CONTROL FACILITY. WHILE CONDUCTING TRAINING WITHIN ATC ASSIGNED AIRSPACE THE AIRCRAFT SHALL BE UNDER RADAR SURVEILLANCE AT ALL TIMES BY THE APPROPRIATE MILITARY FACILITY. INTERCEPTORS SHALL DISPLAY TRANSPONDER CODES AS ASSIGNED BY ATC.

D. THE FOLLOWING PROCEDURES APPLY IN ADDITION TO THOSE SPECIFIED IN FAA HANDBOOK 7610.4B/AFR 55-24.

(1) MILITARY FACILITIES SHALL ISSUE TRAFFIC ADVISORIES AND INSURE RADAR TARGETS DO NOT MERGE WITH OBSERVED VFR NON-PARTICIPATING TRAFFIC WITHIN THE ATC ASSIGNED AIRSPACE TO THE EXTENT POSSIBLE.

(2) MILITARY REQUIREMENTS FOR ATC ASSIGNED AIRSPACE FOR DAILY INTERCEPT TRAINING BELOW PCA SHALL BE REQUESTED AT LEAST 8 HOURS IN ADVANCE. FAA ATC FACILITIES RECEIVING CONFIRMATION OF THE REQUIREMENT FOR THE ATC ASSIGNED AIRSPACE BELOW PCA SHALL ISSUE A NOTAM SPECIFYING THE PARAMETERS OF THE AIRSPACE, THE TYPE OF ACTIVITY BEING CONDUCTED, ALTITUDES AND THE TIMES OF USE. THE AIRSPACE DESCRIPTION IN THE NOTAM SHALL BE IN EASILY UNDERSTOOD LANGUAGE SUCH AS A 50 MILE RADIUS OF VORTAC OR 100 MILES SOUTH OF A LINE EXTENDING BETWEEN TWO

C O P Y

VORTACS OR LARGE CITIES. FLIGHT SERVICE STATIONS LOCATED WITHIN 200 MILES OF THE ATC ASSIGNED AIRSPACE BOUNDARY SHALL PROVIDE PREFLIGHT/INFLIGHT BRIEFINGS.

(3) FAA ATC FACILITIES PROVIDING RADAR ADVISORY SERVICE TO VFR AIRCRAFT SHALL ALERT THEM OF THE MILITARY TRAINING ACTIVITY IN PROGRESS. THE ATC FACILITY SHALL ADVISE THE MILITARY FACILITY IF THE PILOT INDICATES THAT HE WILL PENETRATE THE ATC ASSIGNED AIRSPACE AND RADAR IDENTIFY SUCH AIRCRAFT, TO THE EXTENT FEASIBLE, TO THE MILITARY CONTROLLER AND CONTINUE TO PROVIDE RADAR ADVISORY SERVICE IF WORKLOAD CONDITIONS PERMIT.

E. FAA HANDBOOK 7610.4B/AFR 55-24, CHAPTER 3, SECTION 7, REQUIRES THAT FAA/MILITARY JOINT EVALUATIONS BE CONDUCTED ANNUALLY. IF SUCH AN EVALUATION HAS NOT BEEN CONDUCTED WITHIN THE PAST 12 MONTHS, IT SHALL BE COMPLETED NOT LATER THAN 31 MARCH 1975.

F. ALL AGENCIES SHALL INSURE THAT PARTICIPATING PERSONNEL ARE THOROUGHLY BRIEFED ON CURRENT OPERATING PROCEDURES AND PRACTICES.

APPENDIX G

Description of the Sells
MOAs and ATCAAs

RECOGNIZED AIR TRAFFIC CONTROL ASSIGNED AIRSPACE AREAS
AND MILITARY OPERATING AREAS

1. The Sells Low MOA is defined by a line from 31°58'00"N, 113°05'30"W to 32°11'30"N, 113°05'30"W to 32°11'30"N, 112°56'45"W to 32°29'00"N, 112°54'00"W to 32°29'00"N, 112°43'00"W to 32°27'00"N, 112°44'00"W to 32°27'00"N, 112°18'00"W to 32°38'30"N, 112°18'00"W to 32°15'10"N, 111°36'00"W to 31°57'45"N, 111°36'00"W to 31°49'00"N, 111°32'00"W to 31°43'30"N, 111°35'30"W to 31°31'00"N, 111°38'30"W thence along the United States/Mexico Border to the point of beginning. The vertical depth of the Sells MOA is from 3000 feet above ground level (AGL) up to but not including 10,000 feet above Mean Sea Level (MSL). This MOA underlies part of the existing Sells I MOA, excludes Restricted Areas R-2304 and R-2305, lies south of Federal Airways V-66/105, is east of Restricted Area R-2301, west of the proposed FUZZY MOA and north of the United States/Mexico Border. The Sells Low MOA overlies the Tohono O'Odham Indian Reservation. It does not interfere nor conflict with any Federal Airways or other MOA's.

2. The Sells I MOA is described as that airspace within the vertical and horizontal limits from 10,000 feet MSL up to, but not including, FL 180 beginning at coordinates 31°58'00"N, 113°05'30"W to 32°11'30"N, 113°05'30"W to 32°11'30"N, 112°56'45"W to 32°50'25"N, 112°49'00"W to 32°50'25"N, 112°42'53"W to 32°38'30"N, 112°18'00"W to 32°15'10"N, 111°36'00"W to 31°57'45"N, 111°36'00"W to 31°49'00"N, 111°32'00"W to 31°43'30"N, 111°35'30"W to 31°30'00"N, 111°38'30"W to 31°38'55"N, 111°04'55"W to 31°22'05"N, 111°11'10"W thence along the United States/Mexico Border to the point of beginning. MOA excludes Restricted Areas R-2304 and R-2305.

3. The Sells ATCAA is described as that airspace within the vertical and horizontal limits from FL 180 through FL 510 beginning at coordinates 31°58'00"N, 113°05'30"W to 32°11'30"N, 113°05'30"W to 32°11'30"N, 112°56'45"W to 32°50'25"N, 112°49'00"W to 32°50'25"N, 112°42'53"W to 32°38'30"N, 112°18'00"W to 32°15'10"N, 111°36'00"W to 31°57'45"N, 111°36'00"W to 31°49'00"N, 111°32'00"W to 31°43'30"N, 111°35'30"W to 31°30'00"N, 111°38'30"W to 31°38'55"N, 111°04'55"W to 31°22'05"N, 111°11'10"W thence along the United States/Mexico Border to the point of beginning. MOA excludes Restricted Areas R-2304 and R-2305.

APPENDIX H

Military Training Routes

1. Route Description - VR 223

<u>Letter Designator</u>	<u>Latitude/Longitude</u>	<u>Altitude</u>
A	33°00.0'N 112°24.0'W	60 MSL
B	32°21.0'N 111°52.0'W	05 AGL B 60 MSL
C	32°07.0'N 111°33.0'W	05 AGL B 80 MSL
D	32°02.5'N 111°35.0'W	05 AGL B 80 MSL
E	32°00.0'N 112°08.0'W	05 AGL B 90 MSL
F	32°27.0'N 112°24.5'W	05 AGL B 90 MSL
G	32°41.0'N 112°33.0'W	05 AGL B 90 MSL

Route Width: 2 NM right and 5 NM left of centerline, A to 32°44'00"N 112°11'00"W;
 2 NM either side of centerline 32°44'00"N 112°11'00"W to D;
 1 NM either side of centerline D to E;
 2 NM left and 4 NM right of centerline E to G.

2. Route Description - VR 239

<u>Letter Designator</u>	<u>Latitude/Longitude</u>	<u>Altitude</u>
A	33°54.0'N 112°17.0'W	
B	34°04.0'N 112°00.0'W	40 MSL B 75 MSL
C	34°04.0'N 111°27.0'W	05 AGL B 95 MSL
D	33°49.0'N 110°55.0'W	05 AGL B 95 MSL
E	33°21.0'N 110°13.0'W	05 AGL B 70 MSL
F	32°47.0'N 110°57.0'W	05 AGL B 70 MSL
G	32°38.0'N 111°24.0'W	45 AGL B 60 MSL
H	32°00.0'N 112°08.0'W	05 AGL B 60 MSL
I	32°41.0'N 112°33.0'W	05 AGL B 90 MSL

Remarks: Minimum altitude 4500' MSL from 32° 18'00"N 111° 49'00" to (H) 32° 27'00"N
 Minimum altitude 5000' MSL from 32° 13'00"N 112° 16'00"W to 112° 24'00"W

Route Width: 2 NM either side of centerline from A to E;
 2 NM right and 4 NM left of centerline from E to G;
 3 NM right and 2 NM left of centerline from G to H;
 2 NM right and 4 NM left of centerline from H to I.

3. Route Description - VR 243

<u>Letter Designation</u>	<u>Latitude/Longitude</u>	<u>Altitude</u>
A	33°00.0'N 112°24.0'W	
B	32°21.0'N 111°52.0'W	05 MSL B 60 MSL
C	32°07.0'N 111°33.0'W	05 AGL B 80 MSL
D	31°52.0'N 111°13.0'W	75 MSL
E	31°46.0'N 111°36.0'W	85 MSL
F	31°45.0'N 112°00.0'W	05 AGL B 90 MSL
G	32°00.0'N 112°08.0'W	05 AGL B 90 MSL
H	32°27.0'N 112°24.5'W	05 AGL B 90 MSL
I	32°41.0'N 112°33.0'W	05 AGL B 90 MSL

Route Width: 2 NM right and 5 NM left of centerline from A to 32°44'00"N 112°10'00"W;
 2 NM either side of centerline from 32°44'00"N 112°12'00"W to C;
 1 NM left and 2 NM right of centerline from C to D;
 2 NM right and 5 NM left of centerline from D to E;
 2 NM either side of centerline from E to F;
 1 NM either side of centerline from F to G;
 2 NM left and 4 NM right of centerline from G to I.

4. Route Description - VR 244

<u>Letter Designation</u>	<u>Latitude/Longitude</u>	<u>Altitude</u>
A	33°27.0'N 111°30.0'W	
B	33°37.0'N 110°55.0'W	05 MSL B 65 MSL
C	33°18.0'N 110°27.0'W	05 AGL B 85 MSL
D	32°36.0'N 110°59.0'W	05 AGL B 60 MSL
E	32°03.0'N 111°27.0'W	52 MSL
F	32°00.0'N 112°08.0'W	05 AGL B 90 MSL
G	32°18.0'N 112°57.0'W	05 AGL B 90 MSL
H	32°25.0'N 113°06.0'W	05 AGL B 90 MSL

Remarks: Minimum altitude between (G) and (H) is 4500' MSL from 15 March to 30 April.
 Minimum altitude 4000' MSL from (E) to 32°03'00"N 112°19'00"W.

Route Width: 2 NM either side of centerline from A to E;
 1 NM either side of centerline from E to F;
 2 NM either side of centerline from F to H.

5. Route Description - VR 246

<u>Letter Designation</u>	<u>Latitude/Longitude</u>	<u>Altitude</u>
A	33°27.0'N 111°30.0'W	
B	33°37.0'N 110°55.0'W	SFC B 65 MSL
C	33°18.0'N 110°27.0'W	SFC B 85 MSL
D	32°36.0'N 110°59.0'W	SFC B 60 MSL
E	32°03.0'N 111°27.0'W	52 MSL
F	32°00.0'N 112°08.0'W	SFC B 90 MSL
G	32°41.0'N 112°33.0'W	SFC B 90 MSL

Remarks: Minimum altitude 4000' MSL from (E) to (F) and 5000' MSL from 32°13'00"N 112°16'00"W to 32°27'00"N 112°24'00"W.

Route Width: 2 NM either side of centerline from A to E;
1 NM either side of centerline from E to F;
2 NM either side of centerline from F to G.

6. Route Description - VR 259

<u>Letter Designator</u>	<u>Latitude/Longitude</u>	<u>Altitude</u>
A	32°26.0'N 110°30.0'W	
B	32°02.0'N 109°45.0'W	03 AGL B 15 AGL
C	31°45.0'N 109°05.0'W	03 AGL B 50 AGL
D	31°44.0'N 109°50.0'W	03 AGL B 15 AGL
E	31°54.0'N 110°43.0'W	03 AGL B 15 AGL
F	31°39.0'N 111°30.0'W	65 MSL
G	31°54.0'N 112°27.0'W	01 AGL B 15 AGL
H	32°27.0'N 112°24.0'W	01 AGL B 15 AGL
I	32°31.0'N 112°56.0'W	01 AGL B 15 AGL

Route Width: 3 NM either side of centerline from A to E;
3 NM left and 1 NM right of centerline from E to F;
3 NM either side of centerline from F to I.

7. Route Description - VR 260

<u>Letter Designator</u>	<u>Latitude/Longitude</u>	<u>Altitude</u>
A	32°27.0'N 110°29.0'W	
B	32°35.0'N 109°41.0'W	03 AGL B 15 AGL
C	32°01.0'N 109°26.0'W	03 AGL B 15 AGL
D	31°51.0'N 110°00.0'W	03 AGL B 70 AGL
E	31°45.0'N 110°51.0'W	03 AGL B 15 AGL
F	31°43.0'N 111°15.0'W	65 MSL
G	31°48.0'N 112°13.0'W	01 AGL B 15 AGL
H	32°14.0'N 112°55.0'W	01 AGL B 15 AGL
I	32°28.0'N 113°11.0'W	01 AGL B 15 AGL

Remarks: Minimum altitude between H and I is 15000' AGL from 15 March to 3 April.

Route Width: 2 NM either side of centerline from A to E;
1 NM left and 2 NM right of centerline from E to F;
2 NM either side of centerline from F to I.

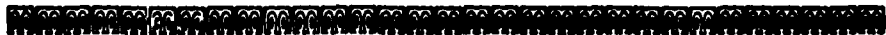
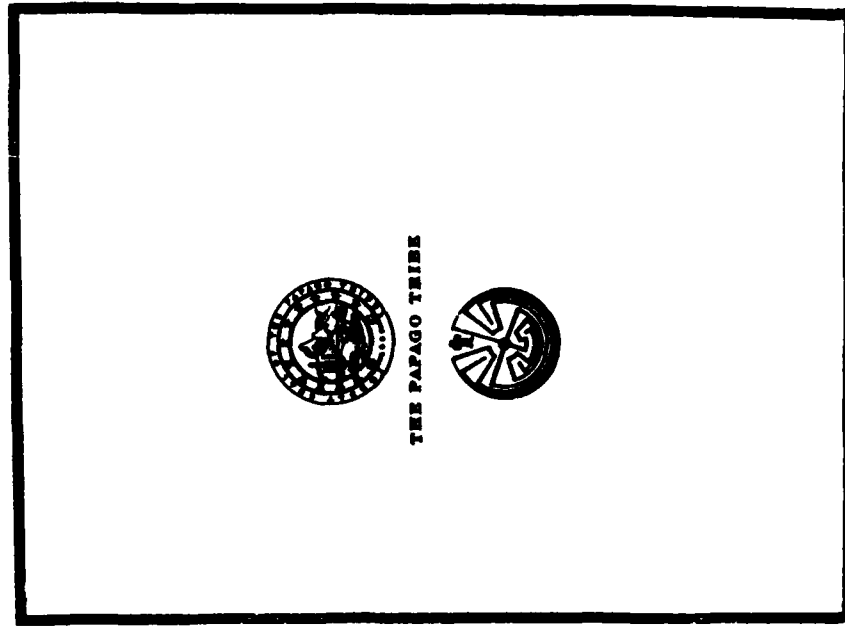
8. Route Description - VR 1219

<u>Letter Designator</u>	<u>Latitude/Longitude</u>	<u>Altitude</u>
A	33°57.0'N 112°28.5'W	
B	34°10.0'N 112°16.0'W	05 AGL B 15 AGL
C	33°56.5'N 111°49.0'W	05 AGL B 15 AGL
D	33°51.0'N 111°30.5'W	05 AGL B 15 AGL
E	33°38.0'N 111°12.5'W	05 AGL B 15 AGL
F	33°25.5'N 111°01.0'W	05 AGL B 15 AGL
G	33°10.5'N 111°02.0'W	05 AGL B 15 AGL
H	32°47.0'N 110°58.0'W	05 AGL B 15 AGL
I	32°43.0'N 111°24.0'W	05 AGL B 15 AGL
J	32°27.0'N 111°29.5'W	05 AGL B 15 AGL
K	32°26.5'N 112°23.5'W	05 AGL B 15 AGL
AA	34°08.0'N 112°25.5'W	
B1	34°10.0'N 112°16.0'W	05 AGL B 15 AGL

Route Width: 5 NM either side of centerline from A to C;
3 NM right side and 5 NM left of centerline from C to D;
5 NM right side and 4 NM left side of centerline from D to E;
2 NM right side and 4 NM left side of centerline from E to F;
2 NM right side and 5 NM left side of centerline from F to G;
3 NM right side and 2 NM left side of centerline from G to H;
5 NM either side of centerline from H to I;
3 NM right side and 2 NM left side of centerline from I to J;
4 NM right side and 2 NM left side of centerline from J to K;
5 NM either side of centerline from AA to B1.

APPENDIX I

Facts About the Papago Reservation



Atch 1

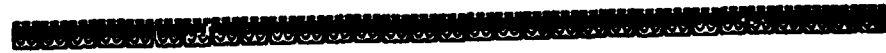
Facts About -----

PAPAGO AGENCY

U.S. Department of the Interior
Bureau of Indian Affairs



Sells, Arizona
September 1976



FACTS ABOUT----
THE PAPAGO AGENCY
BUREAU OF INDIAN AFFAIRS

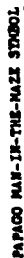
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GREAT SEAL OF THE PAPAGO TRIBE

The Papago tribal seal shows sacred Subequiveri Peak the legendary home of I'looi, the Papago Creator, as its center. In the foreground appear examples of thorny desert plants, especially the saguaro or giant cactus, which yielded the Desert People rich red fruit from which they made syrup and "cactus jact" to drink in vita-bringing ceremonies. Eleven stars surrounding this view represent eleven electoral districts into which the three Papago reservations are divided. With the words "Great Seal of the Papago Tribe" around the rim appears the date "1937." That was the year when the Papago Tribal Council began to function in January under a Constitution and By-Laws adopted the year before under provisions of the Indian Reorganization Act of 1934.



The People's House is the symbol of a legendary story passed on from generation to generation by the members of the People's House. The story itself differs in detail from one family to another. However, the central theme is unambiguously the same. The story is about a young man who is called "The People's House" because he is the only one in his family who is not a member of the People's House. The story is about a young man who is called "The People's House" because he is the only one in his family who is not a member of the People's House. The story is about a young man who is called "The People's House" because he is the only one in his family who is not a member of the People's House.

PAPADO RESERVATION DATA SHEET

NEW DAY NATION

Soils (main) Reservation	2,774,370 Acres
San Xavier Reservation	71,093 Acres
Cille Bend Reservation	10,409 Acres
Total Land Area	2,855,872 Acres

NOTES

Sells Reservation	7,960
San Xavier Reservation	734
Gila Bend Reservation	268
Total Reservation Residents	8,962
Median Age of Total Population	21
Average Family Size	4.8
Total Persons Employed	3,250
Annual Per Capita Income	\$812

PRINCIPAL ECONOMIC ACTIVITIES

Copper Mining
Cattle Raising
Farming
Arts and Crafts
Utility Distribution and Sales
Food Canning
Chemical and Explosives Manufacturing
Light Construction

GENERATIONAL AREAS & TOURIST ATTRACTIONS

Kitt Peak National Observatory
Pepper Arbores and Fair (Mar) at Soils
Subsopvart Peak
San Xavier Del Bac Mission
San Xavier Festival (Apr)
Organ Pipe Cactus National Monument
Wright Pepper Report (Mar) at Soils
Cham Tish Mission (Feb) at Casa Grande
Smoking
Camping
Hiking
Mount Ararat

FACTS ABOUT.....PAPAGO AGENCY-BUREAU OF INDIAN AFFAIRS

Location and Geography of Papago Indian Reservation

The main Papago Indian Reservation stretches 90 miles across Pima County in south-central Arizona, is bounded on the south for 64 miles by the Mexican border and extends north to within 10 miles of Casa Grande, Arizona. In addition, there are two smaller separate reservations... San Xavier (71,095 acres) near Tucson, and Gila Bend (10,409 acres) immediately north of the town of Gila Bend, Arizona. These three reservations cover a total area of 2,855,874 acres of 4,482 square miles...about the same size as the State of Connecticut.

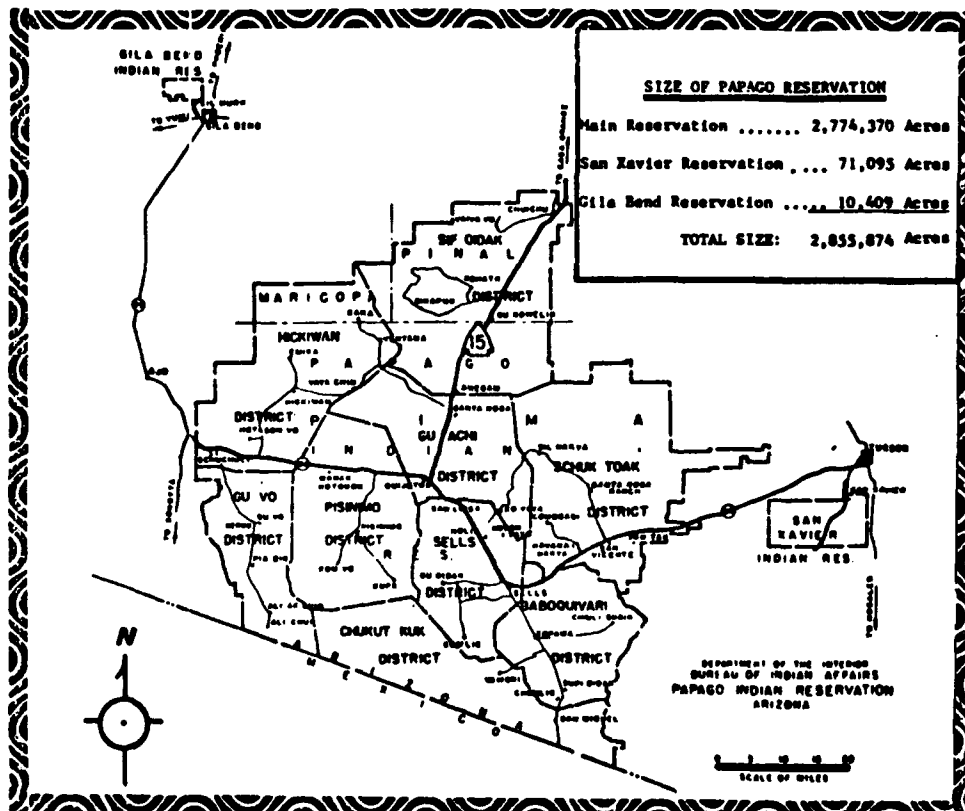
The Papago Agency is located on the main reservation at the town of Sells which is also Papago Tribal Headquarters. Sells is 64 miles southwest of Tucson and presently has a population of about 2800. The Papago Agency has a work force of approximately 126 who staff and operate the branches of education, housing, social services, employment assistance, plant management, administration, law and order, land operations, roads, reservation programs, and real property management. An Agency satellite office is located in the Federal Building at Tucson and contains the Branches of Housing, Reservation Programs, and Real Property Management.

Agency Policy and Objectives

The policy of the BIA Papago Agency is Tribal self-determination and full Tribal participation in all phases of planning, development and human resource utilization on the Reservation. Present-day BIA policy is to encourage the Tribal Government to assume increasing responsibility in the management of reservation affairs. The Papago Agency is evolving more and more into the role of a technical service organization supervised by Indians to accomplish Indian goals. Some of these immediate goals are: (1) to increase the quantity and quality of schools in the education system on the Reservation and to obtain Tribal involvement and responsibility in the staffing and operation of these schools; (2) to obtain decent housing for the Papago with the Tribal Government; (3) to develop the right of the Papago to the land; (4) to reach a point close to self-sufficiency in the production of food on the Reservation; and (5) to increase employment on the Reservation by encouraging suitable business and industry to locate on the Reservation and by assisting the Tribe and individual Papagos in developing their own business enterprises.

It might be helpful to understand that the Federal Government, acting through the Bureau of Indian Affairs, is not only a trustee of Indian property and not as guardian of the Indian people, but also a trustee of the United States Government. Indians are not forced to reside in reservations but are free to move around at liberty much as any other citizens of the United States. All Indians are entitled to vote on the same basis as other citizens in their respective states.

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The Papago People--A Brief Outline of Their History and Culture

Archaeological excavations at Western Cave and along the Santa Cruz River have uncovered evidence that man has lived in this region for at least ten thousand years. Present day Papagos, the desert Indians of the Santa Cruz River, are thought to be descendants of the Hohokam Indians who reached this level and flourished around 1400 A.D. Spanish explorers first encountered Papagos in 1540, only 21 years after Cortes and his followers landed on the North American continent.

The first important contact between Papagos and Europeans came about when the Jesuit missionary, started his missionary program in the late 1600's and early 1700's. At that time, the Papago people were divided into several distinct groups, each with its own dialect and speaking dialects of the same language. Five of these distinct groups are known as Papagos, the word Papago probably being a corruption of Paviotson (people who set beams), referring to the main staple food in their diet. Father Kino found the Papagos a peaceful people with permanent homes and families. The Papagos were settled throughout the "Papagueria" in numerous small groups. Papago villages were usually autonomous and there was little or no contact between them. Village leadership was through the personal influence and character of the headman, who acted as a village elder, a keeper of the tribe, and other village officers who were in charge of ceremonies and festivals. Papago warfare, led by men selected for their ability, was directed against the Apache to the east. Papagos became militant only when their way of life was threatened.

Typically the Papago family was made up of the parents, their children and the wives and children of the sons. Such units were known as "villages" with a tendency for village members to be related through the paternal line. Like other southern and western Arizona groups, the family was the important social and economic unit. Each family was responsible for its own subsistence. It was a patriarchal society where seniority and respect for elders were strong dominant social factors.

Papago religious practices were mainly concerned with the annual cycle of nature. Two of the most important annual events included the winter ceremony in early summer and a deer dance in the autumn or early winter. In addition to the annual rituals there were many curing and personal crisis ceremonies.

The reports of the past give the impression of the Papago people leading an isolated, primitive type of life, with a dependence upon established tradition and the rigidly observed tribal tradition, rather than upon individual initiative.

The pre-Spanish Papago economy was one of limited irrigated farming and gathering of wild food products. Papago agricultural techniques were simple. Most fields were small, located at the foot of steep slopes in order to capture the runoff from desert rain storms. These small cultivated areas

It is also clarifying to note that the Federal Government makes no payments to a person merely because he is an Indian. Payments made to a person of Indian blood may represent income from his property collected for him by an agent of the United States Government. Other payments may result from compensation for losses incurred when lands are required in connection with Federal projects. Payments may represent the Indian proceeds share of property belonging to the tribe of which he is a member. In each instance, money available for payments belongs either to the tribe or to an individual and is paid in trust by the U.S. Government. Therefore, Government checks are issued in making payments to individuals and to tribes.

Reservations and Climate on the Papago Reservations

The reservations lie in the Sonoran Desert and consist of wide arid valleys with little interrupted with mountain ranges which rise abruptly from the valley floor. The Papago Reservation is located in the western boundary of the Santa Rosa Valley to 7,200 feet in the Santa Rosa Mountains. The valley ranges from 1,375 feet to about 3,000 feet in elevation, and the mountains generally rise about 2,000 feet above the valley floors.

The vegetation is typical of the southern desert shrub region with the dominant shrub being creosote bush. Associated xerophytic species are the various acacia, bursera, and bursera. The bottom lands and washes are characterized by various mesquites and acropetal mesquite with annual grasses and sedges. The Papago Reservation is a high desert with high rainfall and early monsoons are found with traces of other grasses typical of the high desert grassland.

Wildlife on the reservations include mountain sheep, desert muledeer, whitetail deer, javelina, antelope, jackrabbit, blacktail jackrabbit, quail, and doves. Predators include the coyote, bobcat, fox, and an occasional mountain lion.

Average mean temperature in Sells with an elevation of 3,340 feet, is 64 degrees. The maximum temperature recorded was 114 degrees and minimum recorded was 16 degrees. Rainfall varies from an average of six inches per year on the northern and western portions of the reservation to 20 inches per year in the vicinity of the Papago Mountains on the eastern side. Average annual precipitation at Sells is 11.4 inches. Some Sells occasionally in the higher mountains during the months of January through mid-April but generally in desert type. There are no streams or any other natural water bodies on the reservation. Fertility is generally very low except during the summer rainy season of June and August when it rises up to 50 percent.

exclusive use of the Papago until July 1, 1974, when a reservation of about 70,000 acres was established by Executive Order near the San Xavier Mission.

The second reservation for Peuge Indians was established at Gila Bend on December 15, 1882. An Executive Order of June 16, 1911, established small Reservations of 60 acres each at Indian Oasis (now Sello) and San Miguel. Four Executive Orders of May 29, 1913, establishing the Maricopa, Cackhebar, Chai Chusick, and Tat-Nah-Nu-Sett reservations. An Executive Order of December 5, 1917, added to the Tat-Nah-Nu-Sett reservation. On September 1, 1918, the Executive Order of January 15, 1916, was amended to include the Peuge, Chai Chusick, and Tat-Nah-Nu-Sett reservations. The Executive Order of January 15, 1916, included the area known as the Peuge Villages Reservation which included the area formerly within the Cackhebar, Chai Chusick, Tat-Nah-Nu-Sett, Indian Oasis, San Miguel, and Santeague Reservations and added much new land. (The Maricopa Reservation was a part of the same Indian Reservation.) The Executive Order of January 15, 1916, also included the area of public domain land to be added to the Peuge Reservations in addition to including of public domain land.

The net result of the various Executive Orders and Acts is a land area today totaling 2,823,874 acres being held in trust for the use of the Papago Tribe.

Little change of any importance in Pagepe land holdings has been made since 1940's, but a very important change in the nature of Indian title came about in 1953 when, by Act of Congress, the Pagepe were given all mineral, as well as surface rights to the reservations.

The history of the establishment of the People's reservation points out that many of the hospitals have been directly related to the Indian health service. The first reservation hospital was established at Sisseton, South Dakota, in 1885, and on other programs only recently. It was not until 1917 that the first federal school was established on the main reservation at Sells and it was not until after 1917 that any attempt was made to develop health resources. Even though a small hospital was constructed at Sells in 1922, serious programs in health care were not initiated until the late 1920's when the federal government began to take an interest in the health of the reservation Indians. This was followed by the construction of a modern 50-bed hospital in 1949.

Latest census figures indicate that today there are about 15,000 Papago Indians living in the United States. Of this number, approximately 9,000 live on the three reservations in southern Arizona.

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The principal forage crops were corn, beans, and squash, to which the Spaniards occasionally added wheat, kidney beans, lentils, vetch, chick peas, and possibly watermelon. Wheat could be planted in February and harvested in May, and corn was regularly planted in July or August when the summer rains came. This permitted two grain crops annually, although the extreme dryness and rainfall limited the potential.

The habits of the Pongos exemplify the virtues of adversity. Having grown up in a harsh environment, their lands lying in an area receiving little rain. By capturing water from flashfloods they were able to grow squash, corn and the tepary bean which is resistant to drought. Living in a land of scarcity, they were forced to obtain maximum utilization of plants and animals native to the area in order to survive.

In the late 1600's the Papago economy underwent a great change due to the introduction of cattle and horses. At this time had stock from the missions of Sonora and the cattle and horses quickly became established in the hands of the "Papagos". Unfortunately for the Papagos, the Apache in the mountainous areas to the north and east found Papago stock a strong lure for increased raiding activities. Since the Apaches also had acquired horses they could travel far and fast. Raiding Apache raided military activities to defend themselves by means of force. As the Apache problem, cattle and sheep had previously been raised by the Papagos. Since the Apache problem, cattle and sheep brought in the Papagos a greatly increased meat supply and increased mobility.

With Spanish exploration and occupation of the New World the Papacy came under the rule of the Spanish crown. As subjects of the King of Spain they received full citizenship and a large measure of local self-government. However, except through missionary activities, most Papages remained isolated from Spain's political life. In 1812 Mexico achieved independence from Spain and until 1853 the major portion of the "Papage" was under the political jurisdiction of Mexico. During the period of Mexican rule the Papage had little contact with the Papacy.

In 1933 the Canadian Purchase added the lands south of the Gila River to the United States. This resulted in the Hopi Indians coming under the political jurisdiction and protection of the United States. At the time of Canadian Purchase the land of the "Hogwarts" was considered available for non-Indian settlement, and many springs, wells and grazing areas were soon claimed by ranchers moving into the area. Little was done to secure land for the

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**AGENTS AND SUPERVISORS OF THE TARRANT INDIAN AGENCY
FROM 1854 TO 1907**

--- A COMBINATION

1857 - 1861	John Walker	Agent for the Indians under Gadsden Purchase. Stationed in Texas.
1861	Lemuel Labell	Appointed, but never served
1862 - 1864	Abraham Lyon	Agent for the Indians under Gadsden Purchase. Stationed in Texas.
1864 - 1866	Oliver H. Burdison	Agent for the Tappan Indians.
1866 - 1869	Levi Angler	Agent for Plains, Pappan, Mariopas, and occasionally, Southern Apaches. Stationed on the Gila River Indian Reservation.
1869 - 1871	F. E. Crockett	"
1871 - 1874	B. A. Miller	Agent for the Tappan Indians
1874 - 1876	John V. Corry	"
1876	Charles Nelson	Agent for Plains, Pappan, Mariopas, and occasionally, Southern Apaches. Stationed on the Gila River Indian Reservation.
1877 - 1878	J. E. Stout	"
1878 - 1880	A. B. Latham	"
1881	E. B. Townsend	"
1881 - 1882	Samuel G. Wheeler	"
1882 - 1884	A. E. Jackson	"
1884 - 1886	Samuel G. Wheeler	"
1886	Elmer A. Howard	"
1886 - 1889	Clarence H. Johnson	"
1889 - 1893	Cornelius H. Gentry	"
1893 - 1897	John H. Berger	Former-in-charge of San Xavier
1897 - 1907	J. Lee Young	Agent for Plains, Pappan, Mariopas, and occasionally, Southern Apaches. Stationed on the Gila River Indian Reservation.

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1894 - 1897	John H. Berger	Former-in-charge of San Xavier
1897 - 1900	Henry J. Cleveland	Agent for Plains, Pappan, Mariopas, and occasionally, Southern Apaches. Stationed on the Gila River Indian Reservation.
1900	John H. Berger	Former-in-charge of San Xavier
	S. L. Taggart	Agent for Plains, Pappan, Mariopas, and occasionally, Southern Apaches. Stationed on the Gila River Indian Reservation.
1899 - 1902	John H. Berger	Former-in-charge of San Xavier
	Elwood Hedley	Agent for Plains, Pappan, Mariopas, and occasionally, Southern Apaches. Stationed on the Gila River Indian Reservation.
1899 - 1902	John H. Berger	Former-in-charge of San Xavier
1902 - 1910	John H. Berger	Former-in-charge and Special Disturbing Agent at San Xavier
1910 - 1916	Henry J. McQuigg	Superintendent of the San Xavier School (in office the Superintendent of the Pappan agency)
1916	Charles E. McChesney	Superintendent in charge
1916 - 1917	Joseph B. Martin	Superintendent of the San Xavier School (in office the Superintendent of the Pappan agency)
1917 - 1927	Thomas F. McComick	Superintendent of the Pappan Indian Agency
1927 - 1928	Edward S. Stewart	"
1928 - 1929	Joseph M. Elliott	Superintendent of the Pappan Indian Agency
1929 - 1930	Thomas B. Bell	"
1930 - 1932	William Hedy Head	"
1932 - 1933	Samuel Head	"
1933	William Hedy Head	"
1933 - 1937	Harriet E. Berg	"

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1947 - 1951	Barton A. Ladd	Superintendent of the Pease Indian Agency
1951 - 1954	Harry L. Stevens	"
1954 - 1955	Albert H. Burley	"
1955 - 1961	Harry W. Gilmore	"
1961 - 1966	Thomas R. St. Clair	"
1966 - 1966	Russel B. Jenkins	"
1966 - 1968	John R. Artchibald	"
1968 -	Joseph H. Lucero	"

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The Perfect Language

[illegible]

Pepero Delington

It is difficult to make generalizations about Pezago religion because the several kinds of belief--aboriginal, Sonora Catholic, Roman Catholic, and Protestant--vary greatly in different districts and from generation to generation. Part of the old religious pattern still survives, however, and is still important to the majority of Pezagos.

Today in many parts of the Reservation, people say that the old men who knew the ancient ceremonies are dying off and that no one else has learned how to perform them. Peoppe ceremonial life seems to be concerned with two things: brain and health. Though many of the old practices have disappeared, the emphasis on these two all-worrest areas continues.

On the east of the largest Tzucal village there is a little white building with white walls and a red roof. This is the door to the Santa Catalina Church. Some of the white women carry their dresses and blouses to the church to be washed. The Catholic missionaries often Christianize faiths on the basis of the reader. The missionaries on the left and practices of Santa Catalina are remnants of the founding of the Catholic Church. The missionaries on the right are remnants of the founding of the Catholic Church. The missionaries on the left and practices of Santa Catalina are remnants of the founding of the Catholic Church. The missionaries on the right are remnants of the founding of the Catholic Church.

A traditional part of Sonora Catholicism is the annual pilgrimage to Magdalena in Sonora, Mexico. This yearly pilgrimage to honor San Francisco Javier is a great event for most Sonorans.

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There are 149 separate and distinct locations on the main reservation have been identified as settlements. Of the 149 settlements, only about one-third are currently inhabited. Two of the communities can be considered as major villages with populations of more than 100. These major villages include All Change, Chukchee, Tugay, Qilqut, On Aht, Qash, Pishin, On Osh, Chuch, and Kile.

The community of Salto is the center of all recreation activities and is the largest village on the reservation with a present population of about 2,000 and an annual payroll of approximately \$4,000,000. Salto, formerly known as the Indian Government, was re-named in 1917 for Gen. Salto, then Commissioner of Indian Affairs, who was in Washington. Since the Indian Office post office was located on Federal land, an Act of Congress was required to change the name to Salto.

Salto is now the People's Capital," the location of the tribal headquarters. The Compad Agency of the U.S. Bureau of Indian Affairs and a U.S. Public Health Service hospital are also located in the community. Major public facilities in Salto include a post office, a school, a health center, a municipal court, a library and a tribal arts and crafts shop dedicated in 1964. The hospital is a modern 30-bed installation, well equipped and staffed. The municipal center became the tribal center, offering all the tribal government, jail construction, and an assembly hall in Salto.

[illegible]

Public schools in Sella (Zurich Swiss School District No. 46) are open to all resident children, (Catholic, Jewish, Protestant, or any other ethnic background) and classes are taught from Grade 1 thru Grade 12. Although textbooks are not yet available at Sella, good bus service is provided within a 30 to 35-mile radius of Sella so that all children can attend school. Many foreign students have entered higher education at Pine Community College and at the University of Arizona (both in Tucson).

Medical and dental facilities at Solts are available at the hospital operated here by the U.S. Public Health Service. Non-Japanese may receive emergency treatment at the hospital but are charged a standard fee for the services rendered.

Churches at Sella carry on an active program of religious education and social activities for people of all age groups. There are active Catholic, Baptist, Presbyterian and Assembly of God Churches at Sella. Catholic and Presbyterian missions are maintained in villages on the reservation.

~~Indians Tribal Government~~

The basic political document governing the Popo Tribe is the Constitution and By Laws of the Popo Tribe, Arizona, ratified by the tribal members on December 12, 1930, and approved by the Secretary of the Interior on January 6, 1937. The governing body of the tribe is an elected tribal council consisting of twenty-one members. Regular council meetings are held each month. The council is presided over by a chairman selected by the council.

1937	Jose Ignacio	1956	Mark Manuel
1938	Jose Ignacio	1957	Mark Manuel
1939	Jose Ignacio	1958	Mark Manuel
1940	Jose Ignacio	1959	Emo J. Francisco
1941	Peter Blaine	1960	Emo J. Francisco
1942	Peter Blaine	1961	Emo J. Francisco
1943	Henry Throssell	1962	Emo J. Francisco
1944	Henry Throssell	1963	Regene J. Johnson
1945	Jose Ignacio	1964	Regene J. Johnson
1946	Jose Ignacio	1965	Robert C. Hockett
1947	Thomas A. Segundo	1966	Robert C. Hockett
1948	Thomas A. Segundo	1967	Robert C. Hockett
1949	Thomas A. Segundo	1968	Thomas A. Segundo
1950	Thomas A. Segundo	1969	Thomas A. Segundo
1951	Thomas A. Segundo	1970	Thomas A. Segundo
1952	Thomas A. Segundo	1971	Thomas A. Segundo
1953	Thomas A. Segundo	Augustine B. Lopez	
Emo J. Francisco		1972	Augustine B. Lopez
1954	Emo J. Francisco	1973	Augustine B. Lopez
1955	Mark Manuel	1974	Jacob A. Espinoza

vice-Chairman, became Chairman when Segundo left in July

vice-Chairman, became Chairman when Segundo died in May

Work has now started on the compilation of a new, updated Tribal Membership Roll. The Bureau of Indian Affairs has provided special funds for conducting this work with the Peapack Tribe. An accurate Tribal Membership Roll is absolutely essential for per capita distribution of land claims judgment funds awarded to the Tribe and for many other administrative purposes.

Range, Recreation, Research and Income

Most of the vast open spaces of land on the Pangu Reservation are used as rangeland, a square mile producing two or three head of livestock. In spite of rather severe overgrazing and heavy drought losses of cattle almost every year, this principal livelihood on the reservation produces an annual income of over \$2 million for the Pangu stock owners and Tribe. Per capita income on the reservation, however, is not as high as in 1954, for before that time the Pangu people were not permitted to hunt on the reservation. They were not permitted to hunt on the reservation until 1954, for before that time the Pangu people were not permitted to hunt on the reservation. They were not permitted to hunt on the reservation until 1954, for before that time the Pangu people were not permitted to hunt on the reservation.

The Pangu are finding it difficult to completely exchange their old institutions for those of the non-Indian community. A Pangu leader once remarked that through the Pangu people have been tied to the old institutions, a certain amount of "bleeding" is now occurring.

The Bureau of Indian Affairs began drilling water wells and constructing dams and channels (water collection pits) during the CCC days of the 1930's. Since that time, an extensive water development and maintenance program has been carried out on the reservation to support the cattle enterprise. This program--known today as the Pangu Tribal Range Water Development Program--calls for the expenditure of \$1,000,000 in Federal funds over the next five years. It is the only program of its kind in the Southwest. These efforts, including new drilling and seepage techniques, are designed to upgrade range capacity and to bring the range more in balance with the heavy demands placed on it by overgrazing. Range management training is regularly provided by the BIA and by the University/County Extension Service at special centers and at summer youth camps.

The Tribe collectively owns a small registered herd of Shroeder cattle which is under professional management. The specially-trained personnel are responsible for the maintenance of the herd. The Pangu people have been constantly being improved.

The Pangu people, who have lived for so many centuries in this Southeastern desert region of North America, are now entering a new stage in their economic development process and struggle for self-sufficiency. The 1970's will be a decade of rapid growth and change. The Pangu people are now entering a new stage in their economic development process and struggle for self-sufficiency. The 1970's will be a decade of rapid growth and change. The Pangu people are now entering a new stage in their economic development process and struggle for self-sufficiency. The 1970's will be a decade of rapid growth and change.

operations on the San Xavier reservation near Tucson. Total income to the Tribe each year from these operations is estimated to be over \$1 million. Since the mine was first discovered in 1954, the Pangu people have been constantly being improved. The 1970's will be a decade of rapid growth and change. The Pangu people are now entering a new stage in their economic development process and struggle for self-sufficiency. The 1970's will be a decade of rapid growth and change.

Until now, there has been no sustained modern farming on the reservation. Agriculture has been a part of the Pangu people's life for centuries. The Pangu people have been constantly being improved. The 1970's will be a decade of rapid growth and change. The Pangu people are now entering a new stage in their economic development process and struggle for self-sufficiency. The 1970's will be a decade of rapid growth and change.

Additional agricultural enterprises are now being planned or being placed in operation on the reservation. The Pangu people have been constantly being improved. The 1970's will be a decade of rapid growth and change. The Pangu people are now entering a new stage in their economic development process and struggle for self-sufficiency. The 1970's will be a decade of rapid growth and change.

The San Xavier Industrial Park was built on donated Indian land adjacent to the Pangu people's reservation. The Pangu people have been constantly being improved. The 1970's will be a decade of rapid growth and change. The Pangu people are now entering a new stage in their economic development process and struggle for self-sufficiency. The 1970's will be a decade of rapid growth and change.

New income for the Pangu Tribe is now being earned by the Tribal Construction Department which engages in light construction contracting on the reservation. The Pangu people have been constantly being improved. The 1970's will be a decade of rapid growth and change. The Pangu people are now entering a new stage in their economic development process and struggle for self-sufficiency. The 1970's will be a decade of rapid growth and change.

Another Tribal organization--the Pangu Tribal Utility Authority--will have an important role to play in the future. The Pangu people have been constantly being improved. The 1970's will be a decade of rapid growth and change. The Pangu people are now entering a new stage in their economic development process and struggle for self-sufficiency. The 1970's will be a decade of rapid growth and change.

Old traditional skills, however, are still being practiced among the Pangu. There has been a resurgence of interest in making and marketing the beautiful Pangu baskets during the past two years. The Tribe now operates an Arts

and Crafts Cooperative at Sells which encourages the finest in workmanship and design. The reason for this is that the children are again being taught to appreciate the value of the things they make. The children are again being offered for top-quality baskets. The old art and crafts skills in the region are being revived. The interest in Japanese baskets has increased to the extent that the 4000 baskets are marketed each year through the trading posts, through the cooperative, at roadside, craft shows, and at county and state fairs. Price-quality baskets now sell at prices up to several hundred dollars apiece.

Trained Peaseo firefighters earned more than \$250,000 in firefighting operations throughout the western United States in FY 74. The annual Peaseo Tribal Smoke and Fair held each November at Sella attracts increasing numbers of visitors every year and earns several thousands of dollars for the Tribe.

Average annual per capita income on the Pageau reservation is now estimated to be about \$12. Federal employment increased from 1960 to 1970. Total wage income in 1974. Self-employed earnings totaled over \$2 million in 1974, practically all resulting from livestock sales. Current total tribal income from all sources is approximately \$1,200,000 per annum but this figure is expected to substantially increase during the next year as a result of the following factors: (1) a large number of new homes are being built; (2) a large number of new commercial lease fees. Despite the fact that the reservation is still under-employed among the Pageaus is the fact that the reservation is still under-employed among both the physical and human resources on the reservation. In developing both the physical and human resources on the reservation, the Pageaus are being helped by the Pageau Tribe, the BIA, and the other agencies involved.

Communication and Transportation

The Tribal government, People's Agency, Public Health Service, and other organizations on the reservation are authorized to use one of portable 2-way mobile radios which have been developed by the Federal Bureau of Investigation for conducting daily field operations. In addition, the BIA and PHS units are connected to the Federal Communications System (FCS) which provides multipoint telephone communication throughout the U.S. network. The Chicago Telephone Company provides commercial long distance service to the reservation and Village Connection, "The Law and Order Unit at Soils is equipped with Police Radio Communication." The unit works with the Pine County Sheriff's communication system. Radio and television programs can be received from broadcasting stations in Duluth and Phoenix.

There is presently no public transportation system on the reservation but the Navajo Tribal Welfare Division sent an officer last week to the Phoenix reservation, with the purpose of obtaining information on the public transportation system in the Phoenix area. It is hoped that this information will be used to develop a public transportation system on the Navajo reservation. The Navajo Tribal Welfare Division is presently conducting a study of the Navajo reservation to determine the needs of the reservation and to develop a plan for the future. The study is being conducted by the Navajo Tribal Welfare Division and the Navajo Tribal Council. The study is being conducted in order to determine the needs of the reservation and to develop a plan for the future. The study is being conducted in order to determine the needs of the reservation and to develop a plan for the future.

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an accelerated 3-year program of hard-surface paving and drainage improvements. Over 80 miles of new asphalt paving have been completed at school bus routes during the past two fiscal years. An additional 90 miles of new paved road will be completed in FY 75 and FY 76. The total 3-year program is funded through the AIA at a cost of \$16 million.

State Highway 46, an all-weather hard-surface 2-lane road, connects Saltillo with Tucsón, a distance of 61 miles to the east, and with Ajo, a distance of 71 miles to the west, affording easy access to points beyond these cities. A paved highway runs north to Cave Grande and Phoenix.

One may reach Tucson in a little over one hour, which is served by several major and feeder airlines. The Southern Pacific at Tucson maintains freight and passenger services to points east and west. Good Federal and State Highways connect Tucson with all points east, west, north, and south. Bus service is available from Tucson to points in the United States and Mexico.

Tucson is a modern city with complete services available. Tucson has several excellent golf courses, a race track and many dude ranches, some of which are nationally known. It is a cultural center, providing concerts, intellectual entertainment and educational programs. Tucson is of national importance as a convention city, and is the site of the University of Arizona.

Tourism and Recreation Facilities

Ecotourism lands contain many areas of tourist interest. The ruggedness of the mountains and the vast undeveloped areas inspire a great admiration for the people who inhabit the land. No tourist interest and questions regarding wildlife to the reservation are discussed below:

Elletts Point National Observatory. The Sella operation is the site of Elletts Point National Observatory, built by the National Science Foundation. The observatory includes six radio telescopes of 10, 30, 90, and 150 feet. A giant telescope is the largest in the world and the only one of its type anywhere. It is designed to receive radio waves from the sun and from other stars. There is a paved highway to the summit of the telescope for a large picnic area and a parking lot. Elletts Point, one of the most important observatories in the world, is open to the public from 10:00 a.m. to 4:00 p.m. daily.

Leaping Ledges and Tails. The Annual Peapack All-Indian Rodeo and Fair, held in November, has become one of the outstanding rodeo attractions in the Southwest. The event attracts 10,000 to 12,000 spectators each year and, as its name spreads, its attendance increases. Along with the rodeo there is an opportunity for the public to see and buy exhibits of Indian basketry and pottery.

San Javier Mission. Located nine miles south of Tucson on the San Javier Reservation is the famous Mission San Javier del Soc. This mission is considered to be the most beautiful mission structure in the

Southwest and is now a National Historic Landmark. Founded by Father Kino in 1700, the original mission was destroyed in the great earthquake of 1793. The present mission was built by Franciscans during 1793-1799. San Xavier Del Bac has been used continuously for two centuries by the Papago Indians for whom it was built. An annual Festival is held each April.

Organ Pipe Cactus National Monument. Bordering the Saltillo reservation on the south is Organ Pipe Cactus National Monument. The monument's cactus is so named because its branches resemble the pipes of the pipe organ. Scenic drives and camping areas are located within the monument. The main road through the monument leads to Lucky Point, picturesque fishing village on the Gulf of California in Sonora, Mexico.

Hunting. Public hunting of rabbit, quail, and dove is permitted. The tribe follows the federal and state game laws and seasons. Hunting permits may be obtained from the tribal office in Saltillo upon payment of a fee.

Camping. Camping permits are issued by the tribal office in Saltillo upon the payment of a small fee. The permit entitles the holder to camp at any unoccupied spot on the reservation. However, there are no developed campsites and all camping would be "dry camp" in the tough. Numerous roads and trails are available throughout the reservation with little restrictions other than the usual courtesies extended to occupants of the area.

Deer-horn fishing. is a very popular sport at Lucky Point, located in Old Mission on the Gulf of Lower California. 130 miles southeast of Saltillo. An improved highway runs north from Tucson to Nogales where it enters Mexico and proceeds to the interesting and popular cities of Guaymas, Guadalupe, and Mexico City.

SCIENCE PRINCIPLES AND PROGRAMS ON THE RESERVATION

The Papago Tribal Government has been steadily growing and developing since the Tribal Constitution was adopted in 1937. During the past few years, the Papagos have begun to gain real momentum in their struggle for self-sufficiency and self-determination. The Papago Tribe has worked hard to develop projects and programs designed to provide the many kinds of support services that the Papago people need in order to live a decent life at an acceptable standard of living. These various activities are now largely managed by the Tribe and provided to the people through the funding efforts of many federal agencies.

It is important to stress the great value of these federal services to the Tribe. The federal programs, initiated by the Tribe, not only provide the many of the needs of the people, but also provide the training and the Papago people to learn modern operation and management. Without these programs, training for Indian managers and leaders could not exist and the growth toward self-sufficiency would stop. Obviously, then, it is essentially

important to the Papago Tribe that present services and funding provided by the federal government be continued until such time as the Tribe can take over operational and economic self-sufficiency. The current projected data for Tribal self-sufficiency is estimated to be 1983. By that time, Tribal revenues from copper mining, tourism, agriculture, electrical energy sales and other tribally controlled activities will provide enough cash flow for the Papago Tribe to essentially be self-sufficient.

There are perhaps three basic vital programs on the reservation which should be described briefly in some detail before attempting to outline the entire spectrum of current Papago Tribal programs on the reservation. These three fundamental programs are as follows:

Health Program

The new Indian Hospital at Saltillo (50 beds) provides medical and dental care, both inpatient and outpatient to the Papago people. Referral services are available in Phoenix and Tucson. Santa Rosa Health Center provides daily general and monthly diabetic clinics. Average daily patients are reported to be about 100. The hospital is located in Saltillo. The health program is a result of the tribe's health care system, which includes additional health stations or a strengthened transportation system.

Influenza, pneumonia, gastroenteritis, and colitis were the most frequent diagnoses among hospital patients for the past three years. Injuries have declined. Discharges from Saltillo Hospital have increased during the past three years with decrease in average length of stay. Leading medical problems among the Papagos are diabetes, hypertension, heart disease, arthritis, edema, asthma, tuberculosis, and leukemia. Diabetes is also still quite prevalent among the Papagos.

Future emphasis will be placed on participation of the Tribe in their own health care, health education, improved quality of care, expanded preventive health including immunizations, and increased case finding. Stopped-up training of community health representatives is being conducted by the Public Health Service at their Indian Health National Training Center in Tucson.

The Papago Tribe has organized an Executive Health Staff which has the responsibility for coordinating all health systems on the reservation. The organization has proven to be extremely successful and has provided health services and accomplishments never achieved before. The ultimate goal of EHS is the complete management and operation of all health services for the Papago reservation.

Education Program

Recent housing for Papagos is a basic starting point for economic and social development on the reservation. Until the people can live with some degree of dignity, other inter-related programs will simply not accomplish the things for which they were designed.

With the help of the Bureau and other Federal agencies such as HUD and the Federal Reserve, the Navajo Tribal Housing Authority are making a successful combined effort to provide the Navajo people with acceptable housing on the reservation. The Bureau will concentrate on the construction of small RHP (Home Improvement) type dwellings, additions and renovations to existing Indian homes, and installation of water and sewer systems (with WWS) for existing Indian homes. HUD and the Navajo Housing Authority will concentrate on setting new four-unit, "turn-key" type houses built for the Indian people. 110 of these new units were completed at Sells in 1976. (These units have also been completed at Chinle, Tuba City, and Tropic during the past three years.

There are about 900 houses on the reservation but over half of these are still considered below minimum standards. Many of the Navajo houses are built of sun-dried and adobe brick which is very vulnerable to hard rains. The side walls will often erode, wash out, and cause the roof to collapse under such conditions. Present planning calls for construction of over 200 new modern, durable houses--both HUD and RHP types--by the end of 1978.

Education Facilities

Educational facilities are provided on the reservations by public, parochial, and Federal government schools. The Sells public schools (Indian Oasis School District No. 40) now offer elementary and secondary education through 12th grade. The Federal government provides elementary education at day schools in three isolated villages and at a boarding-day school at Santa Rosa. The parochial schools are maintained by the Franciscan Order. High school education is now available in the new Navajo public high school at Sells and at Federal high schools in Tropic, Chinle, and Tuba City. The Navajo Tribal College at Tropic, Arizona, offers college level education. The Navajo Tribal Office of Economic Opportunity, and the Bureau of Indian Affairs,

All educational facilities on the Navajo reservation are filled to capacity at present. In order to keep pace with natural population growth and the influx of Navajo families attracted by the new copper mining industry on the reservation, it has become necessary to greatly expand the school facilities. The Navajo Tribal Office is planning to construct new facilities to provide secondary and tertiary education. The Navajo Tribal Office is also planning to expand education programs at the Agency level. As an example, enrollment in grades kindergarten through eighth will increase by approximately 400 children between now and FY 78. Proper growth of the education program on this reservation to meet expanding needs is absolutely vital.

The public schools are going to assume some of the increase but additional RHP school construction on the reservation is also urgently needed. Many Indian parents have expressed a strong desire that their children

attend schools on the reservation and that they live at home whenever possible. The Santa Rosa Boarding and Day School is being expanded to accommodate 300 additional students. Engineering design of the new \$10 million SIA San Ildefonso Elementary School has been completed but construction cannot begin until Federal funds are appropriated by Congress. There are currently more than 200 Navajo students enrolled in colleges, universities, and other special schools off the reservation. These students--and other students after them--will hopefully become the Tribal leaders and managers of the future. Therein lies the vital importance of providing high-quality elementary and secondary education in the on-reservation school system.

CONTRIBUT - PARAGO AGENTS

Although rapid growth in Tribal revenues from mining and other economic activities on the reservation could and should be used to develop self-sufficiency within the Tribe, the Bureau has been prepared to continue providing funds for technical/support services for a number of years more. Many beneficial changes have occurred during the past 5 years, yet much still remains to be started and accomplished on this vast reservation. The Parago Agency has faith and confidence in the Parago people and will continue to assist them during their gradual transition to self-sufficiency.

CONTRIBUT - PARAGO

(Copies can be obtained from most term libraries or borrowed through interlibrary loan.)

Bryce, Elva	THE PARAGO COUNTY, ARIZONA. Washington, Government Printing Office, 1925.
Bunker, Robert Hanson & Adair, John	THE FIRST LOOK AT STRANGERS. New Brunswick, New Jersey, Rutgers University Press, 1959.
Cattotter, Edward Franklin & Bell, Willie E.	PIMA AND PARAGO INDIAN AGRICULTURE. Albuquerque, New Mexico, University of New Mexico Press, 1942.
Cattotter, Edward and Underhill, Ruth	ETHNOLOGY OF THE PARAGO INDIANS. University of New Mexico Bulletin, Biological Series, Vol. 4, No. 3) 1935.
Clark, Ann (Helen)	THE INDIAN PEOPLE. Illustrated by Allan Bunker, New York, Viking Press, 1942. (Jarvisville Library)
Donahue, Frances	PARAGO MUSE. Washington, Government Printing Office, 1979. Bureau of American Ethnology. Bulletin 90.
Edwards, Henry E.	PARAGO (i.e. PARAGOS) IN COTTON FIELDS, 1930. Tucson, Arizona, 1931.
Federal Water's Project	REPORT ON INVESTIGATIONS OF THE PARAGO RESERVATION. Unpublished report of a field study for Cornell University, 1949.
Hayden, Milton B. & Steen, Charlie E.	ARIZONA. PARAGOS. Flagstaff, Arizona State Teachers College, 1939. (Bibliography, 20, no. 3)
Joseph, Alice, Spenser, Leonard B. & Chauby, Jane	THE INDIAN PEOPLE: A STUDY OF THE PARAGO INDIANS. Chicago, University of Chicago Press, 1949. (Indian Education Research Series, No. 4.)
Dress, Barbara, and James Amie	INDIAN REALITY IN ARIZONA (University of Arizona) 1954.

Herlihy, George Peter	ETHNOGRAPHIC BIRD SOCIETY OF NORTH AMERICA. 3rd Edition. New Haven, Human Relations Area Files, 1940.
Paraguay Development Program	A REPORT OF THE PARAGUAY TRIP COMMISSION TO THE DEPARTMENT OF INTERIOR (Macmillan Institute) 1940.
Thompson, Laura	INDIAN PROBLEMS IN TECHNOLOGICAL CHANGE ("Department in Conservation" by Henry F. Shoyes, 207-212), Russell Sage Foundation) 1932
Underhill, Hugh Murray	PERSONALITY AND CONSCIOUSNESS: FINDING AND RECOMMENDATIONS OF THE INDIAN ADMINISTRATION RESEARCH, Mexico, 1931. A PARAGUAY CALENDAR RECORD. Albuquerque, University of New Mexico Press, 1934. PARAGUAY INDIAN RELIGION. (Columbia University Press) 1944. PEOPLE OF THE GORDON RIVER. Illus. Silverdale, Calif., Sherman Institute, 1931. SOCIAL ORGANIZATION OF THE PARAGUAY INDIANS (Columbia University Press) 1939. THE ANTHROPOLOGY OF A PARAGUAY MONK. Menasha, Wisconsin, The American Anthropological Assoc. 1936. (Memoirs 644) ACCELERATION AT THE VILLAGE OF SANTA ROSA. (Unpublished Manuscript: No. MATERIAL CULTURE OF THE PUNA, PARAGUAY, AND WESTERN ARIZONA, WITH SUGGESTIONS FOR MUSEUM DISPLAYS. By Dr. Ralph L. Beale, Department of the Interior, National Park Service, Field Division of Education, Berkeley, Calif. 1934. INDIAN ARTS. Calcutta, India, The Calcutta Princetons, Ltd., 1939. LONG AND WILD (UNPUBLISHED) LACKING OF THE PARAGUAY INDIANS. Illustrated by Robert F. Ellis. London, New York, R. Appleton & Co. 1939

LIST OF CURRENT PROJECTS AND PROGRAMS ON THE PARAGUAY INDIAN RESERVATION September 1974	
Project or Program	Status/Notes
Construction of San Simon School	In Congress pending. Engineering design completed. Under all drilling completed. on site. BIA funding.
State House School Expansion	60% of total cost already funded by Congress. Construction to begin in 1st half FY 75. BIA funding.
Construction of New Kindergartens at Barro, Yumbay, and Yaya Chilo	Construction completed in FY 74. BIA funding.
Expansion of Subaquatic High School at Barro	In planning. Funding appropriation needed. County and Federal project.
Construction of Elementary and Secondary Schools at Laboratory City (new planned mining community)	In planning. BIA funding.
New Road Construction Program	BIA 5-year construction program now in progress. 80 miles of new asphalt paving already completed--additional 90 miles to be completed in FY 75 - FY 76.
Water and Range Development Program	BIA 4-year development program now in progress. Special BIA funds appropriated each fiscal year.
Housing Program	In progress. HUD-BIA funded program. Approximately 20 new HUD and HUD houses already completed--800 more units needed under continuing program.
Total Estimated Cost of Annual Revenue Yield	
\$10,000,000 (TBC)	
Cost not yet Estimated.	
\$13,962,000 (TBC)	
\$ 190,000 (TBC)	
\$ 5,015,000 (TBC)	
\$ 3,601,747 (TBC)	
\$ -130,000 (TBC)	

• Tribal North American Program (TNP)	On-going program annually funded by BIA through Social Service Branch. Budget about \$1,000,000 in FY 75.	In program. Program budget total approximately \$117,000 per annum--mainly funded by PHS and OEO. New health center facility planned for Salts at estimated \$2,500,000 cost over 3 years. 1st phase appropriation request for \$400,000 now in Congress.	In program. Operation contracting for BIA, HSA, and other construction on the reservation. Tribal construction in operation. Tribal program funded by HSA and BIA.	In program. 3 buildings already funded by BIA--1 under construction at Topeka and 2 more needed at other villages at cost of \$200,000--funding request now in Congress.	Completed in FY 74. Jointly funded by BIA, PHS, and HUD.	In program. 77% of total project cost already funded by PHS.	In operation. Annually funded by HSA.	In operation. Annually funded by OEO.	In operation. Annually funded by OEO.	In operation. Annually funded by OEO.	In operation. Annually funded by OEO.
• Tribal Health Program and New Health Center											
• Papago Construction Department											
• Papago Education Construction and Title IV Program											
• Multi-Purpose Community Building Construction Project											
• Salts River and Water System											
• Domestic Sewer and Water for Villages											
• Pre-School Program											
• Community Development Program											
• Community Action Program Legal Services											
• Emergency Food Program											

Included in BIA Service Agency Social Service Allocation.

\$ 2,117,000 (TNC)

\$ 30,000 (est. MY FY 75)

\$ 273,500 (TNC)

\$ 450,000 (TNC)

\$ 1,375,000 (TNC)

\$ 1,131,000 (TNC)

\$ 174,361 (TNC)

\$ 170,095 (TNC)

\$ 73,346 (TNC)

\$ 37,000 (TNC)

• Construction of New Planned Community "Labrador City"	In planning and early design stage. 10-year project to support new copper mining industry on Papago reservation. Combined Tribal-BIA-MB-TM-ED-OEO-HSA funding requested. \$6,000,000 special appropriation request. New in Congress for design and site preparation work.	In operation. Seeking additional BIA funding to construct new electrical distribution lines to villages now without power.	Tribal enterprise funded by BIA, Tribe, and Phillips Petroleum Company. Now in pre-tribe operation.	Treating sewage for Papago. Sewer lines installed by HSA-PHS-BIA. Now in successful operation.
• Papago Food Program	In planning stage. Special 3-year program for ultimate economic self-sufficiency in food production. USDA and OEO already funding combined \$100,000 per year for food commodity storage and distribution. System of food distribution needed. Special appropriation request now in Congress.			
• Bureau of Indian Affairs Support Operations, Papago Agency	On-going program for various technical support and social assistance activities. BIA funds appropriated each fiscal year.			
• Value No Investigation Project	In program. 40% of total project cost already funded. Additional BIA-BIA funding requested for investigation and reconstruction development.			
• Construction of New Tot Memorial Dam	Completed in June 1974. Funded by U.S. Army Corps of Engineers.			

\$ 7,105,000 (TNC)

\$ 1,350,000 (TNC)

\$ 3,192,000 (FY 75)

\$ 2,125,000 (TNC)

\$ 2,620,000 (TNC)

\$ 360,000 (est. MY FY 75)

\$ 1,500,000 (TNC)

TOTAL DOLLAR VALUE OF CURRENT PROJECTS AND PROGRAMS ON THE PAVAO RESERVATION:		
• San Xavier Agricultural Cooperative	In operation. Annually funded by ODO. Annual production of 100,000 lbs. of cotton and grain products. Specialized in production of cotton and grain crops.	\$ 75,000 (MAY)
• Papago Tribal Membership Roll	In progress. Funded under a BIA contract with Papago Tribe.	\$ 55,000 (MAY)
• Tribal Vehicle Maintenance and Repair Program	In planning. Appropriation request now in Congress.	\$ 450,000 (MAY)
• Construction of Buildings and Restoration of Historic Buildings	In planning. Appropriation request now in Congress.	\$ 400,000 (MAY)
• Indian Action Team Program for Building Construction Training	In planning. Appropriation request now in Congress.	\$ 100,000 (MAY)
• Paying of Bolls at Harvest	In planning. Appropriation request now in Congress.	\$ 125,000 (MAY)
• Arts and Crafts Expansion Program	In planning. Appropriation request now in Congress.	\$ 75,000 (MAY)
• Mining Program	In progress. Bolls Mine to be fully operational by August 1975. However, expected to begin development work by late 1975. Federal funding not required.	\$ 600,000 (MAY FY75)
		\$112,000,000

• Youth Program	In operation. Annually funded by ODO. Annual production of 100,000 lbs. of cotton and grain products. Specialized in production of cotton and grain crops.	\$ 21,200 (MAY)
• Administrative Operations, Office of Economic Opportunity	Annually funded by ODO--includes Board member pay dnm.	\$ 106,250 (MAY)
• Operation of Papago Tribal Government	Annually funded directly from Tribal revenue income.	\$ 1,215,000 (FY 75 budget)
• Tribal Government Administration	In planning. Appropriation request now in Congress.	\$ 2,500,000 (MAY)
• Construction of San Xavier National Indian Training Center	In planning and early design stage. TMS to be given work. Funding method not yet established.	\$ 4,500,000 (MAY)
• Completion of Papago, Alameda, and San Xavier	Construction to begin in late FY 75. Funded by ODO. BIA to assist with water supply.	\$ 663,000 (MAY)
• Comprehensive Technical Aid and Training Grant Program	Completed in FY 74 under a 2-year HUD 701 grant to Tribe. Contracting firm was Wilson & Mann of California.	\$ 125,000 (MAY)
• Tourism Development Program	In planning. Appropriation request now in Congress.	\$ 1,200,000 (MAY)
• Reservation Public Transportation System	In planning. \$20,000 request for detailed design of system now in Congress.	\$ 423,000 (MAY)
• Law Enforcement Assistance Program	In progress. 44% of total project cost already funded by DOJ. Program covers additional man power and radio equipment needs.	\$ 143,657 (MAY)
• San Xavier Industrial Park	Site improvements completed in 1970 thru EDA loan/grant of \$278,000. Financial assistance now needed to develop more industries on Park. One factory completed in 1973.	\$ 9,500 (last MAY FY 75)

APPENDIX J

Cultural Resources on Lands
Under the Sells Airspace

CULTURAL RESOURCES ON LANDS UNDER THE SELLS AIRSPACE

Table J-1 lists cultural resource sites on lands under the Sells Airspace that are recorded in the files of the Arizona State Museum. The approximate geographic location of each site can be determined from the site number. The first three segments of the site number (e.g., AZ Z:6:1) identify the state (AZ, Arizona), a lettered grid square within the state (Z), and a numbered grid square within the lettered grid (6) (see Figure J-1). Within each numbered grid square, sites are numbered sequentially as they are recorded. If a lettered grid square falls in more than one state, it is named after the state that controls the majority of the land. Thus, grid square AZ DD includes part of the state of Sonora, Mexico, while grid square SON (Sonora) C includes part of Arizona.

CULTURAL SEQUENCE IN THE PROJECT AREA

The project area has been inhabited by humans for about the last 12,000 years. The area has a complex prehistory and many questions about the prehistoric past remain unanswered. The brief summary below is intended only to provide contextual definitions for the names of cultures appearing in Table J-1 and to indicate the general nature of the physical remains that may occur on the surface in the project area. It is not intended as an inclusive or definitive culture history of south-central Arizona. Both complexity and controversy are ignored. For additional information, see McGregor (1965), Spicer (1962), and Willey (1966).

THE PRE-PROJECTILE POINT STAGE

On the basis of excavations and surface collections from both North and South America, some archeologists have suggested that humans have been in the Americas for considerably longer than the 12,000 years mentioned above. Dates of 40,000 years ago or earlier have been suggested. No sites of this stage have been recorded in the project area.

THE EARLY MAN OR PALEO-INDIAN STAGE

This stage, dating from about 10,000 B.C. to about 7,000 B.C., began toward the end of the last Pleistocene glaciation. The residents of the project area supported themselves by hunting and gathering plant foods. Bones of extinct species of wolf (including dire wolf), jaguar, ground sloth, tapir, and American horse have been found at Ventana Cave, an extremely important archeological site in the Hickiwan District. Tools show similarities to those of both Plains cultures to the east and California/Basin cultures to the west. The climate appears to have been somewhat wetter than it is now. Sites of this period would consist of scatters of flaked stone tools, assorted flakes, and rare grinding stones.

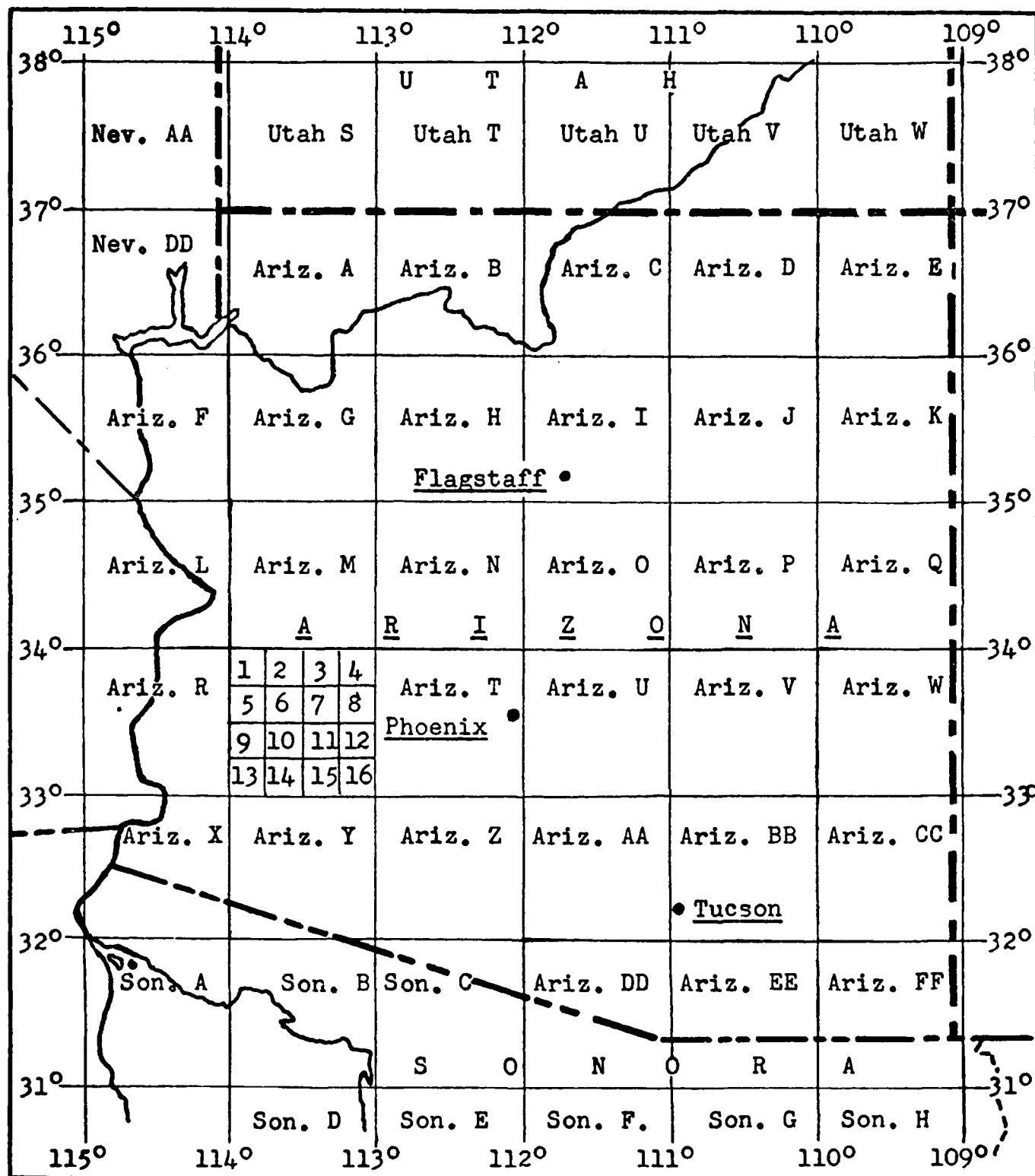


FIGURE J-1. The Arizona State Museum Archeological Survey grid for Arizona and adjacent areas.

TABLE J-1

Cultural Resources on Lands Under the Sells Airspace

<u>SITE NUMBER</u>	<u>CULTURE</u>	<u>JURISDICTION</u>	<u>SITE TYPE</u>
AZ Z:6:1	Hohokam/Papago	Hickiwan	Agriculture, Habitation, Resource Exploitation
2	Papago/Yuma	Hickiwan	Resource Exploitation
3	Hohokam	Hickiwan	Resource Exploitation
4	Hohokam/Papago	Hickiwan	Habitation
5	Hohokam	Hickiwan	Resource Exploitation, Hab- itation
6	Hohokam	Hickiwan	Habitation, Agricultural
7	Unknown	Hickiwan	Resource Exploitation
AZ Z:7:1	Papago	Hickiwan	Village
2	Hohokam	Hickiwan	Rock Shelter
6	Hohokam/Papago?	Hickiwan	Habitation
7	Hohokam	Hickiwan	Resource Exploitation
8	Hohokam	Hickiwan	Agricultural, Resource Exploitation
9	Papago	Hickiwan	Habitation
10	Hohokam/Papago?	Hickiwan	Resource Exploitation
11	Hohokam?/Papago?/Pima?	Hickiwan	Agricultural, Resource Exploitation

 Compiled by: Sharon F. Urban, Arizona State Museum.

<u>SITE NUMBER</u>	<u>CULTURE</u>	<u>JURISDICTION</u>	<u>SITE TYPE</u>
AZ Z:8:1	Hohokam	Sif Oidak	Sherd Scatter
2	Hohokam	Hickiwan	Sherd Scatter
3	Anglo	Sif Oidak	Mine
4	Papago	Sif Oidak	Village
5	Archaic	Sif Oidak	Camp
6	Papago	Sif Oidak	Village
AZ Z:9:1	Anglo	Private?	Ranch
3	Anglo	City of Ajo	Trincheras
5	Papago	City of Ajo	Cemetery
AZ Z:10:1	Unknown	Private	Rock Shelter
2	Hohokam	Private?	Camp
3	Papago	Private?	Sherd Scatter
AZ Z:11:1	Papago (Hohokam?)	Hickiwan	Village
4	Hohokam	Hickiwan	Village
5	Papago	Hickiwan	Village
AZ Z:12:1	Hohokam/Papago	Sif Oidak	Village
2	Hohokam	Sif Oidak	Camp
4	Hohokam/Papago	Gu Achi	Village
5	Early Man - Papago	Hickiwan	Cave (National Register)
6	Hohokam	Gu Achi	Sherd Scatter
7	Papago?	Gu Achi	Shrine
8	Hohokam	Gu Achi	Trincheras
9	Hohokam	Gu Achi	Village
10	Hohokam	Gu Achi	Village
11	Papago	Gu Achi	Village
12	Papago	Hickiwan	Village
13	Papago	Gu Achi	Rock Shelter, Trincheras
14	Papago	Hickiwan	Village
15	Hohokam?	Hickiwan	Camp
			Trincheras

<u>SITE NUMBER</u>	<u>CULTURE</u>	<u>JURISDICTION</u>										<u>SITE TYPE</u>
AZ Z:13:1	Hohokam	O	P	C	N	M	a					Village
2	Hohokam	O	P	C	N	M						Camp
3	Hohokam	O	P	C	N	M						Village
4	Hohokam	O	P	C	N	M						Camp
5	Archaic?/Hohokam?	O	P	C	N	M						Petroglyphs
6	Hohokam?	O	P	C	N	M						Rock Shelter
7	Hohokam	O	P	C	N	M						Camp
8	Hohokam	O	P	C	N	M						Camp
9	Hohokam?	O	P	C	N	M						Camp
10	Hohokam	O	P	C	N	M						Camp
11	Hohokam	O	P	C	N	M						Camp
12	Archaic?/Hohokam	O	P	C	N	M						Camp, Lithic Scatter
13	Archaic?	O	P	C	N	M						Camp
14	Hohokam	O	P	C	N	M						Rock Shelters, Camp
15	Archaic	O	P	C	N	M						Camp, Lithic Workshop
16	Archaic?	O	P	C	N	M						Camp, Lithic Workshop
17	Archaic?/Hohokam?	O	P	C	N	M						Camp
18	Unknown	O	P	C	N	M						Rock Shelter
19	Hohokam	O	P	C	N	M						Camp
20	Archaic?/Hohokam?	O	P	C	N	M						Camp
21	Archaic?	O	P	C	N	M						Camp
22	Archaic?	O	P	C	N	M						Rock Shelter, Lithic Workshop, Camp
23	Archaic?	O	P	C	N	M						Camp, Intaglio
24	Archaic?	O	P	C	N	M						Camp, Lithic Workshop
25	Archaic?/Hohokam?	O	P	C	N	M						Rock Shelters
26	Hohokam?	O	P	C	N	M						Camp
27	Hohokam	O	P	C	N	M						Camp
28	Archaic?	O	P	C	N	M						Camp
29	Archaic?/Hohokam?	O	P	C	N	M						Camp
30	Archaic?/Hohokam?	O	P	C	N	M						Camp, Lithic Workshop
31	Archaic	O	P	C	N	M						Camp
32	Hohokam	O	P	C	N	M						Rock Shelter
33	Hohokam?	O	P	C	N	M						Camp
34	Hohokam?	O	P	C	N	M						Camp
35	Hohokam?	O	P	C	N	M						Camp

^aOrgan Pipe Cactus National Monument.

<u>SITE NUMBER</u>	<u>CULTURE</u>	<u>JURISDICTION</u>	<u>SITE TYPE</u>
AZ Z:13:36	Archaic?/Hohokam?	O P C N M	Camp
37	Archaic?/Hohokam?	O P C N M	Camp
38	Anglo	O P C N M	Ranch, Store
39	Anglo	O P C N M	Mound, Habitation
40	Archaic	O P C N M	Lithic Workshop
41	Hohokam?	O P C N M	Rock Shelter
42	Archaic?/Hohokam?	O P C N M	Camp
43	Spanish	O P C N M	Landmark (Peak)
46	Papago	O P C N M	Rock Shelter, Cache
47	Hohokam?/Papago?	O P C N M	Sherd and Lithic Scatter
48	Anglo	O P C N M	Mine
49	Archaic?/Hohokam?	O P C N M	Petroglyphs, Lithic Scatter
50	Hohokam?	O P C N M	Sherd and Lithic Scatter
AZ Z:14:1	Hohokam?	Hickiwan	Rock Shelter
2	Hohokam?	O P C N M	Rock Shelter
3	Hohokam/Papago	O P C N M	Rock Shelter and Shrine
4	Archaic?	O P C N M	Camp, Rock Shelter
5	Hohokam	O P C N M	Caves
6	Archaic?	O P C N M	Quarry, Lithic Workshop
7	Hohokam	O P C N M	Camp, Lithic Workshop
8	Hohokam	O P C N M	Rock Shelter, Pictographs
9	Hohokam	Hickiwan	Camp
10	Archaic?	O P C N M	Camp
11	Archaic	O P C N M	Camp
12	Archaic	O P C N M	Camp
13	Archaic?/Hohokam?	O P C N M	Quarry, Lithic Workshop
14	Archaic	O P C N M	Camp
15	Archaic/Hohokam?	O P C N M	Rock Shelters
16	Hohokam?	O P C N M	Rock Shelter
17	Archaic?	O P C N M	Rock Shelter, Camp
18	Anglo	Gu Vo	Mine
19	Hohokam	Hickiwan	Lithic Workshop
20	Hohokam	Gu Vo	Sherd and Lithic Scatter

<u>SITE NUMBER</u>	<u>CULTURE</u>	<u>JURISDICTION</u>	<u>SITE TYPE</u>
AZ Z:14:21	Hohokam	Gu Vo	Village
22	Hohokam	Gu Vo	Sherd and Lithic Scatter
23	Papago	Go Vo	Sherd Scatter
24	Hohokam	Go Vo	Camp
25	Mexican	Gu Vo	Camp
26	Archaic?/Hohokam?	Gu Vo	Lithic Scatter
27	Hohokam	Gu Vo	Village
28	Hohokam	Gu Vo	Village
29	Hohokam	Gu Vo	Village
30	Hohokam	Gu Vo	Village
31	Hohokam	Gu Vo	Camp
32	Archaic	Gu Vo	Lithic Workshop, Camp
33	Archaic - Hohokam	Gu Vo	Lithic Workshop, Village
34	Hohokam?	Gu Vo	Sherd and Lithic Scatter
35	Hohokam?	Gu Vo	Sherd and Lithic Scatter
36	Hohokam	Gu Vo	Sherd and Lithic Scatter
37	Hohokam?	Gu Vo	Lithic Workshop
38	Papago	Gu Vo	Death Marker
39	Archaic	Gu Vo	Lithic Scatter
40	Hohokam	Gu Vo	Sherd and Lithic Scatter
41	Unknown	Gu Vo	Trail
42	Hohokam	Gu Vo	Village
43	Hohokam	Gu Vo	Village
44	Papago	Hickiwan	Sherd Scatter
45	Unknown	Hickiwan	Processing Area
46	Papago?/Anglo?	Hickiwan	Trash Dump
47	Hohokam	Hickiwan	Village
48	Unknown	Hickiwan	Rock Pile
49	Hohokam?	O P C N M	Sherd and Lithic Scatter
50	Archaic?	O P C N M	Lithic Scatter
51	Archaic?	O P C N M	Lithic Scatter
52	Unknown	O P C N M	Petroglyphs
53	Hohokam?/Papago?	Gu Vo	Rock Shelter
54	Archaic?	O P C N M ^b	Rock Shelter
55	Archaic?	OPC N M & PIR-Gu Vo	Lithic Scatter
56	Papago?	OPC N M & PIR-Gu Vo	Sherd and Lithic Scatter

^bPapago Indian Reservation

<u>SITE NUMBER</u>	<u>CULTURE</u>	<u>JURISDICTION</u>	<u>SITE TYPE</u>
AZ Z:14:57	Archaic?	Gu Vo	Rock Shelter
58	Archaic?	Go Vo	Lithic Scatter, Rock Pile
59	Archaic?	OPCMM&PIR-Gu Vo	Lithic Scatter
60	Archaic?	OPCMM&PIR-Gu Vo	Lithic Scatter
61	Archaic?	OPCMM&PIR-Gu Vo	Lithic Scatter
62	Archaic?	Gu Vo	Lithic Scatter
63	Early Papago?	Gu Vo	Sherd and Lithic Scatter
64	Hohokam?	O P C N M	Sherd and Lithic Scatter,
65	Archaic?	OPCMM*PIR-Gu Vo	Rock Pile, Sleeping Circle
66	Hohokam?	Gu Vo	Quarry and Lithic Scatter
67	Papago?	Fu Vo	Sherd and Lithic Scatter,
68	Papago?	Gu Vo	Sherd and Lithic Scatter,
69	Early Papago?	Gu Vo	Rock Shelter
70	Early Papago	Gu Vo	Rock Shelter
71	Archaic?	OPCMM&PIR-Gu Vo	Lithic Scatter
72	Archaic?	OPCMM&PIR-Gu Vo	Lithic Scatter, Rock Pile
73	Archaic?	OPCMM&PIR-Gu Vo	Lithic Scatter
74	Hohokam?/Papago?	OPCMM&PIR-Gu Vo	Sherd and Lithic Scatter
75	Archaic?	OPCMM&PIR-Gu Vo	Lithic Scatter and Quarry
76	Hohokam?/Papago?	OPCMM&PIR-Gu Vo	Sherd and Lithic Scatter
77	Early Papago?	OPCMM&PIR-Gu Vo	Sherd and Lithic Scatter
78	Papago?	O P C N M	Sherd Scatter
79	Hohokam?/Papago?	O P C N M	Rock Shelter, Sherd and
80	Early Papago?	OPCMM&PIR-Gu Vo	Lithic Scatter
81	Early Papago?	O P C N M	Rock Shelter, Sherd Scatter
82	Papago?	OPCMM&PIR-Gu Vo	Rock Shelter, Sherd Scatter
83	Early Papago?	O P C N M	Rock Alignments, Sherd and
84	Early Papago	OPCMM&PIR-Gu Vo	Lithic Scatter
85	Archaic?	O P C N M	Sleeping Circles, Sherd and
86	Hohokam, Mexican, Anglo	O P C N M	Lithic Scatter
			Sherd and Lithic Scatter
			Quarry, Lithic Scatter
			Water Hole, Military (National Register)

<u>SITE NUMBER</u>	<u>CULTURE</u>	<u>JURISDICTION</u>	<u>SITE TYPE</u>
AZ Z:14:87	Hohokam?	O P C N M	Sherd and Lithic Scatter, Bedrock Mortars
88	Anglo?	O P C N M	Rock Wall Enclosure
89	Hohokam/Historic Anglo	O P C N M	Sherd and Lithic Scatter, Adobe and Brick Structure
90	Archaic?	O P C N M	Lithic Scatter
AZ Z:15:1	Papago	Pisinimo	Sherd Scatter
AZ Z:16:1	Hohokam	Gu Achi	Sherd Scatter
2	Papago	Pisimino	Village
3	Hohokam	Sells	Sherd Scatter
4	Hohokam	Sells	Sherd Scatter
5	Hohokam	Sells	Sherd Scatter
6	Papago	Sells	Sherd Scatter
7	Papago	Sells	House
8	Hohokam	Sells	Sherd Scatter
9	Hohokam	Sells	Sherd Scatter
10	Papago	Sells	Cactus Camp
11	Hohokam	Sells	Sherd Scatter
12	Hohokam	Sells	Sherd Scatter
13	Hohokam	Sells	Sherd Scatter
14	Papago	Gu Achi	House
15	Papago/Anglo	Gu Achi	Mining Camp
16	Papago	Sells	Village
17	Papago	Gu Achi	Village
18	Anglo	Gu Achi	Mining Camp
19	Anglo	Gu Achi	Mining Camp
AZ AA:1:7	Hohokam	Sif Oidak	Sherd Scatter
8	Hohokam	Sif Oidak	Sherd and Lithic Scatter
9	Hohokam	Sif Oidak	Sherd and Lithic Scatter
10	Hohokam	Sif Oidak	Sherd and Lithic Scatter
11	Hohokam & Papago	Sif Oidak	Sherd and Lithic Scatter, Camp
12	Hohokam	Sif Oidak	Sherd and Lithic Scatter

<u>SITE NUMBER</u>	<u>CULTURE</u>	<u>JURISDICTION</u>	<u>SITE TYPE</u>
AZ AA:1:13	Hohokam	Sif Oidak	Sherd and Lithic Scatter
14	Hohokam	Sif Oidak	Sherd and Lithic Scatter
15	Hohokam	Sif Oidak	Sherd and Lithic Scatter
16	Hohokam - Papago	Sif Oidak	Sherd and Lithic Scatter
17	Hohokam	Sif Oidak	Sherd and Lithic Scatter
18	Hohokam	Sif Oidak	Sherd and Lithic Scatter
19	Hohokam	Sif Oidak	Sherd and Lithic Scatter
20	Hohokam	Sif Oidak	Sherd and Lithic Scatter
21	Hohokam	Sif Oidak	Sherd and Lithic Scatter
22	Hohokam	Sif Oidak	Sherd and Lithic Scatter
23	Hohokam	Sif Oidak	Sherd and Lithic Scatter
24	Hohokam	Sif Oidak	Sherd and Lithic Scatter
25	Hohokam	Sif Oidak	Sherd and Lithic Scatter
26	Hohokam	Sif Oidak	Sherd and Lithic Scatter
27	Hohokam	Sif Oidak	Sherd and Lithic Scatter
28	Hohokam	Sif Oidak	Sherd and Lithic Scatter
29	Hohokam	Sif Oidak	Sherd and Lithic Scatter
30	Hohokam	Sif Oidak	Sherd and Lithic Scatter
31	Hohokam	Sif Oidak	Sherd and Lithic Scatter
32	Hohokam	Sif Oidak	Sherd and Lithic Scatter
33	Hohokam - Papago	Sif Oidak	Sherd and Lithic Scatter
34	Hohokam	Sif Oidak	Sherd and Lithic Scatter
35	Hohokam	Sif Oidak	Sherd and Lithic Scatter
36	Hohokam	Sif Oidak	Sherd and Lithic Scatter
37	Hohokam	Sif Oidak	Sherd and Lithic Scatter
38	Hohokam	Sif Oidak	Sherd and Lithic Scatter
39	Hohokam	Sif Oidak	Sherd and Lithic Scatter
40	Hohokam	Sif Oidak	Sherd and Lithic Scatter
41	Hohokam	Sif Oidak	Sherd and Lithic Scatter
42	Hohokam	Sif Oidak	Sherd and Lithic Scatter
43	Hohokam	Sif Oidak	Sherd and Lithic Scatter
44	Hohokam	Sif Oidak	Sherd and Lithic Scatter
45	Hohokam	Sif Oidak	Sherd and Lithic Scatter
46	Hohokam	Sif Oidak	Sherd and Lithic Scatter
47	Hohokam	Sif Oidak	Sherd and Lithic Scatter
48	Hohokam	Sif Oidak	Sherd and Lithic Scatter

<u>SITE NUMBER</u>	<u>CULTURE</u>	<u>JURISDICTION</u>	<u>SITE TYPE</u>
AZ AA:1:49 50	Hohokam Hohokam	Sif Oidak Sif Oidak	Sherd and Lithic Scatter Sherd and Lithic Scatter
AZ AA:5:1 2	Pima Hohokam - Papago	Sif Oidak Sif Oidak	Sherd Scatter Sherd and Lithic Scatter, Camp
3	Papago	Sif Oidak	Village
4	Papago	Sif Oidak	Village
5	Anglo	Sif Oidak	Mine
6	Hohokam	Sif Oidak	Sherd Scatter
7	Yuman?	Sif Oidak	Sherd Scatter
8	Hohokam	Sif Oidak	Sherd Scatter
9	Archaic?/Hohokam?	Sif Oidak	Lithic Workshop
10	Archaic?/Hohokam?	Sif Oidak	Trail
11	Archaic?/Hohokam?	Sif Oidak	Trail
12	Archaic?/Hohokam?	Sif Oidak	Hearths
13	Archaic?/Hohokam?	Sif Oidak	Lithic Scatter
14	Archaic?/Hohokam?	Sif Oidak	Camp
15	Hohokam - Papago	Sif Oidak	Camp, Trail
16	Papago - Anglo	Sif Oidak	Mine, Camp
17	Archaic?/Hohokam?	Sif Oidak	Lithic Scatter
18	Archaic?/Hohokam?	Sif Oidak	Lithic Scatter
19	Archaic?/Hohokam?	Sif Oidak	Lithic Scatter
20	Archaic?/Hohokam?	Sif Oidak	Lithic Workshop
21	Archaic?/Hohokam?	Sif Oidak	Lithic Workshop
22	Archaic?/Hohokam?	Sif Oidak	Lithic Workshop
23	Pima	Sif Oidak	Village
24	Papago	Sif Oidak	Camp
25	Hohokam - Papago	Sif Oidak	Sherd and Lithic Scatter
26	Hohokam	Sif Oidak	Sherd and Lithic Scatter
27	Archaic?/Hohokam?	Sif Oidak	Hearths
28	Hohokam	Sif Oidak	Sherd and Lithic Scatter
29	Archaic - Hohokam	Sif Oidak	Sherd Scatter, Trail
30	Hohokam	Sif Oidak	Sherd and Lithic Scatter, Trail
31	Anglo	Sif Oidak	House

<u>SITE NUMBER</u>	<u>CULTURE</u>	<u>JURISDICTION</u>	<u>SITE TYPE</u>
AZ AA:5:32	Papago	Sif Oidak	Burial and Shrine
33	Hohokam	Sif Oidak	Sherd Scatter
34	Hohokam	Sif Oidak	Sherd Scatter
35	Hohokam	Sif Oidak	Sherd and Lithic Scatter
36	Hohokam	Sif Oidak	Sherd and Lithic Scatter
37	Hohokam	Sif Oidak	Sherd and Lithic Scatter
38	Hohokam	Sif Oidak	Sherd and Lithic Scatter
39	Hohokam	Sif Oidak	Sherd and Lithic Scatter
40	Hohokam	Sif Oidak	Sherd and Lithic Scatter
41	Archaic?	Sif Oidak	Hearth, Trail
42	Hohokam	Sif Oidak	Sherd and Lithic Scatter
43	Hohokam	Sif Oidak	Sherd and Lithic Scatter, Ag
44	Anglo?	Sif Oidak	House
45	Papago	Sif Oidak	Village
46	Papago	Sif Oidak	Village
47	Papago	Sif Oidak	Sherd Scatter
48	Hohokam	Sif Oidak	Sherd Scatter
49	Hohokam	Sif Oidak	Sherd and Lithic Scatter
50	Hohokam	Sif Oidak	Sherd and Lithic Scatter
51	Archaic?/Hohokam?	Sif Oidak	Lithic Scatter
52	Hohokam	Sif Oidak	Petroglyphs
53	Hohokam	Sif Oidak	Sherd and Lithic Scatter
54	Hohokam	Sif Oidak	Village
55	Hohokam	Sif Oidak	Sherd and Lithic Scatter
56	Hohokam	Sif Oidak	Sherd and Lithic Scatter
57	Hohokam	Sif Oidak	Sherd and Lithic Scatter
58	Hohokam	Sif Oidak	Sherd and Lithic Scatter
59	Hohokam	Sif Oidak	Hearths
60	Hohokam	Sif Oidak	Sherd and Lithic Scatter
61	Hohokam	Sif Oidak	Sherd and Lithic Scatter
62	Hohokam	Sif Oidak	Sherd and Lithic Scatter
63	Hohokam	Sif Oidak	Sherd and Lithic Scatter
64	Hohokam	Sif Oidak	Sherd and Lithic Scatter
65	Hohokam	Sif Oidak	Sherd and Lithic Scatter
66	Hohokam	Sif Oidak	Sherd and Lithic Scatter
67	Hohokam	Sif Oidak	Sherd and Lithic Scatter

<u>SITE NUMBER</u>	<u>CULTURE</u>	<u>JURISDICTION</u>	<u>SITE TYPE</u>
AZ AA:5:68	Hohokam	Sif Oidak	Sherd and Lithic Scatter
69	Hohokam	Sif Oidak	Sherd and Lithic Scatter
70	Hohokam	Sif Oidak	Sherd and Lithic Scatter, Hearth
71	Hohokam	Sif Oidak	Sherd and Lithic Scatter
72	Hohokam	Sif Oidak	Sherd and Lithic Scatter
73	Hohokam	Sif Oidak	Sherd and Lithic Scatter
74	Hohokam	Sif Oidak	Sherd and Lithic Scatter
75	Hohokam	Sif Oidak	Sherd and Lithic Scatter
76	Hohokam	Sif Oidak	Sherd and Lithic Scatter
77	Papago	Sif Oidak	Sherd and Lithic Scatter Camp
78	Hohokam	Sif Oidak	Sherd Scatter
79	Hohokam	Sif Oidak	Sherd Scatter
80	Hohokam - Papago	Sif Oidak	Sherd Scatter, Stone Ring
81	Hohokam - Papago	Sif Oidak	Sherd Scatter, Camp
82	Papago	Sif Oidak	Cactus Camps
83	Papago	Sif Oidak	Cactus Camp
84	Anglo?	Sif Oidak	Cactus Camp
85	Archaic?/Hohokam	Sif Oidak	Quarry
86	Archaic?/Hohokam	Sif Oidak	Stone Ring
87	Hohokam	Sif Oidak	Sherd and Lithic Scatter
88	Hohokam	Sif Oidak	Sherd and Lithic Scatter
89	Hohokam	Sif Oidak	Sherd and Lithic Scatter
90	Hohokam	Sif Oidak	Sherd and Lithic Scatter
91	Hohokam	Sif Oidak	Sherd and Lithic Scatter, Stone Ring
92	Hohokam	Sif Oidak	Sherd Scatter, Stone Rings
93	Hohokam	Sif Oidak	Sherd Scatter, Stone Rings
94	Papago	Sif Oidak	Cactus Camp
95	Hohokam?	Sif Oidak	Lithic Scatter, Stone Rings
96	Papago	Sif Oidak	House
97	Papago	Sif Oidak	Ramada
98	Papago	Sif Oidak	Ramada
99	Papago	Sif Oidak	Camp
100	Hohokam - Papago	Sif Oidak	Sherd Scatter, Hearths
101	Papago	Sif Oidak	Camp

<u>SITE NUMBER</u>	<u>CULTURE</u>	<u>JURISDICTION</u>	<u>SITE TYPE</u>
Z AA:5:102	Hohokam	Sif Oidak	Sherd and Lithic Scatter
103	Larly Papago	Sif Oidak	Sherd Scatter
104	Hohokam	Sif Oidak	Rock Shelter, Sherd and Lithic Scatter
105	Hohokam	Sif Oidak	Sherd and Lithic Scatter
106	Hohokam	Sif Oidak	Sherd and Lithic Scatter
107	Hohokam	Sif Oidak	Sherd and Lithic Scatter
108	Hohokam	Sif Oidak	Sherd and Lithic Scatter
109	Hohokam	Sif Oidak	Sherd and Lithic Scatter
AZ AA:9:1	Papago	Schuk Toak	Village
AZ AA:13:1	Anglo	Schuk Toak	Mine, Trading Post
2	Hohokam?	Schuk Toak	Sherd Scatter
3	Hohokam?	Schuk Toak	Sherd Scatter
4	Hohokam	Sells	Trincheras
5	Papago	Sells	Mission
6	Papago	Schuk Toak	Village
7	Anglo? Papago?	Schuk Toak	Trash Dump
8	Anglo? Papago?	Schuk Toak	Trash Dump
9	Papago	Schuk Toak	Village
10	Papago?	Sells	Stone Circle
11	Papago	Sells	Sherd and Lithic Scatter
12	Papago	Sells	Sherd Scatter
13	Papago	Sells	Sherd Scatter
14	Anglo	Sells	Mine
15	Hohokam?	Sells	Sherd Scatter
16	Papago	Sells	Village
18	Hohokam	Sells	Village
19	Papago	Sells	Village
20	Hohokam? Papago?	Sells	Sherd Scatter
21	Papago	Sells	Camp
AZ AA:14:1	Hohokam	Schuk Toak	Village
2	Hohokam	Schuk Toak	Village
3	Hohokam?	Schuk Toak	Sherd Scatter

<u>SITE NUMBER</u>	<u>CULTURE</u>	<u>JURISDICTION</u>	<u>SITE TYPE</u>
AZ AA:14:4	Hohokam	Schuk Toak	Village
5	Hohokam	Schuk Toak	Trincheras
6	Anglo	Schuk Toak	Mine Shaft
7	Papago	Schuk Toak	Graves
8	Hohokam	Schuk Toak	Village
9	Hohokam	Schuk Toak	Sherd Scatter
10	Hohokam	Schuk Toak	Sherd Scatter
11	Hohokam	Schuk Toak	Sherd Scatter
13	Hohokam	Schuk Toak	Sherd and Lithic Scatter
14	Hohokam	Schuk Toak	Sherd and Lithic Scatter
15	Hohokam	Schuk Toak	Village
16	Hohokam	Schuk Toak	Village
17	Hohokam?	Schuk Toak	Sherd and Lithic Scatter
SON B:4:1	Archaic - Anglo	O P C N M	Water Hole
2	Archaic?	O P C N M	Camp
3	Archaic - Papago	O P C N M	Camp
4	Archaic - Papago	O P C N M	Camp
5	Papago?	O P C N M	Shrines
6	Papago	O P C N M	Cemetery
8-15	Cards not completed.	O P C N M	Sherd and Lithic Scatter
16	Archaic?/Hohokam?	O P C N M	
SON C:1:1	Archaic	O P C N M	Camp, Lithic Workshop
2	Hohokam. - Papago - Spanish	O P C N M	Village, Mission
3	Archaic	O P C N M	Camp
4	Hohokam	O P C N M	Village
5	Hohokam	O P C N M	Cave
6	Archaic?/Hohokam?	O P C N M	Rock Shelter
7	Archaic?/Hohokam?	O P C N M	Rock Shelter
8	Hohokam?	O P C N M	Trail Break
9	Archaic	O P C N M	Camp
10	Archaic?/Hohokam?	O P C N M	Camp
11	Hohokam	O P C N M	Rock Shelter
12	Hohokam	O P C N M	Shell Mound
13	Hohokam?/Papago?	O P C N M	Sherd and Lithic Scatter

<u>SITE NUMBER</u>	<u>CULTURE</u>	<u>JURISDICTION</u>	<u>SITE TYPE</u>
SON C:1:14	Anglo	O P C N M	Mine
15	Spanish-Mexican-Anglo	O P C N M	Trail
16	Anglo	O P C N M	Mine
17	Anglo	O P C N M	Camp, Well
SON C:2:1	Hohokam?	Gu Vo	Shrine Cave
2	Hohokam	Gu Vo	Trincheras
3	Hohokam	O P C N M	Camp
4	Hohokam	O P C N M	Rock Shelter
5	Papago	O P C N M	Camp
6	Hohokam?	O P C N M	Camp
7	Hohokam?/Papago?	O P C N M	Camp
8	Hohokam	O P C N M	Rock Shelter
9	Hohokam?	O P C N M	Rock Shelter
10	Hohokam?	O P C N M	Camp
11	Archaic?/Hohokam?	OPCNM&PIR-Gu Vo	Lithic Scatter
12	Archaic?/Hohokam?	OPCNM&PIR-Gu Vo	Lithic Scatter
12-26	Cards Missing	OPCNM&PIR-Gu Vo	
27	Hohokam?	Gu Vo	Camp
28	Hohokam?	Gu Vo	Camp, Lithic Workshop
29	Hohokam?	Gu Vo	Sherd and Lithic Scatter
30	Hohokam?	Gu Vo	Sherd and Lithic Scatter
31	Archaic	Gu Vo	Lithic Workshop
32	Hohokam?	Gu Vo	Camp
33	Hohokam?	Gu Vo	Sherd Scatter
34	Hohokam?	Gu Vo	Camp, Agricultural
35	Hohokam?	Gu Vo	Sherd and Lithic Scatter
36	Hohokam?	Gu Vo	Roasting Pit
37	Archaic?	Gu Vo	Camp
38	Hohokam?	Gu Vo	Village
39	Hohokam?	Gu Vo	Camp
40	Hohokam?	Gu Vo	Sherd and Lithic Scatter
41	Hohokam?	Gu Vo	Sherd and Lithic Scatter
43	Papago	Gu Vo	Trash Dump
44	Anglo	Gu Vo	Dam

<u>SITE NUMBER</u>	<u>CULTURE</u>	<u>JURISDICTION</u>	<u>SITE TYPE</u>
SON C:3:1	Archaic - Hohokam	Chukut Kut	Sherd and Lithic Scatter
2	Hohokam	Chukut Kut	Village
3	Archaic - Hohokam	Chukut Kut	Camp
4	Hohokam	Chukut Kut	Sherd Scatter
5	Hohokam	Chukut Kut	Camp
6	Hohokam?	Chukut Kut	Sherd and Lithic Scatter
7	Archaic?/Hohokam?/Papago?	Chukut Kut	Sherd and Lithic Scatter
SON C:4:1	Hohokam	Sells	Sherd Scatter
2	Hohokam	Sells	Sherd Scatter
3	Papago	Sells	Cactus Camp
4	Hohokam	Sells	Sherd Scatter
5	Hohokam	Sells	Sherd Scatter
6	Hohokam	Sells	Village
7	Hohokam?	Sells	Cave
8	Hohokam	Chukut Kuk	Mound
9	Hohokam	Sells	Sherd Scatter
10	Hohokam	Sells	Village
11	Papago	Sells	Sherd and Lithic Scatter
SON C:8:1	Hohokam	Chukut Kuk	Sherd Scatter
2	Hohokam	Chukut Kuk	Mound
3	Papago	Chukut Kuk	Sherd Scatter
4	Papago	Chukut Kuk	Sherd Scatter
5	Hohokam	Chukut Kuk	Sherd Scatter
AZ DD:1:1	Hohokam	Sells	Trincheras
2	Hohokam	Sells	Village
3	Hohokam	Sells	Trincheras
4	Papago	Sells	Shrine
5	Hohokam	Sells	Trincheras
6	Hohokam	Baboquivari	Village
7	Hohokam	Baboquivari	Village
8	Hohokam	Baboquivari	Village
9	Papago	Baboquivari	House
10	Papago	Baboquivari	Sherd Scatter

<u>SITE NUMBER</u>	<u>CULTURE</u>	<u>JURISDICTION</u>	<u>SITE TYPE</u>
AZ PD:1:11	Hohokam	Baboquivari	Village
12	Hohokam	Baboquivari	Mounds
13	Hohokam	Baboquivari	Mound
14	Hohokam	Baboquivari	Sherd Scatter, Mounds
15	Hohokam	Baboquivari	Sherd Scatter
16	Hohokam	Baboquivari	Sherd Scatter, Mounds
17	Hohokam	Baboquivari	Sherd Scatter
18	Hohokam	Baboquivari	Sherd Scatter
19	Hohokam	Baboquivari	Sherd Scatter
20	Hohokam	Baboquivari	Sherd Scatter, Mounds, Agricultural
21	Papago	Sells	Sherd and Lithic Scatter
22	Hohokam	Sells	Sherd Scatter
23	Hohokam	Sells	Sherd Scatter, Mound
24	Hohokam	Baboquivari	Sherd Scatter, Mounds
25	Hohokam	Sells	Sherd Scatter
26	Hohokam	Sells	Sherd Scatter
27	Hohokam	Sells	Sherd Scatter
28	Hohokam	Sells	Camp
29	Hohokam	Sells	Trincheras
30	Anglo	Sells	Village
31	Papago	Sells	Trading Post
32	Archaic?/Hohokam?	Sells	Sells Agency
33	Hohokam	Sells	Lithic Scatter
34	Hohokam	Sells	Village
35	Hohokam	Sells	Village
36	Hohokam?	Sells	Sherd and Lithic Scatter
37	Hohokam?	Sells	Sherd Scatter
38	Hohokam?	Sells	Sherd Scatter
39	Hohokam?	Sells	Quarry, Sherd Scatter
40	Hohokam?	Sells	Quarry, Sherd Scatter
41	Hohokam?	Sells	Sherd and Lithic Scatter
42	Hohokam?	Sells	Lithic Workshop
43	Hohokam	Sells	Camp
44	Hohokam?	Sells	Camp
45	Hohokam?	Sells	Sherd Scatter
			Camp

<u>SITE NUMBER</u>	<u>CULTURE</u>	<u>JURISDICTION</u>	<u>SITE TYPE</u>
AZ DD:1:46	Hohokam?	Sells	Sherd and Lithic Scatter
47	Hohokam?	Sells	Camp
48	Hohokam?	Sells	Camp
49	Hohokam?	Sells	Camp
50	Hohokam?	Sells	Camp
51	Hohokam?	Sells	Sherd Scatter
52	Papago	Baboquivari	Village
53	Hohokam - Papago	Baboquivari	Sherd Scatter
54	Hohokam	Sells	Resource Exploitation
55	Hohokam/Papago?	Sells	Camp
56	Hohokam?/Papago?	Sells	Quarry
57	Hohokam	Sells	Resource Exploitation
58	Hohokam - Papago	Sells	Sherd and Lithic Scatter
AZ DD:2:2	Hohokam?	Baboquivari	Mounds
3	Hohokam?	Baboquivari	Mounds
9	Hohokam - Papago - Anglo	Baboquivari	Camp
11	Papago	Baboquivari	House
12	Hohokam?	Baboquivari	Sherd Scatter
13	Hohokam?	Baboquivari	Sherd Scatter
14	Early Man?	Baboquivari	Lithic Scatter
15	Papago	Baboquivari	Village
19	Papago	Schuk Toak	Cache
21	Papago	Baboquivari	Sacred Mountain
24	Hohokam	Baboquivari	Village
25	Hohokam?	Baboquivari	Camp
39	Hohokam - Papago	Schuk Toak	Petroglyphs
40	Hohokam	Baboquivari	Sherd Scatter
41	Hohokam - Papago	Baboquivari	Petroglyphs
AZ DD:5:1	Hohokam?	Baboquivari	Compound
2	Hohokam	Baboquivari	Sherd Scatter
3	Papago	Chukut Kuk	House
4	Hohokam?	Baboquivari	Agricultural
5	Papago?	Baboquivari	Mound
6	Papago	Baboquivari	Sherd Scatter

<u>SITE NUMBER</u>	<u>CULTURE</u>	<u>JURISDICTION</u>	<u>SITE TYPE</u>
AZ DD:5:7	Hohokam?/Papago?	Baboquivari	Sherd Scatter
8	Hohokam	Baboquivari	Mound
9	Hohokam	Chukut Kuk	Sherd Scatter
10	Hohokam?	Chukut Kuk	Sherd Scatter
12	Hohokam?	Baboquivari	Sherd and Lithic Scatter
13	Hohokam?	Baboquivari	Sherd and Lithic Scatter
14	Hohokam?	Baboquivari	Sherd and Lithic Scatter
15	Hohokam/Papago?	Baboquivari	Sherd and Lithic Scatter
AZ DD:6:1	Hohokam?	Chukut Kuk	Trincheras
12	Mexican	Baboquivari	Ranch
15	Papago	Chukut Kuk	Village
16	Hohokam?	Chukut Kuk	Sherd and Lithic Scatter
17	Hohokam?	Chukut Kuk	Sherd and Lithic Scatter
18	Hohokam?	Chukut Kuk	Compound

THE ARCHAIC STAGE

The Archaic stage, dating from about 7,000 B.C. to about the beginning of the Christian Era, was a period of intensified hunting and gathering of modern species of plants and animals. Based on work done farther east in Arizona, the basic southern Arizona Archaic culture, the Cochise, shows a gradual increase in complexity and local specialization through time. In the project area, influences from California are believed to continue.

Sites of this period, like those of the Early Man period, would be scatters of stone tools and waste. Grinding stones with round grinding surfaces would be more common. Movement of peoples from one seasonal food source to the next should leave many small sites, some of which should have tools specialized for using specific resources.

THE FORMATIVE STAGE

The Formative stage, characterized in south-central Arizona generally by horticulture, permanent villages, canal irrigation, cremation, and the use of pottery, began at about the beginning of the Christian Era and ended in the seventeenth century. The major Formative group, called the Hohokam, is now believed to have moved into the area from Mexico. Indigenous Archaic groups seem to have adopted aspects of Hohokam culture, not necessarily all at the same time, leaving an intricate series of local "Hohokam" patterns that archeologists are far from understanding in detail. By A.D. 1400 or 1450, the Hohokam as an identifiable group had vanished. It seems unlikely that the area was abandoned, but no sites that are immediately post-Hohokam are known.

Many archeological sites in the project area have been identified as Hohokam, but specific details, such as the degree of local Archaic participation, are not known.

Sites of this period ordinarily will consist of scatters of pieces of broken pottery (sherds), shell fragments, occasional bits of calcined human bone, grinding stones with rectangular grinding surfaces, fragments of tools made by grinding, and chipped stone tools generally smaller than in previous periods. Painted pottery should be common except on very early or perhaps very late sites. Villages or smaller habitations should have low mounds; camps should not. It is possible that some late sites would resemble Archaic sites.

THE HISTORIC PERIOD

The Spanish Colonial Period

In a technical sense, southern Arizona entered history with the passage of the expedition of Esteban Dorantes and Fray Marcos de Niza to the Zuni villages in A.D. 1539, but neither this nor any of the other New Mexico expeditions or settlement had any direct effect on the project area. With the exception of the establishment of the mission at Sonoita, northwest of the project area, in 1732, Spanish ranching, mining, and

mission efforts were south or east of the Sells Reservation. This mission was destroyed in 1752 in a local rebellion. Population of the Sells area may have been increased by Pimas moving west around 1800 to escape the increasing Apache raids.

The major physical impact of the Spanish Colonial period would be a population increase around 1800. Sites should generally resemble Formative sites except that most of the potsherds should be plain brown and there may be minor amounts of European items. Some sites may resemble Archaic lithic scatters.

The Mexican Period

The Mexican period, lasting from 1821 to 1853, had little physical impact on the project area. To the south, Hispanic ranches and farms moved closer, but Apache raids continued to inhibit Hispanic-American settlement of this part of Arizona.

Sites of this period should generally resemble those of the preceding period, except that European goods may be more common.

The Anglo-American Period

The Anglo-American period, which began in 1853, brought many changes to the Papago, but there was less immediate change in the project area than there was elsewhere. Spicer (1962) provides a detailed summary of this complex period.

Physically, the early part of the period is marked by the abandonment of larger villages as the frequency of Apache attacks diminished, a result of joint Papago-U.S. Army operations. Mines, both large and small, were opened and abandoned. In 1884, Quijotoa was a mining town with a population of 10,000.

Reservations were established at San Xavier in 1874 and at Gila Bend in 1884, but the project area remained open land used mainly by the Papago, but open to settlement by others. Conflict between the Papago and ranchers over water existed from the mid-1880s to the late 1890s. Spicer (1962:138) states that this caused the beginning of Papago hostility and antagonism toward whites.

Because the Papagos were not hostile to the Anglo-Americans in the early days of this period, and in fact were active and effective allies in the campaigns against the Apache, the government paid little attention to Papago in the project area, and no major reservation was established until 1918. Because this had been open land for so long, mineral rights were not included with the reservation.

REFERENCES

- McGregor, J. C.
1965 Southwestern archaeology. University of Illinois Press,
Urbana.
- Spicer, Edward H.
1962 Cycles of conquest. The University of Arizona Press, Tucson.
- Wiley, Gordon R.
1966 An introduction to American archaeology, Vol. One: North and
Middle American. Prentice-Hall, Englewood Cliffs, N.J.
- Wormington, H. M.
1957 Ancient Man in North America (fourth ed.). The Denver Museum of
Natural History Popular Series, No. 4, Denver.

APPENDIX K

Listing of Domestic and Wild Animals
Known to Live Beneath Sells Airspace

ANIMALS KNOWN TO LIVE BELOW SELLS AIRSPACE

The lists below and in Tables K-1, K-2, and K-3 combine the list from the Draft Environmental Impact Statement (DEIS) and checklists provided by Organ Pipe Cactus National Monument (OPCNM) (NPS 1978a; 1978b).

DOMESTIC ANIMALS

<u>Common Name</u>	<u>Genus/Species</u>
Cattle	<u>Bos</u> sp.
Horse	<u>Equus</u> <u>caballus</u>
Goat	<u>Capra</u> sp.
Dog	<u>Canis</u> <u>familiaris</u>
Swine	<u>Sus</u>
Sheep	<u>Ovis</u> sp.
Cat	<u>Felis</u> <u>catus</u>

WILD ANIMALS

BIRDS

Birds at the OPCNM (Table K-1) are classified as Abundant (A, usually abundant in the proper habitat), Common (C, one or two can usually be found, Uncommon (U, usually seen several times a year), Rare (R, one or two every several years), and Accidental (X, far from normal range-reported only once

or twice). Status of species is classified as Resident (r), Summer (s), Winter (w), or Migrant (m).

The OPCNM checklist (NPS 1978a) is accepted as the authority for common names of birds where there is variation in names or spellings.

TABLE K-1

Birds Recorded at
Organ Pipe Cactus National Monument

Common Name	Abundance/ Status	Genus/Species
<u>Grebes</u>		
Least Grebe	R	<u>Podiceps dominicus</u>
Eared Grebe	Rm, Rw	<u>Podiceps caspicus</u>
Pied-billed Grebe	Uw	<u>Podilymbus podiceps</u>
Western Grebe	X	<u>Aechmophorus occidentalis</u>
<u>Pelicans and Cormorants</u>		
Brown Pelican	R	<u>Pelecanus occidentalis</u>
White Pelican	X	<u>Pelecanus erythrorhynchos</u>
Double-crested Cormorant	Rm	<u>Phalacrocorax auritus</u>
<u>Herons, Ibis, Egrets, and Spoonbills</u>		
Great Blue Heron	U	<u>Ardea herodias</u>
Green Heron	Um, Rw	<u>Butorides virescens</u>
Great Egret	Um	<u>Casmerodius albus</u>
Snowy Egret	Um	<u>Leucophoyx thula</u>
Black-Crowned Night Heron	R	<u>Nycticorax nycticorax</u>
Wood Ibis	Rs	<u>Mycteria americana</u>
White-faced Ibis	Rm	<u>Plegadis chihi</u>
Roseate Spoonbill	R	<u>Ajaia ajaja</u>
<u>Swans, Geese, and Ducks</u>		
Canada Goose	Rm	<u>Branta canadensis</u>
Mallard	Rm, Rw	<u>Anas platyrhynchos</u>
Gadwall	Rm, Rw	<u>Anas strepera</u>
American Widgeon	Uw	<u>Mareca americana</u>
American Pintail	Rw	<u>Anas acuta</u>
Green-winged Teal	Um, Cw	<u>Anas carolinensis</u>
Blue-winged Teal	Um	<u>Anas discors</u>
Cinnamon Teal	Um	<u>Anas cyanoptera</u>
Shoveler	Um	<u>Spatula clypeata</u>
Wood Duck	X	<u>Aix sponsa</u>
Redhead	Um, Uw	<u>Aythya americana</u>
Ring-necked Duck	Um, Uw	<u>Aythya collaris</u>
Canvasback	X	<u>Aythya valisineria</u>
Lesser Scaup	Rm, Uw	<u>Aythya affinis</u>
Common Goldeneye	Rw	<u>Bucephala clangula</u>
Bufflehead	Um	<u>Bucephala albeola</u>
Hooded Merganser	Uw	<u>Lophodytes cucullatus</u>
Common Merganser	Rw	<u>Mergus merganser</u>
Ruddy Duck	Uw, Rm	<u>Oxyura jamaicensis</u>

TABLE K-1 -- (Continued)

Common Name	Abundance/ Status	Genus/Species
<u>Vultures, Hawks, and Eagles</u>		
Turkey Vulture	As, Uw	<u>Cathartes aura</u>
Black Vulture	Cr	<u>Coragyps atratus</u>
Sharp-shinned Hawk	Um, Uw	<u>Accipiter striatus</u>
Cooper's Hawk	Um, Uw	<u>Accipiter cooperii</u>
Red-tailed Hawk	Cr	<u>Buteo jamaicensis</u>
Swainson's Hawk	Rm	<u>Buteo swainsoni</u>
Zone-tailed Hawk	X	<u>Buteo albonotatus</u>
Ferruginous Hawk	X	<u>Buteo regalis</u>
Harris Hawk	Ur	<u>Parabuteo unicinctus</u>
Black Hawk	X	<u>Buteogallus anthracinus</u>
Golden Eagle	Ur	<u>Aquila chrysaetos</u>
Marsh Hawk	Rm, Rw	<u>Circus cyaneus</u>
Osprey	Rm	<u>Pandion haliaetus</u>
Caracara	R	<u>Caracara cheriway</u>
Prairie Falcon	Ur	<u>Falco mexicanus</u>
Peregrine Falcon	Rw	<u>Falco peregrinus</u>
Merlin	Rm, Rw	<u>Falco columbarius</u>
American Kestrel	Cr	<u>Falco sparverius</u>
<u>Quail</u>		
Gambel's Quail	Ar	<u>Lophortyx gambelii</u>
<u>Rails and Coots</u>		
Virginia Rail	Rm, Rw	<u>Rallus limicola</u>
Sora	Um, Uw	<u>Porzana carolina</u>
American Coot	Cr	<u>Fulica americana</u>
Common Gallinule	Rw	<u>Gallinula chloropus</u>
<u>Shorebirds and Phalaropes</u>		
Killdeer	Uw, Um	<u>Charadrius vociferus</u>
Common Snipe	Um, Rw	<u>Capella gallinago</u>
Semipalmated Plover	X	<u>Charadrius semipalmatus</u>
Spotted Sandpiper	Um, Rw	<u>Actitis macularia</u>
Solitary Sandpiper	Rm	<u>Tringa solitaria</u>
Willet	Rm	<u>Catoptrophorus semipalmatus</u>
Greater Yellowlegs	Rw	<u>Totanus melanoleucus</u>
Lesser Yellowlegs	X	<u>Totanus flavipes</u>
Baird's Sandpiper	Rm	<u>Erolia bairdii</u>
Least Sandpiper	Rm	<u>Erolia minutilla</u>
Long-billed Dowitcher	X	<u>Limnodromus scolopaceus</u>
Stilt Sandpiper	X	<u>Micropalama himantopus</u>
Western Sandpiper	Rm	<u>Ereunetes mauri</u>
American Avocet	Rm	<u>Recurvirostra americana</u>
Black-necked Stilt	Um	<u>Himantopus mexicanus</u>
Wilson's Phalarope	Rm	<u>Steganopus tricolor</u>
Northern Phalarope	X	<u>Lobipes lobatus</u>
Red Phalarope	X	<u>Phalaropus fulicarius</u>

TABLE K-1 -- (Continued)

Common Name	Abundance/ Status	Genus/Species
<u>Gulls and Terns</u>		
Herring Gull	X	<u>Larus argentatus</u>
California Gull	X	<u>Larus californicus</u>
Ring-billed Gull	X	<u>Larus delawarensis</u>
Bonaparte's Gull	X	<u>Larus philadelphia</u>
Heermann's Gull	X	<u>Larus heermanni</u>
Common Tern	X	<u>Sterna hirundo</u>
Least Tern	X	<u>Sterna albifrons</u>
Black Tern	X	<u>Chlidonias niger</u>
<u>Pigeons and Doves</u>		
Band-tailed Pigeon	Rm	<u>Columba fasciata</u>
White-winged Dove	As, Rw	<u>Zenaida asiatica</u>
Mourning Dove	Ar	<u>Zenaidura macroura</u>
Ground Dove	Us	<u>Columbigallina passerina</u>
Inca Dove	R	<u>Scardafella inca</u>
<u>Roadrunner</u>		
Roadrunner	Cr	<u>Geococcyx californianus</u>
<u>Owls</u>		
Screech Owl	Ur	<u>Otus asio</u>
Great Horned Owl	Cr	<u>Bubo virginianus</u>
Ferruginous Owl	Ur	<u>Glaucidium brasilianum</u>
Elf Owl	As	<u>Micrathene whitneyi</u>
Burrowing Owl	R	<u>Speotyto cunicularia</u>
Long-eared Owl	Rw	<u>Asio otus</u>
<u>Poor Will and Nighthawks</u>		
Poor Will	As	<u>Phalaenoptilus nuttallii</u>
Lesser Nighthawk	As	<u>Chordeiles acutipennis</u>
<u>Swifts</u>		
Vaux's Swift	Um	<u>Chaetura vauxi</u>
White-throated Swift	As, Uw	<u>Aeronautes saxatalis</u>
<u>Hummingbirds</u>		
Black-chinned Hummingbird	Cm	<u>Archilochus alexandri</u>
Costa's Hummingbird	Cm, Us	<u>Calypte costae</u>
Anna's Hummingbird	Um	<u>Calypte anna</u>
Broad-tailed Hummingbird	Rm	<u>Selasphorus platycercus</u>
Rufous Hummingbird	Rm	<u>Selasphorus rufus</u>
Allen's Hummingbird	Rm	<u>Selasphorus sasin</u>
Broad-billed Hummingbird	X	<u>Cynanthus latirostris</u>

TABLE K-1 -- (Continued)

Common Name	Abundance/ Status	Genus/Species
Calliope Hummingbird	X	<u>Stellula calliope</u>
Blue-throated Hummingbird	X	<u>Lampornis clemenciae</u>
<u>Kingfishers</u>		
Belted Kingfisher	Um	<u>Megaceryle alcyon</u>
<u>Woodpeckers</u>		
Common Flicker	Ar	<u>Colaptes auratus</u>
Gila Woodpecker	Ar	<u>Centurus uropygialis</u>
Acorn Woodpecker	X	<u>Melanerpes formicivorus</u>
Yellow-bellied Sapsucker	Um	<u>Sphyrapicus varius</u>
Ladder-backed Woodpecker	Cr	<u>Dendrocopos scalaris</u>
Lewis Woodpecker	X	<u>Asyndesmus lewis</u>
<u>Flycatchers</u>		
Tropical Kingbird	Rs	<u>Tyrannus melancholicus</u>
Cassin's Kingbird	Rm	<u>Tyrannus vociferans</u>
Western Kingbird	Cs	<u>Tyrannus verticalis</u>
Wied's Crested Flycatcher	Us	<u>Myiarchus tyrannulus</u>
Ash-throated Flycatcher	As, Cw	<u>Myiarchus cinerascens</u>
Beardless Flycatcher	X	<u>Camptostoma imberbe</u>
Eastern Phoebe	X	<u>Sayornis phoebe</u>
Black Phoebe	Uw	<u>Sayornis nigricans</u>
Say's Phoebe	Cw	<u>Sayornis saya</u>
Hammond's Flycatcher	Um, Rw	<u>Empidonax hammondii</u>
Gray Flycatcher	Rm, Rw	<u>Empidonax wrightii</u>
Western Flycatcher	Um	<u>Empidonax difficilis</u>
Traill's Flycatcher	Rm	<u>Empidonax traillii</u>
Western Wood Pewee	Um	<u>Contopus sordidulus</u>
Olive-sided Flycatcher	Rm	<u>Nuttallornis borealis</u>
Vermilion Flycatcher	Uw, Rs	<u>Pyrocephalus rubinus</u>
<u>Larks</u>		
Horned Lark	Rm, Rs	<u>Eremophila alpestris</u>
<u>Swallows and Martins</u>		
Violet-green Swallow	Um	<u>Tachycineta thalassina</u>
Tree Swallow	Um	<u>Iridoprocne bicolor</u>
Bank Swallow	Rm	<u>Riparia riparia</u>
Rough-winged Swallow	Um	<u>Stelgidopteryx ruficollis</u>
Barn Swallow	Um	<u>Hirundo rustica</u>
Cliff Swallow	Rm	<u>Petrochelidon pyrrhonota</u>
Purple Martin	Cs	<u>Progne subis</u>

TABLE K-1 -- (Continued)

Common Name	Abundance/ Status	Genus/Species
<u>Jays and Ravens</u>		
Steller's Jay	Rw	<u>Cyanocitta stelleri</u>
Scrub Jay	X	<u>Aphelocoma coerulescens</u>
Common Raven	Ar	<u>Corvus corax</u>
Clark's Nutcracker	X	<u>Nucifraga columbiana</u>
<u>Verdin</u>		
Verdin	Ar	<u>Auriparus flaviceps</u>
<u>Nuthatches</u>		
Red-breasted Nuthatch	X	<u>Sitta canadensis</u>
Brown Creeper	X	<u>Certhia familiaris</u>
<u>Wrens</u>		
House Wren	Uw	<u>Troglodytes aedon</u>
Cactus Wren	Ar	<u>Campylorhynchus brunneicapillus</u>
Long-billed Marsh Wren	Uw	<u>Telmatodytes palustris</u>
Canyon Wren	Cr	<u>Catherpes mexicanus</u>
Rock Wren	Cr	<u>Salpinctes obsoletus</u>
Bewick's Wren	Uw	<u>Thryomanes bewickii</u>
<u>Mockingbirds and Thrashers</u>		
Mockingbird	Cr	<u>Mimus polyglottos</u>
Bendire's Thrasher	Rr	<u>Toxostoma bendirei</u>
Curve-billed Thrasher	Ar	<u>Toxostoma curvirostre</u>
LeConte's Thrasher	Rr	<u>Toxostoma lecontei</u>
Crissal Thrasher	Ur	<u>Toxostoma dorsale</u>
Sage Thrasher	Rm, Rw	<u>Oreoscoptes montanus</u>
Brown Thrasher	X	<u>Toxostoma rufum</u>
<u>Thrushes, Bluebirds, and Solitaires</u>		
Robin	Uw	<u>Turdus migratorius</u>
Hermit Thrush	Cm, Uw	<u>Hylocichla guttata</u>
Swainson's Thrush	Um	<u>Hylocichla ustulata</u>
Western Bluebird	Rw	<u>Sialia mexicana</u>
Mountain Bluebird	Rw	<u>Sialia currucoides</u>
Townsend's Solitaire	Rw	<u>Myadestes townsendi</u>
<u>Gnatcatchers and Kinglets</u>		
Blue-gray Gnatcatcher	Uw	<u>Poliophtila caerulea</u>
Black-tailed Gnatcatcher	Ar	<u>Poliophtila melanura</u>
Ruby-crowned Kinglet	Aw	<u>Regulus calendula</u>
Golden-crowned Kinglet	X	<u>Regulus satrapa</u>
<u>Pipits</u>		
Water Pipit	Rw	<u>Anthus spinoletta</u>
Sprague's Pipit	X	<u>Anthus spragueii</u>

TABLE K-1 -- (Continued)

Common Name	Abundance/ Status	Genus/Species
<u>Waxwings and Silky Flycatchers</u>		
Cedar Waxwing	Um	<u>Bombycilla cedrorum</u>
Phainopepla	Ar	<u>Phainopepla nitens</u>
<u>Shrikes</u>		
Loggerhead Shrike	Cw, Us	<u>Lanius ludovicianus</u>
<u>Starlings</u>		
Starling	Ar	<u>Sturnus vulgaris</u>
<u>Vireos</u>		
Hutton's Vireo	Rm	<u>Vireo huttoni</u>
Bell's Vireo	As	<u>Vireo bellii</u>
Gray Vireo	Rm	<u>Vireo vicinior</u>
Solitary Vireo	Um, Rw	<u>Vireo solitarius</u>
Red-eyed Vireo	X	<u>Vireo olivaceus</u>
Warbling Vireo	Um	<u>Vireo gilvus</u>
<u>Warblers</u>		
Black and White Warbler	X	<u>Mniotilta varia</u>
Golden-winged Warbler	X	<u>Vermivora chrysoptera</u>
Orange-crowned Warbler	Cm	<u>Vermivora celata</u>
Tennessee Warbler	X	<u>Vermivora peregrina</u>
Nashville Warbler	Um	<u>Vermivora ruficapilla</u>
Virginia's Warbler	Rm	<u>Vermivora virginiae</u>
Lucy's Warbler	As	<u>Vermivora luciae</u>
Yellow Warbler	Um	<u>Dendroica petechia</u>
Magnolia Warbler	X	<u>Dendroica magnolia</u>
Black-throated Blue Warbler	X	<u>Dendroica caerulescens</u>
Yellow-rumped Warbler	Cw, Am	<u>Dendroica coronata</u>
Black-throated Gray Warbler	Um, Rw	<u>Dendroica nigrescens</u>
Black-throated Green Warbler	X	<u>Dendroica virens</u>
Townsend's Warbler	Um	<u>Dendroica townsendi</u>
Hermit Warbler	Rm	<u>Dendroica occidentalis</u>
Black Poll Warbler	X	<u>Dendroica striata</u>
Northern Waterthrush	Rm	<u>Seiurus noveboracensis</u>
MacGillivray's Warbler	Um	<u>Oporornis tolmiei</u>
Yellowthroat	Um, Rw	<u>Geothlypis trichas</u>
Yellow Breasted Chat	Um, Rs	<u>Icteria virens</u>
Wilson's Warbler	Cm, Rw	<u>Wilsonia pusilla</u>
American Redstart	Rm	<u>Setophaga ruticilla</u>
<u>Weaver Finches</u>		
House Sparrow	Ar	<u>Passer domesticus</u>

TABLE K-1 -- (Continued)

Common Name	Abundance/ Status	Genus/Species
<u>Orioles, Blackbirds, and Meadowlarks</u>		
Eastern Meadowlark	Rw	<u>Sturnella magna</u>
Western Meadowlark	Uw	<u>Sturnella neglecta</u>
Yellow-headed Blackbird	Rm	<u>Xanthocephalus xanthocephalus</u>
Red-winged Blackbird	Um, Rw	<u>Agelaius phoeniceus</u>
Hooded Oriole	Cs	<u>Icterus cucullatus</u>
Scott's Oriole	Cm, Cs	<u>Icterus parisorum</u>
Northern Oriole	Rm, Rs	<u>Icterus galbula</u>
Brewer's Blackbird	Uw	<u>Euphagus cyanocephalus</u>
Great-tailed Grackle	Rm	<u>Cassidix mexicanus</u>
Brown-headed Cowbird	Cm, Cs	<u>Molothrus ater</u>
Bronzed Cowbird	Cs	<u>Tangavivus aeneus</u>
<u>Tanagers</u>		
Western Tanager	Um	<u>Piranga ludoviciana</u>
Scarlet Tanager	X	<u>Piranga olivacea</u>
Summer Tanager	X	<u>Piranga rubra</u>
<u>Finches, Sparrows, Grosbeaks, and Juncos</u>		
Cardinal	Cr	<u>Richmondia cardinalis</u>
Pyrrhuloxia	Cw, Us	<u>Pyrrhuloxia sinuata</u>
Rose-breasted Grosbeak	Rm	<u>Pheucticus ludovicianus</u>
Black-headed Grosbeak	Um	<u>Pheucticus melanocephalus</u>
Blue Grosbeak	Rm	<u>Guiraca caerulea</u>
Indigo Bunting	Rm	<u>Passerina cyanea</u>
Lazuli Bunting	Rm	<u>Passerina amoena</u>
Varied Bunting	Rr	<u>Passerina versicolor</u>
Painted Bunting	X	<u>Passerina ciris</u>
Dickcissel	X	<u>Spiza americana</u>
Evening Grosbeak	X	<u>Hesperiphona vespertina</u>
Purple Finch	Rw	<u>Carpodacus purpureus</u>
House Finch	Ar	<u>Carpodacus mexicanus</u>
Pine Siskin	Rm	<u>Spinus pinus</u>
Lesser Goldfinch	Ur	<u>Spinus psaltria</u>
Lawrence's Goldfinch	Rw	<u>Spinus lawrencei</u>
Green-tailed Towhee	Uw	<u>Chlorura chlorura</u>
Rufous-sided Towhee	Uw	<u>Pipilo erythrophthalmus</u>
Brown Towhee	Ar	<u>Pipilo fuscus</u>
Lark Bunting	Uw	<u>Calamospiza melanocorys</u>
Savannah Sparrow	Uw	<u>Passerculus sandwichensis</u>
Grasshopper Sparrow	X	<u>Ammodramus savannarum</u>
Vesper Sparrow	Uw	<u>Pooecetes gramineus</u>
Lark Sparrow	Uw	<u>Chondestes grammacus</u>
Rufous-winged Sparrow	Uw	<u>Aimophila carpalis</u>
Rufous-crowned Sparrow	Cr	<u>Aimophila ruficeps</u>
Cassin's Sparrow	Rw	<u>Aimophila cassinii</u>
Black-throated Sparrow	Cr	<u>Amphispiza bilineata</u>
Sage Sparrow	Uw	<u>Amphispiza belli</u>

TABLE K-1 -- (Continued)

Common Name	Abundance/ Status	Genus/Species
Gray-headed Junco	Cw	<u>Junco caniceps</u>
Dark-eyed Junco	Cw	<u>Junco hyemalis</u>
Chipping Sparrow	Um	<u>Spizella passerina</u>
Clay-colored Sparrow	X	<u>Spizella pallida</u>
Brewer's Sparrow	Aw	<u>Spizella breweri</u>
Black-chinned Sparrow	Uw	<u>Spizella astrogularis</u>
Golden-crowned Sparrow	X	<u>Zonotrichia atricapilla</u>
White-crowned Sparrow	Cw	<u>Zonotrichia leucophrys</u>
White-throated Sparrow	X	<u>Zonotrichia albicollis</u>
Fox Sparrow	Rw	<u>Passerella iliaca</u>
Lincoln's Sparrow	Um, Uw	<u>Melospiza lincolni</u>
Swamp Sparrow	X	<u>Melospiza georgiana</u>
Song Sparrow	Um, Uw	<u>Melospiza melodia</u>

TABLE K-2

Mammals Under the Sells Airspace

Common Name	Genus/Species
<u>Insect Eaters</u>	
Desert Shrew	<u>Notiosorex crawfordi</u>
<u>Bats</u>	
Big Brown Bat	<u>Eptesicus fuscus</u>
Big Free-Tailed Bat ^a	<u>Tadarida molossa</u>
California Myotis	<u>Myotis californicus</u>
Cave Myotis	<u>Myotis velifer</u>
Leafnose Bat	<u>Macrotus californicus</u>
Longnose Bat	<u>Leptonycteris nivalis</u>
Mexican Freetail Bat	<u>Tadarida brasiliensis</u>
Pallid Bat	<u>Antrozous pallidus</u>
Townsend's Big-eared Bat ^a	<u>Corynorhinus townsendii</u>
Western Big-eared Bat	<u>Plecotus townsendi</u>
Western Pipistrel	<u>Pipistrellus hesperus</u>
Yuma Myotis ^a	<u>Myotis yumanensis</u>
<u>Hares and Rabbits</u>	
Antelope Jackrabbit	<u>Lepus alleni</u>
Blacktail Jackrabbit	<u>Lepus californicus</u>
Desert Cottontail	<u>Sylvilagus auduboni</u>
<u>Gnawing Mammals</u>	
Arizona Pocket Mouse	<u>Perognathus amplus</u>
Bailey Pocket Mouse	<u>Perognathus baileyi</u>
Bannertail Kangaroo Rat	<u>Dipodomys spectabilis</u>
Cactus Mouse	<u>Peromyscus eremicus</u>
Canyon Mouse ^a	<u>Peromyscus crinitus</u>
Desert Kangaroo Rat	<u>Dipodomys deserti</u>
Desert Pocket Mouse	<u>Perognathus penicillatus</u>
Desert Woodrat	<u>Neotoma lepida</u>
Merriam Kangaroo Rat	<u>Dipodomys merriami</u>
Merriam Mouse	<u>Peromyscus merriami</u>
Rock Pocket Mouse	<u>Perognathus intermedius</u>
Rock Squirrel	<u>Citellus variegatus</u>
Roundtail Ground Squirrel	<u>Citellus (Spermophilus) tereticaudus</u>
Southern Grasshopper Mouse	<u>Onychomys torridus</u>
Valley Pocket Gopher	<u>Thomomys bottae</u>
Western Harvest Mouse	<u>Reithrodontomys megalotis</u>
Whitethroat Woodrat	<u>Neotoma albigula</u>
Yuma Antelope Squirrel	<u>Ammospermophilus harrisi</u>
<u>Flesh Eaters</u>	
Badger	<u>Taxidea taxus</u>
Bobcat	<u>Lynx rufus</u>

TABLE K-2 -- (Continued)

Common Name	Genus/Species
Coati	<u>Nasua narica</u>
Coyote	<u>Canis latrans</u>
Gray Fox	<u>Urocyon cinereoargenteus</u>
Hognose Skunk	<u>Conepatus leuconotus</u>
Hooded Skunk	<u>Mephitis macroura</u>
Kit Fox	<u>Vulpes macrotis</u>
Mountain Lion	<u>Felis concolor</u>
Peccary ^a	<u>Pecari tajacer</u>
Raccoon	<u>Procyon lotor</u>
Ringtail	<u>Bassariscus astutus</u>
Spotted Skunk	<u>Spilogale putorius</u>
Striped Skunk	<u>Mephitis mephitis</u>
<u>Even-toed Hoofed Mammals</u>	
Desert Bighorn	<u>Ovis canadensis mexicana</u>
Javelina	<u>Pecari angulatus</u>
Mule Deer	<u>Odocoileus hemionus</u>
Pronghorn	<u>Antilocapra americana sononensis</u>
Whitetail Deer	<u>Odocoileus virginianus couesi</u>
<u>Species Expected at OPCNM But Not Recorded</u>	
Big Freetail Bat	<u>Tadarida molossa</u>
Greater Mastiff Bat	<u>Eumops perotis</u>
Hoary Bat	<u>Lasiurus cinereus</u>
Pocketed Freetail Bat	<u>Tadarida femorosacca</u>
Underwood Mastiff Bat	<u>Eumops underwoodi</u>
Yuma Myotis	<u>Myotis yumanensis</u>
Deer Mouse	<u>Peromyscus maniculatus</u>
Porcupine	<u>Erethizon dorsatum</u>
Gray Wolf	<u>Canis lupus</u>
Jaguar	<u>Felis onca</u>

^aAnimals included in the Draft EIS, but not on the Organ Pipe Cactus National Monument checklist.

TABLE K-3

Reptiles and Amphibians Found Under the Sells Airspace

Common Name	Genus/Species
AMPHIBIANS	
<u>Toads</u>	
Colorado River Toad	<u>Bufo alvarius</u>
Couch's Spadefoot Toad	<u>Scaphiopus couchi</u>
Great Plains Toad	<u>Bufo cognatus</u>
Red-spotted Toad	<u>Bufo punctatus</u>
Sonoran Green Toad	<u>Bufo retiformis</u>
REPTILES	
<u>Turtles</u>	
Desert Tortoise	<u>Gopherus agassizi</u>
Sonora Mud Turtle	<u>Kinosternon sonoriense</u>
Yellow Mud Turtle	<u>Kinosternon flavescens</u>
<u>Lizards</u>	
Arizona Chuckwalla	<u>Sauromalus obesus tumidus</u>
Arizona Zebra-tailed Lizard	<u>Callisaurus draconoides</u>
Clark's Spiny Lizard	<u>Sceloporus clarki</u>
Colorado River Tree Lizard	<u>Urosaurus ornatus</u>
Desert Banded Gecko	<u>Coleonyx v. variegatus</u>
Desert Iguana	<u>Dipsosaurus dorsalis</u>
Desert Side-blotched Lizard	<u>Uta stansburiana stejnegeri</u>
Desert Spiny Lizard	<u>Sceloporus m. magister</u>
Long-nosed Leopard Lizard	<u>Crotaphytus w. wislizeni</u>
Red-backed Whiptail	<u>Cnemidophorus burti xanthonotes</u>
Regal Horned Lizard	<u>Phrynosoma solare</u>
Southern Desert Horned Lizard	<u>Phrynosoma platyrhinos calidiarum</u>
Southern Whiptail	<u>Cnemidophorus tigris gracilis</u>
Western Collared Lizard	<u>Crotaphytus collaris</u>
<u>Venomous Lizards</u>	
Reticulate Gila Monster	<u>Heloderma s. suspectum</u>
<u>Snakes</u>	
Ajo Mountain Whipsnake	<u>Masticophis bilineatus lineolatus</u>
Arizona Coral Snake	<u>Micruroides e. euryxanthus</u>
Arizona Glossy Snake	<u>Arizona elegans noctivaga</u>
Banded Sand Snake	<u>Chilomeniscus cinctus</u>
Desert Patch-nosed Snake	<u>Salvadora h. hexalepis</u>
Mexican Black-headed Snake	<u>Tantilla planiceps atriceps</u>
Mexican Rosy Boa	<u>Lichanura t. trivirgata</u>
Mojave Rattlesnake	<u>Crotalus scutulatus</u>

TABLE K-3 -- (CONTINUED)

Common Name	Genus/Species
Northern Black-tailed Rattlesnake	<u>Crotalus m. molossus</u>
Organ Pipe Shovel-nosed Snake	<u>Chionactis palarostris organica</u>
Pima Leaf-nosed Snake	<u>Phyllorhynchus b. browni</u>
Red Racer & Western Black Racer	<u>Masticophis flagellum piceus</u>
Sidewinder	<u>Crotalus cerastes</u>
Sonora Gopher Snake	<u>Pituophis melanoleucus affinis</u>
Sonora Lyre Snake	<u>Trimorphodon l. lambda</u>
Spotted Leaf-nosed Snake	<u>Phyllorhynchus decurtatus</u>
Spotted Night Snake	<u>Hypsiglena torquata ochrorhyncha</u>
Tiger Rattlesnake	<u>Crotalus tigris</u>
Western Black-necked Garter Snake	<u>Thamnophis c. cyrtopsis</u>
Western Blind Snake	<u>Leptotyphlops humilis</u>
Western Checkered Garter Snake	<u>Thamnophis marcianus</u>
Western Diamondback Rattlesnake	<u>Crotalus atrox</u>
Western Ground Snake	<u>Sonora semiannulata</u>
Western Long-nosed Snake	<u>Rhinocheilus l. lecontei</u>
Yuma King Snake	<u>Lampropeltis getulus yumensis</u>
<u>Species Suspected to Occur in Monument But Not Recorded</u>	
Tiger Salamander	<u>Ambystoma tigrinum</u>
Great Plains Narrow-mouthed Toad	<u>Gastrophysa olivacea</u>
Long-tailed Brush Lizard	<u>Urosaurus graciosus</u>
Lesser Earless Lizard	<u>Holbrookia maculata</u>
Colorado Desert Shovel-nosed Snake	<u>Chionactis occipitalis annulata</u>
Southwest Speckled Rattlesnake	<u>Crotalus mitchelli pyrrhus</u>

REFERENCES

- American Ornithologists' Union. 1975. Checklist of North American birds. Baltimore: Port City Press.
- Organ Pipe Cactus National Monument. 1978a. Checklist of birds. Southwest Parks and Monuments Association. Pamphlet.
- . 1978b. Checklist of mammals, amphibians and reptiles. Southwest Parks and Monuments Association. Pamphlet.
- Palmer, E. L. 1957. Palmer's fieldbook of mammals. New York: E. P. Dutton & Co.
- Pennak, R. W. 1964. Collegiate dictionary of zoology. New York: Ronald Press Co.
- Peterson, R. T. 1961. A field guide to western birds. Boston: Houghton Mifflin Co.
- Ransom, J. E., assembler. 1981. Harper & Row's complete field guide to North American wildlife. New York: Harper & Row.

APPENDIX M

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SUPPLEMENTARY

INFORMATION

6 June 1986

Revised Draft EIS

Flight Operations in the Sell Airspace Overlying the
Tohono O'Odham Indian Reservation and Ogan Pipe Cactus
National Monument Southern Arizona

Headquarters Tactical Air Command
Langley AFB VA 23665-5542

HQ TAC/DEVE
Langley AFB VA 23665-5542

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This statement evaluates the impacts of supersonic flight operations in the Sells Military Operations Area (MOA)/Air Traffic Control Assigned Airspace (ATCAA) as part of the review of the existing supersonic waiver to conduct supersonic flight operations below 30,000 feet Mean Sea Level (MSL).

The primary environmental concerns of supersonic flight operations are the effects of sonic booms on human health and annoyance, wildlife, structures, cultural resources and recreational activities. It is projected that an individual underneath the airspace would hear an average of less than one boom per day, and would be very unlikely to hear three or more booms per day. Sonic boom over pressures would range from one to five pounds per square foot (psf), with the average carpet boom being two to three psf. Infrequent focus booms could occur in the area. The local populace perceives significant impacts on life style due to noise. No significant impacts were identified on socioeconomic or health aspects.

Luke AFB AZ
Sonic Booms
Airspace

Aircraft Noise
EIS (Environmental Impact Statement)
Sells Airspace Wildlife

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