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Sonic-Boom Research—Selected Bibliography With Annotation

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Introduction

This document has been prepared, on request, for the USAF Noise and Sonic Boom Impact Technology (NSBIT) Advanced Development Office It is a selected bibliography, with some annotation, of sonic-boom-related research papers significant to the NSBIT Program They are grouped together for convenience into the following sections· general sonic-boom publications, prediction and measurement of steady-flight sonic booms, steady-flight sonic-boom minimization by design and operation, prediction and measurement of accelerating-flight sonic booms, sonic-boom propagation, sonic-boom simulator technology, and effects of sonic booms on people and communities, animals, birds, structures, and terrain For those sections relating to the effects on animals, birds, people, communities, and structures, the scope is enlarged to include some aircraft-noise-related papers as well

Our intent is to include those papers which collectively represent the state of the art in each of the subject areas of concern to the NSBIT Program Certain key documents are listed first and abstracts are included when available Other documents are then listed in chronological order without annotation All documents are believed to be available, on request, from one of the sources listed below. The appropriate acquisition numbers are included when available to facilitate the filling of requests from the following sources

Source	Type of Material	Acquisition Number
American Institute of Aeronautics and Astronautics Technical Information Service 555 West 57th St , 12th Floor New York, NY 10019	AIAA papers and published literature available from AIAA or in journals, conferences, etc , as indicated	A Numbers Example A75-25583
National Technical Information Service (NTIS) 5285 Port Royal Road Springfield, VA 22161	Report literature having no distribution limitation	N Numbers Example N67-37604
NASA Scientific and Technical Information Facility (STIF) P O Box 8757 B W I. Airport, MD 21240	Report literature having some kind of distribution limitation	X Numbers Example X71-83753
Defense Technical Information Center Cameron Station Alexandria, VA 22314	Report literature with or without distribution limitation	AD Numbers Example AD 475 662

For those documents having no acquisition number listed, copies may be obtained from NTIS, provided a complete citation is furnished Some relevant documents have not been listed because it is known that certain material was published in other forms In the latter case, preference is given to the more recent publications Many of the key documents, particularly those listed as general publications, have extensive reference lists and bibliographies which are complementary to those listed herein.

1. General Sonic-Boom Publications

1 **Proceedings of the Sonic Boom Symposium.** J Acoust Soc America, vol 39, no 5, pt 2, May 1966, pp S1–S80

A66-33020

The proceedings contain 11 state-of-the-art papers on generation, propagation, prediction, and measurement of sonic booms The response of people and communities and an assessment of the problem for future vehicles are included

2 Nat Sonic Boom Evaluation Off **Sonic Boom Experiments at Edwards Air Force Base.** NSBEO-1-67 (Contract AF 49(638)-1758), Stanford Res Inst , July 28, 1967

N67-36765

This document contains discussions of the plans for the Edwards Air Force Base Sonic-Boom research and the results of meteorological studies, flyover tests of human subjects, structural response measurements, seismic measurements, and observations of responses of farm animals

3. Seebass, A R , ed **Sonic Boom Research** NASA SP-147, 1967

N68-21413

The proceedings document contains 12 papers on basic sonic-boom theory, wind tunnel and flight measurements, atmospheric effects, effects on people and structures, and sonic-boom reduction by operations and design

4 Schwartz, Ira R , ed **Second Conference on Sonic Boom Research** NASA SP-180, 1968

N68-34907

The proceedings contain 18 state-of-the-art papers on sonic-boom theory, measurements, control of signature shape, lift effects, nonlinear effects, and propagation through caustics

5. Wadsworth, J **Bibliography on Sonic Bangs.** RAE-Libr -Bibliogr -287, British R A E , Jan 1968

X68-19452

Sources consulted were R A E Library subject catalogue, NASA STAR 1962-67, International Aerospace Abstracts 1962–67, Engineering Index 1955-67, British Technology Index 1962–67, Ministry of Aviation R and D Abstracts 1963-67, FAA "Sonic Boom Bibliography," Oct 1966, T D C K (Netherlands) "Sonic Boom—Literature Survey," May 1966 (T D C K 45316), Ministry of Aviation TIL "Noise Bibliography" to 1967, and R A E Library S S T list 1967 The sections are in alphabetical order of author's name Where there is no author cited, entries are at the end of the section in date order

6 **Second Meeting of the Sonic Boom Panel, Report of the U S Delegation** IGIA-17/4 8, 1970

N71-21976

The report contains a condensed summary of the current knowledge, as of 1970, about the effects of sonic booms on human beings, property, animals, and terrain

7. Schwartz, Ira R , ed **Third Conference on Sonic Boom Research.** NASA SP-255, 1971

N71-28363

The proceedings contain 29 papers and the summary of a panel discussion on the theoretical and experimental aspects of sonic-boom generation, propagation, and minimization

8 **Sonic Boom Symposium** J Acoust Soc America, vol 51, no 2, pt 3, Feb 1972, pp 671–798

A72-21901

State-of-the-art papers are presented on sonic-boom prediction, minimization, propagation, focusing in maneuvers, simulation devices, seismic and underwater responses, building responses including damage, animal responses, and human responses

9 Rylander, R , ed **Sonic Boom Exposure Effects. Report From a Workshop on Methods and Criteria, Stockholm 1971** J Sound & Vib , vol 20, no 4, Feb 22, 1972, pp 477–544

A72-23320

Summary papers and discussions from a workshop held near Stockholm, Sweden, on September 9-11, 1971, are presented on several aspects of sonic-boom exposure effects, including generation and propagation, sonic-boom research, effects on structures and terrain, sleep effects, startle responses, annoyance reactions, effects on animals, and sonic-boom generators

10 Warren, C H E **Sonic Bang Investigations Associated With the Concorde's Test Flying.** Paper presented at 13th RAeS, AIAA, and CASI Anglo-American Aeronautical Conference (London, England), June 4–8, 1973

A73-41174

Some of the Concorde's supersonic test flying has been conducted along a so-called West Coast Route of Great Britain, and opportunity was taken to glean information on the effects of the sonic bangs The sonic-bang waveform was measured for each flight at up to 12 measuring stations positioned along the route The results of these measurements were analyzed, providing information on the signal interval, characteristic overpressure, and maximum pressure rise rate Some indication of the subjective effects on humans was obtained from analysis of complaints Qualitative studies were made on some animals, birds, and fish Observations and measurements were made on various buildings, and two specific studies on terrain effects were made

11 Gottlieb, J J **Sonic Boom Research at UTIAS.** Canadian Aeronaut & Space J , vol 20, no 5, May 1974, pp 199–222

A74-46239

The sonic-boom research program recently initiated at UTIAS has already become quite extensive A summary of research work already completed and in progress has been made It includes many projects such as prediction techniques of sonic-boom phenomena (corridor width, effects of aircraft maneuvers on focusing of sonic boom, spiked and rounded sonic booms from atmospheric turbulence effects, and sonic-boom signature in the shadow zone), the development of sonic-boom simulation facilities (portable simulator, loudspeaker-driven booth, and traveling-wave horn), and effects of sonic boom on humans (hearing loss, heart-rate change, and automobile-driver behavior), animals (damage to cochleae of mice), and structures (cracking of plaster panels)

12 Maglieri, Domenic J , Carlson, Harry W , and Hubbard, Harvey H **Status of Knowledge of Sonic Booms.** Noise Control Eng , vol 15, no 2, Sept -Oct 1980, pp 57–64

A81-11822

Authors present definitions of sonic-boom carpets, both primary and secondary, and discuss existing experience with primary sonic booms, including the status of overpressure predictions and boom minimization methodology through airplane design They also give indications of the nature of sonic-boom waveforms and their audibility, along with data on focus booms resulting from aircraft maneuvers and the effects of abnormal atmospheric conditions on these maneuver booms

13. Aircraft Sonic Boom: Studies on Aircraft Flight, Aircraft Design, and Measurement. PB-81 805 665, National Technical Information Service, Apr 1981 (Supersedes NTIS/PS-79/0264)

N81-77103

2. Prediction and Measurement of Steady-Flight Sonic Booms

Key Documents

14 Randall, D G **Methods for Estimating Distributions and Intensities of Sonic Bangs.** R & M No 3113, British A R C , 1959

N-57934X

The methods are applied to several flight maneuvers and the results are discussed in detail The effect on sonic-bang distributions and intensities of refraction (caused by the temperature gradient existing in the actual atmosphere) are also considered

15 Maglieri, Domenic J , Parrott, Tony L , Hilton, David A , and Copeland, William L **Lateral-Spread Sonic-Boom Ground-Pressure Measurements From Airplanes at Altitudes to 75,000 Feet and at Mach Numbers to 2 0** NASA TN D-2021, 1963

N64-10451

Measured data are presented for two different sizes of aircraft and for a range of flight conditions Measurements were made out to about 40 miles perpendicular to the ground track and for different weather conditions

16. Hilton, David A , Huckel, Vera, Steiner, Roy, and Maglieri, Domenic J **Sonic-Boom Exposures During FAA Community-Response Studies Over a 6-Month Period in the Oklahoma City Area.** NASA TN D-2539, 1964

N64-30081

Measurements of sonic-boom ground overpressures have been made for the period February to July 1964 and for several flights each day Data were obtained both inside and outside of buildings at locations on the ground track and at distances from the ground track of about 5 and 10 miles Statistical analyses have been performed for both the overpressure and impulse data

17. Hubbard, Harvey H , Maglieri, Domenic J , Huckel, Vera, and Hilton, David A **Ground Measurements of Sonic-Boom Pressures for the Altitude Range of 10,000 to 75,000 Feet.** NASA TR R-198, 1964 (Supersedes NASA TM X-633)

N64-24824

The U S Air Force, National Aeronautics and Space Administration, and Federal Aviation Administration have engaged in a joint research program for the purpose of measuring sonic-boom pressure signatures These measurements are presented for several locations for flight-testing of fighter and bomber airplanes in the altitude range from about 10,000 to 75,000 ft and at Mach numbers from about 1 1 to 2 0 Data were obtained for a variety of atmospheric wind and temperature gradients and for various flight paths and acceleration rates

18. Carlson, Harry W , Mack, Robert J , and Morris, Odell A **Sonic-Boom Pressure-Field Estimation Techniques.** J Acoust Soc America, vol 39, no 5, pt 2, May 1966, pp S10–S18

A66-33022

Current theoretical methods of estimating the flow field surrounding airplanes in supersonic flight are based on Whitham's solution for the flow about bodies of revolution and on other theoretical work that makes possible the representation of a complete airplane as an equivalent body of revolution This paper presents a review of the fundamental theory and discusses the use of high-speed digital computers in providing rapid and reliable analysis of sonic-boom characteristics of complex airplane configurations Application of the estimation techniques is illustrated in correlation with wind-tunnel and flight-test measurements

19. Maglieri, Domenic J **Some Effects of Airplane Operations and the Atmosphere on Sonic-Boom Signatures.** J Acoust Soc America, vol 39, no 5, pt 2, May 1966, pp S36–S42

A66-33026

This paper is a report on the state of knowledge of sonic-boom phenomena The pressure buildups in the transonic-speed range and the lateral extent of the pattern in steady flight for quiescent atmospheric conditions are described Also discussed are recent data from flight-test studies relating to atmospheric dynamic effects on the sonic-boom signatures. The acceleration and lateral-spread phenomena appear to be fairly well understood and predictable for current and future aircraft Variations in the sonic-boom signature as a result of the effects of the atmosphere can be expected during routine operations From the data evaluated to date, very similar variations in pressure signatures are noted for both fighter and bomber aircraft

20. Carlson, Harry W , and Maglieri, Domenic J **Review of Sonic-Boom Generation Theory and Prediction Methods.** J Acoust Soc America, vol 51, no 2, pt 3, Feb 1972, pp 675–685

A72-21901

Within the past two decades, the combined contributions of scientists and engineers in this country and abroad have resulted in development of systematic and reliable methods for the prediction of sonic-boom phenomena The prediction techniques reviewed in the present paper permit the calculation of sonic booms produced by rather complex conventional supersonic aircraft designs performing level, nonaccelerated flight in a quiet atmosphere It has been found that the calculated characteristics for a quiet atmosphere are representative of nominal conditions in a statistical sense for a real atmosphere Basic concepts of supersonic flow analysis, for representation of an airplane as a linear distribution of disturbances and for determination of the resultant pressure field complete with shocks, are outlined Numerical techniques for implementation of the theory are discussed briefly, and examples of the correlation of theory with experimental data from wind tunnel and flight tests are presented Special attention is given to presentation of a simplified method for rapid "first-cut" estimation of far-field bow-shock overpressure Finally, some problems encountered in attempts at applying the prediction techniques for the near field at high supersonic Mach numbers are recognized, and the need for further refinement of present techniques or the development of new systems is discussed

21. Carlson, Harry W **Simplified Sonic-Boom Prediction.** NASA TP-1122, 1978

N78-20078

A simplified method for the calculation of sonic-boom characteristics for a wide variety of supersonic airplane configurations and spacecraft operating at altitudes up to 76 km has been developed Sonic-boom overpressures and signature duration may be predicted for the entire affected ground area for vehicles in level flight or in moderate climbing or descending flight paths The outlined procedure relies to a great extent on the use of charts to provide generation and propagation factors for use in relatively simple expressions for signature calculation Computational requirements can be met by hand-held scientific calculators, or even by slide rules A variety of correlations of predicted and measured sonic-boom data for airplanes and spacecraft serve to demonstrate the applicability of the simplified method

Other Documents

22. Dumond, Jesse W M , Cohen, E Richard, Panofsky, W K H , and Deeds, Edward **A Determination of the Wave Forms and Laws of Propagation and Dissipation of Ballistic Shock Waves** J Acoust Soc America, vol 18, no 1, July 1946, pp 97–118

23. Hayes, Wallace D **Linearized Supersonic Flow.** Ph D Thesis, California Inst of Technol , 1947

24. Lilley, G M , Westley, R , Yates, A H , and Busing, J R **On Some Aspects of the Noise Propagation From Supersonic Aircraft.** Rep No 71, College of Aeronautics (Cranfield, England), Feb 1953

N64-81676

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26. Rao, P Sambasiva **Supersonic Bangs—Part 2.** Aeronaut Q , vol VII, pt II, May 1956, pp 135–155

27. Whitham, G B **On the Propagation of Weak Shock Waves.** J Fluid Mech , vol 1, pt 3, Sept 1956, pp 290–318

28. Walkden, F **The Shock Pattern of a Wing-Body Combination, Far From the Flight Path.** Aeronaut Q , vol IX, pt 2, May 1958, pp 164–194

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30. Lina, Lindsay J , and Maglieri, Domenic J **Ground Measurements of Airplane Shock-Wave Noise at Mach Numbers to 2.0 and at Altitudes to 60,000 Feet.** NASA TN D-235, 1960

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31. Smith, Harriet J **Experimental and Calculated Flow Fields Produced by Airplanes Flying at Supersonic Speeds.** NASA TN D-621, 1960

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32. Carlson, Harry W **An Investigation of the Influence of Lift on Sonic-Boom Intensity by Means of Wind-Tunnel Measurements of the Pressure Fields of Several Wing-Body Combinations at a Mach Number of 2.01.** NASA TN D-881, 1961

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N62-71454

34. Carlson, Harry W **Wind-Tunnel Measurements of the Sonic-Boom Characteristics of a Supersonic Bomber Model and a Correlation With Flight-Test Ground Measurements.** NASA TM X-700, 1962

N68-83530

35. Carlson, Harry W **The Lower Bound of Attainable Sonic-Boom Overpressure and Design Methods of Approaching This Limit.** NASA TN D-1494, 1962

N62-16515

36. Morris, Odell A **A Wind-Tunnel Investigation at a Mach Number of 2.01 of the Sonic-Boom Characteristics of Three Wing-Body Combinations Differing in Wing Longitudinal Location.** NASA TN D-1384, 1962

N62-15168

37 Carlson, Harry W , and Shrout, Barrett L **Wind-Tunnel Investigation of the Sonic-Boom Chracteristics of Three Proposed Supersonic Transport Configurations.** NASA TM X-889, 1963

N70-77674

38. Carlson, Harry W **Influence of Airplane Configuration on Sonic-Boom Characteristics.** J Aircr , vol 1, no 2, Mar -Apr 1964, pp 82-86

A64-16685

39. Hubbard, Harvey H , and Maglieri, Domenic J **Noise and Sonic Boom Considerations in the Operation of Supersonic Aircraft.** ICAS Paper No 64-548, Aug 1964

A65-30925

40. Barger, Raymond L **Some Effects of Flight Path and Atmospheric Variations on the Boom Propagated From a Supersonic Aircraft.** NASA TR R-191, 1964

N64-15406

41 Carlson, Harry W **Correlation of Sonic-Boom Theory With Wind-Tunnel and Flight Measurements.** NASA TR R-213, 1964

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43. Carlson, Harry W , McLean, F Edward, and Middleton, Wilbur D **Prediction of Airplane Sonic-Boom Pressure Fields.** Conference on Aircraft Operating Problems, NASA SP-83, 1965, pp 235-244

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44 McLean, F Edward **Some Nonasymptotic Effects on the Sonic Boom of Large Airplanes.** NASA TN D-2877, 1965

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103. Green, Karen S , and Putnam, Terrill W **Measurements of Sonic Booms Generated by an Airplane Flying at Mach 3 5 and 4.8.** NASA TM X-3126, 1974

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104. Findley, Donald S **Comparison of Measured and Calculated Aircraft Lift Generated Pressures** NASA TM X-72707, 1975

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105. Mendoza, Joel P **Sonic Boom Pressure Signatures of the Space Shuttle Launch Vehicle.** NASA TM X-62441, 1975

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106 Carlson, Harry W , and Mack, Robert J **A Study of the Sonic-Boom Characteristics of a Blunt Body at a Mach Number of 4 14.** NASA TP-1015, 1977

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107. Carlson, Harry W , and Mack, R J **A Wind-Tunnel Study of the Applicability of Far-Field Sonic-Boom Theory to the Space Shuttle Orbiter.** NASA TP-1186, 1978

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108. Ashby, George C , Jr **Near-Field Sonic-Boom Pressure Signatures for the Space Shuttle Launch and Orbiter Vehicles at Mach 6** NASA TP-1405, 1979

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109. Garcia, Frank, Jr , Morrison, Karen M , Jones, Jess H , and Henderson, Herbert R **Preliminary Sonic Boom Correlation of Predicted and Measured Levels for STS-1 Entry.** NASA TM-58242, 1982

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110. Garcia, Frank, Jr , Jones, Jess H , and Henderson, Herbert R **A Comparison of Measured and Theoretical Predictions for STS Ascent and Entry Sonic Booms.** Shuttle Performance Lessons Learned, Part 2, James P Arrington and Jim J Jones, compilers, NASA CP-2283, Pt 2, 1983, pp 1277–1301

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111. Garcia, F , Jr , Jones, J H , and Henderson, H R **Preliminary Sonic Boom Correlation of Predicted and Measured Levels for STS-5 Launch.** NASA TM-58253, 1983

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112. Darden, Christine M **An Analysis of Shock Coalescence Including Three-Dimensional Effects With Application to Sonic Boom Extrapolation.** NASA TP-2214, 1984

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113. Garcia, Frank, Jr , Jones, Jess H , and Henderson, Herbert R **Correlation of Predicted and Measured Sonic Boom Characteristics From the Reentry of STS-1 Orbiter.** NASA TP-2475, 1985

N85-29694

3. Steady-Flight Sonic-Boom Minimization by Design and Operation

Key Documents

114. Schwartz, Ira R , ed **Third Conference on Sonic Boom Research** NASA SP-255, 1971

N71-28363

Section III of this conference contained two experimental papers relating to flights at cutoff Mach number and for definition of lateral cutoff Ten analytical papers relate to minimizing the strength of sonic booms from steady flight operations Such topics as shock coalescence, airstream alteration, low-sonic-boom body shapes and unconventional configurations are included

115. Seebass, R , and George, A R **Sonic-Boom Minimization.** J Acoust Soc America, vol 51, no 2, pt 3, Feb 1972, pp 686–694

A72-21903

There have been many attempts to reduce or eliminate the sonic boom Such attempts fall into two categories (1) aerodynamic minimization and (2) exotic configurations In the first category changes in the entropy and the Bernoulli constant are neglected and equivalent body shapes required to minimize the overpressure, the shock pressure rise, and the impulse are deduced These results include the beneficial effects of atmospheric stratification In the second category, the effective length of the aircraft is increased or its base area decreased by modifying the Bernoulli constant a significant fraction of the flow past the aircraft A figure of merit is introduced which makes it possible to judge the effectiveness of the latter schemes

116. Darden, Christine M **Sonic Boom Theory: Its Status in Prediction and Minimization.** J Aircr , vol 14, no 6, June 1977, pp 569–576

A76-18726

This paper gives a brief review of the currently accepted understanding of sonic-boom phenomena and describes the manner in which modified linearized theory and geometric acoustics are used to predict the sonic boom caused by a complex aircraft configuration Minimization methods that have evolved in recent years are discussed, with particular attention given to a method developed by Seebass and George for an isothermal atmosphere which was modified for the real atmosphere by Darden An additional modification which permits the relaxation of the nose bluntness requirement in the defining aircraft is also discussed Finally, an overview of current areas of sonic-boom research is given

Other Documents

117. Carlson, Harry W **The Lower Bound of Attainable Sonic-Boom Overpressure and Design Methods of Approaching This Limit** NASA TN D-1494, 1962

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118. Friedman, Manfred P , and Chou, David C **Behavior of the Sonic Boom Shock Wave Near the Sonic Cutoff Altitude.** NASA CR-358, 1965

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120. McLean, F Edward, Carlson, Harry W , and Hunton, Lynn W **Sonic-Boom Characteristics of Proposed Supersonic and Hypersonic Airplanes.** NASA TN D-3587, 1966

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121. Barger, Raymond L **Design of Bodies To Produce Specified Sonic-Boom Signatures.** NASA TN D-4704, 1968

N68-31484

122 Runyan, Harry L , and Henderson, Herbert R **Evaluation of Certain Minimum Boom Concepts.** Second Conference on Sonic Boom Research, Ira R Schwartz, ed , NASA SP-180, 1968, pp 47–55

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123. Seebass, R **Minimum Sonic Boom Shock Strengths and Overpressures** Nature, vol 221, no 5181, Feb 15, 1969, pp 651–653

A69-19903

124. Seebass, R **Sonic Boom Theory.** J Aircr , vol 6, no 3, May–June 1969, pp 177-184

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125. George, A R **Lower Bounds for Sonic Booms in the Midfield.** AIAA J , vol 7, no 8, Aug 1969, pp 1542–1545

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126. Miller, David S , and Carlson, Harry W **A Study of the Application of Heat or Force Fields to the Sonic-Boom Minimization Problem.** NASA TN D-5582, 1969

N70-13356

127 Rethorst, S , Alperin, M , Behrens, W , and Fujita, T **Reduction of Shock Wave Strength by Means of Nonuniform Flow.** AFFDL-TR-69-62, Pt 1, U S Air Force, 1969

128. Carlson, Harry W **Some Notes on the Present Status of Sonic Boom Prediction and Minimization Research.** Third Conference on Sonic Boom Research, Ira R Schwartz, ed , NASA SP-255, 1971, pp 395–399

N71-28363

129 Miller, David S **Status of Research on Boom Minimization Through Airstream Alteration.** Third Conference on Sonic Boom Research, Ira R Schwartz, ed , NASA SP-255, 1971, pp 325–340

N71-28387

130 Nicholls, J M **A Note on the Calculation of "Cut-Off" Mach Number** Meteorol Mag , vol 100, no 1183, Feb 1971, pp 33–46

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131 Lipfert, F W **Sonic Boom Minimization Through Air Stream Alteration.** Rep No FAA-RD-71-90, July 1971

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132. Miller, David S , and Carlson, Harry W **Application of Heat and Force Fields to Sonic-Boom Minimization.** J Aircr , vol 8, no 8, Aug 1971, pp 657–662

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133. Goethert, B H , Pan, Y S , Chandhuri, S N , Kohl, R , Gruschka, H , and Kessel, Philip **Fundamental Research on Advanced Techniques for Sonic Boom Suppression** Rep No FAA-RD-73-4, Nov 1972

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134 Ferri, Antonio, Wang, Huai-Chu, and Sorensen, Hans **Experimental Verification of Low Sonic Boom Configuration.** NASA CR-2070, 1972

N72-30007

135 Carlson, Harry W , Barger, Raymond L , and Mack, Robert J **Application of Sonic-Boom Minimization Concepts in Supersonic Transport Design.** NASA TN D-7218, 1973

N73-24065

136. Dugan, James F , Jr **Preliminary Study of Supersonic-Transport Configurations With Low Values of Sonic Boom.** NASA TM X-2746, 1973

N73-18039

137. Kane, Edward J **A Study To Determine the Feasibility of a Low Sonic Boom Supersonic Transport** NASA CR-2332, 1973

N74-15713

138. Kulfan, Robert M **High-Transonic-Speed Transport Aircraft Study.** NASA CR-2465, 1974

N74-31505

139. Swigart, Rudolph J **An Experimental Study of the Validity of the Heat-Field Concept for Sonic-Boom Alleviation** NASA CR-2381, 1974

N74-18648

140 Darden, Christine M **Minimization of Sonic-Boom Parameters in Real and Isothermal Atmospheres.** NASA TN D-7842, 1975

N75-17343

141. Darden, Christine M **Comparison of Sonic Boom Minimization Results in Real and Isothermal Atmospheres** J Aircr , vol 12, no 5, May 1975, pp 496–497

A75-38578

142. Sigalla, A , Runyan, L J , and Kane, E J **The Overland Supersonic Transport With Low Sonic Boom—A Feasibility Study.** Acta Astronaut , vol 4, no 1/2, Jan /Feb 1977, pp 163–179

A77-30014

143. Perley, Richmond **Design and Demonstration of a System for Routine, Boomless Supersonic Flights.** Rep No FAA-RD-77-72, Apr 1977

N79-16828

144. Darden, Christine M **Sonic-Boom Minimization With Nose-Bluntness Relaxation.** NASA TP-1348, 1979

N79-15000

145. Mack, Robert J , and Darden, Christine M **Wind-Tunnel Investigation of the Validity of a Sonic-Boom-Minimization Concept.** NASA TP-1421, 1979

N80-10102

146 Mack, R J , and Darden, C M **Some Effects of Applyıng Sonic Boom Minimızation to Supersonıc Cruıse Aircraft Design** J Aırcr , vol 17, no 3, Mar 1980, pp 182–186

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147. Darden, Chrıstıne M **Charts for Determining Potential Minimum Sonic-Boom Overpressures for Supersonic Cruise Aircraft** NASA TP-1820, 1981

N81-21016

4. Prediction and Measurement of Accelerating-Flight Sonic Booms

Key Documents

148 Lansing, Donald L **Application of Acoustic Theory to Prediction of Sonic-Boom Ground Patterns From Maneuvering Aircraft.** NASA TN D-1860, 1964

N64-37223

The acoustic theory of the propagation of weak disturbances through an atmosphere having a linearly decreasing sound speed is applied to the problem of determining the location of the shock wave produced by a maneuvering aircraft A graphical procedure involving ray tracing and an analytical procedure based on the ballistic wave are discussed Some examples are given which show the effects typical flight maneuvers may have upon the ground shock pattern

149 Maglieri, Domenic J , and Lansing, Donald L **Sonic Booms From Aircraft in Maneuvers.** NASA TN D-2370, 1964

N64-21271

Superboom measurements and calculated pressure patterns have been made for fighter aircraft in level accelerated flight and in turn maneuvers A summary of the main findings of these superboom studies, qualitative comparisons with analysis, and a physical explanation of some of the observed phenomena are presented

150 Lansing, Donald L , and Maglieri, Domenic J **Comparison of Measured and Calculated Sonic-Boom Ground Patterns Due to Several Different Aircraft Maneuvers.** NASA TN D-2730, 1965

N64-25808

Detailed comparisons of the measured and calculated ground-shock pressure patterns resulting from aircraft performing pushover-dive-pullout, longitudinal-acceleration, pullup-climb-pushover, and circular-turn maneuvers are presented Calculation of the arrival time of the shock wave and the pressure amplitude as a function of distance along the ground are compared with the measurements from an array of microphones Specific cases are also presented in which the superboom phenomena were obtained

151 Pierce, Allan D **Maximum Overpressures of Sonic Booms Near the Cusps of Caustics.** Noise and Vibration Control Engineering, Malcolm J Crocker, ed , Purdue Univ , c 1972, pp 544–553

A72-29586

Under certain circumstances, it is possible for a maneuvering supersonic aircraft to produce sonic booms with overpressures much larger than would be nominally expected Such superbooms occur at points near those where the geometrical acoustics rays tend to focus Linear acoustics allows the possibility of such focusing occurring along a surface in space known as a caustic The generation of cusped caustics as a consequence of maneuvering or accelerating supersonic aircraft is discussed, and a simplified theory for the estimation of the peak overpressure at a caustic cusp is presented

152. Wanner, Jean-Claude L , Vallee, Jacques, Vivier, Claude, and Thery, Claude **Theoretical and Experimental Studies of the Focus of Sonic Booms.** J Acoust Soc America, vol 52, no 1, pt 1, July 1972, pp 13–32

A72-36506

Knowledge of sonic booms produced by airplanes in steady rectilinear flight is not sufficient to allow for good predictions of the phenomena In order to improve the knowledge of the effects of accelerations and curvatures of the flight path, the French Working Group on sonic booms has undertaken a set of theoretical and experimental studies on that subject Theoretical studies of the propagation of the shock waves have helped identify the different cases of focus (linear acceleration, turn, pushover) and superfocus (entry to turn) They have also shown that, after measurement of the actual characteristics of the atmosphere, it was possible to guide an airplane in order to produce focusing in a measurement zone of realistic size During the four experimental exercises of "Operation Jericho" the accuracy of prediction of propagation and guidance of the airplane has shown that focus factors are higher than those predicted

153. Wanner, J C **Some Conclusions Regarding the Sonic Boom Following the Latest French Experiments.** Rev Med Aeronaut Spat , vol 12, 1st Q , 1973, pp 42–45

A73-36907

Results of theoretical and experimental studies of the problem of the supersonic boom are presented These results concern the structure of the shock wave system generated by an aircraft traveling at supersonic speed in rectilinear flight, the changes in this structure during rectilinear acceleration, turning in the horizontal plane, and descent, and the value of the amplification coefficient due to focusing or superfocusing of the overpressure wave accompanying a sonic boom

154. Taylor, Albion D **The Traps Sonic Boom Program.** NOAA Tech Memo ERL ARL-87, U S Dep Commerce, July 1980

A new program called TRAPS has been written having the capability of modeling an aircraft-created sonic boom Like an earlier program (ARAP), this program allows the aircraft to perform an arbitrary sequence of maneuvers, accelerations, and decelerations, and it uses a stratified atmospheric model of either a standard or user-specified composition The new program introduces the new feature of accounting for sonic booms which travel upward initially, but are subsequently refracted from the stratopause (≈50 000 m) or the thermosphere (≈100 000 m) Overpressures and shocks are computed from an initial aircraft *F*-function on the basis of Aging and Hilbert Transforms applied according to the travel paths (rays) of the acoustic energy In addition, input procedures are simplified and information is made available as to what proportion of the aircraft sonic boom can intercept the ground

155 Galloway, W J **Studies To Improve Environmental Assessments of Sonic Booms Produced During Air Combat Maneuvering.** AMRL-TR-83-078, U S Air Force, Oct 1983

N84-22368

Fighter aircraft, when engaged in air-to-air combat training maneuvers where supersonic flight is permitted, produce sonic booms Definition of the noise environment at locations on the ground below these maneuver areas must rely on statistical descriptions of aircraft operating parameters and geographic location Distribution functions for pertinent parameters are developed here for different fighter airplanes by analysis of tracking data obtained by air combat maneuvering instrumentation at supersonic military operating areas associated with Luke and Nellis Air Force Bases In a second part of these studies a variety of pressure-time histories produced at ground microphone positions by sonic booms produced by an F-104 in an early NASA study are analyzed to obtain A-weighted and C-weighted sound levels Particular attention was paid to the difference between peak unweighted overpressure, when expressed in decibels, and frequency-weighted sound exposure levels for sonic booms near a caustic produced by focusing during accelerated maneuvers and as lateral cutoff conditions are approached

156. Plotkin, Kenneth J **Sonic Boom Focus Conditions Due to Tactical Air Operations.** WR 84-8, Wyle Labs , Feb 1984

A review has been performed of sonic-boom focusing phenomena associated with U S Air Force supersonic training exercises Specific aircraft considered were the F-4, F-15, F-16, and SR-71 Results for the three fighter aircraft are applicable to supersonic fighters in general, including the F-14 and F-18 It was found that, while the area over which focal zones occur is never more than a small fraction of the total boom footprint, virtually all transonic accelerations will generate some focus This covers the normal training range of fighters and the initial phase of SR-71 supersonic missions A matrix of focusing maneuvers, for which footprints should be computed, has been prepared

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157. Barger, Raymond L **Some Effects of Flight Path and Atmospheric Variations on the Boom Propagated From a Supersonic Aircraft** NASA TR R-191, 1964

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158 Bartlett, Charles J , and Friedman, Manfred P **A Method for Calculating the Effect of Aircraft Maneuvers on Sonic Booms.** J Aircr , vol 2, no 5, Sept -Oct 1965, pp 353–356

A65-34371

159 Maglieri, Domenic J **Some Effects of Airplane Operations and the Atmosphere on Sonic-Boom Signatures.** J Acoust Soc America, vol 39, no 5, pt 2, May 1966, pp S36–S42

A66-33026

160. Vallee, [J] **Mesure de l'Intensité des Bangs Soniques Engendrés par un Avion Volant en Palier Accéléré Supersonique.** Rapp d'Étude No 272, Centre d'Essais en Vol, Annexe d'Istres, Oct 1967

161. Tarnogrodzki, A , and Luczywek, E **Approximate Method of Determination of Location of a Sonic Boom in Accelerated Motion of an Aircraft.** Arch Mech Stosow , vol 19, no 3, 1967, pp 411–420

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162. De Maistre, A , Thery, C , Vallée, J , Vivier, C , and Wanner, J -C **Sonic Boom—Theory and Experimentation of the Phenomenon of Focalization** Assoc Tech Maritime Aéronaut Bull , no 69, May 1969, pp 183–197

A70-19130

163. Vallee, J **Étude Éxperimentale des Focalisations de Bangs Soniques Engendrées par le Vol Supersonique en Accélération Rectiligne ou en Virage d'un Avion Mirage IV á l'Altitude de 11 000 m.** Rapp d'Étude No 277, Centre d'Essais en Vol, Annexe d'Istres, May 1969

164. Haefeli, Rudolph C **Sonic Boom Propagation From Maneuvering Aircraft.** AIAA Paper No 69-1134, Oct 1969

A70-10606

165. Beasley, W D , Brooks, J D , and Barger, R L **A Laboratory Investigation of N-Wave Focusing.** NASA TN D-5306, 1969

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166. Haefelı, Rudolph C **Effects of Atmosphere, Wind, and Aircraft Maneuvers on Sonıc Boom Signatures.** NASA CR-66756, 1969

N69-24184

167. Nıcholls, J M , and James, B F **The Location of the Ground Focus Line Produced by a Transonically Accelerating Aircraft** J Sound & Vıb , vol 20, no 2, Jan 22, 1972, pp 143–167

A72-19645

168 Vallee, J **Essais de Focalisatıon et de Superfocalisation de Bangs Soniques.** Rapp d'Étude No 291, Centre d'Essaıs en Vol, Annexe d'Istres, Mar 1972

169 Batdorf, S B **On Sonic Boom Avoidance** Aeronaut J , vol 76, no 741, Sept 1972, pp 541–542

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170 Rıbner, H S **Supersonıc Turns Without Superbooms.** J Acoust Soc Amerıca, vol 52, no 3, pt 2, Sept 1972, pp 1037–1041

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174. Haglund, George T , and Kane, Edward J **Analysıs of Sonıc Boom Measurements Near Shock Wave Extremities for Flight Near Mach 1.0 and for Airplane Accelerations.** NASA CR-2417, 1974

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175 Henderson, Herbert R , and Hılton, Davıd A **Sonic-Boom Ground Pressure Measurements From the Launch and Reentry of Apollo 16.** NASA TN D-7606, 1974

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176. Henderson, Herbert R , and Hılton, Davıd A **Sonic-Boom Measurements in the Focus Region During the Ascent of Apollo 17.** NASA TN D-7806, 1974

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177. Reed, Jack W **Sonic Boom Measurements From Accelerating Supersonic Tracked Sleds.** NASA CR-132388, 1974

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178. Page, N W **Sonic Boom Propagation at Low Supersonic Speeds** ARL/A-143, Aeronaut Res Labs , May 1975

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179 Plotkın, K J , and Cantrıl, J M **Prediction of Sonic Boom at a Focus** AIAA Paper 76-2, Jan 1976

A76-18727

180 Sanaı, M , Toong, T -Y , and Pıerce, A D **Ballistic Range Experiments on Superbooms Generated by Refraction.** J Acoust Soc Amerıca, vol 59, no 3, Mar 1976, pp 513–519

A76-26746

181. Sanaı, M , Toong, T -Y , and Pıerce, A D **Ballistic Range Experiments on the Superboom Generated at Increasing Flight Mach Numbers.** J Acoust Soc Amerıca, vol 59, no 3, Mar 1976, pp 520–524

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182. Obermeıer, Frank **Behavior of a Sonic Boom Near a Caustic** Rep MPIS-28/1976, Max-Planck-Instıtut Stroemungsforschung, 1976

N77-24908

183. Schıllıng, H **Supersonic Maneuvers Wıthout Superbooms.** Paper presented at 24th Annual Conference on Avıatıon and Astronautıcs (Tel Avıv and Haıfa, Israel), Feb 17–18, 1982

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184. Schıllıng, H **Occurrence and Intensity of Focussed Sonic Booms.** VDI-Z Fortschr -Ber , Reıhe 7—Strom tech , no 63, 1982

A82-39388

185. Schıllıng, H **Strength of Focused Sonic Booms for the Example of a Straight Level Flight.** Ing -Arch , vol 53, no 3, 1983, pp 181–195

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187. Plotkin, Kenneth J **Sonic Boom Prediction Model for Supersonic Flight Corridors.** WR 85-25, Wyle Labs , Aug 1985

188. Plotkin, Kenneth J **Focus Boom Footprints for Various Air Force Supersonic Operations.** WR 85-22, Wyle Labs , Oct 1985

5. Sonic-Boom Propagation

Key Documents

189. Kane, Edward J, and Palmer, Thomas Y **Meteorological Aspects of the Sonic Boom.** SRDS Rep No RD64-160, FAA, Sept 1964

AD 610463

This report is a study of the effect of changing meteorological conditions on the sonic boom produced during steady level flight The influence of variations in atmospheric temperature, pressure, and wind on this noise are investigated Simplified methods are established for estimating the effect of these variations Combinations of meteorological conditions which can produce anomalous propagation such as complete cutoff, focusing, and extreme lateral spread are discussed The effect of air turbulence near the ground is considered A number of comparisons with test data measured at Oklahoma City (1964) are presented, and recommendations for additional experimental and theoretical work are outlined

190. Maglieri, Domenic J **Sonic Boom Flight Research: Some Effects of Airplane Operations and the Atmosphere on Sonic Boom Signatures** Sonic Boom Research, A R Seebass, ed, NASA SP-147, 1967, pp 25–48

N68-21416

Flight-test results obtained with the aid of small, medium, and large aircraft are presented to show the significance of the atmosphere and aircraft operation on sonic-boom exposures The acceleration and lateral-spread phenomena appear to be fairly well understood and predictable for current and future aircraft Variations in the sonic-boom signature as a result of the effects of the atmosphere can be expected during routine operations From the data evaluated to date, very similar variations in pressure signatures are noted for small, medium, and large aircraft That portion of the atmosphere below about 2000 ft is shown to be most influential, although in some cases the higher portions may also be important Aircraft motions, in the form of perturbations about the normal flight track, are shown not to contribute significantly to observed sonic-boom signature variations For cases where a large number of overpressure data points are available, the average measured values correlate well with current theoretical predictions

191 Garrick, I E, and Maglieri, D J **A Summary of Results on Sonic-Boom Pressure-Signature Variations Associated With Atmospheric Conditions** NASA TN D-4588, 1968

N68-24662

This report reviews the most pertinent information obtained in recent years relating to atmospheric effects on the sonic boom and, in particular, includes some results of various flight programs These atmospheric effects are complex, and a statistical approach appears necessary The statistics of peak pressures follows approximately a log normal distribution, a result that is indicated by existing theory for pure (sinusoidal) sound A tabular summary of the flight data gives the standard deviations of pressure peaks relative to nominal calculated values of the mean Information is included on observed variations of sonic-boom signatures for different types and sizes of airplanes Measurements indicate that wavelike spatial patterns exist in which peaked and rounded waves may alternate and vary with time Such variations are shown to be induced by the atmosphere rather than by effects of airplane unsteady motion The spectral content of some ideal and some measured pressure signatures is exhibited and discussed with reference to peakedness or roundness of the wave

192. Pierce, Allan D, and Maglieri, Domenic J **Effects of Atmospheric Irregularities on Sonic-Boom Propagation.** J Acoust Soc America, vol 51, no 2, pt 3, Feb 1972, pp 702–721

A72-21905

A review is given of information obtained in recent years concerning the effects on sonic-boom signatures of departures of the atmosphere from a perfectly stratified time invariant model These effects include the observed random variations in boom overpressures from those expected for a stratified atmosphere, the anomalously large and variable rise times, and the occurrence of spiked or rounded waveforms rather than the characteristic *N* waves The extent of the variability in data recorded during actual flight tests is summarized in the form of histograms representing experimentally obtained probability density functions The physical mechanisms believed to be responsible for the variations and the anomalous features in the signatures are described These include refraction and subsequent wavefront rippling by turbulence, the possible focusing or defocusing of rays, the formation of caustics, and the phenomena of wavefront folding, diffraction, and scattering Recent statistical theories of shock propagation through a turbulent atmosphere proposed by Crow, George and Plotkin, Pierce, Horning, and others are reviewed

193. Liszka, Ludwik **Long-Distance Focusing of Concorde Sonic Boom.** J Acoust Soc America, vol 64, no 2, Aug 1978, pp 631–635

A78-48052

Infra-acoustic signals from supersonic flights of the Concorde are regularly recorded in northern Sweden at distances up to 5000 km from the aircraft Relatively high signal amplitudes (up to 0 1 N/m^2) are explained by a kind of long-distance focusing effect Principle and consequences of the focusing effect are discussed

194. Rogers, Peter H, and Gardner, J H **Propagation of Sonic Booms in the Thermosphere.** J Acoust Soc America, vol 67, no 1, Jan 1980, pp 78–91

A80-20399

A nonlinear theory for the long-range propagation of sonic booms through the thermosphere has been developed A realistic atmosphere is employed, and consideration is given to nonlinear stretching and decay of the wave, the effects of the caustic, the linear caustic attenuation, and the increase in Mach number due to the decreasing density at high altitudes Results are presented for Concorde SST in straight, level, and steady flight at 17 5 km and a velocity of Mach 2 The sound level is a minimum along the flight track with the maximum signal strength occurring about 300 km off the flight track The strongest received signal travels initially downward and reflects off the surface of the ocean to the thermosphere The wave turns around at an altitude of 160 km and is returned back to the ground at a horizontal distance of 320 km from the launch point Ninety percent of the wave's energy is attenuated below 100 km with 99 percent attenuated by the time the wave reaches the turning point

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196 Friedman, Manfred P , Kane, Edward J , and Sigalla, Armand **Effects of Atmosphere and Aircraft Motion on the Location and Intensity of a Sonic Boom.** AIAA J , vol 1, no 6, June 1963, pp 1327–1335

A63-17956

197 Maglieri, Domenic J , and Parrott, Tony L **Atmospheric Effects on Sonic-Boom Pressure Signatures** Sound, vol 2, no 4, July–Aug 1963, pp 11–14

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198 Dressler, Robert, and Fredholm, Nils **Atmospheric Scattering of Sonic-Boom Intensities.** ICAS Paper No 64-583, Aug 1964

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199 Warren, C H E **The Propagation of Sonic Bangs in a Nonhomogeneous Still Atmosphere.** ICAS Paper No 64-547, Aug 1964

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200. Dressler, Robert F **Sonic-Boom Waves in Strong Winds.** FFA-97, Aeronautical Research Institute of Sweden, Oct 1964

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201. Hilton, David A , Huckel, Vera, Steiner, Roy, and Maglieri, Domenic J **Sonic-Boom Exposures During FAA Community-Response Studies Over a 6-Month Period in the Oklahoma City Area.** NASA TN D-2539, 1964

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202. Friedman, Manfred P **A Description of a Computer Program for the Study of Atmospheric Effects on Sonic Booms** NASA CR-157, 1965

N65-15745

203. Friedman, Manfred P , and Chou, David C **Behavior of the Sonic Boom Shock Wave Near the Sonic Cutoff Altitude.** NASA CR-358, 1965

N66-12141

204. Maglieri, Domenic J , and Hilton, David A **Significance of the Atmosphere and Aircraft Operations on Sonic-Boom Exposures** Conference on Aircraft Operating Problems, NASA SP-83, 1965, pp 245–256

N65-31106

205. Maglieri, Domenic J , and Hubbard, Harvey H **Atmospheric Effects on Sonic-Boom Signatures.** NASA TM X-56436, 1965

N66-29326

206. Maglieri, Domenic J **Some Effects of Airplane Operations and the Atmosphere on Sonic-Boom Signatures.** J Acoust Soc America, vol 39, no 5, pt 2, May 1966, pp S36–S42

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6. Effects of Sonic Booms and Aircraft Noise on People and Communities

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238. Borsky, Paul N **Community Reactions to Sonic Booms in the Oklahoma City Area.** AMRL-TR-65-37, U S Air Force, Feb 1965

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During a period of six months from February to July 1964, the Oklahoma City, Oklahoma, area was repeatedly exposed to sonic booms generated to simulate overpressure levels that are expected for supersonic transport overflights The schedule provided for eight sonic booms per day During the 6-month period, almost 3000 local residents were interviewed 3 times to determine the nature and extent of their reactions to the sonic booms This report contains a detailed description of the overall study design including the selection of households, selections of respondents, training and selection of interviewers, and samples of questionnaires used during the interviews

239 Warren, C H E , and Webb, D R B **Physical Characteristics of the Sonic Bangs and Other Events at Exercise Westminster** British R A E TR-55248, Nov 1965

X66-16041

Exercise Westminster was a demonstration of sonic bangs, together with some explosive bangs and flyovers by a jet aircraft, staged for an invited audience This report describes how the exercise was conducted, from the operational point of view, and what monitoring measurements were made An analysis of the physical characteristics of the sonic bangs and other events is made

240 Nixon, Charles W , and Hubbard, Harvey H **Results of USAF-NASA-FAA Flight Program To Study Community Responses to Sonic Booms in the Greater St. Louis Area.** NASA TN D-2705, 1965

•N65-23688

Data are presented from a series of community-reaction flight experiments in which the population of a large city was repeatedly exposed to sonic booms in the range of overpressures up to about 3 1 lb/ft^2 Results were obtained from direct interviews, analyses of complaint files, and engineering evaluations of alleged damage and are correlated with information on aircraft operations and sonic-boom pressure measurements

241 Warren, C H E , and Webb, D R B **An Investigation of the Effect of Bangs on the Subjective Reaction of a Community** British R A E TR-66072, Mar 1966

X66-23222

An investigation has been made, using explosive charges as the source of the bangs, of the effect of bangs on the subjective reaction of a community Although the exercise had many imperfections, the two main facts that emerged were that the percentage of persons annoyed became less as the bangs became an established feature of the environment and that the exchange rate found between the effect of frequency and the effect of intensity was not inconsistent with that implied by the noise and number index concept introduced by the Wilson Committee on the problem of noise

242. Nixon, Charles W , and Borsky, Paul N **Effects of Sonic Boom on People St Louis, Missouri, 1961–1962.** J Acoust Soc America, vol 39, no 5, pt 2, May 1966, pp S51–S58

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The vicinity of St Louis, Missouri, was repeatedly exposed to sonic booms ranging in overpressures up to about 3 lb/ft^2 during 1961–1962 Data obtained from over 2300 direct interviews, analyses of complaints, and engineering evaluation of alleged damage are related to information on aircraft operations and sonic-boom overpressure measurements

243 Von Gierke, Henning E **Effects of Sonic Boom on People Review and Outlook** J Acoust Soc America, vol 39, no 5, pt 2, May 1966, pp S43–S50

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This introduction to the second part of the Sonic-Boom Symposium reviews the history of observations on human reactions to the sonic boom from the time when the boom was a demonstration curiosity to the present day where reaction of the population to the sonic boom is a scientific problem of technical, economic, social, and political consequences at the national and international level The field programs conducted by the USAF and NASA over the last 15 years and over the last 5 years by the FAA were all of limited scope with respect to exploring direct and indirect physiological and psychological human reactions to sonic booms of different intensity and exposure frequency Although the data accumulated might be adequate to decide on preliminary stopgap exposure criteria, it is obvious that a broader approach to the problem is required Laboratory work in support of these questions has hardly been started Neither conventional acoustic and vibration generators for boom-type simulation nor special equipment for high-fidelity sonic-boom simulation have been fully utilized Some of the open questions and possible approaches are discussed as part of a broad, long-range research program required to come up with scientific data as bases for operational sonic-boom exposure criteria

244. Johnson, D R , and Robinson, D W **The Subjective Evaluation of Sonic Bangs.** Acustica, vol 18, no 5, 1967, pp 241–258

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An experiment is described in which 61 subjects used the method of direct magnitude estimation to judge the relative annoyance of sonic bangs, explosions, and jet aircraft noise Artificial white noises were included to test the subjects' performance for individual consistency and to compare their results with the established relationship between subjective magnitude and objective level

245 Borsky, P N **Sonic Boom Exposure Effects II 4 Annoyance Reactions** J Sound & Vib , vol 20, no 4, Feb 22, 1972, pp 527–530

A72-23321

A review is given of recently published research on human reactions caused by sonic booms Some of the limitations of these studies are pointed out, and recommendations are presented with respect to the requirements and optimum course of future research It is shown that the development of an annoyance reaction is dependent upon several primary reactions in addition to non-exposure-related factors in the environment This report is from a workshop on methods and criteria held in Stockholm, Sweden

246 Rice, C G **Sonic Boom Exposure Effects II.2 Sleep Effects.** J Sound & Vib , vol 20, no 4, Feb 22, 1972, pp 511–517

A72-23319

A review is given of quantitative data which express sleep interference in terms of certain aspects of sleep patterns (sleep stage and accumulated sleep time), individual differences (age, sex, temperament, and responsiveness), and stimulus variables (type of sound and intensity) The findings of laboratory studies and their relationship to real-life situations are discussed, together with suggestions for standardization of some of the experimental techniques used in different laboratories in order to receive the maximum information from research efforts on sleep disturbance due to sonic booms This report is from a workshop on methods and criteria held in Stockholm, Sweden

247 Thackray, R I **Sonic Boom Exposure Effects II.3· Startle Responses** J Sound & Vib , vol 20, no 4, Feb 22, 1972, pp 519–526

A72-23320

A review is given of human reactions to impulsive acoustic stimuli of the sonic-boom kind in terms of startle reflexes, orienting responses, and effects on performance Various aspects of reflex response measurement and conditioning are discussed, including overt behavioral, physiological, and subjective indices, relevant stimulus parameters, and factors modifying the response to impulsive stimulation Recommendations on needed research are presented This report is from a workshop on methods and criteria held in Stockholm, Sweden

248 Von Gierke, H E , and Nixon, C W **Human Response to Sonic Boom in the Laboratory and the Community.** J Acoust Soc America, vol 51, no 2, pt 3, Feb 1972, pp 766–782

A72-21901

Present-day estimates regarding the acceptability of sonic booms by man are derived from various observations, overflight programs, and experimental field and laboratory studies conducted both within and outside the United States The loudness and annoyance of individual booms and their dependence on the boom overpressure and pressure-time function as well as the complex reaction of individuals, groups, and communities exposed to sonic booms of varied magnitude and frequency are discussed The few experiments available proving that even sonic booms of the maximum intensity presently feasible do not produce direct medical injury are described Based on the integrated body of results of recent physiological, psychoacoustic, behavioral, and sociological studies in various countries, estimates of the effects and acceptability of regular, frequent supersonic commercial overland flight schedules are presented and discussed in terms of aircraft noise pollution in general and of potential certification of aircraft with respect to noise and sonic boom Findings support the current policy that commercial supersonic transport aircraft will not be permitted to fly over the United States unless and until the noise factors are brought within acceptable limits

249 Zepler, E E , Sullivan, B M , Rice, C G , Griffin, M J , Oldman, M , Dickinson, P J , Shepherd, K P , Ludlow, J E , and Large, J B **Human Response to Transportation Noise and Vibration.** J Sound & Vib , vol 28, no 3, June 8, 1973, pp 375–401

A73-35328

Research during the past decade at the Institute of Sound and Vibration Research, University of Southampton, on a number of aspects of human response to transportation noise and vibration is reviewed These aspects include the following sonic boom, subjective acoustics test procedures, human response to vibration, the effects of noise on performance and comfort, development of a mathematical model to determine the economic impact of achieving reduced community noise levels from aircraft, case studies of the effects on communities of aircraft noise, and construction site noise

250. Boutelier, C , Demange, J , and Vettes, B **Effect of Sonic Boom on Man and Animals—Review of Principal Studies Carried Out in France.** Rev Med Aeronaut Spat , vol 13, 3rd Q , 1974, pp 222–227

A75-17374

The present work discusses some of the main conclusions drawn from various studies on the effects of sonic boom on hearing and balance, sleep, and the cardiovascular system in man, on the breeding of certain production animals, and on some physiological indices of experimental animals It is shown that the physiological effects of sonic boom in man and animals are not such as to have any serious consequences for the organism and that the annoyance caused by the boom must be of psychological nature

251. Thackray, Richard I, Touchstone, R Mark, and Bailey, Joe P **Reactions to Sonic Booms A Report of Two Studies and a General Evaluation of Startle Effects** Aviat, Space, & Environ Med, vol 46, no 4, Apr 1975, pp 369–376

A75-29578

The first study reported was conducted primarily to determine an exposure level below which arm-hand startle responses to simulated sonic booms would not occur The second study was concerned with an investigation of habituation effects The results of the two experiments reported make it possible to conduct an evaluation of startle effects over a reasonably wide range of exposure levels A summary of the behavioral, physiological, and subjective data obtained is presented in a table

252. Lukas, Jerome S **Noise and Sleep. A Literature Review and a Proposed Criterion for Assessing Effect** J Acoust Soc America, vol 58, no 6, Dec 1975, pp 1232–1242

A76-18378

A brief discussion of human sleep is followed by presentation of data describing the variables that appear to affect human responsiveness to noise during sleep Results from several studies that were conducted in different laboratories and that used several types of noises, age groups, and sexes are then combined to show that when EPNdB units are used as the measure of noise intensity, the correlation coefficient between intensity and the probability of no disturbance of sleep is −0 86 It is suggested also that a coefficient of similar magnitude would be obtained if units of EPNdBA were used Some implications of these data are then exemplified

253 Bennett, Ricarda L, and Pearsons, Karl S **Handbook of Aircraft Noise Metrics** NASA CR-3406, 1981

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Information is presented on 22 noise metrics that are associated with the measurement and prediction of the effects of aircraft noise Some of the instantaneous frequency-weighted sound level measures, such as A-weighted sound level, are used to provide multiple assessment of the aircraft noise level Other multiple-event metrics, such as day-night average sound level, were designed to relate sound levels measured over a period of time to subjective responses in an effort to determine compatible land uses and aid in community planning The various measures are divided into (1) instantaneous sound level metrics, (2) duration-corrected single-event metrics, (3) multiple-event metrics, and (4) speech communication metrics

254 Fields, James M **A Catalog of Social Surveys of Residents' Reactions to Environmental Noise, 1943–1980.** NASA TM-83187, 1981

N81-33678

Two hundred social surveys of peoples' responses to environmental noise in residential areas are briefly described The surveys are indexed by country, noise source, and date of survey The publications and reports about each survey are listed in a bibliography Recent English translations of 14 publications are listed separately Nineteen surveys are listed which are available for secondary analysis from a data archive

255. Kryter, Karl D **Physiological, Psychological, and Social Effects of Noise.** NASA RP-1115, 1984

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The physiological and behavioral effects of noise on man are investigated Basic parameters such as definitions of noise, measuring techniques of noise, and the physiology of the ear are presented prior to the development of topics on hearing loss, speech communication in noise, social effects of noise, and the health effects of noise pollution Recommendations for the assessment and subsequent control of noise are included

256 Stevens, K N **A Survey of Background and Aircraft Noise in Communities Near Airports** NACA TN 3379, 1954

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259. Kryter, Karl D, and Pearsons, Karl S **Some Effects of Spectral Content and Duration of Perceived Noise Level** NASA TN D-1873, 1963

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260. Broadbent, D E, and Robinson, D W **Subjective Measurements of the Relative Annoyance of Simulated Sonic Bangs and Aircraft Noise** J Sound & Vib, vol I, no 2, Apr 1964, pp 162–174

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262. Kryter, K D , and Pearsons, K S **Laboratory Tests of Subjective Reactions to Sonic Boom** NASA CR-187, 1965

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263. Kryter, K D **Laboratory Tests of Physiological-Psychological Reactions to Sonic Booms** J Acoust Soc America, vol 39, no 5, pt 2, May 1966, pp S65–S72

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265. Kryter, Karl D **Review of Research and Methods for Measuring the Loudness and Noisiness of Complex Sounds** NASA CR-422, 1966

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266. Kryter, K D **Concepts of Perceived Noisiness, Their Implementation and Application.** J Acoust Soc America, vol 43, no 2, Feb 1968, pp 344–361

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267. Rice, C G , and Coles, R R A **Auditory Hazard From Sonic Booms?** Int Audiol , vol 7, Mar 1968, pp 85–91

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268 Subcommittee on Human Response **Report on Human Response to the Sonic Boom** National Academy of Sciences—National Research Council, June 1968

269. Hinterkeuser, Ernest G **Synthesis of Aircraft Noise.** Progress of NASA Research Relating to Noise Alleviation of Large Subsonic Jet Aircraft, NASA SP-189, 1968, pp 537–545

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271 Kryter, Karl D , Johnson, Paul J , and Young, James R **Judgment Tests of Aircraft Noise.** Progress of NASA Research Relating to Noise Alleviation of Large Subsonic Jet Aircraft, NASA SP-189, 1968, pp 587–600

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272. Lukas, Jerome S , and Kryter, Karl D **A Preliminary Study of the Awakening and Startle Effects of Simulated Sonic Booms.** NASA CR-1193, 1968

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273 Pearson, Richard G , and Hart, Franklin D **Studies Relating the Individual Characteristics of People With Their Responses to Noise.** Progress of NASA Research Relating to Noise Alleviation of Large Subsonic Jet Aircraft, NASA SP-189, 1968, pp 561–572

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281 Kryter, K D **Possible Modifications to the Calculation of Perceived Noisiness.** NASA CR-1636, 1970

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282. Kryter, Karl D **The Effects of Noise on Man** Academic Press, Inc , 1970

283. Lukas, Jerome S , Peeler, Donald J , and Kryter, Karl D **Effects of Sonic Booms and Subsonic Jet Flyover Noise on Skeletal Muscle Tension and a Paced Tracing Task** NASA CR-1522, 1970

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284 Lukas, Jerome S , and Kryter, Karl D **Awakening Effects of Simulated Sonic Booms and Subsonic Aircraft Noise on Six Subjects, 7 to 72 Years of Age.** NASA CR-1599, 1970

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285 TRACOR, Inc **Public Reactions to Sonic Booms** NASA CR-1665, 1970

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288 Edge, Philip M , Jr , Chambers, Randall M , and Hubbard, Harvey H **Evaluation of Measures of Aircraft Noise** NASA Aircraft Safety and Operating Problems, Volume I, NASA SP-270, 1971, pp 429–437

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292. Lukas, J S **Awakening Effects of Simulated Sonic Booms and Aircraft Noise on Men and Women.** J Sound & Vib , vol 20, no 4, Feb 22, 1972, pp 457–466

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297. Ludlow, J E , and Morgan, P A **Behavioural Awakening and Subjective Reactions to Indoor Sonic Booms.** J Sound & Vib , vol 25, no 3, Dec 8, 1972, pp 479–495

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7. Effects of Sonic Booms and Aircraft Noise on Structures

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8. Effects of Sonic Booms and Aircraft Noise on Animals and Birds

Key Documents

460 Bell, Wilson B **Animal Response to Sonic Booms** J Acoust Soc America, vol 51, no 2, pt 3, Feb 1972, pp 758–765

A72-21909

Individual domestic or pet animals may react to a boom, a simple startle response being the most common reaction However, specific reactions differ according to the species involved, whether the animal is alone, and perhaps whether there has been previous exposure Occasional trampling, moving, raising head, stampeding, jumping, and running are among the reactions reported Avian species occasionally run, fly, or crowd Reactions vary from boom to boom and are not predictable Animal reactions to booms are similar to their reactions to low-level subsonic airplane flights, helicopters, barking dogs, blown paper, and sudden noises Conclusive data on effects of booms on production are not available, but no change in milk production by one dairy herd was noted The reactions of mink to sonic booms have been studied in considerable detail Female mink with kits may be alerted, pause in activity, and look for source of sound Sleeping females may awaken and mating pairs may show momentary alertness, but the mating ritual is not disturbed The effect of booms on eggs being hatched under commercial conditions was examined in detail, and no effects on hatchability were found However, a mass hatching failure of the Dry Tortugas sooty tern occurred in 1969, and the circumstantial evidence suggests that physical damage to the eggs by severe sonic booms caused by low-level supersonic flights was responsible

461 Cottereau, Ph **Sonic Boom Exposure Effects II 5 Effects on Animals** J Sound & Vib , vol 20, no 4, Feb 22, 1972, pp 531–534

A72-23322

Brief review of studies on the effects of sonic booms on poultry, farm and wild animals, and pets To date there has been only a limited number of controlled studies of animal response to sonic booms The literature yields relatively few meaningful data on wild animal response Recommendations about needed future research are presented This report is from a workshop on methods and criteria held in Stockholm, Sweden

462 Travis, H F , Bond, J , Wilson, R L , Leekley, J R , Menear, J R , Curran, C R , Robinson, F R , Brewer, W E , Huttenhauer, G A , and Henson, J B **An Interdisciplinary Study of the Effects of Real and Simulated Sonic Booms on Farm-Raised Mink (Mustela Vison).** FAA-EQ-72-2, Aug 1972

N73-12028

Studies were conducted at three sites on Mitkof Island, Alaska, to determine the effects of three real or three simulated sonic booms of about 6 lb/ft^2 overpressure upon reproduction in farm-raised mink Control animals were not boomed No differences were found among experimental treatments of length of gestation, number of kits born per female whelping, number of kits alive per female at 5 and 10 days of age, weight of kits at 49 days of age, and kit pelt value and selling price A behavioral study showed no evidence that the female mink under observation were sufficiently disturbed by sonic booms to engage in kit packing, kit killing, or to disrupt normal lactation Results of necropsy examinations showed no mink deaths attributable to real or simulated sonic booms Likewise, no evidence was found that bacterial disease was induced in the herd following exposure to sonic booms There were no detectable differences in the overall health of the females at the three sites The conclusion drawn from these studies is that exposure of farm-raised mink to intense sonic booms during whelping season had no adverse effect on their reproduction or behavior,

463. Bond, James, Rumsey T S , Menear, J R , Colbert, L I , Kern, Dona, and Weinland, B T **Effects of Simulated Sonic Booms on Eating Patterns, Feed Intake and Behavioral Activity of Ponies and Beef Cattle.** U S Dep Agriculture paper presented at the International Environment Symposium (Univ of Nebraska, Lincoln), Apr 1974

Eight ponies, 2 open cows, 6 cows with calves, and 24 steers fed *ad libitum* were used in a series of 6 trials to study the effects of simulated sonic booms on eating patterns, feed intake, and behavioral activity Eating patterns were monitored for 5 days before exposure, during exposure, and for 5 days after exposure to simulated booms by means of photoelectric cells and a time-operation recorder The animals were similar in temperament to those found on small farms The behavioral activity of all animals was monitored before, during and after the exposure to simulated sonic booms On the day of exposure, one boom was generated at 10 00 a m and one at 10 15 a m by a 4 1-m-diameter exponential horn, into which two charges of compressed air were released sequentially by time-controlled ruptures of two diaphragms The resulting boom from the horn produced overpressures of approximately 200 N/m^2 All animals clearly showed a startle response, but the animals returned to preboom behavioral activity comparable to that in baseline observations The eating patterns and feed intake of the animals after exposure were not distinguishable from those of the same animals before exposure Less overt response to the later boom suggests that the animals adapted or habituated quickly to recurring booms Of more importance was the total absence of continual arousal or general panic in any of the animals

464 Boutelier, C , Demange, J , and Vettes, B **Effect of Sonic Boom on Man and Animals—Review of Principal**

Studies Carried Out in France Rev Med Aeronaut Spat, vol 13, 3rd Q, 1974, pp 222-227

A75-17374

The present work discusses some of the main conclusions drawn from various studies on the effects of sonic booms on hearing and balance, sleep, and the cardiovascular system in man, and on the breeding of certain production animals and some physiological indices of experimental animals It is shown that the physiological effects of sonic booms in man and animals are not such as to have any serious consequences for the organism, and that the annoyance caused by the boom must be of psychological nature

Other Documents

465 Parker, J B, and Bayley, N D **Investigations on Effects of Aircraft Sound on Milk Production of Dairy Cattle 1957-58** ARS 44-60, U S Dep Agriculture, Feb 1960

466 Bond, James, Winchester, Clarence F, Campbell, L E, and Webb, J C **Effects of Loud Sounds on the Physiology and Behavior of Swine** Tech Bull No 1280, U S Dep Agriculture, Mar 1963

467. Hinshaw, W R, Bell, W B, Ladson, T A, McNeil, E C E, and Taylor, J P **An Annotated Bibliography on Animal Response to Sonic Booms and Other Loud Sounds** PB-199034, National Academy of Sciences—National Research Council, Dec 1970

N73-73665

468. Bond, James **Effects of Noise on the Physiology and Behavior of Farm-Raised Animals.** Physiological Effects of Noise, Bruce L Welch and Annemarie S Welch, eds, Plenum Press, 1970, pp 295-304

A71-13166

469. Boutelier, C **Animal Reactions to Sonic Boom** Rev Med Aeronaut Spat, vol 9, 2nd Q, 1970, pp 79-81

A71-13097

470. Ruddlesden, F **Some Observations on the Effect of Bang Type Noises on Laying Birds** British R A E TR-71084, Apr 1971

X71-83753

471 **Effects of Noise on Wildlife and Other Animals.** NTID 300 5, U S Environmental Protection Agency, Dec 1971

N75-77214

472 Bond, James **Noise—Its Effect on the Physiology and Behavior of Animals.** Agric Sci Rev, vol 9, no 4, 4th Q, 1971

473 Espmark, Yngve **Behaviour Reactions of Reindeer Exposed to Sonic Booms.** Deer, vol 2, no 7, Mar 1972, pp 800-802

474. Teer, James G, and Truett, Joe C **Studies of the Effects of Sonic Boom on Birds** FAA-RD-73-148, Sept 1973

N74-10039

475 Higgins, Thomas H **The Response of Songbirds to the Seismic Compression Waves Preceding Sonic Booms.** FAA-RD-74-78, May 1974

N74-32433

476. Lynch, Thomas E, and Speake, Dan W **The Effect of Sonic Boom on the Nesting and Brood Rearing Behavior of the Eastern Wild Turkey.** FAA-RD-75-2, Jan 1975

N75-29730

477. Dancer, A, and Franke, R **Investigation of the Cochlear and Evoked Potentials of Guinea Pigs Subjected to the Action of N-Shaped Waves Simulating the Sonic Boom** Acustica, vol 35, no 1, Apr 1976, pp 55-62

A76-31829

478 Reinis, S **Bleeding Into Inner Ears of Chinchillas Caused by Simulated Boom** J Sound & Vib, vol 59, no 4, Aug 22, 1978, pp 611-614

A78-51847

479. Fletcher, John L, and Busnel, Rene Guy, eds **Effects of Noise on Wildlife—9th International Congress on Acoustics.** Academic Press, 1978

480 Jehl, Joseph R, Jr, and Cooper, Charles F, eds **Potential Effects of Space Shuttle Sonic Booms on the Biota and Geology of the California Channel Islands: Research Reports** Tech Rep 80-1, Center for Marine Studies, San Diego State Univ, Dec 1980

481 Cooper, Charles F, and Jehl, Joseph R, Jr **Potential Effects of Space Shuttle Sonic Booms on the Biota and Geology of the California Channel Islands: Synthesis of Research and Recommendations.** Tech Rep 80-2, Center for Marine Studies, San Diego State Univ, Dec 1980

9. Effects of Sonic Booms on Terrain

Key Documents

482 Cook, J C , and Goforth, T **Seismic Effects of Sonic Booms.** Sonic Boom Experiments at Edwards Air Force Base, NSBEO-1-67 (Contract AF 49(638)-1758), Stanford Res Inst , July 28, 1967, pp E-1–E-17

N67-36765

This paper includes a brief introduction to the science of seismology, gives examples of results obtained in field experiments with actual sonic booms, and provides preliminary interpretations

483 Cook, J C , Goforth, T , and Cook, R K **Seismic and Underwater Responses to Sonic Boom** J Acoust Soc America, vol 51, no 2, pt 3, Feb 1972, pp 729–741

A72-21907

Sonic booms produced by aircraft moving at supersonic speeds apply moving loads to the Earth's surface In deep water, a moving underwater pressure field is observed to accompany the hyperbolic boom trace sweeping over the surface The pressure waveform underwater near the surface is almost identical to that of the *N*-wave in air, but it is rapidly smoothed and attenuated with depth, typically becoming one-tenth as large at a depth less than 0 6 of the *N*-wavelength Adequate quantitative theories for the underwater effect have been developed and have been verified by scale-model experiments On land, which is generally stratified, there are two major effects the 'static' deformation field traveling with the surface load, and air-coupled Rayleigh wave trains following each *N*-wave transient Present quantitative theories for the major seismic effects agree reasonably well with the experiments Seismic forerunner waves, which begin at least 7 sec before arrival of the sonic boom, might be exploited for automatic warnings to lessen the startle effect Sonic booms probably cannot trigger earthquakes, but might possibly precipitate incipient avalanches or landslides in exceptional areas which are already stressed to within a few percent of instability

484. Weber, G **Sonic Boom Exposure Effects II 1. Structures and Terrain.** J Sound & Vib , vol 20, no 4, Feb 22, 1972, pp 505–509

A72-23318

This paper contains an evaluation of sonic-boom effects on topographical features and ground motion effects on structures, and a discussion of damage-pertinent structural parameters The attempt is made to present conclusive statements on sonic-boom exposure and on occurrence of damage to structures on the basis of the extensive data on sonic-boom damage accumulated over the past 10 years This is a report from a workshop on methods and criteria held in Stockholm, Sweden

485. Waters, John F **Penetration of Sonic Boom Energy Into the Ocean. An Experimental Simulation.** Noise and Vibration Control Engineering, Malcolm J Crocker, ed , Purdue Univ , c 1972, pp 554–557

A72-29587

Current theory treats the case of a sonic-boom *N*-wave impinging upon a flat air-water interface at an angle greater than the critical angle, which is about 13° An acoustically scaled sonic-boom simulation experiment was performed, and its results verify the validity of current theoretical predictions of the penetration of sonic-boom energy into a flat ocean The effects of the penetration of sonic-boom energy into the ocean should not be significant at depths greater than about 100 ft, on the basis of comparisons with ambient sound pressure levels

Other Documents

486. Lillard, David C , Parrott, Tony L , and Gallagher, Dale C **Effect of Sonic Booms of Varying Overpressures on Snow Avalanches.** SST 65-9, FAA, Aug 1965

AD 468 794

487 Baron, Melvin L , Bleich, Hans H , and Wright, Joseph P **An Investigation of Ground Shock Effects Due to Rayleigh Waves Generated by Sonic Booms.** NASA CR-451, 1966

N66-23618

488 Espinosa, A F , and Mickey, W V **Observations of Coupled Seismic Waves From Sonic Booms, A Short Note** Acustica, vol 20, no 2, 1968, pp 88–91

A68-41859

489. Goforth, Tom T , and McDonald, John A **Seismic Effects of Sonic Booms** NASA CR-1137, 1968

N68-35151

490 Hubbard, Harvey H **Recent Results of Sonic Boom Research** NASA TM X-61240, 1968

A70-16795

491 McDonald, John A , and Goforth, Tom T **Seismic Effects of Sonic Booms. Empirical Results** J Geophys Res , vol 74, no 10, May 15, 1969, pp 2637–2647

A69-29880

492 Cook, John C , and Goforth, Tom T **Ground Motion From Sonic Booms.** J Aircr , vol 7, no 2, Mar – Apr 1970, pp 126–129

A70-28078

493 Cook, Richard K **Penetration of a Sonic Boom Into Water** J Acoust Soc America, vol 47, no 5, pt 2, May 1970, pp 1430–1436

A70-34095

494. Glass, R E , and Waters, J F **Penetration of Sonic Boom Energy Into the Ocean—An Experimental Simulation** HRC-TR-288 (Contracts N00014-70-C-0374 & DOT-FA70WAI-185), Hydrospace Research Corp , June 1970 (Available from DTIC as AD 711 963)

N71-10094

495. Second Meeting of the Sonic Boom Panel, Report of the U S. Delegation. IGIA-17/4 8, 1970

N71-21976

496. Schaffar, M , Carrie, B , and Amardei, L P **Effect of Sonic Boom on Avalanches—Preparation for Flight of a Supersonic Jet Over the Lavey Valley** ISL-13/72, Institut Franco-Allemand de Recherches (St Louis, France), June 1972

N73-21940

497. Urick, R J , and Tulko, T J **Sonic Booms in the Sea A Recent Observation.** J Acoust Soc America, vol 52, no 5, pt 2, Nov 1972, pp 1566–1568

A73-12967

498. Grover, F H **Geophysical Effects of Concorde Sonic Boom.** R Astron Soc Quart J , vol 14, no 2, June 1973, pp 141–160

A73-39624

499 Goforth, Tom T , and Rasmussen, Robert K **Study of the Characteristics of Seismic Signals Generated by Natural and Cultural Phenomena.** NASA CR-132606, 1974

N76-32751

10. Sonic-Boom Simulator Technology

Key Documents

500 Hawkins, S J , and Hicks, J A **Sonic Bang Simulation by a New Explosives Technique** Nature, vol 211, no 5055, Sept 17, 1966, pp 1244–1245

A66-42417

An investigation of the line charge technique for simulating sonic bangs is reported Many complex waveforms can be synthesized by detonating linear charges contracted from multiple strands of detonating fuse of different lengths, it is shown schematically how sonic-bang simulants (Mark I) have been developed in this way A Mark II simulant, which is complementary to Mark I in that it simulates the energy of sonic bangs in the high-frequency range and is thus suitable for ear-response studies, is also described This type of simulant is composed of two identical line charges arranged side by side and detonated consecutively with an appropriate time delay

501 Edge, Philip M , Jr , and Hubbard, Harvey H **Review of Sonic-Boom Simulation Devices and Techniques.** J Acoust Soc America, vol 51, no 2, pt 3, Feb 1972, pp 722–728

A72-21906

Research on aircraft-generated sonic booms has led to the development of special techniques to generate controlled sonic-boom-type disturbances without the complications and expense of supersonic flight operations This paper contains brief descriptions of several of these techniques along with the significant hardware items involved and indicates the advantages and disadvantages of each in research applications Included are wind tunnels, ballistic ranges, spark discharges, piston phones, shock tubes, high-speed valve systems, and shaped explosive charges Specialized applications include sonic-boom generation and propagation studies and the responses of structures, terrain, people, and animals Situations for which simulators are applicable are shown to include both small-scale and large-scale laboratory tests and full-scale field tests Although no one approach to simulation is ideal, the various techniques available generally complement each other to provide desired capability for a broad range of sonic-boom studies

502. Warren, C H E **Sonic Boom Exposure Effects II 6 Sonic Boom Generators.** J Sound & Vib , vol 20, no 4, Feb 22, 1972, pp 535–539

A79-23323

This paper gives a review of the research facilities for the study of sonic-boom effects and discussion of the types of study for which these facilities are suitable Sonic-boom simulators for field and laboratory studies discussed include explosive charges, acoustic guns, traveling-wave devices, speakers, and pistons The characteristics are enumerated that research facilities must have in order that meaningful and relevant experiments may be performed This is a report from a workshop on methods and criteria held in Stockholm, Sweden

503 Glass, I I, Ribner, H S, and Gottlieb, J J **Canadian Sonic Boom Simulation Facilities.** ICAS Paper No 72-26, Aug 1972

A72-41151

The motivation, design, theory, and initial performance of two Canadian sonic-boom simulation facilities—a loudspeaker-driven booth and a large traveling-wave horn—are described Early performance and some research results are outlined, and the potential for a variety of future investigations is pointed out The horn and booth-type simulators complement each other by providing flexibility for the study of human, animal, and structural response to sonic boom This study is to provide the information needed in the preparation of accurate guidelines for new legislation that will govern SST flight paths as affected by Canadian weather, terrain, wildlife, and population distribution

504. Garen, W , Synofzik, R , and Frohn, A **Shock Tube for Generating Weak Shock Waves** AIAA J , vol 12, no 8, Aug 1974, pp 1132–1134

A74-38614

A pneumatic valve is described which can be used to replace the diaphragm of a conventional shock tube The device opens practically independently of the pressure difference between the driver section and the driven section, permitting the use of very low driver pressures in order to obtain low shock Mach numbers It can be opened always at exactly the same driver pressure, so a good reproduction of the state of the shocked gas is possible Results of test runs are presented and analyzed

Other Documents

505. Edge, Philip M , Jr , and Mayes, William H **Description of Langley Low-Frequency Noise Facility and Study of Human Response to Noise Frequencies Below 50 cps.** NASA TN D-3204, 1966

N66-14904

506 Dhalke, Hugo E , Kantarges, George T , Siddon, Thomas E , and van Houten, John J **The Shock Expansion Tube and Its Application as a Sonic Boom Simulator.** NASA CR-1055, 1968

N68-24966

507 Schwartz, Ira R **Sonıc Boom Sımulation Facilıtıes** Aırcraft Engıne Noıse and Sonıc Boom, AGARD-CP-42, May 1969, pp 29-1–29-18

N70-13164

508 Hawkıns, S J , and Hıcks, J A **Sonic Bang Simulatıon by Explosıves** Aerodynamıc Noıse, Unıv of Toronto (Canada), 1969, pp 409–422

A70-16796

509 Tomboulıan, Roger **Research and Development of a Sonıc Boom Sımulatıon Devıce.** NASA CR-1378, 1969

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510 Kurze, Ulrıch J , Hayden, Rıchard E , Madden, Rıchard, Allen, Clay H , and Ungar, Erıc E **Sonıc Boom Sımulatıon by Means of Low-Pressure Sources.** NASA CR-66969, 1970

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A71-18625

513 Thery, C , Peter, A , and Schlosser, F **The Sonic Boom Sımulator at ISL** ISL-R 15/71, Instıtut Franco-Allemand de Recherches (St Louıs, France), June 1971

N72-22323

514. Rash, L C , Barrett, R F , and Hart, F D **Development and Evaluation of a Device To Simulate a Sonic Boom** NASA CR-112117, 1972

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515 Ellıs, N D , Rushwald, I B , and Rıbner, H S **A One-Man Portable Sonic Boom Simulator.** J Sound & Vıb , vol 40, no 1, May 8, 1975, pp 41–50

A75-32427

516 Gottlıeb, James J **Simulation of a Travelling Sonic Boom ın a Pyramidal Horn.** Prog Aerosp Scı , vol 17, no 1, 1976, pp 1–66

A77-33749

517. Gottlıeb, J J **An Experimental and Analytical Study of a New Flap Valve for Generating Sımulated Sonic Booms.** J Sound & Vıb , vol 72, no 3, Oct 8, 1980, pp 283–302

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518. Rıbner, Herbert S , and Roy, Dıpankar **Acoustics of Thunder. A Quasilinear Model for Tortuous Lightning** J Acoust Soc Amerıca, vol 72, no 6, Dec 1982, pp 1911–1925

A83-16315

519 Shepherd, Kevın P , and Powell, Clemans A **Status and Capabilities of Sonıc Boom Sımulators** NASA TM-87664, 1986

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16 Abstract
Citations of selected documents are included which represent the state of the art of technology in each of the following subject areas: prediction, measurement, and minimization of steady-flight sonic booms, prediction and measurement of accelerating-flight sonic booms, sonic-boom propagation, the effects of sonic booms on people, communities, structures, animals, birds, and terrain, and sonic-boom simulator technology Documents are listed in chronological order in each section of the paper, with key documents and associated annotation listed first The sources are given along with acquisition numbers, when available, to expedite the acquisition of copies of the documents

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