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GOVERNMENT

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NOISE CONTROL ACT OF 1971 AND AMENDMENTS

DOCUMENTS

MAY 17 1972 HEARINGS

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BEFORE THE

SUBCOMMITTEE ON AVIATION

OF THE

COMMITTEE ON COMMERCE

UNITED STATES SENATE

NINETY-SECOND CONGRESS

FIRST SESSION

ON

S. 1016

TO CONTROL THE GENERATION AND TRANSMISSION OF NOISE
DETRIMENTAL TO THE HUMAN ENVIRONMENT, AND
FOR OTHER PURPOSES

S. 1566

TO AMEND THE FEDERAL AVIATION ACT OF 1958 IN ORDER
TO PROVIDE FOR MORE EFFECTIVE CONTROL
OF AIRCRAFT NOISE

JULY 12 AND 13, 1971

Part 2

Serial No. 92-48

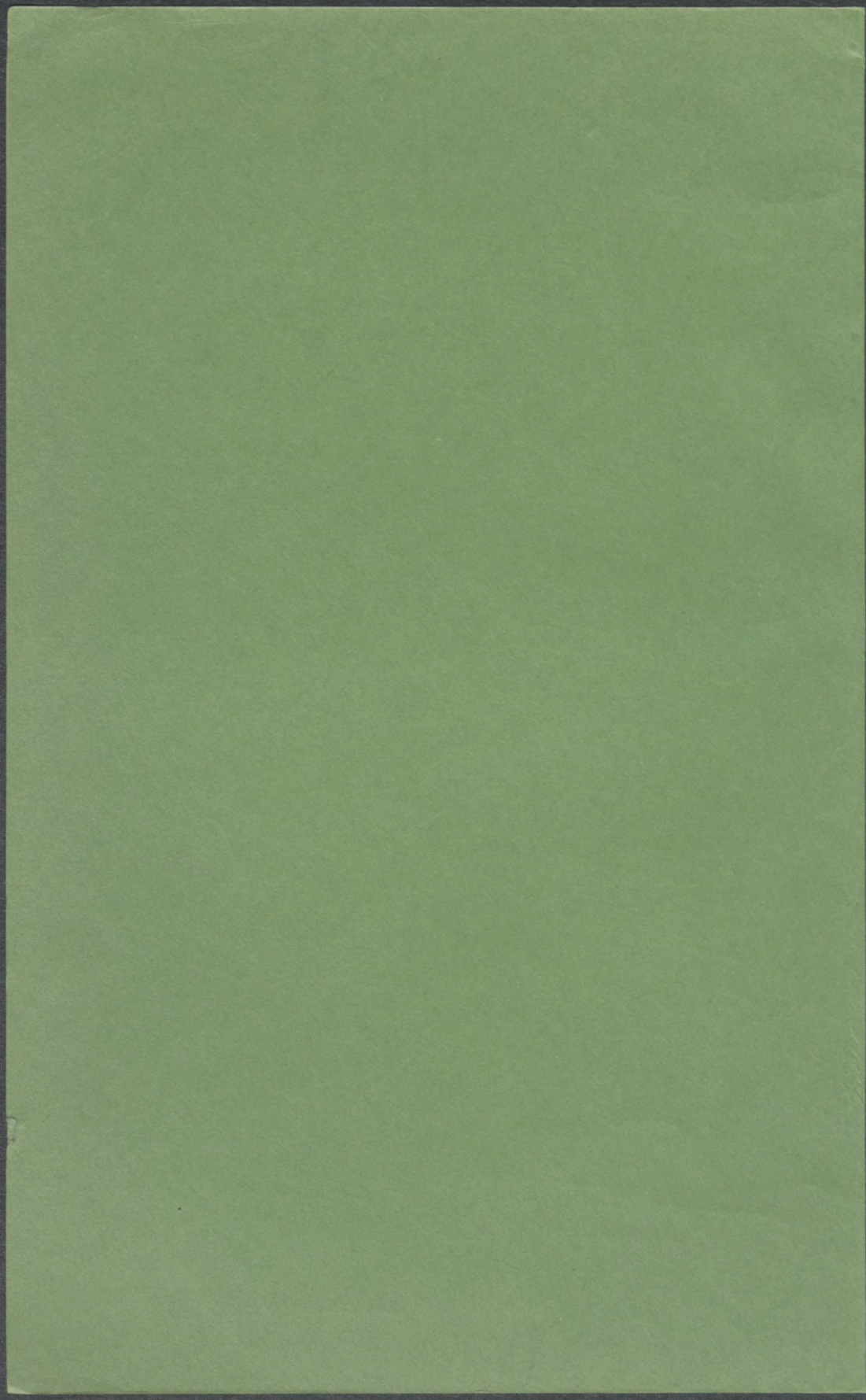
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U.S. GOVERNMENT PRINTING OFFICE

WASHINGTON : 1972

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NOISE CONTROL ACT OF 1971 AND AMENDMENTS

MONDAY, JULY 12, 1971

U.S. SENATE,
COMMITTEE ON COMMERCE,
SUBCOMMITTEE ON AVIATION,
Washington, D.C.

The subcommittee met at 9:05 a.m., in room 5110, New Senate Office Building, Hon. Howard W. Cannon (chairman of the subcommittee) presiding.

Present: Senators Cannon and Moss.

OPENING STATEMENT OF THE CHAIRMAN

Senator CANNON. The hearings will come to order.

Today's hearing concerns the broad question of aircraft noise; its impact on the environment; and how to reduce and control it. In particular, the subcommittee is interested in hearing testimony on two legislative proposals regarding aircraft noise now pending.

First is S. 1016, the administration's proposal dealing with noise control in general. The administration's bill is pending before the Subcommittee on Environment which has heard testimony already. However, one section of that bill specifically deals with aircraft noise and amends the Federal Aviation Act by establishing new authority to set noise standards for aircraft.

Specifically, the administration's bill would amend the Department of Transportation and Federal Aviation Administration's sole authority to establish standards for the control of aircraft noise. Under the administration's proposal, the standards, rules and regulations set by the Department of Transportation and the FAA would be subject to the veto of the Administrator of the Environmental Protection Agency.

Since 1968 when Congress first enacted legislation dealing with aircraft noise, the FAA and DOT have been moving forward by establishing rules and regulations pertaining to noise from aircraft. For this reason, the Subcommittee on Aviation wishes to explore the regulatory steps that have been taken so far, in order to assess whether Congress should reassign ultimate responsibility for regulation in this area to the new agency.

The other bill before us is S. 1566, sponsored by Senator Cranston and others. Basically the bill requires significant aircraft noise reduction be accomplished through retrofit of current aircraft as of January 1, 1976. In addition, the legislation would authorize appropriations for research and development to accomplish this goal and

Staff member assigned to these hearings: Robert E. Ginther.

would provide Government-guaranteed loans to the airlines to finance the retrofit costs. It would also direct the Civil Aeronautics Board to approve any air carrier fare increase that the carrier shows is necessary to pay for the cost of a retrofit program or for early retirement of aircraft.

The Cranston bill raises important technical and social issues which the committee wishes to consider in an attempt to assess whether a program of retrofit and early retirement of present-day aircraft is realistic technically and economically, and whether it will provide meaningful and measurable relief to communities affected by aircraft noise, and finally whether the cost of such a program, if approved, should be borne by the general public, by the air carriers or by the passengers who patronize the airlines.

Unfortunately, there presently exists a wide diversity of opinion regarding many of the technical and economic aspects of this important question.

In addition, the control of aircraft noise is a relatively new technological undertaking and there is a rather limited amount of knowledge about what is presently technologically feasible.

The committee will hear a number of expert witnesses from Government, industry, from public agencies and from the private sector on the subject in an attempt to better understand the current situation.

(The bills and agency comments follow:)

92D CONGRESS
1ST SESSION

S. 1016

IN THE SENATE OF THE UNITED STATES

FEBRUARY 26 (legislative day, FEBRUARY 17), 1971

Mr. COOPER (for himself, Mr. HATFIELD, Mr. ALLOTT, Mr. BAKER, Mr. BAYH, Mr. BEALL, Mr. BENNETT, Mr. BOGGS, Mr. BROCK, Mr. BUCKLEY, Mr. DOLE, Mr. DOMINICK, Mr. FANNIN, Mr. GURNEY, Mr. HART, Mr. HRUSKA, Mr. JAVITS, Mr. JORDAN of Idaho, Mr. MATILIAS, Mr. MUSKIE, Mr. PACKWOOD, Mr. PASTORE, Mr. PEARSON, Mr. PERCY, Mr. PROUTY, Mr. RANDOLPH, Mr. SAXBE, Mr. SCHWEIKER, Mr. SCOTT, Mr. SPONG, Mr. TAFT, Mr. TOWER, and Mr. WEICKER) introduced the following bill; which was read twice and referred to the Committees on Commerce and Public Works

A BILL

To control the generation and transmission of noise detrimental to the human environment, and for other purposes.

1 *Be it enacted by the Senate and House of Representa-*
2 *tives of the United States of America in Congress assembled,*
3 That this Act may be cited as the "Noise Control Act of
4 1971".

FINDINGS AND POLICY

6 SEC. 2. (a) The Congress finds—
7 (1) that inadequately controlled noise presents a
8 growing danger to the health and welfare of the Na-
9 tion's population, particularly in urban areas;

1 (2) that the major sources of noise include trans-
2 portation vehicles and equipment, machinery, appliances,
3 and other manufactured articles that move in commerce;
4 and

5 (3) that, while primary responsibility for control of
6 noise rests in many respects with the States and local
7 governments, Federal action is essential to deal with
8 major noise problems requiring national uniformity of
9 treatment.

10 (b) The Congress declares that it is the policy of the
11 United States to promote an environment for all Americans
12 free from noise that jeopardizes their health or welfare. To
13 that end, it is the purpose of this Act to establish a means for
14 effective coordination of Federal research and activities in
15 noise control, to supplement existing Federal authority for
16 regulation of the noise characteristics of articles moving in
17 commerce, and to authorize Federal noise labeling require-
18 ments for such articles. Nothing in this Act is intended to
19 diminish the responsibilities of State and local governments
20 to regulate other aspects of noise within their jurisdictions.

21

DEFINITIONS

22

SEC. 3. As used in this Act the term—

23

24

(a) "Administrator" means the Administrator of
the Environmental Protection Agency;

1 (b) "person" means any private person or entity,
2 any officer, department, agency, or instrumentality of
3 any State or local unit of government, and, except with
4 respect to the provisions of section 12 (a), any officer,
5 department, agency, or instrumentality of the Federal
6 Government;

7 (c) "product" means any article or good manu-
8 factured for sale in, or introduction into, commerce,
9 including but not limited to transportation vehicles and
10 equipment, machinery, and appliances: *Provided*, That
11 it does not include (i) aircraft, aircraft engines, pro-
12 pellers, or appliances that are covered by title VI of the
13 Federal Aviation Act of 1958 (49 U.S.C. 1421-32),
14 (ii) those military aircraft, weapons, or equipment that
15 are designed for combat use; or (iii) those aircraft,
16 rockets, or equipment that are designed for research or
17 experimental or developmental work to be performed
18 by the National Aeronautics and Space Administra-
19 tion, or other machinery or equipment designed for use
20 in experimental work done by or for the Federal
21 Government;

22 (d) "ultimate purchaser" means the first person
23 who in good faith purchases a new product for purposes
24 other than resale;

1 (e) "new product" means a product the equitable
2 or legal title to which has never been transferred to an
3 ultimate purchaser;

4 (f) "manufacturer" means any person engaged in
5 the manufacturing or assembling of new products or who
6 acts for, and is controlled by, any such person in connec-
7 tion with the distribution of such products; and

8 (g) "commerce" means trade, traffic, commerce,
9 transportation, or communication among the several
10 States, or between a place in a State and any place out-
11 side thereof, or within the District of Columbia or a
12 possession of the United States, or between points in the
13 same State but through a point outside thereof.

14 COORDINATION AND EVALUATION OF FEDERAL PROGRAMS

15 SEC. 4. (a) The Administrator shall promote coordina-
16 tion of the programs of all Federal departments and agencies
17 relating to noise research and noise control. Each Federal
18 department or agency shall, upon request, furnish to the Ad-
19 ministrator such information as he may reasonably require to
20 determine the nature, scope, and results of the noise-research
21 and noise-control programs of the department or agency.

22 (b) On the basis of regular consultation with appro-
23 priate Federal departments and agencies, the Administrator
24 shall compile and publish, from time to time, a report on the
25 status and progress of Federal activities relating to noise re-

1 search and noise control. This report shall describe the noise
2 programs of each Federal department or agency and assess
3 the contributions of those programs to the Government's
4 overall efforts to control noise.

5 NOISE CRITERIA AND CONTROL TECHNOLOGY

6 SEC. 5. (a) The Administrator shall, after consulta-
7 tion with appropriate Federal departments and agencies,
8 develop and publish such criteria for noise as in his judg-
9 ment may be requisite for the protection of the public health
10 and welfare. Such criteria shall reflect the scientific knowl-
11 edge most useful in indicating the kind and extent of all
12 identifiable effects on the public health or welfare which
13 may be expected from differing quantities and qualities of
14 noise. The Administrator shall confer with the Secretaries
15 of Health, Education, and Welfare, and of Labor to assure
16 consistency between the criteria published under this sub-
17 section and the criteria and standards for occupational noise
18 exposure produced under the Occupational Safety and
19 Health Act of 1970.

20 (b) The Administrator shall, after publication of the
21 initial criteria pursuant to subsection (a) of this section and
22 after consultation with appropriate Federal departments and
23 agencies, compile and publish a report or series of reports
24 identifying major sources of noise and giving information
25 on techniques for control of noise from such sources. This

1 information shall include such data as are available on the
2 technology, costs, and alternative methods of noise control.

3 (c) The Administrator shall from time to time review
4 and, as appropriate, revise or supplement any criteria or in-
5 formation on control techniques published pursuant to this
6 section.

7 (d) The publication or revision of any criteria or in-
8 formation on control techniques pursuant to this section shall
9 be announced in the Federal Register, and copies shall be
10 made available to the general public.

11 NOISE-GENERATION STANDARDS

12 SEC. 6. (a) If the Administrator, in a report published
13 pursuant to section 5, identifies as a major source of noise
14 any product or class of products of one or more of the fol-
15 lowing types:

- 16 (1) construction equipment,
17 (2) transportation equipment (including recre-
18 reational vehicles and related equipment), or
19 (3) equipment powered by internal combustion
20 engines.

21 he may, after consultation to the extent desirable with appro-
22 priate Federal departments and agencies, by regulation pre-
23 scribe and amend standards limiting the noise-generation
24 characteristics (including reasonable durability over the life
25 of the product) of such product or class of products. The

1 standards so prescribed shall be the standards that the Ad-
2 ministrator determines, consistent with criteria published
3 pursuant to section 5, to be requisite to protect the public
4 health and welfare. In prescribing and amending such
5 standards the Administrator shall consider whether any pro-
6 posed standard is economically reasonable, technologically
7 practicable, and appropriate for the particular products to
8 which it will apply, and whether the particular products can
9 more effectively be controlled through Federal regulation of
10 interstate commerce or through State or local regulations:
11 *Provided*, That no standards prescribed under this section
12 shall apply to products manufactured on or before the effec-
13 tive date of such standards.

14 (b) The Administrator shall publish any standards pro-
15 posed under subsection (a) in the Federal Register at least
16 sixty days prior to the time when such standards will take
17 effect. In addition to submissions of written views, any per-
18 son who will be adversely affected by such proposed regu-
19 lation may, within forty-five days of the date of publication
20 of the proposed regulation, or within such other time period
21 as the Administrator may prescribe, file objections with the
22 Administrator and request a public hearing. Requests for a
23 public hearing made by a manufacturer of a product cov-
24 ered by the proposed standards shall be granted. Requests for
25 a public hearing by other persons may be granted at the

1 discretion of the Administrator. If a public hearing is held,
2 final regulations will not be promulgated by the Adminis-
3 trator until after the conclusion of such hearing.

4 (c) Section 611 of the Federal Aviation Act of 1958
5 (49 U.S.C. 1431) is amended as follows:

6 (1) In subsection (a), after "with the Secretary of
7 transportation", insert "and subject to the approval of the
8 Administrator of the Environmental Protection Agency".

9 (2) At the end of subsection (a), insert "Standards,
10 rules, and regulations prescribed and amended under this
11 section shall become effective only upon approval by the
12 Administrator of the Environmental Protection Agency:
13 *Provided, That,* all standards, rules, and regulations pre-
14 scribed pursuant to this section prior to the effective date
15 of the Noise Control Act of 1971 shall remain in effect until
16 amended or revoked by subsequent standards, rules, or reg-
17 ulations prescribed and approved pursuant to this section."

18 (3) After subsection (a), insert the following new sub-
19 sections:

20 "(b) The Administrator of the Federal Aviation Ad-
21 ministration shall not issue a type certificate under section
22 603 of this Act for any aircraft, or for any aircraft engine,
23 propeller, or appliance that affects significantly the noise
24 or sonic boom characteristics of any aircraft, unless he shall
25 have prescribed standards, rules, and regulations under this

1 section that apply to such aircraft, aircraft engine, propeller,
2 or appliance.

3 “(c) If at any time the Administrator of the Environ-
4 mental Protection Agency has reason to believe that an ex-
5 isting standard, rule, or regulation under this section does
6 not protect the public from aircraft noise or sonic boom to
7 the maximum extent that is consistent with the considera-
8 tions listed in subsection (d) of this section, he may re-
9 quest the Administrator of the Federal Aviation Adminis-
10 tration to review and report to him on the advisability of
11 revising such standard, rule, or regulation. Any such re-
12 quest shall be accompanied by a detailed statement of the
13 information on which it is based.”

14 (4) Subsections (b) and (c) are redesignated as (d)
15 and (e).

16 (d) No State or subdivision thereof shall adopt or en-
17 force, with respect to any product for which noise-generation
18 standards have been prescribed by the Administrator under
19 subsection (a) of this section, any standard limiting noise-
20 generation characteristics different from the standards pre-
21 scribed by the Administrator. Nothing in this section shall
22 diminish or enhance the rights of any State or subdivision
23 thereof otherwise to control, regulate, or restrict the use,
24 operation, or movement of such products.

LABELING

SEC. 7. (a) The Administrator may by regulation designate products or classes thereof:

(1) that produce noise capable of adversely affecting the public health or welfare; or

(2) that are sold wholly or in part on the basis of their effectiveness in reducing noise.

(b) For each of such products or classes the Administrator may, after consultation to the extent desirable with appropriate Federal departments and agencies, by regulation require that a notice of the actual level of noise generation, or notice of the actual effectiveness in reducing noise, be affixed to the product and to the outside of its container at the time of its sale to the ultimate purchaser. He shall prescribe the form of the notice and the methods and units of measurement to be used for this purpose.

(c) Nothing in this section shall preclude or deny to any State or subdivision thereof the right to regulate product labeling in any way not in conflict with regulations promulgated by the Administrator under this section.

PROHIBITED ACTS

SEC. 8. (a) The following acts or the causing thereof are prohibited:

(1) in the case of a manufacturer of new products, the sale, the offering for sale, or the introduction

1 or delivery for introduction into commerce of any prod-
2 uct manufactured after the effective date of regulations
3 promulgated under section 6 (a) (respecting noise-gen-
4 eration characteristics) that are applicable to such prod-
5 uct, unless it is in conformity with such regulations (ex-
6 cept as provided in subsection (b) of this section) ;

7 (2) in the case of an owner or operator of a prod-
8 uct, the use in commerce of such product after the effec-
9 tive date of regulations promulgated under section 6 (a)
10 that are applicable to such product, unless it is in con-
11 formity with such regulations (except as provided in
12 subsection (b) of this section) ;

13 (3) the removal or rendering inoperative by any
14 person, other than for purposes of maintenance, re-
15 pair, or replacement, of any device or element of design
16 incorporated into any product in compliance with reg-
17 ulations promulgated under section 6 (a), prior to its
18 sale or delivery to the ultimate purchaser or during its
19 term of use.

20 (4) in the case of a manufacturer of new products,
21 the sale, the offering for sale, or the introduction or
22 delivery for introduction into commerce of any product
23 manufactured after the effective date of regulations pro-
24 mulgated under section 7 (respecting noise labeling)
25 that are applicable to such product, unless it is in con-

1 conformity with such regulations (except as provided in
2 subsection (b) of this section) ;

3 (5) the removal by any person of any notice af-
4 fixed to a product or container pursuant to regulations
5 promulgated under section 7, prior to sale of the product
6 to the ultimate purchaser ;

7 (6) the importation into the United States by
8 any person of any product in violation of regulations
9 promulgated under section 13 that are applicable to
10 such product; and

11 (7) the failure or refusal by any person to permit
12 access to, or copying of, records or to make reports or
13 provide information required under section 9.

14 (b) (1) The Administrator may exempt any product,
15 or class thereof, from paragraphs (1), (2), (4), and (6)
16 of subsection (a), upon such terms and conditions as he may
17 find necessary to protect the public health or welfare, for
18 the purpose of research, investigations, studies, demonstra-
19 tions, or training, or for reasons of national security.

20 (2) A product intended solely for export, and so labeled
21 or tagged on the outside of the container and on the product
22 itself, shall not be subject to paragraph (1), (2), or (4)
23 of subsection (a).

1 RECORDS, REPORTS, AND INFORMATION

2 SEC. 9. (a) Every manufacturer of a product for which
3 applicable regulations have been promulgated under section
4 6 (a) or section 7 shall establish and maintain such records,
5 make such reports, and provide such information (which
6 may include the availability of products coming off the as-
7 ssembly line for testing by the Administrator) as the Ad-
8 ministrator may reasonably require to enable him to deter-
9 mine whether such manufacturer has acted or is acting in
10 compliance with this Act and shall, upon request of an
11 officer or employee duly designated by the Administrator,
12 permit such officer or employee at reasonable times to have
13 access to such information and to copy such records.

14 (b) All information obtained by the Administrator or
15 his representatives pursuant to subsection (a) of this sec-
16 tion, which information contains or relates to a trade secret
17 or other matter referred to in section 1905 of title 18 of the
18 United States Code, shall be considered confidential for the
19 purpose of that section, except that such information may
20 be disclosed to other Federal officers or employees, in whose
21 possession it shall remain confidential, or when relevant in
22 any proceeding under this Act.

23 (c) This section shall apply only to manufacturers in
24 the United States.

FEDERAL PROGRAMS

SEC. 10. The Congress authorizes and directs that all agencies of the Federal Government shall, to the fullest extent consistent with existing authority, administer the programs within their control in such a manner as to further the policy declared in section 2 (b).

RESEARCH, TECHNICAL ASSISTANCE, AND PUBLIC
INFORMATION

SEC. 11. In furtherance of his responsibilities under this Act and to complement, as necessary, the noise-research programs of other Federal departments and agencies, the Administrator is authorized to—

(a) Conduct research, and finance research by contract with other public and private bodies, on the effects, measurement, and control of noise, including but not limited to—

(1) investigation of the psychological and physiological effects of noise on humans and the effects of noise on domestic animals, wildlife, and property, and determination of acceptable levels of noise on the basis of such effects;

(2) development of improved methods and standards for measurement and monitoring of noise, in cooperation with the National Bureau of Standards, Department of Commerce; and

1 (3) determination of the most effective and practic-
2 able means of controlling noise generation, transmission,
3 and reception;

4 (b) Provide technical assistance to State and local gov-
5 ernments to facilitate their development and enforcement of
6 ambient noise standards, including but not limited to—

7 (1) advice on training of noise-control personnel
8 and on selection and operation of noise-abatement equip-
9 ment; and

10 (2) preparation of model State or local legislation
11 for noise control; and

12 (c) Disseminate to the public information on the effects
13 of noise, acceptable noise levels, and techniques for noise
14 measurement and control.

15 **ENFORCEMENT**

16 SEC. 12. (a) (1) Any person who violates section 8 (a)
17 of this Act shall be subject to a civil penalty of not more than
18 \$25,000 for each violation, which may be assessed by the
19 Administrator or by a court in any action authorized by sub-
20 section (b) or (c) of this section.

21 (2) In any proceeding by the Administrator to assess
22 a civil penalty under this subsection, no penalty shall be
23 assessed until the person charged shall have been given
24 notice and an opportunity for a hearing on such charge. In

1 determining the amount of the penalty, or the amount agreed
2 upon in compromise, the Administrator shall consider the
3 gravity of the violation and the demonstrated good faith of
4 the person charged in attempting to achieve rapid com-
5 pliance after notification by the Administrator of a violation.
6 Upon failure of the offending party to pay any penalty
7 assessed, the Administrator may request the Attorney Gen-
8 eral to commence an action in the appropriate district court
9 for appropriate relief.

10 (3) For the purpose of this subsection, the commission
11 of any act prohibited by paragraph (1), (2), (3), (4),
12 (5), or (6) of section 8 (a) shall constitute a separate viola-
13 tion for each day or product involved.

14 (b) The district courts of the United States shall have
15 jurisdiction of actions brought by and in the name of the
16 United States to restrain violations of this Act or to enforce
17 civil penalties authorized by this Act. Any civil action au-
18 thorized to be brought by the United States under this Act
19 shall be referred to the Attorney General for appropriate
20 action.

21 (c) By agreement with any State, with or without re-
22 imbursement, the Administrator may authorize law enforce-
23 ment officers or other personnel of such State to enforce the
24 prohibitions of section 8 (a) by bringing actions in the ap-
25 propriate State courts. When authorized by State law, the
26 courts of such State may entertain actions brought by such

1 officers or personnel to restrain violations of this Act or to
2 enforce civil penalties authorized by this Act. In any action
3 under this subsection, any civil penalty imposed shall be pay-
4 able one-half to the State and one-half to the United States
5 Treasury.

6 IMPORTS

7 SEC. 13. (a) Products offered for importation shall be
8 subject to the same general standards and labeling require-
9 ments that are applied to like domestic products. The Ad-
10 ministrator shall by regulation prescribe the procedures by
11 which this will be accomplished with a minimum detrimen-
12 tal effect on domestic and international trade.

13 (b) The Secretary of the Treasury shall, in consultation
14 with the Administrator, issue regulations to carry out the
15 provisions of this Act with respect to products offered for
16 importation.

17 APPROPRIATIONS

18 SEC. 14. There are authorized to be appropriated to
19 carry out this Act for fiscal year 1972 and for each fiscal
20 year thereafter such sums as are necessary.

21 REPORT OF NOISE STUDY

22 SEC. 15. Section 402 (a) of the Clean Air Act
23 is amended by deleting everything before "a full and com-
24 plete investigation" and inserting in lieu thereof "The
25 Administrator shall carry out".

92^D CONGRESS
1ST SESSION

S. 1016

IN THE SENATE OF THE UNITED STATES

JUNE 21, 1971

Referred to the Committees on Public Works and Commerce, and ordered to
be printed

AMENDMENTS

Intended to be proposed by Mr. HATFIELD (for himself, Mr. HART, and Mr. CRANSTON) to S. 1016, a bill to control the generation and transmission of noise detrimental to the human environment, and for other purposes, viz:

1 On page 5, line 6, strike "The" and insert in lieu thereof
2 "Within ninety days from the date of enactment of this Act,
3 the".

4 On page 5, line 20, strike "after" and insert in lieu
5 thereof "Within ninety days of the".

6 On page 5, line 23, strike "or series of reports".

7 On page 6, strike lines 12 through 15 and insert in lieu
8 thereof:

9 "SEC. 6. (a) Within one year from the date of the en-

Amdt. No. 216

1 actment of this Act, with respect to the following products
2 or classes of products:”.

3 On page 6, line 21, strike “he may” and insert in lieu
4 thereof “the Administrator shall”.

5 On page 6, line 23, strike “and amend”.

6 On page 6, line 25, after “products.” insert the follow-
7 ing: “The Administrator may also by regulation prescribe
8 standards for any other products or classes of products if he
9 determines that such standards are desirable for the protec-
10 tion of the public health and welfare. All standards which
11 are prescribed pursuant to this Act shall become effective
12 no later than two years from the date of issue: *Provided*,
13 That the effective date of such standards may be suspended
14 if the Administrator determines that such extension is in
15 the public interest. The Administrator may amend such
16 standards at any time subject to the procedures of this sec-
17 tion governing the prescribing of such standards.”

18 On page 7, line 22, beginning with “Requests” strike
19 all through the period in line 1, page 8, and insert in lieu
20 thereof the following: “Requests for a public hearing shall
21 be granted unless determined by the Administrator to be in-
22 appropriate. All public hearings authorized by this subsec-
23 tion shall consist of the oral and written presentation of data,
24 views or arguments pursuant to section 4 of the Administra-
25 tive Procedure Act (5 U.S.C. 553).”

1 On page 10, line 14, between "purchaser." and "He"
2 insert the following sentence: "The Administrator shall by
3 regulation require that a notice of the actual level of noise
4 generation be affixed within one year of the date of enact-
5 ment of this Act to all products or classes of products used
6 primarily in or about the home excepting (1) those products
7 which have as their primary purpose the emission of sound
8 and (2) those products which emit only negligible noise."

9 On page 14, strike lines 1 through 6 and insert in lieu
10 thereof the following:

11 "FEDERAL PROCUREMENT

12 "SEC. 10. (a) No Federal agency may enter into any
13 contract for the procurement of goods, materials, or services
14 with any person who has been assessed a civil penalty under
15 section 12 when such contract is to be performed at a facility
16 at which the violation which gave rise to such penalty oc-
17 curred if such facility is owned, leased, or supervised by such
18 person. The prohibition in the preceding sentence shall con-
19 tinue until the Administrator certifies that the condition giv-
20 ing rise to such penalty has been corrected.

21 "(b) The Administrator shall establish procedures to
22 provide all Federal agencies with the notification necessary
23 for the purposes of subsection (a).

24 "(c) In order to implement the purposes and policy of
25 this Act, the Persident shall, not more than one hundred and

1 eighty days after its enactment, cause to be issued an order
2 (1) requiring each Federal agency authorized to enter into
3 contracts and each Federal agency which is empowered to
4 extend Federal assistance by way of grant, loan, or contract
5 to effectuate the purposes and policy of this Act in such con-
6 tracting or assistance activities, and (2) setting forth pro-
7 cedures, sanctions, penalties, and such other provisions, as
8 the President determines necessary to carry out such re-
9 quirement.

10 “(d) The President may exempt any contract, loan, or
11 grant from all or part of the provisions of this section where
12 he determines such exemption is necessary in this paramount
13 interest of the United States, and he shall notify the Con-
14 gress of such exemption.”.

15 On page 15, line 4, between “technical” and “assistance”,
16 insert “and financial”.

17 On page 15, line 6, strike “ambient”.

18 On page 16, beginning after “may” on line 7, strike all
19 through line 9 and insert in lieu thereof “commence an
20 action in the appropriate district court for appropriate relief
21 or request the Attorney General to commence such an
22 action.”.

23 On page 16, line 19, strike “shall” and insert in lieu
24 thereof “may be brought by the Administrator or may”.

1 On page 17, strike lines 21 to 25 and insert in lieu
2 thereof:

3 "OFFICE OF NOISE ABATEMENT AND CONTROL

4 "SEC. 15. The Administrator shall carry out his func-
5 tions under this Act through the Office of Noise Abatement
6 and Control established under section 402 (a) of the Clean
7 Air Act.

8 "ANNUAL REPORT

9 "SEC. 16. Not later than fourteen months after the date
10 of enactment of this Act and annually thereafter, the Admin-
11 istrator shall submit to the Congress a report which shall
12 include the following:

13 "(1) a description of activities conducted pursuant
14 to the Act during the preceding year;

15 "(2) areas of responsibility under this Act which
16 require increased attention in the future;

17 "(3) a summary of the extent to which cooperation
18 has been achieved with State and local governments;

19 "(4) a review of new psychological, physiological,
20 and technical information relevant to criteria published
21 pursuant to this Act, including areas requiring further
22 study; and

23 "(5) any other material which he determines to be
24 of value.

1 "CITIZEN SUITS

2 "SEC. 17. (a) Except as provided in subsection (b),
3 any person may commence a civil action for injunctive relief
4 on his own behalf—

5 "(1) against any person (including (A) the United
6 States, and (B) any other governmental instrumentality
7 or agency to the extent permitted by the eleventh amend-
8 ment to the Constitution) who is alleged to be in viola-
9 tion of a standard or regulation under this Act, or

10 "(2) against the Administrator where there is al-
11 leged a failure of the Administrator to perform any act
12 of duty under this Act which is not discretionary with
13 the Administrator.

14 The district courts shall have jurisdiction, without regard to
15 the amount in controversy or the citizenship of the parties to
16 enforce such a standard or regulation, or to order the Ad-
17 ministrator to perform such act or duty, as the case may be:
18 *Provided*, That nothing herein shall be construed to prevent
19 or preempt State courts from exercising jurisdiction in such
20 action.

21 "(b) No action may be commenced—

22 "(1) under subsection (a) (1) —

23 "(A) prior to thirty days after the plaintiff has
24 given notice of the violation (i) to the Adminis-
25 trator and (ii) to any alleged violator of the stand-
26 ard or regulation or

1 “(B) if the Administrator or any State has
2 commenced and is diligently prosecuting a civil ac-
3 tion in a court of the United States or a State to re-
4 quire compliance with the standard or regulation,
5 but in any such action any person may intervene as
6 a matter of right; or

7 “(2) under subsection (a) (2) prior to thirty days
8 after the plaintiff has given notice of such action to the
9 Administrator. Notice under this subsection shall be given
10 in such manner as the Administrator shall prescribe by
11 regulation.

12 “(c) In any action under this section, the Administrator,
13 if not a party, may intervene as a matter of right.

14 “(d) The court, in issuing any final order in any action
15 brought pursuant to subsection (a) of this section, may
16 award costs of litigation (including reasonable attorney and
17 expert witness fees) to any party, whenever the court deter-
18 mines such award is appropriate.

19 “(e) Nothing in this section shall restrict any right
20 which any person (or class of persons) may have under any
21 statute or common law to seek enforcement of any standard
22 or regulation or to seek any other relief (including relief
23 against the Administrator or a State agency).”.

92D CONGRESS
1ST SESSION

S. 1566

IN THE SENATE OF THE UNITED STATES

APRIL 19, 1971

Mr. CRANSTON introduced the following bill; which was read twice and referred to the Committee on Commerce

A BILL

To amend the Federal Aviation Act of 1958 in order to provide for more effective control of aircraft noise.

1 *Be it enacted by the Senate and House of Representa-*
2 *tives of the United States of America in Congress assembled,*
3 That section 611 of the Federal Aviation Act of 1958,
4 relating to the control and abatement of aircraft noise and
5 sonic boom, is amended by inserting at the end thereof the
6 following:

7 “(d) Effective on and after January 1, 1976, all
8 subsonic transport category aircraft operating within the
9 jurisdiction of the United States shall reduce their takeoff,
10 approach, and sideline noise each by 10 EPnDb from their
11 1971 noise levels or to the levels as set forth in appendix C

II

1 (not including section C 36.5 (c)) (14 CFR chapter 1,
2 part 36), and as prescribed in docket numbered 9337 (34
3 F.R. 18364), November 18, 1969, and amended by amend-
4 ment 36-1 (34 F.R. 18815, November 25, 1969; 34 F.R.
5 19025, November 29, 1969), whichever noise reduction is
6 greater. No airplane shall operate in violation of the pre-
7 scribed noise levels.

8 “(e) (1) The Administrator shall undertake by con-
9 tract an immediate program of research on representative
10 aircraft models prior to January 1, 1974, to demonstrate
11 compliance by prototype flight test with subsection (d) of
12 this section. Such contracts may be entered into without
13 regard to sections 3648 and 3709 of the Revised Statutes
14 (31 U.S.C. 529 and 41 U.S.C. 5), and shall provide that
15 each contractor shall repay the amount of the research and
16 development grants if the sound reduction devices developed
17 pursuant to those grants are sold commercially. Such pay-
18 ments shall be covered into the Treasury as miscellaneous
19 receipts.

20 “(2) There is authorized to be appropriated \$35,-
21 000,000 to carry out the provisions of this subsection.

22 “(3) The findings of all research and development
23 grants made pursuant to this section shall be made available
24 to foreign aircraft corporations which produce or have pro-

1 duced aircraft covered by the noise standards of subsection
2 (d) of this section.

3 “(f) (1) The Administrator may, upon terms and con-
4 ditions prescribed by him, guarantee in whole or in part
5 the repayment of any loan or other form of financing made
6 to an air carrier for the purpose of modifying airplanes
7 prior to January 1, 1976, to meet the requirements of sub-
8 section (d). The total amount guaranteed pursuant to this
9 subsection shall not exceed \$1,000,000,000.

10 “(2) No guaranty shall be made under this subsection—

11 “(A) unless the Administrator finds that without
12 such guaranty, in the amount thereof, the carrier would
13 be unable to obtain necessary funds, on reasonable terms,
14 for the purposes for which the financing is sought;

15 “(B) if in the judgment of the Administrator the
16 financing involved is at a rate of interest which is un-
17 reasonably high;

18 “(C) if the terms of such financing permit full
19 repayment more than fifteen years after the date thereof;
20 or

21 “(D) unless the Administrator finds that the pros-
22 pective earning power of the applicant carrier, together
23 with the character and value of the security pledged, if
24 any, furnish reasonable assurance of the applicant's

1 ability to repay the financing within the time fixed
2 therefor and reasonable protection to the United States.

3 A statement of the findings of the Administrator required
4 under the provisions of this subsection shall be made a mat-
5 ter of public record by the Administrator with respect to
6 each guaranty under the provisions of this subsection.

7 “(3) The Administrator may consent to the modifica-
8 tion of the provisions as to rate of interest, time of payment
9 of interest or principal, security, if any, or other terms and
10 conditions of any guaranty which it shall have entered into
11 pursuant to this subsection, or the renewal or extension of any
12 such guaranty, whenever the Administrator shall determine
13 it to be equitable to do so.

14 “(4) Payments required to be made as a consequence
15 of any guaranty by the Administrator made under this sub-
16 section shall be made by the Secretary of the Treasury from
17 funds hereby authorized to be appropriated in such amounts
18 as may be necessary for the purpose of carrying out the pro-
19 visions of this subsection.

20 “(5) In the event of any default on any such guaran-
21 teed financing, and payment in accordance with the guaranty
22 by the United States, the Attorney General shall take such
23 action as may be appropriate to recover the amount of such
24 payments, with interest, from the defaulting carrier, car-
25 riers, or other persons liable therefor.

1 “(6) The Administrator shall prescribe and collect a
2 guaranty fee in connection with each guaranty under this
3 subsection. Such fees shall not exceed such amounts as the
4 Administrator estimates to be necessary to cover the ad-
5 ministrative costs of carrying out the provisions of this sub-
6 section. Sums realized from such fees shall be deposited in
7 the Treasury as miscellaneous receipts.

8 “(g) The Civil Aeronautics Board shall not reject any
9 increase in rates, fares, or charges filed by an air carrier pur-
10 suant to section 403 of this Act if such carrier files with the
11 tariff showing such increase adequate proof that such in-
12 crease is due to costs of complying with subsection (d) of
13 this section. Such cost shall include both the cost of retro-
14 fitting aircraft with sound reduction devices and the early
15 retirement of aircraft due to implementation of the standards
16 imposed by this Act.

17 “(h) (1) The Administrator is authorized to make
18 grants to State and local agencies, subject to such terms and
19 conditions as he may determine appropriate for the purposes
20 of this section, to assist in paying the cost of administering
21 airport noise monitoring programs.

22 “(2) Not more than 15 per centum of the funds ap-
23 propriated pursuant to this section in any fiscal year may be
24 granted to agencies in any one State.

25 “(3) For the purpose of this subsection the term ‘State’

- 1 includes the Commonwealth of Puerto Rico, the Virgin Is-
- 2 lands, and Guam.
- 3 “(4) There is authorized to be appropriated not to ex-
- 4 ceed \$20,000,000 to carry out the provisions of this sub-
- 5 section.”

COMPTROLLER GENERAL OF THE UNITED STATES,
Washington, D.C., May 10, 1971.

B-75409.

HON. WARREN G. MAGNUSON,
Chairman, Committee on Commerce,
U.S. Senate.

DEAR MR. CHAIRMAN: This refers to your letter of March 16, 1971, in which you requested our comments on S. 1016, which would be cited as the "Noise Control Act of 1971."

The principal purpose of S. 1016 would be to control the generation and transmission of noise detrimental to the human environment.

We have no special information as to the advantages or disadvantages of the bill and therefore make no comments concerning its enactment.

The word "good" on line 7, page 3, should be changed to "goods." The word "transportation" on line 7, page 8, should read "Transportation."

Sincerely yours,

R. F. KELLER,
Assistant Comptroller General of the United States.

U.S. DEPARTMENT OF THE INTERIOR,
Washington, D.C., June 30, 1971.

HON. WARREN G. MAGNUSON,
Chairman, Committee on Commerce,
U.S. Senate, Washington, D.C.

DEAR MR. CHAIRMAN: This is in response to your request for the views of this Department on S. 1016, a bill "To control the generation and transmission of noise detrimental to the human environment, and for other purposes."

We recommend the enactment of this bill.

S. 1016, proposed by the Environmental Protection Agency, provides for continuing coordination of Federal activities relating to noise control and research. The Administrator of the Environmental Protection Agency is authorized to publish criteria concerning the effects of noise on public health and welfare. The Administrator is also authorized to promulgate standards concerning the noise generating characteristics of specific types of equipment and thus focus on the problems that are of serious current concern. To assure consistency and to avoid undue interruption of manufacturing operations, States would be precluded from issuing standards for any product for which a standard has been prescribed by the Administrator. A provision requiring labeling of noise characteristics on certain products designated by the Administrator is included. The Administrator also is given certain research, technical assistance and public information responsibilities in support of the noise-control program and enforcement authority to insure compliance with the requirements.

S. 1016 introduces an orderly, efficient, progressive noise-control program within the comprehensive framework of the Environmental Protection Agency, and enactment is strongly recommended.

The Office of Management and Budget has advised that there is no objection to the presentation of this report and that enactment of S. 1016 would be in accord with the Administration's program.

Sincerely yours,

HOLLIS M. DOLE,
Assistant Secretary of the Interior.

DEPARTMENT OF STATE,
Washington, D.C., June 30, 1971.

HON. WARREN G. MAGNUSON,
Chairman, Committee on Commerce,
U.S. Senate, Washington, D.C.

DEAR MR. CHAIRMAN: The Secretary has asked me to reply to your letter of March 16, 1971, requesting the Department's views on S. 1016, a bill to control the generation and transmission of noise detrimental to the human environment, and for other purposes.

The Department has no objection to this bill from the foreign policy point of view. We would, however, defer to the views of agencies more directly concerned.

The Office of Management and Budget advises there is no objection to the submission of this report and that enactment of S. 1016 would be in accord with the Administration's program.

Sincerely yours,

DAVID M. ABSHIRE,
Assistant Secretary for Congressional Relations.

DEPARTMENT OF AGRICULTURE,
Washington, D.C. July 7, 1971.

HON. WARREN G. MAGNUSON,
*Committee on Commerce,
U.S. Senate, Washington, D.C.*

DEAR MR. CHAIRMAN: This is in response to your letter of March 16 requesting comments on S. 1016, a bill "To control the generation and transmission of noise detrimental to the human environment, and for other purposes."

The bill declares that it is the policy of the United States to promote an environment free from noise that jeopardizes the health and welfare of people. The bill, therefore, is designed to coordinate and supplement Federal research and noise abatement activities.

The Administrator, Environmental Protection Agency, is directed, after consultation with appropriate Federal agencies, to develop and publish noise criteria requisite to protection of the public health and welfare.

The Administrator, Environmental Protection Agency, is authorized to prescribe standards by regulation limiting noise from:

1. Construction equipment
2. Transportation equipment
3. Equipment powered by internal combustion engines

Standards are to be published in the Federal Register at least 60 days prior to date when such standards will take effect. Any person adversely affected by the standards may, within 45 days after publication, file objections with the Administrator and request a public hearing.

Manufacturers of new products are prohibited from selling or offering for sale products not in conformity with noise standards established by regulations pursuant to the act.

Violators are subject to civil penalty up to \$25,000.

Imported products are subject to the same noise standards fixed by regulations as are those of domestic manufacture.

The Department of Agriculture supports the enactment of S. 1016 with the understanding that the Secretary of Agriculture is to be consulted before any actions are taken under the authority of this bill that will have an impact on the design, price, or use of farm equipment.

The bill provides needed authorities and procedures for noise control.

The Office of Management and Budget advises that there is no objection to the presentation of this report and that enactment of S. 1016 would be in accord with the Administration's program.

Sincerely,

J. PHIL CAMPBELL,
Acting Secretary.

CIVIL AERONAUTICS BOARD,
Washington, D.C. July 8, 1971.

HON. WARREN G. MAGNUSON,
*Chairman, Committee on Commerce,
U.S. Senate, Washington, D.C.*

DEAR MR. CHAIRMAN: This is in reply to your request for the Board's views on S. 1016, a bill "To control the generation and transmission of noise detrimental to the human environment, and for other purposes."

The bill, which is an Administration proposal, would, in general, vest the Administrator of the Environmental Protection Agency with primary responsi-

bility for promoting coordination of Federal programs relating to noise. The Administrator would be authorized to prescribe criteria for noise to protect the public health and welfare. Also, the Administrator would be required to identify and set noise generation standards for transportation, construction and other equipment, and to establish labeling requirements for products producing noise as designated by the Environmental Protection Agency. In addition, the existing authority of the Administrator of the Federal Aviation Administration to prescribe standards for the control of aircraft noise would be made subject to the approval of the EPA Administrator.

The Board is in accord with the objectives of the bill. However, the Board defers to the views of the Federal Aviation Administration and the Environmental Protection Agency with respect to the bill since the responsibilities of such agencies would be affected by its provisions.

The Office of Management and Budget has advised that there is no objection to the submission of this report from the standpoint of the Administration's program.

Sincerely,

WHITNEY GILLILLAND,
Acting Chairman.

NATIONAL SCIENCE FOUNDATION,
Washington, D.C., July 14, 1971.

HON. WARREN G. MAGNUSON,
*Chairman, Committee on Commerce,
U.S. Senate, Washington, D.C.*

DEAR MR. CHAIRMAN: This is in further response to your letter of April 22, 1971 requesting the comments of the National Science Foundation on S. 1016, a bill "To control the generation and transmission of noise detrimental to the human environment, and for other purposes." The Foundation supports the enactment of this bill.

While a great deal is known about the auditory effects of noise, there remain large gaps in our knowledge of its nonauditory effects. As your Committee may be aware, we are supporting research on such effects and in the broader field of acoustics. We shall of course share knowledge flowing from this research with the Environmental Protection Agency as provided in section 4 of the bill and look forward to coordinating our efforts and cooperating with the EPA on future research.

Finally, I suggest that the Committee on Hearing and Bio-Acoustics (CHABA) of the National Academy of Sciences—National Research Council, might be able to contribute to the consideration of this bill by your Committee.

The Office of Management and Budget has advised us that there is no objection to the submission of this report from the viewpoint of the Administration's program.

Sincerely yours,

THOMAS B. OWEN,
Acting Director.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION,
Washington, D.C., August 20, 1971.

HON. WARREN G. MAGNUSON,
*Chairman, Committee on Commerce,
U.S. Senate, Washington, D.C.*

DEAR MR. CHAIRMAN: This is in further reply to your request for the comments of the National Aeronautics and Space Administration on the bill S. 1016, "To control the generation and transmission of noise detrimental to the human environment, and for other purposes."

S. 1016 sets forth in detail the responsibilities of the Environmental Protection Agency in noise control and abatement. The functions and responsibilities provided for are in conformance with those of that Agency in other areas of pollution. The bill recognizes the separate responsibilities of other agencies both in programs and in R&D, with EPA as the central regulating and coordinating Agency. In this connection, it is noted that NASA responsibility in aircraft noise abatement and control R&D would not be altered.

The bill provides for the exemption of certain products from the standard-setting and labeling provisions of sections 6 and 7. In this connection, subsection 3(c) provides that "product" shall not include aircraft or aircraft components covered by title VI of the Federal Aviation Act of 1959, any article designed for military combat use, and aircraft, rockets or equipment designed for research or experimental or developmental work to be performed by NASA or for the Federal Government.

The National Aeronautics and Space Administration recommends enactment of S. 1016.

The Office of Management and Budget has advised that there is no objection to the submission of this report to the Congress, and that enactment of S. 1016 would be in accord with the program of the President.

Sincerely,

GERALD J. MOSSINGHOFF,

By H. DALE GRUBB.

Assistant Administrator for Legislative Affairs.

COMPTROLLER GENERAL OF THE UNITED STATES,
Washington, D.C., June 11, 1971.

HON. WARREN G. MAGNUSON,
*Chairman, Committee on Commerce,
U.S. Senate.*

DEAR MR. CHAIRMAN: By letter of April 26, 1971, you requested our comments on S. 1566, 92d Congress, which would amend the Federal Aviation Act of 1958 to provide for more effective control of aircraft noise.

We have no special information as to the advantages or disadvantages of the measure and therefore make no comments regarding its merits.

We note, however, that the bill contains no requirement that grantees under the proposed subsection (h) make the accounting records used to support the amount of their grants available for audit by the Administrator of the Federal Aviation Agency or the Comptroller General. We suggest that language to this effect be included in the bill. This could be accomplished by adding the following language to subsection (h) :

"(5) Each recipient of a grant under this subsection shall keep such records as the Administrator may prescribe, including records which can be used to support fully the amount of his grant, and such records as will facilitate an effective audit.

"(6) The Administrator and the Comptroller General of the United States, or any of their duly authorized representatives, shall have access for the purpose of audit and examination to any books, documents, papers and records of the recipient of any grant under this subsection which are pertinent to such grant."

The word "section" at line 23, page 5, should be changed to "subsection."

Sincerely yours,

R. F. KELLER,

Assistant Comptroller General of the United States.

Senator CANNON. Our first witness this morning is Hon. Alan Cranston, the senior Senator from California, who will testify on behalf of his bill, S. 1566.

Senator Cranston, we are glad to have you here, and you may proceed.

STATEMENT OF HON. ALAN CRANSTON, U.S. SENATOR FROM CALIFORNIA

Senator CRANSTON. Mr. Chairman, I deeply appreciate the opportunity to appear before you today, and I am very grateful to you for

scheduling these hearings on a matter that is of great importance to many, many Americans.

I have a prepared statement I would like to submit for the record, but I would just like to speak informally and briefly on the subject matter of my bill.

It is designed to reduce noise to a very, very significant degree for millions of Americans that live close to airports where jet planes come in and leave in a noisy fashion that interferes with the life and, quite conceivably, with the health of all too many Americans.

The FAA has set regulations that will require that future generations of planes, starting January 1 of next year, will have to be fitted with noise reduction devices in ways that will very significantly cut the noise that those planes make.

However, this leaves untouched present generations of planes, both flying and still in production, that would not be affected in any way. Somewhere between 1,600 and 2,000 planes will therefore be flying anywhere from 10 to 20 more years, producing noise at unacceptable levels for these million of Americans.

My bill proposes to do for those planes and for those people what the FAA has done for the future planes, by requiring that these present planes be retrofitted in a way that will reduce the noise that they produce anywhere from 50 to 75 percent.

Other witnesses who are highly qualified will testify before these hearings that it is totally within the capacity of the aerospace industry at present to retrofit these planes in these ways.

My bill would authorize \$35 million for the final research and development work necessary to insure that this retrofit can be done successfully; and it mandates a 1.5-percent increase in air fares to cover the cost of retrofitting the planes.

The airlines themselves have testified before the CAB that such a rate increase would have no harmful effects on their business. A rate increase would seem quite fair since the cost of the noise reduction would be borne by the passengers flying, whose convenience is served by flying in these jet planes, at the inconvenience of those who suffer the consequences in terms of noise.

The actual figures indicate that 3.5 million individuals now live in what are called unacceptable aircraft-noise environments, according to a study published just last month by the National Academy of Engineers. Many more live where their lives are inconvenienced by the noise in perhaps less hazardous ways.

Countless hospitals and schools are interfered with tremendously by this noise. A recent study conducted around Heathrow Airport in London reported that admissions to mental hospitals from areas with high noise pollution were 25 percent greater than admissions from other areas, indicating there may be a very severe health hazard involved in all of this.

Senator CANNON. Of course, that study does not indicate that that is the sole reason, and there may be many other factors. There may be many factors that exist in those areas.

Senator CRANSTON. That is right. They tried to factor out those other factors into the study. And it is not conclusive evidence, but it is something that certainly bears consideration.

I would also think the bill would serve the purposes of the aircraft industry, or rather, the airline industry. I call your attention, in case you did not see it, to an article that appeared in the New York Times just yesterday on the front page under the heading "New Jetports Held Up by Protest Movements." It points out in that article—which I would like to submit for the record—that there is a growing wave of protests over the use of current airports and the expansion of those airports and the development of new airports, primarily because of the noise that has developed since jet planes have started flying.

It indicates that there is so much opposition now that the ability to keep pace with our flying needs is in jeopardy because of this noise factor; and I believe that this bill would, therefore, serve that purpose for the flying public and for the airlines, as well as meet the needs of people who live in this noisy area around the airports.

One other factor which I think is quite important is that this work would employ something like 30,000 aerospace workers for approximately 2 years doing the retrofit work. And at a time when we have such widespread unemployment in that particular industry and such great talent, that would seem to be an important factor to be considered.

I would be delighted to answer any questions you might have. Otherwise, my prepared statement covers the matter.

Senator CANNON. Thank you very much. Your bill would require all transport aircraft in the United States, both piston and jet, to reduce their noise level by 10 EPnDb by January 1, 1976. Are you aware of any studies which would indicate that this level of noise reduction would provide meaningful and noticeable relief for citizens living near or under flight paths to airports?

Senator CRANSTON. We have one study in California by Inglewood, Calif., which I will submit for the record, which does indicate that the answer to your question is positive.

Senator CANNON. That the 10-EPnDb reduction would meet those standards?

Senator CRANSTON. Yes. This is from the city of Inglewood, Calif. It is a complete analysis of the cost and benefits of a quite-engine retrofit program and it goes into what can be achieved.

The American Society of Engineers has also made a study that indicates this is possible and is within the state of the art.

Senator CANNON. If you can submit that, we would appreciate it very much.

The American Society of Engineers does not come to the conclusion that you represent. Are you aware of the joint DOT and Society of Automotive Engineers Conference on Aircraft and the Environment concluded earlier this year? I quote from their report:

A reduction of 20 EPnDb may be necessary for a really significant impact on airport community acceptance. On the other hand, good will may result from a

retrofit program even though reductions are quite small. A halving of noise on approach would be considered a marked improvement insofar as human response is concerned.

Senator CRANSTON. I certainly do not think goodwill purposes alone would be achieved. I believe more significant results than that can be achieved. Burt Raynes, head of the Rohr Corp. in California that has done a great deal of work on this, will testify later to the achievability of exactly what you are asking about.

Senator CANNON. You are aware of course that the FAA is experimenting now with changes in flight patterns to further reduce the noise level; that is, steeper descents and steeper climbouts. As a matter of fact, in the Washington area, they make a steep climbout to a fixed altitude and then reduce power until they get out of the high-density area to further reduce noise levels.

Senator CRANSTON. Yes; I am aware of that. I think that is a very fine step. I do not believe that it will provide the solution that retrofit would provide.

Senator CANNON. Of course, the thing that gives me some concern is whether, in view of that study I just referred to, a reduction of only 10 EPnDb as provided for in your bill would provide meaningful and noticeable relief from aircraft noise. In other words, if we just achieve a minor reduction that is not going to provide any meaningful relief it is going to be a tremendously costly program, at a time when the industry itself is probably in a poor position to begin a program of this magnitude.

Senator CRANSTON. Well, the studies that this bill would authorize, beyond studies already made, would be designed to verify that this can be done. There is very significant evidence that it can; and as the bill requires, the noise level would be reduced from 66 to 75 percent. Assuming that that can be done—and I believe the case can be established firmly it can—that is a very significant reduction.

Senator CANNON. How long do you envision it would take to accomplish this result?

Senator CRANSTON. We are talking about the deadline in the bill, January 1, 1976.

Senator CANNON. You have the deadline of 1976, but when would you first see the results? Would it be 1975, for example, before any results are achieved because of the problem of gearing up and getting the retrofit kits ready, and so on?

Senator CRANSTON. I am not certain of the answer to that point, but that is probably correct, sometime in 1975.

Senator CANNON. The reason I question that is because many of these retrofitted airplanes would actually be obsolete and would be retired normally by 1980 in any event. If we are not going to have a significant noise reduction, in the face of a very costly program, then you have to look at the economics of it, of whether the cost is going to be justified for the relatively short life remaining for these planes. The new family of engines now entering service are showing very significant reductions in noise level.

Senator CRANSTON. Somewhere around 70 percent of certain types of the present planes that we are considering will—apparently three-

engine aircraft—will still be flying by 1975. Forty percent of the 707's and the DC-9's are expected to be still flying by then. So there is a significant period—that is a 10-year period—of this noise continuing to harass those who are on the ground, inconveniencing them for the convenience of those who are flying. And this sharing of the costs, or covering the costs of those people, would seem to be a proper, equitable approach.

Senator CANNON. Are you aware of any studies which would indicate that the technology is now available to make the required reductions specified in your bill on the B-727, the B-737, and the DC-9, all powered by Pratt & Whitney JT8D engines?

At the present I am not aware of any evidence to indicate that those engines could be quieted to the point where they could meet the standards required in S. 1566.

Senator CRANSTON. Burt Raynes of the Rohr Corp., who will testify tomorrow at your hearing, will testify on that point and indicates that the answer is "Yes."

Senator CANNON. Of course, the Rohr study was simply a theoretical, paper study which did not actually design, test, or retrofit any aircraft, as I understand it.

Senator CRANSTON. Well, that is the way you start these programs. But I will leave it to Mr. Raynes to defend that study, and I am sure he will do it eloquently and forcefully.

Senator CANNON. Do you have any cost-benefit studies that you could give us, or an estimate on what the retrofit will cost?

Senator CRANSTON. The study from Inglewood, Calif., which I am submitting for the record, does cover that. It goes into a great deal on cost and the cost benefits.

Senator CANNON. Senator Moss?

Senator Moss. Thank you, Mr. Chairman.

I apologize for coming in late, and I did not get to hear the testimony of the Senator from California, although I have begun to glance through it.

I have considerable interest in this problem, and although I am no expert, I do not know the details of it, it is a problem and something that we must address ourselves to, it seems to me.

Therefore, I am here to learn and listen, and I am not in a position to do any questioning at this point.

Senator CRANSTON. Thank you very much for your interest in this matter.

Senator CANNON. In your statement, you stated that your bill would reduce commercial aircraft noise from one-half, and in some cases to less than one-fourth, its present level within the next 5 years. I have a hard time following you because you talk in terms of a 10-EPnDb reduction.

Now a B-707, for example, creates about 118 EPnDb on approach; and if you reduce that by 10, you are down to 108, which is roughly 10 or 11 percent rather than a factor of 66 to 75 percent.

Senator CRANSTON. It works on a logarithmic scale rather than a percentage scale, and I would prefer to leave it to, for example, Mr. Raynes, to respond to that question in more detail.

Senator CANNON. Allright; thank you very much. We appreciate your being here. And I must say that there are really some important economic questions in this whole issue that are very, very disturbing, because we are in a period now in which the airline industry is at the lowest ebb of its whole economic history, and to require a multibillion-dollar retrofit program, on top of all of their other woes, might not be very practical or wise.

It is unfortunate that we seem to locate an airport and then everyone moves in close about it; and then they complain about the noise and want the airport moved, even though they deliberately went into that area where the airport was in existence.

You in your own State, in your own city of Los Angeles, have seen that very evident, even to the point that the airport authority finally went in and purchased all those homes that have been built within the past 20 years between the airport and the Pacific Ocean, to try to eliminate part of this problem.

Senator CRANSTON. Well, I recognize those problems. I think the economic problems will be more immense if this is not done. I think the economic problems that are confronting the airlines now, and the airports now, and the obstacles to their proceeding with development that is necessary from their point of view, are not going to be resolved unless steps like the one I propose are taken, along with the steps that have already been taken by the FAA in regard to future planes.

I would like to read briefly from the New York Times article. They recount all the opposition—

Senator CANNON. Is that classified?

Senator CRANSTON. I do not know. There is no classified mark on the document.

After recounting all the opposition to expanding Kennedy Airport, which is strangling in many ways, as you well know, the article says:

With local variations, the kind of resistance that has thwarted the airport expansion here is also blocking or delaying jetport projects in Atlanta, Boston, Los Angeles, Minneapolis-St. Paul, New York, San Jose, and St. Louis.

Citizens with sentiments much in common with those in Portland and Boston are also opposing projects in Tokyo, Zurich, Switzerland, and Dusseldorf, West Germany. Environmental opposition led Britain recently to choose a site for London's third airport 56 miles from the city on the English Channel, far from the populated areas where aviation interests wanted the new jetport.

In the United States, airline and Government aviation specialists are warning that the increasing delays and rejection of airport projects could severely limit the Nation's air commerce, starting perhaps in 1975 but becoming serious after 1980.

Then John H. Shaffer, Administrator of the FAA, is quoted as saying: "Public resistance to new airports has become almost paranoid."

He is quoted as saying that—

FAA forecasts indicated that the Nation would need about 100 new commercial airports between now and 1981. But he said the "odds of getting those airports, in time, are not favorable unless public antipathy and community apathy can be overcome."

In itself, opposition to jetports is not a new phenomenon. It began to surface more than a decade ago, when the first jet airliners began disturbing the quiet around airport communities.

I think the noise factor just has to be taken into account on the other side economically in terms of what is going to happen if the opposition stops expansion of air travel in the United States.

Senator CANNON. I think eventually we will reach a head-knocking situation between those who object to the noise and those who insist, for other economic purposes, on having air transportation, and the issues are going to have to be balanced.

In the New York area, they are in a very difficult position now because they cannot find a suitable location for another airport. They are talking now in terms of using the site of the old Stewart Air Force Base, which is some 60 miles outside of New York City, which would require the establishment of a high-speed ground transportation system to move people in and out of the population centers.

Senator CRANSTON. On the matter of placing a burden on the airlines, I refer again to the fact that they sought larger fare increases than they received at the recent go-around with FAA, and they gave testimony that indicated that this sort of an increase would have no adverse effects on their business.

And this is not a burden placed upon the airlines. It would be paid by the passengers flying on those airlines.

I would like to ask permission, Mr. Chairman, to submit additional material for the record regarding the effectiveness of noise reductions of the sort that we are talking about.

Senator CANNON. We would be very happy to have you submit additional information as you desire for the committee's use.

I cannot let that statement go by unchallenged. I am not one who agrees completely with the airlines that these rate increases will have no effect on them. I think they run a serious danger of perhaps pricing themselves off of the market. I think we have seen it actually happen in some markets.

As a result, some of the airlines are now reducing fares in some markets to attract new passengers rather than continually raising them to the point where they are driving passengers away, particularly the passengers that do not have to travel for business purposes.

Senator CRANSTON. I think what the committee has to weigh is the airlines being subjected to circumstances that give them great difficulty, whether they are going to be noise-factored out of effectiveness, or price-factored out. And I think if you weigh the two, I think you will find the price factor is the more desirable one to pay.

Senator CANNON. Thank you very much.

Senator CRANSTON. I thank you a great deal.

(The statement follows:)

STATEMENT OF HON. ALAN CRANSTON, U.S. SENATOR FROM CALIFORNIA

I would like to begin by thanking the Subcommittee and Senator Cannon for holding these hearings on the Aircraft Noise Reduction Bill.

Congress has paid great attention to the problems of air and water pollution. But up to now it has given insufficient attention to the problems of aircraft noise pollution.

Some 3.5 million individuals now live in an "unacceptable" aircraft noise environment according to a study published last month by the National Academy of Engineers. Of these, 700,000 live around Kennedy Airport in New York alone.

The seriousness of the problem is evident from a recent report issued by the Department of Transportation. By 1975, it predicts, FAA-designated aircraft

noise sensitive areas around only three of the nation's larger airports will encompass about 2½ million, will take in a total land area of 288 square miles and include 338 schools, 119 parks and 27 hospitals. Similar studies of other noise affected communities will multiply the above total manyfold.

Noise pollution, like air and water pollution, impairs our physiological and psychological health. Aircraft noise interferes with rest, privacy and sleep. It increases tension and causes breakdowns in the heart and glandular systems.

A recent study conducted around Heathrow Airport in London reported that admission to mental hospitals from areas with high noise pollution were 25% greater than admissions from other areas.

The International Standardization Organization reported at its conference in Geneva, Switzerland last month that if airplane and vehicular noise continue to climb at their present rates, everyone will be stone deaf by the year 2000.

Airplane noise makes living unpleasant as well as unhealthy. People who live in flight paths—whether they be infants or aged, whether they be in sound health or infirm, live with almost constant aircraft noise—while they read, while they watch TV, while they listen to music, while they talk and while they sleep.

The retrofit bill which is the subject of these hearings will reduce noise emissions from aircraft to one half of their present level. A reduction of that magnitude will improve the noise environment of 2.3 million individuals (70% of the population living in noise blighted areas) from "unacceptable" to "acceptable" according to Federal Aviation Administration standards. These standards were developed for both Federal Aviation Administration and the Department of Housing and Urban Development by the nation's leading acoustical engineering firm.

The goals set out in the retrofit legislation can be achieved if we commit the needed resources. Matt Lukens, Director of Airports for the Port of New York Authority and former president of the Airport Operators Council International spoke well and accurately about noise in January 1970 when he stated:

"One of the most difficult conditions we face is aircraft noise. The overwhelming public reaction to excessive aircraft noise has resulted in restrictions to operations and widespread opposition to expansion or airports or development of badly needed new airports. The technology to reduce aircraft noise at its source exists. We have the legislative tools to implement that technology. The time to act is now."

On the issue of technology Mr. Lukens is well supported by the NASA-Douglas-Boeing-Rohr studies of retrofit. He is also well supported by the public demand that something be done about it. Development of a new power package, in lieu of a retrofit program, will just not happen soon enough. We cannot afford to wait another 10 to 15 years until the present generation of aircraft are phased out to do something about this problem.

Finally, this bill provides the airlines with the wherewithall to purchase the retrofit devices. The bill provides for loan guarantees of up to \$1 billion to help the airlines purchase the retrofits without impairing their other capital requirements. The bill also mandates the Civil Aeronautics Board to grant a 1½ fare increase to pay for the retrofits. According to an economic study conducted by the FAA, a fare increase of that magnitude would pay for the cost of the retrofits. During last year's CAB hearings on fare increases, all of the major airlines testified that a fare increase of that size would have no significant impact on passenger demand.

During the last few years, thousands of talented aerospace workers have lost their jobs. The development and production of retrofit equipment would re-employ 35,000 of these workers for a two year period. Applying the skills of these workers for the improvement of our environment should be one of our nation's principal goals.

Senator CANNON. Our next witness is the Honorable John H. Shaffer, Administrator of the Federal Aviation Administration.

STATEMENT OF HON. JOHN H. SHAFFER, ADMINISTRATOR, FEDERAL AVIATION ADMINISTRATION, DEPARTMENT OF TRANSPORTATION, WASHINGTON, D.C.; ACCOMPANIED BY CHARLES E. ANDERSON, FAA DEPUTY GENERAL COUNSEL; AND RONALD W. PULLING, FAA DEPUTY ASSOCIATE ADMINISTRATOR FOR PLANS

MR. SHAFFER. Mr. Chairman, and members of the committee, I welcome this opportunity to appear before you today to present the views of the DOT on S. 1016 and S. 1566, both dealing with the control of noise. With me today are Mr. Charles E. Anderson, the FAA Deputy General Counsel; and Mr. Ronald W. Pulling, the FAA Deputy Associate Administrator for Plans. Other members of the staff are also present and available to answer specific questions.

S. 1016 is an important part of President Nixon's 1971 environmental program. In his message to the Congress on February 8, 1971, the President pinpointed the issue that is before this committee today:

Environmental control efforts too often have been limited to cleaning up problems that have accumulated in the past. We must concentrate more on preventing the creation of new environmental problems and on dealing with emerging problems. . . . We must roll back increasingly annoying and hazardous levels of noise in our environment, particularly in the urban environment. Our goal in dealing with emerging environmental problems must be to ward them off before they become acute, not merely to undo the damage after it is done.

The Administrator of the EPA proposed this legislation to the Congress on February 10, 1971, and testified in support of it last week before the Subcommittee on Environment of this committee. As I will detail for you in a moment, the aviation community has recognized for many years the fundamental issue the President describes, and is continuing a strong and positive program to meet that issue.

The administration's proposal—the Noise Control Act of 1971—represents a legislative framework for noise control and abatement. The proposal would give EPA the authority to—

- (1) Prescribe criteria for noise to protect the public health and welfare;
- (2) Identify and set standards for the following major sources of noise:
 - (a) Construction equipment;
 - (b) Transportation equipment (including recreational vehicles and related equipment);
 - (c) Equipment powered by internal combustion engines;
- (3) Establish labeling requirements for designated products or classes of products; and
- (4) Promote the coordination of Federal programs relating to noise research and noise control.

Specifically, the bill would amend the provisions of the Federal Aviation Act of 1958 with respect to control of noise from civil aircraft and aircraft components in several respects. FAA standards, rules, and regulations would be subject to approval by EPA. However, existing standards, rules and regulations would not be affected unless revised after enactment of the bill. Furthermore, FAA could issue a

type certificate for any aircraft only after prescribing standards governing the noise characteristics of that aircraft. If the Administrator of EPA had reason to believe any existing standard, rule or regulation on noise under the Federal Aviation Act inadequately protected the public from noise, he could request that FAA review such matter and report on the advisability of revising it. The Department of Transportation supports S. 1016, and believes that this proposal reflects laudable objectives that must be sought on a Government-wide basis, in fact on a nationwide basis. The DOT urges the committee and the Congress to enact S. 1016 and to make these objectives a national commitment.

The exemplary effort of the aviation community to combat noise and air pollution demonstrates to all the environmental benefits that a concentrated program may yield. Aviation's efforts also show the potential for success of a comprehensive attack on the noise problem. So, I want to spend a few minutes in giving you a rundown of aviation's programs that deal with current environmental problems and our efforts to prevent the creation of new ones.

The aviation "community" embraces elements of both the private and public sectors. It includes airmen (pilots, engineers, navigators, controllers, mechanics, and repairmen), air carriers and many other aircraft operators, aircraft (airframe and powerplant) manufacturers and public and private agencies that own and operate the Nation's airport system, and also the DOT's FAA, the DOD, the National Aeronautics and Space Administration, and this committee and its House counterpart. Over the past several years, aviation's program to deal with noise moved forward on three basic fronts—

- (1) The source of the noise: The aircraft and its powerplant;
- (2) The path of the sound: The flight path of the aircraft;
- (3) The "receiver" of the sound: The person who hears noise at a specific location.

As this committee knows, the FAA's commitment to preserving environmental quality began several years ago. As a matter of fact, the FAA was among the first Federal agencies to demonstrate its concern for environmental quality when it established the Office of Noise Abatement in 1966. With its establishment, FAA was equipped to spearhead the organization, development and implementation of a cooperative Government industry aviation noise management program. Recently, we expanded the responsibilities of that Office and restructured it as the Office of Environmental Quality. The Environmental Quality Office now has overall responsibility within FAA to develop policies and procedures for aircraft noise, smoke emission, exhaust pollution and aircraft waste programs. We believe that we now are well equipped to handle the broad spectrum of environmental challenges facing aviation, and to look ahead to new ones on the horizon.

On July 21, 1968, the Congress enacted Public Law 90-411—(exhibit 1), that begins "In order to afford present and future relief and protection to the public from unnecessary aircraft noise and sonic boom. * * *" This statute represented the premier substantive congressional enactment to recognize the environmental impact of noise on the public, and followed the lead set by section 4(a) of the De-

partment of Transportation Act. Many members of this committee participated in the hearings and debates leading to the enactment of the new authority. As a key element of the "community" of aviation you too were among the first to take action to deal with the threatening "environmental crisis."

Since you gave us this mandate and the set of tools to combat the problem, we have been working to build a wall against and a lid on the top of aviation noise. We have adopted noise standards for aircraft type certification (exhibit 2). With an eye toward quieting older jets, we have issued an advance notice of proposed rulemaking that would require the engines of the present jet fleet to be retrofitted with acoustical material. We now are reviewing and evaluating the many comments that we have received on the proposal, and we will be deciding the next step on this proposed rule in the near future. Although not quite as dramatic, we also have adopted rules to prohibit the escalation of noise that may result from modifications made to aircraft. We have provided the committee with a timetable for our other activities in the noise regulatory area (exhibit 3).

The environmental benefits of the noise standards are becoming more and more noticeable as the new widebody jets enter service. The Boeing 707 has been in service for just over a year now, and soon to be introduced is the McDonnell-Douglas DC-10 with the Lockheed L-1011 to follow. All of these widebody aircraft use jet engines that are products of a new technology that recognizes and respects environmental guidelines. These new aircraft are more than twice as powerful as their predecessors, yet they are perceptibly quieter and unbelievably free from undesirable emissions. And they are reliable.

To date, the Boeing 747 utilizing the Pratt & Whitney JT9D has materialized into an aircraft that has been the most successful of any new aircraft ever introduced by the U.S. aviation industry. Last month the DC-10 visited New York's La Guardia and Boston's Logan airports. The press reported that the DC-10 was "like a tiger with laryngitis". Airport neighbors were "delighted with the improvement". So are we. Our success in aircraft noise reduction will be more and more noticeable as these "quiet giants" move into the fleet.

Our work to reduce noise at the source is increasingly successful, and we are heartened by indications from research and development programs now under way. The NASA "quiet-engine" program is yielding a wealth of data which will be put into practice as soon as possible. Other programs of noise research are expected to absorb about \$3.5 million in fiscal year 1971, and a comparable amount in fiscal year 1972.

We have several programs that consider the path of sound (noise). We select "preferential runways" based on studies linking the noise exposure to an area that arises from the use of a given runway, with the makeup of the population in that area. In turn, use of these runways to the greatest extent possible reduces the noise to which the community is exposed. We have a similar program to establish airport departure procedures so that aircraft on takeoff generate the least amount of noise while maintaining the necessary safety of flight. Our controllers are implementing the FAA "Keep 'Em High" program.

Under this program, aircraft en route and in the terminal areas are kept at higher altitudes, and let down for approach only when they are ready and it is their time to land. We also are continually reworking the air traffic patterns throughout the country to reduce noise impact on the ground.

We are working with the approach navigation aids to see how they can be operated or reworked to reduce noise around airports. A pilot on approach now intercepts the glide path of the instrument landing system (ILS) at a height of about 1,500 feet above the airport's elevation. We are considering moving that up to 3,000 feet. This will allow the pilot to reduce power and begin an earlier descent. Also, we are examining other possibilities—a steeper glide slope and “dual” or two segment approach. The ILS glide slopes now are 2.5°. By raising the glide slopes to 3°, all approaches will be 300 feet higher when 6.5 miles from the end of the runway. This has the effect of reducing noise. With the “dual” or two segment approach, a pilot begins the approach using a 6° glide slope angle, and then flattens his approach to a 3° angle at an altitude of about 1,000 feet. This also will keep the aircraft higher as it approaches the airport thereby lowering its noise level.

Turning to the “receiver” of the noise, the strong environmental considerations which the Congress enacted in sections 16(c)–(e) and 18(4) now guide the FAA in administering the new Airport and Airway Development Act of 1970. We have taken action to implement this new authority—exhibit 4—and we are convinced that the small expenditure of time and money they may involve will pay untold dividends in the good community relations that will result.

In line with this new authority are existing FAA programs to make “good neighbors” of our airports. New airports are being built on large tracts of land to insulate neighbors from airport operations. The Dallas-Fort Worth airport is on 20,000 acres, and Dulles—not yet 10 years old—was built on 10,000 acres. When Dulles was built, those 10,000 acres seemed enormous; today we wonder. The reason we wonder is because developers have started to impact or encroach upon the airport with the development of two housing projects, identified as Sterling Park and Greenbrier. We also are working with the Department of Housing and Urban Development, and State and local units of government to work out compatible land use and development plans for areas around airports. We recognize that we have a long way to go to insure that the land use patterns do not “grow like Topsy,” but more public officials now recognize the need for land use compatible with the operation of an airport. We are working hard on promoting this principle.

At this point, Mr. Chairman, with your permission, I would like to show you a movie entitled “May We Have a Little Quiet, Please?” that we have produced to underscore the need for greater effort in this program of making a good neighbor out of the airport and a good citizen out of the airplane.

Senator CANNON. You may proceed.

(Movie presentation.)

Mr. SHAFFER. While he is winding down the machine, Mr. Chairman, I would like to quantify the real progress that has been made

with the wide-bodied airplanes. The Boeing 747, for example, is capable of delivering three times the transportation service of a Boeing 707 for less than one-half of the noise. It is really a six-times improvement in units of transportation per unit of noise. This is an example of the kind of progress that is possible when you concentrate on prospective improvement.

The Douglas DC-10 is possibly even more impressive in quantifiable numbers than the Boeing 747. From the movie you saw that the noise standards are set at 108 EPNdB for the new airplanes certified after December 1969. The DC-10, as a result of our confirmation of design which we conducted about a month ago, is better than that on approach. As I recall, the DC-10 is 105 EPNdB on approach, 98 EPNdB on departure, and 96 EPNdB on the sidelines. Thus, it is remarkably better than even our aspirations or hopes were when we set that rule in 1969.

We have not yet checked out the Lockheed 1011, but our people have flown it and their estimate of it is that it too is a superb airplane. It is conceivable that it will be equal to or better than the DC-10 in terms of environmental impact. Thus, as you can see, it is possible to make great progress in this area.

Now on the general aviation side of things, the Cessna Citation (Cessna 500) is better than the noise rule by a wide margin on all three parameters: approach noise, departure noise, and sideline noise. So with a minimum investment during the design phase of a new aircraft project, it is possible to make fantastic gains in environmental pollution abatement. As you will hear later in my testimony, I suggest that is the appropriate course for our Nation to take.

I was here when your previous witness was testifying, and I think it would be appropriate if I comment at this point on the problem facing our Nation. There is no question that pollution abatement is a national objective, and certainly is a national commitment. But I would remind us all that pollution abatement, as such, contributes very little to efficiency of planning, and I am now talking about the total activity of our Nation in the economic sense. Pollution abatement contributes very little to the value of a product, and as a result, it will show up on one side of the ledger and one side of the ledger only. In other words, pollution abatement measures will not make the company more profitable, and they will not make the product better, except in the sense of social and moral values that are quantifiable and attractive.

We cannot forget, or cannot neglect to consider, the drain that environmental control is going to have on our economy if we go about it in an unprogrammable way. When I speak of industry, I include all the people, the energy cells that do all the work, and those are the people who live in the United States. Those people are the ones who are going to have to do all of the environmental control work and those people are going to have to pay for it. Each one of us is involved, and all of us should be mindful of what it is going to take to accomplish this total environmental objective. End of my philosophic editorializing.

In the broad view, covering not just noise pollution but all environmental factors, is the 10-year national aviation system plan and the Annual National Aviation System Planning Review Conference on

which the 10-year plan is based. In essence, this is the product of the ideas of the interested public and the Federal Government. We want and we need the transfusions of new thoughts and ideas that we gain at each annual conference. The conference is wide open—we welcome all comers. Today, before this committee and as a matter of public record, I want to give my personal invitation to every person who cares about the complex relationships between aviation and the environment: Attend the 1972 National Aviation System Planning Review Conference. We want to hear your ideas. We urge you to bring them to us. We both will benefit measurably from that exchange.

Our program is a good one, but I am the first to say that we can still do more. But as we do, may I remind all of us that the first mission of the FAA is the safety of flight. We can reduce noise by redesign of the machine—the airframe, the powerplant, or in combination in the aircraft. We can reduce noise by changing procedures to change the path the noise takes. We can work with communities to consider the “receiver” of the sound—the people who live nearby. But the changes we make must not compromise the safety, health, and welfare of those who fly—the pilots, flight crews, and passengers. Each change, each step must be tested. We must ask each time: Is this the safe as well as the right thing to do?

Aviation was and is in the vanguard of those who are both concerned and acting to deal with environmental problems we face today or foresee tomorrow. The United States can have the clean air, the pure water, the quiet atmosphere and the green spaces that it had in 1771, but that must be accomplished within the social and economic structure of today—for the world society will never return to 1771. I want those who misrepresent our accomplishments to realize that the airplane is not a predator on the environment. Technology is not the villain that holds the environments' mortgage. We can have quiet, and clean air, and clear water, and green spaces. We cannot, as we sometimes hear said so dogmatically, make the United States a wonderful place in which to live by getting rid of all the progress that has made us the richest, strongest, and healthiest nation in the world. I suggest that the technology which is so often criticized for creating mankind's environmental problems is either the answer to those problems or there is no answer.

Before I close, Mr. Chairman, let me briefly address S. 1566 that also would amend section 611 of the Federal Aviation Act. This bill has five basic features:

1. Requires subsonic transport category aircraft to reduce their effective perceived noise levels by 10 effective perceived noise decibels (EPNdB) below present levels by the end of 1975;
2. Authorizes a \$35 million aircraft noise research and development and design demonstration program;
3. Authorizes a \$1 billion program to guarantee loans for air carriers to noise retrofit their present fleet;
4. Prohibits the CAB from rejecting air carrier fare increases to recover the costs of aircraft noise reduction;
5. Establishes a Federal grant program to underwrite local airport noise monitoring programs.

The authority we now have to regulate aircraft noise under section 611 is fully adequate to protect the public from aircraft noise. As I have outlined for you, our noise program is in the vanguard, and we are constantly moving ahead. We believe that a requirement to reduce noise levels by 10 EPNdB for all aircraft is arbitrary because it is beyond our capacity technologically—the state of the art has not yet reached that point. Although it may be possible to obtain this goal for some aircraft under certain conditions, current technology has not demonstrated that an across-the-board requirement is possible at this time. In addition, any decision regarding the retrofitting of aircraft is a technical and complex issue closely related to aviation safety. We believe that for these reasons this issue is better handled by administrative proceedings—like those we already have instituted—rather than by a flat legislative mandate.

The Department believes that the loan guarantee authority is both unnecessary and unwarranted. Furthermore, the guarantee authority would apply solely to retrofit loans, and fails to consider the costs of a reequipment program. A noise reequipment program may often prove to be both cheaper and more effective than a noise retrofit program. As to the wisdom of barring the CAB from refusing fare increases intended to recoup noise reduction costs, we defer to their views. As a general matter, however, we must observe that *carte blanche* provisions like this invite abuses that a regulatory agency is established to prevent. As to the program to aid local noise monitoring programs, we are persuaded that our noise certification program and the evolving programs to abate noise through operational techniques are the best areas for Federal investment. While we have no objection to noise monitoring at the local level, we have not determined that it should be supported by a Federal program at this time. The aviation programs that I have outlined to you directly enhance the environment. In sum, S. 1566 is basically unnecessary. In addition, its programs are either of doubtful necessity or beyond our technological capacity to accomplish.

In conclusion, Mr. Chairman, we recommend enactment of S. 1016 because we believe that the comprehensive attack on noise pollution that it represents is essential. We strongly oppose S. 1566, as being regressive and unnecessary. We look forward to working more closely with EPA under the provisions of S. 1016, and together we will work out whatever procedures and relationships may be needed to implement S. 1016, and thus protect and enhance the welfare of those who hear the noise, as well as those who use aviation. We in the Department of Transportation's Federal Aviation Administration are moving ahead as fast as we can using existing technology. Frankly, enactment of S. 1016 will have a relatively minor impact on our regulatory activities and will not impair our aviation safety mission. We will share what we have learned with our sister agency and jointly develop the best possible solutions to mutual environmental problems. All of society will benefit from this relationship and this dedicated effort.

That concludes my prepared statement, Mr. Chairman. My associates and I will be pleased now to respond to questions you may have.

Senator CANNON. Thank you, Mr. Administrator.

In 1968 when Congress enacted the aircraft noise control statute, which you are now implementing, there was much discussion about

where the rulemaking authority should be vested. Although the administration recommended the authority be given to the Secretary of Transportation, the Congress ultimately empowered the Administrator with the rulemaking power.

Now, 3 years later, the administration is recommending that this rulemaking function be transferred to the EPA. Why has this change in policy been made?

Mr. SHAFFER. Mr. Chairman, I really believe that from a policy standpoint the thrust of the administration's proposal is to collect all activity that would regulate noise, or in the positive sense seek to produce pollution abatement as an objective, in one agency. I do not believe that there would be any great advantage to having EPA, as such, set standards without any fundamental technical expertise. EPA should review all standards of all of the modal administrations and make certain, or insure that every standards so set is technically feasible and economically practical, which are the fundamental words used in the original law or mandate of Congress.

Senator CANNON. Would you envision that the Environmental Protection Agency would make that decision as to whether they are economically practicable with respect to aviation problems?

Mr. SHAFFER. No, sir; I think the FAA has the expertise, the background and the knowledge to set better standards relating to aviation noise. I would hope that the net result of your hearings and your analysis of the situation will result in Congress authorizing EPA to coordinate, consult with, and review all standards to ensure that they are precisely what we are capable of accomplishing, without causing any short-term or long-range economic impact. My concern is basically with the economic impact of aircraft noise standards.

Senator CANNON. The bill seems to go beyond that, it would give the EPA the authority to veto the rules and regulations—the standards, rules, and regulations established by the Administrator of the FAA.

What technical expertise and manpower exists in EPA which would equip it to approve or reject standards for the control of aircraft noise emissions?

Mr. SHAFFER. Mr. Chairman, I think the proposal as written and submitted is not impeccable. I am interpreting the bill to mean that EPA would consult with us, and would establish or approve standards that we, in effect, would recommend to them, and thus the technical expertise would remain in the FAA. The FAA for its entire lifetime has developed an expertise that in my opinion is second to none anywhere in the world. To duplicate that expertise, or create a similar body of excellence elsewhere in the Government would be unnecessary.

Hopefully, the law that the Congress will produce will be one that would require EPA to consult with and approve the work of the modal administrations where the expertise relative to their equipment, and I think the national objectives, truly reside. It is certainly true that Federal expertise on aviation related matters resides in the Department of Transportation, and specifically in the FAA. I do not take any credit for that expertise for I inherited a fine organization, and I believe that what I am saying is an honest statement of fact. The aviation expertise resides in the FAA, and it does not need to be developed elsewhere in the Government.

Senator CANNON. Then, actually, what you are saying is that you do not agree with that provision of the bill, as I interpret it. I may say I do not agree with it either at this point.

It seems to me that the EPA would not be capable, in a technical sense, of adopting noise control procedures, rules and regulations relating to aircraft when, as you say, in the FAA you have that established capability at the present time. Why set it up in another agency and give that agency the veto power or the authority to establish the rules and regulations?

Mr. SHAFFER. Well sir, I do not want to try to polarize a position. I have indicated previously that as I interpret the bill, and I do not think its language is impeccable, EPA would approve the aircraft noise standards that we establish (the standards that we say are possible and the standards that are not only possible but practical), and their expertise should begin and end with a capability of knowing what is available technically, and then they would pass judgment on our work. EPA should not duplicate in any sense the numbers of people we have doing this type of work.

Senator CANNON. If they are going to pass judgment on your work they are going to have to have the expertise to know whether your work is right. What this bill would do is really give the EPA that authority to pass judgment on your work. You make your recommendations. They can veto them. They can approve them. They are not required to approve them. So they must therefore have the capability to decide and make the determination independently of whether those are feasible, whether they are economically sound, whether they are attainable.

It looks to me like we are establishing another bureaucracy on top of one that is already pretty large.

Mr. SHAFFER. Mr. Chairman. I certainly do not want to debate this issue with you. I am simply saying that a person with reasonable experience and normal intelligence would be able to clearly decide whether we were doing all that is possible to do, or all that is necessary to do, within a specific time frame. In other words, EPA should insure that the work we are doing is what we must do, can do, and that the Nation can afford it.

I believe it is possible to achieve this kind of management overview in an agency such as EPA. There may be a tendency in a department such as the FAA to have myopia, because sometimes you are so close to the trees that you do not see the forest. Thus, it is conceivable that someone outside the agency, like EPA, would be able to objectively audit the work that we are doing to make certain that we are doing everything that is possible, practical, and achievable at a specific point in time.

When the first pure turbojets were introduced in 1958, I do not believe that anyone would have ever thought that we would be able to silence them. The objective then, of course, was to increase the horsepower or thrust rate of an aircraft, and any man who has spent any time in a technical department understands that performance usually deteriorates if you attempt to convert energy into reducing noise by artificial means. By artificially reducing noise you add weight to the airplane, and a pound of empty weight is a very precious commodity

indeed, as you know from your own flying experience. Nevertheless, we have been able to reduce aircraft noise by devoting attention to noise reduction devices, and by intelligent developmental efforts. We have suggested that it is possible to reduce aircraft noise in the future, and as I have indicated, a modest amount or level of technical expertise would provide EPA with an overview capability that should be beneficial to us all.

Senator CANNON. Well, of course, I think what we are differing on is what is an overview capability. I think this bill goes far beyond that. As I said earlier when the noise control statute was enacted, which you are now implementing, at that time the administration wanted to place this authority in the DOT. However, Congress saw fit to give that authority to the FAA because of the expertise that they possess.

The current law provides, among other things, for example, that the Administrator shall, in prescribing and amending the standards and rules and regulations, consider whether any proposed standard, rule, or regulation is economically reasonable, technologically practicable, and appropriate for the particular type of aircraft, aircraft engine, appliance, or certificate to which it will apply.

That is just one of several items; it seems to me that if we were to give that authority to EPA, it is certainly going to have to set up a staff with technical expertise so that the Agency will know actually whether it should veto the proposed rules or whether it should have them changed or what have you.

I, for one, think that we are just creating another bureaucracy when there is really no necessity for doing it. I do not think that the EPA, without building up such a capability and technical staff, would be able to veto or approve noise-control procedures, rules, and regulations relating to aircraft.

Mr. SHAFFER. Mr. Chairman, again I do not want to leave the impression that I am debating an issue. I am simply suggesting that whatever resources the Congress decides to give the EPA will not be duplicated in the FAA, for I can control what the FAA does.

Currently we have a very modest staff that is working this problem very well in conjunction with industry, which is where we really go to get the work done. We do not do the work in-house, and we believe that we are getting the kind of progress that will make any reasonable man happy, and I happen to believe that the EPA Administrator is a reasonable man. Of course, that does not mean that those who will succeed the present EPA Administrator will view our work in the same way. We construe EPA's proposal to mean that their purpose is to insure compatibility with the overall national goal, and not to second-guess the FAA in the aircraft noise regulatory area.

Senator CANNON. Then, if we should see fit to approve this bill, do you think we ought to rewrite the language to make absolutely certain that that would be the limit of EPA's authority; to oversee and not to second-guess the FAA, Mr. Administrator?

Mr. SHAFFER. Mr. Chairman, I will answer your question this way: I think the original law passed by the Congress in 1968 has produced results that no one can quarrel with. I know of no one else, no other mode of transportation, or no other machinery manufacturer of any

kind who has accomplished a job, similar to the outstanding job that the aviation industry has accomplished, in the short period of time since 1968. We are working with fantastic horsepower machines and producing tremendous units of transportation with a much quieter, gentler sound source than we had just 3 to 4 years ago. The results are impressive because the aviation industry has been making steady progress while most other people have just been talking.

Senator CANNON. I tend to agree with you. I think you have made a lot of progress. I am wondering, did you take part in drafting this bill, S. 1016?

Mr. SHAFFER. Yes, sir; we were asked to comment on it.

Senator CANNON. Were you asked to comment on it after it was drafted?

Mr. SHAFFER. Yes, sir; however, we obviously did not win all of our points.

Senator CANNON. Did you subscribe to the provisions that I just was discussing with you? Did you recommend approval of those provisions or did you recommend that that be taken out?

Mr. SHAFFER. We did not recommend deletion of those provisions. We construe the bill to mean that EPA's role will be to insure, after an analytical appraisal of our efforts, that the results we have obtained, and the programs that we have underway, represent as much progress that any reasonable person could expect to result from today's state of the art.

Senator CANNON. Does the EPA have any technical staff with expertise in aircraft noise and its control at the present time; and if so, how many?

Mr. SHAFFER. Mr. Chairman, I have not really read the educational and experience pedigree of their work force.

Senator CANNON. Why do you not call on some of your staff? I am sure that somebody on your staff could tell us that EPA has only one man on its staff involved in the field of aircraft noise abatement, and have somebody verify that.

Mr. SHAFFER. Mr. Chairman, Dr. Powers will respond to that question.

Dr. POWERS. Mr. Chairman, there are two gentlemen that I know of, a Dr. Albin Myers, and Mr. John Setena, a gentleman who formerly worked in the FAA/SST Office.

Senator CANNON. So they now have two men?

Dr. POWERS. Yes, sir; I believe so.

Senator CANNON. How many men do you have in this field?

Mr. SHAFFER. We have approximately 21 employees working in this area in our headquarters, and we also have other personnel in the field and particularly in the Civil Air Medical Laboratory in Oklahoma City where we are doing noise and sonic boom research.

Senator CANNON. And what would your total staff be, then, involved in this area?

Mr. SHAFFER. Mr. Chairman, I think it would be best if I supplied that information for the record because we have several part-time consultants, and other people in the field who devote some of their time to other efforts.

Senator CANNON. All right. Supply that for the record then, if you will.

Senator CANNON. Now, Mr. Administrator, the Administration has currently pending its own aircraft noise retrofit proposal which is in the form of an advanced notice of proposed rulemaking. Would you explain to the committee the nature of this proposal and how it differs with the provisions of the Cranston bill?

Mr. SHAFFER. I will ask Dr. Powers to comment on the noise retrofit program in a moment, but let me first say that the pure turbojet aircraft of the four-engine variety—the Boeing 707's, the Douglas DC-8's—have what we consider to be a remaining useful service life of 3 to 5 years. The improved four-engine airplanes, the so-called turbofan airplane—also the Boeing 707's and the Douglas DC-8's—have from 5 to 8 years of useful service life left, and it is our view that the kind of noise abatement that has been demonstrated thus far would not be of sufficient magnitude to be perceptible to the receiver of the noise in the technical sense. If you measure noise abatement in technical terms it appears to be in the area of what Senator Cranston's bill proposes, or 10 EPNdB. However, when you are talking about reducing the level from 118 to 108 EPNdB, it is very difficult to see the advantages of that noise reduction in an objective sense.

Dr. Powers can elaborate on this matter in a moment, but we believe that the greatest benefit in the retrofit program will be to the two- and three-engine turbofan airplanes that are equipped with the JT-8D engine, or the Boeing 737's, 727's, and the Douglas DC-9's. Those airplanes will be in the commercial fleet for 10 years and beyond, and they are the airplanes that most frequently come and go. The airplanes that we think have a greater noise impact on the communities, and on a far greater percentage of our population, are the larger four-engine jets. Furthermore, the big four-engine airplanes, the Douglas DC-8's and the Boeing 707's, are going to be quickly replaced by the new wide-bodied jets. The Boeing 747's, Douglas DC-10's, and Lockheed 1011's will quickly replace the large four-engine airplanes for two very good reasons: First, a quiet airplane sells better because it is more acceptable to the community. Second, the new widebodies are so fantastically better in terms of economics, because they produce air transportation services for far less direct operating costs, that the operators will want to acquire at the earliest possible moment so that he can use the newer airplanes instead of the older airplanes. I also believe—and I think the CAB witness should address this point—that the book value of the older four-engine airplanes is now somewhere between \$416,000 and \$1.5 million. Thus, to add or double the capital investment in an old airplane, by retrofitting it to reduce noise, is simply not a good use of capital.

Senator CANNON. Do you have the figures on the economics; that is the cost of the retrofit program, or does Dr. Powers?

Mr. SHAFFER. Yes, sir; Dr. Powers can give you the projected costs of the noise retrofit program.

Dr. POWERS. Mr. Chairman, the cost of the noise retrofit program is pretty strongly a function of the extent of noise reduction that you seek. We have made some cost estimates based on our Rohr study which indicates that it may be feasible to seek a 5 EPNdB reduction on take-

off, and about a 10 EPNdB reduction on approach, at a cost of approximately \$0.8 to \$1 billion. That figure represents the estimated cost for retrofitting the domestic fleet of approximately 1,820 aircraft.

Senator CANNON. Now, that was eight-tenths of one—

Dr. POWERS. The cost would be between \$0.8 and \$1 billion.

Senator CANNON. Between \$800 million and \$1 billion to get that type of reduction?

Dr. POWERS. Yes, sir; that is correct for the domestic fleet. Now, if we look at the world fleet—

Senator CANNON. Your estimate would include aircraft some of which have only a useful life from 3 to 5 years?

Dr. POWERS. Yes, sir; and that cost projection includes all aircraft that would be capable of being retrofitted. If we expand that cost projection to the world fleet, we believe the costs would be in the order of \$1.6 billion.

Senator CANNON. Well, now, in your judgment, is some type of retrofit program for current generation jet aircraft necessary to protect the public from excessive aircraft noise? Perhaps I should ask you, Mr. Administrator.

Mr. SHAFFER. Mr. Chairman, as I previously indicated, our proposed rule, as well as all of our current planning, is concentrated pretty much on the two- and three-engine airplanes. Specifically, we have awarded a contract on the Boeing 727 airplane, and we believe that this Boeing 727 hardware contract should be complemented, or supplemented, with a similar contract on the Douglas DC-9. Again, this is basically the thrust of our noise retrofit program. Incidentally, our program encompasses the big part of the commercial fleet, or the largest number of airplanes.

Senator CANNON. Those two types represent the greatest number of aircraft in use?

Mr. SHAFFER. Yes, sir; there are approximately 1,300 aircraft of this type, and they are still being delivered. Therefore, our programs' thrust is toward making these aircraft gentler and kinder to the environment, and we believe that this is easier to do on the JT-8D engine than it would be on the pure jet engine, or the JT-3D.

Senator CANNON. Now, would your proposed rule require that conversion or retrofit be made at the time of an engine overhaul?

Mr. SHAFFER. Sir, at this point in time we do not know the answer to that question. However, I would like to say that in my experience I have never seen a procedure that works as well as the administrative rulemaking procedure within the Federal Aviation Administration. Our rulemaking is not done by a bunch of people locked up in a soundproof room making decisions in secret. Our rulemaking is done in a completely open and above-board consultative manner, with all of the public, or everyone who has an opinion on a rule or amendment to a rule, expressing their opinion. We assess those opinions, and the necessary technical facts, in such a way that ultimately we come up with what we believe is the best possible rule on a specific subject.

We have not yet decided how to accomplish the noise retrofit program, but I will assume, in order to be specific about an answer, that ultimately we will produce noise retrofit kits that would be installed on the airplane at the time of the major inspection on the airframe and on the engine, or as you said, at the time of engine overhaul. In other words, the noise retrofit kits would be installed at a time when there

would be the least economic impact on the operators of the airplane. We believe that this type of approach is in the public interest.

Senator CANNON. But you do not in that proposed rule envision covering the DC-8's and the 707's?

Mr. SHAFFER. Mr. Chairman, we have not yet made that decision or determination, but as I previously stated, the sentiment is clearly in the direction of concentrating on the two- and three-engine airplanes which constitute the bulk of the commercial fleet. We are concentrating on those airplanes principally because the older and more tired airplanes probably will be phasing out of the domestic fleet.

Mr. GINTHER. Mr. Administrator, in S. 1566 the required reductions would be 10 EPNdB at the three measurement points. Under the rule-making procedure which is now pending for the three-engine and two-engine jets, would you contemplate the same level of noise reduction; that is, 10 EPNdB?

Dr. POWERS. Mr. Ginther, allow me to say that we are still in the rulemaking process and that these details have not been finally determined yet. Actually, from the technical work that has been accomplished to date, the possibility of getting a 10 decibel reduction at all three measuring points is extremely remote. However, as I previously stated, we are still in the rulemaking process and these are determinations that will be made in that process.

Mr. GINTHER. Given present technology, is it your view that a reduction of 10 EPNdB can be achieved at all three measuring points with the JT-8D engine?

Dr. POWERS. No, sir; I do not believe that reduction could be achieved with either the JT-8D or the JT-3D engines.

Senator CANNON. What does the Rohr study indicate? Does that go into that phase?

Dr. POWERS. The Rohr study did look at the estimates of potential noise reductions, but their estimates were not substantiated in all cases by flyable hardware. In other words, the Rohr study contains acoustics estimates, and the detail that is missing, and the detail that we really need, is a means of reducing the jet or the core engine noise. The core engine noise dominates on takeoff and sideline and we really do not have this technology well in hand. The technological ability to reduce that noise is part of what we are seeking with our current program with the Boeing Co.

Senator CANNON. Mr. Administrator, in your prepared statement you mentioned some flight control procedures which the FAA is now studying in an effort to reduce aircraft noise. Why has the Agency not yet adopted standard and uniform noise abatement flight procedures for takeoff and landing across the United States?

Mr. SHAFFER. Mr. Chairman, each specific geographical location has peculiarities that do not lend themselves to a uniform set of procedures. Specifically, here in Washington, D.C., there is a preoccupation with the fact that we concentrate all of our arrival and departure traffic at Washington National in the Potomac estuary. However, we do not have that concentration because we do not like the people who live along the George Washington Parkway. We direct flights over the Potomac estuary principally because it is the safest as well as the quietest approach and departure route for aircraft using National.

The river does not object, and to my knowledge the noise does not disturb the ecology of the Potomac.

Senator CANNON. You say it is the safest. Why do you say it is the safest route?

Mr. SHAFFER. Mr. Chairman, I say that for two reasons. First, there are no basic obstructions, no high buildings, beneath that path of flight. Second, were we to have an unfortunate accident there would be no one living directly under the approach, and any airplane that would fall to the ground for any reason would not—

Senator CANNON. That is rather a remote safety consideration, is it not?

Mr. SHAFFER. I do not think so, Mr. Chairman, but again, you are an experienced pilot and I am not really arguing this point with you. Nevertheless, we do have people flying through buildings and other obstructions. The matters that the FAA is concerned with, and which the law requires us to be concerned with, encompass not only the safety of the occupants of the airplane but also the safety of the people on the ground. In the case of the Potomac estuary it is simply a matter of being the safest arrival and departure route, in overall terms, of any of those that we use servicing National Airport.

Senator CANNON. Now, you indicated that you are experimenting now with increasing the ILS glide slope intercept angle. Why has this glide slope angle not been increased in a uniform manner throughout the United States?

Mr. SHAFFER. Mr. Chairman, as an experienced pilot I'm sure you know the answer to that question. In the early part of the jet engine program we had an acceleration program involving the spool-up problem with the engine, and aerodynamically we also had a very clean airplane.

As a result, we all got used to flying the flat approach simply because that was the best way to bring an airplane to a stop after we landed it on the runway. Then we developed the engine thrust reversers which gave us a greater stopping capability. We do not have to maintain exact "bug" speed, or lowest safe flying speed, just prior to touchdown. With the improved engines, the greater spool-up or acceleration capability, and newer powerplants, it is now possible to do some things with these airplanes that we could not do with the so-called first generation, or early jet airplanes.

The increase in the glide slope has been a consideration, however, a big problem has been encountered in getting the pilot community to accept the higher angle. The pilots do not like it, or did not like it, they are quite comfortable with the current ILS glide slope, and they are reluctant to universally accept the higher descent angle.

Senator CANNON. What is the status now? Is that still under consideration, or has a steeper intercept angle requirement been discarded?

Mr. SHAFFER. Mr. Chairman, we have not discarded the higher glide slope concept. We have been moving it up, that is, we moved the glide slope up from $2\frac{1}{2}^\circ$ to 3° , and I think 85 of our ILS's are now located at 3° instead of $2\frac{1}{6}^\circ$. We are also conducting tests at Atlantic City with the dual segment or two-segment approach—in other words—with a higher initial glide slope angle and then a flatter angle close in or over the threshold.

As I previously stated, this is really a matter of pilot technique, and of making certain that the pilot believes in, and is comfortable with, the new procedure. We think the concept of increasing the glide slope angle is reasonable, we are moving in that direction, and we are confident; however it involves selling the concept to the pilots.

Senator CANNON. If you adopted a $3\frac{1}{2}^\circ$ intercept angle that would have a very significant impact on the noise levels, would it not?

Mr. SHAFFER. We could go from a 3° to a 6° glide slope angle, and yes, it would have a very significant impact on the noise levels. It is quieter not because the engines are any quieter, but because the source of the sound is further from the receiver.

Senator CANNON. The curve that you showed on the board would be a much sharper curve?

Mr. SHAFFER. Yes, sir; that is right, and that is also the reason that the new airplanes are quieter on departure. The airplanes are still generating noise, but they are higher over the community at the same geographic point during approach and departure. In other words, they are up and out like homesick angels in contrast to the older waterwagons that flew over communities at much lower altitudes. The new airplanes are going to receive very warm reception, and are going to be loved by more people because of their lower noise levels.

Mr. GINTHER. Mr. Administrator, are you familiar with the report referred to earlier commissioned by the city of Inglewood, Calif., which apparently indicates that there is a significant community benefit when noise reduction of, say, 10 EPNdB is achieved?

Mr. SHAFFER. Yes, sir, we are familiar with that study, and we agree with it. As a matter of fact, the original rule in part 36 of the Federal Aviation Regulations established an upper noise limit of 108 EPNdB, and I believe that is where this magic number of 10 EPNdB comes from. That is, the current Boeing 707 is 118 EPNdB, our current rule is 108 EPNdB, and that leaves the 10 EPNdB. Actually, all of our new airplanes can operate below the 108 EPNdB perceived noise level, and this proves that it is feasible and possible to produce quieter airplanes with an intelligent developmental program. It is not as easy to reduce the perceived noise level of the older airplanes, and as Dr. Powers indicated the big problem is with the core engine noise, or with the exhaust itself.

There are three basic sources of aircraft noise: First, there is the machinery noise, that is, the pumps, the generators and the gears that drive the power systems in the airplane—the electrical power generation and the air conditioning or climatization systems. Second, there is the hot gas or exhaust noise. Third, there is the compressor noise, which is usually the noise that is spewing out the front end of the engine.

Our objective is to reduce all three sources of aircraft noise. However, each noise source dominates the other sources at a certain point. In other words, when you are reducing the noise level of one source there is a certain point beyond which it is needless to go if you cannot bring about similar noise reductions in the other sources. That is, the three sources of noise must be attacked intelligently and in concert in order to get them all to respond. For example, no one would appre-

ciate our work if we did nothing about the core engine noise, while we reduced the machinery noise to zero by adding a lot of acoustical material in the cell area of the airplane to contain the noise.

Senator CANNON. If we could obtain a reduction of 10 at each of the three measuring points that would be a significant community benefit situation where the public would notice the difference very measurably. Is that correct?

Mr. SHAFFER. Yes, sir, that is correct. Dr. Powers is able to respond to that question, but I think that a reduction of 10 EPNdB represents more than a one-half reduction in the sound power of the source noise. In other words, it is a measurable reduction in aircraft noise.

Dr. POWERS. Mr. Chairman, the 10 EPNdB noise reduction that we normally talk about is considered to be a halving of perceived noise based on psychoacoustics studies. In other words, it is based on how would you and I would we react to a 10 EPNdB reduction in noise. If we heard two noises side by side differing by 10 EPNdB, we would judge one to be either half as loud or twice as loud, depending on which way the 10 EPNdB went. Thus, it is purely a psychol-acoustic scale but a very meaningful scale in terms of the subjective evaluation of noise.

Senator CANNON. Thank you very much, Mr. Administrator. We appreciate you being here.

(The exhibits to the statement follow:)



Public Law 90-411
90th Congress, H. R. 3400
July 21, 1968

An Act

To amend the Federal Aviation Act of 1958 to require aircraft noise abatement regulation, and for other purposes.

82 STAT. 395

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That title VI of the Federal Aviation Act of 1958 (49 U.S.C. 1421-1430) is amended by adding at the end thereof the following new section:

Aircraft noise
control.
72 Stat. 775.

"CONTROL AND ABATEMENT OF AIRCRAFT NOISE AND SONIC BOOM

"SEC. 611. (a) In order to afford present and future relief and protection to the public from unnecessary aircraft noise and sonic boom, the Administrator of the Federal Aviation Administration, after consultation with the Secretary of Transportation, shall prescribe and amend standards for the measurement of aircraft noise and sonic boom and shall prescribe and amend such rules and regulations as he may find necessary to provide for the control and abatement of aircraft noise and sonic boom, including the application of such standards, rules, and regulations in the issuance, amendment, modification, suspension, or revocation of any certificate authorized by this title.

"(b) In prescribing and amending standards, rules, and regulations under this section, the Administrator shall—

Administrative
provisions.

"(1) consider relevant available data relating to aircraft noise and sonic boom, including the results of research, development, testing, and evaluation activities conducted pursuant to this Act and the Department of Transportation Act;

"(2) consult with such Federal, State, and interstate agencies as he deems appropriate;

80 Stat. 931.
49 USC 1651
note.

"(3) consider whether any proposed standard, rule, or regulation is consistent with the highest degree of safety in air commerce or air transportation in the public interest;

"(4) consider whether any proposed standard, rule, or regulation is economically reasonable, technologically practicable, and appropriate for the particular type of aircraft, aircraft engine, appliance, or certificate to which it will apply; and

"(5) consider the extent to which such standard, rule, or regulation will contribute to carrying out the purposes of this section.

"(c) In any action to amend, modify, suspend, or revoke a certificate in which violation of aircraft noise or sonic boom standards, rules, or regulations is at issue, the certificate holder shall have the same notice and appeal rights as are contained in section 609, and in any appeal to the National Transportation Safety Board, the Board may amend, modify, or reverse the order of the Administrator if it finds that control or abatement of aircraft noise or sonic boom and the public interest do not require the affirmation of such order, or that such order is not consistent with safety in air commerce or air transportation."

72 Stat. 779.
49 USC 1429.

SEC. 2. That portion of the table of contents contained in the first section of the Federal Aviation Act of 1958 which appears under the center heading "TITLE VI—SAFETY REGULATION OF CIVIL AERONAUTICS" is amended by adding at the end thereof the following:

"Sec. 611. Control and abatement of aircraft noise and sonic boom."

Approved July 21, 1968.

LEGISLATIVE HISTORY:

HOUSE REPORT No. 1463 (Comm. on Interstate & Foreign Commerce).

SENATE REPORT No. 1353 (Comm. on Commerce).

CONGRESSIONAL RECORD, Vol. 114 (1968):

June 10: Considered and passed House.

July 11: Considered and passed Senate.

Federal Aviation Regulations

VOLUME III

**PART 36
Noise Standards :
Aircraft Type Certification**

**DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION**



Part 36—Noise Standards: Aircraft Type Certification

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Adoption of Part 36

Adopted: November 3, 1969

Effective: December 1, 1969

(Published in 34 F.R. 18355, November 18, 1969)

This amendment adds new Part 36 to the Federal Aviation Regulations. The purpose of this amendment is to implement 49 U.S.C. 1431 (Public Law 85-726, Title IV, § 611, as added Public Law 90-411, § 1, July 21, 1968, 82 Stat. 385), by prescribing noise standards for the type certification of subsonic transport category airplanes and for the type certification of subsonic turbojet powered airplanes regardless of category. This amendment also contains procedural changes to Part 21 of the Federal Aviation Regulations made necessary by the addition of new Part 36. This amendment initiates the noise abatement regulatory program of the Federal Aviation Administration under the new statutory authority.

This amendment is based on a notice of proposed rule making (Notice 69-1) issued on January 3, 1969, and published in the Federal Register on January 11, 1969 (34 F.R. 453).

I. *Relation to responsibility of airport proprietors.* Compliance with Part 36 is not to be construed as a federal determination that the aircraft is "acceptable," from a noise standpoint, in particular airport environments. Responsibility for determining the permissible noise levels for aircraft using an airport remains with the proprietor of that airport. The noise limits specified in Part 36 are the technologically practicable and economically reasonable limits of aircraft noise reduction technology at the time of type certification and are not intended to substitute federally determined noise levels for those more restrictive limits determined to be necessary by individual airport proprietors in response to the locally determined desire for quiet and the locally determined need for the benefits of air commerce. This limitation on the scope of Part 36 is required for consistency with the responsibilities placed upon the airport proprietor by the United States Supreme Court in *Griggs v. Allegheny County*, 369 U.S. 84 (1962). Consistent with this limited scope, this amendment specifies that the Federal Aviation Administration makes no determination, under Part 36, on the acceptability of the prescribed noise levels in any specific airport environment (see §§ 36.5 and 36.1581(a)).

II. *Summary of public comments.* A total of 1,428 public comments were received. These comments generally fell into two major groups. One major group contained approximately 1,000 comments from private citizens, citizen associations or committees and local airport authorities, of which approximately 960 comments were identical form letters submitted from the Los Angeles, California, area. The other major group included comments from aviation trade associations, aircraft manufacturers, and aircraft operators. With few exceptions, both major groups of commentators generally concluded that the standards in the Notice should be changed, but for directly opposite reasons, the first group contending that Congress intended greater reductions in noise levels than those proposed, and the second group contending that the statutory requirement to prescribe technologically practicable and economically reasonable noise standards could only be met with noise levels higher than those proposed.

III. *Comments from individual citizens.* The above-mentioned 960 form letters stated that the noise standards should be "based on the technology available instead of that which would be the most advantageous to the airlines." The FAA agrees that available technology must be applied in the reduction of aircraft noise. The noise standards in this amendment are intended to accomplish this result consistent with the requirement in Section 611(b)(4) that the Administrator must consider whether the standards are economically reasonable and technically practicable.

One person stated that proposed Part 36 "does not adequately reflect the will of Congress in enacting Public Law 90-411, especially in the area of takeoff noise. In 1966-67, certain realistic standards for noise limits were set. These limits have undergone various changes so that in the new Part 36 the prescribed limits represent a regression rather than progress in noise control." While noise values discussed in 1966 and 1967 were the best prediction then available concerning noise limits that might be reasonably achievable after the passage of a public law authorizing noise standards in type certification, the subsequent studies and research accomplished during and after the

period of the promulgation of Public Law 90-411, and particularly the FAA's review of the greatly expanded economic studies conducted in response to Notice 69-1 have indicated that the noise levels in Appendix C of this amendment represent appropriate noise reductions under the statutory requirement that the Administrator must consider the economic reasonableness and technological practicability of the rule. For this same reason, it would not be appropriate, at this time, to require compliance with the prescribed noise levels at the takeoff measuring point suggested by this commentator, namely 3 statute miles. However, as technology makes further reasonable noise reductions possible, the FAA will act to ensure that the lowest reasonable noise levels are achieved at the noise measurement points in this amendment. The commentator stated that the terms of the Notice would not "bring about a reduction of aircraft noise in established communities, as was the intent of Congress." In fact, the noise levels for new type designs in this amendment are substantially lower than those associated with the current fleet of jet aircraft.

The commentator further stated that the takeoff test conditions in the Notice prohibit the operators of new aircraft from using operating procedures that have heretofore been successful in minimizing noise over established residential areas. The FAA has not determined whether a minimum takeoff profile should be proposed in the form of operating regulations. However, pending the issuance of such operating regulations, the takeoff test conditions in this amendment, being type certification conditions only, do not in any way affect the operation of aircraft at airports.

One commentator stated that he assumed that the Notice was intended to protect the public from adverse physiological and psychological effects, and that a noise envelope accomplishing this must be placed within airport boundaries. The FAA agrees that protection of the public from the adverse effects of aircraft noise, by controlling the noise source, must be achieved by regulation consistent with the statutory obligation, on the part of the Administrator, to consider whether the regulations are economically reasonable, technologically practicable, and appropriate for the type of aircraft to which they apply. The FAA noise abatement regulatory program is intended to accomplish this objective with respect to the current state of the art. Further noise reductions will be required as the technology of noise abatement progresses.

One commentator stated that the noise levels should be expressed as "1-pound pressure." The FAA believes that its chosen unit of noise measurement (effective perceived noise level in decibels) is far superior to the measurement of sound pressures alone. The commentator requested that the rule be extended to other classes of aircraft. The FAA agrees that a more complete solution of the aircraft noise problem requires that other classes of aircraft be considered for future rulemaking, and intends to do so as more fully discussed below.

Several comments requested that sonic boom protection be assured. While not a part of this rulemaking action, study of the sonic boom problem is continuing so that appropriate action can be taken specifically in that area.

One comment expressed concern that these noise standards may be a "two-edged sword" that may conflict with safety in operation at airports. The question of compatibility between noise and airworthiness standards has been of primary concern to the FAA throughout its noise abatement activities, and particularly in the development of the standards in this amendment. This amendment is drafted (see § 36.3) to ensure that the airplane meets the applicable airworthiness requirements under all conditions in which noise compliance is shown, and that all procedures for showing noise compliance and all noise abatement information developed for the flight crew are consistent with the applicable airworthiness regulations. This amendment is thus drafted to ensure that the noise standards do not amend any airworthiness standard but, rather, provide an entirely separate source of type certification standards that must, in all cases, be compatible with the applicable airworthiness standards.

One comment stated that the FAA should limit the noise levels to those that do not exceed industrial health standards, vehicle emission standards, construction welfare standards, or commercial activities standards, and the FAA should permit local standards to prevail if they are more stringent than FAA standards. It is agreed that the ultimate objective of aircraft noise abatement is the achievement of aircraft noise levels similar to, or lower than, those of other industrial operations. The FAA believes that this ob-

jective is to a significant degree achieved by this amendment at the measuring points prescribed in Appendix C (see, for example, United States Department of Labor occupational noise exposure standards prescribed at 34 F.R. 7948 on May 20, 1969). However, it is recognized that certain locally desired noise levels may not be achievable within the constraints of 49 U.S.C. 1431 which requires that economic reasonableness and technological practicability be considered in the issuance of noise standards by the FAA. This being the case, the FAA, in response to the *Griggs* decision (see above), recognizes the right of state or local public agencies, as the proprietors of airports, to issue non-discriminatory restrictions with respect to the permissible level of noise that can be created by aircraft using their airports. However, the FAA does not recognize any right of any state or local government agency that is not an airport proprietor to issue any regulation controlling the flight of aircraft for noise purposes. The relationship between Public Law 90-411 (49 U.S.C. 1431) and local government initiatives was specifically discussed as follows in Senate Report 1353 (emphasis supplied) :

"The courts have held that the Federal Government presently preempts the field of noise regulation insofar as it involves controlling the flight of aircraft. Local noise control legislation limiting the permissible noise level of all overflying aircraft has recently been struck down because it conflicted with Federal regulation of air traffic. *American Airlines v. Town of Tempstead*, 272 F. Supp. 226 (U.S.D.C., E.D. N.Y., 1966). The court said, at 231, 'The legislation operates in an area committed to Federal care, and noise limiting rules operating as do those of the ordinance must come from a Federal source.' H.R. 3400 would merely expand the Federal Government's role in a field already preempted. It would not change this preemption. *State and local governments will remain unable to use their police powers to control aircraft noise by regulating the flight of aircraft.*

However, the proposed legislation will not affect the rights of a State or local public agency, as the proprietor of an airport, from issuing regulations or establishing requirements as to the permissible level of noise which can be created by aircraft using the airport. Airport owners acting as proprietors can presently deny the use of their airports to aircraft on the basis of noise considerations so long as such exclusion is nondiscriminatory.

Just as an airport owner is responsible for deciding how long the runways will be, so is the owner responsible for obtaining noise easements necessary to permit the landing and takeoff of the aircraft. The Federal Government is in no position to require an airport to accept service by larger aircraft and, for that purpose, to obtain longer runways. Likewise, the Federal Government is in no position to require an airport to accept service by noisier aircraft, and for that purpose to obtain additional noise easements. *The issue is the service desired by the airport owner and the steps it is willing to take to obtain the service. In dealing with this issue, the Federal Government should not substitute its judgment for that of the States or elements of local government who, for the most part, own and operate our Nation's airports. The proposed legislation is not designed to do this and will not prevent airport proprietors from excluding any aircraft on the basis of noise considerations.*

One comment suggested that the FAA consider the use of certain sound-suppressing materials for buildings. While the use of such materials is encouraged, the FAA does not have authority to regulate building construction practices around airports, and this amendment does not involve such regulation.

Other comments from individual citizens presented views similar to those discussed above.

IV. **Comments from citizens' associations and committees.** One citizens' committee submitted comments identical to the 960 form letters from individuals requesting that the use of available noise reduction technology should be required by the rule. As stated above, this amendment initiates a regulatory program that is intended to ensure the maximum noise reduction that is consistent with the statutory requirement to consider economic reasonableness and technological practicability.

One citizens' association submitted the results of a noise study indicating that the introduction of commercial passenger traffic to their local airport would have large costs

in their community and that the noise limits in the Notice would not be acceptable in their community. Noise limits of 90 to 95 EPN dB were requested. The FAA is convinced after thorough study that the current state of the art in the field of aircraft noise reduction simply does not allow the attainment of the requested noise levels, for the larger aircraft, consistent with the statutory requirement that economic reasonableness and technological practicability be considered by the Administrator in issuing noise abatement regulations. Further, the judicial decisions and the legislative history of PL 90-411 have made it clear that the Federal Government should not substitute its judgment for that of the airport operator in determining the service desired by the airport operator or the steps that the responsible airport operator is willing to take to obtain the service, and that the Federal Government should recognize the airport operator's right to issue regulations or establish requirements as to the permissible level of noise which can be created by aircraft using the airport (see Senate Report 1353). However, it should be pointed out that this amendment requires that takeoff noise levels may not exceed 93 EPNdB before trade-off, for aircraft with maximum weights of 75,000 pounds or less. The commentator also stated that the proposed rules do not account for tones such as high pitched whines. To the contrary, as stated in the Notice, the means of measurement, using the concept of effective perceived noise level (EPNL) in units of EPNdB, was developed to specifically account for the effects of tones, among other factors, in order to evaluate the qualities of aircraft noise that are particularly offensive to persons on the ground. One comment consisted of an agenda for a meeting of a sound abatement coordinating committee that illustrated the extent of community concern with respect to ameliorating the effects of aircraft noise in the community. The FAA encourages affected airport communities to make their needs known to the responsible airport authorities, and is committed to ensuring that the aircraft that will use the airports incorporate all noise abatement design features that technology makes available and economically reasonable.

V. *Comments from State and local authorities (including airport authorities).* A comment from one airport commission recognized that the Notice represents "no more than first steps toward an ambitious goal," and concluded that, in issuing noise standards, the FAA should take full cognizance of the views of the airport neighbors, as well as the views of the aviation industry. The FAA agrees and has fully reviewed each of the many comments received from those members of the public that are directly affected by aircraft noise. The public docket has been extremely valuable in defining the magnitude of the airport noise problem that remains to be solved. These public comments have greatly assisted the FAA in determining, after analysis of all comments, that the many and substantial costs to be imposed on the air transportation industry by this amendment are reasonable and appropriate.

The commentator also submitted comments and analyses of the proposed rules prepared by a university professor. These comments make the following points: The commentator states that the views of airport neighbors were not taken into account. As stated above, the FAA has reviewed all comments from this segment of the public and has found them useful and informative. The commentator stated that the proposed levels are not adequate because they are not socially acceptable. Under the above mentioned statutory constraints, socially acceptable noise levels can only be required insofar as they involve economically reasonable burdens on the aircraft industry and are technologically practicable. The commentator stated that the proposed regulations would allow aircraft to be noisier than present aircraft. To the contrary, the FAA believes that the noise values in Appendix C of this amendment represent actual noise levels significantly lower than those now generated by transport category or turbojet powered airplanes. The commentator stated that present airplanes should also be regulated. The FAA agrees, is now studying retrofit standards, and will issue such standards as proposals for public comment at the earliest possible time. Pending the development of retrofit standards, § 21.93(b) provides that, for transport category or turbojet powered airplanes already type certificated (i.e., the entire current U.S. jet fleet), all changes that may increase the noise levels created by those airplanes are "acoustical changes" in type design. As such, these changes would require the airplane to be substantiated under, and meet, Part 36 as applicable to "acoustical changes" in type design (see § 36.1(c)). This feature will ensure that no further escalation of noise can occur in the current U.S. fleet of jet aircraft pending the issuance of retrofit requirements. The commentator

stated that the noise values in the proposal, if issued as final rules, "will be hardened for all times and will never be improved." To the contrary, the FAA is firmly committed to lowering the prescribed noise limits as fast as technology reasonably permits. This will not only be done during type certification, but also after certification in the form of retrofit requirements applying to aircraft operators, where appropriate and economically reasonable.

The commentator stated that noise limits should not be related to airplane weights, since "it is the volume of noise produced that is critical, not the machine that makes it." The FAA agrees that weight is not related to the social or subjective acceptability of noise. However, weight is directly related to the amount of power or thrust needed by the airplane, and this factor is directly related to the amount of noise reduction that can be required consistent with economic reasonableness. This amendment must reflect this fact. The commentator stated that the takeoff, sideline, and approach measuring points are inadequate since the airplane generates noise during most of the takeoff and landing paths. The FAA believes that the prescribed measuring points in fact measure the capability of the aircraft to achieve maximum reasonable noise reductions at points representative of frequently occurring distances between the aircraft and the airport neighborhoods. This comment appears to be related to the commentator's statement that the airplane should not exceed certain noise limits at any point along the takeoff and approach paths "where there are inhabited residences." As stated above, the actual noise generated at a given airport in operation is not a question for type certification, but involves the right of airport proprietors to limit the permissible levels of noise that can be created by aircraft using the airport. If further noise reduction must be achieved at a given airport, the judicial decisions and the legislative history of P.L. 90-411 have made it clear that this is a matter for the airport proprietor. The commentator objected to the noise prediction allowance and the trade-off provisions of proposed Appendix C. For reasons discussed in connection with the comments from the aircraft manufacturers, the noise prediction allowance is eliminated under this amendment. However, the trade-off feature is maintained since the total noise exposure created by an airplane is related to the noise transmitted to all three measuring points (sideline, approach, and takeoff). It would, therefore, not be rational to deny a type certificate to an aircraft that only slightly exceeds the required noise levels at one or two points if the exceedances can, in fact, be made up or offset at the remaining measuring point(s), so that the net result is an aircraft whose total noise exposure is no worse than that of an aircraft that barely met the requirements at all three measuring points. The commentator stated that the proposed rules do not ensure that a noise-approved airplane will be operated in the same manner as it was operated to obtain the approval. This comment is correct. Further, as stated above, the FAA has not determined whether a minimum takeoff profile should be proposed in the form of an operating rule. The commentator stated that any aircraft, pilots, or airlines that continually violate the standards met by the prototype aircraft should lose their certificates.

With respect to aircraft that no longer conform to the noise-approved type design, the FAA would consider action against the airworthiness certificate as in the case of any nonconformity with the type design. With respect to pilots and air carriers, the FAA has not ruled out the possibility of certificate sanctions related to noise abatement regulations. However, such action is not contemplated based on the type certification test procedures since they do not, by themselves, regulate aircraft operators. The commentator stated that the proposals did not apply to takeoff and landing noise associated with supersonic aircraft (apart from sonic boom). The FAA agrees that civil supersonic airplanes should be regulated for takeoff and landing noise purposes (in addition to sonic boom) and is in the process of determining what standards will allow the maximum use of available noise reduction technology for such aircraft consistent with the statutory requirement that economic reasonableness be considered. This is more fully discussed below.

One comment from a city manager stated, in addition to comments similar to those treated above, that the FAA should "take a more militant stand in favor of the general public and opposed to the private monetary interests of airlines and aircraft manufacturers." It should be emphasized that the FAA does not intend to "favor" or "oppose" any segment of the public in its noise abatement activities. Rather, the FAA intends to impartially administer the language of 49 U.S.C. 1431 in the light of the pertinent state-

ments of Congressional intent concerning the public law, such as the statement in Senate Report 1353 that "a completely quiet airplane will not be developed within the foreseeable future. However, with the technological and regulatory means now at hand, it is possible to reduce both the level and the impact of aircraft noise. Within the limits of technology and economic feasibility, it is the view of the committee that the Federal Government must assure that the potential reductions are in fact realized." The FAA intends to ensure that its noise abatement regulatory program requires aircraft manufacturers to achieve the greatest noise reductions that are consistent with the economically reasonable limits of noise reduction technology.

Other State and local authorities submitted comments similar to those discussed above, and made the following additional points: One comment stated that the proposed regulation "should be in terms of noise exposure to residential uses with grants withheld if an airport has not made all residential areas with greater exposure compatible with the airport." While the FAA agrees that the airport proprietor is responsible for assuring compatibility of the airport with neighboring land uses, this amendment does not involve the grant or withholding of any funds, but rather is limited to prescribing design standards that must be met by aircraft manufacturers, for noise abatement purposes, as a condition to FAA approval of their products. The commentator also stated that the proposed regulation should not permit noncompliance by manufacturers for economic reasons. Under 49 U.S.C. 1431, economic reasonableness and technological practicability must be considered by the Administrator in determining the noise limits that must be complied with.

One comment recommended that the FAA should "avoid the current practice" under which pilots fly at full power up to the measuring device, reduce power over the measuring device, and then reapply full power when out of range of the measuring device. While these amendments do not regulate the operation of airplanes, it should be noted that the conditions of noise measurement under this amendment are intended to be sufficiently conservative to ensure that the noise values demonstrated during certification can be duplicated in operation under relatively high power or thrust conditions, so that noise levels demonstrated during type certification can be safely achieved by flight crews without the need for further power reductions over the measuring devices. Thus, these amendments require that no power or thrust reductions may go below that power or thrust that will provide level flight with one engine inoperative, or below that power or thrust that will maintain a climb gradient of at least four percent, whichever power or thrust is greater. In addition, takeoff power or thrust is required, during the type certification tests, from the start of the takeoff to the point at which a substantial altitude above the runway is reached. These features of the type certification noise test should minimize the future incentive for flight crews to make large power reductions to satisfy airport noise limitations. This should ensure that the noise levels obtained during type certification can be used as dependable guides to airport planning at the local level.

One comment from a State aeronautics department stated that no compromise with 100 percent control of aircraft noise should be made except compromises made in the interest of safety. While the FAA agrees that safety must not be adversely affected by noise abatement actions, it should be noted that 49 U.S.C. 1431 directs the FAA to consider economic reasonableness and technological practicability, in addition to safety, in the issuance of noise abatement regulations.

One comment from the department of airports of a major city stated that more severe standards are necessary and particularly that the lateral noise values allowed by the proposed standards would eventually force the acquisition of an additional block of homes paralleling one runway. FAA studies indicate that the lateral noise levels allowed by this amendment represent a substantial improvement when compared with existing airplanes of the same weight. Further noise reductions will be required by the FAA as noise reduction technology progresses. In any case, responsibility for assuring compatibility with land uses around the airport, such as by acquiring additional land, rests with the airport proprietor.

One comment representing the airport operators contained several of the points discussed above, and also made the following suggestions for improving the regulation: The commentator stated that a noise limited weight should be established that is different from the airworthiness limited weight and that the FAA should permit the use of either

weight depending on the noise sensitivity of the particular airport. While the FAA has considered such an approach as a possibility, it is now believed that the noise limited weights should be general operating limitations since: (1) a requirement for compliance with noise limits at low weights only would reduce industry incentive to achieve maximum reasonable noise reductions at the higher weights; and (2) the primary responsibility for ensuring that airport operation is compatible with surrounding neighborhoods rests with the airport operator.

However, the FAA realizes that an unjust situation could result if an aircraft, for which a noise limited weight less than the airworthiness maximum weight is established under § 36.1581(b), were required to operate at the lower weight from a particular airport or runway at which there is no noise problem whatsoever. In order to accommodate these infrequent situations and at the same time prohibit a general erosion of the noise protection provided by Part 36, the FAA will handle these situations on a case-by-case basis, under the exemption authority of Section 601(c) of the Federal Aviation Act of 1958. Under that section, the Administrator would require proof that, in fact, there is no noise sensitivity associated with the particular airport or runway and that an exemption from the requirement to comply with operating limitations (see § 91.31(a)) is in the public interest. When such proof is made, appropriate limitations would be placed in the exemption to ensure that the resulting operation does not affect any noise sensitive areas. The concurrence of the affected airport operator would, of course, be required as a condition to the granting of such an exemption. All of this would be accomplished under Part 11 of the Federal Aviation Regulations.

The commentator suggested that certification should be denied until additional noise reduction features have been incorporated in the airplane to permit additional noise reduction at the source. The FAA agrees with this concept and, as more fully discussed below, will not rely solely on the noise limits currently prescribed in Appendix C of Part 36 but will issue further regulations, during the type certification process, where necessary to ensure that the maximum reasonable use of noise reduction technology is applied to the airplane. The commentator finally suggested that certification could be predicated on the use of higher thrust engines with no increase in maximum takeoff weight, so that lower noise levels would result. The FAA intends to ensure that the noise limits applied to aircraft ensure that all economically reasonable and technologically practicable design provisions are employed to reduce noise, including the use of powerplants that provide the greatest noise reduction.

One comment from a State port authority stated that the standards in Part 36 should be at least as stringent as those informally proposed by the FAA in 1966, namely, 106 EPNdB for very large aircraft. Information submitted under the FAA's public rule making procedures indicates that the noise values being considered in 1966 could not be prescribed, for those same airplane weights, consistent with the statutory requirement that economic reasonableness be considered. After thorough review of comments submitted, the FAA believes that this amendment contains the lowest noise levels that are currently economically reasonable and technologically practicable for the very large aircraft mentioned by the commentator. However, as noise reduction technology develops, the FAA intends to ensure that the noise levels mentioned by the commentator, and lower noise levels, are achieved when the impact of such lower noise levels will be economically reasonable.

The commentator also stated that the noise measurement distances should be reduced in order to protect more residents. The objective of the noise limits specified at the measurement points in this amendment is to achieve all noise reduction that is economically reasonable and technologically practicable. Therefore, the measurement distances could not be shortened, consistent with the statutory requirement to consider technological practicability and economic reasonableness, unless the noise levels were correspondingly raised over those contained in this amendment. Further, while no single set of measuring points can represent all airport/community situations, it is believed that the measurement points in this amendment are no less typical than those suggested by the commentator.

The commentator cited Department of Transportation and NASA studies concerning the progress that can and must be made in the field of aircraft noise reduction, and stated that "only by reducing to a minimum the geographic areas affected by maximum

aircraft noise levels can a compatible land use program be manageable." The FAA recognizes that much remains to be done. This amendment is but the first step, under 49 U.S.C. 1431, in a noise abatement regulatory program whose primary objective is that cited by the commentator, namely, the greatest protection of the greatest number of airport neighbors from aircraft noise by reducing affected noise sensitive areas to the absolute minimum consistent with the statutory requirement that the FAA must consider economic reasonableness and technological practicability relative to the affected aircraft.

The port authorities of two major metropolitan areas submitted comments containing many of the points discussed above, and in addition submitted the following comments: One commentator stated that a reasonable portion of the increased efficiency of new engine designs should be required to be absorbed in noise abatement. The FAA agrees. It is the intent of the FAA noise abatement regulatory program to ensure that each new technological advance contributes its reasonable share to the ultimate solution of the noise problem. Both commentators mentioned that airport operators may have difficulty in monitoring and enforcing noise standards determined as prescribed in this amendment, and one comment stated that the FAA should monitor and enforce, in operation, the noise levels prescribed in this amendment. It should be emphasized that nothing in this amendment is intended to substitute federal judgment for that of the airport proprietor in the determination of the noise levels, noise measurement, or noise evaluation techniques that are most responsive to the particular and unique noise problems facing each airport proprietor.

VI. Comments from aviation trade associations (other than aircraft manufacturers and operators).

One comment stated that airline pilots are concerned about disparities between certification performance and actual operational performance "under line conditions." The commentator stated that while the certification procedures are acceptable for the purposes of noise certification testing, it should be made clear that the flight procedures in the NPRM are not necessarily representative of airline operating techniques nor will they necessarily produce the minimum amount of total noise exposure on the ground. As stated above, the FAA has not determined whether a minimum takeoff profile should be proposed in the form of an operating rule. Consistent with safety, however, the FAA agrees that the airport proprietor should be permitted to use any nondiscriminatory restrictions on the use of his airport for noise abatement purposes. Nothing in this amendment, or in any later promulgated operating rule, will affect in any way the airport proprietor's authority to determine the noise sensitivity of his neighbors and restrict the use of his airport accordingly. Consistent with safety, and with this recognized authority in the airport proprietor, the procedures in Part 36 serve the following necessary purposes: First, by prescribing full power or thrust to a substantial altitude and substantial power or thrust after cutback of power or thrust, together with a speed of at least $V_2 + 10$ knots, the type certification procedures should ensure that the resulting demonstrated noise levels are conservative so that the public will not be misled and so that flight crews can achieve these values with safe reserves of power and speed. Secondly, by standardizing the measurement conditions, the type certification procedures ensure that the resulting noise values have the same meaning for all aircraft of the same class so that valid comparisons between those aircraft can be made.

The commentator stated that noise measurements made for aircraft following an approach angle of 3° with a tolerance of $\pm 0.5^\circ$ must be corrected for the actual position in respect to the glide slope at the time the measurement was taken. The FAA believes that the intent of this comment is accounted for since Section A36.3(c)(2) of Appendix A provides that the EPNL values obtained from the measured approach path must be corrected to the reference flight path (i.e., approach path of 3° and aircraft height of 370 feet vertically above the approach measurement location).

The commentator stated that the rule should provide that all engines must be operating at the appropriate approach power or thrust settings for the specific procedure. The FAA agrees and has furnished specific approach test conditions, including power or thrust settings, in § C36.9.

The commentator stated that the minimum altitude for power cutback in § C36.7(a) should be raised to 1,500 feet. This comment is not accepted since the altitudes prescribed in this Part are believed to be adequate for safety and will allow a reasonable flexibility in the use of power in meeting the prescribed noise levels.

The commentator stated that the minimum speed for compliance with the takeoff test should be no less than " V_2+20 knots or the maneuvering speed, whichever is greater." The FAA believes that the speed V_2+10 knots is an appropriate and safe minimum speed for the takeoff noise test and that no higher speed, such as V_2+20 knots or the maneuvering speed, is necessary for a valid and conservative demonstration of takeoff noise.

The commentator stated that § C36.7 should provide that flap settings must be consistent with those used during normal operations. The FAA believes that a constant airplane configuration is necessary throughout the takeoff noise test (§ C36.7(d)), as more fully discussed below. The applicant may select this configuration so that it is not inconsistent with normal operations.

One comment from an association representing the flight engineers stated that the Notice of Proposed Rule Making was acceptable as published.

One comment from a technical society made several editorial suggestions for improving Appendix B as proposed. Those comments are adopted. The comment also stated that the concept of Effective Perceived Noise Level (EPNL) is an imperfect one and therefore suggested that the regulations should provide for an appeal to a panel or jury of listeners for comparison with known noise references. The FAA agrees that the concept of EPNL is imperfect and should be continuously refined to more adequately measure the qualities of aircraft noise that cause subjective annoyance. However, this comment is not accepted since (1) no jury concept has been shown to be compatible with equal regulation of all applicants according to predictable well defined guidelines, and (2) it is believed that the concept of EPNL, as used in this amendment, is sufficiently precise, and responsive to the annoyance factors in aircraft noise, to provide a fair basis for ensuring that all noise reduction technology that is currently economically reasonable and technologically practicable is applied to the airplane, and to provide that all similar type designs are similarly regulated.

VII. Comments from aircraft manufacturers and air carriers. Comments were received from an individual air carrier and from associations representing aircraft manufacturers and air carriers.

The comment from the individual air carrier made the following suggestions: The commentator stated that the flap position used for takeoff and initial climb should be the largest deflection approved for takeoff at maximum weight, and that flap deflection should not be reduced before reaching the takeoff measuring point. The commentator also stated that the initial climb speed should be not less than V_2+10 knots or stall speed plus 40 knots, whichever is greater, and that no deceleration should be permitted in the initial climb speed from liftoff to the takeoff measuring point. The FAA agrees that a takeoff test airspeed of V_2+10 knots is adequate for safety and will not preclude a valid noise test. This comment is therefore accepted with respect to the speed V_2+10 knots. However, the FAA also believes that by requiring a constant takeoff configuration and takeoff power or thrust from the start of the takeoff to the point at which a substantial altitude is reached, Part 36 ensures that the takeoff noise test is fully compatible with safe operating procedures. The commentator also stated that the approach speed should not be less than 130 percent of the stall speed plus 10 knots and should be essentially constant during the approach. The FAA agrees. As more fully discussed below, this was the intent of the term "reference airspeed" as used in the Notice. Part 36 ensures that the approach noise test is fully compatible with safe operating procedures by providing that the test must be conducted with the aircraft stabilized and following the prescribed glide angle at proper approach power or thrust for maximum allowable landing flap settings, with an approach speed of $1.30V_S+10$ knots over the approach noise measuring point (see § C36.9). The commentator stated that the noise type certification procedures should be "compatible with good and practicable operating practices." The FAA agrees, and believes that Part 36 contains procedures that can be duplicated practicably and safely in normal operations. The commentator further stated that all references to operating procedures should be deleted from the rule, and that the flight manual should contain performance data instead. Apparently, the commentator, like several other persons who commented, assumed that operating procedures established during noise type certification and placed in the airplane flight manual were intended to be mandatory procedures for operators. This is not the case. The data and procedures

developed under Part 36 are placed in the airplane flight manual as operating procedures and performance information only. In order to prevent further confusion, § 36.1581(a) provides that no operating limitations may be furnished under that section (except as provided in § 36.1581(b)). However, as stated above, operating rules may later be proposed. Such rules would be operating regulations amending Part 91 or 121 rather than airplane flight manual operating limitations for noise abatement purposes.

The comments representing the aircraft manufacturers and air carriers contained analyses of the economic impact of the proposed rules, together with detailed recommendations for changing the regulations. Both commentators concluded that the proposed standards were so severe in their effects that the proposals violated the statutory requirement that economic reasonableness be considered. In addition, the comment representing the aircraft manufacturers stated that the Notice of Proposed Rule Making was unacceptable, should be discarded, and should be replaced in its entirety with an alternative noise type certification regulation prepared by the association representing the manufacturers. Numerous changes were requested. However, in view of the large volume of detailed comments, only the most significant comments can be discussed herein.

The most significant changes requested by the aircraft manufacturers and air carriers are as follows: (1) it was requested that the noise prediction allowance be eliminated; (2) it was requested that the minimum altitude for reduction of power or thrust be lowered from 1,000 feet (as proposed) to 700 feet; (3) it was requested that the prescribed noise levels be relaxed, the air carrier comment requesting that the sliding scale of the noise levels with respect to aircraft weights be changed, and the manufacturer's comment stating that an increase of 2 EPNdB should be granted, across the board, particularly to allow a more relaxed requirement for airplanes with high maximum weights; (4) it was requested that growth airplanes be allowed to increase noise levels above the "parent" airplane, and at least 2 EPNdB higher than the originally applied levels of Appendix C, provided that the growth airplane meets the applicable higher noise ceiling criteria; (5) it was requested that the power or thrust level required, after reduction of power or thrust during the takeoff test, be the power or thrust necessary to provide level flight in the event of engine failure, but not less than a climb equivalent of 4 percent (as opposed to 6 percent as proposed in the Notice); (6) it was requested that the tradeoff provision be relaxed to provide for a maximum of 3 EPNdB at any one measuring point, with a total of 5 EPNdB to be offset at the remaining measuring points (as compared with the proposed values of 3 EPNdB and 2 EPNdB, respectively); (7) it was requested that the distance for measuring sideline noise be extended from 0.25 nautical miles to 0.35 nautical miles; (8) it was requested that the FAA issue all of the proposed regulatory material concerning the measurement and evaluation of noise (proposed as Appendices A and B respectively) in the form of nonregulatory Advisory Circulars; (9) it was requested that the FAA eliminate its intention to require each aircraft to be designed to be as quiet as practical during type certification, eliminate the announced intent to achieve a low noise level or "floor" of 80 EPNdB and replace this approach with the concept of periodic reviews with industry "aimed at future noise reductions;" and finally, (10) it was stated that the initial application to type designs for which application was received prior to the effective date of Part 36 is not acceptable in principle.

A large volume of detailed economic data was submitted by the aircraft manufacturers and operators. This information was submitted in order to permit the FAA to establish the best possible understanding of the economic implications of the proposed rule, in accordance with the requirement in Section 611(b)(4) of P.L. 90-411 that the Administrator "shall . . . consider whether any proposed standard, rule, or regulation is economically reasonable, technologically practicable, and appropriate for the particular type of aircraft . . . to which it will apply." The submitted data represented in detail the economic requirements of the air carriers in the 1972 to 1975 time period, and covered a broad spectrum of airplane designs. For these aircraft, the data described the economic impact of the proposed rules with respect to aircraft design selection and performance, propulsion requirements, the complex interrelations between aerodynamics, acoustics, and weight, and the resultant economic effects on payload, fuel requirements, runway requirements, and in particular the impact of these factors on route structures used by the air carriers, from the shortest domestic routes to the longest intercontinental routes. The

analysis included airplane operating costs and the impact of these costs on airline system economics.

A thorough review of all data submitted has convinced the FAA that the current state of the art of noise reduction, as related to the impact of noise reduction on the economic life of affected aircraft, requires that certain modifications in the proposed rules be granted at this time for airplanes with more than three turbojet engines, because of the weight and design mission requirements of those airplanes. These modifications could not be withheld by the FAA consistent with the statutory requirement to consider the economic reasonableness and technological practicability of the rules. In addition, certain changes are made, for all airplanes, that should not adversely effect the noise levels created by those airplanes.

First, it is believed that no adverse effect on the validity of the takeoff noise test will result if the requested change in power required after cutback is granted. This is true since the power necessary for a 4% climb gradient without failure of one engine, or a zero climb gradient after such failure, is still a high enough power setting so that the resulting noise levels are conservative and can be duplicated easily and safely in operation. This change is, therefore, made in § C36.7 of Appendix C. This change is an economically necessary relaxation for airplanes having more than three turbojet engines. For other airplanes, the requirement to maintain at least a zero climb gradient is sufficiently severe so that no real relaxation results.

Secondly, since it is not a relaxation, it is believed that the requested elimination of the proposed noise prediction allowance can be accomplished with no adverse effect on noise levels. It is not understood why the industry regarded the noise prediction allowance as a restriction since the allowance provided for exceedance privileges, *above* the normal noise limits, if certain conditions were met. This amendment eliminates the allowance for noise prediction. Under this amendment, no provision is permitted for exceeding the values obtained after applying the trade-off exceedance values. Thirdly, a limited relaxation is made in the definition of "major change" in type design in order to provide a clear noise limit within which growth of the airplane may proceed without the need for meeting amendments to Part 36 that are issued after the airplane is first type certificated. The Notice of Proposed Rule Making stated that any change that may increase the noise of the airplane would be classified as a "major change." The FAA believes that this approach is still valid for airplanes that have not fully complied with Appendix C of Part 36, including all aircraft not type certificated under Part 36, in order to ensure that the escalation of aircraft noise has been stopped by this amendment. For these aircraft, no change from the Notice is appropriate. However, the FAA recognizes that the aircraft manufacturer requires a firm noise limit within which growth can occur under the rules applicable to the original type certification under Part 36. The FAA believes that this degree of certainty can be given the manufacturer, consistent with the public interest, for aircraft for which compliance was shown with the noise limits of Appendix C as applicable to the date of application for the original type certification under Part 36. However, in no case should aircraft growth, that may make the aircraft noisier than the original limits prescribed in Appendix C, be permitted.

This amendment permits aircraft that are quieter than Appendix C requirements to grow up to the limits of Appendix C with respect to noise. This relaxation does not satisfy the aircraft manufacturer's request that room for growth be added above the proposed Appendix C values. However, the FAA believes that the approach discussed above provides a reasonable balance between the manufacturer's legitimate need for a certain and defined growth potential, and the public need for an orderly and progressive deescalation of aircraft noise. In short, §§ 21.93(b) and 36.1(c) will ensure that noise reduction technology sufficient to achieve Appendix C limits must be applied before further aircraft noise growth can occur. This applies to the entire fleet of transport and jet airplanes now extant. The FAA believes that this priority of values is necessary in order to prevent a continual erosion in aircraft noise. It should be pointed out that this aspect of the rule merely limits future noise escalation and is no substitute for supplementary retrofit requirements that will later be adopted to effect a positive reduction in the noise of the current fleet. Finally, while the Notice designated these changes as noise related "major changes," this amendment redesignates them as "acoustical changes." This editorial change, plus the statement in § 21.93(b) that "acoustical

changes" are so designated for the purpose of complying with Part 36 only, insure that no acoustical judgments will, in any way, alter the previously established criteria for determining whether a change in type design is "minor" or "major" for airworthiness purposes. Nothing in this amendment affects the distinction between minor and major changes for airworthiness purposes or affects the procedural or substantive requirements applicable to either kind of change. The proposed amendment to § 21.115 is withdrawn in connection with this change.

With respect to the comment concerning application of Part 36 to aircraft for which type certification application was made prior to the effective date of the Part, the FAA is in partial agreement. This amendment contains three departures from the Notice with respect to type certification applications now pending. First, since there are no such applications pending with application dates between the date of publication of the Notice and the publication date of Part 36, the proposal to require only the development of procedures and information to achieve the lowest reasonable noise level (in addition to compliance with the remaining applicable sections of Part 36) for aircraft not having high bypass ratio engines, is extended to cover all applications prior to the effective date of Part 36 (rather than only those applications prior to the publication date of the Notice, as proposed). No actual regulatory change results and the effectivity of Part 36 is simplified by this change. If an application is filed between the publication and effective dates of Part 36 for such aircraft, further regulatory action will be considered. Secondly, it is believed that the requested increase in the trade-off provision, to allow a sum of exceedance of 5 EPNdB (rather than 3 EPNdB as proposed), and a greatest single exceedance of 3 EPNdB (rather than 2 EPNdB as proposed), is necessary to provide flexibility for aircraft with more than three engines that are already undergoing type certification, but will minimize the resultant noise increase by requiring, as the Notice did, that all exceedances must be offset by reductions at other measuring points. This change appears in § C36.5(c). The remaining, and most significant, departure from the Notice concerning the standards to be applied to aircraft currently undergoing type certification is as follows:

In section 36.201(b) of this amendment, consideration of acoustic requirements placed on aircraft for which application for the type certificate was made prior to January 1, 1987, is addressed. These aircraft, for example the Boeing 747, were in advanced phases of their design cycle prior to the establishment of definitive indications of probable certification noise levels. Regardless of the lack of definite acoustic design goals, the manufacturers of these aircraft have developed designs which represented the application of the most advanced acoustic technology available to them. As a consequence, these aircraft will produce noise levels considerably below those of present day aircraft even though the levels may not, in every way, comply with the requirements of Appendix C of this amendment. In recognition of the advances in the state of aircraft acoustic art demonstrated by these aircraft, the initial compliance with this amendment is to be considered on the basis of the use of acoustic techniques which will insure that these aircraft are as quiet as is technologically practical. However, the type certificate will contain an expiration period after which the manufacturer will be required to show compliance with the requirements of Appendix C. In this connection, § 36.201(d) provides that, for aircraft to which paragraph (b)(1) of that section applies, and that do not meet Appendix C, a duration period will be placed in the type certificate, upon the expiration of which the type certificate will be subject to suspension or modification (with full notice and appeal rights as contained in 49 U.S.C. 1429) unless the type design of later aircraft is modified to show compliance with Appendix C.

The request that nonregulatory Advisory Circulars be used for the procedures for measuring and evaluating noise cannot be accepted. Proper noise measurement and evaluation is necessary for a valid acoustical analysis of the airplane. Flexibility can be provided in the regulatory form by permitting the applicant to submit alternative procedures and show that those procedures are equivalent to those in Appendix A or B. As in the Notice, Part 36 therefore contains noise measurement and evaluation standards in regulatory form (Appendices A and B).

It would also be inappropriate for the FAA to accept the request to eliminate the intent to achieve all reasonable noise reductions in each type certification program. The net result of this request, if adopted by the FAA, is that the noise limits prescribed in

Appendix C would become guaranteed values that could be generated as a matter of right even if the FAA could reasonably determine, during the type certification process, that lower noise levels were economically reasonable. This result would be inconsistent with the FAA's commitment to achieve the greatest reasonable noise reductions as soon as technology permits. As stated in the Notice, "the FAA cannot responsibly accept (the noise limits specified in Appendix C) as satisfactory where further noise reductions are available and reasonable. Where those further reductions are available, are economically reasonable, technologically practical, and appropriate to the particular type design, the FAA cannot ignore them by waiting until all type designs are expected to be quiet enough to permit lowering the noise ceiling for the entire class. By then, of course, any type designs that could have been substantially quieter would have been approved, and aircraft produced under them, without the realization of the actually available noise reductions. It is not believed that such a result is consistent with Public Law 90-411." However, the FAA recognizes that, since the technology of noise abatement is relatively new, the standards applied to the manufacturers should be precise and definite. In this connection, several comments requested that the general language in the Notice ("economically reasonable . . ." (etc.)) should be replaced with specific regulatory language. In order to accept this reasonable request and also preserve the intent of the Notice to achieve all reasonable noise reduction in each type certification program, the following approach will be adopted (for airplanes to which Appendix C applies):

Appendix C of Part 36, being the FAA's best estimate of the maximum reasonable noise reductions possible for given aircraft weights, will apply, for each aircraft weight, unless the FAA determines in a given type certification program that either Appendix C was originally unduly lenient, or developments in noise reduction technology render Appendix C unduly lenient for the particular type of aircraft. When this determination is made, the FAA will administer § 21.17(a)(1)(i) of the Federal Aviation Regulations (which in effect provides that the applicable type certification standards are not those in effect on the date of application for the type certificate where "otherwise prescribed by the Administrator") to issue precise and definite standards, with notice and public procedure, that will accomplish the intent of the general language proposed in the Notice to prevent the issuance of a type certificate for any aircraft for which available and reasonable noise reduction design practices have not been incorporated.

The FAA has determined that the request to remove the noise "floor" of 80 EPNdB from the regulatory language is reasonable and should be granted. This noise floor, not being currently achievable, could have no immediate legal effect. Further, it has become evident that the number 80 EPNdB might be misconstrued as being a value that is federally determined to be "acceptable" in a given local airport environment. In order to prevent this result, the reference to the noise "floor" is deleted from the final rule.

With respect to the requested increase in sideline measuring distance, the FAA concludes that, in combination with the prescribed noise limits, the proposed distance of 0.25 nautical miles would result in economic penalties that are unduly severe for airplanes having more than three turbojet engines. This defect could be cured by raising the noise limits at the proposed measurement point or by extending the measurement distance to a point at which the proposed noise limits become economically reasonable. While the effect of either approach would be the same with respect to the increase in sideline noise that would be permitted, the FAA believes that since the noise level numbers prescribed in the Notice have been widely publicized for land planning purposes, any actions that may now be underway to achieve land use compatibility with those noise levels should be less affected by altering the measurement distance than by introducing new and unfamiliar noise levels. Therefore, this amendment extends the required measuring distance from 0.25 nautical miles to 0.35 nautical miles for airplanes with more than three turbojet engines instead of raising the noise limits at the proposed sideline measuring distance. This distinction between the sideline measuring requirement for two and three engine turbojet airplanes and that for larger turbojet airplanes also reflects the fact that the larger airplanes will generally be operated out of larger airports only, while the smaller airplanes will be operated out of smaller airports as well as larger airports.

With respect to the requested lowering of the proposed takeoff noise test minimum altitude for power reduction to 700 feet, the FAA believes that a responsible assessment

of the economic impact of the proposed altitude of 1,000 feet requires that this modification be granted for airplanes with more than three turbojet engines. This relaxation can be accomplished consistent with safe operating practices and will permit a valid and conservative takeoff noise test since a substantial power setting is required after power cutback.

With respect to the further requested raising of the noise limits and the remaining requested relaxations, the FAA has evaluated the economic data submitted by the aircraft manufacturers and air carriers, and concludes that the requested relaxations in the regulation are not justified and that the claim of unreasonable economic impact cannot be responsibly accepted.

In particular, the submitted information does not justify any relaxation in the trade-off, sideline, or takeoff power cutback altitude requirements for two- and three-engine turbojet airplanes. To the contrary, the submitted information clearly showed the economic effect of the proposed rules on the two- and three-engine airplanes to be far less than the impact on four engine airplanes. In fact, certain industry comments indicated that further noise reductions may be economically reasonable and appropriate in the near future for the smaller turbojet engine powered airplanes. The FAA is undertaking study of the advisability of such additional rulemaking.

The commentator stated that the proposed rules were defective in that they will impose more economic burden on the largest, noisiest aircraft than on the smallest, less noisy aircraft. This result is, to some extent, inevitable. There is simply no way in which the escalation of noise can be effectively arrested without increasing the severity of noise suppression regulations as the noise generated by the aircraft increases.

The commentator states that it could not accept the basic measurement concept of Effective Perceived Noise Level (EPNL) unless all specific requested relaxations from the proposed rules (i.e., overall increase of 2 EPNdB, etc.) are granted. This amendment nevertheless adopts the concept of EPNL, with refinements, since (1) the basic validity of this unit of measurement does not depend on whether all requested relaxations are adopted; (2) the commentator's submitted data and analyses indicate that EPNL provides a sufficiently precise basis for predicting economic impact (although the FAA disagrees with certain of the data submitted); and (3) as discussed above, EPNL provides the best known basis for objectively measuring the qualities of aircraft noise that are most offensive to persons on the ground.

The Notice proposed to permit the applicant to select a weight for takeoff noise compliance that is less than the maximum weight, provided that the lesser weight is furnished as an operating limitation. This allowance was not proposed for the landing weight used in complying with the approach noise requirements. This difference is not intended. Section 36.1581(b), therefore, permits any weights to be selected by the applicant for showing compliance with the takeoff and approach noise requirements provided that any selected weights that are less than the maximum weight or design landing weight must be furnished as operating limitations in the Airplane Flight Manual. This amendment also moves the approach test condition requirement from Appendix A to Appendix C, so that the conditions for approach and for takeoff would be specified together in the same Appendix. This is done in new § C36.9 of Appendix C. The Notice proposed that the approach airspeed must be the "reference airspeed." The intent of this proposal was to require an airspeed that is highly typical of normal approach airspeeds, so that a realistic approach noise is generated. The speed $1.30 V_S + 10$ knots is such an airspeed and is therefore specified in § C36.9(d). The following additional changes from the Notice are made in the takeoff and approach test conditions. For the takeoff test, the reference to "takeoff flap" is changed to "takeoff configuration," since lift control devices other than flaps may be included. One comment stated that the applicant should be permitted to use any configuration schedule consistent with the airworthiness requirements and stated that some configuration change may be appropriate for minimizing community noise. The FAA does not know of any takeoff configuration schedule that will result in less total community noise than that resulting from maintaining a constant takeoff configuration throughout the takeoff noise test. The objective of the takeoff noise test is to determine the noise generated by the airplane under conditions representative of those actually necessary in operations if minimum total community noise exposure is to be achieved.

The commentators suggested several editorial changes which are adopted in whole or in part.

One comment stated that the word "turbojet" should be broadened to specify also "turbofan" engines. This change is not accepted since the word "turbojet" has been used without confusion, throughout the type certification regulations, to include "turbofan" engines.

The Notice proposed that a statement of noise compliance be placed on the airworthiness certificate of aircraft type certificated under Part 36 for international recognition purposes. This proposal may have merit but final rulemaking thereon is withheld pending international agreement concerning the manner in which noise type certification is to be recorded for international recognition.

The proposed listing of specified noise sources and means of noise reduction is withdrawn since developments in noise reduction technology could rapidly obsolete such a listing. As stated above, however, the FAA will prescribe all additional regulations deemed necessary to ensure that all available and reasonable noise reduction technology is applied during type certification.

Since the general language proposed in the Notice ("economically reasonable . . ." (etc.)) is deleted from this amendment (except for airplanes with high bypass ratio engines for which application was made prior to January 1, 1967), a formal basis for providing more detailed regulations, at the applicant's request, will not be needed to a sufficient degree to justify retaining proposed § 21.16(c), which proposed special conditions for noise purposes if requested by the applicant. That proposal is therefore withdrawn.

With respect to foreign aircraft, the Notice proposed to amend § 21.29 to provide that compliance with applicable aircraft noise regulations is to be certified by the foreign country as well as compliance with airworthiness regulations. This proposal is changed in this amendment to be consistent with § 21.29 as amended by Amendment 21-25 (published at 34 F.R. 14067 on September 5, 1969). As pertinent here, these changes (1) limit the products to those that are to be imported into the United States, and (2) provide that all submitted listings must be presented in the English language. Other changes are made for consistency with the airworthiness procedures affecting import aircraft. There is no basis for distinguishing between airworthiness and aircraft noise standards in the acceptance by the FAA of statements of compliance by competent foreign authorities.

This rule, which is appropriate for the conventional subsonic aircraft, contains many concepts which are inappropriate for aircraft that are designed to operate vertically (VTOL), that have short takeoff and landing capabilities (STOL), and for aircraft that cruise at supersonic speeds (SST). Specifically, the vertically operating aircraft exhibit a unique acoustic characteristic since their propulsive thrust is generally obtained from large rotors, the short takeoff and landing aircraft will have acoustic characteristics related to the use of thrust to obtain lift, and the supersonic aircraft necessarily has a propulsive system which is sized for the high thrust requirements necessary to obtain supersonic speeds. Accordingly, the noise certification of the VTOL aircraft may require consideration of acoustic qualities which will need special psychoacoustic evaluation and the STOL aircraft may require consideration of the unconventional thrust mode and operational environment. On the other hand, the extraordinarily high acceleration required by the SST in the transonic operation will necessarily produce performance capabilities at ground levels which have important implications concerning its noise characteristics. For instance, unusually high takeoff thrust will produce higher sideline noise levels in the vicinity of the airport; however, the resulting high gradient of climb will produce significantly lower noise levels over the communities underlying the takeoff flight path. Accordingly, the responsibility of local airport authorities to insure land use compatibility as discussed in Senate Report 1353, must be exercised with particular care in the case of the SST because of the above mentioned unique acoustic characteristics. As a consequence of these considerations, this amendment excludes SST aircraft and does not contain specific additional regulations for VTOL and STOL aircraft since the acoustic technology associated with these classes of aircraft requires further study before the FAA can comply with the statutory requirement to consider whether the related noise standards are appropriate to the particular type of aircraft, are technologically

practicable, and are economically reasonable. Separate rulemaking for these classes of aircraft is necessary to assure that all available and reasonable sources of noise reduction are realized as a basis for acoustically responsive land use planning by the responsible local airport proprietor. This rulemaking will be proposed for public comment at the earliest possible time.

In §§ A36.2(c) and (d) and A36.5(a) of Appendix A of this amendment, the text and specifications contained in certain technical publications are incorporated by reference pursuant to 5 U.S.C. 552(a)(1) and 1 CFR Part 20. Approval for those incorporations by reference was granted on September 25, 1969, by the Director of the Federal Register.

Pursuant to 49 U.S.C. 1431, the Federal Aviation Administration has consulted with the Secretary of Transportation, concerning all matters contained herein, prior to the adoption of this amendment.

Interested persons have been afforded an opportunity to participate in the making of these amendments. Due consideration has been given to all matter presented. In other respects, for the reasons stated in the preamble to the Notice, the rule is adopted as prescribed herein.

This rule is intended to apply to airplanes now nearing the completion of the type certification process. However, a complex document of this type may require an unusually long processing time between the date it is filed with the Federal Register and its publication therein. For this reason, a copy of the rule is being provided by certified mail to each manufacturer of transport category and turbojet engine powered airplanes. Since it is the purpose of this rule to prevent, at the earliest possible date, any escalation of aircraft noise, I find that good cause exists for making the rule effective on December 1, 1969, even though that date may be less than 30 days after its date of publication in the Federal Register.

In consideration of the foregoing, Subchapter C of Chapter I of Title 14 of the Code of Federal Regulations is amended, effective December 1, 1969.

These amendments are issued under the authority of sections 313(a), 601, 603, and 611 of the Federal Aviation Act of 1958 (49 U.S.C. 1354, 1421, 1423, and 1431) and section 6(c) of the Department of Transportation Act (49 U.S.C. 1655(c)).

Amendment 36-1

Approach Noise Test Conditions

Adopted: November 21, 1969

Effective: December 1, 1969

(Published in 34 F.R. 18815, November 25, 1969)

This amendment changes the type certification approach noise test conditions for subsonic transport category airplanes and for subsonic turbojet powered airplanes regardless of category. The purpose of this amendment is to ensure that the approach noise type certification test (1) is conducted with the same airplane configuration as that used during airworthiness type certification; and (2) does not result in noise levels less than those that will be generated by the airplane in normal operation.

Part 36, Noise Standards: Aircraft Type Certification was issued by the Administrator on November 3, 1969, and will be effective on December 1, 1969. Section C36.9 of Appendix C of that part contains the test conditions applicable to all approaches conducted in showing compliance with Part 36. That section contains two provisions that require amendment when Part 36 becomes effective.

First, paragraph (b) of § C36.9 currently provides that the airplane's configuration must be "that specified by the applicant." It now appears that this language could be regarded as permitting the applicant to specify configurations that are not the same as those used in showing compliance with the landing requirements in the airworthiness regulations. This result is not intended. While the general requirement of compatibility between noise and airworthiness type certification test conditions and procedures in-

cludes approach noise test conditions and procedures, it is believed advisable to remove any question that may be caused by § C36.9(b). Therefore, that paragraph is amended to specifically provide, in part, that the airplane's configuration during the approach noise test must be "that used in showing compliance with the landing requirements in the airworthiness regulations constituting the type certification basis of the airplane."

Second, paragraph (e) of § C36.9 currently provides that the approach noise test must be conducted with engines operating at not less than the "power or thrust required for the maximum allowable flap setting." The intent of this provision is to ensure that the noise generated during the approach noise type certification test will not be less than that later generated by the airplane in normal operation. However, configuration aspects other than flap may affect the noise of the airplane. In addition, there is no need to specify a particular power or thrust once a specified configuration is identified since § C36.9 also specifies the glide angle and minimum approach speed, requires that both be "steady," and requires that the approach be continued to a normal touchdown with no configuration change. In the light of the above, it is believed that the objective of ensuring that approaches made later in normal operation will not be noisier than the published noise levels of the airplane can be more effectively achieved by providing, in § C36.9(b), that "if more than one configuration is used in showing compliance with the landing requirements in the airworthiness regulations constituting the type certification basis of the airplane, the configuration that is most critical from a noise standpoint must be used" in showing compliance with the approach noise requirements of Part 36. This amendment is necessary to ensure that the approach noise levels generated by the airplane during type certification will be representative of approach noise levels generated in normal operations.

This amendment is issued in full consideration of comments received with respect to Notice 69-1, issued on January 3, 1969 (34 F.R. 453), including consideration of economic data submitted by affected aircraft manufacturers and operators, and has been determined to be economically reasonable, technologically practicable, and appropriate to the aircraft to which it applies.

Pursuant to Section 611 of the Federal Aviation Act of 1958 (49 U.S.C. 1431), the Administrator has consulted with the Secretary of Transportation concerning the matters contained herein, prior to the adoption of this amendment.

Like Part 36, which becomes effective on December 1, 1969, this amendment to that Part applies to airplanes now nearing the completion of the type certification process. Therefore, it is essential that this amendment become effective on the same date as Part 36. Therefore, I hereby find that notice and public procedure, in addition to that already provided by Notice 69-1, is impracticable. In addition, I find, for the reasons stated above, that good cause exists for making this amendment effective on less than 30 days notice after publication thereof in the Federal Register.

In consideration of the foregoing, § C36.9 of Appendix C of Part 36 of the Federal Aviation Regulations which becomes effective on December 1, 1969, is amended, effective on that date.

This amendment is issued under the authority of Sections 313(a), 601, 603, and 611 of the Federal Aviation Act of 1958 (49 U.S.C. 1354, 1421, 1423, and 1431), and Section 6(c) of the Department of Transportation Act (49 U.S.C. 1655(c)).

Part 36—Noise Standards: Aircraft Type Certification

Subpart A—General

§ 36.1 Applicability.

(a) This Part prescribes noise standards for the issue of type certificates, and changes to those certificates, for subsonic transport category airplanes, and for subsonic turbojet powered airplanes regardless of category.

(b) Each person who applies under Part 21 of this chapter for a type certificate must show compliance with the applicable requirements of this Part, in addition to the applicable airworthiness requirements of this chapter.

(c) Each person who applies under Part 21 of this chapter for approval of an acoustical change described in § 21.93(b) must show that the airplane meets the following requirements in addition to the applicable airworthiness requirements of this chapter:

(1) The noise limits prescribed in Appendix C of this Part, for airplanes that can achieve those noise levels, or lower noise levels, prior to the change in type design.

(2) The noise levels created by the airplane prior to the change in type design, measured and evaluated as prescribed in Appendixes A and B of this Part, for airplanes that cannot achieve the noise limits prescribed in Appendix C of this Part prior to the change in type design.

§ 36.2 Special retroactive requirements.

(a) Notwithstanding § 21.17 of this chapter, and irrespective of the date of application, each applicant covered by § 36.201(b) and (c)(1), and § 36.5(c) of this Part who applies for a new type certificate, must show compliance with the applicable provisions of this Part.

(b) Notwithstanding § 21.101(a) of this

chapter, each person who applies for an acoustical change to a type design specified in § 21.93(b) of this chapter must show compliance with the applicable provisions of this Part.

§ 36.3 Compatibility with airworthiness requirements.

It must be shown that the airplane meets the airworthiness regulations constituting the type certification basis of the airplane under all conditions in which compliance with this Part is shown, and that all procedures used in complying with this Part, and all procedures and information for the flight crew developed under this Part, are consistent with the airworthiness regulations constituting the type certification basis of the airplane.

§ 36.5 Limitation of Part.

Pursuant to 49 U.S.C. 1431(b)(4), the noise levels in this Part have been determined to be as low as is economically reasonable, technologically practicable, and appropriate to the type of aircraft to which they apply. No determination is made, under this Part, that these noise levels are or should be acceptable or unacceptable for operation at, into, or out of, any airport.

Subpart B—Noise Measurement and Evaluation

§ 36.101 Noise measurement.

The noise generated by the airplane must be measured under Appendix A of this Part or under an approved equivalent procedure.

§ 36.103 Noise evaluation.

Noise measurement information obtained under § 36.101 must be evaluated under Appendix B of this Part or under an approved equivalent procedure.

Subpart C—Noise Limits**§ 36.201 Noise limits.**

(a) Compliance with this section must be shown with noise levels measured and evaluated as prescribed in Subpart B of this Part, and demonstrated at the measuring points prescribed in Appendix C of this Part.

(b) For airplanes that have turbojet engines with bypass ratios of 2 or more and for which—

(1) Application was made before January 1, 1967, it must be shown that the noise levels of the airplane are no greater than those prescribed in Appendix C of this Part, or are reduced to the lowest levels that are economically reasonable, technologically practicable, and appropriate to the particular type design; and

(2) Application was or is made on or after January 1, 1967, it must be shown that the noise levels of the airplane are no greater than those prescribed in Appendix C of this Part.

(c) For airplanes that do not have turbojet engines with bypass ratio of 2 or more and for which—

(1) Application was made before December 1, 1969, it must be shown that the lowest noise levels, reasonably obtainable through the use of procedures and information developed for the flight crew under § 36.1501 are determined; and

(2) Application was or is made on or after December 1, 1969, it must be shown that the noise levels of the airplane are no greater than those prescribed in Appendix C of this Part.

(d) For aircraft to which paragraph (b)(1) of this section applies and that do not meet Appendix C of this Part, a time period will be

placed on the type certificate. The type certificate will specify that, upon the expiration of this time period, the type certificate will be subject to suspension or modification under Section 611 of the Federal Aviation Act of 1958 (49 U.S.C. 1431) unless the type design of aircraft produced under that type certificate on and after the expiration date is modified to show compliance with Appendix C. With respect to any possible suspensions or modifications under this paragraph, the certificate holder shall have the same notice and appeal rights as are contained in Section 609 of the Federal Aviation Act of 1958 (49 U.S.C. 1429).

Subpart G—Operating Information and Airplane Flight Manual**§ 36.1501 Procedures and other information.**

All procedures, any other information for the flight crew, that are employed for obtaining the noise reductions prescribed in this Part must be developed. This must include noise levels achieved during type certification.

§ 36.1581 Airplane Flight Manual.

(a) The approved portion of the Airplane Flight Manual must contain procedures and other information approved under § 36.1501. Except as provided in paragraph (b) of this section, no operating limitations may be furnished under this section. The following statement must be furnished near the listed noise levels:

"No determination has been made by the Federal Aviation Administration that the noise levels in this manual are or should be acceptable or unacceptable for operation at, into, or out of, any airport."

(b) If the weight used in meeting the take-off or landing noise requirements of this Part is less than the maximum weight or design landing weight, respectively, established under the applicable airworthiness requirements, those lesser weights must be furnished, as operating limitations, in the operating limitations section of the Airplane Flight Manual.

Appendix A

Aircraft Noise Measurement Under Section 36.101

§ A36.1 Noise certification test and measurement conditions.

(a) *General.* This section prescribes the conditions under which noise type certification tests must be conducted and the measurement procedures that must be used to measure the noise made by the aircraft for which the test is conducted.

(b) *General test conditions.* (1) Tests to show compliance with established noise type certification levels must consist of a series of takeoffs and landings during which measurements must be taken at the measuring points defined in Appendix C of this Part. The sideline noise measurements must also be made at symmetrical locations on each side of the runway. On each test takeoff, simultaneous measurements must be made at the sideline measuring points on both sides of the runway and also at the takeoff flyover measuring point. If the height of the ground at each measuring point differs from that of the nearest point on the runway by more than 20 feet, corrections must be made as defined in § A36.3(d) of this Appendix.

(2) Locations for measuring noise from an aircraft in flight must be surrounded by relatively flat terrain having no excessive sound absorption characteristics such as might be caused by thick, matted, or tall grass, shrubs, or wooded areas. No obstructions which significantly influence the sound field from the aircraft may exist within a conical space above the measurement position, the cone being defined by an axis normal to the ground and by a half-angle 75° from this axis.

(3) The tests must be carried out under the following weather conditions:

(i) No rain or other precipitation.
(ii) Relative humidity not higher than 90% or lower than 30%.

(iii) Ambient temperature not above 86° F. and not below 41° F. at 10 meters above ground.

(iv) Airport reported wind not above 10 knots and crosswind component not above 5 knots at 10 meters above ground.

(v) No temperature inversion or anomalous wind conditions that would significantly affect the noise level of the aircraft when the noise is recorded at the measuring points defined in Appendix C of this Part.

(c) *Aircraft testing procedures.* (1) The aircraft testing procedures and noise measurements must be conducted and processed in an approved manner to yield the noise evaluation measure designated as Effective Perceived Noise Level, EPNL, in units of EPNdB, as described in Appendix B of this Part.

(2) The aircraft height and lateral position relative to the extended centerline of the runway must be determined by a method independent of normal flight instrumentation such as radar tracking, theodolite triangulation, or photographic scaling techniques to be approved by the FAA.

(3) The aircraft position along the flight path must be related to the noise recorded at the noise measurement locations by means of synchronizing signals. The position of the aircraft must be recorded relative to the runway from a point at least 4 nautical miles from threshold to touchdown during the approach and at least 6 nautical miles from the start of roll during the takeoff.

(4) The takeoff test may be conducted at a weight different from the maximum takeoff weight at which noise certification is requested if the necessary EPNL correction does not exceed 2 EPNdB. The approach test may be conducted at a weight different from the maximum landing weight at which noise certification is requested provided the necessary EPNL correction does not exceed 1 EPNdB. Approved data may be used to determine the variation of EPNL with weight for both takeoff and approach test conditions.

(5) The takeoff test must meet the conditions of § C36.7 of Appendix C of this Part.

(6) The approach test must be conducted with the aircraft stabilized and following a $3^\circ \pm 0.5^\circ$ approach angle and must meet the conditions of § C36.9.

(d) *Measurements.* (1) Position and performance data required to make the corrections referred to in § A36.3(c) of this Appendix must be automatically recorded at an approved sampling rate. Measuring equipment must be approved by the FAA.

(2) Position and performance data must be corrected, by the methods outlined in § A36.3(d) of this Appendix to standard pressure at sea level, an ambient temperature of 77°F ., a relative humidity of 70%, and zero wind.

(3) Acoustic data must be corrected by the methods of § A36.3(d) of this Appendix to standard pressure at sea level, an ambient temperature of 77°F ., and a relative humidity of 70%. Acoustic data corrections must also be made for a minimum distance of 370 feet between the aircraft's approach path and the approach measuring point, a takeoff path vertically above the flyover measuring point and for difference of more than 20 feet in elevation of measuring locations relative to the elevation of the nearest point of the runway.

(4) The airport tower or another facility must be approved for use as the location at which measurements of atmospheric parameters are representative of those conditions existing over the geographical area in which

aircraft noise measurements are made. However, the surface wind velocity and temperature must be measured near the microphone at the approach, sideline, and takeoff measurement locations, and the tests are not acceptable unless the conditions conform to § A36.1(b)(3) of this Appendix.

(5) Enough sideline measurement stations must be used during tests so that the maximum sideline noise is clearly defined with respect to location and level.

§ A36.2 Measurement of aircraft noise received on the ground.

(a) *General.* (1) These measurements provide the data for determining one-third octave band noise produced by aircraft during testing procedures, at specific observation stations, as a function of time.

(2) Methods for determination of the distance from the observation stations to the aircraft include theodolite triangulation techniques, scaling aircraft dimensions on photographs made as the aircraft flies directly over the measurement points, radar altimeters, and radar tracking systems. The method used must be approved.

(3) Sound pressure level data for noise type certification purposes must be obtained with approved acoustical equipment and measurement practices.

(b) *Measurement system.* (1) The acoustical measurement system must consist of approved equipment equivalent to the following:

(i) A microphone system with frequency response compatible with measurement and analysis system accuracy as stated in paragraph (c) of this section.

(ii) Tripods or similar microphone mountings that minimize interference with the sound being measured.

(iii) Recording and reproducing equipment characteristics, frequency response, and dynamic range compatible with the response and accuracy requirements of paragraph (c) of this section.

(iv) Acoustic calibrators using sine wave or broadband noise of known sound

pressure level. If broadband noise is used, the signal must be described in terms of its average and maximum r.m.s. value for a nonoverload signal level.

(v) Analysis equipment with the response and accuracy requirements of paragraph (d) of this section.

(c) *Sensing, recording, and reproducing equipment.* (1) The sound produced by the aircraft shall be recorded in such a way that the complete information, time history included, is retained. A magnetic tape recorder is acceptable.

(2) The characteristics of the system must comply with the recommendations given in International Electrotechnical Commission (IEC) Publication No. 179 with regard to the sections concerning microphone and amplifier characteristics. The text and specifications of IEC Publication No. 179 entitled: "Precision Sound Level Meters" are incorporated by reference into this Part and are made a part thereof as provided in 5 U.S.C. 552(a)(1) and 1 CFR Part 20. This publication was published in 1965 by the Bureau Central de la Commission Electrotechnique Internationale located at 1, rue de Varembe, Geneva, Switzerland, and copies may be purchased at that place. Copies of this publication are available for examination at the DOT Library, Federal Office Building 10A Branch and at the Office of Noise Abatement both located at Headquarters, Federal Aviation Administration, 800 Independence Avenue, S.W., Washington, D.C. Moreover, copies of this publication are available for examination at the Regional Offices of the FAA. Furthermore, a historic, official file will be maintained by the Office of Noise Abatement and will contain any changes made to this publication.

(3) The response of the complete system to a sensibly plane progressive sinusoidal wave of constant amplitude must lie within the tolerance limits specified in IEC Publication No. 179, over the frequency range 45 to 11,200 Hz.

(4) If limitations of the dynamic range of the equipment make it necessary, high

frequency pre-emphasis must be added to the recording channel with the converse de-emphasis on playback. The pre-emphasis must be applied such that the instantaneous recorded sound pressure level of the noise signal between 800 and 11,200 Hz does not vary more than 20 dB between the maximum and minimum one-third octave bands.

(5) The equipment must be acoustically calibrated using facilities for acoustic free-field calibration and electronically calibrated as stated in paragraph (d) of this section.

(6) A windscreen must be employed with the microphone during all measurements of aircraft noise when the wind speed is in excess of 6 knots. Corrections for any insertion loss produced by the windscreen, as a function of frequency, must be applied to the measured data and the corrections applied must be reported.

(d) *Analysis equipment.* (1) A frequency analysis of the acoustical signal shall be performed using one-third octave filters complying with the recommendations given in International Electrotechnical Commission (IEC) Publication No. 225. The text and specifications of IEC Publication No. 225 entitled "Octave, Half-Octave and Third-Octave Band Filters Intended for the Analysis of Sounds and Vibrations" are incorporated by reference into this Part and are made a part hereof as provided in 5 U.S.C. 552(a)(1) and 1 CFR Part 20. This publication was published in 1966 by the Bureau Central de la Commission Electrotechnique Internationale located at 1, rue de Varembe, Geneva, Switzerland, and copies may be purchased at that place. Copies of this publication are available for examination at the Office of Noise Abatement and at the DOT Library, Federal Office Building 10A Branch both located at Headquarters, Federal Aviation Administration, 800 Independence Avenue S.W., Washington, D.C. Moreover copies of this publication are available for examination at the Regional Offices of the FAA. Furthermore a historic, official file will be maintained by the Office of Noise Abatement and will contain any changes made to this publication.

(2) A set of 24 consecutive one-third octave filters must be used. The first filter of the set must be centered at a geometric mean frequency of 50 Hz and the last of 10 kHz.

(3) The analyzer indicating device must be analog, digital, or a combination of both. The preferred sequence of signal processing is:

- (i) Squaring the one-third octave filter outputs,
- (ii) Averaging or integrating, and
- (iii) Linear to logarithmic conversion.

The indicating device must have a minimum crest factor capacity of 3 and shall measure, within a tolerance of ± 1.0 dB, the true root-mean-square (rms) level of the signal in each of the 24 one-third octave bands. If other than a true rms device is utilized, it must be calibrated for nonsinusoidal signals and time varying levels. The calibration must provide means for converting the output levels to true rms values.

(4) The dynamic response of the analyzer to input signals of both full-scale and 20 dB less than full-scale amplitude, shall conform to the following two requirements:

(i) When a sinusoidal pulse of 0.5 second duration at the geometrical mean frequency of each one-third octave band is applied to the input, the maximum output value shall read 4 dB ± 1 dB less than the value obtained for a steady state sinusoidal signal of the same frequency and amplitude.

(ii) The maximum output value shall exceed the final steady state value by 0.5 ± 0.5 dB when a steady state sinusoidal signal at the geometrical mean frequency of each one-third octave band is suddenly applied to the analyzer input and held constant.

(5) A single value of the rms level must be provided every 0.5 ± 0.01 seconds for each of the 24 one-third octave bands. The levels from all of the 24 one-third octave bands must be obtained within a 50 millisecond period. No more than 5 milliseconds of data from any 0.5 second period may be excluded from the measurement.

(6) The amplitude resolution of the analyzer must be at least 0.25 dB.

(7) Each output level from the analyzer must be accurate within ± 1.0 dB with respect to the input signal, after all systematic errors have been eliminated. The total systematic errors for each of the output levels must not exceed ± 3 dB. For contiguous filter systems, the systematic correction between adjacent one-third octave channels may not exceed 4 dB.

(8) The dynamic range capability of the analyzer for display of a single aircraft noise event must be at least 55 dB in terms of the difference between full-scale output level and the maximum noise level of the analyzer equipment.

(9) The complete electronic system must be subjected to a frequency and amplitude electrical calibration by the use of sinusoidal or broadband signals at frequencies covering the range of 45 to 11,200 Hz, and of known amplitudes covering the range of signal levels furnished by the microphone. If broadband signals are used, they must be described in terms of their average and maximum rms values for a nonoverload signal level.

(e) *Noise measurement procedures.* (1) The microphones must be oriented so that the maximum sound received arrives as nearly as reasonable in the direction for which the microphones are calibrated. The microphones must be placed so that their sensing elements are approximately 4 feet above ground.

(2) Immediately prior to and after each test, a recorded acoustic calibration of the system must be made in the field with an acoustic calibrator for the two purposes of checking system sensitivity and providing an acoustic reference level for the analysis of the sound level data.

(3) For the purpose of minimizing equipment or operator error, field calibrations must be supplemented with the use of an insert voltage device to place a known signal at the input of the microphone, just prior to and after recording aircraft noise data.

(4) The ambient noise, including both

acoustical background and electrical noise of the measurement system, must be recorded and determined in the test area with the system gain set at levels which will be used for aircraft noise measurements.

§ A36.3 Reporting and correcting measured data.

(a) *General.* Data representing physical measurements or corrections to measured data must be recorded in permanent form and appended to the record except that corrections to measurements for normal equipment response deviations need not be reported. All other corrections must be approved. Estimates must be made of the individual errors inherent in each of the operations employed in obtaining the final data.

(b) *Data reporting.* (1) Measured and corrected sound pressure levels must be presented in one-third octave band levels obtained with equipment conforming to the standards described in § A36.2 of this Appendix.

(2) The type of equipment used for measurement and analysis of all acoustic aircraft performance and meteorological data must be reported.

(3) The following atmospheric environmental data, measured at hourly intervals or less during the test period at the observation points prescribed in § A36.1(d)(4) of this Appendix, must be reported:

(i) Air temperature in degrees Fahrenheit and relative humidity in percent.

(ii) Maximum, minimum, and average wind in knots and their direction.

(iii) Atmospheric pressure in inches of mercury.

(4) Comments on local topography, ground cover, and events that might interfere with sound recordings must be reported.

(5) The following aircraft information must be reported:

(i) Type, model, and serial numbers (if any) of aircraft and engines.

(ii) Gross dimensions of aircraft and location of engines.

(iii) Aircraft gross weight for each test run.

(iv) Aircraft configuration such as flap and landing gear positions.

(v) Airspeed in knots.

(vi) Engine performance in pounds of net thrust, engine pressure ratios, jet exit temperatures, and fan or compressor shaft rev./min. as recorded by cockpit instruments and manufacturer's data.

(vii) Aircraft height in feet determined by a method independent of cockpit instrumentation such as radar tracking, theodolite triangulation, or approved photographic techniques.

(6) Aircraft speed and position and engine performance parameters must be recorded at an approved sampling rate sufficient to correct to the noise type certification reference conditions prescribed in § A36.3(c) of this Appendix. Lateral position relative to the extended centerline of the runway, configuration, and gross weight must be reported.

(c) *Noise type certification reference conditions.*

(1) *Meteorological conditions.* Aircraft position and performance data and the noise measurements must be corrected to the following noise type certification reference atmospheric conditions:

(a) Sea level pressure of 2116 psf (76 cm mercury),

(b) Ambient temperature of 77° F. (ISA + 10° C.),

(c) Relative humidity of 70 percent.

(d) Zero wind.

(2) *Aircraft conditions.* The reference condition for takeoff is the maximum weight except as provided in § 36.1581(b).

The reference conditions for approach are:

(a) Design landing weight, except as provided in § 36.1581(b),

(b) Approach angle of 3°,

(c) Aircraft height of 370 feet above noise measuring station.

(d) *Data corrections.* (1) The noise data must be corrected to the noise type certification reference conditions as stated in § A36.3(c) of this Appendix. The measured atmospheric conditions must be those obtained in accordance with § A36.1(d)(4) of this Appendix. Atmospheric attenuation of sound requirements are given in § A36.5 of this Appendix.

(2) The measured flight path must be corrected by an amount equal to the difference between the applicants predicted flight paths for the test conditions and for the noise type certification reference conditions. Necessary corrections relating to aircraft flight path or performance may be derived from approved data other than certification test data. The flight path correction procedure for approach noise must be made with reference to a fixed aircraft height of 370 feet and a glide angle of 3°. The effective perceived noise level correction must be less than 2 EPNdB to allow for:

(a) The aircraft not passing vertically above the measuring point.

(b) The difference between 370 feet and the actual minimum distance of the aircraft's ILS antenna from the approach measuring points.

(c) The difference between the actual approach angle and 3°.

Detailed correction requirements are given in § A36.6 of this Appendix.

(3) If aircraft sound pressure levels do not exceed the background sound pressure levels by at least 10 dB in any one-third octave band, approved corrections for the contribution of background sound pressure levels to observed sound pressure levels must be applied.

(e) *Validity of results.* (1) The test results must produce three average EPNL values and their 90% confidence limits, each being the arithmetic average of the corrected acoustical measurements for all valid test runs at the takeoff, approach, and sideline measuring points, respectively. If more than one acoustic measurement system is used at any single measurement location (such as for the sym-

metrical sideline measuring points), the resulting data for each test run must be averaged as a single measurement.

(2) The minimum sample size acceptable for each of the three certification measuring points is six. The samples must be large enough to establish statistically for each of the three average noise type certification levels a 90% confidence limit not exceeding ± 1.5 EPNdB. No test result may be omitted from the average process unless otherwise specified by the FAA.

(3) The average EPNL values and their 90% confidence limits obtained by the foregoing process must be those by which the noise performance of the aircraft is assessed against the noise type certification criteria, and must be reported.

§ A36.4 Symbols and units.

(a) *General.* The symbols used in Appendixes A and B of this Part have the following meanings.

Symbol	Unit	Meaning
ant.....	—	<i>Antilogarithm to the Base 10</i>
C(k).....	dB.....	<i>Tone Correction.</i> The factor to be added to PNL(k) to account for the presence of spectral irregularities such as tones at the k-th increment of time.
d.....	sec.....	<i>Duration Time.</i> The length of the significant noise time history being the time interval between the limits of t(1) and t(2) to the nearest second.
D.....	dB.....	<i>Duration Correction.</i> The factor to be added to PNLM to account for the duration of the noise.
EPNL.....	EPNdB...	<i>Effective Perceived Noise Level.</i> The value of PNL adjusted for both the presence of discrete frequencies and the time history. (The unit EPNdB is used instead of the unit dB.)
f(1) or f.....	Hz.....	<i>Frequency.</i> The geometrical mean frequency for the i-th one-third octave band.

Symbol	Unit	Meaning	Symbol	Unit	Meaning
$F(i, k)$ -----	dB-----	<i>Delta-dB</i> . The difference between the original and background sound pressure levels in the i -th one-third octave band at the k -th interval of time.	PNL-----	PNdB-----	<i>Perceived Noise Level</i> . The perceived noise level at any instant of time (the unit PNdB is used instead of the unit dB.)
h -----	dB-----	<i>dB-Down</i> . The level to be subtracted from PNLTM that defines the duration of the noise.	PNL(k)---	PNdB-----	<i>Perceived Noise Level</i> . The perceived noise level calculated from the 24 values of SPL(i, k) at the k -th increment of time. (The unit PNdB is used instead of the unit dB.)
H -----	%-----	<i>Relative Humidity</i> . The ambient atmospheric relative humidity.	PNLM-----	PNdB-----	<i>Maximum Perceived Noise Level</i> . The maximum value of PNL(k) that occurs during the aircraft flyover. (The unit PNdB is used instead of the unit dB.)
(i) or i -----	-----	<i>Frequency Band Index</i> . The numerical indicator that denotes any one of the 24 one-third octave bands with geometrical mean frequencies from 50 to 10,000 Hz.	PNLT-----	PNdB-----	<i>Tone Corrected Perceived Noise Level</i> . The value of PNL adjusted for the presence of spectral irregularities (discrete frequencies) at any instant of time. (The unit PNdB is used instead of the unit dB.)
(k)-----	-----	<i>Time Increment Index</i> . The numerical indicator that denotes the number of equal time increments that have elapsed from a reference zero.	PNLT(k)---	PNdB-----	<i>Tone Corrected Perceived Noise Level</i> . The value of PNL(k) adjusted for the presence of discrete frequencies that occurs at the k -th increment of time. (The unit PNdB is used instead of the unit dB.)
log-----	-----	<i>Logarithm to the Base 10</i> .	PNLTM-----	PNdB-----	<i>Maximum Tone Corrected Perceived Noise Level</i> . The maximum value of PNLTM(k) that occurs during the aircraft flyover. (The unit PNdB is used instead of the unit dB.)
$\log n(a)$ -----	-----	<i>Noise Discontinuity Coordinate</i> . The log n value of the intersection point of the straight lines representing the variation of SPL with log n .	$s(i, k)$ -----	dB-----	<i>Slope of Sound Pressure Level</i> . The change in level between adjacent one-third octave band sound pressure levels at the i -th band for the k -th instant of time.
$M(b), M(c)$ -----	-----	<i>Noise Inverse Slope</i> . The reciprocals of the slopes of the straight lines representing the variation of SPL with log n .	$\Delta s(i, k)$ ----	dB-----	<i>Change in Slope of Sound Pressure Level</i> .
n -----	noy-----	<i>Perceived Noisiness</i> . The perceived noisiness at any instant of time that occurs in a specified frequency range.	$s'(i, k)$ ----	dB-----	<i>Adjusted Slope of Sound Pressure Level</i> . The change in level between adjacent adjusted one-third octave band sound pressure levels at the i -th band for the k -th instant of time.
$n(i, k)$ -----	noy-----	<i>Perceived Noisiness</i> . The perceived noisiness at the k -th instant of time that occurs in the i -th one-third octave band.	$\bar{s}(i, k)$ -----	dB-----	<i>Average Slope of Sound Pressure Level</i> .
$n(k)$ -----	noy-----	<i>Maximum Perceived Noisiness</i> . The maximum value of all of the 24 values of $n(i)$ that occurs at the k -th instant of time.			
$N(k)$ -----	noy-----	<i>Total Perceived Noisiness</i> . The total perceived noisiness at the k -th instant of time calculated from the 24-instantaneous values of $n(i, k)$.			
$p(b), p(c)$ -----	-----	<i>Noise Slope</i> . The slopes of the straight lines representing the variation of SPL with log n .			

Symbol	Unit	Meaning	Symbol	Unit	Meaning
SPL-----	dB re 0.0002 microbar	<i>Sound Pressure Level.</i> The sound pressure level at any instant of time that occurs in a specified frequency range.	T-----	°F-----	<i>Temperature.</i> The ambient atmospheric temperature.
SPL(a)----	dB re 0.0002 microbar	<i>Noise Discontinuity Coordinate.</i> The SPL value of the intersection point of the straight lines representing the variation of SPL with log n.	α 1-----	dB/ft-----	<i>Test Atmospheric Absorption.</i> The atmospheric attenuation of sound that occurs in the i-th one-third octave band for the measured atmospheric temperature and relative humidity.
SPL(b)----	dB re	<i>Noise Intercept.</i> The intercepts on the SPL-axis of the straight lines representing the variation of SPL with log n.	α 1'-----	dB/1000 ft.	
SPL(c)----	0.0002 microbar		α 10-----	dB/ft-----	<i>Reference Atmospheric Absorption.</i> The atmospheric attenuation of sound that occurs in the i-th one-third octave band for the reference atmospheric temperature and relative humidity.
SPL(l, k)---	dB re 0.0002 microbar	<i>Sound Pressure Level.</i> The sound pressure level at the k-th instant of time that occurs in the l-th one-third octave band.	α 10'-----	dB/1000 ft.	
SPL'(l, k)---	dB re 0.0002 microbar	<i>Adjusted Sound Pressure Level.</i> The first approximation to background level in the l-th one-third octave band for the k-th instant of time.	β -----	degrees-----	<i>First Constant Climb Angle.</i>
SPL''(l, k)---	dB re 0.0002 microbar	<i>Background Sound Pressure Level.</i> The final approximation to background level in the l-th one-third octave band for the k-th instant of time.	γ -----	degrees-----	<i>Second Constant Climb Angle.</i>
SPL1-----	dB re 0.0002 microbar	<i>Maximum Sound Pressure Level.</i> The sound pressure level that occurs in the l-th one-third octave band of the spectrum for PNL-TM.	δ -----	degrees-----	<i>Thrust Outback Angles.</i> The angles defining the points on the takeoff flight path at which thrust reduction is started and ended respectively.
SPL1c-----	dB re 0.0002 microbar	<i>Corrected Maximum Sound Pressure Level.</i> The sound pressure level that occurs in the l-th one-third octave band of the spectrum for PNLTM corrected for atmospheric sound absorption.	ϵ -----	degrees-----	
t-----	sec-----	<i>Elapsed Time.</i> The length of time measured from a reference zero.	η -----	degrees-----	<i>Approach Angle.</i>
t(1), t(2)---	sec-----	<i>Time Limit.</i> The beginning and end of the significant noise time history defined by h.	θ -----	degrees-----	<i>Takeoff Noise Angle.</i> The angle between the flight path and noise path for takeoff operation. It is identical for both measured and corrected flight paths.
Δt -----	sec-----	<i>Time Increment.</i> The equal increments of time for which PNL(k) and PNL(k) are calculated.	λ -----	degrees-----	<i>Approach Noise Angle.</i> The angle between the flight path and the noise path for approach operation. It is identical for both measured and corrected flight paths.
T-----	sec-----	<i>Normalizing Time Constant.</i> The length of time used as a reference in the integration method for computing duration corrections.	$\Delta 1$ -----	EPNdB-----	<i>PNLT Correction.</i> The correction to be added to the EPNL calculated from measured data to account for noise level changes due to differences in atmospheric absorption and noise path length between reference and test conditions.
			$\Delta 2$ -----	EPNdB-----	<i>Noise Path Duration Correction.</i> The correction to be added to the EPNL calculated from measured data to account for noise level changes due to the noise duration because of differences in flyover altitude between reference and test condition.

Symbol	Unit	Meaning
$\Delta 3$ -----	EPNdB	<i>Weight Correction.</i> The correction to be added to the EPNL calculated from measured data to account for noise level changes due to differences between maximum and test aircraft weights.
$\Delta 4$ -----	EPNdB	<i>Approach Angle Correction.</i> The correction to be added to the EPNL calculated from measured data to account for noise level changes due to differences between 3° and the test approach angle.
ΔAB -----	feet	<i>Takeoff Profile Changes.</i> The changes in the basic parameters defining the takeoff profile due to differences between reference and test conditions.
$\Delta \beta$ -----	degrees	
$\Delta \gamma$ -----	degrees	
$\Delta \delta$ -----	degrees	
$\Delta \epsilon$ -----	degrees	

FLIGHT PROFILE IDENTIFICATION POSITIONS

Position	Description
A-----	Start of takeoff roll.
B-----	Liftoff.
C-----	Start of first constant climb.
D-----	Start of thrust reduction.
E-----	Start of second constant climb.
Ec-----	Start of second constant climb on corrected flight path.
F-----	End of noise certification takeoff flight path.
Fe-----	End of second constant climb on corrected flight path.
G-----	Start of noise certification approach flight path.
Gr-----	Start of noise certification approach on reference flight path.
H-----	Position on approach path directly above noise measuring station.
I-----	Start of level off.
Ir-----	Start of level off on reference approach flight path.
J-----	Touchdown.
K-----	Takeoff noise measuring station.
L-----	Sideline noise measuring station (not on flight track).
M-----	End of noise type certification takeoff flight track.
N-----	Approach noise measuring station.
O-----	Threshold of approach end of runway.
P-----	Start of noise type certification approach flight track.
Q-----	Position on measured takeoff flight path corresponding to PNLTm at station K.
Qc-----	Position on corrected takeoff flight path corresponding to PNLTm at station K.

Position	Description
R-----	Position on measured takeoff flight path nearest to station K.
Re-----	Position on corrected takeoff flight path nearest to station K.
S-----	Position on measured approach flight path corresponding to PNLTm at station N.
Sr-----	Position on reference approach flight path corresponding to PNLTm at station N.
T-----	Position on measured approach flight path nearest to station N.
Tr-----	Position on reference approach flight path nearest to station N.
X-----	Position on measured takeoff flight path corresponding to PNLTm at station L.

FLIGHT PROFILE DISTANCES

Distance	Unit	Meaning
AB-----	feet	<i>Length of Takeoff Roll.</i> The distance along the runway between the start of takeoff roll and lift off.
AK-----	feet	<i>Takeoff Measurement Distance.</i> The distance from the start of roll to the takeoff noise measurement station along the extended centerline of the runway.
AM-----	feet	<i>Takeoff Flight Track Distance.</i> The distance from the start of roll to the takeoff flight track position along the extended centerline of the runway for which the position of the aircraft need no longer be recorded.
KQ-----	feet	<i>Measured Takeoff Noise Path.</i> The distance from station K to the measured aircraft position Q.
KQc-----	feet	<i>Corrected Takeoff Noise Path.</i> The distance from station K to the corrected aircraft position Qc.
KR-----	feet	<i>Measured Takeoff Minimum Distance.</i> The distance from station K to point R on the measured flight path.
KRc-----	feet	<i>Corrected Takeoff Minimum Distance.</i> The distance from station K to point Rc on the corrected flight path.
LX-----	feet	<i>Measured Sideline Noise Path.</i> The distance from station L to the measured aircraft position X.

Distance	Unit	Meaning
NH-----	feet-----	Aircraft Approach Height. The vertical distance between the aircraft and the approach measuring station.
NS-----	feet-----	Measured Approach Noise Path. The distance from station N to the measured aircraft position S.
NSr-----	feet-----	Reference Approach Noise Path. The distance from station N to the reference aircraft position Sr.
NT-----	feet-----	Measured Approach Minimum Distance. The distance from station N to point T on the measured flight path.
NTr-----	feet-----	Reference Approach Minimum Distance. The distance from station N to point Tr on the corrected flight path; it equals 369 feet.
ON-----	feet-----	Approach Measurement Distance. The distance from the runway threshold to the approach measurement station along the extended centerline of the runway.
OP-----	feet-----	Approach Flight Track Distance. The distance from the runway threshold to the approach flight track position along the extended centerline of the runway for which the position of the aircraft need no longer be recorded.

§ A36.5 Atmospheric attenuation of sound.

(a) *General.* The atmospheric attenuation of sound must be determined in accordance with the curves of Figure 15 presented in SAE ARP 866 or by the simplified procedure presented below. SAE ARP 866 is a publication entitled: "Standard Values of Atmospheric Absorption as a Function of Temperature and Humidity for Use in Evaluating Aircraft Fly-over Noise" and the recommendations presented therein are incorporated by reference into this Part and are made a part hereof as provided in 5 U.S.C. 522(a)(1) and 1 CFR Part 20. This publication was published on August 31, 1964, by the Society of Automotive Engineers, Inc., located at 2 Pennsylvania

Plaza, New York, New York 10001, and copies may be purchased at that place. Copies of this publication are available for examination at the DOT Library, Federal Office Building 10A Branch and at the Office of Noise Abatement both located at Headquarters, Federal Aviation Administration, 800 Independence Avenue, S.W., Washington, D.C. Moreover, copies of this publication are available for examination at the Regional Offices of the FAA. Furthermore, a historic, official file will be maintained by the Office of Noise Abatement and will contain any changes made to this publication.

(b) *Reference conditions.* For the reference atmospheric conditions of temperature and relative humidity equal to 77° F. and 70%, respectively, and for all other conditions of temperature and relative humidity where their product is equal to or greater than 4000, the sound absorption must be expressed by the following equation:

$$a_{io}' = f_i/500 \quad (\text{dB}/1000 \text{ ft.})$$

a_{io}' is the atmospheric attenuation of sound that occurs in the i -th one-third octave band for the reference atmospheric conditions and f_i is the geometrical mean frequency for the i -th one-third octave band.

(c) *Nonreference conditions.* (1) For all atmospheric conditions of temperature and relative humidity where their product is equal to or less than 4000, the relationship between sound absorption, frequency, temperature, and humidity must be expressed by the following equation:

$$500 a_i' / f_i = (2/3) \quad [(11/2) - (HT/1000)]$$

a_i' is the atmospheric attenuation of sound that occurs in the i -th one-third octave band for a relative humidity of H percent and a temperature of T° Fahrenheit.

(2) Figure A1 graphically illustrates the simplified relationship. The second equation represents the inclined line which is valid for all values of HT up to and including 4,000. For all values of 4,000 and greater, the horizontal line, represented by the first equation, is valid. The minimum, reference, and maximum values of humidity and temperature are indicated in Figure A1.

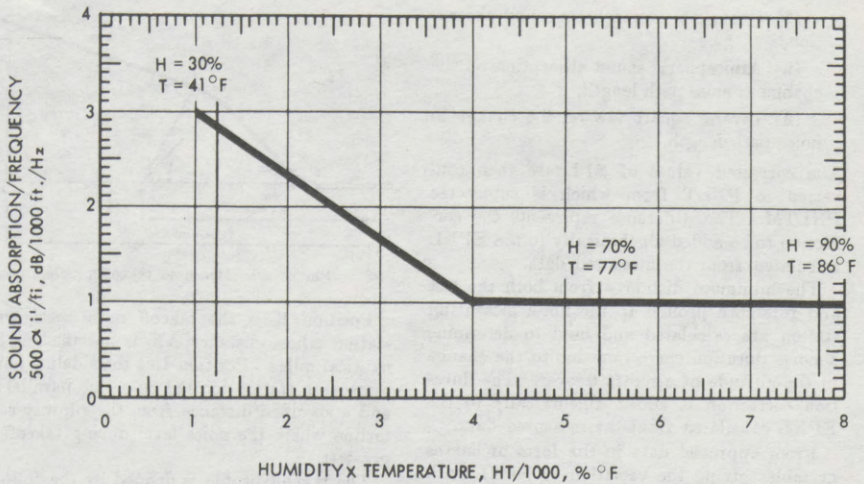


FIGURE A1. Simplified relationship between atmospheric sound attenuation, frequency, humidity, and temperature.

§ A36.6 Detailed correction procedures.

(a) *General.* If the noise type certification test conditions are not equal to the noise certification reference conditions, appropriate positive corrections must be made to the EPNL calculated from the measured data. Differences between reference and test conditions which lead to positive corrections can result from the following:

- (1) Atmospheric absorption of sound under test conditions greater than reference,
- (2) Test flight path at higher altitude than reference, and
- (3) Test weight less than maximum.

Negative corrections are permitted if the atmospheric absorption of sound under test conditions is less than reference and also if the test flight path is at a lower altitude than reference.

The takeoff test flight path can occur at a higher altitude than reference if the meteorological conditions permit superior aerodynamic performance ("cold day" effect). Conversely, the "hot day" effect can cause the takeoff test flight path to occur at a lower altitude than reference. The approach test

flight path can occur at either higher or lower altitudes than reference irrespective of the meteorological conditions.

The correction procedures presented in the following discussion consist of one or more of five possible values added algebraically to the EPNL calculated as if the tests were conducted completely under the noise type certification reference conditions. The flight profiles must be determined for both takeoff and approach, and for both reference and test conditions. The test procedures require noise and flight path recordings with a synchronized time signal from which the test profile can be delineated, including the aircraft position for which PNLTM is observed at the noise measuring station. For takeoff, a flight profile corrected to reference conditions may be derived from manufacturer's data, and for approach, the reference profile is known.

The noise paths from the aircraft to the noise measuring station corresponding to PNLTM are determined for both the test and reference profiles. The SPL values in the spectrum of PNLTM are then corrected for the effects of:

- (1) Change in atmospheric sound absorption,
- (2) Atmospheric sound absorption on the change in noise path length,
- (3) Inverse square law on the change in noise path length.

The corrected values of SPL are then converted to PNLT from which is subtracted PNLTM. The difference represents the correction to be added algebraically to the EPNL calculated from the measured data.

The minimum distances from both the test and reference profiles to the noise measuring station are calculated and used to determine a noise duration correction due to the change in the altitude of aircraft flyover. The duration correction is added algebraically to the EPNL calculated from the measured data.

From approved data in the form of curves or tables giving the variation of EPNL with takeoff weight and also for landing weight, corrections are determined to be added to the EPNL calculated from the measured data to account for noise level changes due to differences between maximum and test aircraft weights.

From approved data in the form of curves or tables giving the variation of EPNL with approach angle, corrections are determined to be added algebraically to the EPNL calculated from measured data to account for noise level changes due to differences between 3° and the test approach angle.

(b) *Takeoff profiles.* Figure A2 illustrates a typical takeoff profile. The aircraft begins the takeoff roll at point A, lifts off at point B, and initiates the first constant climb at point C at an angle β . The noise abatement thrust cutback is started at point D and completed at point E where the second constant climb is defined by the angle γ (usually expressed in terms of the gradient in percent).

The end of the noise type certification takeoff flight path is represented by aircraft position F whose vertical projection on the flight track (extended centerline of the runway) is point M. The position of the aircraft must be recorded for a distance AM of at least 6 nautical miles.

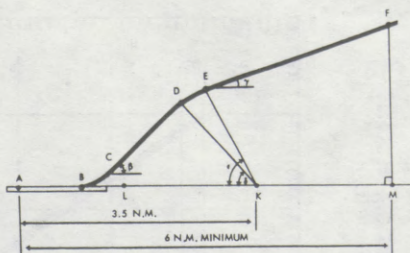


FIGURE A2. Measured takeoff profile.

Position K is the takeoff noise measuring station whose distance AK is specified as 3.5 nautical miles. Position L is the sideline noise measuring station located on a line parallel to and a specified distance from the runway centerline where the noise level during takeoff is greatest.

The takeoff profile is defined by the following five parameters: AB, the length of takeoff roll; β , the first constant climb angle; γ , the second constant climb angle; and δ and ϵ , the thrust cutback angles. These five parameters are functions of the aircraft performance and weight and the atmospheric conditions of temperature, pressure, and wind velocity and direction. If the test conditions are not equal to the reference conditions, the corresponding test and reference profile parameters will be different as shown in Figure A3. The profile

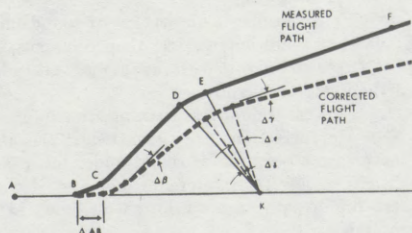


FIGURE A3. Comparison of measured and corrected takeoff profiles.

parameter changes, identified as ΔAB , $\Delta \beta$, $\Delta \gamma$, $\Delta \delta$, and $\Delta \epsilon$, can be derived from the manufacturer's data (approved by the FAA) and can be used to define the flight profile corrected

to the reference conditions. The relationships between the measured and corrected takeoff flight profiles can then be used to determine the corrections, which if positive, must be applied to the EPNL calculated from the measured data.

NOTE.—Under reference atmospheric conditions and with maximum takeoff weight, the gradient of the second constant climb angle, γ , is specified to be not less than 4%. However, the actual gradient will depend upon the test atmospheric conditions, assuming maximum takeoff weight and the parameters characterizing engine performance are constant (rpm, epr, or any other parameter used by the pilot).

Figure A4 illustrates portions of the measured and corrected takeoff flight paths including the significant geometrical relationships influencing sound propagation. EF represents the measured second constant flight path with climb angle γ , and E_cF_c represents the corrected second constant flight path at reduced altitude and with reduced climb angle $\gamma - \Delta\gamma$.

Position Q represents the aircraft location on the measured takeoff flight path for which PNLTM is observed at the noise measuring station K, and Q_c is the corresponding position on the corrected flight path. The measured and corrected noise propagation paths are KQ and KQ_c , respectively, which form the same angle θ with their flight paths.

Position R represents the point on the measured takeoff flight path nearest the noise meas-

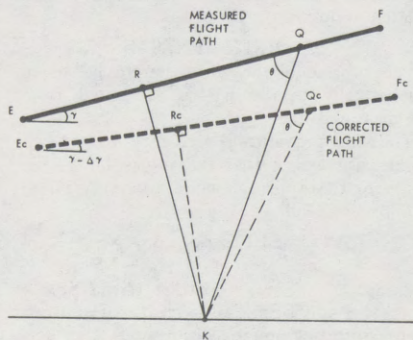


FIGURE A4. Takeoff profile characteristics influencing sound propagation.

uring station K, and R_c is the corresponding position on the corrected flight path. The minimum distance to the measured and corrected flight paths are indicated by the lines KR and KR_c , respectively, which are normal to their flight paths.

(c) *Approach profiles.* Figure A5 illustrates a typical approach profile. The beginning of the noise type certification approach profile is represented by aircraft position G whose vertical projection on the flight track (extended centerline of the runway) is point P. The position of the aircraft must be recorded for a distance OP from the runway threshold O of at least 4 nautical miles.

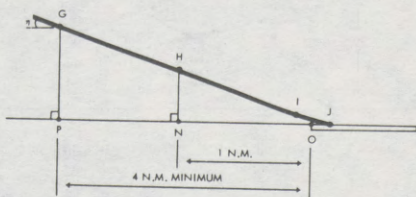


FIGURE A5. Measured approach profile.

The aircraft approaches at an angle η , passes vertically over the noise measuring station N at a height of NH, begins the level off at position I, and touches down at position J. The distance ON is specified as 1.0 nautical mile.

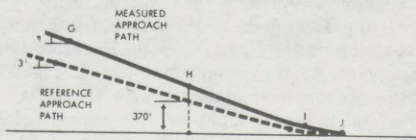


FIGURE A6. Comparison of measured and corrected approach profiles.

The approach profile is defined by the approach angle η and the height NH which are functions of the aircraft operating conditions controlled by the pilot. If the measured approach profile parameters are different from the corresponding reference approach parameters (3° and 370 feet, respectively, as shown in Figure A6), corrections, if positive, must

be applied to the EPNL calculated from the measured data.

Figure A7 illustrates portions of the measured and reference approach flight paths including the significant geometrical relationships influencing sound propagation. GI represents the measured approach path with approach angle η , and GrIr represents the reference approach flight path at lower altitude and approach angle of 3° .

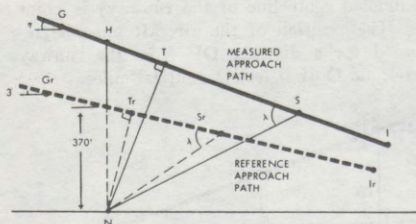


FIGURE A7. Approach profile characteristics influencing sound propagation.

Position S represents the aircraft location on the measured approach flight path for which PNLTM is observed at the noise measuring station N, and S_r is the corresponding position on the reference approach flight path. The measured and corrected noise propagation paths are NS and NS_r , respectively, which form the same angle λ with their flight paths.

Position T represents the point on the measured approach flight path nearest the noise measuring station N, and Tr is the corresponding point on the reference approach flight path. The minimum distances to the measured and reference flight paths are indicated by the lines NT and NTr , respectively, which are normal to their flight paths.

NOTE.—The reference approach flight path is defined by $\eta = 3^\circ$ and $NH = 370$ feet. Consequently, NTr can also be defined; $NTr = 369$ feet to the nearest foot and is, therefore, considered to be one of the reference parameters.

(d) *PNLT corrections.* Whenever the ambient atmospheric conditions of temperature and relative humidity differ from the reference conditions (77° F. and 70%, respectively) and whenever the measured takeoff and ap-

proach flight paths differ from the corrected and reference flight paths respectively, it may be necessary or desirable to apply corrections to the EPNL values calculated from the measured data. If the corrections are required, they must be calculated as described below.

Referring to the takeoff flight path shown in Figure A4, the spectrum of PNLTM observed at station K, for the aircraft at position Q, is decomposed into its individual SPLi values. A set of corrected values are then computed as follows:

$$\begin{aligned} \text{SPLic} = & \text{SPLi} + (a_i - a_{io}) KQ \\ & + a_{io} (KQ - KQc) \\ & + 20 \log (KQ/KQc) \end{aligned}$$

where SPLi and SPLic are the measured and corrected sound pressure levels, respectively, in the i -th one-third octave band. The first correction term accounts for the effects of change in atmospheric sound absorption where a_i and a_{io} are the sound absorption coefficients for the test and reference atmospheric conditions, respectively, for the i -th one-third octave band and KQ is the measured takeoff noise path. The second correction term accounts for the effects of atmospheric sound absorption on the change in the noise path length where KQc is the corrected takeoff noise path. The third correction term accounts for the effects of the inverse square law on the change in the noise path length.

The corrected values of SPLic are then converted to PNLT and a correction term calculated as follows:

$$\Delta 1 = \text{PNLT} - \text{PNLTM}$$

which represents the correction to be added algebraically to the EPNL calculated from the measured data.

The same procedure is used for the approach flight path except that the values for SPLic relate to the approach noise paths shown in Figure A7 as follows:

$$\begin{aligned} \text{SPLic} = & \text{SPLi} + (a_i - a_{io}) NS \\ & + a_{io} (NS - NS_r) \\ & + 20 \log (NS/NS_r) \end{aligned}$$

where NS and NS_r are the measured and reference approach noise paths, respectively. The remainder of the procedure is the same as for the takeoff flight path.

The same procedure is used for the sideline flight path except that the values for SPL_{ic} relate only to the measured sideline noise path as follows:

$$SPL_{ic} = SPL_i + (a_i - a_{io}) LX$$

where LX is the measured sideline noise path from station L (Figure A2) to position X of the aircraft for which PNL_{TM} is observed at station L . Only the correction term accounting for the effects of change in atmospheric sound absorption is considered. The difference between the measured and corrected noise path lengths are assumed negligible for the sideline flight path. The remainder of the procedure is the same as for the takeoff flight path.

(e) *Duration corrections.* Whenever the measured takeoff and approach flight paths differ from the corrected and reference flight paths, respectively, it may be necessary or desirable to apply duration corrections to the EPNL values calculated from the measured data. If the corrections are required, they shall be calculated as described below.

Referring to the takeoff flight path shown in Figure A4, a correction term is calculated as follows:

$$\Delta 2 = -10 \log (KR/KR_c)$$

which represents the correction to be added algebraically to the EPNL calculated from the measured data. The lengths KR and KR_c are the measured and corrected takeoff minimum distances, respectively, from the noise measuring station K to the measured and corrected flight paths. The negative sign indicates that, for the particular case of a duration correction, the EPNL calculated from the measured data is reduced if the measured flight path is at a greater altitude than the corrected flight path.

The same procedure is used for the approach flight path except that the correction relates to the approach minimum distances shown in Figure A7 as follows:

$$\Delta 2 = -10 \log (NT/369)$$

where NT is the measured approach minimum distance from the noise measuring station N to the measured flight path and 369 feet is the

minimum distance from station N to the reference flight path.

No duration correction is computed for the sideline flight path because the differences between the measured and corrected flight paths are assumed negligible.

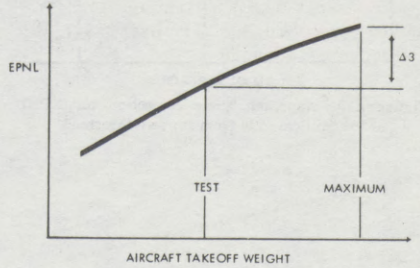


FIGURE A8. Takeoff weight correction for EPNL at 3.5 nautical miles from brake release.

(f) *Weight corrections.* Whenever the aircraft weight, during either the noise type certification takeoff, sideline, or approach test, is less than the corresponding maximum takeoff or landing weight, a correction must be applied to the EPNL value calculated from the measured data. The corrections are determined from approved data in the form of tables or curves such as schematically indicated in Figures A8 and A9. The data must be applicable to the noise type certification reference atmospheric conditions.

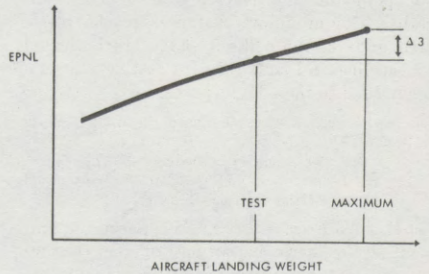


FIGURE A9. Approach weight correction for EPNL at 1.0 nautical mile from runway threshold.

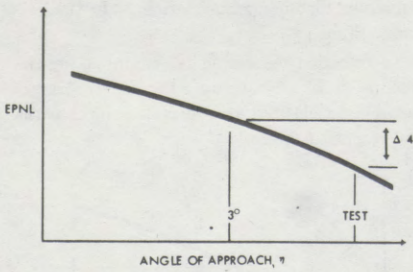


FIGURE A10. Approach angle correction for EPNL at 1.0 nautical mile from runway threshold.

(g) *Approach angle corrections.* Whenever the aircraft approach angle during the noise type certification approach test is greater than 3° , a correction must be applied to the EPNL value calculated from the measured data. The corrections are determined from approved data in the form of tables or curves such as schematically indicated in Figure A10. The data must be applicable to the noise type certification reference atmospheric conditions and to the test landing weight.

Appendix B

Aircraft Noise Evaluation Under Section 36.103

§ B36.1 General.

The procedures in this Appendix must be used to determine the noise evaluation quantity designated as effective perceived noise level, EPNL, under § 36.103. These procedures, which use the physical properties of noise measured as prescribed by Appendix A of this Part, consist of the following:

(a) The 24 one-third octave bands of sound pressure level are converted to perceived noisiness by means of a noy table. The noy values are combined and then converted to instantaneous perceived noise levels, PNL(k).

(b) A tone correction factor, C(k), is calculated for each spectrum to account for the subjective response to the presence of the maximum tone.

(c) The tone correction factor is added to the perceived noise level to obtain tone corrected perceived noise levels, PNL_T(k), at each one-half second increment of time. The instantaneous values of tone corrected perceived noise level are noted with respect to time and the maximum value, PNL_{TM}, is determined.

$$\text{PNLT}(k) = \text{PNL}(k) + C(k)$$

(d) A duration correction factor, D, is computed by integration under the curve of time corrected perceived noise level versus time.

(e) Effective perceived noise level, EPNL, is determined by the algebraic sum of the maximum tone corrected perceived noise level and the duration correction factor.

$$\text{EPNL} = \text{PNLTM} + D$$

§ B36.2 Perceived noise level.

Instantaneous perceived noise levels, PNL(k), must be calculated from instan-

taneous one-third octave band sound pressure levels, SPL(i,k), as follows:

Step 1. Convert each one-third octave band SPL(i,k), from 50 to 10,000 Hz, to perceived noisiness, n(i,k), by reference to Table B1, or to the mathematical formulation of the noy table given in § B36.7 of this Appendix.

Step 2. Combine the perceived noisiness values, n(i,k), found in step 1 by the following formula:

$$N(k) = n(k) + 0.15 \left[\left[\sum_{i=1}^{24} n(i,k) \right] - n(k) \right]$$

$$= 0.85 n(k) + 0.15 \sum_{i=1}^{24} n(i,k)$$

where n(k) is the largest of the 24 values of n(i,k) and N(k) is the total perceived noisiness.

Step 3. Convert the total perceived noisiness, N(k), into perceived noise level, PNL(k), by the following formula:

$\text{PNL}(k) = 40.0 + 33.3 \log N(k)$
which is plotted in Figure B1. PNL(k) may also be obtained by choosing N(k) in the 1000 Hz column of Table B1 and then reading the corresponding value of SPL(i,k) which, at 1,000 Hz, equals PNL(k).

§ B36.3 Correction for spectral irregularities.

Noise having pronounced irregularities in the spectrum (for example, discrete frequency components or tones), must be adjusted by the correction factor C(k) calculated as follows:

Step 1. Starting with the corrected sound pressure level in the 80 Hz one-third octave

Table B1. Perceived Noisiness (NOYs) as a Function of Sound Pressure Level.

Table B1. Perceived Noisiness (NOYs) as a Function of Sound Pressure Level.

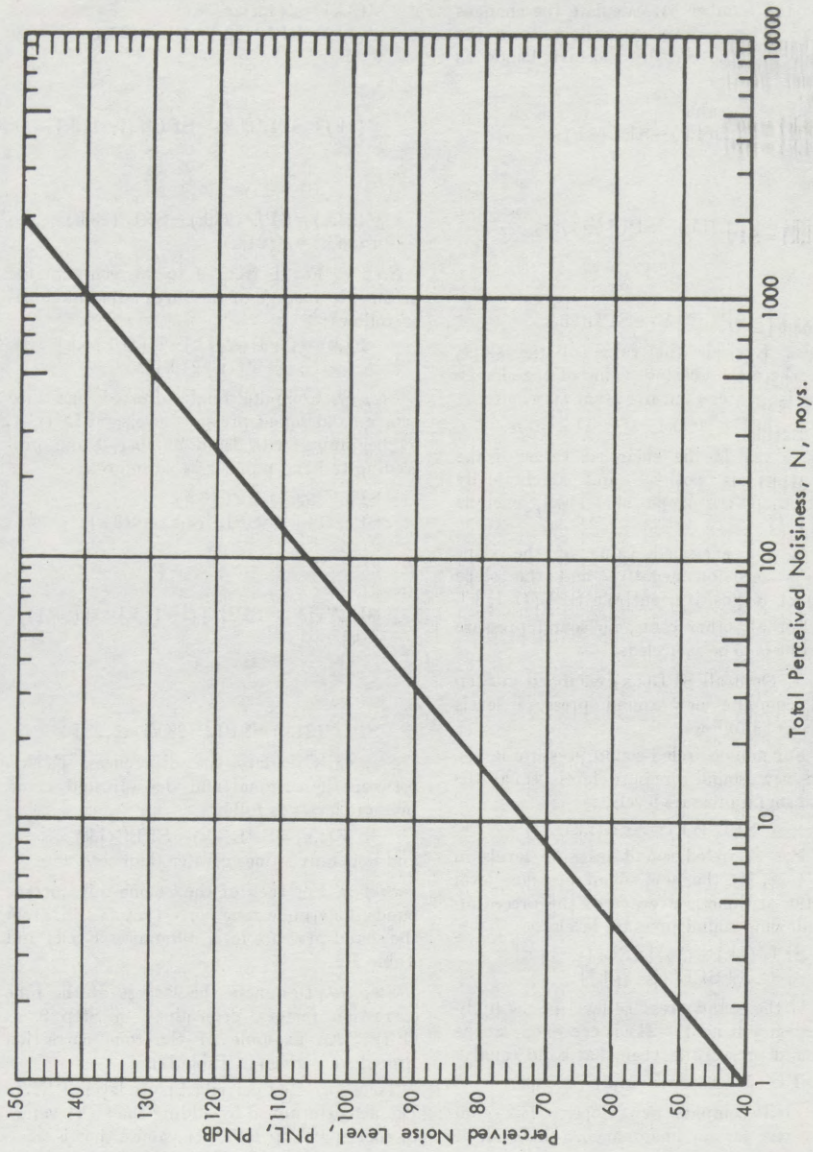


FIGURE E1. Perceived noise level as a function of noys.

band (band number 3), calculate the changes in sound pressure level (or "slopes") in the remainder of the one-third octave bands as follows:

$$s(3,k) = \text{no value}$$

$$s(4,k) = \text{SPL}(4,k) - \text{SPL}(3,k)$$

.

.

$$s(i,k) = \text{SPL}(i,k) - \text{SPL}[(i-1),k]$$

.

.

$$s(24,k) = \text{SPL}(24,k) - \text{SPL}(23,k)$$

Step 2. Encircle the value of the slope, $s(i,k)$, where the absolute value of the change in slope is greater than five; that is, where

$$|\Delta s(i,k)| = |s(i,k) - s[(i-1),k]| > 5$$

Step 3. (a) If the encircled value of the slope $s(i,k)$ is positive and algebraically greater than the slope $s[(i-1),k]$, encircle $\text{SPL}(i,k)$.

(b) If the encircled value of the slope $s(i,k)$ is zero or negative and the slope $s[(i-1),k]$ is positive, encircle $\text{SPL}[(i-1),k]$.

(c) For all other cases, no sound pressure level value is to be encircled.

Step 4. Omit all $\text{SPL}(i,k)$ encircled in Step 3 and compute new sound pressure levels $\text{SPL}'(i,k)$ as follows:

(a) For non-encircled sound pressure levels, let the new sound pressure levels equal the original sound pressure levels,

$$\text{SPL}'(i,k) = \text{SPL}(i,k)$$

(b) For encircled sound pressure levels in bands 1-23, let the new sound pressure level equal the arithmetic average of the preceding and following sound pressure levels,

$$\text{SPL}'(i,k) = \left(\frac{1}{2}\right) [\text{SPL}[(i-1),k] + \text{SPL}[(i+1),k]]$$

(c) If the sound pressure level in the highest frequency band ($i=24$) is encircled, let the new sound pressure level in that band equal

$$\text{SPL}'(24,k) = \text{SPL}(23,k) + s(23,k)$$

Step 5. Recompute new slopes $s'(i,k)$, including one for an imaginary 25-th band, as follows:

$$s'(3,k) = s'(4,k)$$

$$s'(4,k) = \text{SPL}'(4,k) - \text{SPL}'(3,k)$$

.

.

$$s'(i,k) = \text{SPL}'(i,k) - \text{SPL}'[(i-1),k]$$

.

.

$$s'(24,k) = \text{SPL}'(24,k) - \text{SPL}'(23,k)$$

$$s'(25,k) = s'(24,k)$$

Step 6. For i from 3 to 23, compute the arithmetic average of the three adjacent slopes as follows:

$$\bar{s}(i,k) = (1/3) [s'(i,k) + s'[(i+1),k] + s'[(i+2),k]]$$

Step 7. Compute final adjusted one-third octave-band sound pressure levels, $\text{SPL}''(i,k)$, by beginning with band number 3 and proceeding to band number 24 as follows:

$$\text{SPL}''(3,k) = \text{SPL}(3,k)$$

$$\text{SPL}''(4,k) = \text{SPL}''(3,k) + \bar{s}(3,k)$$

.

.

$$\text{SPL}''(i,k) = \text{SPL}''[(i-1),k] + \bar{s}[(i-1),k]$$

.

.

$$\text{SPL}''(24,k) = \text{SPL}''(23,k) + \bar{s}(23,k)$$

Step 8. Calculate the differences, $F(i,k)$, between the original and the adjusted sound pressure levels as follows:

$$F(i,k) = \text{SPL}(i,k) - \text{SPL}''(i,k)$$

and note only values greater than zero.

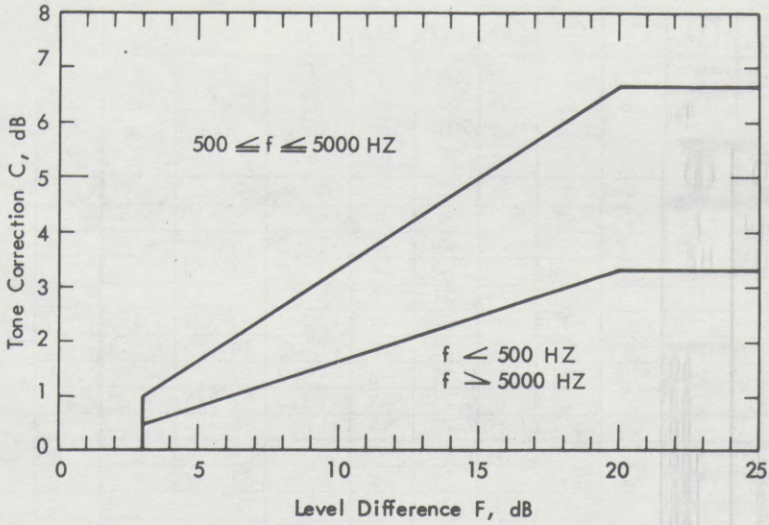
Step 9. For each of the 24 one-third octave bands, determine tone correction factors from the sound pressure level differences $F(i,k)$ and Table B2.

Step 10. Designate the largest of the tone correction factors, determined in Step 9, as $C(k)$. An example of the tone correction procedure is given in Table B3.

Tone corrected perceived noise levels $\text{PNLT}(k)$ are determined by adding the $C(k)$ values to corresponding $\text{PNL}(k)$ values, that is,

$$\text{PNLT}(k) = \text{PNL}(k) + C(k)$$

TABLE B2. Tone correction factors.



Frequency f , HZ	Level Difference F , dB	Tone Correction C , dB
$50 \leq f < 500$	$F < 3$ $3 \leq F < 20$ $20 \leq F$	0 $F/6$ $3 \frac{1}{3}$
$500 \leq f \leq 5000$	$F < 3$ $3 \leq F < 20$ $20 \leq F$	0 $F/3$ $6 \frac{2}{3}$
$5000 < f \leq 10000$	$F < 3$ $3 \leq F < 20$ $20 \leq F$	0 $F/6$ $3 \frac{1}{3}$

TABLE B3. Example of tone correction calculation for a turbofan engine.

①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪
Band (i)	f HZ	SPL dB	S dB Step 1	ΔS dB Step 2	SPL' dB Step 4	S' dB Step 5	$\bar{S}$ dB Step 6	SPL'' dB Step 7	F dB Step 8	C dB Step 9
1	50	-	-	-	-	-	-	-	-	-
2	63	-	-	-	-	-	-	-	-	-
3	80	70	-	-	70	-8	-2 1/3	70	-	-
4	100	62	- 8	-	62	-8	+3 1/3	67 2/3	-	-
5	125	(70)	+ (8)	16	71	+9	+6 2/3	71	-	-
6	160	80	+10	2	80	+9	+2 2/3	77 2/3	2 1/3	-
7	200	82	+ (2)	8	82	+2	-1 1/3	80 1/3	1 2/3	-
8	250	(83)	+ 1	1	79	-3	-1 1/3	79	4	2/3
9	315	76	- (7)	8	76	-3	+ 1/3	77 2/3	-	-
10	400	(80)	+ (4)	11	78	+2	+1	78	2	-
11	500	80	0	4	80	+2	0	79	1	-
12	630	79	- 1	1	79	-1	0	79	-	-
13	800	78	- 1	0	78	-1	- 1/3	79	-	-
14	1000	80	+ 2	3	80	+2	- 2/3	78 2/3	1 1/3	-
15	1250	78	- 2	4	78	-2	- 1/3	78	-	-
16	1600	76	- 2	0	76	-2	+ 1/3	77 2/3	-	-
17	2000	79	+ 3	5	79	+3	+1	78	1	-
18	2500	(85)	+ 6	3	79	0	- 1/3	79	6	[2]
19	3150	79	- (6)	12	79	0	-2 2/3	78 2/3	1/3	-
20	4000	78	- 1	5	78	-1	-6 1/3	76	2	-
21	5000	71	- (7)	6	71	-7	-8	69 2/3	1 1/3	-
22	6300	60	-11	4	60	-11	-8 2/3	61 2/3	-	-
23	8000	54	- 6	5	54	-6	-8	53	1	0
24	10000	45	- 9	3	45	-9	-	45	-	-
							-9			

Step 1	③ (i) - ③ (i-1)
Step 2	④ (i) - ④ (i-1)
Step 3	see instructions
Step 4	see instructions
Step 5	⑥ (i) - ⑥ (i-1)

Step 6	[⑦ (i) + ⑦ (i+1) + ⑦ (i+2)] ÷ 3
Step 7	⑨ (i-1) + ⑧ (i-1)
Step 8	③ (i) - ⑨ (i)
Step 9	see Table B2

For any i -th one-third octave band, at any k -th increment of time, for which the tone correction factor is suspected to result from something other than (or in addition to) an actual tone (or any spectral irregularity other than aircraft noise), an additional analysis may be made using a filter with a bandwidth narrower than one-third of an octave. If the narrow band analysis corroborates that suspicion, then a revised value for the background sound pressure level, $SPL''(i,k)$, may be determined from the analysis and used to compute a revised tone correction factor, $F(i,k)$, for that particular one-third octave band.

§ B36.4 Maximum tone corrected perceived noise level.

The maximum tone corrected perceived noise level, PNLTM, is the maximum calculated value of the tone corrected perceived noise level, PNLT(k), calculated in accordance with the procedure of § B36.3 of this Appendix.

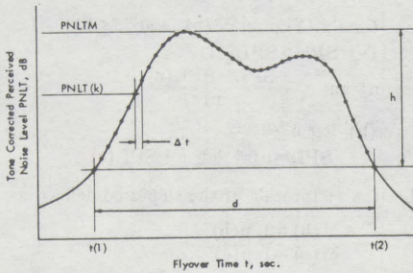


FIGURE B2. Example of perceived noise level corrected for tones as a function of aircraft flyover time.

Figure B2 is an example of a flyover noise time history where the maximum value is clearly indicated. Half-second time intervals, Δt , are small enough to obtain a satisfactory noise time history.

If there are no pronounced irregularities in the spectrum, then the procedure of § B36.3 of this Appendix would be redundant since PNLT(k) would be identically equal to

PNL(k). For this case, PNLTM would be the maximum value of PNL(k) and would equal PNL M .

§ B36.5 Duration correction.

The duration correction factor D is determined by the integration technique defined by the expression:

$$D = 10 \log \left[\left(\frac{1}{T} \right) \int_{t(1)}^{t(2)} \text{ant} [\text{PNLT}/10] dt \right] - \text{PNLTM}$$

where T is a normalizing time constant, PNLTM is the maximum value of PNL T , and $t(1)$ and $t(2)$ are the limits of the significant noise time history.

Since PNL T is calculated from measured values of SPL, there will, in general, be no obvious equation for PNL T as a function of time. Consequently, the equation can be rewritten with a summation sign instead of an integral sign as follows:

$$D = 10 \log \left[\left(\frac{1}{T} \right) \sum_{k=0}^{d/\Delta t} \Delta t \text{ ant} [\text{PNLT}(k)/10] \right] - \text{PNLTM}$$

where Δt is the length of the equal increments of time for which PNL $T(k)$ is calculated and d is the time interval to the nearest 1.0 second during which PNL $T(k)$ is within a specified value, h , of PNL TM .

Half-second time intervals for Δt are small enough to obtain a satisfactory history of the perceived noise level. A shorter time interval may be selected by the applicant provided approved limits and constants are used.

The following values for T , Δt , and h , must be used in calculating D :

$$\begin{aligned} T &= 10 \text{ sec.}, \\ \Delta t &= 0.5 \text{ sec.}, \text{ and} \\ h &= 10 \text{ dB.} \end{aligned}$$

Using the above values, the equation for D becomes

$$D = 10 \log \left[\sum_{k=0}^{2d} \text{ant} [\text{PNLT}(k)/10] \right] - \text{PNLTM} - 13$$

where the integer d is the duration time defined by the points that are 10 dB less than PNLT_M.

If the 10 dB-down points fall between calculated PNLT(k) values (the usual case), the applicable limits for the duration time must be chosen from the PNLT(k) values closest to PNLT_M-10. For those cases with more than one peak value of PNLT(k), the applicable limits must be chosen to yield the largest possible value for the duration time.

If the value of PNLT(k) at the 10 dB-down points is 90 PNdB or less, the value of d may be taken as the time interval between the initial and the final times for which PNLT(k) equals 90 PNdB.

§ B36.6 Effective perceived noise level.

The total subjective effect of an aircraft flyover is designated "effective perceived noise level," EPNL, and is equal to the algebraic sum of the maximum value of the tone corrected perceived noise level, PNLT_M, and the duration correction, D . That is,

$$\text{EPNL} = \text{PNLT}_M + D$$

where PNLT_M and D are calculated under §§ B36.4 and B36.5 of this Appendix.

The above equation can be rewritten by substituting the equation for D from § B36.5 of this Appendix, that is,

$$\text{EPNL} = 10 \log \left[\sum_{k=0}^{2d} \text{ant} [\text{PNLT}(k)/10] \right] - 13$$

§B36.7 Mathematical formulation of noise tables.

The relationship between sound pressure level and perceived noisiness given in Table B1 is illustrated in Figure B3. The variation of SPL with $\log n$ for a given one-third octave band can be expressed by either one or two straight lines depending upon the frequency range. Figure B3(a) illustrates the double line case for frequencies below 400 Hz and above 6300 Hz and Figure B3(b) illustrates the single line case for all other frequencies.

The important aspects of the mathematical formulation are:

1. the slopes of the straight lines, $p(b)$ and $p(c)$,
2. the intercepts of the lines on the SPL-axis, $\text{SPL}(b)$ and $\text{SPL}(c)$, and
3. the coordinates of the discontinuity, $\text{SPL}(a)$ and $\log n(a)$.

The equations are as follows:

Case 1. Figure B3(a), $f < 400$ Hz.

$f > 6300$ Hz.

$$\text{SPL}(a) = \frac{p(c) \text{SPL}(b) - p(b) \text{SPL}(c)}{p(c) - p(b)}$$

$$\log n(a) = \frac{\text{SPL}(c) - \text{SPL}(b)}{p(b) - p(c)}$$

$$(a) \text{SPL}(b) \leq \text{SPL} \leq \text{SPL}(a)$$

$$n = \text{ant} \frac{\text{SPL} - \text{SPL}(b)}{p(b)}$$

$$(b) \text{SPL} \geq \text{SPL}(a)$$

$$n = \text{ant} \frac{\text{SPL} - \text{SPL}(c)}{p(c)}$$

$$(c) 0 \leq \log n \leq \log n(a)$$

$$\text{SPL} = p(b) \log n + \text{SPL}(b)$$

$$(d) \log n \geq \log n(a)$$

$$\text{SPL} = p(c) \log n + \text{SPL}(c)$$

Case 2. Figure B3(b), $400 \leq f \leq 6300$ Hz.

$$(a) \text{SPL} \geq \text{SPL}(c)$$

$$n = \text{ant} \frac{\text{SPL} - \text{SPL}(c)}{p(c)}$$

$$(b) \log n \geq 0$$

$$\text{SPL} = p(c) \log n + \text{SPL}(c)$$

Let the reciprocals of the slopes be defined as,

$$M(b) = 1/p(b)$$

$$M(c) = 1/p(c)$$

Then the equations can be written,

Case 1. Figure B3(a), $f < 400$ Hz.

$f > 6300$ Hz.

$$\text{SPL}(a) = \frac{M(b) \text{SPL}(b) - M(c) \text{SPL}(c)}{M(b) - M(c)}$$

$$\log n(a) = \frac{M(b) M(c) [\text{SPL}(c) - \text{SPL}(b)]}{M(c) - M(b)}$$

$$(a) \text{SPL}(b) \leq \text{SPL} \leq \text{SPL}(a)$$

$$n = \text{ant} M(b) [\text{SPL} - \text{SPL}(b)]$$

$$(b) \text{SPL} \geq \text{SPL}(a)$$

$$n = \text{ant} M(c) [\text{SPL} - \text{SPL}(c)]$$

$$(c) \ 0 \leq \log n \leq \log n(a)$$

$$SPL = \frac{\log n}{M(b)} + SPL(b)$$

$$(d) \ \log n \geq \log n(a)$$

$$SPL = \frac{\log n}{M(c)} + SPL(c)$$

Case 2. Figure B3(b), $400 \leq f \leq 6300$ Hz.

$$(a) \ SPL \geq SPL(c)$$

$$n = \text{ant } M(c) [SPL - SPL(c)]$$

$$(b) \ \log n \geq 0$$

$$SPL = \frac{\log n}{M(c)} + SPL(c)$$

Table B4 lists the values of the important constants necessary to calculate sound pressure level as a function of perceived noisiness.

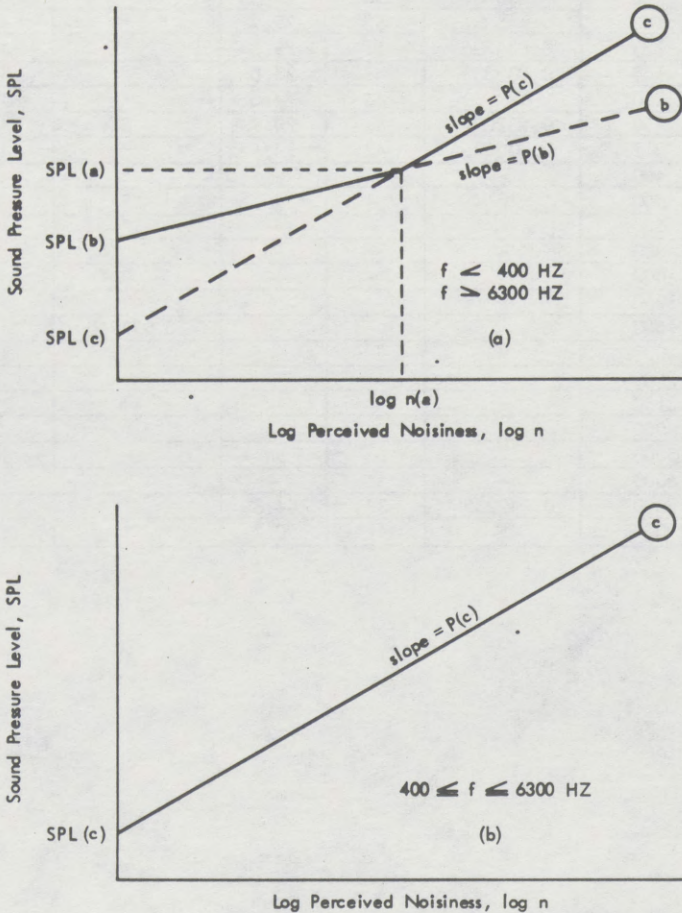


FIGURE B3. Sound pressure level as a function of noys.

TABLE B4. Constants for mathematically formulated noy values.

Band (i)	f HZ	M(b)	SPL (b) dB	SPL (a) dB	M(c)	SPL (c) dB
1	50	0.043478	64	91.0	0.030103	52
2	63	0.040570	60	85.9	"	51
3	80	0.036831	56	87.3	"	49
4	100	"	53	79.9	"	47
5	125	0.035336	51	79.8	"	46
6	160	0.033333	48	76.0	"	45
7	200	"	46	74.0	"	43
8	250	0.032051	44	74.9	"	42
9	315	0.030675	42	94.6	"	41
10	400	-	-	-	"	40
11	500	-	-	-	"	"
12	630	-	-	-	"	"
13	800	-	-	-	"	"
14	1000	-	-	-	"	"
15	1250	-	-	-	"	38
16	1600	-	-	-	0.029960	34
17	2000	-	-	-	"	32
18	2500	-	-	-	"	30
19	3150	-	-	-	"	29
20	4000	-	-	-	"	"
21	5000	-	-	-	"	30
22	6300	-	-	-	"	31
23	8000	0.042285	37	44.3	"	34
24	10000	"	41	50.7	"	37

Appendix C

Noise Levels for Subsonic Transport Category and Turbojet Powered Airplanes Under Section 36.201

§ C36.1 Noise measurement and evaluation.

Compliance with this Appendix must be shown with noise levels measured and evaluated as prescribed, respectively, by Appendix A and Appendix B of this Part, or under approved equivalent procedures.

§ C36.3 Noise measuring points. Compliance with the noise level standards of § C36.5 must be shown—

(a) For takeoff, at a point 3.5 nautical miles from the start of the takeoff roll on the extended centerline of the runway;

(b) For approach, at a point 1 nautical mile from the threshold on the extended centerline of the runway; and

(c) For the sideline, at the point, on a line parallel to and 0.25 nautical miles from the extended centerline of the runway, where the noise level after liftoff is greatest, except that, for airplanes powered by more than three turbojet engines, this distance must be 0.35 nautical miles.

§ C36.5 Noise levels.

(a) *General.* Except as provided in paragraphs (b) and (c) of this section, it must be shown by flight test that the noise levels of the airplane, at the measuring points described in § C36.3, do not exceed the following (with appropriate interpolation between weights);

(1) For approach and sideline, 108 EPNdB for maximum weights of 600,000 lbs. or more, less 2 EPNdB per halving of the 600,000 lbs. maximum weight down to 102 EPNdB for maximum weights of 75,000 lbs. and under.

(2) For takeoff, 108 EPNdB for maximum weights of 600,000 lbs. or more, less 5 EPNdB per halving of the 600,000 lb. maximum weight down to 93 EPNdB for maximum weights of 75,000 lbs. and under.

(b) *Tradeoff.* The noise levels in paragraph (a) may be exceeded at one or two of the measuring points prescribed in § C36.3, if—

(1) The sum of the exceedance is not greater than 3 EPNdB;

(2) No exceedance is greater than 2 EPNdB; and

(3) The exceedances are completely offset by reductions at other required measuring points.

(c) *Prior applications.* For applications made before December 1, 1969, for airplanes powered by more than three turbojet engines with bypass ratios of two or more, the value prescribed in paragraph (b)(1) of this section may not exceed 5 EPNdB and the value prescribed in paragraph (b)(2) of this section may not exceed 3 EPNdB.

§ C36.7 Takeoff test conditions.

(a) This section applies to all takeoffs conducted in showing compliance with this Part.

(b) Takeoff power or thrust must be used from the start of the takeoff to the point at which an altitude of at least 1,000 feet above the runway is reached, except that, for airplanes powered by more than three turbojet engines, this altitude must not be less than 700 feet.

(c) Upon reaching the altitude specified in paragraph (b) of this section, the power or

thrust may not be reduced below that power or thrust that will provide level flight with one engine inoperative, or below that power or thrust that will maintain a climb gradient of at least 4 percent, whichever power or thrust is greater.

(d) A speed of at least $V_s + 10$ knots must be attained as soon as practicable after liftoff, and must be maintained throughout the takeoff noise test.

(e) A constant takeoff configuration, selected by the applicant, must be maintained throughout the takeoff noise test, except that the landing gear may be retracted.

1 C36.9 Approach test conditions.

(a) This section applies to all approaches conducted in showing compliance with this Part.

(b) The airplane's configuration must be that used in showing compliance with the land-

ing requirements in the airworthiness regulations constituting the type certification basis of the airplane. If more than one configuration is used in showing compliance with the landing requirements in the airworthiness regulations constituting the type certification basis of the airplane, the configuration that is most critical from a noise standpoint must be used.

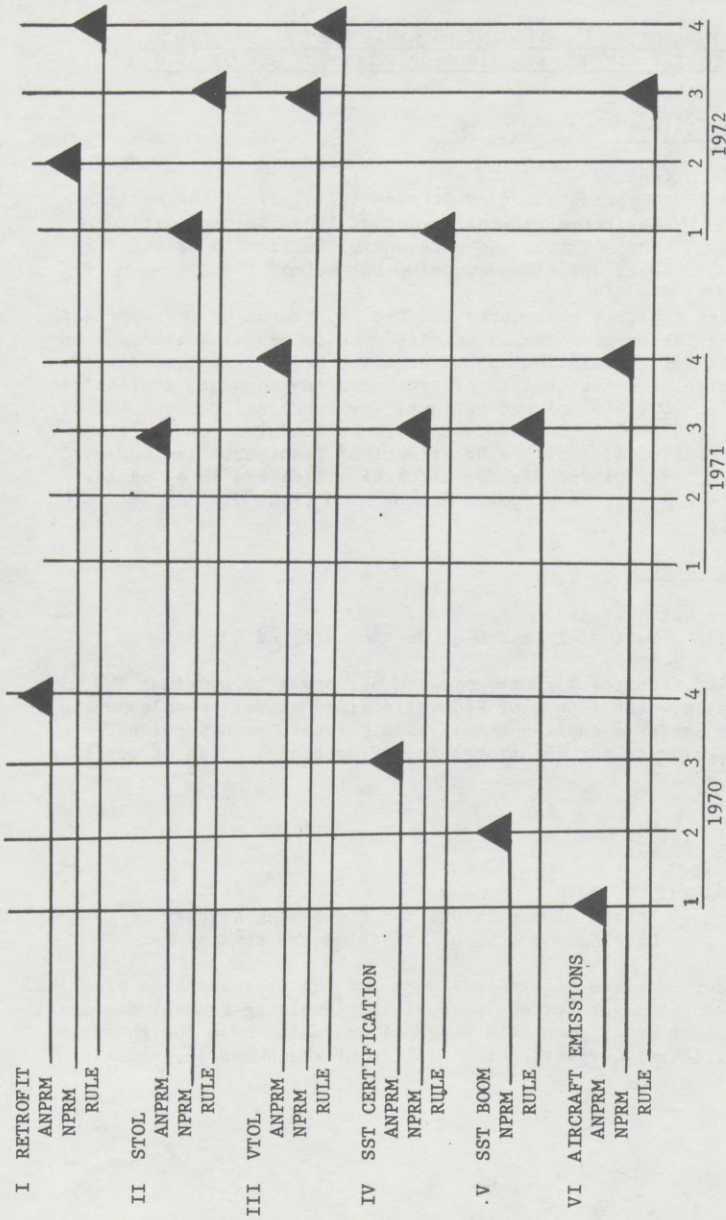
(c) The approaches must be conducted with a steady glide angle of $3^\circ \pm 0.5^\circ$ and must be continued to a normal touchdown with no airframe configuration change.

(d) A steady approach speed of not less than $1.30 V_s + 10$ knots must be established and maintained over the approach measuring point.

(e) All engines must be operating at approximately the same power or thrust.

(Amdt. 36-1, effective Dec. 1, 1969, published in 34 F.R. 18815, Nov. 25, 1969)

AIRCRAFT NOISE PROGRAM
ESTIMATED SCHEDULE DATES - RULEMAKING



KEY = ANPRM - ADVANCE NOTICE PROPOSED RULEMAKING
 NPRM - NOTICE PROPOSED RULEMAKING
 RULE - AMENDMENT TO FEDERAL AVIATION REGULATIONS

PUBLICATIONS IMPLEMENTING ENVIRONMENTAL PROVISIONS
OF THE AIRPORT AND AIRWAY DEVELOPMENT ACT OF 1970

DOT Order 5610.1

Issued on October 7, 1970

Subject: Implementation of Section 102(2)(c) of the National Environmental Policy Act of 1969, Section 4(f) of the DOT Act, and portions of Section 16 of the Airport and Airway Development Act of 1970.

This order outlines procedures for the Department of Transportation regarding the preparation of detailed environmental statements on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, as required by Section 102(2)(c) of the National Environmental Policy Act of 1969 (P.L. 91-190). It also sets forth procedures for implementation of Section 4(f) of the Department of Transportation Act of 1966 (P.L. 89-670) and Section 16(c)(4), 16(d) and 16(e) of the Airport and Airway Development Act of 1970 (P.L. 91-258).

FAA Order 5050.1

Issued on April 4, 1970

Subject: Potential Impact of Section 4(f) of DOT Act

This order requires Airports program personnel to consider the potential adverse impact of Federally aided airport development upon the Nation's environment in timely fashion and provides interim guidance for the processing of potential cases of conflict.

FAA Order 5050.2

Issued on July 7, 1970

Subject: Interim Instructions for Processing Airport Development Actions Affecting the Environment

This order provides interim guidance for the processing of proposed airport development actions potentially involving Federal financial aid (Airport Development Aid Program) and which have the potential of significantly affecting the quality of the human environment.

FAA Order 6900.4

Issued on June 30, 1970

Subject: FAA Plans for Meeting Mandate of National Environmental
Policy Act of 1969 (Public Law 91-190)

This order outlines basic policy, a plan of action, and establishes responsibility for ensuring that the FAA take all possible measures, with respect to its facilities, plans, programs, policies, and operations, to lead in the nationwide effort to protect and enhance the quality of our environment and natural resources.

FAA Order 5900.1

Issued on September 25, 1970

Subject: Planning Grant Program (PGP) Handbook

This order establishes an interim Planning Grant Program Handbook. The objective of the Program is to promote the effective location and development of airports and the development of a National Airport System Plan. These interim guidelines assist the public and agency personnel in implementing section 13 of the Airport and Airway Development Act of 1970, which authorizes grants of funds to public agencies for airport master planning and to planning agencies for system planning.

FAA Order 5100.15

Issued on September 2, 1970

Subject: FAA Participation in Environmental Hearings
Under the Airport and Airway Development Act

This order provides policy guidance on participation by Federal Aviation Administration (FAA) personnel in environmental hearings conducted by sponsors pursuant to the Airport and Airway Development Act of 1970, P.L. 91-258.

FAA Advisory Circular 150/5100-7

Issued on January 4, 1971

Subject: Requirement for Public Hearings in the Airport Development
Aid Program

This advisory circular provides guidance to sponsors of airport development projects under the Airport Development Aid Program (ADAP) on the necessity for and conduct of public hearings.

FAA Advisory Circular 150/5100-8

Issued on January 19, 1971

Subject: Request for Aid; Displaced Persons; Public Hearings;
Environmental Considerations; Opposition to the Project

This advisory circular provides general guidance on the information and coordination required in support of a request for aid for an airport development project under the Airport and Airway Development Act of 1970.

FAA Notice of Proposed Rule Making 70-50

Issued on December 29, 1970

Subject: Airport Development Aid

This Notice of Proposed Rule Making would completely rewrite Part 151 of the Federal Aviation Regulations to accommodate the new requirements of the Airport and Airway Development Act of 1970, and to terminate the Federal Aid to Airport Program.

Senator CANNON. The next witness is Mr. John Tyler, head of the technical committee, National Organization to Insure the Sound Controlled Environment, New York.

STATEMENT OF JOHN TYLER, HEAD OF THE TECHNICAL COMMITTEE, NATIONAL ORGANIZATION TO INSURE THE SOUND CONTROLLED ENVIRONMENT, MINEOLA, N.Y.

Mr. TYLER. I am speaking for the organization called NOISE (National Organization to Insure a Sound Controlled Environment). This is an organization of municipalities located in areas surrounding large U.S. airports. Membership fees come from the town budgets. The purpose of this organization, which is taking on a national significance, is to develop channels of communication with the authorities which operate the U.S. airports. It is anticipated that when the problems of towns surrounding airports are recognized action will be taken in their behalf.

I will speak on S. 1016 which authorizes the Administrator of the EPA to—"by regulation prescribe standards limiting the noise generation characteristics"—of construction equipment, transportation equipment and internal combustion engines. The bill, however, exempts aircraft noise certification from limitations established by the EPA and leaves that responsibility with the Secretary of Transportation with approval by the EPA. Our organization believes this to be a satisfactory and proper step for the Congress to take provided further action is taken.

Following the Administrator of the FAA, I feel privileged and I would like to transmit the thoughts of our organization that the FAA is doing a tremendous job and that our organization would not want to detract from or interfere with that work in any way. We support it completely and we think their efforts are quite productive.

The further action which our organization believes is necessary is as follows:

That the EPA be directed to make agreements with the local municipalities around airports wherein the EPA would set boundaries for noise exposure contours and the municipalities would zone the areas within these boundaries for uses compatible with this noise exposure. This would permit both the air transport system and the municipalities to plan constructively for the future.

Before I go on, I would just like to say that this is a plan which has surfaced in many government committees in the past and I think the timing in 1971 is appropriate for this action to be taken.

Regarding the background of this situation, the organization NOISE concurs with the following findings of many research groups and government task force programs:

(1) That lack of control of aircraft noise in areas near airports presents a serious problem to both the airport neighbors and the air transport industry. To airport neighbors because of the invasion of the serenity of their homes, the interruption of sleep, of speech communication, of the enjoyment of music, radio, TV programs and the loss of the use of grounds around their homes for outdoor living and entertainment. To the air transport industry because this noise prob-

lem has made it virtually impossible to obtain permission to establish much needed new airports in rapidly growing urban areas.

(2) That the impact of aircraft noise on people living and working near airports can be specified in terms of noise exposure (NE) units where the NE of any point in the area near an airport is in proportion to the total noise energy reaching that point from all aircraft operations in the vicinity of the airport in a 24-hour period.

(3) That the impact of noise on people living and working near airports, expressed in units of NE, is dependent on several factors which are under the control of several different Government agencies and other organizations, none of which has aircraft noise as its primary concern. There are five different factors controlled by five different agencies or organizations. These factors and agencies or organizations are:

(a) Noise produced by the aircraft: This is certified by the FAA to be within specified limits at specified points on the ground during certification tests of takeoff and landing of new aircraft, but the FAA does not require that these limits be applied under airline operating conditions or at any other point on the ground around the airport.

(b) Number of aircraft operating from the airport in a 24-hour period: This is controlled by the CAB, which authorizes airline routes; airports to be served; and number of flights.

(c) Runway location and orientation and flight tracks of takeoffs and landings at the airport: (Flight tracks are vertical projections of flight paths onto the ground)—these factors are controlled by the airport, the local FAA tower and the airlines jointly.

(d) Aircraft operating procedures during takeoff and landing: These procedures are controlled, within the limits established for safety by the FAA, by the airlines. Each airline has its own operating procedures. Some are much better than others from a noise standpoint.

To digress here for a moment, I think I might mention the movie which you saw and the comments regarding the Northwest procedure which is appreciably better than other airlines using similar equipment.

(e) Distribution of operations throughout the 24-hour period: This is also under the control of the airline, except where a curfew is imposed on night operations as at Washington National Airport.

(4) That while it may be both necessary and logical that these several factors be controlled by these different agencies and/or organizations: safety and noise certifications limits by the FAA, flight number by CAB, flight tracks by the airport and others, and operating procedures and schedules by the airline, this leaves the aircraft noise situation in the airport communities in a continuously changing, confusing and unpredictable condition.

(5) That due to the separation of powers between the Federal Government and the States, in which the Federal Government regulates interstate and foreign commerce and the local governments within the States control land use in areas surrounding the airports, a serious

conflict has developed regarding the compatibility of aircraft operations and land use in areas of high aircraft noise exposure.

This situation is exacerbated locally because the airport is usually operated by a large city which it serves, whereas the areas subjected to high noise exposure levels are under the jurisdiction of smaller governmental units. Thus the large municipality can operate airports for its benefit and ignore the hardships imposed on the smaller adjacent municipalities.

This fragmentation of authority, first between the Federal Government and the States, and, second, between the organization within the State which deals with the Federal Government—the operator of the airport—and the organization representing the people who bear the burden of the aircraft noise leaves the latter with no representation or even any official lines of communication with the authorities which control aircraft noise exposure levels.

Another important factor which has increased the burden of noise interference with the airport neighbors use of their properties is the lack of proper planning and zoning near airports. This situation is not just the result of local contractors building houses in areas known or expected to have high aircraft noise exposure. The local authorities have no information predicting the ultimate noise exposure planned for the area around an airport which could be used to establish permanent zoning regulations for compatible land uses.

(6) That without planned air transport operations, at planned noise exposure levels with fixed or programed geographical boundaries for aircraft noise exposure contours, land use planning in the communities around airports based on noise exposure levels is impossible. With aircraft noise reductions made possible by quieter aircraft and with the use of noise abatement operating procedures now being made available the areas enclosed within the critical aircraft noise exposure contours can be greatly reduced and with sufficient reduction in these areas compatible land use planning becomes practical.

(7) That due to the separation of powers between the Federal Government and the States the Congress cannot control the use of land in areas surrounding U.S. airports. This power is reserved to the States or local municipalities, therefore, the Federal Government must persuade the local government to enter into an agreement which is made attractive to the municipality by some incentives offered by the Federal Government. In this case the need is for cooperative planning and zoning; planning of aircraft operations and noise exposure on the one hand and zoning of land in areas which have, or are predicted to have, high noise exposure levels on the other. The municipalities surrounding the airport would expect benefits to their people in return for restrictions placed on the use of land near the airport by zoning regulations. Both the benefits to the people, by aircraft noise reduction and the zoning regulations which can result from cooperative planning are long overdue. Now, regarding the action required to implement these ideas. NOISE believes that for the benefit of the airport community and of the air transport industry, and for the public health and welfare of the Nation, it is necessary to direct the EPA to:

1. Enter into agreements with local governments having jurisdiction over areas surrounding U.S. airports to do cooperative planning

involving the establishment of limits on aircraft noise exposure contours and the planning of land use in high noise exposure areas which compatible with high noise exposures.

2. Report to the Congress and the public on the status of work being done to eliminate incompatibilities between aircraft noise exposure and land uses around airports.

3. Identify the most serious incompatible land uses where no practical solution is available so that priority may be given to finding solutions to these problems.

The EPA has been selected for this program because its primary function is to control pollution, including noise pollution by establishing practical limits on pollution, whereas other agencies have other primary functions. For example, the primary function of the FAA is to promote the growth of an efficient and safe air transport industry; the primary function of the CAB is to ensure widespread air transport service, and so forth.

The authority assigned to the EPA to make agreements with local governments establishing geographical boundaries for critical noise exposure contours in return for the establishment of local zoning compatible with these fixed boundaries shall in no way infringe on the authority of the FAA to certify aircraft and approve aircraft operating procedures; the authority of airport operators to design and operate airports; the authority of the CAB to certify airline routes; the prerogatives of airlines to establish operating procedures or of pilots in flying the aircraft. The EPA shall establish boundaries for the critical noise exposure contours at practical levels taking into account the burden on the air transport system and the burden on the communities subjected to aircraft noise, which are therefore a part of the system, and then permit the various factors in the system to be adjusted by the agencies and organizations involved so as to meet the noise limitations with a minimum economic impact on the airlines and a minimum loss of service to the public.

The incentive for the communities to enter into agreements with the Federal Government is primarily that noise exposure levels would be reduced or future increases would be held to a minimum. A secondary incentive is that the EPA limitations on noise will apply only where agreements have been made. If noise limitations are imposed at some airports and not at others, or off the ends of some runways and not others, the airlines and airports would tend to use the quieter aircraft to insure meeting the noise limitations where they exist.

Now, regarding the noise criteria and noise control technology, NOISE requests the Congress to direct the Administrator of the EPA to develop and publish rules, after consultation with appropriate Federal departments and agencies, for establishing the geographical boundaries within which the critical 30 and 40 noise exposure contours around all U.S. airports must be maintained to compatibility between the NE levels and land uses which are, or can be made, appropriate for the areas enclosed within these contours. These rules shall be based on an analysis of the following:

(1) Present size and need for growth. The rules shall recognize the need for the maintenance of air transport service to the community and the need for increase in airport operations as the community air transport service needs increase. Therefore, the boundaries for the NE

contours shall be based on the ultimate potential capacity of the airport if it is expected to grow.

(2) Planned noise reductions. The rules shall call for a scheduling of NE contour boundaries which are based on planned noise reductions as new quieter aircraft come into service and as noise abatement operating procedures are put into effect.

(3) Land use studies. The rules shall be designed to reduce the area enclosed within the NE contours to a size which could eventually be used for purposes compatible with NE levels or higher. Where this achievement seems to be well out of reach of the present air transport community system design the Administrator shall identify this situation as a critical problem needing immediate attention by Congress in the form of new R. & D. programs to develop compatibility in line with the drastic needs of the situation.

(4) Airports with open space. The rules shall be applied as soon as possible to airports having unimproved land within the predicted eventual NE contours.

The Administrator shall implement the rules for establishing geographical boundaries for these NE contours by entering into agreements with local governments of communities near airports exposed or predicted to be exposed to more than 30 NE to limit the NE levels as prescribed by the rules in return for agreements by the local government to zone the areas within its jurisdiction above 30 NE for uses compatible with the NE levels predicted for these areas.

In working out these agreements the Administrator may negotiate financial agreements between the proper authorities for the use of funds made available by the Airport and Airways Development Act of 1970, for the purchase of, or rezoning of land in high NE areas.

(5) Airport operator as agent. The Administrator shall require each airport operator to report the predicted operations from his airport for periods in advance and the NE contours produced by these operations. The airport operators report shall include all necessary data used in predicting the NE contour locations and shall show the boundaries established by the Administrator for the NE contours. The airport operator shall also report the actual operations, including all necessary data to predict NE contours, at the end of each period designated by the Administrator.

The airport operator shall make whatever adjustments may be necessary in operations from the airport to maintain the NE contours within the boundaries established by the Administrator or to reduce the area enclosed by the NE contours to boundaries established by the Administrator. If the airport operator is in need of assistance in interpreting the procedures available to him for controlling or adjusting the NE contours to the required boundaries he may consult with the Administrator prior to the due date for his report so that his report may be submitted in time.

This concludes my remarks on S. 1016. I also have comments to make on S. 1566.

Regarding the Cranston bill, S. 1566, NOISE wishes to go on record as supporting each feature of the bill as steps in the right direction. However, NOISE wishes to support the use of noise exposure limits set by an objective agency such as EPA and give the

FAA and the CAB, the airlines, the airports and others as much flexibility as possible in achieving the desired result. In fact, I would say NOISE concurs completely with the remarks submitted by the witness preceding me, Administrator Shaffer.

To be more specific, S. 1566 calls for a 10-EPNdB noise reduction or a reduction to the new certification levels, whichever is greater by 1976. This would require a retrofit of engine nacelles for many aircraft. We are not sure that the retrofit called for would be the most productive of reductions in noise exposure per dollar expended on the system. It may be that less expensive retrofits to facilitate the use of noise abatement operating procedures would be more effective. We believe that the FAA and the airlines working with the manufacturers and NASA should have the freedom to use the most effective technical approaches they can find.

Regarding the \$35 million for the developments of retrofits and the \$1 billion authorization for guaranteeing loans, again, NOISE believes that funds should be channeled into developments which will provide the maximum reduction in noise exposure.

Funds for noise monitoring programs will be needed in the future. However, NOISE, would like to see this program administered in such a way as to permit each segment of the industry to police itself on its own responsibilities and let the monitoring system record the end result. As long as the end result is acceptable, there is no need for monitoring in great detail.

Mr. Chairman, I would like to comment that a recommendation from Congressman Rosenthal's office has been sent to the committee with regard to the general concept which has just been presented and that further details will be provided later.

Senator CANNON. All right. Thank you very much, Mr. Tyler.

You certainly make some very worthy recommendations here. I think that one of the problems has been that the local authorities have been slow in moving to zone areas to protect the airport area and, in turn, protect the community until dangers have already grown to a considerable magnitude, and certainly if a concerted effort were made and the planning and zoning authorities acted from the standpoint of good planning practices, it would certainly lead to a better system than we have in effect at the present time.

Thank you very much for your testimony and the committee will give full consideration to it in its deliberations.

Mr. TYLER. Thank you.

Senator CANNON. The next witness is Mr. R. L. Hurlburt, environmental standards supervisor, city of Inglewood, Inglewood, Calif.

STATEMENT OF R. L. HURLBURT, ENVIRONMENTAL STANDARDS SUPERVISOR, CITY OF INGLEWOOD, INGLEWOOD, CALIF.

Mr. HURLBURT. Good morning, gentlemen. It is a privilege to be here this morning and I apologize that our mayor, Mr. Mergell, from Inglewood could not come, but I hope to give his testimony to you and convey the thoughts of the city of Inglewood.

I would like to clarify, if I may, a little bit of what Mr. Tyler just said. Mr. Mergell, our mayor, is the vice president of the National

Organization To Insure a Sound Controlled Environment, and just a month ago in its national meeting, that organization did adopt a resolution supporting Senator Cranston's bill, S. 1566.

I believe that the issue of environmental noise, particularly aircraft noise, is an important one and, fortunately, it is one area of our environment where we can make significant inroads in a reasonable period of time.

The city of Inglewood is a town of approximately 90,000 people located just east of the Los Angeles International Airport. Although our closest boundary is almost 2 miles from this airport, the noise from planes flying overhead as they land at LAX is so severe as to have blighted nearly one-half of our city. And the problem gets worse as more and more aircraft operate into this airport.

At the present time there are almost 800 flights per day that land over Inglewood. Because of prevailing westerly winds, there are this many aircraft over Inglewood every day, 365 days a year. Nearly all of the flights are commercial jets, and they are at altitudes of only 500 to 1,000 feet. In some areas of Los Angeles County to the west of Inglewood, the jets are even lower (and louder) than they are over Inglewood.

Sort of in reply to some of the comments that have been made earlier, Inglewood was incorporated as a city in 1908 and by 1950 it was almost completely built up. In the forties and fifties we enjoyed excellent relations with our airport neighbor. The noise problem started when jet planes were introduced in 1959. The problem has gotten progressively worse as more and more aircraft have flown into Los Angeles. The conversion from turbojet to turbofan engines, which occurred in the early sixties, reduced takeoff noise, but compounded our problem by increasing landing noise to the high pitched shriek that is so prevalent today.

As a city government, we are trying to do everything we can to provide a good environment for our citizens. We have taken the initiative in starting a program of rezoning, redevelopment, and soundproofing to help alleviate this problem. We are also actively enforcing a noise ordinance which prohibits unreasonable sound from those sources which we can control. But we do not seem to be able to control aircraft noise, which is why we are turning to you for help.

The Los Angeles and Inglewood problem is certainly one of the most severe cases of noise pollution in the world, but is far from being the only one. Most other large airports, such as New York, Chicago, Boston, Atlanta, and San Francisco and others all have noise pollution problems rivaling ours.

And the trouble is not only limited to the big airports; even small airports which you may never have heard of, such as Orange County, Burbank, and Ontario airports in California have real problems. In fact, any airport that has jet operations and people nearby probably has a noise problem. And there are several hundred such airports in the country.

It is not hard to understand why even one jet flight at present noise levels creates trouble. You know how annoyed you get when some kid guns his hot rod without mufflers past your house—well, the chances are he made less than 95 EPNdB of noise. A jet flyover makes much

more than this, 115 EPNdB or more. In the language of acoustics, this means that the annoyance caused by one aircraft flyover is approximately equivalent to 100 of those hot rods accelerating past your house. Can you imagine what 500 aircraft (or more) would be like?

Estimates of the number of people adversely affected by aircraft noise range from 2 to 30 million. We believe a figure around 10 million is reasonably close to right. But we think it unreasonable, and not at all right that 10 million of our taxpaying citizens should have to live with noise equivalent to thousands of hot rods driving up and down their street. Ten million people is equivalent to a city the size of New York.

The bill you have before you, S. 1566, will reduce noise from today's loudest aircraft by approximately 10 EPNdB. This means that where there are presently 500 aircraft per day flying over some neighborhood, with the modified engines the noise will be approximately equivalent to only 50 airplanes per day. Where there are now 50 airplanes per day, the change will make the noise environment equivalent to five airplanes per day. In spite of what anyone says about the 10 EPNdB, this is a dramatic change. We agree that it does not solve the problem entirely, but it is a major step. We believe that it is a step that is reasonable to take now, and represents a satisfactory holding action until a further 10-EPNdB noise reduction can be made in the generation of aircraft which will be built in the 1980's. (Incidentally, we will probably need legislation from you shortly to mandate that noise reduction, too. The airline industry and its regulatory agencies do not seem willing to institute such changes on their own.)

We do not think that a 1 percent or even a 2 percent increase in air fares should be sufficient to deter implementation of this noise reduction program. Briefly, the benefits to be realized from such an expenditure are:

The living and sleeping environment for millions of people around airports will be dramatically improved.

The educational environment for children in schools near airports will be improved, and there are thousands of children in schools around these airports.

There will be a greatly reduced need to soundproof homes, which, incidentally, is quite expensive, schools, hospitals, and commercial buildings near airports.

The utility of public lands such as beaches and parks near airports will be greatly improved.

Homes whose value has been depressed for years will once again be salable.

Also, the airlines themselves will necessarily benefit from this bill, Senator Cranston's bill. There are several reasons that I say this. One is that it will be much easier to locate sites for new airports once aircraft have been made quieter and once real progress has been shown in trying to make aircraft compatible with communities. Furthermore, much less effort will have to be spent fighting off damage claims because of noise. I might say also that 48 percent of the cost that we are talking about will not be borne by the airlines themselves, but actually by the Federal Government in general because of the income tax.

Finally, the fact that implementation of this program will provide employment in the aerospace industry is very important. We have here an excellent opportunity to help redirect the talents of this important industry into solving one of the important social problems of our time.

For your information, we recently conducted a survey in Inglewood to find the views of our residents regarding many crucial issues such as race relations, aircraft noise, crime, traffic congestion, schools, et cetera. The results showed that 61 percent thought solution of the noise problem was of extreme importance, and 20 percent felt it was very important. The noise problem ranked second only to crime control as a major public issue. This I think gives you some idea of just how great a problem noise is.

For those interested, I am making available copies of a cost-benefit study of retrofit, which has been referred to earlier, which we prepared several months ago and which elaborates on many of the points I have just made.

Summarized quickly, just consider 2 million people affected severely by noise and we found that the benefits of the retrofit program outweighed the cost by two to one.

I would like to quickly summarize by referring to the main points you brought up in your opening statement, Senator Cannon. First of all, is retrofit and early retirement of present day aircraft realistic technically and economically? I believe that it is technically. The programs of NASA, McDonnell-Douglas and Boeing Corp. have shown that it can be done on four-engine jets and I believe testimony you will hear tomorrow from Rohr Corp. will show that further work is particularly possible on three-engine aircraft.

Economically I believe it is possible for the reasons I just mentioned on our cost-benefit study. Also, if, in fact, the airlines are planning to retire their four-engine jets which are the noisiest aircraft in the next 3 to 8 years, then I would say they should have no objection whatsoever to a measure such as Cranston's bill because it would become effective in 1976 and if the airplanes are going to be retired by that date, then they certainly will meet the noise criteria.

The second question was whether it would provide meaningful and measurable relief to communities, and I maintain that it will, based on the analogy I mentioned earlier about the hot rods and also the psycho-acoustic scales mentioned by Dr. Powers show that 10 EPNdB would be a halving of noise.

Finally, should the cost of the program be borne by the general public or by the air carrier or the passenger that patronizes the airlines? Certainly, I wouldn't propose it be borne by the air carriers who indeed are in financial problems at the present time. I believe it should be borne by the passengers. These are the people who use the airlines. Rightfully, they should pay the full cost, including the social cost of the noise. Some of it will be borne by the general public, no doubt, in terms of the income tax, the 48 percent that I mentioned.

So finally, I respectfully request on behalf of the citizens of Inglewood and all citizens around airports that your committee stand up for the rights of people and approve Mr. Cranston's bill. Thank you.

Senator CANNON. Thank you very much, Mr. Hurlburt, and thank you for the statement of the mayor. We appreciate having your views and also having copies of your study made available.

Mr. GINTHER. Mr. Hurlburt, so the record will be clear, do you dispute the testimony of the FAA that it is not now technologically possible to refit all the aircraft in the U.S. fleet so as to achieve 10 EPNdB reduction in noise at all three measuring points?

Mr. HURLBURT. I question that testimony in that the research at Boeing and McDonnell-Douglas has shown great steps in this regard. The paper study of the Rohr Corp. has indicated it further to be possible and other indications from various people indicate that this can be done.

Mr. Cranston's bill authorizes \$35 million I believe for research to fully confront this problem and to make the technology available for the retrofit program.

Senator CANNON. Thank you very much.

The next witness is Capt. Alex Bonner, Delta Airlines, vice president, Air Line Pilots Association, Washington, D.C.

STATEMENT OF ALEX C. BONNER, FIRST VICE PRESIDENT, AIR LINE PILOTS ASSOCIATION

Mr. BONNER. Mr. Chairman, I am Captain Bonner, first vice president of the Air Line Pilots Association. I am employed by Delta Airlines as a captain and have 30 years of airline and military flying experience.

The Air Line Pilots Association represents 31,000 pilots of 39 commercial airlines and 12,000 stewards and stewardesses of 22 commercial airlines. I appreciate this opportunity to appear before your subcommittee on behalf of the Association concerning the two bills on noise abatement now under consideration.

In recognition of the committee's important mission and the limited time available for all participants who wish to be heard, I will confine my remarks to the general position of our pilots in regard to the noise problem. However, I wish to offer important supplementary data for the record which will give more specifics and background for our position.

First of all, I would like to make the point that the pilots of the Nation's commercial air carriers are mere pawns in this game of technology versus ecology. We side with the general public in regard to the growing danger that noise presents to the health and welfare of the population. We have lived with excessive noise levels all of our professional flying lives and are well aware of its implications. In fact, one of the hazards of our profession is early deafness which can disqualify us as commercial pilots.

Pilots are caught in the middle between those who want to reduce aircraft noise levels and those who want to fly with the greatest degree of safety possible. Our business is safety and we will cooperate with those who want noise levels reduced so long as safety of passengers, crew, and plane is not compromised. But I respectfully submit that the pilot does not have it in his power to do anything about the noise levels designed into his airplane and his engines. Neither does he have

it in his power to legislate where airports are located, what routes shall be flown to get to them nor the rules governing noise abatement on takeoffs and landings.

For many years, our association has been pointing out to all who would listen that the airframe and engine manufacturers must make the technological improvements that will alleviate the problem. And the FAA must give us takeoff and landing profiles that we can fly with a satisfactory margin of safety. We have spelled out the improvements that we think should and can be made. Industry and the FAA know what these are. They are within the state of the aircraft and engine design arts.

Apparently, no one has been listening to us. Today, we are operating aircraft where noise has become the first consideration and safety is now in second place. To alleviate noise, we are required to operate our aircraft close to the edge of the safety envelope and we are getting closer to that edge every day. We are being asked to land from steeper approaches and reduce power on engines after takeoff. As a pilot of the stretched version of the DC-8 I can tell you that when the aircraft is loaded it is downright dangerous to pull back very far on the throttles and reduce thrust just so that the noise level on the ground will be reduced.

To substantiate the dangers involved, I invite your attention to the supplemental data I am supplying, wherein are discussed our views concerning the use of preferential runways, turns during the climb-out, low speed climb-out, power cutbacks and our recommendations for noise alleviation. You will see that we feel we have been pressed to the limits with arbitrary noise limits during the operation of our aircraft. You will also find that we have maintained a cooperative attitude and have done, and will continue to do, our part to solve this vexing and complex problem.

I would like to state here and now that if airline pilots must make a choice between making noise and flying their passengers safely, they will favor the side of safety every time. We insist that the pilot in command retain the right to decide what is safe for his aircraft when it becomes a question of noise versus safety. I am sure that the flying public would not have otherwise.

I will be happy to answer any questions on this subject or furnish information at any time.

Senator CANNON. Thank you, Captain Bonner.

Are you suggesting here that some of the regulations now in effect are actually jeopardizing the safety of the flights or are you just simply saying that it is approaching that point?

Mr. BONNER. I am saying, sir, that it approaches that point. I am saying that there are certain regulations that consider a perfectly clear day and all factors concerning them are perfect. What we are saying is, and we have to have a margin of safety that if something does occur, and we cannot gain altitude—we must maintain altitude. The airplane flies with the wing and power and we must have the power to keep it in the air.

Senator CANNON. What about the experimentation that is being done now with a higher intercept angle of the ILS and a steeper approach?

Mr. BONNER. Well, to answer you candidly, sir, I noticed in Mr. Shaffer's remarks that he was referring to a two-segment approach and I do not know if that means that you are then going to have to apply it to two ILS systems or just one, where you start out at a steep angle and then you reduce it to a smaller angle as you approach the ground. I did not hear his comments on whether it was one type or two type approaches.

However, in a turbofan engine, in order to maintain our margin of safety. We must maintain spool-up power on that engine in preparation for a go-around if it becomes necessary.

Senator CANNON. So you are suggesting that a two-level approach might create some added problems then if a steeper—

Mr. BONNER. We have not seen it demonstrated, sir, and have not evaluated that. We would be happy to do so.

Senator CANNON. I took it from his testimony that it probably would require some changes in the instrumentation itself because to make a steeper approach for one segment of the ILS and then level off and make a more gradual approach, I do not know how they are going to bend that system actually, but that is the way I interpret his testimony—you would have a steeper approach until you got in closer to the airport, and then have a shallower approach for the very final approach.

Mr. BONNER. Well, sir; the takeoff profile is something else. The airline pilots would like the jet aircraft to be able to take off and fly straight and level directly away from the airport to an assigned altitude, but restrictions are such that we cannot do it. We are required to level off at lower altitude than we desire, reduce our power, maintain speeds, which in some cases are over congested areas, and then when they request that we climb immediately to an altitude which calls for maximum power on the engines to attain that altitude by a certain point, we then get complaints from that area because the nose of the plane goes up and the noise goes down.

Mr. GINTHER. Captain Bonner, what about the recommendation regarding changing the actual angle of the glide slope itself from $2\frac{1}{2}^\circ$ to 3° ? Do you have any comments on that proposal?

Mr. BONNER. There are certain airports that we are evaluating at this time that have done just this. We have a safety forum, in fact this month, which will bring out our recommendations for this type operation, increasing it to $3\frac{1}{2}^\circ$ slope. I will be prepared and happy to provide you with those answers from our safety forum.

Senator CANNON. Do some of your safety experts work very closely with the FAA when they come out with these proposed rules?

Mr. BONNER. Yes, sir. We are very happy that we do have a relationship with FAA. We are invited to participate in their hearings. Not that our recommendations are always accepted, but they have extended us the courtesy; yes, sir.

Senator CANNON. So you feel that the arrangement now that does exist is satisfactory as far as the pilots are concerned?

Mr. BONNER. Yes, sir. As long as we have a listening post and our views are allowed to be aired before them and they listen to us, as long as safety is concerned, yes, sir; but we do not have any interest in multiple agencies directing us or regulating our rules and regulations of flying. It has become quite difficult.

Senator CANNON. I take it you are inferring that to the question I raised about the EPA having the authority to approve the rules and regulations.

Mr. BONNER. I certainly do, sir, and also, if we are going to have one agency to regulate pilots, then we feel very strongly that that agency should have the power to regulate our rules around cities as well as up in the air.

Senator CANNON. Now do you have any specific recommendations that you would make to us to get at this problem of noise pollution as to what we might do that we are not doing at the present time?

Mr. BONNER. Well, sir, of course, this supplemental data does in fact give quite a few recommendations and the position of the Air Line Pilots Association, and I think my short statements here will state also that we feel that the manufacturers of the airplanes and the engines have the capabilities of establishing the desired noise levels if they are required to do so.

Senator CANNON. Well, it appears that this will be done. Of course, with the new generation of aircraft, all indications are that very substantial progress is being made. But the real problem now is the problem in the interim period before the new jets completely come into the inventory and what we do with current generation aircraft. Can we go ahead and retrofit those aircraft economically, because the economics do have to be taken into consideration, and will this achieve the desired result within feasible limits.

Mr. BONNER. I would like to answer you in this manner: that, No. 1, yes, the airplanes can be retrofitted. Whether or not it is economically feasible for the airlines to survive with that particular plane after it has been retrofitted is something that I am not qualified or competent to answer.

But I would insist on reiterating that the pilots would not jeopardize the safety of the passengers and the crew. We would still maintain that margin and that envelope of safety.

Senator CANNON. Well, that is very commendable and this committee would certainly urge that your association take every step necessary to be sure that the safety of the passengers and the airplane is paramount in all operations because that should be the principal consideration.

Mr. BONNER. Yes, sir. In conclusion I would say that in this envelope of safety I spoke of, there are always the occasions where we have to maintain our stability as regarding emergency conditions and we would obviously oppose any legislation that would require us to do certain things that are impossible within this envelope of safety.

Senator CANNON. Well, I would hope that you would not be confronted with that choice. I would certainly hope that this committee and the Congress would not approve any type of legislation that is going to jeopardize safety in any way, shape, or form.

Mr. BONNER. Thank you very much.

Senator CANNON. Thank you. We appreciate you being here.

The committee will stand in recess until 10 o'clock tomorrow morning.

(Whereupon, at 11:45 a.m., the committee recessed, to be reconvened on Tuesday, July 13, 1971, at 10 a.m.)

(The following was referred to on p. —:)

A COMPLETE ANALYSIS OF
THE COSTS AND BENEFITS OF
A QUIET ENGINE RETROFIT PROGRAM

Randall L. Hurlburt
Acoustical Engineer
Noise Abatement Division

City of Inglewood
105 E. Queen Street
Inglewood, California 90301

January 15, 1971

William Goedike, Mayor

Patrick D. Tobin, Councilman	R. Gary Smith, Councilman
Tim Benson, Councilman	Merle Mergell, Councilman

Douglas W. Ayres, City Administrator

SUMMARY

This report analyzes the costs and benefits of a retrofit program designed to reduce noise levels of existing aircraft. It uses the basic result of the Rohr Corporation study that a 10 decibel noise reduction can be achieved for both takeoff and landing for a total cost of approximately \$1.2 billion.

This report assesses the benefits which retrofit would have to the community by first estimating the total number of families who are affected by noise. A theoretical model is developed to predict this and yields a conservative estimate of 570,000 families in the NEF 30 and 40 areas of the nation's 147 hub airports.

The report then continues by establishing economic criteria for assessing the environmental damage caused by noise. These are then translated into economic benefits for (1) the airlines, and (2) the community at large. If the recommendations listed below are followed, the benefits will exceed the costs as follows:

Net Gain to Airlines	\$ 955,000,000
Net Gain to Communities	<u>\$1,222,000,000</u>
Net Overall Gain	\$2,177,000,000

A major benefit aside from noise considerations is the reduction of unemployment among aerospace workers.

Recommendations - We consider the following actions to be necessary if the above gains are to be realized:

(1) Require approximately a 10 EPndB reduction in takeoff and landing noise (to the levels of Part 36 of the Federal Air Regulations). This is consistent with configuration 4A of the Rohr Report.

(2) Finance the retrofit program by a 1% fare increase. This is more than sufficient to pay for all costs and will have no effect on passenger demand. This fare increase should be implemented immediately.

(3) Provide government loan guarantees for costs of initial capital investment.

(4) Amend the Federal Aviation Regulations, Part 36, to include all aircraft according to the following schedule:

Effective Date of Regulation - December 31, 1971

Compliance Required by All Aircraft - June 30, 1975

Additionally, we recommend that the FAA consider as soon as possible another rule which will require all aircraft manufactured after 1980 and all aircraft operated after 1990 to be 10 dB quieter than FAR Part 36 levels.

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INTRODUCTION

This report attempts to make a complete assessment of the costs and benefits associated with a quiet engine retrofit program. (As used herein, "quiet engine" means acoustically treated nacelles plus daisy exhaust nozzles with ejectors. It does not refer to the NASA research engine frequently referred to as the "Quiet Engine.") While it is fairly easy to assign a dollar figure to the actual cost of engine or nacelle modifications, it is more difficult to do the same thing for the social and economic benefits which accrue to a community because of an improved noise environment. Nevertheless, such an assessment must be made, based on some reasonable criteria, if reasonable decisions are to be made regarding the efficiency of a retrofit program.

An assessment of all costs and benefits of retrofit must be made.

There obviously are many people who stand to gain by having noisy aircraft. Airline executives and stockholders can reduce costs and increase their profits by doing nothing substantial about noise abatement. Airline passengers may buy their tickets for less if the cost of aircraft noise is borne entirely by people living near airports and not by the air transportation system itself.

Some people gain and some people lose because of aircraft noise.

On the other hand there are many people who lose because of aircraft noise. Residents near airports lose sleep, lose the utility of their outdoor areas, lose the efficiency of their schools, hospitals, and outdoor recreational areas. Companies lose money when it is necessary to soundproof office buildings near airports.

Aircraft noise is economically and socially efficient if

- (1) the amount gained by those who benefit from noise is greater than the amount lost by those who are hurt by the noise, and
- (2) the gainers actually compensate the losers for the full extent of their losses, keeping the difference as their "profit."¹

This really is a question of resource allocation: "One of the primary requirements for an economically efficient use of resources is the inclusion of all costs of production into the price of a good or service produced, and the charging of this price to the consumer or user. Only then can the consumer judge whether the product is worth its cost to him."²

There is no question that so far the gainers have not compensated the losers. Those who travel by air have flown and continue to fly at the expense of people living near airports while making no attempt to compensate them for their losses.

If the benefits of a retrofit program outweigh the costs (condition 1 above), and if a retrofit program is then implemented, a major step toward satisfying condition 2 will have been taken.

The purpose of this paper is to weigh the benefits against the costs to aid the Federal Government in making its decision regarding an engine retrofit program.

INTERNAL AND EXTERNAL COSTS

One problem in balancing the costs and benefits is that many of the costs of noise (or benefits of retrofit) are external to the air transportation system. Airline and airport management has been able to avoid paying these costs in the past and will no doubt fight to avoid doing so in the future. Their argument

Those who benefit from noise should compensate those who are hurt by it.

A retrofit program would be one form of compensation.

is that charging full airport noise costs to the users may adversely affect the development of the air transport system. Actually this argument means that "the air transport system, in its present technical form, is not worth its costs when all of those costs are counted and charged to users in an identifiable form."²

Airlines don't
want to pay
external costs.

Of course the reason for placing any enterprise (in this case the airlines) under government control is to eliminate the attitude noted above. Government cannot logically consider any costs or values as external. It has the public responsibility of making appropriate adjustments to account for the failures of the private enterprise system. If the government fails to internalize all relevant costs, it defaults in an important aspect of its responsibility.² Figure 1 shows in diagrammatical form the present Government/Industry/Community Relationship. Figure 2 shows the relationship which is needed.

Government is
responsible
for internalizing
all costs.

This paper classes all costs and benefits first as external or internal to the air transport system but then balances both together. Table 1 lists those costs or benefits which must somehow be considered and placed in a logical context.

MARGINAL ANALYSIS

Another problem in discussing the value of any action taken is one of "average costs" vs. "marginal costs." The marginal cost approach implies that an enterprise should undertake any activity that adds more to revenues than it does to costs. The average cost approach holds that an activity should not be undertaken unless revenues are sufficient to cover average or "fully-allocated" costs which include all indirect and overhead costs

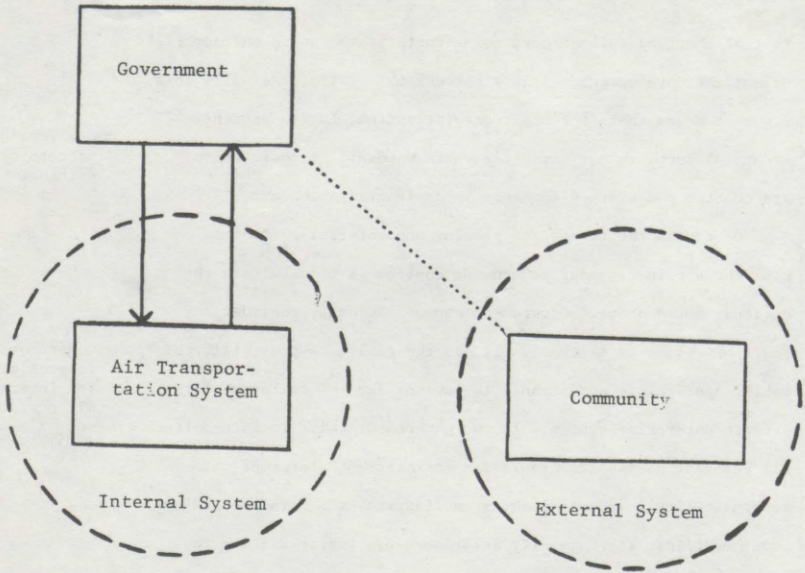


FIGURE 1. PRESENT GOVERNMENT/INDUSTRY/COMMUNITY RELATIONSHIP

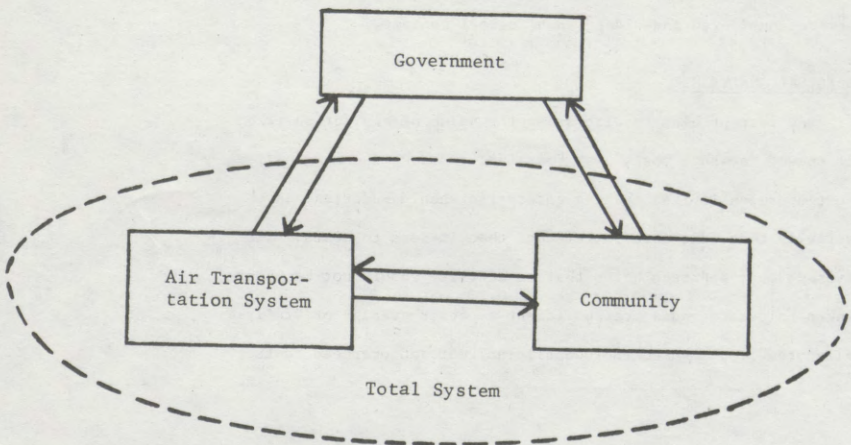


FIGURE 2. NEEDED GOVERNMENT/INDUSTRY/COMMUNITY RELATIONSHIP

TABLE 1. COSTS AND BENEFITS OF RETROFIT.

Cost of aircraft modification.

Cost of operating modified aircraft.

Benefit in improved ability to locate new airports.

Benefit in savings because less land needed for new airports.

Benefit in reduced need for airports to condemn and acquire adjacent property.

Benefit in reduced need for residential soundproofing.

Benefit in improved utility of outdoor home areas.

Benefit in improved education at schools near airports.

Benefit in reduced need to soundproof schools.

Benefit in reduced need to soundproof hospitals.

Benefit in reduced need to soundproof commercial buildings.

Benefit in reduced need for airlines to follow noise abatement procedures.

Benefit in improved utility of public lands near airports.

Benefit in improved property values for homeowners near airports.

Benefit in improved ability to sell homes in reasonable time.

Benefit in reduced possibility of damage settlements against airports or airlines.

Benefit in reduced need for research on aircraft noise abatement.

Benefit in reduced need for airports and airlines to employ lawyers and public relations experts.

Benefit in additional employment for unemployed aerospace workers.

associated with the entire enterprise. The marginal approach is the most appropriate one when the enterprise already exists and is operating as is the air transportation system.³

Another way to think of this is that we are not trying to answer such questions as "Does aviation benefit the nation and community?" or "Should airports adjoin residential areas?" Rather, the question we are trying to answer is: "By making a certain change (retrofit) do the gains offset the costs?"

To do this we must establish who will benefit from engine retrofit and what will be the extent of these benefits. We must then weigh these benefits against the costs. We propose to do this in two steps: (1) Development of a model to estimate the total number of people affected by noise, and (2) Development of a balance sheet to weigh costs against benefits to establish a net cost or benefit.

DEVELOPMENT OF NOISE POPULATION MODEL

To our knowledge no one has ever attempted to estimate the total number of people affected by aircraft noise. Many statements have been made by representatives of both airports and communities, but few have honestly attempted to quantify the total magnitude of the problem.

Yet such quantification is absolutely necessary for any decision about the benefits of retrofit. Despite the obvious shortcomings of any attempt at such quantification, simplifications and value assessments must be made and decisions made based on the best information available.

The most significant costs of aircraft noise are felt by the

Problem not one of absolute value of airplanes or noise but one of relative improvement vs. cost.

No one has previously tried to assess total benefit to community.

people who reside near airports. The most important work of our effort to quantify the benefits of a retrofit program must, therefore, be directed toward this problem.

In this section we develop a model which attempts to estimate the total number of people or families affected by aircraft noise. The philosophy of our model will always be to develop a conservative estimate. We will make every attempt not to inflate the estimates so that any decisions eventually made will be based on rock bottom values. We intend for there to be no "fat" in this model.

Obviously we must first define what we mean by "affected" population. For the purpose of this model, and in keeping with our conservative philosophy, we will consider only those families who reside within the NEF 30 and NEF 40 contours to be "affected." This definition was developed by the acoustical firm of Bolt Beranek and Newman, Inc. for the FAA, and is the best available criterion that exists today.⁴ Table 2 shows that residential areas, schools, churches, hospitals, theaters, offices and public buildings are either marginally acceptable or unacceptable within these contours.

Actually noise problems also exist outside the NEF 30 contour. Areas far away from large airports (such as Beverly Hills and Palos Verdes, California) and areas close to small airports (such as Burbank and Newport Beach, California) have significant noise problems even though the NEF value may be as low as 20 or even lower. If we included these areas in our model we would see that several times as many families are affected as our model now predicts.

The fundamental principle of the model which we will now

We will develop conservative estimates of these benefits.

Model considers area within NEF 30 and NEF 40 contours to be affected by noise.

Several times as many people outside the NEF 30 contours are adversely affected by aircraft noise but are not included in our conservative model.

LAND USE COMPATIBILITY CHART FOR AIRCRAFT NOISE

NOISE EXPOSURE FORECAST AREAS	LAND USE COMPATIBILITY								
	Residential	Commercial	Hotel, Motel	Offices, Public Buildings	Schools, Hospi- tals, Churches	Theaters, Auditoriums	Outdoor Amphi- theaters	Outdoor Recrea- tional (Non- Spectator	Industrial
A	yes	yes	yes	yes	Note (C)	Notes (A) and (C)	Note (A)	yes	yes
B	Note (B)	yes	Note (C)	Note (C)	no	no	no	yes	yes
C	no	Note (C)	no	no	no	no	no	yes	Note (C)

NOTE (A) - A detailed noise analysis should be undertaken by qualified personnel for all indoor or outdoor music auditoriums and all outdoor theaters.

(B) - Case history experience indicates that individuals in private residences may complain, perhaps vigorously. Concerted group action is possible. New single-dwelling construction should generally be avoided. For apartment construction, Note (C) applies.

(C) - An analysis of building noise reduction requirements should be made and needed noise control features should be included in the building design.

TABLE 2. COMMUNITY NOISE CRITERIA

develop is that the number of families affected by aircraft noise can be related to the number of operations at the airport and the average population density of the county within which the city and airport are located. Obviously such a model cannot predict accurately the affected population at any specific airport. This is because population concentrations within counties and the mix of aircraft types and flight paths at airports vary widely from one location to another. However, the model should predict with order of magnitude accuracy the total number of affected people at all airports combined.

The steps involved in this model are shown in block diagram form in Figure 3 and are discussed more fully below. The numbers in the discussion refer to the numbers in each block of Figure 3.

1) For this study we have chosen the 147 large, medium, and small air traffic hubs as defined by the FAA and shown in Figure 4.⁵

147 air traffic
hubs included
in study.

2) The number of air carrier flights (departures or landings) was determined for the 25 busiest airports and for the remaining large, medium, and small air traffic hubs.^{6,7} These values are shown in Table 3.

3) The population density was determined using population and area statistics valid as of July 1, 1966.⁸ This information was converted to families per square mile by using an average of 3.2 persons per family.⁹

4) The location of the large and medium hub airports with respect to concentrations of population was reviewed using a VFR planning chart and aeronautical sectional charts.¹⁰ The population density in the vicinity of the airport relative to the average population density of the county was then estimated using the weighting factors

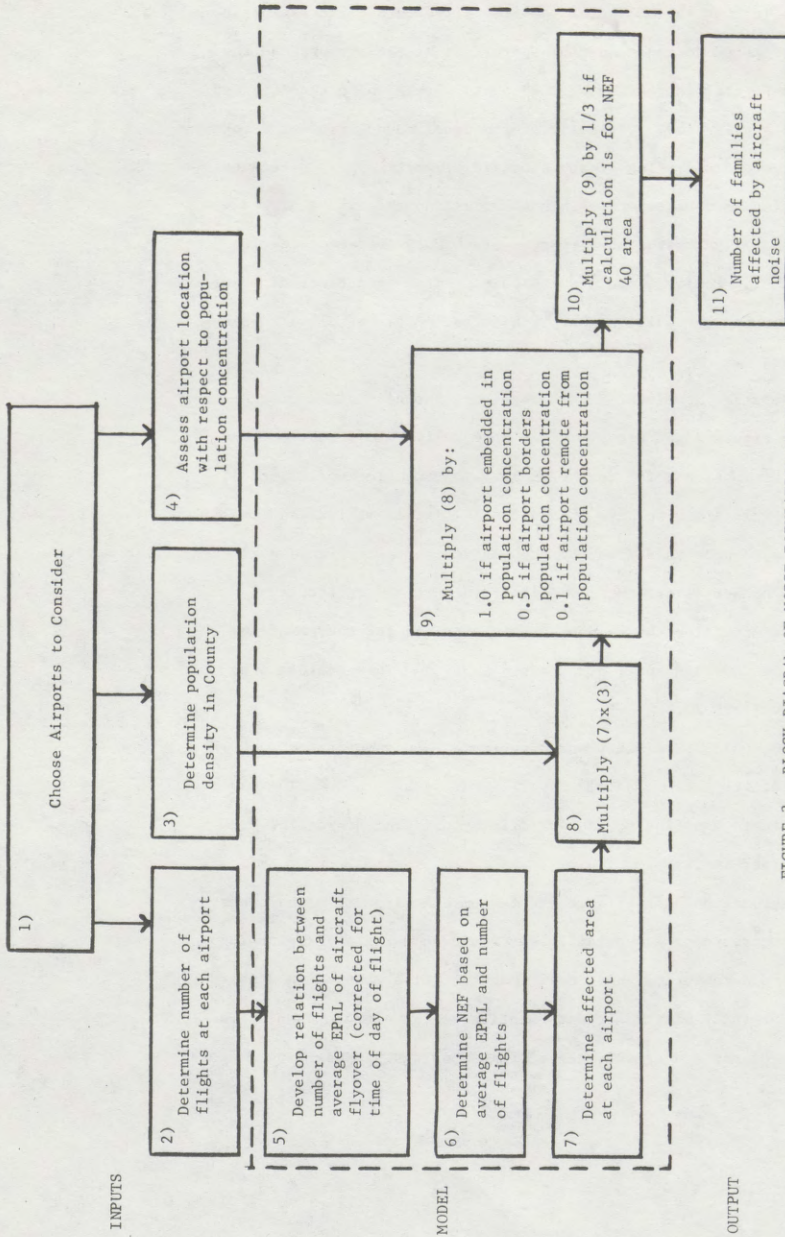


FIGURE 3. BLOCK DIAGRAM OF NOISE POPULATION MODEL.

AIR TRAFFIC HUBS

December 31, 1968

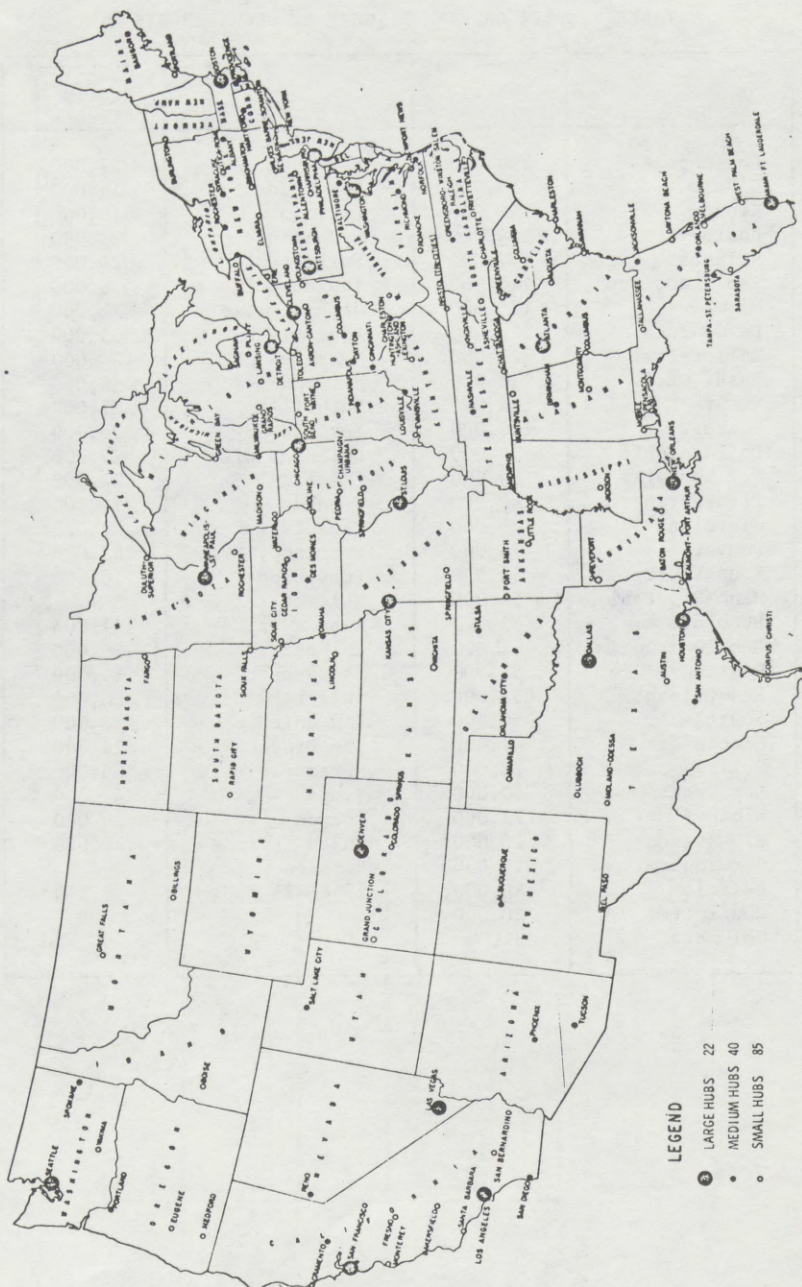


FIGURE 4. AIR TRAFFIC HUBS

TABLE 3. AIR CARRIER FLIGHTS AT HUB AIRPORTS

HUB	Number of Yearly Flights	HUB	Number of Yearly Flights
Los Angeles	219,000	Dayton	27,000
O'Hare	315,000	Des Moines	14,000
Kennedy	199,000	El Paso	18,000
Boston	104,000	Greensboro	21,000
Atlanta	157,000	Hartford	29,000
San Francisco	149,000	Indianapolis	36,000
Miami	128,000	Jacksonville	22,000
La Guardia	126,000	Louisville	33,000
Dallas-Love	122,000	Memphis	44,000
Wash. Natl.	118,000	Milwaukee	34,000
Newark	104,000	Nashville	27,000
Detroit	100,000	Norfolk	20,000
Philadelphia	99,000	Oklahoma City	25,000
St. Louis	89,000	Omaha	22,000
Pittsburgh	80,000	Orlando	17,000
Cleveland	75,000	Phoenix	38,000
Denver	74,000	Portland, Ore.	43,000
Kansas City	69,000	Providence	16,000
Minn/St. Paul	64,000	Raleigh	
Honolulu	62,000	Reno	11,000
Houston	61,000	Rochester	29,000
Baltimore	59,000	Sacramento	14,000
New Orleans	53,000	Salt Lake City	28,000
Seattle	50,000	San Antonio	26,000
Cincinnati	47,000	San Diego	20,000
Dulles	28,000	Syracuse	25,000
Las Vegas	40,000	Tampa	41,000
Albany	23,000	Tucson	16,000
Albuquerque	20,000	Tulsa	20,000
Birmingham	20,000	Richmond	
Buffalo	40,000	89 Small Hubs	8,500 ea
Charlotte, N.C.	30,000		
Columbus	31,000		

1.0 if the airport was embedded in the area of concentrated population, 0.5 if the airport was close to but not inside the area of population concentration, and 0.1 if the airport was remote from areas of population concentration.

5) The formula for NEF at any location is

$$NEF = EPnL + 10 \log n - \text{constant}$$

For a full NEF calculation, NEF must be computed separately for each type of aircraft with differing noise characteristics (EPnL) and for daytime and nighttime operation with the number of flights (n) and the value of the constant adjusted accordingly. Then all such NEF's must be combined on an energy basis to determine total NEF. However, this is very cumbersome and has never been done except for a few of the largest airports. Therefore, this model makes the simplification that relative to the largest airports, the smaller airports have a lower average value of EPnL and a lower percentage of nighttime flights. These factors are both combined into a "reduced average equivalent EPnL." The maximum extent of this variability is approximately:

	7 dB reduction from 4 to 2 and 3 engine jets
	10 dB reduction from 2 and 3 engine jets to propeller aircraft
	10 dB reduction when night flights are eliminated
total	27 dB maximum possible reduction in average equivalent EPnL from the largest to the smallest air carrier airports.

This information can then be related to airport size by an approximation:

$$\text{Reduction in EPnL} = 12 \log \frac{N}{n}$$

where n = number of air carrier departures or landings at the airport in question

N = number of air carrier departures or landings at the largest airport under consideration.

This approximation results in an average equivalent EPnL which is reduced by 12 dB for an airport with 1/10 the air carrier traffic of the largest airport, by 24 dB for an airport with 1/100 the air carrier traffic of the largest airport, and by 27 dB or more for airports with less than 1/178 the air traffic of the largest airport (airports with less than 1,770 departures per year in our model).

6) The reduction in NEF can then be related to the reduction in average equivalent EPnL by adding the factor $10 \log \frac{N}{n}$ to the value obtained in step 5. Therefore

$$\text{Reduction in NEF} = 22 \log \frac{N}{n}.$$

7) The above calculations yield the reduction in NEF at a given location from the busiest to the least busy air carrier airports. To relate this to a relative change in area within the NEF 30 and NEF 40 contours we must make use of the approximate relation that aircraft noise falls off at a rate of approximately 10 dB for every doubling of the distance at distances of concern to the community noise problem. This may be expressed mathematically by the equation:

$$\text{Change in dB} = 33.3 \log \frac{d_2}{d_1}$$

where d_2 and d_1 are two different distances from where noise measurements are made to the aircraft.

Since the area in any noise contour is proportional to the square of its linear dimension, the following relation may be derived:

$$\frac{a}{A} = \left[\frac{1}{\text{antilog} \left(\frac{\text{Reduction in NEF}}{33.3} \right)} \right]^2$$

where a is the area within a certain NEF contour at a given airport and A is the comparable area at the largest airport under consideration.

Combining the above equation with the results of steps 5 and 6 we get the final result

$$\frac{a}{A} = \left(\frac{n}{N} \right)^{1.32}$$

Figure 5 shows this relation where Chicago-O'Hare has been chosen as the largest airport with the values A (NEF 40) = 24.2 square miles and N = 315,000 departures or landings per year. The upper curve is based on the average result for the four airports shown that the area between the NEF 30 and NEF 40 contours is 2.7 times as great as the area within the NEF 40 contour. (For the remainder of this report "NEF 30 area" will mean the area between the NEF 30 and NEF 40 contours.) The specific data points shown on Figure 5 were measured from 1970 contours except Boston which was based on 1967 contours.^{11,12,13,14} As can be seen, although the model does not predict areas accurately for each airport, it should provide reasonable estimates for the overall problem.

8) A first estimate of the number of families within an NEF area is obtained by multiplying step 8 by 1.0, 0.5, or 0.1 depending on the proximity of the airport to centers of population as described in step 4.

10) The final estimate is obtained by multiplying the value from step 9 by 1/3 if the NEF 40 area is being considered, and by 1.0 otherwise. This is because the airport and related industrial and commercial land uses take up a relatively large proportion of the NEF 40 area as compared to the NEF 30 area.

11) The final output of all the calculations of this model is the number of families within the NEF 40 area and the number of families within the NEF 30 area at each airport and also a total for the nation.

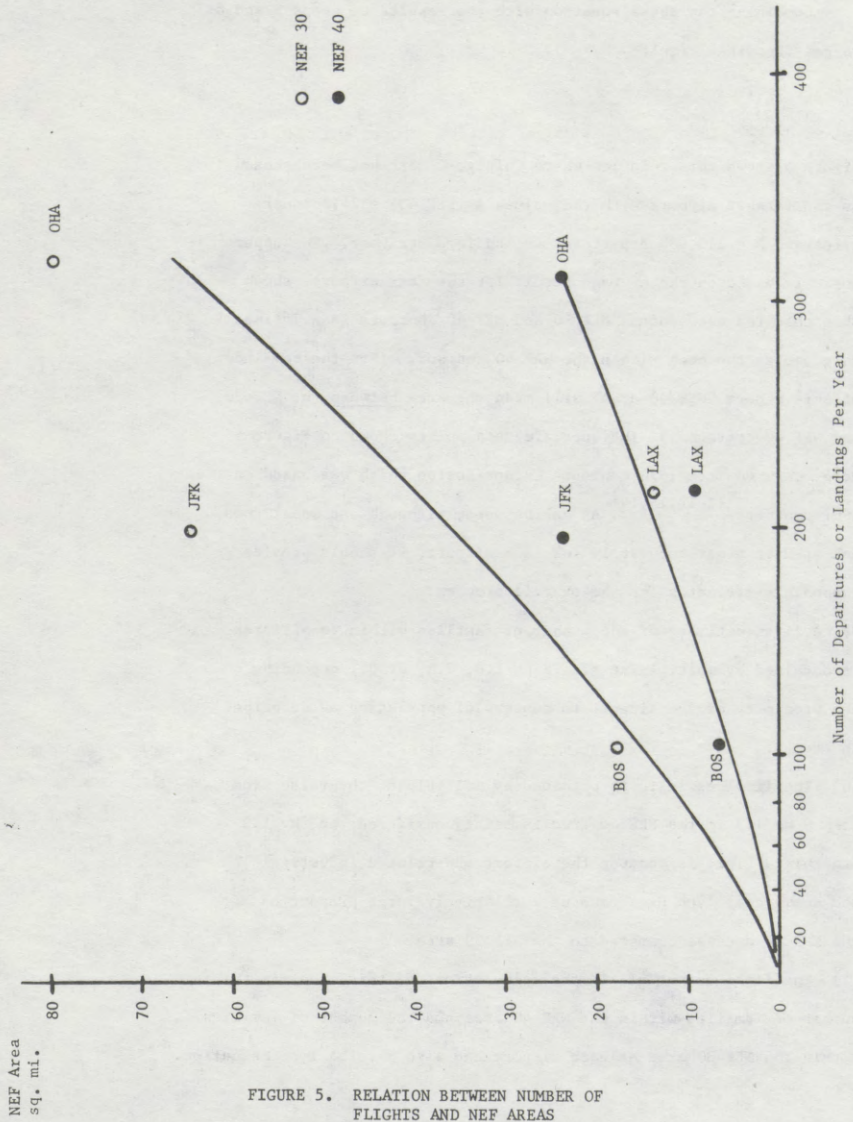


FIGURE 5. RELATION BETWEEN NUMBER OF FLIGHTS AND NEF AREAS

Computations using this model were made for each of the large and medium sized hub airports and for small hubs as a whole. The result is a conservative estimate of 569,822 families adversely affected by aircraft noise; 509,547 of these are in the NEF 30 area, 60,275 are in the NEF 40 area.

At least
570,000
families
in noise
zones.

Several data points should be considered to validate this model. We have chosen three where some sort of information is available.

Los Angeles - The model predicts 1,650 families in the NEF 40 area and 7,520 families in the NEF 30 area. This is an ultra-conservative estimate since 10,000 families in Inglewood alone are known to be in the NEF 40 area. Total number of families in the NEF 40 area at Los Angeles is probably in the vicinity of 20,000. The model predicts 7,520 families in the NEF 30 area. Since there is at least 2 - 3 times as much residential land in the NEF 30 area as in the NEF 40 area, there are probably 40 - 60,000 families in the Los Angeles NEF 30 area. The model therefore predicts values for Los Angeles which are low by a factor of ten.

Estimate for
Los Angeles
conservative
by a factor
of ten.

Boston - In 1967 there were 8,300 families within the NEF 40 area and 50,000 families within the NEF 30 area around Boston.¹⁴ This corresponds to estimates from the model of 8,300 and 70,000 respectively. This is a very close estimate, and considering growth in noise and population from 1967 to 1970 the estimate is probably conservative.

Estimates
for Boston
and Atlanta
very good.

Atlanta - In 1965 11,750 families lived in the NEF 30 area (CNR zone B) and 400 families in the NEF 40 area (CNR zone C) around the Atlanta airport.¹⁵ Because of noise and population growth

these were expected to grow to 17,400 and 2,900 respectively by 1980. Our model predicts 9,400 and 1,130 for 1970. This seems to be a very reasonable prediction.

The model which we have just developed is certainly very complex. It also has many shortcomings. Nevertheless, the only alternative would be to make a complete survey of every airport including an NEF calculation and a survey of population densities in the NEF areas. This would be a valuable exercise, but would be quite time consuming and would come far too late to assist our present decision regarding whether or not to retrofit aircraft with quiet engines.

RETROFIT AND OPERATING COSTS

The outcome of this whole study must be a balance sheet which shows whether the benefits of engine retrofit offset the costs. We start by discussing the costs of aircraft modification and operation.

Retrofit Cost - Of all the possibilities studied in the Rohr Corporation report only configuration 4A makes sense for actual implementation (see Table 4).¹⁶ Configuration 1 in most cases results in less than 5 dB noise reduction. Although this is the least expensive and the change would be noticeable, it would certainly be ineffective in solving or greatly reducing the airport noise problem. Configurations 2 and 3 would both be greatly beneficial to Inglewood and to other communities in the approach zones since they reduce noise there by 8 - 13 dB. Maybe we could stop there since approach noise is the most critical of all aircraft noise situations.¹⁴ But in the long run configuration 4 seems to be the one we should really strive for because it reduces aircraft noise significantly in all critical areas (by approximately 10 dB). This is the only configuration that brings

Retrofit configuration 4A only sensible alternative.

CONFIGURATION	1	2	3	4
NOISE REDUCTION (EPNdB)				
TAKEOFF	1.1	1.1	1.1	6.5
CUTBACK (80% THRUST)	4.2	4.2	5.0	9.1
APPROACH	3.3	8.3	10.0	10.6
SIDELINE	1.1	1.3	1.3	6.2
4 ENGINE				
TAKEOFF	3.0	3.5	3.1	6.6
CUTBACK (80% THRUST)	4.3	7.8	8.0	10.1
APPROACH	5.5	11.0	13.0	12.0
SIDELINE	2.0	2.5	2.5	4.0
TOTAL INDUSTRY COST (\$) (ALL AFFECTED AIRCRAFT)	212,000,000	682,000,000	856,000,000	1,246,000,000
15 AIRLINE AVERAGE Δ DOC (1978) (%)				
SMALLEST (727)	.7	1.6	2.4	3.7
MEAN	1.0	2.4	3.1	4.5
LARGEST (737-200)	2.0	3.1	4.8	7.5
15 AIRLINE AVERAGE Δ ROI (1978) (%)				
SMALLEST	.04	.10	.12	.17
MEAN	.08	.20	.30	.41
LARGEST	.19	.31	.44	.66
FARE INCREASE REQUIRED (1978) (%)	.08	.20	.30	.40

TABLE 4. SUMMARY OF ROHR STUDY MAJOR RESULTS

noise levels from existing aircraft down to those established in FAR Part 36 for future aircraft. Configuration 4A is the least expensive of the configuration 4 alternatives, and is the one we will use for further analysis. We recommend that the few pure jets such as the Boeing 707-320 for which retrofit is almost completely ineffective be phased out entirely by the deadline date for completion of retrofit.

At this point we must take exception to a company report which indicates that nacelle acoustic treatment will not be effective in reducing community noise exposure.¹⁷ If proper values of present noise levels and retrofit attenuation are used in conjunction with power cutbacks and elimination of pure jets on takeoffs, then an 8 - 10 EPndB total noise reduction will be realized for both take-off and landing situations, both indoors and outdoors. Compare Table 5 herein with Table 3 of Reference 17.

TABLE 5. ESTIMATED RELATIVE CONTRIBUTION TO TOTAL NOISE EXPOSURE OF VARIOUS AIRCRAFT TYPES DURING APPROACH

Aircraft	(1) Relative Noise Level	(2) Correction To Total Exposure For Number of Flights	(3) Total Relative Contribution (Unsuppressed) (1)+(2)	(4) Estimated Possible Suppression	(5) Total Relative Contribution (Suppressed) (3)+(4)
4-Engine Turbofan	100	0	100	11	89
4-Engine Turbojet	92	-7	85	0	85
2- and 3- Engine Turbofan	92	+5	<u>97</u> 102.0	10	<u>87</u> 92.0
Net Improvement				9.9 EPndB	

The cost of retrofit to configuration 4A is \$1,246,000,000.

This is not entirely an internal cost to the airlines, however, since their corporate income tax may be as high as 48% at the margin. Using an average marginal tax rate of 40%, we find that the internal cost of retrofit is only \$746 million whereas \$500 million is an "external" cost being borne by the public at large in the form of reduced federal government tax income.

Cost of
retrofit
\$1.2 billion.

Operating Costs - The direct operating costs associated with retrofit which are apart from costs of equipment manufacture and installation must also be considered. (Indirect operating costs (burden) need not be considered in this marginal analysis.) According to the Rohr report these direct costs are a small percentage of the equipment cost. Inspection of the data they present indicates that approximately \$28 million per year would be direct operating cost to the 15 airlines which were studied. Extrapolating this to 5 years and including all airlines indicates a total cost of \$220 million. Of this \$88 million is an external cost and \$132 million is an internal cost because of the assumed 40% tax rate at the margin.

DIRECT BENEFITS TO COMMUNITIES

To continue developing our balance sheet we must assign a dollar value to each entry, including those benefits which are of a social nature. We must somehow select criteria which afford reasonable means of estimating this dollar value. We do this in the following paragraphs.

Residential Soundproofing - We prefer to use the term "utility of the indoor environment" to discuss the costs or benefits often related to soundproofing of residential structures. However, sound-

proofing costs are a very real measure of the economic degradation of the indoor environment. The average cost of soundproofing a home in the NEF 30 area is approximately \$3,000.^{18,19,20} Spread over a structure life of 20 years one may conclude that economic degradation to the indoor environment of any family within the NEF 30 area is \$150 per year. This certainly is small compensation by any standards. Soundproofing costs in the NEF 40 area and the corresponding economic degradation will be about double those in the NEF 30 area.

Soundproofing costs measure indoor benefit.

The number of years that the retrofit program is effective depends on the length of time present day aircraft remain in service. (One function of a retrofit rule, of course, will be to prevent unreasonably loud aircraft from remaining in service for indefinite lengths of time.) The Rohr report considers the remaining useful life after retrofit to be 5 - 10 years. In keeping with our conservative philosophy we will from now on base all calculations on a five year effectiveness period.

At present noise levels the degradation of the indoor environment in NEF 30 areas can be expected to be equal to the total number of families times \$150 per family per year times 5 years. This comes to \$380 million. Not all of the above cost is actually a savings if retrofit is accomplished. In terms of our marginal analysis we must recognize that some families will still be adversely affected and the net change is what is important. An NEF change of 10 will mean all the families in the present NEF 30 area are no longer affected, so the entire \$380 million will be gained. The families in the NEF 40 area will still be in an NEF 30 area, so only half of the \$90 million is gained. The net gain is therefore \$425 million.

\$425 million benefit to indoor environment.

Outdoor Environment - Aircraft noise makes outdoor home areas unuseable or at least severely degrades their utility. There is no way of escaping the noise outdoors. One means of compensating a family for this degradation would be to finance a vacation each year away from the noise area. This concept provides a means of assessing the economic value of the outdoor degradation. A minimum vacation will cost at least \$300 for a family. This amount would be appropriate for families in the NEF 30 area. Six hundred dollars would be more appropriate for families in the NEF 40 area. Since these values are just double the indoor environment values, the marginal net gain by retrofit is \$850 million.

\$850 million
benefit to outdoor environment.

Public Lands - Closely related to the outdoor environment in residential areas is the utility of public lands in the vicinity of airports. Parks, beaches, golf courses and other recreational areas are severely degraded by intense noise. If 1% of the area affected by noise is public land, then the marginal net gain by retrofit is \$8 million.

School Environment - In a pilot study around Los Angeles International Airport (which included Inglewood) the average cost to soundproof a single classroom was approximately \$5,000 in the NEF 30 area and \$10,000 in the NEF 40 area, based on preliminary results. If 60% of the 1.2 children per family are of school age, and there are 30 children to each classroom, the national costs for school soundproofing would be \$61 million in NEF 30 areas and \$14 million in NEF 40 areas. The marginal benefit created by retrofit is thus \$68 million.

Commercial Soundproofing - We estimate that at least three office buildings per year will be built in the noise zones around each of the 25 largest airports. Soundproofing will most likely add \$100,000

to the cost of each building.²⁰ This means \$37.5 million will be spent on commercial soundproofing. As was seen in the residential calculations above, about 90% of this amount will be saved by a 10 decibel noise reduction, or \$34 million. If the airlines themselves build two buildings at each airport they will save another \$5 million.

Hospital Soundproofing - There is approximately one hospital bed to every 10 families around Logan Airport in Boston.¹⁴ Based on this average, and considering the degraded environment to be comparable to that experienced indoors in residential areas, the benefit by retrofitting in terms of improved environment or reduced need for soundproofing of hospitals is approximately \$42 million.

Property Values - Ask any resident or real estate man and he will tell you that property values are reduced by aircraft noise. Researchers on the subject don't always bear this out, perhaps because the value is still there if the property could be converted to commercial or industrial use (with mass displacement of residents). But the Los Angeles County Assessor, in a letter to the City of Inglewood, stated: "Past experience with airport approach problems indicate that there will be a slow-down in the rate of price increase compared to property further removed from the airport."²¹

We believe that property values would be increased in the NEF 30 and NEF 40 areas by at least \$1,000 per family. This increase will come without retrofit in 10-15 years as older aircraft are phased out. With retrofit this increase will be realized in 5 years. The marginal benefit from retrofit is the difference in the present value of this increase if it occurs 5 years from now and the present value of this increase if it occurs, say, 10 years from now. The total national gain is \$570 million; the present value with retrofit

is \$450 million and the present value without retrofit is \$350 million based on a 5% discount rate. The marginal benefit from retrofit is therefore \$100 million.

Ease of Selling Homes - There is little doubt that it takes considerably longer to sell a house in the noise zone. This is a financial burden to the family who wants to move out, and may be valued at several months rent per family selling a house. However, since the turnover rate is not known in the noise areas we will not include this benefit in our balance sheet.

Condemnation Costs - Many airports are finding it necessary to condemn homes in areas surrounding their facilities. Los Angeles airport has acquired or plans to acquire a total of 2,565 homes valued from \$23,000 to more than \$100,000 each. If the average price is \$27,000, this effort will cost them about \$70 million. The cost to displaced residents themselves will also be high -- the effects of displacement, expenses involved in moving, and inability to find comparable homes in convenient areas are very real, even though difficult to quantify.

The balance sheet which we are developing will not show any costs or benefits for the airport portion of this item. Although the costs and political implications of condemnation are very real, the property so acquired can most likely be used for airport and related purposes thereby recovering the costs involved. The costs to residents is conservatively estimated at \$1,000 per family, or \$2.6 million for Los Angeles, or \$5 million for the total system. These costs can never be recovered once the residents are displaced. However, the costs need not be incurred at all if a retrofit program is undertaken.

Lawsuit Damage Payments - The foregoing discussion has already resulted in \$1.532 billion direct benefits to the community (external gains).

The question of lawsuit damage payments requires special attention, however. First, there is little precedent for estimating the expected costs of damage findings. More importantly, though, legal action is one means by which the external costs of noise become internal costs. Therefore, the \$1.5 billion external gains mentioned above could actually have been considered internal gains in terms of reduced damage payments made possible by engine retrofit. In any case gains are gains so the particular column we show them under is of small importance to the overall decision. One additional comment should be made here for clarification: the \$1.5 billion should not be construed as the total amount of damage suits or possible damage payments; it is only the marginal change in this amount which would be caused by a retrofit program. The total amount may be considerably larger.

Legal action is one means by which the external costs of noise become internal costs.

DIRECT BENEFITS TO AIRLINES

The airlines are presently seeking to expand their services to more and more people by building new airports or expanding old ones. Their efforts are severely impeded because no one wants them with their noisy airplanes. Three obvious examples of this present situation are New York's fourth airport, the Palmdale, California airport, and the Long Beach, California service expansion. This inability to locate or expand airports costs the airlines and the public in at least four ways to be discussed below. Noise abatement procedures and noise abatement research cost the airlines additional money every year. Quieter service from retrofitted aircraft would relieve

these situations and therefore benefit all concerned.

Reduced Traffic Growth - The slow rate of traffic growth today has severely hurt the airlines financially. This slow growth is due in large part to the increased surface travel time required to reach airports and the situation could be eased by location of new airports. The problem is compounded by airlines' overcapacity caused by new equipment acquisition. Therefore, new ways of stimulating passenger demand are mandatory. If a fourth airport in New York could increase system wide traffic by only one-fourth of New York's present passenger traffic then a profit of only \$5 per passenger would generate \$645 million in five years. .

\$645 million
benefit to
airlines in
locating new
airports.

Land Acquisition - If new airports can be located today, the amount of land they must purchase to contain the noise is tremendous. At Palmdale alone Los Angeles intends to purchase 17,000 acres at \$3,000 per acre. An engine retrofit program would reduce the land requirement by more than two-thirds -- a savings of \$30 million at Palmdale alone.

Airborne Delays - Airport congestion causes numerous airborne delays every day. This costs the airlines money in fuel costs (to say nothing of costs to passengers in missed connections). These delays average 25 minutes on a flight from Chicago to Los Angeles.²² Considering only the number of yearly flights from five airports (O'Hare, Los Angeles, Kennedy, La Guardia and Newark), using fuel costs of \$10 per minute,²³ and considering that maybe only 10% of the delays could be saved by location of new airports, we find that retrofit could save the airlines \$100 million in five years by allowing construction of needed new facilities.

Passenger Traffic Delays - The surface travel time for an average flight from Chicago to Los Angeles is expected to increase 35 minutes over the next five years.²² Using the same reasoning as in the preceding paragraph and valuing the passenger's time at only \$1 per hour, the public gain from having new airports 5 years earlier is \$10 million.

Noise Abatement Procedures - The present fleet of noisy aircraft require strict noise abatement procedures at many airports of the world. This costs the airlines money at the rate of approximately \$10 per extra minute of flight time. For example, noise abatement departures at Logan Airport alone cost the airlines an estimated \$260,000 annually.²³ At Los Angeles and New York all jet flights make extended approaches and departures which cost the airlines an estimated several million dollars annually at each airport. System wide, we estimate these costs to run \$15 million per year, or \$75 million in five years.

Noise Abatement Research - Once an actual program of installing quiet engines is embarked upon, the spending by the federal government, airlines, and airports for research, public relations experts, and legal counsel to deal with the various aspects of the aircraft noise problem will be reduced. However, in keeping with the philosophy to be more fully developed in the next section, unemployment of research, PR, and legal people must be counted not only as an internal gain but as an external cost. The total spending for these functions by the airlines, manufacturers, FAA, and NASA is unknown, but since the costs exactly balance the benefits the total value is unimportant. In keeping with airline publicity on this matter we will use the figure \$20 million per year or \$100 million in five years as the costs and benefits associated with this item.

BENEFIT IN REDUCING UNEMPLOYMENT

One of the critical problems facing the nation today is unemployment among aerospace workers as a result of reduced military spending by the government. It appears likely that a valuable national resource will dry up if the talents of these people are not put to constructive use. A retrofit program would provide jobs for these people and allow a transition period during which they could focus their skills on civilian rather than military problems. Thus retrofit to configuration 4A would be a \$1.2 billion external benefit.

\$1.2 billion
benefit in
reduced un-
employment.

In reality the benefits of reduced unemployment go deeper than just creation of so many more jobs. There is a leverage effect in that creation of new jobs means more people making money and therefore demanding goods and services. This in turn employs people to meet these demands, they have their own demands, and so on. Furthermore, the need for government spending on welfare and unemployment compensation is reduced.

Therefore, the full benefits of higher employment may be several times as great as the basic \$250 million per year cost of retrofit. However, in our conservative philosophy we will allow only the basic \$1.2 billion as the total external benefit resulting from an improved employment picture.

COST/BENEFIT BALANCE SHEET SUMMARY

The preceding four sections are summarized in a cost/benefit balance sheet (Table 6) which may be summarized as follows.

Total Internal Costs	\$878 million
Total Internal Gains	<u>\$955 million</u>
Net Internal Gain	\$ 77 million

Total External Costs	\$ 688 million
Total External Gains	<u>\$2788 million</u>
Net External Gains	\$2100 million

Net overall
benefit \$2.2
billion.

Net overall Gain \$2,177,000,000

TABLE 6. COST/BENEFIT BALANCE SHEET

Cost/Benefit	Internal		External	
	Costs	Gains	Costs	Gains
Retrofit Configuration 4A	\$746 M		\$500 M	
Direct Operating Costs Due to Other Than Depreciation	\$132 M		\$ 88 M	
Reduced Residential Soundproofing Requirement				\$425 M
Improved Outdoor Home Environment				\$850 M
Improved Utility of Public Land				\$ 8 M
Improved Utility of Schools (No Need to Move or Soundproof)				\$ 68 M
Reduced Need for Commercial Soundproofing		\$ 5 M		\$ 34 M
Better Service at Hospitals				\$ 42 M
Improved Property Values				\$100 M
Improved Ease of Selling Houses				--
Reduced Condemnations		--		\$ 5 M
Reduction in Possible Lawsuit Damage Payments		See Text (\$1,532 M)		
Allow New Airports Five Years Sooner		\$645 M		
Less Land for New Airports		\$ 30 M		
Reduced Airborne Delays		\$100 M		
Reduced Traffic Delays for People Using Airports				\$ 10 M
Noise Abatement Procedures		\$ 75 M		
Noise Abatement Research		\$100 M	\$100 M	
Employment of Aerospace Workers				\$1,246 M
Totals	\$878 M	\$955 M	\$688 M	\$2,788 M
Net Internal Gains		\$ 77 M		
Net External Gains				\$2,100 M
Net Overall Gains	\$2,177,000,000			

The results of this analysis therefore overwhelmingly favor a ten decibel noise reduction retrofit program (Rohr Configuration 4A). Both airlines and communities stand to benefit by such a program.

METHODS OF FINANCE

Aside from the substantial net benefit which we have just seen results from an engine retrofit program, there are other serious questions to consider. There are costs involved, so who should really bear them? The balance sheet shows a net gain even in the case of internal costs vs. benefits - but if some of these gains don't materialize, what would be the effect on the airlines' return on investment? What if the cost estimates themselves are not exactly correct?

Who Should Bear Costs - Several considerations enter the picture here. First, one of the major benefits is the employment of aerospace workers - it certainly is not fair to make the airlines subsidize this since the problem was caused by the cutback in our entire national effort on military and space technology. Secondly, other major benefits are external, so perhaps the airlines should not have to bear the cost for that either. On the other hand, they are the ones making the noise, so perhaps logically they should have to pay for it. But in the final analysis it is the passengers and shippers who benefit from air transportation. The airlines will certainly pass all costs along to them and rightly so. The airlines are a highly regulated industry, however. They cannot change their fares or services at will. So it will be up to the government to see that the costs are placed where they should be.

Airlines are a highly regulated industry. They should not be forced to absorb all costs.

The only logical alternative is to pay for the retrofit program by a fare increase. Whether the increase is specifically earmarked for retrofit or merely allowed and the airlines required to accomplish the retrofit is immaterial.

The Rohr report indicates that the fare increase required to offset all retrofit costs is less than 1% in 1975 for configuration 4A and decreases to 1/10 of 1% in 1982.¹⁶ The report further concludes that a 1% fare increase would have no effect on passenger demand. This conclusion was recently reinforced by an American Airlines' vice president who believes even a 5% fare increase would not affect demand.²⁴

A 1% fare increase is most satisfactory solution.

The effect of a fare increase would then be to put all costs on our balance sheet (Table 6) into the "External" column. The overall result would then be as follows:

Total Internal Costs	-0-
Total Internal Gains	<u>\$955 million</u>
Net Internal Gains	<u>\$955 million</u>
Total External Costs	\$1.566 billion
Total External Gains	<u>\$2.788 billion</u>
Net External Gains	<u>\$1.222 billion</u>

Net Overall Gain \$2,177,000,000 (no change)

Airline Return on Investment - The worst case for the airlines would be if they had to bear all the internal costs and the internal gains failed to materialize. In this case there would still be only a small change in return on investment - slightly less than 1% before taxes or 1/2 of 1% after taxes.¹⁶ If the gains predicted are realized, there would be a very slight increase in return on investment. If the costs are financed by fare increases and the predicted gains are also realized, the airlines' return on investment will increase by 1% before taxes of 1/2 of 1% after taxes. With a 1% fare increase

the only effects on airlines will be beneficial.

Effect of Cost Changes - The costs estimated by the Rohr Corporation are the best possible estimates available and should be very close to the actual costs which would be incurred. The estimates certainly are not exactly correct; there are some unanswered questions about serviceability, loss of commonality, and reliability of estimates. But the chances that costs will decrease are just as great as the chances that they will increase. In fact, the report indicates that a savings may be realized by adding the aft end treatment of configuration 4 to the front end treatment of configuration 2, thereby bypassing configuration 3 which added \$174 million to the cost with only very slight reductions in noise.¹⁶

In any case, the Rohr report suggests that a 10 percent change in costs might reasonably occur (either up or down). As can be seen from our previous discussion on costs and benefits, this would not be sufficient to offset the net gains which retrofit will achieve. Furthermore, in keeping with our discussions on fare increases, we must again recall that the airlines are a regulated industry. Therefore, if cost increases are incurred the CAB may grant further fare increases to keep the airlines financially sound. These fare increases would be so slight that they could not conceivably affect demand. Therefore, concern about small inaccuracies in cost estimates should not deter implementation of a retrofit program.

Capital Improvement - There is still the question of where the money will come from to pay the initial capital investment in new equipment. This \$1.2 billion investment for configuration 4A would certainly be a large burden for the airlines. We suggest that these funds be provided by government loans, to be paid back over the depreciation life of the equipment out of the funds to be

Fares can be adjusted to account for cost changes.

Initial investment to be funded by Government loans.

generated by the 1% fare increase. If this fare increase were implemented immediately, some revenue would already exist when the first requirement for loan funds came in.

SAFETY

An important consideration in a program of this sort is of course safety. All due precautions should be taken in the development tests and initial in-service safety evaluations. If these precautions are made, there should be no more danger involved in this program than there is in the introduction of any other new piece of equipment.

SCHEDULE

A firm schedule must be established immediately. The constant procrastination which has occurred in the past hurts everyone and makes planning for the future almost impossible.

So far as anyone knows today, present noise levels may continue to 1985, even though the noisiest aircraft will probably not be operated by the major airlines at that time. The Rohr report recommends that engineering must start in early 1970 to complete installation by the end of 1974. We have already lost a year from that schedule.

Now the FAA is asking for a 15 month feasibility study to verify the analytical results of the Rohr Corporation report and improve the takeoff noise reduction of two and three engine aircraft. Since Congress has not funded this study, results are at least two years away, rulemaking three years away, and benefits eight years away. Congress obviously does not want further study and neither do the people. Implementation was required by PL 90-411 and should take place without further delay.

FAA Philosophy:
Study, it to
Death!

We recommend that the schedule shown in Figure 6 be adhered to. Although admittedly fast-paced, it is needed under the circumstances.

We further recommend that the FAA consider as soon as possible another rule which will require all aircraft manufactured after 1980 and all aircraft operated after 1990 to be 10 dB quieter than FAR Part 36 levels. These are the levels actually required by people and communities around airports. The airlines and manufacturers should be given the longest possible notice of the noise levels they will have to meet with follow-on generations of transports.

Require all aircraft to meet FAR Part 36 noise levels by 1975.

Another 10 dB noise reduction actually needed.

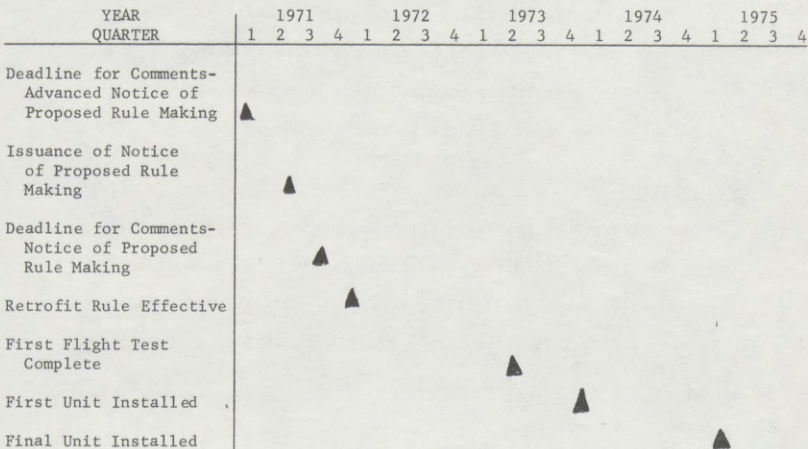


FIGURE 6. RECOMMENDED SCHEDULE FOR RETROFIT

CONCLUSIONS

The foregoing analysis results in these conclusions:

- Retrofit configuration 4A (Rohr report) is the one most suitable for detailed consideration because it significantly reduces noise at all locations around airports.
- The benefits to the community outweigh the costs of retrofit.
- Airline profits will be increased by retrofit.
- A retrofit program will reduce unemployment among aerospace workers.
- The most equitable method of finance is a 1% fare increase. This will have no affect on passenger demand.
- Government loans should be made available to defray initial capital investments. These should be paid back out of the funds from the 1% fare increase.

THE DECISION

We believe that the facts point to only one logical decision:

The Federal Aviation Regulations should be amended effective December 31, 1971, to require that all aircraft meet FAR Part 36 noise levels by June 30, 1975.

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NOISE CONTROL ACT OF 1971 AND AMENDMENTS

TUESDAY, JULY 13, 1971

U.S. SENATE,
COMMITTEE ON COMMERCE,
SUBCOMMITTEE ON AVIATION,
Washington, D.C.

The subcommittee met, pursuant to recess, in room 5110, New Senate Office Building, at 10:05 a.m., Hon. Howard W. Cannon (chairman of the subcommittee) presiding.

Present: Senators Cannon, Baker, and Stevens.

Senator CANNON. The committee will come to order.

Today the subcommittee will continue to hear testimony on aircraft noise, its control and reduction, and specifically two legislative proposals now pending relating to the subject matter S. 1016 and S. 1566.

Our first witness this morning is the Honorable Alphonzo Bell, Congressman from the 28th District of California, Beverly Hills.

We are very happy to have you here this morning.

STATEMENT OF HON. ALPHONZO BELL, U.S. REPRESENTATIVE FROM THE 28TH DISTRICT OF CALIFORNIA

Mr. BELL. Thank you, Mr. Chairman.

The immense dangers of noise pollution are clearly apparent. Medical World News has concluded that noise pollution is as much a threat to certain patients as air pollution is to asthmatics or patients with emphysema. Medical studies have shown many vascular, digestive, and nervous disorders to be the result of sudden, sharp noise or prolonged exposure to noise. All of us in this committee room have lost a substantial portion of our hearing mechanism due to unwanted sound.

And a major source of today's noise problem is jet aircraft. Twenty million Americans are bombarded every few minutes with the thunderous roar from our major airports. It is to these citizens that S. 1566, and my companion bill in the House of Representatives, are addressed.

The experiences of the 28th California Congressional District, which I have the pleasure of representing, are illustrative of the distressing consequences of airport noise.

Thirty schools and forty thousand children are affected daily by the operations of the Los Angeles International Airport. The teaching process in many of these schools is interrupted continually—in one school, approximately every 9 minutes. Early last year an elementary school and a junior high school were forced to close due to the excessive noise; many schools had to be insulated in order to continue operations.

(797)

Parents, meanwhile, have watched their homes slowly depreciate in value. During a recent 6-month period 92 homes were listed for sale in one suburban community near Los Angeles International Airport; only 11 homes were sold; listings eventually expired or were canceled on 68.

Renters remain for only 2 or 3 months. For those who do finally sell their homes, sales are normally made to speculators at \$5,000 or \$10,000 below market value.

It is not surprising that Americans no longer wish to move into airport communities; noise vibration can be particularly damaging. Cracks have appeared in the stucco exteriors of homes. Gas appliances are moved and leave the ever present danger of fire from gas leaks. Wall tiles have been shaken loose. Nail heads have come through the plaster.

Damages have led to law suits. A total of nearly \$4 billion in noise suits have been filed against Los Angeles airports. To that sum, we should add the costs of attorney fees and court time.

Losses accrue to the entire southern California community. One of the only two Los Angeles city beaches has become virtually unusable. This represents a serious loss when we consider the extreme scarcity of natural and recreational resources in America today.

The list of harms from jet aircraft noise is endless. Children can no longer play in their patios or in the neighborhood park. Man-hours are lost due to loss of sleep, headaches, earaches, loss of powers of concentration, and general irritability.

And the future offers no relief. A study conducted by the University of Southern California planning department forecasted that by 1990 the noise level throughout the Los Angeles basin would be as high as 95 EPNdB or roughly the sound of a subway train.

The FAA has initiated programs of preferential runways, airport departure spacing, higher en route altitudes, and steeper glide slopes. The mail from my district complaining of aircraft noise, however, continues to increase.

An immediate program of noise suppression of jet aircraft promises to be extremely effective. A study conducted by William Dunn and James Rogers of Jet-Sonics, Inc. and revealed earlier this year found that jet engine noise can be reduced in the future from 17 to perhaps as much as 40 decibels. Furthermore, the current fleet of jet engine aircraft can be completely retrofitted within 2 years.

The airline corporations, though, have no reason to voluntarily take on a program of noise suppression. The joint DOT-NASA civil aviation research and development policy study described the present situation:

In the case of aircraft noise, there appears to be no market mechanism that can respond promptly and effectively to the deleterious effects of aircraft noise. * * * No one is directly in the business of buying quietness.

State and local governments do not have the jurisdiction to legislate a program of retrofitting.

And Federal aviation regulations are inadequate and show no sign of rapid improvement. Part 36 of FAA regulations limits engine noise only on subsonic aircraft commissioned after December 1, 1969. The majority of aircraft now in service do not fall under its dictates.

S. 1566 simply carries out the intent of Congress. In July of 1968, the Senate Committee on Commerce set as "the first order of business * * * to stop the escalation of aircraft noise by imposing standards which require the full application of noise reduction technology."

S. 1566 requires a technologically possible reduction in jet aircraft noise in a more than adequate amount of time. If required to meet the standards set out in S. 1566, the takeoff of a Boeing 707 would sound roughly half as loud as it does now.

S. 1566 is a first, but extremely necessary step in the complete abatement of aircraft noise.

Opponents have argued that retrofitting is too costly. The argument is invalid for two reasons.

First, recent studies have shown retrofitting costs to be as low as \$1.2 billion maximum for the current jet fleet. The price is minor in comparison to the nearly \$4 billion in noise suits against Los Angeles alone.

Second, Congress has many times established that the economic interest of the airlines should not automatically override the public interest and public environment.

Jet aircraft noise affects all of our lives. It disrupts our schools, our hospitals, and our places of worship. It prevents outdoor concerts and plays. It impairs the the health and disposition of every citizen. It interferes with the proper use, enjoyment, and benefit of residential, business, and public property.

For all of these reasons, it is imperative that Congress take this important step in the direction of aircraft noise control.

Senator CANNON. Thank you for a very fine statement. You refer to those suits against Los Angeles. Have any of those actually been disposed of?

Mr. BELL. Very few of them have been disposed of.

Senator CANNON. In other words, they are all pending?

Mr. BELL. Yes, most of them are pending.

Senator CANNON. Has the Los Angeles Airport Authority attempted to settle any of them or do you know?

Mr. BELL. They have attempted to settle a relatively few minor suits.

Senator CANNON. You refer to a study conducted by William Dunn and James Rogers. I have never heard of that before. Have you a copy of the study?

Mr. BELL. I could supply you with the information.

Senator CANNON. We would be very happy to have you supply us with one if you could. I raise the question because all of the expert testimony that we have heard so far has indicated that the present state of the art would not permit a reduction of that magnitude from 17 to perhaps as much as 40 decibels. As a matter of fact, the experts yesterday indicated reductions would be considerably less than that within the present state of the art, and I think you are talking now from the standpoint of retrofit which means the retrofitting of present engines in existence. Now, if they were to go back and redesign the core and go into that sort of a project, perhaps reduction of this kind could be made.

Mr. BELL. I don't have the details on this, Mr. Chairman, but I will supply you with them. They will indicate that it is very close to that.
(The letter follows:)

CONGRESS OF THE UNITED STATES,
HOUSE OF REPRESENTATIVES,
Washington, D.C., July 13, 1971.

HON. HOWARD W. CANNON,
Vice Chairman, Subcommittee on Aviation, Committee on Commerce, U.S. Senate
Washington, D.C.

DEAR SENATOR CANNON: This letter is in reply to your request for more information on the studies conducted by William Dunn and James Rogers of Jet-Sonics, Inc., N.Y. The information on their study was contained originally in a brief prepared by the Attorney General of the State of New York; a copy of the pertinent passage is enclosed. Unfortunately, Jet-Sonics has not yet obtained a patent on their improvements in jet engine noise suppression; technical details, therefore, will not be revealed until later this year when funding of further development has been arranged. No formal report has been issued.

Dunn and Rogers conclude that materials and fabrication technologies can now be developed so that jet engine noise can be reduced from 17 to perhaps as much as 40 decibels. Apparently, this reduction can be accomplished on the present generation of jet aircraft engines as well as on new engines being manufactured. According to Jet-Sonics, Inc., the weight increment will be less than 100 pounds per engine and the variation in power will be from 3% to plus 10%. Modification of present engines, seemingly, can be accomplished during overhaul with only very slight time loss.

With best wishes, I am,
Sincerely yours,

ALPHONZO BELL,
U.S. Congressman.

Enclosure

Senator CANNON. You testified that it would cost \$1.2 billion maximum to retrofit the current jet fleet. What level of noise reduction do you envision for that price?

Mr. BELL. It would involve the 4A configuration of the Rohr Corp.—approximately the noise reduction envisioned in S. 1566.

Senator CANNON. This would probably be nacelle treatment which would provide considerably less reduction than the figure you gave earlier.

Thanks very much. We appreciate having you here today.

The next witness is the Honorable Secor D. Browne, Chairman of the CAB.

Mr. Chairman, we are happy to have you here today.

You may proceed.

STATEMENT OF HON. SECOR D. BROWNE, CHAIRMAN, CIVIL AERONAUTICS BOARD

Mr. BROWNE. Mr. Chairman, it is a pleasure to be with you, sir. I have a statement which I would like to read, if I may.

Senator CANNON. Yes, sir.

Mr. BROWNE. Mr. Chairman, I appreciate this opportunity to appear before you in connection with your consideration of S. 1016 and S. 1566, bills relating to aircraft engine noise emissions.

S. 1016, an administration proposal, is designed to vest the Administrator of the EPA with primary responsibility for promoting coordination of Federal programs relating to noise control.

The Board has expressed accord with the bill's objectives in a report submitted to your committee last week, but deferred to the views

of FAA and EPA since the responsibilities of those agencies would be affected by the bill's provisions. I do not have anything additional to add to the Board's report.

Enactment of S. 1566 would require all subsonic transport category aircraft operating within the jurisdiction of the United States to be retrofitted by January 1, 1976, so as to comply with noise standards prescribed in FAA regulations for new subsonic aircraft.

Let me clearly state that I am fully in accord with the goals of quieter communities and a healthier and more tranquil environment for all of us. I recognize very well that there is a noise problem in the vicinity of airports that must be alleviated as soon as we can effectively and economically do so.

Speaking in the context of the Board's statutory mandate to oversee the economic posture of the air transport industry, however, I am far from convinced of the wisdom of a massive retrofit program for the existing commercial jet fleet. I am opposed to the enactment of this bill for the following reasons:

1. Technological problems including a disproportionate time-frame requirement.

2. An unacceptable economic burden with resulting unsatisfactory cost/benefit ratios.

3. International difficulties.

4. Better approaches to the problems are available and can be implemented.

Let me elaborate on each of these points.

TECHNOLOGY AND TIMING

Despite the research and study done in this area to date, there still appears to be some serious questions of the technological feasibility of a retrofit program. Indeed, the sponsor of the bill seems to be well aware of the imperfect existing state of the art.

Speaking of the \$35 million which would be authorized for research on retrofitting techniques, he said that he had been advised, "That with that amount of money, retrofitting technology could be perfected within 2 years."

Without getting into the semantics of the word "perfected," I must say as an engineer, that I do not share his optimistic view of the estimated time frame.

Another very important technological consideration is the fact that the earlier model straight jet aircraft—of which approximately 250 remain in the commercial fleet—apparently cannot be made perceptibly more quiet, and therefore, could never meet the standards imposed by this bill. Such aircraft would have to be retired by the carriers and presumably their remaining book value written off with severe economic consequences for the carriers and the traveling public.

It is my opinion that any benefits resulting from such a proposed retrofit program with existing technology would be only marginally discernible by those residing near airports.

Noise perception and annoyance levels are very subjective concepts. Jet exhaust rumble, fan whine, relative intensities in landing or take-

off modes, and sideline noise are different aspects of the total noise problem calling for different approaches and solutions.

More study and research must be done into the noise annoyance factors and their components as they affect people. Test stand experiments and instrument readings should not be the conclusive criteria for analyzing the cost-benefits for such an expensive and comprehensive program.

COST FACTORS

At this troubled time the industry itself cannot finance such a program. The carriers' financial condition cannot support new capital requirements in the range of one-half to a million dollars per aircraft that would produce no productivity gain and which would make no measurable addition to the service life of the aircraft. The loan guarantee provision in the legislation obviously will not pay the bill.

If there is to be a retrofit program, funds for that program must be obtained by the carriers. The ultimate source contemplated by the bill is the fare-paying passenger. Present fare levels do not include any allowance for noise retrofitting costs.

S. 1566 compels a fare increase to the extent of the retrofit costs. I do not believe that the retrofit program is worth the cost to the public.

Furthermore, it is certain to have a negative impact on passenger demand, particularly in view of the airport airways taxes and the fare increases recently found justified by the Board.

Like my predecessors, I oppose as a matter of principle, granting fare increases by statute. These matters are better left to the sound discretion of the Board, based upon an evidentiary record.

Additional cost burdens on the air carriers, which S. 1566 does not recognize, would result from the considerable amount of aircraft downtime required for retrofitting and the performance sacrifice due to increased weight, or airflow inefficiencies, or both.

INTERNAL IMPLICATIONS

The legislation does not encourage the achievement of international understanding and cooperation in aircraft noise problems. Presumably, the United States would impose our standards on the foreign-flag carriers holding rights to operate in U.S. airspace. Other countries are trying other approaches to the noise problem and the International Civil Aeronautics Organization has it under study.

I would prefer to see more international discussion take place before we impose this standard on our foreign friends or we place U.S.-flag carriers at a considerable cost disadvantage in international markets.

BETTER SOLUTIONS

I have made some recommendations to FAA in the past that certain changes in air traffic control procedures be implemented to significantly improve the noise problem around our airports. These procedures would not require additional equipment, would impose no burden

on the flight*crew, and should contribute to increased safety of commercial air operations.

I have recommended that the FAA consider undertaking the following programs:

1. Amend air traffic control procedures to raise the minimum ILS intercept altitude to 3,000 feet above ground level. This would reduce noise exposure by a substantial amount, allow the crew a longer time period on the ILS, resulting in a safer approach, and provide controllers with better opportunity to space and control traffic.

2. Amend air traffic control procedure to require full-powered departures except in those areas where study shows there would be a noise penalty. While this would increase the noise intensity in close proximity to the runway, the climb capabilities of the modern jet transport are such that effectively quiet altitudes could be reached almost immediately. This procedure would enhance the safety of operations and would expedite traffic flow thereby improving controller workload and carrier economics.

I would also like to point out the very noticeable progress that is being made in the design and production of quieter new aircraft. The second generation of jet transports—the 747, DC-10 and the L-1011—are much quieter and cleaner than the families of 707's and DC-8's. These new wide-body jets meet the existing FAA standards for new production jet equipment.

When one considers that these new aircraft are about $2\frac{1}{2}$ times more powerful and more productive than the existing first generation aircraft, one must conclude that we are making real progress from an environmental as well as a technical point of view.

It is my opinion that the real hope for progress in the area of aircraft noise abatement lies with the development of new propulsion systems that are engineered with noise control being a major design criteria.

I believe that properly applied research and development funds could produce an engine designed to be quiet and clean, and which could be made adaptable to the airframes in the existing commercial fleet in about $3\frac{1}{2}$ years. This schedule would be comparable with my estimates for the proposed retrofitting effort.

Such a new engine would add to the productivity and service life of the existing aircraft, not detract from it. While the ultimate cost of such a program would be more than retrofit, the economic and engineering justification is correspondingly stronger. The industry, the traveling public and noise-conscious constituents would all realize greater benefits by looking forward to totally new, quiet power packages rather than looking backward to the improvised retrofit program of questionable effectiveness as contemplated by S. 1566.

Mr. Chairman, that concludes my statement. I stand ready to answer your questions.

Senator CANNON. Thank you very much, Mr. Browne.

You advocate the development of a new, quiet engine rather than the program of modifying present engines.

Do you have any estimate of the costs involved in developing such an engine?

Mr. BROWNE. I do not. My conclusions are based simply on preliminary conversations with engine manufacturers.

But it seems to me the place to get at the program is at the source, the noise-generating machine, the engine, not trying to—

Senator CANNON. Who should bear the cost of the development and production of a quiet engine, if it were undertaken, in your judgment?

Mr. BROWNE. Mr. Chairman, this is one of our problems. Where do we get research and development for new engines on which continuation of our civil air transport industry must depend, without military programs to develop engines? It is my feeling that other sources within the Government will have to be found to fund such development efforts.

Senator CANNON. How did you arrive at this period of 3 to 3½ years estimate?

Mr. BROWNE. It is simply a guess on my part, Mr. Chairman.

Senator CANNON. Is that from consultation?

Mr. BROWNE. Consultation with engine manufacturers.

Senator CANNON. If a quiet engine were developed in that time-frame, you are talking of an engine that would be suitable for existing aircraft, are you not?

Mr. BROWNE. Yes.

Well, I am talking about what I hope would become a family of engines, that is, quieter engines that could be retrofitted to existing airframes, improving their performance, noise level and service level at the same time as the family would be the basis for additional new transport models.

Senator CANNON. Don't we have a quiet engine in the new jets, the wide-bodied jets now?

Mr. BROWNE. We certainly do, but these are very large engines. So far as I know, only the French are developing now a quiet engine in the 20,000-pound thrust class.

Senator CANNON. So, you are really talking about the usability of that engine in the smaller aircraft, that is not the big wide-bodied types?

Mr. BROWNE. That is right. To reequip our existing airframes, and possibly make it possible for us to have an airplane that will compete with the new Dassault Mercure airplane.

Senator CANNON. If a quiet engine was developed, would you propose that regulations should require it be installed on all jets in the U.S. fleet at the time the engine was certificated?

Mr. BROWNE. I would hate to follow that pattern. I would think, Mr. Chairman, than an engine which was economically more attractive and environmentally more attractive, would cause the airlines themselves to want to retrofit or reequip on engine change time, rather than to continue with their present fleet.

I would not think we would want to try to legislate such a re-equipment program.

Senator CANNON. I think you get into perhaps a real problem there on some of the older aircraft now, that would be approaching their useful lifespan.

Mr. BROWNE. That is why I think to try to get that into legislation, would be terribly complex, and we would still have the problem of the 250 jet aircraft that we cannot do anything with.

Senator CANNON. Do you think it is technologically and economically feasible to adopt a single new type of engine to all diverse aircraft models that are in the older fleet today?

Mr. BROWNE. Well, again I am not begging the question, Mr. Chairman. When I say a new type, I am referring to a family of engines with a new technology to make a quieter plane. Presumably, as in existing engines, these would come in a family of sizes.

Senator CANNON. Congressman Bell referred to a study conducted by William Dunn and James Rogers of Jet Sonics, Inc., that found jet engine noise could be reduced in the future from 17 to perhaps as much as 40 decibels.

Are you aware of any such study as that?

Mr. BROWNE. I am not aware of the study. Like you, I am going to ask Mr. Bell for a copy.

Senator CANNON. We have received no expert testimony so far that would indicate improvements of that magnitude are possible.

Mr. BROWNE. It seems very extensive.

Senator CANNON. Thank you very much, Mr. Chairman. We appreciate your being here.

Mr. BROWNE. Thank you.

Senator CANNON. Our next witness is Mr. Robert E. Pendley, chief project engineer—noise alleviation programs, Douglas Aircraft Co., McDonnell-Douglas Corp.

**STATEMENT OF ROBERT E. PENDLEY, CHIEF PROJECT ENGINEER—
NOISE ALLEVIATION PROGRAMS, DOUGLAS AIRCRAFT CO.,
McDONNELL-DOUGLAS CORP.; ACCOMPANIED BY A. L. McPIKE,
CHIEF ACOUSTICS ENGINEER, DOUGLAS AIRCRAFT CO.**

Mr. PENDLEY. Mr. Chairman, I am Robert E. Pendley, chief project engineer for noise-alleviation programs of the Douglas Aircraft Co., of McDonnell-Douglas Corp.

It is a pleasure to appear today in response to your letter of July 1, 1971, and to describe the results of our studies related to the reduction of noise emissions from DC-8 and DC-9 airplanes.

Our presentation this morning will be shared with Mr. A. L. McPike, who is chief acoustics engineer at the Douglas Aircraft Co., who will supplement his discussion with tape recordings.

Our studies related to DC-8 and DC-9 noise reduction consist chiefly of two programs sponsored by the NASA and a company-sponsored study of the feasibility of applying the NASA program results to the entire family of DC-8 and DC-9 models.

One of the NASA programs dealt with a study of retrofitting a selected DC-8 model (the DC-8-61) with completely new quiet engines and with new acoustically treated nacelles, and the other dealt with a study of retrofitting another DC-8 model (the DC-8-55) with new acoustically treated nacelles, but with continued use of the existing JT3D turbofan engines.

We shall summarize both of these studies, as well as our own study of the feasibility of fleetwide application of the technology developed.

Here is a sketch of a typical turbofan engine installation. Air enters the inlet duct at this point, enters the fan at this station, and part of the fan-flow after passing through the fan is discharged through exhaust ducts shown here, being discharged overboard through the nozzle at this point.

The rest of the air enters the compressor, flows through the compressor, combustor, turbines, and exhaust out of the discharge nozzle.

The chief sources of noise from the installation are as follows: There are noises radiated forward from the fan and compressor, and these noises propagate out through the inlet duct.

Other internally generated noise is shown here. There is also, typically, noise generated within the turbine that is discharged out the nozzle here.

Finally, there is the externally generated noise, generated downstream from the nacelle at the boundaries of the jet wakes, produced by the shearing action of the jet flow through the adjacent, slower moving atmosphere. We will speak of that today as the jet roar.

Now, the fan noise, which is a very audible component of the noise of today's turbofan engines, is one of our chief sources of noise particularly at low-power conditions, and is perceived as a whistle, or whine.

Senator CANNON. You get that normally on approach, is that right?

Mr. PENDLEY. That is right, chiefly on approach; most prominent on approach. Then the noise from the jet boundaries, the jet roar, is heard as chiefly a low-frequency roaring and rumbling sound.

In the first mentioned NASA program involving a completely new quiet engine, the design of the new engine and the new nacelle supplied with it is compared with the existing JT3D in this chart. The shaded area represents the engine manufacturer's engine, and the rest of the sketch shows the nacelle and pylon components that would be supplied by Douglas.

You notice that the chief difference in the size of the engine results from its substantially larger fan and turbine. The intent of this design was to accomplish a significant reduction both in the jet roar and the fan whine.

It accomplished a reduction in the jet roar by lower design jet velocities.

It accomplished a reduction in the fan whine by introduction into the fan design of modern technology providing low noise generation at the source within the fan stages.

Then, finally, acoustical treatment was installed in both the fan inlet and the fan discharge duct to further suppress fan whine.

The chief results of that study are tabulated on this next chart indicating that the larger engine increased the empty weight. Despite the increase in weight, the added improvement brought about by modern design actually improved all of the important airplane performance properties.

Also, it was appreciated that this kind of a change would make a significant reduction to the noise.

Senator CANNON. You say you got improvements in various factors but what did that do to the gross weight of the aircraft?

Did that mean that the gross weight had to be reduced by 9,800 pounds?

Mr. PENDLEY. The certified maximum gross weight for the airplane, sir, would largely be dependent on the wing structure.

Of course the effort was made not to change that wing structure. So, it reduced the amount of fuel that could be put aboard, in order to compensate for the increased weight. But, due to the reduced fuel consumption of the new high-bypass-ratio design, the installation worked out favorably in that regard.

The net balance was favorable on performance.

Senator CANNON. How did the bypass ratio compare? Was it a considerably higher bypass ratio?

Mr. PENDLEY. Yes; it was of the order of 5.5 compared to today's JT3D's and JT8D's of 1 to 1.3.

The undesirable aspect of the study was connected with the cost of the modification. The modification required quite a bit of change, and it was estimated that it would cost about \$6 million per airplane, a good deal of which is in the new engines.

It was judged that this amount of money being spent that late in the airframe life would be economically undesirable, and an operator faced with that kind of an investment would be much better off to take the money and add it to the additional sum necessary to buy both a new airframe with the late airframe technology to go along with the new engine and its technology.

The second study that we performed for the NASA dealt with a lesser scope change in which continued use of the JT3D engine in the DC-8 airplane was studied.

This is a sketch of the nacelle that was designed, fabricated, and flight-tested in a DC-8 short-duct airplane. The DC-8-55 is the model used in this program.

The acoustical treatment added to the nacelle consisted of acoustically absorptive duct lining materials installed on the walls of the inlet cowl, on both sides of the concentric ring-vane in the inlet duct, and on all available internal surfaces within the fan discharge duct. Acoustical treatment was applied in this manner for the reduction of fan whine.

The fan exhaust ducts were lengthened from their present 24 inches to 48 inches.

Now an effort was made to try to minimize the economic impact of this change, and it was found possible to design the nacelle so that continued use of the existing primary thrust reverser located in this area would be practical. However, the revised contours and location of the fan nozzles would require new fan thrust reversers.

The major results of this program are tabulated in terms of noise on this chart. The upper part of the chart indicates the measured noise reduction achieved at the landing approach condition, where the noise was reduced markedly as indicated here, 10.5 EPNdB.

However, under takeoff conditions with maximum takeoff thrust and at a position $3\frac{1}{2}$ miles from brake release, lesser reductions were observed of the order of 3.5 EPNdB. Under cutback conditions, a reduction of 5.5 EPNdB was measured and finally, at full power on a 1,500-foot sideline, the reduction was approximately 3.

The NASA program included a detailed study of the cost of developing, certifying and manufacturing the nacelle modifications.

Senator CANNON. By the way, what did that do to the weight of the airplane?

Mr. PENDLEY. Simultaneously with the design of the modified ducts, it was possible to upgrade the design of the nacelle by using some advances in mechanical and aerodynamic design accomplished in our later model DC-8's. These advances largely offset the increased weight and duct friction brought about by the acoustically treated ducts.

We estimated the net weight increase would be only 83 pounds per nacelle, and, as a result, minor performance changes were indicated. I will indicate later in another chart what happened to the airplane performance.

The result of the detailed cost studies of the modification is indicated here as a function of the number of aircraft that might be retrofitted. This chart indicates that if all 250 of that particular class of DC-8's were to be retrofitted, the cost of the kit and its installation would be about \$650,000 per airplane, and if lot sizes of less than 100 were to be considered, the price would rise to the order of a million dollars per airplane.

The small weight change, and the upgraded aerodynamics that were applied in the design, resulted in small performance changes.

We estimated an increase in takeoff field length of 800 feet. The cruise performance was actually improved slightly; we predicted on the basis of the flight test data, an increase of 3 percent in maximum-range capability.

Estimates of the direct operating cost increment consisting of estimates of the changes in fuel consumption, depreciation, maintenance and insurance, indicated an operating cost increase of approximately 4.5 percent.

Now, at this time I will—

Senator CANNON. Did you compute there any downtime for the aircraft to go through the program, as to what that would likely involve?

Mr. PENDLEY. No, sir. That cost allows nothing for downtime.

If I may, Mr. Chairman, Mr. McPike will now discuss his analysis of the projection to the change in the total national noise exposure that might result from application of the acoustical technology to the full fleet, and I will return for some more discussion of technical and economic factors of fleetwide application.

Mr. McPIKE. Mr. Chairman, the information I have this morning treats purely with an estimation of the effect on community noise exposure of applying the available noise suppression technology to the current fleet of transport aircraft.

As Mr. Pendley pointed out, there are noises generated inside the engine, and there is the externally generated noise behind the engine.

That generated inside the engine, we refer to as the turbomachinery whine; that generated outside the engine, we refer to as the jet exhaust roar.

The current technology, that has been demonstrated, permits the achievement of a significant reduction in the whine, but no technology has been demonstrated in flight on the current aircraft, to achieve a significant reduction in the jet roar.

Therefore, what we will examine is the effects of reducing the fan whine without reducing the jet exhaust roar. In examining that, we will look at the reductions in noise level that might be achieved both at the FAA noise certification measuring locations and for additional points around an airport. Additionally, we will take a look at the reductions in total community noise exposure that might be anticipated.

Senator CANNON. To get back to what Mr. Pendley pointed out, do I understand correctly, then, that you assumed a rather substantial reduction in your approach noise, a very minor reduction in your takeoff noise, and a very minor reduction at cruise; is that correct?

Mr. McPIKE. Yes, sir; that is approximately true.

To illustrate this perhaps more clearly, I have some magnetic tape recordings which will show just what the difference in noise is during takeoff and approach, both for DC-8-type aircraft, and for DC-9-type aircraft.

Senator CANNON. But those are the comparable results, then, when you relate that to community noise exposure; is that right?

Mr. McPIKE. Yes, sir. That is true.

The slide here is perhaps a bit technical, but, with the aid of the tape recording, I think you will be able to appreciate what has been accomplished.

The tape recording I have is one that was made during our NASA program on a DC-8. We have a recording of the aircraft before it was suppressed, immediately followed by a recording of the aircraft when it had the noise suppression treatment on it.

The sound equipment I have, incidentally, has been very carefully calibrated. While it is not as powerful as desirable, and it does not generate levels as high as may be experienced in some of the airport neighborhoods, the relative differences between the noise levels of the suppressed, and unsuppressed aircraft are directly comparable.

The first recording deals with the approach case and is for a fly-over at a 370-foot altitude. The jet roar is noted here by the very low frequency noise, the fan whine is noted up here by the higher frequency noise.

The solid line is for an unsuppressed airplane. When the suspension was applied, there was no change in the noise level of the jet roar, but there was a substantial reduction in the level of the fan whine.

The total reduction in EPNdB that was achieved was 10.5 EPNdB.

I will play the recording in which you will hear the unsurpressed followed by suppressed.

(A recording was played.)

As you can tell, there was a substantial reduction in the whine but essentially no change in the jet exhaust roar.

At takeoff, the jet exhaust roar is a much more important part of the total noise of the aircraft.

The fan whine, while present during takeoff, is a much smaller part of the total noise. As a consequence, a reduction of only 3 EPNdB was accomplished with nacelle noise suppression at that power setting.

I will now play another tape recording. This is for a 1,500-foot altitude takeoff, unsuppressed followed by suppressed.

(A recording was played.)

Senator CANNON. Is that at full takeoff power in both instances?

Mr. McPIKE. Yes, sir, in both cases.

These modifications in noise level would be applicable to the DC-8 type aircraft with the turbomachinery or fan-noise suppression under discussion.

While Mr. Pendley pointed out that on the DC-8's that we tested we did not lose much in the way of performance of the aircraft, some of our other DC-8's would be subjected to performance penalties in terms of increased weight from added fuel consumption by such modifications.

I have provided an example on this chart for our DC-8-62, which is a long-range aircraft, to determine the total effect of the fan noise suppression on takeoff noise for aircraft performing a 5,000 nautical mile mission.

If we apply the fan noise suppression, we reduce the noise of the engine by 3 EPNdB. However, because there is a loss in thrust associated with that suppression, the aircraft can no longer climb as efficiently. It loses about 200 feet in altitude as it passes over a community which will increase the noise by 2 EPNdB.

In addition, there is an increase in fuel consumption. The aircraft must, therefore, carry more fuel to perform the 5,000 nautical mile mission. This increase in fuel increases the weight of the aircraft, which results in a further decrease in the altitude, a reduction of 250 feet for a 3 EPNdB noise level.

The net effect is a reduction of 450 feet in altitude and an increase in the community noise level of 2 EPNdB.

For the turbojet-powered DC-8 airplanes—this particular one is powered by the JT4A engine—we would estimate that there is very little that could be accomplished by turbomachinery or fan-noise suppression.

If we look at the approach case, while there is compressor whine in the high-frequency part of the curve, there is just about as much jet-exhaust noise at the high frequencies. Thus, there should be no more than 3 EPNdB and probably no reduction obtained from turbomachinery noise treatment even at approach power.

At takeoff power, the noise is completely dominated by the jet roar. We would expect no reduction in effective perceived noise level.

Senator CANNON. How many of those aircraft do you have?

Are you familiar with the figure, sir?

Mr. McPIKE. No, sir, other than the figure that Mr. Browne gave.

Senator CANNON. Can anybody answer that for me?

Is it 69 aircraft in the inventory of that type?

Mr. VON KANN. It is slightly over 200, sir, pure jets.

Senator CANNON. The 200 includes the earlier aircraft, the one before the last that you showed on the chart?

Mr. McPIKE. Yes. Mr. Pendley indicated that he does have a chart a little later in the presentation that will provide those numbers.

Here now is a very important, we think, consideration in terms of the overall evaluation. This is the noise level information for the DC-

9-type aircraft, powered by the JT8D engine, which is the engine that also powers the 727's and 737's.

We have not flown fan noise suppression on these aircraft, but we have estimated what we expect the possible noise reduction might be. We made this estimate based on some static data obtained from Pratt and Whitney Aircraft, and we have prepared a tape in which you will hear first the fly-over noise of an actual recording of a DC-9 unsuppressed.

We then modified the tape by reducing the high-frequency noise on the tape to simulate the amount of high frequency noise reduction indicated in the Pratt and Whitney test program.

So you will hear an actual fly-over unsuppression, and a simulated fly-over suppressed as we think it would be. The noise reduction we estimated for the aircraft was 5 EPNdB at the approach power setting.

(A recording was played.)

I think you can tell from the tape and from the chart that with this particular engine, even at approach, the jet-exhaust roar is a more important part of the total noise than the fan whine compared to the earlier four-engine type aircraft.

At takeoff condition, the fan whine contributes almost nothing to the total noise, and we have calculated a reduction of only 0.5 EPNdB.

(A recording was played.)

Now, the examination we have just made was for recordings made out-of-doors, and generally speaking, the comparisons were made quite close to the aircraft, especially for the approach condition. As the distance from an aircraft increases, the high-efficiency whine is reduced more than the low-frequency roar. This is due to the nature of the atmosphere.

Also, as the sound passes from outside to inside a house, the high-frequency whine is reduced more than the low-frequency roar. This is true for any house construction.

As a consequence, we felt it important to take a look at what would happen for perhaps the more typical neighbor who, when he would experience this change in noise level, would be inside his house and the more typical neighbor, of course, lives more than 370 feet away from the aircraft.

So in the next chart we have redone the evaluation using a 1,500-foot flyover approach altitude and using the Society of Automotive Engineers' house noise reduction for a typical single-family frame house with a normal condition of windows and doors partially opened.

I will replay just the approach part—first for the JT3D engine—to hear the effect of that suppression under this condition.

(A recording was played.)

In this case, the reduction in EPNdB was 8.5 EPNdB. I did not make a tape recording for the indoor for the takeoff case. The reduction there would be only 1 EPNdB.

Here is an indoor recording now for the JT8D, which is the DC-9-type engine, again at 1,500 altitude. Again because the jet roar is a more dominating part of the noise at this condition, the amount of total reduction achieved by turbomachinery or fan-whine reduction was only 2 EPNdB.

(A recording was played.)

At the takeoff power condition, there would be essentially no reduction expected.

This chart summarizes the noise reductions that we have seen on the last several charts. For approach it shows essentially that if are outdoors at 370 feet that we can achieve seemingly significant reductions in the JT3D noise, marginal noise reduction in the JT8D noise and none in the turbojet. At takeoff power, there does not seem to be much noise reduction obtained at 1,500 feet either outdoors or indoors.

If we look indoors for the 1,500 case at approach power, we still have a reasonably large noise reduction for the four-engine jets, but for the two- and three-engine jets we see only a very small noise reduction, and again none for the turbojets.

One general conclusion from this evaluation is that, as far as takeoff noise is concerned, there is really not much that we can accomplish without jet-exhaust noise suppression on these engines.

At approach conditions, however, it seems that we can get some suppression on the one engine type and not much suppression on the other types. We had to take a further look to try to determine the possible benefits of suppressing noise on approach, and we have made the following evaluation to estimate the possible reductions in community approach noise exposure obtained from fan-noise suppression.

There are two primary factors in community noise exposure rating systems: One is the magnitude of the noise or how much noise the aircraft makes; the second is the number of times the noise occurs. The more often the noise occurs, the greater the noise exposure.

During the approach, the average noise level of the four-engine fanjet is higher than the average noise level of the two- and three-engine fanjets. Therefore, they should contribute more to the community annoyance.

However, in the United States, the two- and three-engine fanjets operate nearly four times as often as the four-engine fanjets. This is for two reasons: First, there are about twice as many of them; Second, because they operate only over short periods of time, each one operates more times per day. The result of the four times as many operations is to essentially cancel out the effect of the higher noise of the four-engine aircraft. The net effect is that the contribution of two- and three-engine fanjets to the total approach noise exposure is equal to or greater than that of the four-engine fanjets.

I should point out that this is not for any particular airport. If one had an airport where there were only four-engine jets, the situation would be different. But for the overall average in this country, I think this is a fairly valid conclusion.

This chart summarizes a study we did in terms of noise exposures to determine or estimate the effect of applying the nacelle treatment. First, outdoors at 370 feet, if we suppress the four-engine fanjets only, we would obtain an equivalent reduction in noise exposure of 2.4 EPNdB. The reason for the small reduction was that the two- and three-engine jets have a strong effect on the exposure.

If we were to suppress turbomachinery noise on all turbofans, we would obtain a reduction of 6.4 EPNdB outdoors at 370 feet. At our more typical situation, indoors at 1,500 feet, we found by suppressing

the four-engine fanjets only, a reduction in exposure of 1.6 EPNdB, and by suppressing turbomachinery noise on the two-, three-, and four-engine fanjets, a reduction of 3.3 EPNdB.

Our summary from the information we have presented here is that meaningful reductions in airport community noise exposure will require the reduction of both the jet roar and the fan whine of current low-bypass-ratio turbofan engine.

This concludes the information I have.

I will turn the microphone back to Mr. Pendley.

Mr. PENDLEY. In discussing technical and economic factors involved in retrofitting all of the DC-8 and DC-9 aircraft with noise reduction technology, I will first of all develop a bit of a broad view of the scope of the work involved.

This chart tabulates all of the major categories of DC-8 and DC-9 model airplanes and also indicates that there are five basically different powerplant common design packages within the family of two airplanes.

Over here in this column is tabulated the total number of each type of basic powerplant design in service, showing that they range from relatively few in number, 29 Conways, to relatively more numerous, about 600 DC-9's.

Now, within these five basic categories of different powerplant installation designs there are approximately 15 different engine models installed.

The next three charts indicate the overall nature of each of the five basic powerplant packages. This is the JT4, one of the earliest developed DC-8 jet installations. This is the Conway. The air enters here and discharges in both of these engines from a single exhaust nozzle, which is a jet-noise suppression device consisting of a lobed nozzle and an ejector/reverser.

The two JT30 families of DC-8 nacelles—the short duct which was studied in the NASA program and the later model long ducts—are illustrated here.

In the case of the short duct, the fan exhaust is discharged at this point here, the hot primary exhaust is discharged here. For the later model, the fan exhaust duct flows entirely to the aft area where it is discharged almost coplanar with the primary exhaust. You can see there are major differences in the architecture of the nacelle. In fact, the structure of the pylons in the two cases is different.

The DC-9 installation is pictured on this sketch.

In the case of this engine, all of the fan and primary air are combined and discharged through this internal section here and finally discharged overboard as a single jet at this point.

Now, the JT-4 and Conways, as Mr. McPike mentioned, are not subject to much additional reduction in flyover noise. We have no technology to offer to accomplish any significant jet-noise reductions in those installations. Since they are, in the case of the JT4, nearing the end of their useful life and because Conways are few in number, it would not appear that either category is a candidate for retrofit.

The rest of our discussion deals with the two short duct installations on the DC-8, these two here, both with JT3D engines and the DC-9's with JT8D engines. In addition to modifications to the nacelles them-

selves, modifications may be needed in the airframe structure outside the nacelle. This is brought about because, generally, modified nacelles will change the weight and change the aerodynamic forces applied to the airframe structure. Existing structures must be analyzed then to determine if it has the capability to accept the increased loads.

I appreciate that you cannot read this chart. It isn't necessary to go through it. In the printed version it will be clear that this is a tabulation of the major structural categories within this family of DC-3 and DC-8 airplanes. They are categorized by maximum takeoff weight and also wing area. It will be necessary in considering the retrofit of different nacelles to go through a case-by-case analysis of each of these airframe structures, determine whether or not some areas must be modified to provide additional strength, and then conceive feasible design solutions to modifying the structure of aircraft in service.

Next, I will describe some of the major tasks that will be required to go ahead with the program and indicate some of the timing factors involved.

This chart is an estimate of the total program that might exist from this point forward—this is July 1, 1971—until the end of complete retrofitting of the entire fleet shown at this point, late 1979.

Within that span of time, the development and certification activities are shown here spanning about $2\frac{3}{4}$ years, which we judge at this moment an ambitious schedule to accomplish a work program of this scope.

The events leading up to that comprise three studies that are underway at this time. In the first one, the FAA is sponsoring a program to cope with whether or not meaningful reductions in jet roar can be accomplished. As Mr. McPike said, this appears to be the thing that must be accomplished to achieve a meaningful result. That work is now going ahead.

In addition, the DOT and the FAA are both studying, and we are supporting studies, in the matter of community benefits of the modifications, total program cost, and schedule. We have assumed in laying out the schedule that after these data are in hand, an NPRM, a proposed rule, would be released transmitting all these data with a judgment on the balance between the cost and benefits. In this case we have allowed a 3-month period that we assume would be permitted for an industry response.

We have then indicated two other major tasks: The first (task 6) is one in which the airlines and the manufacturers would negotiate firm business commitments offered by the manufacturers and therefore firm cost and schedule data would be at hand.

The second (task 7) is a continuing effort to define the method by which the airlines would recover the costs, and finally, assuming that all of these things so far indicate we have achieved a meaningful solution and the economic cost is reasonable, then, a rule could conceivably be adopted at this point in time—early 1974 according to our assumed schedule.

Following development and certification, the major activities there being production design and production tooling, and a development test program which I will describe a little bit more in the next chart,

certification test parts fab and assembly, certification testing, and then the manufacture of the parts for the full fleet retrofit which would occur within this 3-year time period here.

Senator CANNON. You are speaking about the total Douglas fleet retrofit. A little earlier you eliminated a part of the fleet for reasons that you stated. Is this figure the remainder of the fleet or is this the total fleet, going back to both the JT8 engine and the other engine, the JT3 engine?

Mr. PENDLEY. Mr. Chairman, I am corrected. I should not say total. This is the total turbofan-powered DC-8 and DC-9 fleet.

I have excluded the earlier DC-4's and the Conways from consideration.

Senator BAKER. It is just the three configurations you are dealing with on that duct?

Mr. PENDLEY. Yes sir. The long duct and short duct DC-8's and the DC-9's.

Senator CANNON. The time required for fleet modification—did you compute that at regular overhaul cycles or did you figure a downtime there for modification?

Mr. PENDLEY. The 3 years is consistent with airline practices in complete airframe overhaul, and our studies of this have indicated that this would be the time that modification could be accomplished without interruption of service. We have considered whether or not it would be feasible to shorten this some. Two or three problems are evident if we attempted to do this, one of which being some reduction in service resulting from the temporary reduction in the number of available seats. Some kind of an added economic cost would result from removal of airplanes from service for retrofit at other than scheduled overhaul times. Also, in considering the rate at which all these airplanes would be modified, it is not clear that a tractable program could be built with so many airplanes being modified in such a short time.

Senator CANNON. The first modification would occur about mid-1977 in that time frame?

Mr. PENDLEY. Yes, sir, that is correct, mid-1977.

Development tasks that are required in a program of this nature are shown here. We have shown the tasks as they might be required for the three major categories of powerplant packages. Also we are indicating on here the status to which previous efforts have applied to some of the work required.

The notation is C, the particular task have been completed; P, it has been partially completed; and, NA, it is not applicable in this particular program.

Preliminary design is that period of time in which alternate configurations are studied and the optimum configuration selected.

Wing tunnel programs involve these activities. Determination of thrust reverser effectiveness and loads is a prominent part of the powerplant development package. This is the first information on whether the thrust reverser has the designed capabilities. Since we are affecting loads into the wing primarily for the DC-8 models, the capability of the wing to accept the revised loads without serious effects on the flutter characteristics is another important part. The concentric rings involve a new inlet ice-protection system, and it is necessary that icing tunnel tests be made there.

The boiler plate program is meant to signify the construction of nacelle parts that are not necessarily flight weight but are adequate for ground testing to evaluate aerodynamic and acoustical properties.

In making these tests we also learn whether or not the modifications to the ducting have excited any different fan blade stresses over those allowable, and we then get our second look at the effectiveness of the thrust reverser and develop loads information needed for the production design and development of the actual thrust reverser parts.

Acoustical materials strength testing, details on how the acoustical materials will be secured, is a minor testing program indicated here.

Durability testing: parts built from production tools must be cycled through many cycles to demonstrate that they have the required integrity. The thrust reverser system is the most important part of this program. In his case an ice protection system, and some other affected systems would be involved also.

Finally flight testing validating both the performance and noise benefits and final certification.

The NASA contribution to the work on the short-duct fan-noise suppression system is for the DC-8 is indicated on the chart. We have some preliminary design studies completed for long duct DC-8 and DC-9 airplanes. We have mentioned earlier that we have allowed about $2\frac{3}{4}$ years for the development and certification period, and we feel that the third task indicated on the program, that of studying the schedule, must deal very carefully with the issue of whether or not our assumed schedule is feasible. We are impressed with the scope of the facilities problem and also to do a program of this nature there are a number of specialized personnel that must be involved. We see an unusual demand for those skilled personnel and facilities.

The scope of the problem is illustrated here in terms of facilities. If Boeing and Douglas Aircraft were to go ahead within the same span of time, the Nation's resources would be put to work developing six basic new powerplant packages involving 15 different engine models and 16 different wing designs. These are the critical development facilities that are normally used, and oftentimes in the past we find, for example, 9 months to a year's leadtime needed to get into one facility like this.

So, a serious effort needs to be applied to studying the allocation of all those facilities.

The next couple of charts indicate some of the factors involved in the compatibility of the timing of the delivery of the modifications and the retirement of the fleet. This is a chart for the DC-9 fleet: The upper chart—the total fleet, both foreign and domestic airplanes. We have projected that DC-9 sales will continue for several years and finally cease at some point in the order of 1976 and the fleet will remain relatively constant for several years.

The climate at this time is unfavorable to the idea of a rapid acquisition and introduction into the fleet of new technology airplanes. Our best estimate of the industry outlook indicates continued operation of this category of airplane until something like early 1981 and then a gradual retirement along this schedule ending with the last airplane going out of service in 1988. However, it is very likely that in a few years from now, the health of the industry will be improved and the

industry may be in a position to respond to pressures to introduce new technology airplanes at an earlier date than is indicated by this chart. Pressures being mainly twofold, that of accomplishing the reduced noise that the new technology can offer, and that of achieving the improved return on investment that completely new aircraft and engines could offer. It is therefore possible the retirement schedules in reality may more closely approach the 12-year depreciation interval that is a widespread industry practice for a write-off period.

So, we must observe that the actual retirement plan is a matter of some doubt at the moment, and it may occur somewhere in between, say, these two curves.

The earlier chart indicated that the first retrofit kit might be made available at this point in time, early 1977. Now, in the case of the DC-9, we still have a full fleet in operation at that time according to this estimate, but they are nearing the point of retirement somewhere in here. Naturally, an airplane would not be retrofitted if it is shortly to be retired from service. Therefore, a decision would have to be made as to the minimum depreciation interval over which this kind of investment should be amortized. If, for example, we assume that 5 years is a reasonable period over which to amortize the cost for modification, then the fleets qualifying for retrofit under these rules would be either here in the delayed conversion to new technology, or here if the 12-year rule should govern. If the 12-year rule were to govern or something of that nature, we would be faced with a prospect of a retrofit of something of a half or less of the fleet.

If only the United States were involved in the program, of course, potentially quite small fleets might be retrofitted, which tends to thwart the objective of reducing community noise and also offers the difficulty of increasing the unit cost in that the nonrecurring costs would be spread over a smaller base.

An analysis for the turbofan-powered DC-8 families shows a similar result. In this case, we are predicting a somewhat earlier trend toward retirement, airplanes in fact going out of service in the very near future at a gradual rate and then accelerating in the period 1980 and the years following. Clearly, the crucial issue in judging the feasibility of a program is going to depend upon proper judgments made in these several vital factors.

In studying the total cost of a retrofit program, in addition to the changes in the nacelle and the changes in the airframe, the effect of modifications to the airplane's performance must be considered in an economic context. The DC-8 long duct nacelle, as Mr. McPike indicated, is a little bit more sensitive to modifications since later technology to offset the performance effects of the acoustically-treated ducts is not available. We have made a brief analysis here to indicate the nature of changes in performance and how it should be accounted for in estimating overall economic impact. This is a concept for modification of the long duct. It is not necessarily the best one. The idea here is to provide a two-ring treated inlet. The existing fan exhaust ducts are in four segments. It appears the most economical way of retrofit would be to modify just these two duct segments and also not modify the external access doors and outer cowl structure.

In doing that, some increase in duct flow velocities are caused due to the restriction brought about by the thicker acoustical materials, creating some resistance to the flow from the discharge duct.

We estimated a reduction in takeoff thrust of approximately 6 percent due to the combined inlet and fan exhaust duct effects, a weight increase of approximately 1,900 pounds per airplane, and a cruise fuel consumption increase of the order of 3 percent. When these effects are considered on maximum payload at maximum range capabilities, there is a potential loss in payload on some segments. This is a tabulation of some 23 long-range city pairs that are considered important to long-range service in the future for which the DC-8 long duct 62 airplane was specifically designed. What we have tabulated here is the maximum payload reductions in terms of equivalent number of passengers that would be required to make good the particular city pair after the modification.

So, it reflects both the increased fuel required to make the trip and also the effect of the runway length at the particular airport involved.

You see in some cases there would be no loss in payload. In others, the payload loss could be rather significant and probably so large as to require the airplane be removed from nonstop service on that route.

Senator CANNON. San Francisco to Tokyo, 145 passengers?

Mr. PENDLEY. Yes. Baltimore to Honolulu, 95. The Baltimore problem basically arises from runway length.

Senator CANNON. That would just about fill up the airplane now.

Mr. PENDLEY. Well, the requirement here is to analyze this kind of an impact on routing airplane assignments, and it would be an economic factor that needs to be considered in the total assessment of the problem.

Mr. Chairman, your letter requested any comments we might have on S. 1566, and we would like to defer comments specifically on the bill. We feel there is some clarification needed of the section (d) part that describes the noise reduction requirements. As we understand them now, we don't foresee technology providing us the capability to meet the requirements, and we would urge that the intent of the bill be clarified, especially with regard to aircraft that meet FAR part 36 in 1971.

It has been a pleasure to have presented the foregoing information, and we trust it will be of use to the subcommittee.

Senator CANNON. Thank you very much. You have been very, very helpful.

In earlier testimony today we heard reference to a study conducted by Mr. William Dunn and James Rogers of Jet Sonics, Inc. which purportedly showed that jet engine noise could be reduced in the future from 17 to perhaps as much as 40 decibels.

Are you familiar with any such study?

Mr. PENDLEY. No, sir, we are not.

Senator CANNON. And that level of reduction certainly wouldn't be possible as a result of a retrofit program in any event, would it? It would have to be in a new engine development, would it not?

Mr. PENDLEY. We would see no possibility of any retrofit program approaching that magnitude of reduction.

Senator CANNON. How do you view the technological and economic feasibility of the development and production of a new quiet engine as called for this morning by the chairman of the CAB?

Mr. PENDLEY. We consider it both technically and economically feasible and indeed a proper investment.

Senator CANNON. Has your company explored this concept with the major U.S. engine manufacturers?

Mr. PENDLEY. Yes, sir. We are continually studying with them ways in which such an engine could be put together.

Senator CANNON. You are studying it. Is it beyond the study stage at the present time? Is it still in the talking and studying stage?

Mr. PENDLEY. Yes, sir. There are a number of optional ways in which such an engine could make use of all available noise reduction and thermodynamic design technology, and we are searching for the optimum combination. There is widespread concern about funding available to proceed with development, which is very much needed.

Senator CANNON. Have you completed all of your studies for NASA now, or do you have any in-house studies that you are presently conducting in this area for them?

Mr. PENDLEY. We have none in the area of retrofit, sir.

Senator CANNON. Senator Stevens?

Senator STEVENS. Do I understand your presentation to mean that if we proceeded with a total concept of your retrofit program, that by the time it could be tested, approved and installed, the maximum number of these three configurations that could be built would total about 200 American planes?

Mr. PENDLEY. The answer to the question requires an assumption on the actual retirement rate, Mr. Stevens, which we mentioned is a matter of some uncertainty. I would need guidance on what assumptions to make in terms of retirement in order to answer the question.

Senator STEVENS. More specifically, I am curious as to whether it is mechanically feasible to envision trying to make use of the equipment of the past and whether we should not confine our attention solely to the concept of designing a quiet engine for the future.

Have you reached a conclusion on that yourself?

Mr. PENDLEY. We feel that it is premature for us to state a conclusion until the impending work on the first three tasks we mentioned in the overall plan is completed.

Senator CANNON. Do you have any idea how long that will be?

Mr. PENDLEY. Yes, sir. We understand that the present program calls for availability of results in about 18 months.

Senator STEVENS. Thank you very much, Mr. Chairman.

Senator CANNON. Thank you, very much, Mr. Pendley and Mr. McPike. You have been very helpful.

(The statement follows:)

STATEMENT OF ROBERT E. PENDLEY AND A. L. MCPIKE,
DOUGLAS AIRCRAFT COMPANY, McDONNELL DOUGLAS
CORPORATION, LONG BEACH, CALIFORNIA

Mr. Chairman and members of the Subcommittee: My name is Robert E. Pendley. I am Chief Project Engineer of Noise Alleviation Programs at the Douglas Aircraft Company of the McDonnell Douglas Aircraft Corporation. It is a pleasure to appear today in response to the Chairman's letter of 1 July 1971 and to describe the results of our studies related to the reduction of noise emissions from DC-8 and DC-9 airplanes. I am accompanied by Mr. A. L. McPike, Chief Acoustics Engineer at the Douglas Aircraft Company, who will share the presentation with me and will supplement his discussion with tape recordings.

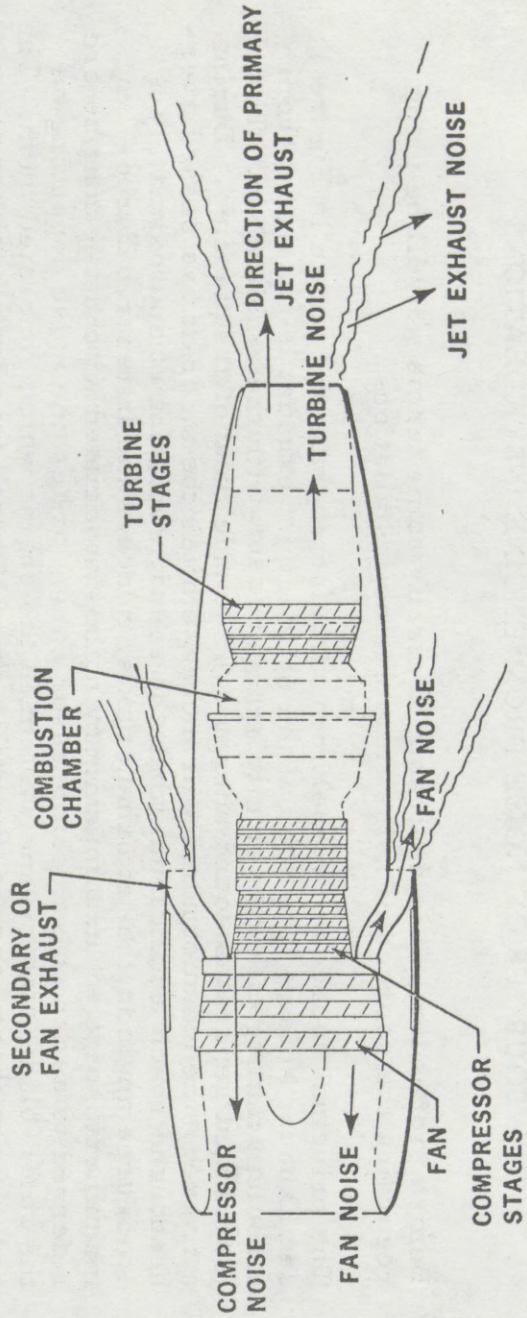
Our studies related to DC-8 and DC-9 noise reduction consist chiefly of two programs sponsored by the NASA and a Company-sponsored study of the feasibility of applying the NASA program results to the entire family of DC-8 and DC-9 models. One of the NASA programs dealt with a study of retrofitting a selected DC-8 model (the DC-8-61) with completely new quiet engines with new acoustically treated nacelles, and the other dealt with a study of retrofitting another DC-8 model (the DC-8-55) with new acoustically treated nacelles, but with continued use of the existing JT3D turbofan engines. We shall summarize both of these studies as well as our own study of the feasibility of fleet-wide application of the technology developed,

SOURCES OF NOISE FROM ENGINE INSTALLATIONS

Before proceeding, it is desirable to clarify some terms we will be using regarding the sources of noise from engine installations.

The principal sources of noise from turbofan engines are shown in Figure 1: Jet Exhaust Noise - The roar of the primary jet exhaust is generated from turbulent mixing of high-velocity exhaust gases with the ambient air. The jet exhaust generates sound energy over a wide band of frequencies. During a flyover, the exhaust noise will increase after the aircraft has passed overhead, and reach a maximum when the sound, radiating at approximately a 45-degree angle to the jet exhaust axis, reaches the listener. Turbo-machinery Noise - Turbomachinery noises associated with the jet engine are referred to as fan noise, compressor noise, or turbine noise depending on the rotor-blade/stator-vane system in the engine which generated them. The sound from these sources is usually characterized by a low-level broadband noise, and higher level discrete frequency tones where a substantial amount of energy is concentrated. Much of the sound energy from the turbomachinery noise sources is at higher frequency than the jet exhaust noise and the discrete frequency tones are heard as a whistle or whine. These tones occur at blade passage frequencies and their harmonics.

FIGURE 1
PRINCIPAL NOISE SOURCES - TURBOFAN ENGINES

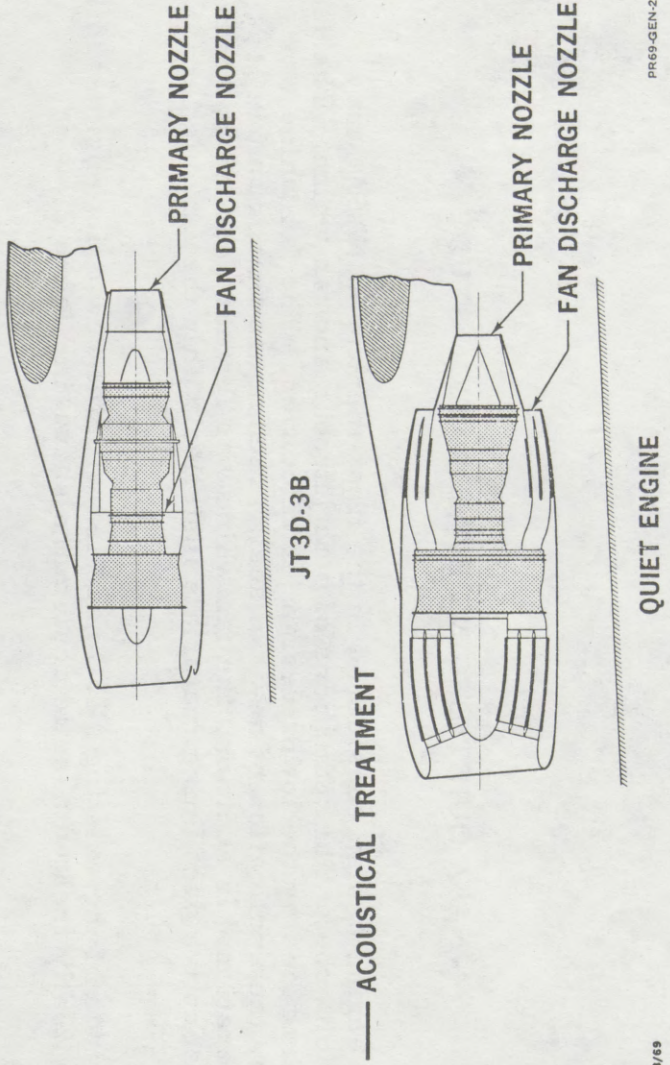


NASA QUIET ENGINE INTEGRATION STUDY

The quiet engine design considered in the first-mentioned NASA study provided for substantial reductions of both jet roar and fan whine. The jet roar was reduced by the lower design jet velocities. The fan whine was reduced by the application of new fan design techniques that result in less noise generation. In addition, the fan whine was further reduced by acoustically absorptive duct lining materials installed within the fan inlet and exhaust ducts.

A comparison of the existing JT3D nacelles with the new quiet engine and its new acoustically treated nacelle design are shown in Figure 2.

FIGURE 2
COMPARISON OF JT3D-3B AND
QUIET ENGINE INSTALLATIONS



Principal results of the study are shown in Figure 3. It was concluded that the initial and operating costs of the modifications were so high and the average airframe life remaining after retrofit would be so short that it would be economically preferable to invest the capital involved in new technology airplanes with a full useful life over which to amortize the investment.

FIGURE 3
RESULTS OF QUIET ENGINE INTEGRATION STUDY

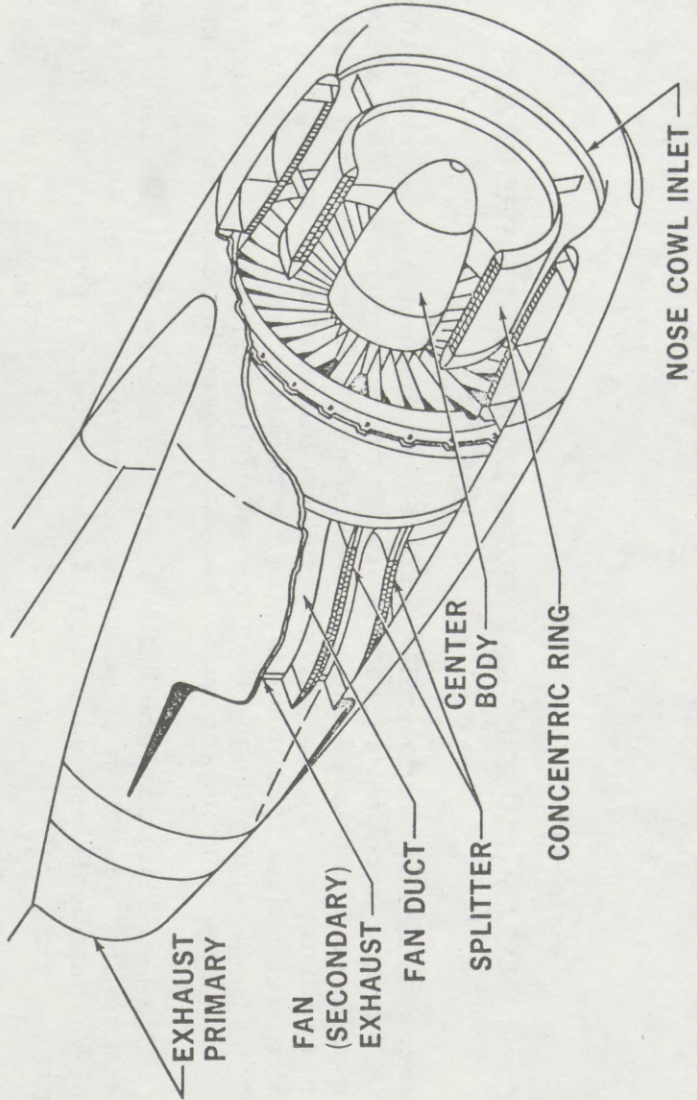
- OWE INCREASED 9800 LB
- DC-8-61 WING STRENGTH AND FLUTTER SATISFACTORY
- POWERED ELEVATOR AND REDUNDANT YAW DAMPER REQUIRED
- RANGE INCREASED 500 N MI WITH NORMAL PAYLOADS
- RETROFIT COST IN EXCESS OF \$6,000,000 PER A/P FOR 300 A/P
- DOC INCREASED 50% FOR 5-YEAR DEPRECIATION OF RETROFIT COST

NASA ACOUSTICALLY TREATED NACELLE PROGRAM

The acoustically treated nacelle designed, built, and flight-tested in the NASA Treated Nacelle Program is illustrated in Figure 4. This design was compatible with continued use of the existing JT3D engine and the existing primary thrust reverser. It required new fan inlet and exhaust ducts incorporating acoustical treatment for the reduction of fan whine. The fan exhaust ducts were 24 inches longer than the existing ones, which would require new fan thrust reversers to accommodate the revised fan exhaust duct contours.

The flight test articles were built to provide a correct evaluation of the effects of the modified design on noise and aerodynamics performance. Other nacelle components needed in a production nacelle were not built for this program.

FIGURE 4
ACOUSTICALLY TREATED NACELLE
INVESTIGATED IN NASA PROGRAM
DC-8 SHORT DUCT NACELLES



Noise reductions measured in the flight program are tabulated in Figure 5.

FIGURE 5

LANDING NOISE REDUCTIONS AT 370-FT HEIGHT UNDER A 3-DEGREE LANDING FLIGHT PATH

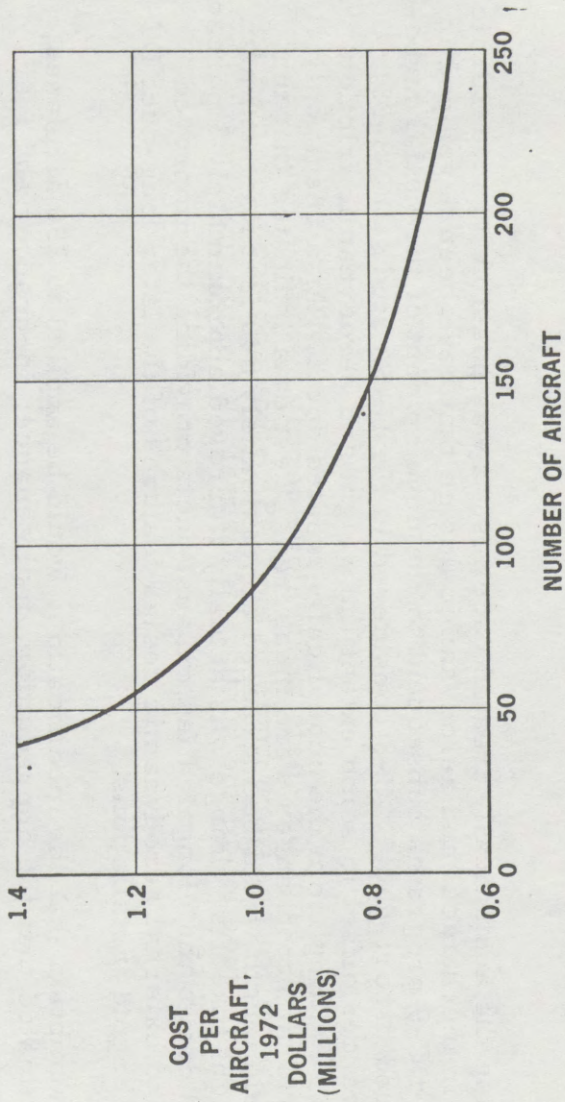
LANDING WEIGHT (LB)	NOISE REDUCTION (EPNdB)
240,000	10.5

TAKEOFF NOISE REDUCTIONS

TAKEOFF WEIGHT (LB)	NOISE REDUCTION UNDER FLIGHT PATH AT 3.5 N MI FROM BRAKE RELEASE (EPNdB)		REDUCTION IN MAXIMUM NOISE LEVEL ALONG 1500-FT SIDELINE (EPNdB)
	TAKEOFF- RATED THRUST	THRUST FOR 6% CLIMB GRADIENT	
325,000	3.5	5.5	3

Detailed estimates of the costs to develop, certify, produce, and install the nacelle modifications were made in the NASA study and are presented in Figure 6 as a function of the number of aircraft for which modification kits might be required.

FIGURE 6
ESTIMATED KIT COSTS
NASA ACOUSTICALLY-TREATED NACELLES
DC-8-50/-61 AIRPLANES; 20% SPARES

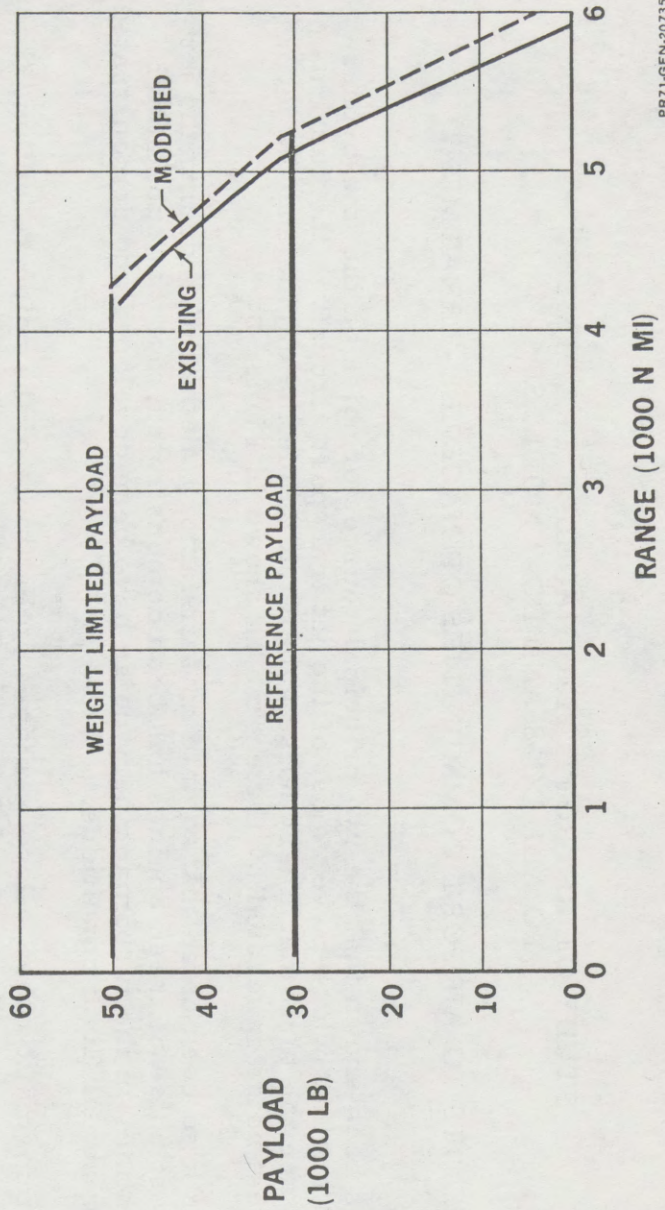


In designing the acoustically treated nacelles, it was possible to incorporate advances in mechanical and aerodynamic design that have been developed in DC-8 and DC-9 programs subsequent to the development of the initial turbo-fan-powered "short-duct" DC-8 considered in the NASA study (DC-8-55). These advances offset to some extent the weight and aerodynamic friction increases resulting from the acoustically treated ducts. As a result only minor performance changes were measured. Test data indicated that the takeoff field length would be increased approximately 800 feet for maximum gross weight takeoffs. Range was actually improved approximately 3 percent (Figure 7) due to the elongated fan exhaust ducts providing the improved internal and external aerodynamic design features of the later long-duct DC-8 and DC-9 engine installations.

On the assumption that the modifications would be applied to 250 airplanes, it was estimated that the depreciation, maintenance, insurance, and fuel cost changes would result in a direct operating cost increase of approximately 4.4 percent, almost all of which would result from the increased depreciation.

FIGURE 7 EFFECT OF NACELLE MODIFICATIONS ON PAYLOAD RANGE

DC-8-55



STUDY OF RETROFITTING NACELLE TREATMENT TO ALL DC-8 AND DC-9 MODELS

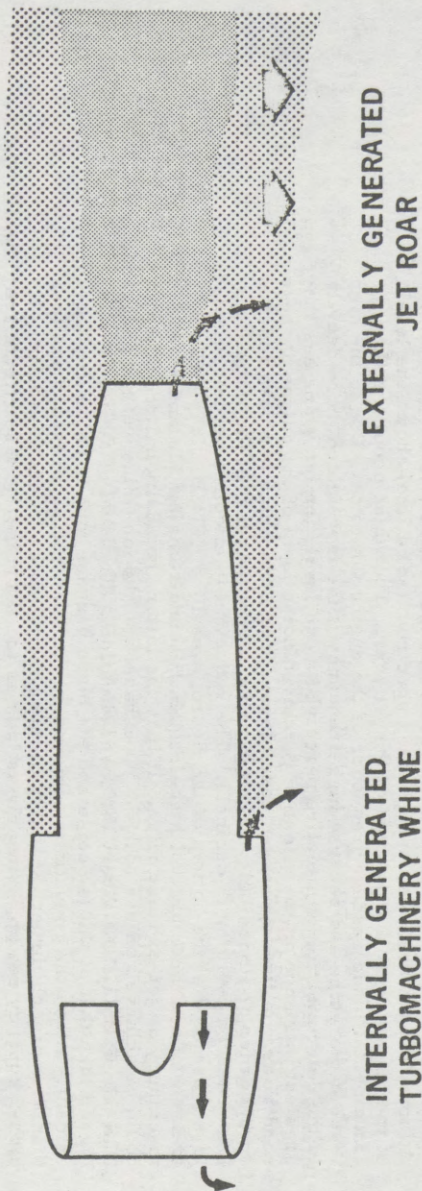
BENEFITS TO AIRPORT COMMUNITIES OF NACELLE-TREATMENT RETROFIT

It has been shown that the two principal sources of noise on the low-bypass-ratio engines which power most of the jet transport aircraft in the current fleet are the turbomachinery noise generated inside the engine and the jet exhaust noise generated by the engine as shown in Figure 8.

It has also been noted that to date no satisfactory method of reducing the jet exhaust noise of these engines has been demonstrated, but that substantial reductions in the turbomachinery noise have been developed and demonstrated under actual flight conditions.

The information that follows provides an estimate of the noise reductions that could be accomplished for DC-8 and DC-9 aircraft using the available technology to reduce engine turbomachinery noise. Consideration is also given to the change in total noise exposure which airport neighbors might experience if this technology were applied to the current fleet.

FIGURE 8
PRINCIPAL NOISE SOURCES
TURBOFAN ENGINES



NOISE REDUCTION OF A JT3D WITH TREATED NACELLE - OUTDOORS

Figure 9 shows an example of the noise reduction that was achieved outdoors by the nacelle treatment utilized in the NASA program. The reduction achieved during landing approach power is shown at the left and that at takeoff power is at the right. Approach data are for an altitude of 370 feet which corresponds to the FAA noise certification requirements. Takeoff data are for an altitude of 1500 feet, which, at the time the data were taken, approximated the distance for the sideline requirement of FAA noise certification. At approach powers, the unsuppressed spectrum (solid line) shows the level of the fan whine well above that of the jet roar. The whine occurs at the fundamental blade passage frequency of the engine fan rotor. Due to the high level of the whine and because high-frequency noise is weighted more heavily in the determination of effective perceived noise level, the fan whine has the greatest influence on the effective perceived noise level of the engine at these conditions. In the suppressed case (dashed line), the whine has been reduced on the order of 20 decibels. The fan noise, other than that of the whine, has been reduced by 10 to 15 decibels. The reduction in effective perceived noise level, as noted at the bottom of the figure, was 10.5 EPNdB. It is difficult to say whether the source of high-frequency sound remaining is turbo-machinery or jet-exhaust noise. If it is the latter, no additional reduction could be achieved unless both the jet exhaust and the fan whine were suppressed. The takeoff data show a very different situation. The level of the jet roar is higher than that of the fan noise and the blade passage tone is not nearly as evident. Also, the reductions achieved by the fan noise suppressors are less than at approach thrust, probably because the jet noise level, even in the high-frequency region, is nearly as high as the fan noise. These effects are reflected in the reduction of effective perceived noise level, which is only 3 EPNdB. Thus the effectiveness of fan noise-suppression depends on the elimination of strong tones and also on the relative level of the jet exhaust noise and the fan whine. Furthermore, for some current turbofan powered aircraft, the addition of fan noise-suppression treatment would result in a loss in aircraft performance. This would cause the aircraft to pass over a community, during takeoff, at a lower altitude. Thus, for an aircraft performing a specific mission, the result of adding nacelle treatment could be an increase in noise levels in communities under the takeoff flight path.

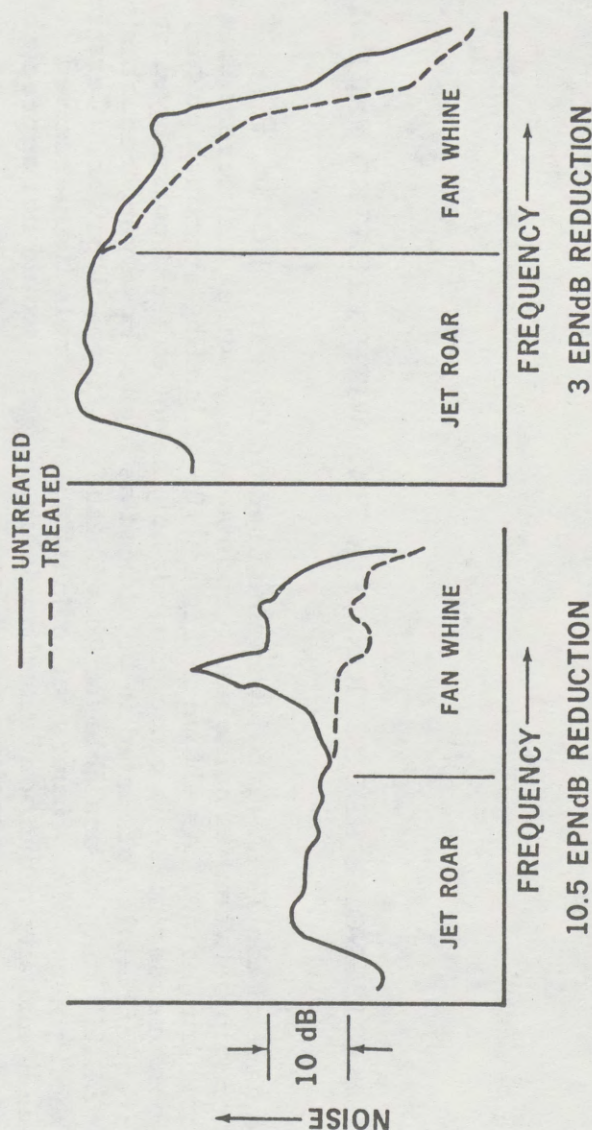
FIGURE 9

DC-8 - NACELLE NOISE SUPPRESSION - JT3D SHORT DUCT POD

POSSIBLE REDUCTIONS BASED ON NASA PROGRAM RESULTS

LANDING APPROACH POWER (370-FT ALTITUDE)

TAKEOFF POWER (1500-FT ALTITUDE)



ESTIMATED NOISE REDUCTION OF A JT4A WITH TREATED NACELLE

In the case of the JT4A turbojet engine used on the early DC-8s, the relationship between jet noise and turbomachinery noise is different than for the turbofan engine. As shown in Figure 10, at landing approach power, the inlet compressor noise is quite distinct but the jet exhaust noise level at high frequencies is estimated to be almost as high. However, reductions of a few EPNdB may be possible for this engine at approach power. Certainly at takeoff power, the primary jet exhaust noise controls the perceived noisiness and any reduction in turbomachinery noise would not appreciably reduce the effective perceived noise level.

DC-8 - NACELLE NOISE SUPPRESSION - TURBOJET JT4A

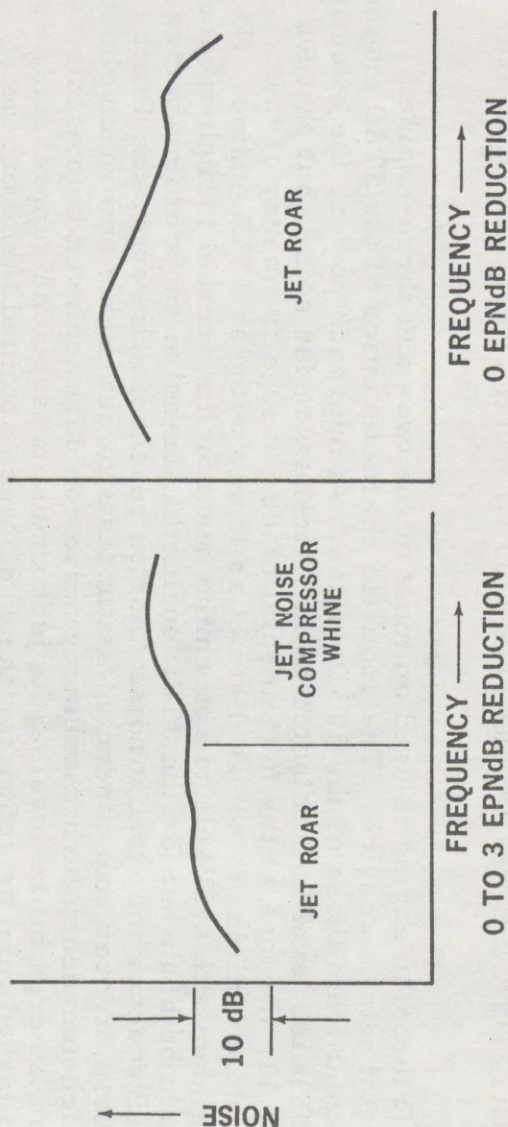
FIGURE 10

ESTIMATED POSSIBLE REDUCTIONS

LANDING

APPROACH POWER
(370-FT ALTITUDE)

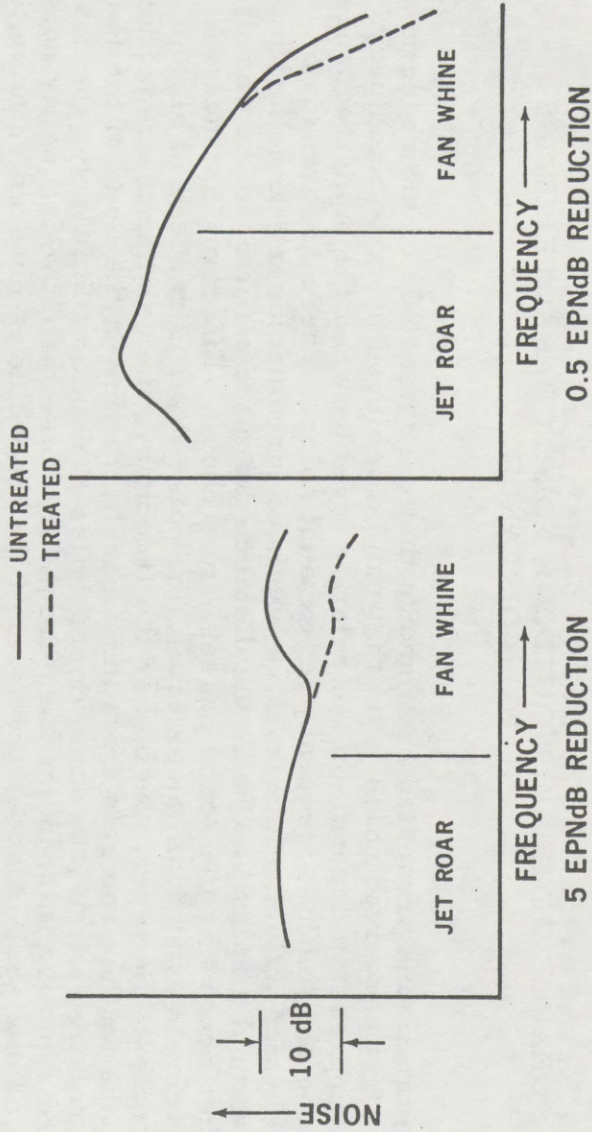
TAKEOFF POWER
(1500-FT ALTITUDE)



ESTIMATED NOISE REDUCTION OF A JT8D WITH TREATED NACELLE

The JT8D turbofan engine is used on most of the two- and three-engine commercial jets in service. The acoustic characteristics of the JT8D engine are different from those of the JT3D engine. At approach power, the effective perceived noise level is dominated by high-frequency fan noise, but as seen in Figure 11, the tone at the fundamental blade passage frequency of the engine, while audible, is not as distinct as it was with the JT3D engine. No flight test data are available to determine how much reduction in high-frequency noise could be achieved for the JT8D engine by fan noise suppression before the high-frequency jet exhaust noise floor is reached. However, the Pratt and Whitney Aircraft has conducted static tests to determine how much reduction in high-frequency turbomachinery noise could be achieved before this noise was lowered to the level of the jet exhaust noise. The suppressed spectra (dashed line) as shown for the JT8D were obtained by taking the measured spectra of an unsuppressed DC-9 (solid line) and applying the noise reductions provided by Pratt and Whitney Aircraft. This procedure approximates the results that might be accomplished by installing fan noise suppression treatment in the JT8D engine. The estimated reduction achieved was 5 EPNdB at approach power at a 370-foot altitude. At takeoff power, no fan tone is apparent in the spectrum and the high-frequency noise is probably controlled by jet exhaust noise. A reduction of 0.5 EPNdB was estimated for takeoff power at 1500-foot altitude.

DC-9 - NACELLE NOISE SUPPRESSION - JT8D
ESTIMATED POSSIBLE REDUCTIONS
LANDING APPROACH POWER **TAKEOFF POWER**
(370-FT ALTITUDE) **(1500-FT ALTITUDE)**



CHANGE OF INDOOR/OUTDOOR NOISE CHARACTERISTICS WITH DISTANCE

The comparisons presented have shown that the magnitude of the reduction in effective perceived noise level that can be achieved by turbomachinery noise suppression depends on the relative level between the high-frequency fan whine and the low-frequency jet exhaust noise. There are two major factors which influence the relative levels of turbomachinery noise and jet noise around airports. One is the distance from the aircraft to the observer; the other occurs as the sound passes into a house. Effect of Distance: As sound travels away from an aircraft, the noise level is reduced at all frequencies. However, the higher the frequency, the greater the reduction. Thus, the farther one gets from the aircraft, the lower the level of the fan whine relative to the jet roar. House Noise Reduction: Similarly, the house is more effective in reducing high-frequency noise than low-frequency noise. Thus, as one goes indoors, the level of the fan whine is lowered relative to the level of the primary jet roar. Because comparatively few airport neighbors live in a location where aircraft pass within 370 feet of them on approach and because people are not always outdoors when they are subjected to aircraft noise, it is important to consider these factors in assessing the possible benefits of fan noise suppression for current aircraft.

AS THE DISTANCE FROM AN AIRCRAFT IS
INCREASED THE HIGH-FREQUENCY WHINE IS
REDUCED MORE THAN THE LOW-FREQUENCY
ROAR

AS THE SOUND PASSES FROM OUTSIDE TO
INSIDE A HOUSE, THE HIGH-FREQUENCY WHINE
IS REDUCED MORE THAN THE LOW-FREQUENCY
ROAR

COMPARISON OF INDOOR NOISE LEVELS, APPROACH AND TAKEOFF POWER

The information shown in Figure 12 is based on data taken during the flight test phase of the NASA program mentioned previously. In this case, data were taken with the aircraft at a distance of 1500 feet for both approach and takeoff powers. To the data, which were obtained out-of-doors, typical house noise reductions were applied. The reductions were obtained from a proposed Aerospace Recommended Practice of the Society of Automotive Engineers for a single-family frame house with windows partly open. Note that at approach power for the untreated engines, the highest level of the jet roar is about equal to the level of the fan whine. By contrast, as was shown in Figure 9, the relative level of the jet roar was much lower outdoors at 370 feet. Because of this relative change in low-to-high-frequency noise levels, the reduction achieved due to fan whine suppression is only 8.5 EPNdB at approach power. At takeoff power where the level of the jet roar is much higher than that of the fan whine, the overall suppression is only 1 EPNdB.

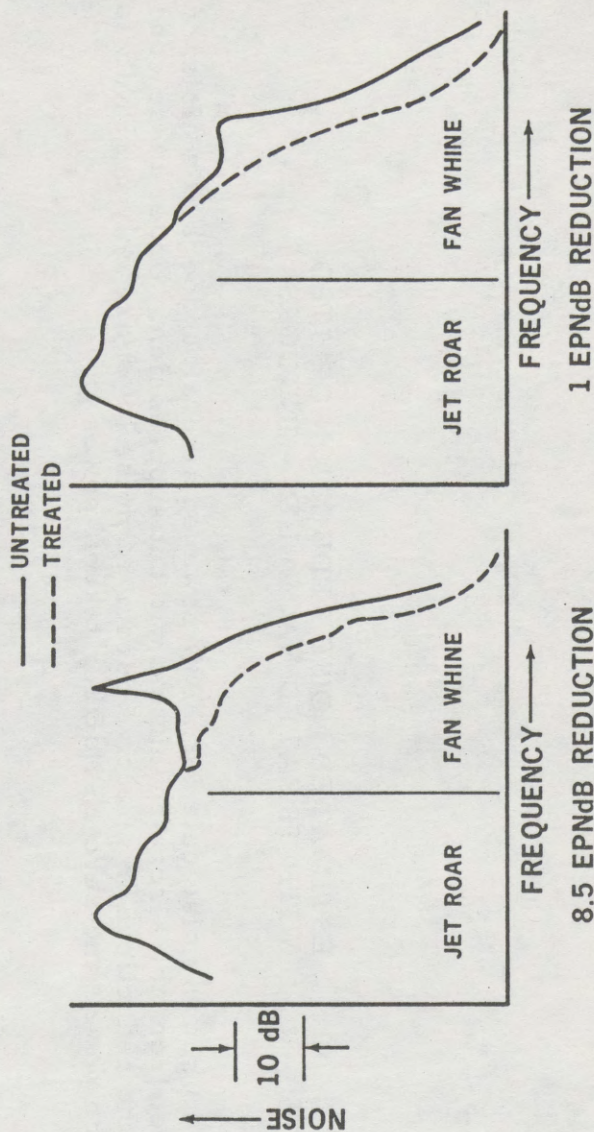
FIGURE 12

DC-8 - NACELLE NOISE SUPPRESSION - JT3D

ESTIMATED POSSIBLE REDUCTIONS - INDOORS

LANDING APPROACH POWER (1500-FT ALTITUDE)

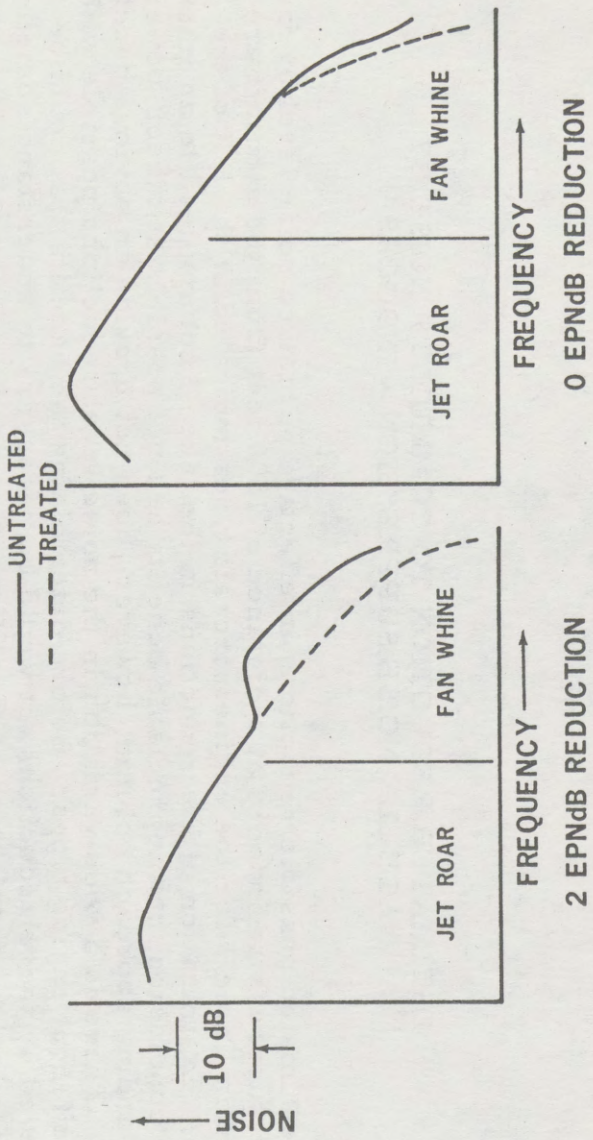
TAKEOFF POWER (1500-FT ALTITUDE)



ESTIMATED NOISE REDUCTION OF JT8D WITH TREATED NACELLES - INDOORS

Figure 13 shows noise data for JT8D powered aircraft indoors at a distance of 1500 feet from the aircraft with and without suppression. Under these conditions, the reductions in effective perceived noise level are only 2 EPNdB for approach power and zero EPNdB for takeoff power.

FIGURE 13
DC-9 - NACELLE NOISE SUPPRESSION - JT8D
 ESTIMATED POSSIBLE REDUCTIONS - INDOORS
LANDING APPROACH POWER **TAKEOFF POWER**
 (1500-FT ALTITUDE) (1500-FT ALTITUDE)



ESTIMATED REDUCTION TO COMMUNITY NOISE BY NACELLE NOISE SUPPRESSION - INDOORS

The estimated possible reductions in effective perceived noise level by fan noise suppression indoors at a distance of 1500 feet from the aircraft are shown in Table 1 for the engine/aircraft types indicated at the left of the table. Examination of the reductions in the takeoff column lead to an immediate conclusion that appreciable benefits are not possible at takeoff power. The landing approach column, however, does not provide an obvious conclusion. There is a wide variation in the noise level reductions possible with the different engine types. Before determining the benefits that could be achieved by these reductions, it would be necessary to understand something of the relative contribution of the different engine/aircraft types to the neighborhood noise exposure.

TABLE 1
ESTIMATED BENEFITS OF NACELLE
NOISE SUPPRESSION INDOORS

ENGINE/AIRPLANE	LANDING APPROACH POWER	TAKEOFF POWER
JT3D TURBOFAN DC-8, 707, 720	8.5	1
JT8D TURBOFAN DC-9, 727, 737	2	0
JT4A TURBOJET DC-8, 707, 720	0	0

NOTE: REDUCTIONS IN EPNdB

RELATIVE CONTRIBUTION TO COMMUNITY NOISE - EXPOSURE BY AIRCRAFT TYPES

850

Nearly all methods developed to rate airport community noise exposure are based on the noise levels and the number of takeoffs and landings at the airport. Table 2 summarizes the effect on community noise exposure of the number of flights of the predominant aircraft types in the U.S. The first column shows, for each aircraft/engine type, the percentage of the total jet transports in commercial service. The second column shows the ratio of each category compared to a reference of the four-engine turboprop. Note that there are 1.7 times as many of the two- and three-engine turboprop-powered aircraft as there are of the four-engine turboprop-powered aircraft. The third column considers another factor which influences the number of exposures. Because the two- and three-engine aircraft operate over shorter ranges, they make about twice as many flights a day (and consequently twice as many takeoffs and landings) as the four-engine aircraft. The combined effect of the greater number of aircraft and flights per aircraft results in 3.4 times as many operations for the two- and three-engine aircraft as for the four-engine turboprop aircraft. Doubling the number of noise occurrences is equivalent to increasing the level of annoyance by 3 EPNdB. Comparing the two- and three-engine to the four-engine aircraft, i.e., almost twice as many aircraft and twice as many flights per aircraft, combines to effect a 5.3-EPNdB correction. Because there are so few four-engine turbojets in domestic operation, their contribution to noise exposure would be reduced by 7 EPNdB relative to the four-engine turboprops using this same method of calculation.

TABLE 2
ESTIMATED EFFECT ON COMMUNITY NOISE EXPOSURE
OF THE NUMBER OF FLIGHTS FOR VARIOUS
COMMERCIAL AIRCRAFT TYPES IN U.S. SERVICE

AIRCRAFT TYPE	PERCENTAGE OF TOTAL IN SERVICE	NUMBER OF AIRCRAFT RELATIVE TO 4-ENGINE TURBOFAN	NUMBER OF FLIGHTS/DAY RELATIVE TO 4-ENGINE TURBOFAN	CORRECTION TO TOTAL EXPOSURE FOR NUMBER OF FLIGHTS
4-ENGINE TURBOFANS	34	1.0	1.0	EPNdB 0
4-ENGINE TURBOJETS	7	0.2	1.0	-7
2- AND 3-ENGINE TURBOFANS	58	1.7	2.0	+5.3

RELATIVE CONTRIBUTION TO ANNOYANCE DURING APPROACH

Table 1 demonstrated that, for takeoff power, no benefits could be expected for typical airport neighbors by applying fan noise suppression to the engines on the current fleet of turbofan-powered aircraft. Because the benefits at landing approach power were not so clear, estimates have been prepared showing the reduction in total noise exposure outdoors at the FAA certification location and indoors at 1500 feet. Table 3 considers the relative contribution to total annoyance of the various aircraft categories outdoors at 370 feet.

Column 1 gives the noise levels of the three categories relative to an arbitrary level of 100 EPNdB selected for the four-engine turbofan aircraft. There may be different opinions as to what these levels are, but, for the purpose of this evaluation, only relative levels are important. The four-engine turbojet and the two- and three-engine turboprops, both about 5 EPNdB below the average of the four-engine turboprops, are entered at 95 EPNdB. Column 2 introduces corrections for the number of flights developed in Table 2. Column 3 combines Columns 1 and 2 to get an index of the total relative contribution for each aircraft category in an unsuppressed condition. Note that for the four-engine turbojet, the lower noise level and smaller number of occurrences result in the smallest contribution. For the two- and three-engine aircraft, however, the greater number of operations compensate for the lower noise levels and the total contribution to the exposure is about the same as for the four-engine turboprops. The logarithmically combined total index of annoyance for all three categories is given at the bottom of Column 3. The combined total of 103.3 EPNdB in Column 3 might appear at first to be an error. Adding the numbers in the column arithmetically would result in a much higher total. However, in combining the noise level of different sources in EPNdB, logarithmic addition is used. The number of 103.3 is consistent with a general noise rule that two noises of the same level combine to form a new level which is 3 EPNdB higher than that of the individual sources. Column 4 contains the estimated possible suppression for each category as described in Figures 9, 10 and 11. Column 5 combines the data in Columns 3 and 4 to obtain an estimate of what the total relative contribution of each aircraft category would be if estimated fan noise reduction were achieved. The two- and three-engine aircraft category would then make the greatest contribution to the noise exposure. Again the combination of the contributions to annoyance for all three categories is given at the bottom of Column 5.

TABLE 3
ESTIMATED RELATIVE CONTRIBUTION TO TOTAL NOISE
EXPOSURE OF VARIOUS AIRCRAFT TYPES DURING
APPROACH OUTDOORS AT 370 FT

AIRCRAFT	(1) RELATIVE NOISE LEVEL	(2) CORRECTION TO TOTAL EXPOSURE FOR NUMBER OF FLIGHTS	(3) TOTAL RELATIVE CONTRIBUTION (UNSUPPRESSED) (1) + (2)	(4) ESTIMATED POSSIBLE SUPPRESSION	(5) TOTAL RELATIVE CONTRIBUTION (SUPPRESSED) (3) + (4)
4-ENGINE TURBOFAN	100	0	100	10.5	89.5
4-ENGINE TURBOJET	95	-7	88	0	88
2-AND 3-ENGINE TURBOFAN	95	+5.3	100.3	5	95.3
TOTAL INDEX OF ANNOYANCE (IN UNITS OF EPNdB)			103.3		96.9

TOTAL RELATIVE ANNOYANCE OUTDOORS AT 370 FEET

Table 4 uses the information developed in Table 3 for the 370-foot altitude approach case outdoors to compare the total relative annoyance if either four-engine or all turbofan aircraft were treated. The first column presents the total relative annoyance level for the three conditions noted. 103.3 and 96.9 EPNdB came directly from Table 3. The 100.9 EPNdB was obtained by adding, logarithmically, the contribution of the four-engine turbofan category when suppressed to that of the other two categories when unsuppressed. The total reduction achieved is shown in the second column. The data indicate that only a very small reduction would be achieved by treating only the four-engine turbofan category, but that an appreciable reduction in approach noise could be achieved at 370 feet if all turbofans were treated.

TABLE 4
ESTIMATED TOTAL RELATIVE ANNOYANCE LEVELS
OUTDOORS AT 370 FT DURING APPROACH

CURRENT CONFIGURATIONS	RELATIVE LEVEL	REDUCTION ACHIEVED
4-ENGINE TURBOFANS ONLY SUPPRESSED	103.3	0
ALL TURBOFANS SUPPRESSED (IN UNITS OF EPNdB)	100.9	2.4
	96.9	6.4

TOTAL RELATIVE ANNOYANCE INDOORS AT 1500 FEET

Table 5 examines the effect on total approach-noise exposure for the typical neighbor indoors at 1500 feet. As before, a level of 100 EPNdB has been selected for the noise level of the four-engine turbfan. As shown in Column 1, the noise of the aircraft in the other two categories is only 3 EPNdB below that of the reference aircraft. The correction to total exposure in Column 2 is the same as developed in Table 2. Column 3 indicates that, in the unsuppressed case, the two- and three-engine aircraft contribute more in total annoyance than the four-engine turbfan aircraft. If the possible suppressions of Column 4 are applied, then the contribution of the two- and three-engine aircraft would be much greater than that of the four-engine turbfan aircraft.

TABLE 5
ESTIMATED RELATIVE CONTRIBUTION TO TOTAL ANNOYANCE
OF VARIOUS AIRCRAFT TYPES DURING APPROACH
INDOORS AT 1500 FT

AIRCRAFT	(1) RELATIVE NOISE LEVEL	(2) CORRECTION TO TOTAL EXPOSURE FOR NUMBER OF FLIGHTS	(3) TOTAL RELATIVE CONTRIBUTION (UNSUPPRESSED) (1) + (2)	(4) ESTIMATED POSSIBLE SUPPRESSION	(5) TOTAL RELATIVE CONTRIBUTION (SUPPRESSED) (3) + (4)
4-ENGINE TURBOFAN	100	0	100	8.5	91.5
4-ENGINE TURBOJET	97	-7	90	0	90
2-AND 3-ENGINE TURBOFAN	97	+5.3	102.3	2	100.3
COMBINATION OF THE CONTRIBUTIONS (IN UNITS OF EPNdB)			104.5		101.2

SUMMARY OF TOTAL RELATIVE ANNOYANCE INDOORS AT 1500 FEET

Table 6 uses the information developed in Table 5 to show (a) treatment of the four-engine turboprops would result in a reduction of 1.6 EPNdB in total exposure to the typical neighbor, and (b) treating all the turboprops would result in a reduction of 3.3 EPNdB in the exposure for this neighbor, during approach. Recalling that for the neighbor indoors there is essentially no benefit when the aircraft is at takeoff power, the average improvement at takeoff and landing powers would be less than 2 EPNdB. While no examination of the improvements has been made where noise abatement thrust reductions are utilized after takeoff, it is not expected that the average improvement would be significantly modified by such a procedure. In addition, it should be recalled that, as one gets farther than 1500 feet from the aircraft, the benefits are further reduced. Also people in houses with doors and windows closed and buildings with some sound insulation or with air-conditioning would experience less in the way of benefits even at 1500 feet.

TABLE 6
ESTIMATED TOTAL RELATIVE ANNOYANCE LEVELS
INDOORS AT 1500 FT DURING APPROACH

	RELATIVE LEVEL	REDUCTION ACHIEVED
CURRENT CONFIGURATIONS	104.5	0
4-ENGINE TURBOFANS ONLY SUPPRESSED	102.9	1.6
ALL TURBOFANS SUPPRESSED (IN UNITS OF EPNdB)	101.2	3.3

SUMMARY

A number of assumptions were necessary to develop the information presented. Actual reductions in noise exposure which could be achieved for any particular airport community would depend on the combination of aircraft types at that airport, the relative contribution of takeoffs and landings, the distance from the aircraft flight paths to the communities, the type of dwellings in the community, etc. The information does raise a serious question as to whether or not meaningful reduction in community noise exposure can be accomplished without reducing jet exhaust noise in addition to turbomachinery noise. This question is applicable even if the turbomachinery noise could be eliminated immediately. Another important consideration is the time needed to implement a noise-suppression program and qualify the system for flight certification. During this time, the makeup of the fleet would be considerably changed. The JT3D-powered aircraft, which would benefit the most from fan noise-suppression, would become a smaller percentage of the total fleet. This would be due to the expected retirement of the current four-engine jets, the continued deliveries of the JT8D-powered aircraft and of the new wide-bodied jets powered by high-bypass-ratio turbofan engines. A more detailed examination of the overall question of the possible benefits from nacelle suppression is needed.

MEANINGFUL REDUCTIONS IN AIRPORT COMMUNITY
NOISE EXPOSURE WILL REQUIRE THE REDUCTION OF
BOTH THE JET ROAR AND THE FAN WHINE OF
CURRENT LOW-BYPASS-RATIO TURBOFAN ENGINES

861

PR71-GEN-20726

TECHNICAL AND ECONOMIC FEASIBILITY OF NACELLE TREATMENT RETROFIT

Description of Douglas Fleet

DC-8 and DC-9 transports presently in service number approximately 1100 airplanes. As shown in Figure 14, these airplanes involve five basically different powerplant nacelle designs, within which 15 different engine models are installed. Airplanes equipped with the different designs vary in number from relatively few (29 Conways) to relatively numerous (598 DC-9's).

Approximately half of the fleet is in the service of foreign operators.

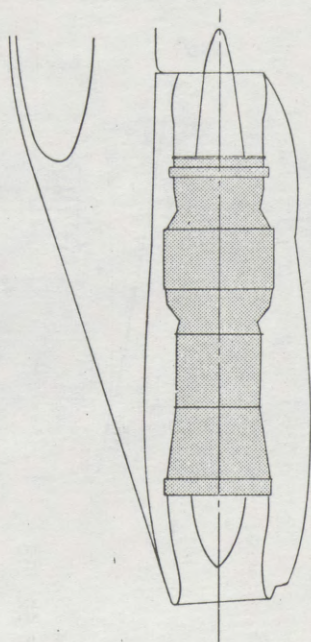
FIGURE 14
DC-8 AND DC-9 TRANSPORTS PRESENTLY IN SERVICE

MODEL	ENGINES	NACELLE CONFIGURATION	NUMBER AIRCRAFT WITH COMMON NACELLES		
			USA	FOREIGN	TOTAL
DC-8	20 -21 -31 30 -32 -33	STANDARD JT4	71	27	98
	JT4A,-3,-9 JT4A -3 JT4A,-3,-10 JT4A,-9,-11,-12				
	41 40 -42 -43				
	R CO 12 R CO 12 R CO 12				
	51 52 53 54F 55 61 61F	SHORT DUCT *	140	92	232
	JT3D -1 JT3D -1 JT3D -3 JT3D -3 JT3D -3,-3B JT3D -3B JT3D -3B				
	60 -62 -62F -63 -63F				
	JT3D,-3B,-7 JT3D,-3B,-7 JT3D,-3B,-7 JT3D -7				
	10 20 30 40	STANDARD DC-9	351	247	598
	JT8D,-1,-5,-7 JT8D,-9,-11 JT8D,-1,-7,-9,-11 JT8D,-9,-11				
DC-9					

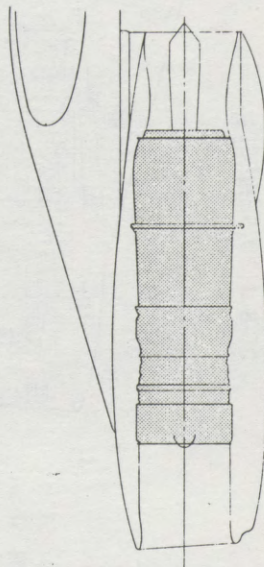
*STUDIED IN NASA PROGRAM

Sketches of the existing nacelle designs are presented in Figures 15, 16, and 17. The shaded areas in the sketches represent the engines delivered by the engine manufacturers. The remaining components indicated represent the nacelles and supporting pylons provided by Douglas.

FIGURE 15
DOUGLAS FAMILY OF POWER PLANT INSTALLATIONS
DC-8 JT4 AND CONWAY SERIES

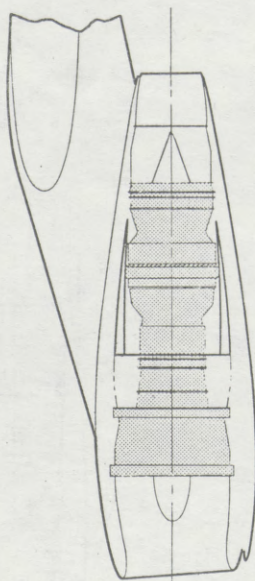


JT4

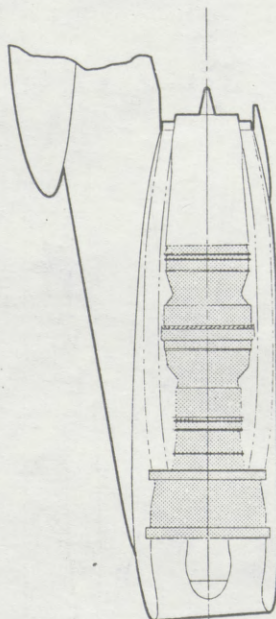


CONWAY

FIGURE 16
DOUGLAS FAMILY OF POWER PLANT INSTALLATIONS
DC-8 JT3D SERIES

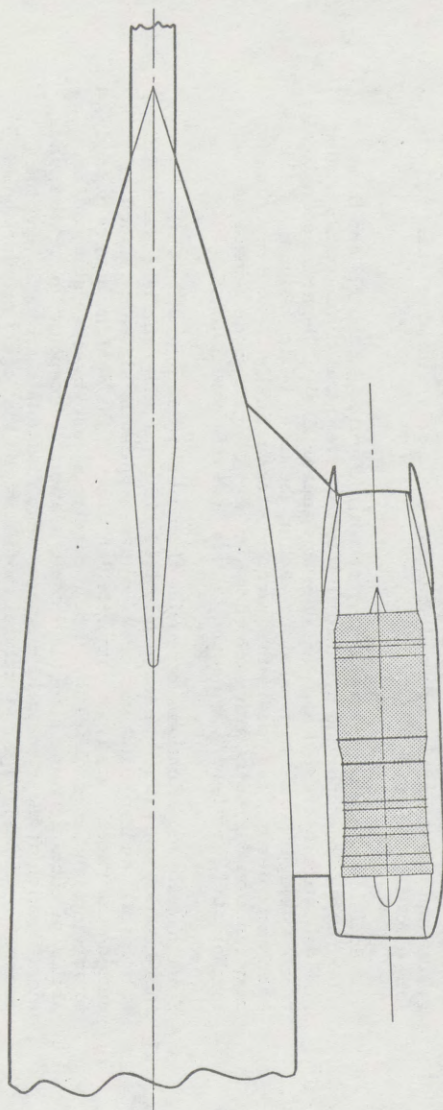


DC-8-50/-61
(STUDIED IN NASA
PROGRAM)



DC-8-62/-63

FIGURE 17
DOUGLAS FAMILY OF POWER PLANT INSTALLATIONS
DC-9 SERIES



Tasks Needed to Develop Acoustically Treated Designs

Both jet-roar and fan-whine noises are radiated from JT4- and Conway-powered DC-8's. For these engines, however, the jet noise is dominant and the suppression of compressor noise would not appreciably reduce the annoyance perceived in airport communities. In addition, these airplanes were the earliest of the Douglas jet transports to enter service, and most likely will be retired from service relatively soon. For these reasons, JT4- and Conway-powered airplanes are not believed to be prospects for retrofit programs and the remainder of my discussion deals only with short-duct DC-8's, long-duct DC-8's, and DC-9's.

The nacelles under consideration for retrofit (Figures 16 and 17) and their interfaces with supporting pylons differ to the extent that commonality among new acoustically treated nacelles does not appear likely. Separate acoustically treated designs would be needed for each of the three basic designs. Within each basic design, it appears that a common acoustically treated modification may function correctly with each of the different engine models involved, but further study and testing is needed to establish this possibility.

Since nacelle modifications to provide acoustical treatment will usually increase the weight and aerodynamic loads acting on the nacelles, the modification will usually result in increased loads applied to airframe structure outside the nacelle area. A complete definition of the design changes needed to accomplish the modifications would require a case-by-case study of the ability of each airframe structural configuration to accept the increased loads, identification of the structural members with inadequate strength, and the generation of designs for structural modifications that could provide the needed additional strength.

A large number of such cases would require study owing to the large number of structural variants within the families of DC-8 and DC-9 models. Figure 18 is a tabulation of some of the major structural variants, categorized primarily by wing area and design gross weight. Within many of the cases listed in Figure 18, subvariants exist due to variations in certified weights other than maximum gross weight (e.g., maximum zero fuel weight and maximum landing weight).

FIGURE 18
LIST OF JT3D-POWERED
DC-8, AND ALL DC-9 AIRPLANES

AIRPLANE MODEL AND SERIES	ENGINE MODEL	WING AREA (SQ FT)	PRERETROFIT MTOW (LB)
DC-8-51DM	JT3D-1	2772.5	276,000
DC-8-51DM	JT3D-1	2883.6	276,000
DC-8-51DM	JT3D-3	2883.6	276,000
DC-8-51DM	JT3D-3B	2772.5	276,000
DC-8-51DM	JT3D-3B	2883.6	276,000
DC-8-51DM	JT3D-3B	2883.6	286,000
DC-8-52OW	JT3D-1	2772.5	300,000
DC-8-52OW	JT3D-3	2883.6	300,000
DC-8-52OW & 52OM	JT3D-3B	2883.6	300,000
DC-8-53OW	JT3D-1	2772.5	315,000
DC-8-53OW	JT3D-3	2883.6	315,000
DC-8-53OW	JT3D-3B	2883.6	315,000
DC-8-54JT	JT3D-3	2883.6	315,000
DC-8-54JT	JT3D-3B	2883.6	315,000
DC-8-55JT	JT3D-3B	2883.6	325,000
DC-8-61; 61CF	JT3D-3B	2883.6	325,000
DC-8-62; 62CF, 62AF	JT3D-3B	2926.8	335,000
DC-8-62AF	JT3D-7	2926.8	335,000
DC-8-62; 62CF	JT3D-3B	2926.8	350,000
DC-8-62	JT3D-7	2926.8	350,000
DC-8-63	JT3D-3B	2926.8	350,000
DC-8-63; 63CF, 63AF, 63PF	JT3D-7	2926.8	355,000
DC-8-63; 63CF	JT3D-7	2926.8	350,000
DC-9-11, -12, -13, -14, -15	JT8D-1, -7, -7A	934.3	90,700
DC-9-21	JT8D-9, -11	1000.7	100,000
DC-9-31	JT8D-1, -7, -7A, -9, -11	1000.7	105,000
DC-9-31	JT8D-1, -7, -7A, -9, -11	1000.7	108,000
DC-9-32	JT8D-1, -7, -7A, -9, -11	1000.7	108,000
DC-9-32F	JT8D-1, -7, -7A, -9, -11	1000.7	108,000
DC-9-33F	JT8D-1, -7, -7A, -9, -11	1000.7	114,000
DC-9-41	JT8D-9, -11	1000.7	114,000

LEGEND:

DM — DOMESTIC
OW — OVERWATER
JT — JET TRADER
AF — ALL FREIGHTER
CF — CONVERTIBLE FREIGHTER
PF — PASSENGER FREIGHTER
F — FREIGHTER

Tasks and Schedule Requirements for a Fleet Retrofit Program

An estimated schedule of the major tasks required to accomplish a total retrofit program for the DC-8/DC-9 fleets is indicated in Figure 19. The first task refers to two programs recently initiated by the FAA that are directed at the evaluation of concepts for the reduction of both the jet roar and the fan whine from JT3D and JT8D engines. The FAA and the DOT Office of Noise Abatement are also performing studies of the types indicated as Tasks 2 and 3.

It is assumed that a notice of proposed rule making (NPRM) will follow in the event that the data generated in Tasks 1, 2, and 3, together with previously generated data, will substantiate the issuance of a proposed rule. It is further assumed that, should the industry concur that the proposed rule is technologically feasible, appropriate to the particular designs involved, and economically reasonable, the negotiation of firm offers by qualified suppliers and arrangements to provide for the recovery of costs by the airlines will precede rule adoption. On this basis, airframe manufacturers' go-ahead is estimated to occur early in 1974. Development and certification tasks would follow, for which a period of slightly more than two and one-half years is assumed.

A service evaluation of approximately ten engine sets of each modified nacelle design is believed required prior to the initiation of full fleet retrofit. This evaluation is needed because of the potentially rapid build-up rate of modified airplanes in the assumed 3-year installation program. A large installation rate of new nacelles without service experience correspondingly represents a large exposure to costly rework and temporary service interruptions to resolve any discrepancies revealed in service.

FIGURE 19
TOTAL DOUGLAS FLEET RETROFIT
ESTIMATED PROGRAM SCHEDULE

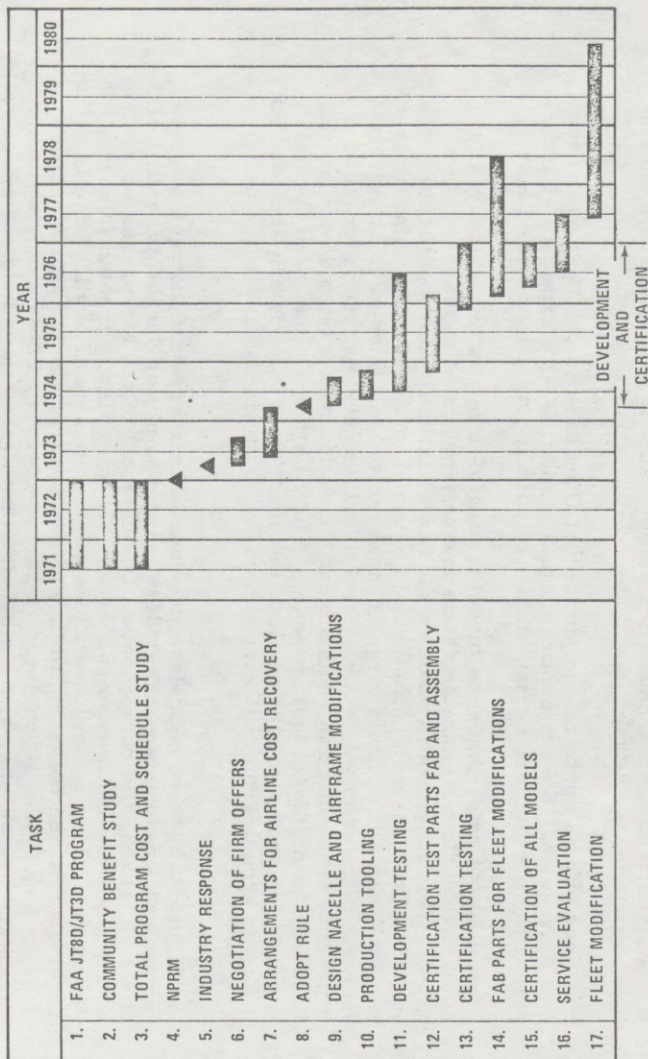


Figure 20 lists the major tasks required to develop nacelle modifications to the point of certification and indicates the extent to which previous efforts have completed each task.

Previous efforts applicable to short-duct DC-8's were chiefly those of the NASA program. Efforts applicable to long-duct DC-8's and to DC-9's consist of the preliminary design studies of possible nacelle modifications.

Figure 20 indicates that wind tunnel testing of drag, buffet, stability and control, and flutter characteristics are not applicable to the short-duct DC-8. This judgment is made on the basis that the NASA modification would require minor changes to the nacelle external loft lines and a minor increase in nacelle weight. Should larger changes in the loft lines or nacelle weight increment be indicated as a result of a further development program or a different noise reduction requirement, it would be necessary to review the need for a wind tunnel test program. Flutter studies would need special emphasis in such a program, since the short-duct DC-8 family includes six different wing designs that vary substantially in wing stiffness and design strength.

As Figure 20 further indicates, previous efforts have not included ice protection and fan thrust-reverser development work, or durability testing of flight-weight nacelle components. Development of the ice-protection system would require two-dimensional tests of the acoustically treated inlet ring design in an icing tunnel to verify existing estimates of leading edge heat flux requirements and the compatibility of the required compressor bleed flow with the engine bleed-flow limits. Thrust-reverser development work would verify existing estimates of the new fan thrust-reverser loads and effectiveness, and would also verify that the thrust reverser is compatible with fan discharge flow requirements at all positions from stowed to reverse. Flight testing would verify the ice-protection system effectiveness and, since the thrust reversers of DC-8 airplanes are used for inflight deceleration and emergency descent, would verify the structural integrity and functional adequacy of the thrust-reverser system throughout the approved speed-altitude envelope.

FIGURE 20
DEVELOPMENT TASKS REQUIRED
FOR RETROFIT PROGRAM

TASKS	DC-8		DC-9
	DC-8-50/61 (NASA PROGRAM)	DC-8-62/63	
PRELIMINARY DESIGN	C	P	P
WIND TUNNEL			
DRAG, BUFFET, STABILITY AND CONTROL	NA		
THRUST REVERSER EFFECTIVENESS, LOADS	NA		
FLUTTER			
INLET ICING			
"BOILERPLATE" PROGRAM			
NOISE	P		
ENGINE PERFORMANCE AND OPERATION	P		
BLADE STRESSES	P		
THRUST REVERSER EFFECTIVENESS, LOADS	P		
ACOUSTICAL MATERIALS STRENGTH TESTING	P		
DURABILITY TESTING			
THRUST REVERSER SYSTEM			
ICE-PROTECTION SYSTEM			
OTHER AFFECTED SYSTEMS			
FLIGHT TESTING	P		
CERTIFICATION			

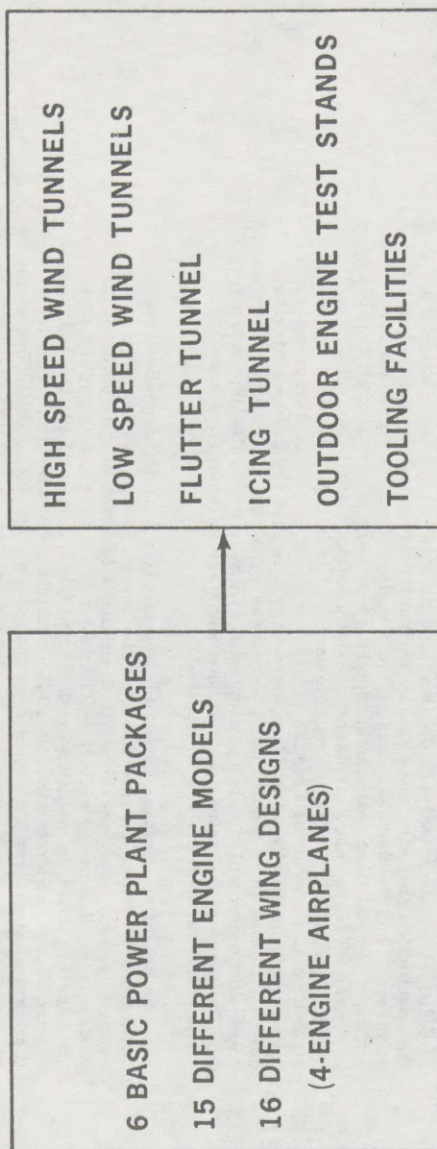
LEGEND: C = COMPLETED P = PARTIALLY COMPLETED NA = NOT APPLICABLE

Additional study is needed to validate the two and one-half year assumption of Figure 19 for the time required to develop and certify modifications for all affected Douglas models.

The efforts required to simultaneously develop new acoustically treated powerplant installations for all McDonnell Douglas and Boeing JT3D- and JT8D-powered transports, when added to the efforts involved in other development programs active during the time period of interest, may require resources of special facilities and technical skills in excess of those available. Thus, it may be necessary to stagger the initiation of work related to some of the models involved in order to reconcile tasks and resources.

The scope of the facilities scheduling problem is indicated in Figure 21. The unprecedented demand for the specialized facilities involved in powerplant development work needs thorough study to assure an adequate schedule estimate for this work.

FIGURE 21
SCOPE OF FACILITIES SCHEDULING PROBLEM



RETROFIT PROGRAM TIMING COMPATIBILITY

Some of the factors influencing the viability of a retrofit program are illustrated in Figures 22 and 23 for the DC-8 and DC-9, respectively. In each case the total fleet and that portion of the total in the service of domestic operators are shown separately as they might exist in the 20-year period beyond 1970.

Two differing retirement schedules are illustrated: A schedule based upon the assumption that airplanes will be retired at the end of their twelfth year of service, and a schedule based on the Douglas Company's present best estimate of total fleet retirement trends if new technology aircraft capable of replacing JT8D-powered airplanes are not developed and introduced into service during the period shown. However, it is believed likely that such new aircraft will materialize because of pressures for improved return-on-aircraft investment and quiet engine noise technology. In that event, the retirement curve will tend more toward the 12-year curve, which corresponds to those points in time at which existing airplanes will have been fully depreciated. For the moment the actual retirement trends are in doubt, and may follow some trend between the two illustrated.

The number of aircraft qualifying for retrofit is primarily dependent upon capability for useful service life after the noise reductions have been accomplished. Useful service life is in turn a function of the compatibility of development timing and fleet retirement rates. On the assumption that the nacelles could be modified according to the schedule of Figure 19, Figure 22 would indicate that the DC-9 retrofit program would begin near the start of the aircraft's retirement phase. In such a situation, kits would not be installed on airplanes due shortly for retirement. Some minimum period of operations with the modified nacelle would be required in order to limit the resultant depreciation expense increase to reasonable levels. If a minimum amortization period of 5 years is assumed to be reasonable, the fleet size qualifying for retrofit would be that fleet in service in early 1982 (early 1977 plus 5 years), which as indicated in Figure 22, would, assuming a 12-year retirement, amount to about one-third of the existing fleet: approximately 270 airplanes of the total fleet, and about 80 airplanes of the domestic fleet. Conversely, based upon the delayed retirement rate, about 620 airplanes of the total fleet, and 360 domestic airplanes, would qualify for retrofit.

The prospect of retrofitting only a fraction of the fleet raises two issues bearing on the feasibility of a retrofit program. First, a partial retrofit program would tend to thwart the objective of the program by reducing the benefits to airport communities. Second, the reduced program size requires that nonrecurring costs be spread over a smaller production lot, resulting in increased unit kit costs.

A similar analysis for DC-8 aircraft produced similar results, as shown in Figure 23. It was assumed that the DC-8 program would be accomplished essentially concurrent with the DC-9.

Clearly, the number of airplanes of each type of powerplant installation that could be modified is a crucial consideration regarding the feasibility of retrofit. Further, the slopes of those parts of the curves in Figures 22 and 23 that define the fleet sizes during the retirement phase indicate that the estimated retrofit fleet sizes are a sensitive function of the several assumptions on which the retirement rates are based. A proper judgment of the feasibility of a retrofit program depends vitally upon a proper judgment of the likely modification schedule and retirement rates.

In assessing the total economic impact of a retrofit program, the effects of changes in aircraft performance must be assessed. A brief investigation of a possible modification for a DC-8 airplane with long-duct nacelles indicates that more performance changes may be expected for this design than for the short-duct nacelle design studied in the NASA program. The concept investigated is sketched in Figure 24.

The inlet cowl is lengthened 11 inches to provide for the acoustical treatment in the inlet. It is almost identical in design with the inlet tested in the NASA program, differing only in the incorporation of a second acoustically treated ring. In view of the importance of initial retrofit cost to the incremental direct operating cost, the acoustical materials in the fan exhaust ducts are applied to the two duct segments that appear to be capable of modification at the least initial cost. The increase in duct wall thickness required by the acoustical material is allowed to encroach on the internal duct flow area rather than on the space required for the nacelle external doors. This arrangement avoids the increased cost of new nacelle doors conforming to the shape of larger fan exhaust ducts and a related increase in external drag. On the other hand, the duct internal flow velocities would be increased, resulting in more internal aerodynamic friction and therefore reduced engine thrust.

FIGURE 22
POTENTIAL FLEETS QUALIFYING FOR RETROFIT
DC-9 AIRCRAFT

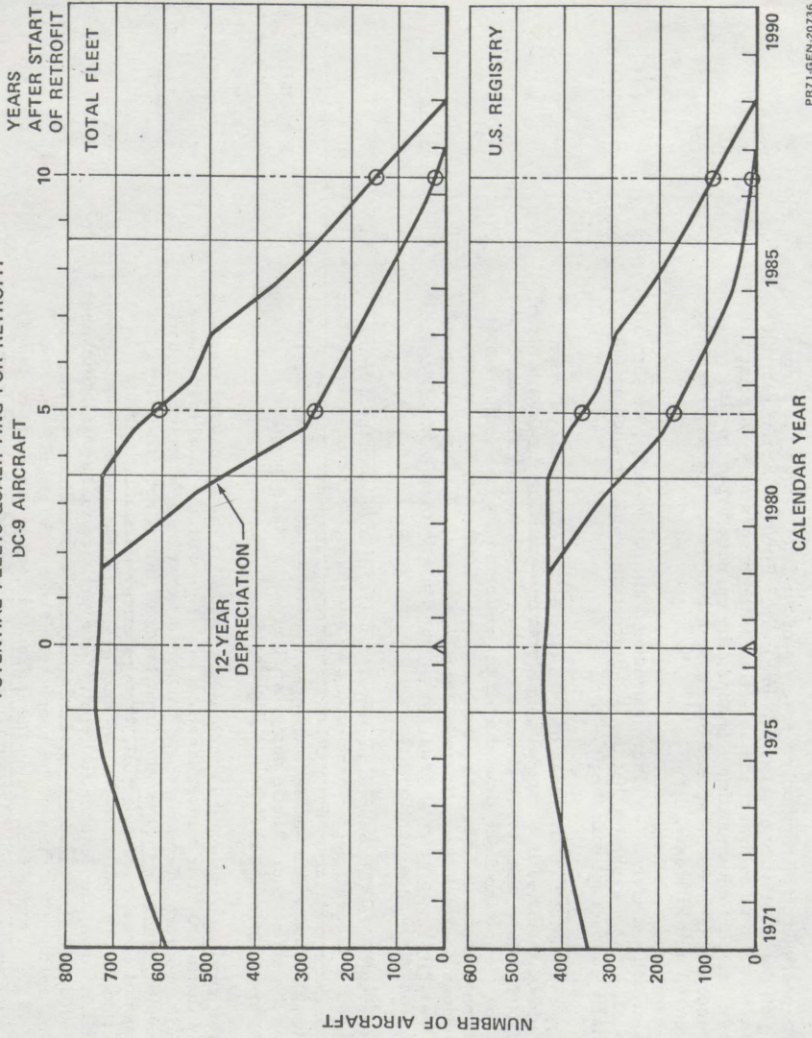


FIGURE 23
POTENTIAL FLEETS QUALIFYING FOR RETROFIT
DC-8 AIRCRAFT

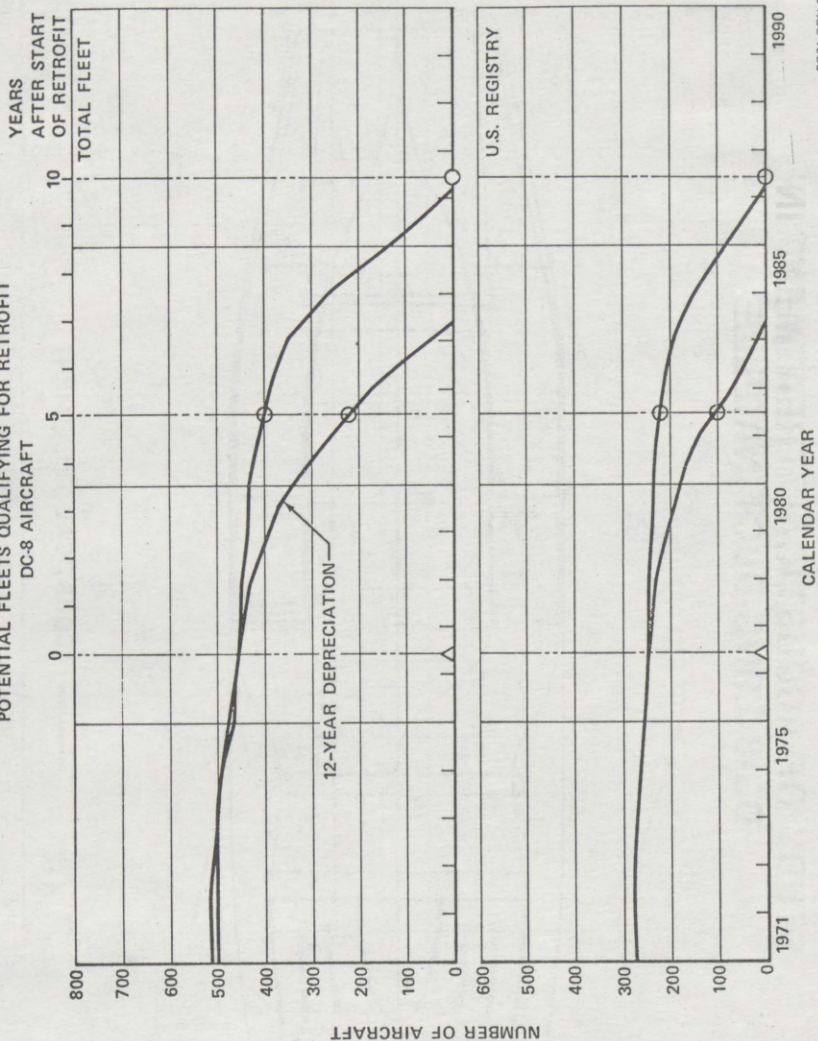
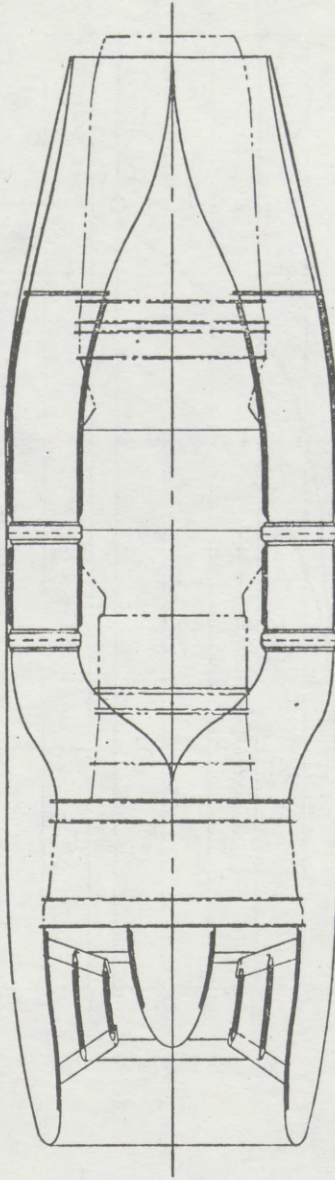


FIGURE 24
STUDY OF ACOUSTICAL TREATMENT IN
DC-8 LONG-DUCT NACELLE



— ACOUSTICAL TREATMENT

Although further study and full-scale test data are needed to determine whether the approach shown in Figure 24 is an appropriate one for a retro-active modification, some preliminary estimates have been made of its effects on weight, airplane performance, and direct operating cost. The estimated changes in basic propulsion system performance characteristics are:

Rated takeoff thrust	-6.6 percent
Cruise fuel consumption	+2.7 percent
Airplane empty weight	+1900 lb

These changes are more adverse than those of the short-duct modification investigated in the NASA program, since improvements in propulsion system technology that were included in the short-duct modification have already been applied to the existing long-duct nacelles, and are therefore not available to offset the adverse effects of acoustical materials installations. It is estimated that the propulsion-system weight and performance changes would reduce the maximum range capability of the airplane by approximately 200 nautical miles. Estimated changes in takeoff field length requirements indicated that the reduced takeoff performance would increase the takeoff distance, or for operations from an airport with a limited runway length, would reduce the payload or range capability of the airplane from that airport.

Specific examples of maximum payload restrictions are presented in Figure 25. In preparing these data, it was assumed that the maximum payload contained passengers, baggage, and belly cargo. The reductions in maximum payload are expressed as an equivalent reduction of passengers on the basis of 200 lb per passenger and his baggage. The payload reductions reflect the effects of the specific runway lengths at the airports of departure as well as the equivalent still-air range requirements.

For those cases where the payload reductions are so large as to result in the abandonment of nonstop service, the resultant changes in fleet route structure would require an analysis of the overall economic impact of the modification.

FIGURE 25
**POTENTIAL LOSSES IN PAYLOAD
 CAPABILITY - DC-8-62 AIRPLANES**

	FLIGHT SEGMENT	ESA DISTANCE (N MI)	MAXIMUM PAYLOAD REDUCTIONS, EQUIV NO. OF PASSENGERS
1.	ROME - RIO DE JANEIRO	5210	5
2.	PARIS - RIO DE JANEIRO	5142	50
3.	GENEVA - RIO DE JANEIRO	5157	0
4.	NEW YORK - TEL AVIV	4714	0
5.	PARIS - LOS ANGELES	5319	85
6.	AMSTERDAM - LOS ANGELES	5179	20
7.	JOHANNESBURG - BRUSSELS	4862	90
8.	LOS ANGELES - LONDON	5099	1
9.	BUENOS AIRES - NEW YORK	4754	0
10.	HONOLULU - MANILA	5050	0
11.	LAS PALMAS - BUENOS AIRES	4716	58
12.	SAN FRANCISCO - TOKYO	5123	145
13.	HONOLULU - SYDNEY	4681	0
14.	MADRID - RIO DE JANEIRO	4577	0
15.	PARIS - HOUSTON	5047	30
16.	NEW YORK - HONOLULU	4801	0
17.	BANGKOK - ATHENS	4795	64
18.	ATHENS - NEW YORK	4851	5
19.	BALTIMORE - HONOLULU	4762	95
20.	AMSTERDAM - CURACAO	4539	0
21.	COPENHAGEN - SEATTLE	4426	0
22.	MADRID - BUENOS AIRES	5703	50
23.	LOS ANGELES - TOKYO	5450	53

Comments on S. 1566

We believe that a clarification of an important provision of S. 1566 is needed before we can prepare specific comments regarding the Bill.

As we interpret the present language of paragraph (d) beginning on line 7 of page 1, more noise reduction is required than can be provided by projected advances in noise reduction technology. It is recommended that the intent of this paragraph be clarified, especially with regard to aircraft complying in 1971 with Appendix C of FAR Part 36.

Mr. Chairman, we are pleased to have provided the foregoing information, and trust that it will be of use to the Subcommittee.

Senator CANNON. The next witness is Mr. Vaughn L. Blumenthal, director, product development, commercial airplane division, the Boeing Co., Renton, Wash.

STATEMENT OF VAUGHN L. BLUMENTHAL, DIRECTOR, PRODUCT DEVELOPMENT, COMMERCIAL AIRPLANE DIVISION, BOEING CO., RENTON, WASH.; ACCOMPANIED BY RICHARD E. RUSSELL

Mr. BLUMENTHAL. Mr. Chairman and members of the committee, I am Vaughn L. Blumenthal of the Boeing Co. I am here to describe briefly the results of some of the Boeing noise reduction research aimed at alleviating community noise caused by the current 707, 827 and 737 commercial fleet. Estimates of potential noise reductions and performance penalties will be shown along with projected development, schedules and costs.

In addition, my colleague, Mr. Dick Russell, will make recommendations for additional research required to establish the basis for retrofit decisions. The bulk of our presentation is contained in a Boeing paper entitled, "Noise Status—707, 727 and 737 Airplanes," which I have provided to the committee.

I would like to apologize to the rest of the gathering here for not bringing enough papers along for general distribution. I will put what I have on the desk.

I would like to suggest a word of caution in viewing the data that I am about to show. Whereas we have used the best information available in making our noise reduction statements, additional full-scale tests based upon detailed designs are needed to verify many of the acoustic configurations that will be described. In addition, flight demonstrations are imperative to establish that the potential retrofit changes will in fact be discernible to the public.

Although the current fleet is not subject to the standard FAR part 36 noise regulations, it is convenient to show the relationship of these airplanes to the FAR 36 rules.

The first three charts will deal with the noise level of the airplanes as they currently exist in comparison to the line describing the FAR 36 rule. The circles are the current airplane noise levels which we call the base line for the current fleet today, the 707-320B here, the 707-120B, the 720B, the 727-200, and the 737-200.

The shaded bars extending downward represent the noise levels that we expect we could achieve with fan-suppression alone, and the hashed bars with a combination of fan-suppression and jet-suppression.

I will show you in more detail as we go along how we would expect to achieve these types of reductions. I would point out, however, that the cost-benefit of relationship of these types of reductions has certainly not been proven. In many cases, the performance losses are excessive.

This is the curve for the takeoff condition under the FAR part 36 rule. It shows the power cut-back noise levels at the $3\frac{1}{2}$ -mile measuring point.

This is a similar curve for the approach condition, and, as you will notice later, the reason for the major reduction available in approach, particularly for these 707 airplanes here, is that our NASA program entered into in 1967 and completed in 1969, was devoted almost entirely

to fan-jet suppression. We achieved about a $15\frac{1}{2}$ EPNdB reduction.

This is the side-line noise level here. In this case what we have been able to achieve so far has been very minimal, and what we can do with jet-suppression is still much in the questionable stage.

We have been working the noise problem quite aggressively for a number of years. This table is an indication of the amount of money that we have put in in the form of either Boeing research funds or Government contract funds in working noise reduction. You can see that between 1958 and the end of this year that it will total approximately \$60 million.

I think you can appreciate the health of the Boeing Co. won't permit us to continue expenditures of that nature very long.

This is a summary of the airplane types that we have under consideration. We have about 2,000 airplanes in the commercial fleet today. About 160 of those are pure jets and are not shown on this tabulation. We consider that they are too old for consideration of retrofit. Furthermore, we have nothing to suggest in the form of retrofit.

You will notice these broken into three distinct groupings, although there are in the neighborhood of seven different types of airplanes. Here are 707-120B airplanes at about 258,000 pounds, the 720B at 235,000 pounds, running up to the 320B at 336,000. These use JT3D engines. We think that one configuration would take care of all three of these types of airplanes.

I must point out, however, that in tuning an airplane—by that I mean arriving at a final configuration of an airplane—flutter is a very critical point in a design consideration. It is the first thing to be tested when an airplane is in its initial flight-test stages, and the positioning of the nacelle on the wing is quite critical as far as flutter is concerned. We think that we will be flutter-free on all three of these. We have, however, only checked it out on the 320B to any detail.

In both the other two groupings here, there is a short body and a long body airplane. Particularly in the case of the 727, additions to the weight of the nacelle installation at the back end of the airplane begin to create balance problems that in many cases involve ballast on the front end of the airplane in order to make it operational.

The three types of nacelles, then, that we are looking at are, one with the JT3D engine, and two with the JT8D. This picture shows the one JT8D mounted on the side of the body on the 727. There is another one in the center of the body on the tail-end, but it poses no particular problems in addition to those that would be encountered in mounting the ones on the side.

The JT8D on the 737, whereas it is the identical engine, does pose completely different problems, however, in mounting the engine up close to the wing relative to the mounting on the side of the body. So, they must be handled as individual design problems.

Now, with respect to the 707 airplane in more detail, this graph is an indication of the noise levels broken into components versus engine thrust. The most important point to notice is the component of noise contributed by the jet. It is down for both the takeoff and the approach conditions. It is significantly down from the noise exhibited by the fan-inlet or the fan-exit.

This suggests, then, that considerable noise reduction can be obtained, particularly at the approach conditions with fan-treatment

only before we run into a jet-floor. If you keep this chart in mind when we get to the JT8D, you will find that the characteristic is considerably different on the JT8D and the jet noise is predominant.

This upper chart represents the current production nacelle with short fan ducts; the fan air exhausting here; the primary air exhausting at this point.

The contract we had with NASA involved lengthening the fan duct to make it a full length duct, putting treatment in the fan duct to absorb the fan noise, and significant treatment in the inlet in the form of inlet rings to absorb the noise coming out of the front end of the engine.

About 70 square feet of treatment was added to the front end, and in the order of 207 square feet at the back end.

We were not particularly pleased with the performance results from this configuration and have continued research in an effort to improve the overall quality of the airplane that could result with better treatment aboard.

I will show some of the configurations that have been examined since 1969. Recently we have had on our test stand at Wichita, a configuration similar to the one shown here. Whereas the NASA cowl had a long duct that extended coplanar with the primary duct, we have foreshortened the duct, we have made use of advancements in treatment technology, such that we can get the same noise reductions but with lesser square feet of treatment involved in the fan duct. The inlet is the same as we tested in the NASA program previously. That is still associated with fan-treatment only.

This particular configuration here is one that we have been examining with an eight-lobe jet suppressor attached to the back end of the previous configuration. This is an effort to quiet the jet noise and to reach an overall noise level somewhat lower than we could achieve with fan-treatment alone.

In addition to an eight-lobe nozzle, we have included a variable area primary nozzle which would permit further noise reductions on power cutback after takeoff.

All of these designs that I am describing, involve a complete new nacelle, approximately 25 inches added to the length, some increase in diameter, and the most costly portion of it is that it does involve a new fan-thrust reverser. We would retain the current primary thrust reverser.

Senator CANNON. What does it weigh?

Mr. BLUMENTHAL. You are a good, straight man, Mr. Chairman.

The weight increases that we ascribed to the NASA configuration were on the order of 800 pounds per nacelle, about 3,100 pounds per airplane. This means that we would either reduce the fuel aboard or reduce the payload by that amount.

In our effort to improve the performance losses, the second configuration that I have shown reduced this weight penalty to approximately 2,200 pounds. By the time we put the jet suppression on, the penalty increases to approximately 2,700 pounds.

Now, associated with the weight penalties, however, are some drag increases and some changes in fuel consumption, such that the resulting range degradation that we had estimated for the NASA program

was in the order of 200 miles, for the improved configuration about 175 miles—still fan-treatment alone—and with the multi-lobe nozzle, about 340 miles. This is a very important point to consider because most of the analyses involving direct operating costs that we have seen referred to in the press and other places do not reflect the reductions or potential reductions in city pairs involved in performance losses of this magnitude, and they certainly need to be taken into consideration.

As far as the noise reductions, this is shown in the upper portion of the chart. At full takeoff power, the basic airplane creates an EPNdB in the order of 115. As shown on the NASA contract, this was reduced to 111.5 or a reduction of $3\frac{1}{2}$ EPNdB. As you heard on the tapes earlier by Mr. McPike, that amount is hardly discernible.

Our improved configuration had the same takeoff noise reduction. We would increase that to $4\frac{1}{2}$ with the jet suppressor.

At the cutback power, the airplane basically is 113 EPNdB. We can reduce it by 6 with fan-treatment alone, or by 9 when we put a jet suppressor on.

The approach noise, which is much more responsive to fan-treatment, is reduced $15\frac{1}{2}$ EPNdB, and that is something that you can clearly notice. The same exists with the jet suppression.

On sideline we get $4\frac{1}{2}$, $4\frac{1}{2}$, and $7\frac{1}{2}$.

Incidentally, the costs that we had estimated for the NASA configuration were in the order of a million dollars per ship set. The improvements in the foreshortened cowl brought this down to \$750,000 per ship set. When we put jet suppression on, our estimate is that it would be in the order of \$1.25 million per ship set based upon a 400 airplane modification program.

We have recently been awarded an FAA contract to further develop this configuration. Work is going on in our Wichita facility. Go ahead was July 1 of this year. We expect to complete the ground demonstrations in 15 months. This will include flight-worthy hardware and include the development of a thrust reverser. Assuming production go ahead immediately upon completion of this contract, we believe we can complete the entire retrofit at the end of an additional 60 months. This means the fleet of 400 airplanes, 707's in this case, would be accomplished about the end of 1977.

Now, I would like to turn to the 727 airplane. Based upon the information that we picked up in our NASA contract earlier and were able to incorporate into the 727 program, we have successfully designed, tested and we believe flight-certified a new advanced 727-200 airplane. It has only been announced within the last couple of months. In doing that, we were attempting to pay attention to the problem that is illustrated on this chart wherein you can see that the jet noise has risen considerably from that shown on the JT3D engine.

There is only a modest amount that we can do with fan treatment alone—this area here and only a small amount in this area.

The configuration that I spoke of that we have recently certified is shown on this chart. Here is the basic production version that exists on the majority of our 727 airplanes to date. This is the configuration that is on our new advanced 727 airplane. It involves treatment in the inlet, treatment in the Pratt & Whitney engine fan ducts, and treat-

ment on the tailpipe. In spite of the fact that we have every expectation of being able to certify this airplane configuration to meet FAR Part 36 rule levels, it is very clear from listening to the airplane and from looking at the resulting noise levels that reduction in jet noise is very highly desirable if the effect is going to be noticeable and provide relief to the community.

For the past several years, we have been tackling this problem aggressively. This is a listing of full-scale ground and flight test hardware that we have built and tested in an effort to achieve some sort of a breakthrough in the reduction of jet noise. Unfortunately, there is very little known today about the mechanism of jet noise and what to do about it, and we have been faced with a cut-and-dry procedure that is very time-consuming and very costly.

We have had probably more failures than we have had successes, but we think we are making progress. The pictures that I want to show you here indicate some of the things we have tried in an effort to find something, regardless of how practical it is, that could make a dent in the jet noise. Then we could begin to focus our attention on something more practical.

One of our earlier trials was a configuration shown here on the back end of a JT8D engine involving 19 tubes. That didn't give us anything noticeable as far as reducing the jet noise. We went to the next step, and on the back end of each of those 19 tubes, we put 10 lobes. That began to make some noise reduction. It still was far from being satisfactory. Incidentally, we don't know how we would handle anything like that on an airplane.

The next piece of hardware that we built involved 12 lobes. The idea was to bring air in from the outside from around the nacelle, get it down deeply into the primary core, generate mixing, and reduce the shear noise between the primary jet and the ambient air. This looked good enough to us on ground tests that we put it on a 737 and actually made flight tests. I stood in the center of the runway listening to the airplane fly over. Unfortunately, if I closed my eyes, I could not tell which engine had the throttle forward. We did not accomplish much.

The next thing we tried was a six-lobe suppressor, again attempting deep penetration. This one we put onto, again, the 737 airplane and flight-tested it. It looks like a very normal kind of installation, something that could be hung on an airplane. It did provide some reduction in sideline noise and a modest amount of reduction in takeoff noise. Unfortunately, at the same time the approach noise went up. It didn't appear very satisfactory.

There had been some discussion of directional nozzles, the idea being that if you stood off to the side of an oval nozzle, you might get less noise reaching you than if you were standing off in this direction from the nozzle. This we found to be true, but the differences were in the order of 1 EPNdB and certainly not worthwhile hanging on an airplane.

You will recall that the JT8D engine has the primary exhaust and the fan exhaust both exhausting through a common exit nozzle. We thought that perhaps we would make some dent in the noise if we separated those two. So, we extended the primary nozzle that is normally buried within the engine exit. We extended it aft to be coplanar with the fan nozzle exit. All this did was to increase the noise.

So, although we laugh at these things now, I had to defend the funds on every one of these, and we were serious. We had something going for each when every one of these things was tested.

This one is an internal mixing nozzle where we were attempting to get more mixing within the nacelle prior to exhausting through the primary exit. What we found from this was that the nozzle, as it is currently constructed, does a very excellent job of mixing, and we couldn't improve on it.

The next thing we tested was a 48 lobe suppressor, this time behind a J75 engine. We began to get some impressive noise reductions. In this case, a J75 being a pure jet, had only high velocity, high temperature gas coming out through the tail pipe and exhausting through these small lobes, peripheral to a large center plug.

This looked interesting enough to us that we took that installation, separated the fan air on a JT8D from the primary air, extended the primary air through a long duct and tested that to see if the characteristics of slower, lower temperature primary air would still give some noise reduction. In addition, we put a silencer or shroud around the lobes such that we could put treatment inside the shroud, and absorb noise that might be generated within the shroud.

The chart here indicates why we were doing that. This is a chart showing noise versus frequency. The primary nozzle of a JT8D exhibits this sort of a spectrum. When we put the 48-lobe nozzle on the back end of the JT8D primary duct, it brought the noise level down in the low frequency level significantly; it increased the high frequency noise, and this is roughly what we would have expected.

Then, by putting a shroud around the nozzle, we were able to absorb the high frequency noise. This showed, virtually across the entire spectrum, an ability to reduce the noise on the order of 20 decibels. Bear in mind, this was on the primary only, and we still didn't have anything that we felt we could hang on to an airplane, but we thought we were opening the door to at least an avenue of further investigation.

The next step, then, was to build a 36-lobe nozzle designed specifically for a JT8D where both the fan air and the primary air went through the lobes. Here you can see the 36 lobes. This is the shroud, not in place.

This is a picture showing the shroud around the lobes and showing an avenue for air ingress to essentially surround the lobes with external air. You will hear this type of a configuration referred to as an ejector-suppressor.

These were tested full-scale, so we have some appreciation, from ground test at least, as to what noise levels could be accomplished. Here is the basic airplane showing 100 EPNdB at cutback thrust, 109 at approach and 108 at sideline. Those are noise levels that the majority of the 727 fleet exhibit today.

With the fan treatment alone that I showed on the earlier chart and the one that we have flight tested on the advanced 727 airplane, we can get a reduction of one EPNdB at cutback, six at approach, and nothing at sideline. You can see that that is really not much to write home about.

When we put the jet suppressor on, we got five reduction at cutback, 10 at approach, and eight at sideline. And more significantly, we got a

change in the quality of the noise. The thing sounds different, and perhaps as far as the community is concerned, that might be as significant as reducing the noise level itself. We don't know.

Senator CANNON. Does it sound better or worse?

Mr. BLUMENTHAL. It still sounds like an airplane. The fan treatment configuration involves a weight penalty of about 378 pounds—that is about a passenger and a half or two passengers—or a range loss of 35 miles. So, this is not prohibitive.

This, then, becomes somewhat the objective of the FAA contract, which we have, to further develop jet suppression on the 727 airplane. Our preliminary estimates indicate that range losses, perhaps in the order of 8 to 15 percent, may come about with this kind of jet suppression. I can't stress this enough. I think that it does represent the state of art in noise suppression that we know today. It doesn't represent anything in the ballpark with reference to the paper that we heard about this morning.

Senator CANNON. Are you familiar with that study, by the way?

Mr. BLUMENTHAL. No.

Senator CANNON. Have you ever heard of it before?

Mr. BLUMENTHAL. Never heard of it before.

Senator CANNON. Do you think that is achievable in a retrofit program?

Mr. BLUMENTHAL. That much? I can't answer. I don't know what they are talking about.

One of the attractive reasons for going for jet suppression is indicated on this chart that shows 90 EPNdB contours. Again, I am not sure that in the acoustic business, we understand what these charts mean. We continue to draw them. I am personally concerned that they can be misleading. This is an indication of the area about an airport that would be exposed to 90 EPNdB or more for a normal landing and takeoff of a 727 airplane.

When we put fan treatment on alone, we can get a 10 percent reduction in area. This is almost entirely on the approach end of it. When we include jet suppression, the area is reduced by 75 percent.

The schedules on the 727 are roughly the same as those that we had on the 707. Again, a key point here is continuity of the program. If there is no way for us to start a production program at the conclusion of the FAA contract, this gap will open up. We believe that the fleet could be retrofit by sometime in 1978.

The 737 is an airplane that must be treated individually from the 727. I will not discuss it in any detail other than to say that the problems connected with that installation are unique; they are different from the 727 and they must be developed in their entirety specifically aimed for the 737 type of an installation.

Obviously, if we can develop a jet suppression device that is not too horrendously expensive in terms of performance on the 727, it would be to some extent applicable on the 737. Ground clearance problems must be considered; the weight on the wing, the proximity of the nacelle to the wing, and the problem of bringing air around the nacelle and getting it into a jet suppressor certainly are problems to consider.

We have not made any studies of a 737 installation to date.

I hope I have conveyed to you some of the frustrations connected

with trying to develop noise reduction concepts. We have sincerely tried and we intend to continue so long as our resources hold out.

I would like now to ask Mr. Russell here to describe some of the additional research that we think is necessary to continue with a viable noise reduction program.

MR. RUSSELL. Mr. Chairman, as Mr. Blumenthal has indicated, and not to detract from some of the efforts that we have been involved in, it is probably safe to say at this time that a fair amount of the technology of acoustics and noise reduction is trial and error and cut and try. We have worked on the problem. There are lots of things we don't understand, but if nothing else, we have probably learned pretty well those areas where we think additional work needs to be done and additional resources should be invested.

One problem with making research recommendations is that the subject of R. & D. can cover quite a broad range of technology activities. So what I will try to do today, in making research recommendations, is to include specific recommendations of the work I am referring to so that it will be clear what the funding level covers.

The research will be discussed in two major areas. The first is basic research and the second is applied research. Under the heading of applied research, I will break it down into two subheadings, one called concept development, and the other specific airplane configuration development.

To the best of our knowledge, and having some idea of the work that is going on in the country today, these recommendations will be for work that is beyond the research work that is currently in progress.

Under the heading of basic research, what I mean, is understanding the basic mechanisms of noise generation, and, in addition to the generation process, understanding the suppression or attenuation processes that are involved in aircraft noise. The basic research includes understanding of these mechanisms, development of methods of analysis, a mathematical understanding of what is involved, and also includes the requirement to generate some basic experimental data to use in conjunction with the analytical approaches.

First, the area under the heading of basic research includes what I call turbo-machinery source design for low noise. Work that we think needs to be done in this area include, for example, trades in picking fan tip speed. There are some optimizations or some trades available as far as optimum speeds are concerned.

Other areas include blade selection for low noise, the possibility of surface aerodynamic flow control, the possibility of variable geometry being used in the design, and also one area that has had probably the least attention is low turbine noise or the design of turbines for low noise levels.

We also feel there is a need for the development of scaling laws to reduce the cost of research of this kind, and also the development of source noise analysis methods.

Excluding the rather costly and expensive full-scale developmental type of research, in other words, to constrain the recommendations being made, we feel that a minimum of \$2 million a year could be very profitably invested in this area of research.

The second chart shows the second basic area of research required. It is simply understanding better the mechanisms of what is involved in jet noise generation and jet noise suppression. We feel that there are some very extensive unknowns in areas such as jet noise variation with engine by-pass ratio—the selection of engines for optimum air frame configuration in conventional airplanes.

There exists today some contradictory results as far as flight velocity effects on jet noise, and in the contribution of the core engine. It is an area that very little is known about. We feel that configuration and suppression of high bypass ratio jet noise can have a very strong influence on optimum airplane design and powerplant selection and installation.

We have mentioned the concept of the ejector/suppressor. We feel there is a potential for application of the concept in high bypass ratio as well as low bypass ratio installations. It includes trying to determine the best means of breaking up the flow and then with the flow break-up, where the noise sources that remain are located and suppressed with the ejector lining.

Again, excluding costly large-scale research, we foresee a minimum of somewhere between \$1 million and \$2 million a year invested in basic jet noise research.

Acoustic lining technology is a third area. An idea of the kinds of things we are looking for, include a better and a more intelligent tailoring of the lining for the specific noise source, and in fact a better understanding of noise propagation in the ducts. Again, with the ejector suppressor concept, the technology that is available today for the ejector lining to put around the jet exhaust shroud is practically unknown, and is an area that requires fundamental and basic research and understanding. The idea of variable lining with distance is one for which we can use additional basic research.

Again, as a recommendation, something in the area of \$2 million per year in fundamental lining research is required.

The problem of appropriate community assessment and associated design decision assessment of various design options, including retrofit options, is one area that I think bothers a number of people. We have a desire and need to increase our understanding of what acceptability criteria should be, what the noise units should be, and what new noise units are required for several classes of craft, for example, conventional and STOL airplanes.

We, as manufacturers are particularly interested in a clearer understanding of acceptability criteria, because it defines our design objectives for airplanes, both STOL and conventional, as well as retrofit.

The continuation of technical tool building includes computer automation of suppression devices. This is an area that requires additional work. Also, we are finding that airplane installation and configuration effects probably constitute a noise source or a pseudo-source as important as jet noise or turbomachinery noise. As a recommendation, something about \$2 million a year in basic research is needed at this point in time.

All of these concepts and devices effect propulsive performance of the airplane. I think there is a need and desire for improved analyti-

cal, prediction, and design tools to improve the propulsive impact of the loss due to noise suppression devices. A recommendation of about \$1 million to \$2 million a year, to improve the propulsive aspects of noise suppressive devices, is in order.

The summary, then, for basic research is something at least in the order of \$10 million per year. Once again, this is in the very fundamental basic understanding of the mechanisms involved in noise generation as well as reduction.

Under applied research, the first category, as I mentioned initially, was called concept development. What I mean in concept development is the combination of a number of elements, that would come out of basic knowledge and basic research, into new suppression devices and mechanisms.

Two areas in particular that I would identify under concept development include jet exhaust suppression concepts; for example, a second generation or improved ejector/suppressor based on an adequately funded basic research program, as I mentioned earlier. The second area could include or would include new engine design studies, again pulling together and integrating the results of fundamental research into new quiet engine concepts.

Recommendation here is at least a minimum of \$5 million to cover these two specific concept development areas.

Under the second heading of applied research is configuration development. What this means is simply putting the noise configuration candidates together for specific airplane installations, wherein, you are bound by the constraints of the airplanes, the 727 and the 737 and the DC-9, for example. The definition, as I use it here, does not include final production design and FAA certification.

In other words, the recommendation will cover the activities that would be required to adopt and select configuration for these airplanes, but would not include the final design and FAA certification.

As mentioned earlier today, the FAA feasibility contract which we have, which is a minimum contract, does cover the activity of configuration development for the 727 and 707 airplanes.

In addition to this contract, we feel that configuration development is essential to the 737, the DC-9 and, as Mr. Pendley mentioned, several DC-8 models of aircraft. The recommendation here is for a minimum of something in the order of \$20 million to cover this additional configuration development in support of retrofit.

In summary, then, in terms of the research recommendations, basic research on a sustaining basis of at least the \$10 million per year; concept development, the two specific concepts that were mentioned, is at least \$5 million, and configuration development of at least \$20 million.

The final chart that will be used here will summarize the comments that both Mr. Blumenthal and myself have made. Our conclusions and recommendations for this status report are six in number. We feel we have extended a significant effort in noise reduction research at the Boeing Co. at this point in time. We have been working on it since 1958 very aggressively; we have learned a lot, and we have had successes and we have had failures.

We believe that as a result of this work, there are varying degrees of retrofit that are technically feasible on both the JT8D and JT3D

powered aircraft. That conclusion does not say that we think any of them should necessarily be endorsed at this point in time, just that to some degree they are technically feasible at this point.

The performance penalties and costs can be large and, as you would expect, the larger the reduction, the larger the potential penalty.

We believe that a justifiable retrofit program must reduce airport community noise to a significant extent, and that the public must be able to assess and sense that something meaningful has been done in terms of the noise problem. In other words, we cannot support or endorse a cosmetic retrofit that is ineffective.

Item five ties two, three, and four together. We feel that additional work is needed, that the work should be funded at an adequate level, and we hope the outlook would be to reduce the risks, improve the performance, and improve noise reduction.

Finally, we believe private financing of research work is becoming increasingly difficult as time goes on.

Senator CANNON. Does that conclude your presentation now?

Mr. BLUMENTHAL. Yes, sir.

Senator CANNON. Do you have any specific comments with relation to S. 1566?

Mr. BLUMENTHAL. We have studied that bill to some extent. I guess the first comment we would have is that the noise levels currently described in that bill are lower than we know any way of accomplishing. I think that is probably the primary item that we would have concern on.

We do think that reference in the bill to the current 747, DC-10, and L-1011 should be eliminated. We think that a research program or a development program should precede the establishment of actual noise levels such that something irrational is not established that later on has to be rescinded because of lack of ability to carry out the accomplishment, and, therefore, the establishment of the noise level should be left to the administrator.

And, further, we believe that the effective date of the program cannot be established in advance of a program go ahead and should be in some manner related to the R. & D. progress.

I think that is all I could say.

Senator CANNON. How do you view the technological and economic feasibility of the development and production of a new quiet engine as called for this morning by Chairman Browne?

Mr. BLUMENTHAL. New engines would certainly improve the overall performance of the airplane and remove some of the performance penalties that we have indicated in our presentation here this morning. However, in throwing away the existing engines, replacing them with new engines, and in many cases getting into the heart of the airplane itself, making such a retrofit would begin to be exorbitantly costly and does not appear, at least in the preliminary reviews that we have made, to be the proper way to effect the noise reduction.

The costs appear to run in the neighborhood of \$5.5 million to \$6 million per airplane when retrofit is considered. Certainly, the airlines are in no position to afford anything of that magnitude.

Senator CANNON. Have you discussed that issue with the major U.S. engine manufacturers?

Mr. BLUMENTHAL. We have been in discussion with Pratt and Whitney, G. E., Rolls, and to some extent Allison, for, to my knowledge, the last 4 years describing the type of an engine that we would like to have in the 22,000 to 25,000 pound thrust class. We think that it would be possible to develop a single engine that could be put on both a 707 and a 727 with proper airplane modifications that could in effect increase the overall earning power of the airplane and significantly decrease the noise. However, when we come to the retrofit part of it and think in terms of the modification that would be required in the airplane to permit hanging that kind of an engine on in retrofit, we begin to back off somewhat.

Senator CANNON. Thank you very much, Mr. Blumenthal, and Mr. Russell. We appreciate your helpfulness to the committee. The committee will stand in recess until 2 p.m.

(The statement follows:)

STATEMENT OF V. L. BLUMENTHAL, R. E. RUSSELL, AND J. M. STRECKENBACH, THE BOEING COMPANY—COM- MERCIAL AIRLINE GROUP—SEATTLE, WASH.

ABSTRACT

This paper presents the results of some of the Boeing noise reduction aimed at alleviating community noise caused by commercial operation of aircraft equipped with low-bypass engines. Estimates of noise reductions resulting from acoustic treatment are shown, along with projected developmental schedules and costs. In addition, recommendations are made for research required to establish the basis for retrofit program decision making.

INTRODUCTION

The current world fleet of commercial transport aircraft powered by low-bypass-ratio turbofan engines is the target of airport community residents who are annoyed with high noise levels. The Boeing models included in this fleet (707, 727, and 737) all exceed the noise limits that were established by Federal Aviation Regulation (FAR) Part 36 for new aircraft. Although the current fleet is not subject to the regulation, the data on figures 1, 2, and 3 are a convenient means of showing the relationship of these airplanes to FAR Part 36 new-airplane levels. The circles in the figures represent the takeoff (power cutback), approach, and sideline noise levels of these airplanes at the FAR Part 36 prescribed measuring stations. The solid and dashed bars extending downward from the circles represent current estimates of levels to which the noise of each model might be lowered by means of various fan and jet noise acoustic treatments. The means that might be used to attain such noise reductions will be discussed later in this paper. It is pointed out, however, that these treatments merely represent the current status of noise-reduction studies and do not necessarily represent reasonable cost-benefit solutions. (Although the 747 models are included in figs. 1, 2, and 3, they are not included in the low-bypass-ratio turbofan fleet.)

Boeing has been studying means of reducing the community noise levels of the current family of turbofan aircraft for over 12 years. The effort has been continuous, generally at an increasing level over the years, and has included model- and full-scale ground testing and flight testing of numerous noise-reduction concepts. This has been and still is a costly program that, to date, has advanced the noise reduction state-of-the-art significantly but has not yet established satisfactory solutions for the several aircraft models involved in the program. Table 1 summarizes the yearly expenditures of company and government contract funds, beginning with 1958, and shows a total estimated research expenditure of over 58 million dollars by the end of 1971.

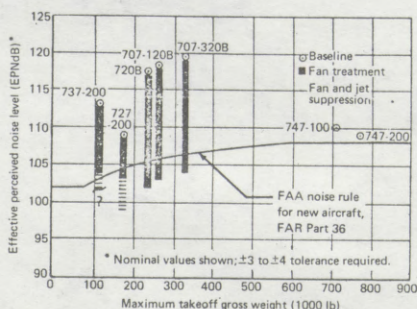


Figure 2. Approach Noise—1.0 NMI

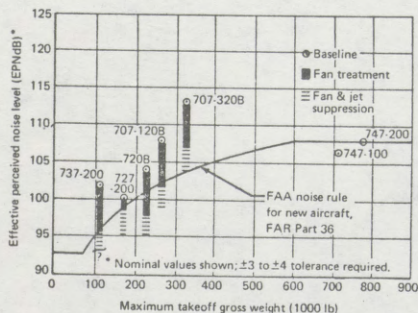


Figure 1. Takeoff (Cutback) Noise—3.5 NMI

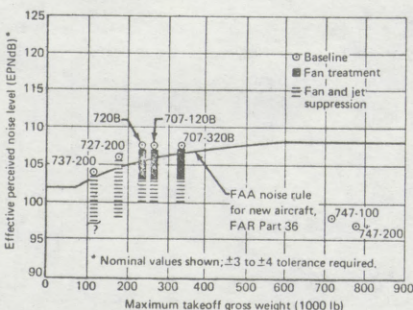


Figure 3. Sideline Noise—0.35 NMI, 707, 747; 0.25 NMI, 727, 737

Table 1. Boeing Noise Reduction Expenditures (Millions of Dollars)

Year	R&D	Contract	Total
1958	0.601	—	0.601
1959	0.106	—	0.106
1960	0.282	—	0.282
1961	0.472	—	0.472
1962	0.550	—	0.550
1963	0.310	0.022	0.332
1964	0.140	0.300	0.440
1965	1.384	0.210	1.594
1966	2.528	0.925	3.453
1967	3.197	3.464	6.661
1968	10.957	6.878	17.835
1969	8.508	2.873	11.381
1970	4.447	1.082	5.529
^a 1971	3.039	^b 6.000	9.039
Total	36.521	21.574	58.275

^a Estimated^b Possible government contract

Note: Above expenditures do not include airplane program or preimplementation costs.

The remainder of this paper will discuss the noise-reduction studies that have been conducted to date on the 707, 727, and 737 turbofan models, projected developmental schedules and costs, and recommendations for research required to establish a basis for retrofit program decision making.

A few words of caution are in order. The data contained in this paper are based on the best factual or estimated information available at this time. Detailed designs and full-scale tests are needed to verify most of the configurations. In addition, demonstrations of retrofit nacelle candidates are imperative to establish that the potential retrofit changes will, in fact, be discernible by the public as favorable.

THE BOEING FLEET

As of the start of 1971, the worldwide fleet of Boeing commercial airplanes totaled 1955, including about 160 pure jets. It is assumed that the pure-jet aircraft are too old to be considered for retrofit. Only the low-bypass-ratio turbofan airplanes are shown on table 2; they use three distinct powerplant installations, one using the JT3D and two using the JT8D. The characteristics of these three installation types are sufficiently different that individual attention must be given each in developing potential retrofit kits for noise abatement. Figure 4 shows the existing engine installation designs currently installed on over 85% of the present Boeing world commercial fleet.

Table 2. Summary of Boeing Airplane Types

Group	Model	Maximum taxi weight	Engines	Initial delivery	Fleet as of January 1971	
					U.S.	Foreign
I	707-120B	258,000	JT3D-1	Mar 1961	107	4
			JT3D-3			
			JT3D-3B			
	707-320B/C	336,000	JT3D-3	Apr 1962	261	159
II	720B	235,000	JT3D-1	Feb 1961	80	14
			JT3D-3			
			JT3D-3B			
	727-100/200	161,000 to 176,000	JT8D-1 JT8D-9 JT8D-11S	Jan 1964	663	153
III	737-100/200	104,000 to 116,000	JT8D-7 JT8D-9	Dec 1967	152	107

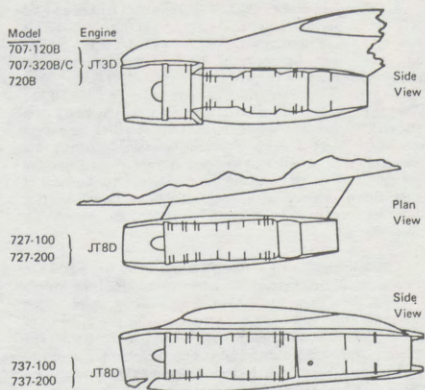


Figure 4. Schematic of Current Boeing Airplane Engine Installations

707 Retrofit

The Pratt & Whitney JT3D series engines, powering the 707-series turbofan airplanes, have a bypass ratio of 1.4 and produce from 17,000 to 19,000 lb sea level static takeoff thrust. Figure 5 shows how the noise produced by these engines originates from the engine inlet, the fan exit, and the primary jet. There are other noise sources; however, these are the most significant. Note that at full thrust the inlet, fan exit, and jet all require suppression, while at lower power the jet exhaust becomes less important. The chart is divided into two portions, with takeoff and cutback powers indicated on the right and approach on the left. The discontinuous plot is due to the different altitudes and speeds identified for the two flight conditions.

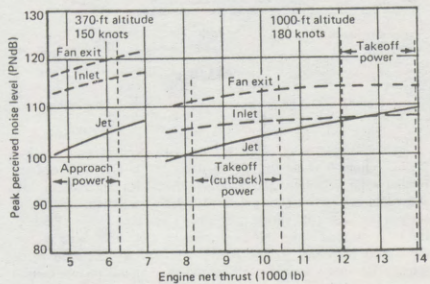


Figure 5. JT3D Single Engine Component Noise Levels

NASA contracts awarded to Boeing and Douglas in 1967 established the technical feasibility of accomplishing significant reductions in approach fan noise and modest reductions in takeoff fan noise with acoustic treatment of fan inlet and fan exit ducts alone. Flight tests of experimental nacelle configurations were completed in 1969. It should be noted that the nacelles tested were not production hardware quality certified for commercial use.

A comparison of the current 707 production nacelle and the configuration developed under the NASA contract is shown on figure 6. Long, acoustically treated fan exit ducts and treated walls, nose dome, and rings in the inlet were the principal changes investigated in 30 hr of experimental flight testing. Note that 70 sq ft of acoustic treatment was added to the inlet and 267 sq ft to the long fan ducts in the areas shown by heavy dark lines. This required lengthening the inlet and enlarging the nacelle diameter—in effect, a complete nacelle redesign. Sufficient data were obtained to permit acoustic, performance, operational, and economic analyses. The program did not include development of a new thrust reverser or FAA-compliant hardware, both of which are required to properly evaluate the design for commercial use.

Lining material used in the 707 acoustically treated nacelle consisted of fiberglass structural sandwich panels. These panels contained three elements: (1) a porous facing sheet, (2) a honeycomb core, and (3) a nonporous backing sheet. All three were of polyimide resin-impregnated fiberglass cloth material. The durability of panels of this type has since been proven in service tests by operating airlines. In over 18 months of operation, no deterioration has been detected.

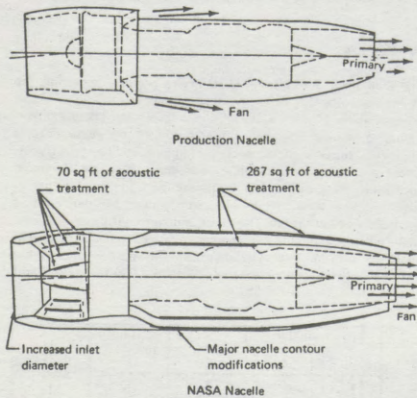


Figure 6. Production and NASA Contract Nacelle Comparison

Continued research and testing have been carried out by Boeing subsequent to the NASA tests in an effort to obtain further noise reductions and to reduce the performance penalties and costs associated with noise-reduction installations. Figure 7 shows the current choice for fan treatment only. Recent full-scale ground tests have confirmed that the same noise reductions identified in the NASA tests can be obtained with shorter fan ducts by more efficient use of acoustic treatment. The major effect is to save approximately 900 lb in airplane installed weight over that estimated for the NASA configuration.

Figure 8 is one of the configurations under study and test to reduce the jet roar as well as fan noise from the JT3D engine. This involves an eight-lobe nozzle on the primary jet designed to reduce sideline and full-power takeoff noise in combination with a dual-area nozzle to provide further noise reduction during cutback after the initial climbout. The dual-area nozzle has been tested full scale on a JT3D. The eight-lobe nozzle has been tested

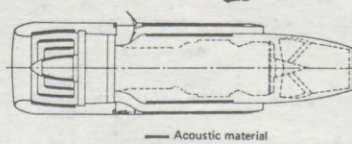


Figure 7. 707-320B Fan Noise Treatment Only

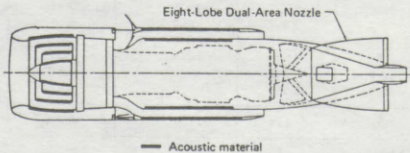


Figure 8. 707-320B Fan Noise Treatment Plus Eight-Lobe Dual-Area Primary

in model scale. Flight demonstrations must be made before it can be determined if the acoustic benefits justify the significant penalties in performance, operation, and cost. A summary of estimated performance is shown in table 3.

Table 3. 707-320B Retrofit Data Summary (JT3D-3B Engines)

Type of treatment	Basic	NASA contract results	Fan treatment (acoustic material)	Jet suppression + fan treatment + eight-lobe dual-area primary
Takeoff	115	111.5 (-3.5)	111.5 (-3.5)	110.5 (-4.5)
Noise* (EPNdB)	113	107 (-6.0)	107 (-6.0)	104 (-9.0)
Cutback	119.5	104 (-15.5)	104 (-15.5)	104 (-15.5)
Approach	119.5	104 (-15.5)	104 (-15.5)	104 (-15.5)
Side	107.5	103 (-4.5)	103 (-4.5)	100 (-7.5)
Δ Weight (lb)	—	+3140	+2200	+2700
Δ SFC (%)	—	-0.9	-0.2	+2.8
Δ Range (NMI)	—	-200	-175	-340
Retrofit\$ (millions)	—	1.0	0.75	1.25

* Nominal noise values shown; ±3 to ±4 tolerance required.

As demonstrated in the NASA tests, fan treatment alone will result in a takeoff noise reduction of about 6 EPNdB at cutback power, 15.5 on approach, and 4.5 on sideline at the standard FAR Part 36 measuring points. Current jet suppression estimates increase the cutback and sideline values from 6 to 9 and from 4.5 to 7.5, respectively.

Unfortunately, preliminary analyses indicate that these two levels of treatment are accompanied by an airplane empty weight increase of from 2200 to 2700 lb and a range loss of 175 to 340 mi. Retrofit kit costs for the two configurations are estimated at between \$750,000 and \$1,250,000 per shipset.

An FAA contract in final negotiation with Boeing includes a JT3D effort aimed at refining the aforementioned concepts and defining the acoustic and airplane performance characteristics through full-scale ground testing of production quality hardware. A tentative schedule for the FAA program followed by production and retrofitting of the 707 fleet is shown in figure 9. The schedule assumes continuity of effort with production go-ahead at completion of the FAA program.

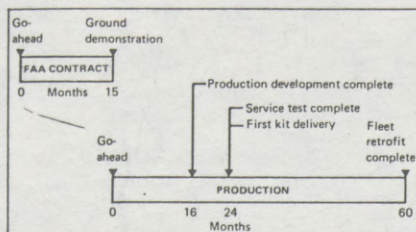


Figure 9. Tentative Schedule, 707 Quiet-Nacelle Retrofit

727 Retrofit

The Pratt & Whitney JT8D engines used on the 727 airplanes have a bypass ratio of 1.0 and produce from 14,000 to 15,000 lb sea level static takeoff thrust. The noise contributions of the engine inlet, the fan exit, and the primary jet, related to engine thrust, are shown in figure 10.

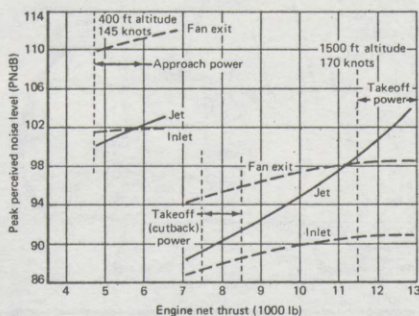


Figure 10. JT8D Single Engine Component Noise Levels

A comparison of this illustration with figure 5 shows that the problems of quieting the JT8D installation on the 727 are quite different from those experienced on the JT3D installation on the 707-series airplanes. For example, in the takeoff power range of the JT8D, it can be seen that the primary jet noise predominates, whereas on the JT3D the fan exit noise was predominant. This means that, while fan duct acoustic lining in the JT3D installation results in nominal sideline and takeoff power noise reductions for the 707 (table 3), no similar noise-reduction benefits can be expected by acoustically treating the JT8D fan alone. On the other hand, figure 10 shows that, at lower thrust levels, in the ranges of cutback and approach power, fan exit noise becomes predominant, indicating potential community noise benefits through acoustical lining in the fan ducts.

Based on this analysis and on experience gained during the previously discussed NASA contract effort on the 707, an acoustically lined nacelle configuration was designed, ground tested, and flight tested on a 727 airplane. Figure 11 compares the 727 production side nacelle with an acoustically treated configuration. The treatment incorporates (1) a polyimide

resin-impregnated fiberglass honeycomb liner on the inlet wall (similar to the material described for the 707), (2) Pratt & Whitney porous metal lining in the fan ducts (P&WA BG-19 treatment), and (3) a perforated stainless steel honeycomb lining in the tailpipe. It is noted here that a basic difference between the JT3D and JT8D engines is that the JT3D fan ducts exhaust independently of the core engine exhaust, whereas the JT8D fan ducts are integral with the engine case and exhaust into the tailpipe along with the primary jet gases. Therefore, the tailpipe lining mentioned above constitutes fan noise treatment additional to the P&WA fan duct lining.

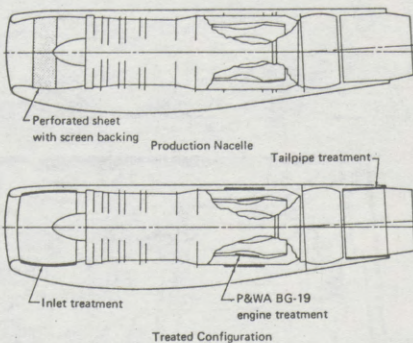
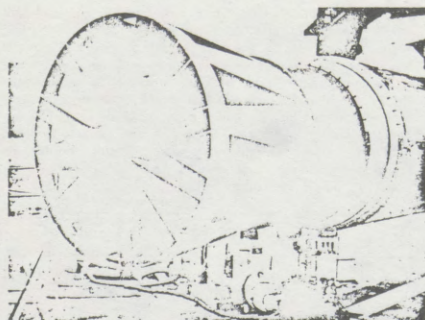


Figure 11. 727 Treated-Nacelle Configuration

As was predicted, based on the noise source analysis of figure 10, ground and flight testing of the treated configuration demonstrated no noise reduction in the full-power takeoff or sideline measurements but attained 1- and 6-EPNdB reductions in the cutback and approach conditions, respectively. These are very nominal reductions, measurable with instrumentation, but probably not significant to the average community resident. Because of the noise "floor" established by the primary jet component (fig. 10), it is not possible to reduce the 727 noise levels further without first developing a means of significantly reducing the noise contribution of the jet roar. However, the low frequency range of this noise source is not amenable to attenuation by practical sound-absorbent linings such as those used for reducing the high-frequency fan whine. Development of means of quieting jet noise has been, and continues to be, the subject of extensive research at Boeing. To date, dozens of model-scale and full-scale jet noise suppressors have been designed, built, and tested. Figure 12 illustrates several full-scale concepts that have been tested on JT8D engines, some having been tested both on the ground and in flight on 727 or 737 aircraft.

Because little is known about the mechanisms of jet noise or means of attenuating it, these full-scale concepts have been derived from many scale-model empirical tests. The fabrication and testing of the full-scale configurations have been costly and time consuming. As had been previously determined analytically and confirmed by these tests, multi-element nozzles (such as some of the multitube and multilobe concepts shown in fig. 12) reduce the low-frequency noise appreciably but do not necessarily reduce the overall acoustic energy level. In general, the configurations tested offered minimal noise reduction and caused engine performance losses that were unacceptable. One factor



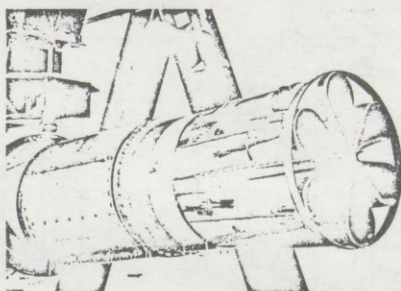
12-Lobe Suppressor



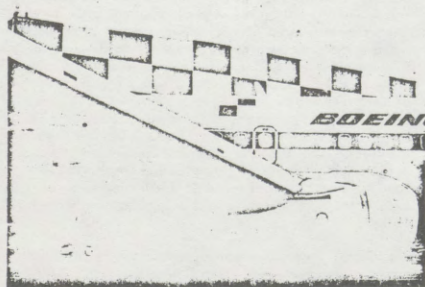
19-Tube Suppressor



19-Tube Suppressor With 10-Lobe Nozzles



Six-Lobe Suppressor



Six-Lobe Suppressor Flight Test, 737 Airplane

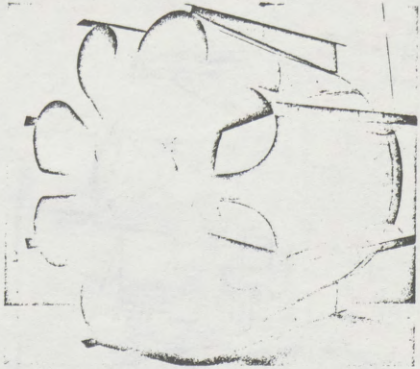


Coaxial Nozzle

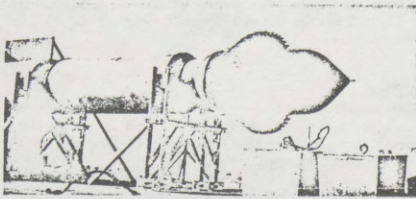
Figure 12. Examples of Full-Scale Jet Noise Suppressor Tests on JT8D Engine



Directional Nozzle



Fan and Primary Mixer



48-Lobe Suppressor Ground Tested on JT8D



48-Lobe Suppressor With Two-Stage Lined Ejector

Figure 12. (Concluded)

that was confirmed, however, is that the reduction in jet roar offered by multi-element nozzles is accompanied by a shift of the acoustic energy to higher frequency levels, as is shown for the 48-lobe nozzle in figure 13. Since the higher frequency energy is more amenable to absorption by acoustic linings, the 48-lobe nozzle was also tested with a lined ejector shroud (last photograph in fig. 12). Figure 13 shows that the shroud acoustic lining provided substantial reduction in the high-frequency portion of the noise spectrum, adding to the reduction in the low-frequency range attained with the bare 48-lobe suppressor. In addition to providing a means of installing acoustic lining materials, the shroud, designed in the form of an ejector, provided the additional bonus of a positive thrust increment that helped to reduce the high engine thrust losses typical of multi-element sound suppressors.

Although the 48-lobe hardware was not adaptable to a 727 airplane, it served to demonstrate the beneficial sound suppression capabilities of the ejector/suppressor concept. More recent investigations have been directed toward applying this lined ejector/suppressor concept to the specific requirements of the JT8D engine and keeping it within the installation constraints of the 727 airplane. Figure 14 shows two views of an ejector/suppressor concept designed for that application. The configuration consists of a 36-lobe suppressor nozzle and a lined ejector. The two views show the installation with the ejector shroud in place and removed. Ground tests of this configuration, along with fan treatment on the JT8D engine, have been encouraging

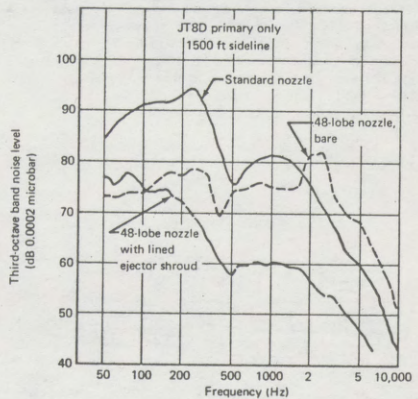


Figure 13. Spectral Distribution of Noise for a 48-Lobe Nozzle, Compared With a Standard Conical Nozzle (JT8D Ground Tests)

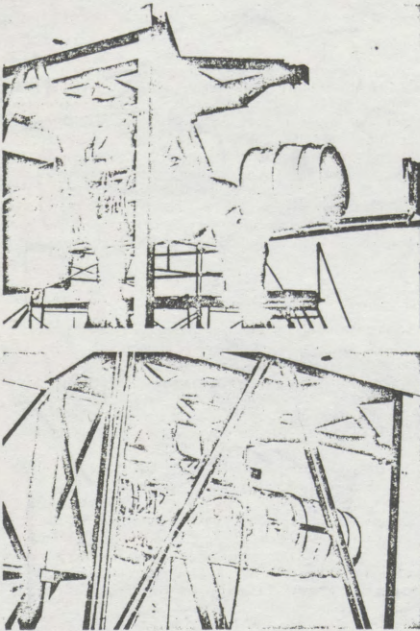


Figure 14. Experimental Ejector/Suppressor Concept on JT8D Engine Test Rig

from a noise-reduction standpoint. They have indicated 727 quieting on the order of 5, 10, and 8 EPNdB, in the cutback, approach, and sideline conditions, respectively, as compared to the reductions of 1, 6, and 0 EPNdB previously discussed for fan treatment alone. In addition, the quality of the noise is noticeably altered. Figure 15 is a schematic illustration of the configuration tested showing inlet treatment (acoustically treated ring and nose dome in addition to that shown in fig. 11), the P&WA BG-19 fan duct treatment, and the 36-lobe nozzle surrounded by an acoustically lined ejector.

The noise reduction estimated for the ejector/suppressor configuration shown in table 4 is not without its problems.

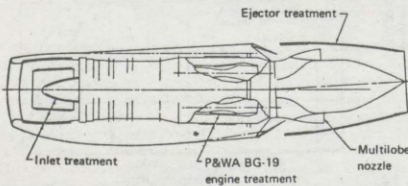


Figure 15. 727 Fan Treatment Plus Ejector/Suppressor (Developmental Concept)

Table 4. 727-200 Retrofit Summary (JT8D-9 Engines)

Type of treatment	Basic	Fan treatment	Jet suppression
Noise ^a (EPNdB)	Cutback Approach Sideline 100 109 106	99(-1) 103(-6) 106(0)	95(-5) 99(-10) 98(-8)
Δ Weight (lb)	—	378	To be determined
Δ Block fuel (%)	—	+ 1.0	
Δ Range (nmi)	—	-35	
Retrofit \$ (millions)	—	0.182	

^a Nominal noise values shown; ± 3 to ± 4 tolerance required.

Although performance data are yet to be determined, preliminary indications are that as much as 8% to 15% range loss may result from this configuration. It is obvious that further development is desirable on this type of concept to make it more acceptable from an operational standpoint. An FAA contract in final negotiation with Boeing is aimed at refining the concept to provide significant noise reduction along with reasonable performance capabilities. Flight demonstrations will show whether the concept actually provides noticeable relief to the airport communities.

In addition, production costs, performance losses, operating peculiarities, flight characteristics, and equipment durability will be determined prior to committing large retrofit expenditures. This same type of demonstration is required on other JT8D installations to avoid costly or catastrophic errors involving a major portion of the world fleet.

Figure 16 shows the time involved, beginning with the FAA contract, and the subsequent production and retrofitting of the 727 fleet. The schedule assumes continuity of effort following completion of the FAA contract program.

737 Retrofit

The Boeing 737 airplanes are powered with JT8D engines, as are the 727 models. The expensive effort of developing a viable JT8D jet noise suppression concept is being carried out on 727 programs discussed earlier. Following development of an acceptable and practical jet noise-reduction concept for the 727, the available technical knowledge will be used, as appropriate, to modify the concept to the specific 737 application. The following discussion relates mainly to development work done on fan noise treatment for the 737.

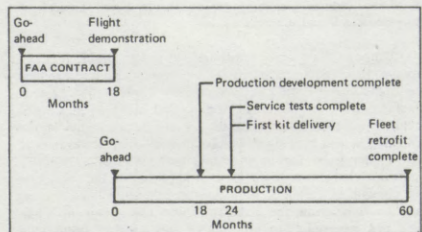


Figure 16. Tentative Schedule, 727 Quiet-Nacelle Retrofit

From the standpoint of developing a fan noise treatment for the 737, the same general approach as used on the 727 is appropriate. Figure 17 shows a schematic comparison of the current production nacelle and a modified installation employing acoustic lining materials in the inlet, fan ducts, and tailpipe. Note that considerably more inlet treatment is used than in the 727 fan noise treatment (fig. 11). The under-the-wing engine installation of the 737 versus the body-mounted engines on the 727, differences in airflow into the engine, and ground clearance differences dictate that each airplane noise-reduction program be tailored to that specific installation, even though the same engine is used.

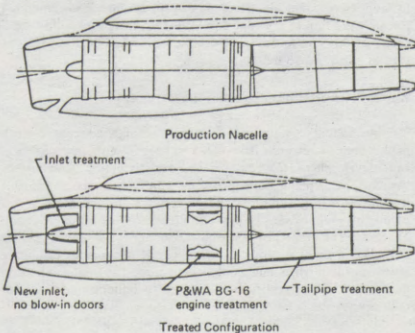


Figure 17. 737 Treated-Nacelle Configuration

A prototype 737 quiet-nacelle installation similar to that of figure 17 was flight tested in late 1968 and in 1969. Data from those tests indicated that noise reductions of 6, 9, and 0 EPNdB could be attained in the takeoff (cutback), approach, and sideline conditions, respectively. During 1968, this prototype configuration was also flight tested with a six-lobe jet suppressor installed (fig. 12). Very minimal improvements of 1 and 3 EPNdB were experienced in the cutback and sideline conditions, respectively, but the approach noise was 1 EPNdB higher than with fan treatment alone.

Table 5 summarizes the acoustic and performance data related to the fan treatment concept of figure 17. Note that the airplane performance penalties are minimal, although it has not yet been demonstrated that the acoustic results would be significantly beneficial to airport communities. It is currently estimated that the shipset kit cost of the treatment configuration of figure 17 would be in the order of \$160,000.

Table 5. 737-200 Retrofit Data Summary—JT8D-9 Engines

Type of treatment		Basic	Treated nacelle
Noise ^a (EPNdB)	Cutback	102	96(1-6)
	Approach	113	104(1-9)
	Sideline	104	104(0)
Δ Weight (lb)		—	+490
Δ Block fuel (%)		—	+1.2
Δ Range (nm)		—	-70
Retrofit \$ (millions)		—	0.160

^a Nominal noise values shown; ±3 to ±4 tolerance required.

RECOMMENDED RESEARCH AND DEVELOPMENT

Information presented and described to this point has provided background and has described Boeing noise-reduction research efforts to date. This section provides, in brief form, the recommended level and content of further research and development work required to accomplish significant additional noise reduction. The difficulty in making such recommendations lies in defining the work embodied under specific dollar recommendations, i.e., the term "research and development" has been used to cover an extremely broad range of technical work. For this reason, an attempt will be made to clarify and define the content of recommended additional noise-reduction research over and above that currently in progress or known to be planned for the near term.

Basic Research

Activities under this heading include the development of an understanding of the physical mechanisms of noise generation and noise suppression. This includes the development of methods of analysis, mathematical models, and the generation of basic data for use in subsequent applied research noise-reduction programs. Until this understanding is achieved, "cut and try" programs similar to those previously discussed must prevail.

Turbomachinery Source Design for Low Noise. All current and foreseeable aircraft propulsion systems provide thrust through moving large quantities of air by multiple stages of turbomachinery. As in past and current turbojet engines, the rows of fans, compressors, and turbines constitute one of the two major sources of engine noise. Research in developing design techniques for low noise is required to support new quiet-engine development in areas of low- and high-speed fan concepts, blade airflow selection for low noise, development of scaling laws, variable-geometry blade rows, blade surface flow control, and optimum turbine design. Excluding costly full- or large-scale test work, basic research funding of at least \$2 million per year is recommended.

Jet Exhaust Noise. The second major noise source that today constitutes a "floor" to further noise reduction is the low-frequency jet exhaust noise rumble or roar. Although alleviated significantly with the high-bypass-ratio engine, this noise source is still critical when attempts are made to reduce noise to levels acceptable to airport neighbors. Basic research in jet exhaust suppression should include work in understanding the mechanisms of noise generation and noise suppression, both low velocity and high velocity. Further understanding of the location of noise sources in the external exhaust stream, as well as understanding what part of exhaust noise is generated inside the engine, is required. The change in jet noise levels and suppression, especially for two-flow engines, between ground and in flight is also little understood. Basic research funding for jet noise reduction of between \$2 and \$3 million per year is recommended.

Acoustic Lining and New Materials. Although sufficient knowledge exists in the absorption of turbomachinery noise through acoustic lining for application to current airplanes, additional work remains to maximize noise reduction and minimize performance losses. Fruitful areas of additional basic research include more precise tailoring of the lining design to the engine source characteristics. Also, additional knowledge is required of the acoustic characteristics of various materials and improved manufacturing quality control. Recent accomplishments in lining theory have demonstrated that the potential exists for new and improved approaches that have not yet been attempted under test conditions. New acoustic linings are also

required for use in conjunction with jet exhaust suppression concepts. A recommended level of basic research funding in support of the above-outlined lining program would be on the order of \$2 million per year.

Community Assessment. Significant advances are required in improving and developing adequate means of assessing community reaction to noise. Research is required in developing, through subjective testing of people, acceptable measures of noise for several different classes of aircraft sounds. Limits of acceptability are required for making noise-reduction option decisions and for locating new airport sites. Engineering design objectives for noise reduction and for new airplanes are required that are more accurate and meaningful than exist today. Computer automation of the noise source, jet suppression, and lining attenuation options require further improvement to help generate decision-making information. Airplane configuration effects, such as the location of the engine, are proving to be extremely significant in airplane design decisions for minimum noise. Research funding in this area at a level of approximately \$2 million per year is recommended.

Propulsion Performance. Few if any noise-reduction options or concepts reduce noise without penalties or losses to the aircraft propulsion system. Jet exhaust suppression in particular, based on technology available today, has a severe impact on airplane performance due to propulsion losses. Research is required in developing new or improved analytical tools for exhaust nozzle design to combine noise reduction with acceptable performance losses. Improved methods are required to tailor the engine and external airflow streams to be compatible with noise-reduction devices. Research funding in this area of between \$1 and \$2 million per year is recommended.

Summary. Basic research in developing and broadening our technology base for noise-reduction concepts of around \$10 million per year is recommended. It should be emphasized that the work recommended above is mainly in generating additional fundamental knowledge through the development of analytical tools and test programs that exclude costly full-scale engine development or airplane flight test programs. Recommendations for these applied kinds of research follow.

Applied Research—Concept Development

Research under this heading involves the combination of several elements of basic research, described above, into a new concept or device for noise reduction. As used here, concept development is general in nature, i.e., the development of a general noise-reduction mechanism without a specific application to a particular airplane as an end objective. This type of work is accomplished in the early stages of melding basic research results together, in the absence of airplane and flight constraints.

Several examples of work required include the development of new, more effective jet exhaust suppression concepts, making use of the results of basic research recommended before. The objective of these concepts would be to significantly reduce community annoyance due to low-frequency noise from jet exhausts, with an optimum combination of noise reduction and performance loss, to better ensure the successful application of noise-reduction technology. Another example of concept development includes design studies of new engine concepts for use on future conventional and STOL airplanes. Work of this type combines the output of noise research, such as source, lining, and jet suppression, into new engine design concepts prior to expensive full-scale development programs. Recommended research funding in concept development for new jet-suppression concepts and new advanced-technology quiet-engine concept studies is around \$5 million.

Applied Research—Configuration Development

As opposed to applied research concept development, work in this area of research is involved in specific airplane configuration development for community noise reduction. Considering the current airplane noise problem, configuration development would result in ground test and, in selected instances, flight test of prototype hardware to prove the feasibility of noise-reduction concepts. The results of research recommended below would be ground and flight demonstration of configurations for candidate airplanes for retrofit but would not include the final production design or FAA certificates of the production design for commercial use.

The current retrofit feasibility contract sponsored by the FAA will result in a JT8D configuration development for one airplane, the 727-200. Similar configuration demonstrations will be required for 737 and DC-9 airplanes, both powered by JT8D engines. In addition, configuration development through ground test is being sponsored by the FAA for the 707-series airplanes. Similar installations will be required for DC-8 short-cowl and DC-8 long-cowl aircraft types. Recommended funding to cover configuration development for the 737, DC-9, and two DC-8 airplanes is on the order of \$20 million.

In summary, basic technology research of around \$10 million per year has been discussed. Concept development for jet suppression and future engine design studies of around \$5 million have been recommended. Configuration development funding to supplement the existing FAA contract for retrofit feasibility for four additional airplane types of around \$20 million has been recommended.

NOISE STATUS

THE BOEING COMPANY, JULY 13, 1971

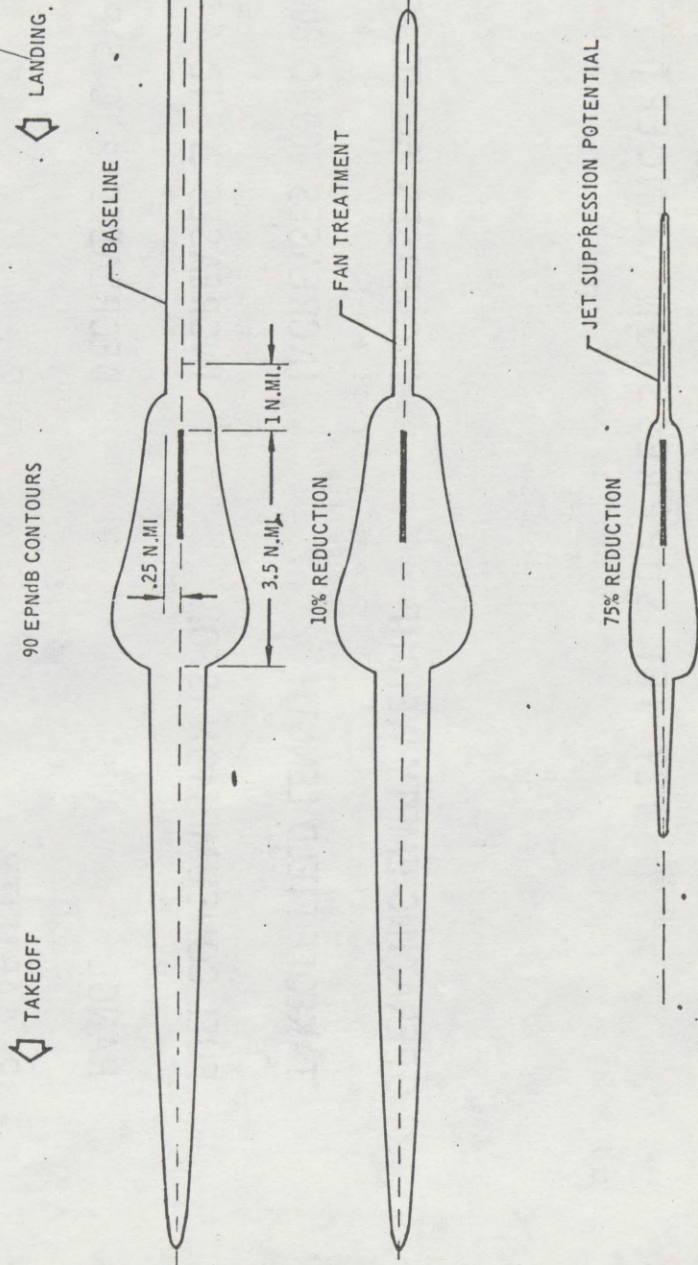
INTRODUCTION

IN PREPARING THIS NOISE REDUCTION INFORMATION, ESTIMATES OF PERFORMANCE, SCHEDULES AND COSTS WERE BASED ON THE BEST DATA AVAILABLE AT THIS TIME. DETAILED DESIGNS AND FULL SCALE TESTS ARE NEEDED TO VERIFY MANY OF THE CONFIGURATIONS.

FULL SCALE TEST SUMMARY

<u>DATE</u>	<u>CONFIGURATION</u>	<u>GROUND/FLIGHT</u>
MID 1968	19 TUBE, 12 LOBE SUPPRESSORS ON JT8D	GROUND
NOV 1968	12 LOBE SUPPRESSOR ON 737	FLIGHT
MAR 1969	737 FAN TREATMENT & 6-LOBE SUPPRESSOR	GROUND
APR 1969	MIXER, OVAL NOZZLE ON JT8D	GROUND
APR 1969	737 FAN TREATMENT & 6-LOBE SUPPRESSOR	FLIGHT
OCT 1969	48 LOBE SUPPRESSOR ON J-75 ENGINE	GROUND
SEPT-DEC, 1969	48 LOBE & 9 TUBE SUPPRESSOR ON JT8D PRIMARY	GROUND
	JT8D NOISE ISOLATION COMPONENTS	GROUND
SEPT-NOV, 1970	36 LOBE EJECTOR SUPPRESSOR (JT8D)	GROUND
AUG 1970	737 FAN TREATMENT	FLIGHT
NOV-DEC, 1970	727 FAN TREATMENT	FLIGHT
JAN 1971	727 FAN TREATMENT	FLIGHT
MAR 1971	727 FAN TREATMENT	FLIGHT

727-200 NOISE REDUCTION ALTERNATIVES



CURRENT STATUS

727 JET SUPPRESSION CONCEPT

OPERATING EMPTY WEIGHT

INCREASES 1500 TO 2000 LB

TAKEOFF FIELD LENGTH

INCREASES 400 TO 800 FT

FUEL CONSUMPTION (SFC)

INCREASES 2.5 TO 4 PERCENT

RANGE

DECREASES 8 TO 15 PERCENT

RELIABILITY

?

COST

?

RESEARCH RECOMMENDATIONS

PROBLEM: SPECIFIC DEFINITION OF WORK MUST ACCOMPANY RECOMMENDATION
FOR LEVEL OF RESEARCH EFFORT

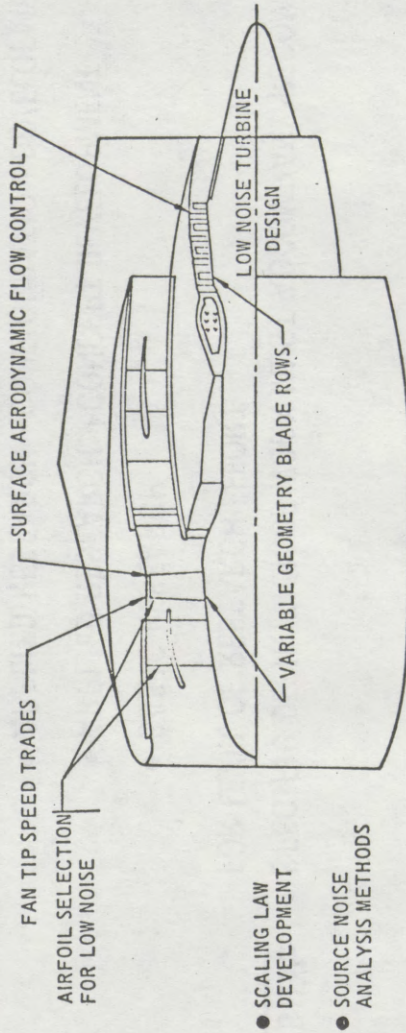
- BASIC RESEARCH
- APPLIED RESEARCH - CONCEPT DEVELOPMENT
- APPLIED RESEARCH - CONFIGURATION DEVELOPMENT

RECOMMENDATIONS ARE FOR WORK BEYOND CURRENT OR KNOWN NEAR-TERM RESEARCH

BASIC RESEARCH

DEFINITION: UNDERSTANDING PHYSICAL MECHANISMS - DEVELOP METHODS OF ANALYSIS -
GENERATE BASIC EXPERIMENTAL DATA

TURBOMACHINERY SOURCE DESIGN FOR LOW NOISE -

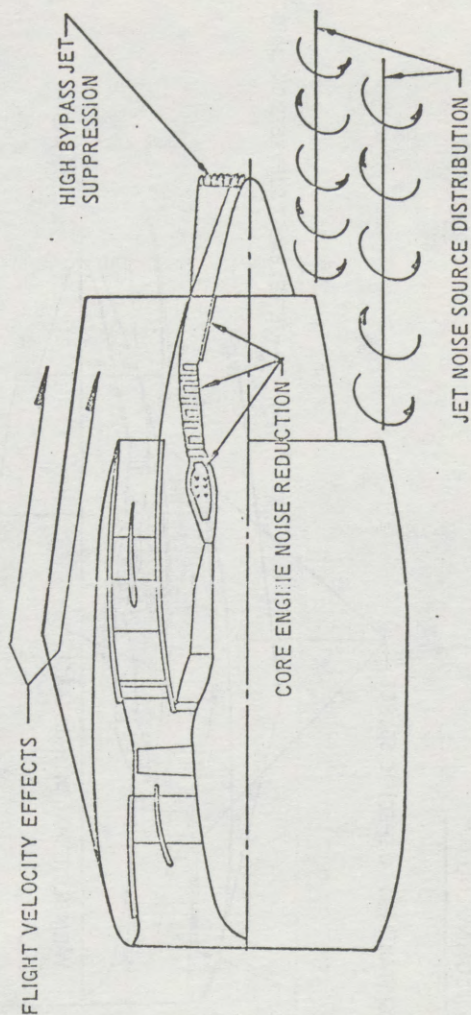


RECOMMENDATION: MINIMUM OF \$2,000,000/YR. - EXCLUDES FULL OR LARGE SCALE TEST WORK

BASIC RESEARCH

JET EXHAUST NOISE

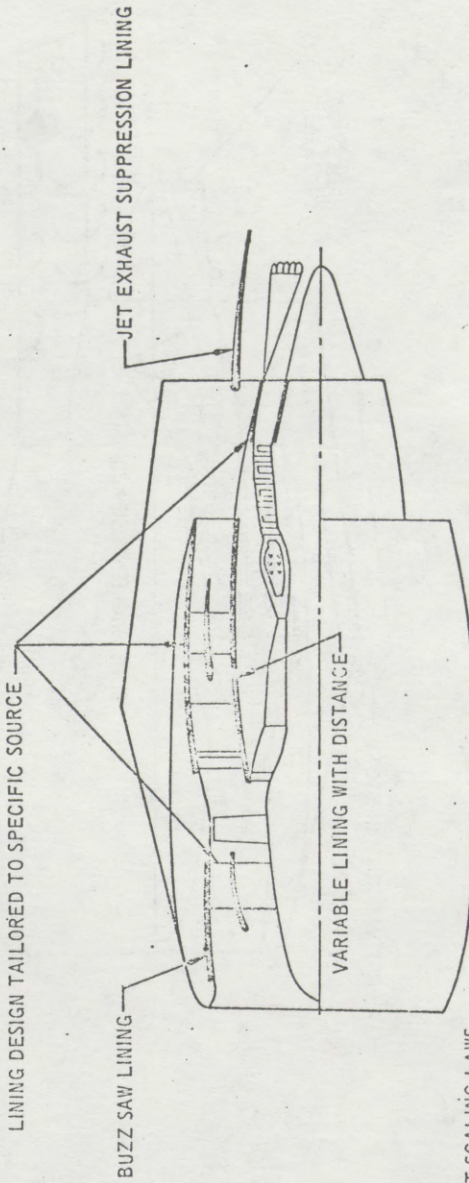
- ◉ JET NOISE VARIATION WITH ENGINE BYPASS RATIO



RECOMMENDATION: MINIMUM OF \$2 TO \$3,000,000/YR.

BASIC RESEARCH

ACOUSTIC LINING TECHNOLOGY -



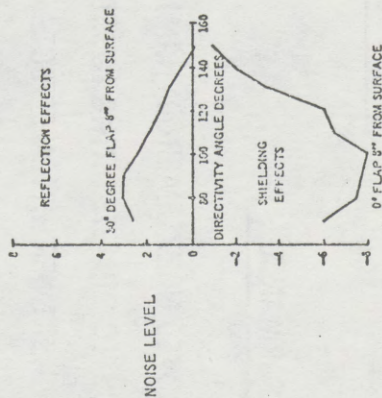
- TREATMENT SCALING LAWS
- MANUFACTURING QUALITY CONTROL
- NEW MATERIALS QUALIFIED FOR FLIGHT

RECOMMENDATION: MINIMUM OF \$2,000,000/YR.

BASIC RESEARCH

COMMUNITY ASSESSMENT -

- ACCEPTABILITY CRITERIA - SEVERAL CLASSES OF AIRCRAFT SOUNDS
- IMPROVED DESIGN OBJECTIVES
- COMPUTER AUTOMATION OF SOURCE, JET, AND LINING ATTENUATION
- AIRPLANE CONFIGURATION EFFECTS



RECOMMENDATION: MINIMUM OF \$2,000,000/YR.

BASIC RESEARCH

PROPULSION PERFORMANCE -

- IMPROVED NOZZLE AERODYNAMIC PERFORMANCE TOOLS
- ACOUSTIC SPLITTER/RING LOSSES
- LINING-SKIN FRICTION EFFECTS

RECOMMENDATION: MINIMUM OF \$1 TO \$2,000,000/YR.

SUMMARY: AT LEAST \$10,000,000/YR. BASIC RESEARCH
(EXCLUDES FULL SCALE DEMONSTRATOR PROGRAMS)

APPLIED RESEARCH - CONCEPT DEVELOPMENT

DEFINITION: SEVERAL ELEMENTS OF BASIC RESEARCH INTO A NEW NOISE REDUCTION
CONCEPT - NOT SPECIFIC TO ANY AIRPLANE. (DEPENDENT UPON
ADEQUATE BASIC RESEARCH.)

- JET EXHAUST SUPPRESSION CONCEPTS
- NEW ENGINE DESIGN STUDIES - FUTURE STOL & CTOL AIRPLANES

RECOMMENDATION: MINIMUM OF \$5,000,000

APPLIED RESEARCH - CONFIGURATION DEVELOPMENT

DEFINITION:

NOISE REDUCTION CONFIGURATION DEVELOPMENT FOR SPECIFIC AIRPLANE MODELS. GROUND TEST AND SELECTED FLIGHT DEMONSTRATION OF PROTOTYPE HARDWARE. (EXCLUDES FINAL PRODUCTION DESIGN AND FAA CERTIFICATION.)

REFERENCE:

FAA RETROFIT FEASIBILITY CONTRACT - CONFIGURATION DEVELOPMENT FOR 707 AND 727 AIRPLANES.

RECOMMENDATION:

CONFIGURATION DEVELOPMENT FOR 737, DC-9, AND SEVERAL DC-8 MODELS ~ MINIMUM OF \$20,000,000

OVERALL SUMMARY

- BASIC RESEARCH - AT LEAST \$10,000,000/YR.
- CONCEPT DEVELOPMENT - AT LEAST \$5,000,000
- CONFIGURATION DEVELOPMENT - AT LEAST \$20,000,000
737, DC-9, DC-8

BOEING STATUS REPORT
CONCLUSIONS AND RECOMMENDATIONS

1. A SIGNIFICANT EFFORT IN NOISE REDUCTION RESEARCH HAS BEEN EXPENDED BY BOEING TO DATE.
2. VARYING DEGREES OF RETROFIT ARE TECHNICALLY FEASIBLE ON BOTH JT8D AND JT3D POWERED AIRCRAFT.
3. PERFORMANCE PENALTIES AND COSTS CAN BE LARGE.
4. A JUSTIFIABLE RETROFIT PROGRAM MUST REDUCE AIRPORT COMMUNITY NOISE TO A SIGNIFICANT EXTENT AND BE PERCEIVED AS FAVORABLE BY THE PUBLIC.
5. ADDITIONAL WORK IS NEEDED, FUNDED TO AN ADEQUATE LEVEL, TO REDUCE PROGRAM RISKS, IMPROVE PERFORMANCE, AND IMPROVE NOISE REDUCTION.
6. PRIVATE FINANCING OF RETROFIT RESEARCH IS BECOMING INCREASINGLY DIFFICULT.

(Whereupon, at 12:35 p.m., the hearing was recessed, to reconvene at 2 p.m., this same day.)

AFTERNOON SESSION

Senator CANNON. The hearings will come to order.

Our next witness is Mr. Clifton F. von Kann, senior vice president, operations and airports, ATA.

We are very happy to have you here, General.

STATEMENT OF CLIFTON F. VON KANN, SENIOR VICE PRESIDENT, OPERATIONS AND AIRPORTS, AIR TRANSPORT ASSOCIATION OF AMERICA, WASHINGTON, D.C.

Mr. VON KANN. Thank you, Mr. Chairman. Nice to be here. I will go through my statement as quickly as possible.

We appreciate the opportunity to be heard on these important hearings because the airlines are indeed interested in doing anything we can to reduce our impact on the environment and to improve the environment.

I might say by way of background that commercial jets are the cleanest form of transportation since the turbine engine consumes virtually all its fuel, and the very few emissions that result from this highly efficient combustion process amount to about 1 percent of all air pollutants. The airlines and manufacturers you have heard from this morning are vigorously seeking to reduce this 1 percent as well as the noise.

The visible portion—the unburned particulates, or smoke—are rapidly disappearing right now as new improved engines and engine combustors are introduced into service.

Now, noise is a more difficult problem than emissions. Yet, here again, a great deal has been done, and I would like to mention a few of those things.

First, when the jets went into airline service in the late 1950's they were equipped with noise suppressors costing over \$150 million. The loss of efficiency resulting from these suppressors costs \$10,000 per plane every year.

Second, less than 3 years after the first jets came into service, the airlines introduced the fan-jet engine which produced fewer emissions than the early jets and operated with lower takeoff noises. Almost all airline aircraft operating in the United States today are equipped with fan-jet engines.

Third, new aircraft currently being delivered are treated with extensive acoustical materials which reduce noise levels and alleviate the annoying high frequency whine. For example, the 747 weighs almost $2\frac{1}{2}$ times as much as the 707 and can carry over twice the number of people, yet it produces less noise in EPNdB's, and the noise it does make is appreciably less annoying. The new trijets—the L-1011 and the DC-10—will be even quieter.

Fourth, in addition to these modifications, special approach and take-off patterns are in effect at major urban airports to minimize the noise in surrounding neighborhoods. These patterns under so-called con-

ditions of wind and weather, reduce the capacity of Kennedy International by 50 percent. And on many occasions airlines must accept penalties in the form of reduced payloads to avoid creating excessive noise.

Fifth, the airlines have underwritten the costs of runway realignments and extensions, as well as the purchase of residential areas for the establishment of clear zones, as at Los Angeles International Airport.

These things have been done. Future progress depends largely on research and testing directed at a more complete understanding of noise-generating mechanisms and of the propagation and attenuation of noise in the atmosphere, about which we know very little.

In the recent hearings on the DOT/FAA fiscal year 1972 budget we have made specific recommendations for a comprehensive R. & D. program to investigate these unknowns. In this regard we have included funds for such retrofit investigation as we believe to be practical, and for the studies necessary to establish realistic retrofit objectives. Attachment 1 details our R. & D. proposals.

I might note in passing that these proposals are quite similar in nature to those proposals which were outlined by the Boeing representative this morning.

Now, in this light we offer our comments on S. 1566. Briefly, this bill has the following weaknesses:

1. It would establish retrofit standards that are technologically impossible to meet.
2. It fails to recognize that some variations from standard will occur due to unusual local conditions of weather, altitude and terrain.
3. It is unrealistic in its assumptions as to the time needed to carry out a retrofit program.
4. It underestimates the funds which a fleet retrofit program would require.

5. Guaranteed loans as described in the bill would not insure the necessary financing.

6. It would not be equitable for the airlines, their passengers and shippers to bear the total financial burden of a retrofit program.

Attachment 2 amplifies our objections to S. 1566, and these in brief are the reasons why we oppose S. 1566.

Turning now to the administration's bill S. 1016, this bill, though basically sound in leaving primary authority for aircraft noise reduction with the FAA, proposes a potential impediment to further progress by giving to the EPA Administrator a veto vote. The result can only be delay in coordination between the two agencies, or stalemates, which would be worse. However, with some small amendments, the administration bill would be a step forward.

My statement goes into some of the background here which I don't believe is necessary to repeat at this point in time, and I will now turn to the specific problems that we have with the bill as now written.

We feel that there has been an oversight of the purely technical nature in subsection 6(d) of the bill. Because of the three obviously necessary exclusions in the definition of "product" in subsection 6(d) by negative implication might erroneously be read to suggest that a

state of subdivision thereof is permitted to set different noise standards for military aircraft; for aircraft; rockets and equipment used by NASA; and for aircraft engines and equipment covered by title VI of the Federal Aviation Act.

Since a typical airliner may in 1 day land in 12 separate States while overflying 27 others, it is evident that these categories of equipment cannot be subject to different State noise standards.

Further, such an interpretation would be anomalous viewed alongside the prohibition against such differing standards with respect to the other broad product categories listed in subsection 6(a).

We therefore suggest that subsection 6(d) of the bill be amended as follows:

After "enforce" and before the comma, insert: "any standard limiting noise-generation characteristics with respect to any item excluded from the definition of product in subsection (c) of section (e) or".

I might say our only purpose in offering this language is to correct what can only be an oversight on the part of the draftsmen of the bill. We are not attempting to use this bill to affect such issues as preemption or the authority of airport proprietors. However, an unintended negative implication of the bill without amendment might suggest that commercial aircraft, military aircraft, and NASA aircraft would be subject to the regulation by any locality. This would, of course, be contrary to the existing long-standing state of the law with respect to each category.

So, that is our intent and purpose in recommending this change, and we have no other axe to grind.

Next, our last point with respect to S. 1016 concerns the veto power given to the Administrator of the EPA in subsections 6(c)(1) and 6(c)(2).

As previously observed, noise regulation with respect to aircraft is inextricably related to considerations of safety. Regulation of aircraft noise affects either the design of aircraft, the operation of aircraft, or both; that is, it must take the form of design of new engines or modification of existing engines, or design or modification of the airframe, or control of operational procedures involved in landings, takeoffs and flight.

With today's highly sophisticated aircraft, complex navigation systems, crowded airspace and limited airport facilities, no such regulation can be divorced from the most serious considerations of safety, both to passengers and crew and to persons on the ground.

Nor, in our view, can these highly technical questions of safety be delegated to an agency for which that consideration is not an area of its primary concern. The EPA does not have, nor should it be charged with, the responsibility to concern itself with safety of aircraft. This has long been a duty discharged by the FAA. The safety record of the scheduled air carriers is proof that FAA has responded well to this mandate.

Because regulation of aircraft noise cannot be divorced from the need to maintain "the highest degree of safety," recognized by Congress in section 611 of the Federal Aviation Act and because such safety considerations must be paramount, we recommended that the EPA Administrator not be given a veto power over aircraft noise regulations.

In promulgating aircraft noise regulations under section 611 of the Federal Aviation Act the FAA Administrator has already been directed to take into account the same basic statutory criteria proposed for use by the EPA Administrator with respect to his regulation of other "products" pursuant to subsection 6(a), and as we have seen, substantial progress has already been made under FAA auspices.

Rather than a veto at the end of the regulatory process, it would be more appropriate to provide for consultation between the two agencies from the outset and to leave final promulgation and administration of aircraft noise regulations to FAA, the agency charged with safety. We have therefore suggested appropriate language to make that modification.

The proposed amendment, I might add, would also create consistency between this bill and the provisions of the Clean Air Act of 1970 since the relationships established in the bill would then parallel those already established by law in the field of air pollution.

In summary, the airlines endorse the concept that noise is a problem requiring uniform regulation and agree with the fundamental recognition in the bill that because of consideration of the public interest in the national air transport system and its safety, the regulation of aircraft noise not only requires uniform Federal regulation, but regulation by the FAA, in consultation with the EPA. This arrangement would also be in the interest of regulatory consistency.

We are in essential agreement with the policies embodied in S. 1016, and believe that the suggested amendments will strengthen the bill and are consistent with the objectives they express.

I might make one or two remarks in concluding, if I may, Mr. Chairman. Both of these bills have a very definite relationship to the economics of operating airlines which tends to be overlooked.

You may have noted in Mr. Pendley's presentation this morning that one of the retrofit programs was estimated to add something like 4.4 percent to airline DOC's, and I would like to indicate what that means.

In 1970 the direct operating costs paid out by the members of the Air Transport Association amounted to over \$5 billion. The figure I ran off this morning was \$5,421 million rounded. So when we mention 4.4 percent of a figure like that, we are talking of \$238 million; even a 1 percent change in DOC's is \$50 million.

Changes of this magnitude can also be generated by regulatory action when the basic problems of technology, safety, and the economics of airline operation are not well understood.

Although we have no problem with the duties of the EPA, the EPA was not brought into existence because of its understanding of airline operations. As a matter of fact, it was probably not meant to be a particularly reasonable agency. We strongly feel that the final decisions on any aspect of our operation must be made by FAA and cannot be turned over to another agency.

Those complete my remarks, sir. I will be glad to answer any questions.

Senator CANNON. How do you see us correcting or improving this situation in the interim period before new airplanes and new engines come into the inventory and solve the problem?

Mr. VON KANN. The noise problem, sir?

Senator CANNON. Yes.

Mr. VON KANN. I think improvement is already in progress. As the wide-bodied jets come into the field and replace the noiser 707's and DC-8's, there is improvement.

We support the idea that the possibilities for retrofit of the JT8 fleet, which is roughly 50 percent of the number of aircraft in the airline fleet, which because of the number of operations accounts for 50 percent of the noise, needs to be explored, and it may well be that a retrofit program for that part of the fleet will develop.

We frankly feel at the rate the 707/DC-8 fleet is phasing out, because our figures estimate by 1980 there will probably be maybe 400 of these aircraft in existence as against over 800,000, we feel that the whole environment is becoming quieter and will become quieter, and that the programs we are recommending will serve to move that improvement along.

Senator CANNON. What about some of the other steps that are now being experimented with by the FAA? Do you have a view of those, steepening the approach angles and things of this sort?

Mr. VON KANN. I do think there are some possibilities here, and we are working with the FAA. We in general support the 3° glide slope program. Steps of this nature where you prevent an airplane from dragging in on a long approach at a low altitude, things like this should be eliminated.

On the 3,000-foot interceptor glide slope, we have no trouble with that on straight-in approaches. Where you have got to fly it downwind and then come back, it could add a good deal of mileage.

We think there are probably ways to come in staying above the altitude of the outer marker and getting the same result without intercepting at 3,000. But in principle we go along with that objective and we are working with the FAA.

As you probably know, there is something like 90 locations now where you have 3° glide slopes as against the 2.5° to 3° degree glide slopes. I believe this is true at most of the noise-sensitive airports.

So, we are thoroughly in harmony with that, and we feel as improved cockpit equipment becomes available where you can use steeper approach angles without any safety penalty that this should be explored, too, and it will be.

Senator CANNON. Do you think there is the opportunity to steepen approaches without endangering safety in any way?

Mr. VON KANN. At this time, sir?

Senator CANNON. Yes.

Mr. VON KANN. I have to lean on the position taken by our Flight Operations Committee in ATA, which consists of the vice presidents in charge of flights. In other words, these are the flight managers of the pilots who now still fly but on the other hand represent management in this respect. To them the 3° glide slope is acceptable at this time. I think that they would say that any further steepening would have to depend upon improved cockpit equipment, so that the timing of the flare and all that leaves no possibility of too steep a descent at a critical moment.

Senator CANNON. Thank you very much. We appreciate your being here.

(The statement follows:)

STATEMENT OF CLIFTON F. VON KANN, SENIOR VICE PRESIDENT, OPERATIONS AND AIRPORTS, AIR TRANSPORT ASSOCIATION OF AMERICA

My name is Clifton F. von Kann. I am Senior Vice President, Operations and Airports, of the Air Transport Association, which represents virtually all the scheduled air carriers of the United States. The airlines appreciate this opportunity to appear and testify on S. 1566 and S. 1016, for they share your concern about environmental quality and recognize that the matters of noise standards and noise regulation are of critical importance.

Commercial jets are the cleanest form of transportation since the turbine engine consumes virtually all its fuel. The very few emissions resulting from this highly efficient combustion process amount to about 1 percent of all air pollutants. The airlines and manufacturers are vigorously seeking to reduce this 1 percent; the visible portion—unburned particulates, or smoke—is rapidly disappearing as new, improved engines and engine combustors are introduced into service.

WHAT HAS BEEN DONE ABOUT NOISE

Noise is a more difficult problem. Yet, here again, much has been done and—and at no small cost.

First, when the jets went into airline service in the late 1950's, they were equipped with noise suppressors costing over \$150 million. The loss of efficiency resulting from these suppressors costs \$10,000 per plane every year.

Second, less than 3 years after the first jets, the airlines introduced the fan-jet engine which produced fewer emissions than the early jets and operated with lower takeoff noises. Almost all airline aircraft operating in the United States today are equipped with fan-jet engines.

Third, new aircraft currently being delivered are treated with extensive acoustical materials which reduce noise levels and alleviate the annoying high frequency whine. For example, the 747 weighs almost 2½ times as much as the 707, and can carry over twice the number of people; yet it produces less noise in EPNdBs, and the noise it does make is appreciably less annoying. The new tri-jets—the L-1011 and the DC-10—will be even quieter.

Fourth, in addition to these modifications, special approach and take-off patterns are in effect at major urban airports to minimize the noise in surrounding neighborhoods. These patterns, under some conditions of wind and weather, reduce the capacity of Kennedy International by 50 percent. And on many occasions airlines must accept penalties in the form of reduced payloads to avoid creating excessive noise.

Fifth, the airlines have underwritten the costs of runway realignments and extensions, as well as the purchase of residential areas for the establishment of clear zones, as at Los Angeles International Airport.

These things have been done. Future progress depends largely on research and testing directed at a more complete understanding of noise generating mechanisms, and of the propagation and attenuation of noise in the atmosphere, about which we know very little. In the recent hearings on the DOT/FAA FY-1972 budget, we have made specific recommendations for a comprehensive R&D program to investigate these unknowns. In this regard we have included funds for such retrofit investigation as we believe to be practical, and for the studies necessary to establish realistic retrofit objectives. Attachment 1 details our R&D proposals.

S. 1566

In this light we offer our comments on S. 1566. Briefly this bill has the following weaknesses:

1. It would establish retrofit standards that are technologically impossible to meet.
2. It fails to recognize that some variations from standard will occur due to unusual local conditions of weather, altitude and terrain.
3. It is unrealistic in its assumptions as to the time needed to carry out a retrofit program.
4. It underestimates the funds which a fleet retrofit program would require.
5. Guaranteed loans as described in the bill would not insure the necessary financing.
6. It would not be equitable for the airlines, their passengers and shippers to bear the total financial burden of a retrofit program.

Attachment 2 amplifies our objections to S. 1566.

These, in brief, are the reasons why we oppose S. 1566.

Turning now to the Administration's bill, S. 1016, this bill, though basically sound in leaving primary authority for aircraft noise reduction with the FAA, proposes a potential impediment to further progress by giving to the EPA Administrator a veto power. The result can only be delay in coordination agreement between the two agencies, or stalemates, which would be worse. However, with some small amendments, the Administration bill would be a step forward.

BACKGROUND

Perhaps more than in any other field of commerce, the regulation of air transport involves complex matters of the public interests. The public interest in air transport has been defined by the Congress to include "the regulation of air commerce . . . to best promote its development and safety and fulfill the requirements of national defense" and "the control of the use of the navigable airspace of the United States . . . in the interest of safety and efficiency". (49 U.S.C. § 1303)

Moreover, in 1968, by the passage of Section 611 of the Federal Aviation Act (49 U.S.C. § 1431), Congress expressly recognized both the need for uniform national regulation of sonic boom and aircraft noise and the necessity that regulation of these environmental problems be vested in the same agency that regulates the other interrelated aspects of the public interest—particularly, aircraft safety and the efficient use of the navigable airspace.

Pursuant to the 1968 amendment, Congress expressly authorized the Federal Aviation Administration to establish standards for noise measurement and to prescribe economically reasonable, technologically practicable rules and regulations for the control of sonic boom and aircraft noise consistent with both the public interest in the national air transport system and "the highest degree of safety in air commerce". (49 U.S.C. § 1431). The FAA has already taken substantial action under this mandate. We submit a list of actions taken by FAA to reduce noise. (Attachment 3)

S. 1016 reaffirms the long standing recognition of the Executive and Legislative Branches and of all responsible groups concerned with the air transport system that noise regulation is inextricably related to other aspects of regulation in the public interest, (i.e., efficiency and safety of operation).

SOME CLARIFICATION NEEDED

There is what appears to be an oversight of a purely technical nature in subsection 6(d) of the bill. Because of the three obviously necessary exclusions in the definition of "product" in subsection 3(c) of the bill, subsection 6(d) by negative implication might erroneously be read to suggest that a state or subdivision thereof is permitted to set different noise standards for military aircraft; for aircraft; rockets and equipment used by NASA; and for aircraft engines and equipment covered by Title VI of the Federal Aviation Act. Since a typical airliner may in one day land in 12 separate states while overflying 27 others, it is evident that these categories of equipment cannot be subjected to differing state noise standards. Further, such an interpretation would be anomalous viewed along side the prohibition against such differing standards with respect to the other broad product categories listed in subsection 6(a).

We therefore suggest that subsection 6(d) of the bill be amended as follows:

After "enforce" and before the comma, insert: "any standard limiting noise-generation characteristics with respect to any item excluded from the definition of product in subsection (c) of section e or"

FAA AUTHORITY MUST NOT BE DILUTED

Our last point with respect to S. 1016 concerns the veto power given to the Administrator of the Environmental Protection Agency in subsections 6(c)(1) and 6(c)(2). As previously observed, noise regulation with respect to aircraft is inextricably related to considerations of safety. Regulation of aircraft noise affects either the design of aircraft, the operation of aircraft, or both; that is, it must take the form of design of new engines or modification of existing engines, or design or modification of the airframe, or control of operational procedures involved in landings, takeoffs and flight. With today's highly sophisticated aircraft, complex navigation systems, crowded airspace and limited airport facilities, no such regulation can be divorced from the most serious considerations of safety, both to passengers and crew and to persons on the ground.

Nor, in our view, can these highly technical questions of safety be delegated to an agency for which that consideration is not an area of its primary concern. The EPA does not have, nor should it be charged with, the responsibility to concern itself with safety of aircraft. This has long been a duty discharged by the FAA. The safety record of the scheduled air carriers is proof that FAA has responded well to this mandate.

Because regulation of aircraft noise cannot be divorced from the need to maintain "the highest degree of safety", recognized by Congress in Section 611 of the Federal Aviation Act (49 U.S.C. § 1431), and because such safety considerations must be paramount, we recommended that the EPA Administrator not be given a veto power over aircraft noise regulations. In promulgating aircraft noise regulations under Section 611 of the Federal Aviation Act, the FAA Administrator has already been directed to take into account the same basic statutory criteria proposed for use by the EPA Administrator with respect to his regulation of other "products" pursuant to subsection 6(a), and as we have seen, substantial progress had already been made under FAA auspices.

Rather than a veto at the end of the regulatory process, it would be more appropriate to provide for consultation between the two agencies from the outset, and to leave final promulgation and administration of aircraft noise regulations to FAA, the agency charged with safety. We therefore suggest the following amendments of subsection 6(c) of S. 1061:

In subsection 6(c) (1), strike "subject to the approval of" and insert "with".

In subsection 6(c) (2), strike "Standards, rules, and regulations prescribed and amended under this section shall become effective only upon approval by the Administrator of the Environmental Protection Agency: *Provided*, that all", and insert "All" instead.

This proposed amendment would also create consistency between this bill and the provisions of the Clean Air Act of 1970 since the relationships established in the bill would parallel those already established by law in the field of air pollution.

In summary, the airlines endorse the concept that noise is a problem requiring uniform regulation and agree with the fundamental recognition in the bill that because of consideration of the public interest in the national air transport system and its safety, the regulation of aircraft noise not only requires uniform federal regulation, but regulation by the Federal Aviation Administration, in consultation with the Environmental Protection Agency. This arrangement would also be in the interest of regulatory consistency. We are in essential agreement with the policies embodied in S. 1016, and believe that the suggested amendments will strengthen the bill and are consistent with the objectives they express.

Thank you again for this opportunity to be heard.

AVIATION NOISE R&D

As has been noted, R&D in aviation noise has been sparse and entirely inadequate considering contemplated expenditures in noise abatement and the information required for these expenditures to be both prudent and wise. The recommended R&D program is detailed below by priority in both basic and applied categories.

Basic Research

1. Subjective Response (per year)----- \$2, 000, 000

Of first priority is research on the subjective effects of aircraft noise on people. Research to date, culminating with the TRACOR Study, has not provided conclusive results. The subjective content of individual annoyance remains unknown. The expenditure by the public of large sums of money for noise abatement cannot be justified on the basis of presumed benefits. As a consequence, it is essential that subjective response information be developed.

2. Jet Noise (per year)----- 6, 000, 000

Recent research programs offer many design avenues for the reduction of noise caused by the fan, compressor, and turbine. The potential offered by these new approaches for the abatement of noise generated by the turbo-machinery of current and future aircraft brings the question of primary jet noise suppression into focus as the major barrier to further reduction of the aircraft noise environment. Thus there is a need to develop a clear theoretical understanding of the mechanisms of jet noise production as well as reliable and effective techniques for jet noise suppression.

- | | |
|---|---------------|
| 3. Engine Noise (per year)----- | \$2, 000, 000 |
| With a particular view of future engine designs and V/STOL needs, research should be increased in the fundamental mechanisms of turbo machinery noise including wake/blade interaction, wake development and control as well as in energy transport in compressor and turbine sections. | |
| 4. Acoustic Lining (per year)----- | 3, 000, 000 |
| Acoustic treatment has been demonstrated to be an effective technique in the suppression of fan-generated noise and research on materials and techniques should be continued. | |
| 5. Quiet Engine Program (to complete)----- | 9, 000, 000 |
| The NASA Quiet Engine Demonstration Program should be completed. The fan noise reduction techniques being developed are quite promising and are applicable to next-generation engines. | |

APPLIED R&D

There is increasing consideration and pressure for retrofit of at least a portion of the current airline fleet for noise reduction. However, the objectives of a retrofit program are not at all clear. The cost/benefit objectives within the constraints of technical and economic reasonableness have not been established. Therefore, a two-step retrofit exploration program is indicated.

Retrofit Exploration

- | | |
|---|---------------|
| a. In order to define retrofit objectives it is necessary to conduct a short term research program in psychoacoustic testing and in cost/effectiveness-benefit analysis of aircraft retrofit options... | \$2, 000, 000 |
| b. It is anticipated that the results of item a. will indicate particular promise in certain retrofit options for the JT8D powered fleet. It will then be necessary to conduct a feasibility program to verify noise reductions, performance changes, costs, safety and reliability aspects forecast for certifiable noise retrofit modifications proposed for current 727, 737 and DC-9 fan jet powered aircraft | 30, 000, 000 |

The psychoacoustic testing and cost/effectiveness analysis short term research program should have the following elements. First, it must be determined whether noise reductions which are technologically achievable are "meaningful". It should be possible to provide this needed answer with a well conceived psychoacoustic test program. It should be possible to simulate over a short period of time the change in noise exposure that would occur with and without noise retrofit of current aircraft. To be complete, the psychoacoustic test part of the program should be combined with an evaluation of noise exposures at representative airports, including a cost-benefit analysis of all relevant factors. The methodology evolved in the ICAO Committee on Aircraft Noise, Working Group A, is applicable. The methodology would consider such factors as: runway layout, flight path, number of operations, runway utilization, fleet composition, aircraft noise levels and performance and retrofit acoustical, performance and economic change to determine the change in noise contour areas. With cost information, monetary value, and population density inputs and the annoyance weighting factor from the psychoacoustic testing, cost-benefit may be determined, providing a basic evaluation of aircraft retrofit options. In this fashion, the basic information necessary to establish the retrofit objectives may be generated.

WEAKNESSES IN S. 1566

IMPOSSIBLE STANDARDS

Subparagraph (d) of the proposed amendment to Section 611 of the Federal Aviation Act of 1958, would establish a reduction of 10 EPNdB for subsonic transport category aircraft for takeoff, approach and sideline noise, or the levels of FAR Part 36, whichever reduction is greater. This provision, if adopted, would be impossible to meet, through nacelle retrofit on fan jet aircraft, given the present state of the art. Attached are 3 charts, the first 2 of which indicate what noise reductions can be achieved for the B-707, DC-8, DC-9, B-737 and B-727 types of aircraft. The third chart indicates existing noise levels for turbojet aircraft now in the U.S. fleet for which there are no known method to reduce

the noise produced. Reference to this chart will indicate there is no means by which a 10 EPNdB reduction in noise can be accomplished at all three measurement points. It should also be noted that S. 1566 would require a 10 EPNdB reduction at all three measurement points for the piston and propeller airplanes now in the fleet, as well as the Boeing 747.

IGNORES LOCAL VARIATIONS

The last sentence of the proposed paragraph (d) states, "No airplane shall operate in violation of the prescribed noise levels." It is important for us to point out to the Committee, that even if today's aircraft such as the DC-8, B-707, the DC-9, and B-727 could meet the strict noise levels prescribed for *certification* under the S. 1566, the aircraft would not meet these levels in day-to-day operations on many flights because of such factors as the following: (a) higher ambient temperatures than those which the aircraft was noise certificated; (b) high altitude airports (above sea level); (c) cloud cover and inversions; (d) wind direction and velocity; and (e) surrounding terrain features. To require line pilots to operate these airplanes differently, because of the changes of such factors as those I have mentioned, would have severe adverse effects on the safety of operations.

UNREALISTIC TIMING

Even if the levels prescribed in Subparagraph (d) could be met, the January 1, 1974 date prescribed is far too early. Of the eight families of aircraft which would be involved in nacelle retrofit "incomplete" work has only been accomplished on but two of these families of aircraft, through the NASA contract on the B-707/320B and the DC-8-55. Completion of research and development on these aircraft models, could not be earlier than 1975, and retrofit could not be completed on all models until after, January 1, 1978, at the earliest. (Subparagraph (f) (1) of S. 1566 would set this date as January 1, 1976.)

UNDERESTIMATED RETROFIT FUNDS

The guaranteed loan provision provided in paragraph (f) (1) would authorize \$1 billion for this purpose. It is the considered opinion of many airline experts that the total amount needed for retrofit for all eight families in the fleet would be more on the order of \$1½ to \$2½ billion. The exact amount, of course, would not be known until specific noise retrofit modifications are spelled out, and guaranteed retrofit costs are provided the industry.

GUARANTEED LOAN/PROPOSAL INADEQUATE

The loan guarantee program provides a method of obtaining financing for noise reduction retrofit if private sources are not available at reasonable rates. However, under S. 1566 the guarantee could be withheld by the FAA Administrator if airlines cannot furnish reasonable assurance for repayment. This is no different from normal financing procedures. Further, what alternative does a carrier have if he cannot retrofit due to inability to obtain the required funds either through the private sector or by the guaranteed loans?

INEQUITIES

Since an airport is a community asset, the cost of the program should be shared by the local beneficiaries of air transportation and not placed solely upon the users of air transportation, many of whom would not even be passengers at noise sensitive airports.

CHART 1.—NOISE DATA IN EPND¹
[Boeing Turbofan]

Aircraft	Approximate Number U.S. aircraft in 1970	Fly over		Lateral		Approach	
		Actual level	Estimated retrofitted reduced level	FAR 36 level	Actual level	Estimated retrofitted reduced level	FAR 36 level
B-707/100B	107	108	102	102	108	1105 ± 103.5	105
B-707/300B	116	113	107	104	108	1105 ± 103.5	106
B-707/300C ²	149	114	(108)	104	108	1105 ± 103.5	106
B-720B	81	104	98	101	108	1105 ± 103.5	105
B-727/100	424	103	102	99	105	1107.5 ± 102.5	105
B-727/200	222	100	99	99	106	103	104
B-737/200	157	102	100	96	104	103	104
Total	1,256					113	103

¹ These are estimates based on a less expensive retrofit proposal which it is estimated will reduce approach noise by 10.5 EPND¹ and lateral noise by 3 EPND¹.

² These are estimates based on the actual retrofit noise reductions measured on the B-707/300C under a NASA contract. The approach noise was reduced by 15.5 EPND¹ and the lateral noise was reduced by 4.5 EPND¹.

³ Of the 7 models of Boeing Turbofan powered aircraft shown on this chart, only the reduction levels in parentheses are actually measured noise reductions as the result of hardware retrofit accomplished on a B-707/300C airplane under a NASA contract. All other reduced levels are estimated.

Note: Tolerances associated with the above aircraft are: ± 3 EPND¹.

CHART II.—NOISE DATA IN EPNDB
[Douglas Turbofans]

Aircraft	Engine model	Approximate number of U.S. aircraft in 1970	Fly over		Lateral		Approach	
			Actual level	Estimated retrofitted reduced level	FAR 36 level	Actual level	Estimated retrofitted reduced level	FAR 36 level
DC-8-50	JT3D-1	20	115	112	103	106	106.5	106
DC-8-50	JT3D-3	(39)	115	112	103	117	106.5	106
DC-8-50	JT3D-3B	(39)	114	111	103	117	106.5	106
DC-8-55	JT3D-3B	9	116	(113)	104	118	(107.5)	106
DC-8-55	JT3D-3B	72	116	113	104	118	(107.5)	106
DC-8-62	JT3D-3B	7	112	109	104	112	101.5	106
DC-8-62	JT3D-3B	10	112	109	104	115	104.5	107
DC-8-62	JT3D-7	55	112	109	104	116	105.5	107
DC-8-63	JT3D-7	16	93	92.5	94	101	105	102
DC-8-10	JT8D-5	60	94	93.5	94	110	105	103
DC-8-10	JT8D-1	34	93	92.5	94	110	105	103
DC-9-30	JT8D-7	72	93	92.5	95	109	104	103
DC-9-30	JT8D-7	153	97	96.5	96	110	105	103
DC-9-30	JT8D-7	10	100	99.5	96	111	106	103
DC-9-30	JT8D-9							
Total		557						

Note: Tolerances associated with the above aircraft are: ± 3 EPNdB.

1 Of the 14 models of Douglas Turbofan powered aircraft shown here, only the reduction levels in parentheses are actually measured noise reductions, as the result of hardware retrofit accomplished on a DC-8-55 airplane under a NASA contract. All other reduced levels are estimated.

CHART III.—NOISE DATA IN EPNdB
NOISE OF THESE AIRCRAFT (TURBOJET) CANNOT BE REDUCED

Aircraft	Approximate No. U.S. aircraft in 1970	Fly Over		Lateral		Approach	
		Actual level	FAR 36 level	Actual level	FAR 36 level	Actual level	FAR 36 level
Boeing turbojet: ¹							
B-707/100.....	17	113	102	109	105	112	105
B-707/200.....	4	105	102	111	105	111	105
B-707/300.....	37	107	102	110	106	109	106
B-720.....	51	108	101	109	105	109	105
Douglas turbojet: ²							
DC-8-20.....	32	107	102	109	106	110	106
DC-8-30.....	25	113	103	109	106	111	106
Convair turbojet:							
Convair 880.....	45	115	100	109	105	107	105
Convair 88M.....	1	117	100	109	105	107	105
Total.....	212						

¹ Tolerances associated with the above aircraft are: ± 4 EPNdB.

² Tolerances associated with the above aircraft are: ± 5 EPNdB.

TABLE 1.—ESTIMATED NUMBER OF JET (NONPROPELLER) AIRCRAFT IN THE SCHEDULED U.S. AIRLINE FLEET

[As of June 30 for each year]

Aircraft type	1970 (actual)	1975	1980
B-707-120/200.....	20		
B-707-320.....	34	7	
B-723.....	67	3	
B-707-120B.....	103	82	57
B-707-320 B/C.....	253	234	206
B-720B.....	59	25	
B-727-100/200.....	585	634	577
B-737-100/200.....	134	145	154
BAC-111.....	60	23	23
SE-210 (Caravelle).....	20		
Convair-880.....	41		
DC-8-21, 31, 32, 33.....	69	41	41
DC-8-51, 52, 53, 54F, 55, 61, 61F.....	131	101	97
DC-8-62, 62F, 63, 63F.....	40	40	27
DC-9.....	323	357	383
B-747.....	40	126	173
3-engine wide body type.....		267	555
Concorde.....		(?)	(?)

Note: The above information was obtained basically from a survey of the U.S. scheduled airlines, and in a few cases, estimated by ATA. Therefore, in view of the length of the forecast period as well as the necessity to estimate certain data this aircraft inventory should be regarded as a general forecast and not a definite inventory plan at any given date.

SUMMARY OF FAA NOISE ACTIONS

1952 TO DATE

1. Established "preferential runways".
2. Established noise abatement routings.
3. Established noise abatement takeoff procedures i.e. thrust reduction after takeoff and modifications thereof.
4. Established special navigation aids for noise abatement.
 - a. ILS's.
 - b. VASI's (visual approach slope indicators).
 - c. Lead-in lights.
5. Flight procedures.
 - a. Regulation on flying higher on ILS glide slopes.
 - b. Flying higher on all approaches to terminal areas.
 - c. Tests of 2-segment approaches on ILS's.
 - d. Development of noise abatement takeoff procedures.
6. Certification Regulations and others.
 - FAR 36—noise certification rule.
 - ANPRM—engine acoustical modifications.
 - NPRM—sonic boom.

7. International Standards—
 - a. ICAO standards for certification of new subsonic jets.
 - b. Consideration of engine/nacelle retrofit of existing subsonic jets.
 - c. Supersonic transport rules and control of sonic boom—(on going).
8. Acoustical Research.
9. Acquisition of land buffer zones—
 - a. Dulles.
 - b. Clear zones.
10. Extensions of runways for noise purposes. Examples—Kennedy, Los Angeles.
11. Monitoring Flight Profiles. Many locations.

DISCUSSION OF FAA NOISE ACTIONS—1952 TO DATE

The Federal Aviation Administration and its forerunners have been active in the area of noise abatement going back to the era of piston engine aircraft in the early 1950's.

Some of these actions enumerated below taken by FAA are typical and there may be many others that we just haven't recalled. For example, starting in 1952 FAA adopted the use of "preferential runways" and noise abatement routings at Newark. Preferential runways are those that are used under less than optimum wind conditions because the flight paths to and from them avoid flight over noise sensitive communities.

These special procedures have been adopted at Kennedy, Washington National, O'Hare, San Francisco, Los Angeles, Miami, New Orleans, Boston and Minneapolis, to name some of the more important airports.

At Washington National, FAA developed noise abatement take off procedures that requires a reduced thrust (less noise) climb that is employed shortly after takeoff and is continued until the aircraft is ten miles from the airport.

The follow-the-river approach and departure path flown under visual conditions at Washington National is familiar to all who use that airport.

At National, FAA has installed a special ILS that is used for south landings to keep aircraft away from heavily populated areas and more or less over the river or parkways. In addition, they have provided special lead-in lights from Memorial Bridge to the north end of the north/south runway to assist pilots in negotiating turns into that runway at night. A similar system is used on the Canarsie approach to Kennedy.

As an additional step, they have furnished a visual approach slope indicator on the north end of this runway to provide pilots with visual cues both day and night as to the proper glide angle to maintain.

These visual approach slope indicators are used at a number of airports for giving pilots information on glide or approach angle when a full instrument landing system is not available. It prevents the low drag-in approach that often results when a visual or electronic approach system is not provided.

While still on the flight procedure aspects, FAA has had ongoing tests of new procedures. Over the years, some of these that have shown benefit have been adopted. For example, FAA requires flying on the high side of instrument landing system glide slopes and has adopted a regulation to that effect. Most recently, they have adopted a "keep-em-high" policy, requiring controllers to keep arriving aircraft as high as possible when entering terminal airspace and not permitting descent for landing until the last practicable moment. This has avoided low, slow, noisy approaches, often directed before by traffic control starting many miles from the airport.

Tests of a two-segment approach were concluded at FAA's experimental facility at Atlantic City as recently as this April.

Following the amendments to the Act passed by the 90th Congress, FAA has issued Federal Air Regulation 36, regulating the noise of new subsonic aircraft.

The Boeing 747 was noise certificated under these regulations. Presently, the McDonnell Douglas DC-10 and an advanced version of the Boeing 727-200 are undergoing the certification process.

Federal Air Regulation 36 has served as a model for international standards. The ICAO member nations are expected to adopt similar standards for aircraft used in international operations this August. The Department of Transportation and the FAA provided much of the leadership in this effort. And the effort is ongoing.

ICAO is now working on sonic boom, regulation of the noise characteristics of supersonic transports and the possibility of retrofitting subsonic jet aircraft. In all of these, the Department of Transportation and the FAA have been providing technical inputs.

FAA, itself, has addressed each of these subjects, highly technical and complex matters, in Advanced Notices of Proposed Rule Making. These are under active consideration.

In Research and Development, FAA has contracted with acoustical experts to develop noise indices of community response to aircraft noise to permit better planning of new airport facilities. These were performed by acoustical experts such as BB&N and Wylie Laboratories.

Recently, they sought guidance on the economic impact of retrofitting existing subsonic jets. Preliminary answers were received, but of insufficient depth, and an extension of this study is now proposed to provide final answers on this subject.

In other actions, FAA attained large land buffer zones off the ends of the Dulles runways to permit aircraft to be higher when departing or arriving over the aircraft premises.

They funded runway extensions at such places as Kennedy and Los Angeles to permit aircraft to become airborne sooner and thus be higher when crossing the airport boundary.

They have continued to monitor aircraft flight profiles, most recently at Miami, to determine if more rigid adherence to procedures would result in noise reduction.

As pointed out, these are a few, but by no means all of the efforts by FAA and DOT.

Senator CANNON. Our next witness is Mr. Donald Reilly, executive vice president, Airport Operators Council International.

**STATEMENT OF J. DONALD REILLY, EXECUTIVE VICE PRESIDENT,
AIRPORT OPERATORS COUNCIL INTERNATIONAL, WASHINGTON,
D.C.; ACCOMPANIED BY JACK E. KOEPKE, VICE PRESIDENT,
LEGAL SERVICES**

Mr. REILLY. Good afternoon, Senator.

As I have a fairly lengthy statement, Senator, I would like to submit it for the record, and with your permission I would like to highlight some of the salient features of the statement.

Senator CANNON. Yes.

Mr. REILLY. I am J. Donald Reilly, executive vice president of the Airport Operators Council International. Accompanying me today is Mr. Jack E. Koepke, vice president of legal services.

Mr. Chairman, we appreciate the opportunity to express the views of our membership on S. 1566 and S. 1016. The Airport Operators Council International recognizes that aircraft noise pollution today constitutes a primary constraint upon aviation system capacity, inability to build major new airports, and to expand existing airports as a result of community opposition to aircraft noise pollution.

For these reasons AOCI supports S. 1566 and is in support of the basic principles of S. 1016. These proposals provide an economically reasonable and technologically practicable approach to alleviating the aircraft noise problem.

Unless aircraft noise reduction technologies are promptly tested and implemented at the Federal level, the needed airport capacity to serve the public in the seventies and eighties may never come to fruition.

While there are several possible ways to attack the noise problem, S. 1566 takes the approach which seems to offer the greatest potential

for broad results. This means attacking the problem at its source, the aircraft engine.

NASA studies show and document noise reductions of up to 10-15 EPNdB possible through retrofit. The Rohr study done for FAA in 1969-70 also proved the possibilities of noise reduction through retrofit and, further, showed it economically reasonable. These data, more fully developed in our written statement, deserve the committee's full consideration and review.

Today FAA has the authority and the responsibility to reduce noise for the current jet fleet. It has had this authority since 1968, but unfortunately, there is still no noise rule covering jets in current civil operation.

What is needed now is a new impetus. Passage of S. 1566 would achieve that by, first, giving a reasonable target date, 1976, to achieve responsible noise levels for current jet aircraft or develop a scheme to provide for early retirement of such aircraft.

Second, and most important, S. 1566 would provide a definitive answer as to whether retrofit of current civil jet aircraft would result in meaningful noise reductions. S. 1566 would do this by providing \$35 million for prototype flight tests. This is the only real answer to the ever-discussed issue of water retrofit is a viable and economical concept.

Third, S. 1566 would permit Federal loan guarantees and increased airline fares to help fund a retrofit program. We wholeheartedly endorse some financing mechanisms, these or others, which would provide the least direct financial burden on the airlines or, for that matter, any other segment of the industry.

The Federal Government must recognize that aircraft noise is a truly national problem and the financing of its solution must involve Federal Government leadership and participation.

In this respect, I feel the Congress could better apply the \$20 million provided by S. 1566 for local monitoring of aircraft noise directly to the retrofit program. Noise monitoring will be unnecessary if meaningful retrofit is implemented and current jet aircraft are certificated for operation at the noise levels established by the current FAR part 36.

Notwithstanding the feelings of some that FAA is moving too slowly in attacking the aircraft noise problem, we would suggest that it may be premature to pass FAA's basic authority to regulate aircraft noise to the EPA as suggested in S. 1016.

A more reasonable approach might well be, for example, to give FAA the means to provide a prototype aircraft retrofit program, as under S. 1566, and only then if FAA should show an inability or unwillingness to move ahead, at that time to consider granting EPA specific regulatory authority in this area.

For the time being, EPA should be restricted to an active but advisory capacity to FAA to better reflect the public interest and concern for aircraft noise.

Until such time as the Federal Government is prepared to accept the financial responsibility in local aircraft noise cases, we would oppose restrictions on local public owners and operators of civil airports prohibiting their promulgation of noise abatement rules based on local needs. As the local airport operator is being held financially liable in aircraft noise litigation, we must have this tool to reduce this liability. In this respect we support the language of S. 1016. .

The human cost of noise annoyance and airport congestion is incalculable. Since the inception of the jet age economic expediency and technological efficiency have allocated the cost of aircraft noise pollution to airport neighbors. This cost is potentially so great and so incapable of measurement that it is largely ignored. Considering the present human climate in communities exposed to aircraft noise, dollars cannot be equated with decibels.

In closing, therefore, I cannot overemphasize the feeling of public airport operators of the need for a federally funded research program which would permit the retrofitting of a cross section of the current civil jet fleet, and their actual operation in day-to-day scheduled service at airports. This is the most responsible, if not the only, way to establish the actual and true efficiency of the retrofit program. This would be provided in S. 1016.

Thank you, Mr. Chairman.

Senator CANNON. Thank you, Mr. Reilly.

Why do you place so much emphasis on the Rohr report indicating that the noise reduction level specified in S. 1566 can be met when the overwhelming testimony of the experts before this committee is that these levels cannot be met with any existing technology and that there is still no acceptable answer to the problem of significantly reducing the noise at all three measuring points for the B-727, B-737, and the DC-9?

Mr. REILLY. Senator, not being a technical person, I must rely solely on what I read in those reports. As you are well aware, the NASA study was done by Boeing and Douglas, and the Rohr report was done under contract to the FAA.

Now, we have to assume that within NASA there is sufficient technical capability to evaluate fully what came out of their contract studies with Boeing and Douglas. On reading of those studies there seems to be on the face of them, which NASA again, I understand as late as yesterday or the day before, reaffirmed the retrofit capabilities. There is some meaningfulness to being able to achieve between the 3 EPNdB noise reduction takeoff, to as much as 15 EPNdB reduction on approach. I can only rely on those figures.

Again, with the Rohr study—

Senator CANNON. The NASA study only deals with the B-707 and the DC-8.

Mr. REILLY. That is correct, sir.

Senator CANNON. You heard or you saw the display here this morning that indicates that that is not more than 50 percent of the problem, it is not even equal to 50 percent of the problem.

Mr. REILLY. Very true, Senator. I must say in reply to that question, though, that today's aircraft noise problem is being created solely by the aircraft that are flying today. If in fact we face the continuation of the use of the 707 for 5 or 6 years into the future, when one considers the environmental restrictions on development of new airports in the United States today, it becomes a very difficult proposition to envision how we will ever be able to not only expand current airports but produce new airports to take care of the growth that is going to occur.

Senator CANNON. That as a statement is all well and good, but you completely disregard the time factor that it would take to retrofit if you went ahead with the retrofit program.

As you saw this morning, the estimates indicate about 6 years from the time of go-ahead, and the question still remains whether we are ready for go-ahead now. So, you are not really being realistic, I don't believe, in your ultimate assessment there, are you?

Mr. REILLY. Let me put it this way, Senator, I think there definitely is a need for some collaboration between the manufacturers and NASA to finally settle this point. NASA is still saying publicly that from the point of go-ahead there seems to be substantial indication that 5 years would be needed for full retrofit of the fleets that they envision here.

Senator CANNON. I do not think that NASA has said that they could meet the noise levels specified in S. 1566 at the three measuring points.

Mr. REILLY. No, Senator. In our statement we develop that point. I agree that for some aircraft, particularly if you are talking about the more recent aircraft that have had acoustical treatment provided in their engine, to expect a full 10 EPNdB as a further reduction would certainly be unrealistic.

We certainly feel there is great room and more latitude to move ahead with substantial reductions if in fact we can rely on the NASA studies. I think to some extent we have to rely on various technical inputs. Certainly NASA's input cannot be overlooked.

Senator CANNON. I do not think anyone is suggesting that their input can be overlooked. I am just saying I think you are reading something into it that is not there.

If you are indicating that the levels in S. 1566 can be met, that NASA says can be met, and they can be met on the 727 and the 737 and the DC-9 at the three measuring points, that just is not true, at least as I understand it.

Do you disagree with that?

Mr. REILLY. As I understand the legislation, sir, it either aims at reducing aircraft noise by 10 EPNdB or meeting 108 EPNdB established by FAR 36, and obviously for some aircraft this cannot be achievable, the full 10 EPNdB reduction.

I believe some of the retrofit concepts that have been advocated propose being able to meet 108 for the 727 and the 737.

Senator CANNON. Thank you very much. We appreciate your being here.

(The statement follows:)

STATEMENT OF J. DONALD REILLY, EXECUTIVE VICE PRESIDENT, AIRPORT OPERATORS COUNCIL INTERNATIONAL

Mr. Chairman and members of the subcommittee, I am J. Donald Reilly, Executive Vice President of the Airport Operators Council International (AOCI). Accompanying me is Jack E. Koepke, Vice President of Legal Services. The Airport Operators Council International is the association of the governmental bodies which own and operate the principal airports served by the scheduled airlines in the fifty states, Puerto Rico and the Virgin Islands, as well as in many countries abroad. In 1970, U.S. member airports enplaned about 90% of the domestic and virtually all of the U.S. international scheduled airline passenger and cargo traffic. In addition, our local government members

operate many reliever and other general aviation facilities which supplement the larger airports in their communities and regions. (A listing of our United States members is appended for your information.)

Mr. Chairman, we appreciate the opportunity to express the views of our membership on S. 1566, a bill to control aircraft noise and on S. 1016, a bill which gives certain noise regulatory functions to the Environmental Protection Agency. The Airport Operators Council International recognizes that aircraft noise pollution today constitutes a primary constraint upon aviation system capacity. Inability to build major new airports and to expand existing airports is a result of community opposition to aircraft noise pollution. For these reasons, AOCI stands strongly in support of S. 1566 and in support of the basic principles of S. 1016. These proposals provide an economically reasonable and technologically practicable approach to alleviate the aircraft noise problem.

HISTORY OF THE AIRCRAFT NOISE PROBLEM

We wish to trace briefly the history of the aircraft noise problem in the United States. Aircraft noise was critical in 1965 when the White House convened the Jet Aircraft Noise Panel.

The aircraft noise problems highlighted by that Panel became acute in the summer of 1968, when some of the major U.S. airports reached the saturation point. Hourly quotas imposed by FAA were then necessary to prevent complete deterioration of the national air transportation system.

As part of the Interagency Aircraft Noise Abatement Program, NASA initiated a project in 1966 to "identify promising nacelle modifications on current four-engine turbofan powered aircraft that would reduce the noise under the approach path by up to 15 EPNdB." Since it was recognized that this would require modifications on existing aircraft, certain constraints were placed on the design of the modification. "The problem was one of designing a modification to the nacelle that was practical, that could reduce the approach noise by a substantial amount, that would have as small a performance penalty as possible, and that could be manufactured and installed at reasonable cost." In October, 1969, NASA contractors reported on the results achieved under the contracts. The acoustic measurements showed the following *reduction* of noise in EPNdB:

Operation	DC-8 McDonnell Douglas	707 Boeing
Approach (1 nautical mile).....	10.5-12	15.5
Takeoff thrust (3.5 nautical miles).....	2-3.5	3.0
Reduced thrust (3.5 nautical miles) (6 percent climb gradient).....	3.0	3.5

In 1969-1970, the Rohr Corporation completed a study for the FAA on the economic impact of implementing acoustically treated nacelle and duct configurations applicable to low bypass turbofan engines. According to Rohr's studies, retrofit will reduce landing noise by 10 EPNdB for DC-9, B-727 and B-737 aircraft, and by 13 EPNdB for 707 and DC-8 type aircraft. It will reduce takeoff noise by 8 EPNdB, including power cutback on four-engine turbofans, and by 5 EPNdB on two- and three-engine turbofans.

The acoustical treatment would require a configuration comprising a double ring lengthened inlet, fan exhaust treatment and acoustic material described as follows: low porosity, perforated face sheet bonded to a 1/2" thick honeycomb core which is bonded to a solid backing. Such a configuration would cost 0.6% of passenger fares collected in Calendar Year 1975, 0.3% in 1978, and 0.08% in 1982 to equip all air carrier fleets of jet aircraft. The costs cover interest and amortization on capital costs of retrofit kits as well as incremental operating costs due to nacelle configurations, fuel consumption, etc.

The need for noise reduction in existing aircraft was recognized by the Congress early in 1968 through the passage of P.L. 90-411. This new law vested in the Federal Aviation Administration (FAA) a legislative mandate for regulation of aircraft noise. The Administrator of the FAA was thereby authorized to establish comprehensive noise regulations covering present and future aircraft. In the past two years, the FAA has implemented only a portion of P.L. 90-411 through the adoption of Part 36 of the Federal Aviation Regulations, which es-

establishes 108 EPNdB (at three measuring points) as the noise limitation for *future subsonic* aircraft. The current jet fleet is comprised of such aircraft as the DC-8, DC-9, Boeing 727 and the Boeing 707, all of which operate at noise levels considerably in excess of the Part 36 limitation for *future* aircraft. No noise regulations have been adopted for the *present* jet fleet with the exceptions of the DC-10 and those Boeing 747's manufactured after December 31, 1971.

FAA'S ANPRM ON RETROFIT

On November 4, 1970, pursuant to the authority of P.L. 90-411, the FAA issued an Advance Notice of Proposed Rule Making (ANPRM), (Docket No. 10664; Notice No. 70-44) on Civil Airplane Noise Reduction Retrofit Requirements. The FAA's Advance Notice of Proposed Rule Making constitutes the agency's first significant step toward adopting any noise regulations for the current fleet of jet aircraft. At the time of the issuance of the ANPRM, FAA Administrator John H. Schaffer stated that "... [A]ircraft noise is the single greatest impediment to airport development in the United States at the present time and prompt remedial action is required if we are to meet the projected growth of aviation in 1970's and beyond. The FAA is committed to using every legal regulatory technique at its disposal to reduce aircraft noise at the source."

The AOCI is concerned about limitations and delays which have already seriously impaired the FAA's rulemaking procedure. According to the FAA's own time schedule, no noise rule applicable to today's aircraft can possibly be expected from the FAA before the 4th quarter of 1972. Even this estimate is highly optimistic in view of the fact that the FAA did not obtain funds necessary to test the feasibility of retrofitting today's three-engine aircraft. The FAA requested \$3.5 million for a 1971 retrofit research project on the DC-9 and the Boeing 727, but received only \$1 million. Virtually no work has been done on the project. It is not unreasonable to conclude that the FAA's attempt to regulate the noise of today's jet fleet has reached a major, if not hopeless, impasse. New legislation is necessary to break the impasse.

PROPOSALS OF S. 1566

Having made this brief historical review of the aircraft engine noise problem, we turn to the major provisions of S. 1566 to demonstrate that this proposal would solve the problem. The salient features of S. 1566 provide that:

1. By 1976, the noise levels of current aircraft must be reduced by 10 EPNdB (a halving of noise levels) or meet FAR Part 36 noise levels of 108 EPNdB, whichever noise reduction is greater. This would apply to *all* transport aircraft operating within the U.S. (domestic and foreign);
2. The U.S. government shall provide \$35 million for research on representative aircraft models to demonstrate compliance by prototype flight tests;
3. The U.S. government may guarantee, up to \$1 billion, the repayment of loans to carriers for the purpose of modifying their aircraft prior to January 1, 1976;
4. The Civil Aeronautics Board will approve increases in airline rates to cover costs of retrofitting aircraft with sound reduction devices *and* early retirement of aircraft in order to meet the reduced noise levels prescribed by this bill;
5. The FAA Administrator is authorized to make *grants* to state and local agencies to assist in paying the cost of "administering airport noise monitoring programs." Up to \$20 million is authorized to carry out this provision.

We turn now to a specific discussion of the five major features of the bill:

1. By 1976, the noise levels of current aircraft should be reduced by 10 EPNdB (a halving of noise levels) or meet FAR Part 36 noise levels of 108 EPNdB, whichever noise reduction is greater. This should apply to *all* transport aircraft operating within the U.S. (domestic and foreign).

The NASA Douglas/Boeing studies and the FAA Rohr report indicate that a complete fleet retrofit can be accomplished within five years from the time a program is established. If the necessary regulations had been issued immediately after the NASA report, the public could have expected significant relief from four-engine turbofan noise by the end of 1974. The public interest in noise abatement and the growth of civil aviation now demand immediate action.

Considering the speed with which nacelle acoustical treatment is being produced and installed in the Boeing 747 and air-bus-type aircraft now in produc-

tion, current aircraft types could be completely equipped with retrofit treatment by the spring of 1975, if action were started now. The 1976 compliance date proposed in section (d) of the bill is not unreasonable, assuming that the proposal receives expeditious Congressional action and provided that the proposal is adequately financed.

The format of Appendix C of the Federal Aviation Regulations (FAR) Part 36 should serve as a basic guide for the establishment of noise levels. Since the strict application of Appendix C levels as a function of takeoff weight may not be feasible for current turbofan aircraft, the criteria of 108 EPNdB for four-engine turbofans and 103 EPNdB for two- and three-engine turbofans should be established for landing at the FAR 36 measuring point (1 n. mi. from threshold). These levels are achievable with current technology and would result in significant improvement in approach noise levels, which are currently the most serious source of noise around airports. Aircraft which meet the proposed approach criteria will also produce less takeoff and side-line noise.

We recommend that the language of the bill in paragraph (d) which requires a 10 EPNdB reduction from 1971 noise levels should be deleted. This requirement appears to apply to the newly manufactured Boeing 747 and DC-10 which already show marked noise reduction improvements nearly in accord with the standards of Part 36, Appendix C, of the Federal Aviation Regulations. On the other hand, we submit that much of the current fleet of jet aircraft including the Boeing 727, DC-8, Boeing 707 and DC-9 can, and should, be brought into compliance with Part 36, Appendix C, requirements.

2. The U.S. government should provide \$35 million for research on representative aircraft models to demonstrate compliance by prototype flight tests.

The debate over retrofit constantly returns to the issue of defining "meaningful relief" for airport neighbors. "Meaningful relief" is obviously a subjective term. It cannot be quantified nor made clearer by argument. AOCI, therefore, vigorously supports the S. 1566 proposal for a federal research program designed to demonstrate the effectiveness of noise abatement technology as applied to a cross section of today's aircraft. The airlines have suggested lack of sufficient technical data as a partial defense against retrofitting the Boeing 707 and DC-8 aircraft (which were studied in the NASA report), and as a complete defense against retrofitting the three-engine jet fleet powered by the JT8D engine. The type of psycho-acoustical data demanded by the airlines can only be obtained by actually retrofitting a cross section of prototype aircraft and flying these prototype aircraft at today's airports.

The NASA report has already contributed the first major building block by demonstrating the technological feasibility of retrofitting the four-engine transport aircraft such as the DC-8 and the Boeing 707 powered by the JT8D engine. The FAA unsuccessfully requested the inadequate sum of \$3.5 million for a 1971 retrofit research project designed to continue the NASA-originated program by retrofitting aircraft powered both by the JT8D and JT3D engines. The current bill's proposed allocation of \$35 million for research on representative civil aircraft models is a more reasonable estimate of the costs of such a program in view of the fact that the NASA study required \$17 million for retrofitting the DC-8 and the Boeing 707.

AOCI submits that the noise levels of today's jet fleet can be brought very nearly into conformance with the requirements of FAR Part 36. Such compliance is within the state of the art of current technology. But if, as some claim, compliance is not technologically practicable, then those aircraft which cannot comply with Part 36 noise levels should be retired as provided in the bill.

3. The U.S. government should be authorized to guarantee, up to \$1 billion, the repayment of loans to carriers for the purpose of modifying their aircraft prior to January 1, 1976.

Retrofit is expensive, and because the benefits of retrofit will be shared by a large number of people, the airlines should not be expected to carry the full financial burden of the retrofit program. We fully support the use of federal loan guarantees as one acceptable financial means of spreading the cost of aircraft noise abatement in the national, public interest.

4. The Civil Aeronautics Board should approve increases in airline rates to cover costs of retrofitting aircraft with sound reduction devices and early retirement of aircraft in order to meet the reduced noise levels prescribed by the bill.

The reasonableness of a user tax to pay the cost of abating noise pollution is justified in view of the fact that the Airport and Airway Development Act of

1970 has selected user taxes as a primary means of promoting airport and airway development. The Rohr report has indicated that the cost of retrofit can be met by a nominal fare increase.

5. The FAA Administrator should be authorized to make grants to state and local agencies to assist in paying the cost of "administering airport noise monitoring programs." Up to \$20 million is authorized to carry out this provision.

AOCI questions the need for this provision of the bill on two grounds: (a) the noise monitoring provision will be unnecessary if the FAA properly certifies aircraft at the noise levels established in FAR Part 36; and (b) the allocation of \$20 million to carry out this provision constitutes an unnecessary burden on the general tax funds when the funds could be better spent, perhaps in Federal subsidization of the retrofit hardware program.

ECONOMIC REASONABLENESS OF RETROFIT

Having covered the five major features of the Cranston/Wilson Bill, we turn to a discussion of the economic reasonableness of attempts to abate aircraft noise through retrofit and/or retirement of noisy aircraft in the current jet fleet. P.L. 90-411 directs the Administrator of the FAA to "consider whether any proposed standard, rule, or regulation is economically reasonable, technologically practicable, and appropriate for the particular type of aircraft, aircraft engine, appliance or certificate to which it will apply."

The NASA report shows that areas exposed to noise in excess of 100 EPNdB can be reduced by 85% under the approach path and by 50% to 55% under the takeoff path for the type of aircraft and retrofit treatment used in NASA studies. The indication in the Rohr report that the cost of retrofit can be recovered by a passenger fare increase ranging from 60¢ per \$100 in 1975 to 8¢ per \$100 in 1982 offers little evidence of any excessive economic penalty or burden. The Rohr report estimated the cost of retrofit at about \$600 million for the current U.S. jet fleet.

Those who oppose such standards argue as follows: (1) Aircraft noise standards must be economically reasonable and technologically practicable; (2) The cost of a technologically practicable retrofit (estimated by the Rohr Corporation at about \$856 million for the current jet fleet) is too high in comparison to the benefits to be achieved by retrofit; and therefore, (3) No technologically practicable aircraft noise standard is economically reasonable for the current jet fleet. The defect in this reasoning is in its failure to count *all* the costs and to properly gauge the alternatives to retrofit. On the basis of a full cost benefit analysis, retrofit is economically reasonable. The following factors must be considered in computing the true economics of aircraft noise abatement.

1. *The human cost*: The human cost of noise annoyance and airport congestion is incalculable. Since the inception of the jet age, economic expedience and technological efficiency have allocated the cost of noise pollution to airport neighbors. This is potentially so great, and so incapable of measurement, that it is largely ignored.

Considering the present climate in communities exposed to aircraft noise, dollars cannot be equated with decibels. Terms such as "meaningful relief" are highly subjective and cannot be quantified. The Rohr report shows that the noise of four-engine turbofan aircraft can be reduced by 13 EPNdB on approach and by 8 EPNdB on takeoff. Since a 10 EPNdB reduction represents a 50% reduction in annoyance, the Rohr figures must be classed as "meaningful."

2. *The cost of land acquisition*: The cost of acquiring land adjacent to just the ten largest U.S. airports would amount to as much as \$50 billion and would involve the relocation of hundreds of thousands of people from noise sensitive areas. Compatible land use planning is clearly not feasible at older, heavily impacted U.S. airports where the airport owner holds little or no zoning control over the use of lands not owned by the airport. Because airports and municipalities lack the financial, legal and political power to control the development of non-airport property, land use planning is unrealistic at current impacted airports, but offers a valuable planning tool at new airports.

3. *The cost of noise abatement operating procedures*: The carriers possess a considerable body of data which demonstrates the extraordinary costs of congestion and delay which they incur at existing airports, some of it attributable to operational penalties resulting from noise problems. Retrofit performance penalties to the airlines, according to the Rohr report, are rather minimal and

may, in fact, be non-existent as retrofit aircraft should be able to avoid many current aircraft noise abatement flight procedures which lengthen flight routes. From time to time, the argument is made the aircraft engine noise can be largely overcome through improved aircraft operating procedures. These procedures include the use of preferential runways, noise abatement takeoff procedures, turns away from heavily populated areas and ground run-up procedures. Such techniques are already fully utilized at most of today's noise-affected airports. Noise abatement flight procedures represent only a very limited approach to the problem of reducing aircraft engine noise. The public cannot expect any significant relief through further implementation of aircraft noise abatement flight procedures, and these procedures certainly do not constitute an alternative to retrofit.

4. *The cost of limitations on operations:* Although the courts have held most airport curfews invalid, the possibility of public movements toward major operational curfews constitutes a growing danger at U.S. airports. The State of California has passed legislation which becomes effective December 1 of this year. This legislation would force serious curtailment of civil aircraft operations at Los Angeles International Airport. Community reaction to noise has brought about a limitation on night operations at some airports, Morristown, New Jersey and Washington National airports, for example. Such curfews are particularly damaging to the profitability of all-cargo planes where night operations are advantageous. As cargo flights increase at major U.S. airports, the danger of numerous night curfews steadily increases.

5. *The cost of litigation:* On the basis of a recent survey of noise litigation now pending, AOCI estimates the amount claimed against operators of local public airports in noise suits in excess of \$3.8 billion.

6. *The cost of ground transportation:* If the effect of aircraft noise causes airports to locate 10 miles or farther from the population area served, the additional cost, according to a joint DOT-NASA Report (DOT TST-10-4, NASA SP-265), to travelers and employees could exceed \$30 million annually for each major airport.

7. *The cost of aircraft operating delays:* Many airports are experiencing delays in aircraft operations because of noise-caused restrictions on the use of runways and airspace. It is conceivable that noise restrictions could reduce the capacity of an airport by 20 percent according to a joint DOT-NASA Report (DOT TST-10-5, NASA SP-266). Thus, an airport with an annual demand of 450,000 operations could suffer an annual aircraft-delay cost of about \$1 million.

On the basis of a complete cost benefit analysis which reflects the true costs of the alternatives to retrofitting the current jet fleet, we contend that retrofit is economically reasonable. AOCI supports any and all means of reducing aircraft noise pollution. Aircraft noise alleviation can, to some extent, be achieved through compatible land use planning at new airports. Noise abatement flight procedures constitute another tool for achieving some reduction of aircraft noise. But in the last analysis, S. 1566 offers the most economically reasonable and technologically practicable means of *substantially* reducing the aircraft noise of the current jet fleet and of alleviating the problem of aircraft noise annoyance for airports and their neighbors.

PROPOSALS OF S. 1016

The Administration's proposal, S. 1016, is entitled as the Noise Control Act of 1971. The bill would authorize the establishment in the Environmental Protection Agency of a broad framework for noise control and abatement. The salient features of S. 1016 would give the EPA authority to do the following:

1. Prescribe basic noise criteria for the protection of the public health and welfare.

2. Identify and set standards for major sources of noise with respect to construction equipment, transportation equipment and equipment powered by internal combustion engines.

3. Prevent any State or subdivision thereof from adopting noise-generation standards with respect to any product for which noise-generation standards have been prescribed by the Administrator of EPA.

4. Approve all noise standards, rules and regulations prescribed by the FAA under P.L. 90-411 (Sec. 611 of the Federal Aviation Act of 1958).

5. Request the Administrator of FAA to review and report to EPA on the advisability of revising existing noise standards, rules and regulations.

6. Establish labeling requirements for designated products or classes of products.

7. Promote the coordination of Federal programs relating to the development and publication of noise research and noise control.

We turn now to a specific discussion of the 7 major features of the bill:

1. Prescribe basic noise criteria for the protection of the public health and welfare.

Section 5 of S. 1016 authorizes the Administrator of the EPA, after consultation with appropriate Federal departments and agencies, to develop and publish such criteria for noise as in his judgment may be requisite for the protection of the public health and welfare. We understand that the language of Sec. 5(a) as modified by the words "for products" require that the Administrator of EPA should, after consultation with appropriate Federal departments and agencies, develop and publish for products such criteria for noise as in his judgment may be requisite for the protection of the public health and welfare.

The word "criteria" is not defined in the bill, nor does the bill clearly distinguish noise "criteria" from noise "standards." With respect to aircraft noise, FAA has the technological expertise to set federal noise criteria and federal noise standards due to the in-house competence of the Agency. The words "for products" properly limit the authority of the EPA as Sec. 3(a)(i) defines "products" to exclude "aircraft, aircraft engines, propellers or appliances that are covered by Title VI of the Federal Aviation Act of 1958 (48 U.S.C. 1421-32)."

2. Identify and set standards for major sources of noise with respect to construction, transportation equipment and equipment powered by internal combustion engines.

S. 1016, Sec. 6(a) gives the Administrator of EPA blanket authority to set standards for equipment powered by internal combustion without specifically stating whether piston driven aircraft engines and aircraft auxiliary power units are included in the definition of "equipment powered by internal combustion engines." Since Sec. 6(a) also refers to equipment powered by internal combustion engines as "any product or class of products," we recommend that internal combustion engines be interpreted as excluding aircraft, aircraft engines, propellers or appliances covered by Title VI of the Federal Aviation Act of 1958.

3. Prevent any State or subdivision thereof from adopting noise-generation standards with respect to any product for which noise-generation standards have been prescribed by the Administrator of EPA.

This authority is established under Sec. 6(d) of the bill which refers back to Sec. 6(a) giving the Administrator authority to prescribe and amend standards limiting the noise-generation characteristics of such things as internal combustion engines. Since internal combustion engines are referred to as "any product or class of products," we again recommend that the authority of the public airport operator to adopt noise-generation standards with respect to aircraft, aircraft engines, propellers or appliances covered by Title VI of the Federal Aviation Act of 1958 remain unabridged and undiminished under Sec. 6(a) of the bill.

The authority of the individual airport operator, operating in his capacity as landlord of airport property, to set noise standards with respect to his respective airport has been carefully protected in P.L. 90-411 (Sec. 611 of the Federal Aviation Act of 1958), the legislative history to P.L. 90-411, and in Part 36 of the Federal Aviation Regulations. Since the legal and financial liability for aircraft noise has, since *Griggs v. Allegheny*, 142 A.2d 187 369 U.S. 84 (1958), rested solely upon the individual airport operator, AOCI feels that the right of the individual airport operator to limit his legal responsibility and financial liability must remain unimpaired. As has frequently been stated, we feel that the area of aircraft noise liability should be entirely preempted by the Federal government. If the FAA or EPA deprive the individual airport of its right to set standards for aircraft noise, the Federal government should also assume financial liability for aircraft noise.

4. Approve all noise standards, rules and regulations prescribed by FAA under P.L. 90-411 (Sec. 611 of the Federal Aviation Act of 1958).

5. Request the Administrator of FAA to review and report to EPA on the advisability of revising existing noise standards, rules and regulations.

The authority for EPA to approve noise standards, rules and regulations prescribed by the FAA under P.L. 90-411 is stated in Sec. 6(c) of the bill. AOCI cannot support this aspect of S. 1016. The language of 6(c)(1)(2) and Sec. 6(c)(3)(b) gives the Administrator of EPA what is in effect veto power over

the aircraft noise rule making power of the FAA. We feel that such veto power may not properly be vested in the EPA Administrator for the following reasons:

(a) The FAA has aircraft technical expertise which enables the Agency to be responsive to the total field of aviation of which noise and the environment constitute only one aspect. The FAA is in the best position to weigh the problem of setting noise standards in balance with the technological feasibility of such standards.

(b) The responsibilities of FAA are already subject to the approval of DOT. The environmental goals of DOT are already subject to the authority of the Council on Environmental Quality. We feel that the placing of aircraft noise regulatory power in the EPA would serve to further dilute the direct responsibility of the FAA without achieving any substantial service or benefit to the environment.

(c) The DOT/FAA is presently responsible for coordinating the United States' position of the International Civil Aviation Organization (ICAO) Committee on Noise (CAN). We feel that the responsibility of DOT/FAA in this area cannot properly be assigned to EPA.

(d) We feel that the EPA has, as a proper role, the function of consulting with DOT/FAA and all other Federal Agencies responsible for regulating noise. Such consultation can, however, be done informally and without the sanction or authority of statute.

For these reasons we recommend that Sec. 6(c) (1) (2) and Sec. 6(c) (3) (b) be deleted from S. 1016. In place of these sections we recommend that Sec. 6 (c) (3) (c) be redesignated as Sec. 6(c) and that this new Sec. 6(c) be reworded to give the Administrator of EPA power to consult informally with the Administrator of FAA both with respect to current and future noise criteria and standards. The new Sec. 6(c) should be rewritten as follows:

6(c). Section 611 of the Federal Aviation Act of 1958 (49 U.S.C. 1431) is amended as follows:

1. In subsection (a) after "with the Secretary of Transportation", insert "If at any time the Administrator of the Environmental Protection Agency has reason to believe that an existing standard, rule or regulation or any future FAA standard, rule or regulation does not protect the public from aircraft noise or sonic boom to the maximum extent that is consistent with the considerations listed in section (b) of Section 611, the Administrator of the Environmental Protection Agency may request the Administrator of the Federal Aviation Administration to review and report to him on the advisability of revising such standard, rule or regulation. Any such request shall be accompanied by a detailed statement of the information on which it is based."

Sec. 6(c) (4) should be deleted for reason of conformity.

Rather than placing a veto at the end of the regulatory process, this amendment would more appropriately provide for consultation between the FAA and EPA from the very outset. But this amendment would leave final promulgation and administration of aircraft noise regulations to FAA, the Agency charged with flight safety and equipped with aviation technical expertise.

(6). Establish labeling requirements for designated products or classes of products.

Since "products or classes of products" is defined in Sec. 3(c) (i) to exclude "aircraft, aircraft engines, propellers or appliances that are covered by Title IV of the Federal Aviation Act of 1958 (49 U.S.C. 1421-32)," AOCI takes no position with respect to this portion of S. 1016.

7. Promote the coordination of Federal programs relating to the development and publication of noise research and noise control.

Sec. 4 of S. 1016 authorizes the Administrator of EPA to promote coordination of all Federal departments and agencies relating to noise research and noise control. The Administrator is further authorized to publish a report upon the status and progress of Federal activities relating to noise research and noise control. AOCI fully supports this section of the bill, as providing a valuable service as authority for regulating Federal noise programs has been widely scattered throughout the Federal Government. We feel the coordinating efforts of EPA would be valuable in assessing the contributions of the Federal government's overall efforts to control noise.

In summary, AOCI endorses the concept that aircraft noise constitutes a grave national problem which threatens to severely restrict the growth of aviation. We believe that noise requires uniform regulation in many areas. We agree

with the fundamental position of S. 1016 that the consideration of public interest in an environmentally sound aviation system requires the regulation of aircraft noise by the Federal Aviation Administration in consultation and close liaison with the Environmental Protection Agency. We do not, however, feel that EPA should hold a veto power over an area of technology in which EPA does not have adequate technical expertise. Although the FAA has not always moved in the aircraft noise area as rapidly as airport operators would recommend, AOCI would prefer to allow the aircraft noise problem and its regulation to remain under the primary control of the FAA—at least until such future time as they display an inability to regulate in the public interest.

Senator CANNON. The next witness is Mr. John R. Wiley, director of aviation, the Port of New York Authority.

**STATEMENT OF JOHN R. WILEY, DIRECTOR OF AVIATION, THE
PORT OF NEW YORK AUTHORITY; ACCOMPANIED BY MISS ISOBEL
MUIRHEAD, OFFICE OF THE GENERAL COUNSEL**

Mr. WILEY. Thank you, Mr. Chairman, and good afternoon.

I am accompanied by Miss Isobel Muirhead, who is in the office of the general counsel of the Port of New York Authority.

My name, sir, is John R. Wiley. I am the director of aviation for the Port of New York Authority, which operates Kennedy International, LaGuardia, and Newark Airports, the largest terminal facilities in the United States.

I have submitted a statement of the port authority's position on S. 1566 for your consideration and for the record of these proceedings. I will not take the time of the committee to read the statement. With your permission sir, I would like to make a brief précis on the contents of that statement.

The statement expresses our support for this legislation which we believe would accomplish the urgent purpose Congress intended in Public Law 90-411. This directive to the FAA to provide the public with relief from unnecessary aircraft noise has not been carried out. The FAA's consideration of a retrofit program has been marked by delay. It has already fallen some 15 to 18 months behind the announced schedule. We are convinced that new impetus is needed.

This legislation, we believe, provides this impetus. It presents a reasonable and an achievable timetable for implementing a retrofit program and answers the industry's valid concerns about its funding.

The effectiveness of retrofit has been demonstrated by NASA testing. The noise suppression material which would be used is virtually the same as that used on new aircraft such as the Boeing 747, the DC-10 and the L-1011, and that which is being installed and currently being produced on new models of the advanced 727-200.

For this reason it is difficult to see, with the new advanced stretched models of the 727-200 on the production line coming out with retrofitted nacelles, why there is the necessity for so much further testing and experimental work.

For more than 20 years now aircraft noise has adversely affected the quality of life in communities near hub airports across the country. We firmly believe that these communities should not be denied any longer the relief that today's technology can deliver.

We are convinced that retrofit or, as we heard this morning from the Chairman of the CAB, refitting with a new, quiet engine, is the

most effective and immediate means for alleviating a problem affecting millions.

We support S. 1566 and its companion measure in the House, H.R. 8642, which provide for the prompt implementation of this necessary program.

With regard to S. 1016, the Noise Control Act of 1971, while the port authority is not taking a position on this bill, I cannot avoid commenting on a proposed amendment to this bill and its companion bill, H.R. 5275, recommended by the Air Transport Association.

In this respect, what I am about to say here after listening to General von Kann's testimony, will serve as an amendment to the paper we had submitted before, because that paper had been based on a different premise. After hearing him explain that it was not ATA's intent to prevent the local airport authority from exercising its proper function in establishing antinoise regulations, I would like to make these comments.

ATA urges that this bill, that is S. 1016, be amended to prevent the States and their subdivisions from prescribing aircraft noise standards. However, this amendment is subject to the interpretation by others that there be complete Federal preemption of the entire field of aircraft noise, even to the point of nullifying the historical right of local airport operators, such as Port of New York Authority, to provide noise limitations on the aircraft which use their facilities.

Such an amendment, if so interpreted, would be directly contrary to Congress' intent in adopting the Noise Certification Act of 1968, Public Law 90-411, 49 U.S.C., Sec. 1431.

The Senate Commerce Committee, which recommended this legislation, stated: "... the proposed legislation will not affect the rights of a State or local public agency, as the proprietor of an airport, from issuing regulations or establishing requirements as to the permissible level of noise which can be created by aircraft using the airport. Airport owners acting as proprietors can presently deny the use of their airports to aircraft on the basis of noise considerations so long as such exclusion is nondiscriminatory."

Again I quote: "... the Federal Government is in no position to require an airport to accept service by noisier aircraft and, for that purpose to obtain additional noise easements. The issue is the service desired by the airport owner and the steps it is willing to take to obtain the service. In dealing with this issue the Federal Government should not substitute its judgment for that of the States or elements of local government who, for the most part, own and operate our Nation's airports. The proposed legislation is not designed to do this and will not prevent airport proprietors from excluding any aircraft on the basis of noise considerations."

The ATA recommendation, if so interpreted, is thus in direct conflict with Congress's intent in passing the Noise Certification Act.

The FAA has itself recognized Congress' intent in this respect when, in issuing noise regulations with regard to the certification of new aircraft is stated:

"Responsibility for determining the permissible noise levels for aircraft using airports remains with the proprietor of that airport."

Again I quote: "This limitation on the scope of part 36 is required for consistency with the responsibilities placed upon the airport pro-

prietor by the United States Supreme Court in *Griggs v. Allegheny County*, 369 U.S. 84, (1962)."

The FAA's position in this matter was once again recognized in its Advance Notice of Proposed Rule-Making issued on November 4, 1970, with regard to possible rules concerning the retrofit of existing aircraft for noise purposes.

It is inconceivable to me that Congress can adopt the ATA recommendation with this risk of interpretation present without at the same time placing upon the Federal Government monetary liability for the acquisition of whatever air easements are constitutionally required to accommodate aircraft in the course of their landing and takeoff maneuvers.

To do so would create an impossible situation for airport operators, since in many instances, only by restricting the use of jet aircraft at their airports can such operators avoid monetary liability to property owners aggrieved by aircraft noise.

Unless Congress is willing to go the full way of assuming complete Federal monetary liability and thus reverse the U.S. Supreme Court decision in the Griggs litigation by legislative means, the Congress should not, and most probably cannot, take away the historical right of an airport proprietor to control the noise characteristics of the jet aircraft which use their facilities.

Thank you very much for this opportunity to testify.

Senator CANNON. Thank you.

What is the status of the noise lawsuits that have been filed in New York? Have you had any of them disposed of by the courts?

Miss MUIRHEAD. We do not have any lawsuits asking for monetary relief except one old one that was commenced in 1961 and which has been going on for many years.

We do have a suit brought by the attorney general of the State of New York last year which seeks to mandate the port authority to require the airlines to retrofit—it is also against the airlines—to retrofit their aircraft to reduce the noise characteristics. That is still pending.

Senator CANNON. Didn't you have a few years ago some suits filed for injunctive relief and damages in the alternative on having noise?

Miss MUIRHEAD. That was the old *Trippe* case. It was a damage action. It was 809 property owners who sued us.

Mr. WILEY. Northeast of the airport.

Senator CANNON. What was the disposition there?

Miss MUIRHEAD. It is dormant. In another action, the PA sued to upset an ordinance by the town of Hempstead, a town bordering JFK, to limit operations at that airport.

Senator CANNON. Certainly we recognize that you airport operators have a problem with all of the complaints that you are getting and have been getting.

I wonder, you have had a lot of experience now with the 747's, have your complaints reduced in light of the 747's coming in?

Mr. WILEY. As one of the gentlemen said this morning, Mr. Chairman, you are a good straight man. Thank you very much for asking that question.

Yes; the 747 has helped a great deal, and we think the DC-10 and the 1011 will help even more.

The chairman may recall that the DC-10, having been on demon-

stration at the Paris Air Show, came back to Boston and LaGuardia and Kennedy Airports, and was demonstrated to elected officials, community leaders, and the press, all three being present at one time, which is a rather unusual precedent.

I may say the DC-10 established itself immediately as a good neighbor, and I am sure the L-1011 would have done the same thing had it come back for the same demonstration since both aircraft are comparable.

The reaction of the elected officials who are very much concerned with the noise and the environmental issues in the New York area was very positive. They hailed the DC-10 as a great step forward, the community leaders likewise, and I think the reaction of the press was enthusiastic. One reporter described the airplane as being like a tiger with laryngitis.

It was quite a vindication of the work that General Electric, Rolls Royce, Douglas, and Lockheed have put into developing these new technology airplanes designed to meet the requirement of FAR 36. I think that the public will accept them as great steps forward. They may help to reverse the very bad situation with respect to development of additional airports or expanding present airports as witnessed by the extensive article on this subject in the New York Times last Sunday which indicated on a worldwide basis what we have all known for sometime; namely, that airport development is slowly but surely coming to a grinding halt unless we can deal with these environmental issues.

Senator CANNON. You heard the presentations here this morning. Do you dispute those findings, these two studies, where they point out the time that would be required to achieve retrofit?

Mr. WILEY. I must say that I give great credence to the independent studies that were done by NASA and the Rohr Co., when they were developing the raw facts and data on which could be based a decision for proceeding or not proceeding with retrofit.

I really believe, as I said in the paper that I just referred to, I really believe that the technology exists today, without substantial further research, to equip certain of the aircraft in the fleet with quieter nacelles.

The 727 stretch 200 now in production is being advertised by Boeing and the engine manufacturing company as being capable of meeting FAR 36 requirements, and really that is all we are asking because that would in itself be a big step forward.

Senator CANNON. S. 1566, would require much more in the way of meeting standards than the regulation now requires.

Mr. WILEY. Generally I agree with that, and I understand that, and I think that what is unreasonable and impossible to achieve, obviously we cannot insist on. But I think there must be token steps in that direction, and if the first step in that direction is to achieve 108 EPNdB or the figure appropriately adjusted for the gross weight of the aircraft in accordance with FAR 36, we must go in that direction. It is not the airport operator that is going to say what is going to be accepted at his airport, it is the people that live in the vicinity of those airports speaking through their elected representatives who are going

to have their say, and I am afraid for the future of aviation if we do not begin to make some steps in that direction.

Senator CANNON. I think you are going to have a lot of problems from here on out because if we were to say right now we have the technology and we go ahead and retrofit, you are still talking of a program of 5 to 6 years.

Mr. WILEY. Let's get on with it. Let's get started. I think we can deal with it.

Senator CANNON. I think we have got to take a harder look at some other possible solutions in the interim period than some of these we have been talking about, because you are not going to be able to live with those people who surround your airports for another 5 or 6 years under present conditions, I do not believe.

Mr. WILEY. I think you are right, sir. However, I think that our ability to live with them—and take it from me, this is a man who has been on the firing line for 20 years now with the airport neighbors—

I believe we could live with them if we began to show some steps in that direction, if we began to modify some airplanes.

We are tremendously encouraged by the fact that this summer we are going to begin to introduce the DC-10 into service. American has already announced that it is going to start some service with the DC-10 beginning late August or September. All of these steps are tangible evidence that something is going to be done, and I think we have got to get started.

Senator CANNON. You will get some relief certainly from the new airplanes, there is no question about that; everyone agrees on that. But if you heard those reports here this morning, I do not think you are going to find any appreciable difference in acceptance from your communities based on the type of reductions that we heard here today. It is not very substantial or very meaningful.

Mr. WILEY. Now, let me put myself in the shoes of the airport neighbors for a moment. The difficulty is that it is going to cost a lot of money to do these things, but the people who live in the vicinity of the airports are not interested in that. They want relief. This is what they will be clamoring for.

If it costs money, well, that is too bad. That is part of the price of progress today. I do not believe that the airlines should be burdened with these costs. I think that the cost should come from those who fly.

Senator CANNON. It is obvious that the airlines cannot stand it, and I am not sure how much more the passengers can stand, particularly when you airport operators continually raise your costs.

Would you be willing to give up some of your revenues to the airlines to see these go into effect?

Mr. WILEY. Everyone's expenses are going up today. It is a way of life.

Senator CANNON. You did not answer my question.

Mr. WILEY. I am not authorized to answer that question, Mr. Chairman.

Senator CANNON. Thank you very much. We appreciate your presentation.

Mr. WILEY. Thank you.

(The statement follows:)

STATEMENT OF JOHN R. WILEY, DIRECTOR OF AVIATION, THE PORT OF NEW YORK
AUTHORITY

My name is John R. Wiley. I am the Director of Aviation for The Port of New York Authority, the agency of the States of New York and New Jersey responsible for the promotion and protection of the commerce of the region's port and for the development of terminal facilities, including the region's three major airports.

The Port Authority operates John F. Kennedy, LaGuardia and Newark airports—the largest single complex of civil airports in the world. Our passenger volume last year was approximately 37.5 million and the number of aircraft movements nearly 900,000. Aircraft noise has been a serious problem in communities around these three airports for twenty years and a cause of much antagonism between the communities and the aviation industry. As a result, we are unable to obtain community acceptance of a badly needed new major airport site or major expansion of existing airports. Accordingly, the alleviation of the aircraft noise problem is of great importance to the New Jersey-New York metropolitan region.

There are, basically, three ways of treating the aircraft noise problem: (1) move the noise away from the people, (2) move the people away from the noise, and (3) reduce the noise made by the airplane.

The first method has been applied extensively at our airports for the past 19 years. This includes establishment of approach and departure paths to minimize flight over residential areas, use of preferential runways to make maximum use of open or uncongested areas, and steeper climb and descent paths consistent with safety and existing technology. This summer we are computerizing the preferential runway system at Kennedy in an effort to provide some additional relief. Despite these efforts, continuing public opposition to aircraft noise is evidence that this approach does not offer adequate relief.

The second method, even if it were economically feasible, is, in my opinion, unacceptable. The relocation of hundreds of thousands of people, the disruption of their lives, and the destruction of entire communities is no solution. It is fallacy. Yet, well-meaning but insensitive government officials and industry executives continue to press for what they call a "land-use program."

To illustrate the magnitude of the problem, let me quote from a recent study of the Department of Transportation and the National Aeronautics and Space Administration entitled "Civil Aviation Research and Development Policy Study:—"

The high noise area around the J. F. Kennedy Airport in New York includes 35,000 dwellings, 22 public schools and several dozen churches and clubs. This area, plus that surrounding the Los Angeles and Chicago airports, estimated at 42,000 acres, is three times greater than all the land redeveloped during the 16 years of urban renewal at a cost of \$5 billion.

The value of this land has been estimated at \$17 billion.

I would not under any imaginable circumstances recommend to those 35,000 families living near Kennedy International Airport that they move to solve a problem not of their own making. It should be further noted that the National Academy of Sciences, in its environmental study of Kennedy Airport and Jamaica Bay, estimated that 700,000 people reside in communities near the airport which it defined as noise impacted.

By contrast, the industry does have a technologically feasible, economically practicable way of applying the third noise-reduction method. This, of course, is the retrofit program which is the subject of this hearing.

In contrast to the billions of dollars that would be required by a land-use program, approximately the same goal can be achieved through retrofit at a cost of perhaps \$600 million. Even the highest cost estimates are only about one billion dollars. Further, by reducing the noise of the aircraft, the benefits of noise abatement accrue to residents near all airports everywhere, not just those which have a land-use program.

Accordingly, the Port Authority supports the bill that is the subject of this hearing, which would require the acoustical treatment of engine nacelles of all present aircraft—a process commonly known as retrofit—by January 1, 1976.

We believe that this legislation would accomplish the urgent purpose Congress intended in Public Law 90-411, i.e., that the Federal Aviation Administration provide the public with present and future relief from unnecessary aircraft noise and require the acoustical treatment of present aircraft for noise abatement purposes.

We regard the tests conducted under the auspices of the National Aeronautics and Space Administration as conclusive evidence of the noise reduction potential of retrofit. These tests on the DC-8 and the Boeing 707 have demonstrated that retrofit can reduce the noisiness of landing turbo-fan aircraft by up to half and reduce the noise-affected area under approach paths by as much as 85 percent. The noise of jet aircraft on take-off, in the case of turbo-fan aircraft, can be reduced in the communities near airports. We are certain that retrofitting other present aircraft will provide comparable noise-reduction advantages.

For more than 20 years now, aircraft noise has adversely affected the quality of life in communities near hub airports across the country. We firmly believe that these communities should not be denied any long the relief that today's technology can deliver.

We are deeply concerned by the delays that have crept into the FAA's consideration of retrofit. The FAA has stated that it will proceed with the next phase of its retrofit rule-making procedure in the first half of 1972, with a final rule to be issued in the fourth quarter of 1972. This timetable for rule-making represents a slippage of 15 to 18 months from the schedule the FAA announced just 16 months to a group of concerned Congressmen. These delays, in our opinion, are not justifiable.

The target date for retrofit that S. 1566 would impose, on the other hand, is reasonable. The acoustical material to be used has been extensively tested and is, in fact, essentially similar to the material installed on new aircraft such as the DC-10 and L-1011. The Boeing Company announced last month that similar soundproofing material will be installed on an advanced 727-200 aircraft currently in production, which will be in commercial service within a year's time. This will permit the aircraft to meet the noise certification levels established by the FAA in FAR Part 36. If this material can be authorized for installation in these aircraft now, it can certainly be authorized for retrofitting existing aircraft with minimal additional testing.

We are convinced that retrofit is the most effective and immediate means available today for alleviating a problem adversely affecting millions of people in communities near airports. We are further convinced that the aviation industry will benefit by the improved relationship with communities that would result. The antagonism between airport and community engendered by the noise problem has been the greatest deterrent to social and political acceptance of needed new airport facilities in this country and around the world. The cost of a retrofit program would be a fraction of the economic loss stemming from the aviation industry's inability to expand present airports and build new airports.

We are pleased that S. 1566 addresses the question of funding a retrofit program—a major and valid concern of air carriers. It would authorize the Federal government to provide the necessary seed money by guaranteeing loans up to a total of \$1 billion to carriers. It would require the Civil Aeronautics Board to grant a fare increase to meet the cost of the program, including early retirement of some aircraft, if necessary, and recover any government funds advanced. As indicated in a study conducted by the Rohr Corporation for the FAA, a fare increase of one percent, that is, \$1.00 on a \$100.00 ticket, would finance the complete cost of a retrofit program.

There is no disagreement on the need to solve the problem. Secretary of Transportation John A. Volpe has said that "We regard an effective noise reduction retrofit regulatory program as being necessary in the broad public and national interest, not only because of the relief it may bring to airport neighbors, but also because aircraft noise reduction retrofit is directly related to the further promotion, encouragement and development of civil aeronautics."

FAA Administrator John H. Shaffer has called "Aircraft noise . . . the single greatest impediment to airport development in the United States . . . prompt remedial action is required if we are to meet the projected growth of aviation in the 1970's and beyond. The FAA is committed to using every legal regulatory technique at its disposal to reduce aircraft noise at the source."

We agree completely with these statements. We regret that we have seen no indication of firm resolve to act upon them.

S. 1566 and its companion measure in the House, H.R. 8642, offer the mechanism for promptly implementing retrofit and for providing for its funding. We believe this bill merits the support of all those affected by the aircraft noise problem and those concerned with the quality of our environment.

With regard to S. 1016, the Noise Control Act of 1971, while the Port Authority is not in any way opposed to this bill, I cannot avoid commenting upon a proposed amendment to its companion bill, H.R. 5275, recommended by the Air Transport Association (ATA). ATA urges that H.R. 5275 be amended to provide, in effect, for complete Federal Government preemption of the entire field of aircraft noise, even to the point of nullifying the historical right of local airport operators to provide noise limitations on the aircraft which use their facilities. Such an amendment would be directly contrary to Congress's intent in adopting the Noise Certification Act of 1968 (P.L. 90-411, 49 U.S.C., Sec. 1431). The Senate Commerce Committee, which recommended this legislation, stated:

"... The proposed legislation will not affect the rights of a State or local public agency, as the proprietor of an airport, from issuing regulations or establishing requirements as to the permissible level of noise which can be created by aircraft using the airport. Airport owners acting as proprietors can presently deny the use of their airports to aircraft on the basis of noise considerations so long as such exclusion is nondiscriminatory."

* * *

"... The Federal Government is in no position to require an airport to accept service by noisier aircraft, and for that purpose to obtain additional noise easements. The issue is the service desired by the airport owner and the steps it is willing to take to obtain the service. In dealing with this issue, the Federal Government should not substitute its judgment for that of the States or elements of local government who, for the most part, own and operate our Nation's airports. The proposed legislation is not designed to do this and will not prevent airport proprietors from excluding any aircraft on the basis of noise considerations."

The ATA recommendation is thus in direct conflict with Congress's intent in passing the Noise Certification Act. The FAA has itself recognized Congress's intent in this respect when, in issuing noise regulations with regard to the certification of new aircraft, it stated:

"Responsibility for determining the permissible noise levels for aircraft using an airport remains with the proprietor of that airport."

* * *

"This limitation on the scope of Part 36 is required for consistency with the responsibilities placed upon the airport proprietor by the United States Supreme Court in *Griggs v. Allegheny County*, 369 U.S. 84 (1962)."

The FAA's position on this matter was once again recognized in its Advance Notice of Proposed Rule Making issued on November 4, 1970 with regard to possible rules concerning the retrofit of existing aircraft for noise purposes.

It is inconceivable to me that Congress can adopt the ATA recommendation without at the same time placing upon the Federal Government monetary liability for the acquisition of whatever air easements are constitutionally required to accommodate aircraft in the course of their landing and take-off maneuvers. To do so would create an impossible situation for airport operators, since in many instances, only by restricting the use of jet aircraft at their airports can such operators avoid monetary liability to property owners aggrieved by aircraft noise. Unless the Congress is willing to go the full way of assuming complete Federal monetary liability and thus reverse the U.S. Supreme Court decision in the *Griggs* litigation by legislative means, the Congress should not, and most probably cannot, take away the historical right of an airport proprietor to control the noise characteristics of the jet aircraft which use their facilities.

Thank you.

Senator CANNON. The next witness is Mr. Burt F. Raynes, Chairman of the Board of the Rohr Corporation.

STATEMENT OF BURT F. RAYNES, CHAIRMAN AND CHIEF EXECUTIVE OF ROHR CORP.

Mr. RAYNES. I am glad to be here to talk to you about a subject that has been of great interest to me for many years. Most people don't know what Rohr Corporation is. They are not as familiar with

us as they are with Boeing and Douglas and some of the other people that are in the aircraft industry, but our corporate headquarters are in San Diego—really Chula Vista—which is near San Diego, and we are primarily an aerospace company. We are a sub-contractor, we have been the largest factor in this aerospace sub-contracting over the past 30 years, and we employ approximately 10,000 people in nine plants spread geographically across the country, and our sales volume this year will be about \$335 million.

Our principal product over the past 30 years of our existence has been aircraft and nacelles or powerplant packages. We design, tool, and manufacture these assemblies for such companies as Boeing, McDonnell Douglas, Lockheed, and Grumman. We have made this our way of life. In performing this work, we receive the engines from Pratt-Whitney or General Electric or sometimes Rolls Royce, and we add the fuel systems, the hydraulic, pneumatic and electric systems, and components such as starters and generators. The major effort, of course, is in the manufacture of the engine inlet cowl, the forward thrust reversers, the core engine cowl, tailpipes and thrust reversers. We do this for both military and commercial work. About 75 percent of our work is commercial, however.

We feel that we have a considerable degree of expertise in this business because we do build 90 percent of all the American-manufactured nacelles and 94 percent of all the thrust reversers.

I have got some slides here which will show some of this. I will try to run through just a little of it.

This is what we call a powerplant assembly. This happens to be a DC-9. It shows the engine with the inlet cowl, the engine cowl here, and then the reverser. This design is a design that we perfected under the direction of the Douglas Company, and it is a complete unit. In designing this, our position is the same as Douglas. We have to stand for the structural integrity, the fit and function, compartment temperatures, percent of reverse thrust, and if there is a problem in the eyes of the airlines who use it, it is our problem. We have got to fix it.

Senator CANNON. Where does the fan reverser come in there?

Mr. RAYNES. This is the JT8D engine, and there is no fan reverser except that the reverser can take all the air on a JT8D out the back end, and this is what we call a target-type reverser. As some of these fellows here know, we are somewhat addicted to target-type reverse, although we build both kinds. All the air goes through the engine, it goes through the ducts here, and it is dumped in with the primary air and it comes out of this big nozzle back here, and this target fan reverser breaks the fan and primary air on a JT8D engine.

This just shows a 747 powerplant assembly, to give you some idea of the kind of complexity which we ship out to the Boeing Company.

This is a DC-10 power plant for Douglas. Part of the cowl is open. It is just an example of one of our newer power plant assemblies.

This is a 737 power plant for the Boeing Company showing again a target-type reverser, the JT8D engine.

This is just another power plant assembly for the 727, Boeing, JT8D again.

This is a familiar old 707 JT3D. That is the fan there. That translates aft and opens up and has doors for the fan reverser.

This is just a view of our engine assembly line.

We build 90 percent, as I said, of the power packages. We build 94 percent of all the thrust reversers.

This shows one of our research—what we call cookie cutters or splitters in the inlet to reduce the fan noise. As you saw this morning with the presentation, either that type of design or a design with double rigs, these are all acoustically treated inside the inlet cowl and on both sides of the cookie cutters and that gives a great reduction in fan noise, and it is very successful.

This shows a JT8D, and most of my remarks will refer to the JT8D engine, showing a multi-lobe sound suppressor in the back mounted on a test stand.

This shows the same multi-lobe sound suppressor with an ejector on the back end, this being the front end of the engine and this being the back end. The purpose of the ejector is to cause a greater mass flow of air to come through the engine. The mass is important. But using the exhaust to pump additional air, as some of the slides this morning in their later designs of the Boeing Company show, that the use of an ejector is a very crucial thing on reducing the takeoff noise of an airplane. I think you can well establish from the slides you saw this morning for both companies that the landing noise is not difficult to get rid of. They showed reductions considerably over the 10 EPNdB that are required by the legislation at hand here. So, there is just one way that anybody can say that that cannot be done, because it has been done by numerous people in different places at different times.?

Now, when you start talking about the JT8D engine, this is the 2 and 3 engine airplane, and they are the only ones that ought to be discussed here, I feel you have to have some form of an ejector. The ejector in this case, this and other ejectors that we have developed, show a static thrust increase of 8 to 10 percent. Now, why is this static thrust increase important? It is important because it allows the airplane to accelerate faster, and when the airplane accelerates faster, it gets to rotation speed further and it climbs faster and you get the airplane higher. If you did not have any kind of sound suppressor on it at all, just the fact that it is higher puts you in a position to feel less noise on the ground. That is one of the elements that an ejector does.

The other thing is there is added mixing. If you would look at this engine and see the length after the engine flange which is there, the full length, you have got them longer than this, the engine is much longer than the present nacelle installations that are common on the 727s and the DC-9s, 27s, and 37s. You have more area for treatment, you have introduced more air, and so shearing forces that cause the noise, the noise is caused aft of the engine. The jet roar that you heard talked about here this morning occurs out of the engine, it is aft of the engine, and by having a greater amount of mixing, by surrounding that area that is being mixed with the ejector, you can reduce the noise substantially.

The next slide just shows this same type of installation mounted high to keep it away from the ground. You cannot really see it, but there are microphones arrayed all around this. This is one of our men standing here. It just gives you some idea of some of the work that we have done.

There is certainly no question that you gentlemen are familiar with the ways of measuring sound, and I would like to say that it is difficult to say what constitutes an objectionable airplane from a community standpoint. What may be good for one person might not be good for some other person, or that same person at a different time. But today I think most of the existing jets, with the exception of the 747, are objectionable at one time or another. The same airplane is not nearly as objectionable on one day as it is on another day, or on one field as it is on another field. I think the conversation in the last two days here has been entirely too general, and there are sweeping assumptions that have been made that are just not relevant to the particular situation at hand.

I would like to make sure that you know that my remarks refer to the older aircraft, the 4-engine DC-8's and 7's, and the 3- and 2-engine 727's, 737's, and DC-9's. I specifically want to exclude the 747 and the DC-10, because they are in a completely different category.

Senator CANNON. You are aware of the fact that Boeing actually flight-tested this system, the type system you are suggesting, and that they come up with markedly less noise reduction than you say can be accomplished?

Mr. RAYNES. I don't think Boeing had very many flight tests on ejector systems.

Senator CANNON. I think the testimony this morning was that they flight-tested a 727-200.

Is the Boeing man here?

Mr. BLUMENTHAL. Sir, we tested a six-lobe suppressor without a shroud on a 737 airplane. At that time we got about 3 EPNdB reduction on takeoff noise and 1 EPNdB increase in approach noise. We did not have a shroud around that installation. We did test on the ground a shroud installation with many more lobes than that which Mr. Raynes has referred to.

Senator CANNON. Thank you.

Mr. RAYNES. I think the thing we have got to talk about is the take-off and climb-up portion of the spectrum. If you look at the reports that are given to you by the Boeing Co. and the Douglas Co., there is no question on the landing mode. The landing mode can be treated very easily.

Those two problems are largely separated one from the other. One is the front end of the engine and the fan portion of the engine, and the other is the noise that comes out of the steering action after the engine.

If you don't put some kind of an ejector or shroud around that portion where the noise is being made aft of the nozzle, you don't have much result.

Now, speaking to the matter of the community noise, what does 10 EPNdB mean? That is a tough number to come up with. It represents approximately a 50-percent reduction in the annoyance factor. If you go strictly by the numbers, 6 dB would be a halving of the sound pressure level.

So when you get all the other factors of time and tone values, I will say that 10 EPNdB will reduce the annoyance factor by about 50 percent.

You heard one recording this morning by McDonnell-Douglas of $8\frac{1}{2}$ EPNdB reduction on takeoff. I thought that was a remarkable reduction. It was on landing; $8\frac{1}{2}$ by that recording was a remarkable thing.

A little more is a little more, and I think "10" is a fairly good number. I think less than that, however, would not be meaningful to the people around the airport.

That is a difficult thing to substantiate, and I really can't substantiate it. I would defer to Mr. Wiley, whose remarks, I think, carried a great deal of weight on that just a few minutes ago.

I would progress now to the technical feasibility, which I guess is the thing where I have to disagree with some of the people who have come before us today here.

We spent several million dollars of company funds. Unfortunately, we haven't had any NASA or Government money to do any of the hardware research that we have done.

The study that has been alluded to as a Rohr study was an economic study, and an economic study only, based on some of our hardware experience and the hardware experience of others. But it was an economic study to try to get some handle on what the cost is. You have to have costs that are within reason.

But I can tell you that from our hardware studies we believe that it is entirely practical to reduce the annoyance factor, the EPNdB, by a matter of 50 percent. That is the "10, 10, and 10."

I know you saw charts here where the fellows said they couldn't do it. And I hate to disagree with my customers' representatives. But I must do it, because I don't believe they are being as optimistic as they could be.

Senator CANNON. Could you supply us any test data that would substantiate your conclusions, such as the test data that was provided this morning to us?

Mr. RAYNES. I can supply test data that would be substantially improved over what was shown today; yes.

Senator CANNON. We would like to have any test data that you have, particularly that disagrees with this, because earlier testimony was quite detailed, I thought, this morning, and we certainly would like to have any such test data that you have to support your position.

Mr. RAYNES. Let me hit a more direct answer to that point in a moment.

Now, anybody with almost any airplane can reduce the noise level remarkably by the manner in which you fly the airplane, the amount of load you put on the airplane.

If you take a flight like they have nonstop flights out of Chicago for Honolulu or out of Dallas for Honolulu, those flights are heavy. They are heavy with fuel. They are heavy with passengers. And the airplane has everything in it that can go in. They are taking off at maximum gross weights.

That airplane is going to make a lot more noise over O'Hare, for instance, and the people surrounding that airport than that exact same airplane with that same number of passengers that are going to Denver or San Francisco, because the airplane is a lot heavier.

I think we have got to separate out that kind of thing, because it is a matter of whether the airlines are willing to limit themselves to what they are going to do with the airplane.

The airlines today have an alternative. They didn't have an alternative 3 or 4 years ago. They didn't have any airplanes for long-range flights other than the DC-8's and the 707's.

Today the 747 is rapidly taking over the operation of these long-range flights, and the DC-10's are coming up very rapidly, will be in service late this year, and the DC-10's will take over a lot of the long-leg flights. This is an opportunity for the airlines—they have a viable alternative.

We also talked about the matter of the airplanes that had not been converted to fans or were not fans. I don't think that is a responsibility of the people who live under the airplanes.

Some airlines, American Airlines, converted all their airplanes to fans. Just because some other airline didn't see fit to do that and spend the money for it, that is not a responsibility of the Congress and it is not a responsibility of the people who live under the airplanes or the people who manage and operate the airports. They have got to be brought to the table to cause them to do so. That is the function of this hearing.

Another matter is whether or not the four-engine airplane should be retrofitted at all. I personally don't think that the JT3 powered airplanes really should be retrofitted, because they are going to be forced out of operation by 747's, by DC-10's, and that is the airplane that is going to take over the segment of the airline operation that is now covered by DC-8's and 707's in a relatively short period of time—3 or 4 years—the overseas flights, that flight that leaves Chicago for Honolulu.

Flights that leave Los Angeles for Paris, nonstop flights, I have taken it myself a number of times, they can stop for fuel somewhere, but they don't have to stop for fuel if it is a 747. They can fly that flight, and so can the DC-10, without fuel stops and without creating noise.

The problem of retrofit lies squarely, in my opinion, on the two- and three-engine airplanes, the airplanes that have a JT8D powerplant.

We at Rohr have concentrated almost all of our effort in that area, because that is the area we felt a chance of producing some sort of result in.

I wouldn't want to go much further without saying that some of the airlines—I think you may have heard something from Northwest and others who are operating their airplanes in a different way—can by the manner in which they run the airplane greatly affect the amount of sound that is heard down in the community. There is a lot of things that they can do.

The method now of certifying an airplane and determining its noise under certain ideal conditions is great for the manufacturer, and it is great for the airlines. But it doesn't mean a damn thing to the guy who is down on the ground who is listening to that airplane being operated.

This bill provides that there be community monitoring of the noise and provides some money to get that going. I think that puts realism and it puts teeth into what is otherwise a rather laissez-faire situation. It is like putting smog controls on automobiles and then never checking them. After the automobile has run 10,000 miles, you hardly know it is on there.

To talk about economics and the general considerations, the thing that has kept this whole problem of sound suppression in limbo for a good many years is the unwillingness of the airlines to spend the money or to make the demands for the money to be spent to fix the situation.

I don't blame the airlines. If I were the president of any one airline, I wouldn't do a thing about it, either, because the other airlines wouldn't do it and I would be at a disadvantage.

The thing about this bill here now, S. 1566, is that it puts everybody under the same ground rule. The guys who are still operating those straight jets are forced to do something about them like some of the other airlines have already done.

The airlines are out of money. They are in a bad shape. If they are going to be putting up any money for retrofits, the loans have to be guaranteed and they have to have some way of getting that money back.

I think this bill provides that.

Further, the bill has one little sentence in here which I think most people have ignored, a very important sentence. It is on page 5, and it says:

Such cost shall include the cost of retrofitting aircraft with sound-reduction devices and the early retirement of aircraft due to implementation of the standards imposed by this Act.

I consider that to be a crucial statement in the act, because the retirement of aircraft is going to be a necessity. There are some aircraft that should not be retrofitted.

Yet, there are a lot of them that ought to be. Let's get the number out.

Deliveries through May of this year on the JT8 powered airplanes, there are 853 727's, there are 269 737's, and there are 613 DC-9's—over 1,700 aircraft. And that isn't the end of the run. We all have orders for those airplanes. We are building more of them. We are building airplanes, and we are planning to build them.

You saw it in the testimony this morning. We are planning to build airplanes that are no better delivered to an airline a year from now than the airplanes that were delivered 3 or 4 years ago. They are going to be as unsatisfactory delivered a year from now as the airplanes that were delivered 3 and 4 years ago; 1,700 airplanes—that is too much to tolerate, in my opinion. I am only giving you my opinion. I just think something ought to be done, and I think it ought to be done relatively soon.

Senator CANNON. Do you think it can be done sooner than the estimate given by the people who testified this morning?

Mr. RAYNES. If you looked at those charts carefully, you could see there was a disparity of about 50 percent between the two companies.

One, we were going to get them in 1977, the first one, and we were going to get them in 1975 with the other.

There is quite a little disparity between the two testimonies that went on this morning. I really believe we can get retrofit powerplants out in 1975, certified, if we really have to do it.

I will get to that in a little bit.

Our economic study showed that the retrofitting of the existing fleet or the fleet that will exist in 1975 or 1976 would require about a billion dollars. I would like to modify that, a report we made for the FAA,

and say if you reduce that down to just those airplanes that have JT8D engines, that number will come down to about \$500 million. That is the retrofitting on just the two- and three-engine airplanes. Those are the only ones that I feel really should be retrofitted.

I think that the special funds for accelerated research are a very vital thing. This is a tough area. Nobody knows better than those of us who have worked on it.

The fellows who have talked here this morning and myself, we all know how tough this is. We need more flight hardware.

I couldn't agree with anybody more than with the Boeing statement: We have put enough of our own dough into this thing. We are not going to put any more in it—because it would be just somebody developing, as some people have, a crashproof bumper, energy-absorbing bumper, for a car, when there is no legislation that requires it.

Legislation is the thing that we need. If we had legislated 5 or 6 years ago a requirement that today—said that there had to be a certain level of noise from all jet transports, believe me, the job would have been done by now if that legislation had spelled it out that it was a requirement.

There is no automobile manufacturer that is ever going to put a padded dash on the front of his automobile, he is not going to put headrests, he is not going to put seatbelts, he is not going to put anti-smog devices in his car, unless he knows he has got to do it and all of his competitors have got to do it.

Take Muskie's bill. Did you hold hearings on that and ever get the automobile manufacturers to agree to the regulations that went out for 1975? Never, Right today they are saying they will never make it, and they are working to get it done. And they will get it done.

I am serious about that. They will do it.

But they are only doing it because Congress in its wisdom had the foresight and had the guts to step up and ask industry to do the job that industry had to do and gave them the economic incentive. They had to do it.

I've got a little thing here that I will submit to you for your consideration.

Here is the current issue of the Journal of the SAE, the automotive industry. It just came to my house last week.

It shows pictures of automobiles with their energy-absorbing bumpers.

You can't pick up an automobile magazine today—and I happen to be in the truck-and-bus business, too—that doesn't have big articles on pollution, all the efforts they are going through, all the efforts they are going through to make their cars safer.

You got their attention. You got their attention by legislation. I don't think you can get anybody's attention on these items, because they are economic items—nobody is going to do it until you legislate.

I believe we have the technology. I believe we can meet the requirements of this S. 1566. I believe we can meet the time frame. I think it gives the relief to the airlines in terms of loan guarantees and a way of getting their money back.

It gives you people the relief that if the research that is done for the \$35 million results in production, you get part of your money back. That is no bad thing, either. You ought to get your money back. And the consumer ought to pay for it.

In my mind, the consumer certainly is paying for the antismog devices that are going on automobiles, and they are paying for the seatbelts, and they are paying for the headrests and everything else. The consumer has got to pay. It shouldn't be the guy who is sitting with his house underneath the airplane.

I just guess I would have to tell you, I recommend the passage of this bill, S. 1566, because I believe it is necessary to cause industry to step up to do the job that they can do. And I believe that technically we have the expertise to do it.

I think you ought to give us the inspiration by passing a bill that requires that.

Thank you.

Senator CANNON. Thank you, sir. We appreciate your being here. (The statement follows:)

STATEMENT OF BURT F. RAYNES, CHAIRMAN AND CHIEF EXECUTIVE OF ROHR CORPORATION

INTRODUCTION

I am pleased to testify concerning the proposed legislation on aircraft sound suppression—it is a most interesting and important subject. Before presenting my specific views on the Bill, it is appropriate that I should make a few introductory comments since most of you are not as familiar with the Rohr Corporation as you are with some of the other company representatives who will also be testifying. Our Corporate Headquarters is south of San Diego in Chula Vista, California. We are primarily aerospace subcontractors and have maintained a position as the largest factor in this business over the past thirty years. We employ approximately 10,000 people in nine plants which spread geographically over most of the United States. Our sales volume for the fiscal year ending this month will approximate 335 million. Our principal product during these past thirty years has been aircraft and nacelles or powerplant packages. We design, tool, and manufacture these assemblies for such companies as Boeing, McDonnell Douglas, Lockheed, and Grumman. Performing this work we receive the bare engine from the engine manufacturer such as Pratt-Whitney or General Electric and to this engine we add the fuel, hydraulic, pneumatic and electrical systems including such components as starters, generators, pumps, valves, etc. The major effort, of course, is the manufacture of engine inlet cowlings, fan cowlings, forward thrust reversers, core engine cowlings, tailpipes and thrust reversers. We perform this work for both military and commercial programs; however, you may be interested in knowing that our sales volume is more than 75 percent commercial. We feel that we have a considerable degree of expertise in jet engine nacelles as attested by the fact that we have produced over 90 percent of all the American manufactured jet transport nacelles and over 94 percent of all the thrust reversers.

SOUND SUPPRESSION—HOW MUCH IS NEEDED AND HOW MUCH IS POSSIBLE ON A PRACTICAL BASIS

I am assuming that all of you are reasonably familiar with the unit of measure—Effective Perceived Noise Decibels or EPNdB and the three FAA criteria for measuring this noise, namely, sideline noise at the airport during initial ground run and takeoff—takeoff noise underneath the airplane during climb out at a point three miles out from the beginning of the takeoff point—and landing approach noise underneath the airplane at a point one mile prior to runway threshold. Most current jet transports are objectionable in all three categories at most of the nation's airports and are particularly untenable at certain locations with which all of us are familiar.

Just what constitutes an acceptable noise level for jet transports is a difficult thing to determine. First, let me make it perfectly clear that my remarks will refer to the older aircraft such as the four engine DC-8's and 707's and the three and two engine jet transports such as the 727, 737, and DC-9—I specifically want to exclude the Boeing 747 and the new McDonnell Douglas DC-10 because their

sound levels are much lower than those of the older transports. These older transports exhibit sound pressure levels in the takeoff-climb out area of approximately 105-116 EPNdB. It is this takeoff-climb out portion of the flight spectrum that is most difficult to correct from a noise standpoint. Almost all of the airplanes under consideration are powered by Pratt-Whitney JT3D or JT8D engines. It is my own personal belief based on several years of detailed experience in this field that a reduction of less than 50% in the sound pressure level would not be adequate to achieve meaningful results. I recognize that you gentlemen would probably consider that a 50% reduction in sound pressure level would be a very large increment. However, I can assure you that to the average citizen of the community surrounding an airport a 50% reduction in EPNdB is something that would certainly be noticed and appreciated but the residual noise would still constitute a considerable annoyance. The 10 EPNdB in all three categories specified in the legislation before you represents approximately a 50% reduction in sound pressure level. To require substantially larger percentage reductions would, I believe, result in the imposition of rather severe operating penalties to the airlines.

TECHNICAL FEASIBILITY

We, at Rohr, have spent several million dollars over the past four years in an intensive company funded research and development program concerned with the reduction of jet noise. A year ago we performed an economic study for the FAA relating to the economic impact of sound suppression on airline operations. As a result of our own efforts and those of the prime aircraft contractors and the engine builders, I feel confident that it is entirely practical to reduce sound pressure levels on most all flights by a factor of 50%. The only area which I feel to be technically infeasible relates to those four engine transports (707's and DC-8's) which are used for very long range flights. The propulsion performance degradation which is inevitable with sound suppression techniques does not constitute an important factor on the two and three engine jet transports or on shorter range flights. For the four engine transports, however, the penalties are unacceptable for a certain small percent of those flights which are very long range (predominantly overseas). It should be noted that this long range market is rapidly becoming dominated by the new and quieter Boeing 747's and will shortly be feeling the impact of the new and quieter McDonnell Douglas DC-10's.

It is relatively easy to achieve 50% sound pressure level reduction for the landing approach regime. New sound suppression materials have been developed and evaluated which, in conjunction with newly developed nacelle configurations, make possible and practical results that would have been considered technically unattainable or impractical as short as two to three years ago. In addition to modifications to engine nacelles much can be accomplished by the institution of airline operating regulations which control flight patterns and throttle power settings which result in considerably lower community noise levels. The provisions of this legislation relating to community monitoring of the noise performance of operating aircraft puts realism and teeth into an otherwise rather laissez-faire situation.

ECONOMICS AND GENERAL CONSIDERATIONS

As a result of our extensive studies under the FAA program relating to the economics of sound suppression, it was determined that the cost of retrofitting applicable in the United States would amount to a major capital expenditure on the part of the airlines. This expenditure must be financed by companies that are already overburdened with debt. This Bill through the mechanism of Government guaranteed loans provides the necessary relief. The cost of retrofit sound suppression should rightfully be paid for by the consumer and this Bill offers a guarantee to the airlines that the cost of retrofit provisions will be automatically acceptable by the CAB in rate hearings. It is estimated that a fare increase of approximately 1% will be required. The provision of special funds for an accelerated research and development program are a requirement in order to achieve a maximum of results in the shortest possible time frame.

Congress by legislation must set the goals and requirements for aircraft jet noise. Economic pressures prevent technical advancement in sound suppression unless uniform requirements are imposed on all operators. As a parallel case, we all know that no automobile manufacturer of his own free will—in view of economic pressures—would have developed and installed in all automobiles such items as padded instrument panels, collapsible steering columns, head

restraints, seat belts, energy absorbing bumpers or engine pollution control equipment. This could only come about through appropriate legislation—a reduction in jet transport noise levels will only come about through appropriate legislation. I have studied the Bill which you have in hand in great detail and believe it contains the essential elements leading to a speedy solution to a problem which is inflicted upon a great number of United States citizens—I unhesitatingly recommend its passage.

(The following information was subsequently received for the record:)

ROHR CORP.,
Chula Vista, Calif., October 8, 1971.

Senator HOWARD W. CANNON,
Senate Office Building,
Washington, D.C.

DEAR SENATOR CANNON: During my testimony in support of Senator Cranston's proposed legislation regarding aircraft noise (S-1566), you requested data concerning some new technology which I used as the basis for stating my belief that a 10 EPNdB reduction at all three measuring points might be possible for JT8D powered aircraft. The enclosed Preliminary Data Release and Preliminary Cost Release on our new RTN Augmenter/Suppressor provides this data.

As you know from my testimony, I strongly believe that something must be done on the aircraft noise problem. A real step forward would be quieting of the two and three engined aircraft powered by the JT8D. These aircraft account for the majority of the takeoff and landing operations, and will be with us for an easily predictable fifteen years. It is toward this objective that our very substantial investment in sound suppression has been directed, and we are, of course, pleased and excited over the possibility that the RTN Augmenter/Suppressor will be of significant benefit to the noise impacted communities. If you require any additional information concerning our new technology, I will be delighted to provide it.

My most sincere congratulations on your being the recipient of the Wright Brothers Memorial Trophy. I can imagine no finer selection and look forward to being able to congratulate you in person quite soon.

Sincerely,

BURT F. RAYNES.

Enclosure.

JT8D SOUND SUPPRESSION PRELIMINARY DATA RELEASE

A significant advancement in the suppression of jet aircraft low frequency exhaust noise has been attained by Rohr Corporation. This has been accomplished with a Rohr developed device called an RTN augmentor/suppressor. Based on full scale ground tests, the current non-optimized RTN-1 configuration, in conjunction with suitable inlet and duct suppression hardware, has demonstrated static suppression which converts to an 8 EPNdB reduction for each of the take-off, sideline, and approach measuring points specified by FAR Part 36. We are confident that further optimization of the configuration and inflight demonstration will increase these numbers by several EPNdB. Our present model and full scale testing has been directed to the 727, 737 and DC-9 aircraft powered by the JT8D engine, since this fleet will comprise the majority of U.S. airport traffic for the next ten to fifteen years.

Rohr is a specialist in the design and manufacture of engine propulsion packaging for jet transport aircraft. For the past five years, Rohr has, on Company funds, conducted an extensive research and development program in the field of jet aircraft sound suppression. An early contribution was the development of structural acoustical treatment for attenuation of high frequency turbo machinery noise. This material is in current use on the new wide body jets.

To support noise suppression development, Rohr owns and operates a dual flow, hot gas model test facility and a full scale engine test stand. Both of these facilities are equipped to measure engine performance and sound attenuation. These facilities are backed up by a computer installation that indicates engine performance in real time, and through special programming noise levels which are then converted to FAR Part 36 fly-over data.

Figure 1 is a photograph of the full scale test stand with the RTN-1 augmentor/suppressor mounted on a JT8D engine. This stand and the microphone array are at a 30-foot elevation to minimize the ground effects on noise measurements. An acoustically treated, two ring inlet and P&W developed acoustical treatment in the JT8D fan ducts complete the configuration for which the 8 EPNdB was attained. An operable thrust reverser was not provided for this test, but is included in the RTN-1 augmentor/suppressor design.

Figure 2 is a plot of the takeoff noise levels around the engine measured at a 200-foot radius for both the unsuppressed and suppressed JT8D, in terms of noise as a human hears it (PNLT in PNdB). As indicated by the polar plot of noise levels, the aft area of highest engine noise emission is effectively suppressed. The suppression is such that observers can comfortably remove their ear protection and readily communicate while standing at the 165° angle, 200 feet from the engine operating at takeoff power. The suppression of aft quadrant takeoff noise reduces both total noise emission and noise duration to provide the 8 EPNdB reduction when converted to aircraft noise level at the takeoff measuring point.

Figure 3 is a plot of noise levels associated with the suppressed engine at approach power. It is developed in the same manner as described for the data in Figure 2, and indicates a uniform noise reduction.

A note of caution concerning two aspects of this design is considered appropriate. First, the extrapolation of ground static acoustic data to the flight regime is not rigorous, due principally to the lack of ground-to-flight correlation data on the JT8D engine. Although the extrapolation techniques used were considered both appropriate and conservative, a flight test of the RTN augmentor/suppressor is obviously required. Second, the matter of flight performance is not resolved. Preliminary wind tunnel tests indicate that although augmentation is achieved during the takeoff regime, it is less than desired. Similarly, cruise performance losses are somewhat higher than anticipated. Analysis of both of these areas clearly indicates that with flow path optimization and additional wind tunnel and flight test verification, substantial improvement will be attained.

The weight of the RTN-1 unit is expected to stay within the structural limits of the engine. Overall effect on airplane weight and balance due to the entire suppressed nacelle is considered to be reasonable.

To briefly summarize our progress to date, we have achieved a static 8 EPNdB acoustic reduction on the JT8D engine for all three FAR Part 36 measuring points without refinement or optimization of the design. We see clear indications that this reduction and inflight evaluation could result in suppression of 10 or more EPNdB at each of these three points, with resulting halving of community annoyance.

JT8D SOUND SUPPRESSION PRELIMINARY COST RELEASE

Preliminary cost estimates have been made for installation of the suppressed nacelle configuration shown in Figure 1 of the Preliminary Data Release on the three aircraft types involved, DC-9, 727 and 737.

Ground rules for development of these costs are identical to those used by Rohr in preparation of Report Number FAA-No.-70-11 for the FAA titled, "Economic Impact of Implementing Acoustically Treated Nacelle and Duct Configurations Applicable to Low Bypass Turbofan Engines".

In general, they include the costs to develop, qualify, certificate, produce and install all retrofit hardware. Items such as shipping costs, spares, field service, manuals, insurance and excessive down-time costs are included. The factor not included is the cost of any changes to the basic airframe made necessary by installation of the retrofit hardware. The one difference between the costs in Report FAA-No.-70-11 and those given below, is in the calendar period of performance. A 1970 to 1973 period was used in the report, while the 1972 to 1975 period was used in costs given below.

Aircraft quantities listed below were used for the cost projections and are not necessarily correct for the actual number of airplanes which will be retrofitted.

Aircraft type	Quantity to be retrofitted	Installed cost per airplane
DC-9.....	500	\$380,000
727.....	800	500,000
737.....	200	600,000

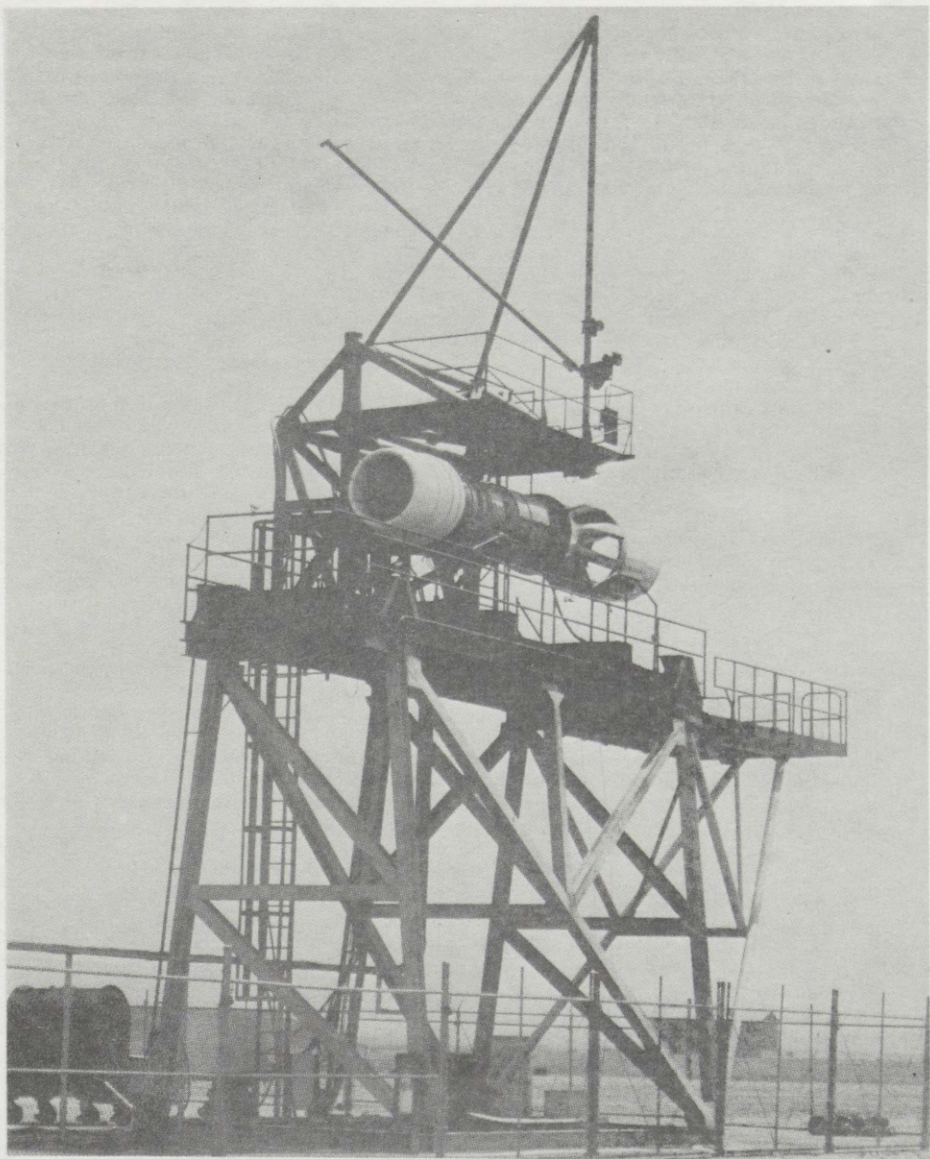


Figure 1. Suppressed JT8D Engine Installed at Rohr Acoustic Facility. In Addition to RTN-1 Nozzle Suppression Turbomachinery Noise is Reduced by Means of Absorptive Materials.

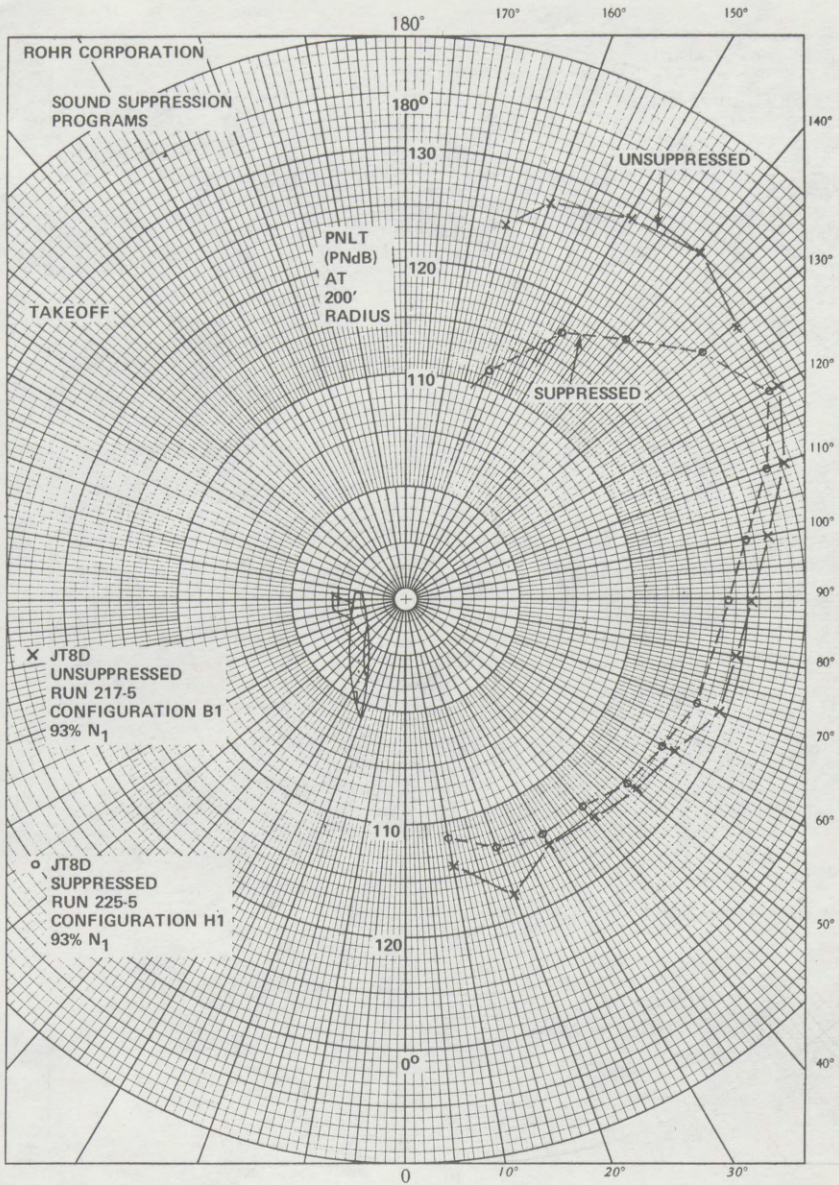


Figure 2. Take-off Noise Levels as Perceived at a 200 Foot Arc for a Suppressed and Unsuppressed JT8D.

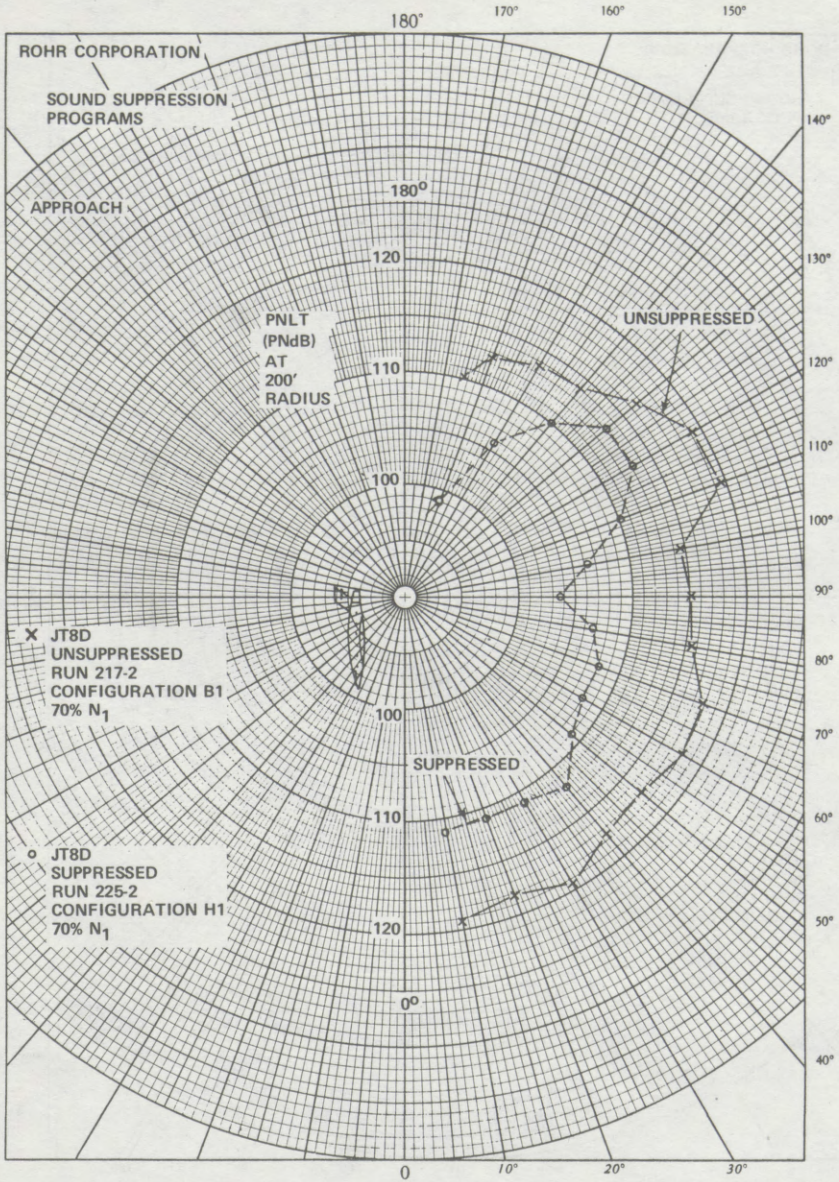
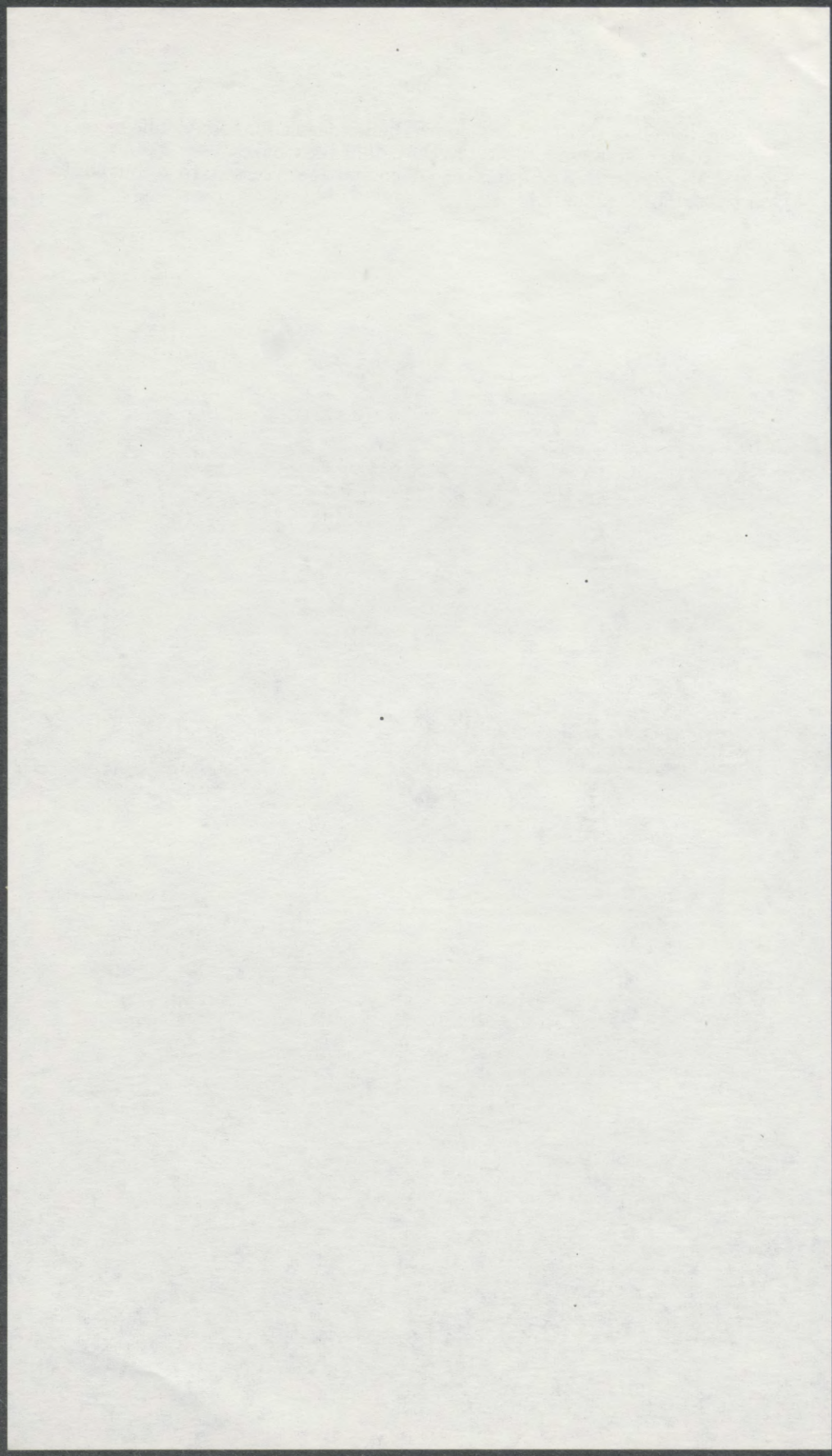


Figure 3. Approach Noise Levels as Perceived at a 200 Foot Arc for a Suppressed and Unsuppressed JT8D.

Senator CANNON. That concludes the witnesses for today. The hearing will stand recessed, subject to the call of the Chair.

(Whereupon, at 3:30 p.m. the subcommittee recessed, to reconvene at the call of the Chair.)



ADDITIONAL ARTICLES, LETTERS, AND STATEMENTS

STATEMENT OF HON. BENJAMIN S. ROSENTHAL, U.S. REPRESENTATIVE
FROM NEW YORK

Mr. Chairman, I am pleased to have this opportunity to present my views to the subcommittee on this vital subject.

We are living today in an age of intense concern with the quality of life and the quality of the environment where we spend that life. The air we breathe, the water we drink, the food we eat—all are objects of increasing concern. Another element in the quality of life is the topic of these hearings, noise.

Acoustics experts have said that everyone living in a city could be stone deaf by the year 2000 if noise levels keep rising at the present rate. Noise pollution has become a serious health hazard, according to evidence presented at last week's meeting of the International Standardization Organization in Geneva, Switzerland. Urban noise has been rising at the rate of one decibel a year, it was shown, and if it continues every urban dweller will be deaf by the end of this century, less than 30 years from now.

We are inundated with all kinds of noises, from all sources and all directions.

Noise, like so many other forms of pollution, is a product of our technological advancement. But this need not be. For far too long we have blindly accepted belching smokestacks, sewage-filled rivers and screeching machinery as signs of progress. We are just beginning to realize they need not be inseparable.

Pollution does not have to be the price of progress.

We have the know-how to clean the air, protect the water and quiet the noise. Too often, however, what has been lacking was the will to put that knowledge to work.

Noise is more than uncomfortable. It is debilitating. It can and does interfere with our sleep, our work and our leisure.

Studies have indicated that loss of efficiency due to noisy working conditions could be reducing our Gross National Product by several billion dollars a year. Billions more in potential workman's compensation claims are believed generated annually by noise-induced hearing losses in perhaps as many as 15 million American workers.

The World Health Organization says industrial noise alone costs the United States more than \$54 billion a year in accidents, absenteeism, inefficiency and compensation claims.

There is evidence of a close relationship between noise exposure and body fatigue as well as psychological and social stresses.

Noise is one of the major problems in my Congressional District. My district is in what may be the world's noisiest city, New York City. It was there that the fire department had to install louder sirens in order to penetrate the noise on the streets.

My constituents are neighbors of LaGuardia airport, one of the nation's busiest. They suffer the consequences of decades of neglect of the noise pollution problem. Most of them have lived in New York City for many years. They live in established communities and not in hurriedly-assembled subdivision tracts. They were there before the jet arrived.

They used to live in comfortable, convenient neighborhoods which, while noisier perhaps than rural areas, nonetheless struck a reasonable balance between city hustle and bustle and suburban quietness. But today, that balance is gone. Now these people come home from their city jobs and find themselves beneath an intolerable roar as jetliner after jetliner screeches over their roofs.

These city-dwellers have lost that balance of toleration which once existed in their neighborhoods. They find that their homes offer not less, but more, noise, more distraction and more simple human discomfort than their offices in the heart of the city.

For too many years, I believe, we have passed the noise problem from one pair of reluctant hands to another.

We cannot afford to delay any longer. Some significant first steps have been taken by the Congress, although Administration response in carrying out this mandate has been somewhat lacking. We in the Congress must continue to prod the Administration and to increase our involvement in improving the quality of our environment and fighting noise pollution.

Unless we act now, we will soon reach a critical stage.

Mr. Chairman, enactment of the legislation currently before this subcommittee, while not representing the ultimate solution to noise pollution, would be another important step toward improving the quality of life for the American people, but I regret it does not go far enough.

I am most disappointed with the aircraft noise provisions of S. 1016 the Administration proposal.

Not only does this legislation give inadequate attention to one of the major causes of noise pollution, but it places responsibility in the wrong hands.

This bill gives to the administrator of the Federal Aviation Administration the authority to prescribe noise standards, rules and regulations applying to aviation. If the administrator of the Environmental Protection Agency feels those measures do not adequately protect the public, he has no power to change them; he may only *request* the FAA administrator to review them.

This is exactly the opposite of the way it should be. The FAA has acted with deplorable slowness in implementing the mandate of the Aircraft Noise Certification Act of 1968 (P.L. 90-411) and has consistently shown itself to be a poor leader in noise abatement.

The FAA is not the one to set noise standards; after all, its prime responsibility, under law, is to promote aviation, not protect the environment—that is the job of the Environmental Protection Agency.

EPA is, therefore, the proper agency to establish standards, rules and regulations for noise, whether the source of that noise is aircraft, motor vehicles, industrial machinery or whatever. Noise pollution is first and foremost an environmental problem.

It is with that in mind that I support the following amendment to H.R. 5275 (and H.R. 5388): (I have offered this amendment to H.R. 5275, the House version of this bill.)

On page 4, after line 13 add:

(h) "Noise Exposure" (also written "NE") is proportional to the weighted total aircraft noise energy reaching a given point on the ground near an airport produced by all of the aircraft operations from that airport in a twenty-four hour period. The NE for group (a) of identical flights, some in the daytime and some during the night, is: $NE_a = EPNL_a + 10 \log N_a + 10 \log 16.67N_a - 88$

where:

$EPNL_a$ is the Effective Perceived Noise Level produced by the aircraft at the point on the ground where the NE is being determined. A complete definition of EPNL and the manner in which it is derived is given in Part 36 appendices A and B, of the Federal Aviation Regulations. N_a is a number of day flights, i.e., during the hours 0700 to 2200, N_n is a number of night flights, i.e., during the hours 2200 to 0700, 16.67 is a constant which weights the flights per hour at night 10 dB higher than the day flights. (For the 9 hours of night vs 15 hours of day the total night flights are multiplied by $10 \times 15/9$ or 16.67) and 88 is an arbitrary constant used to differentiate between NE and EPNL.

The general equation for NE is:

$$NE = 10 \log \sum_i \sum_j \log^{-1} \frac{NE_{ij}}{10}$$

where:

i—indicates the class of aircraft and

j—indicates the flight path and operating procedure

On page 9, strike lines 3 through 13 and insert in lieu thereof:

"(c) The Administrator of the Environmental Protection Agency shall, after consultation with appropriate Federal departments and agencies, establish boundaries around airports beyond which the 30 and 40 aircraft Noise Exposure (NE) forecast contour shall not be permitted."

The impact of aircraft noise on people living and working near airports can be specified in terms of noise exposure (NE) units where the NE of any point in the area near an airport is proportional to the total noise energy reaching that

point from all aircraft operations in the vicinity of the airport in a 24-hour period.

The net effect of my amendment, to put it simply, will be to set noise quotas around airports and leave it to the airlines, airport operators and other responsible authorities to decide just how they will use their quotas. Under this formula, for example, a flight at midnight would use up as much of the noise quota as ten flights at noon by the identical aircraft because the sleeping period is a more noise-sensitive time of day.

* * *

STATEMENT OF CHARLES H. WILSON, U.S. REPRESENTATIVE FROM
CALIFORNIA

I would like to begin by thanking the Subcommittee and Senator Cannon for holding these hearings on the Aircraft Noise Reduction Bill and for allowing me to present this statement.

It's noxious manifestations are not as apparent as a smog-blanketed skyline or a filth-ridden river, which may explain why noise pollution has lingered so low on the list of urban priorities. Yet, most environment health specialists agree that the daily decibel diet already constitutes a physical as well as a psychic hazard. The International Agency in Geneva is quoted as saying that if noise levels continue to increase at their present acceleration rates we will all be deaf by the year 2000. A Tennessee Doctor recently said in a newsletter that "60% of the children in the United States have a definite hearing loss." It appears that technological man is so aware of his strength but not of his weakness—the fact that his pressure on nature has conceivably provoked revenge.

Pollution of any type know no political boundaries. By adding just one alien component to a delicate balance in nature, man sometimes triggers a series of dangerous changes. This is especially true of noise pollution, more specifically of the type of noise pollution we speak of today, that produced by aircraft. The increasing amount of jet traffic effects up to 10 million people now living in jet flight paths around the nation.

The most significant costs of aircraft noise are felt by those people who reside near airports. The residents living in these areas lose sleep and the use of their outdoor recreational facilities. Noise invades and severally effects the use of their schools, hospitals and factories. Companies lose money when it is necessary to soundproof office buildings near airports. To illustrate the magnitude of the problem it should suffice to say that 285,000 people in New York, 183,000 in Boston, 340,000 in Chicago and 400,000 in Los Angeles are living in "unacceptable" noise conditions according to standards set by the Federal Aviation Association. These statistics only incorporate the number of people effected by four of the eight busiest airports in the country. No to mention the millions of people effected by the over 200 jet airports across the nation.

There are three ways of treating the aircraft noise problem :

- (1) Move the noise away from the people.
- (2) Move the people away from the noise.
- (3) Reduce the noise at the source—the airplane.

Moving the noise away from the people has been used with only a small degree of success. The process involves the buying of land around the airport area, use of preferential runways to use open or uncongested areas, establishment of flight patterns to minimize flight over residential areas, and steeper climb and descent paths.

Moving the people away from the noise is not only economically infeasible but totally inequitable. We can not recommend that thousands of people leave their homes and communities to solve a problem not of their own making. Yet, in Los Angeles, at this moment, airport officials are doing just this. Over 6,000 residents have been forced from their homes at a cost of \$300 million to the airports or \$50,000 per home. I submit for the appendix an article from *Newsweek*, August 2, 1971, page 55. While a few of the houses are being resold and moved to different sites, most are being turned over to bulldozers. The costs already incurred to Los Angeles would pay for retrofitting approximately 600 planes or nearly $\frac{1}{3}$ of the entire domestic commercial jet fleet. Yet, the L.A. airport plans to demolish 65,000 more homes at a cost of \$1.6 billion. Thus—one city plans to spend almost 50% more than the total cost necessary to control the entire jet fleet nationwide. That this should occur is intolerable.

The third solution, reducing the noise at its source is not only economically and technologically feasible, but is also the most far-reaching plan. The way to implement this plan would be a quiet engine retrofit program.

We know enough today to make responsible progress in this field, but, the fact remains, that virtually no work has been done on the project. We can conclude without reservation that the FAA's attempt to abate and regulate the noise of today's jet fleet has reached a hopeless stalemate. It is conceded that the airlines are beginning to recognize the noise problem as the new 747's and other wide body aircraft have been installed with quieter engines. Yet, that is only 200 planes of a fleet of 1900. It is conservatively estimated that the other 1700 planes will not be completely phased out for eight to ten years. New and strong legislation is needed to break this intolerable impasse. S. 1566 would solve this problem.

The bill has five salient features which together demonstrate that extensive study and foresight were involved in its drafting. A succinct discussion of each point will show without question that S. 1566 will solve the problem of aircraft noise and the necessity of the bill being passed immediately!

(1) The noise levels of current aircraft must be reduced by 10 EPNdB (equaling a cut of $\frac{1}{2}$ of the present noise levels) or meet FAR part 36 noise levels of 108 EPNdB, whichever noise reduction is greater.

Studies of NASA Douglas/Boeing and the FAA Rohr report indicate that a complete fleet retrofit can be accomplished within five years. Rohr alone has spent several million dollars and four years of research to come to the conclusion that it is entirely practical to reduce sound pressure levels on almost all flights by a factor of 50%. I submit for the appendix an excellent study completed by the city of Inglewood with particular reference to the findings of the Rohr study.

If action were started *now* current aircraft types could be completely equipped with retrofit treatment by Spring of 1977. The speed with which acoustically treated nacelles are being produced for 747's and other wide bodied jets produced now demonstrates that the 1977 deadline proposed in section (d) is not unreasonable, but, the proposal must receive expeditious Congressional action and be properly financed.

(2) The U.S. Government would provide \$35 million for research and development of retrofitting techniques so aircraft noise can be brought down to the levels set in this bill.

Several industry leaders and Research Institutes have advised that with that amount of money, retrofitting can be perfected within two years. The provision of special funds for an accelerated research and development are a requirement for maximum results in the shortest amount of time.

The airlines have suggested a lack of sufficient technical data as a partial defense against retrofitting the 707 and DC 8 aircraft and as complete defense against retrofitting the three engine jet fleet powered by the JT8D engine. The type of data required by the airlines can only be gotten through research and actually retrofitting and test flying prototypes of these aircrafts at today's airports.

NASA has already completed the first step for the airlines by demonstrating the technological feasibility of retrofitting the four engine aircraft such as the DC 8 and the Boeing 707 powered by the JT3D engine. The FAA has unsuccessfully requested a sum of \$3.5 million for 1971 research on retrofitting programs designed to continue the NASA originated project or retrofitting the aircraft powered by the JT8D and the JT3D engines. This sum is totally inadequate. S. 1566's proposed sum of \$35 million for research on representative aircraft models is a more realistic estimate of the costs of such a program. Especially when you consider that the NASA study required \$17 million for retrofitting the DC 8 and Boeing 707.

Companies receiving grants for research and development would be required to repay them if they succeed in marketing a retrofitting process to the airline companies. The firms would pay a percentage of their profits back to the government until the grant is paid back. This would eventually take much of the financial burden off the U.S. government—a factor seldom considered for most U.S. grants.

(3) The U.S. government would be authorized to guarantee, up to \$1 billion, the repayment of loans to carriers for the purpose of modifying their aircraft prior to January 1, 1976.

Retrofitting is very expensive and the benefits of the program will be shared by large numbers of people around the country. For this reason the airlines should not be required to carry the full financial burden of retrofitting.

(4) The Civil Aeronautics Board would be required under the bill to grant the airlines rate increases to make up for the cost of retrofitting, plus earlier retirement of some planes.

In the final analysis it is the passengers and shippers who benefit from air transportation. The airlines will and should pass all costs along to them. The logical alternative is to pay for the retrofit program by a fare increase. The Rohr report indicated that the fare increase required to offset all retrofit costs is less than 1% in 1975 configuration. The report further concludes that a 1% fare increase would have no effect on passenger demand. This conclusion was recently reinforced by an American Airlines' vice president who believes even a 5% fare increase would not effect demand. This fare increase also takes into consideration that the airlines might decide to retire 707's and perhaps other planes earlier than planned rather than go through the expense of retrofitting them. A study done for the FAA indicates that a 1.5 percent fare increase would cover both the costs of retrofitting and early retirement of these planes. If this fare increase were implemented immediately, some revenue would already exist when the first requirement for loan funds came in.

(5) The FAA Administrator would be authorized to make grants to State and local agencies to assist in paying the cost of "administering airport noise monitoring programs." Up to \$50 million is authorized to carry out this provision.

Sound monitoring equipment is necessary to assure that the regulations of the bill are being followed. The provision puts realism into the bill by allowing State and Local governments to enforce the act.

A study of the bill has shown that the bill is economically and technically feasible. Those who oppose the standards argue the following points: (1) The cost of a technologically practical retrofit (estimated by the Rohr Corporation at about \$856 million for the current jet fleet) is too high in comparison to the benefits to be achieved by retrofit; and therefore, (2) The retrofitting program is not economically feasible for the current jet fleet. The problem with this reasoning is that it fails to take into consideration *all* the costs. On a full cost analysis, retrofitting is economically possible and reasonable. The following factors must also be taken into consideration when computing the full economics of aircraft noise abatement.

(1) The human cost: The human cost of noise annoyance is so subjective that it cannot be accurately estimated on an economic scale. Yet, the human cost is potentially very large, and can *not* be ignored.

(2) The cost of land acquisition: This would involve billions of dollars and the relocation of millions of people from the noise sensitive areas. Compatible land use planning is, at this point, unrealistic as communities already border on jet-ports. The current airport land owner has little or no control over the land zoning of nonairport land. However, land-use planning can be a valuable tool for the planning of future airports.

(3) The cost of limitations on operations: Though the public has little legal recourse in the past, the possibility of public support toward operational curfew is a very probable danger to U.S. airports. Community reaction has brought about some limitations on night operations at some airports. This is especially damaging to the cargo carriers which do most of their flying at night.

(4) The cost of litigation: On the basis of a recent survey of noise litigation now pending, the estimated amount claimed against operators of local public airports in noise suits is in excess of \$3.8 billion.

(5) The cost of ground transportation: Aircraft noise has required the airports to move at least 10 miles outside of the population served. This is estimated to be an additional cost to travelers and employees of \$30 million annually for each major airport.

(6) The cost of soundproofing: This cost alone can be extremely expensive and comprehensive. It includes residential soundproofing, Commercial soundproofing, Hospital soundproofing and school soundproofing. All of this would add up to approximately \$165 million per year.

(7) The decline in property values: Any resident or real estate man will tell you that property values are reduced by aircraft noise and, in some cases, by a substantial amount. It is harder for a family to sell their home which can become quite a hardship if it is necessary that they pay for an apartment while waiting

to sell it. This has been the case of many aerospace workers and others that have had to be relocated for one reason or another.

One of the major benefits of retrofitting cannot be overlooked—that of reducing unemployment. This is a critical problem facing the nation today. Unemployment among aerospace workers is especially apparent as a result of reduced military spending by the government. A retrofit program would provide an opportunity for these people to make a transition from military problems to civilian problems.

Approximately 35,000 jobs would be created to build and install retrofitting devices. Creation of so many more jobs often sets off a type of chain reaction. People making more money demand more goods and services and employers find that they need to hire more people to fulfill this demand. Furthermore the need for increased government spending for unemployment and welfare compensation is reduced.

Congress by legislation must regulate jet aircraft noise. It has been proven to be both economically and technically feasible. Without legislation we can be sure that no action will be taken by the airlines themselves to abate the noise problem. We must impose economic sanctions to pressure technical advancement in sound suppression. A parallel case can be found in the area of automobile manufacturing. Without legislation there would be no requirements for the manufacturers to install headrests and seatbelts for safety, or smog controlling devices to help reduce the pollution created by the auto engine.

A firm schedule for retrofitting must be established immediately. The constant procrastination which has occurred in the past hurts everyone and makes planning for the future almost impossible.

Present noise levels will continue to 1985 and may even increase with the demand for greater leisure travel. The Rohr report recommends that engineering must start in early 1970 to complete installation by the end of 1974. We have already lost a year from that schedule. Implementation was required by Public Law 90-411 and should take place without further delay. The Rohr corporation produces 90% of all American manufactured jet transport nacelles and over 94% of all the thrust reversers. They have spent millions of dollars on research. We cannot question their authority in this field and they recommend that we get ourselves in motion. They have proven without a doubt that retrofitting is within the state of the art. All that is necessary is the impetus to get it started.

[From Newsweek, Aug. 2, 1971]

THE HIGH COST OF NOISE

Four years ago, Dr. and Mrs. Thomas Bringard bought a tiny, rundown house on a half-acre of land in the Playa del Rey section of Los Angeles with an eye-goggling view of the Pacific Ocean. The couple immediately started to remodel their domicile, adding six bedrooms, three baths, a hand-finished wood exterior and a two-car garage. Then last spring, a bare two hours after Dr. Bringard had pounded in the final nail, a stranger arrived at the front door. He identified himself as an appraiser from the Los Angeles Department of Airports and said that either the family would have to sell out or their house would be condemned.

To the Bringards and to thousands of their neighbors, the stranger at the door represented the latest technique invoked by Los Angeles International Airport authorities to dispose of the ever-worsening controversy over the ear-splitting noise created by low-flying jet aircraft. The airport's technique is simplicity itself: instead of trying to remove the noise from the people, airport officials are removing the people from the noise.

Desert: In 1967 an airport commission began sending out appraisers to dicker for 2,373 houses in three surrounding communities. Prices may seem generous—ranging from \$28,000 to \$115,000—but dislocation problems for the 6,000 affected residents are severe, and the \$300 million the project stands to cost the airport is truly staggering. While a few of the houses are being resold and moved to different sites, most are being turned over to bulldozers that can dispatch an average frame structure in about twenty minutes. Then, by late in 1972, the airport will have created a barren desert so its planes can operate in peace. "Sometimes I go home sick," admitted Jack E. Long, an airport official involved in the acquisition. "It's such a waste. If this were my sole job at the airport I couldn't stomach it."

As most see it, the problem arose in the first place from monstrosly bad planning—or perhaps more accurately, from no planning at all. As early as 1942, it was known the airport might eventually grow to its present size. But apparently no one bothered to tell the home buyers who were being hustled into the surrounding area by real-estate developers. Finally, when the last runway was opened in 1968, the city planning commission got around to drawing up a master plan for the area—and by then, of course, it was too late.

The final blow may be yet to fall. Sometime during the next few months, the Federal Aeronautics Administration seems likely to promulgate national noise standards for airports. This could force the L.A. airport to try to push people still farther from its runways. One tentative estimate already in hand calls for demolishing 65,000 more homes, at a cost of \$1.6 billion.

STATEMENT OF HON. JOSEPH P. ADDABBO, U.S. REPRESENTATIVE FROM NEW YORK

Mr. Chairman, I appreciate this opportunity to present my views in support of S. 1566 sponsored by Senator Cranston. This legislation would require a substantial reduction of aircraft noise from all aircraft operating within the United States, by January 1, 1976, and would authorize federal research projects and federally guaranteed loans to air carriers to carry out the requirements of this law.

As the Representative of the 7th Congressional District, New York, which includes Kennedy International Airport, I have a very real interest in the noise abatement programs administered by the Federal Aviation Administration. I was a cosponsor of the 1968 Aircraft Noise Abatement Act which first authorized the establishment of federal noise limits on aircraft. Since that time I have been disappointed by the slow progress in enforcing that law and the delays in the rule making process, particularly with respect to a retrofit program for existing aircraft.

It is quite apparent that the FAA does not want to pressure airlines and as a result the millions of Americans who live near our nation's airports have not experienced any noticeable relief from the aircraft noise problem. The intent of Congress in passing the 1968 Act has certainly not been carried out and it is my hope that the 92nd Congress will pass stronger legislation requiring the airlines to meet specific goals in jet noise abatement. Only in this way can the delays of agency rulemaking be bypassed and the objectives of the 1968 Act met without further delay.

The legislation before this Subcommittee is a responsible and meaningful approach to this problem. On the one hand the bill requires the airlines to meet a stated objective—the reduction of noise levels by 10 EPNdB by January 1, 1976 over their 1971 levels. On the other hand the legislation offers federal assistance in the form of research and guaranteed loans where air carriers are unable to obtain necessary funds elsewhere.

I commend Senator Cranston for his leadership in sponsoring this legislation and I am pleased to endorse S. 1566 as the kind of bill we need if the jet noise problem is to be solved in the foreseeable future. S. 1566 establishes a true private-public partnership to solve the noise crisis. It offers a vehicle for the federal government to work side by side with the aircraft industry to find the most economical and practical way to reduce aircraft noise.

The future of the aircraft industry is in jeopardy because of the failure of that industry to make sufficient progress in the battle against community noise and the pollution of the airways. Now is the time to turn back that threat and establish that the airlines can meet their public responsibility. This will happen only if and when the Congress requires it and offers the assistance of federal financial resources.

STATEMENT OF THE MOYAONE ASSOCIATION, INC., ACCOKEEK, MD.

The Moyaone Association, which represents over one hundred homeowners living in Accokeek, Maryland, is gravely concerned about aircraft noise. Although our community is eleven miles south of Washington National Airport, we are continually subjected to loud noise from jet aircraft. We appreciate the opportunity to express our views on S. 1566, a Bill to control aircraft noise, and S. 1016, the Noise Control Act of 1971.

S. 1566 is, in our opinion, a sound initial move in the control of aircraft noise and the Moyaone Association recommends its passage. We also approve of the

basic principles of S. 1016 but would suggest three modifications: that the responsibilities of the Environmental Protection Agency (EPA) be broadened to include the development, as well as the approval, of standards for aircraft and aircraft operations; that these noise standards be made applicable to existing machinery; and that the States be given the authority to prescribe standards that exceed those of the EPA.

Jet noise is a matter of concern for communities other than just those in the immediate vicinity of an airport, as evidenced by the completely unnecessary jet noise level in our area, eleven miles from the runway. Jets approaching Washington National Airport fly over our homes at altitudes of 1500-2500 feet. They then fly at approximately this same altitude for another seven miles, and only then begin to rapidly descend into the airport. The major portion of the air traffic intercepts a Potomac River path at only one junction point—namely, our residence area at Accokeek. As a result, the scream and roar of jets occurs with a frequency of as great as one every minute and a half.

The Moyaone Association has written to and met with officials of the Federal Aviation Administration (FAA). At a meeting with the FAA on April 1, 1971, C. R. Melugin, the manager of National Capital Airports, told us that "what you have going for you" are the following: there are no four engine jets flying into National Airport (only two and three engine jets); there are *only* 60 operations per hour (could there be more?); and there is an 11 p.m. to 7 a.m. "voluntary" curfew (frequently violated). His statement reflects the callous and unresponsive attitude of the FAA to the problems of those on the ground.

We have made several specific recommendations to the FAA for changes that could greatly reduce noise in our area or any other similarly affected area. The first of these was to increase the minimum altitude approaching aircraft are required to maintain over this area. They could easily be required to maintain 5000 feet over Accokeek, which is eleven miles and about 4½ minutes from the runway. The highly publicized "Keep 'Em High" program of the FAA that was recently put into operation has done *nothing* to increase the altitude of the aircraft over our homes. A second recommendation that we offered was to vary the flight patterns such that no one area is subjected to such heavy concentrations of low-flying jets. The approach to National Airport from the south is over the Potomac River, but the entry point onto that course should be varied. The FAA had no clear answer to this second recommendation. Their response to our request for higher altitudes was that planes must fly low in order to intercept the glide slope from below. We do not believe this and, in fact, we have occasionally observed aircraft flying over at altitudes of 4000-5000 feet as they approach the airport. We have also observed that jets can and do enter the river path as close as three miles from the runway. From these observations, it would seem obvious that our recommendations could easily be put into effect; however, no action has been taken by the FAA. In our opinion, the real reason that the planes drop down to such low altitudes while still a great distance from the airport is that this procedure requires less airport controller time with each aircraft and therefore more planes can be packed into National Airport.

It is our judgment that an altitude of 1500 feet is dangerous as there remains little margin for pilot or instrument error. We do not like to remember those scenes of houses demolished in a recent airline crash at East Haven, Connecticut, where the pilot was obviously flying lower than he thought he was. The high density of aircraft traffic to National Airport is equally dangerous. We have too often seen jets cross the same point only 20 seconds apart. Will it require a mid-air collision between jetliners over our homes to convince the FAA?

As you can see, our experience with the FAA convinces us that the FAA has no interest in the comfort or safety of those on the ground and that it represents only the special economic interests of the airlines. The FAA's introduction of jets into National Airport after stating that they would not, and the subsequent lifting of the ban on "stretch jets" can only be described as treacherous. As a result, it is our opinion that the FAA cannot be expected to properly administer, much less formulate, a policy for environmental protection and the comfort and safety of those on the ground. Therefore we feel that it is necessary that congressional action be taken.

RECOMMENDATIONS

S. 1566, a Bill to provide for more effective control of aircraft noise.

The proposed noise reduction of 10 EPNdB, which is approximately a factor of two decrease in sound pressure, will not in itself greatly reduce noise pollution; however, it is a step in the right direction. It requires *specific* results by a *specific* date for all transport aircraft, and includes *presently operating* aircraft as well as those to be built in the future. These are features generally lacking in FAA regulations.

The provision for financial grants to communities to monitor aircraft noise should aid enforcement.

We recommend this Bill as a forward step.

S. 1016, the Noise Control Act of 1971.

This Bill for the control of noise is, in principle, sound, but has three shortcomings with respect to aircraft noise.

First, as presently written in this Bill, the Environmental Protection Agency (EPA) will prescribe standards for all classes of machinery except one, namely aircraft. However, it should be just as easy to prescribe noise standards for aircraft as for trucks or any other machinery. As presently proposed, the EPA would approve noise standards and rules prescribed by the FAA. While this would certainly be an improvement over the present situation, we feel that the EPA should be given broader authority. The FAA can provide expertise in aviation technology, but it is clearly the EPA that will be better suited to make environmental decisions with an overall view of the best interests of all segments of our society. Therefore we recommend that the Bill be rewritten such that the EPA, after technical consultation with the FAA, promulgate rules and standards for aircraft and aircraft operations.

Second, standards prescribed under this Bill would not apply to machinery manufactured before passage of the Bill. The difficulty with this is that some machinery can be quite long-lived; for example, an airplane can last for fifty years. Therefore, the Bill should be rewritten so that noise standards would apply to existing machinery after a period of time, say three years.

Third, a proposed provision of this Bill would prevent any State or subdivision from prescribing noise standards in any case for which the EPA has prescribed standards. This would be most unwise. While we have high hopes for the EPA, we have serious misgivings about placing all authority at the Federal level. A basic principle of this nation has been the division and dispersion of authority. In keeping with this, we believe that the Bill should be rewritten such that States are specifically given authority to prescribe standards and rules that exceed those of the EPA. Thus the Federal government would prescribe national minimum standards, but States could increase them, if necessary, to fit local needs. This would give the citizen a much better chance to participate in the environmental decision-making process.

PITTSBURGH HEARING AND SPEECH SOCIETY, INC.,
Pittsburgh, Pa., July 6, 1971.

Senator WARREN G. MAGNUSON,
Chairman, Senate Committee on Commerce,
Senate Office Building, Washington, D.C.

DEAR SENATOR MAGNUSON: Belatedly, we learned that Senate Bill 1566 (requiring engines on existing jet aircraft to be made quieter) was discussed at public hearings by the sub-committee on Aviation during the week of June 21.

As a community organization long dedicated to hearing conservation, we respectfully request a favorable report of this noise abatement legislation from committee.

Sincerely yours,

MRS. C. G. PATRICIA B. PELKOFER,
Chairman, Public Information Committee.

Enclosures.

PITTSBURGH HEARING AND SPEECH SOCIETY

(Director, *David H. Tornblom*)

COUNSELING CENTER FOR THE DEAF

(Project Director, *Edgar H. Schroyer*)

History—First organized in 1920 as Pittsburgh League for the Hard of Hearing "to provide companionship and show the value of lipreading". Incorporated in 1926; became the Pittsburgh Hearing Society in 1945, the Pittsburgh Hearing and Speech Society in 1966 as its program expanded and the Counseling Center for the Deaf was initiated.

Scope—To identify community needs in communication disorders and to establish programs to meet those needs.

Services—Diagnostic and rehabilitative in the field of audiology, speech and language pathology; Counseling Center services for the deaf. Psychological and psychiatric services, home bound and Montessori pre-school classes for hearing impaired children, parent counseling, social, personal adjustment and other related programs. A growing field is an industrial program for hearing conservation.

Members—There are 360 members. Fees are paid annually. Membership is not required for services, but membership offers the advantage of a service discount.

Clients—In 1970, 1,600 persons, from six-month old infants to the elderly, were served, exclusive of out-patient service.

Organization—A Board of Directors and officers are elected annually by the members.

Support—In addition to membership support, part of the agency's funds come from service fees, some from state and federal projects, and about 36% from the Community Chest.

Facilities—Two IAC double-walled audiological suites for comprehensive hearing testing, pre-school classrooms, therapy rooms, a counseling center and social rooms.

Staff—28 professional and office personnel; 80% of the professional staff members have Master's degrees.

DEFINITION OF TERMS

Noise—Unwanted sound.

Sound—Two main characteristics, frequency and intensity. Frequency is detected as pitch, how low or how high a sound is. Frequencies from 250 to 3,000 cycles per second are the most important for understanding speech.

Decibel—(db) measures the intensity or loudness of sound. A decibel is the faintest sound that can be detected by a keen human ear under very quiet conditions. Loudness, the actual sound pressure on the ear, increases 10 times with each 10-db increase.

Remember—Defective hearing is America's number one physical impairment!

[From Aural Windows, March-April, 1971]

QUIET, PLEASE

Did you know that the roar of noise in our streets and homes is doubling every ten years?

The United States probably produces more noise—and does less to reduce it—than any other civilized nation in the world. Why? Well first of all, we have at least 69 million automobiles, 13 million trucks and 300,000 buses. Think of the din caused by the horns, the defective mufflers, the noisy engines, the squealing tires and screaming brakes!

And second, there is the more than \$72 billion construction industry which employs some three million people to operate its air compressors, pneumatic tools, cranes, hoisting engines and cement mixers. All unmuffled, because it's cheaper that way.

Day after day our environment is invaded not only by the roar of these traffic and construction noises but also by insidious new noises that are all around us. At home, we face the whine of the vacuum cleaner, the grating dissonance of power saws and mowers, the discordant jangle of garbage disposals, exhaust fans, air conditioners, food blenders and other household conveniences.

Noise isn't just a nuisance. It is a menace. Scientists have determined that sustained exposure to sounds over 85 decibels can cause permanent hearing loss.

Temporary deafness can be caused by short exposure to levels between 100 and 125 decibels. Many doctors are also beginning to think there may be a connection between excessive noise and other illnesses—such as ulcers, neuroses, high blood pressure and skin diseases.

Sound in the 80-120 decibel range are getting to be common—from rush hour traffic on a city street corner at 95 decibels, a food blender at 93 and a jack hammer at 130. When several noise sources are operating all at once, the combined assault on people's ears may be permanently damaging.

Young people are particularly vulnerable today due to the popularity of electronically amplified rock music. Sound levels in some dance halls and night clubs soar to 125 decibels. Hearing tests have shown that young members of some combos have already suffered permanent hearing impairment.

Perhaps because noise is so much a part of the environment in industrial Pittsburgh, we are less aware of the rising racket that surrounds us. But urban development consultants, industrial health specialists, leading physicians and staff members of Pittsburgh Hearing & Speech Society are deeply concerned at the insidious effects of our constant exposure to noise.

Potentially, the health hazard of noise is as serious as that posed by polluted air and water. But noise lacks a sense of urgency. It lacks the drama of the air pollution deaths in Donora. As a result, priority is given to water pollution, air pollution and hundreds of other problems shouting louder than noise for attention and support.

Part of the problem is that we have been more concerned with the making of things than with the quality of our environment. Mill workers have accepted stoically the growing deafness that seemed part of their "pay." Noisy garbage trucks, loud television sets and hi-fi's, barking dogs and screaming sirens—all are accepted as part of the price we pay for urban living.

In the past several years, however, John Q. Public—in Pittsburgh and elsewhere in the nation—has become fed up with noise problem. Sonic booms, along with jack hammers, became just too much to endure.

For some years, hearing loss resulting from exposure to excessive industrial noise has been recognized and efforts made to remedy the situation. An industrial worker is naturally exposed to the deafening noise of his job for longer periods than the person who encounters occasional din at the office or at home. And, too, the cost to industry through disability compensation for hearing loss has prompted action.

New strength and direction has been given to industrial hearing safety regulations and personnel protection by recent Federal legislation.

In this industrial field, locally, the services of the Pittsburgh Hearing & Speech Society are already available for consultation, training, plant studies and employee testing.

The most important element in any solution of noise pollution, however, must be citizen awareness.

Memphis, Tenn., for example, is known as the quietest city in the U.S. because it has a reputation for enforcing its motor vehicle noise laws. It is also one of the few cities in North America with decibel standards.

New York City has an active "Citizens for a Quieter City." England has a "Noise Abatement Society," as do many other European nations. In Switzerland, the Federal Anti-Noise Commission has established maximum day and night time decibel levels for various types or areas.

Similarly, in building construction there is apparently not a single code or ordinance in the U.S. which requires any protection against noise—either from the outside or from neighbors through the walls and floors. Yet Canada and several European countries have such control. These people have as their first principle: fight with knowledge and strength, not meaningless complaint.

WHAT NEXT?

Nothing ever happens until somebody gets excited! The most important task is to make the public aware that noise is not just an unpleasant annoyance, to be endured as part of the price of progress . . . that noise can be controlled. There are quieter jack hammers and compressors, even garbage trucks 60 per cent quieter than the models currently in use . . . there are soundproofing products . . . in fact, there is no noise which scientific ingenuity can generate that scientific ingenuity cannot suppress!

Then—if people get angry enough about noise pollution and become actively involved in doing something about controlling it, we may someday have a pleasant and healthful environment.

Otherwise, the next sound you hear may be just too much.

THE NOISE WE LIVE WITH

Useful Definitions

Sound—Small local fluctuations in atmospheric pressure.

Sound has two main characteristics, frequency and intensity.

Frequency is the number of waves passing a given point at a given time. It is detected by human beings as pitch—how high or how low a sound is. The unit of frequency is Hertz (Hz).

The human ear is most sensitive to frequencies from 500–6000 Hz., less sensitive to high and low frequencies, though hearing ranges from 16 to 16,000 Hz.

Intensity or loudness, the other main characteristic of sound, is measured in decibels (db). The lowest sound that can be detected by the human ear under very quiet conditions is called a decibel.

The decibel scale is logarithmic—Loudness, the actual sound pressure on the ear, increases ten times with each 10-decibel increase. Thus a level of 100 decibels is 10,000,000,000 times as intense as one decibel.

Some examples:

	Decibels
Jet plane takeoff-----	150
Threshold of pain-----	140
Pneumatic riveter or jack hammer-----	130
Rock music with amplifiers-----	120
Motorcycle revving up-----	110
Power lawn mower-----	96
Food blender-----	88
Vacuum cleaner-----	85
Garbage disposal-----	80
TV-audio-----	70
Conversation-----	60
Soft whisper at 15 feet-----	30

PENNSYLVANIA ENVIRONMENTAL ACTION, Pittsburgh, Pa., July 6, 1971.

HON. WARREN G. MAGNUSON,
Chairman, Senate Commerce Committee,
U.S. Senate, Washington, D.C.

DEAR SENATOR MAGNUSON: It has come to our attention that Senator Cranston has introduced a bill (S. 1566) which would reduce the often intolerable noise surrounding our aerodrome facilities.

We would like to register our vigorous support of this legislation. It is our feeling that noise pollution must rank with the pollution of the air, water, and land as one of the major sources of environmental degradation, as well as a detriment to the public health.

We believe that the temperate restrictions imposed upon air carriers by Senator Cranston's legislation are appropriate for imposing a due responsibility for the noise created thereby and thus moderating it in the interest of the public good.

We urge its passage.

Yours very truly,

BRADY W. MOORE, III,
Acting State Coordinator.

HARTFORD, CONN., July 17, 1971.

DEAR SIR: I would like to affirm my support of Alan Cranston's bill to restrict noise levels in jet aircraft.

Only a few years ago the automobile manufacturers were in the same position, and testified in the same manner, as the aircraft industry is doing today. Legislation, or the threat of legislation, served to motivate the automobile industry. Today they are knee deep in the manufacture of air pollution control equipment. Let's hope the same thing will occur in the aircraft industry.

Sincerely,

JAMES HODGES.

INDIANA UNIVERSITY OF PENNSYLVANIA,
INDIANA, PA., September 1, 1971.

Hon. WARREN G. MAGNUSON,
U.S. Senate,
Washington, D.C.

DEAR SENATOR: I am writing to express my support for the Aircraft Noise Reduction Bill (S. 1566) sponsored by the Senator Cranston. I would encourage you, as chairman of the Senate Commerce Committee, to do everything in your power to promote the passage of this bill.

I would also urge your support for the Cranston-Taft Population Stabilization-Senator Hugh Scott which proposes a ten year moratorium on the killing of whales.

I believe that the passage of these bills during this session of Congress is of vital importance if we are to improve our environment. I hope that you will support these bills as well as other beneficial environmental legislation.

Sincerely,

ROSE N. NUHFER.

AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC.,
Washington, D.C., October 8, 1971.

Hon. HOWARD W. CANNON,
Chairman, Subcommittee on Aviation, Committee on Commerce, U.S. Senate,
New Senate Office Building, Washington, D.C.

DEAR MR. CHAIRMAN: We followed with interest your Subcommittee's hearings on the aircraft noise portions of S. 1016, the bill to control mechanical noise, and have already urged that the Environmental Protection Agency's role in setting standards be changed from a controlling to an advisory one.

However, our members, the nation's leading manufacturers of aircraft and aircraft engines, are also concerned about Section 6 (c) (3), concerning type certification of aircraft. A literal interpretation of this section would withhold FAA issuance of type certificates for aircraft engines until FAA issuance of type certificates for aircraft engines until FAA standards, rules and regulations are prescribed for such engines. This would change the existing FAA procedure for certification to include noise measurements in the engine certification tests.

Inasmuch as airport community noise is caused by aircraft in flight and since aircraft noise depends not only upon the engine but also upon the aircraft nacelle structure, power requirements, and flight path selection, it is difficult to justify the addition of an engine noise certification to the existing noise certification requirements under FAR 36.

The present noise requirements are quite stringent and adequately safeguard the public's health and well-being. Regulations aimed specifically at engines will yield no additional benefits. It is hoped that the Aviation Subcommittee will consider deleting this burdensome and largely unworkable section.

Yours very truly,

KARL G. HARR, Jr.

AMERICAN ASSOCIATION OF UNIVERSITY WOMEN,
Santa Monica, Calif., November 7, 1971.

Senator WARREN MAGNUSON,
Chairman, Senate Commerce Committee, U.S. Senate,
Washington, D.C.

The Santa Monica Branch of the American Association of University Women supports S. 1566 (Cranston) which would require soundproofing on some 1700 jet airliners now in service. The FAA requires new types of aircraft meet these noise standards after 1/1/72, but not those currently in use. Santa Monica is under the takeoff pattern for International Airport. This will help people living under unacceptable noise conditions around our airport by requiring aircraft noise levels be reduced by at least 50% by 1976.

We urge you to use your position on the Commerce Committee to support this measure and to share my letter with your fellow members.

Sincerely yours,

BETSY GIFFORD,
Legislation Chairwoman.

ENVIRONMENTAL PROTECTION AGENCY,
Washington, D.C.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Commerce,
U.S. Senate, Washington, D.C.

DEAR MR. CHAIRMAN: This is in response to your request for the views of the Environmental Protection Agency on S. 1016 and Senate Amendment No. 216 thereto, which was introduced on June 21, 1971.

S. 1016 is the Administration's bill to control the generation and transmission of noise detrimental to the human environment.

Under a statement of Congressional findings, that bill would provide that inadequately controlled noise presents a growing danger to public health and welfare, particularly in urban areas; that the major sources of noise include transportation vehicles and equipment, machinery, appliances, and other manufactured articles that move in commerce; and that primary responsibility for control of noise in many respects rests with States and local governments but that Federal action is essential to deal with major noise problems which require national uniformity of treatment. It would be the policy of the Federal Government to promote an environment free from noises that jeopardizes public health and welfare.

In summary S. 1016 would authorize EPA, in consultation with other agencies, to:

1. Prescribe criteria for noise to protect the public health and welfare.
2. Identify and set standards for the following major sources of noise :
 - (a) construction equipment
 - (b) transportation equipment (including recreational vehicles and related equipment) and
 - (c) equipment powered by internal combustion engines.
3. Establish labeling requirements for designated products or classes of products.
4. Promote the coordination of Federal programs relating to noise research and noise control.

The Administrator of the Environmental Protection Agency, who would have the primary responsibility for implementing the legislation, would be required to promote the coordination of all Federal programs relating to noise research and control, and all other Federal agencies would be required to furnish him with any information he might reasonably request about their programs. On the basis of regular consultation with appropriate agencies, the Administrator would publish periodic reports on the status and progress of Federal noise abatement activities.

The Administrator would be given authority to develop and publish criteria, after consultation with appropriate Federal departments and agencies, for noise for the protection of public health and welfare and which would reflect the best scientific knowledge in identifying the effects of differing quantities and qualities of noise. He would be directed to confer with the Secretaries of Health, Education, and Welfare and Labor to assure consistency with criteria and standards for occupational noise exposure under the Occupational Safety and Health Act of 1970. After a compilation of initial criteria, the Administrator would compile and publish a report or series of reports to identify major sources of noise and to give information on techniques for the control of such noise which would include available data on technology, costs and alternative methods of control.

The Administrator would also be authorized to prescribe noise standards for construction equipment, transportation equipment, including recreation equipment, and equipment powered by internal combustion engines. In prescribing and amending standards, he would have to consider whether it would be economically reasonable, technologically practicable and appropriate for the particular products and whether the particular products could be more effectively controlled through Federal or State or local regulations. The standards so prescribed would be those requisite to protect the public health and welfare. Standards would apply only to those products manufactured subsequent to the effective date of such standards. Any manufacturer of a product covered by a proposed standard would have the right to a public hearing.

Section 611 of the Federal Aviation Act, which authorizes the regulation of noise or sonic boom characteristics of civil aircraft and components thereof,

would be amended to provide that standards, rules and regulations prescribed by the Federal Aviation Administration subsequent to enactment of this legislation must be approved by the Administrator of EPA. Further, after the effective date of the proposed legislation, the FAA could not issue a type certificate for any aircraft and components thereof unless he has already prescribed standards, rules and regulations for the noise characteristics.

After the Administrator of EPA prescribed noise-generation standards for any product, no State or subdivision thereof could adopt or enforce different standards for such products. However, States or subdivisions would retain the right to control, regulate, or restrict the use, operation or movement of such products.

Under the provisions of this Administration proposal, the Administrator of EPA would also have the authority to designate products or classes of products that (1) produce noise capable of adversely affecting public health and welfare or (2) are sold wholly or in part on the basis of their effectiveness in reducing noise. The Administrator could prescribe noise-generation or noise-reduction labeling requirements for any products so designated to be affixed to the product and the container. These labeling requirements would be far-reaching and apply to many categories of equipment beyond those which would be subject to noise emission standards. States or subdivisions would retain the right to regulate product labeling in any way not in conflict with Federal regulations.

Prohibitions included in the proposal would not allow any manufacturer of new products to sell a product after the effective date of labeling regulations promulgated respecting either noise-generating characteristics or noise reduction unless they conformed to such regulations; or any person, prior to the sale to the ultimate purchaser, to remove the affixed notice or label. Products imported would be subject to the same general standards and labeling requirements as domestic products. Two exceptions to these prohibitions would be provided—the Administrator could exempt any new product upon such terms and conditions as he might find necessary to protect the public health or welfare, for the purpose of research, investigations, studies, demonstrations or training, or for reasons of national security, and products intended solely for export.

Every domestic manufacturer covered by the noise regulations or labeling regulations would be required to maintain records, make reports and provide such information as the Administrator may reasonably need to determine that such manufacturer was in compliance with the Act. Information relating to trade secrets would be kept confidential.

In furtherance of his responsibilities, the Administrator would be authorized to conduct and assist noise research, including the investigation of effects on humans, domestic animals, wildlife, and property; development of improved methods and standards for measurement and monitoring of noise in cooperation with the National Bureau of Standards; and determination of the most effective and practicable means of controlling noise. He would also provide technical assistance to and prepare model legislation for State and local governments and disseminate information to the public.

S. 1016 would provide for civil penalties of not more than \$25,000 for each violation of the Act which could be imposed either by the Administrator, after notice and the opportunity for a hearing, or by a court. In determining the amount of the penalty, the Administrator would consider the gravity of the violation and the efforts to achieve compliance after the notice was given. Penalties could be judicially enforced. The Administrator would be able to enlist the aid of any State to enforce the Act either by suing to restrain violations or by imposing civil penalties. Any civil penalty thus imposed would be payable one-half to the State and one-half to the Federal Government.

The Environmental Protection Agency recommends that the Administration proposal, S. 1016, be enacted. This legislation would provide for noise abatement control which is appropriate and adequate at this time. The Administrator of EPA would have flexibility of management which would allow him to incorporate the best managerial techniques and planning and to apply the most suitable and up-to-date technology available to carry out an effective program. States and local governments would retain responsibility to control certain aspects of noise. The Federal Government would provide technical assistance to them and address the major noise problems where national uniformity is needed.

Amendment No. 216 includes proposed amendments to S. 1016 which establish deadlines for developing and publishing noise criteria, a report on control tech-

nology and noise-generation standards for major source of noise which would be mandatory rather than permissive.

Section 5(a) would be amended to require the Administrator to develop and publish the criteria for noise as in his judgment may be requisite for the protection of public health and welfare "within 90 days from the date of enactment of the Act."

Section 5(b) would be amended to require the publication of a single rather than a series of reports, identifying the major sources of noise and giving information on techniques for control of noise from such sources and that such report be published within 90 days of the publication of the initial criteria under section 5(a).

Section 6(a) would be amended so that publication of standards for the major sources of noise identified in the bill would be required within one year from the date of enactment.

We have no objection in principle to setting time limits for action. However, the time limits proposed are too short and inflexible to develop the kinds of criteria and standards which are necessary. The whole area of noise reduction should be recognized as one in which knowledge of effects, measurement and controls is relatively limited. Because of this, we believe that the process of developing and publishing criteria, control technology documents, standards and labeling requirements is one that should be approached cautiously. We believe an approach involving tight deadlines is unwarranted and that it would be unwise. If time limits are to be set, we would prefer that standards be prescribed within 18 months of enactment of the Act and that no specific limits be set with respect to development of criteria and publication of the report. Criteria must be developed and the report published before standards can be promulgated. We envision that a 15-to-18 month period is necessary to begin to set standards if we are to complete this process in a comprehensive and effective manner. At least this amount of time is necessary to permit reasonable consideration of the problems, alternate solutions, benefits and costs involved in various control actions and to provide opportunities to consult with appropriate organizations and individuals concerned in the Federal and non-Federal sectors.

We believe that the language requiring a single report on control technology rather than a series of reports is neither desirable nor appropriate. There are a variety of noise sources that must be carefully considered and dealt with in control technology reports. Restricting this information to a single report would be cumbersome, could lead to delays of publication of information in some areas if knowledge needed were not readily available on all the areas at the same time, and would make it difficult to revise and update reports if new knowledge becomes available.

Section 6(a) is further amended so that it is mandatory—rather than permissive as in S. 1016—that the Administrator prescribe standards for construction equipment, transportation equipment (including recreational equipment and related equipment), and equipment powered by internal combustion engines. A new provision would give the Administrator authority to prescribe standards for any other products or classes of products if he determines that such standards are desirable for public health and welfare. The amendment further provides that all standards prescribed under the Act would become effective no later than two years from the date of issue with the proviso that the effective date may be suspended if the Administrator determines it to be in the public interest, and that all standards could be amended.

We recommend that the language authorizing establishment of standards for the three classes of equipment be permissive rather than mandatory. We fully intended to set standards for equipment in all three classes that are major sources of noise. However, there will be some specific types of equipment within these classes for which standards will not be necessary or desirable since they do not represent a threat to the public health or welfare.

Again we have no objection in principle to the proposed additional authority to cover other products or classes of products that are major sources of noise and represent a threat to the public health and welfare. However, we believe the areas covered by the Administration bill are those warranting Federal action at this time and that it would not be desirable to attempt to expand the authority into areas where Federal action may not be necessary or there is inadequate knowledge on technology to set standards. We have no objection to that part of the amendment which would make the effective date of standards no later than two

years from the date of issuance. This allows time for the adjustments needed to comply with the standards and we believe it is an improvement that is needed in the bill.

Section 6(b) would be amended to provide that requests for a public hearing shall be granted unless determined by the Administrator to be inappropriate, and that all public hearings be conducted pursuant to Section 4 of the Administrative Procedure Act.

S. 1016, as introduced, would make it mandatory to grant a request for a public hearing by a manufacturer, while requests by others would be granted at the discretion of the Administrator.

We have no objection to this amendment. In any event the Administrator would generally grant a public hearing if adverse effects were shown. If he determined that a public hearing were inappropriate, he would have to give cause.

Section 7(b) would be amended by adding a provision that the Administrator shall by regulation require that a notice of the actual level of noise generation be affixed, within one year of the date of enactment of the Act to all products or classes of products used primarily in or about the home excepting (1) those products which have as their primary purpose the emission of sound and (2) those products which emit only negligible noise. We believe that the proposed deadline for labeling requirements is unduly tight. Hundreds of products could be involved. Such a deadline would be very difficult to meet and could cause major and unnecessary disruptions. We would urge you to leave any such deadlines for establishment by regulations.

Section 10, "Federal Programs" in the Administration bill would be deleted, and a new Section 10, "Federal Procurement," would be added. This amendment would forbid Federal contract negotiations with persons assessed a penalty under Section 12 of the bill. This prohibition would continue until the Administrator certified that the condition giving rise to such penalty had been corrected. The Administrator would establish procedures required, and within 180 days after enactment of the legislation the President would be required to issue an order requiring compliance by all Federal agencies involved in procurement. The President could exempt any contract, loan or grant where such exemption would be paramount to the interest of the United States, and he would notify the Congress of such exemption.

Although the Administration's bill does not specifically deal with this issue, we believe consideration should be given to the use of Federal procurement to further the purposes of the Federal noise control program. However, this substitution deals only with procurement and in no way provides for conformance by Federal agencies with the legislation in their own operations as would S. 1016.

Section 11(b) would be amended so that the Administrator would provide financial as well as technical assistance to State and local governments to facilitate their development and enforcement of noise standards and deletes the modifier "ambient" with respect to those standards which would be developed and enforced with such assistance.

We would object to these changes. We believe that States and localities should develop and enforce such standards principally with their own financial resources. Noise is largely a local problem in terms of its effects and in terms of many actions that can be taken to reduce noise or lessen its effect. Accordingly, the Federal role should be limited to those areas where effective actions cannot be taken at the State or local level, such as (1) setting standards for major noise producing equipment; (2) establishing labeling requirements for certain products; (3) performing research and development; and (4) providing technical assistance. We also believe that the word "ambient" should be retained to avoid confusion between the Federal role in setting source standards and the State local role with respect to ambient standards.

Section 12(a)(2) would be amended to provide that upon the failure of an offending party to pay an assessed penalty the Administrator could commence an action in the appropriate United States district court or request such action by the Attorney General. Similarly Section 12(b) would give the Administrator authority to bring civil actions.

We believe that the Attorney General of the United States or his designee should represent the Federal Government in any court actions.

Section 15 would be amended to establish a statutory "Office of Noise Abatement and Control" rather than vesting the authority in the Administrator of EPA.

We have no objection to the creation of this office as a program office. The noise office should have the same flexibility as our air and water program offices to take advantage of our agency-wide capabilities rather than to have all functions conducted within the office. Through functional management we can do a better job in all of our missions. For example, the noise office might set standards, while enforcement of those standards might be under the Assistant Administrator for Enforcement.

Two additional sections would be added to S. 1016 by the amendments.

Section 16 would require that the Administrator submit a report to the Congress 14 months after the date of enactment of this Act and annually thereafter.

We have no objection to such a report.

The new Section 17 provides for citizen suits. Under this provision any person could commence a civil action for injunctive relief (1) against any person, including the United States and any other governmental agency, allegedly in violation of any standard or regulation under the Act, but no action could be commenced prior to 30 days after notice has been given to the Administrator and to any alleged violator or if the Administrator or any State is prosecuting a civil action to require compliance, or (2) against the Administrator where there is an alleged failure on his part to perform any duty which is not discretionary, but no action could be commenced prior to 30 days after notice has been given to the Administrator in a manner prescribed by regulation. District courts would have jurisdiction but State courts would not be prevented or preempted from exercising jurisdiction. The Administrator could intervene in any action, if not a party thereto.

We have no objection to the inclusion of a citizen suits provision. However, the 30-day waiting period is too short. As in Section 304 of the Clean Air Act, as amended, and Section 10(k) of the proposed amendments to the Federal Water Pollution Control Act, this should be a 60-day period. Also, the Administrator should request the Attorney General or his designee to intervene in any action rather than doing so himself.

The Office of Management and Budget has advised that there is no objection to the presentation of this report from the standpoint of the Administration's program and that enactment of S. 1016 would be in accord with the program of the President.

Sincerely yours,

WILLIAM D. RUCKELSHAUS, *Administrator.*

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