REPORT

of the

HANSCOM FIELD NOISE WORKGROUP

22 September, 1999

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Letter of Transmittal

22 September, 1999

Ms. Virginia Buckingham
Executive Director,
Massachusetts Port Authority
One Harborside Drive
East Boston, MA 02128-2909

Dear Ms. Buckingham:

In 1997, the Massachusetts Secretary of the Environment, in response to issues raised in the 1995 Hanscom Field GEIR Update, asked Massport to "…form a Workgroup made up of its own noise experts and interested, knowledgeable members of the communities surrounding Hanscom…" to consider issues relating to the measurement and abatement of noise, and the content and form of the noise discussion that Massport will include in the year 2000 Hanscom GEIR update. In the spring of 1998, such a Workgroup was formed under Massport auspices, and it has continued its deliberations until the present. Its work is now complete, and the Final Report is herewith submitted.

The Workgroup is pleased to acknowledge the support of Massport personnel throughout this study. In particular, we would like to thank Tom Ennis, Project Manager, Environmental Planning and Permitting; Sara Arnold, Manager, Airport Administration, L.G. Hanscom Field; and Richard Walsh, Government/Community Liaison, for their active and constructive assistance in all phases of this effort. We thank Massport for funding the participation of Robert Miller, of Harris, Miller, Miller, Hanson, Massport's noise consultant, and express our appreciation for his thoughtful input to the process.

The Undersigned, Members of the Hanscom Field Noise Workgroup, hereby signify our unanimous agreement with this Final Report. We earnestly present our findings and recommendations to Massport, to our organizations, and to our fellow citizens for their consideration and adoption. We acknowledge that our signatures do not bind our organizations.

Michael Bahtiarian
Town of Bedford

Reinier Beeuwkes
Town of Concord

Bill Brooks
Minuteman National Historical Park

Julian J. Bussgang
Town of Lexington

Bruce Campbell
Town of Lincoln

Donald L. Dawes
Hanscom Field Advisory Commission (HFAC)

1st Lt. David L. Englin
Hanscom Air Force Base

Bill Fuchs
Minuteman National Historical Park

Anthony G. Galaitsis
Town of Lexington

Janet M. Kennedy
Hanscom Field Advisory Commission (HFAC)

Mark Myles
Town of Concord

Jeffrey Parker
Town of Bedford

Neil Rasmussen
Safeguarding Historic Hanscom Area's Irreplacable Resources (ShhAir)

Edward Rolfe
Town of Lincoln

Dan Schrager
Hanscom Airport Resource Team (HART)

Bradford L. von Weise
Hanscom Airport Resource Team (HART)

John D. Williams
Safeguarding Historic Hanscom Area's Irreplacable Resources (ShhAir

BACKGROUND

Laurence G. Hanscom Field is an airport located in eastern Massachusetts, about 18 miles from Boston. Its boundaries overlap the borders of four historic towns- Bedford, Concord, Lexington, and Lincoln. Since 1974 Hanscom has been owned and operated by the Massachusetts Port Authority (Massport). The facility includes paved runways of 5100 and 7000 foot length, served by an FAA control tower. Several active flight school, charter and fixed base operations are located on the field. The Field is adjacent to a major United States Air Force facility, Hanscom Air Force Base, which includes the Air Force Electronics Systems Center, and the 66th Air Base Wing which manages logistics for regional operations. Heavy and high performance military aircraft are frequent visitors.

Hanscom Field is New England's busiest general aviation airport, handling more than 183,000 operations in 1998. The number of visitors flying in each year is estimated to exceed 100,000. More than 300 people are employed on the Field by Massport and aviation-related businesses. Massport estimates the total economic impact of the Field at $70 million. There is (as of August 1999) no scheduled air carrier service at the airport, but the many charter (Part 135 and Part 121) operations employ aircraft ranging from single engine piston to business jets and 727's.

The surrounding Towns are of a low density residential nature and have great historic and environmental significance. Minuteman National Historical Park, created to commemorate the historic events of April 19, 1775, includes over 900 acres of land, much of which directly abuts the airport boundary. Great Meadows National Wildlife Refuge, home to important migratory water fowl, lies under the Field's western approach and departure paths. Thoreau's Walden Pond, the Old North Bridge and the homes of Louisa May Alcott, Nathaniel Hawthorne and Ralph Waldo Emerson all are located within 3 miles of the runway ends. Accordingly, there is a high level of community interest and involvement in all issues relating to the Field, especially those relating to environmental impact.

In accordance with State statute, Massport is required to submit to the State regular reviews which describe and evaluate the environmental effects of present and projected activities at the airport. These reviews are subject to comment by all interested parties and formal Topic Review Committees.

In 1997, the Massachusetts Port Authority (Massport) submitted its <u>1995 Hanscom Field Generic Environmental Impact Report (GEIR) Update</u> to the Executive Office of Environmental Affairs of the Commonwealth of Massachusetts. In June of 1997, the then Secretary of the Environment, Trudy Coxe issued a formal Certificate to Massport which responded to issues raised in the GEIR and by community-based GEIR Topic Review Committees. In the Noise subsection of the Certificate, the Secretary noted:

> "…the text and comment letters raise serious questions about some of the data, protocols, analysis, and (especially) , proposed mitigation, which need to be answered before Massport begins its 2000 update.".

The Secretary further went on to request that:

> "In the draft section 61 filing Massport should commit to form a Workgroup made up of its own noise experts and interested, knowledgeable members of the communities surrounding Hanscom, or their representatives, to determine and agree upon 1) an appropriate baseline to use as a starting point for measuring Hanscom Field's noise impacts on the surrounding communities and on the value of information derived using that baseline, 2) the metric, or set of metrics, that best describe not only absolute noise values but also the perceived impact of noise events, 3) responsibility, schedule, and nature of mitigation for agreed-upon levels of increases in noise impacts, and 4) the content and form of the noise discussion that Massport will include in the 2000 GEIR update. I expect that Massport will issue invitations to appropriate parties to join this Workgroup by the end of this summer and that the MEPA Unit will be kept informed of the status of the Workgroup's formation and subsequent work in progress. I encourage members of the public willing to participate in this work to make their interest and availability known to Massport. If no members of the public are willing to work with Massport to develop this agreement, the scope for the 2000 GEIR update will detail requirements in these areas, but will lack the benefit of this public process."
>
> (GEIR Update Certificate, June 30, 1997 P.7-8)

In September, 1997, Massport submitted its Draft Section 61 Finding for potential future projects, supplemental information, and response to comments relating to the 1995 Hanscom Field GEIR update. Within this Section 61 finding Massport responded to the request for a Workgroup.

> " Massport recognizes, and asks that the Secretary recognize, the extent of federal preemption concerning the noise emissions of aircraft and noise standards. Even so, Massport proposes to invite two representatives each from the four Hanscom area towns (HATS) communities, the Hanscom Area Resource Team (HART), Safeguarding the Historic Hanscom Area Irreplacable Resources (ShhAir), the Hanscom Field Advisory Commission (HFAC), and the Minutemen National Historic Park (MMNHP) to serve as the noise Workgroup suggested in the certificate. Recognizing that long-term discussion on this topic in the past came to no conclusion, Massport proposes to set a six-month time limit on discussions with this group, after which, if no agreement can be reached, Massport will continue with routine noise analyses using nationally-approved techniques and standards. Note that, as reported in the 1995 GEIR update, Massport will continue with its ongoing enforcement of the Hanscom noise rules. Further, Massport now is working with the ad hoc working group of the HFAC to develop and implement a "friendly flyer" program at Hanscom field. In addition, Massport will explore with the noise Workgroup operational procedures that, if accepted by the FAA, might reduce the extent of noise impacts at and near Hanscom."

In the spring of 1998, Massport issued invitations to the community groups listed in its response to the Secretary of the Environment. In addition, community representatives were selected by selectmen from each of the four adjoining towns - Bedford, Concord, Lexington, and Lincoln).

The first meeting of the Workgroup took place on April 28,1998. Twenty-eight representatives attended, including four from Massport in their official capacity. This initial gathering was contentious, and little was accomplished except to make clear to the participants that progress would require substantially greater commitment to cooperation.

In the second meeting, May 26th, real progress was achieved. A chairperson was selected from among the community representatives, and a statement of goals and procedures was discussed and prepared for adoption.

At the third meeting on June 23rd the mission statement and procedures, as amended, were adopted. By that meeting, a Workgroup E-mail address had been established to facilitate rapid communication among members. Also, in the June 23rd meeting, two subgroups were created. One was established to review issues relating to noise abatement and mitigation, and the second to deal with matters relating to noise metrics and modeling. Each of these "Taskgroups" was made up of Workgroup members whose interest or expertise lay in that topic area. Plans were made for each of these Taskgroups to meet regularly between the meetings of the entire Workgroup. This schedule - meetings of each Taskgroup at least once per month followed by a meeting of the whole Workgroup on the fourth Tuesday evening of a month - was followed through April, 1999. Presentations of importance to all members of the Workgroup were scheduled to be made in the regular full group meetings. Presentations of particular interest to one or the other of the Taskgroups were presented during the intermediate meetings. These were open and announced to the entire group, but focused on the interests of the particular Taskgroup.

Thus, by the third meeting, a Mission Statement had been adopted, regular attendance had been established by most of the community, business, and Air Force representatives, and a regular program of meetings and presentations put in place.

A list of Workgroup members, their affiliations and brief biographies is supplied below. It should be noted that these members brought very substantial qualifications and experience to the Workgroup. More than half have professional degrees, including four at the doctoral level. Six own or operate businesses. Five are pilots, and three are full-time noise professionals. Most have been involved in Hanscom Field issues for many years. All have made a major commitment of time and energy to the success of this important effort.

MISSION STATEMENT

The mission of the Noise Workgroup is to contribute to the reduction of current and long-term noise impacts of aviation operations at Hanscom Field by working toward mutual agreement on the following subjects:

1. Understand, identify, and recommend the metrics and modeling which best describe both the absolute level and the perceived impacts of noise events.

2. Understand the noise environment in the Hanscom communities.

3. Qualitative and where possible quantitative assessment of noise impacts in the Hanscom communities

4. Appropriate and relevant noise standards

5. Proposed noise abatement and mitigation measures for current and future noise impacts.

6. The recommended form and content of the noise discussions that should be used in the next GEIR update or other reports relating to noise impacts at Hanscom field

7. A Report to Massport, the Hanscom aviation communities, participating organizations and the Massachusetts Secretary of Environmental Affairs summarizing the conclusions of the Workgroup.

Workgroup Members

Michael Bahtiarian
Town of Bedford Representative
Member, Metrics and Modeling Taskgroup

Reinier Beeuwkes
Town of Concord Representative,
Workgroup Chairman
Member, Abatement and Mitigation Taskgroup

Bill Brooks
Minuteman National Historic Park Representative

Julian J. Bussgang
Town of Lexington Representative
Member, Metrics and Modeling Taskgroup

Bruce Campbell
Town of Lincoln Representative
Member, Metrics and Modeling Taskgroup

Donald L. Dawes
Hanscom Field Advisory Commission (HFAC) Representative

1st Lt. David L. Englin
Hanscom Air Force Base Representative
Member, Abatement and Mitigation Taskgroup

Lt. Col. Donald A. Flowers
Hanscom Air Force Base Representative
Member, Abatement and Mitigation Taskgroup

Anthony G. Galaitsis
Town of Lexington Representative
Member, Metrics and Modeling Taskgroup

Janet M. Kennedy
Hanscom Field Advisory Commission (HFAC) Representative
Member, Abatement and Mitigation Taskgroup

Mark Myles
Town of Concord representative
Chairman, Metrics and Modeling Taskgroup

Jeffrey Parker
Town of Bedford Representative
Chairman, Abatement and Mitigation Taskgroup

Neil Rasmussen
ShhAir Representative
Member, Metrics and Modeling Taskgroup

Edward Rolfe
Town of Lincoln Representative
Member, Abatement and Mitigation Taskgroup
Member, Metrics and Modeling Taskgroup

Dan Schrager
Hanscom Airport Resource Team (HART) Representative
Member, Abatement and Mitigation Taskgroup

Bradford L. von Weise
Hanscom Airport Resource Team (HART) Representative
Member, Abatement and Mitigation Taskgroup

John D. Williams
ShhAir Representative
Member, Abatement and Mitigation Taskgroup

Workgroup Members

Biographical Information

Michael Bahtiarian
Town of Bedford Representative
Member, Metrics and Modeling Taskgroup

B.S. Mechanical Engineering, Pennsylvania State University, 1985.
M.S. Mechanical Engineering, Rensselaer Polytechnic Institute, 1988.

Mr. Bahtiarian has worked in the field of acoustical engineering and noise control during his 14 year career. He started at General Dynamics Electric Boat Division as a sound & vibration engineer on the SEAWOLF submarine design team. Mr. Bahtiarian is currently a Senior Engineer at the consulting firm of Noise Control Engineering in Billerica MA. The firm's activities include providing acoustical engineering expertise to industrial and government clients. He specializes in industrial noise control and field testing. Mr. Bahtiarian is a member of the Institute of Noise Control Engineers (INCE) and American Society of Mechanical Engineers (ASME). He has served on the board of directors of the Boston Chapter of the Institute of Environmental Science (IES) from 1990 through 1997 and as the President of the chapter in 1996-97. Mr. Bahtiarian's activities for the Town of Bedford include the Design Review Committee for the replacement Davis Elementary School. He also served as the co-chairman of the Noise Topic Review Committee (TRC) during the 1995 Hanscom GEIR submittal process. Mr. Bahtiarian's wife Florence, a Chelmsford Optometrist, and two daughters have lived in Bedford since 1996.

Reinier Beeuwkes
Town of Concord Representative,
Workgroup Chairperson/facilitator
Member, Abatement and Mitigation Taskgroup

B.Sc. Massachusetts Institute of Technology
Ph.D. Harvard University

Dr. Beeuwkes is a licensed pilot. His pre-revolutionary home in Concord is located less than 3 miles from the center of Hanscom Field. His scientific interest has been in instrumentation with emphasis on microanalytic methods. He served on the faculty at Harvard Medical school for 11 years, leaving to become Director of Cardiovascular and Renal Pharmacology at Smith Kline and French Laboratories. He was subsequently appointed Director of Strategic Planning for Smithkline Worldwide R&D. Since leaving Smithkline in 1987, he has divided his time between business, product development, and education. He is author or co-author of more than 80 scientific publications, five textbook chapters and six patents. Dr. Beeuwkes is a principal in several small companies, including Braintree Laboratories (pharmaceuticals) and Cybermedical Corporation (internet). He holds academic appointments at Harvard and the University of Pennsylvania and has been Chairman of the Council of the Harvard Graduate School Alumni Association.

Bill Brooks
Minuteman National Historic Park Representative

Bill Brooks is a Park Ranger with the National Park Service. He has worked at Minuteman National Historical Park since 1994 in the division of Resource Management and Visitor Protection. His duties include the enforcement of Federal and State laws and regulations, providing emergency medical assistance, boundary management, coordinating the bike patrol program, and among other things, serves as the park Safety Officer. Prior to working for the National Park service Bill worked several years for a residential developer. Bill has represented Minuteman NHP to the local town governments on area development issues. He has a bachelor's degree in Urban Studies and Planning from the University of California.

Julian J. Bussgang
Town of Lexington Representative
Member, Metrics and Modeling Taskgroup

B.Sc. (Engineering), University of London, U.K.
M.S.E.E., Massachusetts Institute of Technology
Ph.D. in Applied Physics, Harvard University

Dr. Bussgang is an independent consultant. His training and professional specialty are statistical communication theory and signal processing to extract signals from noise. He was founder and president of Signatron, Inc., a defense electronics R&D company, located for many years on Hartwell Avenue in Lexington. He also served as technical consultant to many major corporations. Prior to founding Signatron, he worked at MIT Lincoln Laboratory, and at RCA in Burlington, MA, where he became Manager, Radar Development, and later, Manager, Applied Research.

He is Fellow of the Institute of Electrical and Electronic Engineers and former chairman of the Boston Section of the IEEE. He served on the Board of Governors of the IEEE Information Theory Group. He was Visiting Lecturer at Harvard and Northeastern Universities teaching graduate courses in Signal Detection and Estimation. He has many publications in the field. He served on the Board of Overseers of the Museum of Science in Boston.

Dr. Bussgang has lived in Lexington for 37 years. He served as an elected Town Meeting Member for a number of years and has been a volunteer member on various town committees, including the Noise Topic Review Committee that worked on the 1995 Hanscom GEIR.

Bruce Campbell
Town of Lincoln Representative
Member, Metrics and Modeling Taskgroup

B.S. (Physics) - Bucknell University
Philosophy Grad Work - Bucknell University

Bruce Campbell lives in Lincoln Center, about 3 miles from Hanscom. His primary business interest is high-tech start-ups. He is currently President of a bio-tech company and a principal in a film special-effects software company. Prior to this, he ran his own consulting practice for five years, providing market planning services and business strategy for high-tech and start-up clients. His projects ranged from technology acquisition, to product line rationalization, to securing funding. Prior to that, he was Director of Marketing for FTP Software for four years, seeing the company from $4 million to $28 million in sales, and helping bring in outside ownership.

Donald L. Dawes
Hanscom Field Advisory Commission (HFAC) Representative
Hanscom Pilots Association

B.S.E.E. Northeastern University

Donald Dawes is an electrical engineer engaged in consulting. He is Principal in Quality Solutions, specializing in the improvement of manufacturing processes. He is a past Examiner for the Massachusetts Quality Award. He is a Registered Professional Engineer in the State of Massachusetts.

Mr. Dawes is a pilot with his own aircraft based at Hanscom Field. Since 1990 he has served as the representative of Hanscom Pilots Association, Inc. to the Hanscom Field Advisory Commission. Hanscom Pilots Association was formed in 1986 to unify the interests of pilots operating at Hanscom field and to demonstrate a sense of responsibility on the part of pilots to the community at large and the neighbors in particular.

David L. Englin
Hanscom Air Force Base Representative
Member, Abatement and Mitigation Taskgroup

B.S. U.S. Air Force Academy
Masters in Public Policy, Kennedy School of Government, Harvard University.

First Lieutenant David L. Englin is Chief of Plans and Programs, Electronic Systems Center (ESC) Public Affairs Office, Hanscom Air Force Base, MA. He is responsible for all office strategic planning maintenance of office checklists and instructions. Additionally, he serves as a public affairs officer; routinely dealing with members of the community on matters of interest regarding Hanscom AFB. He also regularly develops and writes news releases and articles on the many people and programs of the base.

Donald A. Flowers
Hanscom Air Force Base Representative
Member, Abatement and Mitigation Taskgroup

B.S. (Management) University of Alabama
M.S. (Human Resources) Abilene Christian University

Lieutenant Colonel Donald A. Flowers is Commander, 66 Logistics Squadron, Hanscom Air Force Base, MA. He is responsible for supply, transportation, munitions, and transient alert operations for the base, tenant organizations, and more than 200 other geographically separated units throughout the 7-state New England area.

Lt. Col. Flowers is originally from Homewood, Alabama, commissioned through Air Force ROTC from the University of Alabama in 1980, and subsequently attended undergraduate pilot training. Lt. Col. Flowers has held a variety of USAF and joint supply/fuel/logistics assignments covering retail to wholesale level operations. He was selected for an internship with the Department of Energy's Strategic Petroleum Reserve in 1986-1987. In August 1990, he deployed to Bahrain in support of DESERT SHIELD to establish and coordinate the initial theater petroleum support for all Services and Multi-National Forces. In May 1994, Lt. Col. Flowers became the first Commander, Defense Fuel Office Japan, to provide transportation and contracting support for inland petroleum distribution in Japan. He has experience in handling environmental issues with communities such as fuel spills and noise complaints (Col. Flowers has been recently transferred and is now Joint Staff Officer, U.S. Forces Korea. He was thus unable to participate in the final activities of the Workgroup.)

Bill Fuchs
Minuteman National Historical Park Representative

Bill Fuchs is a Biologist with the National Park Service (NPS). He started working with the NPS in 1981, and has worked at nine NPS sites across the country. Bill has worked at Minuteman National Historical Park since 1997 in the division of Resource Management and Visitor Protection. His duties include the environmental and wetlands compliance; supervising inventory, monitoring, and research within the park; control of exotic species; park planning; and providing park management with the information and guidance required to effectively manage park natural resources. Bill regularly represents Minuteman NHP at meetings with other agencies and individuals including town governments, planners, developers, and park neighbors. He has bachelor's degrees in biology and geology, has done extensive graduate work geology, and is a graduate of the NPS Natural Resource Management Training Program.

Anthony G. Galaitsis
Town of Lexington Representative
Member, Metrics and Modeling Taskgroup

B.Sc. City College of the City University of New York
Ph.D. Massachusetts Institute of Technology

Dr. Galaitsis received his Ph.D. in Physics from MIT for research he conducted in the area of Acoustics. He is currently a Division Scientist at BBN Technologies, where he has been performing R&D in Acoustics for over 25 years. He has directed or participated in programs focusing on the characterization of airborne, fluidborne and structureborne noise generation and propagation, and on the passive and active control of such noise. His work extends over both theoretical and experimental studies, including analysis and modeling of noise generating systems, design and manufacturing of noise control treatments, integration of treatments into prototype systems, and test and evaluation of such systems. He has conducted such studies on automobiles, trains, mining equipment, tracked vehicles, aircraft, ships, submarines, specialized machinery, and acoustic test facilities.

He has authored or co-authored more than 60 technical publications in the area of Noise and Vibration control. He is the author of the "Reactive Silencers" chapter of the Noise Control Engineering Applications book (edited by L. L. Beranek and I. L. Ver). He is a member of the Acoustical Society of America, Institute of the Noise Control Engineering, and American Association for the Advancement of Science.

A Lexington resident for more than 20 years, Dr. Galaitsis is a member of the Lexington Planning Board and also a member of the Lexington Town Meeting. He is also one of the contributors to the Four Town Topic Review Committee (TRC) report on Noise prepared in response to the 1995 Hanscom GEIR.

Janet M. Kennedy
Hanscom Field Advisory Commission (HFAC) Representative
Member, Abatement and Mitigation Taskgroup

A.A.S., B.S. Boston University

Ms. Kennedy has been a member of the Hanscom Field Advisory Commission for the past 5 years. During most of the Workgroup’s life, she was Chair of the Commission. A resident of Bedford since 1982, Ms. Kennedy has been actively interested in developments at Hanscom Field and how they affect the communities. She has extensive experience in management, accounting and finance. Ms. Kennedy and her husband own Ultima, Ltd., an automotive business in Waltham, where she is CFO. She is also Controller of Boshco, Inc. in Billerica. She has been Treasurer of the League of Women Voters of Bedford since 1995. An avid skier, she also enjoys competing in offshore sailboat racing.

Mark Myles
Town of Concord representative
Chair, Metrics and Modeling Taskgroup

B.S. Cornell University
M. Eng. (Electrical) Cornell University

Mr. Myles has been involved with measurement instrumentation in a career that spans more than 25 years. He was a consultant and researcher in acoustics and vibration with Bolt Beranek and Newman, Inc. (now BBN Technologies of GTE) for over 9 years. His work at BBN included aeronautical acoustics research for NASA, and transportation noise and vibration work for the US Department of Transportation, the New York City Transportation Authority, MBTA, and others. He also performed numerous environmental noise and psychoacoustic studies for various government agencies, transportation authorities including Massport, utilities, and industrial companies. In all this work, his primary areas of expertise were measurement instrumentation, transducers, and data analysis. He is the author of several scientific papers and technical reports on industrial noise dosimetry, the psychoacoustics of sirens and alarms, railroad noise generation, noise from electric utilities, and wind tunnel noise, among other topics.

In 1980, Mr. Myles joined Hewlett-Packard Company's Test and Measurement Organization as an Applications Engineer responsible for applications support of Fast Fourier Transform-based analyzers, laser interferometers, and data acquisition systems. Applications for these technologies include noise control engineering, general vibration measurement and control, Modal vibration analysis, automotive and aircraft engine test, and industrial vibration modeling and monitoring. Later, he became an Applications Engineering manager for a variety of measurement disciplines, then a Solutions Architect for internet-based measurement and control systems. Today, he has worldwide responsibility for developing technical training curriculums within HP Test and Measurement.

Mr. Myles is an avid whitewater kayaker and outdoor enthusiast, with a goal of eventually becoming a private pilot. He and his family live near the Sudbury River in the Conantum neighborhood of Concord.

Jeffrey Parker
Town of Bedford Representative
Chairperson, Abatement and Mitigation Taskgroup

B.A. Reed College
Ph.D. Massachusetts Institute of Technology

Dr. Parker has lived in Bedford for the past fifteen years. He is a staff member at MIT Lincoln Laboratory specializing in infrared detectors with special interest in the infrared characteristics of the atmosphere. Dr. Parker is author or co-author of numerous scientific papers. He has been a licensed pilot for 24 years and holds a commercial, multi-engine, instrument rating. In addition to being an active general aviation pilot at Hanscom Field, Dr. Parker is a scientific crew member on MIT's Gulfstream II research aircraft. Dr. Parker is an active Bedford community member and has served on numerous town committees concerning Hanscom Field.

Neil Rasmussen
ShhAir Representative
Member, Metrics and Modeling Taskgroup

B.Sc. Massachusetts Institute of Technology
M.S. Massachusetts Institute of Technology

Mr. Rasmussen is founder and Chief Technical Officer of American Conversion Corporation. His special technical interest is Human Factors Engineering. At M.I.T, he studied Auditory Neurophysiology and Psychoacoustics. After graduation from M.I.T. in 1979 he worked at MIT Lincoln Laboratories prior to founding APC in 1981. APC develops and manufactures AC power protection equipment for computer networks and now employs over 5,000 people worldwide. He regularly participates in public discussions regarding the future of Hanscom Field and is a founder of ShhAir.

Neil and his wife Anna are Trustees of The Neil and Anna Rasmussen Foundation which supports local preservation activities.

Edward Rolfe
Town of Lincoln Representative
Member, Abatement and Mitigation Taskgroup,
Member, Metrics and Modeling Taskgroup,

B.Sc.(Eng.)(1st Class Hons), London University
M.A. Theoretical Physics, Brandeis University
S.M. (Chem. Eng.) Massachusetts Institute of Technology
Harvard Business School, Marketing and Communications
Chartered Engineer in the European Common Market

Edward Rolfe has lived in Lincoln for 40 years, and is a member of HFAC. He was apprenticed at the General Electric Company, and became a staff member in the Consulting and General Engineering Lab. During World War II, he was a Captain in the British Army Special Forces, Airborne Royal Electrical & Mechanical Engineers. He has held the positions of Technical Department Manager, Fawley Oil Refinery, Manager Advanced Development American Machine & Foundry Company, Principal Research Scientist AVCO Corp., Manager Plasma Physics Department at the Raytheon Company where he worked on long-range missile detection, re-entry communications, and laser development, and wrote a number of technical papers, Senior Titled Engineer at Stone & Webster Engineering Corp., and is now President of a startup company specializing in computer systems integration. He has 4 patents in electronic and chemical process controls, and was awarded a NASA Science Prize for laser measurement of turbulence in rocket motor flames.

Dan Schrager
Hanscom Airport Resource Team (HART) Representative
Member, Abatement and Mitigation Taskgroup

A.B. Harvard University

Mr. Schrager lives in Concord on Great Meadows, a mile from the runway end at Hanscom Field. He is an instrument rated pilot. He founded and runs the Aviation Insurance Agency and is Principal and cofounder of Aviation Capital Corporation; both located at Hanscom Field. He holds an FAA Aviation Safety Counselor designation and sponsors a variety of aviation safety seminars.

Prior to moving to the Boston Area, he attended the Juilliard School for piano studies. Mr. Schrager developed vocational training programs for several social service collaboratives.

Mr. Schrager has served as Scoutmaster in Concord and as a little league coach. He is an avid bicyclist, hiker and kayaker and remains active in various Chamber Music venues. Has lived in Concord since 1992 with his wife, a special needs teacher and his school age son.

Bradford L. von Weise
Hanscom Airport Resource Team (HART) Representative
Member, Abatement and Mitigation Taskgroup

B.A (Environmental Studies) University of Vermont
Certificate in Real Estate Studies, Boston University

Mr. von Weise is a licensed instrument rated pilot and owner of a Beechcraft A36 Bonanza aircraft, based at Hanscom Field. He is also the Airport Support Network Representative for Hanscom for the Aircraft Owners and Pilots Association (AOPA)and a member of the flight standards committee for Angel Flight Northeast. Professionally, Mr. von Weise is a partner at TarAir Corporation, a corporate aircraft sales and acquisition consulting firm based at Hanscom. He is also currently President of the real estate investment firms of Bredon Hill Investment Corporation and West Midlands, Inc. Additionally, Mr. von Weise is general partner of Whitewater Development Limited Partnership and Managing Director of 195 Corporation Way LLC, both real estate holding companies. Prior to his association with TarAir, he was a partner at Juniper Holdings, Inc., where he was the chief real estate investment officer of the firm. Mr. von Weise was also the senior associate of the real estate group at Boston Capital Partners, Inc. Prior to his involvement with Boston Capital, Mr. von Weise was the Vice President of Finance at American Realty and Financial, Inc. Mr. von Weise is a resident of Carlisle, where he lives with his wife and two daughters.

John D. Williams
ShhAir Representative
Member, Abatement and Mitigation Taskgroup

A.B. Creighton University
Master Theological Studies, Weston Jesuit School of Theology
Chartered Financial consultant, American College.

Founding partner Capital Formation Group Inc. (Financial Services).
Member Boston Estate Planning Council.
Directs estate management and design for CFG.
Serves as trustee for several charitable organizations.
Author of training text on Charitable estate planning.
Member Mass. Society of Insurance Advisors.
member Board of Advisors of The National Heritage Foundation (a public Charity).
Board of Directors, ShhAir, a nonprofit dedicated to safeguarding the environment of the Hanscom area.

PARTICIPATING AND OBSERVING ORGANIZATIONS:
(alphabetically)

Hanscom Air Force Base

Military flying operations at Hanscom began in 1942, with fighter training activities. Since 1945, Hanscom has emerged as the Air Force's leading center for the development and acquisition of electronic systems. In 1952, the Commonwealth of Massachusetts transferred land on the East side of the airport to the Air Force as a permanent location for Hanscom Air Force Base. Presently, the Electronic Systems Center and adjacent university and commercial laboratories employ approximately 10,000 persons. Although no military aircraft are presently based at Hanscom, they are required to use the Field in support of ongoing research programs and medical and supply logistics. The base is home to the 66th Air Base Wing, which is responsible for supply, transportation, munitions, tenant operations, and for more than 200 other geographically separate units across New England.

HART (Hanscom Area Resource Team):

The Hanscom Area Resource Team ("HART") was founded in 1997 to enable the businesses and users of Hanscom Field to participate in the ongoing debate regarding the many issues surrounding Hanscom. Virtually all businesses located at Hanscom, together with their combined 260 employees are members. These businesses serve the general aviation community at Hanscom. The goal of HART is to maintain the current use of Hanscom field as a first-rate general airport that serves the diverse needs of general aviation activity, including private, business, corporate, training, charitable and emergency medical/search and rescue aviation. Additionally HART supports the concept of aviators as good citizens and neighbors and promotes the increased safety of operations to and from Hanscom through education and information. (HART text)

HFAC (Hanscom Field Advisory Commission):

The Hanscom Field Advisory Commission, established by act of the State legislature in 1980, includes 16 members appointed by the selectmen of the four towns surrounding the airport. Of these members, four are Town representatives, and two are appointed from each of the following categories (1) local citizens groups; (2 area wide organizations; (3) other area towns impacted by aviation at Hanscom Field; (4) businesses basing aircraft at Hanscom Field and (5) aviation or aviation related businesses at Hanscom field. In addition, there is one representative from a business - aviation organization and one from a general aviation organization both of whom shall be a regular user of or employee of a regular user of Hanscom Field. The Hanscom Field advisory commission has the following duties: (1) to act as an advisory commission for review and reaction with regard to decisions relating to Hanscom Field and the Hanscom Field area, including but not limited to, land-use, noise abatement and transportation needs as outlined in the Hanscom Field master plan; (2) to provide continued communication between the communities surrounding Hanscom Field and the Massachusetts Port Authority; and (3)to establish an executive committee of members within the commission. (HFAC Text)
The Commission meets monthly.

HMMH (Harris, Miller, Miller, Hanson):

Harris Miller Miller & Hanson Inc. was formed in 1981 to provide quality consulting services on issues of aviation noise. The firm's founders, Andrew Harris, Robert Miller, and Nicholas Miller, worked together on airport noise problems for 10 years at Bolt Beranek and Newman Inc. (BBN), before starting the new company. They were joined a year later by another BBN colleague, Carl Hanson, who with other staff, added expertise in the noise problems of rail systems and highways.

Today HMMH has more than 60 employees and is known and respected internationally for its work in all three transportation modes, though aviation issues account for approximately three quarters of the company's business interests. The firm's senior staff has in excess of 300 years combined experience in noise assessment and control at about 150 commercial, general aviation, and military airfields throughout the U.S. and in Canada, Australia, Italy, Japan, Taiwan, Spain, Hong Kong, Puerto Rico, and Guam. As an extension of its consulting business, HMMH also installs and maintains about 30 monitoring systems at major U.S. airports such as O'Hare, Miami, Denver, San Diego, and Minneapolis and at other airports in Canada, the United Kingdom, Poland, and Italy. In addition, HMMH provides several full-time staff to support the airport noise office on-site at San Francisco International and has done so for Chicago's O'Hare and Midway Airports as well. At the federal level, the firm's aviation clients include the FAA, the U.S. Air Force, the U.S. Navy, NASA, and the National Park Service.

HMMH has been working on noise issues for Massport since its founding and during that time has provided support on some 25 to 30 projects both at Logan and at Hanscom. The company's main offices are located in Burlington, Massachusetts, and it operates a branch office in Sacramento and a branch in the U.K. (HMMH Text)

MASSPORT (Massachusetts Port Authority):

The Massachusetts Port Authority (Massport), enabled by the Massachusetts legislature in 1959, is a world-class independent public authority which develops, promotes and manages airports, the seaport and transportation infrastructure to enable Massachusetts and New England to compete successfully in the global marketplace. An economic engine for the region and an international gateway to New England, Massport is a responsible corporate citizen committed to its employees, customers and the public interest.

Massport's importance to the region is reflected by its economic impact. Although 1200 people work directly for Massport, another 20,000 jobs are generated by its operations and activities. Massport facilities and operations contribute more than $5 billion to the state's economy annually. In addition, because Massport is an independent bond authority, it does not rely on or receive any state tax monies to carry out its critical mission. (Massport web site Text)

Massport operates Logan International Airport in Boston, and Lawrence G. Hanscom Field 18 miles to the west of Boston. Massport and the City of Worcester recently signed a Memorandum of Understanding that is expected to result in Massport's operation of Worcester Regional Airport.

MMNHP (Minuteman National Historical Park):

Minuteman NHP was created by an act of Congress in September of 1959 *"in order to preserve for the benefit of the American people certain historic structures and properties of outstanding national significance associated with the opening of the War of the American Revolution..".* The boundary of the National Historical Park encompasses land on either side of the "battle road," between Rt. 128 in Lexington and Old Bedford Rd. in Concord as well as a parcel around the historic Wayside house and the Old North Bridge in Concord. Minuteman shares a boundary with Mass Port along it's northern edge. The boundary of the park comes to within a few hundred feet of Hanscom Field. The historic battle road is less than half a mile away from one of the runways. The number of people who come to visit the first battle field of the American Revolution each year has been counted at over one million. For the many millions that will visit in the future Congress has charged Minuteman NHP with the following: "*The purpose of the park shall include the preservation and interpretation of the historic landscape along the road between Lexington and Concord, sites associated with the causes and consequences of the American Revolution..."* (MMNHP Text)

ShhAir (Safeguarding the historic Hanscom Area's Irreplacable Resources):

ShhAir was founded in February, 1997 by a group of concerned citizens from the four towns in which Hanscom field is located -- Bedford, Concord, Lexington and Lincoln. Since then, more than 1500 residents have become members. Incorporated as a nonprofit organization, ShhAir's purpose is "to safeguard the historic Hanscom area communities -- the birthplace of our nation -- from the increased noise, ground traffic, and environmental pollution that would result from the expansion of the air traffic at Hanscom field or changes in the character and use of the airport." (ShhAir Text)

Town of Bedford:

The Town of Bedford was incorporated in 1729. Located 14 miles northwest of Boston, Bedford is situated between Concord and Lexington, towns readily identified with the American revolution. Bedford has a proud history as well. Its town flag, carried by the Bedford Minuteman Company at the Battle of the Old North Bridge on the morning of April 19, 1775, is the oldest flag in existence to fly over American fighting men.

Within Bedford's 14 square miles live about 14,000 people from all walks of life. Most of the land is wooded, and the Town retains much of its old rural atmosphere. Visitors are still welcome at the Job Lane house, built before 1720. The Bedford Veteran's Administration Hospital has open grounds that host Summer fireworks and Native American gatherings.

Industrial companies within the Town contribute significantly to advances in high technology and our nation's military preparedness. This role is enhanced due to the proximity of the U.S. Air Force Electronic Systems Center at Hanscom Air Force base. Bedford is generally known as the home of L.G. Hanscom Field, since approximately half of the field lies within the town's boundaries. .

Town of Concord:

The Town of Concord was founded in 1635, as the first inland colony of the Province of Massachusetts Bay. Now a town of nearly 16,000 people, it is still governed by an open Town Meeting. Within Concord's 26 square mile area are many historic sites, including several of national significance. The fact that about 45 percent of the land is protected wetland or conservation land indicates the high level of environmental concern shown by the town's citizens

. This protected land includes a major portion of the Great Meadows National Wildlife Refuge, and Estabrook Woods, a research preserve owned by Harvard University. Walden Pond, the site of Henry David Thoreau's cabin and now a State Park, is a pilgrimage site for visitors from around the world. The Headquarters of Minuteman National Historical Park is located in Concord. This Park, with its memories of Paul Revere and its Old North Bridge, is a patriotic destination for a million Americans every year. The homes of Ralph Waldo Emerson, Louisa May Alcott and Nathaniel Hawthorne, now museums, attract visitors of literary bent.

Yet Concord is also a vibrant modern community. Its schools are among the best in the state, its software and internet industry includes leaders in the field, and its real estate values are rising steadily. Concord is also one of the border towns of L.G. Hanscom Field. Indeed, the Old North Bridge lies directly under the approach end of runway 11, and thus the departure end of runway 29. Operations at the airport, both civilian and military, thus have a great potential impact on the Town, its tourist attractions, and its permanent residents. The Town participates actively in committees and advisory boards relating to the airfield, and one of its citizens presently serves a chairman of the Hanscom Field Advisory Commission.

Town of Lexington:

Lexington is a residential town located in Middlesex County, 11 miles northwest of Boston, 18 miles south of Lowell. The major access roads are Routes 2 and 128. The 1998 census listed the population at 31,913. The area of the town is 16.6 square miles (10,650 acres). Neighboring towns are Lincoln, Bedford, Concord, Woburn, Winchester, Arlington, Belmont and Waltham. The town is governed by a Board of five selectmen and administered by a Town Manager. Budgets are approved by an elected Town Meeting.

Originally settled about 1640 as part of Cambridge, Lexington was incorporated as a separate town in 1713. Early settlers were farmers and workers. The town prides itself on having a balanced population of both low and higher incomes, and of diverse national origins. Housing prices span a range from expensive to moderate. The town has numerous parks, conservation lands, museums and libraries. Purchases of open and wooded land areas have helped preserve the area.

The American Revolution began here. The town's Battle Green is the site where events of that day are commemorated on Patriot's Day. More than 100,000 tourists come every year to view historic sites. Buildings on a typical tour include Buckman Tavern, where Minutemen assembled; Munroe Tavern, British headquarters during the battle; Belfry Tower, where the alarm was sounded; Hancock-Clarke House, where Samuel Adams and John Hancock heard the alarm sounded by Paul Revere; and Museum of Our National Heritage.

Though close to Boston, the town is quiet, historic and maintains open spaces for recreation, farming and wetland preservation. Nature trails, golfing, tennis, swimming, ice skating, cross-country skiing, and sledding are some of the activities accessible to the residents. Recently, a Bicycle Path was added. Residents take special pride in supporting an excellent school system, augmented by the Minuteman Regional Vocational Technical High School (9-12), shared with other communities in the Greater Boston area.

Lexington pays much attention to municipal planning, and selected areas near the highway are designated for offices and light industry. Lexington's industrial community includes the headquarters of Raytheon and StrideRite, the MIT Lincoln Laboratory, as well as young high tech companies.

A portion of the Hanscom Air Force Base and of Hanscom Field are located within the town. Lexington has always supported both establishments, on the premise that Hanscom Field will be used by the military for national needs and by local pilots and businesses, and not as a regional transportation center.

Town of Lincoln:

Lincoln is a residential community, population 5,300, situated about 15 miles west of Boston, adjacent to Hanscom Field in the north, Lexington to the East, and Concord to the West. With an area of approximately l4.5 square miles it has retained a considerable amount of its land for conservation, wetland preservation, and recreation, through the strenuous and generous efforts of its residents who cherish its rural, agricultural character and its historical legacy.

Lincoln was incorporated as a town in 1754, and at that time was principally an agricultural community, with some small mills. Through gradual suburbanization it has become an affluent residential community yet one revered for its dedication to preserve open space, and for its creative planning for land-use management.

Within the town are Drumlin Farm, home to the Massachusetts Aududon Society, The Thoreau Institute, portions of Walden Pond, the DeCordova Museum and Sculpture Park, the Codman House, the Pierce House and Park, the Minuteman Regional High School, and a large portion of the Battle Road with many important historical sites that comprise MinuteMan National Historical Park. Together with the extensive hiking, biking and recreational trails throughout the town, these attract and are enjoyed by thousands of visitors year round.

Industrial development, drastically increased volume and speed of automobile traffic, all challenge the character and pace of the town. The location of a popular and important national park, attracting over 1 million visitors a year, brings more traffic than can be accommodated. Hanscom Field, the Route 128 businesses, and easy access to Greater Boston contribute weekday commuter problems on all main roads in town. Pollution and Aircraft noise have become significant issues to the region. Representatives of Lincoln are devoting considerable time and effort working to mitigate these problems on a collaborative, regional basis.

Workgroup Meetings

(Entire Group)

Date:	Activity/presentations:
April 28, 1998	Organizational
May 26, 1998	Choose Chair Mission Statement Operating Procedures
June 22, 1998	Adopt Mission/Procedures Form Taskgroups FICAN and Research background M. E. Eagan- HMMH
July 28, 1998	Taskgroup reports Review Hanscom operations Civilian- B. Patzner S. Arnold/Massport Military Lt. Col. Flowers/ USAF
September 22, 1998	Taskgroup Reports
October 27, 1998	Taskgroup Reports Abatement efforts elsewhere R. Miller/HMMH
December 8, 1998	Metrics Taskgroup Draft Report Abatement Taskgroup Draft report
April 6, 1999	Abatement presentation and adoption
September 9, 1999	Metrics Draft presentation and adoption
September 22, 1999	Final report adoption and signature

Taskgroup Meetings

Abatement and Mitigation

Date:	Activity/Presentation:
July 7, 1998	Elect Chair Adopt goals Civilian operations and flight patterns Ken MacDonald/ HART Military operations and procedures Captain Wilson, USAF
August 5, 1998	MedFlight presentation Tim Harrison, Dan Thomas Mercury Air Service presentation John Wraga Jet Aviation presentation Chris Wheeler AOPA "Fly Friendly" Presentation Ford von Wiese
September 8, 1998	Possible recommendations
October 13, 1998	FAA positions, Part 150 John Silva/FAA Control Tower operations Jim Merageas/ FAA
November 10, 1998	Revised recommendations
December 15, 1998	Votes on initial list
January 12, 1999	Votes on second list
April 6, 1999	Workgroup presentation, amendment and Adoption
May 27, 1999	Voluntary abatement procedures subgroup
July 9, 1999	Voluntary abatement procedures review

Taskgroup Meetings

Metrics and Modeling

Date:	Activity/ presentation:
July 14, 1998	Elect Chair Adopt goals Review Ldn, other metrics Complaints Monitoring sites/ data
August 6, 1998	Flight track and noise modeling (meeting at HMMH)
September 10, 1998	Integrated Noise Model Massport monitoring capability
October 15, 1998	"Good Metric" criteria "Time Above" metric
November 3, 1998	Initial recommendations
November 24, 1998	Initial recommendations
January 24, 1999	Preparation of Draft
April 8, 1999	Review of Draft Recommendations
June 22, 1999	Revision of Draft
July 21, 1999	Revision of Draft
August 5, 1999	Revision of Draft

ABATEMENT AND MITIGATION

INTRODUCTION

The Abatement and Mitigation Taskgroup was formed in June 1998 as a sub-group of the Hanscom field Noise Workgroup to investigate topics related to the abatement and mitigation of aircraft noise on the surrounding communities. The Taskgroup met nine times between July '98 and February '99. The following people participated:

Sara Arnold (MASSPORT)
Rein Beeuwkes (Concord)
Julian Bussgang (Lexington)
Don Dawes (HFAC)
Lt. David Englin (USAF)
Tom Ennis (MASSPORT)
Lt. Col. Don Flowers (USAF)
Barbara Forster (MinuteMan Paper)
Tory Galaitsis (Lexington)
Paul Gamache (Mercury Air Center)
Mike Goulian (Executive Flight School)
Mark Hanson (citizen)
Tim Harrison (Boston MedFlight)
Janet Kennedy (HFAC)
Ken MacDonald (HART)
Jim Merageas (Hanscom Operations)
Rol Murrow (AOPA)
Mark Myles (Concord)
Jeffrey Parker (Bedford)
Barbara Patzner (MASSPORT)
Ed Rolfe (Lincoln)
Dan Schrager (HART)
John Silva, (FAA)
Daniel Thomas (Boston MedFlight)
Ford von Weise (HART)
Richard Walsh (MASSPORT)
Chris Wheeler (Jet Aviation)
John Williams (ShhAir)
Capt. Wilson (USAF)
John Wraga (Mercury Air Center)

The mission adopted by the Taskgroup was to consider methods and procedures which:

1) may reduce the amount of aircraft noise generated by operations at Hanscom (abatement) and,
2) may reduce the impact of such noise on the surrounding communities (mitigation).

The Taskgroup began its investigation with presentations on aircraft operation at Hanscom Field. Ken MacDonald reviewed the air traffic patterns and described the differences between operations under visual flight rules (VFR) and instrument flight rules (IFR). Captain Wilson of the USAF followed with a review of military operations at the field. The Taskgroup concluded that there may be many ways for pilots to voluntarily modify their flight pattern, altitude, or power setting which could reduce the amount of noise generated by airplanes and that emphasis should be placed on pilot education.

Ford von Weise described the AOPA Fly Friendly Program. This program is written for pilots, addresses aircraft noise issues, and suggests procedures for pilots to follow which might reduce aircraft noise. The Taskgroup felt that the AOPA Fly Friendly Program and its recommendations provide an excellent starting point for educating pilots concerning noise issues.

Sarah Arnold addressed the question of aircraft operations at Hanscom Field and the number of complaints generated. Data grouped by time of day and type of aircraft were presented and the topic was discussed at length. Education of both pilots and of surrounding community members surfaced as a meaningful way to reduce the number of disturbances and complaints.

Following these presentations, the efforts of the Taskgroup turned to an investigation of the use of Hanscom Field. Representatives from three major users, John Wraga from Mercury Air Center, Chris Wheeler from Jet Aviation, and Tim Harrison from Boston MedFlight, described their respective operations. Mr. Wraga and Mr. Wheeler indicated that they would be happy to provide space in their pilot lounges for a noise abatement display. All three presenters expressed an interest in working with the Hanscom communities concerning the noise issue. Discussions were also conducted with the local flight schools.

During these investigations, John Silva from the FAA Airport Division described the FAA's role in noise abatement issues and addressed the FAA's stand on a number of noise related topics. The topics of a Part 150 study and Hanscom's night operation fees were discussed at length. Mr. Jim Meragas (Hanscom Control Tower manager) joined this discussion and described the Control Tower's role at Hanscom. Mr. Meragas stated that he would be happy to review any and all Workgroup ideas/proposals.

After gathering extensive data and carefully reviewing each topic, the Taskgroup formed the 21 recommendations presented below. Certain complex and important issues (such as Part 150 related activities and the related nighttime use fee) could not be adequately dealt with given the time and staff available.

The Taskgroup is pleased to report that it worked extremely successfully with Massport, business, AOPA, and town representatives and believes that a cooperative and productive atmosphere was established between all parties. The Taskgroup believes that adoption of its recommendations will result in significant abatement and mitigation of aircraft noise, with benefit to the entire Hanscom community, the surrounding towns and the airport.

LIST OF ABATEMENT & MITIGATION RECOMMENDATIONS

A1. The Workgroup recommends that a set of voluntary noise abatement procedures be formulated for use at Hanscom Field.

A2. The Workgroup recommends that Massport duplicate the voluntary noise abatement procedures in sufficient quantities so that each flight school can distribute the procedures to all aircraft renters.

A3. The Workgroup recommends that Massport print and distribute informative page markers for Jeppesen and Flightguide handbooks and distribute to local and transient pilots.

A4. The Workgroup recommends that Hanscom flight schools display local noise abatement procedures and information in their flight planning room and should distribute noise abatement information to their pilots. Local noise abatement procedures and the AOPA Fly Friendly program should be briefed to all flight instructors at least annually, and students should be required to view the AOPA Fly Friendly video at some time during their training.

A5. The Workgroup recommends that the Hanscom AFB Flight Training Center (a.k.a. Hanscom AFB Aero Club) display local noise abatement procedures and information in its flight planning room and should distribute noise abatement flyers to its members. Local noise abatement procedures and the AOPA Fly Friendly program should be briefed at Flight Training Center safety meetings at least annually. New club members should be required to view the AOPA Fly Friendly video.

A6. The Workgroup recommends that each FBO institute a guest sign-in sheet and follow up with a letter to each transient pilot describing the voluntary noise abatement procedures at Hanscom.

A7. The Workgroup recommends that Massport expand their public access web site to include the voluntary noise abatement procedures for Hanscom Field.

A8. The Workgroup recommends that a reminder that voluntary noise abatement procedures are in effect be include in the ATIS (Automated Terminal Information System) broadcast. Whenever workload permits, this information should be followed with reminders from the Tower, Ground and/or Clearance Delivery.

A9. The Workgroup recommends that Hanscom AFB representatives to the Hanscom Noise Workgroup brief Electronic Systems Center and 66th Air Base Wing leaders on local noise abatement procedures, sensitivities, and issues. The audience for such a briefing should include program directors, who coordinate flight test support for their programs. The briefing content should highlight the need to consider noise abatement issues and possible alternate locations when coordinating flight test support.

A10. The Workgroup recommends that the Hanscom AFB Transient Alert display and distribute local noise abatement procedures and information to military flight crews using their facility.

A11. The Workgroup recommends that the Electronic Systems Center create a local noise abatement procedures web page that is easily accessible from both public access and restricted access web sites. This page should be mutually linked to Massport and Hanscom Field web sites. It should also be linked to web-based pre-flight planning resources used by both military and civilian pilots.

A12. The Workgroup recommends that the Electronic Systems Center Office of Public Affairs send Hanscom area local newspapers regular (biweekly or monthly) news releases updating area residents on Air Force flight operations, subject to security considerations.

A13. The Workgroup recommends that the Electronic Systems Center Office of Public Affairs add information about Air Force flight operations to the public access section of the Hanscom AFB web site, subject to security considerations.

A14. The Workgroup recommends that Massport purchase and distribute the AOPA Fly Friendly video to all Hanscom pilots.

A15. The Workgroup recommends that Massport provide support to ensure that a representative user group be available to all users, pilots and businesses.

A16. The Workgroup recommends that members of the Hanscom Noise Workgroup brief Town Selectmen on the group's findings. This briefing should include a description of recent efforts to mitigate the effects of noise on surrounding communities as well as an explanation of the local noise abatement procedures. The audience should include both selectmen and all interested townspeople.

A17. The Workgroup recommends that a group representing local pilots, business interests, surrounding communities and Massport be formed to investigate the possibility and implications of reopening the Part 150 study at Hanscom Field.

A18. The Workgroup recommends that a group representing surrounding communities, local pilots, business interests, and Massport be formed to define the scope and purpose of a Model Quiet Airport Study at Hanscom Field.

A19. The Workgroup recommends that a group representing local pilots, business interests, surrounding communities and Massport be formed to explore the idea of establishing a non-profit organization to raise funds to support various noise reduction and awareness programs.

A20. The Workgroup recommends that a group representing local pilots, business interests, surrounding communities and Massport be formed to explore the idea of establishing a Noise Abatement Officer position at Hanscom Field.

A21. The Workgroup recommends that a group be formed, including representatives of the Planning Boards from the towns of Lincoln, Lexington, Bedford and Concord, to study the issues associated with the creation of Noise Overlay Zoning Districts.

ABATEMENT & MITIGATION DETAILED RECOMMENDATIONS

RECOMMENDATION A1: VOLUNTARY NOISE ABATEMENT PROCEDURES

The Workgroup recommends that a set of voluntary noise abatement procedures be formulated for use at Hanscom Field.

Time Frame
Immediate. (A draft completed August 1999. See appendix 1.)

Background
In the past, Massport, HART and HPA have drafted a set of noise abatement procedures for Hanscom Field. The Workgroup recommends that these procedures be immediately formalized and published. Compliance with all procedures will be voluntary, consistent with aircraft and airport safety. The noise abatement procedures should be reviewed annually by a group representing local pilots, FBO's, flight schools, business interests, surrounding communities and airport operations and revised as necessary. The Workgroup recommends that, once these procedures are formalized, Massport print and distribute copies of the procedures to all airport users. Sufficient copies should be made for each flight school so that they can be distributed to local pilots. In addition, Massport should post a copy of the procedures to all Hanscom-based pilots. The committee recommends that large, poster size copies of the procedures be displayed at each flight school, in each FBO's pilot lounge, on the ground floor of the civil air terminal, in the control tower and wherever else deemed useful. In addition, the procedures should be included on the Hanscom web page.

Expected benefits
Formalizing the noise abatement procedures for use at Hanscom Field will provide useful guidance to pilots and help them abate the effect of noise on the surrounding communities. Distributing and displaying these procedures is the first step in educating all airport uses concerning the noise issues.

Potential Adverse Effects
None

Resources required
Volunteer hours necessary to formulate the noise abatement procedures. Massport man-hours and cost to print, duplicate, distribute and display the procedures.

RECOMMENDATION A2: DISTRIBUTION TO RENTERS

The Workgroup recommends that Massport duplicate the voluntary noise abatement procedures in sufficient quantities so that each flight school can distribute the procedures to all aircraft renters.

<u>Time Frame</u>
Immediate

<u>Background</u>
Renters of aircraft at Hanscom Field may not be aware of the recent efforts to mitigate the effect of noise on the surrounding communities. The Workgroup recommends that an information sheet with the voluntary noise abatement procedures be reproduced by Massport in sufficient quantity so that each flight school can distribute the procedures to all aircraft renters. The flight schools should encourage renters to follow the voluntary procedures whenever possible.

<u>Expected benefits</u>
Education of pilots will increase the use of recommended noise abatement procedures and mitigate the effects of noise on the surrounding communities.

<u>Potential Adverse Effects</u>
None

<u>Resources required</u>
Man-hours and expense necessary to duplicate and distribute the information sheet to all flight schools.

RECOMMENDATION A3: INFORMATIVE PAGE MARKERS

The Workgroup recommends that Massport print and distribute informative page markers for Jeppesen and Flightguide handbooks and distribute to local and transient pilots.

Time Frame
Immediate

Background
Pilots own and refer to approach plates and airport facility information in popular handbooks. They often place plastic or cardboard markers in the books to help turn quickly to destination airports. Such place markers are used by many airports to communicate local procedures and noise abatement information. Such markers are not available for Hanscom.

Expected Benefits
Immediate exposure to noise abatement reminders during the flight planning phase (placing markers) and nearing the airport (approach plates or airport diagrams) is likely to increase use of noise abatement procedures.

Potential Adverse Effects
None

Resources required
Printing and die-cutting costs. Free distribution via FBO's , or inclusion in other mailings.

RECOMMENDATION A4: FLIGHT SCHOOL BRIEFINGS

The Workgroup recommends that Hanscom flight schools display local noise abatement procedures and information in their flight planning room and should distribute noise abatement information to their pilots. Local noise abatement procedures and the AOPA Fly Friendly program should be briefed to all flight instructors at least annually, and students should be required to view the AOPA Fly Friendly video at some time during their training.

Time Frame
Immediate

Background
Hanscom flight schools are important and influential member of the Hanscom flying community. They provide means for effective communication of procedures and responsibilities to pilots.

Expected benefits
Education of pilots will increase the use of recommended noise abatement procedures and mitigate the effects of noise on the surrounding communities.

Potential Adverse Effects
None

Resources required
Approximately 15 man-hours per year to post and maintain noise abatement display, distribute information, and brief members.

RECOMMENDATION A5: FLIGHT TRAINING CENTER BRIEFINGS

The Workgroup recommends that the Hanscom AFB Flight Training Center (a.k.a. Hanscom AFB Aero Club) display local noise abatement procedures and information in its flight planning room and should distribute noise abatement flyers to its members. Local noise abatement procedures and the AOPA Fly Friendly program should be briefed at Flight Training Center safety meetings at least annually. New club members should be required to view the AOPA Fly Friendly video.

Time Frame
Immediate

Background
The Hanscom AFB Aero Club is an important and influential member of the Hanscom flying community. It provides a flight planning room and requires its members to attend regular briefings. These provide potential means for effective communication of procedures and responsibilities to both members and other pilots.

Expected benefits
Education of pilots will increase the use of recommended noise abatement procedures and mitigate the effects of noise on the surrounding communities.

Potential Adverse Effects
None

Resources required
Cost of reproducing noise abatement flyers. Approximately 15 man hours per year to post and maintain noise abatement display, distribute flyers, and brief members.

RECOMMENDATION A6: FBO GUEST FOLLOWUP

The Workgroup recommends that each FBO institute a guest sign-in sheet and follow up with a letter to each transient pilot describing the voluntary noise abatement procedures at Hanscom.

Time Frame
Immediate

Background
Many of the transient pilots may not be aware of the recent efforts to mitigate the effect of noise on the surrounding communities. The Workgroup recommends that each FBO institute a guest sign-in sheet and follow up with letters to transient pilots explaining the voluntary noise abatement procedures at Hanscom, and encouraging them to follow the procedures whenever possible.

Expected benefits
Education of transient pilots will increase the use of recommended noise abatement procedures and mitigate the effects of noise on the surrounding communities.

Potential Adverse Effects
None

Resources required
Preliminary discussions with each FBO has taken place. Each FBO has expressed their support. The required resources are the man-hours and postage necessary to send a letter to all transient pilots.

RECOMMENDATION A7: MASSPORT WEB SITE

The Workgroup recommends that Massport expand their public access web site to include the voluntary noise abatement procedures for Hanscom Field.

Time Frame
Immediate

Background
The Internet has become a major pathway for communicating information. A public-access web site allows the release of information to occur in a timely manner. Postings should include information about unusual operations and activities as well as local noise abatement procedures. This web site should be mutually linked to the USAF and other web-based pre-flight planning resources used by both military and civilian pilots.

Expected benefits
Education of both area residents and pilots will help in working towards the common goal of mitigating the effects of noise on the surrounding communities.

Potential Adverse Effects
None

Resources required
Man-hours necessary to maintain the web site.

RECOMMENDATION A8: ATIS BROADCAST

The Workgroup recommends that a reminder that voluntary noise abatement procedures are in effect be include in the ATIS (Automated Terminal information System) broadcast. Whenever workload permits, this information should be followed with reminders from the Tower, Ground and/or Clearance Delivery.

Time Frame
Immediate

Background
At many airports nationwide, noise abatement reminders are included in the ATIS broadcast. Such information is not regularly provided in the Hanscom ATIS broadcast or via Ground, Tower or Clearance Delivery communications.

Expected benefits
The ATIS broadcast normally is the first information concerning current airport conditions and operations that arriving or departing aircraft hear. Including in this broadcast a reminder that voluntary noise abatement procedures are in effect will allow pilots time to plan and, if possible, to modify their flight profiles to mitigate the impact of noise.

Potential Adverse Effects
None

Resources required
FAA, Massport and the Tower Operations need to amend their protocol to include the recommended noise abatement reminders in the ATIS and other communications.

RECOMMENDATION A9: HANSCOM AFB LEADER BRIEFINGS

The Workgroup recommends that Hanscom AFB representatives to the Hanscom Noise Workgroup brief Electronic Systems Center (ESC) and 66th Air Base Wing (66 ABW) leaders on local noise abatement procedures, sensitivities, and issues. The audience for such a briefing should include program directors, who coordinate flight test support for their programs. The briefing content should highlight the need to consider noise abatement issues and possible alternate locations when coordinating flight test support.

Time Frame
Immediate

Background
ESC and 66 ABW leaders and program directors, who may request or coordinate flight tests at Hanscom, have not ordinarily been included in informative programs relating to the potential noise impact of such operations or tests.

Expected benefits
Education of ESC and 66 ABW leaders and program directors will increase the use of recommended noise abatement procedures and mitigate the effects of noise on the surrounding communities.

Potential Adverse Effects
None

Resources required
Approximately 10 man hours to develop and deliver briefing. Approximately 5 man hours per year to maintain briefing and to deliver it annually.

RECOMMENDATION A10: MILITARY FLIGHT CREWS

The Workgroup recommends that Hanscom AFB Transient Alert display and distribute local noise abatement procedures and information to military flight crews using their facility.

Time Frame
Immediate

Background
Local noise abatement procedures have not been readily available to military flight crews in the past due to the absence of displaying such information in Transient Alert. The increasing attention towards aircraft noise warrants military pilot awareness of local community sensitivities.

Expected benefits
Educating military pilots on recommended noise abatement procedures will alert them to community interest regarding aircraft noise and assist in minimizing such noise activity.

Potential Adverse Effects
None

Resources Required
Cost of reproducing noise abatement information.

RECOMMENDATION A11: ESC WEB PAGE

The Workgroup recommends that the Electronic Systems Center create a local noise abatement procedures web page that is easily accessible from both public access and restricted access web sites. This page should be mutually linked to the Massport and Hanscom Field web sites. It should also be linked to web-based pre-flight planning resources used by both military and civilian pilots.

Time Frame
Immediate

Background
The web is becoming a very important planning resource for both military and civilian pilots associated with the Electronic Systems Center. It is also an important resource for members of the public seeking information about efforts to reduce environmental impacts.

Expected benefits
Education of pilots will increase the use of recommended noise abatement procedures and mitigate the effects of noise on the surrounding communities. Area residents are more likely to tolerate Air Force-generated noise if they understand that the Air Force is attempting to mitigate noise by using noise abatement procedures.

Potential Adverse Effects
None

Resources required
Approximately five man hours to create the web page and to comprehensively link it to other web based flight planning tools.

RECOMMENDATION A12: ESC PRESS RELEASES

The Workgroup recommends that the Electronic Systems Center Office of Public Affairs send Hanscom area local newspapers regular (biweekly or monthly) news releases updating area residents on Air Force flight operations, subject to security considerations.

Time Frame
Immediate

Background
The Electronic Systems Center Office of Public Affairs should send Hanscom area local newspapers regular (biweekly or monthly) news releases updating area residents on Air Force flight operations. Security considerations permitting, these news releases should include information about upcoming operations. When security considerations or scheduling issues preclude releasing information prior to an operation, information should be released after the operation has occurred, provided this would not endanger the security of future operations.

Expected benefits
Area residents are more likely to tolerate Air Force-generated noise if they understand why particular operations are necessary. News releases that include reasons for particular flight operations would be more useful than simply releasing flight schedules.

Potential Adverse Effects
None

Resources required
Approximately 3 man hours per month to write information.

RECOMMENDATION A13: ESC WEB SITE NEWS RELEASES

The Workgroup recommends that the Electronic Systems Center Office of Public Affairs add information about Air Force flight operations to the public access section of the Hanscom AFB web site, subject to security considerations.

Time Frame
Immediate

Background
The Air Force currently maintains a web site for Hanscom. The public access section does not include information about Air Force flight operations. Public access to operational information through this site will not compromise security since information posted to the Hanscom AFB web site would be subject to the same security and content considerations as news release information. This section of the Hanscom AFB web site should be mutually linked to MASSPORT and Hanscom Field web sites.

Expected benefits
This would allow the release of information to occur in a more timely and accessible manner than would be possible using only biweekly or monthly news releases.

Potential Adverse Effects
None

Resources required
Approximately 3 man hours per month to write and maintain information.

RECOMMENDATION A14: AOPA VIDEO DISTRIBUTION

The Workgroup recommends that Massport purchase and distribute the AOPA Fly Friendly video to all Hanscom pilots.

Time Frame
Immediate

Background
The AOPA has produced a video to help educate pilots on the issues of noise and noise abatement. Many of the local aircraft owners and pilots may not be aware of this video. Although the Workgroup does not formally endorse the AOPA Fly Friendly video, we recommend that Massport purchase and distribute the video to all Hanscom pilots. A letter of introduction (see appendix) should be included with the video explaining to pilots the role that they can play in mitigation the effects of noise on the communities surrounding the Hanscom airport.

Expected benefits
Education of the local pilots will increase the use of recommended noise abatement procedures and mitigate the effects of noise on the surrounding communities.

Potential Adverse Effects
None

Resources required
Man-hours and cost to purchase and post the AOPA Fly Friendly video to all local pilots.

RECOMMENDATION A15: HANSCOM USER GROUP

The Workgroup recommends that Massport provide support to ensure that a representative user group be available to all users, pilots and businesses.

Time Frame:
Immediately

Background:
During the last three years, the Hanscom Area Resource Team (HART) has taken an active role throughout the GEIR, MOU, Noise Workgroup, etc. processes. Active membership is comprised principally of airport businesses and higher-end private aircraft operators. HART has volunteered to work with Massport to expand its current roster to include all users, pilots and businesses.

Expected benefits:
Substantial benefit can be gained from having a well informed and involved flying public. By virtue of maintaining a viable user group, issues can regularly be communicated and addressed.

Potential adverse effects:
None

Resources required:
Support in kind (i.e. use of copier, meeting room, etc.).
Possibly a $500 to $1000 budget for postage.

RECOMMENDATION A16: SELECTMEN AND TOWN BRIEFINGS

The Workgroup recommends that members of the Hanscom Noise Workgroup brief Town Selectmen on the group's findings. This briefing should include a description of recent efforts to mitigate the effects of noise on surrounding communities as well as an explanation of the local noise abatement procedures. The audience should include both selectmen and all interested towns people.

Time Frame
Immediate

Background

Expected benefits
Education of towns people and their leaders will help in working towards the common goal of mitigating the effects of noise on the surrounding communities.

Potential Adverse Effects
None

Resources required
Approximately 10 man hours to develop and deliver briefing.

RECOMMENDATION A17: PART 150 STUDY

The Workgroup recommends that a group representing local pilots, business interests, surrounding communities and Massport be formed to investigate the possibility and implications of reopening the Part 150 study at Hanscom Field.

Time Frame
Immediate with an end date of one year.

Background
The noise portion on an FAA Part 150 study establishes a baseline of current noise levels for the airport and its surrounding communities which the FAA requires before determining the necessity for and effectiveness of official noise abatement or mitigation procedures. A Part 150 study was started at Hanscom Airfield some years ago but never completed.

The charter of this group will be to understand the history of the original Part 150 study, determine where problems existed, evaluate if and how these problems can be resolved and determine if the Part 150 study should be reopened. The group should evaluate the expected benefits as well as the potential adverse effects of reopening the study.

Expected benefits
A determination of whether or not the necessary conditions for a successful Part 150 study exist at the present time will allow the communities and Massport to make an appropriate decision regarding the matter.

Potential Adverse Effects
None to investigate the possibility and implications of reopening the Part 150 study.

Resources required
Volunteer time, Massport staff participation and support in kind (use of copier, meeting room, etc.)

RECOMMENDATION A18: MODEL QUIET AIRPORT STUDY

The Workgroup recommends that a group representing surrounding communities, local pilots, business interests, and Massport be formed to define the scope and purpose of a Model Quiet Airport Study at Hanscom Field.

Time Frame
Immediate with an end date of one year.

Background
Hanscom Field is a modern general aviation airport situated in a suburban area with great historic significance, many unique sites, extensive open space retention/conservation and recreational facilities, natural resources and scenic waterways, bike paths and walkways. This unique situation may offer a rare opportunity to study issues relating to the running of a modern general aviation airport with the objective of minimal intrusion on the neighboring communities and the National Historic Park.

The charter of this group would be to define the scope and purpose of a Model Quiet Airport Study, indicate how such a study of Hanscom and its surrounding areas could be applied to other airports and investigate forms of funding, both federal, state and local.

Expected benefits
Hanscom Field offers a unique opportunity to study issues relating to combining the goals of a large modern airport and those of historic neighboring communities and a National Historic Park. Results of a such studies could have local implications and help to mitigate noise related problems.

Potential Adverse Effects
None

Resources required
Volunteer time, Massport staff participation and support in kind (use of copier, meeting room, etc.)

RECOMMENDATION A19: NON-PROFIT ORGANIZATION

The Workgroup recommends that a group representing local pilots, business interests, surrounding communities and Massport be formed to explore the idea of establishing a non-profit organization to raise funds to support various noise reduction and awareness programs.

Time Frame
Immediate with an end date of one year.

Background
A number of ideas will be studied by members of the Workgroup in the next year. If any of these ideas are viable, they will require funding. The charter of the group should be to investigate what forms of fund raising are and have been done by others, to define the scope and purpose of a non-profit fund raising organization, and to outline the management and control of such an organization.

Expected benefits
If such an organization could be formed, it might provide funds to support various noise reduction and awareness programs.

Potential Adverse Effects
None

Resources required
Volunteer time, Massport staff participation and support in kind (use of copier, meeting room, etc.)

RECOMMENDATION A20: NOISE ABATEMENT OFFICER

The Workgroup recommends that a group representing local pilots, business interests, surrounding communities and Massport be formed to explore the idea of establishing a Noise Abatement Officer position at Hanscom Field.

Time Frame
Immediate with an end date of one year.

Background
A designated Noise Abatement Officer has been effective at other airports in educating pilots and promoting issues relating to noise abatement and mitigation. A Noise Abatement Officer is ideally a senior pilot with excellent inter-personal skills, who is present in the ramp areas and at pilot gatherings and has access to noise complaint information.

The charter of this group will be to investigate what has been done at other airports, to define the scope and responsibilities of such an officer, to determine if and how such a position would complement the existing Massport staff and to explore the possibility of having the surrounding communities fund this position.

Expected benefits
The group will explore the issues surrounding and define the responsibilities of a designated noise officer.

Potential Adverse Effects
None

Resources required
Volunteer time, Massport staff participation and support in kind (use of copier, meeting room, etc.)

RECOMMENDATION A21: NOISE OVERLAY ZONING

The Workgroup recommends that a group be formed, including representatives of the Planning Boards from the towns of Lincoln, Lexington, Bedford and Concord, to study the issues associated with the creation of Noise Overlay Zoning Districts.

<u>Time Frame</u>
Two years

<u>Background</u>
Prospective buyers and land developers may not be aware of the levels of noise exposure in areas surrounding Hanscom Field. The adverse effect of airfield-related noise can be reduced by managing the built environment in the airfield areas. Noise-sensitive land uses, such as single-family homes and schools could be sited in such a way as to prevent the exposure of area residents to significant noise effects of airport operations. Certain building techniques could be required by zoning that could further lessen the impact of airfield-related noise for both existing and proposed buildings. A Noise Overlay Zoning District is a special type of zoning district that places additional requirements on existing (underlying) zoning districts within a geographical area.

<u>Expected Benefits</u>
Citizens and representatives of the town boards will be better able to understand the potential benefits and consequences of noise overlay zoning.

<u>Potential Adverse Effects</u>
None to study the issues associated with the creation of Noise Overlay Zoning Districts.

<u>Resources Required</u>
Time and resources of Town Planning Boards and Town managements.

I. INTRODUCTION TO NOISE METRICS RECOMMENDATIONS

In the June 30, 1997 Hanscom Generic Environmental Impact Report (GEIR) Certificate, the Massachusetts Secretary of Environmental Affairs asked for formation of a Hanscom Field Noise Workgroup. The Workgroup was made up of community representatives selected by the four Hanscom area towns (Bedford, Concord, Lexington, and Lincoln), representatives from flight groups, including HART and the Air Force, and representatives of Massport.

The Noise Metrics and Modeling Taskgroup is a subcommittee of the Hanscom Field Noise Workgroup. It was created to address three of the issues raised by Massachusetts Secretary of Environmental Affairs. The Noise Metrics Taskgroup was asked to recommend:

i. An appropriate baseline to measure and evaluate noise impacts and evaluate them;

ii. A set of metrics that report not only instrument readings, but also the perceived impact of noise events;

iii. The content and form of noise discussion that Massport is to adopt for the 2000 GEIR Update.

The Workgroup would like to thank Massport for its support of the efforts of the Workgroup. Massport supplied meeting sites, knowledgeable personnel, and paid for the consulting services of their noise experts, HMMH. This spirit of cooperation allowed the production of this report, which we believe can make an important contribution to understanding and quantifying changes in airport noise at Hanscom Field, and help improve community relations.

A significant finding was that the science of noise impacts on people is still developing, and that our recommendations should evolve as more is learned. This report puts forward our current conclusions, but it is likely that further suggestions may arise by the time Massport presents its proposal for the next GEIR. We believe that implementation of these recommendations will facilitate the public assessment of the environmental impacts of current or planned airport activities.

A potentially more important finding was that the noise metrics used in the 1995 GEIR caused a lack of trust, not just of the GEIR, but of the people who created it and paid for it. We believe that implementation of the recommendations outlined herein will improve communications and reduce misunderstanding between the airport and its neighbors. A mutually desirable outcome is a higher level of confidence and cooperation.

Overview of Recommendations

The Noise Metrics Taskgroup recognized that improving noise metrics could involve additional costs to implement. We attempted to minimize costs by using existing noise modeling techniques, existing computer programs, and existing noise instrumentation, as well as better data. We also detailed changes to the noise discussions in future GEIRs to improve communications with the communities. And we recommended a process enhancement to maintain clear understandings between all the parties. These recommendations can be briefly summarized as follows:

- The summary metrics in this report should be used to improve communication with the general public.
- A community group should be chartered to follow up these recommendations.
- The INM model should be used to generate additional noise data in future GEIRs, as per the detailed recommendations provided below.
- The noise discussion in future GEIRs should include information on errors and assumptions, as per the detailed recommendations provided below.

- Additional data and information regarding noise measurements and the computer noise simulation should be provided.
- The noise measurement program should be modified and upgraded.

Approach to Noise Metrics

Designing a noise metric is a difficult job. The first task was to set goals for the metric. After much study, the Metrics Taskgroup developed a number of criteria for an ideal noise metric. An ideal noise metric, or set of metrics, should:

- Account for sound level above ambient noise level
- Account for the duration of aircraft noise events
- Account for the number of aircraft noise events
- Account for the number of people affected
- Account for the absolute sound level of events
- Assess both current aviation operations, and predict impacts of future changes (i.e., changes in the number of operations, or changes in fleet mix)
- Reflect the "peaky" nature of overflight noise (i.e., does not average excessively over space or time)
- Readily express year-to-year and month-to-month changes in the environment caused by overflights
- Correlate, to the best extent possible, to the subjective perceptions of the community affected by overflights
- Provide sufficient detail to allow analysis to understand the root cause of noise and noise trends
- Complement, but not replace, the Day-Night Noise Level (DNL, also referred to as Ldn), which is currently used
- Can be modeled by the Integrated Noise Model (INM) program
- Be measurable by the currently available noise monitoring system
- Permit a rerun of INM data from previous years
- Show the variations of predicted noise levels expected from modeling assumptions and simplifications

It became clear that no single metric meets all these criteria. We determined that at least five metrics were required to adequately show and communicate the various features of aircraft noise impact on the Hanscom area:

1) Time Above (TA) **-** This is a broad metric that changes approximately linearly with the number of aircraft operations, while also showing the effect of changes in fleet mix.

2) Single Event Level Distribution (SEL/D) **-** This is a metric that shows the number of flight operations as a function of noise level.

3) Linear, dimensionless metric of Sound Pressure **-** This is a concept for a metric that expresses the ratio of aircraft-generated sound to the ambient in a non-logarithmic manner (unlike the DNL, which employs decibels, which are based on logarithms). (The Taskgroup made considerable progress toward developing such a metric, but did not complete the work during this phase.)

4) Improved DNL **-** This is an expanded use of DNL.

5) Citizens Summary Metrics - A small subset of the above metrics that can be readily understood by a nontechnical public.

Taken together, we believe that these five metrics could meet the criteria for a good metric. Each metric by itself may cover several of the criteria, but omitting any one metric will cause at least one of the criteria to be unfulfilled.

These metrics are discussed briefly in the Summary Recommendations section (Section II), in the Detailed Explanation of Recommendations (Section III), and in the Technical Discussions section (Section IV). Additional support material is included in Appendix 2.

II. LIST OF THE METRICS RECOMMENDATIONS

In this section we simply list concise statements of each of the 14 Metrcis Recommendations. We supply information on the rationale, details of implementation and expected benefits of each Recommendation individually in Sections III and IV. Readers should take care to read all information on each Recommendation.

M1. The Workgroup recommends that HATS and HFAC take take the responsibility to charter a community group to follow up these metrics recommendations and work with Massport to further develop, refine, and implement the recommendations of this report, review any pre-GEIR data supplied in response to our recommendations, and report to HATS and HFAC on progress related to implementation. This community group, HATS and HFAC should also make suggestions on changes to the noise discussion in the GEIR based on a further review of the 1995 GEIR.

M2. The Workgroup recommends that all future GEIR and annual Hanscom noise reports include the Time Above Contour metric, with areas included within each contour computed, as a clear way to show changes in exposure to a wide range of aircraft noise.

M3. The Workgroup recommends that future monthly, yearly, and GEIR Hanscom noise reports include the Single Event Level Distribution (SEL/D) metric to show changes in the distribution of individual noise events.

M4. The Workgroup recommends that future GEIR Hanscom noise reports include a linear dimensionless metric (to complement the logarithmic decibel metric used for L_{dn}) to show exposure to noise energy. The Workgroup recommends that the Follow-up group described in Recommendation M1 continue to study the design of such a metric and methodology for implementation in the next GEIR.

M5. The Workgroup recommends that the discussion of the noise impact on residential use in future GEIRs include reference to the EPA level of 55 dB DNL and avoid the implication that DNL of less than 65 dB DNL (the FAA mitigation threshold) has no impact.

M6. The Workgroup recommends that future GEIR's and annual noise reports provide Community Summary Metrics - i.e., Monthly Loud Events Count, Area Impacted by Noise per EPA, and Area Experiencing 30 or more minutes per day of 55 dBA or greater Aircraft Noise. These three single-number measures are intended to be easy for people to understand and relate to their personal experience.

M7. The Workgroup recommends that whenever data derived from INM modeling are presented, documentation be supplied including a detailed list of the assumptions and model parameters selected by the Massport noise consultants for input to the INM.

M8. The Workgroup recommends that future GEIRs include: i) a section estimating the expected variation in results from the INM due to the use of different modeling assumptions. Massport should adopt a standard practice of reporting estimated variations as "error bands" when reporting modeled data; ii) the GEIRs should also include a comparison of the results of noise modeling to actual measured noise data, and explanations of differences.

M9. The Workgroup recommends that future GEIRs include a section explaining the expected short-term variations in noise from the long-term average values.

M10. The Workgroup recommends that the next GEIR include a section documenting how changes in the FAA Integrated Noise Model data affect the predicted total noise exposure. 1987 is acceptable as a baseline year, provided that available data from 1978 onward be presented in all year-to-year comparisons.

M11. The Workgroup recommends that three of the six permanent noise monitoring sites be relocated away from local high-level concentrated noise sources.

M12. The Workgroup recommends that more noise monitoring sites be added. Additional monitors should be placed in appropriate off-runway-axis locations to take account of curved flight paths.

M13. The Workgroup recommends that a procedure or system be developed that correlates noise events and data to flight operations and complaints. Massport should work with the aviation community to determine the appropriate constructive use of this capability and information.

M14. The Workgroup recommends that noise data be stored in a publicly-accessible location, such as an internet site.

III. METRICS DETAILED RECOMMENDATIONS

RECOMMENDATION M1: CONTINUING WORK AND FOLLOW-UP

The Workgroup recommends that HATS and HFAC take take the responsibility to charter a community group to follow up these metrics recommendations and work with Massport to further develop, refine, and implement the recommendations of this report, review any pre-GEIR data supplied in response to our recommendations, and report to HATS and HFAC on progress related to implementation. This community group, HATS and HFAC should also make suggestions on changes to the noise discussion in the GEIR based on a further review of the 1995 GEIR.

Applicability and Time Frame
From the time the Noise Workgroup disbands until the issuance of the next GEIR, subject to the concurrence of HATS.

Background
The noise workgroup completed the task regarding metrics recommendations, and made significant progress toward but did not complete the task of suggesting changes to the noise discussions in the GEIR. We believe there is value in continuing this work and that the outcome will be beneficial to both the communities and Massport. In addition, the implementation of these recommendations is likely to require ongoing discussions.

Technical discussion
A supplemental technical discussion for this recommendation is provided under Technical Discussion TD1.

Example
See technical discussion TD1 for examples of the types of changes to the noise discussion of the GEIR that might be appropriate.

Benefits
A mechanism for follow up on the recommendations is provided. In addition, by providing suggestions prior to the draft of the next GEIR, Massport will have the opportunity to incorporate them into the GEIR on the first draft, which has the potential to reduce both conflict and any rework expenses relating to the GEIR.

Resources
A commitment by the HATS subcommittee and a commitment by Massport to work with this group are needed.

RECOMMENDATION M2 TIME ABOVE CONTOURS

The Workgroup recommends that all future GEIR and annual Hanscom noise reports include the Time Above Contour metric, with areas included within each contour computed, as a clear way to show changes in exposure to a wide range of aircraft noise. [See Technical Discussion TD2 for the specific time and level parameters to be used.]

Applicability and Time Frame

The TAC metric should be provided in the next Hanscom Annual Report, but if it were supplied to the communities before that time it would be helpful in interpreting the 1995 GEIR.

Background

By generating contours of Time Above at specified dBA thresholds, and measuring the area inside each contour, a simple metric is created that shows year to year changes in the duration of various levels of aviation noise. Percentage changes in Time Above correlate very well with percentage change in total aircraft operations.

The 1995 GEIR presented measured Time Above data, in tabular format, for L_{90} levels (background noise levels) ranging from 35 dBA to 50 dBA (see Tables 2.3-6 through 2.3-8, and discussion of pages 2-90 to 2-93). This recommendation thus amounts to the calculation and presentation of TA contours corresponding to the same data. We recommend that the data tables like those cited above also be continued.

Technical Discussion

A supplemental technical discussion for this recommendation is provided under Technical Discussion TD2. Samples of Hanscom Time Above Contours that Massport provided as part of this study are included in Appendix 2.

Benefits

As a metric, Time Above Contours provide a very good assessment of the duration of time that sites are impacted by aircraft noise and the changes in that impact caused by changes in operations and fleet mix. For example, in the 1995 GEIR, trends are clearly shown and models correlate well with observations. It is a metric that is easy to explain to the public, and so will enhance communications. For example, if noisy jets are replaced by quiet jets, area residents will see that their house is no longer exposed to 30 minutes a day above 65 dBA, and that the area within the 65 dBA contour has shrunk by a significant amount.

Resources

Massport's noise consultant will be needed to generate a number of Time Above Contours, and to calculate the areas inside these contours. Since Time Above contours are already calculated by the INM, this should require little extra effort or expense.

RECOMMENDATION M3 SINGLE EVENT LEVEL DISTRIBUTION (SEL/D)

The Workgroup recommends that future monthly, yearly, and GEIR Hanscom noise reports include the Single Event Level Distribution (SEL/D) metric to show changes in the distribution of individual noise events.

Applicability and Time Frame
The SEL/D metric should be provided in the next Hanscom GEIR, but if it were supplied to the communities before that time it would be helpful in interpreting the current GEIR.

Background
Some parts of the Hanscom community are most affected by a small number of very loud aircraft events. These noise events are relatively infrequent and of short duration, so they have little effect on "averaged" noise metrics like DNL. These intense and abrupt increases over the ambient, however, may be responsible for significant annoyance in the communities due to sleep disturbance, speech interference, and other activity interference.

By making a bar graph of the count of aircraft operations, with a bar for every 2 dBA above 90 dBA, a metric is created that clearly shows both the quantity and loudness of the noisiest aircraft operations. The levels themselves need not be measured. Rather, they are levels from the EXP database, which catalogs sound levels for takeoff and landing for each aircraft type. The database values are themselves taken from actual measurements of each aircraft type, taken under standard conditions. (The EXP database is used by Massport as the basis of calculations in the Integrated Noise Model.)

This metric will simplify year-to-year comparisons and observation of trends in very loud events. For example, as noisy jets are replaced by quieter jets, the size of the high-dBA bars will drop linearly with the percentage shift to quieter aircraft.

Technical Discussion
A supplemental technical discussion for this recommendation is provided under Technical Discussion TD3.

Benefits
The SEL/D metric provides a good assessment of the impact of very loud aircraft operations and the impact of changes in numbers of very loud events that might occur, for example, as the fleet mix changes. Trends are clearly shown in ways that are easy to explain to the public, and so will enhance communications. For example, if noisy jets are replaced by quiet jets, area residents will see that the 105 dBA bar is lower (see TD3).

Resources
The monthly Hanscom Noise Report already reports the number of operations by aircraft type. Thus, it will be a relatively straightforward matter to apply the EXP database values to the number of operations, and graph them (e.g., via the use of a spreadsheet program.) Thus, once the methodology is established (e.g., developing a spreadsheet) generation of this metric should require little extra effort or expense, and need not require a noise consultant.

RECOMMENDATION M4 LINEAR DIMENSIONLESS METRIC

The Workgroup recommends that future GEIR Hanscom noise reports include a linear dimensionless metric (to complement the logarithmic decibel metric used for L_{dn}) to show exposure to noise energy. We recommend that the Follow-up group described in Recommendation M1 continue to study the design of such a metric and methodology for implementation in the next GEIR.

Time Frame/Applicability
A linear method or metric should be developed and reported in all subsequent GEIRs.

Background
Ldn contours have been generated for past GEIRs using the computer-based Integrated Noise Model (INM). Ldn is a widely used metric, but has been confusing to the public on a number of counts.

The Metrics Taskgroup explored, but did not complete its work on, a linear dimensionless metric. The Taskgroup did agree, however, that a linear dimensionless metric comparing Aviation to Ambient Sound Pressure or Sound Energy remains a worthy goal, as decibels tend to obscure the true scale of noise exposure. For example, an increase of DNL from 55 to 58 dB will seem, to those expecting a linear scale relationship, to be a minor increase. In reality, of course, such an increase actually represents a doubling of sound energy. It is this sort of misinterpretation the Taskgroup seeks to dispel.

Technical Discussion
A supplemental technical discussion for this recommendation is provided under Technical Discussion TD4.

Benefits
A linear noise energy exposure metric will be more easily understood by the public than a logarithmic (dB) metric, and can be scaled to avoid inappropriate comparisons with other noise measurements and metrics. Changes in the area inside each contour related to such a metric provide an easy way to compare one year with another, showing trends and changes in aviation noise energy exposure.

Resources
We expect that Massport's noise consultant will need to be involved in the determination of a linear metric. Thus, funding may be required. It may be appropriate to seek outside or Federal funding for such an effort.

RECOMMENDATION M5: EXPANDED DISCUSSION OF DNL

The Workgroup recommends that the discussion of the noise impact on residential use in future GEIRs include reference to the EPA level of 55 dB DNL and avoid the implication that DNL of less than 65 dB DNL (the FAA mitigation threshold) has no impact.

Applicability and Time Frame
Discussion and explanation of this issue should be provided in the next Hanscom GEIR.

Background
There are conflicting positions on what DNL level constitutes a problem for residential use:

- The FAA defines areas subject to DNL of greater than 65 dB to be "incompatible with residential land use", and such affected areas may be eligible for noise mitigation funding.

- The U.S. EPA has established through reports and administrative comments that 55 dB is the noise limit that is satisfactory to protect human health and welfare in a residential setting –"Outdoor yearly levels on the Ldn [DNL] scale are sufficient to protect public health and welfare if they do not exceed 55 dB in sensitive areas (residences, schools, and hospitals)." (EPA Publication #319, "Protective Noise Levels", 1978).

- Concerns regarding the exclusive use of 65 dB DNL have been expressed repeatedly and consistently at various meetings of the Federal Interagency Committee on Aircraft Noise (FICAN.) The 1997 FICAN Annual Report (p. 16 – 17) makes it clear that the issue of 65 dB DNL as the proper level of land use compatibility is widely questioned, and that this DNL is no longer considered appropriate, particularly in suburban and rural areas.

Given these contrasting opinions, we concluded that discussion of the impact of both 65 dB and 55 dB Ldn levels would provide additional data that would be very useful to present and future Hanscom noise analysts.

Technical Discussion
A supplemental technical discussion for this recommendation is provided under Technical Discussion TD5.

Benefits
Until the disagreement between U.S. agencies is resolved about the optimum use of Ldn, the appropriate level at which there is potential noise impact will remain open to argument. Instead of choosing only one Ldn level or the other, discussion of both levels of potential impact will allow current and future noise analysts to better evaluate and understand impacts and trends, and plan mitigation options, pending agreement on an acceptable Ldn level.

Resources
Massport's noise consultant will be needed to research and write up a discussion of potential impact at the 55 dB Ldn level

RECOMMENDATION M6 COMMUNITY SUMMARY METRICS

The Workgroup recommends that future GEIRs and annual noise reports provide Community Summary Metrics - i.e., Monthly Loud Events Count, Area Impacted by Noise per EPA, and Area Experiencing 30 or more minutes per day of 55 dBA or greater Aircraft Noise. These three single-number measures are intended to be easy for people to understand and relate to their personal experience.

Applicability and Time Frame
These metrics should be used on Hanscom noise data and the results reported in the GEIR, and in the Annual Noise Report.

Background
A great deal of misunderstanding regarding the airport occurs because there are people in the communities who don't understand the Hanscom noise information currently provided by Massport. We found that in many cases it is not the data that is the problem, but rather the way the data is summarized and communicated to the public. For example, table 4.3-3 of the 1995 GEIR shows a count of the Hanscom area residences "impacted by Aircraft Noise", and concludes that 29 residences are impacted in Bedford and zero residences are impacted in Concord, Lexington, and Lincoln. This is confusing to many people in these towns, since (based on their direct experience with Hanscom noise) they consider themselves impacted.

We distilled summary metrics from the detailed noise data. These metrics will be more acceptable to the public, and will overcome many of the problems associated with the more commonly used DNL contours. The necessary calculations have either been performed already, or will be as part of previous recommendations:

- Area Experiencing 30 or more minutes per day of 55 dBA or greater Aircraft Noise. – Time Above Contours recommendation
- Area Impacted by Noise per EPA – present DNL contours
- Monthly Loud Events Count – from monthly operations data and EXP database. (This is a distillation of the results from the SEL/D recommendation.)

Technical discussion
A detailed technical discussion is provided in Technical Discussion TD6.

Example
The three Community Summary Metrics are computed in a straightforward manner from other data used in the INM model as shown:

Metric	Source (how computed)	Include In
Area Experiencing 30 or more minutes per day of 55 dBA or greater Aircraft Noise	Area of 30 minute contour for Time Above 55 dB	GEIR, Annual Noise Reports
Area Impacted by Noise per EPA	Area of 55 dB DNL contour	GEIR, Annual Noise Reports
Monthly Loud Events Count	Events (count) per month > 94 dB departure SEL from EXP database	GEIR, Annual, Monthly Noise Reports

Benefits
The benefits include a greater acceptance of Massport's Environmental Impact Reports by the public, and more confidence on the part of the public that noise impacts are understandable and have been disclosed.

Resources
Additional annual INM runs may be required.

RECOMMENDATION #7: NOISE MODELING ASSUMPTIONS

The Workgroup recommends that whenever data derived from INM modeling are presented, documentation be supplied including a detailed list of the assumptions and model parameters selected by the Massport noise consultants for input to the INM.

Applicability and Time Frame
This information should be provided in the next GEIR, but if it were supplied to the communities before that time it would be helpful in interpreting the current GEIR

Background
Modeling is an attempt to predict the effect of an actual event by purely mathematical means. Interpretation of modeling results requires an understanding of the assumptions that have been made in the math model, as well as the sets of numbers used as inputs. It is standard procedure in scientific disciplines to explicitly state assumptions and input parameters when models are used.

We identified some modeling assumptions that we believe may have serious effect on the INM model results and we find that the nature of the assumptions has not been clearly communicated in the GEIR. Some of these assumptions may be under the control of the person running the model; others are "built in" to the Integrated Noise Model computer program, and therefore not subject to Massport or its consultant's discretion. In either case, GEIR readers should understand and appreciate the assumptions and limitations inherent in the model. Where choices have been made by Massport or its consultant, they should be made explicit. Where the INM allows no options, it should also be made clear.

Technical discussion
A supplemental technical discussion for this recommendation is provided under Technical Discussion TD7

Example
Examples of the types of assumptions that need to be made explicit and validated include:

- Aircraft climb profile assumptions.
- Aircraft takeoff weights
- Noise profile for groups: What noise profile is assumed for an aircraft group if actual aircraft types within the group generate different noise levels?
- Helicopter modeling: Are these flights included in the modeling and are any different assumptions regarding flight tracks or climb profiles used?
- Run-up: Does the INM include "run-up" operations (INM 5.1 Manual, p.9-14)?
- Flap settings: What flap settings (coefficients) are being assumed (INM 5.1 Manual, p. 8-41)?
- Track patterns vs. type: Do track patterns for noisy jets (like G2) differ from quieter jet track patterns (like Class 3)? If yes, are they modeled as one category?
- Temperature: Is the default INM temperature used and is it the appropriate choice?
- Other fundamental assumptions: Any assumptions that are input to the model which may materially affect the output should be made explicit.

Benefits
Listing and justification of all assumptions made in applying the INM can help to establish a confidence level required for a satisfactory and meaningful communication of the model's predictions. If the GEIR comparisons of changes in overflight impacts on the population around the Hanscom Field airport are to be meaningful, then the year-to-year assumptions must be compared explicitly to confirm that they are identical. Making communication of such assumptions part of the GEIR Report clarifies the noise prediction process, and ensures that all comparisons, over any time period, be made with equivalent assumptions. If appropriate, adjustments to the assumptions should be identified and explained, and be made to improve the predictive accuracy of the models.

Resources

Massport should provide the INM documentation to the HATS Environmental Subcommittee and Topic Review Committees, or else include detailed discussions of assumptions and input choices as part of the GEIR. Where information is not available from the INM manual, Massport's noise consultant may need to meet with interested parties to identify assumptions made.

RECOMMENDATION M8: MODELING ERRORS

The Workgroup recommends that future GEIRs include: i) a section estimating the expected variation in results from the INM due to the use of different modeling assumptions. Massport should adopt a standard practice of reporting estimated variations as "error bands" when reporting modeled data; ii) the GEIRs should also include a comparison of the results of noise modeling to actual measured noise data, and explanations of differences.

Applicability and Time Frame
This information should be provided in the next GEIR.

Background
In the past, GEIR Reports have not included any estimates of potential errors associated with the various assumptions made in the input to the model or techniques applied in order to facilitate and simplify the computations. The Workgroup believes that estimation and display of such effects is crucial and recommends that such estimation and display be an integral part of any future GEIR updates. By way of analogy, when predictions are made regarding the expected results of an election or results of public opinion polling are reported, it is standard practice to associate some measure of error with the predicted or sampled result. In other words, modeled DNL data should be accompanied with a statement "this is a 65 dB contour, but the accuracy of this INM modeled data is estimated at ±1 dB or ±10 dB," etc. (as appropriate)

As a second point, we note that it is standard procedure in scientific disciplines to discuss variations in measured data, and differences between modeled and measured data.
This is not simply an academic question because there are some substantial unexplained differences between DNL values predicted by the model and the actual measurements. The measured and predicted values off the ends of the main runway differ by many dB at many of the permanent and temporary sites discussed in the 1995 GEIR.

To understand the magnitude of an 8 dB DNL difference, consider the following: the number of aircraft operations fed to the model would need to be increased by a <u>factor of six</u> to raise the predicted DNL values the 8 dB required to match the measured values.

The Noise Workgroup recognizes that reporting data variation is dependent to a large degree on the capabilities of the Integrated Noise Model and the accuracy of the noise monitoring system. Noise modeling with a distribution of input parameters and modeling assumptions will likely increase the cost of modeling results. Nevertheless, the Workgroup believes that GEIRs must explain and quantify the differences between measured and modeled data, and the variations due to modeling assumptions.

Technical discussion
A supplemental technical discussion for this recommendation is provided under Technical Discussion TD8.

Example
Examples of input data assumptions that impact the results of INM modeling and that should be described include:

- Wind: estimate the effect of the simplifying assumption that wind patterns are uniform from season to season.
- Fleet Mix along different flight tracks: estimate the effect of the simplifying assumption that fleet mix is uniform on all flight tracks.
- Flight track bundling : estimate the expected noise level variation due to simplifying assumptions in the modeling due to ***track bundling*** at various locations within the four-town area and at various distances away from the airport

Benefits
By discussing the sources of variation in the model and the magnitude of their consequences, the public gains greater confidence in the model and of the noise predictions made using the model.

Resources
It may be that this type of information has been developed as part of ongoing refinement of the INM, and as part of successive analyses for Hanscom. However, it is not, to our knowledge, documented. Providing this information will require additional work by Massport and its noise consultant. In particular, much work may be required to quantify the magnitude of data variation.

RECOMMENDATION M9: EXPECTED VARIATIONS FROM AVERAGES

The Workgroup recommends that future GEIRs include a section explaining the expected short-term variations in noise from the long-term average values.

Applicability and Time Frame
This information should be provided in the next GEIR.

Background
The results of noise modeling and measurement are averaged over long periods of time such as months or even a year. Human beings do not average their response over such long durations. Long term averaging can be a misleading predictor for impact for phenomena that occur with "clumps" or "bursts" of activity.

In a 1997 US congressional hearing on aircraft noise, it was pointed out by Representative Rivers that "There's an old saying that if you have a raging fire in front of you and an open window blowing snow behind you, on average, you feel great, but of course you don't".

It is well known in the communities that concentrations of aircraft noise seem to move around from day to day, with some days at a given location being virtually silent while other days at the same site are unbearable.

We found that this variation greatly affects the perceived impact of the airport and that an attempt should be made to understand and quantify this effect, which is obscured by the averaging of the models and measurements.

Technical discussion
Runway use is very much controlled by prevailing winds. Averaging the effect of aviation departures and arrivals over the entire year, results in a lower L_{dn} level per runway than the actual level registered on days that such a runway is used exclusively.

The currently reported L_{dn} levels are estimated by averaging the number of flights over the entire year (done separately by day, night, and runway). However, each Hanscom Field runway (5, 11, 23, and 29) tends to be used exclusively on some days of the year and not at all on other days. Runway usage is determined by wind direction, with takeoffs and landings being made into the wind. It follows that residents under a specific runway are exposed to essentially ambient noise on days the runway is not used, and to a much higher than reported L_{dn} on days the runway is used exclusively.

A supplemental technical discussion for this recommendation is provided under Technical Discussion TD9

Example
To provide an understanding of this effect, LDN under a flight path should be calculated for a location for days where the runway is in use, and then compared with the long term LDN (which includes days when the runway is not in use). In this way it will be possible to understand how much "extra" LDN is experienced on a "traffic" day. The example in the Technical Discussion shows that the Bedford/Lincoln flight paths may experience DNL values 5dB higher than the long term averages on those "traffic" days where the 5/23 runway is in use.

Benefits
Citizens know that aircraft noise moves from day to day. Many citizens have had the experience of a heavy traffic day and do not understand if this indicates growth or how it relates to the averages. We need to explain that such variations are normal and how much a "daily" DNL can be expected to vary from the averages.

Resources
A discussion and calculation similar to that provided in the Technical Discussion could be done by the noise consultants used during the next GEIR.

RECOMMENDATION M10: MAINTAINING CONSISTENCY ACROSS INM MODEL CHANGES

The Workgroup recommends that the next GEIR include a section documenting how changes in the FAA Integrated Noise Model data affect the predicted total noise exposure. 1987 is acceptable as a baseline year, provided that available data from 1978 onward be presented in all year-to-year comparisons.

Applicability and Time Frame
Information about changes in EXP data was provided in the 1995 Hanscom GEIR Update (Tables 2.3-9 and 2.3-10) and this recommendation is to continue to provide and discuss such information in future GEIRs.

Background
The Integrated Noise Model (INM) computes predicted noise exposures based on an underlying set of noise data for individual aircraft types. From time to time, the FAA updates the data on the noise output from different aircraft types. This occurs when new aircraft types are added to the model, and when new or better information about specific existing aircraft types is discovered.

These changes to the underlying data are an attempt to make the model more accurate. However, these model changes can interfere with trending analysis.

This problem was recognized in the 1995 GEIR update and the EXP data was provided using both the past INM model and the latest INM model data. This recommendation is that such analysis become a standard part of the GEIR.

In addition, we note that in the June 30, 1997 GEIR Update Certificate (p. 8), the Secretary requested that before Massport begins its 2000 Update, the Workgroup determine “an appropriate baseline to use as a starting point for measuring Hansom Field’s noise impacts on the surrounding communities and on the value of information derived using this baseline.”

Having reviewed the record of noise studies for Hanscom, we recommend that year-to-year comparisons of noise impacts include all years since 1978 for which comparable data are available. If this is done, the Workgroup is willing to accept the use of 1987 as the “baseline year”, since the aggregate noise impact (as determined by the INM) is approximately the same for 1978 and 1987. Also, 1987 is the first year that database values are available in fully electronic form. It must be noted, however, that the fleet mixes in 1978 and 1987 were different. Thus, “baseline” cannot refer to the number of operations, as noise impacts of different aircraft differ. “Baseline” is used here to refer only to the combined noise impacts.

Technical discussion
A detailed supplemental technical discussion is provided in the Technical Discussion TD10.

Example
The total noise exposure (EXP) is a single number summarizing the acoustic output of the airport and is computed from the SEL values used in the INM database. Massport also breaks EXP down into its military, jet, and single-engine components. To provide continuity, current EXP calculations should be done with the same model that has been used in the last GEIR, and then repeated with the most current model. This will prevent changes in the model from obscuring trending data.

Benefits
This avoids ambiguity regarding whether trending conclusions are affected by model changes, and thereby provides a more complete disclosure of changes in noise impact.

Resources
This work was done in the 1995 GEIR and therefore we do not envision it to be significant incremental work for the next GEIR.

RECOMMENDATION M11: RELOCATION OF NOISE MONITORING SITES

The Workgroup recommends that three of the six permanent noise monitoring sites be relocated away from local high-level concentrated noise sources.

Applicability and Time Frame
Since the equipment at the six noise monitoring sites already exists, relocation could be implemented as soon as a source of funds is identified and the funds are allocated. An estimated period of 2 years would seem more than adequate to complete the project.

Background
Six permanent noise monitoring sites are located in the Hanscom Field area. These are supplemented by a number of temporary monitoring locations. Local site anomalies at three of the permanent sites (sites 34, 35, and 36) result in measurements which do not represent the true ambient noise characteristics of the surrounding local region.

Technical Discussion
A detailed supplemental technical discussion is provided in the Technical Discussion TD11

Benefits
Since the poorly located noise monitors represent nearly 50% of the noise sensors, significant improvements in the accuracy of measurements of the overall noise picture will result from a limited investment. Data to be published in the future GEIRs should more accurately represent the 4-town ambient noise environment.

Resources
It is understood that the resources to move monitoring sites may be significant. Workgroup members have offered to help work with property owners to achieve necessary relocations.

RECOMMENDATION M12: ADDITIONAL NOISE MONITORING SITES

The Workgroup recommends the addition of more noise monitoring sites. Additional monitors should be placed in appropriate off-runway-axis locations to take account of curved flight paths.

Applicability and Time Frame
This is a significant project, requiring study to determine the number and locations of future measurement sites, allocation of funds, project planning, approval by neighbors, installation of the equipment, and reconfiguration of the existing system to accommodate new monitors. A preliminary study and system expansion proposal should be undertaken as soon as possible, with results available within a year. Actual expansion will take much longer.

Background
The six existing monitoring sites are aligned with the axes of the four Hanscom runways (two off each end of runway 11/29, and one off each end of 5/23.) However, as the GEIR makes clear, flight tracks frequently curve well away from straight alignment with the axes of the runways. Therefore, the existing monitors do not adequately measure the noise of aircraft operations that curve away from straight flight tracks.

We recognize the cost associated with acquisition and operation of a more extensive monitoring system. Nevertheless, we believe that adding more monitoring sites is essential for adequately assessing the actual noise impact of Hanscom flight operations.

Examples
Aircraft, especially jets, typically depart runway 29 on a flight toward New York City or other major destinations to the southwest. On takeoff, these aircraft can leave the runway well before its end, and will begin heading southwest even before crossing the western boundary of the airfield. Thus, by the time they are as far from the field as Site 36 (the farthest monitor off the end of Runway 29), they may be more than a mile south of the monitor.

Benefits
Significant improvements in the accuracy of measurements of the overall noise picture of the 4-town area will result from investment in more noise monitors. Data to be published in the future GEIRs should more accurately represent the 4-town ambient noise environment.

Resources
The actual number of monitors needed, their locations, and costs must be determined by further study.

RECOMMENDATION M13: CORRELATE MEASURED NOISE DATA WITH PLANES AND FLIGHT PATHS

The Workgroup recommends that a procedure or system be developed that correlates noise events and data to flight operations and complaints. Massport should work with the aviation community to determine the appropriate constructive use of this capability and information.

Applicability and Time Frame
This information will provide guidelines for aircraft operating procedures aimed at minimizing noise impact without jeopardizing safety. A preliminary study would be needed to determine computer software, data transmission and storage hardware required.

Background
The present procedure is to calculate hourly DNL and other noise statistics locally at each monitor site. The results of the calculations, but not the raw data, are uploaded to the central system once each day for reporting of measured noise and statistics. The lack of event data prevents correlation with flight records and radar tracks.

Technical Discussion
Instead of saving only calculated results, time-stamped measured data at the event level should be saved and transmitted to the central system. This will enable correlation of measured noise events with radar data, which are already stored.

Many airports have this capability and use it to diagnose and quantify problems.

Benefits
Identification of the sources of the most serious noise impacts will become possible. Tools will be provided for more effective noise management and noise abatement at Hanscom Field.

Resources
Expert assistance in noise analysis, data network and storage hardware design and computer programming may be required

RECOMMENDATION M14: STORE NOISE DATA IN A PUBLICLY-ACCESSIBLE LOCATION

The Workgroup recommends that noise data be stored in a publicly-accessible location, such as an internet site.

Technical Discussion

It is recommended that both INM input data and actual measured noise data should be stored in a central system and available to public access via the Internet. Actual noise data should be time stamped and source-identified.

Community groups such as the follow-on group described in Recommendation M1 can perform further analysis, test different models, forming conclusions and recommendations useful to Hanscom Airfield and Massport at no cost to those organizations or to the public.

If summary noise information, such as reports, can be made available via the internet, town residents will be better informed on aircraft noise issues, with increased confidence in abatement measures. Town Planning Boards can easily obtain data specifically targeted at such issues as possible noise overlay zoning, and the siting of suitable land development to minimize noise impact on prospective users.

Example

An excellent example of public access to airfield noise data is the Web site of Minneapolis-St. Paul Airport (MSP), viewable at **www.macavsat.org**. This site shows current and detailed, timestamped flight noise data such as LDNs, at locations selectable by the viewer from a displayed Twin Cities map.

For access to INM data or raw measured noise data, simpler methods such as internet FTP sites or even floppy disk distribution are possible.

Resources

If the raw data is provided it may be possible to get community volunteers to develop the necessary internet capabilities for implementation of this recommendation

IV. DETAILED TECHNICAL DISCUSSIONS IN SUPPORT OF THE RECOMMENDATIONS

TD1. TECHNICAL DISCUSSION: CONTINUING WORK AND FOLLOW-UP

Recommendation:
The Workgroup recommends that HATS and HFAC take take the responsibility to charter a community group to follow up these metrics recommendations and work with Massport to further develop, refine, and implement the recommendations of this report, review any pre-GEIR data supplied in response to our recommendations, and report to HATS and HFAC on progress related to implementation. This community group, HATS and HFAC should also make suggestions on changes to the noise discussion in the GEIR based on a further review of the 1995 GEIR..

Discussion:
The following are examples of suggestions that have resulted from a review of the 1995 GEIR and show the kinds of modifications that may be recommended for future GEIRs:

- Due to the changes in the design and use of Minute Man National Historical Park (MMNHP), the activities at the Visitor Center location should now be categorized as a “short hike” and not as an “overlook” location for purposes of annoyance analysis in the GEIR.
- In GEIR discussions regarding Community Impact, it should be noted that recent research has shown that DNL dominated by Aircraft operations has a significantly higher measured annoyance than DNL resulting from other noise types such as traffic noise. This caveat should be provided in A) the presentation of the “Schultz curve” where it further should be pointed out that this 1978 curve was generated using a mix of noise types and in B) the presentation of Representative DNL Levels from various sources.
- The title of tables containing the type of data in table 4.3-3 from the 1995 GEIR should be relabeled “Residential Land Use Incompatible with Aircraft Noise from Hanscom Field” instead of the current title “Residential Land Use Impacted by Aircraft Noise from Hanscom Field”.
- The calculation of Ldn associated with aviation noise uses averages of noise levels that may be more than 60 dB apart. Equivalently, this implies averaging of quantities (such as acoustic energy levels) that range from a magnitude of 1 to a magnitude of more than 1,000,000. Representation of such a widely varying quantity by a single (average) value is highly questionable, therefore, it should be discussed extensively and closely scrutinized by the HATS' future environmental subcommittee prior to the next GEIR.
- At some airports, notably those in California, measures and metrics make use of the Estimated Perceived Noise Level (EPNL) in addition to, or as a replacement for, those based on A-weighting. This metric has been discussed in the 1996 Logan GEIR Update (page 6-2). The EPNL, like A-weighting, is a frequency broadband measure (i.e., it measures across the entire range of frequencies perceived by the human ear.) But, whereas A-weighting is a simple weighting curve that roughly corresponds to the frequency sensitivity of human hearing, EPNL accounts for the increased annoyance of sounds that are rich in pure tone components. The EPNL was developed specifically to address the annoyance factor of aircraft sounds. The EPNL is measured as part of the Federal Aviation Administration aircraft certification process (FAR, Part 36.) Future review should consider the measurement and evaluation of EPNL-based measures and metrics at Hanscom.

TD2. TECHNICAL DISCUSSION: TIME ABOVE METRICS

Recommendation:
The Workgroup recommends that all future GEIR and annual Hanscom noise reports include the Time Above Contour metric , with areas included within each contour computed, as a clear way to show changes in exposure to a wide range of aircraft noise.

Discussion:
The Time Above (TA) metric was used extensively in the 1995 GEIR. The HATS Topic Review Committee suggested in its comments (*Noise TRC Report*, June 1997) that the Time Above metric needs further attention. We believe Time Above provides the community with more easily understood information about airport noise conditions. We have reviewed the use of this metric, and propose that Massport expand the Hanscom Field Airport noise analysis using an extension of the TA Metric.

TD2.1 Background
Most of the noise metrics used for reporting airport noise are reported in terms of sound pressure levels in decibels (dB). The TA metric is reported in units of time - usually minutes. The metric is the amount of time the noise levels are over a given sound level in dB. For example, the GEIR presented TA data for levels above 85, 75 and 65 dBA. It also presented data for time above the ambient noise level (L_{90}). Table 2-1 is a summary of ambient noise and baseline time above data from the 1995 Hanscom GEIR.

TABLE 2-1: 1995 Baseline Conditions (From Table 2.3-8 of the GEIR)

					Calculated 24 Hour Time Above (minutes) for Average Annual Day						
Loc. #	**Address**	**Meas. L_{90}**	**Meas. L_{dn}**	**Calc. L_{dn}**	**85**	**75**	**65**	**50**	**45**	**40**	**35**
31	Concord Localizer: Measured	34	67	69	2	20	56				559
32	Bedford Localizer: Baseline	43	67	66	1	13	41		215		
33	Lincoln - Brooks Rd: Baseline	37	57	61	0	2	21				480
34	Bedford - DeAngelo: Baseline	50	60	57	0	2	16	126			
35	Lexington - Preston: Baseline	45	61	52	0	2	10		104		
36	Concord Wastewater: Baseline	54	62	55	0	1	14	123			

TD2.2 Review of the data
We conducted a review of the data presented in the 1995 Hanscom GEIR. This review found that the percentage change in TA correlates very well with the percentage change in total aircraft operations. This suggests that appropriately structured TA data is a good indicator of air traffic level. It should be noted that the changes in L_{dn} did not follow these patterns, suggesting that L_{dn} (by itself) is an incomplete metric.

The tables at the end of this section provide this data for the six permanent monitoring locations. Table 2 is a summary of the fleet mix data taken from the GEIR. It lists numbers of aircraft and percentage increases that we calculated. Tables 3 through 8 list the calculated time above 85, 75 and 65 thresholds and time above L_{90}. This data is from Tables 4.3-4, 4.3-6 and 4.3-8 of the GEIR. The second part of each table is the percentage increase. Note that in all locations the TA/L_{90} matches the total % air traffic increase. The TA/65 and TA/75 matches the data, but not as well. The TA/85 does not match at all. This suggests that the lower TA levels will be most useful in this metric.

TD2.3 Time Above Recommendations
We propose two metrics based on the Time Above parameter. They are the Time Above Contour and Area within the Time Above Contour (ATAC).

TD2.3.1 Time Above Contour

The 1995 GEIR presented measured Time Above data, in tabular format, for levels ranging from L_{90}'s of 35 dBA to 50 dBA (see Tables 2.3-6 through 2.3-8, and discussion of pages 2-90 to 2-93). This recommendation thus amounts to the calculation and presentation of TA contours corresponding to the same data. (We also recommend that the data tables like those cited above also be continued.)

We recommend that contours of Time Above for three thresholds be created: 45 dBA, 55 dBA, and 65 dBA.

45 dBA is about the level that exists for the quietest 10% of time (the L_{90}), based upon measurements at noise monitors around Hanscom (see 1995 GEIR, pages 2-90 through 2-93.)

55 dBA is a level for which Massport has calculated Time Above contours for the area surrounding Logan Airport (along with other levels.) 55 dBA is the level defined by the Commonwealth of Massachusetts to be considered in violation of state regulation for noise pollution in 310 CMR 7.3.10, although this regulation is preempted by Federal law for aircraft.

Finally, the 65 dBA threshold represents the amount of time the noise level exceeds the outdoor speech interference level.

The Workgroup recognizes that 45 dBA contours may extend to distances from Hanscom for which the flight track data available does not accurately reflect actual aircraft operations. Further, there are many areas in which other noise sources (e.g., route 128 traffic) may raise the L_{90} to levels above 45 dBA. Thus, if Massport's noise consultant can definitively demonstrate that 45 dBA contours are not practical or meaningful, this part of the recommendation can be dropped.

When used in GEIR-type reports, the computed TACs should be compared to baseline TACs. We believe that changes in the shapes of the multiple TACs will provide a clear and meaningful representation to the community of the perceptible noise effects.

TD2.3.2 Area within TA Contours (ATAC)
Using the computations for the TAC metric discussed above, we recommend that the area within specified contours be computed and reported. The computation should be performed for all meaningful contours. This data should be presented in a table and compared (as percent changes) to appropriate baseline data.

Tabulated TA Contour Area information can be communicated to the public much more effectively than the contour plots and can be used for trending which is very difficult to do with contour plot overlays.

TD2.4 Review of TA Contours for Hanscom Field
Harris Miller Miller & Hanson, Inc., noise consultants, created Time Above Contours at the request of Massport in support of the Metrics Taskgroup of the Hanscom Noise Workgroup. These contours and areas, together with HMMH's discussion are included in Appendix 2. These contours and discussion are very informative, and show clearly the value and practicality of this recommendation. The Workgroup expresses its appreciation to Massport for supporting this additional effort.

TD2.5 Sample Calculations
The following tables, using data from the 1995 GEIR (Tables 2.3-6 through 2.3-8, and Section 4.3.2.1 Tables 4.3-4 through 4.3-8) show present and growth scenario Time Above data at noise monitor locations. The Workgroup finds this data to be valuable and informative, and recommends that this form of presentation be included in future GEIRs.

TABLE 2-2: Aircraft Operation and % Increase for GEIR Scenarios

	# Operations			% Increase over Baseline		
Condition	**Single**	**Jets**	**Total**	**Single**	**Jets**	**Total**
Baseline	447	30	521	-	-	**-**
2000/1%	451	41	548	1%	37%	**5%**
2000/3%	498	46	604	11%	51%	**16%**
2010/1%	459	67	605	3%	123%	**16%**
2010/3%	616	90	812	38%	199%	**56%**

TABLE 2-3: GEIR Data for Location 31, Concord Localizer

24 Hour Time Above	**85**	**75**	**65**	**L_{90} (35)**	**L_{dn}**
Baseline	2	20	56	559	69
2000/1%	2	21	58	589	69
2000/3%	2	23	64	648	69
2010/1%	3	23	63	641	68
2010/3%	0	31	85	856	69
% Increase over Baseline	**85**	**75**	**65**	**L_{90} (35)**	**Δ L_{dn}**
2000/1%	0%	5%	4%	**5%**	0
2000/3%	0%	15%	14%	**16%**	0
2010/1%	50%	15%	13%	**15%**	-1
2010/3%	-100%	55%	52%	**53%**	0

TABLE 2-4: GEIR Data for Location 32, Bedford Localizer

24 Hour Time Above	**85**	**75**	**65**	**L_{90} (45)**	**L_{dn}**
Baseline	1	13	41	215	66
2000/1%	2	14	43	225	67
2000/3%	2	16	47	247	67
2010/1%	2	16	47	244	67
2010/3%	0	21	62	326	68
% Increase over Baseline	**85**	**75**	**65**	**L_{90} (45)**	**Δ L_{dn}**
2000/1%	100%	8%	5%	5%	1
2000/3%	100%	23%	15%	15%	1
2010/1%	100%	23%	15%	13%	1
2010/3%	-100%	62%	51%	52%	2

TABLE 2-5: GEIR Data for Location 33, Lincoln - Brooks Road

24 Hour Time Above	**85**	**75**	**65**	**L_{90} (35)**	**L_{dn}**
Baseline	0	2	21	480	61
2000/1%	0	2	22	507	61
2000/3%	0	3	22	558	61
2010/1%	0	3	24	552	60
2010/3%	0	4	32	738	62
% Increase over Baseline	**85**	**75**	**65**	**L_{90} (35)**	**Δ L_{dn}**
2000/1%	0%	0%	5%	6%	0
2000/3%	0%	50%	5%	16%	0
2010/1%	0%	50%	14%	15%	-1
2010/3%	0%	100%	52%	54%	1

TABLE 2-6: GEIR Data for Location 34, Bedford - DeAngelo Road

24 Hour Time Above	**85**	**75**	**65**	**L_{90} (50)**	**Ldn**
Baseline	0	2	16	126	57
2000/1%	0	2	17	131	58
2000/3%	0	2	19	145	58
2010/1%	0	3	18	141	58
2010/3%	0	3	24	188	59
% Increase over Baseline	**85**	**75**	**65**	**L_{90} (50)**	**Δ L_{dn}**
2000/1%	0%	0%	6%	4%	1
2000/3%	0%	0%	19%	15%	1
2010/1%	0%	50%	13%	12%	1
2010/3%	0%	50%	50%	49%	2

TABLE 2-7: GEIR Data for Location 35, Lexington - Preston Road

24 Hour Time Above	**85**	**75**	**65**	**L_{90} (45)**	**L_{dn}**
Baseline	0	2	10	104	52
2000/1%	0	1	11	109	53
2000/3%	0	1	12	120	54
2010/1%	0	1	12	117	54
2010/3%	0	1	16	156	55
% Increase over Baseline	**85**	**75**	**65**	**L_{90} (45)**	**ΔLdn**
2000/1%	0%	-50%	10%	5%	1
2000/3%	0%	-50%	20%	15%	2
2010/1%	0%	-50%	20%	13%	2
2010/3%	0%	-50%	60%	50%	3

TABLE 2-8: GEIR Data for Location 36, Concord Wastewater

24 Hour Time Above	85	75	65	L_{90} (50)	L_{dn}
Baseline	0	1	14	123	55
2000/1%	0	1	16	129	55
2000/3%	0	1	17	142	55
2010/1%	0	1	17	139	55
2010/3%	0	1	23	185	56
% Increase over Baseline	**85**	**75**	**65**	**L_{90} (50)**	**Δ L_{dn}**
2000/1%	0%	0%	14%	5%	0
2000/3%	0%	0%	21%	15%	0
2010/1%	0%	0%	21%	13%	0
2010/3%	0%	0%	64%	50%	1

TD3. TECHNICAL DISCUSSION: SINGLE EVENT LEVEL DISTRIBUTION (SEL/D)

Recommendation:
The Workgroup recommends that future monthly, yearly, and GEIR Hanscom noise reports include the Single Event Level Distribution (SEL/D) metric to show changes in the distribution of individual noise events.

Discussion:

3.1 Introduction to SEL/D

At the start of this study, we established Criteria for a set of good noise metrics. DNL (as commonly used today) accounts for cumulative exposure to noise energy from the airport. Our recommended Time Above Contours account for the number of people exposed, as well as the total duration of noisy events. The Time Above metric also appears to correlate well with the number of aircraft noise events. These metrics do not, however, account for the absolute sound level of *individual* flight events. Accordingly, we recommend a new presentation of Sound Exposure Level (SEL) data (as presently used in the EXP calculation) to display the number of noise events produced by individual overflight operations.

3.2 Technical Background

Individual overflight operations are of concern to the communities because some operations are well in excess of the steady-state background ambient level. The 1995 GEIR showed that ambient noise levels in the four HATS towns vary from below 40 dBA to the low 50's. The INM database indicates that several aircraft can produce levels in excess of 80 dBA on the ground well outside of the airfield proper. In the extreme cases of a Stage 2 Gulfstream business jet, a Boeing 727, or a military jet, levels in excess of 100 dBA may be generated, resulting in an absolute level increase of 40 to 60 dBA over the ambient for the duration of the overflight. These levels can exist even some distance away from the airfield, such as at the western edge of Concord and beyond.

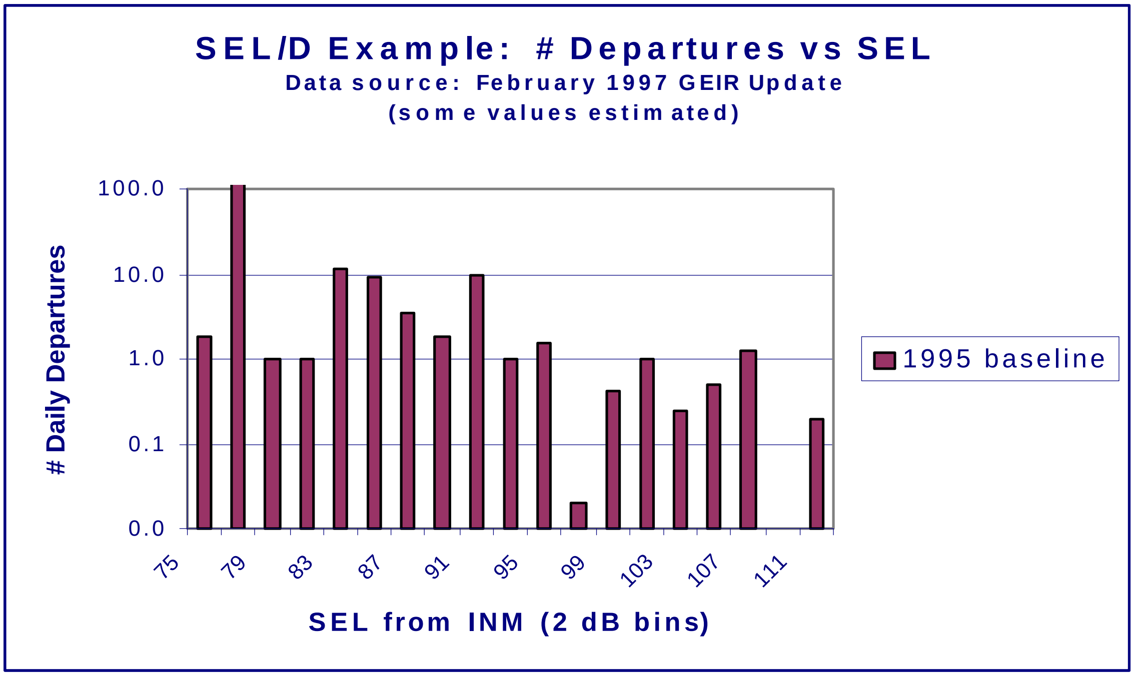
The level of individual noise events is well expressed by the Sound Exposure Level (SEL), which is defined as the constant level which, if maintained for a period of one second, would deliver the same noise energy as the entire event. It is essentially a one-second L_{eq}, and is reported in dBA. As such, it is appropriate for short-duration events like an overflight; the one-second integration normalizes nominally different duration events. The Integrated Noise Model (INM) program, presently used by Massport, uses SEL data, and can plot an SEL contour for an individual flight track. A few SEL values were reported in the 1995 GEIR. Because the Sound Exposure Level is appropriate for quantifying individual noise events like aircraft flyovers, we have chosen to refer to its use in this metric presentation as the ***Single Event Level*** (i.e., both abbreviated SEL.)

There is considerable variability in individual noise events, since each flight operation is unique – varying by runway used, flight track followed, aircraft type, thrust setting, weather conditions, etc. Whereas the DNL *obscures* this variable nature by averaging (over time, geography, aircraft type, flight heading, etc.), we propose to draw attention to the *variation* by plotting the statistical distribution of SEL. By doing this, one can easily see how loud flyovers can be, and often they occur. We call this statistical plot the Single Event Level Distribution, or SEL/D.

By making a bar graph of the count of the SEL of aircraft operations, with a bar for every 2 dBA above 90 dBA, a metric is created that clearly shows both the quantity and acoustic energy of the noisiest aircraft operations. This will simplify year-to-year comparisons and observation of trends in very loud events. Trends are clearly shown in ways that are easy to explain to the public, and so will enhance communications. For example, as noisy jets are replaced by quieter jets, the size of the high-dBA bars will drop linearly with the percentage shift to quieter aircraft.

It should be noted that SEL/D data does *not* come from direct measurement at the time the operations take place at Hanscom. Rather, the SEL values are contained in the EXP database, which is used in INM as currently used by Massport. (These database values result from actual measurements of aircraft under standardized conditions.) Thus, the SEL/D presentation derives from combining the SEL values with data on operations, which Massport already compiles monthly.

3.3 Example SEL/D
The following example shows an SEL/D, using departure SEL data from the February 1995 Hanscom GEIR update. (The data are for the 1995 baseline.)



This type of plot is known in Statistics as a Histogram, or Statistical Distribution. Histograms are commonly used to present any quantity that varies in a large population, and are valuable in that they indicate much more than the average:

- The degree of data variation; (Are the noise levels of departures more-or-less the same, or do they vary widely?)
- Multiple "modes" of variation; (Are there distinct "humps" in the level distribution, indicating that different types of aircraft tend to cluster together in noise level?)
- Extremes in the data; (What is the lowest noise level generated? What is the highest?)
- Imbalances in the data; (We may find that noise levels have a "floor" at a particular low level, but extend, in low numbers, to very high values.)

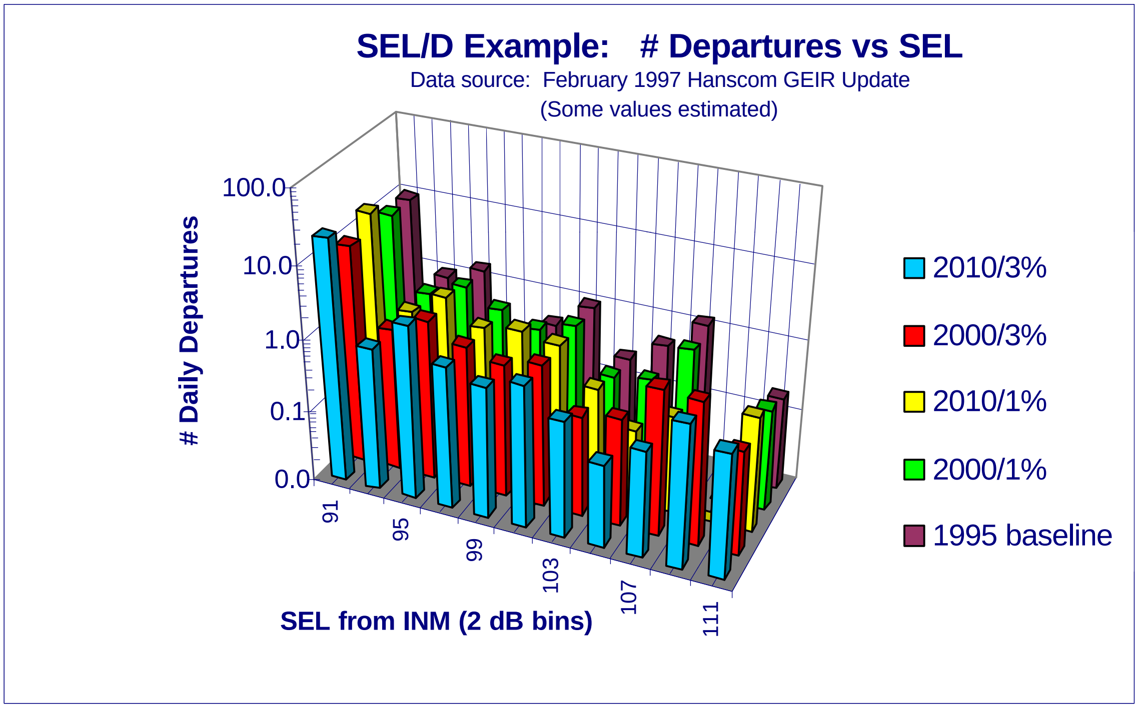
3.4 How to Generate the SEL/D Metric
To create this SEL/D histogram, we start with departure SEL data from the INM database to order the aircraft groups from lowest to highest individual SEL – thus creating a list that orders aircraft types from quietest to noisiest on takeoff. (The same could be done for arrivals.) Then, we group the aircraft types into 2-decibel-wide "bins". For example, here are the aircraft types that compose the bin centered on an SEL of 95 dBA (95 +/- 1 dBA):

Group #	Aircraft Type	Departure SEL (dBA)
12	C140 (MILITARY)	95.5
4A	DA20, N265-80	95.4
4B	HU25	95.4
14B	CS, T-43 (MILITARY)	94.8
14A	DC-9	94.8
18B	C130 - HVY TURBOS (MILITARY)	94.2
18A	G159, CV60 - HVY TURBOS	94.2
28	DC3, CV24 - HVY TWIN PISTON	94.2

All the other aircraft types are contained within other SEL bins; the number of types in each bin will vary, depending on how many types have nearly equal SELs.

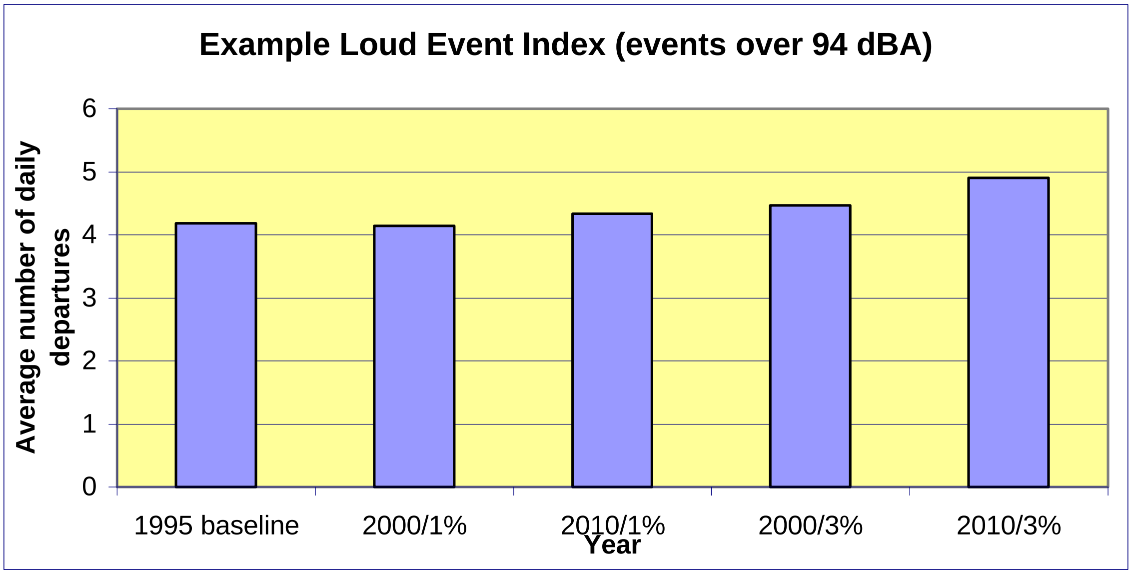
Once we have grouped the aircraft into these bins, we simply add the number of daily departures within each bin and plot the vertical bars for each bin.

To be most useful, it is helpful to see how the SEL levels vary with time. By plotting several SEL/D's in a "stacked" presentation, it is possible to add the time dimension. In the following example, five SEL/D histograms are plotted together to show level variation changes with time (or, in this case, with different growth scenarios.)



For clarity in the plot above, we have shown only the top end of the distribution because these loudest SELs are of the greatest concern. Why? Because community residents will hope to see, through improvements in technology and changes in fleet mix, a reduction in the number of loudest events. The SEL/D will show whether this is happening.

3.5 Application of SEL/D to Community Summary Metrics
Although its use is primarily analytical, the SEL/D can be extended to provide a much less detailed metric that can be more readily understood by the typical citizen. Once noise distribution trends have been established and understood, it is possible to aggregate SEL/D data to create a single number that varies with time.
The Loud Events Index is recommended in Recommendation 6 on Community Summary Metrics. To create the Loud Events Index, we simply count the total number of events above 94 dBA over the course of every month. We then plot these monthly values over time. Using the data from the example SEL/D plotted above, (data from 1997 GEIR Update) we obtain the graph shown below:



This graph clearly shows a trend that is easily understood, although we do not know if it effectively correlates to some community response to noise. The choice of 94 dBA is rather arbitrary; it corresponds roughly to a natural division between two modes (or “humps”) in the distribution of SELs – between quieter single engine aircraft and noisier turboprops and jets. Further work may be required to refine this metric and relate it to community response.

TD4. TECHNICAL DISCUSSION: LINEAR DIMENSIONLESS METRIC

Recommendation:
The Workgroup recommends that future GEIR Hanscom noise reports include a linear dimensionless metric (unlike the logarithmic decibel metric used for Ldn) to show exposure to noise energy. We recommend that the Follow-up group described in Recommendation M1 continue to study the design of such a metric and methodology for implementation in the next GEIR.

Discussion:

4.1 Introduction
Ldn is one of the most frequently used metrics for assessing community exposure to aviation noise, but it is a difficult metric to comprehend without special training in noise measurement and its validity has been questioned (see, for example, the 1997 Annual Report of Federal Interagency Committee on Aviation Noise, page 16). The main source of these difficulties is that, unlike most commonly used metrics (length, volume, weight, etc.) which are linearly related to a property of a physical object or phenomenon, Ldn is both logarithmically related to aviation noise and an average of that noise energy over a day or a longer period of time.

This section contains an example of a candidate linear dimensionless metric. As with all other metrics recommended by the Noise Metrics Taskgroup, the proposed metric is intended to supplement and not replace L_{dn}. It is simply a new way of communicating the same information embodied in L_{dn} and, in that respect, it has the same advantages and limitations as L_{dn}. Even though a linear means of expressing aviation noise will improve the public's comprehension of the reported noise data, we propose that the follow-on group (described in Recommendation M1) study the advantages and disadvantages of such a metric to ensure the optimum implementation of a linear metric in the next GEIR. Therefore, the ***particular*** approach discussed in this section should be viewed as only one possible implementation, as opposed to the ultimate version of the recommended metric.

4.2. Technical Issues
This section:

- Reviews the definition and current use of L_{dn};
- Discusses an alternatedisplay of the L_{dn} information; and
- Illustrates the features of the alternate approach.

4.2.1 Definition of L_{dn}
The formula for calculating L_{dn} (dB) is:

$$Ldn = 10\log_{10}\left(\frac{p^2_{dnAviation}}{p^2_{ref}}\right) \quad (1)$$

$$= 10\log_{10}\left(\frac{\frac{15}{24}\left\langle p^2(t)\right\rangle_{td} + \frac{9}{24}\left\langle 10p^2(t)\right\rangle_{tn}}{p^2_{ref}}\right) \quad (2)$$

where:

p(t) = instantaneous sound pressure
t = time
td = 15 hour period (7:00 am - 10:00 p.m.)
tn = 9 hour period (10:00 p.m. - 7:00 am)
$\log_{10}$ = logarithm to the base 10
$p_{dnAviation}$ = day-night averaged Aviation sound pressure

p_{ref} = reference sound pressure = 20 μPa (microPascal)

$\langle Q(t) \rangle_T$
= average value of Q; averaged over time period T

The formulae in Equation 1 and 2 are complicated, and difficult to understand and interpret. Therefore, we investigated a simpler way to present the same information.

This example metric simplifies the presentation of the information by using a linear scale, which, for example, represents the effect of two noise events as the as the simple sum of the individual effects.

4.2.2 Use of L_{dn} an Aviation Noise Metric

L_{dn} is one of the quantities **as** reported by noise monitoring systems installed around airports, and also a quantity calculated by the Integrated Noise Model (INM). Noise monitoring systems installed near airports collect data and calculate L_{dn} values. However, these systems include too few sensors to provide a comprehensive noise exposure map for the entire community surrounding the airport. Accordingly, the INM is used to "estimate" L_{dn} at locations around the airport where there are no sensors.

With most quantities, combinatorial effects are additive. For example, if one adds 50 lb. of sugar to another 50 lb. of sugar, one expects (and gets) 100 lb. of sugar (Figure 4.1a). This is not true of dB quantities. For example, consider a location exposed to L_{dn} = 50 dB resulting exclusively (and hypothetically) from 10 identical operations per day (i.e., occurring under identical operational and environmental conditions such as: flight track, thrust, wind, temperature, etc.). Now increase the air traffic by an additional and identical 10 operations per day, which by themselves would have resulted in an L_{dn} = 50 dB. The combined result of the 20 identical operations is not L_{dn}=100 dB but L_{dn} = 53 (!) dB (Figure 4.1b) because of how addition of sequential noise events works. This result is a direct consequence of Ldn's logarithmic combination of two values, which makes metrics based on decibels (dB), such as L_{dn}, difficult for many people to comprehend.

4.2.3 A possible linear metric

It is possible to report noise exposure noise exposure in a linear, rather than logarithmic, form, and to relate aviation to an ambient noise level as a ratio (with a potential name such as Aviation-to-Ambient Ratio, or AAR)

$$\text{AAR} = \text{(Aviation noise)/(Ambient noise)} = \frac{p^2_{dnAviation}}{p^2_{refAmbient}} \qquad (3)$$

- The numerator of the ratio is the aviation noise (in units of sound pressure squared), as averaged and day/night-weighted by the procedure used to derive L_{dn}. It is identical to the numerator of the Equation 1 fraction, i.e., it is the same quantity derived by the L_{dn} algorithm but prior to logarithmic conversion by L_{dn}
- The denominator of the ratio is a reference ambient noise (also in units of sound pressure squared). The ambient noise level is routinely approximated by L_{90} (the measured level exceeded 90% of the time), as listed in the 1995 GEIR. The L_{90} level recorded by the six monitoring stations suggested an ambient level between 40 and 45 dBA (Table 2.3-8 of the 1995 GEIR). In the preliminary study of the sample linear metric, we assumed a Reference Ambient level for the Hanscom four-town area of L_{ref_amb} = 45 dBA, corresponding to a

  $p_{refAmbient}$ = Reference Ambient sound pressure = 3.6 mPa (milliPascal)

- The results of this example metric are expressed in terms of ratios, and can be plotted at user selected intervals.

- The lowest contour to be used has a value of 1, i.e., it corresponds to an aviation noise contribution equal to the reference ambient noise contribution.

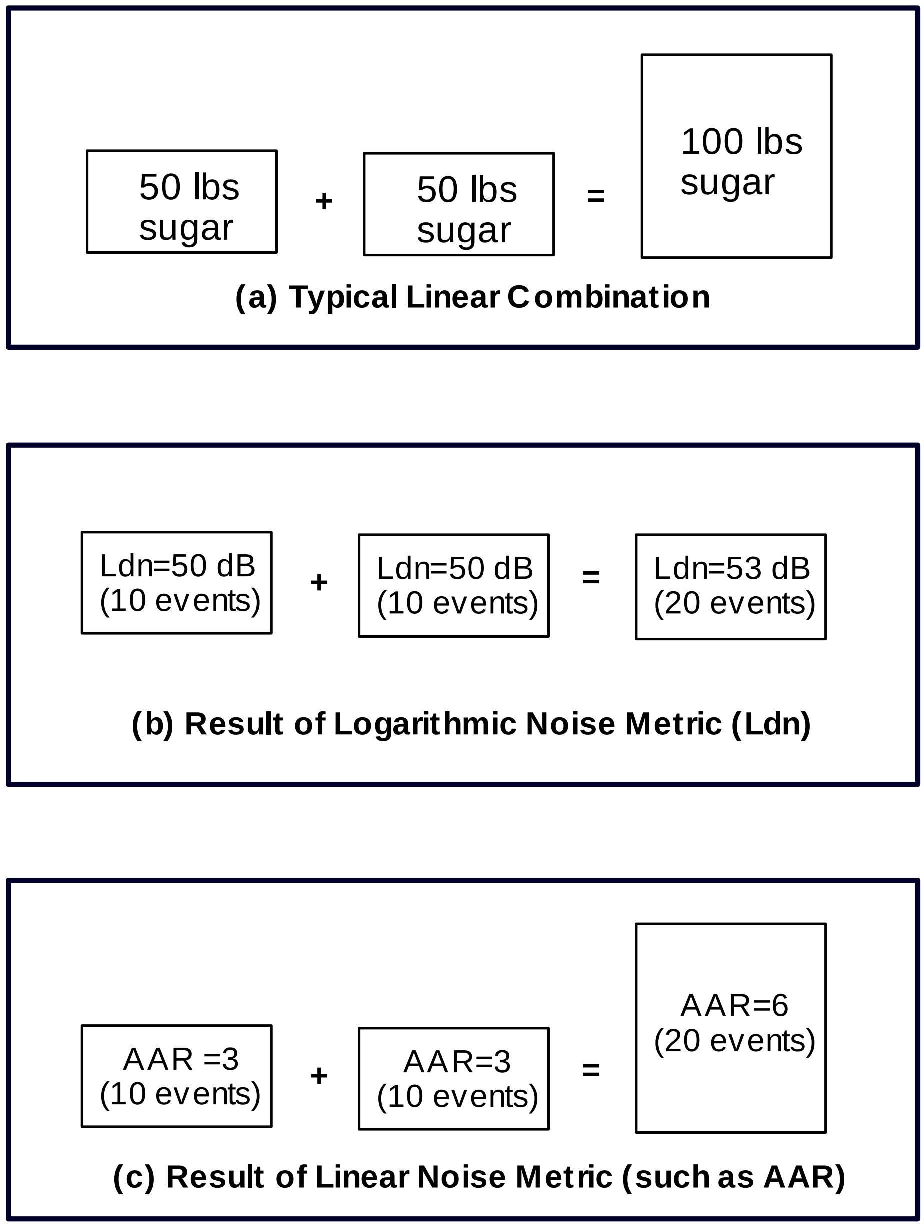


FIGURE 4.1 - Comparison of Combination of Linear and Logarithmic Quantities

Future adaptation of a linear metric, such as the AAR, should include additional and validated information on the appropriate value of L_{ref_amb}.

4.2.4 Comparison of Linear Metric to L_{dn}

Within each of the four HATS towns, Ldn varies from about 45 dBA up to about 60 dBA. Within the same areas, the ratio calculation varies from 1 to 30.

It should be reiterated that this example linear metric and Ldn express ratios of acoustic energy (noise) in different forms (linear vs. logarithmic). These ratios should not be confused with the loudness ratios that are used in some non-aviation applications to express human perception of loudness of similar discrete noise events. While such a metric (loudness) may be appropriate for, say, automobile applications, it is not suitable for aviation noise because of the long time averaging over many and dissimilar noise events, including periods of no events. For example, a linear ratio of 3 cannot be interpreted as 3 times greater loudness; it simply means 3 times more aviation noise energy than ambient noise energy. Similarly, in some cases a linear ratio doubling from 3 to 6 may simply indicate *twice as many audible aviation events* rather than twice as much loudness.

TD 5. TECHNICAL DISCUSSION: Expanded Discussion of DNL

Recommendation:
The Workgroup recommends that the discussion of the noise impact on residential use in future GEIRs include reference to the EPA level of 55 dB DNL (EPA Publication #319, "Protective Noise Levels", 1978) and avoid the implication that DNL of less than 65 dB DNL (the FAA mitigation threshold) has no impact.

Discussion:

5.0 Introduction
During the 1995 GEIR review process, we found that the DNL was difficult to explain, was presented in units (dB) that are easy to confuse with measures of loudness, and invited a wide range of interpretations.

This section discusses the reasons for recommending the expansion of discussions of DNL in future GEIRs. It outlines the shortcomings of the current approach, and shows why changes in current explanations will help to supplement and clarify the information provided.

5.1 Technical Background
The Natural Resources Defense Council has effectively summarized the primary defects with the Ldn/DNL metric:

"…The FAA's use of the DNL metric and the 65 dB DNL threshold is flawed in two significant respects:

> 1) as an average noise measurement, the DNL methodology masks the tremendous number of single noise events of noise that are the most significant aspect of aircraft noise, and
> 2) by setting a compatibility threshold of 65 dB DNL, the FAA underestimates the number of people who are annoyed or impacted by aircraft noise and ignores evidence that would require analysis and mitigation on a case-by-case basis. Until the FAA noise methodology incorporates these factors into its analysis, it will continue to misread community annoyance . . . "
>
> - "Under the Flight Path" NRDC 1997

The averaging problem and the 65 dB threshold problem are discussed below.

5.1.1 The Averaging Problem
A key problem in deciding on metrics relates to the way different people in different locations are affected by noise. Some, especially those far away from the field, receive most noise impact from a few events that greatly exceed the ambient noise level. Others, such as those close to the field, are affected by the sheer number of events - even those that are not as noisy.

A deficiency of the FAA-sanctioned noise metric, the Day-Night Noise Level (DNL or Ldn), is that it integrates the total acoustic energy from a large number of discrete events over an entire day. A few noisy events count the same as a much larger number of relatively quiet events. Thus, one can reduce the Ldn but increase the number of aircraft operations, if noisy aircraft are replaced with quieter ones (e.g., Stage 3 jets for Stage 2 jets). This would satisfy those annoyed by a few loud overflights, but would probably worsen the situation for those bothered by the frequency of audible overflights. For example, the expert review panel on noise for the 1994 Seattle Tacoma Airport pointed out that a DNL reduction due to aircraft mix changes from 70 dB to 67 dB would be barely noticeable, but the same reduction in DNL could be obtained by cutting the number of operations in half, and this would be clearly noticeable to everyone. We found that one business jet generates approximately the same contribution to DNL as do 2000 single engine aircraft. However, people on the ground will probably feel that there is a greater impact from 2000 single engine overflights than from a single business jet overflight.

This defect reduces the effectiveness of DNL as a gauge of the effects of aviation noise in an environment, such as Hanscom Field, that is subject to a mix of disparate aircraft types.

5.1.2 Interpreting the Ldn - 65dB Threshold

The FAA defines areas subject to DNL of greater than 65dB to be "incompatible with residential land use", and such affected areas may be eligible for noise mitigation funding. The Hanscom Field GEIR discusses the DNL only in relation to the Ldn 65dB mitigation threshold. This makes it appear that the FAA and the GEIR don't recognize that citizens experiencing less than 65dB DNL are impacted by the airport, and is contrary to everyday experience. The concern about properly interpreting Ldn and characterizing noise aviation impacts is not unique to Hanscom. In 1993, several federal agencies established a committee known as Federal Interagency Committee on Aviation Noise, or FICAN, which stated its objectives:

- A reexamination of Day-Night Average Sound Level (or DNL) as the primary metric for describing noise,
- An evaluation of the dose-response relationship between DNL and its effects on people (quantified as percent of people highly annoyed)
- The appropriateness of the noise criteria used to define compatibility with different land uses.

Other regulatory bodies have suggested different levels as appropriate measures of impact. The U.S. EPA has established through reports and administrative comments that 55dB is the noise limit that is satisfactory to protect human health and welfare in a residential setting:

> "Outdoor yearly levels on the Ldn [DNL] scale are sufficient to protect public health and welfare if they do not exceed 55dB in sensitive areas (residences, schools, and hospitals). Inside buildings, yearly levels on the Ldn scale are sufficient to protect public health and welfare if they do not exceed 45dB. Maintaining 55dB Ldn outdoors should ensure adequate protection for indoor living."
>
> (EPA Publication #319, "Protective Noise Levels", 1978)

5.2 Conclusion on Ldn

The DNL is a metric that is deficient in a number of areas, and is likely to be a poor predictor of community response and impact at an airport with a diverse and changing fleet mix such as Hanscom Field. Nevertheless, it has been studied extensively, has basis in policy and law, and is widely used. Therefore, its use should be continued at Hanscom Field provided that it is supplemented by other metrics, such as those recommended in this report. The impact of DNL values below 65 dBA should be clarified, both for the general population and for the Minuteman National Park.

TD6. TECHNICAL DISCUSSION: COMMUNITY SUMMARY METRICS

Recommendation:
The Workgroup recommends that future GEIRs and annual noise reports provide Community Summary Metrics - i.e., Monthly Loud Events Count, Area Impacted by Noise per EPA, and Area Experiencing 30 or more minutes per day of 55 dBA or greater Aircraft Noise. These three single-number measures are intended to be easy for people to understand and relate to their personal experience.

Discussion:
In addition to the need to develop metrics that meet the technical requirements for appropriate metrics, there is also a need for metrics which can be used to effectively communicate with the public at large. These metrics should be a subset or summary of the more detailed metrics used for technical analysis.

Community summary metrics are not intended to replace other metrics. Their purpose is to facilitate communications and to improve Massport's credibility with the public. It is assumed that the public will not be familiar with the engineering principles of noise monitoring and will instead need to rely on a simplified heuristic model that has analogy in their everyday experience. For a metric involving community impact to be effective in communicating with the community it would ideally have the following attributes:

> **Zero Value**: Ideally, the zero value for the metrics should equate to zero community impact. This is because in the absence of detailed understanding people assume that zero equates to the absence of the quantity being measured.
>
> **Scale Linearity**: The scale of the metrics should be linear with the magnitude of the impact. This is because people naturally assume that a doubling of the perceived impact should be reflected in a doubling of the metric.
>
> **Minimum Metrics**: If more than one metric is needed, the metrics should be reduced to a minimum in quantity and the purpose for each of the separate metrics should be expressible in a single sentence. This is to reduce the confusion that will arise with the use of too many metrics
>
> **Relation to Experience**: Individual citizens should be able to relate the metrics to their personal situation or experience, so that they can use it to explain their past experience and predict their future experience. This is essential to allow the public acceptance of the metrics.
>
> **Explanatory Title**: The title of the metric should explain the purpose of the metric in lay-language.
>
> **Reference Values**: There should be reference values established on the metrics scale relating to impact. This is to allow a person attach meaning to the absolute value of the metric. For example on the Sound Pressure Level (SPL) scale : 40 dBA= whisper, 65 dBA=speech interference, 90 dBA= hearing damage for long term exposure, etc.
>
> **Simple Numbers**: Whenever possible, the metrics should each be represented as a single number, and graph representations of the metric should be only trend lines vs. time. This is because other graphical forms such as scatter charts, histograms, or contours cannot be effectively communicated to the public in text or as trend descriptions.

The above attributes are in the main self-explanatory and can be achieved for the most part by the suggested Summary Metrics. However, there are two issues that require further clarification: **Relation to Experience** and **Scale Linearity.**

TD6.1.1 Relation to Experience
People want to relate the metrics to their personal situation. We categorized three different classes of affected citizens who potentially have three different concerns with the noise associated with aircraft operations. These classes are concerned with:

Noise exposure: In this case, citizens are concerned with the noise impact of the louder aircraft operations or those smaller aircraft that infrequently fly directly overhead**.**

Event frequency: In this case, citizens are subject to a high volume of events and are concerned with the frequency and repetitive nature of distracting events. They may be concerned with outdoor activities, such as tourism or nature preserves. They are typically close to the airport or on major flight paths.

Rare loud events: In this case, citizens are primarily concerned with very loud events that represent a small fraction of operations. Sleep disturbance is a typical concern. These events are also a primary driver of registered complaints.

It is apparent that a great deal of community misunderstanding and concern regarding metrics results from these three different community perspectives. In order to satisfy the need to for the metrics to address these three classes of impacted citizens, we believe that at least three metrics are required.

- Area Experiencing 30 or more minutes per day of 55 dBA or greater Aircraft Noise (TA 30 min/day @ 55 dB)

- Area Impacted by Noise per EPA (55 dB DNL Contour Area)

- Monthly Loud Events Count (Events per month > 94 dB SEL)

In this way, impacted citizens can focus on the metric that best matches their perception of the problem.

TD 6.1.2 Scale Linearity

It was determined that DNL does not exhibit scale linearity from the point of view of the public, while some other metrics such as TA or Event Counts are linear. One sample approach to modifying DNL to achieve the attribute of scale linearity was developed during this phase and is discussed in Recommendation 4. We also identified another means to satisfy the linearity objective for inherently non-linear metrics like DNL by using land areas. Specifically, to generate a linear summary metric of a non-linear acoustic measurement for citizens, we recommend that the data be presented in terms of land area affected by a defined sound exposure (such as 55 dB DNL). The use of land area for communicating DNL to the public also satisfies a number of the other requirements for effective communication with the public as described below.

TD 6.2 SUMMARY METRICS

We recommend three community summary metrics which, we believe, satisfy the criteria of appropriateness identified above. These are:

Metric	**Source (how computed)**	**Include In**
Area Experiencing 30 or more minutes per day of 55 dBA or greater Aircraft Noise.	Area of 30 minute contour for Time Above 55dB	GEIR, Annual Noise Reports
Area Impacted by Noise per EPA	Area of 55dB DNL contour	GEIR, Annual Noise Reports
Monthly Loud Events Count	Events (count) per month > 94dB departure SEL from EXP database	GEIR, Annual, Monthly Hanscom Noise Reports

TD7. TECHNICAL DISCUSSION: NOISE MODELING ASSUMPTIONS

Recommendation:
We recommend that whenever data derived from INM modeling are presented, documentation be supplied including a detailed list of the assumptions and model parameters selected by the Massport noise consultants for input to the INM.

Discussion:

The prime aviation noise model that was used in the 1995 Hanscom GEIR Update to evaluate aircraft noise impacts in the four-town area was the Integrated Noise Model (INM). Members of the Noise Workgroup attended a presentation on the INM, and have reviewed the INM User's Guide of December 1996 (FAA, INM Version 5.1).

We identified some modeling assumptions which we believe may have serious effect on the INM model results and we find that the nature of the assumptions have not been clearly communicated in the GEIR. In some of the examples provided in the recommendation the issues are self-evident; however, in the cases of Flight Tracks and Profiles, Temperature, and Takeoff Weight, more explanation is required. Additional Technical Discussion is provided below for these cases.

TD7.1 Flight Tracks and Profiles

INM is ***an average value model***, and requires that "flight profiles and tracks must be modeled realistically". However, standard INM departure profile models have ***all*** aircraft climbing continuously to 10,000 feet above field elevation (Guide p. 2-3, item 5). This is somewhat unrealistic for Hanscom with its many "touch and go" operations, and for aircraft taking off east in the direction of Logan, because of the airspace restrictions in that direction. Indeed, INM Version 5.1 has two generic profiles specifically to model "touch-and-go" (TOG) and circuit flight" (CIR) operations (INM User's Guide, p. 2-5, Item 5). It is unclear whether or not, and to what extent, if any, the GEIR modeling used the TOG and CIR options available in the Version 5.1.

Moreover, the actual tracks may be modeled using just a few tracks (called "bundles") in selected locations and on a selected course. Considerable latitude is available to the analyst as to how bundling is done. For example, 100 tracks lined up with a 0º runway can be modeled by the analyst as:

- 100 tracks bundled at 0º, or
- 50 tracks bundled at 5º and 50 at -5º, or
- 50 tracks bundled at 0º, 25 bundled at 5º, and 25 at -5º, etc.

Clearly, the first of these examples would result in the highest L_{dn} along the 0º line. A sample noise levels variation corresponding to a specific set of conditions is illustrated later in Section TD8.

It is critical that future Hanscom GEIR updates explicitly specify the assumptions made in order to enable a valid year-to-year comparison of the results. The GEIR Report should also address the variability of predicted aviation noise levels expected from these alternative bundling options. In other words, if the actual track pattern L_{dn} contours were computed, how many dB would they deviate from the simplified bundled track results?

TD 7.2 Temperature

In addition, the results of the INM for a particular airport depend (among other factors) on the input assumption about the temperature and elevation of the airport. The elevation is certainly fixed for any given airport (Hanscom is close to sea level) but its temperature is clearly variable. The GEIR predictions are based on an assumed average temperature between 30 and 90 degrees. The standard INM data base assumes that aircraft are taking off at a standard-day temperature of 59^{o} F (Guide p. 2-3, item 6).

However, the selection of an average temperature for modeling engine thrust requires a great deal of care because the frequency of aircraft flights has seasonal variations. It is noted that most aircraft fly in the daytime when temperatures at Hanscom, which is inland, are quite a bit higher than at night. Furthermore, aircraft activity data shows more operations in the summer (e.g., 55,393 operations in June, July and August of 1996) than in the winter (e.g., 29,839 operations in December, January and February 1996). Trial estimates of temperature weighted by the time of the day and the month, suggest that the average flight temperature (as opposed to the 24 hour average temperature) is closer to 65 ^{o} F than to 59 ^{o} F. Massport's noise consultant should make clear what effect the use of the actual temperature could be expected to have upon Ldn contours or other calculations presented.

TD 7.3 Takeoff Weight

Another parameter that can influence the accuracy of the INM predictions is the takeoff weight of aircraft. The INM Manual instructs (p. 2-3, item 4) that is more accurate to use the actual average takeoff weight of the aircraft than the most often used stage length surrogate. Furthermore, the INM Manual advises that profile weight should be greater than 75% of the maximum gross landing weight (INM 5.1 Manual, p. 8-19). However, there was no indication as to what weight was used for the 1995 GEIR update, even though the specific choice could affect the results significantly. It is recommended that assumptions related to aircraft takeoff weight be explicitly stated in the future in order to ensure the validity of comparison of data from different years.

TD8. TECHNICAL DISCUSSION: MODELING ERRORS

Recommendation:
The Workgroup recommends that future GEIRs include: i) a section estimating the expected variation in results from the INM due to the use of different modeling assumptions. Massport should adopt a standard practice of reporting estimated variations as “error bands” when reporting modeled data; ii) the GEIRs should also include a comparison of the results of noise modeling to actual measured noise data, and explanations of differences.

Discussion:
We identified some data and modeling assumptions, which we believe may result in significant effect on the numerical outputs from the INM. Additional Technical Discussion is provided below for some of the areas identified. The discussion below shows that it is not enough to simply express a result predicted from a model in terms of a single number (such as an average).

In addition, we believe that the results of INM modeling, whether DNL, Time Above or other, should be compared to available measured data (taken during the same time period as used in modeling), and discrepancies, if any, should be discussed.

TD8.1 Wind
An example of simplifying assumptions (in mapping L_{dn} contours) is that analysts may presume that flight tracks recorded over a small time period (such as 60 days) are a valid representation of the flight tracks for the entire year (rather than use actual flight tracks recorded over the entire year). However, a look at 1997 Logan Airport area wind shows conclusively that wind patterns over any 60 days are not necessarily a realistic representation of average wind patterns over the year. The prevailing winds at Hanscom are from the West, but during summer it is primarily SW (Runway 23), and during winter NW (Runway 29). Consequently, runway use and flight tracks during 60 winter days may be quite different than during 60 summer days. Thus, average runway use over the year is not necessarily the same as average runway use over any 60 days.

TD8.2 Fleet Mix along Different Tracks
During the Noise Workgroup sessions (not in the 1995 GEIR Report), Massport and their consultant HMMH stated that the INM used tracks as recorded, but did not associate actual aircraft types with the tracks. Instead, an equal proportion of aircraft of every type (group) was assumed along each "bundled" track. This assumption introduces a potential source of error.

The INM makes the simplifying assumption that each one of the bundled tracks has the same proportion of aircraft in each category. Thus, if 20% of all operations are jets and 80% propellers, each bundled track is modeled as having 20% of jets and 80% of propellers regardless of whether this assumption is supported by the actual data.

TD8.3 Estimation of Actual Noise Level Impact Adjustment due to Flight Track Bundling
The flight track bundling used to simplify the Integrated Noise Model (INM) calculations may lead to a substantial variation between the predicted L_{dn} contours and actual measurements, particularly at some distance from the airfield (see, for example, Figure 2.3-14 in the 1995 GEIR Update.) Accordingly, it is imperative that predictions also include estimates of the uncertainty of the predicted results.

This section reviews an example involving modeling approximations and recommends procedures for estimating and reporting the associated uncertainty. The example discusses the potential variation of the predicted results due to flight track bundling. The discussion considers a simple case to illustrate the nature of the modeling approximations. The corresponding results do not necessarily represent the actual uncertainty for all the cases and from all aircraft types, but rather illustrates the “type and format of information” that should be developed by Massport and be included in future GEIR updates.

TD8.3.1 Definition of Flight Track Bundling

Flight track bundling is a method used to minimize the amount of data that are fed into the INM and also the number of calculations performed by the INM. Essentially, the spatially distributed large number of actual tracks is replaced by a small number of groups of tracks (bundles). All planes in a bundle are assumed to have identical tracks.

Figure 1 illustrates the process of track bundling using an arbitrarily selected set of flight tracks and estimating the corresponding effects at two points, O1 and O2, on the ground. Initially, all flight tracks are assumed to pass directly above O1 and to the side of O2 (Figure 1a), with closest points of approach (CPA) R and 2R, respectively (Figure 1b). In this example, track bundling divides the flights into two equal groups, G1 and G2 (Figure 1c), assuming that half of the flights make a left turn and the other half a right turn immediately after take-off. [Note: Actual bundling involves many more flights and several "bundles". The small number of flights and bundles of this example are for the purpose of illustration only].

The (Figure 1c) track bundling artificially:

- Increases the separation of all flights from observer O1 (Figure 1d), resulting in a lower predicted aviation noise level for that location, and
- Reduces the separation of some flights from observer O2 (Figure 1d), resulting in a different predicted aviation noise level for that location

Since the predicted aviation noise at location O1 would be lower than actual, a resident near location O1 would have a false indication of the aviation noise at that location. Accordingly, in future GEIR updates, it is imperative that Massport also develop, tabulate, and display an estimate of the prediction uncertainty along with the "bundled model" results.

TD8.3.2 Sample Estimation of Uncertainty due to Track Bundling

To illustrate the approximate magnitude of uncertainty due to track bundling, we estimate the potential noise level variation for the Figure 1 example. The estimation involves mathematics that is commonly used in acoustics***. Area residents are not required to follow the indicated derivation but rather to focus on the results obtained with and without bundling for this one example***. The relationships are presented mainly to clarify the approximate method used to Massport staff involved in the estimation of Hanscom Field noise levels. Actual estimations by Massport should be based on direct INM results obtained for representative sets of tracks with and without bundling.

For the purpose of illustration, we assume that the

- Flights are for a single class of aircraft under uniform conditions in order to separate and isolate the effect of bundling from other effects such as fleet mix changes or environmental conditions,
- initial single group of aircraft is divided into two equal bundles, one to the right and one to the left of observer, O1, and
- relative distances (CPA) between the observers O1 and O2 are given by the sketch of figures 1b and 1d

Furthermore, we assume that the day-night noise level contribution ($L = L_{dn}$) from a bundle is related to the source strength and to the closest point of approach (CPA) through the following relationship

$$L = 10 \log_{10}\left(\frac{Q}{R^2}\right) + C \qquad (1)$$

where:

L = L_{dn} due to aviation
Q = bundle source strength (proportional to number of aircraft in bundle)
r = closest point of approach (CPA) between observer and bundle
C = a constant
$\log_{10}$ = logarithm to the base 10

It follows that the L_{dn} levels, L1B, L2B, L1A, and L2A (where the symbols 1, and 2 correspond to positions O1 and O2, respectively, and the symbols B, and A correspond to conditions “Before bundling” and “After bundling”, respectively), are given by

$$L1B = 10\log_{10}\left(\frac{Q}{R^2}\right) + C = L_0 \tag{2}$$

$$L2B = 10\log_{10}\left(\frac{Q}{(2R)^2}\right) + C = L_0 - 6 \tag{3}$$

$$L1A = 10\log_{10}\left(\frac{Q/2}{(2R)^2} + \frac{Q/2}{(2R)^2}\right) + C = L_0 - 6 = L1B_0 - 6 \tag{4}$$

$$L2A = 10\log_{10}\left(\frac{Q/2}{(R)^2} + \frac{Q/2}{\left(\sqrt{13}R\right)^2}\right) + C = L_0 - 2.7 = L2B + 3.3 \tag{5}$$

Equation 4 and 5 indicate that flight track bundling causes the predicted L_{dn} to appear

- 6 dB lower than actual at position O1, and
- 3.3 dB higher than actual at position O2

Thus, in this particular example, a resident in location O1 may base plans and decisions on the false information that the noise is 6 dB lower than actual at his location.

It should be noted that the above two error quantities (-6 and +3.3 dB) result from the Figure 1 geometry and from the assumptions listed above. Massport should obtain and report a representative noise variation distribution for the 4-town area over a broader range of operating/environmental conditions through the repeated use of the INM.

As to the second point in this Recommendation 8, it is self-evident that results of modeling can be considered as valid only, if they correlate closely wirh measured data taken at a number of sample points. If measured data at sample locations are found to verify the analytically predicted values of INM modeling, then we would have a positive validation that the INM predictions are a dependable model of what would be observed in real life.

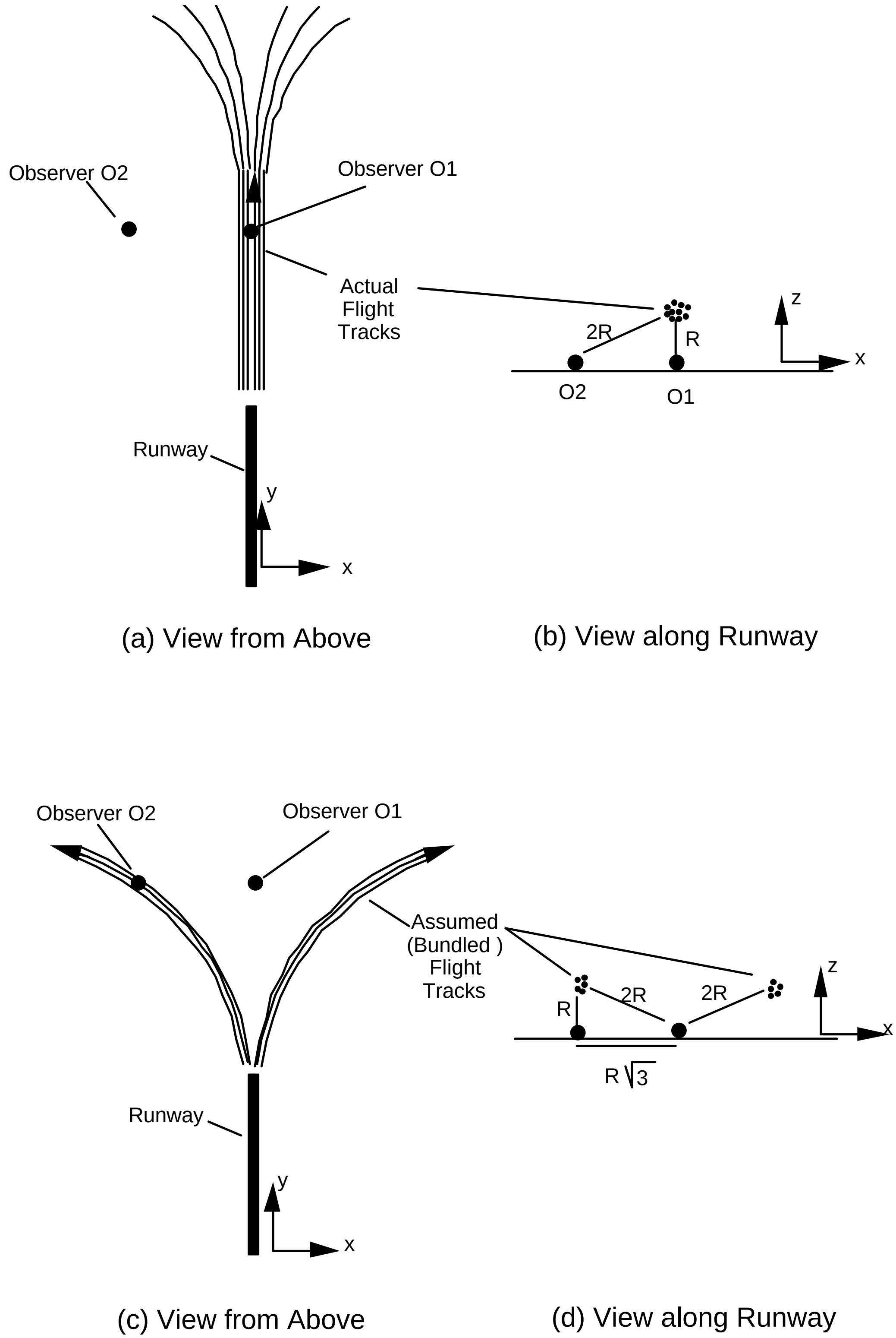


FIGURE 1- Representative Features Of Track Bundling.

TD9. TECHNICAL DISCUSSION: EXPECTED VARIATION FROM AVERAGE

Recommendation:
The Workgroup recommends that future GEIRs include a section explaining the expected short-term variations in noise from the long-term average values.

Discussion:
The daily variation in noise levels from the average values is very significant and is primarily caused by wind patterns. This section relates reported runway use to available wind pattern data for this area, and outlines the procedure for estimating noise level corrections that should be added to the predicted L_{dn} levels in order to account for the higher aviation noise impact during periods of exclusive runway use.

TD9.1 Actual Noise Level Impact Adjustment due to Wind Patterns (Runway Use)

Runway use is very much controlled by prevailing winds. Averaging the effect of aviation departures and arrivals over the entire year, results in a lower L_{dn} level per runway than the actual level registered on days that such a runway is used exclusively.

The currently reported L_{dn} levels are estimated by averaging the number of flights over the entire year (done separately by day, night, and runway). However, each Hanscom Field runway (5, 11, 23, and 29) tends to be used exclusively on some days of the year and not at all on other days. Runway usage is determined by wind direction, with takeoffs and landings being made into the wind. It follows that residents under a specific runway are exposed to essentially ambient noise on days the runway is not used, and to a much higher than reported L_{dn} on days the runway is used exclusively.

TD9.2 Sample Estimation of Uncertainty due to Exclusive Runway Use

The above discussion confirms that because of area wind patterns the Hanscom runways are used

- Nearly 100% of the time on some days, and
- little or not at all on some other days

In turn, this implies that the reported L_{dn}, obtained by noise averaging over the entire year, may be significantly lower than $L_{dn\ 100\%}$, registered only during days of 100% runway use. It is this latter figure that is worthwhile predicting and reporting because it is this noise level that causes area resident annoyance and complaints. Table 1 to provides a sample estimate of the difference between $L_{dn\ 100\%}$ and L_{dn}. The first two columns of Table 1 show the percentage of runway use at Hanscom. Columns 3 and 4 combine the percentages for operations from either end of each runway. Thus, runways 5 and 23 account for 30% of all takeoffs and landings; and, runways 11 and 29 account for the remaining 70% of operations.

The noise averaging over the entire year means that the sound energy produced by runways 11 and 29 over 70% of days in a year, is spread over 100% days of the year. In other words it is diluted by a factor of 100/70=1.4 which is shown in the fifth column of Table 1 ("Increase of Operations Ratio (OR)"). This means that the sound energy on days with 100% use is 1.4 times higher. Similarly, the sound energy produced by runways 5 and diluted by a factor of 100/30=3.3.

A noise level correction, L, that compensates for the above cited dilution may be estimated by using the following formula:

$$\Delta L = Ldn_{100\%} - Ldn$$

$$= 10\log_{10}\left(\frac{100\%\ runway\ use\ sound\ energy}{year\ average\ sound\ energy}\right) = 10\log_{10}(OR) \qquad (1)$$

Upon substitution of the OR = 1.4 and 3.3 into Equation 1, we find that the corresponding correction levels are 5.2 and 1.5 dB, respectively, which are included in the sixth column of Table 1.

The important implication, the bottom line, of this sample estimation of correction levels is summarized in the last two columns of 4 which shows the associated impact on the L_{dn} = 55 contours. Because of the correction, the L_{dn} = 55 dB contour reported for runways 5 and 23 corresponds to an actual level of L_{dn} = 60.2 dB; and the L_{dn} = 55 dB contour reported for runways 11 and 29 corresponds to an actual level of L_{dn} = 56.5 dB. This is a very significant disparity between reported and actual daily L_{dn} levels and it must be addressed and reported in future Hanscom Field GEIRs.

TABLE 1 - CORRECTIONS TO OPERATIONS AND NOISE LEVELS

FOR 100% RUNWAY USE

Hanscom				Increase (Correction) in		Currently	Potentially
Runway No.	% Use per year	Runway Pairs	% Pair Use per year	Operations Ratio	Noise Level (dB)	Reported Ldn (dB)	Corrected Ldn_100% (dB)
5	7						
23	23	5 & 23	30	3.3	5.2	55	60.2
11	26						
29	44	11 & 29	70	1.4	1.5	55	56.5

TD10. Technical discussion: Maintaining Consistency across INM model changes

Recommendation:
The Workgroup recommends that the next GEIR include a section documenting how changes in the FAA Integrated Noise Model data affect the predicted total noise exposure. 1987 is acceptable as a baseline year, provided that available data from 1978 onward be presented in all year-to-year comparisons..

Discussion:

TD10.1 Variation of EXP Values
A comparison of 1996 Noise Exposure data by Aircraft Type (Appendix B of the December 1997 memorandum "1996 Exposure Levels at L. G. Hanscom Field") to similar 1985 data (Table E-1, page E-6, of the March 1988 Hanscom GEIR Update) revealed major differences in the reported Reference Departure SEL (for a location 15,000 ft from Brake Release). Specifically, the Reference Departure SEL (dB) for a few representative aircraft types were as follows:

C-500, C-501:	84.6	in 1985 (position 1);	86.8	in 1996 (position 1A)
LR-24, LR-25:	107.4	in 1985 (position 4);	104.3	in 1996 (position 5A)
G-2, G-3:	101.9	in 1985 (position 5);	107.5	in 1996 (position 7A)
C-140 (MIL):	105.3	in 1985 (position 8);	95.5	in 1996 (position 12)
C-141 (MIL):	109.2	in 1985 (position 10);	103.3	in 1996 (position 13)
C-5A (MIL):	117.6	in 1985 (position 12);	112.0	in 1996 (position 15B)

These are just a few examples. In general, in 1996 some of these numbers are higher and some are lower than in 1985. The SEL values that are picked affect the EXP. The Metrics and Standards subgroup has been informed by Massport that the SEL values for EXP are taken from the INM, and that the INM has been upgraded periodically over the past 15 years. In the past, Massport's EXP modeling has not been upgraded as often as the INM, although it has been done several times in order to use the best noise and performance data that is available at the time. Massport touched upon this issue in the 1995 GEIR Update Report (p. 2-93, Sec. 2.3.3.4) by stating: "In order to maintain consistency with noise contours and current FAA data, Massport intends to modify Reference Level SELs used in the computation of EXP to reflect the FAA's most current data". Indeed, the 1995 GEIR Report presents two tables that permit a comparison of the impacts of these changes to be evaluated between INM version 3.9 data and version 5.0 data (Tables 2.3.-9 and 2.3-10, pp. 2-93 and 2-94).

TD10.2 Variations in DNL, TA and proper comparisons

Massport's revision of the data and their intent to be consistent in presenting EXP data is appreciated. Along those lines, it is recommended that the same consistency be maintained for future GEIRs in order to enable valid year-to-year comparisons of L_{dn} contours, TA contours, and any other related metrics, such as those described in Section TD4. In other words, the current data should be reprocessed through the old INM version, in order to enable valid ("apples-to-apples") comparisons from year to year.

TD11. TECHNICAL DISCUSSION: RELOCATION OF NOISE MONITORING SITES

Recommendation:
The Workgroup recommends that three of the six permanent noise monitoring sites be relocated away from local high-level concentrated noise sources.

Applicability and Time Frame
Since the equipment at the six noise monitoring sites already exists, relocation could be implemented as.

Discussion:
The following measurement sites are affected by local acoustic anomalies, and are therefore inappropriate for characterizing the ambient:

Site 34, DeAngelo Drive, Bedford

This site is aligned with the northern end of Runway 5/23. It is situated adjacent to the sidewalk and street in a light industrial complex, near a cul-de-sac at the end of DeAngelo Drive. This site is heavily influenced by close traffic noise from local employers during rush hours, and thus is not truly indicative of the noise environment in residential areas. We recommend that this monitor be relocated radially outward from the end of Runway 5/23 a short distance into the nearby residential Bedford community.

Site 35, Preston Court, Lexington

Situated in the community off the eastern end of Runway 11/29, Site 35 is the more distant of the two monitors off this end of this runway. It is equipped with weather monitoring instruments. Its location near the crest of a steep hill creates two problems for accurate characterization of the Lexington residential acoustic environment. First, its location gives a commanding acoustic line-of-sight exposure to Route 128 (Interstate 95), which passes .25 mile to the west. Rt. 128 is the major roadway in the western suburbs, and thus contributes substantially to the background sound environment at this location. While 128 is undeniably a major non-aircraft related noise source, we believe this monitoring site is influenced unduly by the roadway, given its prominent hill location overlooking the highway.

The second problem with this site is that it may be strongly influenced by an unusual amount of additional automobile engine noise, as engines must rev to negotiate the steep hill. We recommend that this site be moved along the axis of the runway only a small distance west or east to move it from the crest of the hill.

Site 36, Wastewater Treatment Plant, Concord

This is the more distant of two monitors off the western end of Runway 11/29. Opposition from nearby residents prevented its being sited at the original choice of location near Black Duck Lane. It thus was sited on Town land by the wastewater plant. This location puts it about 1000 feet south of a direct line off the runway (were it farther north and on the runway line, it would be in the middle of the Concord River.)

There is a significant problem with this location. It is only a few feet from - and directly overlooks - the outflow spillway of the wastewater plant. The outflow spillway runs continuously, creating a unique and loud broadband noise source that is completely unrepresentative of the ambient noise environment in the area. The monitoring site must be moved – if possible into the residential community that originally rejected it. Even if it must remain on the wastewater plant site, it must be moved so as not to be dominated by the outflow spillway. (In any case, the river floodplain will prevent its being located directly on the axis of the runway.)

ADOPTION AND SIGNATURE

22 SEPTEMBER, 1999

(SIGNATURE PAGE 2)

APPENDIX 1

VOLUNTARY ABATEMENT PROCEDURES

Hanscom Field

Proposed Voluntary Noise Abatement Procedures

Piston Fixed Wing and Rotorcraft

Introduction

The first Abatement recommendation made by the Hanscom Field Noise Workgroup was that there should be a set of voluntary noise abatement procedures developed by local pilots and operators. After acceptance of this recommendation by the Workgroup, Jeffrey Parker, a local pilot and Chair of the Abatement and Mitigation Taskgroup, took the initiative in assembling a team to formulate and recommend such procedures. Members of the team included:

Mike Goulian, Sr. Executive Flyers, Aerobatic Champion
Dan Schraeger, Aviation Insurance Agency, Local pilot
Ken MacDonald, Aviation Regulatory Consultant, Local Pilot
Sara Arnold, Manager, Airport Administration, L.G. Hanscom Field
Jim Mathieu, Manager, Airport Operations and Maintainance, L.G. Hanscom Field
Tom Hoban, East Coast Aviation, Local Pilot
Isabelle Plante, USAF Flight Training Center, Local Pilot
Anne Umphrey, Local Rotary Wing Pilot
Dr. Susan Wedel, Boston MedFlight, Local Rotary Wing Pilot

This team gathered input from other pilots and operators on the field and developed the set of procedures attached. The processes by which these may be adopted on a voluntary basis are now underway. Although not strictly a Workgroup activity, the development of these procedures is central to many of the Workgroup's Abatement Recommendations. The Workgroup thanks Dr. Parker and this team for their initiative and progress in carrying forward this project.

Hanscom Field
Voluntary Noise Abatement Procedures
Piston Fixed Wing Aircraft

To further our goal of reducing aircraft noise, we recommend that the following noise abatement procedures be followed whenever possible, consistent with safety.

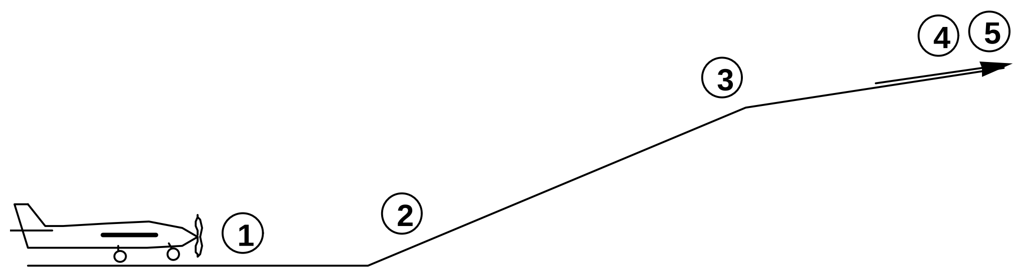
General Procedures

1. Avoid operations between the hours of 11:00 PM and 7:00 AM, whenever possible. A fee applies to all operations during this period.

2. Touch & goes are not permitted between the hours of 11:00 PM and 7:00 AM.

3. Touch & goes are not permitted at any time for aircraft exceeding 12500 pounds.

4. Stay current with manufacturer's noise abatement procedures specific to your aircraft. These procedures are often published as a supplement to the flight manual.



Departure Procedures

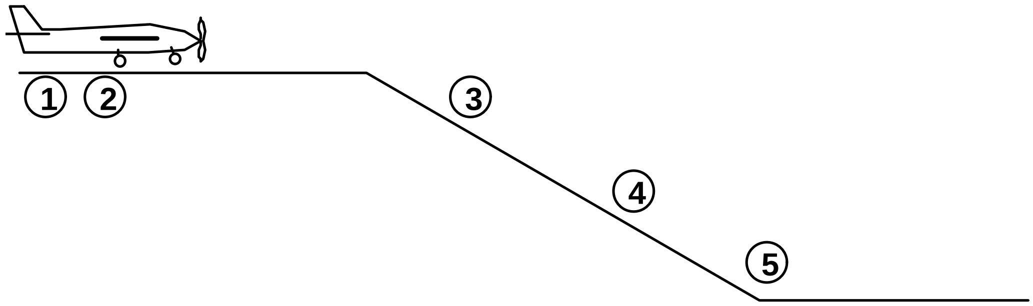
1. Use the full length of the runway for departures, avoiding intersection takeoffs.

2. After lift-off, climb out at the best rate-of-climb airspeed (V_y).

3. Set propeller to the "cruise-climb" power setting before reaching the airport boundary. Avoid flying over residential areas with the propeller set to high rpm.

4. When departing the pattern, unless otherwise directed by ATC, maintain runway heading to 1000 feet MSL before turning on course.

5. When staying in the airport traffic area,
   - climb straight ahead to 500 ft AGL before turning upwind.
   - maintain your traffic pattern as close to the runway as possible.
   - stay at pattern altitude as long as practical.
   - avoid extending your pattern over residential areas.



Arrival Procedures

1. Straight-in approaches should maintain at least 1500 feet MSL until intercepting the VASI/PAPI glide path.

2. VFR aircraft should maintain at least 1500 feet MSL until 3 miles from the airport.

3. On final approach, stay on or above the VASI/PAPI glide path until crossing the airport threshold.

4. Set the propeller to high rpm on short final, after making your final power setting.

5. When practicing touch & goes, touch down within 1000 feet of the runway threshold.

Hanscom Field
Voluntary Noise Abatement Procedures
Helicopters

To further our goal of reducing aircraft noise, we recommend that the following noise abatement procedures be followed whenever possible, consistent with safety.

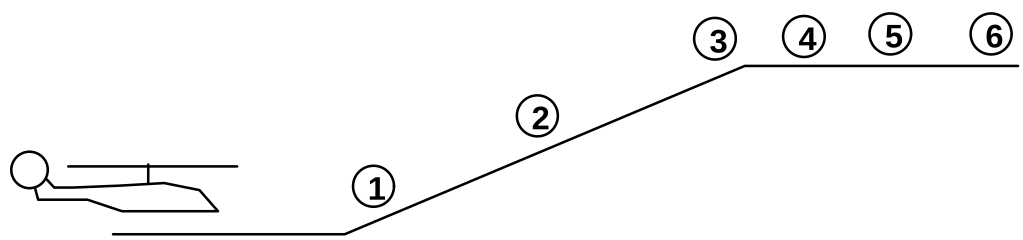
General Procedures

1. Avoid operations between the hours of 11:00 PM and 7:00 AM, whenever possible. A fee applies to all operations during this period.

2. Touch & goes are not permitted between the hours of 11:00 PM and 7:00 AM.

3. Touch & goes are not permitted at any time for aircraft exceeding 12500 pounds.

4. Stay current with manufacturer's noise abatement procedures specific to your helicopter. These procedures are often published as a supplement to the flight manual.



Departure Procedures

1. Climb at the best rate in order to reach altitude as quickly as possible. Avoid maximum power climbs.

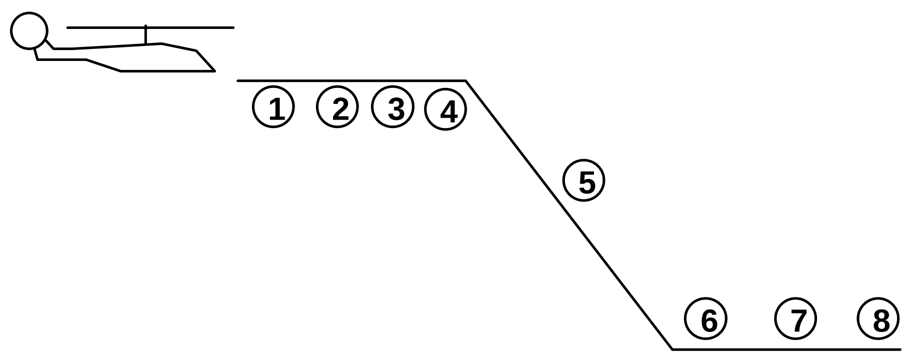
2. Make a smooth transition to forward flight.

3. Avoid residential areas when departing the airport traffic area. Operate over surface routes such as highways whenever possible.

4. Fly as high as practical.

5. Vary the route if possible.

6. When staying in the airport traffic area,
   - maintain your traffic pattern as close to the runway as possible.
   - avoid extending over residential areas.



Arrival Procedures

1. Fly as high as practical.

2. Vary the route if possible.

3. Avoid sharp maneuvers such as rapid high "G" turns.

4. Reduce airspeed below max cruising speed to minimize blade slap.

5. Use steepest glide slope consistent with safety.

6. Make approaches directly to taxiways or ramps.

7. Minimize time spent hovering. When hovering, attempt to turn the helicopter's tail towards noise sensitive areas.

8. When practicing touch & goes, make approaches to taxiways or grass areas as far from noise sensitive areas as possible.

APPENDIX 2

SAMPLES OF TIME-ABOVE CONTOURS