Seaplane Compatibility Issues

A Report About Seaplanes
Focusing on
Safety, Noise and Jurisdiction

Seaplane Pilots Association
4315 Highland Park Blvd., Suite C
Lakeland, FL 33813-1639

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Seaplane Compatibility Issues

Foreword

This document is published by the Seaplane Pilots Association to assist in the resolution of conflicts between the seaplane community and those interested in curtailing seaplane operations.

It addresses as three important subjects seaplane safety, jurisdictional issues relating to seaplane water operation areas and seaplane noise.

David Ketchum of Airside in Bellevue, Washington was responsible for the safety and jurisdiction sections. SPA Vice-president Bob Hamilton of Amphib Air, Inc., Vashon, Washington, and Aron Faegre, SPA member and Airport Noise Consultant of Aron Faegre & Associates, Portland, Oregon, have collaborated to provide synergism on the noise study.

It is hoped that this document will be a valuable aid to the members of the Seaplane Pilots Association.

Seaplane Pilots Association, Lakeland, Florida - May -- 1996

Seaplane Compatibility Issues

Seaplanes are the historical heart of aviation. Pilots have flown off-the-water since the beginning of flying itself.

Yet seaplanes sometimes meet resistance, even strong opposition, from concerned citizens and elected officials. Controversies usually center on safety and noise.

So, are seaplanes safe? Does their record justify their existence on often busy waterways? And how noisy are they – really? This document explores these and other often-asked questions about these unique and versatile aircraft.

SEAPLANES HAVE BEEN USED IN many areas of the world throughout most of the 20th century. Hundreds of seaplanes fly thousands of hours each year in the United States alone. Their ability to land on the water makes them a versatile commercial and recreational tool. Their existence is generally accepted; their operations, uneventful.

From time to time, however, concerns arise about seaplane use. They sometimes escalate to direct opposition and usually center on the issues of safety and noise. Municipalities, port districts or other agencies claiming jurisdiction over the waterways in question are often asked to get involved – to pass ordinances. Essentially they are tasked with determining whether seaplanes are compatible with other vessels, as well as with residences and other uses near and on the water. In the process, deliberations between seaplane operators and those challenging seaplane activity can become heated and confused. Concerns are aired, defenses are put up; frustration and fear often result. It is usually left to a local seaplane pilot or commercial seaplane firm to fight the battle – to keep their flying hobby or business alive. The ability to fly off the water may be on the line.

So what is the best approach?

How do those who fly seaplanes address those who oppose them? First, it is important to remember that concerns about safety and noise are real. Whether they are justified is not the issue. The fact is, they exist. Perspectives about noise and safety will vary depending on individual motivations. But, left unattended, opposition tends to endure, even grow. It is better then to recognize concerns and address them with empathy and irrefutable facts than to ignore or discount them.

Agencies asked to establish waterway uses and regulations often feel responsible for addressing both safety and noise issues during deliberations. Seaplane proponents, therefore, often find themselves addressing two audiences: those who protest their operations and those asked to decide what is appropriate and workable.

This document's goal

This document focuses directly on seaplane safety and noise. It addresses these issues in an objective, factual manner. The information is presented to assist those wishing to promote and protect appropriate seaplane use as they interact with those who oppose them and with elected officials who may be in a position to impact their seaplane flying.

The issue of jurisdiction is also addressed. The unique capabilities of seaplanes to fly, land on the water, tie up to shorelines and docks and, for some, to also use land airports, often makes clear definition of jurisdictional authority difficult. Who is in charge? Who can determine who uses a specific waterway? This is often a difficult question. Many government agencies exert some form of control over seaplane operations. Much of the jurisdiction claimed by government is appropriate and clear; some may not be. Jurisdiction is sometimes claimed and, absent a credible challenge, becomes assumed, appropriate or not, as legitimate over time. It is likely that the issue of jurisdiction over waterways, especially navigable waterways, will never be completely established. There are simply too many variables. *Seaplane Compatibility Issues* forwards, however, some basic concepts that may clarify our perspectives about jurisdiction.

Types of Seaplanes

This section will assist those who are not familiar with the scope and variety of seaplanes.

Seaplane aviation occupies a unique niche within the air transportation system. Seaplanes operate largely outside the structured framework of land-based airports and established air routes. Their ability to operate in the air, on the water and often on land makes them one of the most versatile transportation vehicles in existence.

The basic types of seaplane aircraft are straight floatplanes, amphibious floatplanes and flying boats which may or may not be amphibious. Of these types, the straight floatplane is the most prevalent. Most seaplanes are production aircraft, made by established airframe manufacturers. Kit aircraft that may be assembled by their owners are becoming increasingly popular.

Seaplanes come in low-wing and high-wing models, and in single- and multi-engine styles. The fuselages (main bodies) of some are identical to their land-based counterparts. The fuselages of other seaplanes resemble boats.

Straight Floatplanes

A floatplane is an aircraft that rests on floats or pontoons. Floatplanes are almost always originally designed as land planes, with wheels instead of pontoons or floats, but are specially manufactured with "float kits" for later conversion. These kits equip the aircraft with additional reinforcement, lifting rings, float mounting brackets and corrosion proofing to enable water operations. The conversion from wheels to floats can take as little as one to two hours to perform. Thus, these aircraft can readily operate as floatplanes or as land planes, depending on the need.

Floatplanes normally have two to six seats. The deHavilland Beaver is one of the more popular floatplanes for commercial operations. This aircraft is also occasionally used for recreational purposes. In commercial applications it is often configured with eight seats.

Amphibious Floatplanes

A variation on the floatplane design is the amphibious floatplane. Floats on this type of aircraft have retractable wheels to allow for landings on hard-surfaced runways. This feature provides additional landing options, thereby increasing the aircraft's versatility and safety.

Flying Boats

The term flying boat refers to a type of aircraft that rides on its fuselage in the water. Aircraft of this type have small stabilizing pontoons fitted to the ends of the wings. Retractable wheels are often installed in the fuselage to provide the ability to land on hard-surfaced runways. When wheels are installed, flying boats are another type of amphibious aircraft. The Grumman Goose and Consolidated Catalina are two of the best-known amphibious aircraft from the 1930s and 1940s. Both were used extensively by the U.S. Navy during World War II. Also, flying boats were widely used in trans-oceanic passenger transport during that period. Other famous flying boats include the Boeing 314 and Martin 130 which

Seaplane Safety

What Does The Record Show?

Safety is one of the most often expressed concerns about seaplane use. After all, seaplanes operate off lakes and rivers, even canals and small harbors and many times are in close proximity to boats and beaches. This capability can cause concern. So, are seaplanes safe? Is there reason for concern? One important and accepted method of determining answers about safety is to simply review the record. This is the way it is done with trains, busses, cars and nearly everything else that moves. Seaplanes should be no different.

So, how many seaplane accidents have there been and what caused them? Based on this review, does the seaplane safety record justify operating seaplanes in close proximity to other vessels, and to people and structures? And finally, is the record applicable to my community? When addressing concerned citizens and elected officials, this is what they want to know. And again, though the seaplane community may be convinced of the safety of seaplane operations, its opponent's concerns are real to them and must be objectively addressed.

To review the seaplane safety record we must arrange available statistics about seaplane accidents so that they are understandable and meaningful. Now, we all know that statistics can be manipulated to justify particular positions, so when reviewing the record it is important that we use a straightforward methodology that everyone, regardless of his or her orientation to seaplanes, can understand and believe.

Then, after presenting the raw statistics we must go further. We must try to analyze trends. For instance, is the record improving or not? And we must try to consider some of the more subtle reasons for accidents, reasons that may not be indicated in official accident reports. Then finally, we must prove, beyond any doubt, that the industry as a whole and our individual operations, whether private or commercial, are committed to an ongoing, organized safety program.

Methodology

In order to determine the safety record of seaplanes it is important to establish clear and appropriate review parameters and procedures and then examine a long enough review period to provide a true picture of events. The following guidelines were used in this effort.

- Aviation safety data consisting of accidents and causes of accidents, are gathered and published extensively in the United States by the National Transportation Safety Board (NTSB). NTSB records were used as the basis for this document because of their objectivity and consistency.

- The records reviewed covered the period from January, 1983, through December, 1995. This amounted to 13 years of records totaling 338 individual accidents. We believe this review period is long enough to provide a credible analysis.

- The 338 case histories reviewed included accidents involving aircraft that, *due to their configuration at the time*, were capable of water operations. These records included airplanes, both production and home-built, and helicopters.

- The records reviewed included accidents of all aircraft of civil United States registration wherever they occurred and foreign civil aircraft when operated in the United States, its territories or possessions. This is in keeping with the guidelines of NTSB Part 830.1 "Applicability." paragraph (a).

- For consistency, the NTSB's definition of accident was used. This definition states that an aircraft accident "means an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage." The definitions of serious injury and substantial helped Pan American Airways establish international air routes.

Smaller and more contemporary examples of flying boats include the Lake Amphibian, an aircraft popular with recreational fliers due to its ease of handling and relatively low operating cost.

Kit Aircraft

Seaplane kit aircraft are increasing in popularity among recreational fliers. Kits are produced and sold by manufacturers; the planes are often assembled by individuals. Water-landing kit planes are usually small, seating two to four passengers. Most are straight or amphibious floatplanes.

Kit aircraft assembled by owners must be flown under the experimental aircraft provisions of the Federal Air Regulations. They are therefore restricted from commercial uses. However, as of September 1992, a new federal air regulation (FAR 21) allows kit aircraft to be assembled by the commercial kit builder. This category of light and very light aircraft have lower purchase and operating costs than traditional production aircraft. FAR 21 allows this new category of aircraft to be granted what are called "type certificates." Type certificates issued by the FAA remove the restrictions that exist in the FAA's Experimental category. Thus FAR 21 aircraft can be used by private flyers to carry passengers. They can also be used as commercial rental aircraft and for flight training. This new category of airplane is expected to increase recreational flying of both land and water-based aircraft.

Seaplane Activity

Seaplane activity can be divided into two categories: commercial and recreational. In general, the determining factor is whether or not compensation is paid for the flight. These categories are defined in the Federal Air Regulations (FARs).

FAR Part 91 defines general operating rules for all pilots. Specific rules for commercial pilots are defined in FAR Part 135. Most commercial use comes under the Part 135 air taxi classification, with two principal exceptions:

- Flight training, even when performed for compensation, is technically not covered under Part 135. However, seaplane flight training is often performed by commercial seaplane firms.

- Nonstop sightseeing flights that begin and end at the same point and are conducted within a 25-mile radius are not considered air taxi service according to the FARs.

Determining the exact number of seaplanes and seaplane pilots in the United States and their levels of activity is a challenge. First, many seaplanes are constructed as land planes which have the ability to be fitted with floats. Those who exercise this option are not required to report the fact that they have done so.

Second, though the numbers of pilots who are certified to fly seaplanes are registered with the FAA, this does not establish how many are active.

Third, there is no requirement to report either recreational seaplane operating hours or non-scheduled commercial activity. Only scheduled commercial seaplane flights are reportable.

To gather seaplane activity data, a survey is being conducted by the Seaplane Pilots Association (SPA). The data derived from the survey will be compared with accident data. It will then be possible to determine the seaplane accident rate and, over time, to track accident trends.

damage may be found in the glossary to this document. It is important to note that both serious injury and substantial damage are not required for an accident to be reportable. Either qualifies an occurrence as an accident. Also, the damage and/or injury need not be to the aircraft itself but can be to other vehicles or vessels and to persons other than those occupying the aircraft.

The review then focused on questions intended to answer our primary question. Does the seaplane safety record justify operating seaplanes in close proximity to other vessels, and to people and structures? To do this we asked the following:

- Did the accident, regardless of where or when it happened, occur *because the aircraft was configured for water operations?* In other words, was there something specific about an aircraft's water capability that caused an accident?

- Did the accident occur just prior to, just after or during water operations?

These questions were asked because a number of accidents reviewed in the NTSB records had little or nothing to do with increasing our knowledge about the advisability of operating seaplanes on and off water or in close proximity to other vessels and structures. An example of a nonapplicable accident would be an aircraft equipped with amphibious floats that, while on a flight between two land airports, had an engine failure resulting in a crash landing in a field. The fact that the aircraft could operate on water had nothing to do with the accident. Including this occurrence in the reviewed data would, therefore, not contribute to deliberations over seaplanes and water safety.

Information Sought

The following information is considered pertinent to this issue and has been extracted from these records:

- The date and location of the accident.

- The type of aircraft involved.

- The general circumstances surrounding the accident.

- Damage to the aircraft. Damage categories are "destroyed," "substantial" and "minor." Damage also follows NTSB guidelines.

- Injuries to any person whether occupants of the aircraft or not. Injuries are divided into the categories of "fatal," "serious," "minor" and "none."

During This Review

NTSB Records Were Used.

Period Studied Covered 13 years.

338 Case Histories Were Studied

NTSB 830.1 "Applicability" Was Followed.

Accepted Definition of "Accident" Was Adhered to.

Then We Asked...
Was The Accident Due to Water Configuration or Were Water Operations Being Conducted?

What Did We Find?

1. **Of the 338 accidents reviewed, 195 are relevant to the safety of seaplane operations in the water environment. This is because these accidents happened during or as a result of water operations or because the aircraft were configured for water operations.**

2. **There were a total of 438 individuals involved as aircraft passengers in the 195 water-related accidents. Of these, there were 54 fatalities, 49 who sustained serious injury, 103 who had minor injuries and 232 who were not injured.**

3. **In all of the seaplane accidents which occurred over the 13-year period, three involved boats. Of these, there were three fatalities who were occupants of the boats.**

4. **Some accident investigations identified the sharing of waterways between boats and seaplanes as contributing causes even if collisions between them did not result. Boat wakes were cited as factors in 6 accidents. Avoiding a boat was named in 1 accident.**

5. **Property damage, other than to the aircraft involved in the accidents, was virtually nonexistent over the entire 13-year period.**

Causes of Accidents

Accident investigation experience has shown that accidents are seldom the result of a single, predominant factor. More often than not they are the result of two or more factors that happened within a fairly close time frame. Sometimes, in retrospect, it is determined that pilot attention was eroded or pilot routine was interrupted by an unusual occurrence such as an abnormal engine indication, deteriorating weather or a low fuel condition.

Sometimes, even when faced with contributing causes it is apparent that accidents occur simply because pilots exceeded their personal skill levels or the capabilities of their aircraft. Obviously this, the judgment factor, is difficult to quantify.

Additionally, even considering the often exhaustive effort put into determining the causes of accidents the true reasons behind them may be evasive. Investigators do their best to record the major factors such as weather, mechanical irregularities and pilot actions but they can only do so much.

There are a number of contributing factors that repeatedly appear in accident reports. Factors that either by themselves or in combination with others have played major roles in seaplane mishaps.

Improper technique or procedure

Even though other factors such as high winds or rough water may have been evident, the failure to follow established techniques and procedures and the inability to effectively control the aircraft to a level expected for pilot certification was predominant in 59 accidents. This includes the use of pre-flight judgment about whether the flight should have taken place considering prevailing conditions.

Water Landings With Wheels Extended

Twenty-seven accidents involved landings which were attempted in the water with the aircraft's landing gear extended. This, of course, could only occur with amphibious aircraft which, by no means, account for the majority of the seaplane fleet. Of the 27, 5 wheels-extended accidents involved some kind of mechanical failure with the landing gear.

Poor Weather, Gusty Winds

Turbulent air, unanticipated crosswinds and gusty winds were cited as predominant contributing factors 26 times.

Glassy Water

Glassy water, a condition where it may be difficult for pilots to judge their height above the water during the final stage of landing was recorded 11 times.

Striking a Submerged Object

Objects ranged from sand bars just under the water surface to logs. This occurred 9 times.

Rough Water

Operations in water conditions that were beyond the capabilities of the pilot and/or aircraft were mentioned in 6 cases.

These 6 factors, pilot technique or judgment, landing gear operation, poor weather, glassy water, hitting a submerged object and rough water accounted for a total of 138 or 72 percent of accidents.

The remaining accident reports cited a number of contributing factors. These included fuel exhaustion due to improper planning, fuel starvation caused by mechanical conditions beyond the pilots direct control, unusual swells or waves from boats, overweight or out-of-balance conditions caused by water in the aircraft's hull or floats, overweight or out-of-balance conditions caused by an excessive passenger or cargo load, and porpoising (a condition where, unless decisive corrective action is taken, an aircraft becomes uncontrollable on the water).

From there a wide range of causative factors were named one or two times. These included a case where the pilot made an abrupt maneuver to avoid a jet ski, incapacitation due to drugs or alcohol, medical incapacitation (the pilot did not have a current medical certificate as required), poor communication between instructor pilots and students, collisions with wires, and engine or structural failures. Animals were mentioned twice, once when birds were struck during the final stages of landing and once when an aircraft swerved to avoid an alligator. A table showing all contributing factors is on the following page.

CONTRIBUTING CAUSES OF SEAPLANE ACCIDENTS THAT OCCURRED DURING WATER OPERATIONS 1983-1995

Contributing Cause of Accident	Number of Occurrences
Improper Technique or Procedure - There may have been contributing factors but pilots were found culpable.	61
Landing with in water with wheels extended - Five of these times there was found to be some mechanical failure or improper landing gear indication.	27
Poor weather, gusty winds - This included unanticipated crosswinds and incidents of wind shear.	26
Landing on Glassy Water - A condition where depth perception may be difficult.	11
Striking a Submerged Object - These ranged from logs to sand bars.	9
Rough water - Closely related to weather and wind conditions.	6
Fuel exhaustion - Due to pilot error	3
Fuel starvation - Due to mechanical failure	5
Unusual swell or wave - From boat(s)	6
Unusual swell or wave - Unknown source.	2
Overweight or out of balance condition - Due to water in hull or floats	3
Overweight or out of balance condition - Due to excess load or shifting of load.	5
Porpoising - An on-the-water control problem that some aircraft are more prone to than others	2
Striking a cable during docking - The cable was installed the day prior to the accident.	1
Striking wires in flight - Often electrical wires.	3
Density Altitude - A condition where aircraft performance can be degraded by temperature and altitude.	1
Engine power loss or failure - Not related to fuel.	3
Structural failure - Of the airframe.	3
Miscommunication between trainee and instructor.	3
Alcohol or drugs involvement.	4
Bird strike.	1
Alligator avoidance.	1
Unknown or in-process	14
Total	198

Note: *Factors will not equal total accidents since there are often more than one contributing factor per accident.*

Additional Factors

During this review it was found that two pilots did not have required medical certificates, four pilots were not rated as pilots or as seaplane pilots and two aircraft did not have required certification. Seventy-three seaplane accidents occurred during the takeoff phase of flight; 89 during landing. Fifteen occurred during water taxi, most during the step-taxi phase. Only two accident reports indicated that mishaps occurred during touch-and-go operations.

Where Did The Accidents Happen?
Seventy-two percent of the 195 accidents occurred in seven states: Alaska, Florida, Washington, Michigan, Maine, New York and Wisconsin.

All of the accidents are listed by state below. While an interesting statistic, this information should not be used to draw conclusions since seaplane census and activity data is not available. It is obvious that the highest number of seaplane accidents have occurred in the states with the highest numbers of seaplanes.

SEAPLANE ACCIDENTS BY STATE 1983-1995

State	Number of Accidents	State	Number of Accidents
Alaska	70	Texas	2
Florida	18	Connecticut	2
Washington	15	Arizona	2
New York	10	Maryland	2
Maine	9	Illinois	1
Michigan	9	Utah	1
Wisconsin	9	Pennsylvania	1
California	8	Oklahoma	1
Minnesota	7	Nebraska	1
Louisiana	7	Virginia	1
New Hampshire	6	West Virginia	1
Oregon	6	Unknown	1
Massachusetts	3		
Rhode Island	2	**Total**	**195**

When Did Accidents Happen? What Is The Trend?

SEAPLANE ACCIDENTS BY YEAR 1983 --1995		FATALITIES AND SERIOUS INJURIES BY YEAR 1983-1995		
			Fatalities	Serious
1983	11	1983	6	4
1984	14	1984	1	4
1985	17	1985	1	5
1986	9	1986	7	1
1987	13	1987	1	7
1988	7	1988	3	5
1989	11	1989	1	4
1990	5	1990	1	0
1991	8	1991	1	1
1992	11	1992	3	0
1993	36	1993	11	2
1994	37	1994	15	11
1995	16	1995	6	5
Total	**195**	**Total**	**57**	**49**

Note: *Fatal injuries include those accidents that occurred between boats and seaplanes.*

What Aircraft Were Involved?

Knowing the types of aircraft that were involved in accidents will not help understand accidents better unless census data is available. It is a good idea, however, to track aircraft involvement since, over time and with the introduction of other data it will be meaningful.

The following table lists the aircraft that were involved in the accidents reviewed.

AIRCRAFT INVOLVED IN ACCIDENTS 1983-1995

Aircraft	Number of Accidents	Aircraft	Number of Accidents
Lake Amphibian	50	Maxair	1
Cessna 185	33	Piper PA-22	1
Cessna 206	14	DeHavilland Tw/Otter	1
DeHavilland Beaver	13	Champion	1
Cessna 180	10	Stinson	1
Cessna 172	8	Bellanca	1
Piper PA-18	7	Grumman Albatross	1
Republic Seabee	5	Cessna 170	1
Grumman Widgeon	4	Cessna 150	1
Grumman Goose	4	Cessna 182 B	1
Maule	4	Colonial C-2	1
Taylorcraft	3	Puffin	1
Teal	3	Grumman Mallard	1
Searay	3	Stol UC-1	1
Helio Courier	2	Hudson Rans	1
Volmer	2	Consolidated	1
Aeronca	2	Coyote	1
Cessna 208	2	Buccaneer	1
Osprey	2	Piper PA-12	1
Piper J-3	2	Grumman (unknown)	1
Avid Flyer	2		
		Total	195

Observations About Accidents

Investigating accidents would provide little benefit beyond satisfaction of curiosity and the settlement of insurance claims were we not going to use the information to reduce the likelihood of recurrences. This section discusses issues relating to seaplane accidents

Seaplane versatility requires a higher pilot standard

It is apparent that one of the seaplanes' greatest benefits, its versatility, must be taken into account in any accident prevention program. Pilots are able to visit canals, harbors, remote lakes and rivers. Seaplanes, especially those with amphibious capabilities, are nearly go-anywhere vehicles.

As mentioned earlier, seaplanes operate largely outside the structured framework of our air transportation system. It is this very versatility, this freedom of choice, that must provide the basis for holding seaplane pilots to an unusually high standard, for along with increased freedom comes heightened responsibility. For instance, a pilot departing a land airport often has the benefit of a weather-condition report including winds, temperature and even comments from other pilots. Departing, however, from a remote waterway leaves the seaplane pilot on his own to observe and make judgments about water, wind and weather conditions and about his personal ability and that of his aircraft relative to them.

Cockpit discipline necessary in "freedom" environment

Several times accidents were caused, at least in part, by pilots' failures to "control the situation." Landing in the water with wheels extended, even in the case of mechanical failure, is an example. Adherence to check lists and the establishment and maintenance of good flying habits is vital. This is especially true when something out of the ordinary happens. Often it has been seen that a relatively minor cockpit indication, such as a non-working light or a broken gauge, took an undue amount of pilot attention. This fixation detracted from the primary duty of flying the aircraft. Here too the nature of seaplane flying itself, the individual, personal freedom inherent in the activity, plays a role because it is the antithesis of the thought process that is required for effective cockpit discipline. It is important to establish and consistently apply proper procedures. Then when distractions occur pilots have ingrained habit to rely on.

Judgment, a necessary element of training

Before any flight there is a judgment time, a time when a pilot considers himself, his aircraft, the weather conditions and other factors. In some flight situations this decision period is highly-organized such as that which exists with airline flying. In others it is more personal and contemplative.

Seaplane training can, as with any other commercial endeavor, be affected by costs and efficiencies. Operating a seaplane requires a unique combination of mechanical skills and judgment. When evaluating accident reports it became apparent that, in many cases, a more thorough examination of prevailing conditions as they related to pilots' skills may have been worthwhile. The judgment necessary to safely operate a seaplane, considering the wide-ranging conditions seaplane pilots are likely to encounter, cannot be over emphasized during training.

Judgment is a personal trait extending beyond ones' flying experience to other aspects of life. Flight instructors do, however, have the opportunity to exert considerable influence over judgment and the habits necessary to maximize it where flying is concerned. Most pilots can readily recall significant quotes or tidbits of wisdom from flight instructors they have had along the way.

Emphasizing pre-flight decision making and common sense judgment practices during seaplane flight training must remain an important part of the student/instructor relationship. During training, pilots develop habits and values that will remain with them.

The Risk of Seaplane/Boat Accidents

One of the primary issues regarding seaplane accidents and the potential for them is the risk associated with operating seaplanes on busy waterways in proximity to boats. This is often a concern expressed by communities wishing to curtail or refuse seaplane operations.

Most logical decisions in our society are made by applying what we know to our view of current and future conditions. We then, hopefully, make appropriate judgments. What we know about boat/seaplane accidents is that they are, from a statistical standpoint, nearly non-existent. This is not to discount the importance of the two that did occur. It should also not be cause to forget that the potential for boat/seaplane accident continues to exist. It is simply a fact.

To place this in perspective, compare this to collisions between boats. Boats are familiar to us all. We are comfortable with them and with the operating conditions in which they exist. They are an accepted and appreciated part of life. Consider, however, that, according to the US Coast Guard, in the same 13-year study period there were over 12,000 fatalities involving boats. This is an average of 950 per year. During a recent 5-year period boats collided with other vessels 11,174 times resulting in 381 fatalities and 6,706 injuries.

Conclusions About Seaplane Accidents

Though specific information about seaplane numbers and seaplane activity levels is not available at this time the following conclusions have been made.

- Considering what are probably hundreds of thousands of hours flown by seaplanes over the study period there have been relatively few accidents.
- When accidents have occurred they have almost always involved only the occupants of the aircraft. Only two instances resulted in injuries to other than aircraft occupants.
- Collisions resulting in accidents between seaplanes and other vessels of any kind were very rare. Three occurred in the review period.
- It seems that even serious seaplane accidents are unusually survivable. Remember, unless serious injury or death occurs in an aircraft accident, the aircraft must have had to sustain at least substantial damage for the mishap to qualify as an accident. Yet 335 of the 438 individuals involved received minor injuries or no injuries. This means that over 76 percent of those involved escaped serious injury in aircraft that sustained either substantial damage or that were destroyed.
- Seaplanes have, over the entire period studied, been able to successfully co-mingle with other vessels. The 13-year record simply does not provide substantial evidence to the contrary.
- Also, there is no statistical evidence to show that there is a serious risk to structures, facilities and other property adjacent to waterways.

Additional Conclusions

- The choices afforded the seaplane pilot in selecting landing sites, if properly exercised, contributes to the safety record of seaplanes. The land and water-landing capability of amphibious aircraft further broadens this choice.
- Two other factors have probably contributed to the seaplane safety record. First, seaplanes fly almost exclusively during daylight hours. Second, they virtually always fly under visual flight rules (VFR) conditions.
- Even in the absence of high accident rates for seaplanes and the fact that there are only three instances of recorded boat-seaplane accidents, reasonable judgment leads to the conclusion that a potential exists for mishaps in this segment of aviation. This potential is mostly due to the mix of boats and aircraft operating in close proximity in sometimes crowded harbors. The increasing use of personal watercraft contributes to the accident potential.
- Accident trends do not suggest that seaplane flying is getting safer over time. The table on page 9 indicates that 1994 was the worst

year in the 13 years studied for seaplane accidents, fatalities and serious injuries.

- Though difficult to ascertain, it appears that both the formal and informal networking that is somewhat unique to seaplane pilots contributes to the seaplane safety record. Organizations which distribute procedural and safety information and organized "fly-ins" which facilitate knowledge transfer play a positive role.

- Seaplane flying -- though comparatively safe -- could be made safer. Suggestions include the clear designation of seaplane operating and parking areas in harbors where boats also operate, posted information to inform boaters and seaplane operators of specific boat/seaplane operational procedures at specific harbors, and the regional standardization of seaplane operating rules.

- An opportunity also exists to make seaplane/boat interaction safer. Boaters are routinely involved in training and orientation sessions throughout the US. These are often sponsored by the US Coast Guard or local yacht clubs. Including information about seaplane requirements and operating parameters in these sessions would increase seaplane pilot/boater communication.

What about the basic question?

So, how do we answer our basic question? Are seaplanes able to coexist with boats and other vessels? And are they capable of sustained water operations in proximity to structures and other land and water uses?

While it is obvious, as with any other form of transportation, that seaplane accidents will occur it is also clear that the incidence of accidents, especially serious accidents, is low. Exactly how low we will know when census and activity data is generated over the next few years. It is important that the seaplane community understand how important it is to provide activity data to the SPA so that rates and trends can be generated. With this information, accident prevention programs can be more specifically targeted to problem areas.

The record is clear regarding seaplane/boat accidents. Three such accidents occurred in the 13-year review period. Two of these were fatal to occupants of boats. As regrettable as this is, and as mindful as all seaplane pilots and boaters must be to avoid recurrences, the record simply does not indicate that there is a statistical probability that collisions between boats and seaplanes are likely to occur.

Jurisdiction

Who's in Charge?

Aircraft that land on water have been the subject of jurisdictional debate throughout the United States for many years. This debate is often difficult to resolve for several reasons.

♦ First, seaplanes are very versatile. They are capable of using an endless number of water landing areas. Amphibious seaplanes are also able to access nearly any land airport. This causes them to reach across a broad spectrum of jurisdictional authority at the local, regional, state and federal levels.

♦ Second, seaplane use relates to the significant issues of community growth, ecology, safety, power generation, fisheries management and others. Thus, we find a wide variety of professions with occasional interests in seaplane flying.

♦ Third, the vital element in seaplane activity, water and land adjacent to it, is a resource that is experiencing rapidly increasing pressure from those who wish to develop it and those who oppose development. The development issue is further complicated since even those who agree with development often disagree about how to go about it. There is also a purely economic side of the waterside development issue. There is consistent pressure to develop this resource so that it attains its "highest and best use." Translate this to say that seaplane activity may find itself displaced simply on the basis of not being valuable in comparison to some other uses.

♦ Fourth, jurisdiction itself is far from an exact science. Though the United States has a relatively well defined system of governance, jurisdictions often overlap, directly conflict or are simply unclear. Discussions about seaplane use often take place in a context of confusing regulatory authority.

♦ Then we simply have the conundrum of how to define a seaplane. This relates back to its versatility. Is a seaplane an aircraft or a vessel?

The obvious answer is that it depends on what it is doing at the time. The difficulty is that in the United States jurisdictional authority is often determined by a vehicle's capability. And the broader the capability, the more difficult it is to define clear lines of governance. It is in this context then that seaplanes operate. A context that usually works well but that at times does not.

This document clarifies some of the basic concepts of seaplane jurisdiction. The entire subject is, of course, still very much a "work in progress." Seaplane jurisdiction has been addressed in piecemeal fashion for as long as seaplanes have flown. Though at times federal judges have been involved, most jurisdictional questions have been resolved at the local level. None of the local positions to this writer's knowledge have been either upheld or struck down at the state level. There is, therefore, no national, or collective state position on the subject of seaplane jurisdiction.

Seaplane Jurisdiction is Sometimes Difficult To Resolve For A Number Of Reasons
Seaplane Versatility
Issues Such As Community Growth, Safety and Ecology
Increasing Value Of The Water Resource – Confusion As To How To Achieve "Highest And Best Use"
Conflicting And Overlapping Authority
Definition of Seaplanes Confuses Those Attempting To Control Them

The Various Roles of Government

Authority for Federal Control

The basis for federal involvement in seaplane jurisdiction can be found in a number of areas. Possibly the most predominant is the Commerce Clause of the United States Constitution. It is probably a good idea to pause here and make the point that when considering any jurisdictional issue it is most important to review the *charter or organizational authority* of the entity exercising or attempting to exercise any form of control. All rulemaking of any body must find its roots in its organizational documents and it is not unheard of for such authority to be exceeded.

The US Constitution gives the federal government the power to regulate interstate commerce.[1] This power has long been interpreted to include the "navigable waters of the United States." This phrase applies to rivers that flow between states and to lakes that straddle state lines; it also covers bodies of water that are entirely within one state. [2] The US Army Corps of Engineers interprets this phrase to include almost any water body with "present, past, or a potential presence of interstate or foreign commerce."[3]

Ownership of submerged land has been found at times to be irrelevant in determining jurisdiction where federal authority might be involved. In some areas, federal power has been asserted over isolated prairie potholes on the sole basis that visiting migratory birds might be a subject of interstate commerce.

The Commerce Clause also allows federal regulation of air traffic. This affords, of course, a separate basis for federal preemption over seaplanes.

A number of federal organizations exercise, at times, various levels of control over seaplanes. The primary ones, however, are the Federal Aviation Administration, the US Coast Guard and, as stated, the US Army Corps of Engineers.

[1] US Constitution, Article 1, Section 8

[2] 33 C.F.R. Section 3.329.7

[3] 33 C.F.R. Section 3.329.3

Federal Aviation Administration (FAA)

Commerce involving airplanes is plainly subject to federal authority. Congress established the Federal Aviation Administration (FAA) in the Department of Transportation as the primary agency to exercise federal control in this area.

The FAA regulates:

- Aircraft noise levels.
- Airport security.
- Air travel competitive practices.
- Air traffic.
- Aircraft certification.
- Pilot and aircraft mechanic certification.

Notably, however, the FAA has often taken a "hands off" position with regard to seaplane landing areas that are within municipalities unless federal funds have been used to develop the landing area or to maintain it.

The US Coast Guard

The Coast Guard regulates the navigation of water vessels and enforces federal laws upon the "high seas" and in waters over which the United States has jurisdiction. [4] The scope of the Coast Guard's jurisdiction refers in part to the US Army Corps of Engineers' definition of "navigable waters of the United States."[5]

The Coast Guard's regulations address the following:

- Water navigation.
- Vessel safety.
- Required vessel equipment
- Vessel inspections.

The US Army Corps of Engineers

The US Army Corps of Engineers has authority over a wide variety of subjects affecting the navigable waters of the United States. For instance, placing obstructions in navigable waters requires a permit issued by the Corps under

[4] 14 C.F.R. 81-91

[5] 33 C.F.R. Sections 2.01-2.05

Section 10 of the Rivers and Harbors Act of 1894.

The Corps has ongoing responsibility for numerous civil works projects, such as maintaining recreational lakes that were constructed under the Corps' auspices.[6] The Corps' basis for involvement in these lakes is similar to the FAA's, federal funding means federal control.

Federal Authority and its Use is Sometimes Confusing

While a number of federal agencies such as those just described exercise some form of control over seaplanes and seaplane landing areas, the extent of a given agency's influence is often unclear and inconsistent from region to region and even from official to official. This lack of clarity can be confusing at the local level where flight operations are experienced. It affects local authorities when they try to set operating rules which address safety and noise issues as well as flight managers and pilots when they seek a reasonable operational framework.

Authority for State Control

Possibly a more interesting aspect of seaplane jurisdiction is that which exists, but is seldom exercised, at the state level. While the concept developed here has not been, to this writer's knowledge, applied directly to seaplane operations, it would seem perfectly suited to them.

Ownership of Navigable Waterways and the Public Trust Doctrine

Here we revert back to the charter or organizational authority described on the previous page. Under our system of laws an organization, in order to exercise jurisdiction, must have a legal basis to do so. In reality this is not always the case, of course. That is one of the reason's our courts are so busy.

When individual states achieved statehood they took title to the beds and banks of saltwater and freshwater navigable tidelands, rivers, and lakes, up to the ordinary high water mark.[7] Most states recognize that their ownership is subject to the restrictions of the "Public Trust Doctrine." The Public Trust Doctrine arose from the ancient common law notion of *jus publicum*, that is, the public has the right to use the navigable waters of a state "as a common highway for trade, navigation and commerce." [8] This right can neither be destroyed nor abridged. [9] In other words, it cannot be legislated away.

While the scope and, therefore, the applicability of the Public Trust Doctrine to seaplanes remains largely undefined, it has been extended beyond traditional navigational and commercial rights to include at least "incidental rights of boating, swimming, water skiing, and other related recreational purposes."[10]

To the seaplanes' benefit, individual states have declined to say that the above are the *only* rights encompassed by the doctrine. Although none have considered whether seaplane traffic constitutes navigation protected by the trust; there is considerable authority supporting the view that a seaplane is a "vessel" while on the water as described under US Ports and Waterways Safety Act regulations. There is, therefore, a strong case to be made that seaplanes should share the general right of navigation on the waters of an individual state. Keep in mind that this concept is not contrary to federal regulations and *does not rely on the federal government for its legitimacy.*

The Role of Local Governments

Now to local governments, the heart of the matter since local governments are generally where debate arises regarding seaplane use. Local governments (cities, towns, counties, and in some cases, port districts) derive their authority to govern from state constitutions. The incorporation process is where, again, we see the charter or organizational authority defined.

Local charters are interesting. They have their basis in state law for it is the states that define the

[6] 36 C.F.R. Sections 3.327.4, 3.328

[7] State Constitutions

[8] Caminiti vs. Boyle, 107 Wn. 2d 662, 667 (1987)

[9] Orion, 109 Wn. 2d. 640

[10] Wilbour vs. Gallagher, 77 Wn. 2d 306, 316 (1969)

parameters of the local, municipal rulemaking process. Details within municipal charters are identified during the process of incorporation but the basic framework is consistent within a particular state though it is often adjusted according to the size of a particular community. Additionally, charters given local governments during incorporation are rather broad and involve considerable latitude. Basic principles, however, must be adhered to. These include avoiding the exercise of authority that extends beyond a municipality's boundaries, dealing only with issues that are local in nature and assuring that ordinances and resolutions do not conflict with state law. Still, much is left to the discretion of local rulemaking bodies. This is consistent with our national predisposition to local rule.

Generally, incorporation documents enable local officials to pass rules and regulations concerning such issues as public health, safety, and welfare. This is often called "the police power." Police power provides local officials authority to regulate the local and internal affairs of a community for the special benefit of the citizens who live within its boundaries.

Local governments may also possess additional powers as agents of a state. We are all aware of growing interests and involvement in many states regarding water-related and ecological issues. Much of this is, of course, prompted by federal law. Local governments may follow mandates of their states by passing ordinances they are directed to or may pass such ordinances on their own as a show of support for a state's position. This concept of individual, local jurisdictions fulfilling state requirements through the local rulemaking process is one that has important potential for seaplane interests. This will be explored later.

Examples of the police power that local governments exercise are:

- Development of comprehensive plans.
- Drafting of zoning ordinances.
- Lake and river vessel speed limits.
- The building permit process.
- Enforcement of ordinances.

Another authority that may impose requirements on municipalities are regional planning organizations or RPOs. Many areas of the United States have RPOs that obtain their authority from state governments but, that are not themselves incorporated. RPOs generally engage in strategic planning issues that transcend local boundaries but that are not, necessarily appropriate to deal with at the state level.

The Levels of Jurisdiction

Here then we have the three basic levels of jurisdiction. The federal, state and local governments. Each has a role to play in seaplane operations. Absent federal funding, local control is strongly in favor of local government. Local government exercises its control through police power. Police power is broadly construed as that which is deemed necessary by the local jurisdiction to protect the safety and welfare of its citizens.

Levels of Jurisdictional Authority

Organization and Basis of Authority	Examples of Authority
Federal - US Constitution	
FAA	♦ Aircraft Noise ♦ Airport Security ♦ Air Travel Competition ♦ Air Traffic ♦ Aircraft Certification ♦ Pilot and Mechanic Certification
Coast Guard	♦ Water Navigation ♦ Vessel Safety ♦ Required Vessel Equipment ♦ Vessel Inspections
Corps of Engineers	♦ Federal Civil Works Projects
State - State Constitutions	
Legislatures	♦ Statewide Legislative guidance ♦ State Funding for Statewide Issues
Local Government	♦ Comprehensive Plans ♦ Zoning Ordinances ♦ Lake and River Vessel Speed Limits ♦ Building Permits
RPOs	♦ Strategic Planning that Transcends Local Boundaries

The Potential For Jurisdictional Conflict

Opposition to seaplane operations is often seen at the local level. It is here that, through the exercise of police power, usually by the establishment of water speed limits or restrictive zoning that seaplane operations are threatened.

If the elected officials in a community, an unincorporated area of a county or in a port district view seaplane operations as inappropriate, they may attempt to use police power to exercise their collective will.

It is at this point that jurisdictional confusion may occur. After all, if the subject waterway is navigable, has it not been established that both the state and federal governments have legal interests? Further, it is legitimate to argue that the Public Trust Doctrine which vests ownership of navigable waterways with states not only gives them the right to protect navigation by vessels but *mandates* that they do so. In other words the Public Trust Doctrine is a *public trust* and, therefore, must be exercised consistently by state governments.

There is always the possibility that a proposed, or possibly existing seaplane landing area is simply not safe. In this case, using police power to refuse or cancel operations is legitimate. In fact, to not exercise police power under such a circumstance would amount to a failure on the part of local authorities to properly protect the citizens they are elected to protect. This penchant to err on the side of caution, especially when little is known about the subject, and when there is accident potential, is at the root of many ordinances that are contrary to seaplane operations.

On the other hand, if it can be reasonably shown that seaplane operations are safe, closing waterways to aircraft by using police power is clearly inappropriate. It is here then that we have the potential for direct conflict between federal and state interest in protecting vessel navigation and the exercise of local authority.

Gustafson vs. City of Lake Angelus[11]

Notable events have occurred between federal and local authorities regarding seaplane rights. The Gustafson case is one of them. In 1992 Mr. Gustafson filed suit in federal court alleging that the City had passed ordinances precluding him from operating his seaplane on Lake Angelus. The Honorable Paul Gadola, United States District Judge, found that federal law protected seaplane operations, even on the surface of the lake, and that the City's ordinances banning seaplane operations could not stand.

Within this judgment an important comment was made. Judge Gadola spoke of the need to preserve a "uniform set of regulations governing aircraft operations." Though the judge didn't elaborate, uniformity and standardization are, of course, primary issues relating to flight safety. In fact, standardization is one of the reasons the United States has such a good aviation safety record. This concept, the absolute need for standardization -- a uniform set of regulations -- should make a good argument when addressing communities that attempt to ban seaplanes. Avoidance of a municipal patchwork of regulations is yet another argument for federal preemption This landmark federal case has since been overturned but it does contain some valuable arguments for seaplane rights and it is meaningful that the arguments emanated from such a high authority. Both the decision from Judge Gadola's court and the reversal are simply steps in an ongoing debate about seaplane landing areas.

Politics

In considering this potential conflict between local authority on the one hand and state and federal authority on the other political motivations arise. When local jurisdictions consider passing ordinances closing waterways to seaplanes, elected officials are likely prompted by two forces: their perception of the wishes of the majority of the electorate, for this is how they stay in office, and their own personal resolve about the subject. State and federal authorities, even though there may be some basis for their involvement simply have less political resolve when it comes to interceding in local issues. Seaplane interests are left, then, with the

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[11] Gustafson v. City of Lake Angelus, Civil Action # 92-73976. U.S. District Court, MI. 10/22/93

challenge of lobbying local decision makers. For, even though state and federal authorities can be shown to have legitimate interests, it is the municipality that makes important police power decisions.

What Tools Are Available?

Though it would be naive to assume that local jurisdictions who are opposed to seaplane operations will change their minds overnight, it seems that there are a number of things that can be done to first, protect landing areas and then to generate impetus for additional ones. These are recommended below.

Recommendation 1
Influence Local Jurisdictions at the Regional, State and Federal Levels.

Agreement must me reached among those in the seaplane community to adopt the concepts of federal preemption *and* state authority over navigable waterways. Both are important to embrace. They are not contrary to each other. This should be based on federal law relating to interstate commerce and *jus publicum* and the Public Trust Doctrine at state levels. It is important to adopt clear, concise, language about these issues and assure they are consistent, nationally within the seaplane community.

Should the seaplane community spend more time courting federal or state agencies and officials? Though it is a close call and one that is likely to swing, depending on specific circumstances, the stronger case seems to lie with the authority of individual states. This is probably true for a number of reasons. First, state governments are simply closer both politically and geographically to local governments. Many in state government have served in the communities which must be influenced. Second, though the basic concepts of seaplane flying are generally the same everywhere, regional issues and conditions do exist and the more locally they can be dealt with, the better. Third, there is national attention being given to further empowering states as evidenced by the "smaller government" message, block grants, etc. Additionally, for all practical purposes, it is difficult to get the federal government to be nationally consistent relative to a specific issue. This is not meant as a negative comment, it is simply that the United States is large and diverse and the various regional offices of national administrations are known to advance their own interpretations about any number of subjects.

Again, it is important to establish a position. Part of that position is that both the federal and state governments have not only interests in, but direct responsibilities for, promoting and protecting seaplane operations – even at the local level within municipal structures. The point to be made here is that, for the reasons stated above, neither the federal government nor state governments is free to ignore their responsibilities in this area.

Recommendation 2
Solicit Support

Specific organizations and executive positions at both the state and federal levels should receive clearly written communications stating support for federal and state authority.

These organizations and executive offices include the following:

Federal

- Federal Aviation Administration
    - Administrator
    - Regional Managers of Airports Divisions
    - Managers, Airports District Office
- Legislative
    - Representatives and Senators

State

- Legislative Transportation Committees
- State Administrator of Aviation

Regional

- Regional Planning Offices

Recommendation 3
Obtain Legitimacy Through Planning

Individual communities are influenced strongly by comprehensive planning. This is true especially when those plans involve land use and transportation issues. Many times plans that are formulated at the federal, state or regional levels affect local decisions. Assuring that seaplane aviation is included in strategic planning is important for this provides legitimacy to seaplane operations and forces local planners to consider seaplane activity along with other forms of transportation.

An example of how the planning function, which is a routine part of government at all levels, can be used to address seaplane issues is Washington state's Growth Management Act or GMA. The GMA was adopted to direct rapidly growing regions of Washington to anticipate and plan for the increased strain placed by such growth on public resources. In the GMA was a requirement to address:

- Efficient multimodal transportation systems…
- Aviation facilities.
- Hard to site public facilities.

Though seaplane aviation was not specifically spelled out in the legislation it would be difficult for affected regional planning organizations and municipalities to say they did not qualify. In this way seaplane issues have gained a "place at the table" in the planning arena. This is advantageous since comprehensive plans often overshadow individual political motivations and concerns.

Recommendation 4
Use State Law as A Tool

We are a nation of laws and using them to meet goals is not considered un-American. All states have aviation or aeronautics departments. Usually they are a divisions of state departments of transportation. State aviation divisions are responsible, in part, for promoting legislation that is favorable to aviation. Many times such legislation can be used to influence or even direct local governments.

There is enough that is unique about seaplane flying to warrant special attention in state laws. This approach can be used, for instance, to recognize the Public Trust Doctrine as it relates to the protection of seaplane operating areas, to assure that seaplanes are included in comprehensive planning conducted by all communities that are adjacent to navigable waterways and to require that seaplanes are included in planning that is jointly funded by state and federal governments. We must keep in mind the concepts of *charter and organizational authority*. This is where municipalities can be influenced. They are, to varying degrees and through different methods required to comply with the mandates of state law. Solidifying positions relative to the promotion and protection of seaplane aviation in state regulations carries considerable weight.

Recommendation 5
Find a Friend

Most state legislatures have transportation committees in both the upper and lower houses. Identify an individual in each who is sensitive to seaplane issues. Use them as a legislative conduit for bills intended to protect and promote seaplane aviation. Remember to assure communication and promote coordination between these individuals and the state director of aviation or aeronautics. Inclusion, especially in politics, is very important. The key point to stress when seeking a legislative supporter is that we are not so much talking about supporting aviation or aircraft as we are, in some cases, needing support for a unique and versatile form of transportation that is able to access and serve municipalities.

Recommendation 6
Watch the Money Flow

This is yet another variation on the political theme – another way to influence individual communities.

Municipalities are, as we have said, required to either plan or implement federal or state programs routinely. Many state programs are really federal programs that are given to states as responsibilities by the federal government along with some of the money required to implement them. The big ones today are intermodality, multimodality, transportation in general and transportation infrastructure in specific. Land use and land use planning is also very active.

When time allows, it is vital to keep track of funded programs that require implementation on local levels. Ask "Could this issue involve seaplanes?" If so, go directly to the regional and local planning organizations *who have been given federal or state money* to do their work and ask them if seaplanes are included in the modes they are reviewing. If they say "no" say, "oh, we are sure that is simply an oversight."

There are both state and federal policies that direct planning organizations to be *inclusive* in their planning. One of the best things for seaplane flying, especially commercial seaplane flying,

Seaplane Noise

How Noisy Are They – Really?

1.0 Introduction

What is music to one person's ears may be disagreeable noise to another. Concerned citizens who are interested in curtailing seaplane operations frequently make an issue of the noise generated by seaplanes during water operations.

The question of jurisdiction has been previously addressed and is applicable to the resolution of noise conflicts. The amount of activity at a seaplane water landing area can vary widely. For a major seaplane base, the Federal Aviation Administration (FAA) may provide planning or development funds. It is generally a requirement that a noise impact study be performed if federal funds are assisting in the development of an airport. However, under the rules of FAA Order 5050.4A (Airport Environmental Handbook) a noise impact study for a private airport is not mandated by federal law unless the number of operations exceed 90,000 per year. Since most seaplane water landing areas have considerably less activity than this, noise studies for seaplane bases are generally not funded by the FAA, and if needed for community planning purposes are accomplished by the seaplane base operator and/or local community.

Although the FAA will generally neither fund nor participate in noise studies for seaplane water landing areas, the FAA's noise standards and noise impact methodologies are intended to be applicable to smaller airports. Of course, the FAA always assumes jurisdiction over all airborne aircraft, which includes all of the operational phases of takeoff and landing. Thus, all airports enjoy the benefits of federal jurisdictional preemption. Most states have aeronautics departments that frequently assume a role in establishing state aircraft noise guidelines for community and land use planning purposes. Local and county governments occasionally and sometimes illegally assume jurisdiction over seaplanes as a previous chapter on this complex issue has addressed. Jurisdictionally responsible authorities should be expected to respond in favor of seaplane activities when it can be shown that the noise generated by seaplanes on takeoff is within reasonable levels as discussed below.

While people certainly respond to the noise of a single seaplane operation, the community impact of the single event is best correlated with cumulative metrics which take into account the frequency and intensity of the exposure and allow it to be compared to other long-term environmental noises. The threshold between what is acceptable noise and what is unacceptable noise varies by jurisdiction and situation. The federally accepted residential noise threshold for aircraft is a 65 dBA Ldn level (day-night average sound level -- see Section 4.5 below). This same threshold is also sometimes used for a shore frequented or inhabited by livestock. Cumulative noise levels for a Cessna 185 making 52 takeoffs per year do not exceed 65 dBA Ldn more than 2,000 feet from start of takeoff roll and 250 feet from the takeoff centerline.

Due to the principle of federal preemption and interstate commerce, the resolution of a noise conflict should always be in favor of the seaplane community when it can be proven that the body of water in question is large enough that noise will attenuate below a legal or reasonable threshold. Conflicts with jurisdictions that are biased against aviation may require expensive litigation to appeal and eliminate regulations that are contrary to federal standards or are otherwise biased and unreasonable.

The Ldn descriptor is sometimes not readily accepted by local jurisdictions for seaplane base locations because the reduced operations result in Ldn contours that are very small. In reality, Ldn contours are a most logical basis for reasonable resolution of conflict and their small size should provide a logical proof of the minimal impact of those seaplane operations.

It thus becomes necessary for members of the seaplane community that are involved in the resolution of a conflict to understand the technical side of noise.

would be to be included in regional comprehensive transportation plans. For then, it would be difficult to not be included in companion land use plans. Then, seaplane aviation will take its place as a legitimate method of transportation and the protection of landing as well as docking and beaching areas will be more assured. This approach is not for all circumstances but it is applicable to many.

Recommendation 7
Be Active

It is important that proposed ordinances or other legal actions designed to restrict or ban seaplane activity be strongly challenged before they are enacted.

The school of thought that assumes that, left alone, all will be well, is in most cases misguided. Certainly, there are times when it is best to wait, listen carefully and thoroughly consider actions. But the "don't make waves" attitude will oftentimes allow opponents of seaplane flying to develop public alliances and get a foothold with lawmakers. And politicians, of course, react to public pressure.

Also, the legal system that allows ordinances to be enacted under police power is far from an exact science. Simply because an ordinance is passed doesn't mean that it is legitimate or indisputable. Ordinances, contrary to seaplane operations can sometimes be overturned if for no other reason on the basis that the municipality simply does not have the jurisdiction to restrict the operations of vessels on navigable waterways. Raise the Public Trust Doctrine issue. Municipal councils are powerful organizations but they don't like to strongly pursue issues that might result in legal battles or court actions. That costs money and excessive expenditures of legal funds from public coffers tends to erode public support.

It comes down to the fact that if your seaplane activities or proposed activities are safe and appropriate in your best judgment, fighting activity for them is also appropriate. If you wait for the ax to fall, it probably will.

Conclusion

There are a number of variables that exist in seaplane jurisdiction. The most likely area for conflict is the municipality that is adjacent to a waterway and which decides to ban or refuse seaplane operations.

Circumstances may indicate that the municipality is correct. There may simply not be enough room for safe seaplane operations. But where it is clear that seaplane operations can be or have been conducted safely yet the future of seaplane flying is in jeopardy there are methods that can work.

Municipalities have considerable power to regulate what happens within their boundaries. This is especially true when addressing public health and safety concerns.

Communities are, however, vulnerable in a number of areas. They often take federal and state money for planning and implementation of transportation and land use projects. To exclude a mode of transportation without good cause can create problems for them. So use the system to gain a "place at the table."

Keep in mind as well that police power has been interpreted by many communities to include the entire surface of waterways adjacent to them. This is true to a certain extent. Federal and state governments often rely on local tax dollars and therefore local efforts to police water areas. But the point must be made that both the federal and state governments have a responsibility to assure navigation by vessels and this is a responsibility they cannot walk away from.

It is important that clear and concise positions regarding jurisdiction be agreed to and promoted throughout the seaplane community. This will give direction and purpose to the effort of protecting seaplane landing areas and promoting seaplane aviation.

2.0 Summary

The purpose of this study is to provide information for seaplane pilots to make their case to citizens or local authorities who are concerned about seaplane noise. This is a primer of information on the issue of seaplane noise and its impact on other land uses. The information in this study consists of the following:

- An initial description is provided of the factors that influence the amount of noise created by a seaplane, how that noise is propagated through the air, and how the noise impacts adjacent land uses.

- Detailed information on the technical methodologies for determination of noise impact are then provided. Standard noise descriptors are described that integrate the sound impacts from multiple aircraft flights in order to create cumulative or averaged sound level impacts.

- Regulatory aspects of seaplane noise are discussed. It is shown that airport noise impact standards approved jointly by FAA, HUD, EPA, DOD, and the VA utilize integrated noise levels which can be used to determine actual seaplane noise impact by standard mathematical computation.

- Sample calculations of noise impact are provided for differing types of seaplanes and amounts of use.

- A discussion of noise abatement methodologies, as they relate specifically to typical seaplane operations, are discussed.

The good news is that when compared to the typical airport noise problems at our major urban centers, seaplanes are a relatively minor consideration. If the seaplane is small, and the number of operations is modest, it can be completely compatible with any waterway as its noise level will be similar to that of outboard motors, jet skis and other common waterway sounds. Medium sized seaplanes such as Cessna 185 and 206 can be compatible with a relatively small area as long as the number of operations are small.

3.0 Seaplane Noise

3.1 Takeoff & Landing Profiles

Most aircraft make their greatest noise on takeoff since it is at that point that a large amount of propeller velocity is required to become airborne. In a seaplane, takeoff is usually accomplished at full power in order to rapidly get up onto the step and then off the water. After lift-off, when obstacle clearance is assured, the power should be reduced to climb power to reduce noise.

The landing profile typically consists of an overflight at 500 feet AGL at a reduced power setting to view the landing area, followed by a major reduction in power during the approach.

The reduction of power during landing is so great when compared to takeoff, that for the purposes of this article, noise during takeoff will be the sole consideration in terms of computed noise impact. In fact, seaplane noise levels at low throttle settings are generally below background noise levels and thus are not measurable. An overflight at 500 feet with cruise power can constitute a measurable noise impact and consideration of that phase of flight will be covered when discussing noise abatement. However, because takeoff constitutes the phase of flight which produces the most noise and has the least flexibility for pathway, this study will primarily focus on seaplane takeoff noise impacts.

2. Origin of Noise

The majority of the noise coming from a propeller aircraft is created at the tips of the propeller. There is not much coming from the exhaust pipe. Technical studies have shown that the noise output from a propeller-driven aircraft is determined principally by the propeller tip Mach number (tip speed related to speed of sound at the existing air temperature) and the horsepower input to the propeller. The noise output is also affected by the number of blades and propeller diameter, but these are lesser factors.

Generally, a doubling of horsepower at the same tip speed increases the sound level output by 5 dBA. Likewise a 5% increase in RPM will result in an approximate 1.5 dBA increase. Of course, if the tip speed is higher than .9 Mach, noise levels increase dramatically.

Samples of maximum noise levels of various aircraft are given in Table 1 below, at a standard distance of 1,000 feet during takeoff. Measurements were in a river valley setting, so in larger water areas the noise levels may be slightly less.

Table 1. Seaplane Takeoff Noise Levels

Aircraft Type	Horsepower	Number of Propeller Blades	L Max @ 1,000'	FAA Certificated Noise Levels
Taylorcraft	85	2	65 dBA	
Seabee	215	2	81 dBA	
Stinson	215	2	82 dBA	
C-172K	150	2		75.0 dBA
C-180K	235	2	86 dBA	73.4 dBA
C-U206G	300	3	88 dBA	79.4 dBA
C-TU206G	300	3	88 dBA	79.4 dBA
C-185	300	2	92 dBA	77.7 dBA

The next greatest factor in seaplane noise is the directional nature of the noise relative to the seaplane. The intensity of sound is greatest off the tips of the propeller, at approximately 105 degrees from the front of the aircraft, in other words 15 degrees aft of the wing tips. In the forward direction, the noise level decreases by about 7 dBA up to 30 degrees off the nose, and then decreases very rapidly beyond that. In the aft direction the sound levels decrease much more rapidly, decreasing 12 dBA once reaching 160 degrees aft of the nose (70 degrees aft of the wing tip). Thus, directly in front of or behind the seaplane there is considerably less noise than horizontally beside it. Figure 1 below shows the typical change in sound level relative to the angle between the aircraft and the observer.

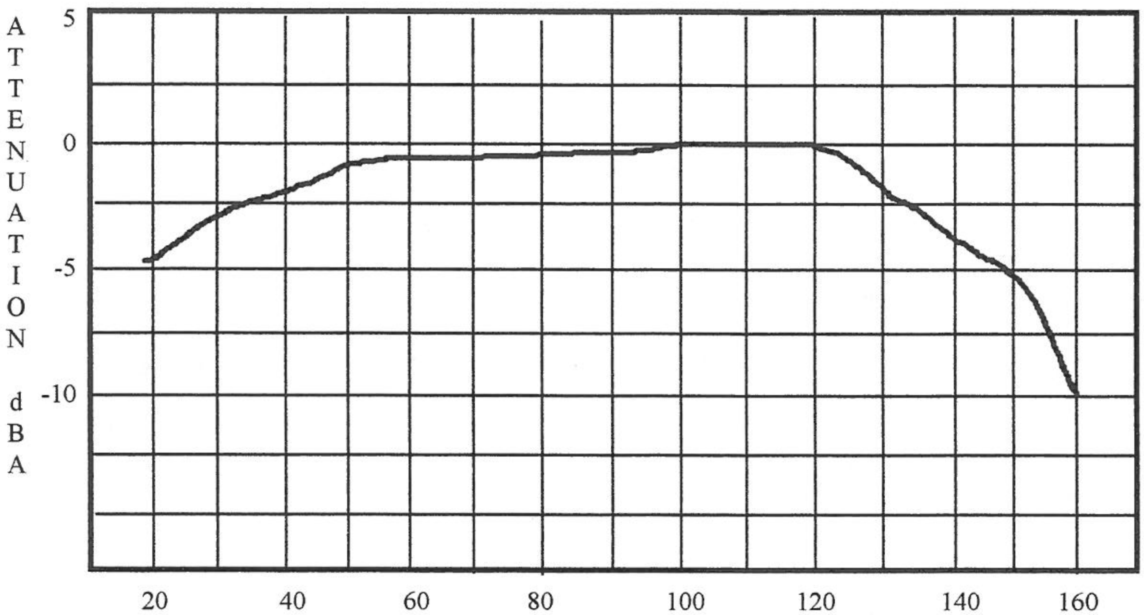


Figure 1: Propeller Noise Directivity

The sonic-speed shock wave noise of the propeller can be a dominant source of takeoff noise from a seaplane. This sharp increase in noise output occurs when the propeller blade gets into the range of .9 to .95 Mach (depending on type of propeller). Three-bladed propellers make less noise than two-bladed propellers. This is because the power delivered by the engine at a given RPM can be converted to thrust by a smaller diameter three-bladed propeller than the two-bladed propeller, thus the noise generating propeller tip speed is lower and quieter. Seaplane owners and manufacturers do the seaplane community a great favor when they modify their seaplanes to mitigate noise generation. Kenmore Air Harbor's experience is that the three-bladed prop reduces the noise impact from a Cessna 185 or 206 by 5 to 6 dBA for McCauley propellers.

The Hartzel Q-tip propeller is sometimes thought to be available as another noise reduction option. The Q-tip propeller has the tips turned back to reduce the airflow off the end of the tip, much as winglets do for the wing on some modern aircraft. Hartzel does not make a claim of noise reduction, however they believe the Q-tip allows use of a replacement propeller that is 2" less diameter than that for its equivalent. Thus at the same RPM, it has the same thrust as a propeller 2" greater in diameter. It obviously achieves this at somewhat less tip speed which in fact must result in less noise impact. The effective shortened dimension and reduction in vortices off the tip reduce the problem of water and cavitating the propeller, which is probably the more significant role of Q-tip props for floatplanes. We look forward to gaining data on the Q-tip propeller to verify the noise reduction capabilities.

3.3 Noise Propagation

Due to the inverse square law, the sound level from a seaplane decreases in intensity as the aircraft increases in distance from the source. Depending on atmospheric and geographic conditions, there is generally a 3 to 7 dBA (say an average of 5 dBA) decrease in sound level for each doubling of distance. Thus if a seaplane creates an 87 dBA impact at 1,000 feet, then as a rule of thumb it will create an 82 dBA impact at 2,000 feet or a 92 dBA impact at 500 feet These are approximate numbers, and geographical features such as hills, cliffs, and adjacent vegetation, as well as strong winds, can have a large effect on sound level.

It is important to note here that distance between seaplane and observer is significantly less a factor than the type of aircraft. For example, a Stinson floatplane with 250 hp Franklin engine at 1,000 feet might typically create an 82 dBA maximum noise level. It is clear that even in the most advantageous of conditions, the Stinson would have to be 5,000 to 6,000 feet away to get the sound level down to the 65 dBA of a Taylorcraft 85 hp floatplane at 1,000 feet Thus, distance is important as an attenuation factor for seaplanes, but the type of seaplane and type of propeller remain much more significant factors.

Besides attenuation due to distance, vegetation can occasionally be a significant factor. If thick grass and shrubbery, or thick forests, exist along the water's edge, and noise sensitive houses are well back within the vegetation, the plants may provide additional attenuation of the sound. The amount of attenuation can be in the range of 5 to 10 dBA per 300 feet of dense vegetation. Very thick forests have on occasion been shown to provide up to 25 dBA of reduction for a 300 feet depth. However, bare deciduous trees during spring, winter, and fall will provide no attenuation whatsoever.

In the water environment, the seaplane does not usually get the help of significant vegetation absorption between the pathway of the seaplane and the observer. The amount of attenuation will generally be very small unless the plant material is very thick and the residences are located far away from the water's edge. In reality, residences usually try to locate with a good direct view of the water rather than hidden behind several hundred feet of thick vegetation. Thus, the type of aircraft and distance from observer remain the most significant aspects of seaplane noise analysis.

3.4 Noise Impact

In our discussion so far, the noise has been created by the seaplane, has propagated some distance, and it has been attenuated to a lower dBA reading. It then reaches the observer. At waterfront locations it is common to have outdoor decks, patios, and docks so there is generally no way to "hide" behind walls or hedges from the noise impact.

Figure 2 below shows an overlay of sample noise level readings from three different seaplanes on takeoff. In each case the seaplanes were approximately 1,000 feet from the noise meter. Since there is no runway center line for seaplanes, distances are more difficult to determine than for land planes. However, because the distances are believed to be accurate within 20%, the noise level readings are therefore accurate within 1 or 2 dBA.

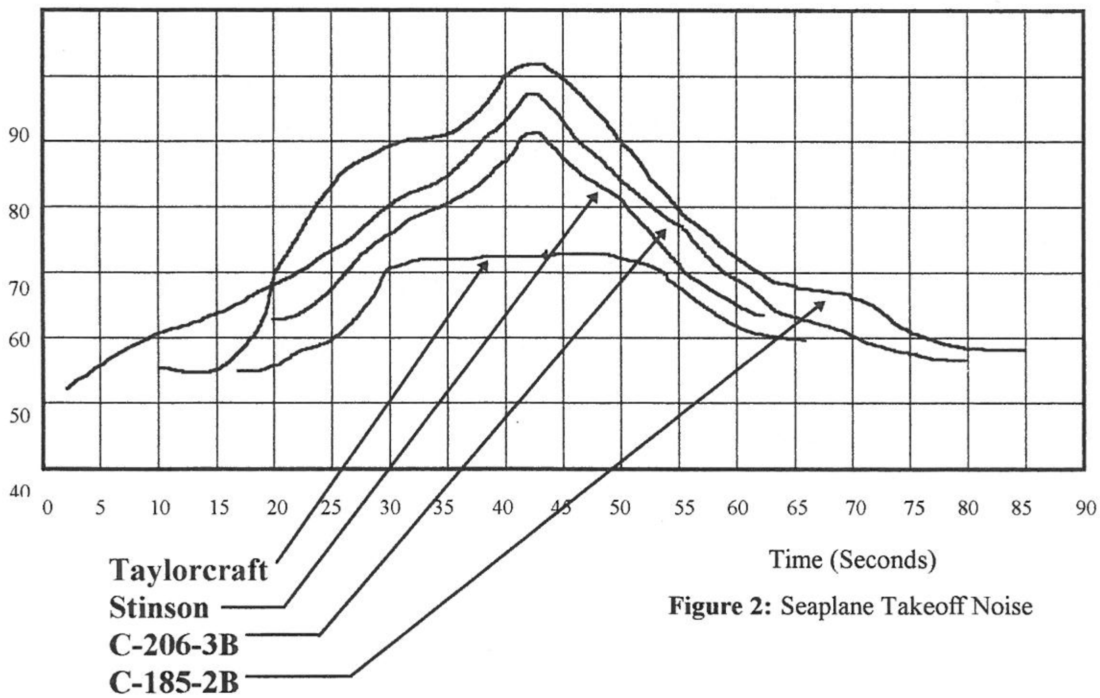


Figure 2: Seaplane Takeoff Noise

It is obvious that there is a great difference in sound impact depending on the type of aircraft. The little two-seat Taylorcraft with 85 hp engine has a maximum sound level of 65 dBA, whereas a Cessna 185 with 300 hp engine and two-bladed propeller reaches a maximum of 92 dBA. A Cessna 206 with 300 hp engine and three-bladed propeller has a maximum of 88 dBA. A Stinson with a 250 hp engine has an 82 dBA maximum noise level.

3.5 Conclusion

The principal factor in the intensity of seaplane noise is the horsepower of the aircraft and the tip speed of the propeller. Factors which attenuate the basic noise produced by a given seaplane type, are in normal order of importance: power setting, RPM setting, angle of aircraft to observer, and distance to observer. Factors generally of much less significance and requiring empirical study for a specific site are: geographical effects of cliffs or canyons, vegetative absorption, wind strength and direction, air temperature and humidity.

4.0 How Much Noise is Too Much?

Now that we have a general understanding of how much noise is produced by different aircraft and how much will reach an observer, we come to the crucial question of "how much noise is reasonable?". This is a question with no black and white answer. Every seaplane base and water landing area will have its own specific conditions that must be evaluated. All of the above discussion has been about the actual noise levels that would be instantaneously measured with a noise meter during a seaplane operation. We will now consider the noise input to the community around the seaplane base -- those to whom seaplane noise is not considered music.

Some people who object to seaplane noise just do not want to hear the seaplane at all. In addressing this issue, it is important to keep the wider context in mind. Motorboats, jet skis, chain saws, lawnmowers, motorcycles, trucks, cars, and wind in the trees all make noise. It is often helpful to take a noise meter to the site of concern and measure other noises in the background. Often, neighborhood sounds can be shown to be of a similar level to that of seaplanes. Likewise, in an urban area, the noise from commercial jets approaching and departing the local international airport often creates significant noise levels that are surprisingly high.

A table is provided below showing a comparison of normal community sounds, as a kind of "thermometer". However, the average citizen gets used to many of these other sounds and to some extent disregards them. A seaplane takeoff is a less commonly experienced or understood event. And in having this additional burden its sound can be more noticeable to a listener. Thus, it can be important to own a sound level meter and work with neighbors to educate them on the sound levels that are already existing in the neighborhood. Once they become conscious of the other sounds and that the seaplane sounds are of a similar nature to say a motorcycle at 50', their concern may diminish.

Table 2: Noise Level Thermometer		
	Seaplanes	Other
110 dBA		
		* Inside Discotheque
		* Chain Saw @ 100' (130dBA @ 3')
100 dBA	* Inside Cockpit of High Perf. Single	
	* C-185 Seaplane 2-blades @ 750'	* Lawnmower @ 3'
	* C-185 Seaplane 2-blades @ 1000'	
90 dBA		
	* C-206 Seaplane 3-blades @ 1000'	
	* C-180 Seaplane 2-blades @ 1000'	* Bus or Truck @ 50'
	* Stinson Seaplane @ 1000'	
80 dBA	* Seabee w/Franklin @ 1000'	
	* Super Cub w/150hp @ 750'	* Bus or Motorcycle @ 100'
		* Inside pickup truck @ 60 mph
		* Neighbor's Lawnmower @ 100'
70 dBA		
	* C-172 overhead cruise @ 1000'	* Dishwasher on in Kitchen @ 10'
	* Taylorcraft Seaplane @ 1000'	* Heavy Rain with no Wind
	* Ranger Widgeon cruise overhead @ 1000'	* Car @ 100'
60 dBA		* TV on in Living Room @ 10'
		* Conversation @ 5' - Inside
	* 3.5 miles from takeoff at small airport	
	* DC-10 at 240 knots overhead @ 5000'	
50 dBA		
		* Robin singing @ 50'
		* 5 mph Wind in Trees @ 50'
40 dBA		
		* Quiet House @ 5:30 AM - Inside
30 dBA		

Note: These data were all measured by the authors. If adding items to this table, please relate the noise level to distance and if possible to actual horsepower and specific brand of equipment, as there is much variety in the noise output from different types of machinery. Aircraft sound levels are at full takeoff power unless noted otherwise.

4.1 Neighborhood Compatibility

To determine the compatibility of a seaplane noise level with a surrounding community, the following factors should be considered:

1. Is the maximum sound level similar to that of other background sound levels in the neighborhood? How does it compare to train, motorcycle, truck, automobile, chain saw, motorboat, and lawnmower sounds in the vicinity? Obviously, the sound of a chain saw or motorcycle at 25 to 50 feet can easily exceed the sound level of a seaplane at 1,000 feet What are the community norms of activity?

2. What is the frequency of seaplane activity when compared to the frequency of similar noise impacts from other neighborhood activities?

3. What is the time of day for seaplane activity? A great advantage of the seaplane is that at least in the lower 48 states, seaplane activity very seldom occurs in the night hours when most people are trying to sleep.

4. What are the cumulative noise impacts from the seaplane activity when taking into account the peak noise levels, the duration of noise, the frequency of use, and the time of activity? How does this relate to the average cumulative noise in the surrounding neighborhood?

The previous discussions have focused on specific noise level readings that are measured with a noise meter during a seaplane takeoff. This section of the report will now go back and define the units of measurement that are shown on the sound level meter. In addition, the mathematical descriptors and methodologies that allow for the integration and/or averaging of sound impacts from multiple flights will be presented.

The only FAA approved method of determining compatibility between aircraft noise and surrounding uses is through the use of integrated and/or averaged sound levels. These descriptors add up the sound impacts from multiple flights and consider the cumulative effect as it compares to the accumulative background noise levels in the neighborhood.

4.2 Noise Measurement

The human auditory response to sound is a complex process which varies with respect to a wide range of frequencies and intensities. In addition, people's reactions to noise differ widely. It is difficult therefore to derive a simple mathematical formula that accurately represents human reaction to noise annoyance. Decibel levels, or "dB", are a form of shorthand that compresses this broad range of intensities into a convenient numerical scale. The decibels scale is logarithmic. For example, using the decibel scale, a doubling or halving of sound energy results in a change of 3 dB; it does not double or halve the sound level dB reading as might be expected. To get into the mathematical basis for this logarithmic scale is beyond the text of this study, and the reader can find references in the library. The result of the use of the logarithm scale is that it allows the very low sound energy of rustling leaves to be compared to the enormous sound energy of a thunderstorm to be compared on a scale that goes only from 0 to 140 dB's, rather than from 0 to 1,000,000.

A change in pressure of approximately 3 dB causes the smallest change in loudness that the average human can sense. A 5 dB change is clearly perceptible, and an 8 to 10 dB change is associated with a perceived doubling or halving of loudness. For measuring ordinary sounds, a decibel level of 0 represents the faintest sound audible to the average person. Conversation level for most people is about 50 to 70 dB. Sounds become physically painful and possibly damaging above 130 dB.

4.3 Frequency of Sound

The human ear is very sensitive to sound frequencies between 500 and 6,000 Hz. Whereas a 1,000 Hz sound is audible to most people at 0 dB, a 60 Hz sound is generally not audible until it reaches a level of 40 dB.

Because a sound level meter can "hear" with equal sensitivity to sounds falling outside of the speech range, sound level meters use a weighting system to adjust the sound level reading to that approximating the human sensitivity to sound frequency. Measurements made with this weighting system are referred to as "A-weighted" and are listed in units called "dBA". Thus, the dBA is an abbreviation for the sound level in decibels determined by the A-weighting circuitry of a sound level meter. All sound level measurements should utilize the A-weighted scale, as that is the norm accepted by virtually all agencies and professionals that work in the field. It is noted that the "A" is sometimes dropped from the decibel notation in reports as a matter of convenience.

4.4 Regulatory Criteria

Water operations at larger FAA approved public seaplane bases are benefited by FAA and federal preemption. Applicable regulations concerning noise may or may not also be found in the various state laws, county building and land development codes, county health departments regulations and city regulations. It is not uncommon for these jurisdictions to not have regulations that are applicable to seaplanes. Nevertheless, in the absence of federal or state assumption of their preemptive authority, the local or county jurisdictions will occasionally attempt to justify seaplane noise regulations based on non-aviation noise standards. The FAA guidelines for considering noise are the most realistic for aircraft noise and their use should be encouraged regardless of the frequency of seaplane operations.

4.5 Yearly Averaged Sound Level

The federally accepted method for evaluating aircraft noise compatibility with surrounding land uses is the use of a yearly averaged sound level. The details of this methodology are contained in the FAA's Federal Aviation Regulations Part 150 Airport Noise Compatibility Planning. This can be obtained from the local FAA Airports District Office or from the Superintendent of Documents, US Government Printing Office. Part 150 defines the procedures, standards, and methodology for the creation of airport noise exposure maps and airport noise compatibility planning. It prescribes a single system for "measuring noise at airports and surrounding areas that generally provides a highly reliable relationship between projected noise exposure and surveyed reaction of people to noise." It provides a single system for predicting the exposure of individuals to noise from the planned operations at a future airport. Part 150 also identifies land uses that are normally compatible with various levels of noise exposure. The document is intended to provide the framework for airport operators in conjunction with local, state, and federal authorities, to create noise compatibility planning and implementation programs.

Part 150 is also the basis of a federally funded program to promote noise compatibility between airports and surrounding communities. The definitions within Part 150 limit the availability of federal funding to public use airports, including "any airport which is used or to be used for public purposes, under the control of a public agency, the landing area of which is publicly owned". This definition would apply to many seaplane bases and water landing areas as many are located on navigable waterways that are controlled and owned by public agencies.

Some state aeronautics divisions have developed state standards for airports that parallel the FAA's standards. The seaplane pilot is encouraged to research their own state regulations to determine if there are mandated requirements relative to utilizing the Part 150 methodology.

In summary, the methodology of Part 150 is to create a "noise exposure map" which shows a scaled depiction of the airport, with noise contours showing the intensity of averaged aircraft noise impact on the surrounding area. Each contour shows the "day-night average sound level" (Ldn) around the airport. The contour of most significance is the 65 dBA average sound level. To go further we will need some definitions:

- Maximum sound level (LAM or Lmax) is the maximum A-weighted, slow response sound level recorded during a single event (e.g., takeoff) during a given time interval. It provides information that is used to calculate the LAE and the Ldn.

- Sound exposure level (LAE), also called a single event level or SEL, is the sum of all of the sound energy within a single event (e.g., takeoff), which is presented as an equivalent intensity of 1 second duration. From a computational standpoint, when the noise environment is caused by a number of different identifiable noise events such as takeoffs or fly-over's by differing aircraft, the LAE provides a convenient calculation method for determining the combined impact as a single Ldn. The LAE is what a noise meter would read if you compacted the whole seaplane takeoff sound energy into a 1 second operation.

- Yearly "Day-night average sound level" (Ldn) means the annual average sound level in decibels, after the addition of 10 dBA to sound levels for the periods between 10 PM and 7 AM. Even though the Ldn is usually computed as a 24-hour average, it is called a "yearly" day-night average sound level because it is intended to be the average of all activity throughout the year.

- "Average sound level" (Leq) means the level, in decibels, of the mean-square, A-weighted sound pressure during a specified period. If there are no activities between 10 PM and 7 AM, the Leq is equal to the Ldn.

4.6 Sample Calculation

As an example computation of an Ldn we will use the following example:

Aircraft:	Cessna 185, 2-bladed prop
Water Lane Location:	1,000 feet distant from observer
Number of Operations:	1 takeoff per day (365 per year)

The first step is to take the noise readings shown in Figure 2 above, and add up all of the sound energy under the curve and normalize it to 1 second. Figure 3 below shows this in a graphical form. Because of the logarithmic nature of decibels, it is not a strict measure of the area under the curve. The reader will refer to technical books for a mathematical description of this conversion. Some sound level meters are able to read out this value directly, which makes this step easier to perform.

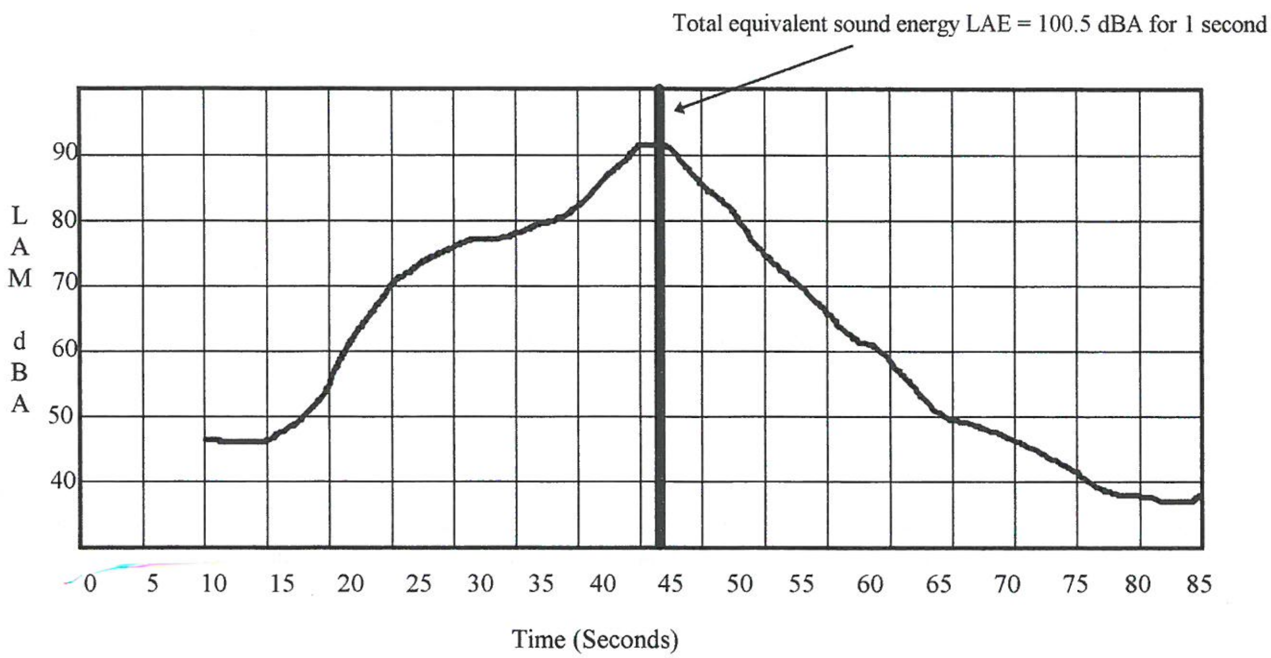


Figure 3: Integrated Seaplane Takeoff Noise

The computation of the Ldn then involves adding the sound energy from the total annual number of these events together (each of which were normalized to 1 second) and then to divide that sum by the number of seconds in a day, which is 86,400 and the number of days in a year, which is 365. The Ldn for our sample case of one Cessna 185 flight per day at a distance of 1,000 feet utilizes the following formula:

$$Ldn = 10 \log \left[\frac{N \times 10^{LAE/10}}{86{,}400 \times 365} \right]$$

where N = 365 flights per year, and LAE = 100.5 dBA

$$Ldn = 10 \log \left[\frac{365 \times 10^{100.5/10}}{86{,}400 \times 365} \right]$$

ldn = 51.1 dBA

Thus, the Ldn at 1,000 feet from a Cessna 185 doing one takeoff a day is a low number. This is because in spite of the annoyance it might give to someone, it is not really producing a large amount of sound. The typical background noise level in most urban areas is in the range of 55 to 65 dBA, with the dense downtown urban core areas being in the range of 65 dBA to 75 dBA. The average background noise in a rural area is typically in the range of 45 to 55 dBA. The 51 Ldn computed above shows that the sound energy from the floatplane of this example on average is not a significant factor in the noise environment of both urban and rural waterways. One could measure the noise impact from motorboats, cars, trucks, motorcycles, chain saws, lawnmowers, and so forth and find that their noise contribution to the environment exceeded that of the floatplane.

One additional formula that may be useful to the pilot is a typical relationship between L_{AE} and L_{AM} as used by the FAA in their Integrated Noise Model:

$$L_{AE} = L_{AM} + 7.19 + 7.73 \log (D/1000)$$

where D is the closest distance in feet between observer and aircraft during the operation.

Thus, for the C-185 shown in Figure 2 above, where $L_{AM} = 92$ dBA and D = 1000 feet, we can compute:

$$L_{AE} = 92 + 7.19 + 7.73 \log (1000/1000)$$

$$= 99.92 \text{ dBA}$$

This is close to the 100.5 dBA computed by the sound meter during the actual noise test and shown in Figure 3 above. It should be noted that this formula is only useful for aircraft while in motion (i.e., not for steady state sounds such as an extended aircraft run-up).

4.7 FAA Part 150 Noise Compatibility

The FAA's Part 150 document includes a table identifying land use compatibility with the Ldn. The table contained in Part 150 is virtually the same table contained in "Guidelines for Considering Noise in Land Use Planning and Control", a federal interagency document adopted by the EPA, DOT, HUD, DOD, and the Veterans Administration.

The detailed table is listed below. It indicates that all of these agencies agreed that *all* land uses are compatible with an Ldn that is below 65. For Ldn impacts greater than 65 there are recommendations that compatibility is questionable, but that it might be achieved if residential or school use buildings are designed to achieve noise level reductions over and above that achieved through normal residential construction.

Table 3: Land Use Compatibility* with Yearly Day-Night Average Sound Levels; Source-FAR Part 150, September 1993

Land Use	Yearly Day-Night Average Sound Level (L_{dn}) in Decibels					
	<65	65-70	70-75	75-80	80-85	>85
Residential	Y	N(1)	N(1)	N	N	N
Residential, other than below						
Mobile home parks	Y	N	N	N	N	N
Transient lodgings	Y	N(1)	N(1)	N(1)	N	N
Public Use						
Schools	Y	N(1)	N(1)	N	N	N
Hospitals & nursing homes	Y	25	30	N	N	N
Churches, auditoriums, concert halls	Y	25	30	N	N	N
Governmental services	Y	Y	25	30	N	N
Transportation	Y	Y	Y(2)	Y(3)	Y(4)	Y(4)
Parking	Y	Y	Y(2)	Y(3)	Y(4)	N
Commercial Use						
Offices, business & professional	Y	Y	25	30	N	N
Wholesale/retail: bldg matls/hardware/farm equip	Y	Y	Y(2)	Y(3)	Y(4)	N
Retail trade: general	Y	Y	25	30	N	N
Utilities	Y	Y	Y(2)	Y(3)	Y(4)	N
Communication	Y	Y	25	30	N	N
Manufacturing & Production						
Manufacturing: general	Y	Y	Y(2)	Y(3)	Y(4)	N
Photographic & optical	Y	Y	25	30	N	N
Agriculture (except livestock) & forestry	Y	Y(6)	Y(7)	Y(8)	Y(8)	Y(8)
Livestock farming & breeding	Y	Y(6)	Y(7)	N	N	N
Mining & fishing, resource production/extraction	Y	Y	Y	Y	Y	Y
Recreational						
Outdoor sports arenas & spectator sports	Y	Y(5)	Y(5)	N	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits and zoos	Y	Y	N	N	N	N
Amusements, parks, resorts & camps	Y	Y	Y	N	N	N
Golf courses, riding stables & water recreation	Y	Y	25	30	N	N

Numbers in parentheses refer to notes.

* The designations contained in this table do not constitute a Federal determination that any use of land covered by the program is acceptable or unacceptable under Federal, State, or local law. The responsibility for determining the acceptable and permissible land uses and the relationship between specific properties and specific noise contours rests with the local authorities. FAA determinations under Part 150 are not intended to substitute federally determined land uses for those determined to be appropriate by local authorities in response to locally determined needs and values in achieving noise compatible land uses.

KEY TO TABLE 3

SLUCM	Standard Land Use Coding Manual.
Y (Yes)	Land Use and related structures compatible without restrictions.
N (No)	Land Use and related structures are not compatible and should be prohibited.
NLR	Noise Level Reduction (outdoor to indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure.
25, 30, or 35	Land used and related structures generally compatible; measures to achieve NLR or 25, 30, or 35 dB must be incorporated into design and construction of structure.

Notes to Table 3

(1) Where the community determines that residential or school uses must be allowed, measures to achieve outdoor to indoor Noise Level Reduction (NLR) of at least 25 dB and 30 dB should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be expected top provide a NLR of 20 dB, thus, the reduction requirements are often stated as 5, 10 or 15 dB over standard construction and normally assume mechanical ventilation and closed windows year round. However, the use of NLR criteria will not eliminate outdoor noise problems.
(2) (2) Measures to achieve NLR of 25 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.
(3) Measures to achieve 30 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.
(4) Measures to achieve NLR of 35 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.
(5) Land use compatible provided special sound reinforcement systems are installed.
(6) Residential buildings require an NLR of 25.
(7) Residential buildings require an NLR of 30.
(8) Residential buildings not permitted.

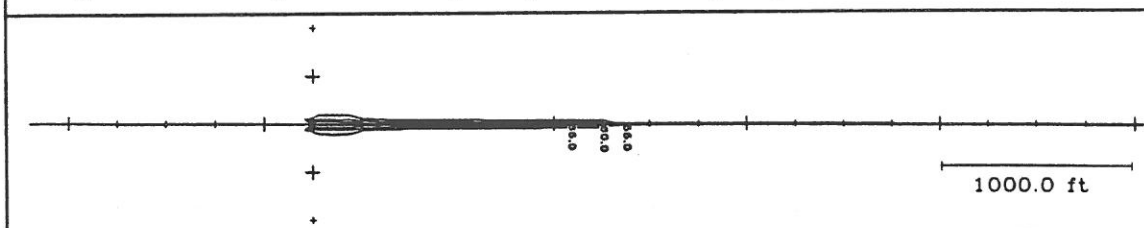
Further analysis of the example computation in Section 4.4 for a Cessna 185 taking off once a day indicates that the Ldn of 65 dBA isn't reached until being within approximately 200 feet of the takeoff path. For a Taylorcraft the Ldn of 65 dBA is located only 50 feet from a daily takeoff path.

The normal method of computing the Ldn noise contours is through the use of an FAA computer program called the Integrated Noise Model (INM). The INM allows input of multiple runway locations, use of multiple types of aircraft, use of multiple approach and departure profiles, with various differing power settings, and allows input of varying takeoff distances and speeds.

The actual creation of a noise exposure map should be created by use of the INM utilizing a detailed input of data that defines the actual seaplane L_{AE} noise levels vs. distance, approach and departure profiles, power settings, takeoff distances, and flight paths. Utilizing the INM with data that corresponds to the aircraft shown in Figure 2, several noise exposure maps showing the 65 Ldn contour are shown below for various amounts of flight activity.

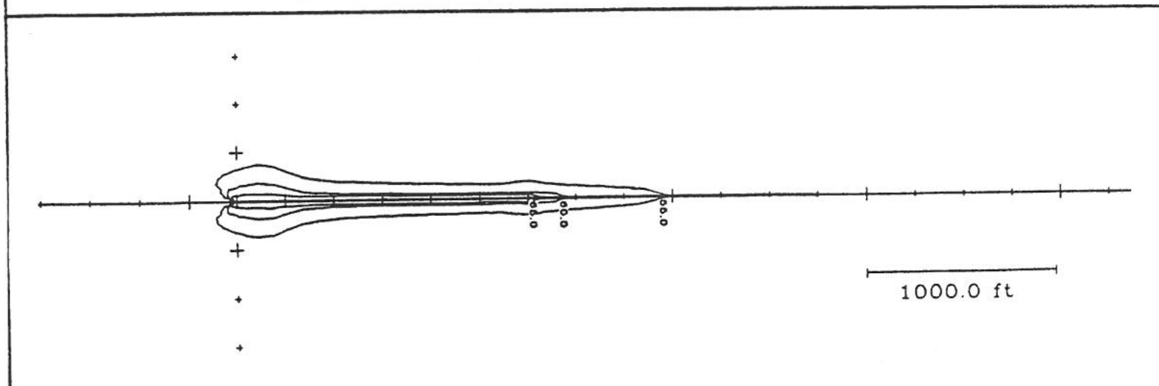
Since the sound exposure of one Cessna 185 with two-bladed prop is the same as three Cessna 185's with 3-bladed prop, nine Stinsons, or 125 Taylorcrafts, the contours represent different numbers of flights depending on the noise output of the aircraft.

Figure 4: Taylorcraft 85 hp Seaplane -- 52 flights/year



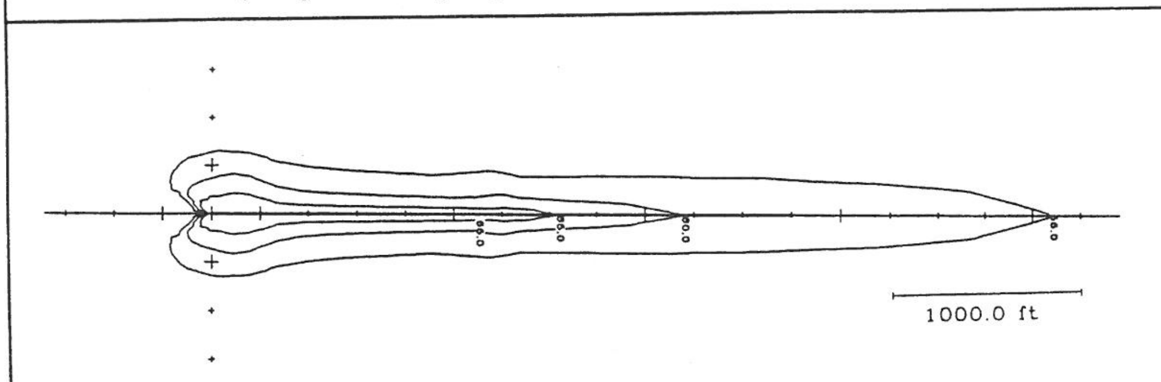
Ldn Contours: 55, 60, and 65 dBA

Figure 5: Stinson 250 hp Seaplane -- 52 flights/year
(or Taylorcraft 85 hp Seaplane -- 722 flights/year)



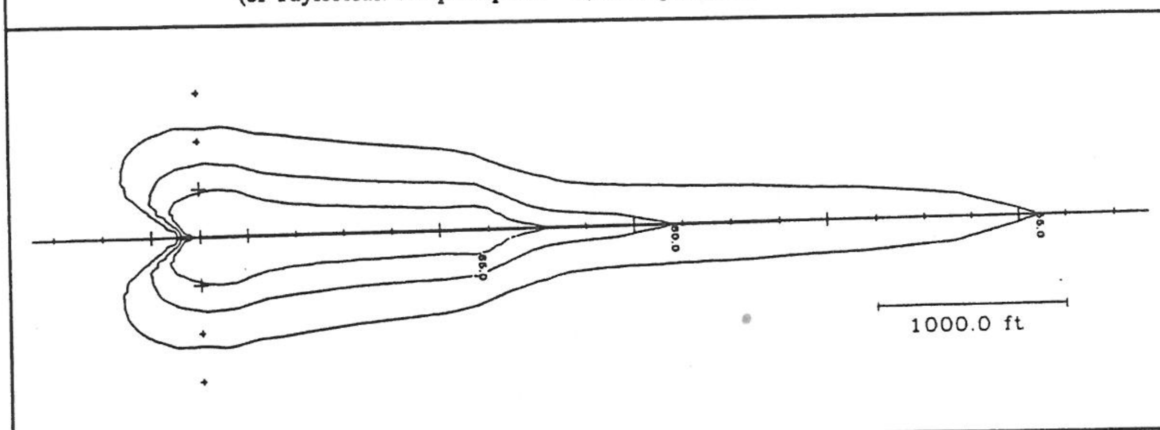
Ldn Contours: 55, 60, and 65 dBA

Figure 6: Cessna 206 300 hp 3-blade propeller -- 52 flights/year
(or Stinson 250 hp Seaplane -- 156 flights/year)
(or Taylorcraft 85 hp Seaplane -- 2,166 flights/year)



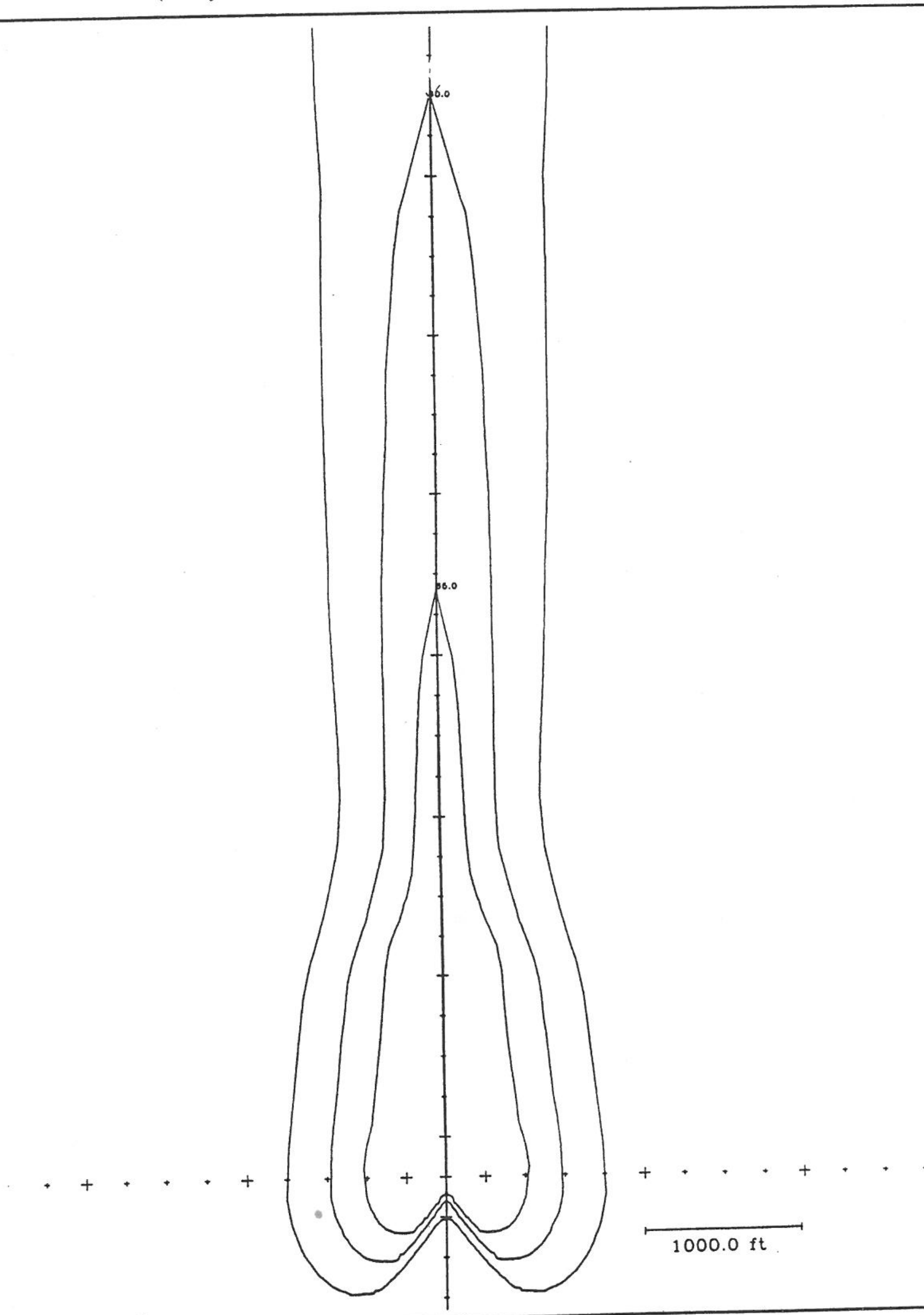
Ldn Contours: 55, 60, and 65 dBA

Figure 7: Cessna 185 300 hp 2-bladed propeller -- 52 flights/year
(or Cessna 206 300 hp 3-blade propeller -- 156 flights/year)
(or Stinson 250 hp Seaplane -- 468 flights/year)
(or Taylorcraft 85 hp Seaplane -- 6,500 flights/year)



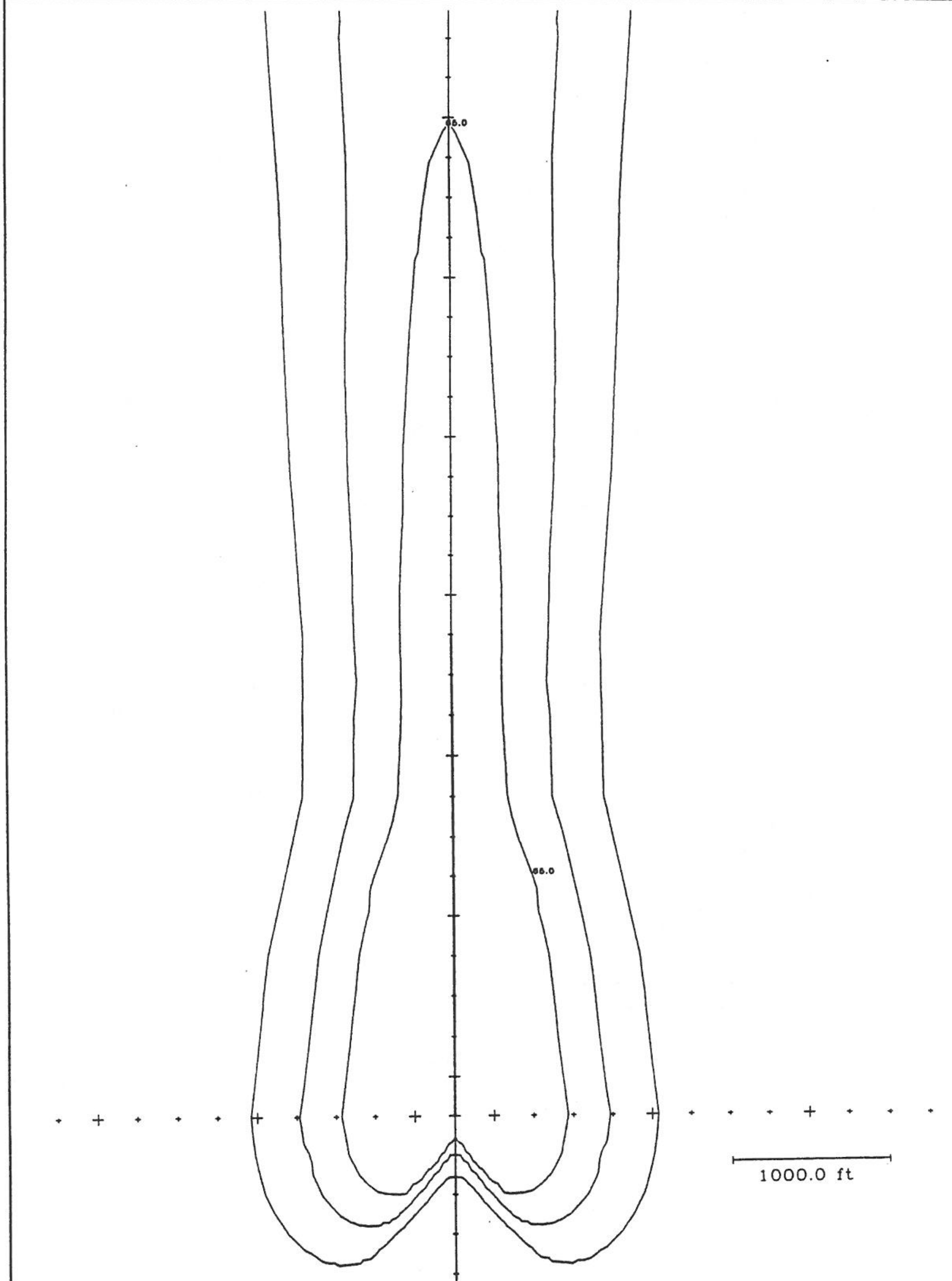
Ldn Contours: 55, 60, and 65 dBA

Figure 8: Cessna 185 300 hp 2-bladed propeller -- 365 flights/year
(or Cessna 206 300 hp 3-blade propeller – 1,095 flights/year)
(or Stinson 250 hp Seaplane – 3,285 flights/year)
(or Taylorcraft 85 hp Seaplane – 45,625 flights/year)



Ldn Contours: 55, 60, and 65 dBA

Figure 9: Cessna 185 300 hp 2-bladed propeller -- 1,000 flights/year
(or Cessna 206 300 hp 3-blade propeller -- 3,000 flights/year)
(or Stinson 250 hp Seaplane -- 9,000 flights/year)
(or Taylorcraft 85 hp Seaplane -- 125,000 flights/year)



Ldn Contours: 55, 60, and 65 dBA

The point of spending the time to go through this much detail is to show that under the FAA's standard methodologies for determining compatibility between airports and surrounding communities, small or modest amounts of seaplane activity will generally be found to be compatible. Even though the seaplane may be clearly audible, the total amount of sound energy will generally be low and not greatly different from that of other sounds occurring in the waterway.

The sound of an airplane may be more annoying to some people than that of a motorcycle or jet ski or chain saw, but as pilots and seaplane base operators we must keep bringing the noise issue back to the fact that the total amount of sound energy from seaplanes is generally very small when compared to other environmental sounds in a neighborhood.

In conclusion, it is clear that there is no set distance that will make a seaplane sound compatible with a community. With smaller seaplanes, it is clear that the sound levels are essentially equivalent to that of a powerboat or other common activity in the community.

4.8 Other Airport Noise Metrics

The Ldn is our federal government's only currently accepted airport-community compatibility noise metric. However some states (or other countries) have adopted slightly different noise metrics. Other metrics include:

- Noise Exposure Forecast (NEF): A descriptor developed in 1967 based on EPNdB as the unit of aircraft noise. Operations during the period 10 PM to 7 AM are weighted by a factor of 16.7 per one operation.

- Time Above a Specified Threshold (TA): The time in minutes that a dBA level is exceeded during a 24-hour period.

- Community Noise Equivalent Level (CNEL): Primarily used in California; is similar to Ldn, however it incorporates a 3 dBA penalty between the evening hours of 7 PM and 10 PM, in addition to the 10 dBA penalty between 10 PM and 7 AM.

- Weighted Equivalent Continuous Perceived Noise Level (WECPNL): Is primarily used by the European Community; based on the PNLT metric with a 3 dBA penalty between 7 PM and 10 PM, and a 10 dBA penalty between 10 PM and 7 AM.

- Equivalent Sound Level During Daytime Hours (LEQDAY): An energy summation of the aggregate environment, normalized to the 15-hours between 7 AM and 10 PM.

- Equivalent Sound Level During Nighttime Hours (LEQNIGHT): An energy summation of the aggregate environment, normalized to the 9-hours between 10 PM and 7 AM.

The current FAA standards listed in Part 150 do not utilize any of these other airport noise metrics. Unless your state has adopted one of these standards, no use should be made of them. If your state requires any of these metrics, the FAA's Integrated Noise Model is able to predict them.

4.9 Noise Level Descriptors Not Normally Used For Aviation

There are some noise level descriptors used in other contexts which it may be advisable for the pilot to be aware of. They are mentioned here only so that the pilot can be aware that differing standards may exist for other purposes, and they are generally to be avoided. The following descriptors are sometimes selected for non-aviation noise studies to characterize sound and predict community response:

- Maximum Sound Level (LAM or Lmax): LAM is the maximum A-weighted sound level for a given time interval or event. Though LAM is occasionally referenced it has little precedent as an acceptable seaplane noise guideline since there is no referenced aviation standard to use for evaluation.

- Percent Sound Level (Ln): Ln is a statistical description where "n" represents the percent of time when A-weighted sound levels exceed a specified level. (Example: L10 means ten percent of the time.) This descriptor should not be applied to aviation noise as there is no referenced aviation standard to use for evaluation.

These descriptors were selected based on the closest correlation with community response and adaptation by various jurisdictional agencies in establishing regulatory or guideline criteria. Numerous other descriptors for assessing noise have been developed but are considered of a lesser importance relative to any seaplane noise study.

Many local zoning ordinances include requirements for maximum allowable noise levels. Typically a zoning ordinance table is created in units of L_{AM}. The table often shows the land use zone of the noise source (such as industrial, commercial, or residential) and then a land use zone of the receiving property (industrial, commercial, or residential). The table is in the form of a matrix and often includes exceptions for shorter or longer duration sounds. These tables usually exempt motor vehicles and noises governed by federal law or standard.

King County, Washington is in the heart of the Northwest seaplane country. As an example, the only noise regulation that is applicable within King County is shown in the King County Code shown in Table 4, which follows. This King County Code also exempts sound originating from aircraft in flight or any sound directly related to flight operations. It is included only for reference purposes.

Table 4: King County, Washington Environmental Noise Levels (dB)

Washington Code Chapters 12.86 - 12.100

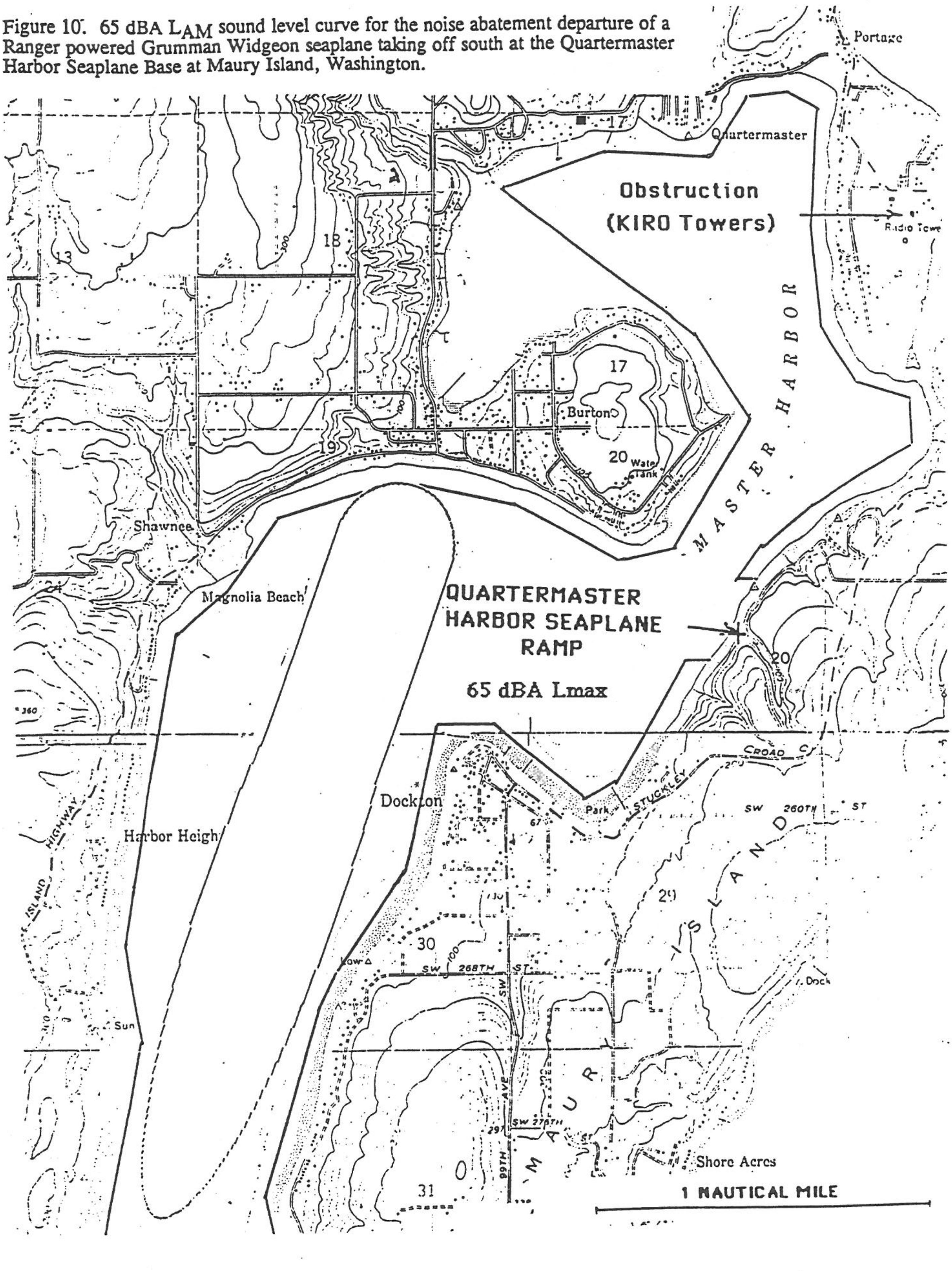
Land Use Zone of Noise Source	Land Use Zone of Receiving Property			
	Rural	Residential	Commercial	Industrial
Rural	49	52	55	57
Residential	52	55	57	60
Commercial	55	57	60	65
Industrial	57	60	65	70

Note: Between the hours of 10 PM and 7 AM during the weekdays and 10 PM and 9 AM on weekends, the level of permissible noise is reduced by 10 dB. For sounds of short duration, the levels may be increased by 5 dB and 15 minutes/hour, and 15 dB for 1.5 minutes/hour. Aircraft are exempted from these standards.

If a local agency tries to make a seaplane comply with this kind of L_{AM} table, the pilot may have a difficult task. This is because many motorcycles, cars, trucks, trains, chain saws, lawnmowers, barking dogs, crowing roosters, car alarms, house alarms, and even itinerant aircraft flying overhead will typically violate the standards listed in this kind of table. It is important for the pilot to carefully evaluate such information, as it should not be applicable to seaplanes due to federal preemption and the existence of FAA standards which already apply.

Figure 10 below shows an example of a 65 dBA L_{AM} contour requested by a local agency in King County, Washington prior to allowing approval of a seaplane base. It shows contours from a "minimum impact" takeoff performed by the seaplane pilot.

Figure 10. 65 dBA L_{AM} sound level curve for the noise abatement departure of a Ranger powered Grumman Widgeon seaplane taking off south at the Quartermaster Harbor Seaplane Base at Maury Island, Washington.



Other agencies have developed guidelines and criteria by which to evaluate noise levels and the effect on communities. Concentrated seaplane water operations are usually easily benefited by FAA and federal jurisdictional preemption. However, for the small seaplane base operator, the FAA often will decline to get involved. Local and county governments with police powers frequently and sometimes illegally assume jurisdiction over seaplanes as a previous chapter on this complex issue has addressed. When these jurisdictions assume such powers the regulations must be reasonable if they are to survive in court. The following agency guidelines are included to help establish what could be considered reasonable. No jurisdictional regulation over seaplanes is implied.

The Federal Highway Administration (FHWA) has identified noise criteria and established procedures for evaluating traffic noise in its Federal Aid Highway Program Manual (U.S. Dept. of Transportation, 1992). The FHWA defines a traffic noise impact to have occurred when the predicted traffic noise levels approach or exceed the noise abatement criteria in Table 5, or when the predicted traffic noise levels substantially exceed the existing noise levels.

Table 5: FHWA Highway Noise Abatement Criteria

Source: U.S. Department of Transportation (1992)

Activity Category	Leq (hourly)	L10 (hourly)	Description of Activity
A	57 (exterior)	60 (exterior)	Lands on which serenity and quiet are of extraordinary significance and serve a public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67 (exterior)	70 (exterior)	Picnic areas, recreation areas playgrounds, active sport areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72 (exterior)	75 (exterior)	Developed lands, properties, or activities not included in Cagtegory A or B avove.
D	52 (interior)	55 (interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

Note: Either hourly Leq or L10 (but not both) may be used on a project.

The Department of Housing and Urban Development (HUD) has published standards to evaluate potential areas for development in its Environmental Criteria and Standards (24 CFR Part 51). HUD considers the following Ldn to be acceptable or unacceptable as listed below:

- up to 65 dB -- acceptable
- up to 75 dB -- normally unacceptable; and,
- above 75 dB -- unacceptable.

Federal funding for housing projects in areas which exceed Ldn of 65 dB is normally withheld unless there is special approval.

The US Environmental Protection Agency (EPA) has no regulations governing environmental noise. It has, however, conducted extensive studies to identify the effects of certain sound levels on public health and welfare and has developed noise guidelines (US Environmental Protection Agency, 1974) as shown in Table 6 below. These guidelines indicate that an exterior Ldn of 55 dBA or less would generally produce no noise impact in residential areas. Adverse noise impacts would exist for a Ldn between 55 and 65 dBA; impacts would be significant with a Ldn above 65 dBA, and unacceptable with a Ldn above 70 dBA.

Table 6: EPA Residential Noise Impact Guidelines

Source: U.S. Environmental Protection Agency (1974)

Exterior Noise Level (LDN)	Noise Impact
less than 55 dBA	Levels are generally acceptable; no noise impact is generally associated with these levels.
55 to 65 dBA	Adverse noise impacts exist; lowest noise level possible should be striven for.
65 t0 70 dBA	Significant adverse noise impact exist; allowable only in unusual cases where lower levels are clearly demonstrated not to be possible.
greater than 70 dBA	Levels have unacceptable public health and welfare impacts.

Note: For residential, hospital, and education activity. For structures not containing relevant exterior activity space, special consideration of the acceptability of the interior noise levels should be made.

Finally, the Occupational Safety and Health Administration (OSHA) has set federal standards at which noise is considered a health problem and actual hearing loss may occur. In summary, OSHA standards are that all noise should be less than 140 dBA and that averaged noise levels (Leq-OSHA, computed slightly different from Leq) must be below a value which varies according to duration. For example, over an 8 hour period the Leq-OSHA must be less than 90 dBA, whereas for 15 minutes or less the Leq-OSHA must be less than 115 dBA. It is clear that although this standard does not apply to aircraft, most seaplane base operations would easily comply with this standard.

4.10 Taking Noise Measurements

Pilots are encouraged to buy a noise level meter (one is available from Radio Shack for a very low price). Seaplane noise abatement procedures are necessary to maintain a "fly neighborly" relationship to others living along and using our nation's waterways. Since it all comes down to personal pilot knowledge, all seaplane pilots would be wise to get together a group of friends and share the cost of an inexpensive noise meter. Measure each other's takeoffs and fly-over's and see how little sound you can make!

While taking your measurements make sure that you're not recording the voices of others nearby, it requires complete silence near the meter microphone or the readings will be no good. If a group of pilots got very interested, they could invest in a recording sound level meter which has a computer chip in it that samples and records the noise level at intervals. This allows a print-out of the data and the computer chip can also create the LAE and the Leq (same as Ldn during daytime) values directly from the meter. There are several good meters for this purpose; the author uses a Larson-Davis 720.

Owning a sound level meter can have a good side benefit. With it the pilot can show neighbors, planning department officials, and other interested parties that the noise level from other vehicles and community activities often are the same or greater than that of seaplanes.

It is important to note that most videotapes and audio tape recorders have automatic volume control circuits within them, and thus they do not provide an accurate record of sound levels. However, if you are using a recording sound level meter it is helpful to have an audio recording of the same event (the author uses a Dictaphone) in order to be able to go back and identify the beginning and end of events as well as other noises which impinge on the noise measurements (such as a noisy boat or a neighbor's lawnmower). Also, a sound level meter microphone must be shielded from the wind, as the meter can record the sound of the wind in the microphone if the observer is not careful.

It is best to repeat noise tests several times if extreme accuracy is required. Values within 3 dBA are generally considered acceptable, since the human ear can generally not distinguish differences of 3 dBA or less.

5.0 Seaplane Noise Abatement

5.1 Takeoff Noise

During takeoff there are three primary issues with the pilot can take into account in order to reduce noise:

- Direction of takeoff,
- Power and RPM settings,
- Flight path.

A takeoff directly away from a noise sensitive area will result in a great attenuation of sound as shown in Figure 2 above. It will also have the benefit of continuously increasing distance from the observer during the takeoff run, which continuously reduces sound level to the observer. However, direction of wind and waves will often generally have to take precedence.

Once off the water, the pilot can consider reducing power and RPM's. This will make a substantial decrease in sound impact, especially with the medium and larger size seaplanes.

Finally, given that the takeoff will be into the wind, once the seaplane is airborne it is desirable to alter the direction of flight to maximize the slant distance between noise sensitive uses and the seaplane. It is noted that where water surface area is small, power and RPM settings are probably more effective in reducing impact to a residential area than rapidly gaining altitude. Using the information contained in this report, the pilot can make a determination on this issue for their specific case. Ultimately it may take the use of a noise meter and discussion with neighbors to determine the procedures most beneficial to the community.

Seaplane pilots do their seaplane community a great favor when they utilize noise abatement procedures. They should be aware that communities affected adversely by seaplane noise always have the right to file a class action nuisance suit against seaplane operations. If seaplane pilots get along with their neighbors, the confrontational stage with them should never occur. If the confrontational stage should occur in spite of strong mitigation efforts by the seaplane community, it will likely not be widely supported.

Noise awareness and abatement procedures education of all concerned seaplane pilots should be aggressively pursued by the seaplane community where intensive seaplane operations occur. Elements of such a program should be worked out specifically for a given area. The largest seaplane base in the lower forty-eight, Washington state's Kenmore Air Harbor, has such a program. Abbreviated elements of Kenmore Air Harbor's Noise Abatement Pilot Bulletin follow as an example:

Table 7: Kenmore Air Harbor Noise Abatement Pilot Bulletin

- No departures prior to 7:30 weekdays and Saturdays and 8:30 Sundays and Holidays.
- Taxi out beyond the first red buoy prior to application of takeoff power.
- Depart on the centerline of the lake.
- Leave the centerline of the lake with a 270 degree left turn only after reaching 900 MSL. Execute this turn inside the confines of the lake. Do not overfly the shoreline.
- Cross the shoreline when departing the lake for both north and south courses, only after reaching a minimum of 1200 MSL and reducing the power back to cruise power.
- In-bound flights from the north shall use the Edmonds-Ballenger route maintaining a minimum of 1500 MSL until past Lake Ballenger. Cross the shoreline on descent with a minimum of 1000 MSL.
- No repetitive takeoffs or landings between Kenmore and Sandpoint.

Kenmore Air Harbor has also found it cost-effective to be proactive in educating a few key public figures. They periodically invite elected officials to the Air Harbor for a guided tour, and they make slide presentations at schools and Rotary Club luncheons. Officials that properly understand hydro-aviation are more likely to wisely mediate seaplane issues within the community.

5.2 Fly-over Noise

Normal seaplane landing procedure is to fly over the water landing site at an altitude of 500 feet AGL on downwind for a final look at wind direction, water debris, boats, other traffic, wave conditions, and docking considerations. The 500 feet AGL is used in lieu of the standard 1,000 feet AGL at a land airport in order to promote better observation and visibility. In fact, if the pilot feels uncertain about landing conditions, the pilot will make a low pass over the water landing area as further reconnaissance prior to landing.

Low flight at high power and high RPM settings can be a substantial noise problem to a community. Figures 8 and 9 show that noise contours can continue well beyond the water landing site if large numbers of seaplanes maintain takeoff power throughout their departures. Sound spreads spherically around the plane and its impact at 500 feet above an observer is not substantially different from what it would be 500 feet horizontally from an observer. In fact, it may be slightly more in the vertical direction because there is no chance of ground absorption of any type. The vertical dimension is further aggravated by the fact that water obviously sits at the lowest elevation whereas the land rises around the sides. 500 feet AWL (above water level) may only be 200 feet AGL where there are hills beside the waterway. In some river sites, within a short horizontal distance, the terrain may rise 300 feet (or more). Obviously in such a location 500 feet AWL equals only 200 feet AGL for the neighbors under the flight path. This could result in a noise impact of 5 to 7 dBA increase over that of the intended 500 feet fly-over.

5.3 Minimizing Noise

Obviously it is necessary to do proper reconnaissance of a water landing site, the key is to plan your flight so that you are maximizing your slant distance (shortest distance on the diagonal) between you and noise sensitive uses such as houses. Thus, pick your downwind flight path to take into account both horizontal and vertical separation and maximize the actual distance between the seaplane and a house or group of people. The second and equally important mitigation is to perform all low altitude fly-over's at the minimum power and RPM settings consistent with safe flight.

It is recognized that this puts some extra burden on the pilot, to add in these considerations during the landing phase of flight, which already has a high level of complexity. The fundamental rule for noise abatement procedures is: "Safety comes first." In other words, perform as much noise abatement as you are comfortable with, but control of the aircraft and safe flight conditions always comes first. For locations where regular visits occur by pilots not familiar with the landing area, a simple diagram can be created and circulated among local seaplane pilots, to encourage the use of noise abatement procedures. Many commercial seaplane bases do this.

If you are able to double the slant distance between your seaplane and a noise sensitive land use, you have reduced the sound energy received to one-fourth its previous level, and the sound level meter will read approximately 5 to 6 dBA less. Likewise, to reduce your power setting to 50% power will reduce the sound level another 5 dBA. Backing off the propeller RPM's can for some aircraft reduce the sound level by 5 to 10 dBA. These kind of reductions are very helpful.

Finally, to deal with the actual takeoff and landing noises while on the water, one can take off or land away from the intended tie-down position and then taxi the final distance. This will be useful when there are large bodies of water available. However, the bigger issue will generally be the fly-over and departure flight paths and the power settings associated with each of these phases of flight.

If the issue of noise impact relates to a need for quiet inside a building, there are building construction methodologies which can be used to attenuate seaplane noise. Insulation can be added to walls, an air conditioner can allow windows to be kept closed, and storm windows can be added to attenuate sound coming through windows. These kinds of building improvements are common around major airports as a method of making commercial jet traffic more compatible with surrounding residential areas. A well constructed house with windows closed will generally provide a noise reduction of 25 to 35 dBA's from that outside the building. If the windows are opened, the noise reduction may only be in the range of 10 to 25 dBA.

6.0 Conclusion

As an airplane pilot, you are primarily regulated by the FAA. Due to the concerns for protecting interstate commerce, the FAA will generally claim federal preemption as concerns all issues concerning flight, including noise. However, the FAA generally does not take an advocacy position for land use decisions concerning the establishment of new airports. The compatibility of a new airport with a surrounding land use is generally left to local agencies such as planning commissions, city councils, and state government.

If you are required to perform noise testing and analysis for establishment of a new seaplane base, you will most likely have to go through an extensive land use process with your local governing agency. From a noise standpoint, you should try to utilize the existing FAA noise compatibility guidelines which are contained in Part 150 and in the five agency "Guidelines" (see Section 4.5 above). By the use of those FAA standards it is generally possible to show that a modest amount of seaplane activity will be compatible with nearby residential land uses.

However if the local land use agency tries to make you comply with a different sound level standard, your approval may be harder to achieve, especially with larger size seaplanes. Many local ordinances have an exemption for activities which are governed by federal standards. If this is available, then you should use this exemption to bring the FAA standards into applicability.

Alternatively, you may need to determine whether the local noise standard (such as a maximum noise level) would prohibit the use of chain saws, motorcycles, cars, trucks, and alarms in any neighborhood. Then you must appeal to a sense of fairness and equality under the law.

The good news is that when compared to the typical airport noise problems at our major urban centers, seaplanes are a relatively minor consideration. If the seaplane is small, and the number of operations is small, it can be completely compatible with any waterway as its noise level will be similar to that of outboard motors, jet skis and other common waterway sounds. Medium sized seaplanes such as Cessna 185 and 206 can be compatible with a relatively small area as long as the number of operations are small.