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Extremely Low Visibility IFR Rotorcraft Approach (ELVIRA) Operational Concept Development

Volume I
Executive Summary

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March 1994
Final Report

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Dear Colleague:

Enclosed is a copy of report **FAA/RD-94/1,I entitled "Extremely Low Visibility IFR Rotorcraft Approach (ELVIRA) Operational Concept Development"**. This report is the culmination of information and decisions made at the ELVIRA Workshop in Santa Fe in August, 1993, by representatives of industry (both manufacturing and operating), academia, and government. This document provides a record of the public discussions and consensus determinations as to the **"Ten Most Wanted" improvements** for rotorcraft to operate in the IFR portion of the NAS, as well as documenting the operational concept developed for doing so in the near, middle, and far term. This provides an update to the 1987 "Zero-zero Rotorcraft Certification Issues" by providing the operational envelope for IFR vertical flight using low altitude routes, approach and departure procedures, and enhanced techniques enabled by improvements in avionics and vehicle design.

As a quick reference, the "Ten Most Wanted" improvements are listed here (there is no prioritization):

1. New Air Traffic Control Procedures to enhance simultaneous rotorcraft and fixed wing operations
2. Rotorcraft Standard Instrument Departures and Standard Instrument Approach Procedures
3. Rotorcraft Approach Categories for 40 to 70 kt Vmini approach speeds
4. ILS Category I Approaches to a Decision Height of 100' with 1/4 mile visibility
5. Autopilot coupled decelerating approaches with DH of 50' at airports
6. Rotorcraft Specific Minima
7. Use of "Area Weather" condition data to determine need for alternate
8. Special weather training for departure operations
9. Rotorcraft visibility minima 1/2 Category A Aircraft
10. Specific Rotorcraft IFR Route Structure.

We welcome your comments on this document, as it provides a baseline operational concept which will evolve as additional improvements are made. Please send any comments to:

> Federal Aviation Administration; Vertical Flight Program Office, ARD-30; 800 Independence Ave., S.W. Washington, D.C. 20591

Peter V. Hwoschinsky
Technical Manager
Vertical Flight Program Office

Enclosure

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16. Abstract

The ELVIRA workshop was the second since 1987 to address the enhancement of safety and reliability of helicopter operations by improving the attractiveness of IFR operations in lieu of special VFR operations. The 1993 workshop was the next logical step in the FAA's Vertical Flight research and development program since significant, relevant analyses, simulation and flight test work has been accomplished in the past six years.

The workshop was held in Santa Fe, New Mexico on August 24-26, 1993. The participants were a select group of 59 industry and government experts in each of their individual disciplines. The group was charged with the task of defining an ELVIRA operational concept in the areas of: operational needs, infrastructure requirements, procedural changes, technology requirements, flight tests, and public benefits. These experts were asked explicitly to address affordable and practical near term solutions to issues previously identified through their experience.

The deliberations at the workshop resulted in the identification near term needs of the operator types who would use ELVIRA, activity regions, safety factors and operational improvements. These needs were analyzed and the operational changes responsive to the needs were documented. The proceedings of the workshop culminated with a recommendation of ten IFR enhancements that would eliminate current penalties for using the IFR system. If action is taken to achieve these changes, safety and mission reliability will be increased through increased flight hours under positive control.

Volume I summarizes the activities and contributions of the participants. Volume II provides an overview of the presentations at the workshop. Volume III documents the perspectives of the participants as recorded by Technical Monitors and observers.

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The material presented in this report is based on extensive research and development work performed by the FAA's Vertical Flight Program Office since the previous workshop on "Zero/Zero" Rotorcraft Certification Issues held in August 1987. This analytical and experimental foundation was performed in conjunction with operators, manufacturers, the National Aeronautics and Space Administration's Ames Research Center, the IAR/NRC Flight Research Center of Canada and private consultants. In addition, the American Helicopter Society and the Helicopter Association International have participated in and provided recommendations and guidance for the ELVIRA and Zero/Zero Workshops.

Mr. Peter V. Hwoschinsky of the FAA's Vertical Flight Program Office has played a critical role in the continual support of industries needs and the development of near term research to attack critical issues. Mr. Hwoschinsky's experience and expertise in helicopter operations, infrastructure requirements, procedural changes and advanced technologies needed to support ELVIRA have enabled this research area to maintain a focus and to develop near term, cost effective solutions. The research and analysis he has supported both technically and, in some cases, financially have included flight tests, simulator evaluations, display development, charting, TERPs requirements analyses and the human factor issues involved with training, certifying and operating helicopters under extremely low visibility conditions. Mr. Hwoschinsky is to be commended and sincerely thanked for his time and effort during FAA projects and on the Society of Automotive Engineers Human Behavioral and Engineering Technology committee.

Eight other individuals are to be similarly commended for their continued support and technical expertise spanning the six years since the first workshop. These gentlemen have been a keystone in the operational concept development for ELVIRA. Their knowledge and experience has been critical to the successes attained and the problems resolved during that time. A sincere thank you is extended to both the individuals and their employers for providing the continued support. These are:

Mr. Jack H. Burke	FAA/AAS-110	Airports Safety and Standards
Mr. Paul S. Faidley	FAA/FTW-AEG	Airworthiness and Engineering
Mr. David L. Green	Consultant	Starmark Corporation
Mr. Jake Hart	Manufacturer	American Eurocopter
Mr. Roger Hoh	Consultant	Hoh Aeronautics Inc.
Mr. Wayne Langston	FAA/FTW-AEG	Airworthiness and Engineering
Mr. John Leverton	Manufacturer	E. H. Industries
Mr. Howard A. Wheeler	Consultant	Veda Inc.

The accomplishments of the 1993 ELVIRA workshop would have been impossible without the enthusiastic participation and operational knowledge provided by two other groups. The FAA's Flight Standards Service and Air Traffic Rules and Procedures Service provided the necessary operational support to ensure that the proposed ELVIRA concepts were feasible. Mr. Jim Carlson (ASW-260) and Mr. Mark Rios (ATP-148) provided outstanding leadership of the Certification & Operations working group and the Airspace & ATC working groups respectively. These two individuals deserve everyone's thanks and formal recognition of their accomplishments over a very short time period.

Finally, and most critically, the workshop was run for and by the helicopter operators. With an agenda set to address the near term, and with continued development of innovative ideas, all of the operators present contributed to the products represented in the following report. Special recognition and thanks is extended to the following individuals for their leadership, honesty and outspokenness:

Mr. Vern Albert	Petroleum Helicopters, Inc.	Mr. Jim Church	United Technologies
Mr. Joel Harris	Flight Safety International	Mr. Nick Lappos	Sikorsky Aircraft
Mr. Tom Salat	ROP Aviation	Mr. Bill Smoot	Omniflight Helicopters

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GLOSSARY OF ABBREVIATIONS

AAD	Office of Airport Safety and Standards
ADS	Automated Dependent Surveillance
AEE	Office of Environment and Energy
AEG	Aircraft Evaluatiion Group
AGL	Above Ground Level
AFC	Automatic Flight control
AFS	Flight Standards Service
AHS	American helicopter Society
AIM	Airman's information Manual
ARA OSAP	Airborne Radar Approach Offshore Approach Procedure
ARD	Research and Development Service
ASW	Southwest Region
ATC	Air Traffic control
ATP	Air Traffic Rules and Procedures Service
AVN	Office of Aviation System Standards
CAA	Civil Aviation Authority
CAT I	Decision Height200' AGL & Runway Visual Range 2400 '
CAT II	Decision Height 100' AGL & Runway Visual Range 1200'
CAT III	Runway Visual Range 700'
CNS	Communication, Navigation and Surveillance
CDI	Course Deviation Indicator
CTR	Civil Tiltrotor
DGPS	Differential Global Positioning System
DH	Decision Height
ELVIRA	Extremely Low Visibility Instrument Rotorcraft Approach
EMS	Emergency Medical Service
ETA	Estimated Time of Arrival
FAA	Federal Aviation Administration
FAF	Final Approach Fix
FMS	Flight Managment System
GLONASS	Russian Global Navigation Satellite System
GNSS	International Global Navigation Satellite System
GPS	Global Position System
HAI	Helicopter Association International
HALS	Helicopter Approach Lighting System
HILS	Helicopter Instrument Lighting System
HMD	Helmet Mounted Display
HUD	Head-up Display
HUMS	Health and Usage Monitoring System
IAR	Institute of Aeronautical Research
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
ITO	Instrument Take-off

JAR	Joint Airworthiness Requirements
LDGPS	Local Differential Global Positioning System
LORAN	Long Range Navigation
MDA	Minimum Descent Altitude

MEL	Minimum Equipment List
MLS	Microwave Landing System
MRI	Magnetic Resonance Imaging
NAPES	Noise/nuisance Abatement Performance Evaluation System
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
OEI	One Engine Inoperative
Ops Specs	Operations Specifications
PAC	Political Action Committee
PHI	Petroleum Helicopters Incorporated
POI	Principle Operations Inspector
R&D	Research and Development
RDA	Rotorcraft Discrete Airways
SAR	Search and Rescue
SAS	Stability Augmentation System
SIC	Special instrument Card
SID	Standard Instrument Departure
STAR	Standard Arrival Procedure
SVFR	Special Visual Flight Rules (VFR)
TERPS	Terminal Instrument Procedures
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
V_{MINI}	Instrument Flight Minimum Speed
Vso	Stall speed in landing configuration

Extremely Low Visibility IFR Rotorcraft Approach
(ELVIRA)
Operational Concept Development

1.0 INTRODUCTION

The ELVIRA workshop was sponsored as an integral part of the FAA's Vertical Flight research and development program. The major goal of the workshop was to enhance safety and reliability of helicopter operations by improving the attractiveness of IFR operations in lieu of special VFR operations. This concept evolved from a previous workshop in 1987 and the analyses, simulation and flight test work performed since that workshop. The development of near term procedures, enabling regulatory changes and the endorsement of the new procedures by Air Traffic Control were enthusiastically supported by operators, manufacturers and the FAA. In addition, the need for and feasibility of, making the needed operational changes were strongly endorsed by the American Helicopter Society and the Operations Committee of the Helicopter Association International.

The ELVIRA workshop was held in Santa Fe, New Mexico on August 24, 25 and 26, 1993. The workshop content, format and agenda were developed by Advanced Aviation Concepts, Inc. as a part of FAA contract number DTFA01-P-92-01203.

This Executive Summary is provided as an overview of the background, objectives, proceedings and accomplishments of the workshop. It is also designed to provide a basic understanding of the issues and near term needs addressed by each of the Working Groups and the concepts developed to address those needs. Separate volumes are provided for those interested in a more complete description of the background research and development discussed during the Plenary sessions (Volume 2) and the detailed technical discussions and recommendations of each Working Group (Volume 3). These volumes will be used to create an Action Plan for the work to be accomplished in the next five years in order to achieve the desired results -- improved safety and reliability.

1.1 Mission Statement

It is important to note that the workshop participants were a select group of industry and government experts in each of their individual disciplines. This group was charged with the task of defining an ELVIRA operational concept in six critical areas.

Operational Needs	-- Who will use ELVIRA? i.e., Types of operators -- Where is it needed? i.e., Activity Regions -- Can ELVIRA be performed safely? -- What operational improvements are expected?
Infrastructure Requirements	-- What Air and Ground changes are needed?
Procedural Changes	-- What are they? and Can they be implemented?
Technology Requirements	-- What is required? What alternatives exist?

Flight Tests & Demonstrations -- Are they required for concept validation?
Public Benefits -- How can they be quantified and communicated?

Additionally, consideration of Extremely Low Visibility IFR Rotorcraft Operations into and out of obstruction rich urban areas mandates the requirement for visual acquisition of the landing area "at some point" during the operation. This requirement may be met at different points along the approach path with different minima depending on the aircraft performance capabilities, control/display and stability augmentation equipment, pilot training/certification, number of pilots and the availability of systems to "augment" visual contact.

Finally, the near term operational goals expressed by the participants (pilots, regulators, manufacturers and researchers) were specified with knowledge of current aircraft/system capabilities, practical limitations of the regulators and cost concerns of the operators. Therefore, the near term ELVIRA minimums were specified as:

- 300 Foot ceiling and 1/2 mile visibility for manually flown GPS non-precision approaches

- 100 Foot ceiling and 1/4 mile visibility for coupled, constant speed approaches

- 50 foot ceilings and 1/4 mile visibility for coupled, decelerating approaches

Regulatory changes, Air Traffic Control procedures, helicopter specific routes, landing facilities development and training requirements for these types of IFR rotorcraft operations should focus on these goals.

1.2 Approach

The workshop was designed to convene a select group of helicopter experts capable of developing a broad operational concept for ELVIRA. These experts were asked explicitly to address affordable and practical near term solutions to issues previously identified through their experience as operators, manufacturers and researchers. The deliberations were to include affordable evolution in the near term consistent with current aircraft, navigation and National Airspace System capabilities. The group was also asked to address far term development of a rotorcraft specific IFR system if sufficient time permitted.

1.3 Objectives

The purpose of the workshop was to **identify IFR enhancements which are needed to encourage use of the IFR system in order to improve safety and mission reliability through increased flight hours under positive control.** The overriding goal of the workshop was to create an "operational concept" of helicopter IFR which would be implemented over the next five (5) years. Also addressed was a far term operational concept which requires technological advancements that may greatly improve instrument approach capabilities and operational safety in the 10 year time frame.

The deliberations of the workshop will be used to develop an "Action Plan" for use by the Air Traffic Service, the Flight Standards Service and the Vertical Flight Program Office of the Federal Aviation Administration. This plan will provide the background information and details needed for planning, budgeting and implementing the near and far term ELVIRA operational concepts defined by the workshop participants.

1.4 Key Findings and Recommendations

The proceedings of the workshop culminated with a recommendation of ten operational needs that will eliminate current penalties for using the IFR system by providing lower minima and other benefits which will provide a large payoff near term and evolve into a fully capable rotorcraft IFR system as the operational capabilities increase. The top ten "most wanted" enhancements for achieving an ELVIRA operational concept are specified in Table 1.0

Table 1.0 TEN MOST WANTED IFR ENHANCEMENTS

- New Air Traffic Control Procedures to enhance simultaneous rotorcraft and fixed wing operations
- Rotorcraft Standard Instrument Departures and Rotorcraft Standard Instrument Approach Procedures
- Rotorcraft Approach Categories for 40 to 70 V_{mini} approach speeds
- ILS Category I Approaches to a Decision Height of 100 feet with $^1/_4$ mile visibility
- Autopilot coupled decelerating approaches with DH of 50' at airports
- Rotorcraft Specific Minima
- Use of "Area Weather" condition data to determine need for alternate
- Special weather training for departure operations
- Rotorcraft visibility minima $^1/_2$ Category A Aircraft
- Specific Rotorcraft IFR Route Structure

2.0 WORKSHOP PROCEEDINGS OVERVIEW

The ELVIRA workshop was organized on the premise that by bringing together the key operating services of the FAA with the operators, manufacturers and researchers, current limitations to helicopter IFR could be addressed and avenues toward their mitigation identified. Safety, practicality, cost and near term implementation were the basic guiding principles underlying all of the discussions.

2.1 Organization

The organizational format included two plenary sessions and two Working Groups: Airspace/ATC, and Certification/Operations. The Working Groups convened for approximately 14 hours in the time between plenaries. The detailed agenda is provided in Table 2.0

Table 2.0 ELVIRA WORKSHOP AGENDA

	PLENARY SESSION I Tuesday - August 24, 1993	
8:30	WELCOME AND INTRODUCTION	FAA/Vertical Flight Program Office - ARD
8:45	KEYNOTE ADDRESS	Industry Perspectives - AHS
9:30	INDUSTRY REQUIREMENTS FOR ELVIRA	HAI's Flight Operations Committee
10:00	QUESTIONS & ANSWERS	
10:15	BREAK	
10:30	R & D PROGRAMS, PRODUCTS & STATUS	Government Panel - (AAS, ARD, AEE, NASA)
11:30	QUESTIONS & ANSWERS	
12:00	LUNCH	
1:00	R & D PROGRAMS, PRODUCTS & STATUS (CONT.)	Government Panel - (AAS, ARD, AEE, NASA)
2:00	QUESTIONS & ANSWERS	
2:30	ELVIRA OPERATIONAL REQUIREMENTS	FAA Flight Standards Service - AFS
3:00	AIR TRAFFIC CAPABILITIES & CHALLENGES	FAA Air Traffic Rules and Procedures - ATP
3:30	BREAK	
4:00	ELVIRA PROGRESS, STATUS AND CAPABILITIES PANEL	Sikorsky, Pacer, Honeywell, McDonnell Douglas, UTSI
5:00	QUESTIONS & ANSWERS	
5:30	WORKING GROUP ORGANIZATIONAL AND GROUND RULE DISCUSSIONS	A. Airspace and Air Traffic Control Capabilities B. Certification and Operations Requirements
6:00	ADJOURN	
	Wednesday - August 25, 1993	
8:00 to 5:30	WORKING GROUPS CONVENE	Simultaneous deliberation of the issues and development of ELVIRA Requirements
	Thursday - August 26, 1993	
8:00	WORKING GROUPS CONVENE	Continued deliberations
10:00	WORKING GROUPS PREPARE SUMMARIES OF OPERATIONAL CONCEPTS & ISSUES	Presentations for afternoon session
3:30	**PLENARY SESSION II**	Exchange findings, discuss issues and develop recommendations
5:30	ADJOURN	

2.2 Workshop Participants

The workshop participants represented a broad spectrum of the helicopter community. Table 3.0 summarizes the participation percentages for government (FAA, NASA, Canada's NRC, etc.), operators/pilots, manufacturers, associations and consultants. Table 4.0 presents the complete list of 59 participants, their affiliations and the Working Group they supported. Participants were assigned to a specific working group using this list. However, as the discussions progressed and their expertise was needed to address specific issues, they were asked to change groups. The members of the HAI's Flight Operations committee were particularly helpful in this "floating" expertise role as was the FAA's representative from Aviation Systems Standards, AVN-540.

Table 3.0 ELVIRA WORKSHOP PARTICIPANTS BY AFFILIATION

PARTICIPANT CATEGORY	NUMBER		PERCENT OF TOTAL
GOVERNMENT	17		29%
Federal Aviation Administration		13	
National Aeronautics & Space Administration		2	
Canadian National Research Council		2	
OPERATORS	11		19%
MANUFACTURERS	14		24%
ASSOCIATIONS	2		3%
CONSULTANTS	15		25%

Table 4.0 DETAILED LIST OF PARTICIPANTS

	NAME	ORGANIZATION	CATEGORY					
			COVT	OPER	MFG	ASSN	CON	W. G.
1.	Catherine A. Adams	Advanced Aviation Concepts					√	B
2.	Richard J. Adams	Advanced Aviation Concepts					√	A
3.	Vern Albert	Petroleum Helicopters, Inc.		√				B
4.	Harry Alexander	Boeing Helicopter			√			B
5.	Stewart Baillie	Flight Research, IAR/NRC	√					A
6.	Brian Bertrand	Flight Research, IAR/NRC	√					B
7.	Jack H. Burke, AAS-110	Airport Safety and Standards	√					A
8.	Malcolm Burgess	Research Triangle Institute					√	A
9.	Jim Bushee, AAS-110	Airport Safety and Standards	√					B
10.	Jim Carlson, ASW-260	FAA, Southwest Region	√					B
11.	James Church	United Technologies		√				A
12.	Ron Clenney, AVN-540	Aviation System Standards	√					A
13.	William A. Decker	NASA Ames Research Center	√					A
14.	Ronald G. Erhart	Bell Helicopter Textron			√			A
15.	Paul Erway, ARD-30	Vertical Flight Program Office	√					A
16.	Paul Ewing, ATP-121	Air Traffic Rules & Proced.	√					A
17.	Paul S. Faidley, FTW/AEC	Southwest Region	√					B
18.	Morris (Rhett) E. Flater	American Helicopter Society				√		B

	NAME	ORGANIZATION	CATEGORY					
			GOVT	OPER	MFG	ASSN	CON	W. G.
19.	Scott Fontaine	D. P. Associates					√	B
20.	Andre Gluck	Norden Systems Center			√			B
21.	Dave Green	Starmark Corporation					√	A
22.	Joel Harris	Flight Safety International		√				A
23.	Jake Hart	American Eurocopter			√			B
24.	Steve Hickok , ARD-30	Vertical Flight Program Office	√					B
25.	Roger Hoh	Hoh Aeronautics Inc.					√	B
26.	Walter Hollister	MIT Lincoln Labs					√	B
27.	Peter V. Hwoschinsky, ARD-30	Vertical Flight Program Office	√					B
28.	Laura Iseler	NASA Ames Research Center	√					B
29.	Leroy Jackson	Air Methods		√				A
30.	David Ketchum	Ketchum & Company		√				A
31.	Jerry Keyser	McDonnel Douglas Helicopter			√			A
32.	Ralph D. Kimberlin	Univ. of Tenn. Space Institute					√	B
33.	Wayne Langston, FTW/AEG	Southwest Region	√					A
34.	Nick Lappos	Sikorsky			√			B
35.	John Leverton	E. H. Industries			√			A
36.	Al McDonough	FAA/Eastern Region	√					A
37.	Andy McJohnston	Air Methods		√				B
38.	Dick Newman	Crew Systems					√	B
39.	Dan Norman	Erlanger Hospital		√				A
40.	Robert A. North	Honeywell SRC			√			B
41.	Alfred Reich	MIT /Lincoln Labs					√	A
42.	Filippo Reina	Augusta Helicopters			√			B
43.	Mark Rios, ATP-149	Air Traffic Rules & Proced.	√					A
44.	Ken Russell	Classic Air Transport		√				A
45.	Tom Salat	ROP Aviation		√				A
46.	Mitch Sams	Wilcox Electric			√			B
47.	Dennis Schmickley	McDonnell Douglas Helicopter			√			B
48.	John Shapley	Consultant					√	B
49.	William K. Smoot	Careflight		√				A
50.	Chuck Stancil	Georgia Tech. Aerospace Lab					√	B
51.	Paul Stringer	Princeton Economic Res. Inst.					√	B
52.	James H. Such	Mobil Corporation		√				A
53.	Jack Thompson	National Air Transport Assoc.				√		B
54.	John Ward	Ward Associates					√	A
55.	Bob Warren	Sikorsky			√			B
56.	Donna Warren, AEE-120	Federal Aviation Administration	√					A
57.	Howie Wheeler	Veda Inc.					√	A
58.	Ryan Wilkins	Boeing Helicopter Company			√			A
59.	Steve Young	Honeywell SRC			√			A
60.	TOTALS		17	11	14	2	15	

2.3 The Need for ELVIRA

Setting the tone for the first day's deliberations, AHS Executive Director, Rhett Flater gave the keynote address and enlightened the participants with his personal experiences and frustrations of trying to operate a scheduled helicopter air servic[illegible] [illegible]e drew attention to the deficiencies and need for changes to the IFR system. He wa[illegible] followed by several panels of speakers, who, through their characterizations of typical IFR scenarios, established the "operational baseline" from which the deliberations of the conference would proceed.

Several panels of FAA staff, manufacturers, operators and researchers presented their perspectives, painting a picture of today's IFR system for helicopter operators as inefficient and uneconomical. Specifically, the current IFR system forces the rotorcraft operator to choose between flying VFR, or not at all because the federal air regulations (FARs) are based on fixed wing flying characteristics, e.g. airspeeds, altitudes, and approaches to runways. Current FARs often prohibit the filing of IFR flight plans while allowing VFR flight (during weather conditions better than 1000-3 yet worse than 2000-3, which requires an alternate). If the rotorcraft operator can file IFR, he is often forced to either fly his helicopter on fixed wing flight profiles where his slower speed and higher operating costs cannot compete, or he/she must abandon the IFR system and fly VFR or Special VFR (SVFR) at lower altitudes, incurring a larger environmental impact (noise) and a higher percentage of operations canceled due to inclement weather.

It was also pointed out that the origins and destinations of the helicopter operators are frequently heliports or uncontrolled airfields. These facilities are typically close enough to be within the same airmass but often do not have a weather reporting capability and are frequently off the IFR airway route system. This lack of weather reporting capability precludes IFR operations for a Part 135 operator. During the opening plenary session, the operators unanimously agreed that their current VFR operations are safe and can be profitable; however, improved access to the current IFR system is required *and* would result in more efficient operations, provide better service to the public, and reduce environmental impacts.

The ELVIRA issues to be discussed were first developed at a 1987 workshop, "'Zero/Zero Helicopter Certification" sponsored by NASA and the FAA. Some of these issues were resolved over the years with research or through technological advances while others had not been fully addressed and needed refinement. Carried over to the 1993 ELVIRA workshop were the primary areas of concern: air traffic control, airspace, flight standards, aircraft performance/handling qualities, avionics, simulation, training, and human factors. Overall emphasis focused on operational aspects and near term improvements. In order to adequately examine the issues and develop recommendations, two working groups were formed: A. Airspace and ATC and B. Certification and Operations. The schedule called for two days of deliberations, by the working groups followed by a Plenary session during which each group presented their recommendations. Conflicting recommendations were discussed in the group as a whole and revised according to what the group negotiated and approved.

The Airspace and ATC working group initiated its discussion with imaginary obstacle clearance planes [as defined by TERPS] associated with a given approach to a heliport. Related issues include ATC concepts for low altitude flexible routing, accuracy and system requirements for ELVIRA operations and regulatory analysis for potential changes due to ELVIRA operations. The operators emphasized the need for the FAA to recognize the low speed performance capabilities of rotorcraft. It was recognized by the FAA that GPS non-precision, manual approaches to 300' and 1/2 mile visibility are well within current helicopter capabilities and should be developed for heliports. Additionally, lower minima are possible using coupled precision approaches: 100' and 1/4 mile visibility for constant speed approaches and 50' and 1/4 mile visibility for decelerating approaches. Other requirements listed included converging simultaneous approaches at airports and creation of a series of approach categories based on rotorcraft speed.

The Airspace and ATC working group also addressed ground and airborne equipment requirements as a function of TERPs criteria and Heliport design criteria. Specifically, revisions to TERPs with the advent of GPS was recommended citing greater approach angle capability and increased accuracy as the basis for change. The discussion also addressed IMC heliport marking and lighting. Recommendations focused on the need to define and standardize the lighting systems to be installed at heliports and that the systems developed should be matched to the guidance system at each heliport. The group charged the FAA with the task of re-evaluating heliport lighting to respond to the development of new technologies and procedures (e.g. GPS approaches and steep approaches).

Looking at ATC concepts for low altitude routing and flexibility, the working group considered the impact of GPS, with its accuracy independent of range from a fixed ground site (allowing for rectilinear protected airspace, i.e. non-expanding), on helicopter route structure. It was noted that different regions experience weather conditions which affect use of the current route structure and that ATC handling of helicopter traffic can be inconsistent. The corporate operator representatives cited the success of the Washington DC to NYC corridor and noted the failure of the NYC and Hartford segment because of the ATC coordination factors. Lower altitude routes are required to minimize the effect of icing on scheduled operations in northern areas and to keep rotorcraft operations separate from fixed wing while providing access to new destinations, i.e. heliports. These lower altitudes pose a radar coverage (surveillance) problem and may, in some areas pose a noise problem. GPS coupled with data link also has the capability of low altitude surveillance which could mitigate the coverage problems.

The precedent of lower altitude routing from airport-to-airport has been successfully established by current Tower enroute control procedures and should be applied to heliport-to-heliport routing in the future.

What type of accuracy and system requirements for ELVIRA operations are envisioned? Future avionics and instrumentation will include flight management systems with approach displays that will enhance situational awareness. Military advancements in "synthetic vision" will become available for civil use and should be endorsed by the rotorcraft community and the FAA through research and development activities. GPS figured heavily in the area of accurate and reliable advanced navigation and guidance systems. Communication, navigation and surveillance requirements (CNS) in the future will also be met through techniques and equipment such as Noise/Nuisance Abatement Performance Evaluation System (NAPES).

The Certification and Operations Group focused on requirements for accurate and reliable advanced navigation guidance, control and landing systems, helicopter productivity limits under current regulations, low airspeed handling qualities, and pilot training and proficiency regulatory requirements. Alternate minima and weather reporting requirements occupied the initial discussion because operators felt these issues were extremely important to their program reliability. Under scrutiny were the current alternate weather minima required for filing an IFR flight plan. Because helicopter mission lengths are limited to generally 200 miles or less, their destination and alternate will most likely be within the same air mass, and consequently will have similar weather.

As a result the operators suggested that the requirement for weather reporting at the destination be modified to allow the use of the local prevailing weather rather than the current requirement to use the lowest forecast weather, including "a chance of" and "occasional" weather, during the time period 1 hour prior to 1 hour after the scheduled ETA. Due to the typically short ranges involved and the similar weather at the destination and alternate, the weather that is temporary is not likely to be a factor at both the destination and the alternate simultaneously. Because of the short duration of flight, weather forecasts are more accurate and weather is less likely to develop other than forecast. If the pilot is allowed to depart IFR, he will be able to make decisions upon arrival based on actual weather. The alternative is the current choice between low altitude VFR or a canceled operation.

Regulatory changes were recommended which would increase the number of IFR operations and thus enhance the schedule reliability of helicopters. Regulations currently stipulate that an alternate is required if, for one hour before and one hour after the ETA, ceilings are below 2000 feet above the airport elevation and visibility is less than three miles. An original recommendation out of the group was for this to be reduced to 1000 and 3. It was noted, however, that some airports, particularly those in mountainous areas, may have published minimums above 1000'. In this case, the change might degrade the safety of the operation. Deliberations during the plenary session reduced the destination minima to 400 feet above the highest published Minimum Descent Altitude at the destination to determine if an alternate is required.

Additionally, pilots thought that the current minima at alternates were too high and that they also often precluded filing IFR. FAR 91.169 requires using the published Alternate minimums for each alternate airport when determining whether that airport is legally suitable as an alternate, or if none are so specified, 600-2 for precision approach procedures and 800-2 for non-precision approach procedures. The group agreed that changing this to 400-1 for a precision approach and 600-1 for a non-precision approach, will enable many more IFR operations to take place while maintaining the same level of safety. The rationale underlying the reduced minima was based on the greater maneuverability (both horizontally and vertically) of rotorcraft at slower speeds and the greater accuracy of short term forecasts for short duration helicopter flights.

Considerable discussion was devoted to categorizing approaches in a manner similar to that of fixed wing aircraft (CAT A, CAT B, etc.). Rotorcraft approach categories should also be based on approach speeds. This would be accomplished through R&D efforts directed toward fully utilizing the unique capabilities of helicopters in all weather. Approaches would reflect these slower speeds and be divided into three categories representing V_{mini} speeds in the range from 40 kts to 70 kts. The FAA's flight test experiments should substantiate these categories and revise TERPs accordingly.

Operator confidence in executing steep approaches was evidenced in discussions concerning approaches up to 9 degrees. Approaches steeper than 9 degrees and especially very steep approaches on the order of 25 degrees raised considerable concern regarding the effects of workload, passenger comfort, ring-vortex and decision making.

A matrix of near, mid and far term operational goals was created: The near term system is the IFR operation in which approach slopes would be 6-9°. Mid term capabilities might be conducted at 12-15° at extremely low visibility while far term approaches would be conducted at "very steep" (25°) angles and in zero/zero conditions. It was noted that while steep approaches will minimize the area affected by noise, they will also tend to concentrate the noise in certain areas close to the landing point. Future testing should examine possible noise problems in conjunction with the steep approach evaluations.

Decision Heights and Runway Visual Range minima were also explored with discussion centering on reduction of current RVR requirements. **F.A.R. 97.3 (d-1) states** that, for helicopters, "The Required visibility minimum may be reduced to one-half the published minimum for Category A aircraft, but in no case may it be reduced to less than one-quarter mile or 1,200 feet RVR." The group recommended removing the 1200 foot RVR limitation and allowing all RVR minima to be reduced by half. The same reasoning, based on greater maneuvering capabilities at lower airspeeds, that was used to make this rule also applies at RVR's less than 1200 feet.

Heliport lighting as it pertains to minima was considered. The group agreed that research into helipad lighting systems should be accomplished in a realistic manner. Operators cautioned that the results **should reflect minimum required capabilities** as opposed to "nice-to-have-but expensive." It was suggested that lighting configurations could be tested in a simulator because of the ability to vary design and intensity by applying varying degrees of visibility and altitude.

The culmination of the three day conference was an afternoon plenary session where each group presented their findings. Differences were negotiated among the two groups as follows:

Group Recommendation	Opposing Recommendation	Final Agreement
1. A-Blanket Approval DH of 100 Ft	100' DH on Case by Case Basis	100 foot DH on Case by Case Basis
2. B-Minimum Visibility $\frac{1}{4}$ mile	No recommendation	Minimum Visibility $\frac{1}{4}$ mile
3. B- 1000'-1 destination minimums	A-Disagreed with 1000'-1	400' above highest approach minimum at destination airport
4. A-50 foot DH with autopilot	B-DH based on approach speeds	Decision Heights based on speed from 40-70 kts.
5. A-Near term enhancement below 50-foot DH at airports	B-50' DH-Far term	Near Term-50' DH- at Airports Mid Term-50' DH at Heliports

3.0 OPERATIONAL CONCEPT DEVELOPMENT

The discussion in this section addresses the paramount reason for convening this second workshop on extremely low visibility helicopter operations. That is: What is the current need for this capability??? The workshop participants addressed this question at the working group level by deliberating airspace, ATC, certification and operational needs individually. They then reached a consensus on those needs in the final Plenary Session. Since the demonstrated need drives the development of the Operational Concept, this section addresses the "devil's advocate" questions first:

-- Who will use ELVIRA? i.e., Types of operators
-- Where is it needed? i.e., Activity Regions
-- Can ELVIRA be performed safely?
-- What are the required operational improvements?

The answers to these questions (Section 3.1) provide the knowledge necessary to understand the operational concept which responds to the current helicopter community's needs and lays the foundation for future rotorcraft operations.

Section 3.2 addresses the participants' consensus on the way to achieve safe, reliable ELVIRA operations in the near term. It summarizes the necessary air and ground infrastructure changes, procedural needs, regulatory impact and the technology solutions which either currently exist or need to be developed. The safety factors associated with either having or not having an ELVIRA capability are then presented. Finally, the participants described the operational improvements that would be achievable with ELVIRA capabilities. Improvements were delineated in the areas of functional (i.e., system) enhancements, economic implications, environmental impact, and political considerations.

3.1 Operational Needs (near term)

ELVIRA Operator Types - The ELVIRA concept answers the need of a broad, non-exclusive, operator community across FAR Part 91 and Part 135. This community characterized itself at the workshop as "taxi drivers" and as with taxi drivers, road blocks restrict operations and reduce revenue producing time. The operators expressed the need for standardized rules tailored to improve safety and enhance reliability. They reported that they typically do not go to locations with weather reporting stations because that is not where their customers are. Current IFR alternate requirements often force the use of "scud runs" which increase risks.

Helicopter flights typically have their origin and destination within the same "air mass" since they are only 50 to 100 miles in length. The pilots get area weather now for a Flight Service Region which may or may not include heliport locations since anything outside 5 miles is not included. The current weather minima requirements are based upon forecast weather, not on reported weather which, again, is not consistent with 50 to 100 mile flights lasting 15-30 minutes. However, clearance for the approach is based on reported weather.

Like the US. Navy, helicopter pilots would like to use a Special Instrument Card (SIC) which enables them to clear themselves for taking off in instrument conditions. The SIC is based upon extensive flying and instrument experience. The consensus was that Part 135 operators would prefer an ops spec change to permit more utilization of the IFR system based upon existing weather conditions. In addition, most operators have a maximum of 1 to 2 hours of fuel on-board. The requirement for one hour before and after arrival is inappropriate because of the limited helicopter flight time, the smaller scale of operation length and lack of a need for a prepared runway.

Recommendations: Near term the operators requested that the FAA upgrade Part 91 and Part 135 to reflect current helicopter and avionics technology. Interim alternative ops spec changes are direly needed. For the 5-10 year horizon (mid-term) they requested that the FAA incorporate rotorcraft needs as specific requirements into advanced systems development programs. The joint FAA/NOAA project to put weather information in the cockpit using Mode S transponder was mentioned as one positive example addressing current needs. Specific recommendations included:

- Allowing helicopter operators to use "area weather" or prevailing weather as opposed to "chance of" forecasts would increase the use of IFR and decrease the number of operations in marginal VFR conditions.

- Eliminating the requirements for one hour before and one hour after, i.e., landing time for flight planning and for alternate weather minimums would also increase the utility of the IFR system.

- Allowing the use of qualified pilot visibility observations for departures would enhance safety and expand operational capability.

ELVIRA Activity Regions - The operators present considered the need for low visibility operations to include: from Vancouver, BC. to Portland and Seattle, Southern California, the Gulf of Mexico, and the NE. corridor.

Safety Factors - Current restricted access to the IFR system forces VFR operations or less desirable special VFR operations. Regulations and procedures have not kept up with capabilities and are precluding the timely utilization of technology. Current impediments to safety (both real and perceived) include: restricted use of real capabilities, out of date regulations and rules which inhibit the application of modern technology to improve operating effectiveness and safety. Also noted was the presence of magnetic resonance imagery (MRI) systems at hospitals which can have an adverse effect on helicopter avionics. Today, it is more practical and cost effective to go SVFR rather than IFR. This needs to be changed.

Safety enhancements which the operators recognized included: rectilinear guidance for obstruction avoidance, GPS guidance to heliports, new rules and procedures which permit simultaneous IFR rotorcraft operations with airplanes, and specific helicopter IFR route structures.

Operational Improvements - The operators expressed a strong interest in developing instrument approaches to heliport locations that were inconceivable a few years ago. The rotorcraft community has much to gain by supporting GPS and the Civil Tilt Rotor. The Helicopter Association International, the American Helicopter Society and all of the pilot groups should develop a comprehensive plan to exploit these technological improvements. Specific recommendations in the areas of functional, economic, environmental and political improvements were suggested as follows:

a. Functional

• Implementation of a complete helicopter IFR route structure is needed to assure all weather, reliable operational capability for a broad user community including current helicopter operators and future Civil Tiltrotor operators.

• The ATC system needs to be enhanced to accommodate helicopter operations

• Procedures for FAA flight checking GPS non-precision approaches need to be developed and implemented.

• A need exists for a new set of approach validation and revalidation procedures.

• HAI and AHS need to take the initiative in requesting FAA approval of a real GPS heliport facility. They need to document the need, present quantitative facts, operational schedules, etc.

• An Advisory Circular is required to assist the industry in accomplishing this approval.

• The FAA may need to augment internal manpower or allow contractors to assist in implementing these requirements.

b. Economic

• The need for IFR heliport approaches is approaching a milestone for both helicopters and civil tilt-rotors. IFR capability provides more efficient operations, growth in business potential and enhanced economics of operation.

• In addition, the opportunity for dual or multiple use of these facilities for civil, military disaster relief and emergency management creates an enhanced need.

c. Environmental

• Communities can maintain control of the IFR helicopter operations. These routes typically imply noise avoidance.

• NAPES involvement guarantees accountability and sensitivity to noise abatement.

• Helicopters and rotorcraft are available for environmental disaster emergency management

d. Political

• There is a need to get the civil helicopters into the IFR system in anticipation of the introduction of the civil tilt rotor (CTR). Since helicopters will serve as the feeders for CTRs, they will add to the transportation infrastructure, provide community friendly operations, contribute to inter modal services and expand the service to rural areas. The helicopter will also provide emergency medical services, disaster relief and community relations for public service activities.

• Negative community perceptions have been and can be turned around with awareness and education. Benefits to the community include: law enforcement, search and rescue, health services and economic development (jobs, heliport facilities, ground traffic reporting/management, tours, etc.).

3.2 Operational Requirements and Changes Responsive to Needs

Infrastructure - Technological advancements and current capabilities far exceed the constraints of the regulatory environment. The FAA needs to drop embedded regulatory methodologies that constrain operations and conflict with capabilities.

a. Ground

- Develop heliport standards from active runway standards -- separate but compatible
- Continue investigation of visual cueing options -- lighting & marking
- Justify HALS or cancel the requirement -- determine real approach lighting requirements
- Revise Part 77 to reflect IFR procedures -- need real Vertical Flight IFR procedures

b. Airspace

- Amend CAT I ILS standards to reflect 100 foot Decision Height and 1/4 mile visibility -- blanket reduction approval for rotary wing aircraft
- Change the altitude approach minimum requirements to 400 feet above highest approach altitude and 1 mile visibility
- Operators need to be able to file IFR to their destination using area forecasts or reported conditions (i.e., predominant weather) rather than forecast weather
- Heliport TERPS approach airspeed should be revised from 90 knots to 70 knots (Handbook 8260.37 9/27/91) and below as technology warrants
- Helicopter specific VFR routes should be developed which underlay IFR routes

Procedural Changes & Implementation Strategies (Near Term - next 5 years)

- Helicopter TERPS criteria should provide the following capabilities
  1. Slow, constant speed GPS based non-precision approaches
  2. Existing ILS facilities should publish "copter" ILS minimums as 100 feet ceiling and 1/4 mile visibility.
- TERPS criteria should specify rotorcraft equipment, pilot training and rotorcraft speed requirements. Operational credit (i.e., lower minima) should be given for levels of capabilities (for example H1, H2, H3 levels of avionics sophistication, and/or low airspeed capability).
  1. Equipment: A Flight Management System and GPS might comprise one level. The addition of Enhanced Vision might be constitute a higher level. Perhaps Enhanced Vision without FMS and GPS would be a third.
  2. Aircrew Training requirements associated with each level need to be determined, required and enforced.
  3. Maximum approach airspeed of 70 knots should be specified for all "copter" approaches (with classes of slower approaches, 40 - 70 knots).
- Criteria for Rotorcraft Discrete Airways should be developed based on GPS. Direct, straight-line RDAs should be used based on rectilinear navigation capabilities and accuracy capabilities.
- Alternate weather requirements need to be revised
  1. Pilots should be authorized to use area forecasts, i.e. prevailing weather.
  2. Criteria should be based upon 1000 foot ceiling and 2 miles visibility or 400 feet above published minimums (whichever is higher).
- Where an alternate is required, desired approach minimums are as follows:
  1. For precision approaches 400 foot DH and 1 mile visibility

2. For non-precision approaches 600 foot DH and 1 mile visibility

- ATC Handbook procedures are required to allow simultaneous rotorcraft and fixed wing operations and to increase the final approach intercept angles used at the Final Approach Fix on radar vector approaches. These will require development of lateral separation standards and examination of heliport locations with respect to fixed wing operations.
- Helicopter training for Air Traffic Controllers needs to be augmented to support ELVIRA operations.
- Standard Instrument Departures (SIDs) need to be developed based upon the above criteria including the GPS impact on vertical and horizontal position accuracy.

Alternative Technologies & Required R & D

- Near Term Solutions
  1. Rapid certification of GPS technology and procedures
  2. Consider helicopter/ELVIRA needs in the development of Global Navigation Satellite Systems (GNSS)
  3. Innovative heliport lighting development and certification
  4. Improved weather support including weather at the landing site and reliable/timely area weather reporting.
  5. Implement moving map displays and synthetic vision as well as other "today" technologies to provide improved situational awareness to the pilot.
  6. Develop training criteria to permit pilots to use technologies to improve safety and reliability of operations.
- Far Term Solutions
  1. Augment radar coverage with Automatic Dependent Surveillance Mode S to support helicopter IFR.
  2. Provide communications & surveillance for all operational areas
  3. Continue to support procedural research to reflect available technology, e.g., flexible curved approaches.
  4. ATC automation support to reduce controller & pilot workload.
  5. Cost effective synthetic vision technology.
  6. Greater R&D for rotorcraft icing protection.
  7. Certification credit (improved reliability) and regulatory credit (required maintenance intervals) for Health Usage Monitoring Systems.

Validation Flight Tests & Demonstrations

- Near Term (next 5 years)
  1. Validate current helicopter ILS approach capabilities to 100 feet DH and 1/4 mile visibility for CAT I (as a general criteria, not on a site-by-site basis).
  2. Validate coupled helicopter ILS approach capabilities to 50 feet DH and 1/4 mile visibility in a decelerating approach (at airports).

3. Validate GPS non-precision stand-alone approach capabilities and the associated TERPS criteria which are currently being compiled.
4. Validate Airspace requirements for runway GPS (rectilinear) guidance. These should include approach, missed approach, enroute and terminal area requirements.
5. Confirm and publish an Advisory Circular for helicopter ELVIRA approaches. (This should address GPS, LORAN/ARA OSAP, et. al.)

- Mid-Term (next 6-7 years)
  1. Evaluate Differential GPS (DGPS) precision approaches for at least 3°, 6° and 9° approach angles.
  2. Evaluate/validate advanced displays/enhanced visibility for remote area operations.
  3. Validate 100 foot Decision Height and 1/4 mile visibility for CAT I operations at heliports and decelerating approaches to 50 foot DH and 1/4 mile visibility at heliports.

Public Benefits Quantification & Communication

- Near Term Quantification of benefits
  1. Local and regional business/economic stimulus through improved commerce (increased reliability and operations), and additional job opportunities for supporting industries.
  2. Improved inter modal transportation and package delivery service to both urban and remote locations.
  3. Environment and air quality benefits including improved safety, controlled noise corridors and reduction of exposure to air pollution.
  4. Noise abatement above 1,200 feet.
  5. City center to city center scheduled commuter service for both business and pleasure.
  6. Transportation flexibility and additional robustness by adding a rapid, short haul air link to both highway and regional air systems.
  7. Rapid emergency and disaster relief capability.

- Near Term Communication of benefits
  1. Increase use of PAC (HAI, AHS)
  2. Increase interaction with the community (more service points)
  3. Better access to rural areas (heliports)
  4. Improved information transfer time and accuracy for medical, food, housing, etc. requirements in emergency and disaster relief support.
  5. Information network to support Fortune 500 companies (improved local economy through creating the need for more jobs and through increased revenues).

- Mid-Term (next 6-7 years)
  1. All weather city commuter operations

2. Civil Tilt Rotor city center/city center
3. True inter modal coordination of operations (heliports and vertiports located at rail and highway nodes).

4.0 SUMMARY OF PROCEEDINGS

An overview of the proceedings of each working group is presented in this section. This includes a brief description of the charter and focus of each group (Sections 4.1 and 4.3) followed by an edited and condensed version of the deliberations (Sections 4.2 and 4.4). The detailed deliberations and minutes from each group are presented in Volume 3 of this report.

4.1 WORKING GROUP A: AIRSPACE & ATC

Co-Chairmen:	Mark Rios, FAA/ATP-120 and John Ward, Consultant
Technical Monitor:	David L. Green, Starmark Corporation
Facilitator:	Howard Wheeler, VEDA, Inc.

• Purpose of the Group: To reach agreement of participants on the need for ELVIRA operations and reach a consensus on a methodology or process for responding to that need in the near term. The focus of this group was airspace and ATC issues currently inhibiting the use of the IFR system. Their charter was to apply the full capabilities of the current air traffic control and IFR system to recommend near term resolutions or action items that would encourage the use of the system in the near term.

• A list of Participants affiliations, and telephone numbers is provided in Table 5.0

• Scope: The working group formatted its deliberations to provide answers to the basic questions: What do the operators really need?, Where are we today on airspace issues (e.g., TERPs)?, How can we facilitate getting approaches into obstacle rich environments?, and How can we provide precision approach capabilities to the few without shutting down SVFR to the majority of operators in the area?

• Consensus: "Developing non-precision approaches for helicopters with GPS does not provide much additional ELVIRA capability if the minimums are 250 feet. **What is needed is the capability of Local Differential GPS (LDGPS using code tracking) precision approaches with minimums as good as, or better than, ILS or MLS.** In order to respond to this need, the following actions are required:

1. The FAA has come a long way in recent years with regard to helicopter approach criteria. The next step is to develop precision approaches into high density areas.

2. There should be different approach criteria for coupled and manual approaches regardless of the sensor/system in use (i.e., MLS, GPS, GLONASS, etc.).

3. ELVIRA approach minimums will be a function of aircraft equipment and the training of the pilots flying these approaches. The precedent for this dependency lies in the requirements for air crew's who fly CAT II and CAT III airplane approaches.

4. The rotorcraft industry recommends that the FAA stop specifying a 90 knot approach speed as a part of the TERPs criteria and that future TERPS reflect the slow speed approach capabilities of rotorcraft.

Table 5.0 WORKING GROUP A PARTICIPANTS

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4.2 Summary of Working Group A Deliberations, Concepts and Recommendations

This working group was asked, as a minimum, to discuss four major current limitations to the use of current IFR airspace and ATC capabilities and to make recommendations which would enhance the capabilities of both the users and the system.

- A.1 TERPS OBSTRUCTION CLEARANCE PLANES
- A.2 ATC CONCEPTS FOR LOW ALTITUDE FLEXIBLE ROUTING
- A.3 ACCURACY AND SYSTEM REQUIREMENTS FOR ELVIRA OPERATIONS
- A.4 REGULATORY ANALYSIS FOR POTENTIAL CHANGES DUE TO ELVIRA OPERATIONS
- A.5 SPECIAL TOPICS AND RECOMMENDED ACTION ITEMS

Detailed deliberations in each of these areas are summarized in the following pages.

A.1 TERPS OBSTRUCTION CLEARANCE PLANES

Description -- The imaginary obstacle clearance planes established by TERPs define the clear airspace associated with a given approach to a heliport. An engine failure (in a multi-engine helicopter) does not relieve the pilot of the responsibility for compliance even though the "clear plane" slope gradient requires a climb out that is twice that which is available in most 10+ passenger helicopters. Operational procedures are required to account for conditions such as One Engine Inoperative (OEI). TERPs criteria are required for steep (9, 12, 15 degree) approaches near term and up to 25 degrees far term.

Discussion -- The attainment of lower helicopter approach minima especially in obstruction rich areas requires the changing of the culture and the regulations from being based upon past experience and airplane precedents to being based on technology and current pilot/aircraft capabilities. For example, there are systems currently capable of hands-off flying of a coupled decelerating approach to a 50 foot hover. Those operators willing to pay the price for these systems in terms of equipment and training should be able to use them to improve operational reliability (i.e., service) and safety.

The operational payoff for these investments in avionics is most dramatic when approaches to heliports vs. approaches to airports are considered. Using the rectilinear GPS guidance and accuracy, a "GPS tube" concept is feasible. This rectangular cross-sectioned airspace eliminates the TERPs "fan area" which currently makes it impossible to approve approaches into obstruction rich areas due to the increased requirements for obstacle free areas. The rectilinear guidance and accuracy of GPS flight paths allow more flexibility and insure more precision in ELVIRA operations. The current TERPs does not consider this concept. Yet, current industry testing of GPS with appropriate displays has provided data to substantiate this capability. It was recommended that the FAA consider this type of data in future ELVIRA TERPs development.

Similarly, mid-field, on-airport landings by helicopters using rectilinear approach guidance are possible for helicopters but cannot be performed by aircraft. This capability would allow many small airports to serve as additional ELVIRA landing sites with the current protected airspace surfaces. Airport capacity would not be affected, yet, helicopter service and reliability would benefit while maintaining safety.

What is needed at this time is for the FAA to approach ELVIRA airspace and operational minima criteria with an open mind and a clean sheet of paper. Future TERPs criteria should consider advanced technology both of the navigation system and in the cockpit. In addition, the low speed, decelerating approach capabilities of current helicopters should be considered for much less than 90 knot approach speeds. The opportunities for reducing obstacle free airspace can be reduced to +/- one-half a mile using these considerations based upon a consensus of the working group. These types of operations would require acknowledgment of the following technical capabilities:

1. TERPs criteria can be developed to reflect rotorcraft equipment and deceleration capabilities for those operators equipped with high technology Flight Management Systems, GPS systems, stability augmentation systems and appropriate display technologies.

2. TERPs criteria that consider slow, constant speed approaches must also be developed for those rotorcraft not having the ultimate avionics suite yet still capable of attaining satisfactory slow speed performance.

3. The development and promotion of Rotorcraft Discrete Airways (RDA).

4. The development of helicopter IFR networks in major helicopter operational areas would enhance safety and improve operational capabilities of both the FAA and the users.

5. Coordination of the technological capabilities, the TERPs limitations and the operational concerns will be accomplished through the efforts of the operators through the Helicopter Association International's Flight Operations Committee. The focus of this group is near term progress and minimization of the necessary FAA changes to regulations or TERPs.

Related Information -- Helicopter operators are much more diverse than commercial airlines and work in a much greater obstacle rich environment. However, they work at much slower speeds and greater maneuverability than airplanes are capable of. Both the current IFR operators and those that would like to have IFR capability, would like to be able to operate to a minimum of 300 - 400 feet without incurring any time penalty in getting down. The operators present asked the FAA to consider:

1. GPS non-precision, non-coupled approaches to 300 feet and 1/2 mile visibility into commercial heliports and hospital heliports. The use of a point-in-space approach that would serve several area landing sites was of considerable interest.

2. Precision coupled approaches into airports, heliports and hospital heliports with 100 foot ceilings and 1/4 mile visibility would be a near term goal (next 5 years).

3. Precision coupled, decelerating approaches into airport heliports to 50 foot DH with 1/4 mile visibility could be used to provide reliability data an no decrement in safety.

4. Expeditious development of rectilinear navigation requirements for approach, departure and missed approach criteria were strongly endorsed.

5. Approach angles from 3 -9 ° are recommended near term.

6. In England, the CAA has allowed the helicopter to track localizer at the DH for up to 10 seconds at airports before commencing a missed approach.

Related Issues -- a. **Multi-directional approach path airspace requirements** : Ideally, the number of available approach/departure paths should only be limited by the necessity to avoid obstacles, other traffic and/or noise sensitive areas. Safety, heliport design and operational flexibility all drive the need for multiple paths and the associated clear airspace.

b. ITO abort procedures - Emergency Landing Facility requirements : There will be only one landing site known to a pilot during ITO under ELVIRA conditions, the one the helicopter just took off from. However, procedures may be designed using "natural routes" without major obstructions. ELVIRA ITO abort procedures may be achievable by electronically extending the visual range and accomplishing the last segment of the autorotation under VFR in IMC.

c. Ground & airborne equipment requirement vs. TERPs criteria and Heliport Design Criteria : The minimum acceptable standards for heliport real and imaginary surfaces will have to be set with a realistic regard for the capabilities and limitations of both onboard and heliport equipment, and location of critical obstacles.

d. IMC Heliport Marking & Lighting : Emphasis on IMC marking and lighting should include the transition from "head-down, eyes-in" to "head-up, eyes-out" references during the approach. Particular importance should be placed on providing good visual references for attitude (pitch) control during low airspeed (nose high) approaches. The consensus for IMC marking and lighting requirements at heliports included:

- Lighting array must support guidance system and breakout and final closure irrespective of final touchdown point.
- Consider that rural and urban heliport sites present different problems (i.e., design specifications) and standardize practical lighting arrays for each requirement.
- Analyze the practicality and impracticality of implementing HILS at existing heliport sites.
- The FAA should reevaluate heliport lighting in view of new technologies and existing applications (i.e., real estate constrained, high ambient light, obstruction rich, etc. all of which may or may not provide the type of visual cues normally provided by a

lighting system). Tradeoffs between onboard precision hover guidance displays and exterior lighting systems need to be determined.

• Define and develop a lighting system based upon the cues needed by the pilot to acquire the landing environment, to provide appropriate attitude reference and to provide closure rate information. The lighting system necessary to meet these safety and obstacle avoidance criteria will differ with heliport location (e.g., black hole vs. concrete canyon vs. on-site medivac operations vs. types of onboard displays and guidance systems).

A.2 ATC CONCEPTS FOR LOW ALTITUDE FLEXIBILITY

Description -- This is an immediate issue being worked today in the Los Angeles area. Local users and FAA Air Traffic personnel are developing low altitude routing alternatives to expedite helicopter flow in congested airspace and in terminal area airspace. This work should be analyzed for its capability to support ELVIRA operations and to identify limitations or need for expansion of the concepts developed. For example, helicopter operators will be capable of obstacle avoidance, collision avoidance, precision and non-precision approaches using advanced on-board systems. However, their operational utility will only be practical if ATC techniques and procedures for flight below or beyond radar coverage are developed. Automatic Dependent Surveillance (ADS) using on-board GPS or some other sensor has been discussed as offering a potential technical solution. This analysis should consider some type of ADS and examine procedures and routing concepts; including alternate surveillance techniques.

Discussion --Near term there are procedures that can be implemented by ATC to increase the economic feasibility of helicopter and advanced rotorcraft operations. GPS can allow operators to fly airways at lower altitudes compared to present systems of ground stations and navaids. Helicopter route structures like the Washington, DC. to NYC routes offer precedents with considerable payoff to the operators. On these routes, the operational requirements of ATC dictate the altitudes that the users fly. This is not a major problem if the basic direct route time and cost savings are available.

Winter flying needs to consider the impact of icing in the northern climates and the need for lower altitude routes. These routes are required for both heliport-to-heliport and airport-to-airport operations. Minimum altitudes for noise abatement are also of primary importance. Current tests by the FAA are addressing the separation requirements and airborne system accuracy requirements to meet these criteria. In addition, the FAA has two operational demonstration projects: one in Los Angeles and one in Fiji, which are developing helicopter specific low altitude airway systems. The use of GPS will facilitate reducing the airway width in these applications. Furthermore, unique helicopter ATC procedures will be developed and tested for their operational effectiveness.

The consensus of Working Group A was that the FAA should continue to work with the operators in development of IFR ATC procedures and publish the results of the two demonstrations as soon as possible. In addition, the development of city-center procedures and terminal area corridors was given a high priority. Finally it was pointed out that the necessary ATC Handbook (7110.65) changes needed to be determined. Particularly, the simultaneous operation of helicopters and airplanes needs to be analyzed and treated in the same manner as simultaneous airplane operations are in today's system. If properly designed and executed, these simultaneous helicopter and fixed wing operations could increase capacity through the use of helicopter specific approach corridors and landing sites at the major hub airports. This concept would allow helicopter operations "underneath" and/or offset from the airplane traffic and free up the current helicopter slots in the queue of fixed wing approaches.

A second major area of concern for helicopter specific routing was the required separation minimums. The operators suggested that the FAA examine the separation standards as they relate to helicopters in five areas: helipad locations on an airport, helicopter separation standards compatible with aircraft standards, ATC helicopter procedure training, validating/changing ATC Handbook criteria for FAF intercept heading changes for helicopters, and simultaneous parallel helicopter and airplane approaches to runways and heliports on the airport.

Related Issues -- **a. ATC Procedures for city-center and terminal area corridors** : Improved ATC procedures for better integration of rotorcraft in terminal areas including city-center heliports, and the design of the Vertical Flight portion of terminal areas need to be evaluated to accommodate the lower airspeeds, steeper descents, and improved instrument capabilities of advanced rotorcraft.

b. Analysis of necessary ATC Handbook (7110.65) Changes : The increasing complexity of operations brought about by ELVIRA operations will necessitate a mutual understanding of the unique operational characteristics of rotorcraft by both pilots and controllers. The ATC handbook represents one of the best ways to provide that information to the controllers. The resulting changes must be carefully considered, and coordinated with changes to the Airman's Information Manual, TERPs, Ops Specs, etc.

A.3 ACCURACY AND SYSTEM REQUIREMENTS FOR ELVIRA OPERATIONS

Description -- The advanced system functions of information sensing and display control inputs to enable the pilot to navigate through the terminal area or to the remote site, to identify the landing site, and to perform an approach to a hover safely will require greater accuracy than what is available in the present systems. A reasonable and realistic set of criteria for such accuracy needs to be developed.

Discussion -- The initial discussions in this area focused on current avionics capabilities in two areas: Flight Management Systems and moving map displays. The operators expressed a desire to utilize the current "situational awareness" technologies to set the baseline future requirements. These technologies combined with synthetic vision and

GPS were recognized as integral pieces of the system requirements for future ELVIRA operations. The FAA was encouraged to explore the development of cost-effective synthetic visual technologies in the near to mid-term. The operators volunteered to collaborate on the clear articulation of rotorcraft operational requirements for this technology, and actively participate in any joint efforts of the commercial or military aviation communities to aggressively research, develop and implement this technology.

GPS was the recommended system for the satisfaction of accuracy and reliability requirements associated with ELVIRA operations. The application of this technology to the specific needs of helicopters and advanced rotorcraft in "obstruction rich" city center environments was identified as a specific need. Several systems currently exist that will track and report helicopter x,y,z position below 2000 feet AGL. The accuracy and cost effectiveness of these systems need to be evaluated in an operational setting prior to endorsement by the FAA or implementation by the operators.

There were three specific recommendations that resulted from the Working Group deliberations in this area. They were:

1. The evaluation of the NAPES system or similar low-cost technology to determine if it is applicable to civil helicopter and rotorcraft operations.

2. Examination of Automatic Dependent Surveillance (ADS) technology systems for certification and use by helicopters.

3. Development of IFR procedures, including Standard Instrument Departures (SIDS) and Standard Terminal Arrival Routes (STARS) for helicopters including the use of GPS.

Related Issues -- a. **Requirements for autonomous precision approach guidance system:** In order to maximize the operational potential of Vertical Flight, particularly with respect to search and rescue (SAR) and air ambulance missions, the capability to make instrument approaches, with vertical as well as lateral guidance, to unprepared remote landing sites will be necessary.

b. Requirement for accurate & reliable advanced navigation & guidance system : Precision navigation and guidance have been assumed for terminal area operations, approach and missed approach. Angular course width is unacceptable at close ranges from the antenna (1000 feet). This characteristic necessitates low speed flight inspections. Accurate, linear precision navigation and guidance systems are required to insure reliable and safe ELVIRA approaches.

c. CNS requirements & cost/benefits analysis for coverage below 2000 feet AGL: Difficulties in navigation and control of helicopters in IMC stem chiefly from the line-of-sight limitations of reference signals generated by ground based facilities. ELVIRA operations will require adequate Communication, Navigation and Surveillance (CNS) coverage from 2000 feet to the surface for approach coverage.

A.4 REGULATORY ANALYSIS FOR POTENTIAL CHANGES TO ACCOMMODATE ELVIRA OPERATIONS

Description -- Existing flight rules may be too restrictive or inadequate for future rotorcraft operations, (e.g., minimum flight visibility for visual operations, right-of-way rules, IFR operations, etc.) and certain unique traffic situations, (e.g., proximity of airports/heliports, concentration of operation, etc.) are not provided for in the general flight rules.

Discussion -- Operational procedures specified in the ATC handbook do not take advantage of vertical flight aircraft's unique operational qualities. For example, low speeds, deceleration/acceleration, close in curved approaches to landing sites away from primary runway areas, etc. To incorporate and adapt these capabilities to the operational environment, changes to FAR Parts 71, 91, 93 and 135 may be required. The consensus of the group was that the recommendations of the 1987 National Airspace Review be adopted. In addition, the issues involved with requirements and procedures of airspace control at heliports should be analyzed.

ELVIRA operations may require new concepts for the designation of airways, route widths, controlled airspace and public vs. special use procedures. Different obstruction avoidance requirements, reporting points and charting specifications should be considered. Also, separate categories of vertical flight approaches relative to vehicle capability, equipment on board and crew training, should be developed.

Related Issues -- **a. FAR Part 91 & 93 applicability to future vertical flight operations:** Developing IFR procedures cannot be done without considering the impact on VFR operations. Advances in helicopter IFR will require new operating rules concerning control zones at heliports. Weather reporting and positive control of the heliport airspace may require staffing at the heliport.

b. FAR Part 71 analysis for ELVIRA impact: ELVIRA operations may require new concepts for the designation of airways, route widths, controlled airspace and public vs. special use procedures. Different obstruction avoidance requirements, reporting points and charting specifications should be considered. Also, separate categories of vertical flight approaches relative to vehicle capability, equipment on board and crew training, should be developed.

A.5 SPECIAL TOPICS AND RECOMMENDED ACTION ITEMS

Several participants in this Working Group expressed specific recommendations and suggestions that would facilitate the implementation of ELVIRA. Their comments are summarized in this section.

• From NASA Ames Research Center -- It was suggested that a significant number of approaches (maybe 300+ by 20 or more pilots) be conducted to demonstrate current capabilities. These procedures should include a fail-to-minimum equipment list (MEL) consistent with modern helicopters (S-76, Bell 412, Aerospatialle 365, etc.). These approaches could be made in a decelerating mode from 120 to 60 knots with ceiling minimums of 200 feet on steep (6° to 9°) approach angles.

1. Near term NASA felt that ILS systems could support tests to low visibility operations at 60 knot airspeeds to Critical Decision Point of existing helicopters. These minima could be established and published today.

2. The ELVIRA procedures should recognize that the helicopter is unique in its ability to get down to approximately 1/2 the airspeed of airplanes CDP's and at that airspeed the helicopter is at or near the BEST climb performance (and One Engine Inoperative, OEI airspeed) of the helicopter as opposed to airplanes being near the stall speed.

3. The objective here should be to achieve "adequate" performance at the expense of increased pilot workload in poor weather conditions. This is not the best engineering solution, but it demonstrates the safety fall-back position which current helicopters and pilots can attain.

4. The maximum airspeed at decision height should be keyed to the CDP for each specific approach angle. When operators suggest 100 feet and 1/4 mile minimums, they tend to imply ILS guidance which specifies a 3° approach angle. If MLS or GPS is used, steeper approach angles and slower speeds are realistic. A pilot needs about 20 seconds to adapt from instrument flight to contact flight (breakout and acquisition of the landing environment) and to comfortably decelerate. These considerations imply that the 100 feet and 1/4 mile minimums can be performed today using ILS. MLS and GPS will permit up to 9° approaches and slower speeds at lower CDP's. For example, the following approach options are achievable "today" for ELVIRA helicopter operations:

- 3° glideslope @ 56 knots and 100 foot ceiling
- 6° glideslope @ 28 knots and 100 foot ceiling
- 9° glideslope @ 18.7 knots and 100 foot ceiling

All of these combinations allow the 20 second instrument-to-contact flight adjustment by the pilot.

• From the FAA's Airport Safety and Standards Office -- The approach to designing heliport airspace is to describe the maximum airspace impacted and note the complexities of each application. This process would identify the areas which a procedures specialist needs to examine prior to establishment of a certified approach or departure procedure. The FAA is not concerned with the geometry or dimensions or slopes of specific non-precision or precision approaches/departures. Furthermore, the Airports Office does not rule on the obstruction free surfaces as long as FAR Part 77 requirements are satisfied.

1. The published heliport lighting standards (HILS and HALS) are currently recommended standards. However, these need to be re-examined (especially HALS)

since they require excessive real estate. A goal of future research should be to develop more appropriate and affordable systems. The development of these systems could be examined with existing simulators.

2. Helipad-to-helipad and helipad-to-runway approach criteria for simultaneous VFR/IFR operations need to be developed.

• From an Air Ambulance Helicopter Operator -- Suggested alternate filing minima for operations to single runway and dual runway airports were presented.

1. If the airport is served by an approach to a single runway either precision or non-precision: add 400 feet to the Decision Height ceiling or Minimum Decision Altitude, and add 1 statute mile to the published visibility.

2. If the airport is served by two approaches to two runways either precision or non-precision: add 200 feet to the higher approaches and add 1/2 statute miles to the published visibility.

• From a researcher -- A specific mechanism should be established to formulate and articulate the rotorcraft need for weather information. This information is needed to ensure safety interests and satisfy rule making regarding weather information required for operations and for aggressively ensuring that their needs are incorporated in FAA and NWS weather and R&D technology implementation programs.

• From another researcher -- The current TERPS criteria should be changed to reflect the rectilinear capabilities of Loran-C, GPS, GLONASS, etc. for cleared airspace approaches and routes.

4.3 WORKING GROUP B: CERTIFICATION & OPERATIONS

Co-Chairmen:	Jim Carlson, FAA/ASW-260 and Jake Hart, EUROCOPTER
Technical Monitor:	Roger Hoh, Hoh Aeronautics, Inc.
Facilitator:	Scott Fontaine, D. P. Associates

• Purpose of the Group: To reach agreement of participants on a methodology or process for responding to industry's needs with near term solutions. The focus of Group B was Certification and Operations issues currently inhibiting the use of the IFR system. Their charter was to apply their joint knowledge of flight standards requirements, certification requirements and operational needs to recommend near term resolutions or action items that could be done today to improve helicopter access to the current IFR system.

• A list of the participants is provided in Table 6.0.

Table 6.0 WORKING GROUP B PARTICIPANTS

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• Scope: The group briefly reviewed the earlier work of the "Zero/Zero" Rotorcraft Certification Issues Forum of August 1987 and then concentrated on identifying current regulatory impediments to IFR system access by helicopters. The group agreed that the ZERO/ZERO issues were still valid but noted that it made no sense to pursue a true zero/zero capability to a heliport until the current IFR system can be fully utilized by helicopters flying to airports.

• Consensus: In response to the purpose and scope, the majority of the group's time and effort was spent on developing recommendations for immediate regulatory changes that reflect the current and unique capabilities of today's helicopters. The following statements summarize the consensus of Working Group B:

"Technology today fully supports current *operational requirements.*"

"If a pilot cannot get out of the flight planning room, a zero/zero approach isn't any use".

Based on these two statements, Working Group B defined a list of near term requirements that was later merged with Group A's near term requirements. The result was previously listed in Table 1.0, the Ten Most Wanted List.

4.4 Summary of Working Group B Deliberations, Concepts and Recommendations

As with Working Group A, this group was also asked to address four major current limitations to the use of current IFR capabilities and to make recommendations which would enhance the capabilities of both the user's and the National Airspace System.

B.1 REQUIREMENTS FOR ACCURATE & RELIABLE ADVANCED NAVIGATION SYSTEM
(including accurate groundspeed or closure rate sensing and display)
B.2 HELICOPTER PRODUCTIVITY LIMITS UNDER CURRENT REGULATIONS
B.3 LOW AIRSPEED HANDLING QUALITIES
B.4 PILOT TRAINING AND PROFICIENCY REGULATORY REQUIREMENTS
(including the use of simulation *for training and certification of air crews)*
B.5 SPECIAL TOPICS AND RECOMMENDED ACTION ITEMS

Detailed deliberations in each of these areas are summarized in the following pages.

B.1 REQUIREMENTS FOR ACCURATE & RELIABLE ADVANCED NAVIGATION, GUIDANCE, CONTROL AND LANDING SYSTEMS (including accurate groundspeed or closure rate sensing and display)

Description -- Precision navigation and guidance have been assumed for terminal area operations, approach and missed approach. Angular course width is unacceptable at close ranges from the antenna (1000 feet). This characteristic necessitates low speed flight inspections. Accurate, linear precision navigation and guidance systems are required to insure reliable and safe low visibility approaches.

Discussion -- Recent advances in Global Positioning Systems, including increased availability, and increased equipment afford ability, have rendered the issue of angular course width moot. Conventional ILS and MLS systems cannot compete for new installations on the basis of both initial and operating costs for ground and airborne equipment when compared to GPS and differential GPS. The working group proceeded on the basis that GPS will be the navigation aid of choice for both enroute and terminal non precision approaches and that Differential GPS will be the precision approach navigation aid for approaches to both heliports and airports not presently equipped with precision approach guidance. Since ground equipment is part of DGPS, some level of inspection will be required, but the group did not discuss the issue to that level of detail.

ELVIRA approach accuracy goals for the near, mid, and far term were discussed at length and the following set suggested as an output of the group.

Table 7.0 RECOMMENDED ELVIRA APPROACH REQUIREMENTS AND CAPABILITIES

	NEAR TERM (< 5 yrs.)	MID-TERM (5-10 yrs.)	FAR TERM (10-20 yrs.)
APPROACH MINIMA			
Onsite	Low CAT II	very low	zero - zero
Offsite	Non-Precision	low	very low anywhere
APPROACH LOCATION			
Onsite	Heliports, airports	Heliports, airports	Heliports, airports
Offsite	selected	selected	anywhere
DISPLAYS	current ok.	current hybrid	advanced HMD's
FLIGHT CONTROLS	current	enhanced SAS and AFCs	enhanced or coupled
CAPABILITY	IFR	ELVIRA	zero - zero
HUMS	No	yes	yes
STEEP APPROACH	9 degrees	15 degrees	> 15 ° < 25 °

Related Issues -- a. **Advanced systems and displays for terminal guidance and obstruction avoidance** . Again, terminal guidance was assumed to be some combination of ILS, MLS, and DGPS, with DGPS being the likely candidate for heliports and airports not currently possessing a precision approach capability. Current display technology has been proven to be effective for approaches at slower airspeeds, down to

V_{mini}. Below V_{mini}, a flight director or some other advanced display or an autopilot capability will be required. Since approach airspeeds from V_{mini} to 90 knots will, in most cases, enable approaches down to 100 feet DH, advanced displays for terminal guidance remains a Mid Term issue. Some form of obstruction avoidance system will be required to be able to ensure the landing spot is clear for a true zero/zero capability. Obstruction avoidance systems and displays, along with zero/zero capability, remain Far Term issues.

b. Requirements for all weather terrain and obstacle avoidance : There is a Mid Term requirement for a means of detecting any obstacles or traffic on the intended point of landing for very low DH. approaches. The Far Term requirement is linked to operations at unprepared sites and may require onboard systems totally independent of ground equipment.

c. Use of precision navigation equipment and display capabilities to provide HUD or HMD : Although this is a Far Term requirement, the working group agreed that work should be started now to establish design standards for HUD and HMD's. Precision navigation coupled with a digital database may help provide terrain and obstacle avoidance.

d. Accurate ground speed (or closure rate) sensing and display -- Helicopter pilots typically compensate for loss of airspeed accuracy below 50 knots by using visual cues gained by reference to the ground. The development and certification of an accurate, reliable system to sense and display closure rate or groundspeed relative to the intended landing point will be critical to ELVIRA operations.

In the near term, there is very little requirement for decelerating below 50 knots while in IMC. Current DH's and runway environments allow ample room to decelerate after visually acquiring the runway environment. Lower DH's, steeper approaches, and smaller landing environments (heliports) will require deceleration under IMC in the mid term. Ground speed, which can be easily computed from precision approach guidance, will be required for decelerating approaches and approaches to a heliport with very low DH's (below 100 feet).

Since groundspeed and airspeed information is closely linked to low airspeed handling qualities by virtue of its effect on workoad, the working group felt that paragraphs B.1.d and B.1.e should be grouped and tracked under the low airspeed handling qualities issues of paragraph B.3. Certain information, properly displayed can eliminate the need for some advanced autopilot functions.

e. Requirements for minimum IFR lateral and longitudinal airspeed components. Less steep approaches may be safely flown by hand or by an autopilot with only groundspeed information. Steeper approaches, with descents close to vortex ring state may require actual low airspeed systems to provide the information necessary to provide an adequate safety margin. New low airspeed systems may not have the installation impact of requiring a standpipe through the rotor mast, and may become easier and less costly to retrofit. Test data is available to show that approaches up to 9 degrees can be safely flown with current technology helicopters, but steeper approaches will require study into tradeoffs between handling qualities, displays, and workload. As mentioned in B.1.d, this issue should also be grouped and tracked under paragraph B.3: Low Airspeed Handling Qualities.

f. **Requirement for highly responsive autopilot with stable heading hold.** There are currently certified auto pilots that will fly the helicopter to a 50 foot hover over a specified point. Current technology supports current operational requirements.

g. **Criteria for airborne imaging technologies.** This is a Mid Term requirement.

h. **Certification credit for advanced systems and displays.** It was noted that, to some extent, credit is being given through the existing certification procedures. If the required performance can be repeatedly demonstrated with an acceptable level of workload, a system can be certified. The system can be composed of a combination of flight control capabilities and advanced displays. Current helicopters have been certified to fly specified approaches at speeds less than V_{mini}. Close cooperation between industry and the FAA is recommended.

B.2 HELICOPTER PRODUCTIVITY LIMITS UNDER CURRENT REGULATIONS

Description -- Federal Aviation Regulations and FAA certification criteria, in an effort to assure adequate margins of safety, impose a severe penalty in the productivity of helicopters operating under IFR. Under existing F.A.R.'s, with certain weather conditions it is often impossible for the helicopter operator to gain access to the current IFR system, while VFR flight is allowed.

Discussion --

a. Since rotorcraft are for the most part range limited to 200 miles or less, their destination and alternate will most likely be in the same air mass and consequently will have similar weather. Current regulations often preclude legally filing an IFR flight plan while at the same time allowing a VFR flight plan. Current regulations (FAR 135.223) require an alternate if the destination forecast (within one hour prior to planned arrival time to one hour after) ceilings are less than 1500 feet above the lowest circling approach MDA; or if a circling approach is not authorized at the destination airfield, if destination forecast ceilings are less than 1500 feet above the lowest published minimum or 2000 feet above the airport elevation, whichever is higher. An alternate is required if visibility for the destination airport is forecast less than 3 miles, or two miles more than the lowest applicable visibility minimums for the instrument approach procedure to be used, whichever is the greater. EMS operators can safely fly to their pickup point in IFR under FAR 91 but may not be able to leave IFR with a patient on board, because FAR 135 then applies. Changing the destination minimum weather that requires an alternate, for both Part 91 and Part 135 operators, to 400 feet and 1 mile visibility, (400+1), above the lowest published minimum will simplify the flight planning process, vastly improve helicopter access to the IFR system, and enhance safety by encouraging its use. These rotorcraft operations will, by definition, be short range and short duration. The 400+1 above approach minimums provide an appropriate safety margin to allow for unforecast weather changes in the short time periods involved.

FAR 91.169 requires using the published Alternate minimums for each alternate airport when determining whether that airport is legally suitable as an alternate, or if none are so specified, 600-2 for precision approach procedures and 800-2 for non-precision approach procedures. Changing this to 400-1 for a precision approach and 600-1 for a non-precision approach, will enable many more IFR operations to take place while maintaining the same level of safety. This will also enhance safety by improving access to the IFR system. It was also noted that rotorcraft are more capable (more maneuverable, both horizontally and vertically) than fixed wing aircraft flying at 1.3 V_{SO} during an approach. Taking this into account, it is not unreasonable to allow lower alternate minimums for rotorcraft.

There is an immediate need for: Simple, straightforward rotorcraft specific rules for determining the requirement for alternates and for determining the alternate weather minima required for filing an IFR flight plan.

b. Current FAR's require a destination "weather reporting facility operated by the US. National Weather Service, or a source approved by the Administrator" in order to begin an instrument approach procedure as a Part 135 operator (FAR 135.225(a)(1)). This often precludes use of the IFR system for helicopter operators flying to uncontrolled airports and heliports. Although there are currently very few instrument approaches to heliports, there are many cases where a flight into an uncontrolled airport will meet a customer's needs and in some cases save a life. GPS is the enabling technology that, in the next few years, will add literally thousands of uncontrolled airports and heliports to this category of a destination field without a weather reporting capability. A well thought out and implemented nationwide system of automated weather reporting and forecasting stations, coupled with the approved use of Area weather forecasts for destination weather filing requirements, will be able to safely and cost effectively support and allow access to all existing and future uncontrolled airports and heliports with instrument approaches. An additional related recommendation of the ELVIRA workshop is the formation of a planning committee with enough power to oversee the installation of automated weather stations throughout the country based on a system of effective area coverage and prioritized by need.

There is an immediate need to: Allow the use of approved Area weather forecasts for destination weather filing purposes and prevailing weather vice "a chance of" forecasts.

c. FAR 91.175(f)(3) requires one-half mile visibility for helicopters for takeoff. If a pilot flies into an uncontrolled field that does not have an FAA approved weather reporting capability, he or she cannot takeoff and climb out on an IFR flight plan because he has no method of legally determining if the weather is above the one-half mile visibility minimum. (The pilot can, if weather permits, maintain VFR until ATC can establish radar contact.) Determination of visibility is straightforward, and with proper training (to include operations from uncontrolled fields) experienced pilots can safely make the determination and gain access to the IFR system. This will become more critical when the use of area weather for destination weather filing requirements is allowed and many more fields become available to the IFR system. There is precedent for such action in the procedures for certifying Part 135 dispatchers.

There is an immediate need to: Allow properly trained and experienced pilots to determine the existing visibility for the purpose of establishing takeoff minimums.

d. FAR 97.3(d-1): "Copter procedures ... The required visibility minimum may be reduced to one-half the published minimum for Category A aircraft, but in no case may it be reduced to less than one-quarter mile or 1,200 feet RVR." This should be changed to read "Copter procedures ... The required visibility minimum may be reduced to one-half the published minimum for Category A aircraft." The same reasoning, based on greater capabilities at lower airspeeds, that was used to make this rule also applies at RVR's less than 1200 feet. A Canadian helicopter operator is currently operating to 600 RVR.

Rewrite FAR 97.3(d-1).

e. FAR 97.3(d-1)allows special applications to decrease the DH. on CAT I approaches to 100 feet DH for rotorcraft. This can and should be done immediately for all existing CAT II approaches, since no additional flight checks are required. Operators present at the workshop agreed to apply for case by case authorization for their own high use CAT I approaches. Again, these changes recognize the greater capabilities of a helicopter at low airspeeds.

There is a need to: Allow ILS CAT 1 rotorcraft approaches to a 100 foot Decision Height.

<u>Related Issues</u> --

a. Acquisition and maintenance costs for on-board electronic systems. Cost flexibility is one of the most important considerations for advanced systems. The increased operating time which the system permits must produce additional revenue necessary to make a profit or the system is not cost effective. Seven to ten percent of total aircraft acquisition cost seems to be about the average acceptable level of expenditure operators are willing to pay provided a significant improvement in operating minima and improved operational reliability can be demonstrated.

There is a need to differentiate between "nice to have" and "need to have" systems. New procedures and regulations should address minimum equipment requirements, realizing that a new capability is not useful if it is not affordable.

b. Performance penalties associated with current regulations . Current helicopters incur a severe productivity penalty during IFR operations due to OEI power limitations. Two limits are the crux of the problem. First, the ability to get onto or off-of a small heliport requires single engine hover in ground effect capability. Second, engine failure during missed approach and departure requires compliance with TERPs clear zone planes. These planes mandate a climb gradient of approximately twice the capability of current 10+ passenger twin engine helicopters. These two criteria impose a requirement for up to a 50% increase in excess power for some helicopters. This means that either greatly improved (very powerful) engines will be needed (which have proportionally higher cost) or severe productivity/payload penalties will be incurred.

These penalties, although they currently exist, were not discussed since they do not arise until the helicopter has gained access to the IFR system. This is expected to become a larger issue as IFR use increases with the advent of the previously recommended regulatory changes.

The pending international rules, JAR OPS 3, will have a major negative effect starting 31 Dec 96. The international rules will ban single engine helicopters from flying at night or in IMC. **Every effort should be made to avoid excluding a major portion of the existing helicopter fleet from future operations.**

c. Operating cost reduction with improved reliability/mission effectiveness .
This was not discussed.

d. Acquisition and operating costs associated with more powerful engines
This was not discussed.

e. Requirements for Health and Usage Monitoring Systems -- It was noted that current usage monitoring systems will require some time before there is enough data available to reliably replace current maintenance procedures based on scheduled inspection and removal times. Accordingly, the group agreed that there was no Near Term requirements for HUMS, but that HUMS could prove valuable in the Mid Term and should continue to be developed. **There is a need to continue development of HUMS and related on-condition maintenance regulations and procedures.**

f. Subsystem failure-mode redundancy requirements
This was not discussed.

g. Low visibility certification requirements for manual backup auto IMC guidance
This was not discussed.

h. Identification and specification of minimum flight critical systems

This was not discussed.

i. Use of HUMs statistical data to provide virtual "spare engines" by predicting failure free approaches and missed approaches -- The question was raised as to what happens when an impending engine failure (on a single engine helicopter) is predicted while the aircraft is IFR. Obviously, the prediction times will have to be related to the length of the average flight. As noted in paragraph B.2.e above, the working group did not consider HUMS useful to ELVIRA in the near term and therefore did not spend much time in discussion.

B.3 LOW AIRSPEED HANDLING QUALITIES

Description -- At low speeds, turn coordination may be neither necessary nor even desirable, so this control input could be "phased out" with computers at airspeeds below 40 knots. Cyclic control displacements should be isolated to control lateral or longitudinal movement only in a precision hover and rudder pedals should only be used to control yaw about the vertical axis. The rate of displacement (airspeed) would also be a function of cyclic input (particularly longitudinal input) through translational lift.

Discussion -- The Low Airspeed Handling Qualities discussion centered around certification requirements for future rotorcraft and rotorcraft systems. It was noted that some of the requirements of FAR Parts 27 and 29 can actually cause degradation in low airspeed handling qualities. An example of this is the Part 27 Appendix B lateral-directional stability requirement for non negative effective dihedral. (Note: refer to Roger Hoh's discussion in Volume 3.)

Advances in helicopter performance, handling qualities, controls systems, displays, and vision systems may require increasing numbers of waivers and special conditions under the current Part 27 and 29 requirements. This is not unique to rotorcraft. The certification of the first fly-by-wire transport (A-320) required many special conditions including one that deleted the requirement for stick fixed and stick free longitudinal static stability. These special conditions are based on demonstrated performance of mission tasks and dependence on the granting of special conditions imposes risk to the manufacturer. Much of the work required to update Parts 27 and 29 has already been accomplished by the military and NASA as part of their effort to update the handling qualities specification for military helicopters some analysis of that work in regard to applicability to civil rotorcraft has also been done. The working group recommended the following approach to updating Parts 27 and 29:

1. Handling Qualities requirements must be evolved to reflect new technologies and to allow growth into the ELVIRA and Zero/Zero arenas.
2. New rules should allow growth of existing rotorcraft into the ELVIRA and Zero/Zero arenas.
3. New rules should recognize the relationship between pilot displays and Handling Qualities certification requirements.

It was recognized that, although the current rules for certification of rotorcraft (i.e. Parts 27 and 29) are satisfactory for today's aircraft, more and more waivers and special conditions will be required in the future and that an update will reduce the risk for manufacturers pursuing new technologies.

There was also some discussion on requirements for flight at airspeeds below Vmini and on the back side of the power curve while in IMC. There is already data available which indicates that operations at such low airspeeds may require a flight director and/or an attitude hold capability. Again, if the relationship between display capability and handling qualities is taken into account, operators will be able to update older equipment and manufacturers will be able to meet the needs of the operators while staying competitive.

Related Issues -- *(These were not discussed as individual issues due to lack of time)*

a. ITO Abort Procedures and Required Control Inputs through translational lift

b. Visual cues for attitude reference during low speed, low visibility flight

c. Maximum required cockpit field-of-view for visual acquisition of landing environment

d. Minimum OEI performance requirements

e. Single-engine vs. Multi-engine hover and autorotation performance

f. Effect of engine reliability improvements on OEI requirements

g. Low speed stability and control in IMC

h. Certification Procedures/guidelines for hover through translational lift

i. Pitch control in IMC hover

j. Yaw control at low airspeeds in crossword/IMC conditions

k. Heading control during low airspeed maneuvers

l. Power settling during hover in IMC

m. Minimum requirements for abstract vs. processed data (flight director) display system

B.4 PILOT TRAINING AND PROFICIENCY REGULATORY REQUIREMENTS
(including the use of simulation for training and certification of air crews)

Description -- As advanced systems are developed to allow ELVIRA approaches in helicopters, pilots will need to learn how to use them safely. Until the eventual goal of "IFR like VFR" is realized, where the pilot simply applies already mastered VFR techniques and skills, the transition period will severely test the instrument rated helicopter pilot's abilities. Standards development will largely depend on system reliability and the degree of "pilot-in-the-loop", i.e.: from fully automated approach to a hands off touchdown (pilot as a systems monitor) to manual control using processed (or even raw) data.

Discussion -- The discussion was lengthy, comprehensive and difficult to capture verbatim in real time. The following summary is provided as a discussion of the topics covered.
Part 135 Flight Training should include:

1. IFR Using Area Weather .... Alternate determination
   WX detection
   Operating radar altimeters
   Training and Checking
2. Operations at uncontrolled airports including a demonstration of missed approaches
3. Airborne weather detection and interpretation
4. Specific training on local meteorological patterns/phenomena
5. IFR takeoffs at heliports and airports with weather estimated by the pilot
   a. Train pilots to correctly estimate visibility on the ground (runway or heliport surface)
   b. Train pilots on uncontrolled airport departure procedures

Related Issues -- *(These were not discussed as individual issues due to lack of time)*

a. Pilot certification - Exam and Check ride requirements

b. IMC Hover capability, Pilot Training & Certification requirements

c. IMC autorotation - Training & Proficiency requirements

d. Categories of approach for various equipment and training combinations

e. Use of simulation for training and certification of air crew's -- The use of simulators for training and certification of airmen will require updating the flight characteristics and fidelity of simulators. Slow speed simulation will require more stability and performance data than normally provided in helicopter Airworthiness certification.

B.5 SPECIAL TOPICS AND RECOMMENDED ACTION ITEMS

Several participants in this Working Group expressed specific recommendations and suggestions that would facilitate the implementation of ELVIRA. Their recommendations are summarized in this section along with supporting discussions.

There is a need to make a distinction between "nice to have" and "need to have". There is a tendency to require nice-to-have hardware that is very expensive. It is important to identify minimum required capabilities for safe operations.

Pilots are flying VFR when they should be flying IFR because of regulations. Regulations actually encourage scud running. There has never been an EMS accident when IFR.

Key issues:

1. Current requirement for destination weather reporting to allow filing IFR for Part 135 operators.

2. Alternate minima are too high.

There was considerable discussion concerning operating over small geographical area where weather is fairly constant. Therefore it is unreasonable to insist on much higher ceilings and visibility at an alternate than for the destination.

PHI has applied for and will receive approval for approaches to airports that do not have weather reporting capability. PHI has agreed to always have alternate minimums, use two pilot crew with special training, have radar altimeter, weather radar, and to raise the MDA 5 ft/nm from location where altimeter setting is.

Some participants opined that single pilot IFR is not safe and they do not trust autopilots. There was disagreement from other operators. No consensus could be reached but the debate was lively and indicated that the issue should be addressed in future R & D.

Most discussion cited EMS operations as an example. It was noted that our [the workshop's] purpose is not just EMS, but all low speed approaches for helicopter IFR.

Nick Lappos (Sikorsky) noted that rotorcraft are basically more capable during approach than fixed wing aircraft operating at 1.3 Vso. Therefore, it is not unreasonable to allow lower minimums for rotorcraft. Jim Carlson (FAA) noted that the Huey is harder to fly than Cessna 310. Operators responded by noting that current rotorcraft certified for IFR fly much better than a Huey.

Current way of circumventing regulatory changes is through computerized operations specifications. Some felt this was good, others felt it was not fair.

It was also noted that simulation would be required to support the training for approaches in such low visibility. Flights with pilots wearing vision restricting devices such as "Foggles"™ would not be appropriate at RVR's below 600 feet RVR.

Ongoing helicopter TERPs development was shown to yield a Decision Height (DH) of 262 feet for a 6 degree glide slope flown at 90 Knots. The higher DH is required to allow sufficient distance from the landing spot to decelerate after breaking out. Current helicopters are certified with V_{mini} as low as 40 knots. Clearly, flying approaches at 90 knots will be unnecessarily restrictive and will yield higher DH's. New helicopter TERPs, currently being developed must take into account the slow speed capabilities of helicopters. A system of approach categories, based on approach speed, is strongly recommended. This should be formulated in time to be of value in TERPs development.

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