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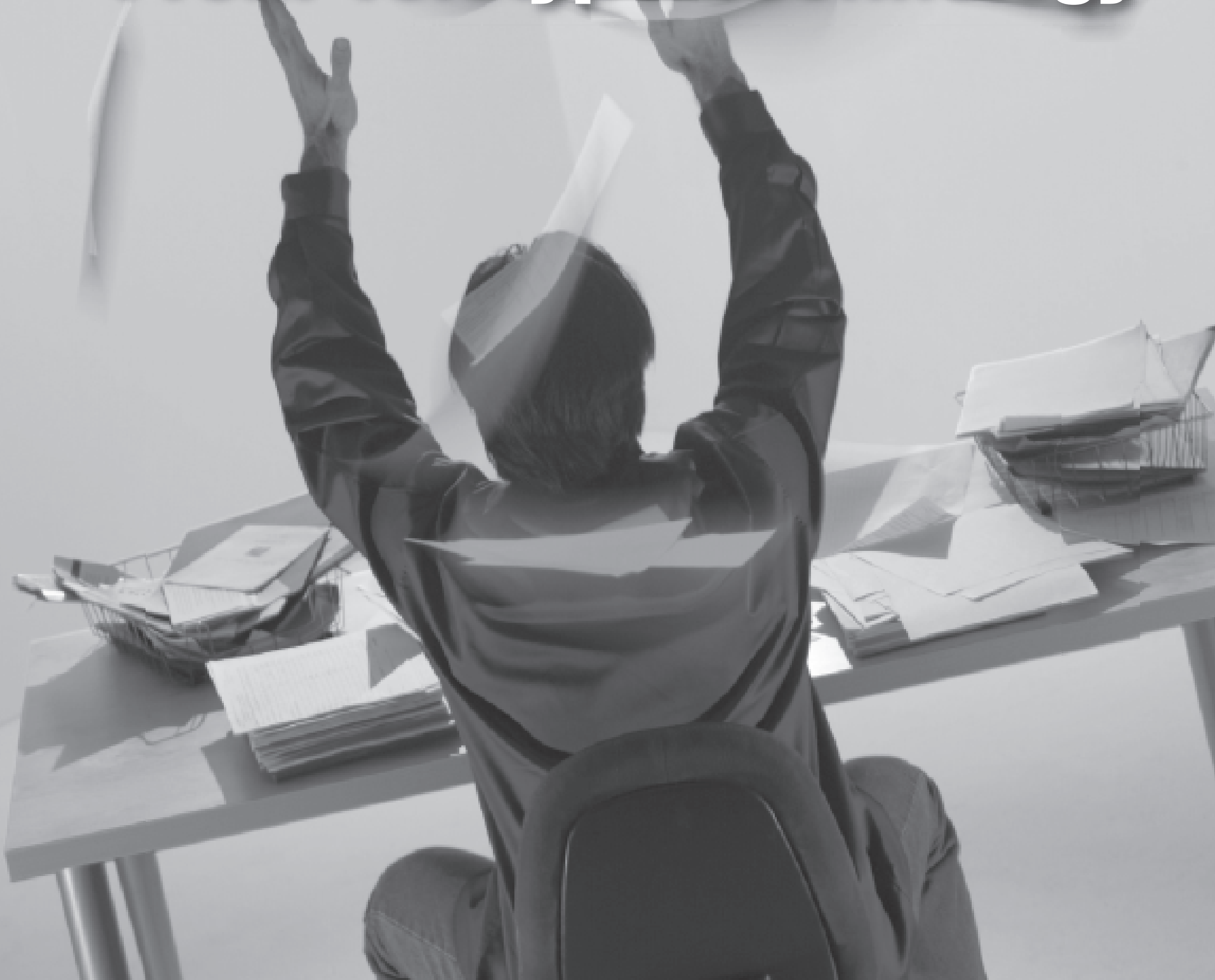
Freeing NOTAMs From Teletype Technology



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Freeing NOTAMs From Teletype Technology

Notices to airmen (NOTAMs) are essential to flight safety. A survey of pilots and dispatchers, and an analysis of the human factors aspects of the system for formatting and distributing NOTAMs show that the system has not kept up with technological advances and is in need of redesign.

— RAEGAN M. HOEFT, FLORIAN JENTSCH, PH.D., AND JANEEN A. KOCHAN

Standards and recommended practices for generating and disseminating notices to airmen (NOTAMs) are prescribed by the International Civil Aviation Organization (ICAO) in *Annex 15 to the Convention on International Civil Aviation*.[1]

ICAO defines "NOTAM" as follows:

> *A notice distributed by means of telecommunication containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.*

Although Annex 15 states that "each NOTAM shall be as brief as possible and so compiled that its meaning is clear without reference to another document," many civil aviation authorities, including the U.S. Federal Aviation Administration (FAA), make widespread use of "contractions" (abbreviations) in assembling NOTAMs, requiring users to consult a list of the contractions and their definitions to clarify their meaning.

Under a research grant from FAA's Air Transportation Human Factors Research Program, the University of Central Florida conducted a human factors evaluation of the U.S. Domestic and International Notices to Airmen System (NOTAMs system). The evaluation considered

NOTAM format and dissemination, and included the development of possible intervention strategies to improve the efficiency of pilot performance in using NOTAMs. Although the evaluation focused on the FAA's NOTAMs system, the findings and results have relevance to systems used by other civil aviation authorities.

To conduct an analysis of the NOTAMs system, it was important to gain an understanding of the current system and how it came to be. Thus, the first two sections of this report focus on the history and current status of the NOTAMs system. The current system is actually a combination of the information from early notices to mariners and the format of weather data that were disseminated to pilots through Teletype machines in the early to mid-20th century. Current notices to mariners are different from current NOTAMs in that they are generated in plain English, while NOTAMs continue to be formatted in contractions and codes. Furthermore, the early format for NOTAMs was based on the capabilities of Teletype technology, which made it necessary to keep the messages as brief as possible. Nevertheless, with today's advanced technology, there is no necessity for keeping NOTAMs in contractions and codes.

This report discusses the complexities of the current NOTAMs system, including the many different kinds of NOTAMs, the multiple sources of NOTAMs and the many stages that a NOTAM must pass through before reaching the end user: pilots. Because of the large amount of information in NOTAMs and the many sources of information, the system is prone to error. The lack of standardization among multiple agencies and NOTAM sources complicates the process of generating and obtaining NOTAMs.

The third section of this report describes problems with the current NOTAMs system and discusses two aircraft accidents in which NOTAMs were cited as contributing factors. Brief descriptions of several other accidents and incidents related to NOTAMs complete the section.

The fourth section of this report discusses a survey distributed to pilots and dispatchers as a means of assessing their usage patterns and opinions regarding the NOTAMs system. The survey was completed by approximately 80 pilots and dispatchers, who rated the system on aspects such as ease of use, efficiency and how likely they were to make errors. The survey solicited information about how pilots seek NOTAM information, the kinds of problems they have experienced and suggestions for improving the system. To gauge pilot performance in using NOTAMs, the survey also included a sample NOTAM and questions about the information in the NOTAM.

The results of the survey showed that, in general, respondents agreed that the current NOTAMs system is clumsy to use and that it is easy to make mistakes using it. When questioned, many respondents were unable to extract a specific, critical piece of information from the sample NOTAM. Moreover, many of those who answered the question correctly believed that it was difficult to answer.

The fifth section of this report discusses the results of a human factors analysis of the NOTAMs system based on design principles from the FAA's *Human Factors Design Guide*, which provides reference information to assist in the design, development and evaluation of FAA systems and equipment. The document contains many human factors principles to which the NOTAMs system does not adhere. Acknowledging that this document is a fairly recent addition to FAA's guidance material, it is appropriate for both the evaluation and the redesign of an existing system, such as the NOTAMs system.

The analysis indicated that the NOTAMs system does not adhere to many FAA human factors design principles and because of the accidents and incidents to which NOTAMs have contributed, the system should be redesigned. Until a redesigned system is in place, improved training for pilots on the current system is recommended.

Background

Except for distribution methods such as direct telephone dial-up data services and the Internet, the NOTAMs system has remained largely unchanged for more than three decades. Pilots currently place calls to flight service stations (FSSs) or use Internet providers, such as the Direct User Access Terminal Service (DUATS), to obtain essential information that may influence decisions about when, where and how to fly. Many pilots are not aware that placing one call to an FSS does not ensure that they receive all NOTAMs that are relevant to a given route. Furthermore, because of the substantial amount of information received during a NOTAM briefing, pilots often are faced with making decisions about how much to read, what NOTAMs actually mean, which NOTAMs are most important, etc. This has the potential of overloading the pilot with information, possibly contributing to a breakdown in the NOTAMs system, which may lead to an accident, incident or a violation of regulations.

In the past decade, there have been numerous calls for improvements to the NOTAMs system. In 1999, for example, the U.S. National Association of Air Traffic Specialists (NAATS) conducted a general aviation summit that resulted in unanimous recommendations, including the replacement of the current NOTAMs system. Furthermore, an FAA system safety and efficiency review team surveyed the pilot community and found that pilots did not have "sufficient understanding" of the NOTAMs system as it currently operates.[2] The team recommended that educational efforts be utilized to improve the efficiency of the system until improvements to the system are made.

NOTAMs have been cited by the U.S. National Transportation Safety Board (NTSB) as contributing causes of accidents and incidents. Recent NTSB incident reports cited inadequate wording of NOTAMs, pilots' failures to obtain NOTAMs, pilots' failures to read all NOTAMs, pilots' failures to heed NOTAM information and the failure of FSSs to issue NOTAMs.

Incident reports are not the only indications of deficiencies in the system. Pilots are an excellent source of information. In a 2002 Internet poll conducted by AVweb, 11 percent of the approximately 670 respondents said that they believed that the current NOTAMs system is "effective"; 23 percent of the respondents said they believed that the current system is "nearly useless."[3]

The NOTAMs system has many flaws that can lead to decreased performance and decreased satisfaction with the system. Pilots for years have complained about the system; nevertheless, no substantive efforts to improve the system have been made. Thus, the questions that guided the research conducted for this report were:

- What is the current NOTAMs system?
- What, if anything, is wrong with the system?
- How can the system be fixed?

History of NOTAMs

During the last 30 years, there have been tremendous technological advances in communications. The introduction of satellite communications, e-mail, cellular telephones, two-way pagers and other technologies has changed the manner in which people interact. Nevertheless, there has been little effort to improve the usability and user-friendliness of the NOTAMs system. Although the methods of disseminating NOTAMs have changed, the format of the NOTAMs themselves — most notably, the use of capital (i.e., uppercase) letters and contractions — has remained the same (Figure 1).

Although the meanings of some contractions used in NOTAMs are intuitive — for example, "ALS" for "approach light system" — some contractions, such as "DPCR" for "departure procedure," are not so easily interpreted (Table 1, page 4).

Notices to Mariners

Before the advancements of aviation in the 1930s and 1940s, intercontinental travel was done by sea. Mariners required current information about their routes. This led to the creation of notices to mariners.[4] Early notices to mariners were issued in weekly bulletins by the U.S. Navy. The notices included changes to navigation aids (e.g., lighthouses), hazards to navigation, corrections to radio aids, route information and new soundings (water-depth measurements). Basically, any new information that could affect a mariner's voyage was contained in the weekly bulletins. A sample notice to mariners from Jan. 5, 1957, is shown in Figure 2.

Because notices to mariners were in plain English, navigators, sailors and even laypersons could pick

Continued on page 8

Figure 1
Typical NOTAM Format

FDC 2/1925 ZJX GA..FT/T AIRWAY ZJX ZTL
V-157 ALMA (AMG) VORTAC, GA. TO LOTTS INT, GA MEA 4000.
V-157 LOTTS INT, GA TO ALLENDALE (ALD) VOR, SC MEA 9000.

NOTAM = Notice to airmen

Source: University of Central Florida

Figure 2
Notice to Mariners (1957)

New Hampshire — Isles of Shoals — Light to be changed — Information. About January 15, 1957, Isles of Shoals Light will be temporarily replaced for a period of 30 days by a light showing *flashing white* every *15 seconds,* flash *3 seconds*, of 9,000 candlepower exhibited from a platform on top of the tower.

About February 15, 1957, Isles of Shoals Light will be reexhibited from the regular tower lantern, and changed to show *flashing white* every *15 seconds*, flash *3 seconds* of 250, 000 candlepower. The temporary light will then be discontinued.

Approx. position: 42° 58' 01" N., 70° 37' 26" W.

Source: University of Central Florida

Table 1
NOTAM Contractions

A	
AADC	Approach and Departure Control
ABV	Above
A/C	Approach Control
ACCUM	Accumulate
ACFT	Aircraft
ACR	Air Carrier
ACTV/ACTVT	Active/Activate
ADF	Automatic Direction Finder
AFSS	Automated Flight Service Station
ADJ	Adjacent
ADZ/ADZD	Advise/Advised
AFD	Airport/Facility Directory
ALS	Approach Light System
ALTM	Altimeter
ALTN/ALTNLY	Alternate/Alternately
ALSTG	Altimeter Setting
AMDT	Amendment
APCH	Approach
APL	Airport Lights
ARFF	Aircraft Rescue and Fire Fighting
ARPT	Airport
ARSR	Air Route Surveillance Radar
ASDE	Airport Surface Detection Equipment
ASOS	Automated Surface Observing System
ASPH	Asphalt
ASR	Airport Surveillance Radar
ATC	Air Traffic Control
ATCT	Airport Traffic Control Tower
ATIS	Automated Terminal Information Service
AVBL	Available
AWOS	Automatic Weather Observing System
AZM	Azimuth
B	
BC	Back Course
BCN	Beacon
BERM	Snowbank/s Containing Earth/Gravel
BLO	Below
BND	Bound
BRAF	Braking Action Fair
BRAG	Braking Action Good
BRAN	Braking Action Nil
BRAP	Braking Action Poor
BYD	Beyond
C	
CAAS	Class A Airspace
CAT	Category
CBAS	Class B Airspace
CBSA	Class B Surface Area
CCAS	Class C Airspace
CCLKWS	Counterclockwise
CCSA	Class C Surface Area
CD	Clearance Delivery
CDAS	Class D Airspace
CDSA	Class D Surface Area
CEAS	Class E Airspace
CESA	Class E Surface Area
CFA	Controlled Firing Area
CGAS	Class G Airspace
CHG	Change
CLKWS	Clockwise
CLNC	Clearance
CLSD	Closed
CMSN/CMSND	Commission/Commissioned
CNCL/CNCLD/CNL	Cancel/Canceled/Cancel
CNTRLN	Centerline
CONC	Concrete
CONT	Continue/Continuously
CRS	Course
CTAF	Common Traffic Advisory Frequency
CTLZ	Control Zone
D	
DALGT	Daylight
DCMS/DCMSND	Decommission/Decommissioned
DCT	Direct
DEP	Depart/Departure
DEPT	Department
DH	Decision Height
DISABLD	Disabled
DLA/DLAD	Delay/Delayed
DLT/DLTD	Delete/Deleted
DLY	Daily
DME	Distance Measuring Equipment
DMSTN	Demonstration
DP	Instrument Departure Procedure
DPCR	Departure Procedure
DRCT	Direct
DRFT/DRFTD	Drift/Drifted Snowbank/s Caused By Wind Action

Table 1
NOTAM Contractions *(continued)*

DSPLCD	Displaced
DSTC	Distance
DWPNT	Dew Point
E	
E	East
EBND	Eastbound
EFAS	En Route Flight Advisory Service
EFF	Effective
ELEV	Elevate/Elevation
ENG	Engine
ENTR	Entire
EXCP	Except
F	
FA	Final Approach
FAC	Facility
FAF	Final Approach Fix
FDC	Flight Data Center
FM	Fan Marker
FREQ	Frequency
FRH	Fly Runway Heading
FRZN	Frozen
FRNZ SLR	Frozen Slush on Runway/s
FSS	Flight Service Station
G	
GC	Ground Control
GCA	Ground Controlled Approach
GOVT	Government
GP	Glide Path
GPS	Global Positioning System
GRVL	Gravel
GS	Glide Slope
H	
HAA	Height Above Airport
HAT	Height Above Touchdown
HAZ	Hazard
HEL	Helicopter
HELI	Heliport
HF	High Frequency
HIRL	High Intensity Runway Lights
HIWAS	Hazardous Inflight Weather Advisory Service
HOL	Holiday
HP	Holding Pattern
I	
IAP	Instrument Approach Procedure
IBND	Inbound
ID	Identification
IDENT	Identify/Identifier/Identification
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IM	Inner Marker
IN	Inch/Inches
INDEFLY	Indefinitely
INOP	Inoperative
INST	Instrument
INT	Intersection
INTST	Intensity
IR	Ice On Runway/s
L	
L	Left
LAA	Local Airport Advisory
LAT	Latitude
LAWRS	Limited Aviation Weather Reporting Station
LB	Pound/Pounds
LC	Local Control
LCL	Local
LCTD	Located
LDA	Localizer Type Directional Aid
LDIN	Lead In Lighting System
LGT/LGTD/LGTS	Light/Lighted/Lights
LIRL	Low Intensity Runway Edge Lights
LLWAS	Low Level Wind Shear Alert System
LMM	Compass Locator at ILS Middle Marker
LNDG	Landing
LOC	Localizer
LOM	Compass Locator at ILS Outer Marker
LONG	Longitude
LRN	LORAN
LSR	Loose Snow on Runway/s
LT	Left Turn After Takeoff
M	
MALS	Medium Intensity Approach Lighting System
MALSF	Medium Intensity Approach Lighting System with Sequenced Flashers
MALSR	Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights
MAP	Missed Approach Point

Table 1
NOTAM Contractions *(continued)*

MCA	Minimum Crossing Altitude
MDA	Minimum Descent Altitude
MEA	Minimum En Route Altitude
MED	Medium
MIN	Minute
MIRL	Medium Intensity Runway Edge Lights
MLS	Microwave Landing System
MM	Middle Marker
MNM	Minimum
MOCA	Minimum Obstruction Clearance Altitude
MONTR	Monitor
MSA	Minimum Safe Altitude/Minimum Sector Altitude
MSAW	Minimum Safe Altitude Warning
MSL	Mean Sea Level
MU	Designates a Friction Value Representing Runway Surface Conditions
MUD	Mud
MUNI	Municipal
N	
N	North
NA	Not Authorized
NBND	Northbound
NDB	Nondirectional Radio Beacon
NE	Northeast
NGT	Night
NM	Nautical Mile/s
NMR	Nautical Mile Radius
NOPT	No Procedure Turn Required
NTAP	Notice to Airmen Publication
NW	Northwest
O	
OBSC	Obscured
OBSTN	Obstruction
OM	Outer Marker
OPER	Operate
OPN	Operation
ORIG	Original
OTS	Out of Service
OVR	Over
P	
PAEW	Personnel and Equipment Working
PAJA	Parachute Jumping Activities
PAPI	Precision Approach Path Indicator
PAR	Precision Approach Radar
PARL	Parallel
PAT	Pattern
PCL	Pilot Controlled Lighting
PERM/PERMLY	Permanent/Permanently
PLA	Practice Low Approach
PLW	Plow/Plowed
PN	Prior Notice Required
PPR	Prior Permission Required
PREV	Previous
PRIRA	Primary Radar
PROC	Procedure
PROP	Propeller
PSGR	Passenger/s
PSR	Packed Snow on Runway/s
PT/PTN	Procedure Turn
PVT	Private
R	
RAIL	Runway Alignment Indicator Lights
RCAG	Remote Communication Air/Ground Facility
RCL	Runway Centerline
RCLS	Runway Centerline Light System
RCO	Remote Communication Outlet
RCV/RCVR	Receive/Receiver
REF	Reference
REIL	Runway End Identifier Lights
RELCTD	Relocated
RMDR	Remainder
RNAV	Area Navigation
RPRT	Report
RQRD	Required
RRL	Runway Remaining Lights
RSVN	Reservation
RT	Right Turn after Takeoff
RTE	Route
RTR	Remote Transmitter/Receiver
RTS	Return to Service
RUF	Rough
RVR	Runway Visual Range
RVRM	RVR Midpoint
RVRR	RVR Rollout
RVRT	RVR Touchdown
RVV	Runway Visibility Value
RY/RWY	Runway

Table 1
NOTAM Contractions *(continued)*

S	
S	South
SBND	Southbound
SDF	Simplified Directional Facility
SE	Southeast
SECRA	Secondary Radar
SFL	Sequenced Flashing Lights
SI	Straight-In Approach
SIR	Packed or Compacted Snow and Ice on Runway/s
SKED	Scheduled
SLR	Slush on Runway/s
SNBNK	Snowbank/s Caused by Plowing
SND	Sand/Sanded
SNGL	Single
SNW	Snow
SPD	Speed
SR	Sunrise
SS	Sunset
SSALF	Simplified Short Approach Lighting System with Sequenced Flashers
SSALR	Simplified Short Approach Lighting System with Runway Alignment Indicator Lights
SSALS	Simplified Short Approach Lighting System
STAR	Standard Terminal Arrival
SVC	Service
SW	Southwest
SWEPT	Swept or Broom/Broomed
T	
TACAN	Tactical Air Navigational Aid
TDZ/TDZL	Touchdown Zone/Touchdown Zone Lights
TFC	Traffic
TFR	Temporary Flight Restriction
TGL	Touch and Go Landings
THN	Thin
THR	Threshold
THRU	Through
TIL	Until
TKOF	Takeoff
TMPRY	Temporary
TRML	Terminal
TRNG	Training
TRSA	Terminal Radar Service Area
TRSN	Transition
TSNT	Transient
TWEB	Transcribed Weather Broadcast
TWR	Tower
TWY	Taxiway
U	
UNAVBL	Unavailable
UNLGTD	Unlighted
UNMKD	Unmarked
UNMON	Unmonitored
UNRELBL	Unreliable
UNUSBL	Unusable
V	
VASI	Visual Approach Slope Indicator
VDP	Visual Descent Point
VFR	Visual Flight Rules
VIA	By Way Of
VICE	Instead/Versus
VIS/VSBY	Visibility
VMC	Visual Meteorological Conditions
VOL	Volume
VOLMET	Meteorological Information for Aircraft in Flight
VOR	VHF Omni-Directional Radio Range
VORTAC	VOR and TACAN (collocated)
VOT	VOR Test Signal
W	
W	West
WBND	Westbound
WEA/WX	Weather
WI	Within
WKDAYS	Monday through Friday
WKEND	Saturday and Sunday
WND	Wind
WP	Waypoint
WSR	Wet Snow on Runway/s
WTR	Water on Runway/s
WX	Weather
/	And
+	In Addition/Also

Source: U.S. Federal Aviation Administration, *Aeronautical Information Manual* up a bulletin and read it without having to translate or decode the information. Current notices to mariners are disseminated in a similar format by the U.S. Coast Guard. Figure 3 shows a notice to mariners issued on Oct. 2, 2001.

Teletype Format Persists

The format of NOTAMs was greatly influenced by procedures for the dissemination of weather information. The U.S. Weather Bureau (now the National Weather Service) was established in 1870 to gather and distribute weather information.[5] In 1928, the U.S. Department of Commerce began using Teletype systems (networks of terminals combining a keyboard and a printer) to collect and distribute aviation weather information.[6]

Figure 4 shows the format of a 1930 weather report.[7] This would not have been the report that was sent through the Teletype system, however. Much of the content of Teletype reports was further shortened into symbols that were deciphered by pilots and dispatchers who needed the information. A sample Teletype sequence from 1940 is shown in Figure 5 (page 9).

Figure 3

Notice to Mariners (2001)

Northern California — San Francisco — San Francisco International Airport — The Coast Guard has established a temporary security zone in the navigable waters of the United States surrounding San Francisco International Airport. This security zone extends 2000 yards seaward from the shoreline of the San Francisco International Airport. All persons and vessels are prohibited from entering, transiting through or anchoring within these waters unless authorized by the Captain of the Port. This security zone will be in effect **through 21 Mar 2002.**

Chart 18650 LNM 40/01 dated 02 Oct

Source: University of Central Florida

Figure 4

Uncoded Weather Report (1930)

CG TRML OVC AT 1 TO 2 THSD WITH LWR SCTD TO BRKN AT 5 HND AND RAIN SHWRS UNTIL NOON. LWR CLDS DCRSG THRFTR BUT BCMG OVC AT 5 HND WITH MDT SHWRS DUE TO COLD FRONT PSG ABT 1500C WITH LGT SHWRS CONTG. VSBY 6 OR BTR XCP BRIEFLY 2 TO 4 IN SHWRS NEAR NOON AND 1500C.

Source: University of Central Florida

The Civil Aeronautics Administration (CAA; an FAA predecessor) improved its Teletype technology; by 1957, Teletype machines that could transmit 100 words per minute were replacing machines that could transmit only 75 words per minute. In 1961, the Federal Aviation Authority (predecessor of the current FAA) introduced a Teletype machine that could transmit weather data at 850 words per minute.

Although Teletype machines eventually were replaced by computer terminals and high-speed printers, the format of weather reports and NOTAMs retains the contracted, all-uppercase-letters format introduced in the 1920s.

DUATs was introduced in the 1980s through various dial-up information-service providers. In 1990, DUATS became available to pilots on the Internet. The system allows pilots to access weather reports and NOTAMs using personal computers. DUATS provides an "English translation" option that translates some contractions into plain English. Although this is a convenient feature, it cannot translate contractions that have multiple meanings.

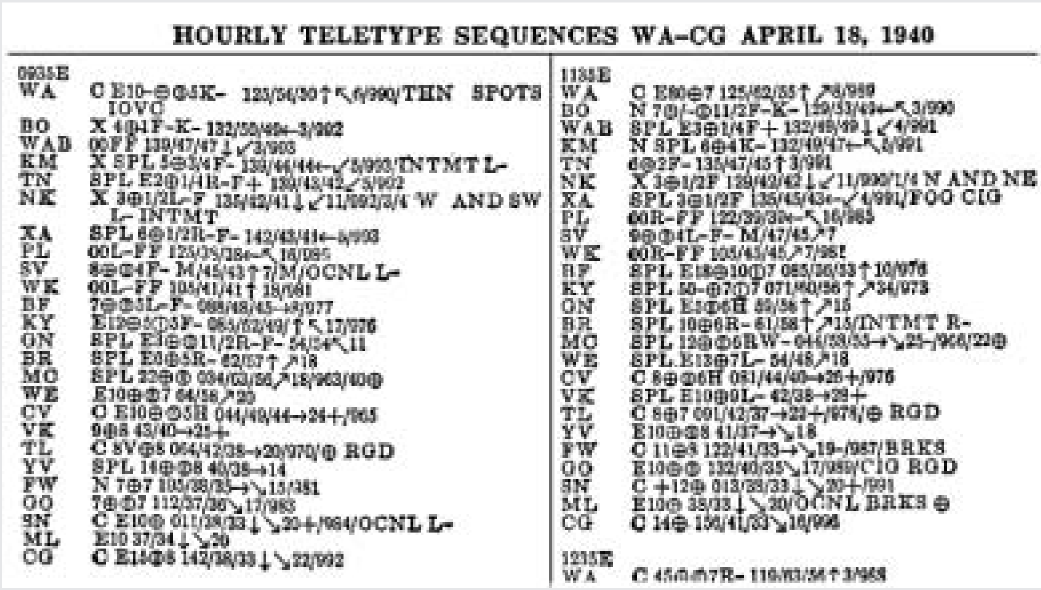
In summary, NOTAMs are the aviation version of notices to mariners, but they were formatted in a similar fashion to the FAA's weather reports to accommodate dissemination through Teletype machines. While the format was necessary in the 1920s, the Internet and personal computers do not require all uppercase letters and condensation of the information with contractions. While DUATS provides NOTAM translators, they are rudimentary in that they translate only some contractions.

Furthermore, the sources, life cycles and dissemination mechanisms for NOTAMs today form a very complex system that is described in the next section.

U.S. NOTAMs System

U.S. Federal Aviation Regulations (FARs) Part 91.103 requires that "each pilot-in-command shall, before beginning a flight, become familiar with all available information concerning that flight." NOTAMs are part of the "available information" with which pilots must become familiar before flying.

Figure 5
Coded Weather Report (1940)


HOURLY TELETYPE SEQUENCES WA–CG APRIL 18, 1940

Source: University of Central Florida

Today, general information regarding the generation, dissemination and communication of NOTAMs is included in numerous government documents, privately published documents and electronic media formats. Most notable of the U.S. government information sources are:

- The *Aeronautical Information Manual* (*AIM*);[8]
- Federal Aviation Order 7930.2J, *Notices to Airmen (NOTAMS)*;[9] and,
- *A Pilot's Guide to Aviation Weather Services*.[10]

NOTAMs can be obtained from a variety of sources. The most common methods of obtaining NOTAM information are telephone briefings by FSS specialists or via government or commercial Internet information sources such as DUATS, Data Transmission Network (DTN), Kavouras, Navtech and Weather Services International (WSI).

To become an FAA-qualified Internet communications provider (QICP), Internet service providers must follow the process prescribed in FAA Advisory Circular (AC) 00-62, *Internet Communications of Aviation Weather and NOTAMs*.

NOTAMs also are published in paper format every 28 days in *Notices to Airmen*, which is available for a fee on a subscription basis or from the FAA *PilotWeb* Internet site.[11]

Electronic access to NOTAMs currently is not an error-proof method of NOTAM dissemination. AC 00-62 recommends that QICPs display a warning, such as: "This QICP does not ensure the quality and currency of the information transmitted to you. You, the user, assume the entire risk related to the information and its use."

QICPs also commonly post precautionary statements such as: "Please check with Flight Service at 1-800-WX-BRIEF for the most current NOTAMs."

The warning statements and the precautionary statements place the responsibility of gathering NOTAMs on the user. The lack of certainty about whether the most current and complete NOTAM information has been gathered is compounded by the fact that not all NOTAM information is available from a single source, as discussed below.

How NOTAMs Are Generated

Federal Aviation Order 7930.2J prescribes "the procedures used to obtain, format and disseminate information on unanticipated or temporary changes to components of or hazards in the National Airspace System (NAS) until the associated aeronautical charts and related publications have been amended."

The order emphasizes that the NOTAMs system is not intended to be used to disseminate data already published or charted. Nevertheless, numerous survey respondents said that there is frequent redundancy of information and/or that NOTAMs remain after the changes are incorporated into the pertinent publications.

Federal Aviation Order 7930.2J specifically addresses any air traffic personnel assigned to a facility that collects and/or disseminates NOTAMs and states that they are to be familiar with the contents of the order relevant to their position. The order describes in detail the appropriate methods for handling every aspect of NOTAMs. FSSs are responsible for the classification, accuracy, format, dissemination and cancellation of NOTAMs, and for coordination with FAA regional air traffic divisions, which are responsible for collecting and disseminating NOTAMs pertinent to their region. The National Flight Data Center (NFDC) has the responsibility to ensure that all data comply with the policies, criteria and formats required by Federal Aviation Order 7930.2J.

Further guidance for the generation of NOTAMs is included in AC 150/5200-28B, *Notices to Airmen (NOTAMs) for Airport Operators*. The format and handling of NOTAM data are outlined, and the process for initiating and canceling NOTAMs is described. Airport operators have the responsibility of issuing NOTAMs that are forwarded to the NFDC, as well as other types of NOTAMs of a local nature.

ICAO Annex 15 contains specific recommendations for international NOTAMs.

ICAO Annex 15 contains specific recommendations for the generation and dissemination of international NOTAMs and specific formats for NOTAMs about snow at airports (SNOWTAMs) and volcanic activity (ASHTAMs).[12]

The Volpe National Transportation Systems Center has designed, developed and implemented a system for the U.S. Air Force to report global positioning system (GPS) NOTAMs. The system, which was implemented in May 1995, generates NOTAMs about GPS satellite outages, which are disseminated through the NOTAMs system. Pilots must specifically request GPS NOTAMs during briefings by FSS specialists. (NOTAMs on other long-range navigation systems, such as Loran and Omega, also must be specifically requested.)

NOTAM Types Vary

There are three types of NOTAMs generated by FAA:

- NOTAMs (L), which are distributed locally;
- NOTAMs (D), which are distributed throughout the NOTAMs system, as well as locally; and,
- National Flight Data Center NOTAMs (FDC NOTAMs), which include changes to published approach procedures and aeronautical charts, and thus are considered by FAA as regulatory in nature.

The "L" in NOTAMs (L) stands for "local." These NOTAMs are distributed to facilities and offices in the area of responsibility of the issuing FSS and retained at that FSS for delivery to pilots operating at the affected airports. They are not included in hourly weather reports. NOTAMs (L) include taxiway closures, persons and equipment near or crossing runways (e.g., for maintenance purposes), outages of airport rotating beacon and other information that would have little effect on non-local operations. DUATS service providers do not supply NOTAM (L) information. NOTAMs (L) remain in effect until the initiator cancels them or they become permanent by publication (e.g., in the FAA *Airport/Facility Directory*).

The "D" in NOTAMs (D) stands for "distant" (i.e., beyond the area for which an FSS is responsible). In addition to local dissemination, these NOTAMs are disseminated throughout the U.S. and, in some cases, internationally. They contain information on all civil public-use airports and navigational facilities that are part of the NAS and can be initiated either by airport managers or FAA offices through FSSs. NOTAMs (D) remain valid until they expire (as determined by the initiator), are canceled or are published in the FAA's biweekly *Notices to Airmen* publication.

FDC NOTAMs are initiated and transmitted by the NFDC at FAA headquarters in Washington, D.C. The NFDC receives information from FAA regional offices, FAA Air Traffic Service offices, airport operators and facility operators. FDC NOTAMs remain in effect until canceled by the NFDC. FDC NOTAMs are considered regulatory because they affect airspace, airways, instrument approach procedures and aeronautical charts.

FDC NOTAMs also are used to disseminate temporary flight restrictions (TFRs), which typically affect areas where an incident or event has generated substantial public interest and is likely to create hazardous air traffic congestion. Major sporting events, parades and natural disasters (e.g., floods, forest fires) are typical reasons for TFRs.

Until they are published in the biweekly *Notices to Airmen*, NOTAMs (D) and FDC NOTAMs are included in standard briefings given by FSS specialists. Unpublished NOTAMs (also called Class I NOTAMs) specifically must be requested by the pilot if he or she has asked the FSS specialist for a nonstandard briefing, such as an abbreviated briefing, outlook briefing or in-flight briefing.

Published NOTAMs (also called Class II NOTAMs) are deleted from the database after publication. Class II NOTAM information typically includes changes and conditions that are temporary but expected to remain in effect for an extended period. The information is published every two weeks until it expires or is canceled. Permanent changes often are published as an interim step before their inclusion on appropriate charts or in the *Airport/Facility Directory*. Temporary information and permanent information are differentiated in the publication by the notations "FI/T" (flight information that is temporary) and "FI/P" (flight information that is permanent).

All FSSs have printed Class II NOTAMs available. An important point about Class II NOTAMs is that they will not normally be provided during a briefing *unless they are specifically requested by the pilot*.

NOTAMs will not normally be provided during a briefing *unless they are specifically requested by the pilot.*

Information in the biweekly *Notices to Airmen* publication is not limited to a specific geographical area, like NOTAMs (L), or to specific airports, facilities, etc., like NOTAMs (D). The publication provides important information to pilots about civil public-use airport openings and closings. It also provides information on runway commissionings, openings, temporary closings and permanent closings at those airports.

For all instrument flight rules (IFR) airports and specific visual flight rules (VFR) airports, Class II NOTAMs provide information on the following:

- Airport operating restrictions for air carriers and aircraft rescue and fire fighting facilities;
- Approach light systems;
- Class C controlled airspace;
- Displaced runway thresholds;
- Other runway information; and,
- Runway light systems.

Class II NOTAMs also provide information on navigation aids (navaids), communications and other services. Information on navaids includes the commissioning of new facilities, decommissioning of old facilities, frequency changes, restrictions and outages. Information on air traffic control (ATC) towers and approach control facilities includes the commissioning, decommissioning and hours of operation. The same type of information is presented for FSSs and remote communications outlets, as well as automated weather observing systems.

Information that is important to flight safety but does not meet the criteria for issuance as a NOTAM is issued as a special notice. Special notices include information on one-time events or annual events that attract unusually high concentrations of air traffic, temporary military operations, issuance of special flight rules, and descriptions of new ATC procedures.

International NOTAMs

International NOTAMs (also called ICAO NOTAMs) also are disseminated as Class I NOTAMs and as Class II NOTAMs. Class I international NOTAMs are distributed by means of telecommunication, whereas Class II international NOTAMs are distributed by means other than telecommunication.

Methods of distributing international NOTAMs and the formatting of the information vary worldwide. In the U.S., the NFDC maintains international NOTAMs on file, and pilots may request them from any FSS.

Life Cycle of a NOTAM

The procedures for creating, disseminating, receiving and interpreting NOTAMs are complicated by the numerous avenues, agencies and methods described above. Gaining an understanding of the NOTAMs system is further complicated by the various types of NOTAMs, also described above.

The complexity of the NOTAMs system is shown in Figure 6 (page 13). Because of the complexity of the system, it is inherently error-prone. A breakdown can occur at any step in the process, or in multiple steps, leading to possibly serious consequences.

Methods of distributing international NOTAMs and the formatting of the information vary worldwide.

For example, an air carrier operator dispatched a flight of approximately 30 minutes' duration to a destination at which the ILS (instrument landing system) was out of service. The NOTAM had not been provided to the flight crew. Because weather conditions at the airport were below VFR minimums, the flight was not conducted in compliance with FARs Part 121.[13]

Problems With the Current NOTAMs System

The following discussion of some recent accidents, incidents and events highlights just how important and fragile the NOTAMs system is, and consequently why improvement of the system is essential.

'Unclear Wording' Cited in Gulfstream III Accident

On March 29, 2001, a Gulfstream III en route on a charter flight from Los Angeles, California, U.S., struck terrain near the threshold of Runway 15 while the crew was conducting a VOR/DME (very-high-frequency omnidirectional radio/distance-measuring equipment) approach in nighttime instrument meteorological conditions to Aspen-Pitken County (Colorado, U.S.) Airport. All 18 occupants were killed.[14]

NTSB said that the probable cause of the accident was "the flight crew's operation of the airplane below the minimum descent altitude [for the nonprecision approach] without an appropriate visual reference for the runway." Among the contributing factors cited by NTSB was "[FAA's] unclear wording of [a] March 27, 2001, [NOTAM] regarding the nighttime restriction for the VOR/DME-C approach to the airport and the FAA's failure to communicate this restriction to the Aspen [ATC] tower."

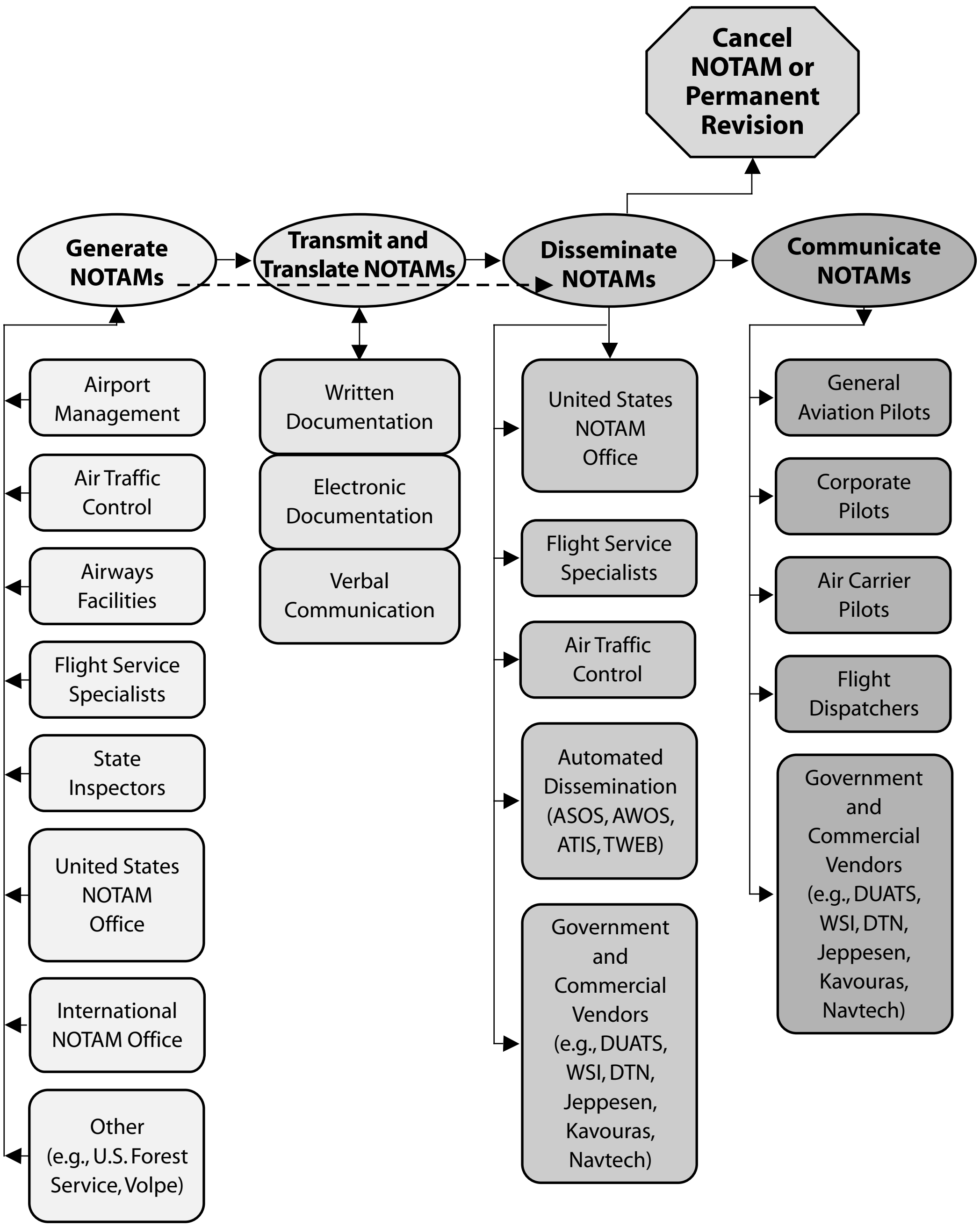
Before departure, the first officer received a briefing from an FSS specialist. The specialist told the first officer that the VOR/DME-C approach procedure had been updated and that circling minimums were no longer authorized at night. This essentially was the text of the NOTAM issued on March 27, 2001.

"The NOTAM was intended to mean that the instrument approach procedure was no longer authorized at night, because only circling minimums were authorized for that procedure," NTSB said in its accident report. "Thus, the NOTAM was vaguely worded because pilots could infer that [conducting] an approach without a circle-to-land maneuver to Runway 15 was still authorized."

(Although the final approach course [164 degrees] was within 15 degrees of the runway centerline and thus met requirements for a straight-in approach, the descent gradient between the final approach fix and the runway threshold crossing height exceeded the requirements for a straight-in approach.)[15]

Figure 6

Life Cycle of a NOTAM



NOTAM = Notice to airmen ASOS = Automated surface observing system
AWOS = Automated weather observing system ATIS = Automatic terminal information system
TWEB = Transcribed weather broadcast DUATS = Direct user access terminal system
WSI = Weather Services International DTN = Data Transmission Network

Source: University of Central Florida

The report said that "because of human error," the NOTAM had not been sent to Aspen Tower. At the time of the accident, the automatic terminal information service (ATIS) broadcast said that pilots could expect to conduct the VOR/DME-C approach and that landing operations were being conducted on Runway 15. An approach controller provided radar vectors to the flight crew to establish the airplane on the final approach course and later cleared the crew to conduct the VOR/DME-C approach.

Federal Aviation Order 8260.19C, *Flight Procedures and Airspace*, (paragraph 226b) states that NOTAM text should use "plain language" and that "specialists must keep in mind that the NOTAM is directed to the pilot and should be worded so that the intended change will not be misinterpreted."

The NOTAM cited in the Aspen accident was based on a recommendation from an FAA flight inspection crew who conducted a flight check at the airport a week before the accident occurred.

"On March 21, 2001, a flight inspection crew from the FAA's Oklahoma City, Oklahoma, Flight Inspection Field Office performed a commissioning flight check at [the Aspen airport] to support a proposed GPS standard instrument approach procedure to Runway 15," the accident report said. "After the inspection, the flight inspection crew noted, on the procedural control form, that circling should not be allowed at night because areas of unlighted terrain conflicted with traffic patterns and circling descent maneuvers near the airport. Afterward, the flight inspection crew provided its comments to FAA staff at the National Flight Procedures Office in Oklahoma City."

Contractions should be unambiguous because of the important information that they must convey to pilots.

This recommendation was not the first indication that nighttime circling approaches in IMC might be hazardous at the Aspen airport. When the VOR/DME-C approach was commissioned in December 1988, the procedure was not authorized at night. This restriction was lifted in December 1994, after complaints from pilots. The NOTAM issued on March 27, 2001, was thus reinstating the original restriction.

A day after the accident, FAA revised the NOTAM to state: "procedure NA [not authorized] at night."

Difficulty of Extracting Information Cited in B-747 Accident

On Oct. 31, 2000, a Singapore Airlines Boeing 747 departing from Taipei, Taiwan, China, for Los Angeles struck concrete barriers and construction equipment on the runway while attempting to take off in nighttime IMC.[16] Eighty-three occupants were killed, and 71 occupants were injured.

Among the findings in the final report on the accident by the Aviation Safety Council of Taiwan (China) were: a typhoon causing heavy rain and strong winds at the airport; "moderate time pressure to take off before the inbound typhoon closed in"; the crew's failure to adequately review the taxi route to their assigned runway, Runway 05L; and the crew's initiation of the takeoff on Runway 05R, although they were aware that a portion of Runway 05R was closed, as indicated by a NOTAM.

The flight crew had been provided with the NOTAM (Figure 7, page 15) and had correctly read back their instruction by ATC to taxi to Runway 05L for takeoff. When the captain initiated takeoff on the wrong runway, he was not questioned by the other crewmembers. After the accident, the crewmembers did not recall the NOTAM.

In its analysis of the NOTAM aspect of this accident, the report said, "The format of these documents often makes the extraction of key information difficult."

Among the recommendations resulting from the accident investigation was to "provide graphical depiction of [NOTAM] information."

Stories From the Field

In February 2001, a retired airline pilot with 30,000 flight hours received a letter from FAA that said, in part, that ATC radar had tracked his Beech 55

Baron transiting an area in which a TFR had been established.

In a report to the U.S. National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS), the pilot said that he was flying his airplane from his home in Florida to an airport in Minnesota.[17] A standard briefing, including a specific request for NOTAMs, was obtained from DUATS, reviewed and carried in the airplane. VFR weather conditions prevailed along the entire route, and no flight plans were filed.

Departing on the third leg of the flight, the pilot chose not to contact ATC for VFR flight-following services. The pilot navigated via GPS direct to the destination at an en route altitude of 6,500 feet. After landing, the ground controller gave him a telephone number to call as soon as he parked his airplane. The telephone number was for Springfield (Illinois) Tower. The pilot was told that the Springfield airport was "NOTAM'd" closed from the surface to 17,000 feet for an air show when he overflew the airport at 6,500 feet. The NOTAM had not been obtained by the pilot during his preflight preparations.

A NOTAM that was canceled but remained in a dispatcher's flight-planning program played a role in an event involving an air carrier aircraft that was dispatched to Portland, Oregon, on a non-stop flight. Upon arrival at the destination airport, the flight crew entered a holding pattern because visibility was below landing minimums specified by a NOTAM that the crew had received from their dispatcher. The NOTAM increased the minimum visibility for the instrument approach in use from 1,800 feet RVR (runway visual range) to 4,000 feet RVR. RVR at the time was 2,400 feet.

After holding for approximately 45 minutes, the flight crew heard a radio transmission from another air carrier crew who were conducting the approach. The flight crew told their company dispatcher that another air carrier aircraft had just landed. The dispatcher telephoned the airport manager and was told that the NOTAM had been canceled.

No system was in place for removing canceled NOTAMs from the automated flight-planning software used by the dispatcher; therefore, he had no way of knowing that the NOTAM was no longer in effect.

Figure 7

NOTAM in Effect at Taipei, Taiwan, China; Oct. 31, 2000

A0606 -------- 31 Aug '00
0009130100/0011220100
PORTION OF RWY 05R/23L(BTN TWY N4 AND N5) CLSD DUE TO WIP
RMK/TWY N4 AND N5 REMAIN AVBL

NOTAM = Notice to airmen

Source: University of Central Florida

The authors found several NOTAMs system discrepancies when they observed two pilots as they obtained separate briefings from an FSS for a flight over the same route. One pilot requested a standard briefing for a VFR flight; the other pilot requested a standard briefing for an IFR flight. Both pilots specifically requested NOTAMs and recorded the information received from their FSS briefings. Analysis of the transcribed briefings indicated that only local NOTAMs were received.

The pilots also obtained standard briefings, with NOTAMs in both contracted and plain English, from DUATS via the Internet.

The proposed flight then was flown to determine the accuracy of the NOTAM information the pilots had obtained. The number of NOTAMs and the content of the NOTAMs varied. For example, a NOTAM about higher approach minimums because of a crane in the vicinity of the airport was disseminated to the pilot who requested a VFR briefing but not to the pilot who requested the IFR briefing. During the flight, the crane was not observed in the location referred to in the NOTAM. When queried about the crane, the airport tower controller said, "It's out there." Nevertheless, soon thereafter, the controller said, "It is gone."

Pilots' Perceptions of the NOTAMs System: Implications and Suggestions for Improvement

In November 1999, FAA hosted a general aviation summit to discuss the improvement of flight services.[18] A unanimous recommendation was for the overhaul of the NOTAMs system. Furthermore, a recent notice posted on the FAA Internet site stated:[19]

> *The System Safety and Efficiency Review team identified a lack of sufficient knowledge about the NOTAMs system within the pilot community. Pilots surveyed did not display sufficient understanding or a working knowledge of the complete NOTAMs system. Their current perception is that by calling a flight service station for a standard briefing, they receive* all *the NOTAM information they need for a given flight. Team members indicated that the NOTAMs system should match pilots' perceptions, but in the meantime educational efforts are necessary to improve the utility of the current system.*

The NOTAMs system is vital to the safety of flight and should be as simple and intuitive as possible. The amount of new information that must be learned to use the system effectively should be minimal.

The evaluation of the NOTAMs system included a survey to determine the subjective perceptions of pilots and dispatchers about the current system, including their satisfaction with the system and their opinions on its ease of learning and its ease of use, and the likelihood of making errors. An objective, declarative knowledge question was added to determine whether the pilots' perceptions of the system reflected their ability to efficiently extract important information from a specific NOTAM.

"Pilots surveyed did not display sufficient understanding or a working knowledge of the complete NOTAMs system."

Seventy-nine respondents completed surveys anonymously and without compensation. They included 66 pilots, 11 dispatchers and two respondents who failed to answer the question regarding their certificate. Ages ranged from 18 to 30. All the pilots reported that they had been flying for more than a year; the median was 1,100 flight hours; average experience during the past year was more than 300 flight hours. Seventy-nine percent of the pilots met requirements to conduct instrument flights, and 60 percent had at least a commercial pilot certificate.

The survey consisted of 13 opinion statements for which the respondents were asked to rate their level of agreement on a six-point Likert attitude-measurement scale (from 1 = strongly disagree to 6 = strongly agree), one declarative knowledge question, nine open-ended qualitative questions and some demographic questions (Figure 8, page 17). The Likert scale statements focused on usability and satisfaction aspects of NOTAMs in general and of a specific NOTAM provided in the survey. The open-ended questions sought information such as how the respondents obtain NOTAM information, what they consider the most important information conveyed by NOTAMs, problems encountered with NOTAMs and suggestions for improvement.

The majority of the surveys were distributed during an aviation training seminar. Other surveys were distributed through airlines and dispatch offices. No time constraints were imposed on the respondents.

Means (averages of the ratings of questions per the Likert scale) and standard deviations (measures of the spread or scatter of the ratings of questions per the Likert scale) from the responses to the first eight questions (perceptions of the current NOTAMs system) are shown in Table 2 (page 19). Means and standard deviations for responses to Question 9 through Question 12 (perceptions of a specific NOTAM) are shown in Table 3 (page 19).

Question 13 (the declarative knowledge question) was scored as correct or incorrect; the results are shown in Table 4, page 19).

Means and standard deviations for responses to Question 14 (about the ease of answering Question 13) are shown in Table 5 (page 20).

As is typical of responses to most open-ended survey questions, many of the survey respondents did not respond to Question 15 through Question 23 (i.e., they left this survey section blank). Thus,

Continued on page 19

Figure 8

Pilot/Dispatcher Survey Form

DIRECTIONS: Please answer the following questions about the current Notices to Airmen (NOTAMs) system by circling the appropriate rating.

Example: **I will enjoy filling out this survey.**

1	2	3	4	5	(6)
Strongly Disagree		Disagree	Agree		Strongly Agree

BLOCK 1: CURRENT NOTAMS SYSTEM STATEMENTS

1. **I am satisfied with the current NOTAMs system.**

1	2	3	4	5	6
Strongly Disagree		Disagree	Agree		Strongly Agree

2. **It was easy to learn the current NOTAMs system.**

1	2	3	4	5	6
Strongly Disagree		Disagree	Agree		Strongly Agree

3. **It is easy to use the current NOTAMs system.**

1	2	3	4	5	6
Strongly Disagree		Disagree	Agree		Strongly Agree

4. **It is easy to make mistakes using the current NOTAMs system.**

1	2	3	4	5	6
Strongly Disagree		Disagree	Agree		Strongly Agree

5. **The current NOTAMs system is efficient for disseminating information to those who need it.**

1	2	3	4	5	6
Strongly Disagree		Disagree	Agree		Strongly Agree

6. **The current NOTAMs system is effective for providing needed information.**

1	2	3	4	5	6
Strongly Disagree		Disagree	Agree		Strongly Agree

7. **The current NOTAMs system uses consistent terminology and contractions.**

1	2	3	4	5	6
Strongly Disagree		Disagree	Agree		Strongly Agree

8. **The current NOTAMs system uses intuitive terminology and contractions.**

1	2	3	4	5	6
Strongly Disagree		Disagree	Agree		Strongly Agree

BLOCK 2: SPECIFIC NOTAM STATEMENTS

DIRECTIONS: The following section contains a current NOTAM for Lakeland Linder Regional Airport. The questions in this section pertain specifically to this NOTAM. Please answer the following questions about this NOTAM by circling the appropriate rating.

FDC 1/7679 /LAL/ FI/T LAKELAND LINDER REGIONAL, LAKELAND, FL. GPS RWY 23, ORIG. S-23: MDA 660/HAT 519 ALL CATS, VIS CAT C 1 1/2, CAT D 1 3/4. CIRCLING: MDA 720/HAA 578 ALL CATS. TAMPA INTL ALTIMETER SETTING MINIMUMS. S-23: MDA 740/HAT 599 ALL CATS. CIRCLING: MDA 800/HAA 658 ALL CATS. ILS RWY 5, AMDT 6. NDB OR GPS RWY 5, AMDT 3. CIRCLING: MDA 720/HAA 578 ALL CATS. TAMPA INTL ALTIMETER SETTING MINIMUMS. CIRCLING: MDA 800/HAA 658 ALL CATS. VOR OR GPS RWY 9, AMDT 3. CIRCLING: MDA 720/HAA 578 ALL CATS. DME MINIMUMS: CIRCLING MDA 720/HAA 578 ALL CATS. VOR OR GPS RWY 27, AMDT 6. DME MINIMUMS: CIRCLING MDA 720/HAA 578 ALL CATS. TEMPORARY CRANE 364 FT MSL 4200 FT N OF RWY 23 THLD.

9. **This NOTAM is easy to read and understand.**

1	2	3	4	5	6
Strongly Disagree		Disagree	Agree		Strongly Agree

10. **The layout of this NOTAM is easy to understand.**

1	2	3	4	5	6
Strongly Disagree		Disagree	Agree		Strongly Agree

11. **I would need to consult the list of contractions provided by the FAA to interpret this NOTAM.**

1	2	3	4	5	6
Strongly Disagree		Disagree	Agree		Strongly Agree

12. **This NOTAM could be easily misinterpreted.**

1	2	3	4	5	6
Strongly Disagree		Disagree	Agree		Strongly Agree

13. **What is the MDA for the VOR RWY 27 approach when Tampa Intl altimeter setting is used?**

14. **The preceding question about this NOTAM was easy to answer.**

1	2	3	4	5	6
Strongly Disagree		Disagree	Agree		Strongly Agree

Figure 8

Pilot/Dispatcher Survey Form *(continued)*

BLOCK 3: CURRENT NOTAMS SYSTEM QUESTIONS

DIRECTIONS: Please answer the following questions by writing in the space provided.

15. **When do you seek current NOTAM information?**

16. **How do you usually obtain current NOTAM information (include specific sources)?**

17. **What other ways have you used to obtain NOTAMs?**

18. **What do you consider to be the most important pieces of information that you need from current NOTAMs?**

19. **List any information that you would like to see in NOTAMs that is not currently provided.**

20. **List any information currently contained in NOTAMs that you think is irrelevant.**

21. **Which other sources of information besides NOTAMs do you consult for similar information (e.g., telephone the airport directly)?**

22. **Please describe any problems you have encountered due to lack of NOTAM information.**

23. **Please describe any changes you would like to see in the current NOTAMs system.**

BLOCK 4: BASIC BACKGROUND INFORMATION

Please check the appropriate group:

Age:	18-30	________	Gender: M	_______
	31-40	________	F	_______
	41-50	________		
	51-60	________		
	>60	________		

U.S. Pilot Certificate: (please check all that apply)

Student	________	Rotorcraft	_______
Private	________	Rating:	
Commercial	________	Instrument	_______
ATP	________	ASEL	_______
CFI	________	AMEL	_______
CFII	________	ASES	_______
MEI	________	AMES	_______
Glider	________	Dispatcher	_______

Please answer as appropriate:

How long have you been flying? _______ Years _______ Months

Total flight hours: _________________

Flight hours past 12 months: ____________

Are you instrument current? ___________ Yes _________ No

Source: University of Central Florida

the data shown in Figure 9 through Figure 15 are based not on the total number of participants, but solely on the responses of the participants who answered the questions. (An insufficient number of answers were provided to Question 20 and to Question 21 to merit further analysis of the responses to these questions.)

Table 2 and Table 3 show that there was not much variation in the ratings given by the respondents. All of the mean scores fall in the middle of the Likert scale, between 3 (disagree) and 4 (agree). Thus, the respondents did not feel strongly regarding most aspects of the current NOTAMs system and about the specific NOTAM

Table 2
Responses to Survey Statements on Current NOTAMs System

Statement	Mean	Standard Deviation	N
1. I am satisfied with the current NOTAMs system.	3.47	1.023	79
2. It was easy to learn the current NOTAMs system.	3.25	0.926	79
3. It is easy to use the current NOTAMs system.	3.28	0.905	79
4. It is easy to make mistakes using the current NOTAMs system.	4.25	1.031	79
5. The current NOTAMs system is efficient for disseminating information to those who need it.	3.17	1.668	78
6. The current NOTAMs system is effective for providing needed information.	3.56	0.971	79
7. The current NOTAMs system uses consistent terminology and contractions.	3.77	0.933	79
8. The current NOTAMs system uses intuitive terminology and contractions.	3.23	0.979	78

Note: Values are based on six-point Likert Scale (1 = Strongly Disagree, 6 = Strongly Agree).

NOTAMs = Notices to airmen N = Number of respondents

Source: University of Central Florida

Table 3
Responses to Survey Statements on Specific NOTAM

Statement	Mean	Standard Deviation	N
9. This NOTAM is easy to read and understand.	3.34	1.131	79
10. The layout of this NOTAM is easy to understand.	3.13	1.036	78
11. I would need to consult the list of contractions provided by the FAA to interpret this NOTAM.	3.45	1.265	78
12. This NOTAM could be easily misunderstood.	4.25	1.082	79

Note: Values are based on six-point Likert Scale (1 = Strongly Disagree, 6 = Strongly Agree).

NOTAM = Notice to airmen N = Number of responses FAA = U.S. Federal Aviation Administration

Source: University of Central Florida

Table 4
Responses to Survey Question 13

Question	Number Correct	Percent Correct	N
13. What is the MDA for the VOR RWY 27 approach when Tampa Intl altimeter setting is used?	51	68.9	74

Note: Answers were scored as incorrect = 0, correct = 1.

N = Number of responses MDA = Minimum descent altitude VOR = Very-high-frequency omnidirectional radio RWY = Runway

Source: University of Central Florida

Table 5
Responses to Survey Question 14

Statement	Mean	Standard Deviation	N
14. The preceding question about this NOTAM was easy to answer.	2.89	1.267	74

Note: Values are based on six-point Likert Scale (1 = Strongly Disagree, 6 = Strongly Agree).
N = Number of responses NOTAM = Notice to airmen

Source: University of Central Florida

provided in the survey. Nevertheless, it is also clear that the respondents were not very satisfied with the current system.

The means of the responses to two questions — Question 4 and Question 12, which were related to the ease of making mistakes and misunderstanding NOTAMs — were higher than 4. This indicates that the respondents believe that the system lends itself to mistakes and misunderstandings.

Question 13 and Question 14 provided additional interesting results. As can be seen from Table 4, approximately 69 percent of the participants were able to correctly answer the declarative knowledge question about the specific NOTAM. The mean for Question 14, which asked how easy it was to answer the preceding question, was 2.89, the lowest for the entire survey, which might indicate that although most participants were able to correctly answer the question, they believed that the question was difficult to answer. Nevertheless, this was *not* the case. Whether a participant was able to supply the correct answer had no bearing on whether they thought the question was easy or difficult to answer (e.g., some participants who answered the question incorrectly said that the question was easy to answer). The statistical correlation between responses to Question 13 and responses to Question 14 was almost nonexistent; the correlation ("r") was –0.003 (i.e., almost zero), and the probability ("p") that there was no correlation was 0.980 (i.e., almost 1.0, which, in the statistical analysis, would indicate no correlation).

This finding indicates that pilots do not have an accurate understanding of their own performance when using the NOTAMs system.

A positive correlation was found, however, between the number of dispatchers who participated in the survey and the number of correct answers the dispatchers provided for Question 13 ($r = 0.31$, $p = 0.008$). The correlation between being a dispatcher and answering the question correctly might be due to the fact that dispatchers work with NOTAMs on almost a daily basis and, thus, might have a better understanding of how the system works and how to interact effectively with the system. This explanation is supported by a statistical analysis of Question 5, which indicated that the dispatchers agreed more strongly than the pilots that the current NOTAMs system is efficient for disseminating information to those who need it.

Figure 9 (page 21) indicates that not all pilots check NOTAMs prior to each flight. Only slightly more than half of the participants who answered the question said that they always check NOTAMs. About one quarter said that they check NOTAMs only when they fly cross-country or to an airport with which they are not familiar. The NOTAMs system is designed to provide up-to-date, time-critical information that affects flight safety. Among the many possible reasons that pilots are not using the system were the difficulty of interpreting and understanding NOTAMs, the perception of being overloaded with information and a lack of trust in the system.

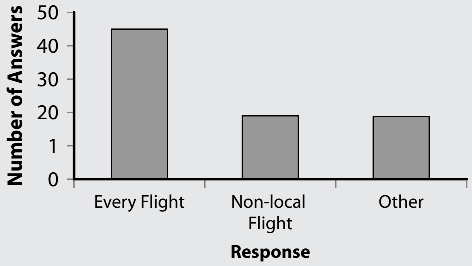
Figure 10 (page 21) and Figure 11 (page 21) show the numerous sources from which pilots obtain NOTAM information. Five specific sources were noted: FSSs, Internet, company, ATIS and DTN. Among "other" sources cited were other pilots, ATC towers and the *Notices to Airmen* publication.

Runway information was cited most frequently by the respondents as the most important information

Figure 9

Response to Survey Question 15

When do you seek current NOTAM information?



Number of answers = 83

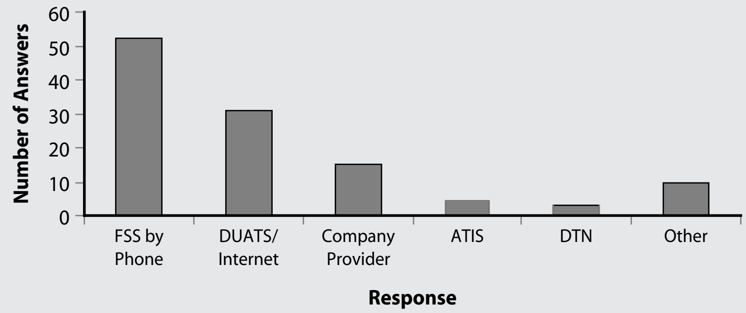
NOTAM = Notice to airmen

Source: University of Central Florida

Figure 10

Response to Survey Question 16

How do you usually obtain current NOTAM information?



Number of answers = 115

NOTAM = Notice to airmen FSS = Flight service station
DUATS = Direct user access terminal system
ATIS = Automatic terminal information system DTN = Data Transmission Network

Source: University of Central Florida

conveyed by NOTAMs, followed by information on navaids, TFRs and airspace, instrument approaches and airports (Figure 12, page 22).

Figure 13 (page 22) shows that although many respondents said that there was "too much (information) already" in NOTAMs, others had some suggestions for information that they would like to see included, such as a legend of contraction definitions, graphic depictions of NOTAM information and the date/time period that the NOTAM is effective.

Respondents cited unexpected restrictions to flights as the most frequent problem they have encountered because of a lack of NOTAM information (Figure 14, page 22).

The change that most respondents would like to occur is to reformat NOTAMs into easy-to-read, plain language (Figure 15, page 23). This is another indication that users might be having difficulty reading NOTAMs in the current format. Many respondents also said that they would like to have a more accessible, single source of NOTAMs.

Internet Poll Showed Similar Results

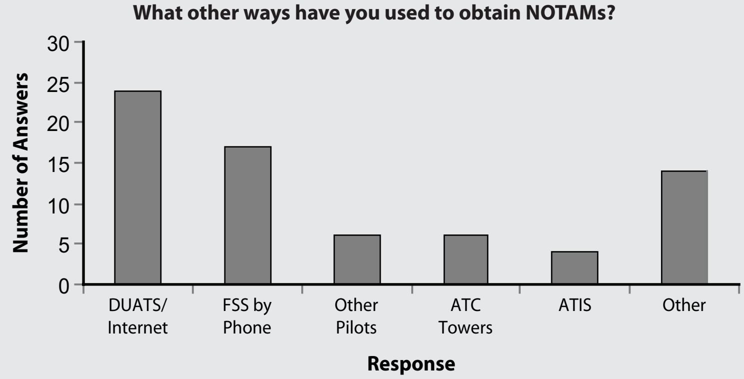
Participants in the Internet poll conducted by AVweb were asked to answer four questions and to give their opinions about the NOTAMs system in general. An analysis of the comments provided by more than 100 respondents to the poll showed many similarities in the issues addressed in the survey discussed above.

Most poll respondents said that NOTAMs should be presented in plain language that is easy to read and understand. It was suggested that FAA "take advantage of modern communications," that "cryptic notations" be eliminated and that NOTAMs "are too important to be published only

Figure 11

Response to Survey Question 17

What other ways have you used to obtain NOTAMs?



Number of answers = 71

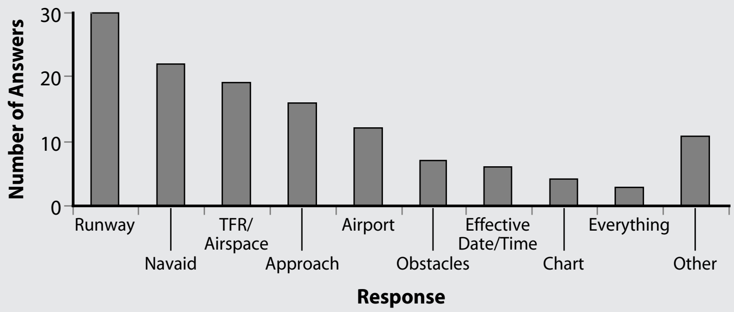
NOTAMs = Notices to airmen DUATS = Direct user access terminal system
FSS = Flight service station ATC = Air traffic control
ATIS = Automatic terminal information system

Source: University of Central Florida

Figure 12

Response to Survey Question 18

What is the most important information in NOTAMs?



Number of answers = 130

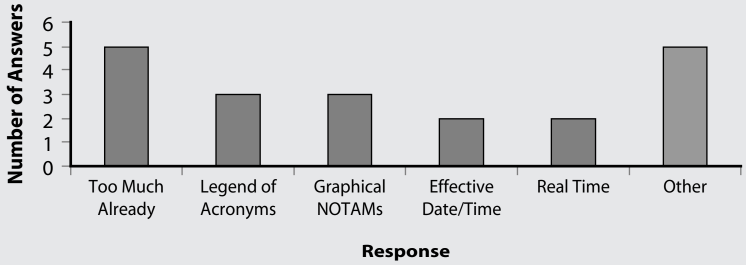
NOTAMs = Notices to airmen TFR = Temporary flight restriction

Source: University of Central Florida

Figure 13

Response to Survey Question 19

List any information that you would like to see in NOTAMs that is not currently provided.



Number of answers = 20

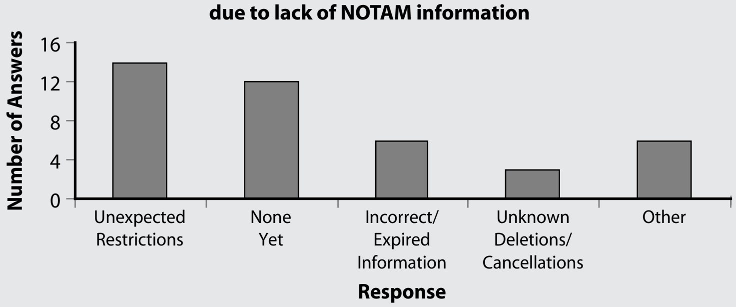
NOTAMs = Notices to airmen

Source: University of Central Florida

Figure 14

Response to Survey Question 22

Describe any problems you have had due to lack of NOTAM information



Number of answers = 41

NOTAM = Notice to airmen

Source: University of Central Florida

in coded format." One respondent said that pilots will "skip over" (disregard) NOTAMs that they do not understand, thus possibly missing key information. These results coincide with the results of the survey on this issue of codes and contractions. Pilots do not like them, nor do they believe that they are necessary any longer.

Many respondents said that they would like to receive NOTAMs that are directly relevant to their route of flight. They complained about being overloaded with information that makes it more difficult to find the truly relevant NOTAMs. One respondent said, "Why should I be told about the Iraqi no-fly zone when I'm flying from central Pennsylvania to northern Virginia?" Another said, "If I am flying in the Southeast, why do I care about NOTAMs concerning Oakland (California) Center?" This corresponds to the responses given in the survey. Pilots want only information that is relevant to their planned flight.

The respondents said that not only is there too much information provided, but that too many sources must be accessed to ensure that all pertinent NOTAMs are obtained. Most suggestions were for a single source, so that a user knows that all the important information has been obtained. This matched the survey responses. Poll respondents said that there is a need to make NOTAMs more accessible and believed that combining all information for access through a common source may be one solution to this problem.

Reports Indicate NOTAM Problems

A database search for "NOTAM" resulted in 1,932 reports from the FAA and the NTSB accident/incident databases, and 1,619 reports from the NASA ASRS database. The reports were reviewed for recurring events and common situations pertaining to all aspects of NOTAMs. General findings include the following:

- NOTAMs were not asked for or were not received by pilots;
- NOTAMs were received by pilots, but the information was disregarded;
- NOTAM information was not received by controlling facilities for dissemination to pilots and dispatchers; and,

- NOTAM information was communicated to and received by pilots, but the information was erroneous or inaccurate.

The following reports exemplify the survey data that were collected and the importance of the NOTAMs system.

An NTSB report on an accident involving an air-taxi pilot who did not receive correct information about the status of snow removal prior to landing stated the following:[20]

A NOTAM in effect at the time of the accident indicated, "(Runway) 11/29 18 IN SNBNK" and "ALL TWY (taxiway) EDGE LGTS (lights) OBSCD BY SNBNKS (snow banks)." The NOTAM did not indicate that the usable width of the runway was reduced. The pilot stated that after landing on Runway 11, while exiting the runway at high-speed Taxiway "C," the left main landing gear collided with an approximate 18-inch-high [46-centimeter-high] berm of ice. He taxied to the ramp, then noted damage to the airplane. Examination of Runway 11/29 by an FAA inspector revealed an 18-inch-high, three-foot-wide [one-meter-wide] berm of ice on either side of the runway, with the inner edge of the berm ice located approximately 6–8 feet [1.8–2.4 meters] inward from each runway edge. The ice berm had an opening for Taxiway C. The nose wheel was determined to be approximately three feet to the left of the lead-off line from the runway to the taxiway at the time of the accident.

The report said that the probable causes of the accident were "the inadequate wording of the NOTAM for failure to identify [that] the usable width of the runway was reduced and the inadequate snow removal by airport personnel."

There were several similar reports of snow, snow plows and other equipment on runways and taxiways.

The result of not properly checking all NOTAMs is described in the following report:[21]

After entering VFR conditions at 6,000 feet MSL (mean sea level), the pilot canceled his IFR flight plan and made a straight-in, visual approach to Runway 14, which had been NOTAM'd closed. During the landing, the airplane struck a lighted barricade, and its left wing contacted a 5- to 6-foot-high [1.5- to 1.8-meter-high] pile of gravel located about 3,100 feet beyond the end of the runway. The pilot stated he re-checked the NOTAMs for the airport after the accident and observed the NOTAM for the closed runway. The pilot said it was possible he did not scroll all the way down on the computer screen when he originally checked the NOTAMs.

The report said that the probable causes of the accident were "the pilot's inadequate preflight planning and his inadequate visual lookout."

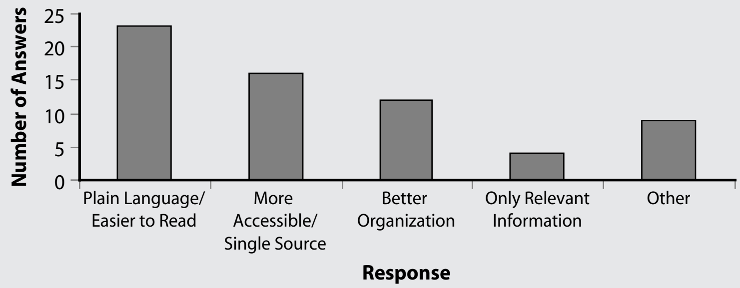
The following report indicates that improper use of the NOTAMs system was a factor in a fatal accident:[22]

During landing on a runway that was undergoing construction, the airplane impacted a dirt bank and nosed over. There was a NOTAM in effect, stating that the airport was closed. When the private pilot received a weather briefing for the cross-country flight, he was not given the NOTAM, since he did not tell the briefer [that] he intended to pass over or stop at the airport. The accident occurred at dusk, 24 minutes before sunset. The runway lights and the airport's rotating beacon were turned off, and the runway threshold was marked with an "X." Construction

Figure 15

Response to Survey Question 23

Please describe any changes you would like to see in the current NOTAMs system.



Number of answers = 64

NOTAM = Notice to airmen

Source: University of Central Florida

The system has remained relatively unchanged for three decades.

workers had removed the old asphalt runway surface and dumped truckloads of dirt along the runway centerline. A witness observed the airplane on a "normal landing approach" to Runway 22. The witness continued to watch the airplane until it disappeared from view behind the tree line. He then saw the airplane's "tail section go up in the air." The witness drove to the airport and found the airplane lying inverted on top of a dirt bank. Examination of the airframe and engine revealed no evidence of any pre-impact mechanical discrepancies that would have prevented normal operation.

The report said that the probable cause of the accident was "the pilot's failure to visually identify the hazardous condition of the runway" and that factors included "the dusk light condition and the pilot's failure to obtain NOTAMs."

A preliminary report on an air carrier accident demonstrates the potential results of inadequate dissemination of NOTAM information to a flight crew:[23]

On July 2, 2002, at 0922 central daylight time, a McDonnell Douglas MD-88 transport category airplane … was substantially damaged when the left wing of the airplane collided with parked construction trucks while taxiing to Gate 29 at the Houston Hobby Airport, near Houston, Texas. There were no injuries to the 58 passengers and the five crewmembers aboard the airplane. There were no reported injuries to anyone on the ground, and the extent of the damage sustained by the trucks is unknown. … After landing, the flight was cleared to cross Runway 22 and taxi to the gate. The pilot taxied on Taxiway Zulu, which is parallel to Taxiway Yankee, which was open. Taxiway Zulu was closed due to construction; however, the construction was not posted on the ATIS, NOTAM or dispatcher's release from the company. Ground control did not mention that Taxiway Zulu was closed.

The FAA inspector who traveled to the accident site reported that the [airplane's] number one slat and the left aileron were damaged, and the left wing sustained structural damage. No fuel spilled from the left wing. The flight taxied to the gate under its own power, where the passengers disembarked the airplane by normal means.

Conclusions

The NOTAMs system plays a fundamental role in aviation, providing critical information to ensure the safety of pilots, passengers, airplanes and ground crews. Considering that the system has remained relatively unchanged for three decades, an assumption could be that pilots have a considerable understanding of how the system functions and how they can benefit from the system. The results of this survey support the argument that this is not the case. The respondents might have been indifferent about many aspects of the NOTAMs system, but they did suggest ways to improve the system. Furthermore, their ability to use the system efficiently appeared to have no relation to how difficult or easy they believed the system actually is to use. This finding indicates that pilots might not have an accurate understanding of the system, even if they believe they do. The cross-checks with the AVweb poll results and the accident/incident databases lend additional support to the survey findings.

The next step in this evaluation was to determine why the NOTAMs system is not functioning as designed. This was accomplished by evaluating whether the NOTAMs system complies with FAA human factors principles.

Applying FAA Human Factors Design Principles to NOTAMs

In 1996, FAA issued the *Human Factors Design Guide* (*HFDG*) to provide "reference information to assist in the selection, analysis, design, development, and evaluation of new and modified [FAA] systems and equipment."[24] The *HFDG* contains guidance on automation, human-equipment interfaces, human-computer interfaces, workplace design and user documentation. The document was prepared specifically to serve as a user-friendly, all-encompassing source of human factors principles.

In 2000, Chapter 8, on human-computer interfaces, was revised and updated. The revision was necessary because of changes in technology, as well as new advancements in human factors research.[25]

An analysis of current NOTAMs based on information in the revised Chapter 8 and in Chapter 10 of the *HFDG* found numerous examples of noncompliance with the human factors principles prescribed by FAA. The following is a discussion of these examples, as well as suggestions for how NOTAMs could be improved to adhere to the human factors principles.

Use of Contractions

Perhaps the most obvious aspect of NOTAMs is that they are in contracted English. The use of contractions does not comply with 10 *HFDG* human factors principles.

Principle 1 (from *HFDG* paragraph 8.1.1.1): *Information should be presented simply and in a well-organized manner.*

The *HFDG* recommends the use of "plain and simple" language and presentation of information in "consistent, predictable locations."

This principle addresses more than one issue of NOTAMs. First, it steers designers away from using contractions and codes. Second, the principle states that information should be well-organized. NOTAMs are presented in numerical order, based on a numbering system devised by FAA. Thus, pilots must read an entire list of NOTAMs and try to pick out the most critical information. Depending on the source, the locations of the NOTAMs can vary and are often interspersed with weather information.

An example of the difficulty of using NOTAMs is a hypothetical situation in which a flight crew is told to expect to conduct the VOR/DME approach to Runway 36L at Orlando (Florida) International Airport. The approach chart that the crew is using depicts a visual descent point 9.1 nautical miles [16.9 kilometers] from the VOR. Nevertheless, among the many NOTAMs in effect for the airport is FDC 2/1300, which indicates that use of the visual descent point is not authorized (Figure 16, page 26).

Although, in theory, every pilot and dispatcher would be familiar with the NOTAMs pertaining to the flight, the reality is that clear, simple information must be readily available. Reading through the NOTAMs for items pertaining to the approach procedure during the final phases of a flight could lead to increased pilot workload and decreased situational awareness.

Principle 2 (from *HFDG* paragraph 8.1.1.4): *Information shall be presented to a user in a directly usable form; a user shall not have to decode or interpret data.*

Most pilots carry with them or make reference to the FAA's list of approved contractions to decipher NOTAMs. This principle clearly states that no decoding should be required for clear understanding of the information.

Principle 3 (from *HFDG* paragraph 8.1.1.7): *The words used in all non-editable text shall be task-oriented and familiar to users.*

The contractions used in NOTAMs clearly are not familiar to all users. If that were the case, pilots would not need to carry or utilize aids to help them read NOTAMs.

Principle 4 (from *HFDG* paragraph 8.2.5.4.1): *When a system or application uses abbreviations in its user-computer interface, the abbreviations shall be unique, distinct and unambiguous so as not to confuse users.*

Not all contractions used in NOTAMs and in weather reports have unique meanings. For example, "BC," which means "back course" in a NOTAM, means "patches" when used in an aviation routine weather report (METAR). Some contractions are similar or identical and could lead to confusion. For example, "BLO," means "below" in a NOTAM and "blowing" in a weather report.

The contractions used in NOTAMs clearly are not familiar to all users.

Principle 5 (from *HFDG* paragraph 8.2.5.4.3): *When the abbreviation of a word is not clear or may be misinterpreted, the entire word shall be used.*

Figure 16

NOTAMs for Orlando (Florida) International Airport

!FDC 2/5609 MCO FI/P ORLANDO INTL, ORLANDO, FL.
CORRECT U.S. TERMINAL PROCEDURES, SE, VOL 3 OF 4, DATED 13 JUN
2002, PAGE 248, ILS RWY 18R, AMDT 6...REF PROFILE VIEW GS ALT AT TUFFE INT SHOULD READ... 2200.

!FDC 2/5488 MCO FI/T ORLANDO INTL, ORLANDO, FL.
VOR/DME OR GPS RWY 36R, AMDT 9B…
GPS PORTION NA.

!FDC 2/5487 MCO FI/T ORLANDO INTL, ORLANDO, FL.
VOR/DME OR GPS RWY 18R, AMDT 5B…
GPS PORTION NA.

!FDC 2/5486 MCO FI/T ORLANDO INTL, ORLANDO, FL.
VOR/DME OR GPS RWY 18L, AMDT 5B…
GPS PORTION NA.

!FDC 2/4083 MCO FI/P ORLANDO INTL, ORLANDO, FL.
CORRECT U.S. TERMINAL SE VOLUME 3 DATED 18 APRIL 2002,
PAGE 252...MINIMUM BOX, ILS RWY 36R (CAT II), AMDT 6B...
SECOND LINE OF MINIMUMS SHOULD READ AS FOLLOWS: S-ILS-36R:
DH 192, VIS RVR 1200, HAT 100, RA 105, CATS A/B/C/D.

!FDC 2/4077 MCO FI/P ORLANDO INTL, ORLANDO, FL.
CORRECT U.S. TERMINAL SE VOLUME 3 DATED 18 APRIL 2002,
PAGE 250. ..MINIMUM BOX, ILS RWY 17 (CAT II), AMDT 2B...
SECOND LINE OF MINIMUMS SHOULD READ AS FOLLOWS: S-ILS-17:
DH 190, VIS RVR 1200, HAT 100, RA 104, CATS A/B/C/D.

!FDC 2/1301 MCO FI/T ORLANDO INTL, ORLANDO, FL.
VOR/DME OR GPS RWY 36R, AMDT 9B...
VISUAL DESCENT POINT NA.

!FDC 2/1300 MCO FI/T ORLANDO INTL, ORLANDO, FL.
VOR/DME RWY 36L, AMDT 4C...
VISUAL DESCENT POINT NA.

!FDC 2/1299 MCO CANCELLED BY FDC 2/5466 ON 06/13/02 11:52.

!FDC 1/7679 LAL FI/T LAKELAND LINDER REGIONAL, LAKELAND, FL.
GPS RWY 23, ORIG. S-23: MDA 660/HAT 519 ALL CATS, VIS CAT C 1 1/2,
CAT D 1 3/4. CIRCLING: MDA 720/HAA 578 ALL CATS.
TAMPA INTL ALTIMETER SETTING MINIMUMS. S-23: MDA 740/HAT 599
ALL CATS. CIRCLING: MDA 800/HAA 658 ALL CATS. ILS RWY 5, AMDT
6.

NOTAMs = Notices to airmen

Source: University of Central Florida

This principle follows the previous principle and the examples given above, in that confusion is possible in the translation of abbreviations. If abbreviations are used, they should not have multiple meanings; and abbreviations should not be so similar as to create confusion.

Principle 6 (from *HFDG* paragraph 8.2.5.4.4): *The use of abbreviations shall be minimized*.

The use of abbreviations is not minimized in NOTAMs.

Principle 7 (from *HFDG* paragraph 8.2.5.4.11): *Abbreviations should retain an alphabetic similarity to the longer word or phrase*.

While, in general, the abbreviations are made up of similar letters to the encoded information, some abbreviations are not intuitively decoded. For example, the weather abbreviations "BC" for "patches" and "BR" for "mist."

Principle 8 (from *HFDG* paragraph 8.2.5.4.12): *Words of five letters or less should not be abbreviated* *unless common usage has rendered the word and its abbreviation completely synonymous in recognition and intelligibility.*

FAA has approved contractions for words that consist of five letters or fewer than five letters. For example: "ABV" for "above," "DLY" for "daily," "L" for "left" and "SN" for "snow."

Principle 9 (from *HFDG* paragraph 10.2.3.1.1): *The text of a document shall be written in clear, simple language, free of vague, ambiguous, unfamiliar and unnecessary words.*

This principle is similar to others that have been discussed above. NOTAMs are not written in a clear, simple language, and they are replete with unfamiliar and sometimes ambiguous contractions.

Principle 10 (from *HFDG* paragraph 10.2.4.8.1): *Abbreviations and acronyms shall be kept to a minimum that is appropriate to the technical understanding and usage of the intended users. After its initial definition, an abbreviation or acronym shall be used whenever the term occurs.*

This principle is also a reiteration of a number of the principles already discussed. Abbreviations make up the majority of "words" in each NOTAM and thus are not kept to a minimum. Furthermore, abbreviations are never defined directly in NOTAMs and are found only in a separate list of approved contractions.

Suggestions for Improvement

While each of the principles discussed in the previous section addresses a unique aspect of using contractions, there is one suggestion for improvement that will accommodate all the different aspects: Stop using contractions. There is no longer a technological necessity to keep the number of characters transmitted and printed on a sheet of paper to a minimum. Networks of Teletype machines no longer are used to transmit this information. The Internet does not limit the amount or format of NOTAM information that can be distributed to the aviation community. Using plain English would minimize the amount of time required to find the list of contractions, decipher the message and then assess its value to the situation. Instead, a pilot would simply be able to read the NOTAM immediately and make a decision based on its content. Furthermore, there would be no need for those who write NOTAMs to encode them, thus saving valuable time in their dissemination.

Organization of NOTAMs

NOTAMs are organized by airport, based on a numbering system. Thus, a NOTAM written on Tuesday will be listed after a NOTAM written on Monday, regardless of content, level of importance, relevance, etc. This can lead to numerous problems. First, pilots and dispatchers must search an entire list of NOTAMs to find the notices that are important to their operations. These lists are often many pages long. Second, although each NOTAM is numbered, there is no indication of when a NOTAM was written. A pilot could try to determine this information based on the number, but that is most likely more work than one would like to embark upon.

Abbreviations make up the majority of 'words' in each NOTAM.

The organization of NOTAMs is contrary to 10 human factors principles presented in the *HFDG*.

Principle 11 (from *HFDG* paragraph 8.1.1.8): *When task performance requires or implies the need to assess the timeliness of information, the display should include time and date information associated with the data.*

The purpose of the NOTAMs system is to make available information that has not yet been published on navigation charts and in flight publications, and to notify pilots and dispatchers of temporary factors that might affect the progress of a flight. For example, tomorrow's runway closures must be provided to pilots today so that they can make appropriate plans for their flights. Thus, the information in many NOTAMs is time-critical and therefore would fall under the category of data to which this principle applies.

When two NOTAMs provide conflicting information, it is difficult to know which NOTAM should be used. For example, a recent NOTAMs list for Plant City (Florida) Airport contained the following notices about the Plant City (PCM) nondirectional beacon (NDB):

- "08/075 PCM NDB OTS [out of service]"; and,
- "05/079 PCM NDB UNMT [unmonitored]."

With no date and time information available, the current NOTAMs system does not comply with this principle.

Principle 12 (from *HFDG* paragraph 8.1.3.9) *Information should be prioritized so that the most important or critical information is displayed all the time and less important or critical information can be displayed upon a user's request.*

NOTAMs are organized by number; they are not prioritized based on their content. The most important NOTAMs are scattered among the less important NOTAMs. Irrelevant information is always provided, whether or not the user requests it.

Principle 13 (from *HFDG* paragraph 8.1.3.10): *Users should be able to control the amount, format and complexity of displayed data as necessary to meet task requirements.*

Similar to the last principle, users cannot control the amount or kind of NOTAMs they receive, aside from specifying the flight plan or area of interest. Furthermore, there is no sorting function, to specify only the most important NOTAMs, such as runway closures. The user has no control over the displayed information.

The user has no control over the displayed information.

Principle 14 (from *HFDG* paragraph 8.1.3.12): *When a window contains task-critical information, that information should be displayed in a way that users can identify easily, (e.g., separating it from other information by a blank space).*

NOTAMs are not displayed in any relevant order; task-critical information must be selected from the list given. The decision of what is task-critical and what is not must be made by the pilot or dispatcher, often under time pressure, thus increasing the chances for misinterpreting or overlooking important information.

Principle 15 (from *HFDG* paragraph 8.1.3.14): *The most important information and controls associated with a task should be located in the upper left part of its window and the least important at the bottom.*

The numerical ordering of NOTAMs contradicts this principle.

Principle 16 (from *HFDG* paragraph 8.1.3.15): *When displayed information is to be used in some spatial or chronological order, its arrangement on the screen shall preserve that order.*

This principle indicates that there should be a chronological order that would aid pilots in their hunt for the most relevant NOTAMs for a given flight plan. For example, if Runway 27R is closed today, but tomorrow there will be a crane obstructing the approach to Runway 27L, then the information for Runway 27R should be displayed before the information for Runway 27L. Because NOTAMs are not date/time-stamped, this is not feasible with the current system.

Principle 17 (from *HFDG* paragraph 8.1.3.16): *When ordering displayed information by sequence, function, frequency or importance is not appropriate, some other method such as alphabetical or chronological shall be followed.*

Although it is entirely appropriate to order NOTAM information by importance, function or sequence, this is not done; nor is alphabetical order or chronological order used.

Principle 18 (from *HFDG* paragraph 8.2.9.5): *Designers should base the order of items on natural rationale such as frequency of use, related functionality or the normal sequence of user actions.*

This principle indicates again that the numerical ordering of NOTAMs is an inefficient method for presenting critical information. This principle states that information should be presented as it would be used — for example, the most often used information should be presented first, information of the same type should be presented together, or information should be presented in the order that it will be used. Each of these organization strategies appears to be superior to the numerical system.

Principle 19 (from *HFDG* paragraph 8.2.9.7): *When there is no apparent logical basis for ordering items, then the items should be listed alphabetically.*

One of the problems with the NOTAMs system is that although there are logical bases for ordering the information, they are not used. This principle states that as a last resort, an alphabetical list should be used; NOTAMs are not organized alphabetically.

Principle 20 (from *HFDG* paragraph 8.2.9.9): *For a long list extending more than one displayed page, a hierarchic structure should be used to permit its logical partitioning into related shorter lists.*

As mentioned, NOTAMs often are presented in long lists from which relevant data must be identified and extracted. Because the information is presented numerically, there is no logical method of partitioning the information into smaller lists. The listing of NOTAMs is not hierarchical.

Suggestions for Improvement

The principles above highlight a variety of problems associated with the ordering system currently in use for NOTAMs. The main problems are that the numbering system is not a viable method for organizing data, the individual NOTAMs are not date-stamped or time-stamped, there appears to be no system for determining the relevance or importance of a NOTAM and displaying it accordingly, and there is no way for pilots or dispatchers to select the type of information they wish to receive.

The first suggestion is to date-stamp and time-stamp all NOTAMs. This would give pilots more information about the issuance of the particular NOTAM and would serve as a stepping stone for other improvements. The information would allow a chronological ordering system if deemed appropriate. Furthermore, when NOTAMs contradict one another, it would be much easier to determine which is the most current. The current numbering system could also be maintained, if necessary, for tracking purposes. An example of a proposed date-stamped and time-stamped NOTAM is shown in Figure 17 (page 30).

The second suggestion for improvement is to change the method of organization. NOTAMs could be organized by relevance, by chronological order, semantically, by a combination of factors or another logical method. Some research may be required to determine which of these ordering methods is most feasible. The advantages and disadvantages of each method are as follows:

Relevance

Organizing NOTAMs by relevance would be more difficult than it may appear because relevance is arbitrary. Nevertheless, one of the criticisms of the NOTAMs system is that it is time-consuming and tiresome to hunt through long lists for critical information. A reorganization strategy could begin by collecting data from pilots to determine what they believe are the most important pieces of information. This could be done by having pilots rate the information on a scale of "most important" to "least important." The results could be used to organize a tier system for NOTAMs, in which the most important information is given a rating of 1, and the least important information is given a rating of 5. This would be advantageous for numerous reasons and would conform to many of the above design principles. For example, Figure 18 (page 31) shows a proposed restructuring of the NOTAM in Figure 17 with minimal contractions and in sentence case.

Chronological Order

With a time stamp and date stamp, NOTAMs could be arranged by the order in which they are issued. NOTAMs also could be arranged according to the date and time at which they take effect. For example, one NOTAM might be issued today that states that Runway 24L will be closed tomorrow at 1600 UTC (coordinated universal time); a second NOTAM might then be issued tomorrow morning stating that Runway 24R will be closed immediately at 1000 UTC. In this situation, the second NOTAM should be

Figure 17

Date/Time-stamped NOTAM

FLIGHT DATA CENTER 1/7679 /ISSUED 06/24/2002 1400UTC, EFFECTIVE 06/27/2002 0900 UTC, VALID UNTIL FURTHER NOTICE/LAL/ FLIGHT INSPECTION/TEMPORY. LAKELAND LINDER REGIONAL, LAKELAND, FL. GPS RUNWAY 23, ORIG. S-23: MDA 660/HAT 519 ALL CATEGORIES, VISIBILITY CAT C 1 1/2, CAT D 1 3/4. CIRCLE TO LAND: MDA 720/HAA 578 ALL CATEGORIES. TAMPA INTERNATIONAL ALTIMETER SETTING MINIMUMS S-23: MDA 740/HAT 599 ALL CATEGORIES. CIRCLING: MDA 800/HAA 658 ALL CATEGORIES. ILS RWY 5, AMDT 6. NDB OR GPS RUNWAY 5, AMENDMENT 3. CIRCLE TO LAND: MDA 720/HAA 578 ALL CATS. TAMPA INTERNATIONAL ALTIMETER SETTING MINIMUMS. CIRCLE TO LAND: MDA 800/HAA 658 ALL CATEGORIES. VOR OR GPS RUNWAY 9, AMENDMENT 3. CIRCLE TO LAND: MDA 720/HAA 578 ALL CATEGORIES. DME MINIMUMS: CIRCLE TO LAND MDA 720/HAA 578 ALL CATEGORIES. VOR OR GPS RUNWAY 27, AMENDMENT 6. DME MINIMUMS: CIRCLE TO LAND MDA 720/HAA 578 ALL CATEGORIES. TEMPORARY CRANE 364 FEET MSL 4200 FT NORTH OF RUNWAY 23 THRESHOLD

NOTAM = Notice to airmen

Source: University of Central Florida

displayed prior to the first NOTAM because its effective time occurs first. Thus, NOTAMs could be arranged based upon when the NOTAMs are active or current.

Semantic Order

The use of a semantic system of order might be a viable alternative to the current numbering system. There are certain types of information that NOTAMs convey. This information could be organized not by level of importance, but by subject. For example, all runway closings could be grouped together, and all information about navigational facilities could be grouped together. The organization should be based, in part, on input from users — pilots and dispatchers — so that any changes reflect the way they understand and organize NOTAMs on their own. For example, rather than grouping runway closings, it might be more effective to group closings of any kind, including runways, airports, facilities, etc. This type of ordering system would allow pilots and dispatchers to go directly to the information they believe is most important.

Combinations of Sort Criteria

NOTAMs could be arranged first by order of importance, then by chronological order within the hierarchical categories of importance level, or any other combination of the above methods. Perhaps the most effective method would be to allow users to organize the data according to their needs. Principle 13 states that the user should have control over the format of the information being presented. Spreadsheet software applications allow for sorting of database information; the user could select a variable (e.g., level of importance, time and date, category, etc.) and then sort by that variable to organize the information according to personal preference. This would create a system that is more in line with the human factors principles for organization.

Use of All Uppercase Letters

The use of all uppercase letters in NOTAMs is an artifact from their transmission by Teletype machines, which generated data and printed data only in uppercase letters. This does not adhere to four human factors principles in the *HFDG*:

- Principle 21 (paragraph 8.2.5.8.1): *Text should be presented in a combination of uppercase and lowercase letters, following standard capitalization rules*;

- Principle 22 (paragraph 8.2.5.8.3): *Capitalization should only be used for: headlines, key phrases or acronyms, short items to draw the user's attention to important text (e.g., field labels or a window title), the first letter in a sentence, or a single character in each word in a title or label*;

Figure 18

Option for NOTAM Restructuring

Lakeland Linder Regional, Lakeland, FL (KLAL)

FDC NOTAM 1/7679, issued 06/24/2002 1400 UTC, effective 06/27/2002 0900 UTC. Due to a temporary crane 364 ft MSL 4,200 ft north of RWY 23 threshold, **approach minimums** are **increased** temporarily as follows:

RWY 23

GPS RWY S-23 —	All categories, MDA 660/HAT 519 Category C, VIS 1 1/2 Category D, VIS 1 3/4
GPS RWY S-23 — (Tampa International Altimeter Setting)	All categories, MDA 740/HAT 599
GPS RWY 23 Circling —	All categories, MDA 720/HAA 578
GPS RWY 23 Circling — (Tampa International Altimeter Setting)	All categories, MDA 800/HAA 658

RWY 5

ILS, NDB, GPS RWY 5 Circling —	All categories, MDA 720/HAA 578
ILS, NDB, GPS RWY 5 Circling — (Tampa International Altimeter Setting)	All categories, MDA 800/HAA 658

RWY 9

VOR, GPS RWY 9 Circling —	All categories, MDA 720/HAA 578
VOR, GPS RWY 9 Circling — (DME Minimums)	All categories, MDA 720/HAA 578

RWY 27

VOR, GPS RWY 27 Circling — (DME Minimums)	All categories, MDA 720/HAA 578

NOTAM = Notice to airmen

Source: University of Central Florida

- Principle 23 (paragraph 8.2.5.8.4): *Mixed case should be used for continuous text, messages, menu descriptions, button descriptions, or screen identification*; and,

- Principle 24 (paragraph 10.3.3.6.3): *The use of uppercase letters for words and phrases in text should be minimized; uppercase letters should not be used to emphasize a word or phrase.*

Suggestions for Improvement

Uppercase letters and lowercase letters should be used in text, in accordance with standard capitalization rules. For example, the first letter of a sentence should be capitalized, while the remainder of the sentence should be lower case, unless there is a proper noun, abbreviation or acronym used within that sentence. This would create text that is easier to read and to comprehend, and that does not contradict FAA's human factors principles.

User Requirements

A basic principle in human factors and usability research is that the user is of utmost importance in the design of anything with which the user must interact. It is necessary to understand the user's point of view to design products that will allow the user to function at optimal levels, and it is important to design the product to accommodate all levels of knowledge, experience, etc. Student pilots who are just beginning their training, as well as air carrier pilots with 20,000 flight hours, must be able to extract important information from NOTAMs. The current NOTAMs system, however, appears to have been designed for experts who have become accustomed to the contractions or who know where to find the necessary aids to help translate the information.

Principle 25 (from *HFDG* paragraph 8.2.1.2): *The format shall be appropriate to the user's level of training and experience.*

The NOTAMs format is not appropriate to various levels of training and experience. Some Internet NOTAM service providers and software applications translate NOTAMs into plain English; however, the NOTAMs system itself provides no guidance for those who are using it for the first time. In addition, there is inadequate formal training to familiarize pilots with NOTAMs and the difficulties inherent in using the NOTAMs system. Inexperienced pilots often must cope with a system for which they have little or no training, and they are expected to use it as efficiently as experienced pilots.

Principle 26 (from *HFDG* paragraph 8.2.1.3): *When appropriate, users should be able to select alternative styles of presentation (e.g., graphical or text).*

An improvement made by FAA in June 2002 was to issue "graphic notices" of TFRs in hard copy and electronically. Although the graphic notice depicts the restricted area in two dimensions by outlining an area on a navigational chart (sectional or terminal area), the text of the NOTAM still must be read to understand the TFR.

Figure 19 shows the text of a TFR issued because of a rescue operation near Lanai, Hawaii; Figure 20 (page 33) shows the graphic notice of the TFR. These two representations give the user a choice in how the information is viewed and are in accordance with Principle 26.

Figure 19

Text of Temporary Flight Restriction

FDC 4/2896 ZHN HI.. FLIGHT RESTRICTIONS HALEPALAOA LANDING, LANAI, HI. EFFECTIVE 0404071600 UTC UNTIL 0404080500 UTC. PURSUANT TO 14 CFR SECTION 91.137(A)(1) TEMPORARY FLIGHT RESTRICTIONS ARE IN EFFECT DUE TO RESCUE OPERATIONS. ONLY RELIEF AIRCRAFT OPERATIONS UNDER DIRECTION OF NATL MARINE FISHERY SERVICE ARE AUTHORIZED IN THE AIRSPACE AT AND BELOW 1500 FEET MSL WITHIN A 1 STATUE MILE RADIUS OF 204836N/1564824.8W AND THE LANAI /LNY/ VORTAC 065 DEGREE RADIAL AT 9.5 NAUTICAL MILES. SARAH MALLOY, TELEPHONE 808-721-5343, IS IN CHARGE OF THE OPERATION. HONOLULU CONTROL FACILTIY /HCF/, TELEPHONE 808-840 6201, IS THE FAA COORDINATION FACILITY.

Source: University of Central Florida

Principle 27 (from *HFDG* paragraph 10.1.1.1): *The procuring agency shall provide a description of the expected users of the document to the document contractor. The description would include the following sorts of information: (1) aptitude profile, (2) reading level, (3) time in job, (4) job-related training, (5) job-related work experience, and (6) job-related skills, knowledge and duties. This description could be iterated between the procuring agency and the technical writers until they mutually agree that it is sufficient.*

The range of capabilities of most users of the current NOTAMs system can be documented by the requirements of the certificates that pilots and dispatchers are required to hold. This information could be incorporated into the design process.

Principle 28 (from *HFDG* paragraph 10.1.1.2): *If the users of a document are expected to vary widely in their skills and levels of experience, the document shall permit use in different ways by people at different levels, or different versions of the document shall be prepared for people at different levels. If a single document is designed for use by people with different skill levels, use by people at one level shall not be hindered by the material relevant to a different level.*

Once the skill and knowledge levels of the system users are known, structuring the NOTAMs system for all levels of understanding could be accomplished.

Suggestions for Improvement

Some type of training should be provided for pilots to ensure that they learn how to use the NOTAMs system and to promote an accurate understanding of the system so that it can be used *efficiently*. There currently exists inadequate formal training for using NOTAMs. Pilots must learn on their own where to get NOTAM information, how to understand NOTAM information, etc. This results in varying levels of understanding of the system, as well as varying levels of interaction with the system. Implementing some type of training for pilots would not only allow the FAA to understand their users, as prescribed in Principle 27, but also to gain an understanding of the different skill levels of those pilots and then accommodate them appropriately.

The system should be revised to allow users to select among various options for formatting and organizing NOTAMs. There are differences in how people learn and how people organize information. Some people are adept at comprehending and interpreting written information, while others need a visual example of whatever is being described. Allowing the user to select the preferred option for NOTAM formatting and organization can promote overall usage of the system, as well as more efficient dissemination of information. Allowing the user to select the preferred formatting and organization could greatly increase efficiency and user satisfaction with the NOTAMs system.

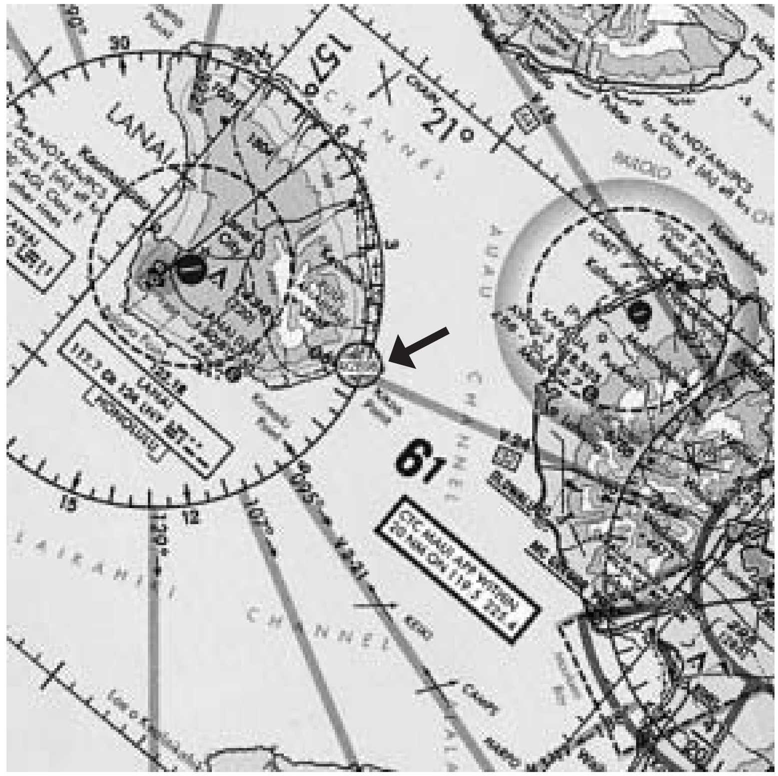
Summary and Outlook

This human factors evaluation of the NOTAMs system revealed several shortcomings. The system initially was developed in parallel with advances in technology; but the system remained unchanged while technology continued to advance. Reports on accidents and incidents, as well as the survey of pilots and dispatchers, indicate that pilots frequently make mistakes using NOTAMs. Training pilots and dispatchers to use the system efficiently is recommended in the near term. Moreover, many pilots favor improving the system and suggested that NOTAMs in plain language from a single source would greatly enhance the efficiency of the system.

A redesign of the current NOTAMs system would be costly, time-intensive and likely to result in a problematic transition period. The system is replete with problems, and most likely trying to make changes within the current system will lead to even more problems or only temporary solutions. Nevertheless, a redesign of the system is a solution that will result in long-term improvements in efficiency, performance and satisfaction.

Figure 20

Graphic Depiction of Temporary Flight Restriction



Note: Graphic depictions of temporary flight restrictions (TFRs) are in color. Arrow added to show area affected by TFR.

Source: University of Central Florida

The following research and development efforts are recommended:

- A comprehensive, multi-modal training program should be developed and distributed to all users of, and contributors to, the NOTAMs system (both domestic and international);
- Prototypes of candidate methods and styles of information presentation should be developed in accordance with human factors design guidelines;
- An evaluation should be conducted to determine which prototypes are liked, used and understood by users. Several iterations of the design should be investigated to develop a "New NOTAMs System" prototype;
- A study should be conducted to determine the benefits (e.g., improved knowledge, ease

of use, user reception) of the new system; and,

- An Internet search engine capable of retrieving *all* pertinent NOTAMs and presenting them in a customized fashion should be developed and tested.■

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Notes

1. International Civil Aviation Organization (ICAO). International Standards and Recommended Practices. *Annex 15 to the Convention on International Civil Aviation: Aeronautical Information Services*. Chapter 5, *NOTAM*.

2. National Aviation Safety Data Analysis Center. Retrieved Jan. 24, 2002, from <http://nasdac.faa.gov/lib/vtopic.exe>.

3. AVweb. "Question of the Week: Real-time Results: NOTAM System." Retrieved June 19, 2002, from <www.avweb.com/qotw/qotwform.cgi?0150>.

4. Hill, J.C.; Utegaard, T.F.; Riordan, G. *Dutton's Navigation and Piloting*. Annapolis, Maryland, U.S.: U.S. Naval Institute. 1957.

5. Moore, L.E. *Elementary Avigation*. Boston, Massachusetts, U.S.: D.C. Heath and Co. 1943.

6. Shields, B.A. *Air Pilot Training*. New York, New York, U.S.: McGraw-Hill Book Co. 1942.

7. Aviation Education Research Group. *Air-Age Education Series: Science of Pre-Flight Aeronautics*. New York, New York, U.S.: Macmillan Co. 1943.

8. FAA. *Aeronautical Information Manual*. Retrieved April 2, 2004, from <www.faa.gov/ATPUBS/AIM/index.htm>.

9. FAA. Federal Aviation Order 7930.2J, *Notices to Airmen (NOTAMS)*. Retrieved Oct. 17, 2002, from <www.faa.gov/ntap/>.

10. U.S. National Weather Service (NWS). *A Pilot's Guide to Aviation Weather Services*. Retrieved July 4, 2002, from <http://www.srh.noaa.gov/elp/aviation/pilot.html>.

11. FAA. *PilotWeb*. Retrieved April 2, 2004, from <https://pilotweb.nas.faa.gov/distribution/atcscc.html>.

12. ICAO. Annex 15. Appendix 2: *SNOWTAM Format*. Appendix 3: *ASHTAM Format*.

13. FAA. U.S. Federal Aviation Regulations Part 121, *Operating Requirements: Domestic, Flag, and Supplemental Operations*. Subpart U, *Dispatching and Flight Release Rules*. Part 121.613, "Dispatch or flight release under IFR or over the top."

14. U.S. National Transportation Safety Board (NTSB). Aircraft Accident Brief DCA01MA034. See also: FSF Editorial Staff. "Reduced Visibility, Mountainous Terrain Cited in Gulfstream III CFIT at Aspen." *Accident Prevention* Volume 59 (November 2002).

15. FAA. *United States Standard for Terminal Instrument Procedures (TERPS)*. Chapter 5, "TACAN, VOR/DME and VOR With FAF."

16. Aviation Safety Council of Taiwan (China). Aircraft Accident Report no. ASC-AAR-02-04-001, *Crashed on a Partially Closed Runway During Takeoff, Singapore Airlines Flight 006, Boeing 747-400, 9V-SPK, CKS Airport, Taoyuan, Taiwan* [China], *October 31, 2000*. See also: FSF Editorial Staff. "Accident Report Provides Lessons Learned About Preventing Takeoff on a Closed Runway." *Accident Prevention* Volume 59 (July 2002).

17. U.S. National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS) report no. 2001GL190013 and personal communication, May 14, 2002.

    NASA ASRS is a confidential incident-reporting system. The ASRS Program Overview said, "Pilots, air traffic controllers, flight attendants, mechanics, ground personnel and others involved in aviation operations submit reports to the ASRS when they are involved in, or observe, an incident or situation in which aviation safety was compromised. … ASRS de-identifies reports before entering them into the incident database. All personal and organizational names are removed. Dates, times, and related information, which could be used to infer an identity, are either generalized or eliminated."

    ASRS acknowledges that its data have certain limitations. ASRS *Directline* (December 1998) said, "Reporters to ASRS may introduce biases that result from a greater tendency to report serious events than minor ones; from organizational and geographic influences; and from many other factors. All of these potential influences reduce the confidence that can be attached to statistical findings based on ASRS data. However, the proportions of consistently reported incidents to ASRS, such as altitude deviations, have been remarkably stable over many years. Therefore, users of ASRS may presume that incident reports drawn from a time interval of several or more years will reflect patterns that are broadly representative of the total universe of aviation safety incidents of that type."

18. Pike, W. *General Aviation Summit*. Retrieved on April 22, 2002, from <www.naats.org/nrofs/gasummit.htm>.

19. FAA Office of Systems Safety.

20. NTSB accident report no. MIA00LA077.

21. NTSB accident report no. NYC00LA003.

22. NTSB accident report no. FTW99FA049.

23. NTSB preliminary accident report no. FTW02LA199.

24. Wagner, D.; Birt, J.A.; Snyder, M.; Duncanson, J.P. *Human Factors Design Guide*. Technical report DOT/FAA/CT-96/1. 1996.

25. Ahlstrom, V.; Longo, K. *Computer-Human Interface Guidelines: A Revision to Chapter 8 of the Human Factors Design Guide*. Technical report DOT/FAA/CT-TN00/30. 2000.

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Further Reading From FSF Publications

FSF Editorial Staff. "New Strategies Prevent ATC Clearances for Operation on Closed Runways." *Airport Operations* Volume 29 (July–August 2003).

FSF Editorial Staff. "Failure to Maintain Situational Awareness Cited in Learjet Approach Accident." *Accident Prevention* Volume 60 (June 2003).

FSF Editorial Staff. "Inadequate Weather Communication Cited in B-737 Microburst-downdraft Incident." *Airport Operations* Volume 29 (January–February 2003).

FSF Editorial Staff. "Solutions Target Chronic Hazards to Aircraft During Airport Construction." *Airport Operations* Volume 28 (September–October 2002).

FSF Editorial Staff. "Erroneous ILS Indications Pose Risk of Controlled Flight Into Terrain." *Flight Safety Digest* Volume 21 (July 2002).

U.S. National Transportation Safety Board. "Aircraft Accident Report: Controlled Flight Into Terrain; Korean Air Flight 801; Boeing 747-300, HL7468; Nimitz Hill, Guam; August 6, 1997." *Flight Safety Digest* Volume 19 (May–July 2000).

FSF Editorial Staff. "Crew Fails to Compute Crosswind Component, Boeing 757 Nosewheel Collapses on Landing." *Accident Prevention* Volume 57 (March 2000).

Adamski, Anthony J.; Stahl, Albert F. "Principles of Design and Display for Aviation Technical Messages." *Flight Safety Digest* Volume 16 (January 1997).

FARs Part 121 Accident Rate Remained at Low End of 20-year Range in 2003

An apparent accident-rate increase for on-demand operations was questioned by the U.S. National Transportation Safety Board because of revisions by the U.S. Federal Aviation Administration to estimates of flight activity.

— FSF EDITORIAL STAFF

Preliminary U.S. aviation accident data for 2003 indicated that accidents per million hours flown under U.S. Federal Aviation Regulations (FARs) Part 121 increased (Table 1, page 37); one accident involving fatalities to airplane occupants occurred. Despite the increase, the 2003 accident rate was lower than in 14 years of the 20 years in the 1984–2003 period. The years with higher rates included 12 years during which Part 121 represented only large transport category airplanes. (Since March 20, 1997, aircraft with 10 or more seats used in scheduled passenger service have been operated under Part 121.) The data were compiled by the U.S. National Transportation Safety Board (NTSB).

The Part 121 accident in which airplane occupants were killed involved a Raytheon Beech 1900 that struck terrain soon after takeoff on Jan. 8, 2003. (Fatalities included two crewmembers and 19 passengers. NTSB determined that the probable cause of the accident was the crew's loss of pitch control during takeoff, which resulted from incorrect rigging of the elevator-control system compounded by the aircraft's center of gravity, which was substantially aft of the certified aft limit.) A tug driver was killed in the only other fatal Part 121 accident, on Sept. 12, 2003, involving a McDonnell Douglas DC-9. (Investigation by NTSB continued when the preliminary 2003 accident data were published.)

In Part 121 scheduled-airline service (Table 2, page 38), the total of 52 accidents represented an increase compared with 2002, as did the rate of 0.531 accidents per 100,000 departures. The corresponding fatal-accident rate for 2003, however, at 0.020 per

The 2003 accident rate was lower than in 14 years of the 20 years in the 1984–2003 period.

Table 1
Accidents and Accident Rates for U.S. Air Carriers Operating Under FARs Part 121, 1984 Through 2003

	Accidents				Aircraft Hours Flown (millions)	Accidents per Million Hours Flown			
Year	Major[1]	Serious[2]	Injury[3]	Damage[4]		Major	Serious	Injury	Damage
1984	2	2	6	6	8.165	0.245	0.245	0.735	0.735
1985	8	2	5	6	8.710	0.918	0.230	0.574	0.689
1986	4	0	13	7	9.976	0.401	0.000	1.303	0.702
1987	5	1	12	16	10.645	0.470	0.094	1.127	1.503
1988	4	2	13	11	11.141	0.359	0.180	1.167	0.987
1989	8	4	6	10	11.275	0.710	0.355	0.532	0.887
1990	4	3	10	7	12.150	0.329	0.247	0.823	0.576
1991	5	2	10	9	11.781	0.424	0.170	0.849	0.764
1992	3	3	10	2	12.360	0.243	0.243	0.809	0.162
1993	1	2	12	8	12.706	0.079	0.157	0.944	0.630
1994	4	0	12	7	13.124	0.305	0.000	0.914	0.533
1995	3	2	14	17	13.505	0.222	0.148	1.037	1.259
1996	6	0	18	13	13.746	0.436	0.000	1.309	0.946
1997	2	4	24	19	15.838	0.126	0.253	1.515	1.200
1998	0	3	21	26	16.817	0.000	0.178	1.249	1.546
1999	2	2	20	27	17.555	0.114	0.114	1.139	1.538
2000	3	3	20	30	18.299	0.109	0.109	1.093	1.475
2001	5	1	18	21	17.752	0.282	0.056	1.014	1.183
2002	1	1	14	25	18.012	0.056	0.056	0.777	1.388
2003	2	2	24	26	17.121	0.117	0.117	1.402	1.519

Note: The 2003 data are preliminary. Since March 20, 1997, aircraft with 10 or more seats used in scheduled passenger service have been operated under U.S. Federal Aviation Regulations (FARs) Part 121.

[1] The U.S. National Transportation Safety Board (NTSB) defines a major accident as one in which a Part 121 aircraft was destroyed; or there were multiple fatalities; or there was one fatality and a Part 121 aircraft was substantially damaged.

[2] NTSB defines a serious accident as one in which there was one fatality without substantial damage to a Part 121 aircraft or there was at least one serious injury and a Part 121 aircraft was substantially damaged.

[3] NTSB defines an injury accident as a nonfatal accident with at least one serious injury and without substantial damage to a Part 121 aircraft.

[4] NTSB defines a damage accident as an accident in which no person was killed or seriously injured, but in which any aircraft was substantially damaged.

Source: U.S. National Transportation Safety Board

100,000 departures, was lower than rates for 12 years during the period. In Part 121 nonscheduled-airline service — representing a small percentage of the Part 121 total — 2003 accidents were lower in number and rate per 100,000 departures than in the previous year (Table 3, page 39).

Part 135 commuter (scheduled-airline) operations resulted in two accidents in 2003, compared with eight in 2002 (Table 4, page 40). Accidents per 100,000 departures declined from 1.67 to 0.37 between 2002 and 2003. The 2003 rate was one of the three lowest in the category for the 20-year period.

The number of accidents increased from 59 in 2002 to 77 in 2003 in Part 135 on-demand (air taxi) operations (Table 5, page 41), and the rate of accidents per 100,000 flight hours rose from 2.03 to 2.61. (No departure data were available in this category.)

NTSB said that the accident rate for on-demand operations was questioned because of "lack of precision in the flight-activity estimates" by the U.S. Federal Aviation Administration (FAA), which supplied flight hours, miles and departures in all categories. NTSB said, "FAA made major revisions to flight estimates in 2002, retroactive to 1992. In 2003, [FAA] revised the flight-hour estimates for 1999–present." The effects of those revisions are shown in Table 6 and Figure 1 (page 42).■

Table 2

Accidents, Fatalities and Rates for U.S. Air Carriers Operating Under FARs Part 121, Scheduled-airline Service, 1984 Through 2003

	Accidents		Fatalities					Accidents per 100,000 Flight Hours		Accidents per 1,000,000 Miles Flown		Accidents per 100,000 Departures	
Year	All	Fatal	Total	Aboard	Flight Hours	Miles Flown	Departures	All	Fatal	All	Fatal	All	Fatal
1984	13	1	4	4	7,736,037	3,258,910,000	5,666,076	0.168	0.013	0.0040	0.0003	0.229	0.018
1985	17	4	197	196	8,265,332	3,452,753,000	6,068,893	0.206	0.048	0.0049	0.0012	0.280	0.066
1986*	21	2	5	4	9,495,158	3,829,129,000	6,928,103	0.211	0.011	0.0052	0.0003	0.289	0.014
1987*	32	4	231	229	10,115,407	4,125,874,000	7,293,025	0.306	0.030	0.0075	0.0007	0.425	0.041
1988*	29	3	285	274	10,521,052	4,260,785,000	7,347,575	0.266	0.019	0.0066	0.0005	0.381	0.027
1989	24	8	131	130	10,597,922	4,337,234,000	7,267,341	0.226	0.075	0.0055	0.0018	0.330	0.110
1990	22	6	39	12	11,524,726	4,689,287,000	7,795,761	0.191	0.052	0.0047	0.0013	0.282	0.077
1991	25	4	62	49	11,139,166	4,558,537,000	7,503,873	0.224	0.036	0.0055	0.0009	0.333	0.053
1992	16	4	33	31	11,732,026	4,767,344,000	7,515,373	0.136	0.034	0.0034	0.0008	0.213	0.053
1993	22	1	1	0	11,981,347	4,936,067,000	7,721,870	0.184	0.008	0.0045	0.0002	0.285	0.013
1994*	19	4	239	237	12,292,356	5,112,633,000	7,824,802	0.146	0.033	0.0035	0.0008	0.230	0.051
1995	34	2	166	160	12,776,679	5,328,969,000	8,105,570	0.266	0.016	0.0064	0.0004	0.419	0.025
1996	32	3	342	342	12,971,676	5,449,997,000	7,851,298	0.247	0.023	0.0059	0.0006	0.408	0.038
1997	44	3	3	2	15,061,662	6,339,432,000	9,925,058	0.292	0.020	0.0069	0.0005	0.443	0.030
1998	43	1	1	0	15,921,447	6,343,690,000	10,535,196	0.270	0.006	0.0068	0.0002	0.408	0.009
1999	46	2	12	11	16,693,365	6,689,327,000	10,860,692	0.276	0.012	0.0069	0.0003	0.424	0.018
2000	50	3	92	92	17,478,519	7,152,260,112	11,043,409	0.286	0.017	0.0070	0.0004	0.453	0.027
2001*	42	6	531	525	17,157,858	6,994,939,000	10,634,051	0.221	0.012	0.0054	0.0003	0.357	0.019
2002	34	0	0	0	16,397,413	6,789,994,000	9,884,540	0.207	—	0.0050	—	0.344	—
2003	52	2	22	21	16,600,000	6,800,000,000	9,800,000	0.313	0.012	0.0076	0.0003	0.531	0.020

Notes: The 2003 data are preliminary. Flight hours, miles and departures are compiled by the U.S. Federal Aviation Administration.

Since March 20, 1997, aircraft with 10 or more seats used in scheduled passenger service have been operated under U.S. Federal Aviation Regulations (FARs) Part 121.

Years marked with * are those in which an illegal act was responsible for an occurrence in this category. These acts, such as suicide and sabotage, are included in the totals for accidents and fatalities but are excluded for the purpose of accident-rate computation. Other than the persons aboard aircraft who were killed, fatalities resulting from the Sept. 11, 2001, terrorist acts are excluded from this table.

Source: U.S. National Transportation Safety Board

Table 3
Accidents, Fatalities and Rates for U.S. Air Carriers Operating Under FARs Part 121, Nonscheduled-airline Service, 1984 Through 2003

	Accidents		Fatalities					Accidents per 100,000 Flight Hours		Accidents per 1,000,000 Miles Flown		Accidents per 100,000 Departures	
Year	All	Fatal	Total	Aboard	Flight Hours	Miles Flown	Departures	All	Fatal	All	Fatal	All	Fatal
1984	3	0	0	0	429,087	169,153,000	232,776	0.699	—	0.0177	—	1.289	—
1985	4	3	329	329	444,562	178,264,000	237,866	0.900	0.675	0.0224	0.0168	1.682	1.261
1986	3	1	3	3	480,946	188,497,000	273,924	0.624	0.208	0.0159	0.0053	1.095	0.365
1987	2	1	1	1	529,785	234,647,000	308,348	0.378	0.189	0.0085	0.0043	0.649	0.324
1988	1	0	0	0	619,496	242,641,000	368,486	0.161	—	0.0041	—	0.271	—
1989	4	3	147	146	676,621	267,849,000	378,153	0.591	0.443	0.0149	0.0112	1.058	0.793
1990	2	0	0	0	625,390	258,545,000	296,545	0.320	—	0.0077	—	0.674	—
1991	1	0	0	0	641,444	266,287,000	311,002	0.156	—	0.0038	—	0.322	—
1992	2	0	0	0	627,689	272,091,000	365,334	0.319	—	0.0074	—	0.547	—
1993	1	0	0	0	724,859	313,402,000	351,303	0.138	—	0.0032	—	0.285	—
1994	4	0	0	0	831,959	365,485,000	413,504	0.481	—	0.0109	—	0.967	—
1995	2	1	2	2	728,578	325,100,000	351,895	0.275	0.137	0.0062	0.0031	0.568	0.284
1996	5	2	38	8	774,436	423,111,000	377,512	0.646	0.258	0.0118	0.0047	1.324	0.530
1997	5	1	5	4	776,447	357,206,000	393,325	0.644	0.129	0.0140	0.0028	1.271	0.254
1998	7	0	0	0	895,108	392,853,000	444,566	0.782	—	0.0178	—	1.575	—
1999	5	0	0	0	861,843	411,987,000	448,070	0.580	—	0.0121	—	1.116	—
2000	6	0	0	0	820,738	371,767,000	414,403	0.731	—	0.0161	—	1.448	—
2001	4	0	0	0	656,333	299,252,000	321,952	0.609	—	0.0134	—	1.242	—
2002	7	0	0	0	588,675	265,967,000	253,684	1.189	—	0.0263	—	2.759	—
2003	2	0	0	0	521,000	237,200,000	202,000	0.384	—	0.0084	—	0.990	—

Notes: The 2003 data are preliminary. Flight hours, miles and departures are compiled by the U.S. Federal Aviation Administration.

FARs = U.S. Federal Aviation Regulations

Source: U.S. National Transportation Safety Board

STATS

Table 4

Accidents, Fatalities and Rates for U.S. Air Carriers Operating Under FARs Part 135, Scheduled-airline Service, 1984 Through 2003

	Accidents		Fatalities					Accidents per 100,000 Flight Hours		Accidents per 1,000,000 Miles Flown		Accidents per 100,000 Departures	
Year	All	Fatal	Total	Aboard	Flight Hours	Miles Flown	Departures	All	Fatal	All	Fatal	All	Fatal
1984	22	7	48	46	1,745,762	291,460,000	2,676,590	1.260	0.401	0.0755	0.0240	0.822	0.262
1985	18	7	37	36	1,737,106	300,817,000	2,561,463	1.036	0.403	0.0598	0.0233	0.703	0.273
1986	14	2	4	4	1,724,586	307,393,000	2,798,811	0.812	0.116	0.0455	0.0065	0.500	0.071
1987	33	10	59	57	1,946,349	350,879,000	2,809,918	1.695	0.514	0.0940	0.0285	1.174	0.356
1988	18	2	21	21	2,092,689	380,237,000	2,909,005	0.860	0.096	0.0473	0.0053	0.619	0.069
1989	19	5	31	31	2,240,555	393,619,000	2,818,520	0.848	0.223	0.0483	0.0127	0.674	0.177
1990	15	3	6	4	2,341,760	450,133,000	3,160,089	0.641	0.128	0.0333	0.0067	0.475	0.095
1991	23	8	99	77	2,291,581	433,900,000	2,820,440	1.004	0.349	0.0530	0.0184	0.815	0.284
1992*	23	7	21	21	2,335,349	507,985,000	3,114,932	0.942	0.300	0.0433	0.0138	0.706	0.225
1993	16	4	24	23	2,638,347	554,549,000	3,601,902	0.606	0.152	0.0289	0.0072	0.444	0.111
1994	10	3	25	25	2,784,129	594,134,000	3,581,189	0.359	0.108	0.0168	0.0050	0.279	0.084
1995	12	2	9	9	2,627,866	550,377,000	3,220,262	0.457	0.076	0.0218	0.0036	0.373	0.062
1996	11	1	14	12	2,756,755	590,727,000	3,515,040	0.399	0.036	0.0186	0.0017	0.313	0.028
1997	16	5	46	46	982,764	246,029,000	1,394,096	1.628	0.509	0.0650	0.0203	1.148	0.359
1998	8	0	0	0	353,670	50,773,000	707,071	2.262	—	0.1576	—	1.131	—
1999	13	5	12	12	342,731	52,403,000	672,278	3.793	1.459	0.2481	0.0954	1.934	0.744
2000	12	1	5	5	369,535	44,944,000	610,661	3.247	0.271	0.2670	0.0222	1.965	0.164
2001	7	2	13	13	300,432	43,099,000	559,402	2.330	0.666	0.1624	0.0464	1.251	0.358
2002	8	0	0	0	251,481	36,492,000	479,110	3.181	—	0.2192	—	1.670	—
2003	2	1	2	2	277,800	41,127,000	539,900	0.720	0.360	0.0486	0.0243	0.370	0.185

Notes: The 2003 data are preliminary. Flight hours, miles and departures are compiled by the U.S. Federal Aviation Administration.

Since March 20, 1997, aircraft with 10 or more seats used in scheduled passenger service have been operated under U.S. Federal Aviation Regulations (FARs) Part 121.

Years marked with * are those in which an illegal act was responsible for an occurrence in this category. These acts, such as suicide and sabotage, are included in the totals for accidents and fatalities but are excluded for the purpose of accident-rate computation. Other than the persons aboard aircraft who were killed, fatalities resulting from the Sept. 11, 2001, terrorist acts are excluded from this table.

Source: U.S. National Transportation Safety Board

STATS

Table 5

Accidents, Fatalities and Rates for Operations Under FARs Part 135, On-demand Operations (Air Taxi), 1984 Through 2003

Year	Accidents		Fatalities		Flight Hours	Accidents per 100,000 Flight Hours	
	All	Fatal	Total	Aboard		All	Fatal
1984	146	23	52	52	2,843,000	5.10	0.81
1985	157	35	76	75	2,570,000	6.11	1.36
1986	118	31	65	61	2,690,000	4.39	1.15
1987	96	30	65	63	2,657,000	3.61	1.13
1988	102	28	59	55	2,632,000	3.84	1.06
1989	110	25	83	81	3,020,000	3.64	0.83
1990	107	29	51	49	2,249,000	4.76	1.29
1991	88	28	78	74	2,241,000	3.93	1.25
1992	76	24	68	65	2,844,000	2.67	0.84
1993	69	19	42	42	2,324,000	2.97	0.82
1994	85	26	63	62	2,465,000	3.45	1.05
1995	75	24	52	52	2,486,000	3.02	0.97
1996	90	29	63	63	3,220,000	2.80	0.90
1997	82	15	39	39	3,098,000	2.65	0.48
1998	77	17	45	41	3,802,000	2.03	0.45
1999	73	12	38	38	3,204,000	2.28	0.37
2000	80	22	71	68	3,930,000	2.04	0.56
2001	72	18	60	59	2,997,000	2.40	0.60
2002	59	18	35	35	2,911,000	2.03	0.62
2003	77	19	45	43	2,955,000	2.61	0.64

Notes: The 2003 data are preliminary. Flight hours are estimated by the U.S. Federal Aviation Administration (FAA). Miles flown and departure information for U.S. Federal Aviation Regulations (FARs) Part 135 on-demand operations are not available.

In 2002, FAA changed its estimate of Part 135 on-demand operations. The revision was retroactively applied to the years 1992 to present. In 2003, FAA again revised flight activity estimates for 1999 to 2002. See Table 6, page 42 for further details about this revision.

Source: U.S. National Transportation Safety Board

STATS

Table 6

Effects of FAA Revision of Flight-hour Estimates for Operations Under FARs Part 135, On-demand Operations (Air Taxi), 1992 Through 2003

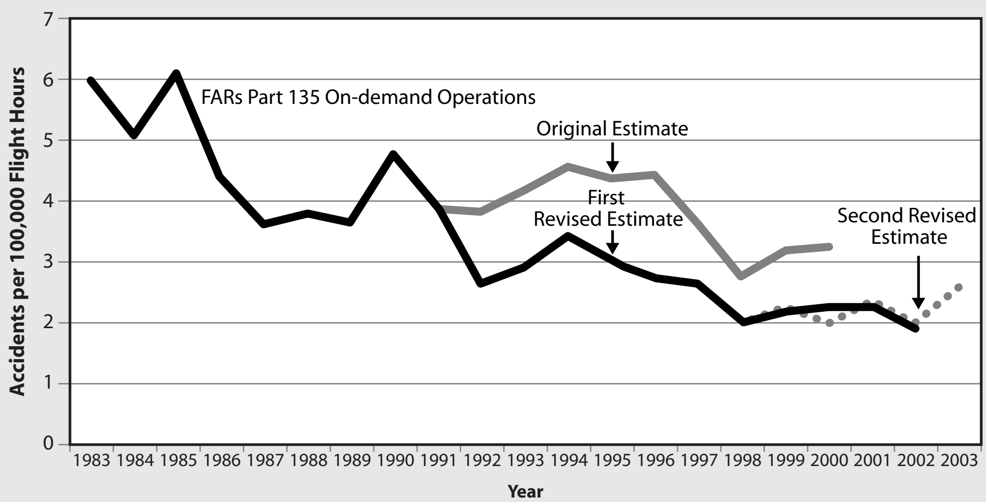
Year	Flight Hours	Revised Estimate	Second Revised Estimate	Percent Increase
1992	1,967,000	2,844,282		44.6
1993	1,659,000	2,324,357		40.1
1994	1,854,000	2,464,874		32.9
1995	1,707,000	2,486,079		45.6
1996	2,029,000	3,219,541		58.7
1997	2,250,000	3,097,724		37.7
1998	2,751,000	3,802,055		38.2
1999	2,260,000	3,297,957	3,204,339	41.8
2000	2,430,000	3,552,881	3,930,163	61.7
2001		3,175,910	2,996,965	
2002		3,051,300	2,910,985	
2003			2,955,500	

FAA = U.S. Federal Aviation Administration FARs = U.S. Federal Aviation Regulations

Source: U.S. National Transportation Safety Board

Figure 1

Effects of Revised Flight-hour Estimates on Accident Rates for Operations Under FARs Part 135, On-demand Operations (Air Taxi), 1983 Through 2003



Note: Revisions in flight-hour estimates were made by the U.S. Federal Aviation Administration.

FARs = U.S. Federal Aviation Regulations

Source: U.S. National Transportation Safety Board

STATS

Technology Exists for Improved Short-term, Aviation-related Weather Forecasting, Report Says

The U.S. Federal Aviation Administration and the industry can take the initiative in upgrading aviation weather-forecasting products, a National Research Council workshop report says.

— FSF LIBRARY STAFF

Reports

Weather Forecasting Accuracy for FAA Traffic Flow Management: A Workshop Report. Committee for a Workshop on Weather Forecasting Accuracy for FAA Air Traffic Control; Board on Atmospheric Sciences and Climate; Division on Earth and Life Studies; National Research Council of the National Academies. Washington, D.C., U.S.: The National Academies Press (NAP), 2003. 61 pp. Figures, illustrations, appendixes, references. Available from NAP.*

Convective weather — thunderstorms, for example — in the national airspace affects the flow of air traffic, resulting in economic costs. According to the U.S. Federal Aviation Administration (FAA), weather is responsible for 70 percent of all air traffic delays, and convective weather accounts for 60 percent of all weather delays.

FAA representatives and workshop participants discussed the difficulty of forecasting convective weather and initiatives to reduce forecasting time and to improve convective forecasting skills. Currently, traffic flow managers require two hours to six hours for effective planning. The report summarizes workshop presentations about the aviation community's weather forecast needs and the status of aviation weather forecasting research.

The report says, "Historically, only a small fraction of the resources allocated to weather forecasting by federal agencies (other than [FAA has]) been focused on the development of weather guidance that supports the needs of the aviation system, and there is no reason to think this will change. Therefore, [FAA] and the commercial airlines will have to take the lead if they want to see development and implementation of the type of operational products needed to improve the safety and efficiency of the aviation weather system. The technology and knowledge to significantly improve the two-[hour] to six-hour convective forecast products for aviation exist now. … Users of the national airspace can simply decide what types of products are needed and build them."

Distribution and Optical Purity of Methamphetamine Found in Toxic Concentration in a Civil Aviation Accident Pilot Fatality. Chaturvedi, Arvind K.; Cardona, Patrick S.; Soper, John W.; Canfield, Dennis V. U.S. Federal Aviation Administration (FAA) Office of Aerospace Medicine (OAM). DOT/FAA/AM-03/22. December 2003. 10 pp. Tables, references. Available on the Internet at <http://www.cami.jccbi.gov> or from NTIS.**

The FAA Civil Aerospace Medical Institute routinely conducts toxicological evaluations on biological samples collected postmortem from pilots in fatal civil aircraft accidents. Samples are analyzed primarily for the presence of combustion gases, alcohol and drugs.

The report describes techniques used to identify the presence of methamphetamine, a drug controlled by the U.S. Food and Drug Administration. Analysis of postmortem samples from a pilot involved in a controlled-flight-into-terrain (CFIT) accident showed that the pilot had ingested methamphetamine orally in a quantity sufficient to impair performance. The report supports the conclusion of the U.S. National Transportation Safety Board that use of a controlled substance contributed to the cause of this CFIT accident.

Books

Know the Risk. Learning From Errors and Accidents: Safety and Risk in Today's Technology. Duffey, Romney B.; Saull, John W. Amsterdam, Netherlands: Butterworth Heinemann, 2003. 242 pp. Figures, tables, appendixes, photographs, references, index, bibliography.

In a world that is continually changing because of technological advances, people live with the knowledge that they may make errors and that they may be exposed to risks leading to injury or death. The book explains what can be learned from experiences, errors and accidents.

Specialists in safety management and human factors, the authors gathered and analyzed large quantities of safety-related event data from airline, transportation, manufacturing, medical and other global industries to determine how accidents and daily risks are related. They found that "large bodies of historical error data are needed, which are systematically collected, defined and analyzed on a common basis, to provide clear trends and estimates."

The book stresses the importance of a learning environment to improve safety, safety management and quality management. The fact that people learn from their mistakes, correcting and offsetting mistakes by reducing the rate at which they occur, is acknowledged. Nevertheless, the book says, "The rate of error reduction (learning) is proportional to the number of errors being made. The learning rate depends directly on the number of errors that are occurring and is dependent on the accumulated experience."

The suggested audience for the book includes human factors specialists, industrial managers, maintenance engineers, safety engineers and others interested in accident prevention.

Airport Systems: Planning, Design, and Management. De Neufville, Richard; Odoni, Amedeo. New York, New York, U.S.: McGraw-Hill, 2003. 882 pp. Figures, tables, references, index.

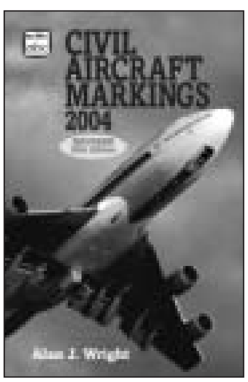
Four trends, the book says, will dominate the airport and airline industries in the 21st century:

- Long-term growth driven by continual demand for expansion and improvement;
- Commercialization replacing government ownership;
- Globalization with transnational airline alliances and airport companies; and,
- Technical changes, especially electronic commerce.

Collectively, the book says, "these trends are substantially changing the context, objectives and criteria of excellence for airport systems planning and design."

The book was written for professionals working in airport planning, management and design and for students of planning and design. With a focus on medium and large commercial airports, major development topics discussed are: airport site characteristics; layout of runways, taxiways and aircraft aprons; design of passenger buildings and their internal systems; analysis of environmental impacts; and ground access planning. Major operational and managerial topics are: air traffic control; management of congestion and queues; peak-hour traffic analysis; forecasting; and financing, pricing and demand management.

At the conclusion of each chapter, readers are presented with situational exercises or mathematical exercises.



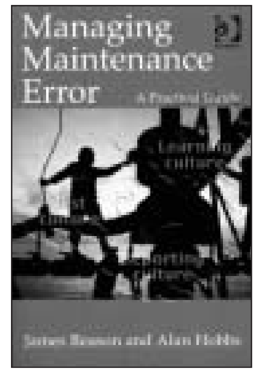
Civil Aircraft Markings 2004. Wright, Alan J. Hersham, Surrey, U.K.: Ian Allan Printing, 2004. 55th edition. 384 pp. Addenda, photographs.

This guide for civil aviation enthusiasts lists civil aircraft registered in Britain and civil airliners likely to be seen at British airports. Also included is registration information for microlight aircraft and toy balloons. The book lists radio frequencies used by larger airfields and airports, airline flight codes for U.K. carriers and non-U.K. carriers, and aircraft appearing on the current British Aircraft Preservation Council Register.

The Standard Handbook for Aeronautical and Astronautical Engineers. Davies, Mark, editor-in-chief. New York, New York, U.S.: McGraw-Hill, 2003. 1,360 pp. Figures, tables, references, index.

This book is said to be the first publication of its kind — a single handbook on aeronautical and astronautical engineering. Contributors to the book included more than 50 specialists, representing academia, research institutions and the aviation industry in France, Germany, Ireland, the Netherlands, the United Kingdom and the United States.

This technical handbook is written for professional engineers and student engineers. There are sections about aircraft safety and aircraft maintenance. Five sections are devoted to basic engineering science and mathematics. Several sections have been adapted from *Mechanical Engineer's Reference Book*, 12th edition, edited by E. H. Smith (1994), and published by Butterworth Heinemann and the Society of Automotive Engineers.



Managing Maintenance Error: A Practical Guide. Reason, James; Hobbs, Alan. Burlington, Vermont, U.S.: Ashgate Publishing, 2003. 198 pp. Figures, tables, notes, index.

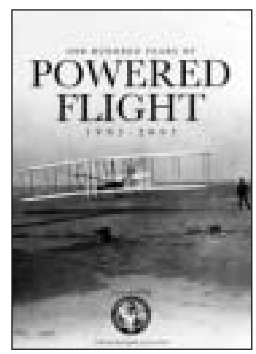
In many industries, automation of tasks previously performed by humans improves safety and reliability. By contrast, maintenance tasks are not as easily automated and continue to rely upon human hands and human minds. As a result, maintenance error can be a significant cause of system failures. Two examples of maintenance-related threats to the integrity of a system are a worker not detecting signs of a failure or a worker introducing the conditions for a failure that otherwise would not have occurred.

On the assumption that risk of maintenance errors can be managed more effectively, if not eliminated entirely, the book is intended to help workers and managers understand why maintenance errors occur and how error risk can be controlled, and to provide various error-management techniques.

With a focus on the human element of maintenance, the book identifies the following three basic error types and describes various ways that they can manifest. Examples of error types and conditions that provoke them are the following:

- Skill-based errors — recognition failures (misidentification of an object), memory lapses (losing one's place in a series of actions), interruptions or slips of action (an automatic routine supersedes an intended action);
- Rule-based and knowledge-based mistakes — incorrect assumptions, bad habits, lack of knowledge or inadequate problem-solving techniques; and,
- Violations — routine (circumventing formal procedures), thrill-seeking (practical jokes) or situational (mismatch between worker and situation or worker and procedure).

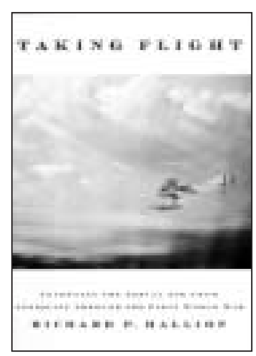
Three maintenance-involved accidents are presented as case studies to illustrate how combinations of workers and events can converge to create errors and subsequently allow the damaging effects of such errors to go unchecked.



One Hundred Years of Powered Flight 1903–2003. Royal Aeronautical Society. Fessey, Wayne, editor. Hadleigh, Essex, U.K.: The Winchester Group (TWG), 2003. 272 pp. Tables, illustrations, photographs. Available from TWG.***

This commemorative publication provides a chronological review of major events in powered flight, highlights endeavors and achievements of the many men and women who contributed to the global evolution of powered flight and includes a historical analysis of developments in aviation over the past 100 years.

Representatives from academia, military, aviation and aerospace sectors contributed featured articles and editorials.



Taking Flight: Inventing the Aerial Age From Antiquity Through the First World War. Hallion, Richard P. New York, New York, U.S.: Oxford University Press, 2003. 531 pp. Photographs, illustrations, index.

The author introduces his study by listing a number of items that are "common knowledge" concerning the history of aviation. Among them are the following:

- "Though the dream of flight dated to antiquity, virtually nothing of significance was accomplished until the end of the 19th century"; and,

- "The Wright brothers, untutored and working in isolation, drawing only upon their own skills, single-handedly invented the airplane, making possible every other plane that has flown to this day. Self-taught bicycle makers, they shrewdly used the simple 'Yankee engineering' approach of the practical craftsman."

The problem with these, and the other examples of conventional ideas cited, is that they are wrong, the book says. "By the Middle Ages, humanity already had a significant grasp on working the air via sails, kites, windmills, helicopter toys, flue turbines in kitchens, and rockets," the book says.

The Wrights did invent the airplane, but not in isolation, according to this account. "They were well aware of all previous work, sought out information and advice, relied (sometimes to their sorrow) on the work of others, and kept abreast of developments in America and abroad, even polishing their language skills in French and German so as to be able to understand the latest in European thought," the book says. "Far from being 'cut and try' craftsmen, the Wrights were highly trained and gifted proto-engineers who kept meticulous records, constantly assessed and evaluated their work, and creatively blended ground and in-flight research."

The book, illustrated with rare photographs and reproductions of historical drawings, delves into the roots of mankind's attempts to fly, Leonardo da Vinci's designs for mechanical flapping wings and helicopter-like devices, the era of balloons and airships, the early fumbling attempts to build an airplane, the origination of viable airplane designs and the use of airplanes in World War I. Extensive use is made of journals, diaries and memoirs of aviation pioneers.

Regulatory Materials

***2003 Guide for Aviation Medical Examiners*.** U.S. Federal Aviation Administration (FAA) Office of Aerospace Medicine (OAM). DOT/FAA/AM-03/22. October 2003. 298 pp. Tables, appendixes, glossary. Available on the Internet at <http://www.faa.gov/avr/aam/Game/Version_2/03amemanual/WEB/AME_Guide_2003.pdf> or from NTIS.**

This 2003 edition supersedes the 1999 edition. The guide reflects the U.S. federal air surgeon's interpretation of the medical standards required by U.S. Federal Aviation Regulations (FARs) Part 67, *Medical Standards and Certification*, and is designed to assist aviation medical examiners (AMEs) in performance of their duties.

The guide identifies required examination equipment and the legal responsibilities and authority of AMEs. The guide contains information on medical-history-examination procedures, disease protocols and courses of action that AMEs should follow. Applicants and AMEs have access to aerospace medical disposition tables for specific medical diseases and conditions which define FAA requirements to determine eligibility of an applicant for medical certification or medical deferral.

New to this edition is an explanation of the AME Assisted Special Issuance process for disqualifying diseases, disorders or medical conditions, and clinical criteria for recertification. Also included are application forms for medical certification, medical intake forms and detailed criteria for qualification.

The online document contains the full text of FARs Part 67. There are Internet addresses for agency forms, lists of flight surgeons and their contact information, a list of FAA Flight Service offices, and the text of FAA Order 8520.2E, *Aviation Administration Examiner System*. ■

Sources

* National Academies Press (NAP)
500 Fifth Street, N.W.
Lockbox 285
Washington, DC 20055 U.S.
Internet: <http://www.nap.edu>

** National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161 U.S.
Internet: <http://www.ntis>

*** The Winchester Group (TWG)
Hadleigh Business Centre
351 London Road
Hadleigh, Essex SS7 2BT U.K.
Internet: <http://www.wingrp.com>

Nonstandard Seating Plan Cited in Rapid Pitch-up During Takeoff

Soon before takeoff, all passengers on the Airbus A320 had been moved to seats behind Row 13. The result was a center of gravity that was 'sufficiently beyond the aft limit.'

— FSF EDITORIAL STAFF

The following information provides an awareness of problems through which such occurrences may be prevented in the future. Accident/incident briefs are based on preliminary information from government agencies, aviation organizations, press information and other sources. This information may not be entirely accurate.

AIR CARRIER

Misunderstanding Blamed for Change in Seating Arrangements

Airbus A320. Minor damage. No injuries.

As the captain began the takeoff from an airport in Greece for a flight to England, the airplane's nose pitched up rapidly. The captain reduced power to idle and applied forward side-stick and gentle braking to lower the nose. He stopped the airplane on the runway, made a public-address (PA) system announcement to the passengers and taxied the airplane back to the gate.

A cabin crewmember had heard a scraping noise after the airplane pitched up; examination of the airplane revealed damage to the rear galley drain mast. The first officer also observed that the nose-wheel oleo strut was "very noticeably extended," an indication of a possible problem with the airplane's center of gravity (CG).

The flight crew's investigation found that all of the 69 passengers were seated aft of Row 13, although the load form and trim sheet indicated that passengers were seated evenly throughout the cabin's 30 rows of seats. The seating plan showed that passengers had been assigned to the first five rows and the last 6 1/2 rows, but neither the captain nor the flight supervisor saw the seating plan. The captain had asked the flight supervisor to move the passengers at the front of the cabin to seats farther back; the flight supervisor's decision to seat all passengers behind Row 13, however, was a misinterpretation of his instructions.

"Effectively, … the commander [captain], FS [flight supervisor] and handling agent were in possession of some of the information, but none of them had the full picture," the incident report said. "The result of the commander asking the FS to move the passengers at the front of the cabin towards the rear was that all the passengers were subsequently seated behind Row 13. This created a CG [that] was sufficiently beyond the aft limit that, when takeoff thrust was selected and the aircraft started its takeoff roll, the aircraft pitched up rapidly."

After the incident, the operator revised the *Ramp Handling Manual* to emphasize correct loading procedures, including the requirement that passengers be seated evenly throughout the cabin on Airbus A320 flights with less than a full load of passengers. The operator also modified standard operating procedures to ensure that the captain and the first officer review the load sheet and trim sheet to ensure that the actual loading of the airplane is shown in the paperwork. A revision was being developed to the operator's *Cabin Crew Safety Manual* to emphasize the importance of seating passengers evenly throughout the airplane.

Cabin Crewmembers Report Hypoxia Symptoms After Depressurization

Fokker F.27 Mk 50. No damage. No injuries.

The airplane was being flown at Flight Level 250 (approximately 25,000 feet) on a domestic flight in Australia when a triple chime, master caution light and cabin altitude annunciator light indicated to the flight crew that the cabin altitude had exceeded 10,000 feet. The flight crew donned oxygen masks and began an emergency descent.

Cabin crewmembers, who had been alerted to the problem by the illumination of the seat belt sign and the change in the aircraft's attitude, used the public-address (PA) system to tell passengers to fasten their seat belts and walked through the cabin to check compliance with that instruction. Soon afterward, the flight crew used the interphone to tell cabin crewmembers about the loss of cabin pressure. The cabin crew made a PA announcement to inform passengers of the problem and then secured the galley before returning to their seats.

The incident report said, "The flight crew advised the cabin crew by interphone when a safe altitude had been reached. The cabin crew then checked the cabin safety and security for landing. The remainder of the flight was of short duration and was continued, with the aircraft unpressurized, at an altitude of 10,000 feet. … The cabin crew subsequently reported symptoms of mild hypoxia, including the tingling of hands, feet and lips."

The report said that, when the seat belt sign illuminated, cabin crewmembers initially were unaware of the loss of cabin pressure and continued to perform their duties. Later, after they were told that it was safe to move about the cabin, they performed duties without supplemental oxygen.

"Cabin crew performance can be critical during emergencies," the report said. "If the cabin crew had used oxygen after the descent had been completed, it would have assisted in recovery from the effects of hypoxia. That use, in turn, would have provided some assurance that cabin crew were able to perform their duties appropriately in any subsequent emergency situation during the remainder of the flight."

After the incident, the operator amended its flight operations manual to require that cabin crewmembers use portable oxygen for at least 30 seconds to one minute after the flight crew tells them that the aircraft has reached a safe altitude.

AIR TAXI/COMMUTER

Design Factors Cited in Opening of Door During Takeoff

Dornier 328-100. Minor damage. No injuries.

In preparation for takeoff from an airport in Scotland for a flight to England, the airplane's forward passenger door was closed and locked, and the flight crew confirmed during their prestart checks that the door was in the correct position. During the takeoff, at about 100 knots, the door opened, and the flight crew rejected the takeoff.

The accident report said that an examination of the airplane revealed that the door and the locking mechanism were not damaged, but the hinge arms on the air stairs "were so severely damaged that it is unlikely that the door and the … stairs would have remained attached had the aircraft continued to accelerate and become airborne."

The report said that the door handle probably was operated inadvertently during the takeoff.

"The ergonomic features of the cabin crew station would have contributed to the handle being inadvertently grasped during this phase of flight," the report said.

The report said that the rear-facing cabin crewmember seat next to the door was equipped with a full safety harness, including an inertia-reel system for shoulder straps. During takeoff, the system "would not have provided significant upper-body restraint," the report said.

"There are two hand-holds within the reach of a seated cabin attendant [that] could be used to brace that person against the effects of aircraft acceleration on the upper body. The handrail of the air stair, positioned just above thigh level and to the right of the cabin attendant, could be easily grasped but would provide little upper-body restraint. However, the door handle is positioned such that when the door is closed, the handle is to the right of the cabin attendant's seat, just above head height, and can be readily grasped by an occupant correctly strapped into the seat. This would provide a more natural bracing mechanism for upper-body restraint. … It is entirely possible that, on this occasion, the cabin attendant grabbed the handle."

The senior cabin crewmember and a ground crewmember had closed the door before the flight, and the cabin crewmember took the seat next to the door and fastened the full safety harness. She said later that her "recollection of events [during the takeoff] was extremely hazy."

The investigation resulted in a recommendation that the European Aviation Safety Agency review the design characteristics of the door-operating mechanism, attachment mechanism and restraint mechanism "to minimize the possibility of inadvertent door operation and to ensure that there is sufficient residual strength in the door/air stair attachments to prevent separation of the door in the event of a door coming open during takeoff or initial climb."

After the incident, the operator asked the captain — and the captain and crew agreed — to fly another airplane to England the same night. The operator subsequently re-emphasized a section of the operations manual that said that, after being involved in an accident, crewmembers "shall not carry out further flying duties" until authorized by the chief pilot after preliminary findings of an investigation are "known or apparent."

Airplane Strikes Terrain After Low-altitude Maneuver Following Takeoff

Cessna 210. Destroyed. One fatality.

As the pilot was conducting a takeoff for a positioning flight in Australia, witnesses said that the airplane began a "wingover-type maneuver" at about 400 feet, then descended and struck the ground.

Before the flight, the pilot had indicated that he planned to conduct a low pass over the runway after takeoff. The accident report said that, in the past, the pilot occasionally had conducted low passes when arriving at the airport or when departing.

The report said that the airplane stalled "and briefly auto-rotated" and that the airplane was in a steep nose-low attitude; to some observers, this maneuver might have appeared similar to a wingover.

The report said that circumstances of the accident were "consistent with the pilot attempting a maneuver after takeoff [that] inadvertently stalled the aircraft at a low height. Control of the aircraft was then lost with insufficient height remaining to effect recovery."

Pilot Disabled Circuit Breakers Before Landing-gear Accident

Piper PA-34-200T Seneca II. Minor damage. No injuries.

The airplane was being flown on a round trip flight in England. Soon after departure on the return leg, the "GEAR UNSAFE" warning light illuminated. The pilot said that, because he could not hear the sounds associated with an extended landing gear and because airplane handling felt normal, he believed that the landing gear was retracted and that the landing-gear hydraulic pump was running. To prevent excessive operation of the landing-gear hydraulic pump, he opened two associated landing-gear circuit breakers.

In preparation for landing, he moved the landing-gear lever down, but because the circuit breakers were still open, the landing gear did not extend. The pilot became distracted by other air traffic and did not conduct a final pre-landing check to determine that the landing gear had extended.

The accident report said that the pilot "did not appear to have considered taking any troubleshooting action to determine whether the landing gear would function correctly, being confident that the 'unsafe' light was related to the gear-retracted position alone."

The report said that "it is considered likely that there was an intermittent problem with the 'UP' position switch." After the accident, the operator issued a notice to pilots to discuss "the importance of not disabling aircraft systems unnecessarily by pulling circuit breakers."

CORPORATE/BUSINESS

Landing Gear Collapse Follows In-flight Problem With Indicator Light

Beech Super King Air 200. Substantial damage. No injuries.

Night visual meteorological conditions prevailed and an instrument flight rules flight plan was filed for the domestic flight in the United States. The pilot said that, after receiving clearance for an approach to land, he moved the landing gear lever "DOWN"; the green light that would have indicated that the nose landing gear was down did not illuminate.

The pilot conducted a low approach to allow a controller in the airport's air traffic control tower to observe the airplane; the controller said that all three landing gear wheels appeared to have been extended. The pilot cycled the landing gear lever "a few times" and conducted the emergency landing-gear-extension procedure, but the same green light did not illuminate.

The pilot said that, immediately before landing, he flew the airplane in a nose-high attitude and held the nose landing gear off the runway as long as possible.

The report said, "Subsequently, when the nose … landing gear touched down on the runway, the right-main landing gear collapsed and the right wing struck the ground." The airplane veered to the right side of the runway and struck a number of taxiway lights and runway lights.

Examination of the right-main landing gear by maintenance personnel revealed that the rod end of the actuator was separated.

Airplane Strikes Terrain During Emergency Landing

Britten-Norman BN2A Islander. Destroyed. Four minor injuries.

Visual meteorological conditions prevailed for the flight to an airport in the United States. The left engine failed during a descent from 6,500 feet, and when the pilot advanced the throttle for the right engine, it did not develop full power. The airplane could not maintain altitude, so the pilot conducted a landing in an open field.

The pilot said that the airplane "touched down long and with excessive speed" and that he tried to conduct a takeoff so that he could fly the airplane around trees and power lines. The airplane struck the trees and the power lines and then struck the ground. All four people in the airplane exited before a post-accident fire. Two people in the airplane and two people on the ground received minor injuries; two others in the airplane were not injured.

Maintenance records showed that the drain-valve o-rings on the wingtip fuel tanks had been replaced the day before the accident and that the wingtip tanks were empty. The pilot said that, because of maintenance, he had decided not to use the wingtip fuel tanks (as he usually did) and not to fuel them. A preliminary accident report said that the pilot was asked whether he selected fuel from the wingtip fuel tanks the day of the accident and that the pilot responded that he was "aware of the wingtip tanks being empty and did not select them."

The report said that an airworthiness directive that applied to the accident airplane included the following caution: "This is a tip-tanked aircraft. Tip tanks are to be filled first [and] used last. … Takeoff and landings are prohibited on main tanks when gauge reads less than three gallons [11 liters] above zero."

Before the accident flight, the fuel quantity gauges indicated that the main fuel tanks held a total of 70 U.S. gallons (265 liters). The pilot said that about 20 gallons (76 liters) of fuel had been used during the previous flight (the first leg of the planned round-trip flight). Fuel samples taken from the fueling facility showed no contamination.

Excessive Brake Application Cited in Turnover Accident

Antonov An-2. Substantial damage. No injuries.

Visual meteorological conditions and a northerly wind of about 10 knots prevailed for the tailwind landing on a grass runway in Sweden. The airplane touched down about 125 meters (410 feet) beyond the threshold of Runway 24, which typically was used for landing because of its uphill slope. As the pilot applied the brakes, the airplane nosed over.

The accident report said that the tracks made on the runway by the main wheels were 80 meters (262 feet) long and that the wheels were locked from about the time the airplane touched down until the airplane nosed over. There was no visible track from the tailwheel.

The pilot told investigators that he had applied the brakes too hard.

The airplane flight manual said that "sudden braking directly after touchdown may lead to airplane turnover" and that "braking must be smooth and done in a few phases."

The report also said that the airplane's center of gravity, although within the range identified by the flight manual as acceptable, was forward of the recommended range.

"The reason why the pilot braked so hard following touchdown was probably that touchdown occurred [farther] into the runway than he had anticipated," the report said. "However, according to … calculations, the remaining runway length was sufficient, with a margin of almost 50 percent."

Jammed Exhaust Guide Cited in Engine Failure

De Havilland DH82A Tiger Moth. Minor damage. No injuries.

The airplane was being flown at 2,000 feet in cruise flight in England when the pilot felt an engine vibration that increased as the engine failed and backfired. The pilot observed smoke from the carburetor air intake. When the throttle was advanced, the vibration increased. The pilot checked magnetos and fuel supply and found no anomalies. He conducted a forced landing on a farm, and during the landing roll, the airplane tipped forward onto its nose.

When maintenance personnel examined the engine, they found that the no. 2 cylinder-inlet rocker arm had broken and that the separated portion was jammed in the exhaust guide. Metallurgical examination of the broken pieces revealed a high-cycle fatigue failure, which had begun in an area of mechanical damage.

The accident report said, "The aircraft, fitted with this engine, had been operated by the current owner for some 30 years with low utilization. The engine had completed 670 [flight] hours since overhaul but only 170 [flight] hours since 1978. The last entry in the logbook for maintenance, which would have entailed the removal of the cylinders and, thus, the rocker arm, was in 1990. It was not possible to determine when or how the damage to the rocker arm occurred."

Proficiency Flight Ends in Bounced Landing

Piper PA-28-235. Minor damage. No injuries.

In preparation for a ferry flight from South Africa to Botswana, the pilot — who had 314 flight hours, including two hours in the aircraft type — conducted a proficiency flight in the airplane, which had been parked for more than four years at an airport in South Africa. (Maintenance personnel had issued a certificate of fitness for flight before the proficiency flight.) Near the end of the flight, as the pilot turned the airplane onto final approach, with an indicated airspeed of about 90 knots to 95 knots, he selected two notches of flaps. On short final approach, he selected full flaps and then had difficulty controlling the airplane.

As the airplane touched down, it bounced and veered off the right side of the runway. The nose landing gear failed.

The accident report said that the cause of the accident was "excessive speed on touchdown, accompanied by incorrect recovery technique." The report said that a contributing factor was the pilot's "limited experience on type."

ROTORCRAFT

Accident Prompts Call for More Information on Loss of Tail-rotor Effectiveness

Bell 206B Jet Ranger III. Destroyed. Three minor injuries.

The helicopter was being flown on a low-level photography flight in England. The pilot planned to fly the helicopter along a relatively straight track before conducting a right turn around a structure "of significant historical interest," the report said.

In a practice attempt, the helicopter was too fast and too close to the structure. In the next attempt, halfway through the turn, the helicopter yawed right. The pilot's application of left pedal to stop the yaw was ineffective, and the helicopter continued yawing right and descending until it struck the ground and rolled onto its right side.

The accident report said that the pilot might have been operating the helicopter "in a part of the flight envelope where the susceptibility to loss of tail-rotor effectiveness was possible."

As a result of the accident, the U.K. Air Accidents Investigation Branch recommended including information on loss of tail-rotor effectiveness in training courses for helicopter pilots.

Fueling Error Cited in Jungle Accident

Eurocopter AS 350B3. Destroyed. Two fatalities, one serious injury.

Visual meteorological conditions prevailed for the ferry flight from Bolivia to Brazil. During the flight, an "engine malfunction" developed, and the helicopter struck trees and then ground in a jungle area in Brazil. The report on the accident provided no further information about the nature of the engine malfunction.

The owner said that before the flight, the helicopter was to have been fueled with 150 U.S. gallons (568 liters) of fuel but that the pilot "inadvertently mistook liters for gallons," and, as a result, the helicopter was fueled with 150 liters (40 gallons) of fuel. Because of the fueling error, the helicopter left Bolivia with 60 percent less fuel than required for the flight, the report said.

Pilot Fails to Remove Skid-gear Clamp Before Attempted Takeoff From Trailer

Robinson R22 Beta. Substantial damage. No injuries.

The helicopter had been transported on a trailer to a game farm in South Africa and was to be used in a game-capturing operation. While being transported, the helicopter was secured with several clamps that attached the skid gear assembly to the trailer. The pilot was to remove the clamps before conducting a takeoff from the trailer platform.

The pilot said that he forgot to loosen one clamp on the right side of the helicopter. During an attempted takeoff, the helicopter rolled right, and the pilot was unable to recover the helicopter from the dynamic rollover. ■

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