

Cockpit Voice Recorders...Sound Retrieval

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Warning Dated Material

All Air Transport category aircraft are equipped with a cockpit voice recorder. This recording device picks up all sound, voices in the cockpit, and records them on a reusable 1/2 hour steel tape that usually survives the crash. Every half hour the loop tape erases the old data and records the latest data.

The tape is supposed to be operative for the flight and the only way to stop it is to pull a circuit breaker (illegal). The only way to erase the tape is to have weight on the wheels and the park brake set, and then a pilot can push a red button and erase the tape.

This tape is the second "black Box" that the investigating agency will retrieve and analyze after an accident. Unfortunately, a recent and untested federal statute from releasing the actual recording precludes the N.T.S.B. Instead, the N.T.S.B. will make a transcript of the voice communications and release them. This of course is a travesty and an obstruction of justice not produce the best evidence.

The tape itself is returned to the aircraft owner after the investigation. (This owner is usually an insurance company that had the HULL damage insurance.) Since the law is so nebulous on this subject at this time, the best thing to do is demand that the government keep a copy of the tape, and demand that the insurer protect the returned original under the threat of spoliation of evidence.

F.O.I.A. requests and confidentiality agreements will not suffice to obtain the tape. An attorney probably will have to resolve this in Federal District Court, and it is this attorney's belief that the best avenue will be to attempt to force the owner to produce the tape under a discovery order after its return to them by the government.

Without much more discussion, it is obvious to the brain dead that the tape itself represents the best evidence of the sounds recorded in the airplane in the last 1/2 hour before impact. I cannot agree that the interpretation of a government investigator as to what was said or who said it is or should be the last word, when the credible substantive evidence exists.

In one case I handled the N.T.S.B could not identify the voices of who said certain things. I volunteered a confidentiality agreement, and volunteered my clients the widows of the Captain and the Co-pilot to listen only to the sections that they could not identify. The N.T.S.B. that is supposed to be interested in thorough investigation and air safety did not care enough to determine who said what.

Further, the N.T.S.B. sound analysis laboratory is pathetic and outdated in methodology. Generally, they get pilots familiar with the airplane to listen to the tape and make educated guesses as to what the sounds recorded emanated from. Cheap and simple. Sometimes it is effective. Altitude alerts, stall warnings, trim noises, proximity warnings, windshear alerts, and TCAS alerts, some warning devices and "Gabbling Gerty" are indeed distinctive and easily identified. Much other data that may be present such as aircraft engine power, vibrations, air noises, voice stress, and incapacitation and switch movement noises demand a far more sophisticated look. The

N.T.S.B. is good at engine power setting noises. I consider their lab almost clueless as to the more sophisticated analysis procedures available. This will be covered under sound analysis.

Since these methods are almost never attempted by the N.T.S.B.

The attorney has good cause to demand the release of the tape for it will always be considered best evidence, and there is data on it that even their best effort will not have analyzed. Many persons associated with the N.T.S.B. don't even know these methodologies exist.

Another facet exists as well. A good laboratory may be able to get information that was supposedly erased from the previous thirty minutes as well. This is very sophisticated and iffy procedure.

SOUND ANALYSIS

Sound Analysis is far more sophisticated than simply listening to a recording and trying to differentiate and identify sounds by human hearing. Either sounds that occur and are recorded on the radio or on cockpit voice recorders are important sources of meaningful data.

Without serious electronic analysis, several valuable data bits can be ascertained simply by listening with trained ears and by friends and acquaintances of the person speaking on the recording. The recorded conversation can be judged as to coherence, and responsiveness to direction and control orders- slurring words, dragging out words, speaking fast or slow. All give clues to capability and state of being.

The recorded words give clue in multi piloted airplanes as to who is flying- it is standard for the non-flying pilot to use the radios. The recorded words of what is actually said are a paramount clue as to what is going on. Words like "mayday "" "Pan" or "I got an emergency" are the clearest and crispest designation of a problem, requiring special help. Too often, the investigator hears the problem over the radio. It is bad listening but good evidence. Sometimes the radio call is good evidence of a problem but the pilot stops just short of the explanation.

Such was the case with a pilot in his F-16 emergency.

"Knock it off, Knock it off, leads got a problem (he was lead) two join on me, three continue the mission." He then turned toward home base and was lost in some low clouds.

Equally important as words are the recording of sounds from the various warning devices used to pass information, alert or warn. These come in the distinctive, bells, intermittent horns, trim noises, steady horns, chimes, buzzers, clackers, stall warnings and shakers, whoop -whoops, and computerized command voices alerting to ground proximity or winds hear. The worst voice is "Gabbling Gerry" a female that forewarns disaster (they ought to program her to say have a nice flight upon engine start)

Since the recorder picks up all sounds, the remaining sounds are very important as well, these may be unidentifiable noises, vibrations, switch, or handle movements, escaping air, gunshot, explosion, and other unidentifiable sounds.

Depending on the status of the investigation the investigator may determine that it is necessary to undertake a serious and expensive sound analysis.

From the outset, it is important to know what such a sound analysis can be used to determine. When done correctly you may gain credible and substantive evidence of:

1. Identification of source of noise
2. If voice, positive identification of speaker.
3. If voice, stress levels
4. If voice, incapacitation and reason, lack of O₂, alcohol, speed
5. Sounds identifiable: flutter mode frequency, engine power, and switch and handle movement, explosion, gunshot, and motor and actuator noises

First, the easy and well established principle of voice identification. Every voice is distinct, just as every fingerprint is unique. Each voice has a unique timber and quality because the vocal chords vibrate at many frequencies and at varying amplitude, the spoken voice controls these amplitudes and frequencies, but does not disguise the basic qualities of that voice. Thus, we will say that each voice has a basic timbre and quality about it that is identifiable.

The analysis device is simply an electronic gadget that analyzes a very small segment or sound bite. (About 1/10 of a second) and repeats the analysis sequentially for the duration of the voice or noise. The analysis consists of scanning every imaginable frequency from zero to 2,000 cycles per second. That choice is arbitrary, but the equipment is standard for looking for submarines so it is available surplus.

The device will then print out the amplitude of each noise recorded at the individual frequency. This one tenth of a second analysis is stored in a computer, as is every sound bite analysis for the duration of the mystery sound or voice. If you plot frequency on the x graph, amplitude on the y scale and time as the z co-ordinate you get a three dimensional graph of the sound.

EXEMPLARS BECOME IMPORTANT

It is important to get a sample of the subject speaking on another tape, and you compare the two. Voiceprint Identification is very reliable; utilizing this method, Exemplars are always useful but not required in the search for incapacitation due to Oxygen lack, alcohol, or speed. These incapacitating agents create a distinct change in the quality and timbre of the sounds produced by the vocal chords and these changes show up graphically. They are clues but not evidence of a problem. The investigator, when presented with such evidence should attempt to find verifying prime evidence from autopsy and toxicology.

As to sound analysis the problem is simplified, suppose a noise starts at about 75 cycles and is of high amplitude (volume) suppose the airplane suffers mid air structural failure. Suppose there is a fingerprint of flutter in the bent metal. This sound is a vibration _ the start of flutter? If it is it occurred at the 75 cps range and that could be compared to the expected frequency onset for the airplane as derived from the shake tests.

Switch and handle movement noises are simple. You go to a sample cockpit and record the sounds of moving switches and handles. You analyze and store these sounds in the computer,

Next, you analyze the sound of the noise that you are trying to identify, and you store it in the computer, depending upon the software, you compare them. If they are identical, they will superimpose with near perfect correlation.

For instance in a 727 to get from flaps zero to fifteen you must lift the lever out of one detent, rub it along aluminum, pass a aluminum guide through a detent and go to the fifteen detent. The movement takes about one to two seconds to move the handle. It makes three distinct sounds as well as the dragging of aluminum on aluminum. This is a very simple sound trail to analyze. If it occurred and was recorded, it is identifiable with an engineering certainty.

A small spring loaded cover protects many switches utilized only in an emergency, and safety wired shut. Here the noise is breaking the wire, removing the cover, and throwing the switch. If it recorded, it is easily identifiable.

Sophistication and electronic wizardry can do marvels. Suppose that in a room where there is a recording going on, there is an Elvis record Heart Break Hotel being played and this covers the sound of switches and noises. Simply analyze the room sounds and store it in the computer, analyze Heart Break Hotel and store in the computer, Correlate starting and finish times of the record. Ask the computer to subtract Heart Break Hotel from the Hotel room. What are left will be the other noises that may now be identifiable. This is not an exact capability by any means.

It is much easier when two simple noises are superimposed, Here the investigator can add exemplars and compare results. Or the investigator may subtract single exemplar sounds from the noise and see what is left and if it is identifiable.

Ambient noises outside normal human voice range can be filtered out (low and high-end frequencies) the remainder can be amplified and analyzed. Similarly, any frequency bands can be analyzed separately thereby emphasizing an area of concern.

Do not expect the N.T.S.B. to do this sophisticated a job. Especially true in General aviation cases. The F.B.I. and C.I.A. has been doing this for years, but their emphasis naturally is on the spoken word not sounds. The Navy has been interested in sounds since they invented sonobouys and SOSUS to listen for submarine noises.

Some of this technology is so new that judges and law clerks will not find help in Evidence texts as to whether such analysis in its most sophisticated forms is admissible. When done correctly it is trustworthy, based on scientific laws, and very helpful to an investigator if not the court. I believe when presented properly it should be admissible under the same standards of other scientific evidence.

A good investigator at the scene will recognize the potential for data retrieval and protect rather than destroy the evidence. When you purchase new computer circuit boards and chips they all come wrapped in a special static electricity free electric insulator bag. There is a reason for that.

The same holds true for accident retrieval of data systems. As such, systems are found they should be wrapped and stored in the same variety of wrapping materials. All such black boxes should be first wrapped, in that material and then in a garbage

sack to preclude water intrusion. Mail/ female connectors to such boxes should be covered with the insulating material and then taped.

Having protected the evidence, it should be stored in an environmental laboratory for analysis. Now you need hire real specialist, and you had better coordinate your investigation plans with all parties since there is a high probability that some information will be lost in the retrieval efforts. This is an instance where no one wants hung with the tag of spoiling the evidence.