ATTACHMENT 6

Reprint of a scientific article on speech analysis by Dr. Alfred Belan
(5 pages)

DOT/FAA/AM-96/10
Office of Aviation Medicine
Washington, D.C. 20591

Methods and Metrics of Voice Communications

Barbara G. Kanki, Editor
Ames Research Center
National Aeronautics and Space Administration
Moffett Field, CA 94035

O. Veronika Prinzo, Co-Editor
Civil Aeromedical Institute
Federal Aviation Administration
Oklahoma City, Oklahoma 73125

Proceedings of a workshop organized by the Federal Aviation Administration, National Aeronautics and Space Administration, and Department of Defense. San Antonio, Texas, May 13-14, 1995.

March 1996

Final Report

This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

U.S. Department of Transportation
Federal Aviation Administration

THE MAIN DIRECTIONS OF CVR DATA ANALYSIS DURING THE ACCIDENT/INCIDENT INVESTIGATION

A. S. Belan
Interstata Aviation Committee, Moscow

It is well known, that the CVR data is an essential source of information for the air safety investigator, as it is often the only recorded source of human performance information.

So, the CVR data analysis is the obligatory one, and is to be made by the field team on the accident site.

However, as the practical experience shows, the special laboratory research is required in some cases. First of all, it is occurred, when the recorder is badly damaged or the CVR data is needed to be defined more accurately. The main stages of this research are presented on the scheme (Appendix 1). As you can see, it is traditional enough.

The main directions of the laboratory research of the aural & sound data are announced in Appendix 2.

The verifying of the results of the listening through include:

— verification of the conversation content;
— verification of the sources;
— verification of timing.

To analyze the above items, different methods of assessment & estimation are utilized.
In order to obtain the additional information about the circumstances of the accident, the special laboratory research include:

— aural communication analysis of the cockpit conversation;
— speech analysis for the evaluation of the actual functional (psychophysical) condition of the crew;
— analysis of the sound situation in the cockpit for the assessment of the warning situation.

So, it is necessary now, to make the detail observation of the above directions (see also the Appendix 3).

The aural communication peculiarity analysis contain:

— indentification of the disturbances in aural communication reception and transmission, identification of the causes of such kind of disturbances and its result
— the research of the peculiarities of the intra-cockpit conversations.

Such methods as the psycho-linguistic method (contect-analysis) & acoustic analysis of different sources are used for this purposes.

Speech is certainly one of the most reach source of information about the condition of the speaker. This is also confirmed by the practice of the accident/incident investigation. The experience of the radioconverstion analysis shows, that a lot of problems, which are important one for the evaluation of the crew condition in flight can be solved with this kind of analysis.

Proceedings of the International Aerospace Congress *IAC* ' 94, (Edited by M. Liberzon), Belan, A.S., The main directions of CVR data analysis during the accident/incident investigation, *pp. 156-159, (1995),* with kind permission from International Aerospace Congress.

So, this problems are:

— psycho-emotional stress dynamics & degree of its intensity (wording normal stress, increased stress, emotional stress);

— degradation of the influence of the negative effects in flight (for example hypoxy, acceleration, vibration & so on);

— condition of the static physic load (including overloads and great strength to the control units).

The applicated complex method include the utilization of the psycholinguistic & acoustic method.

The acoustic (noise) background suggest the indentification of :

— sound warning and alarm signals of the aircraft warning system;

— sound effects of the various bouard systems and units;

— operating engine noise changing;

— sound effects of the sturcture failures and so on.

To achieve the solution of this problems, the special acoustic methods were proposed to use.

The laboratory research of the CVR data requires good theory, update equipment & more over it is requires the excellent personal, which must have good command of language, as well as psychology, physiology & acoustic. Due to the particularity of acoustic research in the accident/incident investigation, the methods & facilities from the other spheres of industry are not useful fot he tasks of the accident/incident inveastigation. Therefore, it is significant to develop the theoretical ways of such kind of research, as the methods of practical operating, too.

According to the actual need of decreasing of the processing the CVR data, the experts of the Scientific Technical Center of the Commission for Flight Safety of the Interstate Aviation Committee created the complex program of the acoustic research on the base of IBM-compatible PC. This program allows to fulfill the following kind of analysis;

— auditing analysis;

— oscillographic (it contains the opportunity to choose & to zoom any content of the oscillographic record);

— analysis of the spectrum, in "frequence - intensity" coordinates (summary spectrum and cuts);

— spectrographic analysis, in "frequency - intensity - time" ("visual speech").

Although this program provides:

— the main useful signal filtration (including filtration for the low frequency, high frequency and other types of filtration);

— the reverse of the content of the oscillographic record (in order to produce the reverse listening of the speech content);

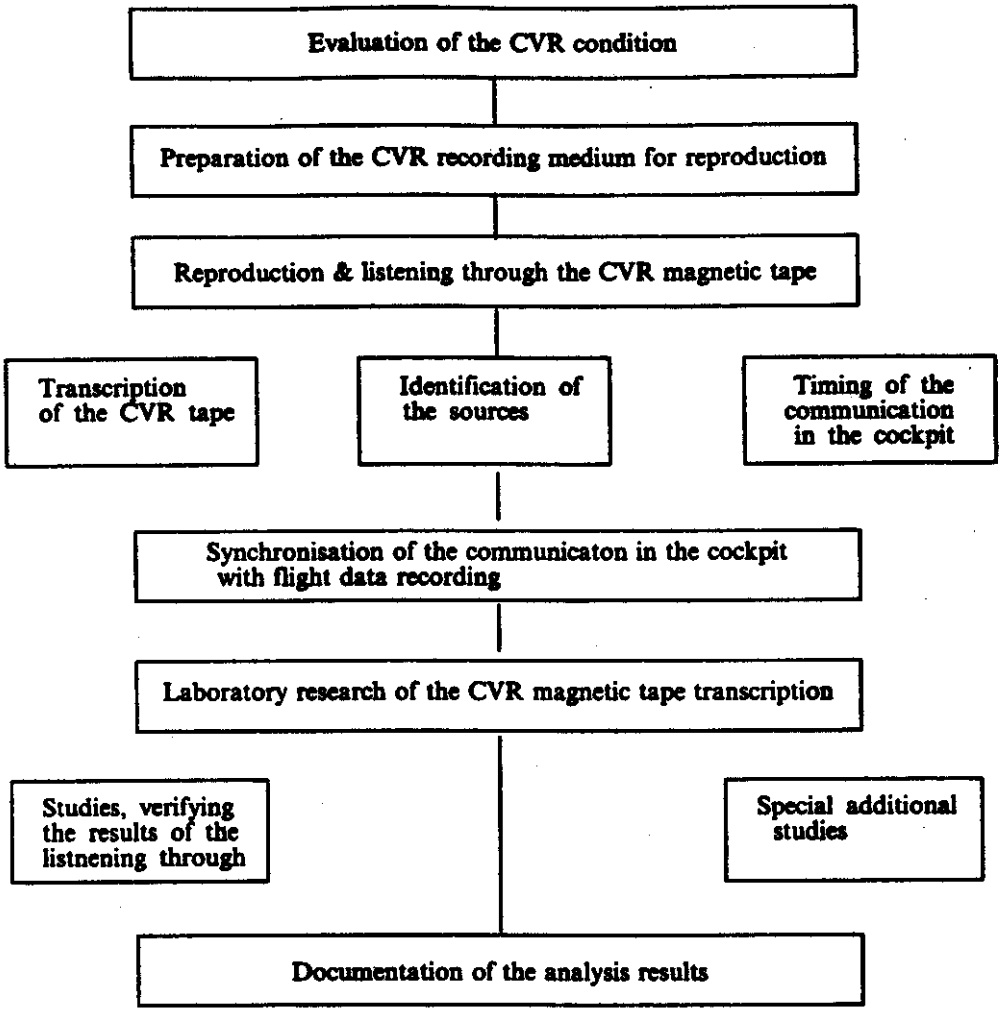
— speech timing as for the separate speech contents as for the full record.

The utilization of this program technically provides the converstaion analysis creation for all above mentioned problems and acoustic research direction.

In conclusion I should like to invite all specialists, who are interested for the cooperation in order to produce a new stage in the acoustic research and to exchange with the experience. Thank You!

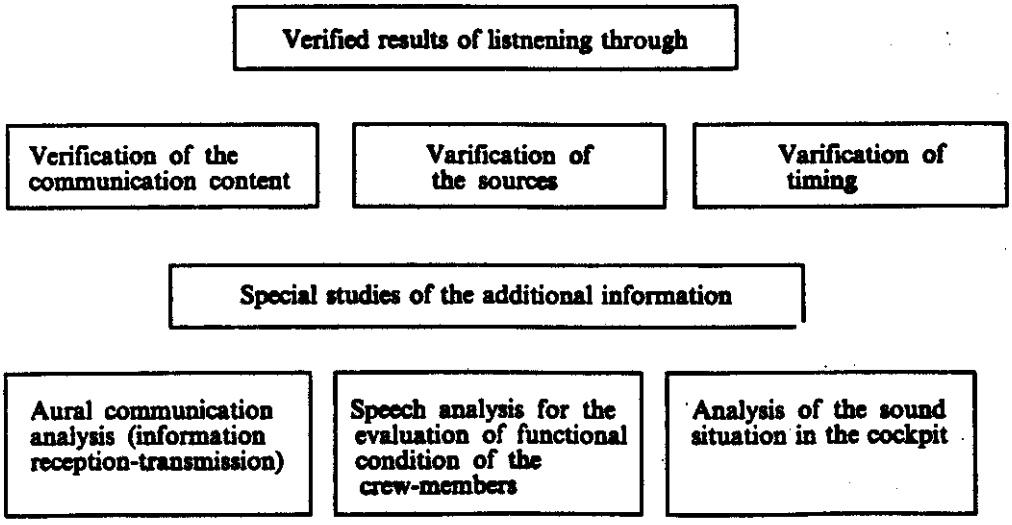
Attâchment 1

The Main Stages Of CVR Data Analysis
During The Accident/Incident Investigation



Attâchment 2

The Main Directions Of The Laboratory Pesearch Into
The Aural And Sound Data, Recorded On The CVR Magnatic Tape



Attâchment 3

The Main Contents & Methods Of Special (Additional) Studies

Analysis of the aural communication	Analysis of the speech to evaluate the dynamics of the functional condition	Analysis of the sound situation in the cockpit
The main tasks: — identification of disturbances in aural information reception and transmission — identification of the cuases of such disturbances — peculiarities of the intracockpit communication — peculiarities of air-to-ground communication	The main tasks: — psycho-emotional stress dynamics — evaluation of the degree of psycho-emotional stress — degradation of the functional condition — influence of hazardous and emergency situations (hypoxy, accelerations, vibrations, static loads)	The main tasks: — identification of the sound warning signals — identification of the sound effects of various systems & instruments operation — evaluation of the operating engines noise changes — identification of sound effects of structure failure and decompression
Methods used: — linguistic analysis — acoustic analysis	Methods used: — psycho-linguistic analysis — acoustic analysis	The method used: — acoustic analysis