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A PRACTIAL METHOD FOR ONLINE IDENTIFICATION OF NOISE RADIATED FROM STARTING AND LANDING AIRCRAFT IN COPENHAGEN AIRPORT.

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INTRODUCTION

In November 1980 an acoustic noise monitoring system, ANMS, based on a central computer and noise monitoring terminals, NMT, was installed in Copenhagen Airport. With the aid of this system the airport authorities control noise from flight operations and aircraft engine service tests.

As noise recorded by ANMS is based on SPL measurements, identifying the noise is a well known problem. Aircraft identification, of recorded noise for the night period, is at present done manually by comparing lists of noise data to lists of flight operations. In 1982 540,000 "noise events" were recorded at 9 NMTs while 158,000 flight operations were registered. Performing the control functions manually means a heavy workload.

Fortunately, information on flight paths is present in the air traffic control, ATC, system. In consequence, development of an automatic aircraft identification system was initiated in spring 1982.

The identification system must extract aircraft position and call sign from the ATC system, for correlation with noise events. The system should be designed so that monitoring flight paths and reporting SPL at an NMT to the pilot is possible. These features shall not be dealt with in this paper.

NOISE MONITORING SYSTEM

At present the ANMS consists of 9 NMTs, connected via telephone lines to the central part of the system: a 16 bit minicomputer, 25MB disk, and terminal equipment. A stand-

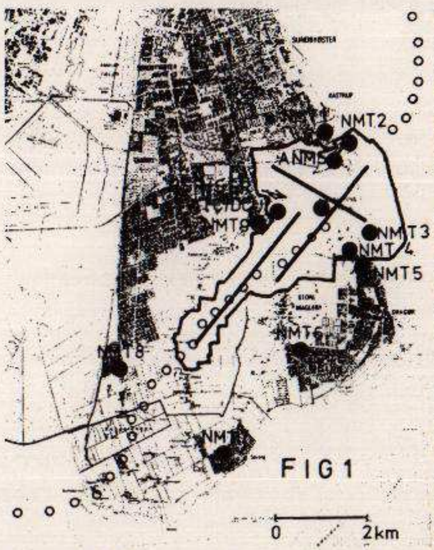

FIG 1

by computer and an analog 22 channel voice logger is also part of the system. See fig.s 1 and 2.

Every second each NMT is requested to transmit SEL values to the ANMS computer. From these data periodic noise exposure, calibration and error status reports in addition to noise event records are generated and stored on disk.

Two types of events are defined: normal and prolonged. A normal noise event, which can be related to flight operations, is determined as follows: The actual SPL at an NMT exceeds a predetermined trigger level, LIM1, for a period, DUR1, of less than 120 seconds. The record layout is shown in fig.3. TIME indicates when L_{max} occurs.

Due to a high ambition level in noise abatement the airport authorities have set the trigger level at 70dB in order to record nuisant flight operations. Thus ANMS is sensitive to other noise sources. Approx. 85% of the noise events recorded in 1982 originated from flight operations. The remainder can be considered unwanted or erroneous, as i.a. stormy weather contributes heavily to the 15%.

AIR TRAFFIC CONTROL SYSTEM

For the purpose of supervising air traffic, radar plots and "track labels" are projected on ATC radar screens by a computer and en-route (RSR) and short survelliance (SSR) radar systems. RSR rotates each 5.5 seconds. The ATC computer sets up a track label record table for each aircraft seen by the radars, and updates it when RSR points at the aircraft. For record layout see fig.3. X,Y-coordinates are maintained by the computer as a predicted aircraft position at next RSR revolution, and they are calculated from the latest 3 succeeding coordinate sets. The predicted position is used for alarm functions, and for positioning track labels in the screen images. The call sign, which is flight

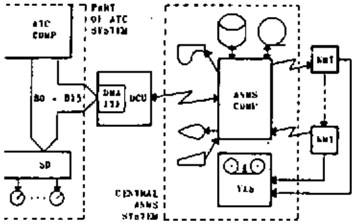

Fig.2. Hardware installation.

or reg. number, is derived from the SSR-code received from an aircraft transponder.

Sometimes the transponder antenna may be shaded, so that the ATC computer cannot identify new coordinates. The track is then forced into history mode, and is dismissed if this interrupt lasts longer than 3 RSR revolutions (the plot is still on radar screens). Approx. 1/3 of tracks are erroneous in this way. See fig.1 for examples.

The basic quantization error of coordinates is 1/8 NM. Adding radar errors, computer rounding, predicted position error etc., the worst case error is approx 1 NM for aircrafts in the airport area, getting worse at greater distance.

Transmission rate on the 16 bit data bus, connecting radar screens via a data selector to the ATC computer, is 167KB/sec.

AIRCRAFT IDENTIFICATION SYSTEM

The following method was selected for automatic aircraft identification: Track data are transferred from the ATC computer to a microcomputer data collection unit, DCU. Track records for aircrafts inside a geographical window covering Copenhagen Airport areas are transmitted from DCU to ANMS. Here track records are stored on disk, and are processed together with noise events. If a track and noise event relates, call sign is transferred to the noise event record. To settle a relationship two tests are performed: Distance between predicted position and an NMT must be less than a predetermined value. Timing occurrence of L_{max} and aircraft position must be within a predetermined interval.

NMT	TIME	SEL	Lmax	LIM1	DUR1	LIM2	DUR2	EXC2
8	9:41:40	97.0	88	70	33	85	4	3

X	Y	CALL-SGN	FL-LEVEL	GROUND-SPD	TRK-MODE
2831	1673	AY813	21B	131	(hist)

Fig.3. Layout for normal event and track rec's.

In principle it would suffice to transfer one track dataset per RSR revolution directly to ANMS. However, two succeeding datasets are transferred to the DCU each second, in order to perform error checks and improved time definition of aircraft positions. The first dataset is compared to data from the preceding second to locate updated track records. The second dataset is then used for error checking. Track records within the window are transmitted to

ANMS via a bit serial asynchronous channel. Because of the performed data reduction the ANMS computer receives in average one track record per second.

The received track records are stored temporarily in a 2 minute buffer. This happens because the maximum duration of a normal event is 2 minutes, and the L_{max} time of the event is unknown before the event terminates. After generating a noise event the ANMS computer searches the buffer for related track records by performing the two tests on each track record. The track record, if more than one relates, giving less NMT to aircraft distance, is selected for identification of the noise event.

Due to the transmission rate on the ATC bus a direct memory access interface, intergrated in the DCU, was constructed. The DCU microcomputer is software compatible with the ANMS computer, and it is equipped with hardware for remote control. The identification system software as well as the original ANMS software are multitask programs written in assembler and in Fortran, running under control of real time operating systems.

CONCLUSION

The present concept for aircraft identification is advantageous in providing simple implementation, and in low requirements for computer ressource time. Furthermore parameters defining NMT to aircraft distance limits etc. are adjustable.

A disadvantage is the possibility of faults in aircraft identification. Fortunately, the predicted position error turns out to be 1/8-1/4 NM, thus better than indicated earlier. Nevertheless, the discussed inconsistency in track data is an identification error source.

At this point, track data may in certain situations be improved by using interpolation and curve shaping techniques. The directivity pattern of aircraft in combination with a flight path direction vector, may also be utilized in the identification. These items, in addition to the noise reporting feature for pilots, are possible subjects for implementation in the aircraft identification system.

If the aircraft types were present in the ATC system, pattern recognition techniques might be useful on SPL time history for aircraft noise at NMTs. In full consequence the ATC system might be redundant if DFT analyses were performed on noise at NMTs.