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MULTI-CHANNEL AIRPORT NOISE MONITORING

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First hand experience has been gained in the design, manufacture and installation of airport noise monitoring systems at several major international airports with the most recent being Birmingham International Airport.

The various technical requirements of design in achieving the required system performance are discussed with particular reference to climatic protection of the microphones and associated electronics, data transmission integrity, and display and reporting procedures.

Potential problems during the installation phase are highlighted in the light of experience gained.

1. Basic requirements of a Multi-Channel Noise Monitoring System

The need to measure noise radiating or being radiated over a large area poses many problems and it is unlikely that a perfect solution to quantifying this noise can be met with any single installation. However, by carefully studying the area under consideration it is possible to place a number of identical measuring stations at strategic locations and channel data collected by them back to a central data bank for processing as required. Experience has shown that almost any system which attempts significant data processing at each measuring station and passes a limited data set to a central point, sooner or later is required to give answers which is outside its reduced data capability and therefore a system that constantly transmits SPL data to the central point ultimately posesses the greatest flexibility of use if a significant degree of intelligence is put into this central data collecting point.

In order to realise this continuous data stream, a communications line must be permanently established between the measuring point and central station and this could be either in a star formation or a loop depending on the type of communications employed. For systems with more than 3 or 4 measuring stations, the risk of line breakdown in a loop system must be weighed against the (normally slight) extra costs of the star system and a direct line between each measuring station and the centre will always offer the greatest flexibility and the least disturbance to the complete system if line troubles occur. In the UK it is unlikely that any company other than British Telecom can supply lines to exactly the positions required by the measuring stations if the positions do not lie on the same customers site as the central station. Thus their maintenance and integrity is not directly under the customers control, a situation similar in most countries and a system feature that cannot inexpensively be altered. The ability for the rest of the system to function continuously and reliably and possibily correct for communications errors is important if data collection on a 24 hr basis is required.

2. Special requirements for a permanent system

The overriding requirement for any permanently installed Noise Monitoring System covering a large area is reliability. Time spent servicing a number of monitoring stations spread over several kilometers can mount up quickly, so maintenance must be kept to a minimum as well. In addition to weather protection, to further reduce microphone unreliability, a heater with a power of 1W is placed around the top of the preamplifier/microphone interface and can usually be safely left on all year round except in the hottest of countries. With a heater in this position, there can be a tendancy for moisture to be drawn towards the preamplier electronics and to prevent this, the preamplier is encapsulated in desiccant crystals. This deteriorates in time along with the material used in the microphone windscreen and a routine maintenance call every 3-6 months to replace these items is usually quite sufficient to keep them in perfect working order.

If one visit every 3-6 months satisfies all routine maintenance, it is obviously desirable that the need for acoustic calibration and other accuracy checks need only be performed at the monitoring station with the same infrequency. For any system in which absolute accuracy is required at all times, remote checking is essential and can be achieved in two ways. Firstly, an acoustic calibration of the microphone SPL, either by means of an insert-voltage method or by an electro-static actuator can be performed at a time when the noise environment is at a level well below the current SPL, eg the early hours of the morning. Secondly a check on the linearity of the full dynamic range of the complete signal conversion and transmission system is equally important. Since the microphone calibration can only guarantee one spot level accuracy, with wide dynamic range, the scope for errors at other levels is large. Accurate stepped attenuators are relatively easy to make and the calibration oscillator can be fed directly into the signal system of the monitoring station via this attenuator. An easily traceable pattern can be generated and each step checked by the central computer for the correct reading. Descriptions and errors can be logged by the control station and action taken if significant deviations occur. The sequence of microphone and linearity checks can be commanded by the central station at any time, so accuracy can be ensured on a 24 hour basis or even each time a specific measurement is made.

The system accuracy will also be enhanced if the climatic conditions in which it is sited do not vary vastly, and an enclosure, sited near the microphone, which can be kept at a fairly constant temperature and humidity will greatly increase the long-term reliability and accuracy of calibration. A well thermally-lined enclosure fitted with rain and sun-deflectors and with an internal heater can maintain remarkably constant conditions at, say 30^{0}C, if engineered correctly.

Locating stations where power, communications and a suitable acoustic location co-exist can be a very difficult problem. A brief interruption in mains supply should not be allowed to put a station out of action, and a battery back-up of all the electonics is usually possible. As most power interruptions are usually less than the working day, a battery system that can keep information being transmitted for 10-12hrs will prevent all but the most serious failures from disrupting the data-flow. The battery must keep the microphone heater powered in order to prevent any possible damage, but need not power the enclosure's heater, since failure is unlikely to lead to a critical temperature occuring inside a thermally insulated enclosure.

3. Special Features for Airport Noise Moinitoring Systems

The requirements of permanent airport noise monitoring usually give rise to multi-channel systems which create special demands upon the central data processing station. Data from each channel must be continuously monitored, calculations made, reports generated and printed, significant events recorded, system housekeeping such as calibration maintained and all without interrupting the collection of raw data.

A multi-tasking computer is ideal for this purpose, and several desk-top models are available which can handle many data communications inputs direct from line, eliminating the need for any further electronics except the communications modem. A balance must be struck between the size and art of the computer, the number of measuring stations, the frequency of reading their data and the number of other processing tasks to be undertaken. Data General Co. offer a wide range of machines suitable for these tasks. The model DG10SP, can be suitable for 8 or 16 stations whilst the model MV2000 could handle 32. Collecting data reliably from these stations is vital for the integrity of the system and computers of this type can perform error dectection on the incoming information to correct minor transmission errors. Other error traps such as 5 consecutive unintelligible or impossible answers may be brought to the operator's attention or lead to an automatic suspension of the station with appropriate messages as to why.

4. Identifying Aircraft Events

Aircraft overflights have fairly predictable 'footprints'. Only overflight information and general background levels are usually required by airport staff and so a means of selecting probable aircraft movements from all other noise is needed. An event can be created which has a high probability of being an aircraft movement by selecting a minimum SPL above which the 'event' must remain for a period greater than a few seconds but less than a few tens of seconds. These levels can be user-selectable on the computer to enable the best aircraft 'fit' offered for a given measurement location. A maximum permissible level can also be assigned during an event and messages flagged if this level is exceeded. By correlation with airport data of the exact times of flight arrivals and departures this data can be allotted to an exact flight or discarded as spurious. Most correlation at present is performed manually, but at airports where secondary radar is available, or where aircraft landing and takeoff time is available in real time a degree of automation is potentially possible, although the computing power required does increase significantly. Once an event is confirmed as an aircraft movement, the flight no, airline, aircraft type, Met information, airport runway can be added to the calculated SEL and Lmax for the overflight. With all this information stored, the computer can be used to sort historical data in many different ways to produce reports of any permutation or combination of recorded data.

5. Installing an Airport Noise Monitoring System - some problems

Manufacturing, testing & cabling any noise monitoring system can readily be accomplished indoors where the computer and measuring stations are in close proximity. The system supplied by Lucas CEL Instruments to Birmingham International Airport recently, incorporates all of the features discussed so far and a few extras, such as indicating to the operator outstation power failures and line problems at any of the 7 measuring stations fitted. Installation started by completing the central station and then fitting each measuring station in turn. The site must be accessible by a vehicle capable of hoisting all the equipment to the desired height. This site must also have a means of supporting the outstation, usually a pole, power and communications. It must not be in an unsuitable acoustic position, be objected to by local councils, residents or anyone else who has a right to complain about its location, and even be of the 'correct' colour, which ranges from white through grey to green depending on the location. Erecting such a station without arousing the interest of the local vandals may also warrant consideration, as acoustically transparent microphone enclosures as rarely very resistant to bricks, air-rifles and catapults.

Once these problems are overcome, the monitoring station can be seen to be functional by means of manual checks at the station, but if it fails to communicate back to the central computer, it may not be possible to immediately tell where the problem lies. Interrogation by the computer of the modems employed can help to eliminate some problems but CEL added two extra parts which simplify fault-finding and give operating confidence. Firstly, inside each monitoring station a liquid crystal display shows the exact value of the data being sent to the central computer, and has a marker on this display which flashes each time the computer reads and correctly understands the data. This will be at a regular and predetermined rate so that at any location, without any special equipment, it is possible to know that full and correct communication with the central station is taking place. Should correct communication not occur, a second system can be used since the comunications protocol has been standardized. A small battery operated micro-computer, the Epson HX-20, plus a portable modem, can be connected to the measurement station at its site and complete 2 way communications tested from a simple programme on the HX-20. This facility is invaluable if problems exist with the communications line and was used at one location in Birmingham to find that only one line of the two wire line supplied by BT was actually connected all the way between the measurement and central stations despite all BT's installation checks.

With these aids, operation and maintenance of the Airport Noise Monitoring System should be a fairly straightforward uncomplicated task and CEL expect these systems to be a major part of Noise Assessment for many years to come.