



AudioSoft

White Paper

Solutions to UAV Recording Requirements

A three point plan for ensuring your UAV complies with DEF STAN 00-970

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Executive Summary

This white paper explains DEF STAN 00-970 (Part 9) Section 4, which, referring to UAV's, states that **"A voice recording system shall be fitted to the control station, and shall be capable of recording all voice commands and comments in the control station"**. However, audio is just one aspect to UAV recording requirements.

This white paper provides:

- ▶ Detail on the requirements for UAV recording
- ▶ Options to fulfil these requirements and gain additional benefits
- ▶ Guidance for specifying the best solution

A well designed, integrated solution can provide audio, video, screen and mission data recording in a single system with the ability to synchronise any or all channels on replay. This will ensure compliance to a number of standards as well as improved incident investigation, training and post-mission analysis.

Audience

This white paper is relevant to:

- ▶ DT Leaders to ensure that their UAV control meets requirements and operational needs
- ▶ Those responsible for specifying the recording system for a UAV
- ▶ Compliance Managers

Step 1: Understand the Requirements on your UAV

UAV's are rapidly becoming commonplace throughout the Defence world. In order to deploy a UAV successfully, the appropriate standards must be adhered to.

For all UAV's, audio communications need to be recorded. This has been mandated in both the civil and Defence sectors both on an international basis and specifically for the UK. It is an ICAO requirement that all ground-to-air and ground-to-ground conversations are recorded and DEF STAN 00-970 (Part 9) Section 4, states that "A voice recording system shall be fitted to the control station, and shall be capable of recording all voice commands and comments in the control station".

However, this is only the tip of the iceberg and many authorities in the UK are now stipulating additional compliance. Depending on the use of the UAV, the recording systems may need to be compliant with ICAO (International Civil Aviation Organisation) legislation, with CAP670 and CAP722 (UK Civil Aviation Authority legislation), with EUROCAE (European Organisation for Civil Aviation Equipment) Specification ED-67A and with DEF STAN 00-970 Part 9 (UK MOD standards for UAV's).

- *ICAO now mandate that surveillance data is recorded. This is generally radar data for standard Air Traffic Control applications but applies to video data in the case of UAV's.*
- *CAP670 takes this requirement further and mandates that the surveillance data is recorded at both "Through the wall" and "At the glass (screenshots)" level.*
- *ICAO, CAP670 and UK MOD require that any communications (e.g. voice and text) are recorded*
- *ICAO and EUROCAE require that ambient audio, i.e. within the GCS, is recorded*
- *UK MOD require that primary mission data be recorded including mission plans and updates, air vehicle commands*
- *UK MOD require that system data be recorded including data link up link commands, data link down link air vehicle data, system health data*

For more information please see Ultra Electronics AudioSoft's white papers "Solutions to ICAO Radar Recording Requirements for ATC" and "Aural Environment (Ambient) Recording: Solutions to New ICAO Requirements for ATC"

The newly formed Military Aviation Authority evaluates all civil legislation with a view to then implementing similar requirements as DEF-STAN's, hence the Defence world is now beginning to see these recording requirements filter through.

Step 2: Understand the options

This section explains what capabilities exist to satisfy these recommendations and requirements.

Option 1: Audio communication only recording

All voice communications between control stations and other Air Traffic Control facilities – such as airports or ACC's – that affects the control of the aircraft needs to be recorded. This is extended to text communications if enabled. Each control station area recorder should have the capacity to record these communications for the maximum duration of each UAV flight.

An independent recording system can passively tap off the audio switch to give a faithful record of the voice communications. This is generally recorded in duplicate, should be time-stamped and stored for 30 days.

Option 2: Addition of ambient audio recording

International Civil Aviation Organisation (ICAO) recommend that "Air traffic control (ATC) units be equipped with devices that record background communication and the aural environment at controller work stations". DEF-STAN 00-970 states that the voice recording system "shall be capable of recording all voice commands and comments in the control station", which can be interpreted as both the voice communications and the ambient environment.

However, due to the sensitivity of such audio in a Defence environment this may not always be appropriate for military UAV control stations. Guidance should be sought from an appropriate body, such as the Military Aviation Authority.

If ambient recording is required, it is a relatively simple task to increase the number of channels specified for the audio comms to allow for microphones in the control station. This can be done in a number of ways though consideration should be given to:

- ▶ How many and where to position the microphones for best quality of recordings
- ▶ Using good quality microphones appropriately (e.g. button microphone for a desk-mount, boundary microphone for ceiling-hanging)
- ▶ Whether or not to use a pre-amp and/or Automatic Gain Control

Option 3: Addition of screen recording

Civil ATC is moving towards recording operator screens, integrated with the audio recording, and the Defence sector is following suit. DEF-STAN 00-970 Part 9 states that "Consideration should be given to video recording the UAV-pilot(s) and UAV Commander's screens together with the voice records." Further DEF-STAN requirements are expected from the MAA presently.

Screen capture provides a comprehensive and system independent record of what was on the controller's screen. Modern recording systems can capture the operator's screen by passively splitting the RGB or DVI video signal to the display. The recording of the display's video signal is system independent and guarantees a faithful record of screen activity. Multiple screens can be recorded through a single interface and the data, whilst large, can be stored efficiently to minimise bandwidth. The benefits of recording in this way are significant:

- ▶ Recording system is completely independent of the UAV control system
- ▶ All user actions as well as the displayed video will be recorded
- ▶ Ideal solution for training purposes as it faithfully recreates the controller's screen

- ▶ Captured screen images can be merged with the recorded audio and exported into industry standard formats for replay in a standard Windows media player.

Option 4: Addition of video recording

UK Air Traffic Control that uses radar information now needs to record, along with the audio, at both “at-the-glass” (screen/CWP) and “through-the-wall” (radar/1s-and-0s). A similar set-up for UAV’s that use video data would be to record both the operator screens and the streamed video.

High-bandwidth video recording is a lot more accessible than previously, with modern IP standard such as VIOVE and DDS allowing recorders to manage the data streams, usually coming in on one or several Gigabit or 10 Gigabit ethernet connections. By intelligent use of lossless and lossy video compression techniques, the video data can be captured at high quality for important data and high compression for the majority of data to enable long-term storage.

By capturing this video with all the other data types through an integrated recording solution, not only does this ensure compliance but it also means that all the data can be replayed synchronously, which is invaluable for incident investigation, post-mission debriefs and training.

Option 5: Addition of data recording

It is standard that any UAV recorder should be capable of recording all primary mission data, and system data, from control station start up to shut down.

The ability to interrogate the full mission data is vital for users and commanders. Recording the mission data will facilitate interrogation of the data during and after each mission for ISTAR purposes.

Mission data including GPS, distance, flight time, etc, will normally be recorded as an IP stream and usually adds little overhead to the recording system in terms of bandwidth.

Option 6: Addition of mouse and keyboard recording

Both mouse actions and keyboard strokes can be recorded by passively splitting the serial inputs. This, when combined with the screen and audio recordings, gives full incident reconstruction and allows for quick searching for user actions.

Recording the complete user data will facilitate incident investigation and improved training. In the event of an incident, the Controller Workstation Position (CWP) can be recreated exactly as the user saw it, showing all interactions in synchronisation and giving the complete picture of what happened. The ability to reconstruct the CWP is vital for Accident Investigators.

A note on security

Because of the sensitive nature of some of the data, it is important that it is all recorded securely. Recordings should therefore be made in a proprietary format, and consideration should be given to securing them through 128 bit encryption. A kill switch should be specified for the recorder so that, should the facility be compromised, an automatic deletion of all mission data can be activated. This is in line with UK GCPD security accreditation.

Step 3: What should I do?

At a minimum the audio communication needs to be recorded.

The addition of options 2-5 listed in the previous section will improve compliance to current and anticipated DEF-STAN requirements, and allow for improved incident investigation, training and post-mission debriefing.

It is therefore recommended that the following user data is recorded by an independent recording system for faithful reconstruction:

- ▶ Voice communications (and text communications if enabled)
- ▶ Screens of all consoles

It is also recommended that all mission data is recorded, most likely as an IP stream:

- ▶ Video feeds from the UAV
- ▶ Mission data including GPS, distance, flight time, etc.

Consideration should also be given to recording of:

- ▶ Ambient audio within the Control Station if appropriate
- ▶ Further Human/Machine Interface (HMI) data such as keyboard, mouse, etc.

	Option 1: Audio communication only recording	Option 2: Addition of ambient audio recording	Option 3: Addition of screen recording	Option 4: Addition of video recording	Option 5: Addition of data recording	Option 6: Addition of mouse/keyboard recording
Compliance	✓	✓	✓	✓✓	✓✓	✓✓
Incident investigation	✗	✓	✓	✓	✓	✓✓
Training	✗	✗	✓	✓	✓✓	✓✓
Post mission debriefing	✗	✗	✗	✓	✓✓	✓✓

Table 1: Analysis of different options for UAV Recording

✗ = unsatisfactory, ✓ = satisfactory, ✓ = good, ✓✓ = excellent

It is recommended that the options outlined in this white paper are discussed in more detail with a specialist Defence recording system manufacturer to ensure the data can be replayed synchronously through an integrated, secure recording system.

References

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- [7] EUROCAE document ED-111, Chapter 4.
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- [13] CAP670 initially produced 1998, now at revision 1/06, dated 30th June 2006, <http://www.caa.co.uk/application.aspx?categoryid=33&pagetype=65&applicationid=11&mode=detail&id=200>
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- [15] ED-112 (Minimum Operational Performance Specification for Crash Protected Airborne Recorder Systems)
- [16] ED-155 - MOPS Minimum Operational Performance Specification For Lightweight Recording Systems - Issued in July 2009
- [17] ED-112 - MOPS for Crash Protected Airborne Recorder Systems including Amendment 1 - 25th July 2003 and Amendment 2 - 22nd September 2003.
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Glossary

ACC: Area Control Centre
ATC: Air Traffic Control
CAA: Civil Aviation Authority
CWP: Controller Workstation Position
DT: Delivery Team
EuroCAE: European Organisation for Civil Aviation Equipment
FDR: Flight Data Recorder
HMI: Human/Machine Interface
ICAO: International Civil Aviation Organisation
IP: Internet Protocol
MAA: Military Aviation Authority
MOD: Ministry of Defence
UAV: Unmanned Air Vehicle