International Civil Aviation Organization

THE THIRTIETH MEETING OF THE COMMUNICATIONS / NAVIGATION AND SURVEILLANCE SUB-GROUP (CNS SG/30) OF APANPIRG

Bangkok, Thailand, 06 - 10 July 2026

Agenda Item 6: Aeronautical Mobile Communications Service and Aeronautical Electromagnetic Spectrum Utilization

RESILIENCE IN VOICE COMMUNICATION CONTROL SYSTEMS (VCCS) AND RADIO INFRASTRUCTURE

(Presented by Thailand)

SUMMARY

This information paper presents Thailand's operational and technical framework for achieving high resilience in sustaining operations of Voice Communication Control Systems (VCCS) and aeronautical radio infrastructure within the Bangkok FIR. The paper outlines multi-layer redundancy architecture, fallback operational concepts, geographic resilience, cybersecurity measures, and operational continuity strategies aligned with ICAO resilience principles.

1. INTRODUCTION

1.1 In response to the ICAO APAC initiative on "Achieving High Resilience in Sustaining Operations of Critical Aeronautical Infrastructure", Thailand has developed a resilient communication architecture designed to ensure continuity of Air Navigation Services under both normal and degraded operational conditions.

1.2 Thailand recognizes that modern CNS/ATM systems must move beyond conventional system availability toward operational resilience capable of anticipating, absorbing, recovering from, and adapting to disruptions, including cyber-attacks, power failures, natural disasters, communication outages, and systemic failures.

1.3 The continuity of VCCS and aeronautical radio infrastructure is considered mission-critical to maintaining the safety of flight, ATM continuity, national security, and the integrity of the Bangkok FIR.

2. DISCUSSION

2.1 **Voice Communication Control System (VCCS) Architecture**

Thailand has implemented a three-tier VCCS architecture consisting of Main Operations (MOPs), Fallback Systems, and Contingency/Training (CON/TRA) systems to ensure resilience-by-design and graceful degradation capability.

2.2 **Main Operations (MOPs)**

The primary VCCS environment incorporates network segmentation, cyber resilience

controls, redundant architecture, and operational absorption capability to ensure uninterrupted support for high-density air traffic operations.

2.3 **Fallback System**

The fallback system is designed with an identical technical configuration and capacity to the Main Operations (MOPs) environment and is co-located within the same operational facility. In the event of a critical failure or disruption rendering the MOPs environment unavailable, operations can be seamlessly and immediately transitioned to the Fallback System. This immediate switchover capability ensures zero operational impact on Air Traffic Control (ATC) duties and prevents any interruption to ATM services.

2.4 **Contingency and Training (CON/TRA)**

The CON/TRA system serves as an independent backup environment capable of providing full Air Traffic Services (ATS). To ensure maximum geographic resilience, it is installed at a completely separate physical location from both the MOPs and the fallback systems. In the event that both MOPs and Fallback systems encounter critical failures, or if the primary operational site becomes inaccessible, Air Traffic Control operations can be entirely relocated to the CON/TRA facility. Under normal operational conditions, this system is actively utilized for ATSEP and ATCO training and simulation.

2.5 **Radio Infrastructure Resilience**

Thailand maintains a four-level radio resilience hierarchy consisting of Main Radio Systems, Standby Radio Systems, On-site Backup Radio Systems, and Off-site Backup Radio Systems to ensure uninterrupted ground-to-air communications.

2.6 **Multi-layer Redundancy**

The radio infrastructure incorporates intra-site redundancy, carrier diversity, technology diversity, and geographic redundancy to eliminate single points of failure and support disaster recovery capability.

2.7 **Main Radio Systems and Standby Radio Systems**

The Main and Standby radio systems are engineered with full, comprehensive redundancy across all technical layers. This architecture ensures seamless, uninterrupted ground-to-air communications, allowing Air Traffic Controllers (ATCOs) to execute their duties with maximum operational efficiency and continuity, completely free from concerns regarding potential radio system vulnerabilities or unexpected service disruptions.

2.8 On-site Backup Radio Systems

The on-site backup radio systems are engineered as entirely independent radio infrastructures, completely isolated from both the Main and Standby radio systems. However, they are co-located and installed directly within the same ATC working positions. This strategic placement ensures that in the unlikely event of a total failure of the primary radio systems, Air Traffic Controllers (ATCOs) can immediately access and utilize the on-site backup radios, thereby guaranteeing absolute continuity of air traffic services.

2.9 Off-site Backup Radio Systems

The off-site backup radio systems are deployed at a completely separate physical location from the primary radio infrastructure. This geographic separation serves as a critical contingency layer, designed to be activated in the event that the primary radio site encounters severe physical damage, facility accessibility issues, or critical signal interference that disrupts the main operational area.

2.10 Cybersecurity Controls

To safeguard the integrity and availability of both VCCS and radio infrastructure, Thailand implements a strict zero-trust cyber resilience framework. Both systems operate entirely on a closed network infrastructure with no external internet connectivity, isolated from corporate or public networks. Furthermore, stringent Identity and Access Management (IAM) controls are enforced across all operational layers; any access to system configurations, administrative tools, or application-level settings strictly requires multi-level user authentication, robust password protection mechanisms, and role-based access permissions.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper; and

b) exchange views and experiences related to resilient CNS/ATM infrastructure and operational continuity management; and

c) encourage continued regional collaboration on CNS resilience, contingency operations, and cybersecurity prepareness within the APAC Region.

…….