Autonomous Navigation Systems (ANS) Standard

AET - Endorsement

NCATT
4801 Marine Creek Parkway
Fort Worth, TX 76179
(817) 515-7264 www.ncatt.org

NCATT Autonomous Navigation Systems Standard
Subject, Performance and Task Knowledge Requirements

I. Safety

II. Slaved Compass System

III. Vertical Gyro System

IV. Inertial Navigation System / Inertial Reference System

V. Heading Reference Systems

There are five (5) *Subject Knowledge, Task Performance and Task Knowledge* activities and functions within the NCATT Autonomous Navigation Systems Standard. This Standard was identified and defined by aerospace industry Subject-Matter-Experts (SMEs) through an NCATT facilitated occupational analysis workshop. NCATT workshops focus on the "job" an individual performs in relation to an identified topic or career field.

The NCATT Autonomous Navigation Systems Standard can be used by Aerospace Industry education and training entities to develop lesson plans as part of a complete education and training program focused on avionic / electronics systems. The Standard can also be used to develop specialized and/or targeted education and training needs.

The depth, complexity and detail of task performance, task knowledge and subject knowledge, required for *NCATT Accredited* programs, can be determined by referring to the NCATT Level Definitions provided below.

Educational entities that wish to align their programs with the NCATT Standards (and required teaching levels) should refer to the NCATT webpage (www.ncatt.org) for additional guidance.

NCATT Level Definitions

	Scale Value	Definition: The Individual
Task Performance Levels	1	***IS EXTREMELY LIMITED.*** (Can do simple parts of the task. Needs to be told or shown how to do most of the task)
	2	***IS PARTIALLY PROFICIENT.*** (Can do most parts of the task. Needs only help on hardest parts.)
	3	***IS COMPETENT.*** (Can do all parts of the task. Needs only a spot check of completed work.)
	4	***IS HIGHLY PROFICIENT.*** (Can do the complete task quickly and accurately. Can tell or show others how to do the task.)
Task Knowledge Levels	a	***KNOWS NOMENCLATURE.*** (Can name parts, tools, and simple facts about the task.)
	b	***KNOWS PROCEDURES***. (Can determine step-by-step procedures for doing the task.)
	c	***KNOWS OPERATING PRINCIPLES.*** (Can identify why and when the task must be done and why each step is needed.)
	d	***KNOWS ADVANCED THEORY.*** (Can predict, isolate, and resolve problems about the task.)
*Subject Knowledge Levels	A	***KNOWS FACTS.*** (Can identify basic facts and terms about the subject.)
	B	***KNOWS PRINCIPLE.*** (Can identify relationship of basic facts and state general principles about the subject.)
	C	***KNOWS ANALYSIS.*** (Can analyze facts and principles and draw conclusions about the subject.)
	D	***KNOWS EVALUATION.*** (Can evaluate conditions and make proper decisions about the subject.)

Explanations

A task knowledge scale value may be used alone or with a task performance scale value to define a level of knowledge for a specific task. (Example: b and 1b)

*A subject knowledge scale value is used alone to define a level of knowledge for a subject not directly related to any specific task, or for a subject common to several tasks.

NCATT Autonomous Navigation Systems Standard
Subject, Performance and Task Knowledge Requirements

I. Safety

1. Autonomous Navigation System Safety
Level B

Outcome: A successful education or training outcome for this task/subject will produce an individual who knows and can identify the relationship of basic facts and state general principles about *safety* and safety issues as applied to general safety practices, flight line operations and maintenance / shop activities. The individual will be able to recognize and use terminology that may be applicable to safety issues specific to this standard, and related to specific subject areas within the standard.

II. Slaved Compass Systems

2. Purpose/Types/Components
NCATT Level B

Outcome: A successful education or training outcome for this task/subject will produce an individual who knows and can identify the relationship of basic facts and state general principles about *Slaved Compass Systems* and be able to recognize and use terminology related to this subject.

As general information, the following terms and components are *typically* associated with slaved compass systems.

- Purpose
  - Provides a simple, comprehensive visual display of an aircraft's heading and position, in relationship to a desired course
  - Alternate names
    - Compass System
    - Heading System
    - Slaved Heading System
- Types (Configuration)
  - Remote Mounted Gyro
  - Internal Gyro – built into the panel mounted indicator
- Slave Compass System Components (Typical)
  - Horizontal Situation Indicator (HSI)
  - Magnetic Azimuth Transmitter
    - Flux Valve
    - Flux Gate
    - Flux Detector
  - Slaving Control Unit / Slaving Panel
  - Slaved Gyro

III. Vertical Gyro System

3. General/Operational Characteristics
NCATT Level B

Outcome: A successful education or training outcome for this task/subject will produce an individual who knows and can identify the relationship of basic facts and state general principles about *Vertical Gyro Systems* and be able to recognize and use terminology related to this subject.

As general information, the following terms and components are *typically* associated with vertical gyro systems.

- General
  - First use circa 1910-11 , Elmer A. Sperry
  - Also known as:
    - Displacement Gyros
    - Attitude Gyros
  - Spinning wheel / disc
  - Spin axis aligned in the vertical direction
  - Principal of gyroscopic rigidity in space
  - Measures movement or change both bank (roll) and attitude (pitch)
  - Mounted in Gimbaled Frame (roll & pitch gimbals)
  - Air or electrically driven
  - High spin rate
- Gyro Operational Characteristics
  - Precession
  - Drift
  - Tumbling / Spilling
  - Bearing wear

IV. Inertial Navigation System (INS) / Inertial Reference System (IRS)

4. General

NCATT Level B

Outcome: A successful education or training outcome for this task/subject will produce an individual who knows and can identify the relationship of basic facts and state general principles about *Inertial Navigation / Inertial Reference Systems* and be able to recognize and use terminology related to this subject.

As general information, the following terms and components are *typically* associated with inertial navigation and reference systems.

- INS Characteristics
  - Automatic Self Alignment and Calibration
  - Independent of External Navigation Aids
  - Continuous Self Monitoring
  - Waypoint Data (present position) accomplished with keyboard
- INS System Components
  - Mode Selector
  - Control Display Panel
  - Battery Module (back-up)
  - Navigation Unit
    - Gyro-Stabilized Frame / Inertial Platform
      - Tilt Table
      - Gyro Gimbal Assembly
      - Accelerometers
  - Computer
- Inertial Reference System (IRS)
  - Advanced Technology Inertial Reference System
  - Inertial Reference Unit (IRU) Components
    - Three Laser Gyros (Pitch, Roll, Yaw)
    - Three Accelerometers (Pitch, Roll, Yaw)
    - Fourteen (14) circuit cards
    - Power Supply
    - Computer
    - Battery Module (back-up)

5. Tie-In/Integration
NCATT Level A

Outcome: A successful education or training outcome for this task/subject will produce an individual who can identify basic facts and terms about *Inertial Navigation / Inertial Reference System Tie-In/Integration*.

As general information, the following terms and components are *typically* associated with tie-in and integration of inertial navigation and reference systems.

- Central Air Data Computer (CADC)
- Distance Measurement Equipment (DME)
- Autoflight / Autopilot / Flight Director
- Flight Display
- Weather Radar System
- Area Navigation (RNAV)

6. Operational Checks / Fault Isolation
NCATT Level 2b

Outcome: A successful education or training outcome for this task/subject will produce an individual who is partially proficient in the performance of the tasks of *Inertial Navigation / Reference System Operational Checks and Fault Isolation*. The individual will be able to do most parts of the task and will need help only on the hardest parts. In addition, they will know the procedures for the task, and can determine step-by-step procedures for doing the task.

As general information, the following is a *typical* list of inertial reference system operational checks and fault isolation activities.

- Operational Checks
  - Alignment
    - Optical
    - Compass
    - Transfer
    - GPS-aided
  - Drift Check
- Malfunctions / Faults
  - Verify Coordinates
  - Verify INS Alignment
  - Drift Errors
  - Built-in-Test-Equipment (BITE)
  - LRU Remove/Replacement
  - Handling, Storing and Shipping INS/IRS Component

V. Heading Reference Systems – Attitude Heading Reference System (AHRS) / Air Data Heading Reference Systems (ADHRS) / Air Data Inertial Reference Unit (ADIRU):

7. General

NCATT Level B

Outcome: A successful education or training outcome for this task/subject will produce an individual who knows and can identify the relationship of basic facts and state general principles about *Heading Reference Systems* and be able to recognize and use terminology related to this subject.

As general information, the following terms and components are *typically* associated with heading reference systems.

- Attitude Heading Reference Systems (AHRS) provide 3-axis sensor information for:
  - Heading
  - Attitude
  - Yaw
- AHRS provides a replacement for mechanical gyroscopic flight instruments
- AHRS components (typical):
  - Solid-State or Silicon Inertial Sensors - Micro-Electro-Mechanical Systems (MEMS)
    - Gyroscopes – Ring Laser or MEMS
    - Accelerometers
    - Magnetometers
  - Kalman Filter
  - External Flux Valve, also known as:
    - Magnetic Azimuth Transmitter / Magnetic Slaving Transmitter
    - Flux Gate / Flux Detector
    - Magnetic Flux Sensor
  - Compensator
    - LRU unit used to correct heading reference / Flux Valve alignment errors
- Air Data Heading Reference Systems (ADHRS)
  - Air Data Computer added to Attitude Heading Reference System
  - Air Data Computer provides
    - Calibrated Airspeed
    - True Airspeed
    - Mach number
    - Altitude
    - Altitude trend data
    - Total Air Temperature
    - Static Air Temperature
- Air Data Inertial Reference Unit (ADIRU)
  - Combines AHRS and ADHRS data information

- ADIRU Components:
  - Air Data Reference (ADR) Unit – ADR Unit provides:
    - Airspeed
    - Angle of Attack (AOA)
    - Temperature
    - Barometric Altitude Data
  - Inertial Reference (IR) Unit – IRU provides:
    - Attitude
    - Flight Path Vector
    - Ground Speed
    - Positional Data
  - Air Data Modules (ADM) – Remote Sensors that Provide:
    - Pitot and Static pressures

8. Tie-in/Integration

NCATT Level A

Outcome: A successful education or training outcome for this task/subject will produce an individual who can identify basic facts and terms about *Attitude Heading Reference Systems Tie-In/Integration*.

As general information, the following is a *typical* list of elements, aircraft systems, segments, components or navigation systems that utilize / tie-in, or are a part of heading reference systems.

- Onboard GPS System
- Autoflight / Autopilot
- Flight Management System
- Flight Displays
- Pitot / Static System

9. Operational Checks / Fault Isolation
NCATT Level 2b

<u>*Outcome*</u>: A successful education or training outcome for this task/subject will produce an individual who knows basic *Attitude Heading Reference Systems* theory of operation. The individual will be partially proficient in the tasks of operational checks of Attitude Heading Reference Systems. They will know the procedures for operational checks and can determine the step-by-step procedures for doing the task. The individual will be able to do most parts of the task and will need help only on the hardest parts.

As general information, the following is a *typical* list of heading reference systems installation, operational checks and faults Isolation activities.

- Pre-Installation Requirements (General/Typical)
  - Current Installation, Operation and Troubleshooting Software
  - Verification of proper operation of aircraft systems to be integrated
  - Aircraft systems data interface
  - Electrical load analysis
- Installation Requirements (General/Typical)
  - Large magnetic field avoidance
  - Mounting location
    - Mechanical
    - Vibration
    - Magnetic Environment
      - Ferrous Metal Objects
      - Large moving Ferrous Metal Objects (i.e., Landing Gear, Flap Actuators)
      - DC and AC Power Cables
    - CG Alignment - Center of Gravity of the “System”
    - Attitude leveling
    - Longitudinal alignment
  - Degaussing Considerations
    - Airframe
    - Control Cables
  - Hard/Soft Iron Alignment
- Post Installation Testing for:
  - Heading Alignment
  - Attitude Alignment
  - Interfaces with other aircraft systems

- Troubleshooting (General)
  - Perform 100% Continuity check
  - Verify primary power applied to proper pins
  - Pull and reset circuit breakers
  - Utilize BITE program in Software package
  - Contact manufacturer customer service
- Returning components to manufacturer (General/Typical)
  - Identification tag to both the equipment and the shipping container
  - Service or repair needed
  - Additional information that may be helpful
  - Use the original shipping container when available
  - In absence of original shipping container use a heavy container
  - Provide adequate padding for protection
  - Seal the container with heavy tape or metal bands
  - Mark the container “FRAGILE, DELICATE INSTRUMENT”