UK National Aerospace NDT Board

c/o The British Institute of NDT
Midsummer House, Riverside Way
Northampton, NN1 5NX
United Kingdom

Tel: +44(0)1604-438251
E-mail: uknandtb@bindt.org

NANDTB/30 – UK NANDTB INTERIM POLICY FOR

3D NON-FILM RADIOGRAPHIC TESTING TRAINING AND QUALIFICATION

1. Status.

Initial issue, approved for publication at the 5 Sep 2022 meeting of the UK NANDTB.

This interim policy expires 5 Sep 2024, unless extended or withdrawn by UK NANDTB.

2. Scope.

This document sets out the UK NANDTB interim policy for 3D Non-Film Radiographic Testing (3DNF RT) training and qualification. It is intended to facilitate the introduction of 3DNF RT conversion training for an initial cadre of EN4179 Level 2 and Level 3 personnel currently qualified in 2D Non-Film RT sub-techniques (eg Computed Radiography, Digital Radiography, etc). Once sufficient 3DNF RT qualified trainers, examiners, supervisors, and mentors are in place, this interim policy will be replaced with a steady-state policy that will allow UK aerospace sector capability in 3DNF RT to develop further.

This interim policy does not cover 3DNF RT:

a. Conversion training for Level 1 personnel qualified in 2DNF RT.
b. Conversion training for personnel qualified only in Film RT.
c. Direct qualification.

Furthermore, this policy does not cover any form of qualification for metrology applications.

3. Background.

Advanced manufacturing processes, eg Additive Manufacturing (AM), often require correspondingly advanced inspection techniques. To address the UK aerospace sector's increasing need for high-resolution, volumetric NDT there is growing demand for 3DNF RT solutions; primarily using Computed Tomography (CT), but also Digital Tomosynthesis (DT).

CT systems generally have high set-up costs and long or uncertain return on investment. DT systems are typically cheaper, but do not yet have the penetrating power or resolution of CT systems. To date, 3DNF RT expertise in the UK aero sector has been mainly confined to a small number of Primes and contractors using CT/DT for R&D, as a supplementary inspection for another NDT approach, or for metrology. Operators are heavily reliant on OEM training and until now, there has been no established pathway to EN4179 qualification via Approved Training Organisations (ATO).

The UK NANDTB recognises CT and DT as sub-techniques that fall within the RT method and the Non-Film technique outlined in EN4179. Whilst EN4179 permits Employers / RL3s to define technique boundaries and specify training requirements in their Written Practice, there is a risk of 3DNF RT standards diverging across industry, if not controlled from the outset.

The UK NANDTB therefore requires standardised 3DNF RT training for EN4179 organisations during this critical initial period. The EN4179 model for emerging methods will be used as a basic template and will incorporate the three main elements for qualification: formal training, experience, and assessment.

4. **Policy Overview**.

The UK NANDTB has appointed an industry Genesis Level 3 (GL3) experienced in 3DNF RT (see Appendix 3). The GL3 will qualify an experienced 2DNF RT Level 3 Trainer/Examiner nominated by the Lead ATO. The Lead ATO Trainer/Examiner will then conversion train and qualify other ATO Level 3 Trainer/Examiners in CT (Appendix 1) and/or DT (Appendix 2). This 'initial cadre' (identified at Appendix 3) will in turn train and qualify Employer personnel.

As the aerospace industry currently has very little 3DNF RT expertise, OEM SME knowledge forms a vital component in successful qualification of EN4179 practitioners. As such, ATO (general theory) classroom-based training must complement OEM (equipment-specific) client practical training.

Figure 1 below shows the basic 3DNF RT qualification hierarchy.

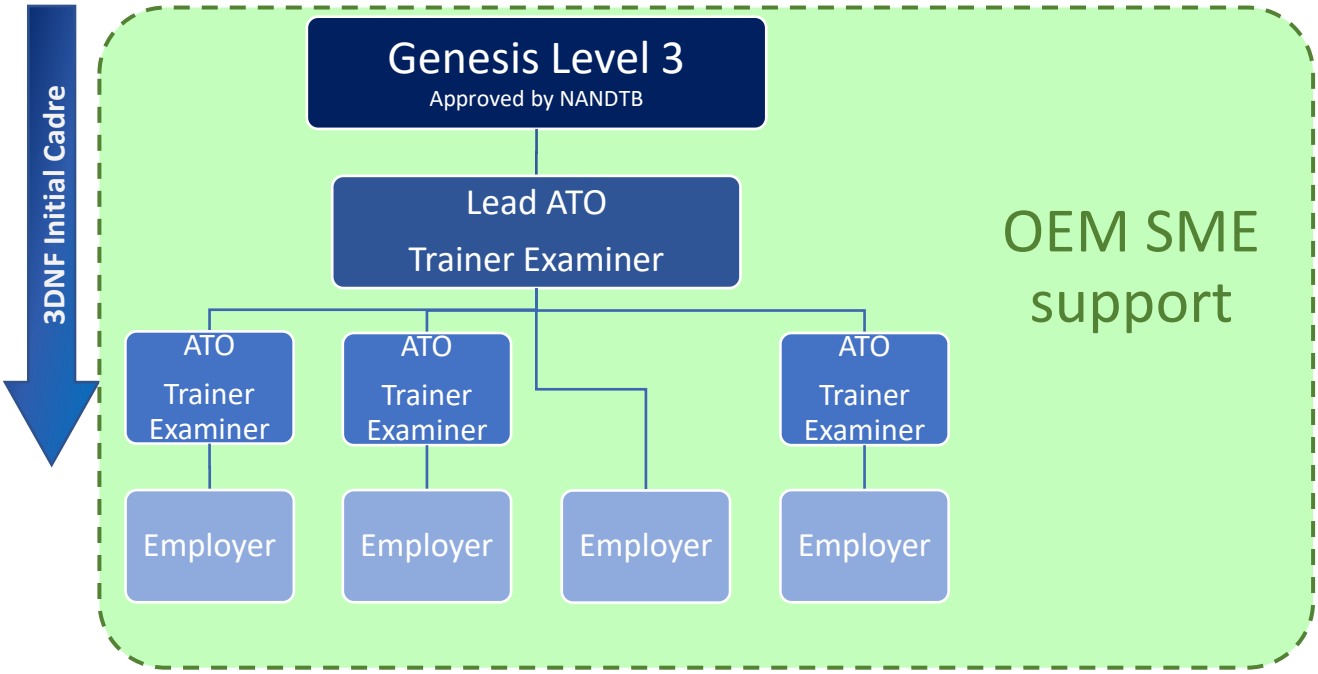

Figure 1 – 3DNF RT qualification hierarchy

5. Regulatory Requirements.

a. None.

6. UK NANDTB Requirements.

a. ATO Approvals. ATOs with a current EN4179 2DNF RT approval may develop and deliver 3DNF RT conversion training for L2/L3 personnel. This arrangement is:

- conditional on the ATO being represented on the NANDTB/30 Working Group.
- subject to Board approval prior to first delivery.
- subject to review before the policy expiry date stated in Para 1.

b. Computed Tomography Qualification. RL3s shall ensure that individuals within their organisation follow the CT Training Outline (Appendix 1).

c. Digital Tomosynthesis Qualification. RL3s shall ensure that individuals within their organisation follow the DT Training Outline (Appendix 2).

d. Personnel Appointments. Direct personnel appointments for initial cadre 3DNF RT conversion are only to be issued by NANDTB. A record of such appointments is at Appendix 3.

7. Recommendations. It is recommended that:

a. ATO (general theory) training should be completed prior to OEM (equipment specific) training.

b. ATO Trainer/Examiners should participate in OEM client training (if they are not already familiar with the make and type of equipment used by the Employer).

8. Guidance. It is advised that:

a. Enquiries regarding 3DNF RT training and qualification policy may be referred to the NANDTB.

Signed for the Board

Kevin Pickup
Chairman of the NAndtB

Appendices:

Appendix 1 - Computed Tomography Conversion Training Outline.

Appendix 2 - Digital Tomosynthesis Conversion Training Outline.

Appendix 3 - NANDTB 3DNF RT Appointment Record.

Appendix 1 to NANDTB/30: Computed Tomography Conversion Training Outline.

1. **Eligibility:** Minimum requirement:

   a. Hold EN4179 Level 2 qualification in a 2D Non-Film RT application (eg Computed Radiography, Digital Radiography, Digital Radioscopy, etc).

   b. Have undergone Radiation Safety instruction in accordance with EN4179 Para 6.1.5(c).

2. **General training:** Minimum 24 hours classroom-based CT-specific theory training, delivered by ATO, covering:

   a. Overview:

      1. Safety requirements.
      2. Basic principles.
      3. Basic terminology.
      4. Basic system configuration.
      5. Basic system performance checks and calibration.
      6. Advantages / disadvantages.
      7. Understanding of NDT applications for aerospace production and in-service maintenance.
      8. Awareness of non-NDT applications (eg metrology, FEA, re-design as part of an accredited Part 21 design certification, etc).
      9. Awareness of the similarities and differences between CT and DT.

   b. Hardware:

      1. Safety features.
      2. Enclosures.
      3. Manipulators.
      4. Turntables.
      5. Component support & mounting materials.
      6. Tube heads (mini/micro focus, open/closed, cone/fan beam, etc).
      7. Detectors (array/linear, fixed/mobile, etc).
      8. Video monitoring.
      9. Component & tube head positioning (including collision avoidance).
      10. Workstation & user interface (UI).

   c. Data Acquisition:

      1. Scan types (2D / 3D / Stack / Spiral / Mosaic / Multi-component / etc).
      2. Sinograms.

3. Tomograms.

4. Volumes.

5. Scan quality attributes (eg resolution, layer separation, number of projections, etc).

6. Reconstruction methods.

7. Calculation & optimisation of scan settings (eg kV, mA, time, wattage, etc).

d. Data Processing:

1. Visualisations.

2. Image optimisation and enhancement.

3. Software evaluation tools:

- Feature location and measurement (linear & volumetric).
- Surface determination.
- Automatic Defect Recognition (ADR).
- Digital Twin Comparison (DTC).

e. Data Handling:

1. File formats.

2. Data export.

3. Archiving and retention.

4. Security.

5. Reporting.

f. Interpretation:

1. Recognition and correction of artefacts (eg lack of penetration, centre-point of rotation, ring artefacts, partial volume effect, beam hardening, under-sampling, noise, etc).

2. Characterization and interpretation of defects (manufacturing flaws) relevant to the material(s), production method(s) and part type(s) **specified by customer RL3**.

3. Characterization and interpretation of faults (in-service failures) relevant to the material(s), production method(s) and part type(s) **specified by customer RL3**.

3. **Specific training.** Recommend minimum 16 hours equipment-related, blended classroom/practical training, delivered by OEM, covering:

1. Safety features.

2. Emergency procedures.

3. Daily / Pre-use checks.

4. User-level maintenance and troubleshooting.

5. Support and software updates.

6. Awareness of OEM-level maintenance, calibration, and repair.

7. Start-up / shut-down procedures.

8. System performance checks.

9. Component handling.

10. Component & tube head positioning (including collision avoidance).

11. Optimisation of scan settings / attributes.

12. Use of software tools for effective interpretation (as Para 2f).

4. **Experience requirements:** Minimum 80 hours of experience (practical consolidation training). The experience is to be relevant and meaningful, as follows:

    a. Individuals shall complete the CT Experience Checklist (EC) at Annex A, under supervision of 3DNF RT L2/L3, ATO Trainer, OEM SME, or other suitable person designated as assessor by the RL3 in writing.

    NOTE. An organisation's RL3 may designate pre-qualification individuals as EC assessors ahead of qualification, only if they are 'first generation', i.e. they have been successfully assessed by 3DNF RT L2/L3, ATO Trainer or OEM SME. This is to prevent dilution of EC standards, whilst allowing the initial cadre rollout to proceed in an efficient manner.

    The EC original (and, where appropriate, record of RL3 designation as EC assessor) shall be retained with the individual's NDT training record. If required, copies may be retained by the individual, their line manager or ATO.

    b. Automated CT scans often have very long durations and may only require intermittent monitoring by operators. Non-productive activity during lengthy scans shall not be counted towards experience hours.

5. **Assessment requirements**:

    a. General Examination. Minimum 30 questions, administered by L3 Examiner (following General Training Course). Closed book. Pass mark: 70%.

    b. Specific Examination. Minimum 30 questions, administered by L3 Examiner (following completion of experience checklist and experience hours). Open book, based on standards / specifications **detailed by customer RL3**. Pass mark: 70%.

    c. Practical Examination. Minimum 2 specimens, administered by L3 Examiner (following completion of experience checklist and experience hours). Each practical examination shall cover acquisition and evaluation. Practical examination specimens shall be representative of the criteria in Paras 2f2 & 3. Pass mark: 70%, averaged across all practical exams.

    d. Overall pass mark 80% (average of General, Specific and Practical marks).

6. **References:** The following list of references is provided for general information only and should not be considered exhaustive or authoritative.

    a. ASTM E1672. Standard Guide for Computed Tomography (CT) System Selection.

    b. ASTM E3166. Standard Guide for Nondestructive Examination of Metal Additively Manufactured Aerospace Parts After Build.

    c. BS EN ISO 15708-1. Non-destructive testing — Radiation methods for computed tomography — Part 1: Terminology.

d. BS EN ISO 15708-2. Non-destructive testing — Radiation methods for computed tomography — Part 2: Principles, equipment, and samples.

e. BS EN ISO 15708-3. Non-destructive testing — Radiation methods for computed tomography — Part 3: Operation and interpretation.

f. BS EN ISO 15708-4. Non-destructive testing — Radiation methods for computed tomography — Part 4: Qualification.

7. **Annexes.**

Annex A - Computed Tomography Experience Checklist.

Annex 1 to Appendix 1 - Computed Tomography Experience Checklist.

Candidate Name:

Organisation & Department:

Examination Target Date:

TASK	STANDARD. The candidate shall…	Date achieved	Assessor name & signature
Health and Safety	Demonstrate knowledge of Health and Safety procedures pertaining to CT: a. Radiation risk assessments. b. Use of local rules and contingency plans c. Risk assessments. d. Emergency procedures..		
Written Practice & MCP	Demonstrate knowledge of the location, function and general content of the Written Practice, Method Control Procedure(s) and other policies pertaining to CT.		
Standards/ Specifications	Demonstrate knowledge of CT standards/specifications and be able to locate relevant information: a. ASTM E1672* b. ASTM E3166* c. BS EN ISO 15708-1* d. BS EN ISO 15708-2* e. BS EN ISO 15708-3* f. BS EN ISO 15708-4* g. h. i. * RL3: add/delete as applicable		
OEM Manual(s) & Operating Procedures	Demonstrate knowledge of the location, function and general content of OEM manual(s) and operating procedures.		
OEM-level Maintenance	Demonstrate awareness of OEM-level: a. Maintenance. b. Technical support. c. Calibration.		
User-level Maintenance	Demonstrate ability to carry out user-level: a. Maintenance. b. Troubleshooting. c. Software updates. d. Calibration.		
Daily / Pre-Use Checks	Demonstrate ability to carry out daily / pre-use checks.		
System Performance Checks	Demonstrate ability to carry out system performance checks.		
Start-up & Shut-down	Demonstrate ability to carry out start-up and shut-down procedures.		

TASK	STANDARD. The candidate must be able to…	Date achieved	Assessor name & signature
Component Positioning	Demonstrate ability to carry out component/part preparation, handling, and positioning.		
Tube-head Positioning	Demonstrate ability to position tube-head and avoid collisions.		
Scan Optimisation	Demonstrate ability to optimise scan settings / attributes.		
Data Acquisition	Demonstrate ability to acquire test data and verify its integrity.		
Data Processing	Demonstrate ability to use software tools to optimise images / visualisations.		
Interpretation	Demonstrate ability to characterize and interpret: a. Artefacts. b. Defects (manufacturing flaws). c. Faults (in-service failures).		
Data Handling & Reports	Demonstrate ability to: a. Format, export, archive, and secure test data. b. Prepare reports.		
Work Instruction Development	Demonstrate ability to prepare a Work Instruction.		
Other Activities as designated by RL3			
Assessor Endorsement	Assessor is satisfied that the candidate: a. Has a documented record of experience that meets the minimum requirement. b. Is sufficiently prepared for Specific & Practical examinations.		

Appendix 2 to NANDTB/30: Digital Tomosynthesis Conversion Training Outline.

1. To be issued.

Appendix 3 to NANDTB/30: NANDTB 3DNF RT Appointment Record.

The following table details 3DNF RT initial cadre personnel directly appointment by the NANDTB:

Role	Name	Organisation	Scope of appointment	Issue	Expiry
Genesis Level 3	James Willcocks	Rolls-Royce	EN4179 Level 3 RT(3DNF)	26 Jul 22	Valid whilst EN4179 L3 RT is held.
Lead ATO Trainer/Examiner	David Blacklock	International School of Aerospace NDT	EN4179 Level 3 RT(3DNF)	tbc	tbc
ATO Trainer/Examiner	Neil Pudney	Aerospace Inspection Training	EN4179 Level 3 RT(3DNF)	tbc	tbc
ATO Trainer/Examiner	Andrew Fox	IMechE Argyll Ruane	EN4179 Level 3 RT(3DNF)	tbc	tbc
ATO Trainer/Examiner	Simon Lewis	South West School of NDT	EN4179 Level 3 RT(3DNF)	tbc	tbc