

# Carbon/Epoxy Composite Overwrapped Pressure Vessels - Visual Inspection Training Course

*NASA White Sands Test Facility (WSTF)*  
and  
*Wendell Hull & Associates, Inc. (WHA)*  
present

VISUAL INSPECTION TRAINING FOR DAMAGE  
TO CARBON/EPOXY COMPOSITE  
OVERWRAPPED PRESSURE VESSELS (COPV)  
*TBA*

Inspection Training for Damage to Carbon/Epoxy Composite Overwrapped Pressure Vessels is an intensive 2-day course offered by NASA Johnson Space Center White Sands Test Facility in conjunction with Wendell Hull & Associates, Inc. WSTF is uniquely qualified to teach this highly applicable course made up of both theory and practice as a result of the successful completion of the joint USAF/NASA COPV Program. One will learn about damage characterization and detection and the understanding of the safety aspects of composite pressure vessels. This will be accomplished via Non-Destructive Evaluation and many hands-on examinations.



This course satisfies the **baseline training** requirements of AIAA S-081A and KHB 710.2B, Appendix B to Annex E, par 2.0b for a trained visual inspector for damage to carbon/epoxy composite overwrapped pressure vessels **and is an integral part of the typical COPV manufacturer and/or end user's inspector certification program.**

## Course Content

### *Overview of COPV Damage Mechanisms*

- COPV in the undamaged condition
- Failure mode/safe-life of undamaged COPVs
- Effects of impact damage
- Stress rupture
- Material compatibility

### ***Overview of Impact Control***

- Threat analysis
- Visual Damage Threshold (VDT)

### ***Overview of Impact Protection***

- Shipping containers
- Indicator covers
- Hard-shell laminate covers



### ***Overview of COPV Inspection Techniques***

- Visual, Infrared, Ultrasonic, Eddy Current, Acoustic Emission Shearography, and X-ray

### ***Receiving and Periodic Inspections***

- Visual inspection
- X-ray of liner
- Record requirements

### ***Laboratory Session***

- Demonstration of IR Thermography
- Acoustic Impedance Testing (coin tapping)
- Thermal deply analysis and results

### ***Laboratory Training Sessions (VT)***

- Types of defects, origins and significance
- Manufacturing anomalies
- Impact damage and variables

### ***COPV Visual Inspection***

- Utilizing actual damaged COPVs
- Covering a wide spectrum of damage types

### ***Course Completion***

- Certificate of course completion
- Confidence to assess actual COPV damage

## Course Instructors

Dr. Harold Beeson (Ph.D. Chemistry, UNM) is Laboratories Office Chief in the Laboratories Department at the NASA Johnson Space White Sands Test Facility. He was the NASA WSTF project manager for the joint USAF/NASA Enhanced Technology for Composite Overwrapped Pressure Vessel Program, and he currently is the program manager for all COPV activities at WSTF. Dr. Beeson is a member of the AIAA COPV Standards working group and has authored several publications on composite damage.

Nathanael J. Greene (M.S. Mechanical Engineering, ISU) is a project manager and the WSTF COPV Group technical lead. He is responsible for technical oversight of test and analysis activities for NESC, CEV, ISS, and Shuttle lifing activities. Nathanael is also a member of the NESC teams assessing stress rupture life concerns on Kevlar® COPVs on the Orbiters and for carbon COPVs on the International Space Station. Current activities include independent assessments of COPV remaining stress rupture life, definition of design requirements for new NASA vehicles and recertification of COPVs for continued use. He is involved in industry standards development for safe use of COPVs with SAE, CSA America and AIAA. Nathanael is also active in the areas of hydrogen combustion hazards assessment and spacecraft fire safety.

Tommy B. Yoder (B.S. Mechanical Eng., NMSU) is project leader ongoing COPV programs at NASA WSTF. This includes impact, stress rupture and sustained load testing of Kevlar®, Carbon, and Zylon® COPVs. He is also currently involved in the AIAA COPV and NGV2 standards working group as well as a member of technical advisory groups for the NESC, STS, ISS, CEV, and NGV2 visual inspection certification. He was senior test conductor for the joint USAF/NASA COPV damage tolerance and detection program, APU Fuel tank fleet leader program, and the ATLAS V solid rocket motor case visual damage threshold program.

***For course technical information, please contact Mr. Tommy Yoder:***

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