



# STARK STATE COLLEGE

## GENERAL SYLLABUS

### Course Information

**Course Name:** Adv Cylinder Hydrotesting  
**Course Number:** ARL236

### Required Materials

**Textbook(s):** Advanced Cylinder Hydrostatic Testing Handbook Ariel Corp.  
**Required Readings:** None  
**Additional Materials:** Scientific Calculator, Laptops, Note Pads, Writing Utensils, Web Links, Handouts and related items as provided in class.

### Course Outline/Calendar

The date of coverage and order of coverage may be modified based on the faculty member and events beyond the control of faculty members that interfere with class times and teaching.

Week	Chapter/Topic/Lab
1: Introduction to Cylinder Requalification	<ul style="list-style-type: none"> <li>• Module: The role of cylinder testing in safety.</li> <li>• Topics:               <ul style="list-style-type: none"> <li>○ Review of hazardous materials and properties of compressed gases.</li> <li>○ Introduction to cylinder life cycles, from manufacturing to requalification and condemnation.</li> <li>○ Overview of the hydrostatic test and other requalification methods.</li> </ul> </li> </ul>
2: Regulatory Framework	<ul style="list-style-type: none"> <li>• Module: Understanding U.S. DOT and international standards.</li> <li>• Topics:               <ul style="list-style-type: none"> <li>○ In-depth review of U.S. Code of Federal Regulations, including 49 CFR Part 180 (Continuing Qualification of Cylinders).</li> <li>○ Introduction to CGA standards and pamphlets, and their integration with DOT rules.</li> <li>○ Comparison of international standards (e.g., ISO, EN) and how they apply to imported cylinders.</li> </ul> </li> </ul>
3: Cylinder Identification and Marking	<ul style="list-style-type: none"> <li>• Module: Deconstructing cylinder markings and documentation.</li> <li>• Topics:               <ul style="list-style-type: none"> <li>○ Decoding DOT and TC (Transport Canada) specification markings.</li> <li>○ Interpreting requalification date stamps and marks (e.g., volumetric expansion, proof pressure, visual inspection).</li> <li>○ Understanding manufacturer, serial number, and special markings.</li> </ul> </li> </ul>
4: The Physics of Pressure Vessels	<ul style="list-style-type: none"> <li>• Module: Metallurgy and engineering principles.</li> <li>• Topics:               <ul style="list-style-type: none"> <li>○ Materials science, including steel, aluminum (especially 6351-T6 alloy), and composites.</li> </ul> </li> </ul>

Week	Chapter/Topic/Lab
	<ul style="list-style-type: none"> <li>○ Principles of stress, strain, elastic expansion, and permanent volumetric expansion.</li> <li>○ Introduction to the design factors behind cylinder burst pressure.</li> </ul>
5: External Visual Inspection	<ul style="list-style-type: none"> <li>● Module: Techniques for identifying external defects.</li> <li>● Topics: <ul style="list-style-type: none"> <li>○ Identifying damage: dents, gouges, cuts, and arc burns.</li> <li>○ Assessing heat damage and potential overheating indicators.</li> <li>○ Understanding corrosion damage: general corrosion, pitting, and line corrosion.</li> </ul> </li> </ul>
6: Internal Visual Inspection	<ul style="list-style-type: none"> <li>● Module: Techniques for identifying internal defects.</li> <li>● Topics: <ul style="list-style-type: none"> <li>○ Using borescope equipment for high-pressure cylinders.</li> <li>○ Inspecting for internal corrosion, contamination, and liner integrity (for composite cylinders).</li> <li>○ Determining the need for cylinder tumbling and cleaning.</li> </ul> </li> </ul>
7: Neck and Thread Inspection	<ul style="list-style-type: none"> <li>● Module: Focus on the most common point of failure.</li> <li>● Topics: <ul style="list-style-type: none"> <li>○ Proper use of thread gauges (e.g., Go/No-Go) for various valve threads.</li> <li>○ Advanced techniques for detecting and assessing neck cracks, especially in aluminum cylinders.</li> <li>○ Eddy current testing as a non-destructive examination method for aluminum cylinders.</li> </ul> </li> </ul>
8: Cylinder Preparation and Safety	<ul style="list-style-type: none"> <li>● Module: Preparing cylinders for hydrostatic testing.</li> <li>● Topics: <ul style="list-style-type: none"> <li>○ Safe procedures for devalving cylinders and handling pressure.</li> <li>○ Drying procedures for cylinders after hydrostatic testing.</li> <li>○ Valve inspection, maintenance, and replacement procedures.</li> </ul> </li> </ul>
9: Volumetric Expansion Testing (Water Jacket)	<ul style="list-style-type: none"> <li>● Module: Theory and practice of the water jacket method.</li> <li>● Topics: <ul style="list-style-type: none"> <li>○ Detailed operation of the water jacket test rig, including calibration procedures.</li> <li>○ Measuring total and permanent volumetric expansion.</li> <li>○ Interpreting test results and calculating the Permanent Expansion Ratio (PER).</li> </ul> </li> </ul>
10: Alternative Requalification Methods	<ul style="list-style-type: none"> <li>● Module: The proof pressure and direct expansion methods.</li> <li>● Topics: <ul style="list-style-type: none"> <li>○ Review of proof pressure testing for low-pressure cylinders and specific applications.</li> <li>○ Understanding direct expansion testing and its limitations.</li> <li>○ Application of CGA standards relevant to these methods (e.g., C-1).</li> </ul> </li> </ul>
11: Non-Destructive Testing (NDT)	<ul style="list-style-type: none"> <li>● Module: Ultrasonic examination (UE) for cylinder integrity.</li> <li>● Topics: <ul style="list-style-type: none"> <li>○ Introduction to automated and manual ultrasonic testing techniques.</li> <li>○ Using UE to detect flaws, cracks, and measure wall thickness.</li> <li>○ Understanding DOT special permits authorizing UE in place of hydrostatic testing.</li> </ul> </li> </ul>
12: Specialized Cylinders and Testing	<ul style="list-style-type: none"> <li>● Module: Handling unique cylinder types.</li> <li>● Topics: <ul style="list-style-type: none"> <li>○ Composite (wrapped) cylinder requalification and service life limits.</li> <li>○ Special procedures for acetylene cylinders with porous fillers.</li> <li>○ Handling and testing cylinders in specific service applications, such as SCBA, SCUBA, and fire extinguishers.</li> </ul> </li> </ul>
13: Facility Management and Record Keeping	<ul style="list-style-type: none"> <li>● Module: Managing a requalification facility.</li> <li>● Topics: <ul style="list-style-type: none"> <li>○ Maintaining records per DOT and CGA requirements.</li> <li>○ Understanding cylinder rejection and condemnation procedures.</li> <li>○ Recordkeeping software and systems for compliance management.</li> </ul> </li> </ul>
14: Special Permits and Exemptions	<ul style="list-style-type: none"> <li>● Module: Navigating complex regulations.</li> <li>● Topics: <ul style="list-style-type: none"> <li>○ Overview of the DOT special permit process.</li> </ul> </li> </ul>

Week	Chapter/Topic/Lab
	<ul style="list-style-type: none"> <li>○ How to locate, interpret, and comply with special permits (e.g., for composite cylinders or alternative testing).</li> <li>○ Review of past and current exemptions affecting the industry.</li> </ul>
15: Safety and Operational Procedures	<ul style="list-style-type: none"> <li>• Module: Ensuring workplace safety.</li> <li>• Topics: <ul style="list-style-type: none"> <li>○ Review of OSHA and Hazmat regulations for testing facilities.</li> <li>○ Development of Standard Operating Procedures (SOPs) for requalification.</li> <li>○ Best practices for handling different gas hazards (e.g., oxygen, flammable gases).</li> </ul> </li> </ul>
16: Final Review and Practicum	<ul style="list-style-type: none"> <li>• Module: Comprehensive assessment.</li> <li>• Topics: <ul style="list-style-type: none"> <li>○ Review of all core modules and key learning objectives.</li> <li>○ A practical, hands-on session covering visual inspection, testing setup, and equipment use.</li> </ul> </li> </ul>