REINHOLD ENVIRONMENTAL ®

2026 Reinhold/PCUG Round Table Presentation

Hosted by TVA, Southern Company and Vistra

in the Sonesta Nashville Airport Hotel, Nashville, TN

on June 22-23, 2026

WELCOME

2026 Reinhold PCUG

Nashville, Tennessee

OPTIMIZING FILTER BAG LIFE AND TESTING METHODS

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And Terry Williamson

How Do I Achieve Maximum Bag Life?

- SELECTION - Select media for the inlet gas constituents & process operation.
- SPECIFICATION - Specify filter media, thread, bag and hardware.
- QUALITY ASSURANCE - QA/QC program to insure what is delivered meets the spec.
- INSTALLATION - Oversee the installation of the bags and perform leak tests.
- BAG MONITORING - Test periodically. Increase frequency if strength or permeability decline steeply.
- IDENTIFY & CORRECT – Immediately fix any leaks or high ΔP.

Preventing the dust from entering the “clean side” of the baghouse and bags is a must.

Product Malfunctions / Quality Issues

- Several players on the Swiss national soccer team had jerseys torn in a match against France at 2016 European Championship
- Puma's analysis showed that there was 1 batch of material where yarns had been damaged during the production process, leading to a weakening in final garment

- The case of a torn shirt does not stop the game
- A similar hole in a fabric filter bag could lead to dust on the "clean side" and ultimately destroy a full bag set

Premature Bag Failure: Typical Causes of Pulse Jet Bag Failures

- Dust on "clean side" – accelerates bag-to-cage wear
- High velocity dust abrasion - Bottom of bag
- Chemical attack from flue gas contaminants coupled with acid dew point excursions
- Bag-to-cage abrasion - Bad fit, poor design, damaged cage
- Bag-to-bag abrasion - Too close, bent cages, high can velocity
- Mechanical abrasion in top 1/3 of bag - misaligned Venturi or pulse pipe
- Process upset conditions - Fabric temperature capability exceeded; particulate is introduced to blind or attack the fabric

Premature Bag Failure: Typical Causes of Reverse Air Bag Failures

- High velocity dust abrasion - Inside bottom of bag
- Chemical attack from flue gas contaminants coupled with acid dew point excursions
- Bag-to-bag abrasion - Low tension, too close, stretching, misaligned support racks
- Bag-to-metal abrasion - Interference with walls or support structure
- Improper bag to thimble attachment - Results in high velocity leakage path
- Process upset conditions - Fabric temperature capability is exceeded; particulate is introduced to blind or attack the fabric
- Accidents - Fires or explosions
- Improper bag fabrication or incorrect design

Fabric Selection Considerations

Gas Stream
- Temperature
- Moisture
- Chemistry
- Dust Loading

Fabric
- Filtration Performance
- Temperature Max
- Release Properties
- Pressure Drop
- Life/Durability
- Costs

Dust Characterization
- Abrasiveness
- Stickiness
- Explosiveness
- Flammability

Other
- Membrane
- Coatings/Treatment
- Scrim
- Hardware
- Blends

Design: Key Issues

- Full process description affecting inlet gas (Vol., Temp., Chem., dust loading – high, low & normal)
- Baghouse specs (G/C, flow distribution
- Bag Spec - Devil in the details (e.g. shrinkage)

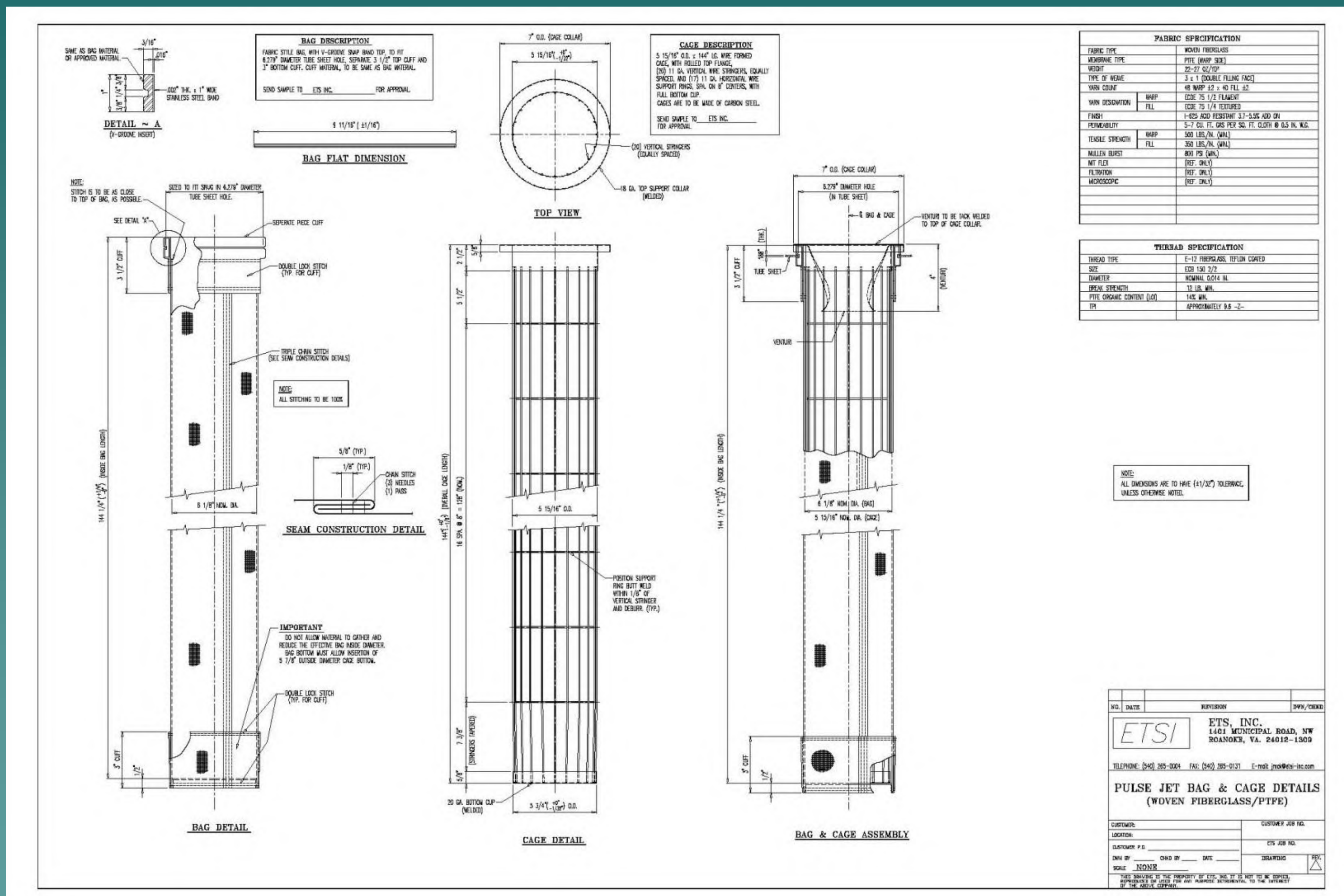
Importance of Fabric & Bag Specifications

- Spec is the basis for the QA/QC
- The details & comprehensive breadth are critical
- Without the spec there can be no recourse
- Drawings & quantitative acceptable tolerances are required

Custom ETS Specifications

- Selection
  - Select the proper media for inlet gas & process conditions.
- Specification
  - Bag drawings include material, dimensional, and fabrication specifications. Minimal acceptance levels including permeability, strength and shrinkage.
- Design
  - Bag and cage fit as well as baghouse design specifications can be provided.

Generic Bag/Cage CAD Drawing



QA/QC Program: Purpose and Description

- To insure a new bag set conforms to a material and construction specification
- Primary focus on specifying and testing of fabric durability & mechanical performance
- Verification of filtration & pressure drop performance
- Prevent contamination of “clean side”

QA/QC Program: Typical Components

- What should be done in a typical QA/QC program for BFPs?
  - Dimensional and construction inspection of prototype & production of bags to verify product specifications
  - Lab validation of mechanical & physical properties of fabric
  - Filtration performance testing

Bag Quality Control Program

- **Fabric**
  - Construction
  - Tensile
  - Permeability
  - Mullen Burst
  - MIT Flex Endurance
  - Finish
  - Filtration Performance
  - Fabric Thermal Stability (% Shrinkage)
  - Organic Matter (LOI)
- **Thread**
  - Material
  - Strength
- **Hardware**
  - Caps
  - Rings
  - Bands
- **Bags**
  - Inspect for general quality of workmanship
  - Length as fabricated
  - Length under tension
  - Cuff to thimble & cap mate
  - Cage Fit

Why Do Third Party QA/QC?

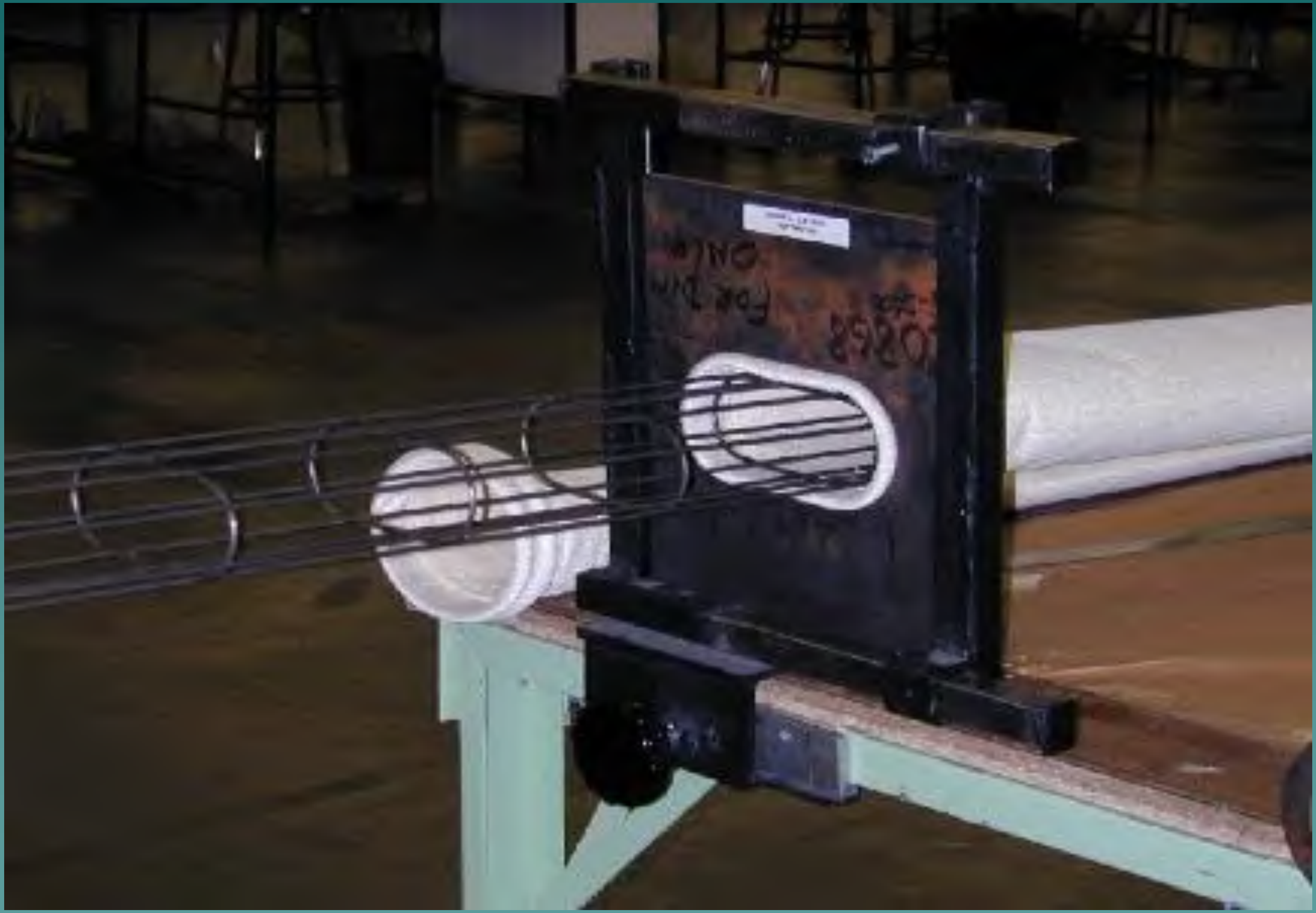
- Ensure bags you receive meet specifications
- Reduce downtime
- Maximize your bag life
- Improve bag set quality
- Unbiased representation
- Provide documentation in case of litigation

Third Party QA/QC Examples

QA/QC Inspection

QA/QC Inspection

QA/QC Inspection



QA/QC Inspection

QA/QC Inspection

QA/QC Inspection

QA/QC Program: Initial Installation of Bags

- The bag set is the most important item in the baghouse
- The entire bag set and associated hardware must be properly installed and is key to successful operation
- Inspect all system components thoroughly before installation and again prior to initial start-up for compliance to specifications and for correct assembly
- Retensioning of RA bags very important

Bag Installation Oversight

Bag Monitoring Program: Purpose and Description

- To determine the retention of strength and flow characteristics of a bag set with on-stream time.
- Used as an aid in determining the useful life and scheduling the replacement of a bag set.
- Diagnostic tool in assisting the client or his agent in troubleshooting a baghouse.

Bag Monitoring Program: Example

UNIT 1		
1-13		1-14
1-11		1-12
1-9		1-10
1-7		1-8
1-5		1-6
1-3		1-4
1-1		1-2

6 mo.	Initial Test	3 bags
1 yr.	2nd Test	3 bags
18 mo.	3rd Test	3 bags
2 yr.	4th Test	3 bags
30 mo.	5th Test	2 bags
33 mo.	**	4 bags
36 mo.	**	4 bags

** When fabric deterioration accelerates increase testing frequency to every 3 months with four bags per pull/test

Test Bag location random – never same hole

Each program is custom designed

Short Bag Life

Physical Failure
or
Plugged Fabric

Inspection
and
Maintenance

Site Specific
or
General Problem

Inspection
and
Failure Log

Mechanical Wear
Thermal Attack
Chemical Attack

Lab Tests

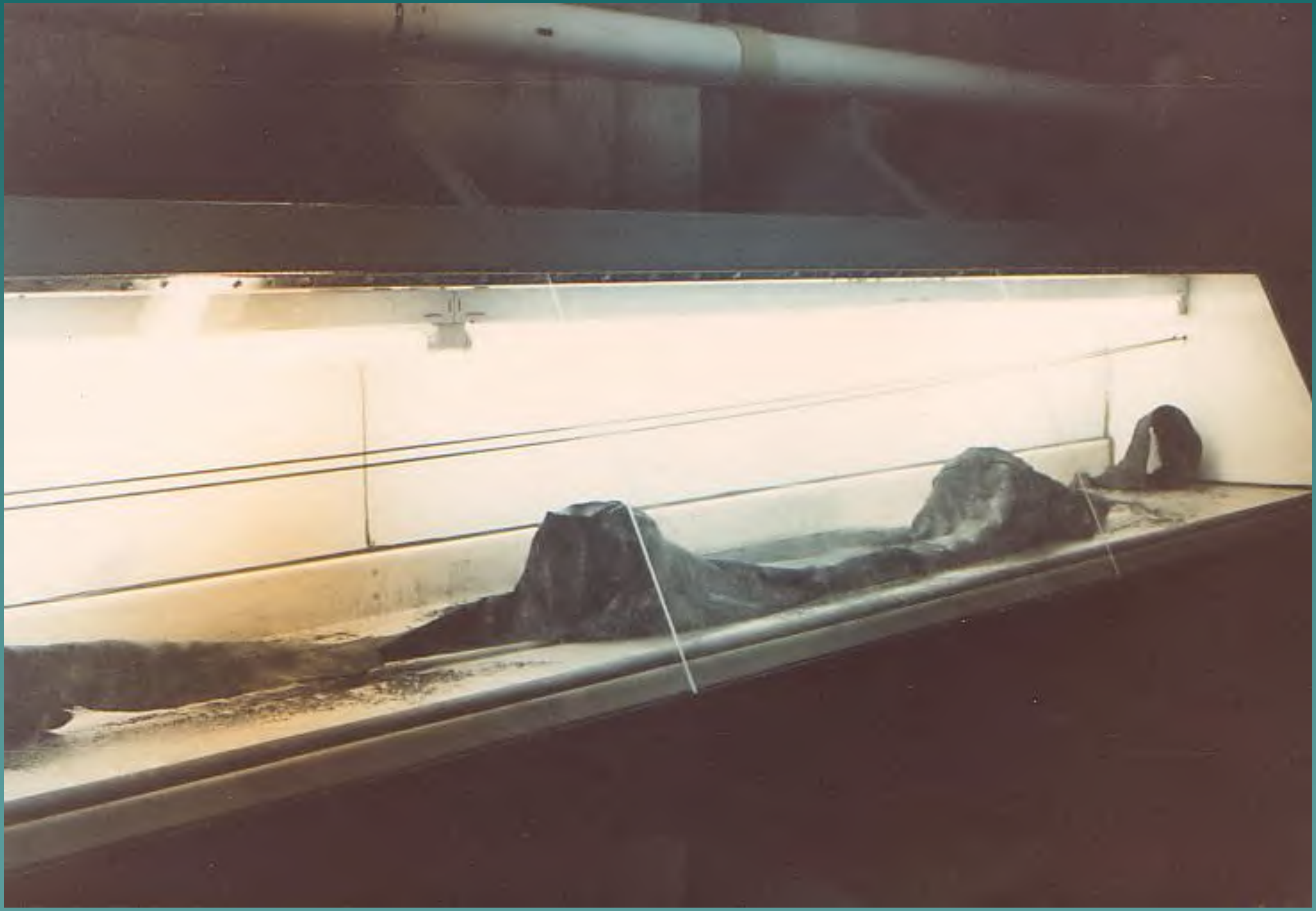
Reasons For Fabric Testing

- Quality Assurance
- Diagnostic Aid or Troubleshooting
- Fabric Monitoring
- Alternative Fabric Selection
- Research & Development
- Bag Replacement Timing

Standard Fabric Tests

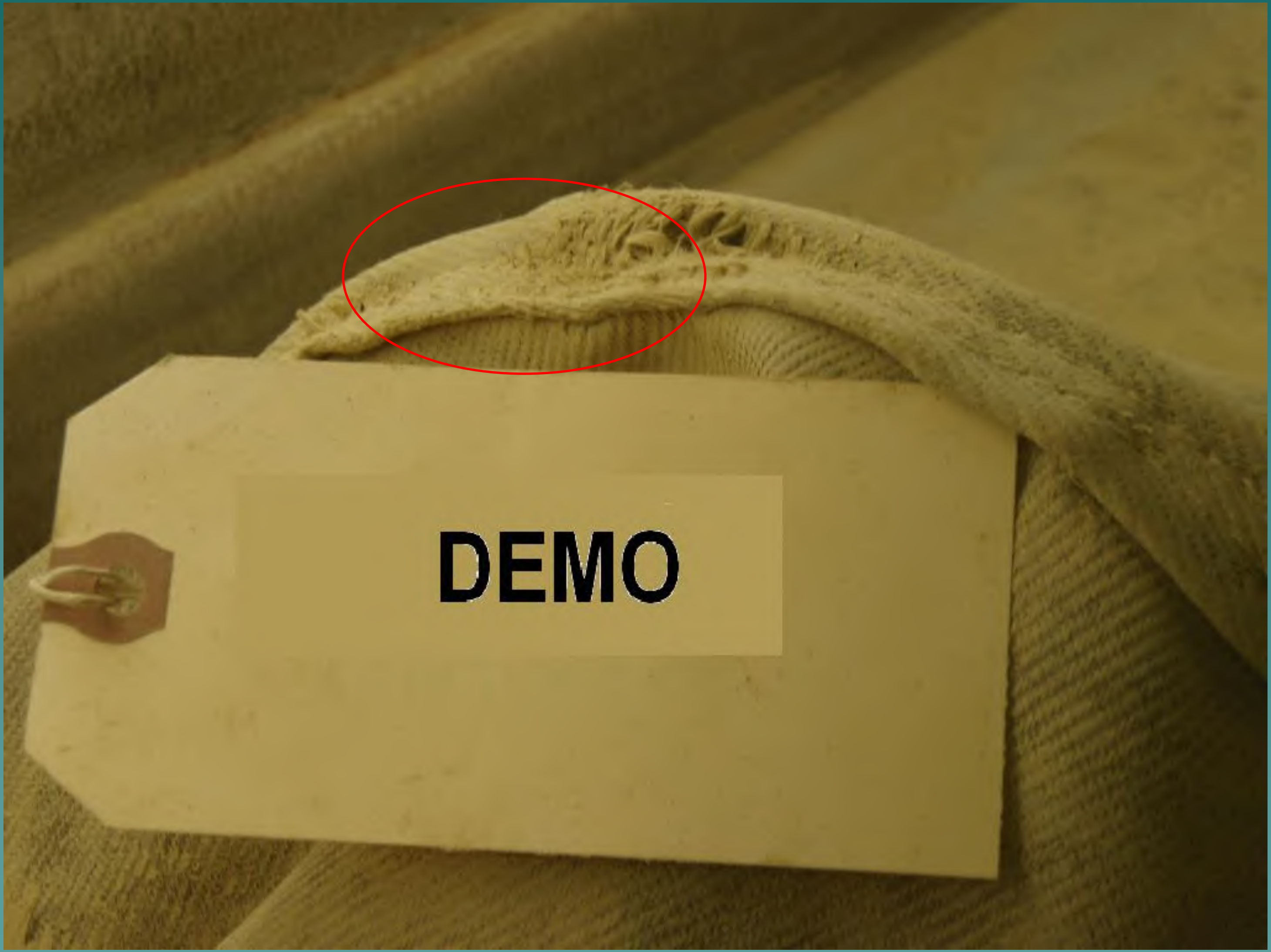
Test	Method
Weight	ASTM D3776
Thickness	ASTM D1777
Count	ASTM D3775
Permeability	ASTM D737
Tensile Strength	ASTM D5035
Mullen Burst	ASTM D3786
MIT Flex	ASTM D2176
Organic Content	ASTM D578
Water Repellency	ASTM D2721
Yarn Weight	ASTM D578
Yarn Twist	ASTM D578
Filtration Performance	ASTM D6830
Surface Resistance	STM 11.11
Volume Resistance	STM 11.12
Two-Point Resistance	STM 11.13

Visual Inspection

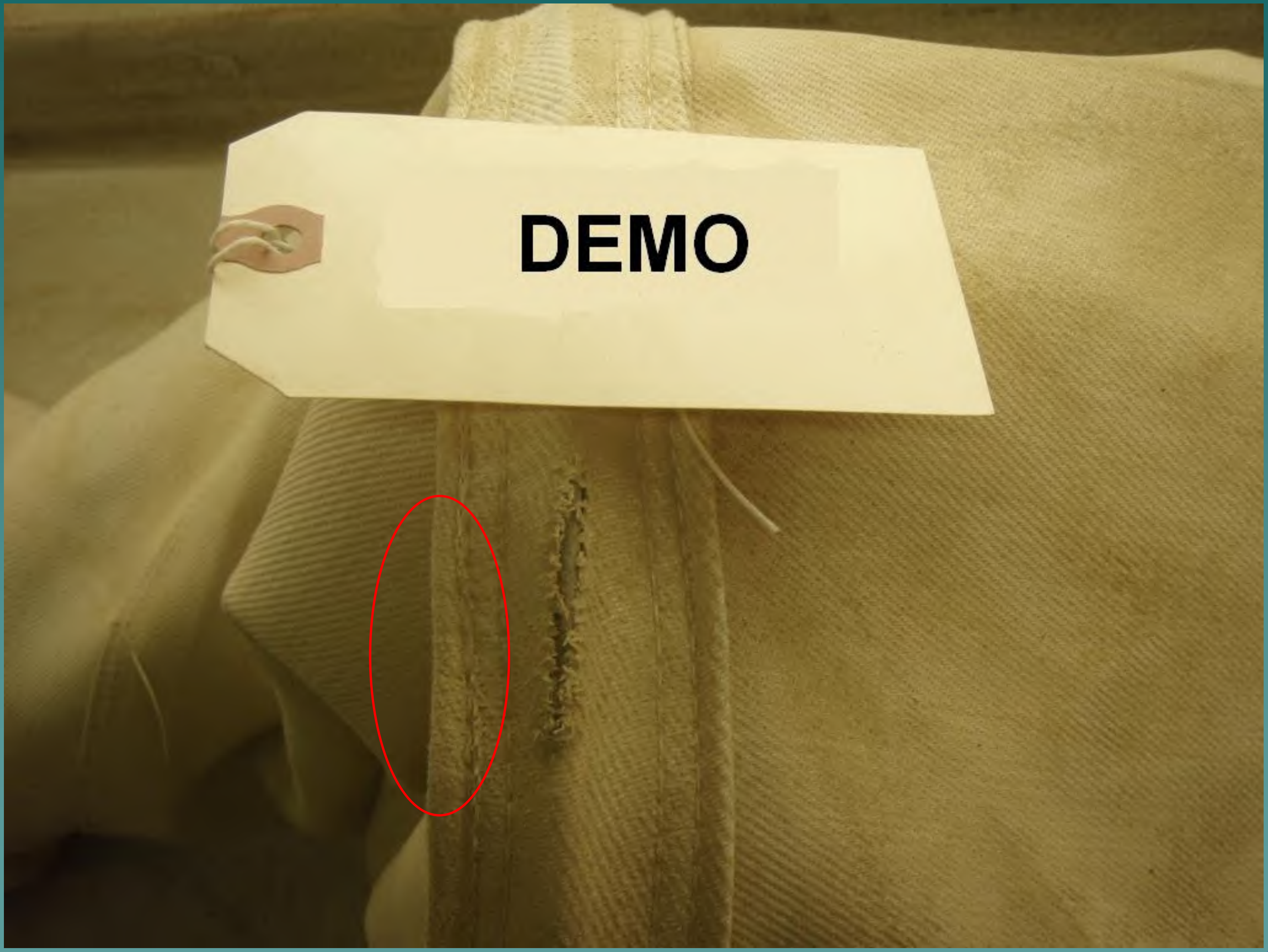


Ring Cover Damage

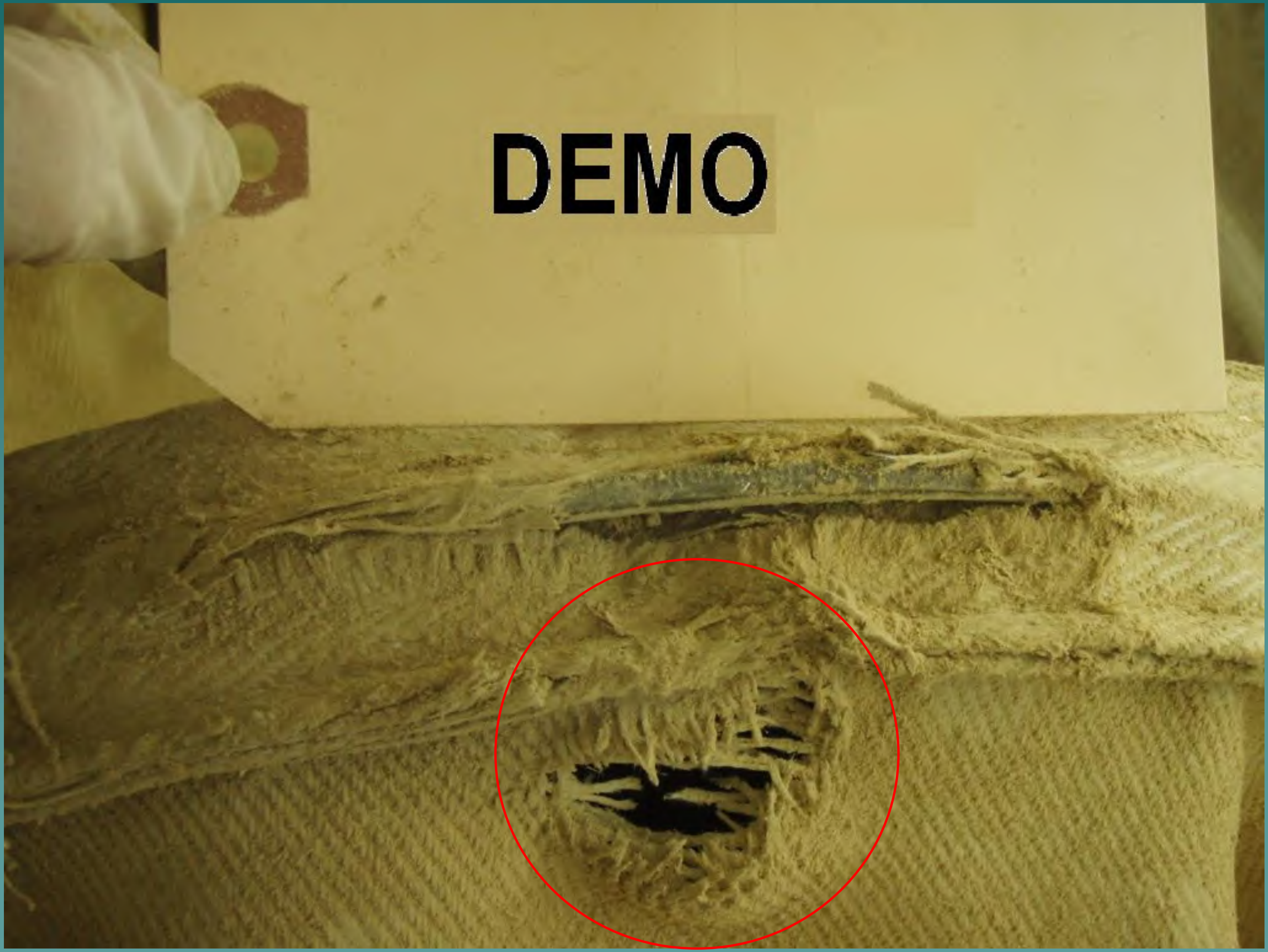
Ring Cover Damage



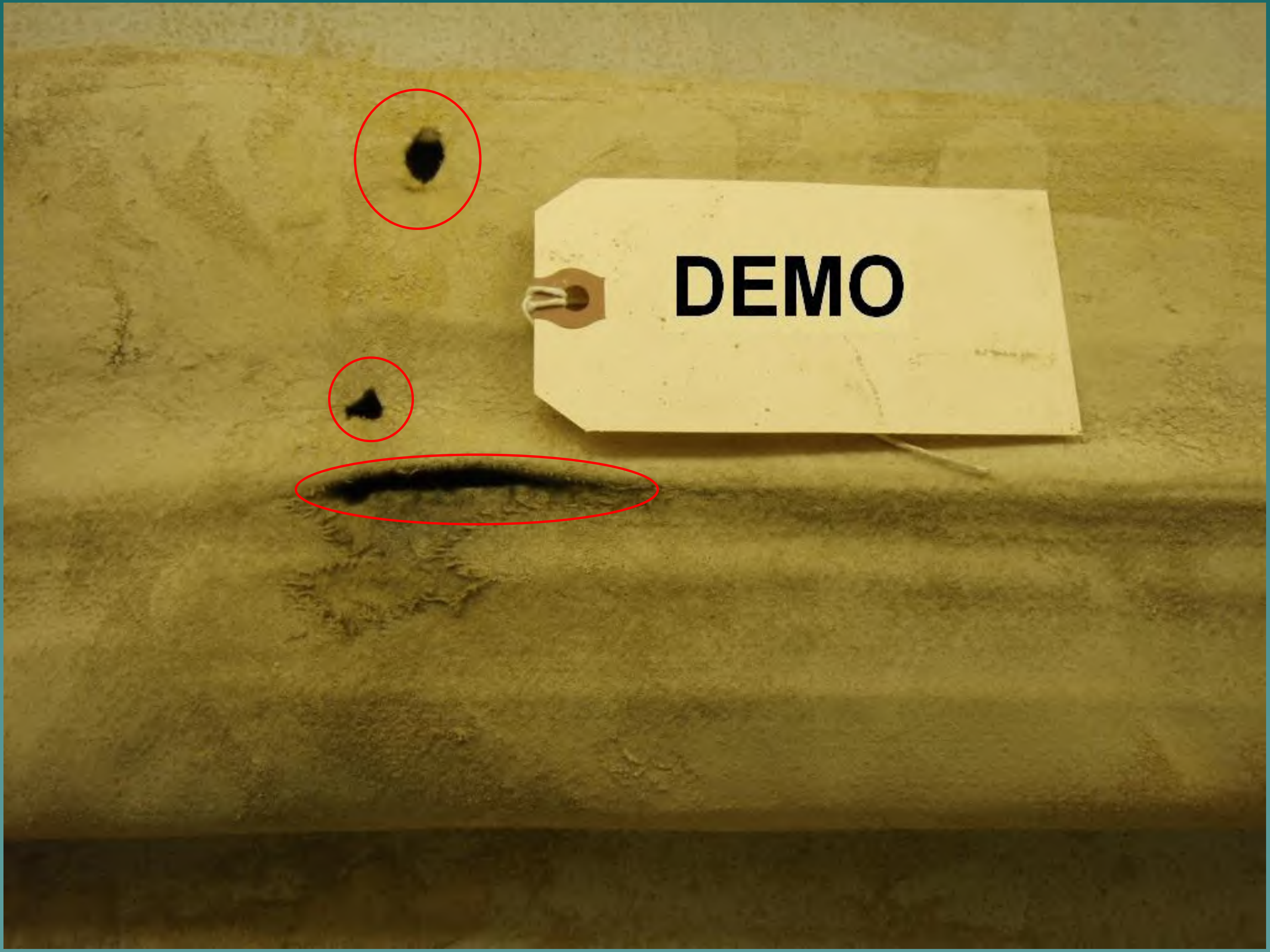
Ring Cover Damage



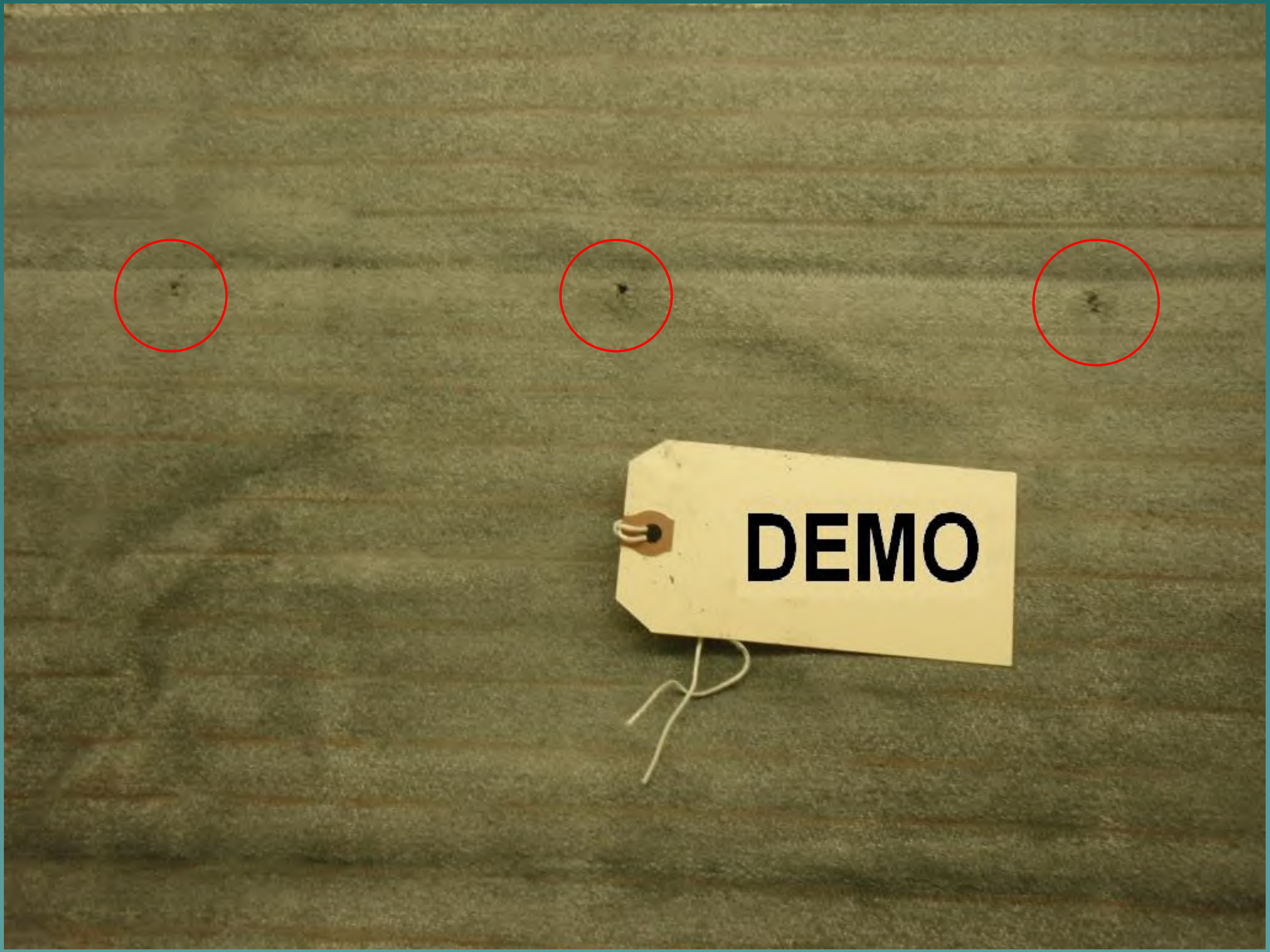
Hole and Ring Cover Damage



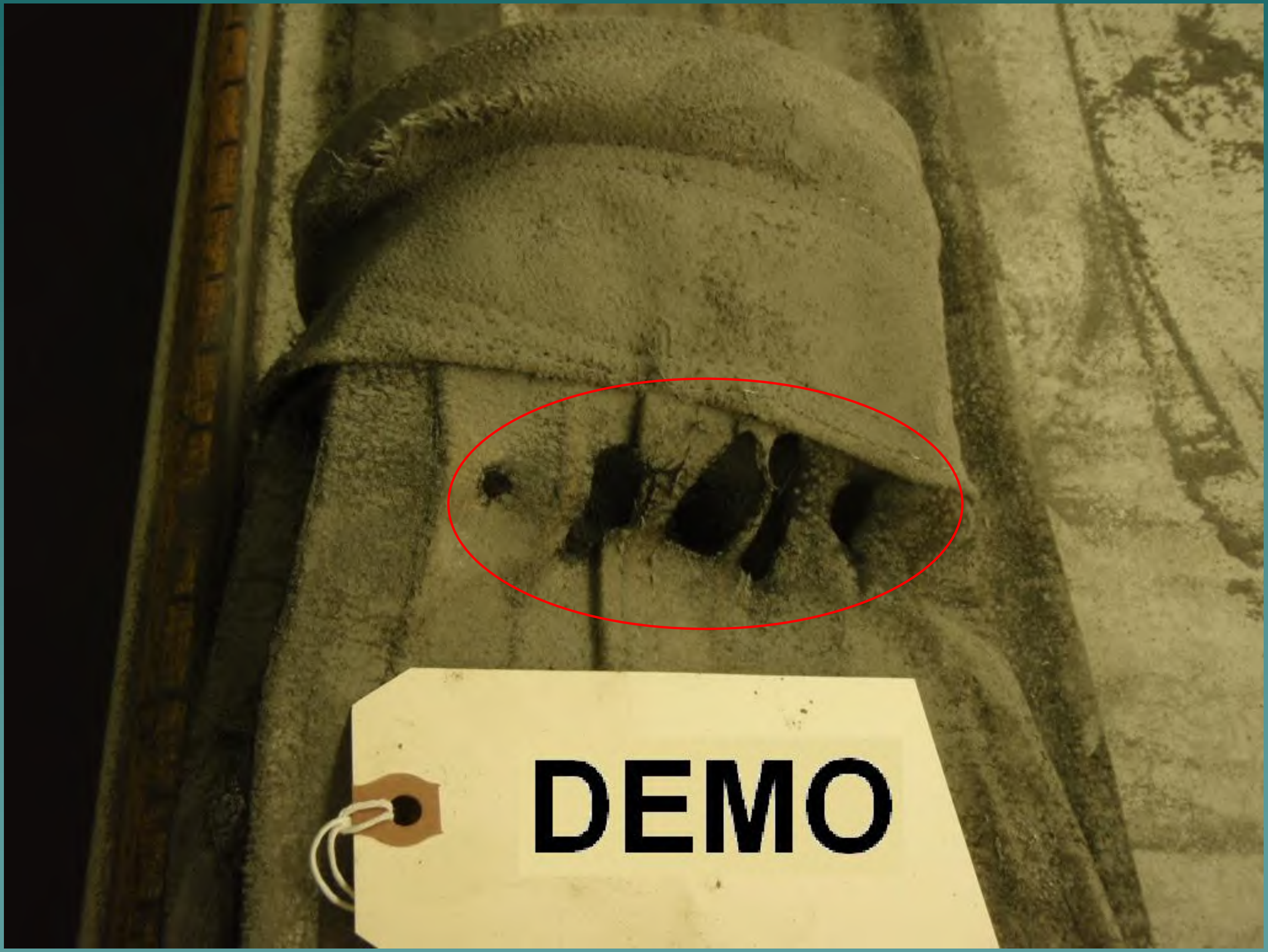
Fabric Holes and Slit



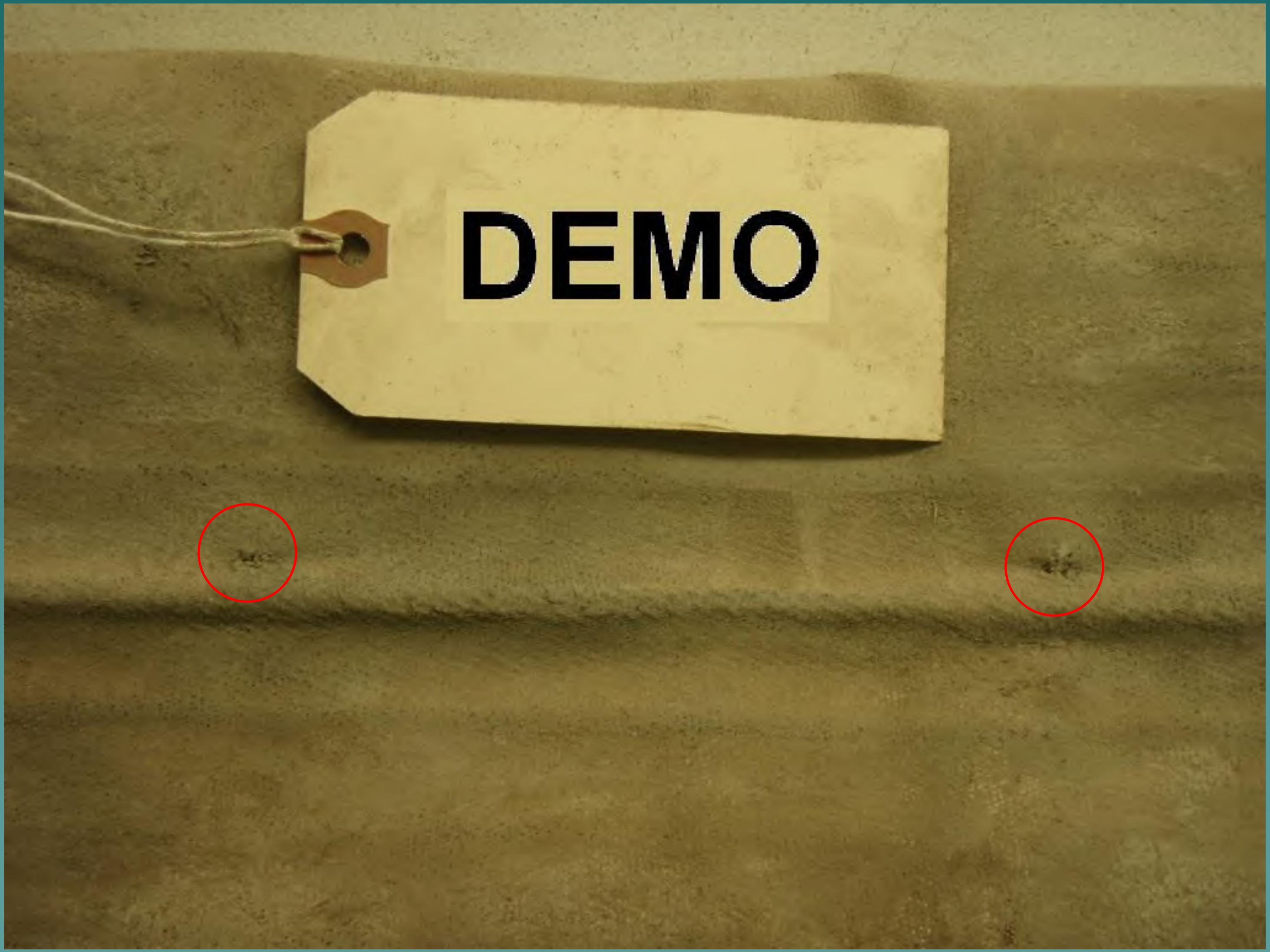
Pinholes



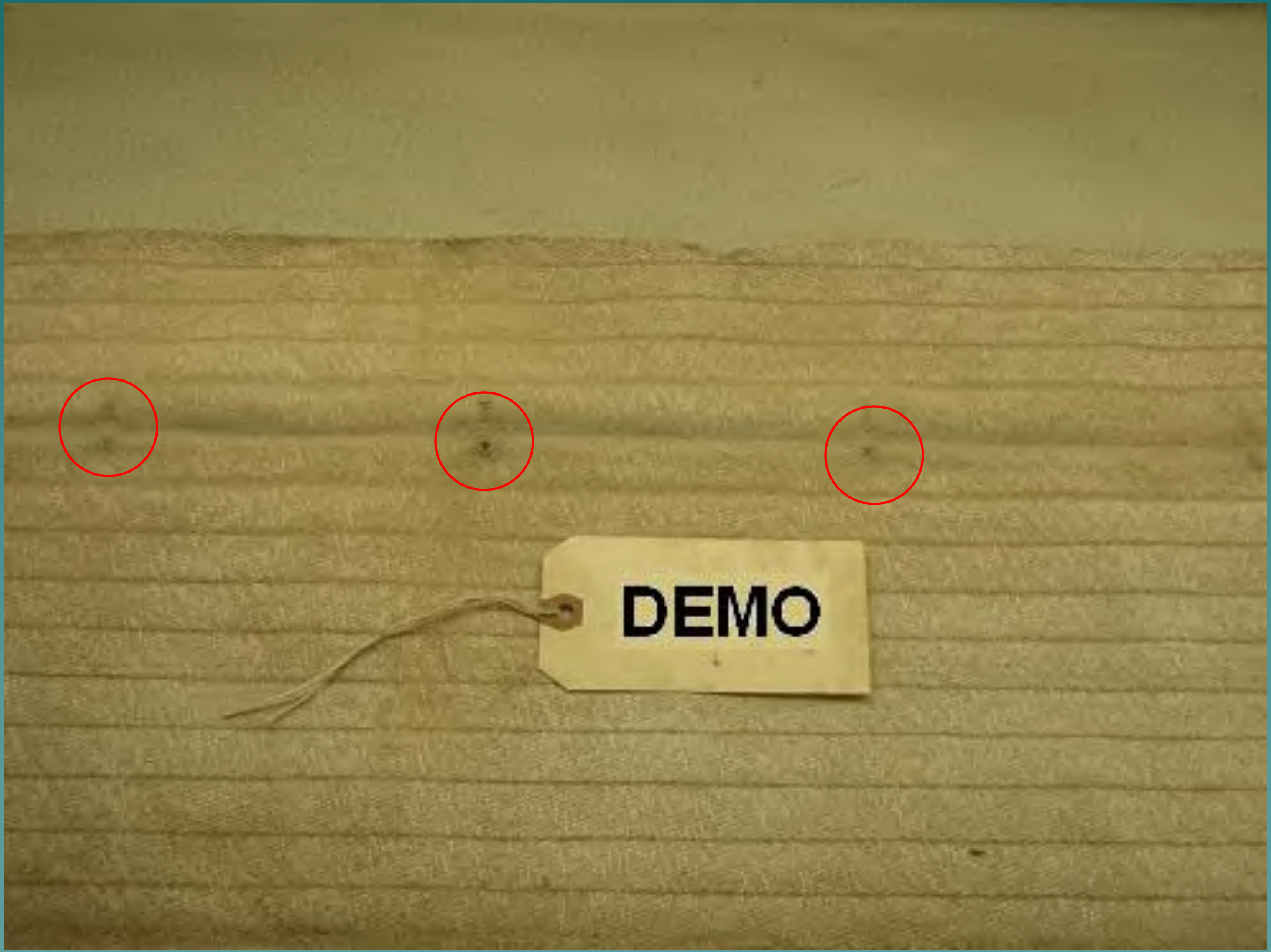
Dust Abrasion



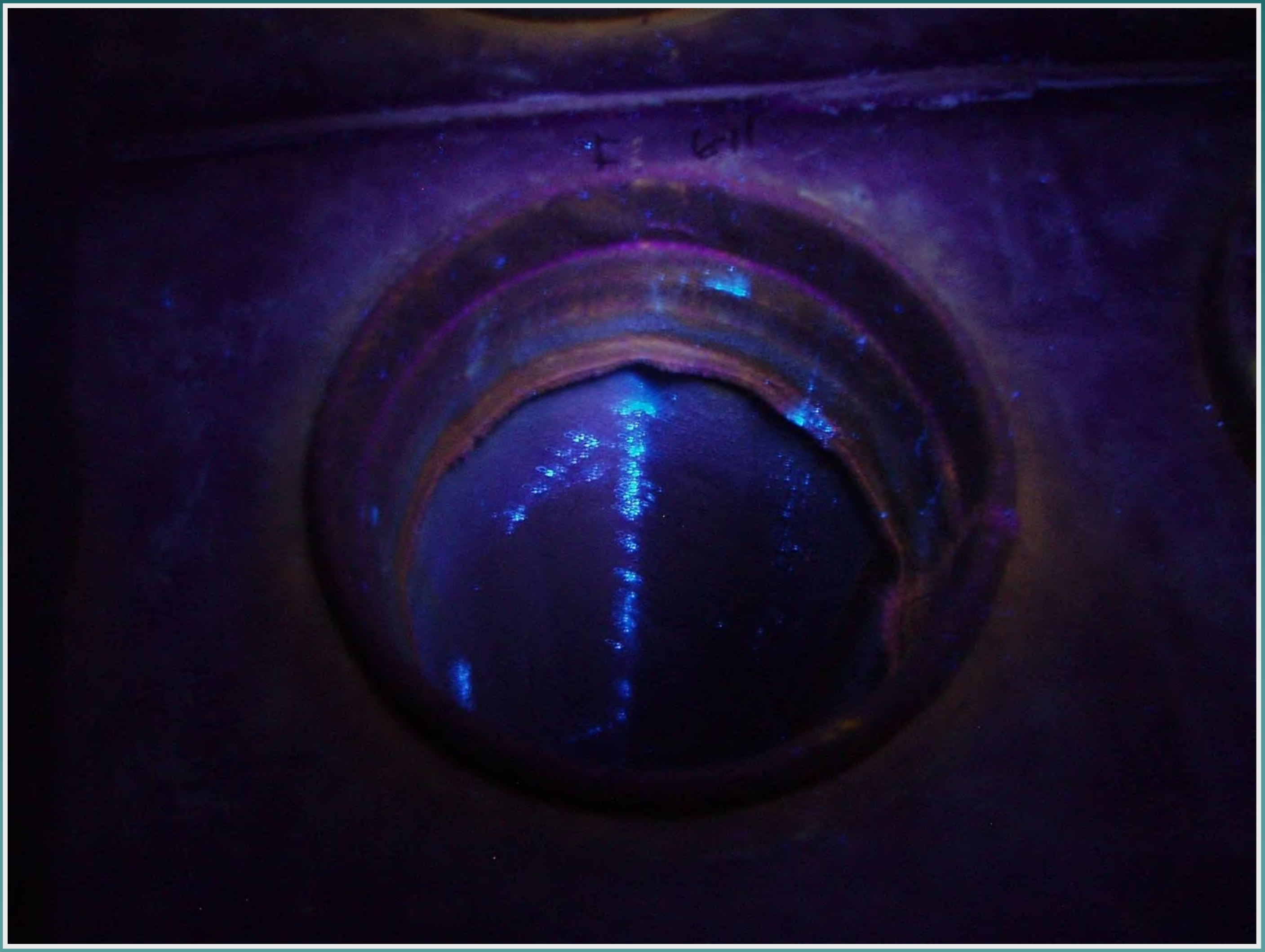
Pinholes/Bag To Cage Abrasion



Pinholes/Bag To Cage Abrasion



Leak Light Dust at the Top Cuff



Dust Abrasion

Clean Side Contamination

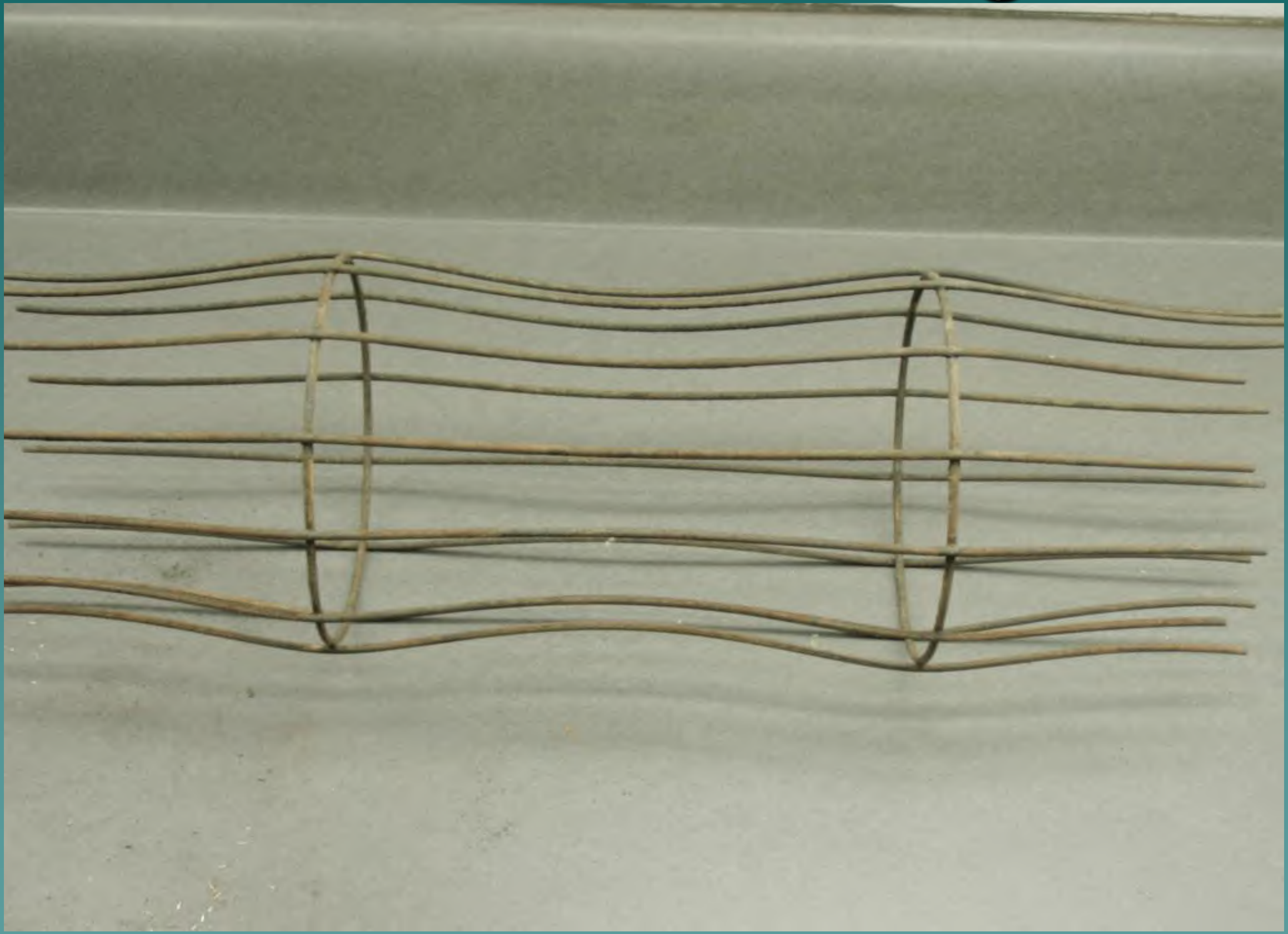
Bag to Cage and Dust Abrasion

Dust Abrasion

Dust Abrasion

Fabric Shrinkage

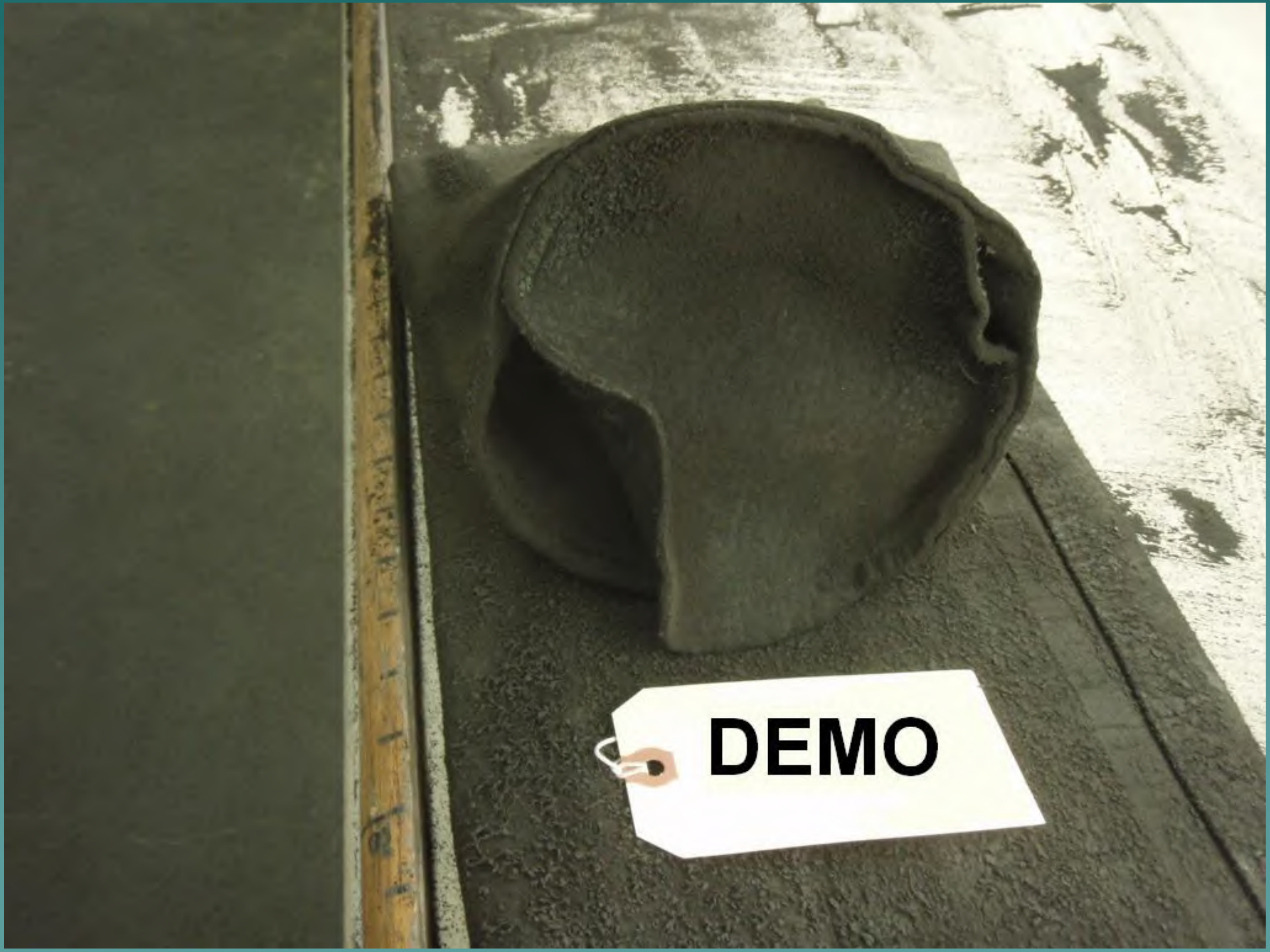
Fabric Shrinkage



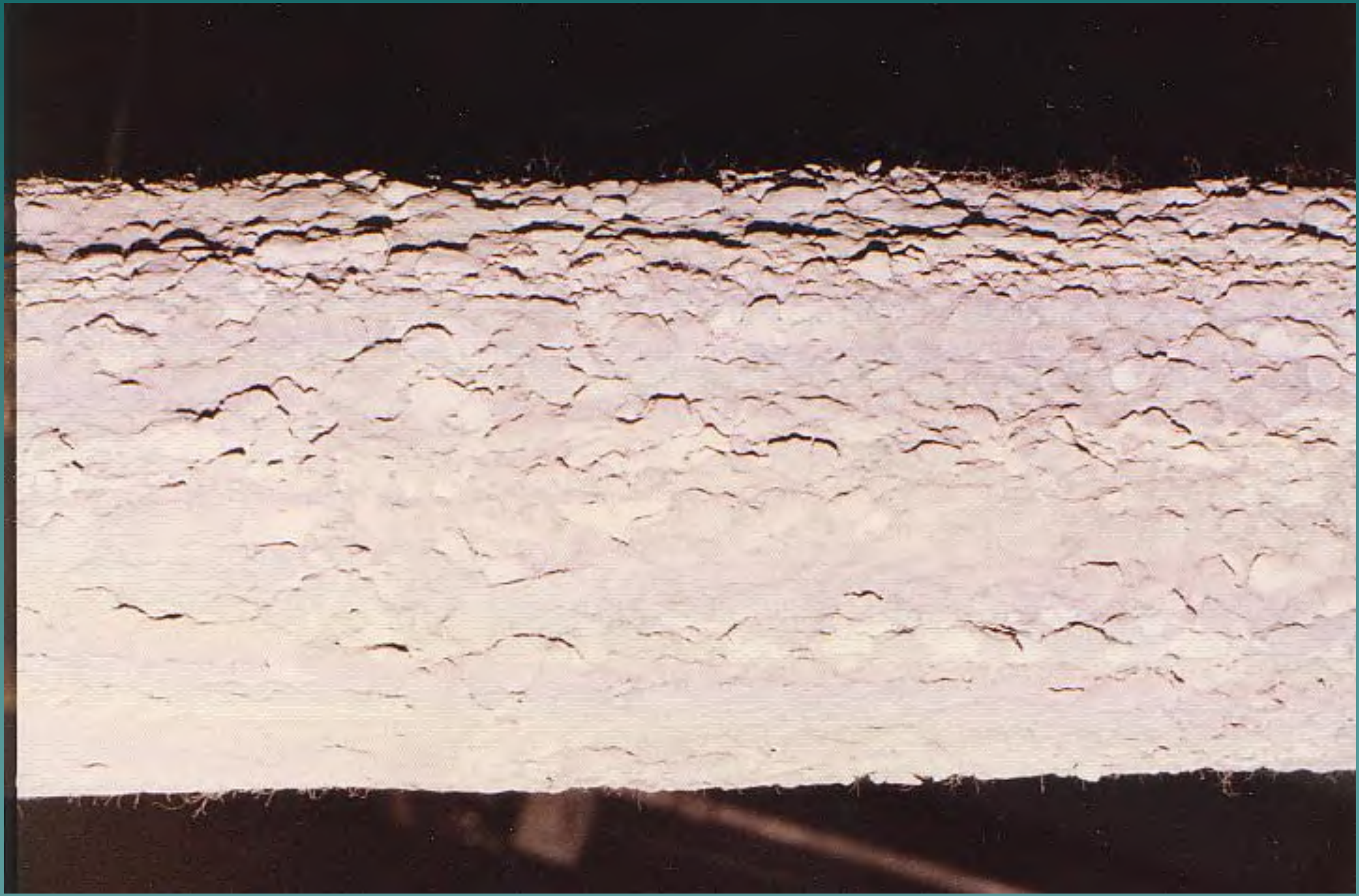
Significant Rust on Bag Cap

Poor Seam Construction

Broken/Missing Thread

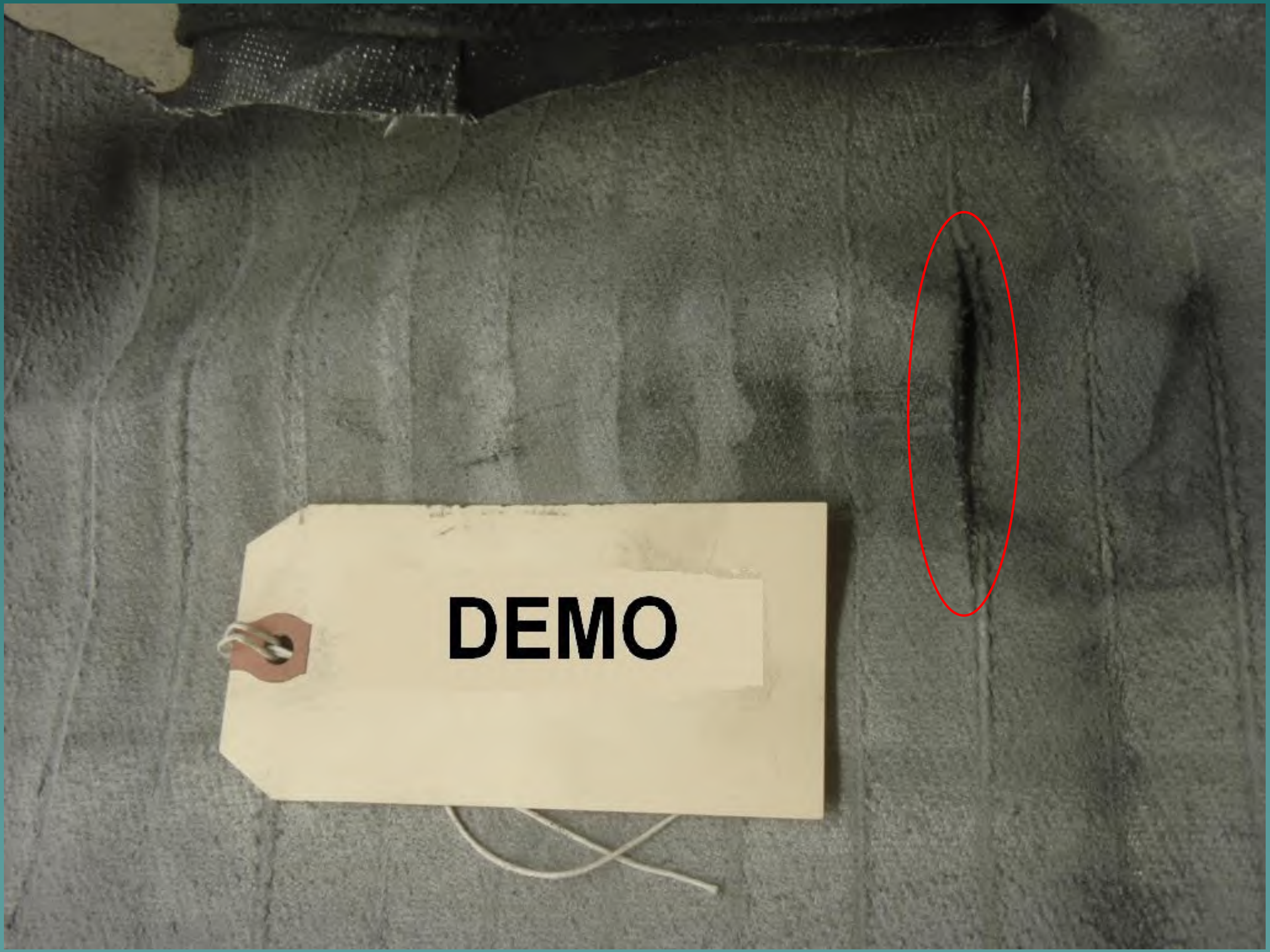


Pearling of Dust

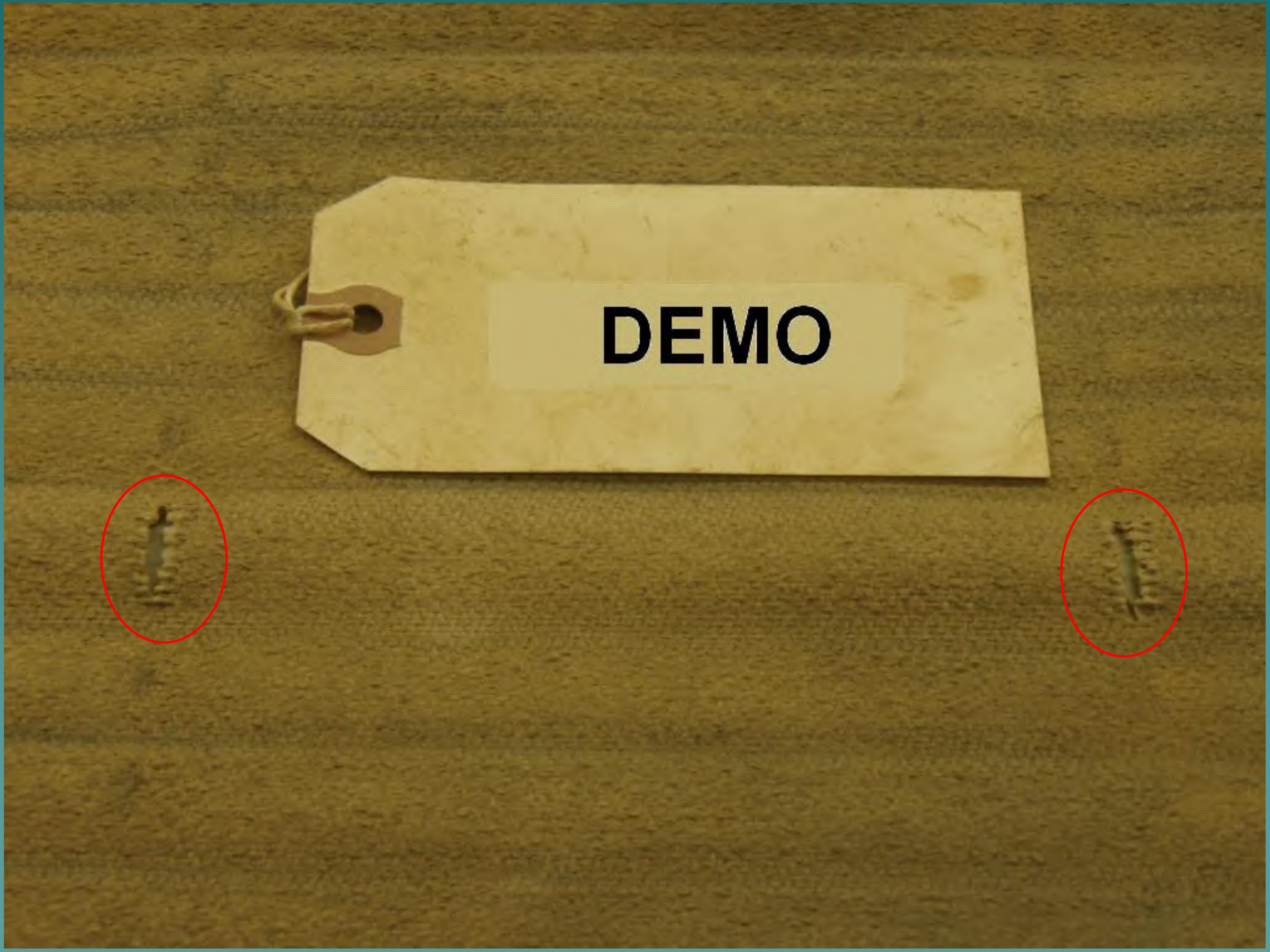


Pearling of Dust

Bag to Cage Abrasion



Bag to Cage Abrasion



Permeability Test

- Frazier Permeability apparatus is used to determine air handling capability of filter media.
- Includes capability to measure air flow over a wide (0-20" w.g.) differential pressure.
- Ambient to 400 °F temperature range.
- Non-destructive manner.

MIT Flex Test

- Primarily measures relative value of fiberglass fabric weaves and finishes to withstand self abrasion from flexing by measuring the number of flex cycles necessary to break a fabric sample

Tensile Test

- Provides stretch, elongation, and tear data for fabrics.
- Measures relative strength of warp and fill yarns in

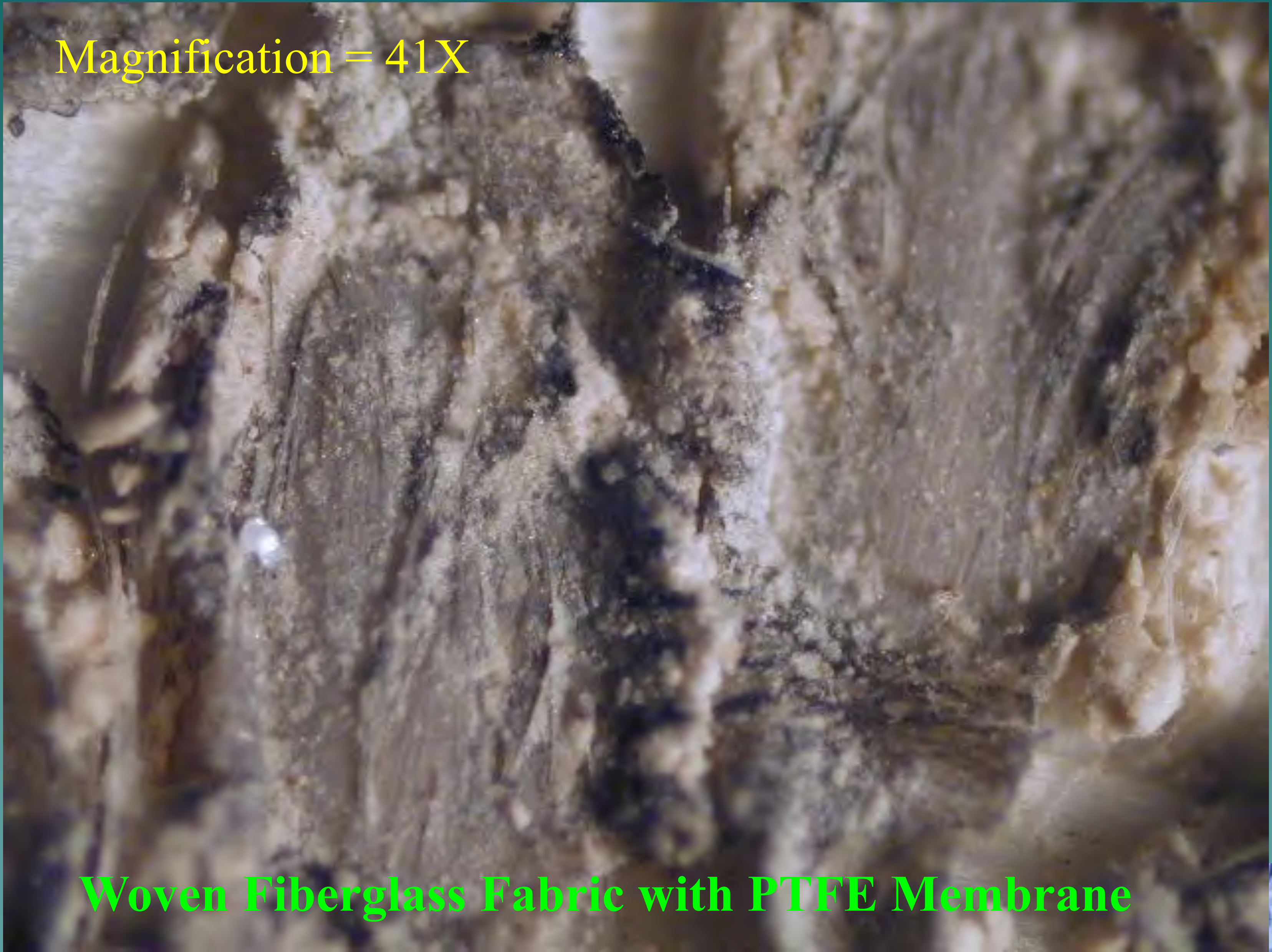
Mullen Burst Test

- Shows the relative total strength of fabrics to withstand severe pulsing or pressure.
- Fabric strength is measured by determining the difference between the total pressure required to rupture the specimen and the pressure required to inflate an expandable diaphragm.

Microscopic Analysis

- Aides in determining causes of bag deterioration and bag blinding.

Photomicrograph

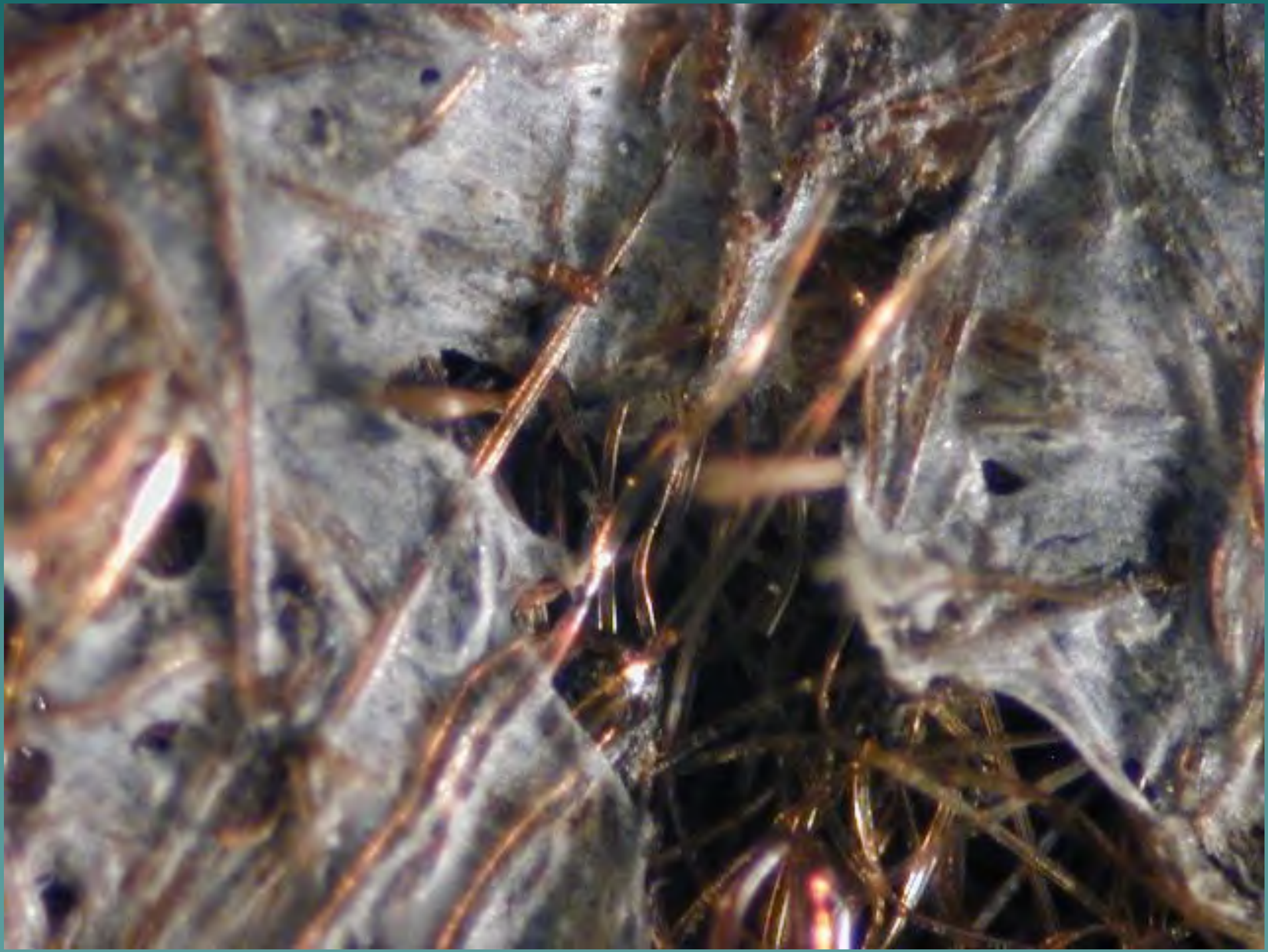


Photomicrograph

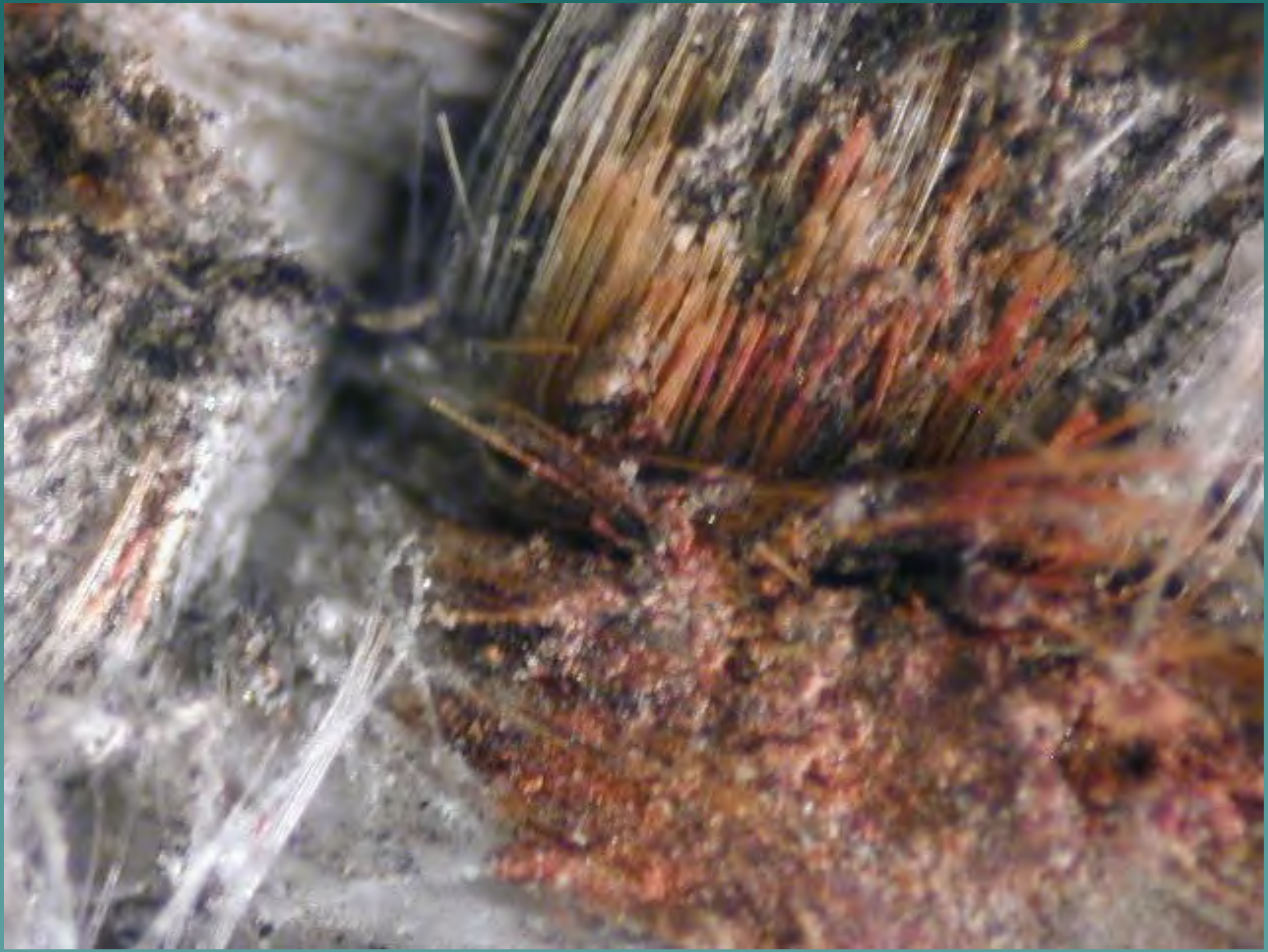
Photomicrograph

Polyester Felt Fabric Cross Section

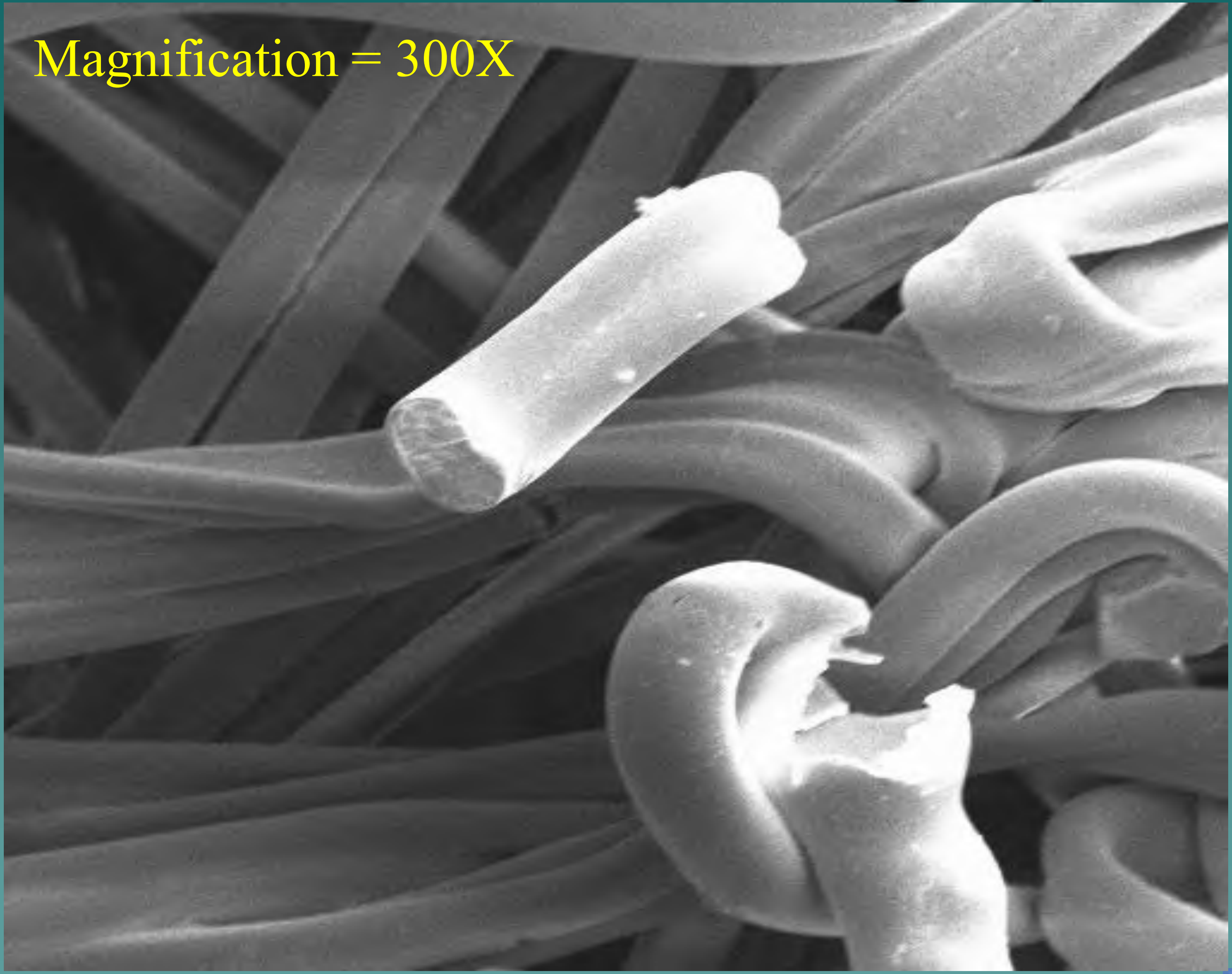
Membrane Damage



Broken Yarns

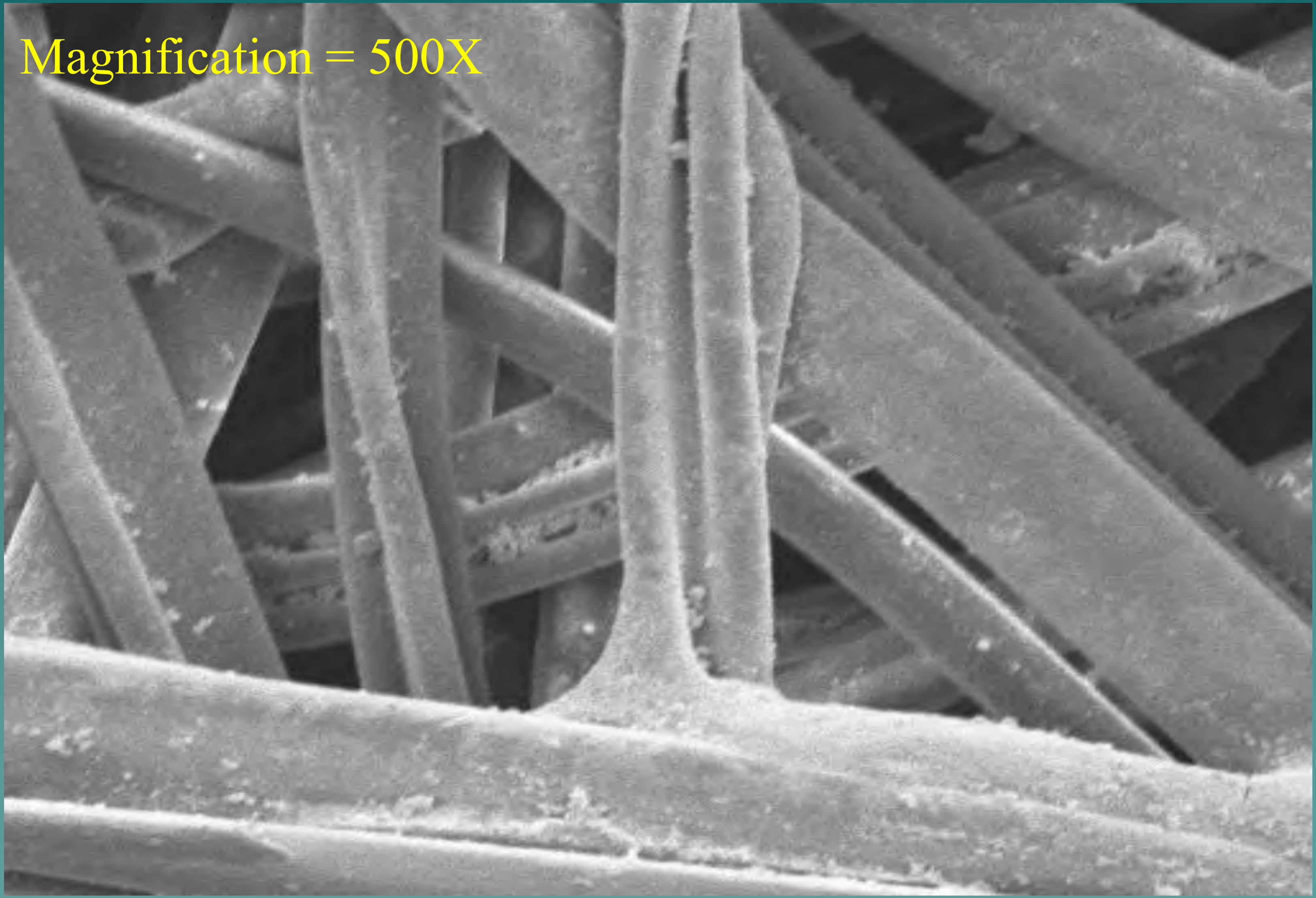


SEM Photomicrograph



Aramid Felt Fabric

SEM Photomicrograph



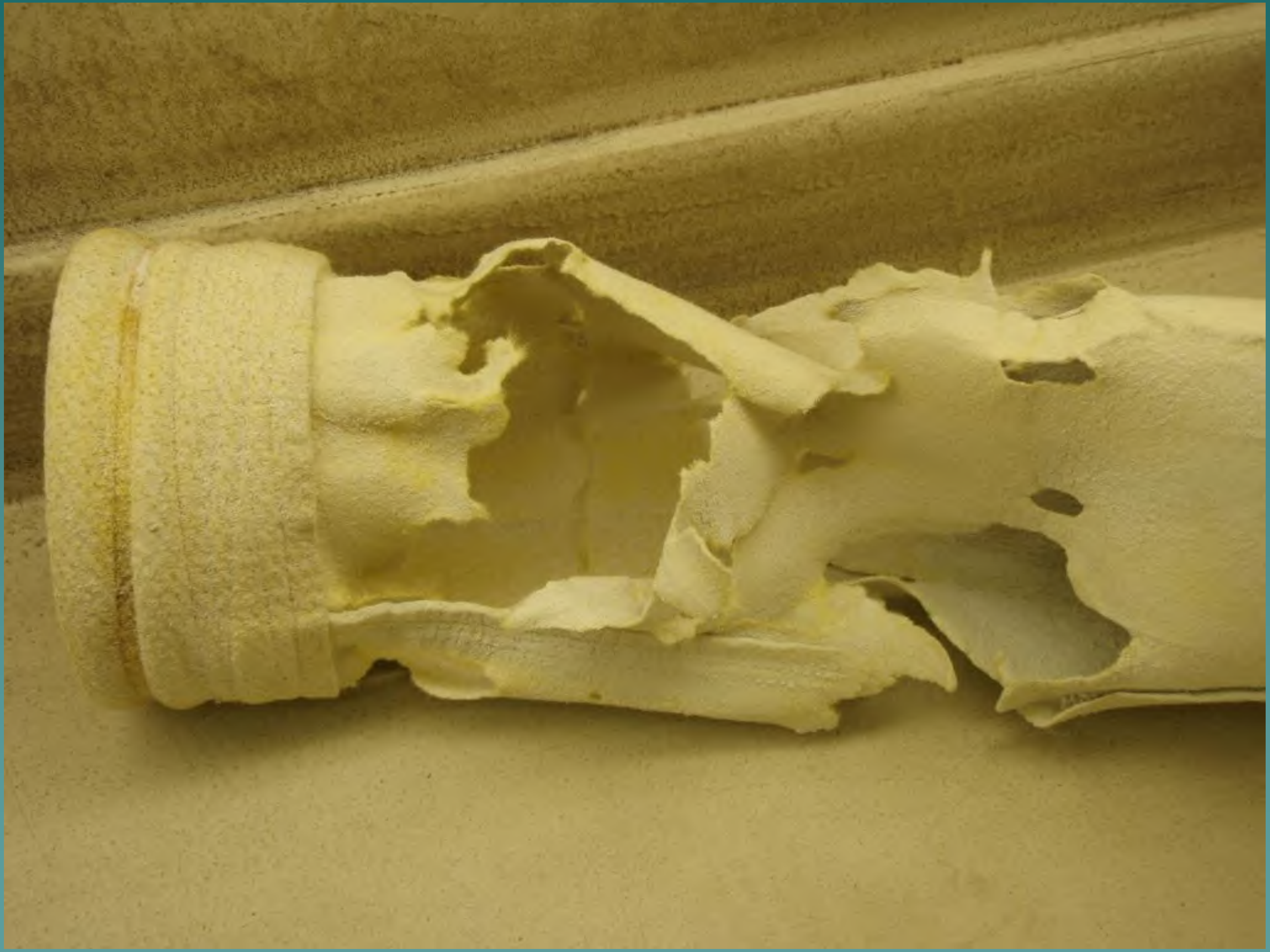
P-84 Felt Fabric

Chemical Analysis

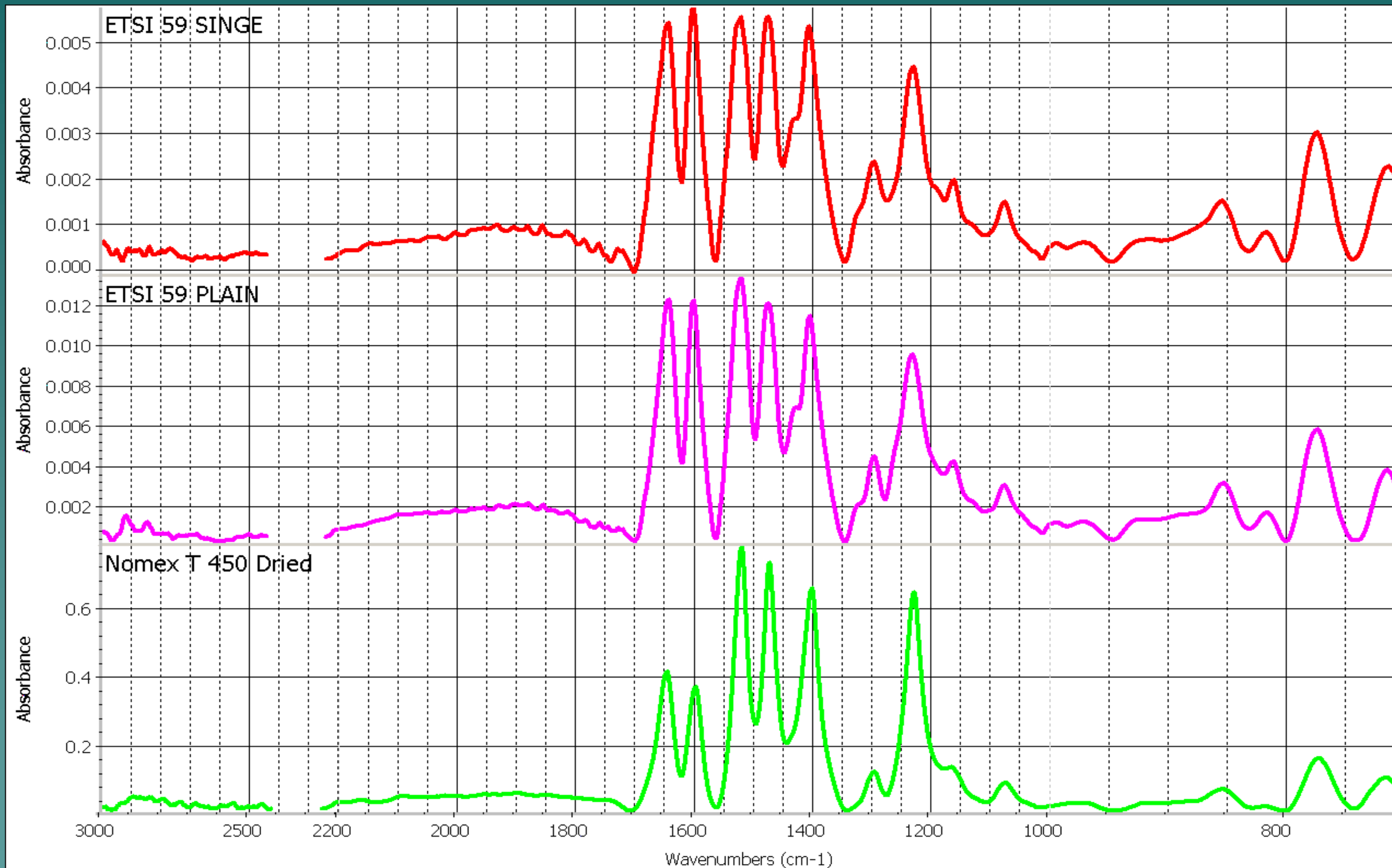
- Used either to predict or determine what effect on-stream conditions would have on the performance of a bag.

Chemical/Thermal Attack

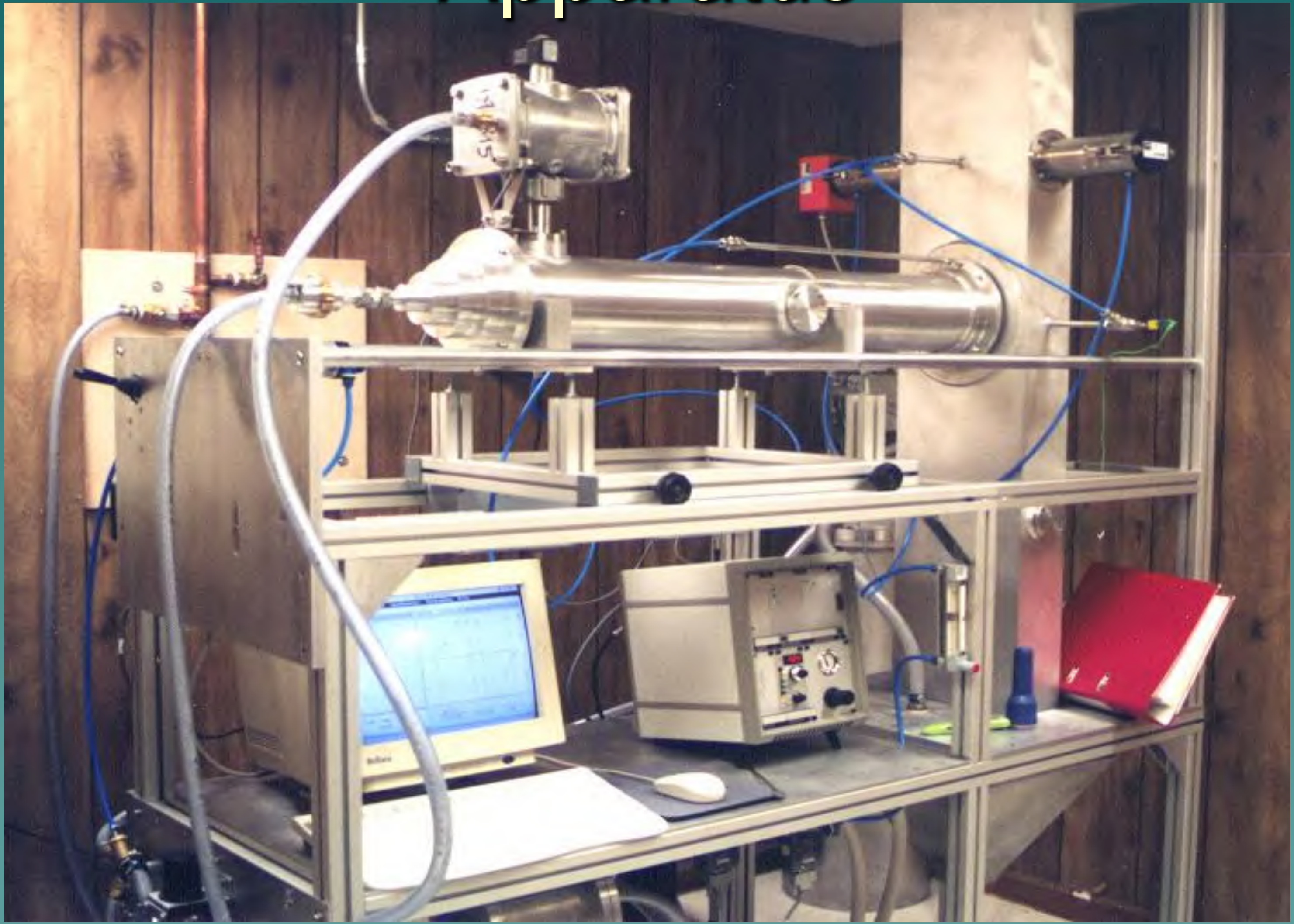
Chemical/Thermal Attack



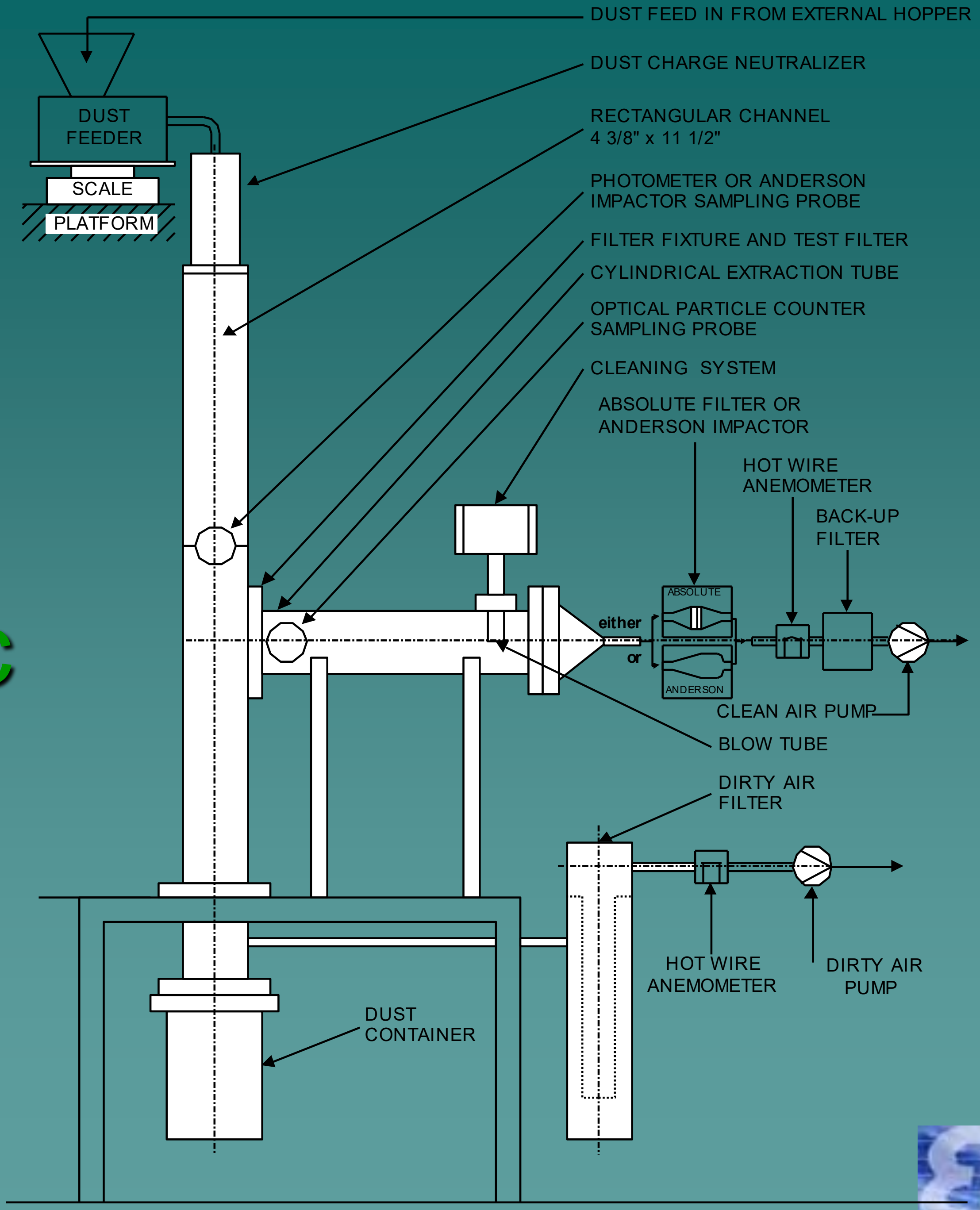
Fiber Identification by FTIR



ETS Filtration Performance Test Apparatus



ETS-FPTA Schematic



Test Program

Each test run consists of 3 phases:

10,000 rapid pulse cycles

30 normal cycles

6-hour performance test

Test Conditions

Raw gas volumetric flow rate	5.8 m^3/hr (3.4 cfm)
Filtration velocity	120 m/hr (6.6 fpm)
Test dust	aluminum oxide - Pural NF
Dust feed rate	100 g/hr
Gas temperature	25 ^oC (77 ^oF)
Pressure drop trigger for cleaning	1000 Pa (4 in wg)
Pulse cleaning pressure	0.5 MPa (75 psi)
Rapid pulse frequency	3 s

ETS FPTA Test Parameters

- Outlet Particle Concentration, PM 2.5
- Outlet Particle Concentration, Total Mass
- Average Residual Pressure Drop
- Initial Residual Pressure Drop
- Filtration Cycle Time
- Number of Filtration Cycles
- Mass Gain of Test Filter

Bag Monitoring With Stream Time

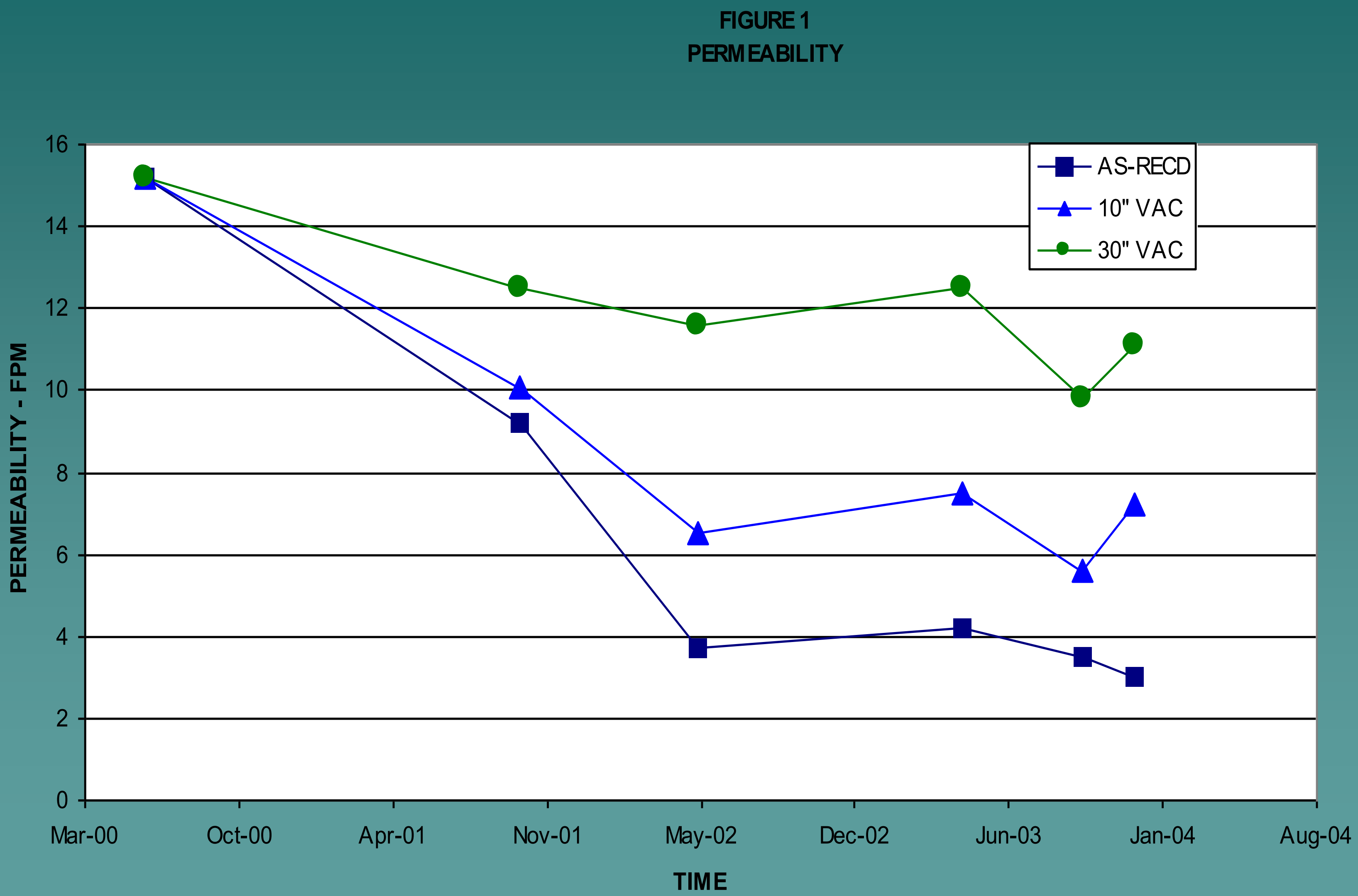
Fabric Type A

Bag Status	Tensile (lb/in)		Flex (#cycles)		Burst (lb/psi)	Permeability (FPM)	
	Warp	Fill	Warp	Fill		Dirty	Clean
New	232	226	3100	778	405	68	68
4-wk	117	57	550	68	209	10.9	83

Fabric Type B

New	123	109	> 50,000	> 50,000	307	37.2	37.2
4-wk	101	81	> 50,000	> 50,000	263	10.8	36.2

Bag Monitoring



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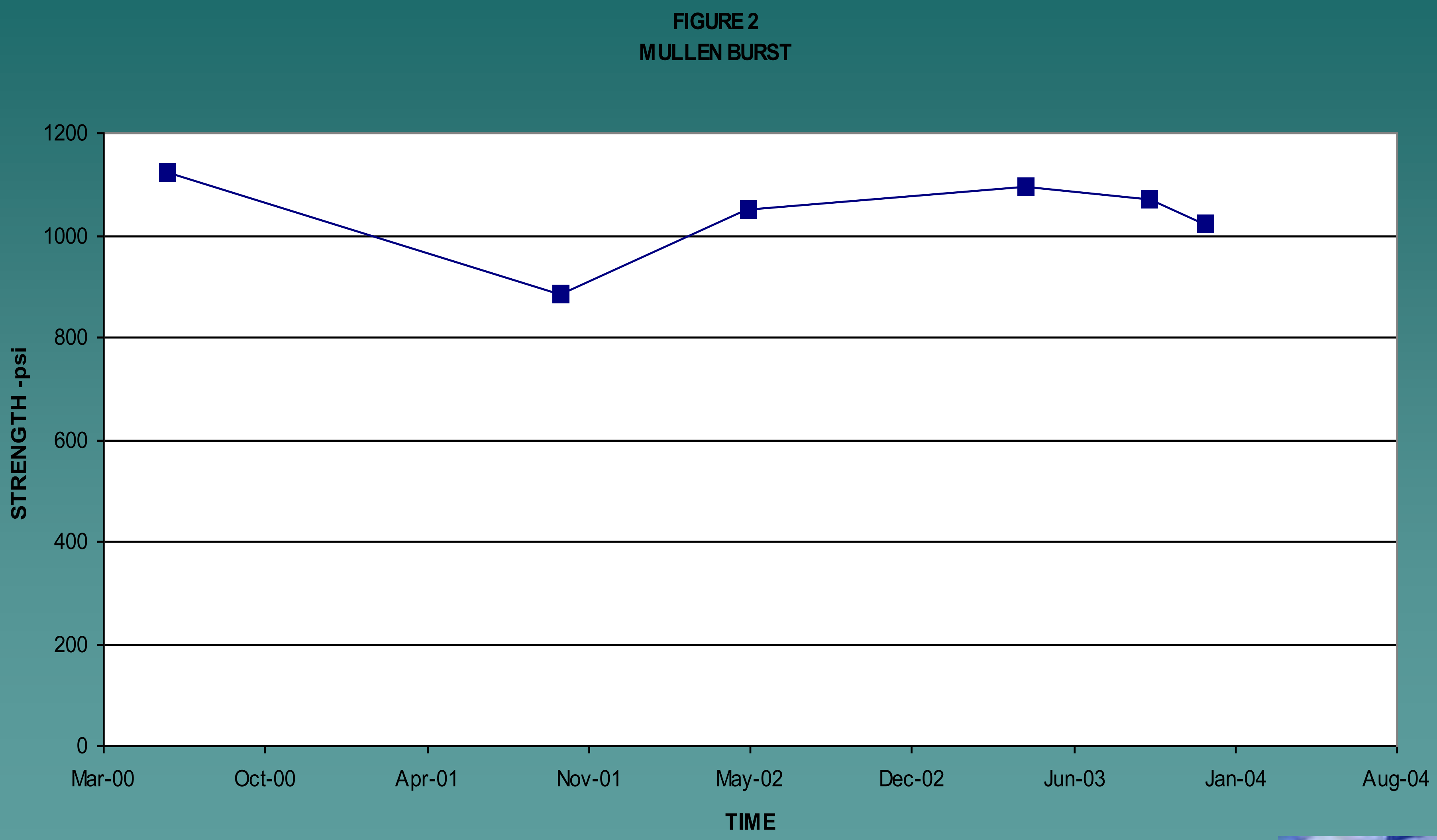

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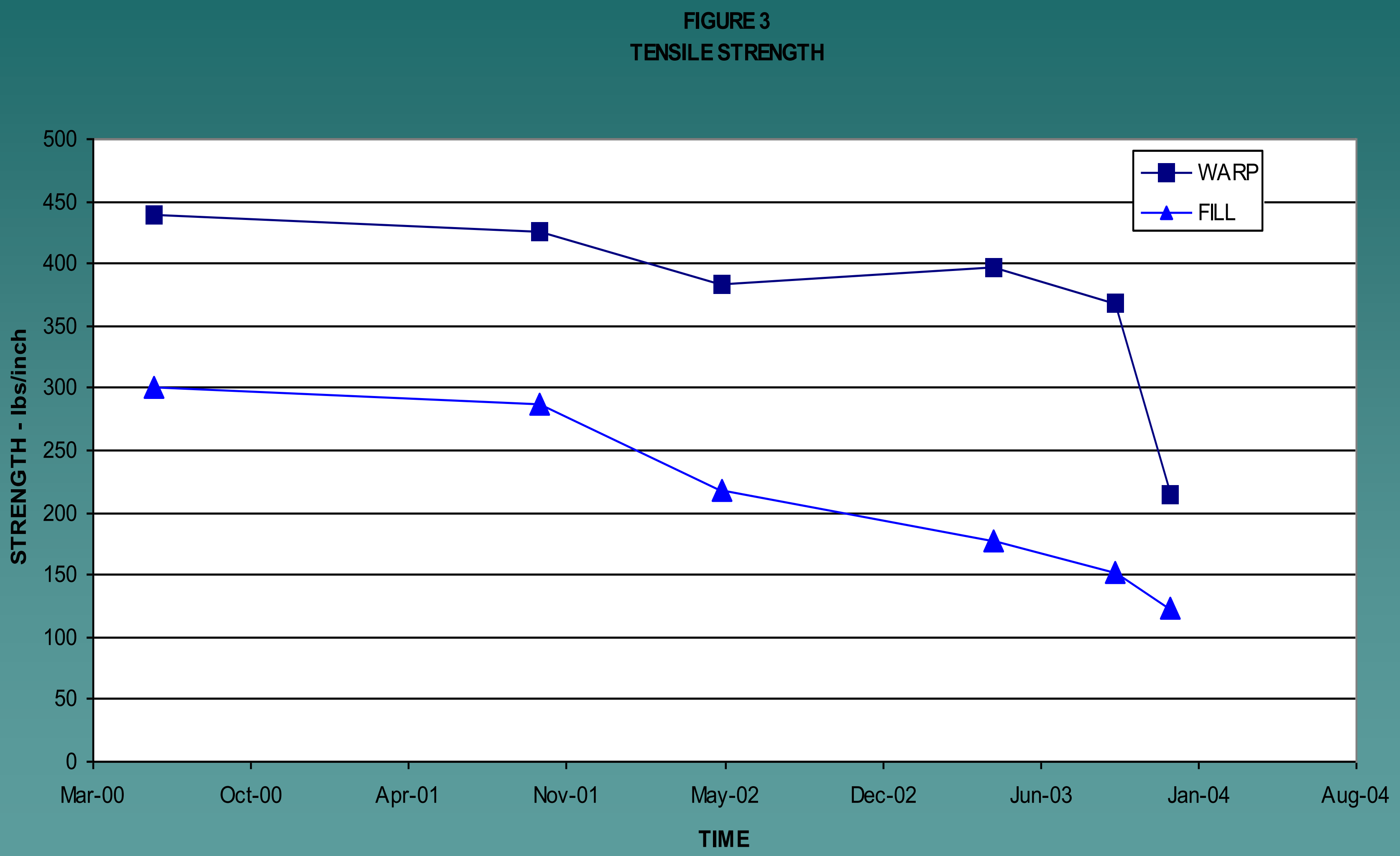

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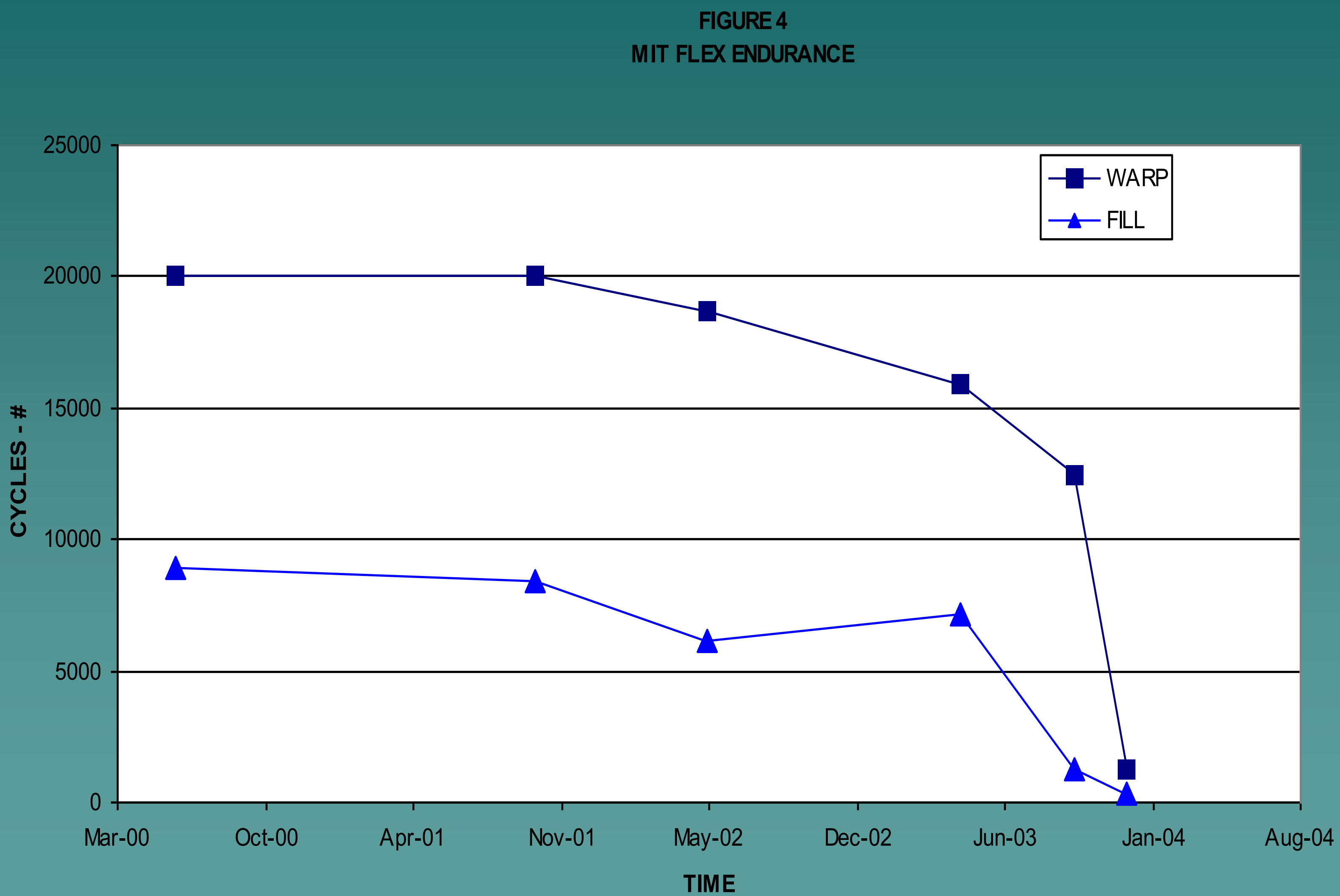

QUESTIONS?

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