QUALITY

LEADERSHIP FORUM

RMV TECHNOLOGY GROUP LLC

a NASA Industry Partner

March 14, 2024

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The COVID Lockdown Consequence of Dried-Out ESD Workstations and Solutions to Mitigate Hazards of Charge Board Effect on Mission Critical Flight Hardware!

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U.S. Copyright Office Submission 7 March 2024

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iNARTE ® Certified ESD Aerospace & Defense Engineer Class of 2023

Bob Vermillion, CPP, Fellow
Certified, ESD Engineer & Product Safety-iNARTE®

- 2023 iNARTE® Engineering Achievement Award
- 2023 NASA Level A Trainer
- 2023 DOD ESD Committee
- 2019 DoD Military Packaging Hall of Fame recipient
- 2018 named NASA ESD Technical Authority & Invited Speaker NASA QLF Cape Canaveral
- 2018 Founder iNARTE® ESD Aerospace & Defense Engineer™ & Technician™ Certification Program
- 2018 James Russell Packaging Engineering Lifetime Innovation Award for Protection of the WarFighter
- Since 1995, Member ESDA Standards Committee for USA
- Since 2015, SAE G-19A Founder Packaging EEE Subgroup
- 2015 Corporation of the Year (NIPHLE)
- 2010 1st to Present on Suspect Counterfeit ESD Packaging & Goods at NASA QLF, Cape Canaveral
- 2007 Institute of Packaging Professionals Induction into (IoPP) College of Fellows
- 2002 IoPP AmeriStar Award 1st Place in the USA Electronics Category
- Published Author and Inventor
- 1999 NASA Mars Mission Approved Material Development

ACKNOWLEDGMENTS

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NASA Kennedy Space Center (Ret.)

John Kolyer, Ph.D.,
Research Scientist, Boeing (Ret.)

Jorg Fischer, iNCE at SSL, UC Berkeley
Director of Mission Assurance & Safety
(Ret.)

Gene S. Monroe, MSEE, iNCE, NASA
Langley (Ret.)

Kory Kienzle, Workmanship/ESD Control
Program: EPA Certifier, NASA GSFC

JUSTIFICATION FOR THIS PRESENTATION

After the COVID-19 Shutdown in 2020 and return to work, NASA's ESD Technical Authority, as an essential worker, Bob Vermillion, was tasked with Certification of the ESD Protected Areas (EPAs) on behalf of a NASA Prime Contractor before work was to start up.

The shutdown in the EPAs had caused Air Conditioner Systems to become inoperable with temperatures in excess of 80^0F to 95^0F. In short, the surfaces of the ESD workstation antistatic topical layers dried out and generated voltages over the <±200 volt limit despite favorable Resistance readings for Resistance to a Groundable Point (RTG) and Point to Point Resistance at <1.0 x 10^9 ohms.

RISK TO FLIGHT HARDWARE?

Risks Found:

In July 2020, several EPA ESD Worksurfaces (mat or laminate) charged in excess of ANSI/ESD S20.20 Limit of <±200 volts. This can lead to damage of flight hardware circuitry when an electronic assembly is moved or placed onto an ESD worksurface, followed by contact with metal tweezers or a solder tip that can cause a Field Induced Model (FIM) discharge.

Circuit card or flight hardware repositioning on an ESD mat inducing voltage is known as the Charge Board Effect (CBE). A partially dehydrated, untreated bulk loaded surfactant ESD mat can charge to several hundred volts despite passing ANSI/ESD STM4.1 resistance to a groundable point (RTG) or point to point (R_{PP} or R_{TT}) resistance testing per NASA-STD-8739.6, Section 7.

During the shut down, several ARC “Not in Service” EPAs did not meet NASA-STD-8739.6 requirements between 30%RH to 70%RH. Consequently, the proprietary Vermillion Charge Board Effect (CBE) Evaluation and Test Method was implemented before EPA reactivation.

In the Space & Defense sector, ESD sensitive devices (ESDS) EEE parts fall within the Sensitivity ranges illustrated in Table 1. Today, both GOTS and COTS are rated at ±50 volts or lower for NASA and the DoD.

THE RISK: FOUND, IDENTIFIED, MITIGATED

- What was found during COVID?
- What was the Risk for NASA programs?
- What was traditional?
- What was mitigated and implemented at ARC?
- What were some of the findings?

Charge Board Effect (CBE)

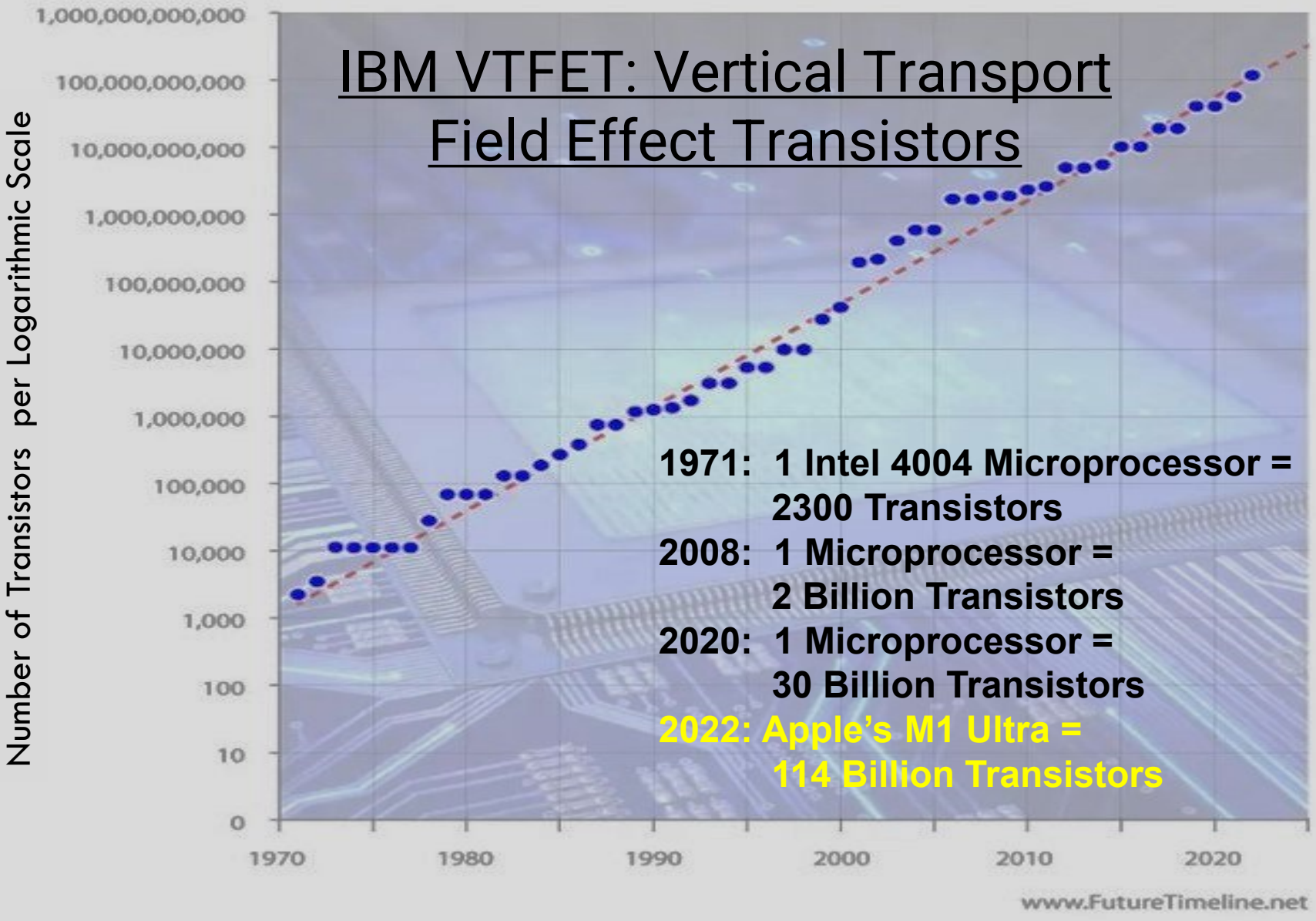


TABLE 1

ANSI-ESDA-JEDEC JS-001	
HBM Classification	Voltage (V)
0Z	<50
0A	50 - <125
0B	125 -<250
1A	250 - <500

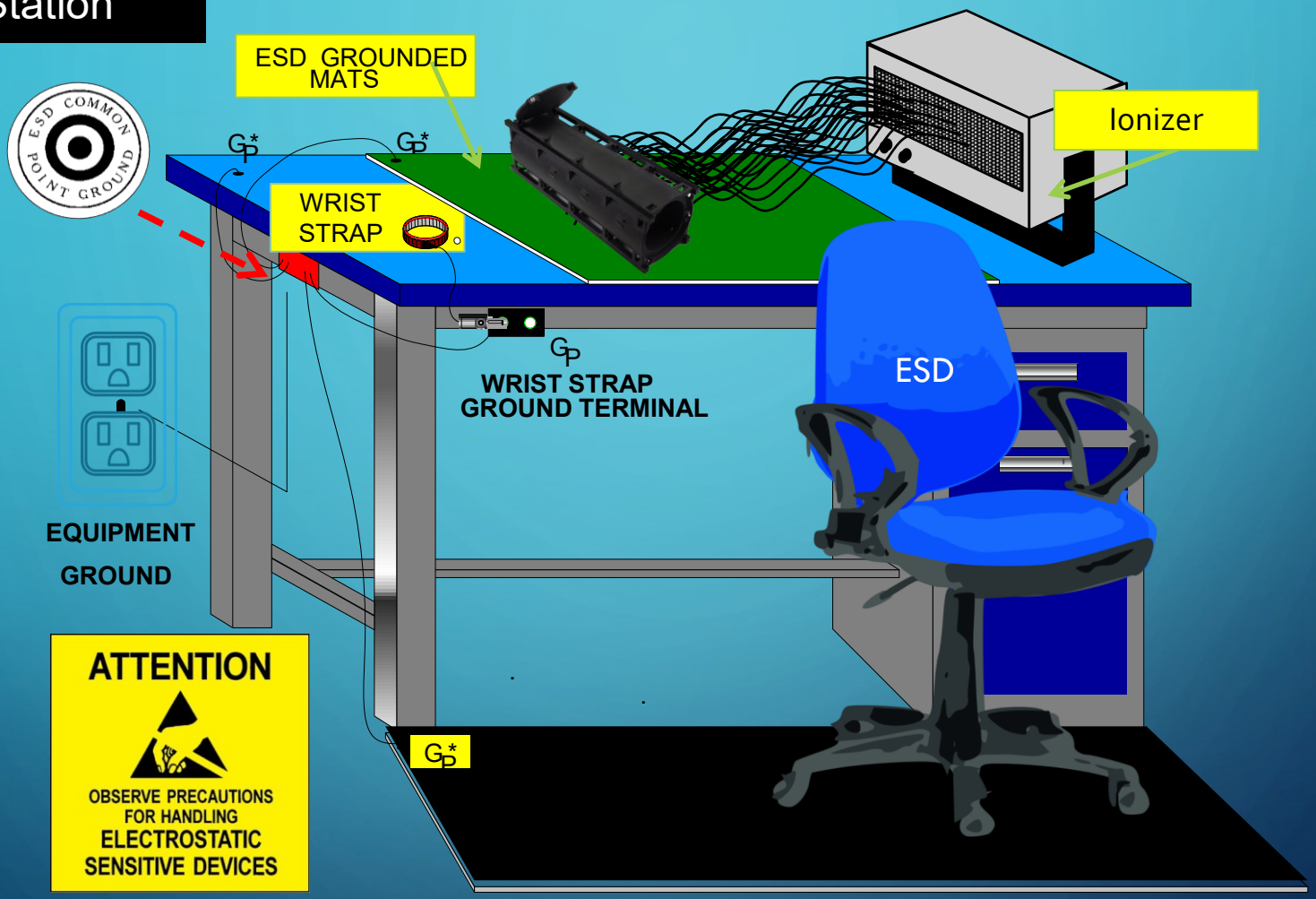
Humidity Dependent "Antistatic" Mats in the EPA

3-Layer Antistat Bulk Loaded Mat at 1.0 x 10^6 Ω to <1.0 x 10^9 Ω

2-Layer Antistat Bulk Loaded Mat at 1.0 x 10^6 Ω to <1.0 x 10^9 Ω

ESD Safe Vinyl Mat Performance is Enhanced in Moderate Relative Humidity Environments

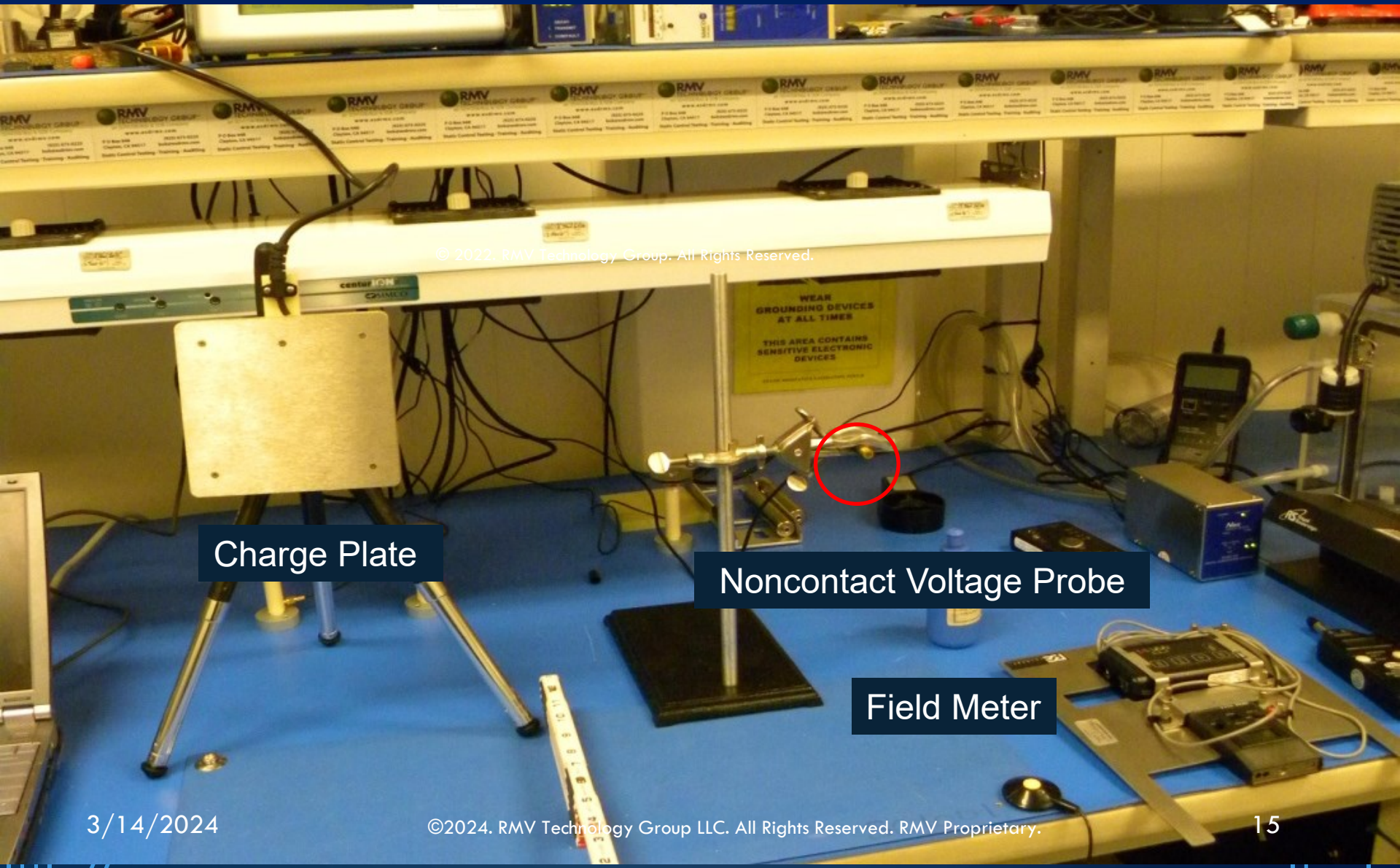
Class A ESD Work Station

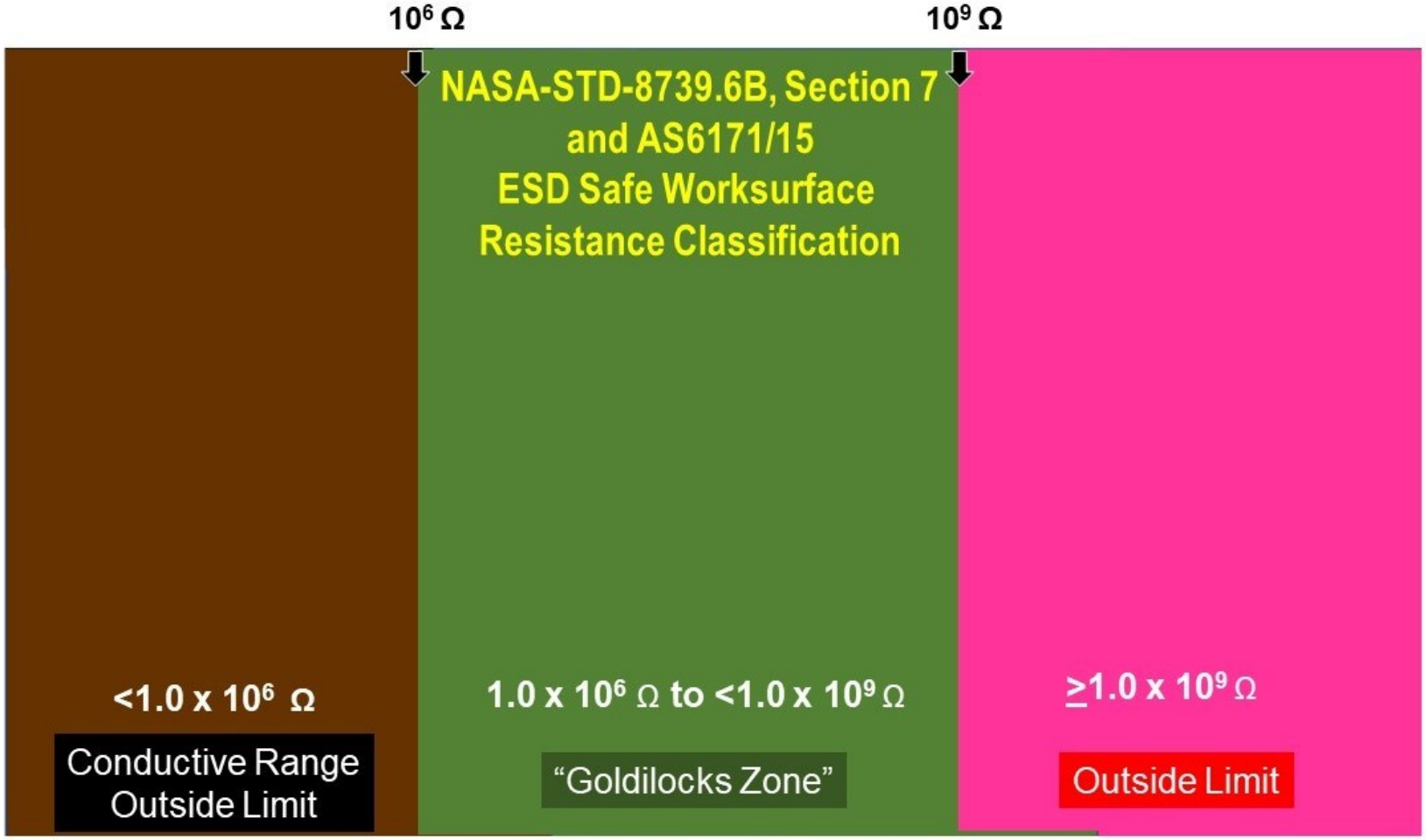


WHY CBE TESTING?

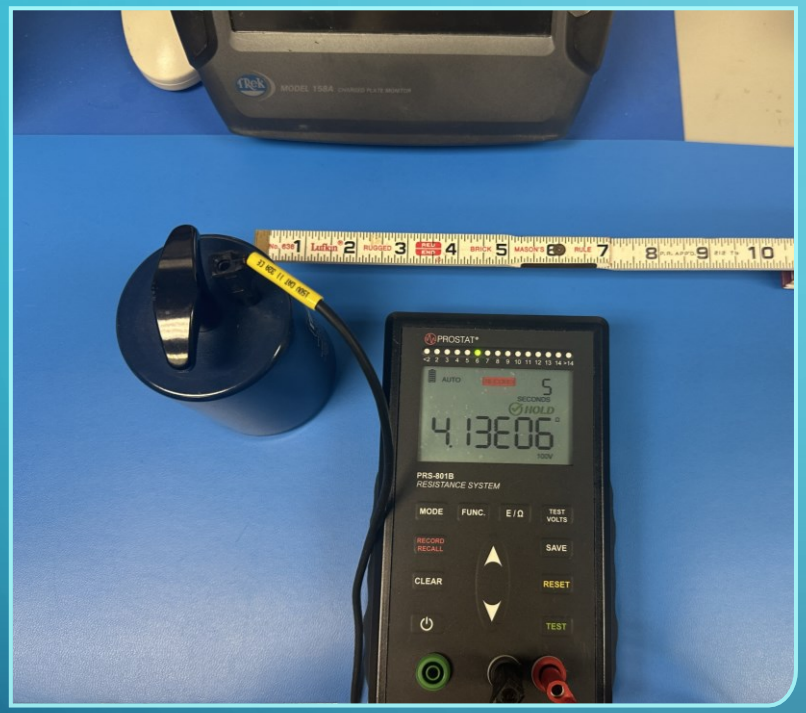
- Densification of Microprocessor driven ESD sensitive devices (ESDS) makes CBE mitigation more important than every before!
- Space & Defense manufacture or assembly of ESDS to <±50 volts.
- Untreated ESD Safe Worksurfaces dry out due to Isopropyl Alcohol (IPA) cleaning and Bulk Loaded Mat Antistat Short Life Cycle.
- ESD Worksurfaces may pass resistance testing yet fail charge generation testing.
- Pandemic Shutdown was responsible for EPA AC systems to shut down, creating dry and hot environments to compromise ESD Mat performance!

Methods of Measuring Charge at the ESD Safe Workstation





ESD WORKSTATION RESISTANCE TEST PASSED BUT DOES IT GENERATE <±200 VOLTS FOR CBE COMPLIANCE?

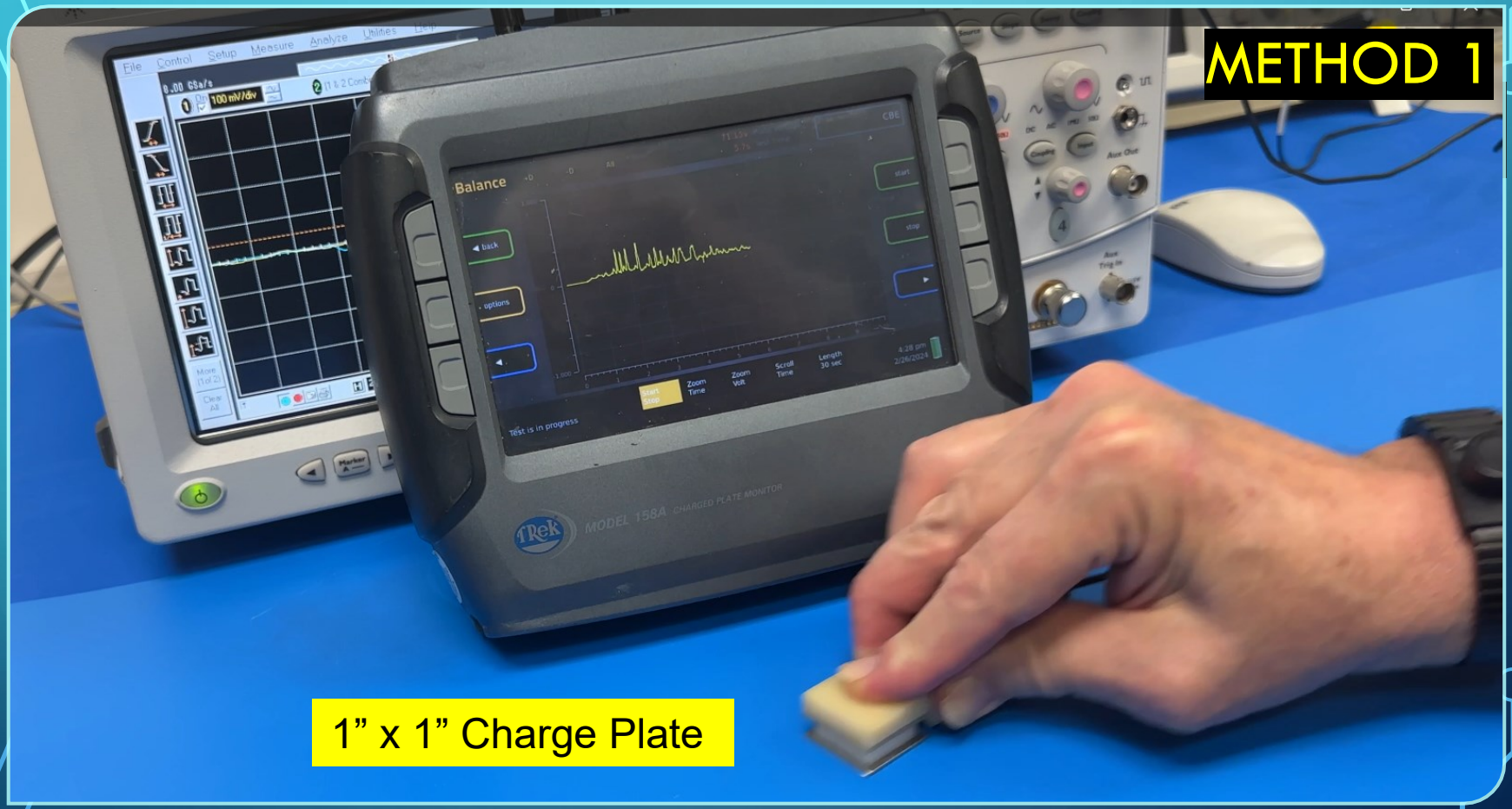


RTG = 4.13 x 10^6 Ω

R_{PP} = 7.88 x 10^6 Ω

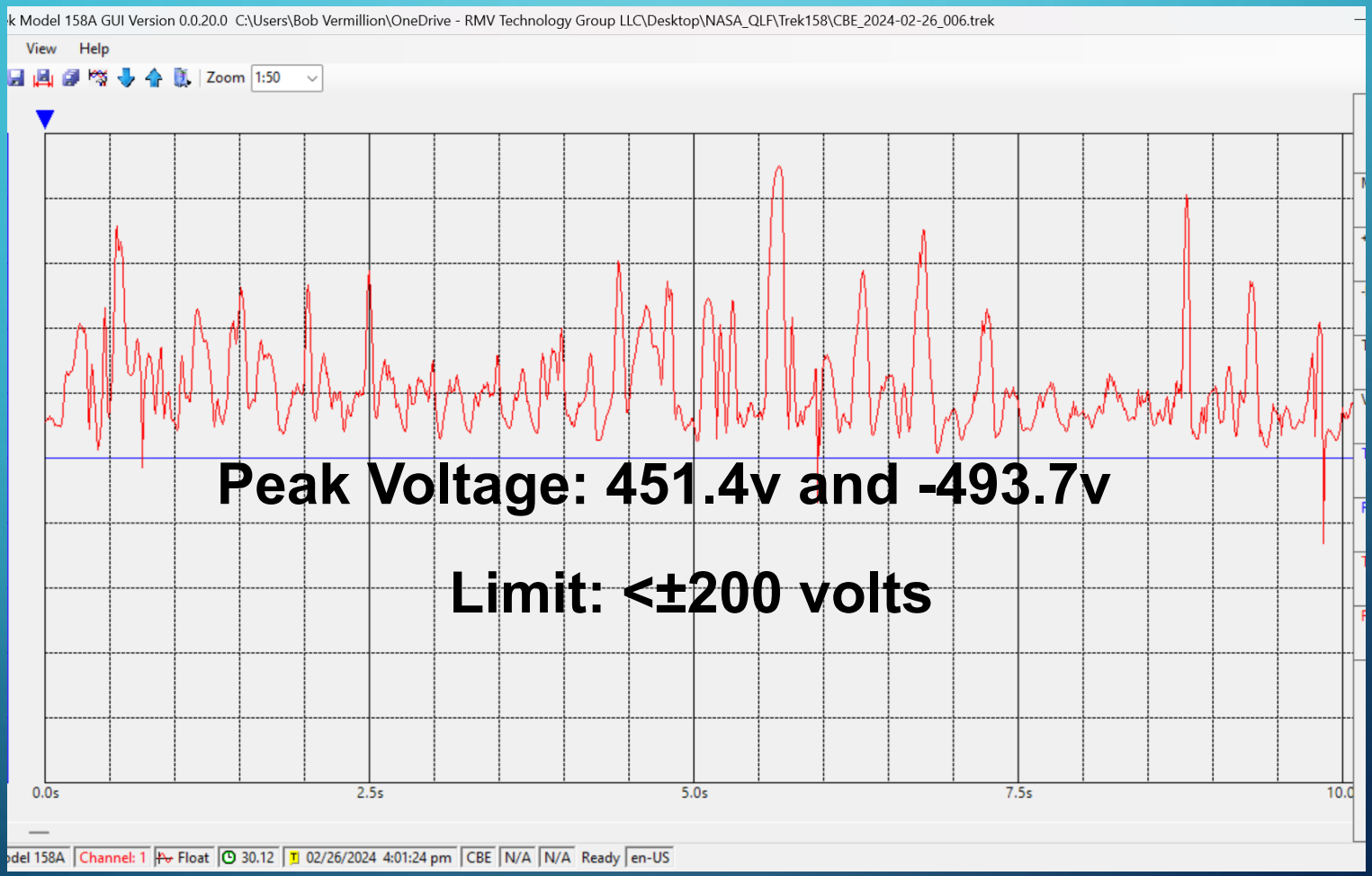
NASA-STD-8739.6B, Section 7
Limit: 1.0 x 10^6 Ω to < 1.0 x 10^9 Ω

VERMILLION CBE TEST METHOD™



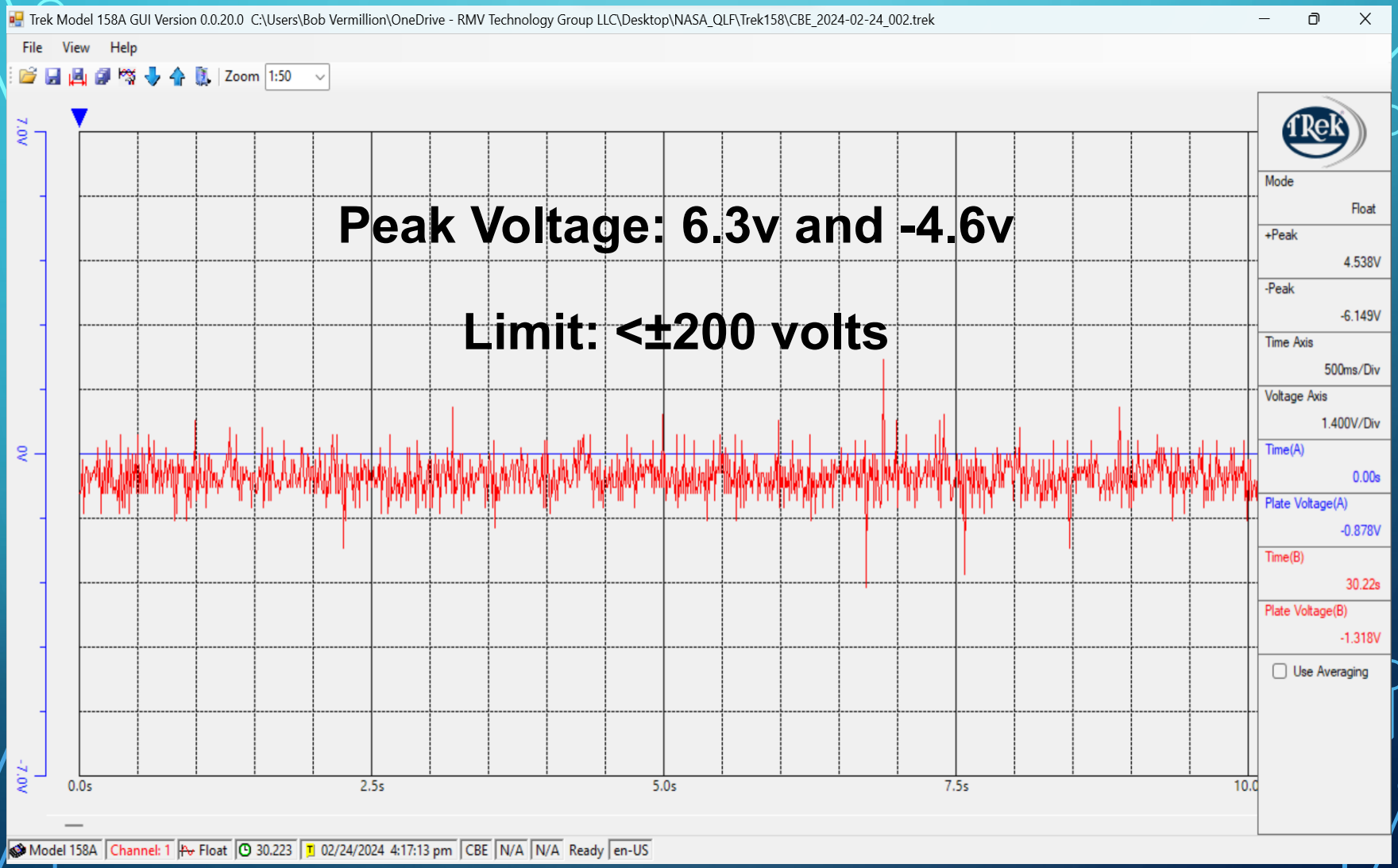
VERMILLION CBE TEST METHOD™

CBE Results PeakV before Treatment

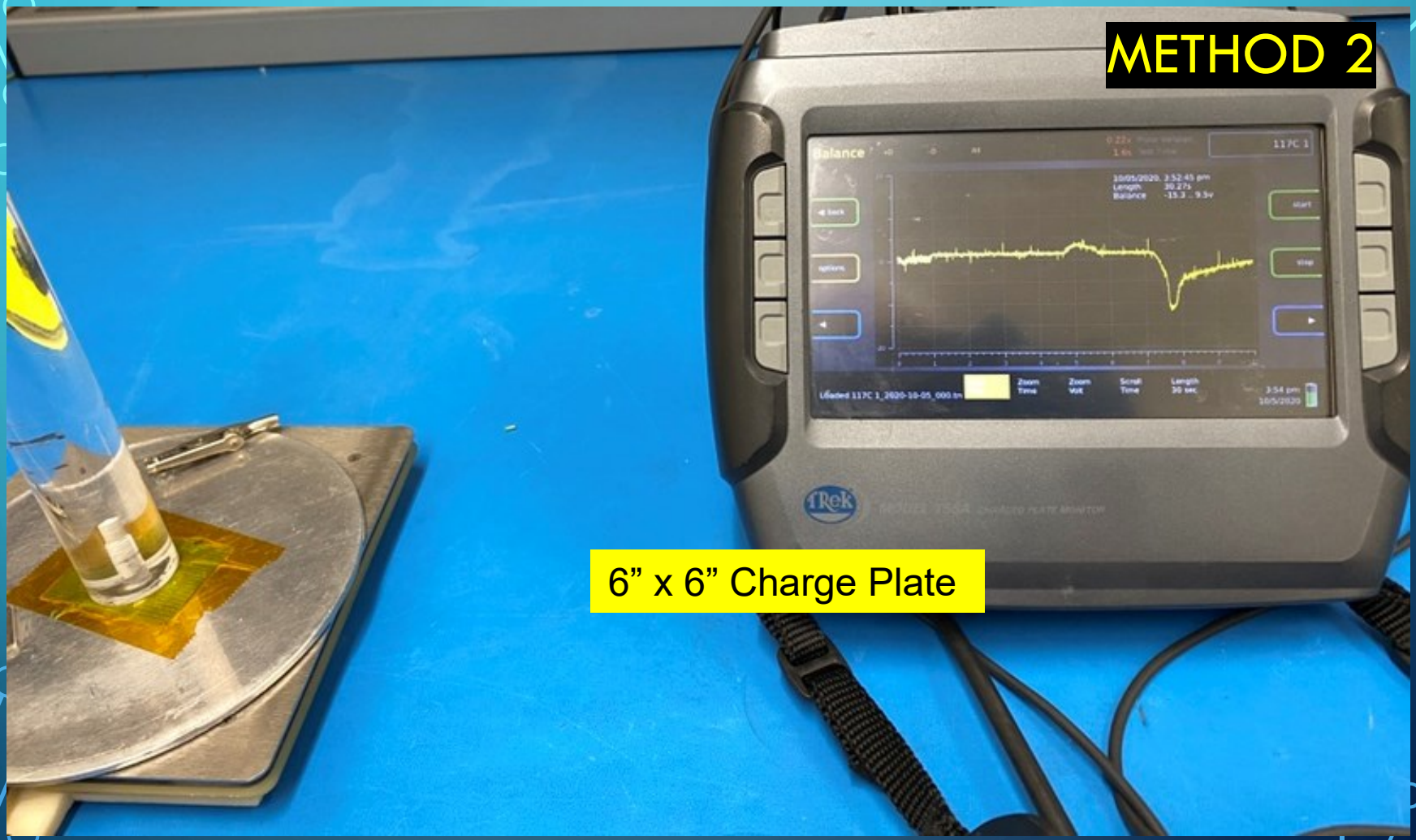


CBE Results PeakV after Treatment

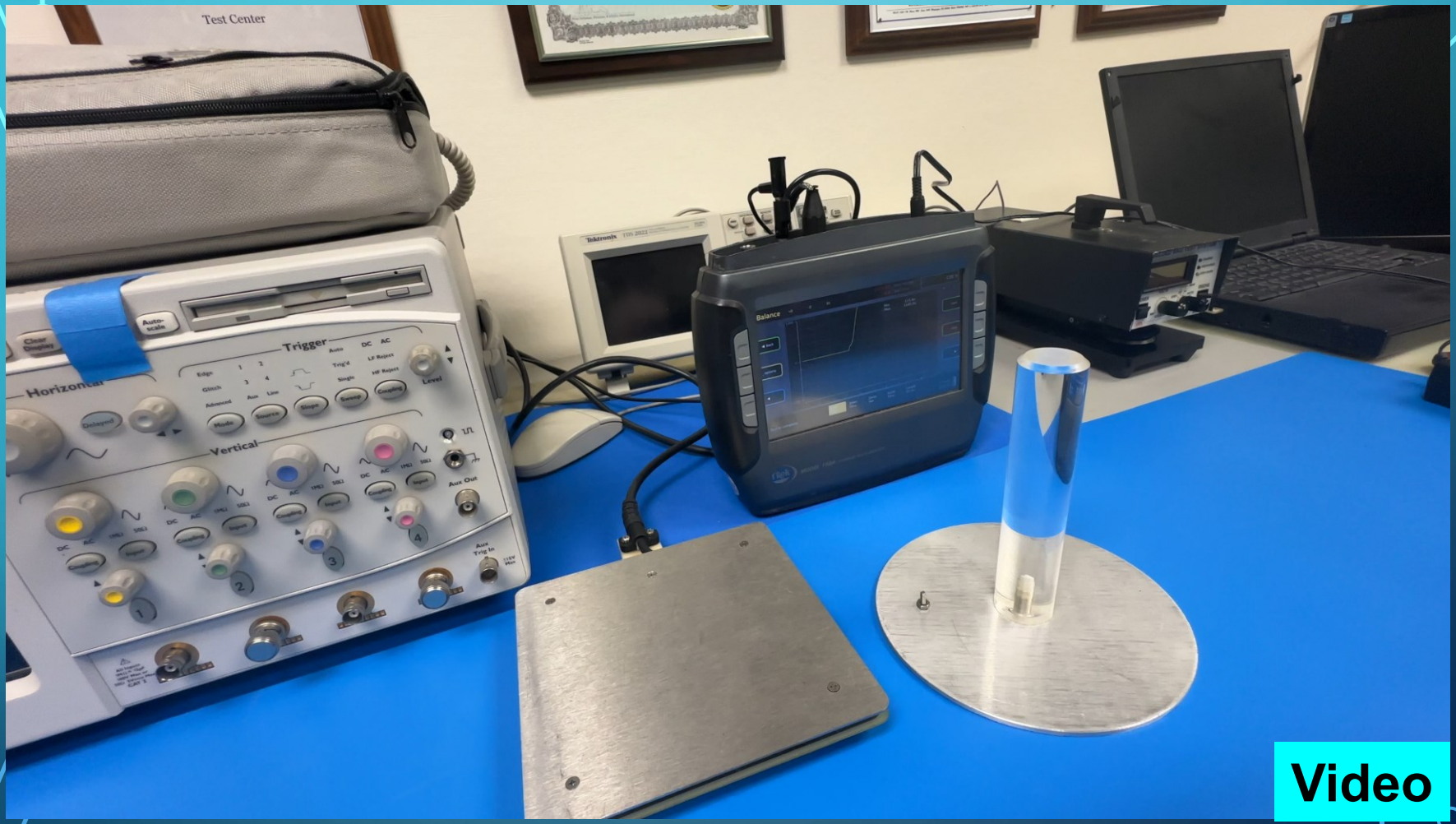
CBE Results PeakV after Treatment



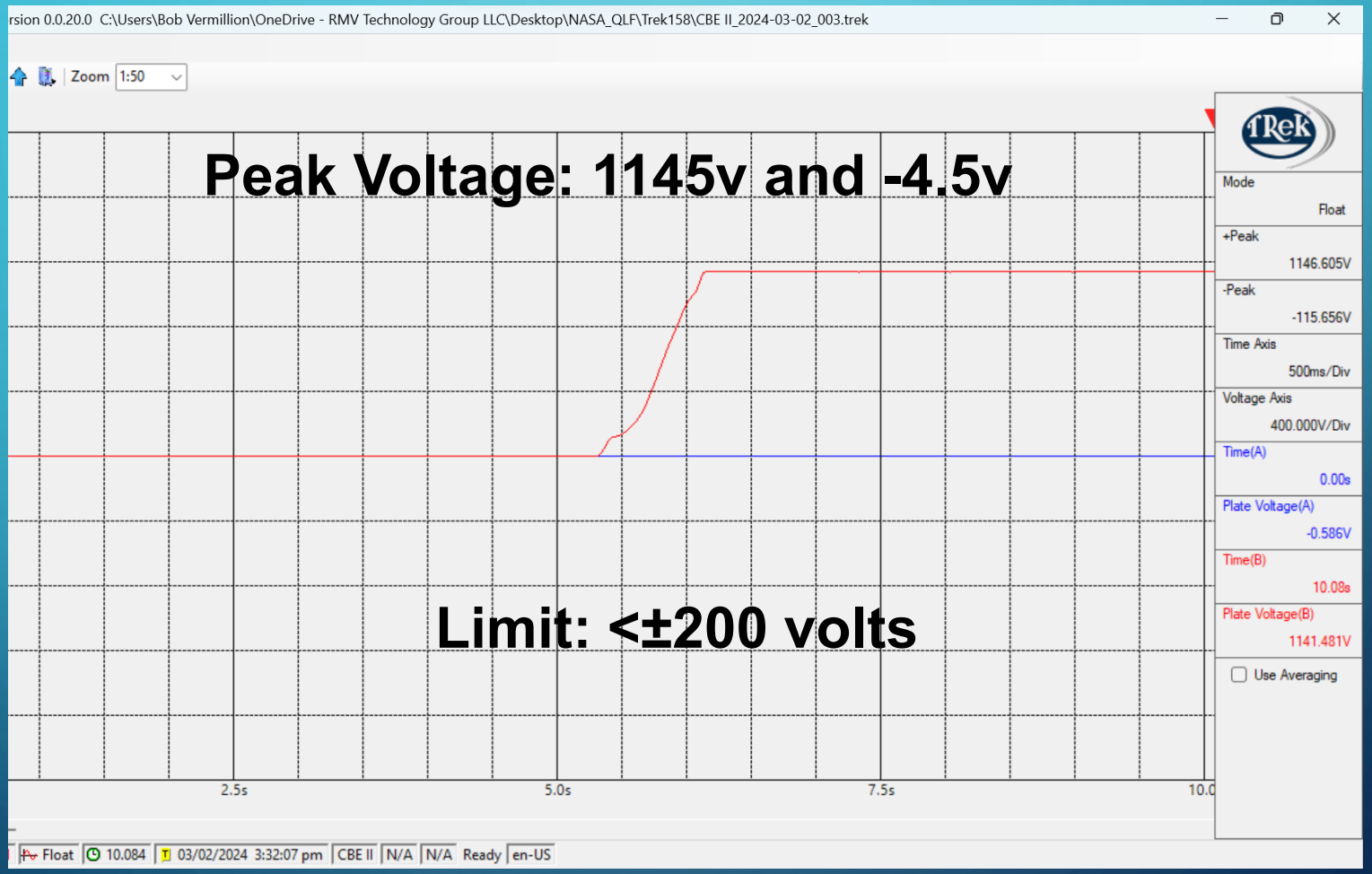
VERMILLION CBE TEST™ FOR WORKSTATION



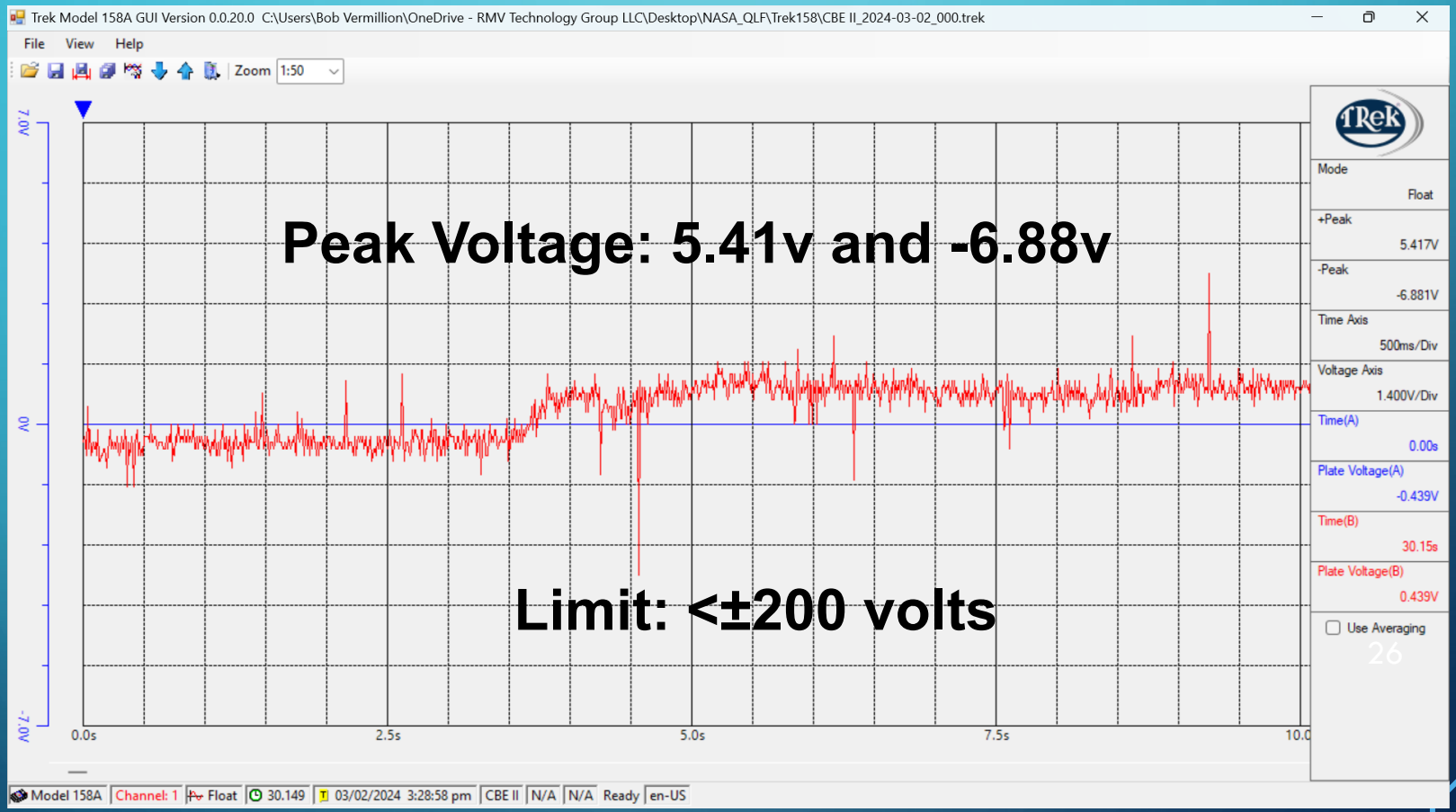
Vermillion CBE Test™ for Workstation



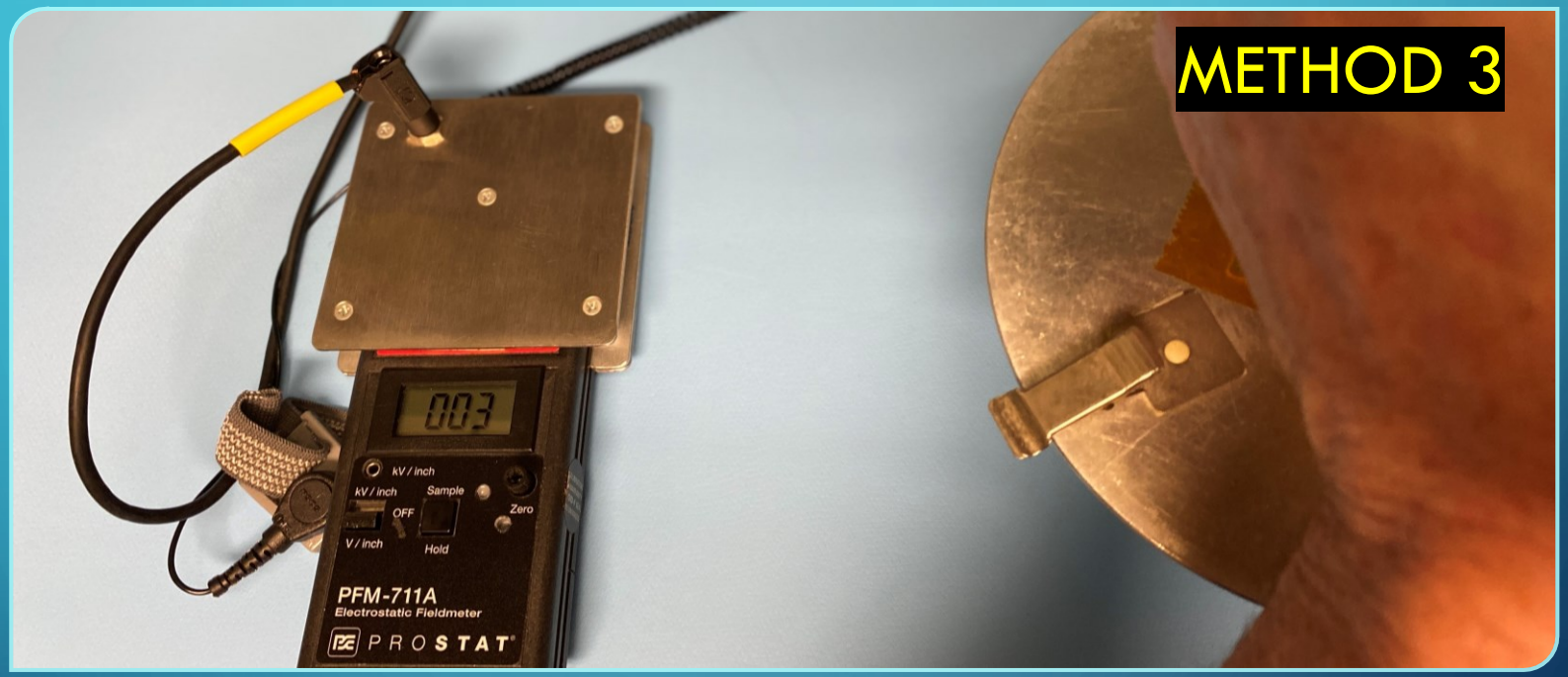
CBE Results PeakV before Treatment



CBE Peak Voltage after Treatment

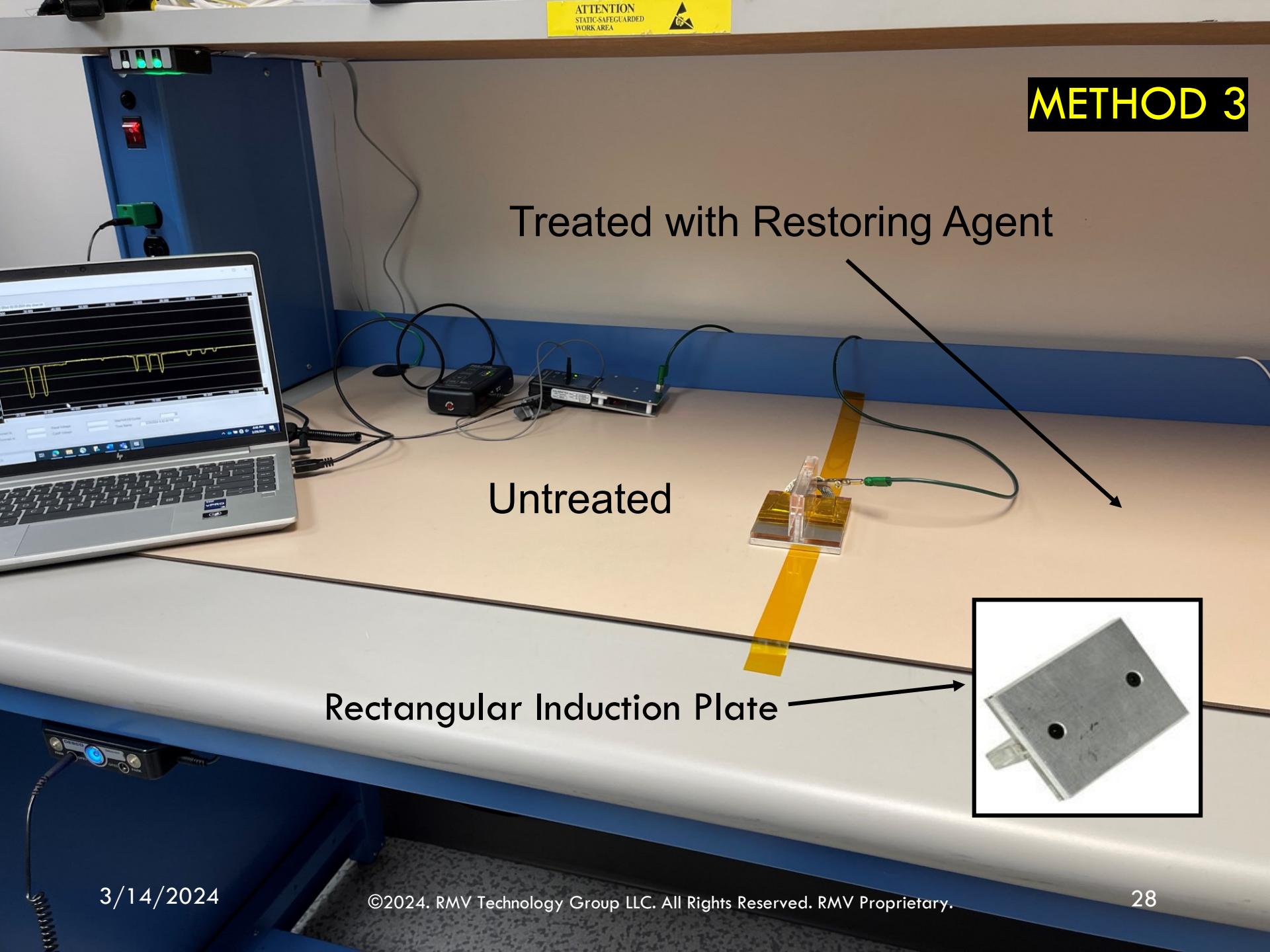


Vermillion CBE Test™ for Workstation

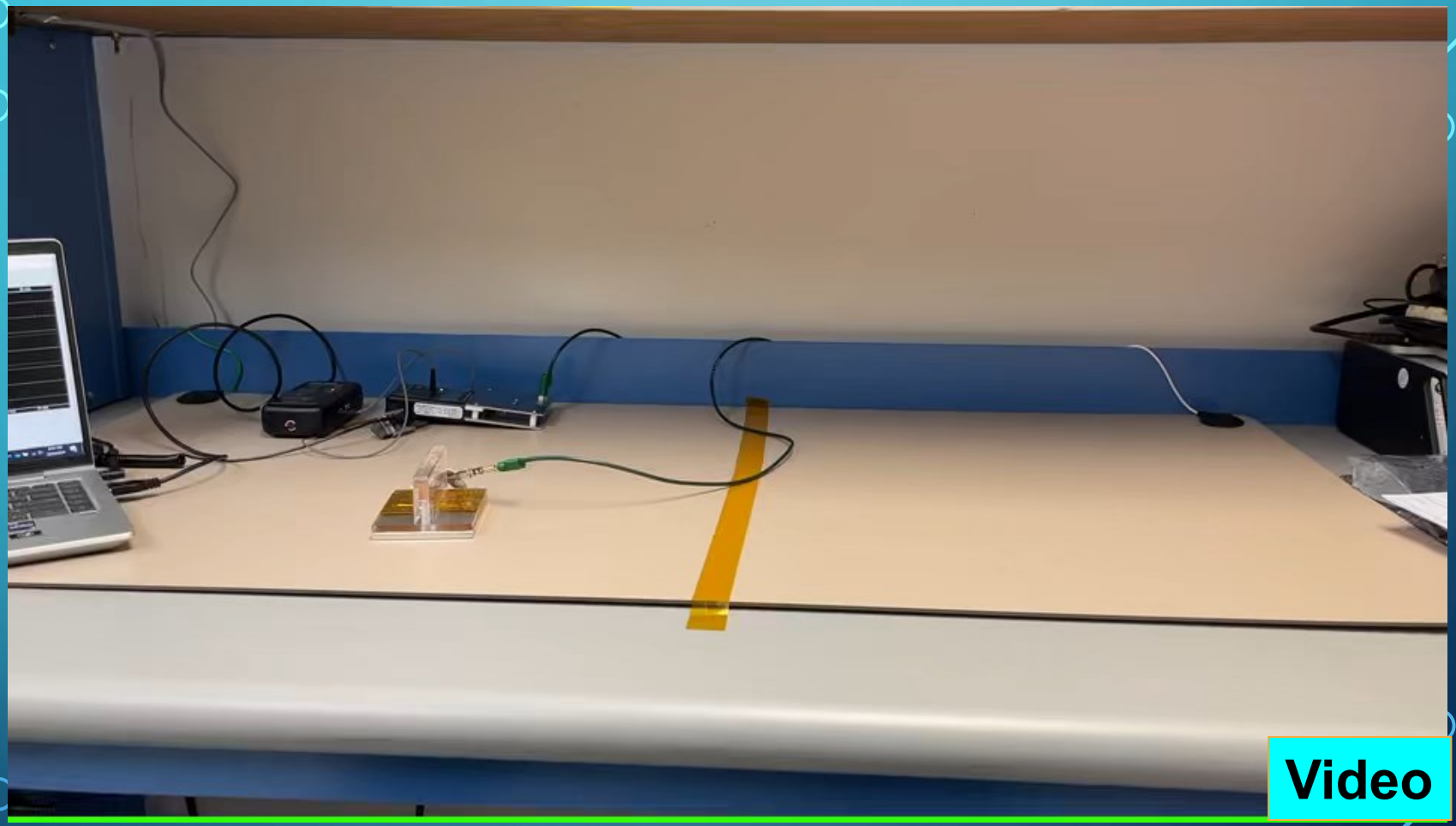


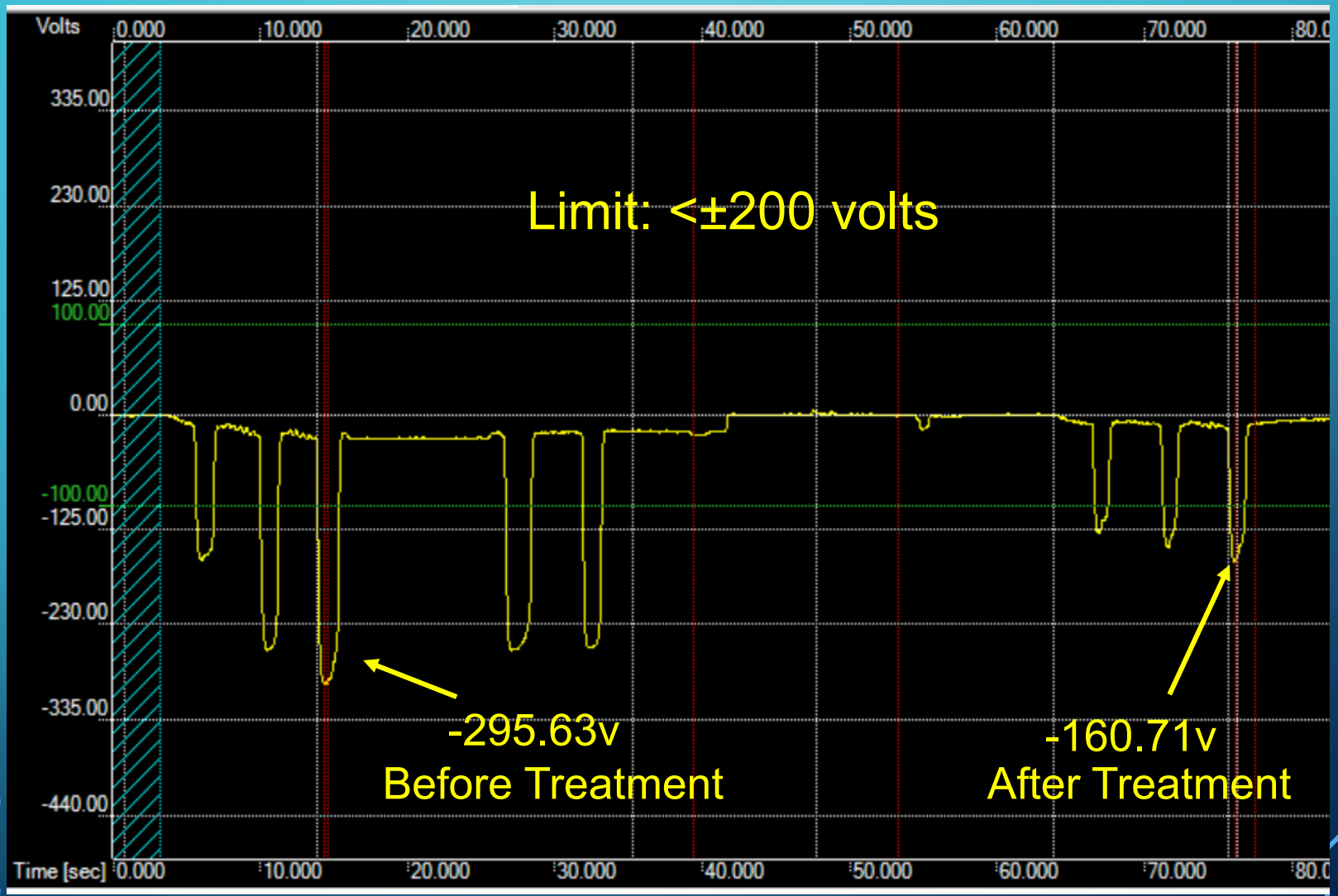
3.25” x 3.25” Charge Plate and Field Meter

METHOD 3



VERMILLION CBE TEST METHOD™

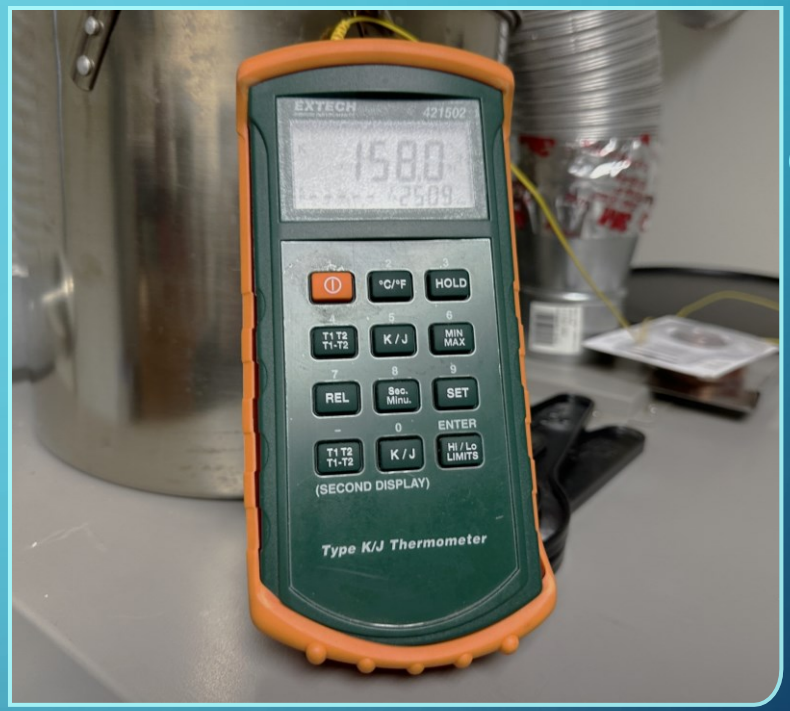




“CBE” CHARGE BOARD EFFECT DUE TO COVID-19 SHUTDOWN

Video

POLYCARBONATE COMPATIBILITY TEST FOR ANTISTAT MIGRATION

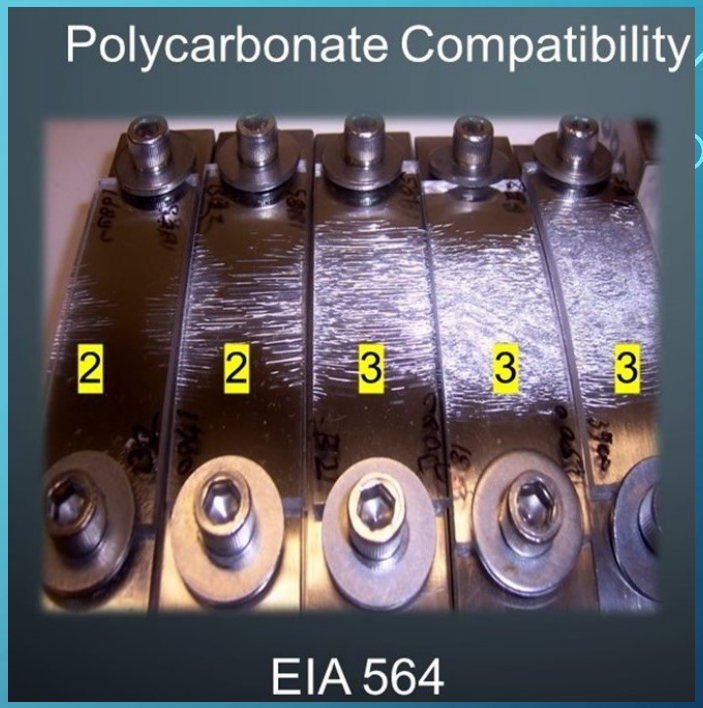


ESD MAT AND RESTORING AGENT, REZTORE®, WERE USED FOR POLYCARBONATE COMPATIBILITY TESTING

EVALUATION OF TEST SPECIMENS

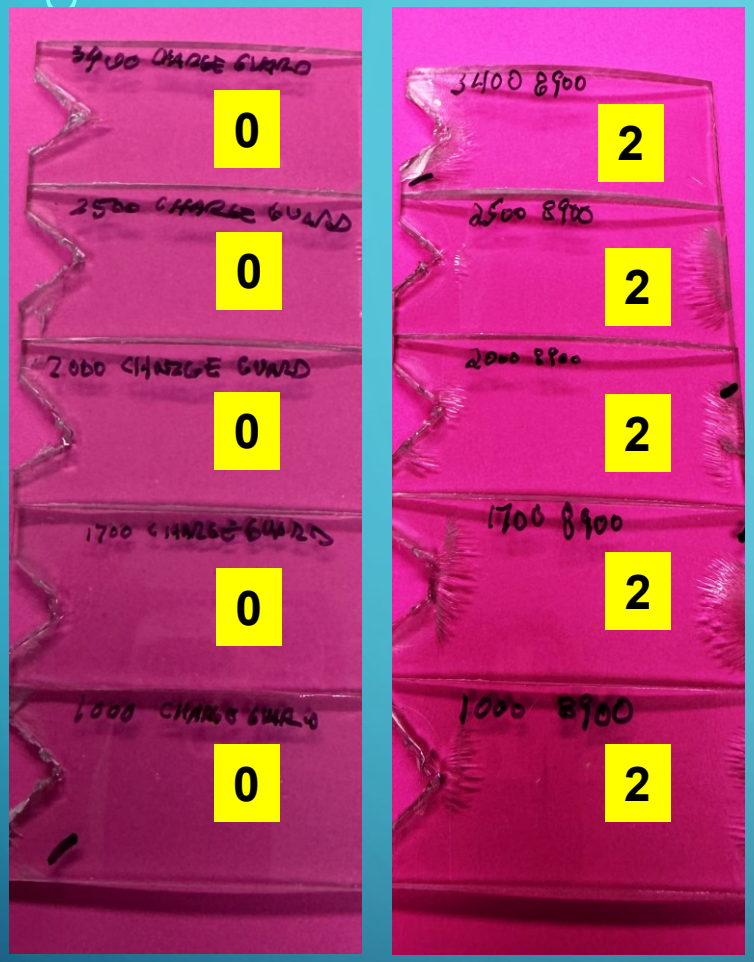
Evaluate each bar according to the following craze rating scheme (see Figure 3 f
pictures of crazes):

RATING	CRAZE DESCRIPTION
0	None - No crazing or cracking.
1	Very Slightly Crazed - Minute edge crazes on surface of ba barely visible.
2	Slightly Crazed - Small crazes visible on both edge and top bar.
3	Crazed - Thin long crazes, very noticeable.
4	Severely Crazed - Thick cracks in bar.
5	Broken - Bar split into more than one piece.



ANTISTATIC BUBBLE POLYCARBONATE COMPATIBILITY TESTING AT 158^{0}F

PASSING = 0 – 2 FAILURE = 3 – 5

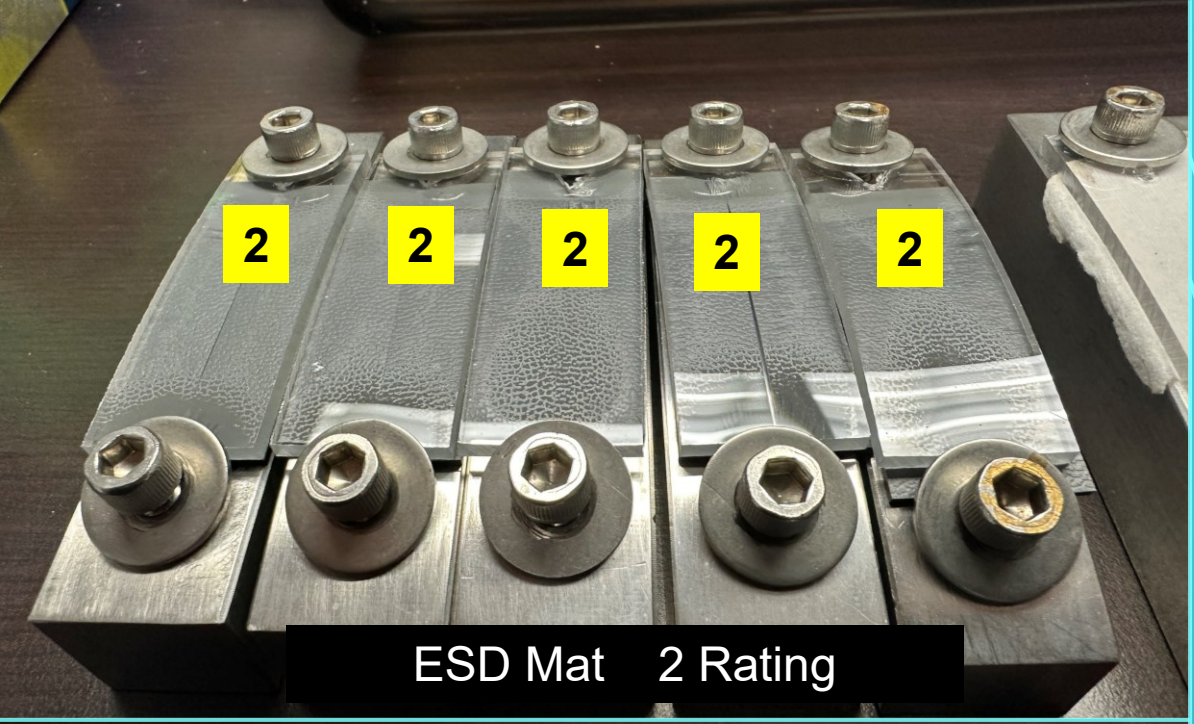


0 Rating
Restoring Agent

2 Rating
ESD Mat

RESULTS AFTER 5 DAYS AT 158^{0}F

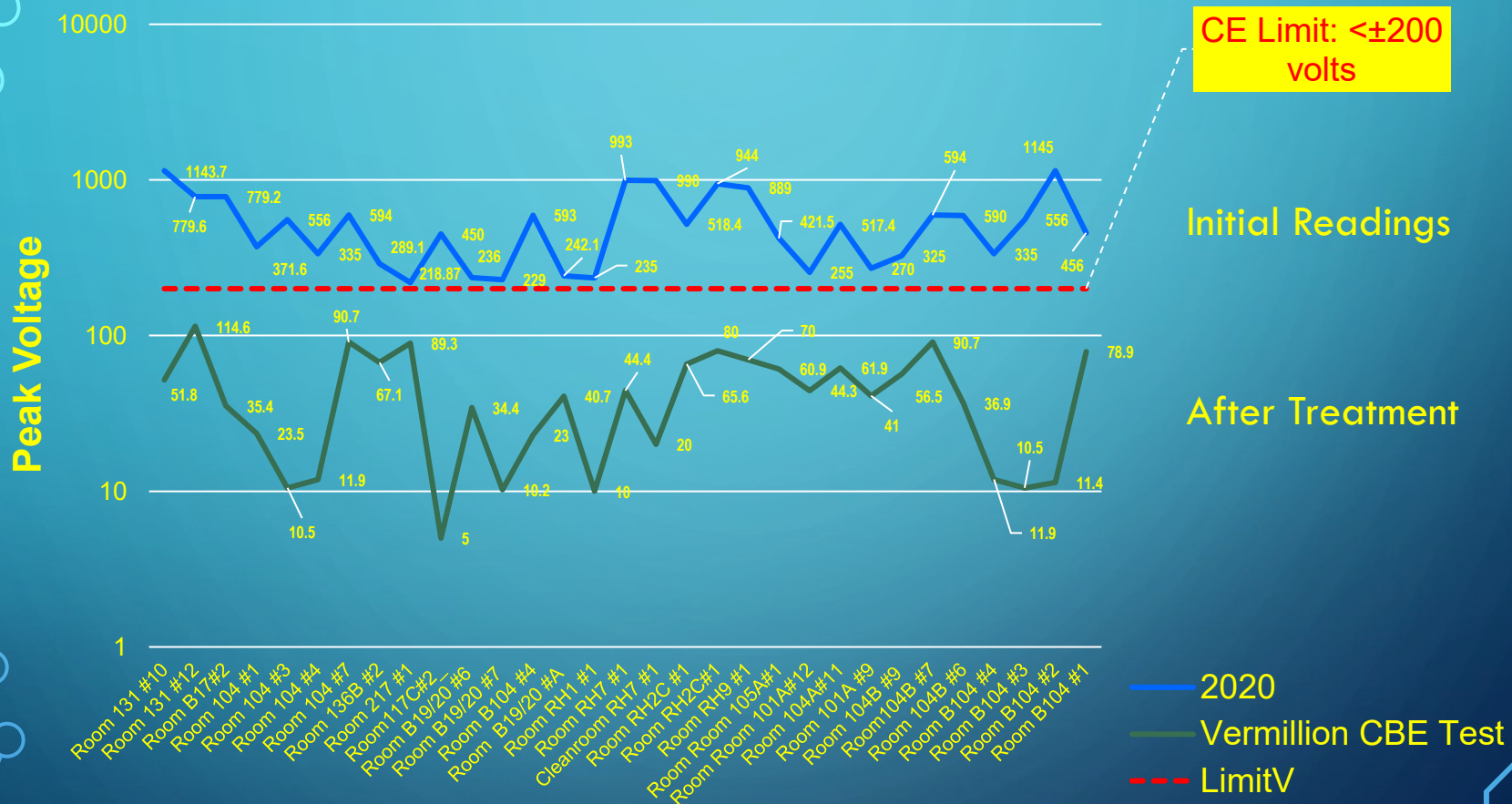
PASSED



RESULTS AFTER 5 DAYS AT 185^{0}F

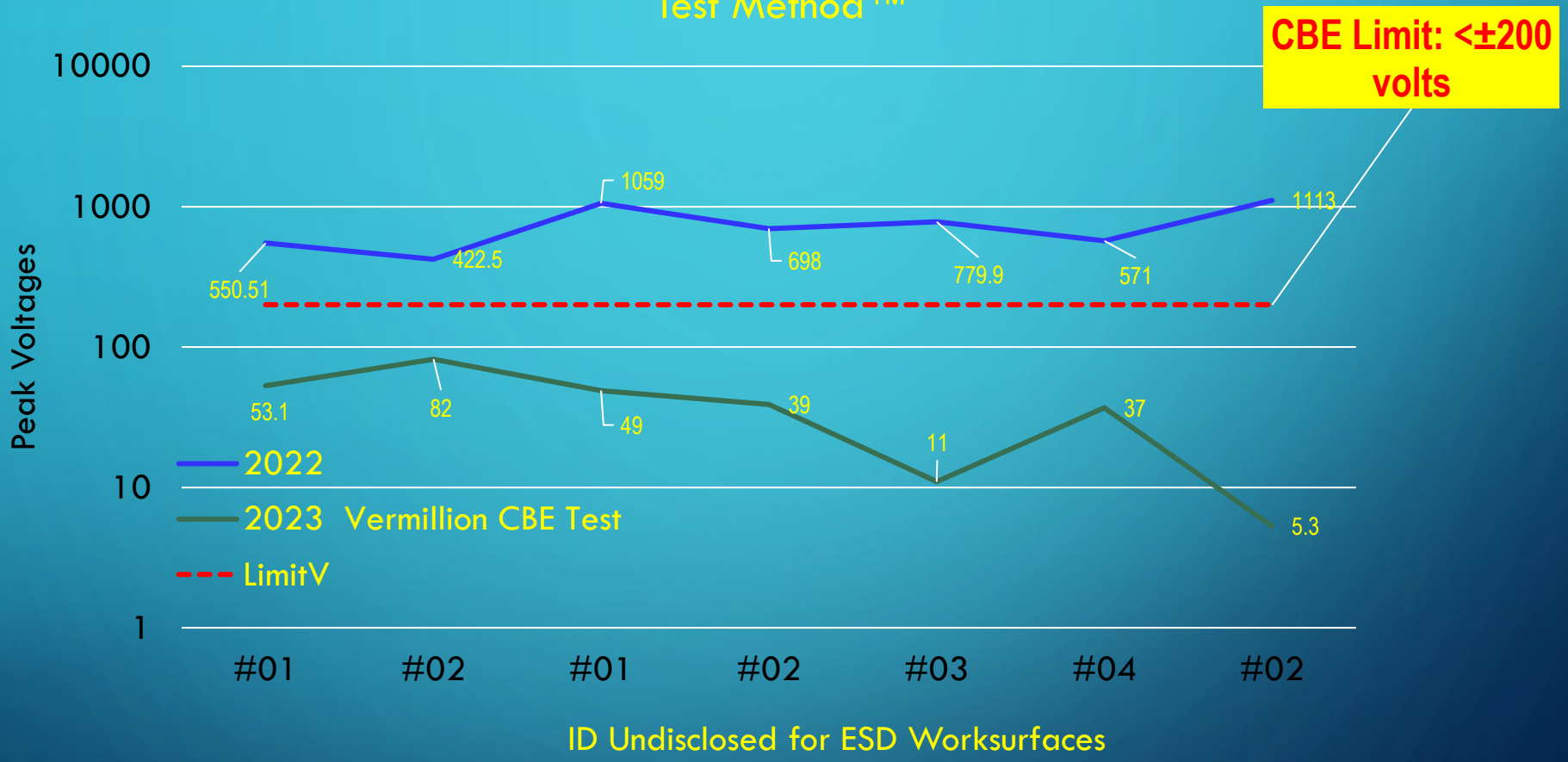
PASSED

Vermillion Charge Board Effect (CBE) with Mitigation in Space EPAs



EPA Areas Affected by Shutdown

Space Contractor's Class 0 EPA Readings after Shutdown and Following Year with the Implementation of Vermillion Charge Board Effect (CBE) Test Method™



Recommended ESD Compliance for ESD Workstation Integrity

1. Retreat ESD Mats with Polycarbonate Compatible Restoring Agent by the operator and/or ESD Program Monitors

2. Maintain a 30%RH to 70%RH controlled EPA controlled environment per NASA-STD-8739.6

3. Qualify Mats for future purchase subjected to ANSI/ESD STM4.1 Qualification Testing

4. Change site ESD Procedures to include antistatic agent restoration treatment with measurement verification

5. Operators undergo 4-hour minimum ESD Training for the 9 step ESD worksurface preparation process by the operators

6. NASA ESD Program Monitors undergo training for the Vermillion Charge Board Effect (CBE) Evaluation and Test Method™

CONCLUSION

- Do Not use IPA to Clean ANSI/ESD STM4.1 Worksurface
- Use Approved ESD Worksurface Restorer
- Position Circuit Card to Prevent Movement
- Ionization performance is line-of-sight that does not minimize charge between the ESD Mat and worksurface.

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