VTOL, LLC
PROTECTIVE LAMINATES

"ASSALT® V1 to V3 IMPROVEMENTS AND FUTURE DEVELOPMENT"

SRE-RAM VII TRAINING SUMMIT
04 NOV 2014

PRESENTER: KEITH COOKE, OWNER AT VTOL LLC

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ASSALT® V1 HISTORY

- In 2004, Army windscreens were being used faster than they could be manufactured due to sand abrasion. Some aircraft flew with unserviceable windows or were grounded until replacements could be sourced.
- There was an aircraft downtime/mission readiness impact due to windscreen issues in both in cost and man-hours.
- To mitigate the high windscreen usage, the Version 1 film was originally developed for the US Army to combat windscreen erosion.

ASSALT® V1 PROBLEMS

- Rapid development of the V1 film addressed the immediate need, saving the Army an estimated 2.8 million dollars in the first year of use. Because of the quick rollout and the nature of a new product, deficiencies began to appear with use.
  - Improper rollout and installation training
  - Resultant failure of the film due to installation errors
  - Hardcoat UV weathering shortcomings
  - Adhesive transfer and clouding
  - Base film deficiencies in weathering causing brittleness
  - Difficulty with use and removal caused decreased confidence and comfort with the product resulting in diminished repeat use despite cost savings

ASSALT® V1 PROBLEMS

- Installation error – trapped particulate matter:

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ASSALT® V1 PROBLEMS

- Hardcoat damage/failure:

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ASSALT® V1 PROBLEMS

- Hardcoat damage/failure:

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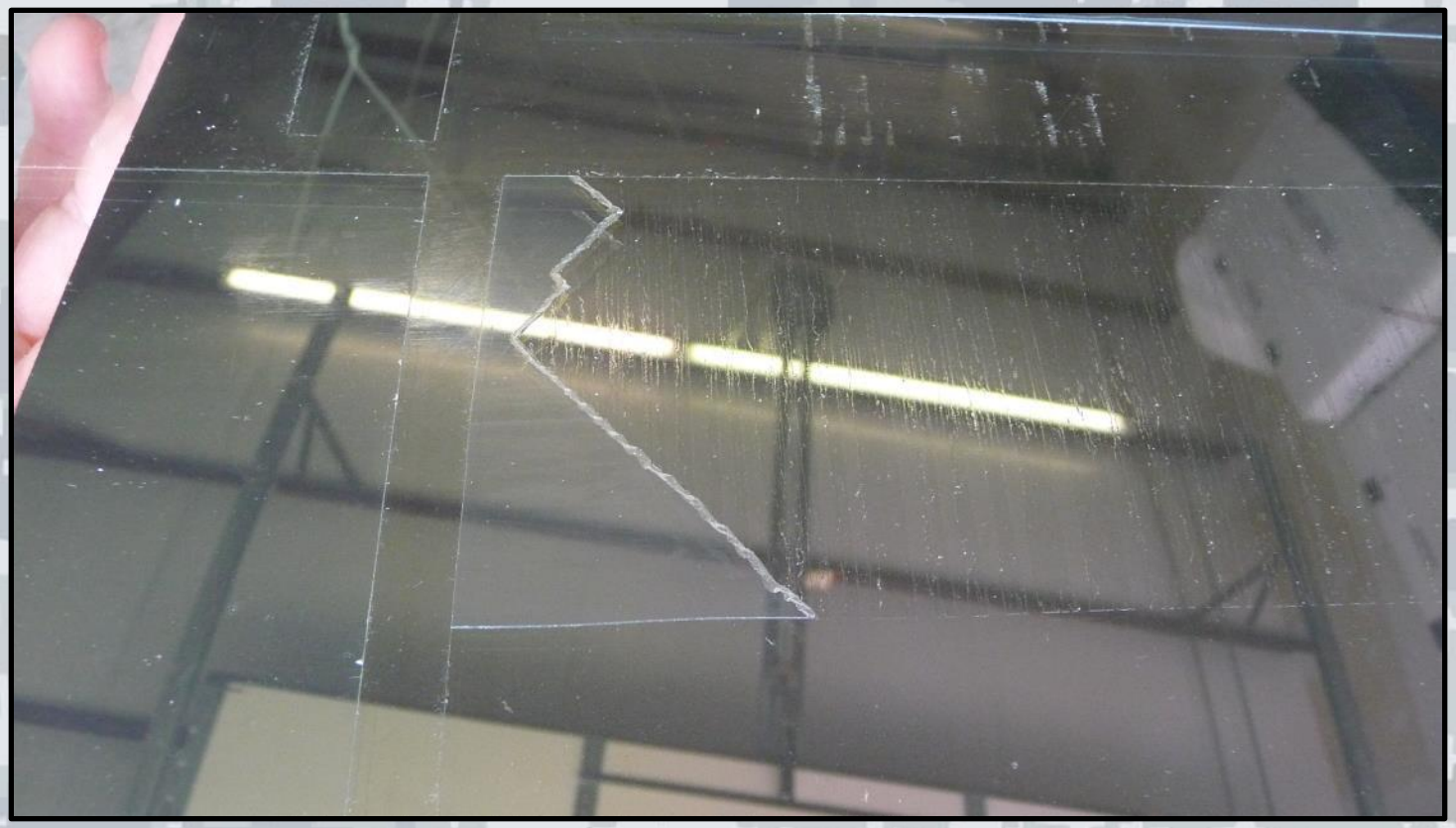
ASSALT® V1 PROBLEMS

- Adhesive transfer/failure:



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ASSALT® V1 PROBLEMS

- V1 to V3 weathering comparison video:

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ASSALT® V2 HISTORY

- In 2007, an attempt to extend the life of the single layer film was made by creating a multilayer film. The product, referred to as V2, consisted of mating the base V1 film with two removable outer layers of 4 mil film resulting in a 3-layer structure.
- The product failed because it utilized the same technologies incorporated into the V1 product. No attempt was made to improve the hardcoat, adhesive, or base film components. The only change was the multilayer structure.
- The adhesive and hardcoat failures of the V1 and V2 product did long term damage to the reputation of protective films with US Army personnel.

ASSALT® V3 DEVELOPMENT

- In 2009, the US Navy inquired about an improved single and multilayer version of the V1 film that would be suitable for use in a marine environment as well as a desert environment.
- In 2010 VTOL, LLC was created as a new and separate company with a mission to conduct work specifically on protective laminate film products for the aviation industry.
- VTOL acquired all of the technology and intellectual property associated with protective windscreen films for aviation use and began work on improvements to the laminate products.
- VTOL personnel worked closely with US Navy engineers and personnel to establish a demanding test matrix that addressed every deficiency of the original US Army V1 product.

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ASSALT® V3 IMPROVEMENTS

- In 2012, VTOL personnel completed work on the V3 product. The V3 product addressed all deficiencies in the original Army V1 and V2 products while also adding new capabilities. The following improvements were made:
  - New UV resistant hardcoat formulation
    - V1 lasted 200 hours in QUV
    - V3 lasts over 3000 hours* in both QUV and Xenon Arc testing without yellowing or degradation
  - New adhesive formulation eliminates clouding and transfer
    - After 3000 hour weathering exposure, adhesive component performs as designed without issue

* sample removed at 3000 hours while performing as desired

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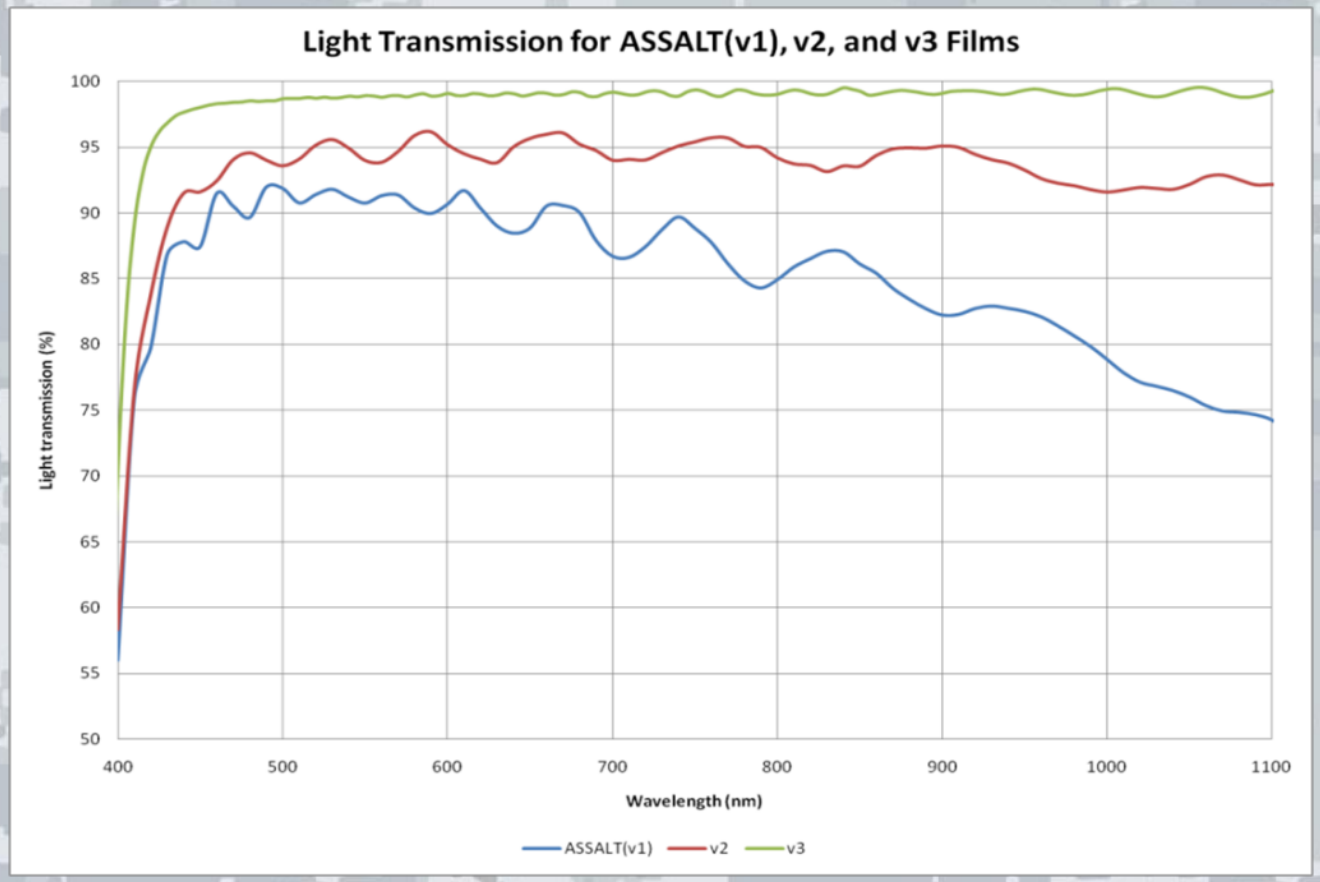
ASSALT® V3 IMPROVEMENTS

- Total light transmission was improved in the Visible and Near IR spectrums up an average of ~16%



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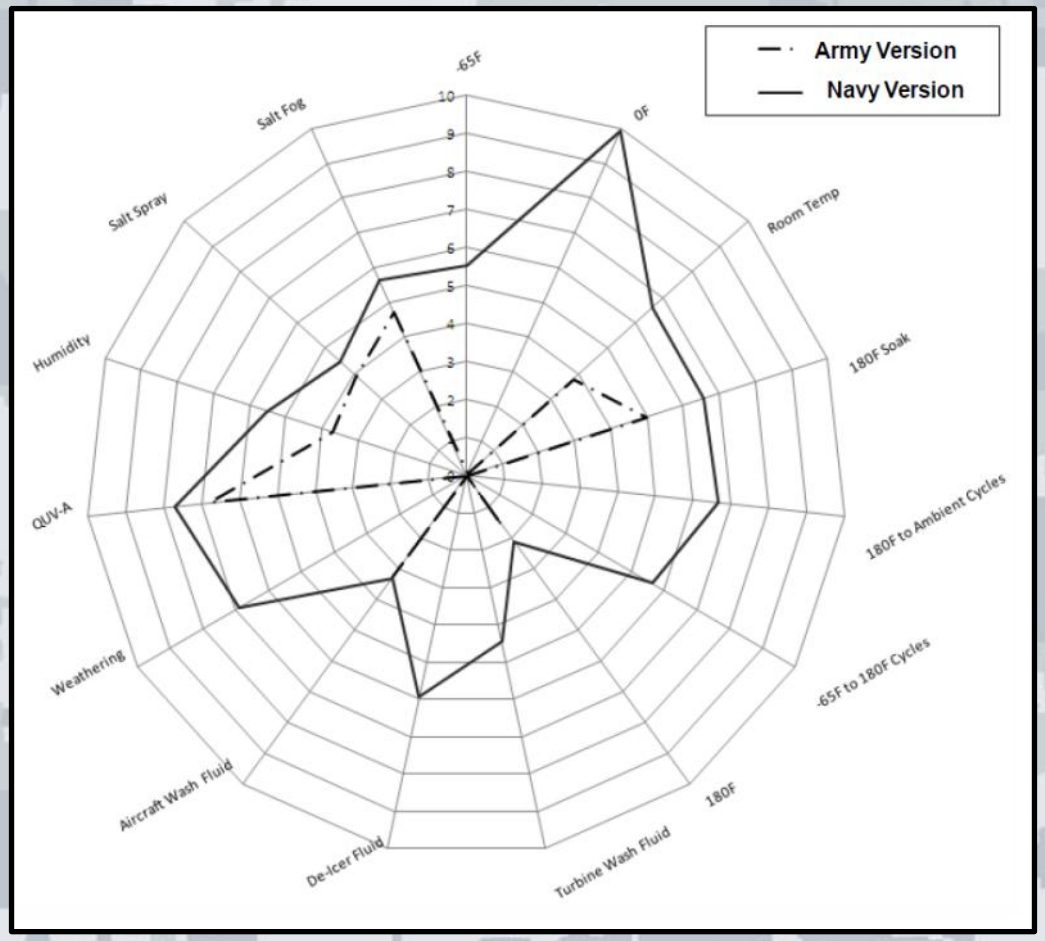
ASSALT® V3 IMPROVEMENTS

- Adhesive bond strength is improved in all conditions and exposures.



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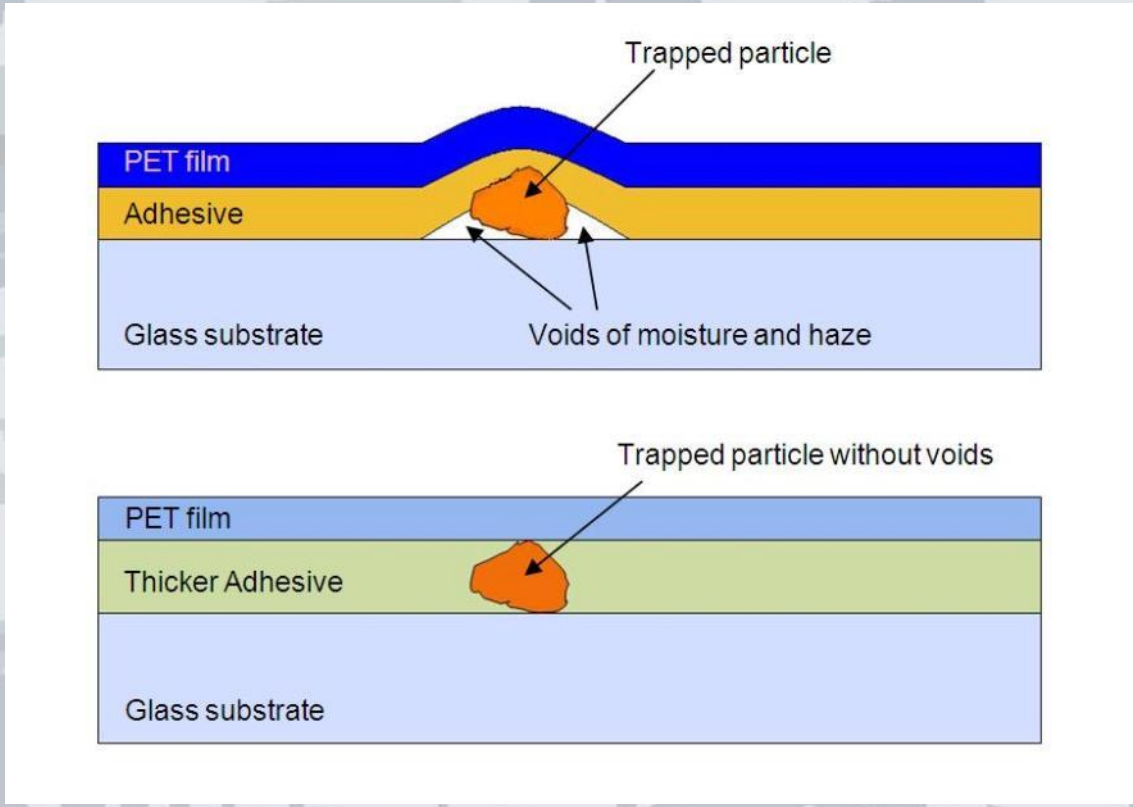
ASSALT® V3 IMPROVEMENTS

- A revised installation method coupled with a thicker reformulated adhesive reduces installation defects and cuts aircraft downtime to 12 hours after installation is completed.



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ASSALT® V3 IMPROVEMENTS

- The base film is improved and resists UV weathering in the absence of a UV weatherable hardcoat.
- The V3 film maintains continued compatibility with all aircraft systems including: windshield wipers, windscreen heat and deice, avionics, and Night Vision Devices including all ANVIS variants and the Thales “Top-Owl” system.
- The V3 film offers increased resistance to solvent and chemical exposure.
- The V3 film offers improved performance in humidity, salt-spray, and salt-fog exposures.

VTOL AND ASSALT® V3 SUCCESSES

- VTOL ASSALT® V3 films are installed on US Navy H-1 and H-60 aircraft.
- VTOL ASSALT® V3 films deployed on US Navy HSC-84 “Red Wolves” aircraft to demanding areas of operation including Afghanistan and Southwest Asia. HSC-84 is one of two US Navy units dedicated to supporting Navy Seal and Special Warfare Combatant-Craft Crewmen (SWCC) Teams as well as Combat Search and Rescue.
- VTOL successfully completed Age Exploration Bulletin (AEB) – 22 with the US Navy in which windscreen usage was cut by 45%, a decrease in associated man-hours was realized, and aircraft availability was increased.

VTOL AND ASSALT® V3 SUCCESSES

- VTOL is a "Quality Approved Supplier" to Airbus Helicopters (formerly Eurocopter).
- VTOL supplies film to other OEMs including Australian Aerospace, Agusta-Westland, Bell Helicopters, and TAI.
- VTOL currently has an active project with the FAA for the purpose of obtaining certification for the ASSALT® V3 films in the civil market. Certification will be in the form of an "Approved Models List (AML) Supplemental Type Certification(STC)."
- VTOL currently supplies protective laminates for the Air Warrior Electronic Data Manager.

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ASSALT® FILM - FUTURE DEVELOPMENTS

- VTOL is currently in the process of flight testing a multilayer version of the V3 film with the US Navy as NAS Patuxent River and MCAS Cherry Point. The multilayer film meets or exceeds all standards and performance required of the single layer and is comprised of 3, 7-mil thick layers. Testing is expected to continue through 3Q, FY15.
- VTOL is currently conducting long term testing on a weatherable and static dissipative hardcoat system combined with the current V3 base film and adhesive. Long term testing is expected to be completed in 2Q, FY15.
- VTOL is currently pursuing additional OEMs and platform managers to expand the usage of VTOL protective laminate products.

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VTOL, LLC CONTACT INFORMATION

VTOL, LLC Business Contact

Andrew Hough-Owner
eahough@vtolfilms.com
980-233-1000

VTOL, LLC Technical Contact

Keith Cooke-Owner
kcooke@vtolfilms.com
980-233-1015

VTOL, LLC Operations Contact

Reggie Drake-Owner
rdrake@vtolfilms.com
704-576-6778

VTOL, LLC
170 Browns Hill Road
Locust, NC 28097

704-781-5006
www.vtolfilms.com

CAGE CODE: 6ENX0

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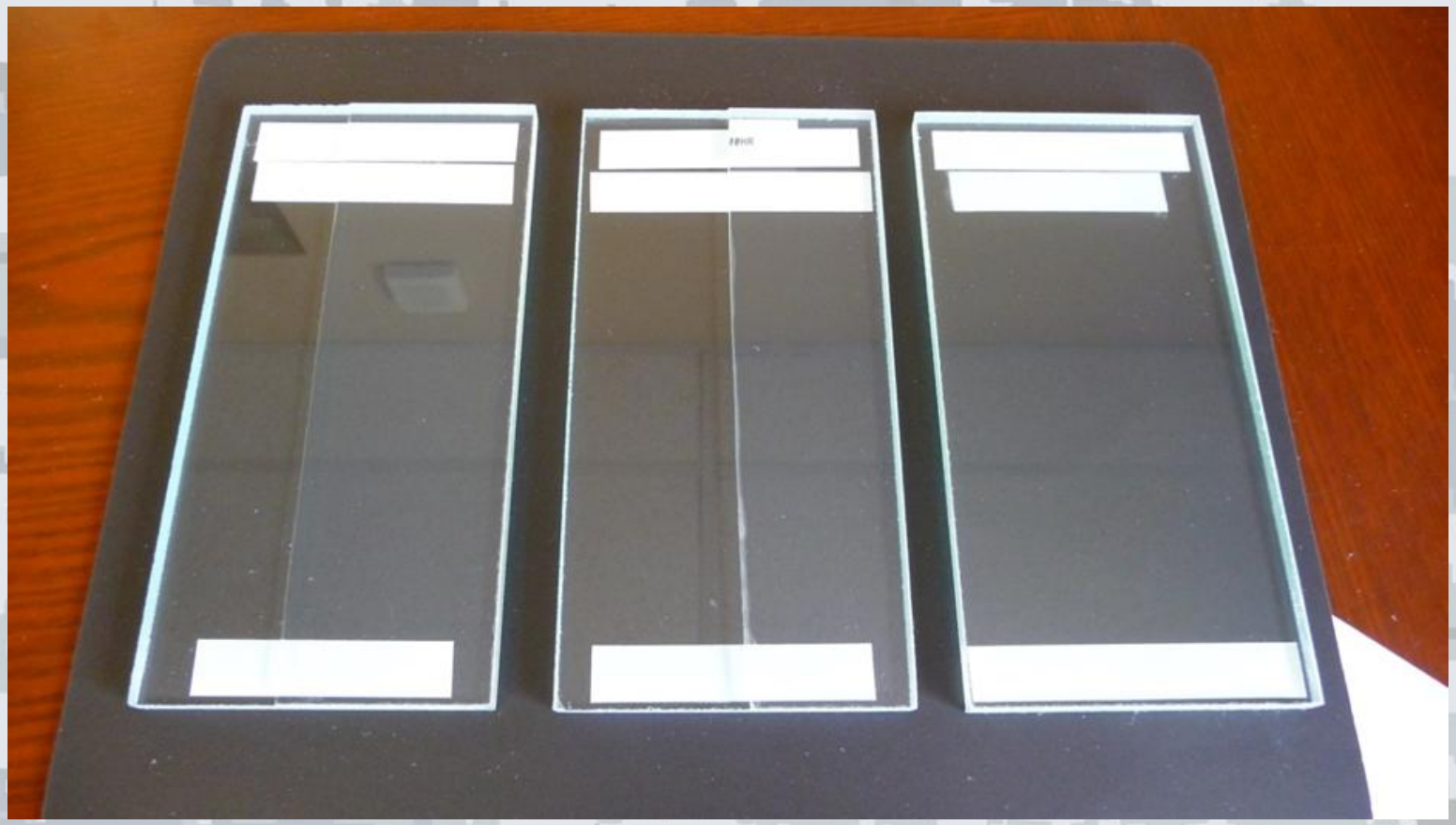
ADDITIONAL SLIDES

From left to right: 1000hr QUV, 2000hr QUV, 2000hr Xenon Arc



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