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Produced by the NASA Center for Aerospace Information (CASI)
NASA TEERM
Project
Corn Based Alternative to Plastic Media Blasting for Aerospace Applications (formerly Corn Based Blasting Media)

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Brian Greene        ITB Inc.    NASA TEERM Office Manager
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Wade Olsen          ITB Inc.    NASA TEERM Sr. Engineer/Assistant Project Manager

www.nasa.gov
What is NASA TEERM?

- The Technology Evaluation for Environmental Risk Mitigation Principal Center (TEERM) – *(formerly AP2)*
- Identifies and validates sustainable pollution prevention technologies through joint activities
- Reduces risk while minimizing duplication and associated costs.
- Commonly involves two or more NASA stakeholders and contractors
- Collaborative approach benefits project members in multiple ways:
  - Resources are shared
  - Increases technical confidence
  - Improves the overall technical quality
  - Accelerates implementation
TEERM Partners

NASA:

• Shuttle Program
• Constellation Program
• KSC Corrosion Laboratory
• Regulatory Risk Analysis and Communication (RRAC) Principal Center
• Recycling and Affirmative Procurement (RAP) Principal Center

DoD:

• Joint Group on Pollution Prevention (JG-PP)
• Air Force Space Command (AFSC)

International:

• Centro Para Prevenção da Poluição (Portuguese Center for Pollution Prevention) (C3P)
• European Space Agency (ESA)
Solid Rocket Boosters

- Commonly called "The SRBs", are retrieved in the Atlantic, refurbished at KSC in Florida and at ATK in Utah

- Space Shuttle SRBs
  - Located on either side of the orange external propellant tank. The pair of large solid rockets used during the first two minutes of powered flight.

- The Ares I
  - First stage is a single, five-segment reusable SRB

- Ares V
  - First stage includes two SRB-derived rockets, which will have five and a half segments instead of the four currently used on the Space Shuttle.
Solid Rocket Booster refurbishment

- SRBs (with aft skirts attached), frustums, and parachutes are recovered by the *Liberty Star & Freedom Star* (NASA Facts On Line (2))

After arriving at the Hanger AF wharf the refurbishment process begins.
KSC CCF and the ARF

The frustum, aft skirt, forward skirt, and the ETA ring are stripped to bare metal at the KSC Corrosion Control Facility (KSC CCF). An SRB Aft Skirt (at right) after plastic media blasting at the Corrosion Control Facility.

At the Assembly and Refurbishment Facility (ARF), SRB components including aft and forward skirts, frustums, nose caps, recovery systems, electronics and instrumentation as well as elements of the thrust vector control system, are refurbished, assembled and tested here (NASA Facts (3)).
ATK Launch Systems, Clearfield Refurbishment Center

A solid rocket segment is loaded onto a railcar at its processing facility in Utah for NASA’s Ares I crew launch vehicle. The hardware will undergo final processing and preparations before being stacked with the other portions of the Ares I-X test rocket.

In Hangar AF workers prepare the separated segments of one of the retrieved SRBs for their transport to the NASA railway. The segments will be sent to ATK in Utah for refurbishment and processing and returned to KSC.
SRB Refurbishment Methods, the Evolution

- Pneumatic (hand sanding): Uses abrasive substrates to scratch coatings off
  - Time consuming (767 rudder = 81 hour strip sanding job)
  - Damaging to delicate substrates (rounds off rivets, screws, leading edges, etc)
  - Dangerous (Dust hazards, flammability, etc)
  - Injurious to workers (Work-related musculoskeletal disorders (WMSDs), HAVS, etc)

- Chemical Stripping: Sprayed or wiped onto coatings, coatings are liquefied
  - Time consuming
  - Dangerous, may release Volatile Organic Chemicals (VOC) or Hazardous Air Pollutants (HAP)
  - "Safer" chemicals don't work very well
  - Contributes to waste stream
Current SRB Refurbishment Method

- Plastic Media Blasting (PMB): used to perform coatings removal as part of maintenance, repair, and overhaul activities. PMB is used on various SRB sensitive components (alloys, composites, etc).
  - Historically inexpensive media (*tied to petroleum prices*)
  - Fast stripping rate
  - Dry process, eliminates wastewater
  - Reusable, (6 – 8 times depending on the job),
  - 100% recyclable –
    - *(if spent media contains haz waste/toxics)* – sent to TSDF, grinded up and added to construction material
  - When properly used, PMB is relatively safe on delicate/sensitive substrates
  - If no post-blast chemical wipe-down is performed, PMB generates no Volatile Organic Chemicals (VOC) or Hazardous Air Pollutants (HAP)
Plastic Media Blasting (PMB)

- Risks:
  - End product liability
  - Derived from virgin, non renewable resources (*no recycled content*)
  - Petroleum based is tied to the price of oil
  - Petroleum based

**SECTION IV – FIRE AND EXPLOSION HAZARD DATA**

<table>
<thead>
<tr>
<th>FLASH POINT</th>
<th>°F</th>
<th>°C</th>
<th>N.A.</th>
<th>FLAMMABLE: N.A.</th>
<th>LEL: N.A.</th>
<th>UEL: N.A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXTINGUISHING MEDIA:</td>
<td></td>
<td></td>
<td></td>
<td>Carbon dioxide, dry chemicals or water fog.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPECIAL FIRE FIGHTING PROCEDURES:</td>
<td></td>
<td></td>
<td></td>
<td>Wear respirator (MSHA/NIOSH approved) and full protective gear. Do not use high-pressure water stream. Fog nozzles are preferable.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNUSUAL FIRE AND EXPLOSION HAZARDS:</td>
<td></td>
<td></td>
<td></td>
<td>Product is a combustible thermoplastic resin. Burns vigorously with heat. High dust concentration could form explosive mixture with air.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SECTION VI – REACTIVITY DATA**

<table>
<thead>
<tr>
<th>STABILITY:</th>
<th>☑ STABLE</th>
<th>☐ UNSTABLE</th>
<th>CONDITIONS TO AVOID:</th>
</tr>
</thead>
<tbody>
<tr>
<td>INCOMPATIBILITY (Materials to avoid):</td>
<td></td>
<td></td>
<td>No specific incompatibility</td>
</tr>
<tr>
<td>HAZARDOUS DECOMPOSITION or BYPRODUCTS:</td>
<td></td>
<td></td>
<td>Smoke, carbon dioxide, carbon monoxide, formaldehyde, hydrogen cyanide at +500°F.</td>
</tr>
<tr>
<td>HAZARDOUS POLYMERIZATION:</td>
<td></td>
<td></td>
<td>☑ MAY NOT OCCUR</td>
</tr>
<tr>
<td>CONDITIONS TO AVOID:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Plastic Media Blasting (PMB)

- Risks:
  - Unnecessary post blast procedures (leaves behind acrylic residue)
  - Petroleum based media increases risk to visual (NDE) inspection
  - Risk of damage to substrate (hardness, fracturability, material deflection)
    - Type II PMB (Urea/Formaldehyde based) = 3.5 Mohs
    - Type V PMB (petroleum based) = 3.5 Mohs
    - Type III PMB (Melamine/Formaldehyde based) = 4.0 Mohs
  - Quality risk
  - USDA BioPreferred Program
ATK, Clearfield Refurbishment Center

The nozzles and spent case segments are transported to ATK Launch Systems at Clearfield for refurbishment. (NASA Facts (3))

- Currently:
  - Use varying amounts of Type III PMB for certain SRB refurbishment processes.
  - Used only once
  - Disposed of in landfill or open pit burning with mixed spent media and coatings debris.

- Concerns:
  - Use of a product containing formaldehyde and melamine
  - Recent EPA ruling puts pressure on ATK to reduce the amount of airborne particulates emitted during open burning of hazardous wastes. (Air Quality Standard Designation Promontory Operations Implications (6)).
  - Future requirements under BioPreferred Program may require ATK to give preference to CHP over PMB
ISC operations at KSC Corrosion Control Facility

Refurbishment of SRB frustum, aft skirt, forward skirt, and ETA ring are performed by ISC at the Corrosion Control Facility at KSC.

- Currently:
  - Use varying amounts of Type II PMB for certain SRB refurbishment processes
  - The media is typically used 6-10 times depending on the process
  - Spent media is recycled off-site and remanufactured into SEALTECH™ Block

- Concerns:
  - Use of the recycled end product below grade
  - Formaldehyde is a toxic substance
  - Potential changes in procurement requirements under BioPreferred Program may require preference to CHP over PMB
USA refurbishment operations at KSC

Refurbishment of SRB components are performed by USA at Hanger AF, and Hanger N, located on the Cape Canaveral Air Force Station.

- Currently assumed:
  - USA uses varying amounts of Type ? PMB
  - 100% is recycled, spent media is reconstituted into SEALTECH™ Block

- Concerns:
  - Unknown amounts, users, etc.
  - Potential procurement requirements under federal BioPreferred Program may require USA to give preference to bio-based media over petroleum based media
Proposed Alternative Blast Media

- Corn Hybrid Polymer blast media (CHP): “Starch Abrasive”, which is a 100% renewable, organic, “engineered bio-based plastic” abrasive made from crystallized corn starch grown and manufactured in the U.S.
- Approved and implemented across commercial, military and aerospace. Meets MILSPEC 85891
- More stable pricing
- Compatible with existing equipment
- Reduces our reliance on fossil fuels and toxic chemicals
- Reusable, (10 - 12 times depending on the job)
- BioPreferred Program approved product (source: R.Buckhalt, USDA)
- 100% recyclable
  - *(if it contains haz waste/toxics)* – remanufactured into toxic waste absorbent, incinerated, and ash is added as an ingredient to cement.
- Less risk of damage to certain delicate/sensitive substrates than current methods (2.0 Mohs)
- CHP generates no Volatile Organic Chemicals (VOC) or Hazardous Air Pollutants (HAP), post blast wipe-down can be performed with water.
Media Blasting Comparison
Origins

CHP
- 100% renewable, organic
- American farm made, biobased product
- Reduces reliance on petroleum.
- BioPreferred approved product
- Product is 100% biodegradable
- Ingredient: Corn

PMB
- Non-renewable, virgin petroleum/chemicals
- Safety concerns
- Oil based furthers our reliance on petroleum.
- Not USDA BioPreferred Program approved
- Not biodegradable
- Ingredients: Acrylate Polymer, Methyl Methacrylate, Anti-Static Agent, Formaldehyde, Melamine, additives, ...
Media Blasting Comparison

Safety

<table>
<thead>
<tr>
<th>CHP</th>
<th>PMB</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Product is non hazardous (source: Envirostrip XL MSDS)</td>
<td>• Type V: combustible thermoplastic resin which burns vigorously with heat (source: Poly V MSDS).</td>
</tr>
<tr>
<td>• Leaves no residue, requires no post blast chemical wipe down</td>
<td>• Type II contains formaldehyde (REACH SIN)</td>
</tr>
<tr>
<td>• Detectable under UV light aids in visual inspection</td>
<td>• Type III contains melamine (REACH SIN)</td>
</tr>
<tr>
<td>• Recycling: “spent” media is remanufactured into a toxic waste absorbent which is subsequently high temp incinerated, ash is added to cement clinker.</td>
<td>• Acrylic residue requires post-blast removal by additional chemical wipe-down or other methods</td>
</tr>
<tr>
<td>• No restrictions on end product use</td>
<td>• PMB has propensity to liquify and fill small cracks – concern for NDE inspection</td>
</tr>
<tr>
<td></td>
<td>• Recycling: “spent” media is ground up and added to construction materials. Above grade use only</td>
</tr>
</tbody>
</table>
## Media Blasting Comparison Performance

<table>
<thead>
<tr>
<th>CHP</th>
<th>PMB</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Designed to meet MIL-P-85891(A)</td>
<td>• Designed to meet MIL-P-85891(A)</td>
</tr>
<tr>
<td>• Uses same equipment and same basic techniques as PMB</td>
<td>• Product &quot;rounds&quot; the more it's used, leading operator to have to either increase pressure or proximity to the substrate to maintain consistent removal rates.</td>
</tr>
<tr>
<td>• As Starch media breaks down it fractures along its crystalline structure creating new cutting edges. The more it is cycled the more aggressive this material becomes.</td>
<td>• Plastic is an &quot;impact&quot; media that fractures coatings through repeated &quot;high energy&quot; impacts. (Hardness 3.5 – 4 Mohs) This process may cause heat, and the potential for substrate deflection and damage.</td>
</tr>
<tr>
<td>• Starch is an extremely sharp material that cuts coatings very effectively, yet is as soft as your fingernail. (Hardness 2.0Mohs)</td>
<td>• Plastic media leaves behind an oily residue which must be removed before subsequent work can continue.</td>
</tr>
<tr>
<td>• Unlike prior bio-based blast media CHP has no moisture concerns and upon drying will return to it's granular state</td>
<td></td>
</tr>
</tbody>
</table>
## Media Blasting Comparison Costs

<table>
<thead>
<tr>
<th>CHP</th>
<th>PMB</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Longer life cycle reduces consumption (10 - 12 times)</td>
<td>• Typically reused (8 -10 times)</td>
</tr>
<tr>
<td>• Less frequent blast booth filter replacements</td>
<td>• Non-renewable resource tied to the price of petroleum</td>
</tr>
<tr>
<td>• Renewable resource, the more we need, the more they grow</td>
<td>• Everywhere CHP has been approved is moving to replace PMB, less demand = less supply = risk of higher prices and less availability</td>
</tr>
<tr>
<td>• Requires no post blast wipe-down, potential for process elimination</td>
<td>• Higher risk of substrate damage leads to more expensive repairs or replacements.</td>
</tr>
</tbody>
</table>
Corn Based Blast Media Usage

- Boeing
- Ft. Wainright
- March AFB
- Lockheed Martin
- Fallbrook Naval Weapons Station
- NADEP North Island
- Hill AFB
- Naval Submarine Base Kings Bay
- Warner Robins AFB
- Tinker AFB
- Randolf AFB
- Corpus Christi Army Depot
- Columbus AFB
- NADEP
- Eglin AFB
- Yorktown Naval Weapons Station
- US Coast Guard Aviation Depot
A Need within NASA

• To simultaneously be on the forefront of new, and novel technologies, while making sure these technologies meet NASA's exacting requirements.

• To use environmentally preferred, best-management practices where possible which help generators meet regulatory requirements such the USDA BioPreferred Program's procurement process for federal agencies and their contractors.

• For a potential process improvement in visual inspection and elimination of costly, time consuming, dangerous procedures.

• To implement processes which last longer, work better, and don't require extensive new training or equipment changes thereby saving money.
Project Justification

- Potentially reduces risks associated with environmental, safety, and health concerns

- Potentially reduces overall operating costs

- Potentially provides more stable pricing forecasts

- Potentially reduces risk of technology obsolescence

- Project is a continuation of previous successful DoD studies conducted by NASA TEERM and JG-PP thus reducing duplication of effort and costs.
Project Goals

- Evaluate corn-based blasting media for removing coatings from delicate substrates
- Evaluate overall coatings removal efficacy and cost feasibility
- Determine if the process meets stakeholder requirements
- Identify approval authorities and implementation paths for corn-based blasting media at NASA facilities
- Determine feasibility and help facilitate implementation
Description

- **Stakeholders:**
  - NASA (Kennedy Space Center, Marshall Space Flight Center), Portuguese Center for Pollution Prevention (C3P), United Space Alliance (USA), ATK Thiokol (ATK), Archer Daniel Midland (ADM), Midvale Technologies, Institutional Service Contract (URS, Yang, EG&G, Dynamac, etc.)

- **Project Set-up (example):**
  - Field Testing
    - Coatings removal at existing facilities
    - Timed strip-rate trials
    - Testing against current specifications
    - Laboratory testing if required.
Special thanks to:
Questions?

Thank you!

NASA
References

7. U.S. Technology Corp. Poly V Material Safety Data Sheet
8. Archer Daniels Midland Company Environstrip XL Material Safety Data Sheet
Supporting Documents

4340 steel, cadmium plated, blasted for 5 seconds

Left side blasted with XL—cadmium remains intact.

Right side blasted with plastic media—cadmium removed.
Supporting Documents

Corn Hybrid Polymer (CHP) Media (eStripTMGPX)
- Polycrystalline cornstarch material
- 100% organic, non-toxic, and biodegradable
- Operating pressures range from 20-35psi
- Used in standard light abrasive blast equipment
- Considered a "drop-in" replacement for many plastic media blasting (PMB) systems
- Meets MIL-P-85891
- Generates minimal waste
- Low dust, non-hazardous
- Manufactured by Archer Daniels Midland (ADM)
- Sole Government distributor is Midvale Environmental Technologies
Supporting Documents

SECTION I

PRODUCT NAME OR NUMBER (as it appears on label)
Polyplus® Plastic Blast Abrasive (Type Two)

MANUFACTURER'S NAME
U.S. Technology Corporation

ADDRESS (Number, Street, City and Zip Code)
1446 W. Tuscarawas St., Canton OH 44702

MATERIAL DESCRIPTION, PROPER SHIPPING NAME
Plastic Abrasive, Polyplus

HAZARD CLASSES (as applicable): N.A.

CHEMICAL FAMILY: Amino Thermoset Plastic

FORMULA: N.A.

SECTION II - INGREDIENTS
(list all ingredients)

<table>
<thead>
<tr>
<th>CAS REGISTRY NO.</th>
<th>Approx. %W</th>
<th>Chemical Name(s)</th>
<th>OSHA PEL</th>
<th>ACGIH TLV</th>
<th>Other Limits Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>9004-34-6</td>
<td>&gt;1%</td>
<td>Polymerized Urea Formaldehyde</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9011-05-6</td>
<td>&lt;1%</td>
<td>Compound w/ Alpha Cellulose Filler</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2764-13-8</td>
<td>&lt;1%</td>
<td>Anti-Static Agent – Cal Stat 600</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5280-80-8</td>
<td>&lt;1%</td>
<td>Pigments and Additives</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SECTION III - PHYSICAL DATA

BOILING POINT ___°F ___ °C | SPECIFIC GRAVITY (H₂O=1): 1.47-1.52
N.A.                          |
MELTING POINT ___°F ___ °C | PERCENT VOLATILE BY VOLUME (%) N.A.
N.A.                          |
VAPOR DENSITY (AIR=1) | EVAPORATION RATE (=1) N.A.
N.A.                          |
SOLUBILITY IN WATER - Not | pH = 4-8
APPEARANCE AND ODOR: Multi-colored granules with slight plastic odor |
MATERIAL FORM: Solid

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT ___°F ___ °C: N.A. | FLAMMABLE: N.A. | LEL: N.A. | UEL: N.A.
EXTINGUISHING MEDIA: Carbon dioxide, dry chemicals or water fog
SPECIAL FIRE FIGHTING PROCEDURES: Do not use high-pressure water stream. Fog nozzles are preferable.
UNUSUAL FIRE AND EXPLOSION HAZARDS: Maintain normal good housekeeping for control of dust.
Supporting Documents

SECTION V – HEALTH HAZARD DATA

EFFECTS OF OVEREXPOSURE – Conditions to avoid:
Mechanical injury to eyes and/or skin can occur. Excessive dust inhalation may be harmful.

THRESHOLD LIMIT VALUE:
PERMISSIBLE EXPOSURE LIMIT:

PRIMARY ROUTES OF ENTRY: ☐ Inhalation ☐ Skin Contact ☐ Other (specify)

EMERGENCY AND FIRST AID PROCEDURES: Inhalation: Remove to fresh air. Skin: Wash affected area with soap and water. Eye: Flush immediately with large amounts of lukewarm water. Call physician if necessary.

SECTION VI – REACTIVITY DATA

STABILITY: ☐ STABLE ☐ UNSTABLE

CONDITIONS TO AVOID: Temperatures over 260C (500°F)

INCOMPATIBILITY (Materials to avoid): Strong acids, bases, oxidizing agents.

HAZARDOUS DECOMPOSITION or BYPRODUCTS: Acrylic monomers

HAZARDOUS POLYMERIZATION: ☐ MAY NOT OCCUR ☐ MAY OCCUR

CONDITIONS TO AVOID: N.A.

SECTION VII – SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Remove open flame, sparks, hot surfaces, and oxidizing agents. Sweep up and place waste in disposal container.

WASTE DISPOSAL METHOD: Sanitary landfill in accordance with Federal, State, and Local regulations.

CERCLA (Superfund) REPORTABLE QUANTITY (in lbs.): N.A.

RCRA HAZARDOUS WASTE NO. (40 CFR 261.33): N.A.

VOLATILE ORGANIC COMPOUND (VOC) (as packaged, minus water): N.A.

☐ Theoretical ______ lbs./gal. ○ Analytical ______ lbs./gal.

SECTION VIII – SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify Type): Where required, use NIOSH/MSHA approved respiratory protection in compliance with OSHA regulations (i.e. 1910.134 et. al.)

VENTILATION

LOCAL EXHAUST (Specify Rate): Where necessary to maintain exposure levels to OSHA permissible levels.

MECHANICAL (General – Specify Rate): Acceptable

SPECIAL: Explosion proof may be necessary if aerated or airveyed.

OTHER:

PROTECTIVE GLOVES (Specify Type): Normal | EYE PROTECTION (Specify Type): Safety goggles

OTHER PROTECTION EQUIPMENT: Respirator hood, if necessary.

SECTION IX – SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: Store in closed, properly labeled containers in cool ventilated area. Keep away from heat, sparks, open flame and oxidizing agents. Do not transfer to unmarked containers.

OTHER PRECAUTIONS: None
Supporting Documents

SECTION I

PRODUCT NAME OR NUMBER (as it appears on label)
Poly V® Plastic Blast Abrasive (Type V)

MANUFACTURER’S NAME
U.S. Technology Corporation

ADDRESS (Number, Street, City and Zip Code)
1446 W. Tuscarawas St., Canton OH 44702

MATERIAL DESCRIPTION, PROPER SHIPPING NAME
Plastic Abrasive

HAZARD CLASSES (as applicable): Non-regulated

CHEMICAL FAMILY: Acrylic Polymer

FORMULA: N.A.

SECTION II – INGREDIENTS
(list all ingredients)

<table>
<thead>
<tr>
<th>CAS REGISTRY NO.</th>
<th>Approx. %W</th>
<th>Chemical Name(s)</th>
<th>OSHA PEL</th>
<th>ACGIH TLV</th>
<th>Other Limits Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>25852-37-3</td>
<td>&gt;1%</td>
<td>Acrylate Polymer (Non-Hazardous)</td>
<td>N.E.</td>
<td>N.E.</td>
<td></td>
</tr>
<tr>
<td>80-62-6</td>
<td>Trace</td>
<td>Methyl Methacrylate Monomer</td>
<td>100</td>
<td>100 ppm</td>
<td></td>
</tr>
<tr>
<td>2764-13-8</td>
<td>&lt;1%</td>
<td>Anti-Static Agent – Cal Stat 600</td>
<td>N.A.</td>
<td>N.A.</td>
<td></td>
</tr>
</tbody>
</table>

SECTION III – PHYSICAL DATA

<table>
<thead>
<tr>
<th>BOILING POINT __ °F __ °C</th>
<th>SPECIFIC GRAVITY (H2O=1):</th>
<th>PERCENT VOLATILE BY VOLUME (%)</th>
<th>PERCENT SOLID BY WEIGHT (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.A.</td>
<td>1.10 – 1.20</td>
<td>N.A.</td>
<td>100</td>
</tr>
</tbody>
</table>

| MELTING POINT __ °F __ °C | | |
|---------------------------| | |
| 132                       | | |

<table>
<thead>
<tr>
<th>VAPOR DENSITY (AIR=1)</th>
<th>EVAPORATION RATE (=1)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>N.A.</td>
<td>N.A.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SOLUBILITY IN WATER</th>
<th>pH=</th>
<th>MATERIAL FORM:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not</td>
<td>4-8</td>
<td>Solid</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>APPEARANCE AND ODOR:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-colored or clear white granules with slight odor or methyl methacrylate</td>
<td></td>
</tr>
</tbody>
</table>

SECTION IV – FIRE AND EXPLOSION HAZARD DATA

<table>
<thead>
<tr>
<th>FLASH POINT __ °F __ °C</th>
<th>FLAMMABLE:</th>
<th>LEL:</th>
<th>UEL:</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EXTINGUISHING MEDIA:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide, dry chemicals or water fog</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPECIAL FIRE FIGHTING PROCEDURES:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Wear respirator (MSHA/NIOSH approved) and full protective gear. Do not use high-pressure water stream. Fog nozzles are preferable.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>UNUSUAL FIRE AND EXPLOSION HAZARDS:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Product is a combustible thermoplastic resin. Burns vigorously with heat. High dust concentration could form explosive mixture with air.</td>
<td></td>
</tr>
</tbody>
</table>
SECTION V – HEALTH HAZARD DATA

EFFECTS OF OVEREXPOSURE – Conditions to avoid:
Mechanical injury to eyes and/or skin can occur. Excessive
dust inhalation may be harmful.

THRESHOLD LIMIT VALUE:_____
PERMISSIBLE EXPOSURE LIMIT:_____

PRIMARY ROUTES OF ENTRY:  ☐ Inhalation  ☐ Skin Contact  ☐ Other (specify)

EMERGENCY AND FIRST AID PROCEDURES: Inhalation: Remove to fresh air. Skin: Wash affected area
with soap and water. Eye: Flush immediately with large amounts of lukewarm water. Call physician if
necessary.

SECTION VI – REACTIVITY DATA

STABILITY:  ☐ STABLE  ☐ UNSTABLE

CONDITIONS TO AVOID: Temperatures over 260°C
(500°F)

INCOMPATIBILITY (Materials to avoid): Strong acids, bases, oxidizing agents.

HAZARDOUS DECOMPOSITION or BYPRODUCTS: Acrylic monomers

HAZARDOUS POLYMERIZATION:
☐ MAY NOT OCCUR  ☐ MAY OCCUR

CONDITIONS TO AVOID:
N.A.

SECTION VII – SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Remove open flame, sparks, hot
surfaces, and oxidizing agents. Sweep up and place waste in disposal container.

CERCLA (Superfund) REPORTABLE QUANTITY (in lbs.): N.A.

RCRA HAZARDOUS WASTE NO. (40 CFR 261.33): N.A.

VOLATILE ORGANIC COMPOUND (VOC) (as packaged, minus water): N.A.
☐ Theoretical ______ lbs. /gal.  ☐ Analytical ______ lbs. /gal.

SECTION VIII – SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify Type): Where required, use NIOSH/MSHA approved respiratory
protection in compliance with OSHA regulations (i.e. 1910.134 et. al.).

VENTILATION
LOCAL EXHAUST (Specify Rate): Where necessary to maintain exposure levels to
OSHA permissible levels.

MECHANICAL (General – Specify Rate): Acceptable

SPECIAL: Explosion proof may be necessary if aerated or airveyed.

OTHER:

PROTECTIVE GLOVES (Specify Type): Normal
EYE PROTECTION (Specify Type): Safety goggles

OTHER PROTECTION EQUIPMENT: Respirator hood, if necessary.

SECTION IX – SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: Store in closed, properly labeled containers
in cool ventilated area. Keep away from heat, sparks, open flame and oxidizing agents. Do not transfer to
unmarked containers.

OTHER PRECAUTIONS: None
**Supporting Documents**

### MATERIAL SAFETY DATA SHEET

#### Section I - Identification

<table>
<thead>
<tr>
<th>Manufacturer's Name</th>
<th>Emergency Telephone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archer Daniels Midland Company (ADM)</td>
<td>450-659-1911</td>
</tr>
<tr>
<td>Address</td>
<td>Telephone Number for Information</td>
</tr>
<tr>
<td>155 Iberia</td>
<td>514-846-8516</td>
</tr>
<tr>
<td>Candiac, Quebec J5R 3H1</td>
<td></td>
</tr>
</tbody>
</table>

#### Section II - Hazardous Ingredients / Identity Information

**CHEMICAL IDENTITY (Common Name):**
- Corn Starch (Starch. Carbohydrate)
- Poly (Methyl Methacrylate) *
- Calcium Carbonate

* Non-reactive - non-hazardous

**DPT Classification:** NIOSH 5mg/m³

**OSHA PEL:** 15mg/m³ over 8 hours

**ACGIH TLV:** Nuisance particulate 15 mg/m³ of total dust or 5 mg/m³ respirable dust.

**OZONE DEPLETING SUBSTANCES (ODS):** No Class I or Class II material is used in the manufacture of this product or is contained in this product.

**CONEG:** Complies with the Conference of Northeast Governor's Model Toxic Legislation.

**HAZARDOUS AIR POLLUTANT:** This product does not contain any ingredient classified as a hazardous air pollutant in the Clean Air Act Amendment dated 11/15/90.

**TSCA:** Included on the TSCA inventory under the Chemical Abstracts number 9005-25-8

Product may be considered to be 100% of the material listed under this CAS number.

### Section III - Physical / Chemical Characteristics

<table>
<thead>
<tr>
<th>Boiling Point: N/A</th>
<th>Specific Gravity (H₂O = 1): 1.45 ± 0.10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vapor Pressure (mm Hg): N/A</td>
<td>Melting Point: N/A</td>
</tr>
<tr>
<td>Bulk Density (Loose): 44lb/ft³ ± 4</td>
<td>Bulk Density (Packed): 48lb/ft³ ± 4</td>
</tr>
<tr>
<td>Solubility in Water: Less than 1%</td>
<td></td>
</tr>
<tr>
<td>Appearance: Yellowish/ Off-white crystals</td>
<td>Odour: None</td>
</tr>
<tr>
<td>Product Name: eSTRIP GPX 16/40 (Code Number): (1698-C)</td>
<td>Issue Date: 31-May-07</td>
</tr>
</tbody>
</table>
**Supporting Documents**

### Section IV - Fire and Explosion Hazard Data

**Flash Point (Method Used):**
- Dust cloud ignition temp. = 430°C

**Flammable Limits (LEL, UEL):**
- 0.07-0.08 /g/l

**Extinguishing Media:**
- Water, carbon dioxide, foam, dry chemical extinguishers.

**Special Fire Fighting Procedures:**
- None

**Unusual Fire and Explosion Hazards:**
- Product as sold is not hazardous. Severe physical degradation to a fine powder (smaller than 125 microns) may cause possibility of an explosion under specific conditions. Avoid accumulation of dust and handling in the presence of high temperature sources.

### Section V - Reactivity Data

**Stability:**
- Stable under normal conditions.

**Conditions to Avoid:**
- Formation of a nuisance particulate dust cloud.

**Incompatibility (Materials to Avoid):**
- None Known

**Hazards Decompositions or Byproducts:**
- None Known

**Hazardous Polymerization:**
- Not known to occur.

**Conditions to Avoid:**
- None Known

### Section VI - Health Hazard Data

**Routes of Entry:**

<table>
<thead>
<tr>
<th>Inhalation:</th>
<th>Skin Absorption:</th>
<th>Ingestion:</th>
<th>Eyes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuisance Dust</td>
<td>No Hazard</td>
<td>Yes</td>
<td>Solids or dust may scratch surface of the eye, which can cause mechanical irritation.</td>
</tr>
</tbody>
</table>

**Health Hazards (Acute and Chronic):**
- None. The following limit values for working atmospheres of inert or nuisance dust will apply. Total dust - 15 mg/m³; respirable fraction 5 mg/m³.

**Carcinogenicity:**
- No

**OSHA Regulated:**
- No

**Signs and Symptoms of Exposure:**
- Excessive concentrations of particulates in workroom air may seriously reduce visibility, may cause unpleasant deposits in eyes, ears and nasal passages, or may cause temporary injury to the skin or mucous membranes by mechanical action.

**Emergency and First Aid Procedures:**
- **Eyes:** Immediately flush with clean lukewarm water (low pressure) until irritation subsides. If irritation persists, get medical attention.
- **Ingestion:** Treat symptomatically. FDA considers corn starch a Generally Recognized as Safe (GRAS) substance.
- **Inhalation:** If exposed to excessive levels of dust, remove to fresh air. Get medical attention if persistent cough or other symptoms develop.

**Skin:** Wash with soap and water.

<table>
<thead>
<tr>
<th>Page 2 of 3</th>
<th>Product Name:</th>
<th>Code Number:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>eSTRIP GPX 16/40</td>
<td>(1698-C)</td>
</tr>
</tbody>
</table>

**Issue Date:** 31-May-07
Section VII - Precautions for Safe Handling and Use

Steps to Be Taken in Case Material is Released or Spilled:
Avoid open flames, smoking, friction sparks, static sparks, welding and cutting tools in dusty surroundings. Sweep up spilled material and place in suitable receptacles for disposal. Flush spill area with water to remove with water to remove residues. Do not flush to storm sewer or waterway.

Waste Disposal Method:
Conform to applicable federal, provincial, state, and municipal regulations. Is not hazardous waste as specified in 40CFR 261. Dispose in an approved landfill in accordance with provincial, state, and municipal regulations.

Precautions to Be Taken in Handling and Storing:
Best storage is under dry, cool, away from heat source. Do not expose to open flame or sparks. Practice good housekeeping.

Other Precautions:
Avoid situations creating dust.

Section VIII - Control Measures

Respiratory Protection (Specify Type):
Use appropriate NIOSH/MSHA-approved mask when necessary.

Ventilation:
Local exhaust (wired to protect against ignition hazards posed by dust) should be used to maintain air-born dust concentrations below applicable OEL standards.

Protective Gloves:  | Eye Protection:
Impervious Gloves  | CSA Approved Safety Glasses

Other Protective Clothing or Equipment:
Good industrial hygiene practice.

Section IX - Preparation Information

Prepared By: ADM
Archer Daniels Midland Company

Telephone #: 450.659.1911
Revision Date: May 31, 2007

<table>
<thead>
<tr>
<th>WHMIS HAZARD RATING INDEX</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>HEALTH</td>
</tr>
<tr>
<td>1</td>
<td>FLAMMABILITY</td>
</tr>
<tr>
<td>0</td>
<td>REACTIVITY</td>
</tr>
<tr>
<td>A</td>
<td>PROTECTIVE EQUIPMENT</td>
</tr>
</tbody>
</table>
## Supporting Documents

<table>
<thead>
<tr>
<th>Approval</th>
<th>Application</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agusta</td>
<td>Composite stripping approval</td>
<td>EnviroStrip XL Corn</td>
</tr>
<tr>
<td>Airbus</td>
<td>Engineering Approval Composites</td>
<td>EnviroStrip Wheat Starch</td>
</tr>
<tr>
<td>Airbus</td>
<td>Adhesive Bond Removal Sncma process guidelines</td>
<td>EnviroStrip XL Corn</td>
</tr>
<tr>
<td>Goodrich Aerospace</td>
<td>Adhesive Bond Removal</td>
<td>EnviroStrip XL Corn</td>
</tr>
<tr>
<td>Boeing Commercial</td>
<td>Broad OEM approval for Metals (&gt;0.032-inch thickness) Unlimited use (all models)</td>
<td>EnviroStrip Wheat Starch</td>
</tr>
<tr>
<td>Boeing Commercial</td>
<td>Broad OEM approval for Composites (all models) Carbon fibre, Fibreglass, Kevlar</td>
<td>EnviroStrip Wheat Starch</td>
</tr>
<tr>
<td>Boeing Commercial</td>
<td>Adhesive Bond Removal</td>
<td>EnviroStrip Wheat Starch</td>
</tr>
<tr>
<td>Boeing Military</td>
<td>Metals KC-135, B-52</td>
<td>EnviroStrip XL Corn</td>
</tr>
<tr>
<td>Bombardier</td>
<td>Metals</td>
<td>EnviroStrip Wheat Starch</td>
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<tr>
<td>Cessna</td>
<td>Adhesive Bond Removal</td>
<td>EnviroStrip XL Corn</td>
</tr>
<tr>
<td>Raytheon</td>
<td>Metals</td>
<td>EnviroStrip WS/XL Corn</td>
</tr>
<tr>
<td>Sikorsky Aircraft</td>
<td>Composite Approval</td>
<td>EnviroStrip XL Corn</td>
</tr>
<tr>
<td>US Army</td>
<td>Helicopter Composite Approval</td>
<td>EnviroStrip Wheat Starch</td>
</tr>
<tr>
<td>Bell Helicopter</td>
<td>Metal and Composites</td>
<td>GPX</td>
</tr>
<tr>
<td>US Coast Guard</td>
<td>Helicopter and Fixed Wing Fleet</td>
<td>GPX</td>
</tr>
<tr>
<td>US Air Force</td>
<td>Mil P 85891A Approved/Fleet</td>
<td>GPX</td>
</tr>
<tr>
<td>Vought Aircraft</td>
<td>Paint and Adhesive Removal</td>
<td>EnviroStrip® WS/XL</td>
</tr>
<tr>
<td>US Navy</td>
<td>Metals and Composites</td>
<td>Environstrip XL &amp; GPX</td>
</tr>
</tbody>
</table>
Supporting Documents

*Media samples - Envirostrip XL and Type V - under ultraviolet (UV) light.*
Supporting Documents

Starch Delivers 4 to 10 Times less Impact than Plastic Abrasive