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Examination of the Possible use of Type VII Blast Media by the Canadian forces

Terry Foster, Head Dockyard Laboratory Pacific

Defence R&D Canada – Atlantic

Technical Memorandum

DRDC Atlantic TM 2009-293

September 2010

Canada

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Abstract

Five Airforce Wing Maintenance Facilities were visited to determine the current practices used to dry strip aircraft components using plastic media. It was observed that the current equipment is old (over 20 years) and is in need of replacement and that some of the blasting practices used by the technicians were not compliant with the current CF dry media blasting specification. A new non-toxic, biodegradable cornstarch dry stripping media (Type VII) was demonstrated to the technical staff. The use of Type VII media at other facilities (US Army, Airforce, Navy and Coast Guard) was examined to determine what would be required to introduce this media into fleet operations. The Type VII media has several advantages over the current media, such as no surface residue after blasting, odourless, can be used on composite and fibreglass surfaces and imparts less residual stress to the blasted surface. The Type VII media is a drop-in replacement for the current media and no equipment changes are required if the Type VII media is specified for use by the Wing Facilities.

Résumé

Cinq installations de maintenance des escadres de la Force aérienne ont été visitées dans le but de connaître les pratiques utilisées pour le décapage par projection d'un abrasif plastique sec des pièces d'aéronef. On a observé que l'équipement actuel avait déjà plus de vingt ans et qu'il devait être remplacé. De plus, les méthodes de décapage par projection d'un abrasif sec appliquées par certains techniciens n'étaient pas conformes aux normes des FC relatives à ce procédé et actuellement en vigueur. Une démonstration de décapage à sec a été faite devant le personnel technique avec de l'amidon de maïs, un nouveau matériau de décapage à sec, non toxique et biodégradable (Type VII). Une étude sur l'utilisation de ce matériau de décapage de type VII a été menée auprès d'autres installations, notamment celles de l'armée, de la force aérienne, de la marine et de la garde côtière des États-Unis, afin de déterminer ce qu'il faudrait pour intégrer l'utilisation de ce matériau à l'exploitation de la flotte. Cet abrasif conforme aux spécifications de type VII présente plusieurs avantages par rapport à celui qui est utilisé actuellement. En effet, propulsé par jet d'air, cet abrasif, qui ne laisse aucun résidu sur la surface, est inodore et peut être utilisé sur les surfaces en composites ou en fibre de verre. De plus, la contrainte résiduelle produite sur la surface traitée est nettement inférieure. Ce matériau de type VII est un substitut direct pour celui qui est utilisé actuellement et la prescription de son utilisation dans les installations de l'escadre ne nécessiterait aucun changement d'équipement.

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Executive summary

Examination of the Possible use of Type VII Blast Media by the Canadian Forces

Terry Foster; DRDC Atlantic TM 2009-293; Defence R&D Canada – Atlantic; July 2010.

Introduction or background: An evaluation of a new non-toxic, biodegradable corn starch media (Type VII, eStrip GPX) for use for dry stripping aircraft substrates was carried out for the Directorate of Technical Airworthiness and Engineering Support (DGAEPM/DTAES 7). This included visits to Wing maintenance facilities to observe the current practices and demonstrate the application and use of Type VII media. Current practices at other organizations were analyzed to determine their relevance to the CF.

Results: During the visit to various Wing maintenance facilities it was observed that the equipment is over 25 years old and needs to be replaced and that some current practices do not meet the current CF media blasting specification. Observations at a demonstration of the Type VII media at Fleet Readiness Center Southwest North Island, San Diego showed the versatility of this media on both composite and aluminum surfaces. Also more training is recommended for technical staff to ensure all are aware of the proper blasting conditions and quality control procedures.

Significance: The adoption of Type VII media would be very easy as the Type VII is a drop-in replacement for the currently used Type V media and no equipment changes would be required. The use of Type VII media would allow for expansion of the use of blast media to composite and fibreglass surfaces thus significantly reducing the time required to strip these surfaces.

This project provided an opportunity to observe the current problems with dry stripping within the Airforce and to give technical staff an introduction to the new media and suggestions to improve the procedures used in dry stripping.

Future plans: After the installation of new equipment and the change to type VII media there should be follow-up visits to the fleet to ensure that the new blast facilities are properly installed and that the technical staff has had sufficient training on the new media.

Sommaire

Examination of the Possible use of Type VII Blast Media by the Canadian Forces

Terry Foster; DRDC Atlantic TM 2009-293; R & D pour la défense Canada – Atlantique; Juillet 2010.

Introduction ou contexte : À la demande de la Direction – Navigabilité aérienne technique et Soutien technique (DGGPEA/DNAST 7), une évaluation de l'utilisation de l'amidon de maïs comme nouveau matériau non toxique et biodégradable (spécification de type VII, eStrip GPX) pour le décapage par projection à sec des substrats d'aéronef a été entreprise. À cette fin, nous avons visité les installations d'entretien d'escadre afin d'observer les pratiques en vigueur et de démontrer l'application et l'utilisation du matériau de type VII. Les pratiques en vigueur dans d'autres organismes ont également été analysées dans le but d'évaluer leur pertinence pour les FC.

Résultats : Plusieurs éléments sont ressortis de la visite des différentes installations de maintenance des escadres : l'équipement actuel a plus de 25 ans et devrait être remplacé et les pratiques actuelles ne sont pas conformes aux normes en vigueur applicables au décapage par projection d'un matériau. Une démonstration de l'utilisation du matériau de type VII qui a eu lieu au *Fleet Readiness Center Southwest North Island* à San Diego a confirmé la polyvalence de ce matériau, tant sur les surfaces composites qu'en aluminium. De plus, il est recommandé de faire suivre une formation supplémentaire aux membres du personnel technique afin de les familiariser avec les conditions appropriées pour le décapage par projection et les procédures de contrôle de la qualité.

Importance : Il serait très facile d'adopter le matériau de type VII puisqu'il est un substitut direct pour le matériau de type V utilisé actuellement et que son utilisation ne nécessiterait aucun changement d'équipement. Le recours au matériau de type VII permettrait également d'étendre le décapage par projection aux surfaces de composites et en fibre de verre, ce qui réduirait considérablement le temps requis pour les décaper.

Ce projet a permis de constater les problèmes actuels associés au décapage à sec dans les installations de la Force aérienne, de présenter le nouveau matériau aux membres du personnel technique et de leur suggérer comment améliorer les procédures de décapage à sec.

Perspectives : Des visites de suivi devraient avoir lieu après l'installation du nouvel équipement et le changement au matériau de type VII afin de vérifier que l'équipement de décapage par projection a été installé correctement et que le personnel technique a suivi une formation adéquate sur l'utilisation du nouveau matériau.

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Acknowledgements

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1 Introduction

This report is an engineering evaluation and validation of a new non-toxic, biodegradable engineered cornstarch media designed to meet the Type VII requirement of MIL-P-85891 for use as the approved airforce media of choice for dry stripping aircraft substrates. The objective of the project is to provide sufficient engineering and technical data and substantiation for Director General Aerospace Equipment Program Management (DGAEPM) to approve the use of the Type VII cornstarch based media as a direct replacement for Type V acrylic plastic media.

Since its introduction in the late 1980's, organic coating removal by Plastic Media Blasting (PMB) and Starch Media Blasting (SMB) has been used sporadically in the Canadian Forces (CF). At Third Line facilities, entire CF-18 aircraft have been stripped in accordance with reference [1] using acrylic plastic (Type V) media. At Wing/Base level, PMB using Type V media has never been fully implemented. It has been generally restricted to aircraft wheels as stipulated at reference [1]. Wings wanting to dry media strip other aircraft components must request permission from the fleet Aircraft Engineering Officer (AEO).

Historically, organic coating removal has been carried out with chemical strippers qualified to MIL-R-81294. These strippers contain a hazardous substance called Dichloromethane (DCM). DCM is a toxic substance that is potentially harmful to worker's health and safety (possible carcinogen) and is detrimental to the environment. Recently, environmental and health and safety issues have jumped to the forefront, encouraging DND to find new and safer alternatives to chemical stripping, including the use of environmentally friendly stripping media. In addition, the Canadian Environment Protection Agency (CEPA) has legislated the reduction of DCM. As such, CEPA has published in Part I of the Canada Gazette reduction targets of 50% by December 2004 and 80% by January 2007, from the 1997 baseline. In order to meet CEPA's reduction targets, Environmentally Acceptable (EA) chemical strippers have been provided as a viable alternative to DCM strippers for most applications. Unfortunately, environmentally acceptable strippers take much longer to remove the coating and are incapable of removing some coatings. Chemical Strippers cannot be used on composites due to possible damage to the resin or on some metal substrates due to corrosion or hydrogen embrittlement concerns. The environmentally acceptable strippers also produce a large amount of hazardous waste for disposal.

For these reasons, a requirement exists to approve and implement a non-toxic, biodegradable, and environmentally friendly removal process to reduce or ideally eliminate the use of chemical strippers.

There were six major objectives of this study and report:

1. Evaluate the current plastic media stripping practices at various Wing facilities and comment on possible changes and improvements

2. Demonstrate the applications of Type VII corn base media to the technical staff at various Wing facilities and compare this to the current application of Type V acrylic media

3. Examine and comment on the lessons learned by other organizations, both military and commercial, that are using or are in the process of using Type VII media

4. Evaluate tests reports and processes used by that have been done on eStrip GPX and comment on the surface effects that the media has on each approved substrate

5. Investigate the advantages and possible disadvantages in adopting the Type VII corn starch based media in lieu of Type V plastic media

6. Make recommendations on the way ahead for DTAES to convert from Type V to Type VII media if this study supports that conclusion

1.1 Type VII Corn Starch Based Media

The classification and characteristics of the various types of media developed over the last twenty years or so and have at some point been used to strip aircraft and aircraft components are shown in Table 1.

Table 1: Important Characteristics of Media Type[1]

Media Type	Material	Hardness	Strip Rate @30 PSI (ft/min)	Consumption @ 30 PSI
Type II	Urea	54-62 Barcol	2.5	8%
Type V	Acrylic	46-54 Barcol	2	8%
Type VIII	Blended Amino	60 Barcol	3	5%
Type VII Corn Starch[2]	Corn	80 Shore D	0.4-1.2	5%
Wheat Starch[2]	Wheat	80 Shore D	0.3-0.8	7%

1 – Type I, III, IV, and VI are omitted since they are not intended for use on airframes.

2 – Corn or Wheat starch mixed with 10% acrylic is considered Type VII media.

Taken from “INDUSTRY SURVEY AND RESEARCH OF DEPAINT METHODS”, Daniel W. DeKruif, Southwest Research Institute® (SwRI®), *2003 Aerospace Coatings Removal and Coatings Conference*

The Type VII corn based media, commercially known as eStrip GPX, was developed by Archer Daniels Midland (ADM) to eliminate some of the short comings of the wheat starch media.

eStrip GPX is classed as a Type VII starch-g-acrylic media that meets the USAF military specification MIL-P-85891A requirements. The manufacturer states the GPX can be used for many applications including stripping of metal and composite surfaces; it has moisture resistance and good flowability and can be used with most types of light abrasive blasting equipment. GPX offers several advantages including longer product life, improved consumption rates and UV fluorescence to assist inspection after stripping.

The physical and chemical properties of the Type VII corn based media are listed below:

- Appearance: Pale yellow or off white-coloured media
- Mesh size: 20 to 50 mesh U.S. std
- Density (g/cm3): 1.45 ± 0.10
- Bulk Density (kg/m3): 641 – 769, (40 – 48 lb/ft3)
- Mesh (US Std): max. 15% on 20 mesh, max. 20% through 50 mesh
- Hardness: 70 - 90 shore, D scale

The following are some of the advantages of Type VII corn based media as stated by the manufacturer:

- Type VII corn based media is non-toxic and biodegradable
- Can be used at low pressures, thus imparting low mechanical impact onto the substrate, thereby reducing or eliminating damage and surface stress
- Can be used in standard blasting cabinets currently used by the CF and is considered a "drop-in" replacement for Type V (Acrylic)
- Meets MIL-P-85891 for Type VII plastic media – non-residue causing media

1.2 Current Practices With Type VII Corn Starch Based Media

Type VII corn starch based media has been approved by several military and commercial users for stripping aircraft and aircraft components. The manufacturer's recommended blasting parameters for Type VII media are shown in Table 2.

Table 2: ADM Recommended Blast Parameters for Type VII Media		
	Composites	**Aluminum**
Nozzle Pressure:	20 – 30 psi	25 – 40 psi
Media Flow (1/2" Nozzle):	10 – 16 lb/min	10 – 16 lb/min
Nozzle Distance From Surface:	4 – 18 inches	4 – 12 inches
Impingement Angle:	20 – 40 degrees	40 – 60 degrees

The parameters specified for stripping composites and metals using Type VII media by the US Airforce, Lockheed Martin, Coast Guard, and US Army and are summarized in Table 3.

Table 3: Blasting Parameters for eStrip GPX Type VII	
substrate thicknesses: Blast pressure	**USAF on T-6 aircraft:** 0.016" - 0.020": 20 psi; 0.025" - 0.028": 28 psi; 0.032" and up: 35 psi
	Lockheed Martin: optimum: 40 psi, not to exceed 50 psi
	US Coast Guard: Aluminum 0.032" and up: 25-40 psi. Composites 0.018" and up: 18-25 psi
	US Army: Aluminum ≤ 0.025", 20-25 psi, ≥ 0.032", 25-40 psi, Composites 20-30 psi
media flow rate	**Lockheed Martin:** not to exceed 10 lbs/min
	US Coast Guard: 6-10 lbs/min (3/8 inch nozzle), 10-18 lbs/min (1/2 inch nozzle), 18-36 lbs/min (3/4 inch nozzle). Aluminum 0.032" and up: 10-16
	US Army: ≤ 0.025", 16-18 lbs/min, ≥ 0.032", 10-16 lbs/min, Composites 10-16 lbs/min (1/2" nozzle)
nozzle stand off distance	**USAF on T-6 aircraft;** ~10"
	Lockheed Martin: 8" -12"
	US Coast Guard: Aluminum 0.032" and up: 6" -18" Composite surfaces 0.018" and up: 8" - 14"

	US Army: Aluminum 4"-14" , Composites 4"-22"
nozzle blast angle	**USAF on T-6 aircraft:** 40° - 60° of incident
	Lockheed Martin: 60° - 80°
	US Coast Guard: Aluminum 0.032" and up: 40°-60°; Composites 0.018" and up: 20° - 40°
	US Army: Aluminum 40°-60° Composites - 20°-40°

1.3 Current DND Plastic Media Blasting PMB Specification

The current specification for PMB (C-12-188-SRM/VC-000, 007 01) was produced in the 1990's around the use of Type V media and the currently approved blast parameters are shown in Tables 4 and 5.

Table 4: Parameters for Blasting Media Type V, Size 20-30 – Subject to Liquid Penetrant Inspection LPI

Substrate	Thickness (Inches)	Media Flow (Lbs/Min)	Pressure (PSI)	Standoff (Inches)	Blast Angle (Degrees)
Aluminum	0.010 - 0.060	8.5 to 10.0	20 to 30	12 to 24	30 to 45
Titanium	0.010 - 0.060	10.5 to 11.8	37 to 41	8 to 12	45 to 60
Steel	0.010 - 0.060	6.7 to 7.5	28 to 33	8 to 12	45 to 60

Table 5: Parameters for Blasting Media Type V, Size 20-30 – Not Subject to LPI

Substrate	Thickness (Inches)	Media Flow (Lbs/Min)	Pressure (PSI)	Standoff (Inches)	Blast Angle (Degrees)
Aluminum/Steel	0.020-0.060	8.5-10.0	20-30	12-24	30-45
Aluminum/Steel	0.061 Min	10.5-11.8	37-41	8-12	45-60
Titanium	0.020 Min	8.5-10.0	20-30	12-24	30-45
Composite	0.060 Min	8.5-10.0	20-30	12-24	30-45

The current specification used at the maintenance facilities also calls for several tests of the blasting procedure and the blast cabinet to be carried out periodically. These include surface roughness, media flow rate, blasting pressure and media cleanliness. The schedule for these checks is every 50 hours of blasting time or whenever the media is replaced. Procedures for these tests are outlined in C-12-188-SRM/VC-001.

2 Analysis of Current Operating procedures at Air Wing Maintenance Facilities

The author, along with WO Coté and a consultant, D. Monette, visited several bases to observe the current practice of stripping with Type V media, to introduce the Type VII media as a possible replacement, and to solicit input from the operators.

2.1 CFB Bagotville

General condition

The blast cabinet at CFB Bagotville is over 20 years old. There are no door safety locks and the lights inside the blast cabinet are not protected. Illumination and sound proofing were also poor. The equipment showed evidence of considerable usage and aging. The blast cabinet was equipped with a matching ¼ inch standard blast hose and nozzle.

Observations

- It was noted that a locally made cover for the blast cabinet's air exhaust was installed (very good idea)
- It was noted that a locally made viewing Plexiglas window was installed in the side door of the cabinet (poor choice of material, windshield glass is better)
- It was reported that locally made extension for the cabinet was made and used periodically (using this extension will adversely affect the dust removal efficiency of the system due to the larger volume of the extended blast cabinet)
- It was noted that the general housekeeping of the equipment was poor
- There was no needle gauge available for nozzle pressure calibration
- No maintenance manual was readily available to the users

Operators

- Some operators did not know the difference between pressure pot and nozzle pressure
- The operators did not know about the existence of the magnetic collector (prevents ferro-magnetic particles from being projected on the work piece)
- The operators did not know how to properly pulse clean the dust filters

2.2 CFB Comox

Equipment

The blast cabinet at CFB Comox is over 20 years old. They are no door safety locks and the lights are inside the blast cabinet. Illumination and sound proofing were also poor. The equipment showed evidence of considerable usage and aging. The apparent sizing of the nozzle and hose was ¼ inch.

Observations

- It was noted that a locally made stainless steel pipe was used instead of the standard blast hose to deliver the blast media from the flow valve to the blast cabinet. Non-standard delivery with possible effects on velocity and dense particles was suspected.
- It was noted that there was a chart on the cabinet showing the relationship between pressure pot pressure and nozzle pressure for a ¼ inch and a 3/8 inch set up. (very good idea)
- It was noted that a locally made height extender for the cabinet was installed (100 mm wood blocks under the cabinet legs) and a movable 100 mm high platform was located in front of the cabinet, allowing tall operators to work without back strains and shorter operators to use the platform. (very good idea)
- Previously, CP-140 wheels required the use of Turco 5469 prior to stripping with Type V media. Turco 5469 was not required with the Type VII media
- It was noted that there was a maintenance manual (old version) located at the dust collector
- It was noted that there was a needle gauge available, however it was not working properly
- It was noted that the media had not been purged from the cabinet in a long time (evidence of high levels of dense particles was observed)

2.3 CFB Shearwater

General condition

The blast cabinet at CFB Shearwater is over 20 years old. There are no door safety locks and the lights inside the blast cabinet are not protected. Illumination and sound proofing were also poor. The equipment showed evidence of considerable usage and aging. The blast cabinet was equipped with a matching ¼ inch standard blast hose and nozzle.

Observations

- The general level of housekeeping was very good

- It was noted that the air inlets on the top of the cabinet were blocked with a plastic film; this reduces the effectiveness of the dust removal process and was explained to the operators

- Radiographic and Almen strip tests indicated high levels of dense particles in the acrylic media working mix used in the cabinet

- A sign posted on the cabinet on how to pulse clean the filters was incorrect

- There was no needle gauge available for nozzle pressure calibration

- There was no maintenance manual readily available

- During trials on wheels, it was noted that the coating came off very fast. It was determined that some wheels were not being prepared for painting correctly

Operators

- Some operators did not know the difference between pressure pot and nozzle pressure

- Some operators did not know about the existence of the magnetic collector

- The operators did not know how to properly pulse clean the dust filters

2.4 CFB Cold Lake

Equipment

The Pauli blast cabinet at CFB Cold Lake is over 20 years old. They are no door safety locks and the lights are inside the blast cabinet. The equipment showed evidence of considerable usage and aging. The apparent sizing of the nozzle and hose was ¼ inch.

Observations

- It was noted that locally made Plexiglas enclosures were installed to protect the lights inside the cabinet. (very good idea)

- It was noted that the maximum nozzle pressure obtained was below capacity, suggesting an obstruction which could not be located during the visit

- It was noted that the shop eating area was located very near the blasting area. (Not a recommended practice for health reasons)

- A maintenance manual was available

- It was noted that there was a serviceable needle gauge available

- The in-use acrylic media was purged before our arrival. Quality control test of the used Type V media were not carried out

Operators

- Some operators did not know about the existence of the magnetic collector

- The operators knew the difference between nozzle pressure and pressure pot pressure

Additional note: During a trial on a CF-18 main wheel, it was noted the anodized layer had been damaged by previous coating removal procedures. It was reported that a few wheels had been accidently processed by an inexperienced operator using an abrasive media meant for steel substrates.

2.5 CFB Trenton

Equipment

The blast cabinet at CFB Trenton is less than 2 years old and is equipped with recessed (outside the blast cabinet) lights and safety door locks. Illumination inside the cabinet was very good and noise level quite low. The blast cabinet was equipped with a standard 3/8 inch hose and blast nozzle.

Observations

- It was noted that part of the dust removal system was missing (misadjusted plate)
- It was noted that media dust was escaping from the guillotine door (damaged door seal)
- It was noted that the door safety locks were not functioning properly (safety locks prevent blasting if the doors are opened)
- There were no needle gauges available for nozzle pressure calibration
- There were no maintenance manual readily available

Operators

- The operators did not appear to know the difference between pressure pot pressure and nozzle pressure. (Blasting with a pressure pot pressure of 20 psi provides a very low nozzle pressure of 8-9 psi.)
- The operators did not know about the existence of the magnetic collector located above the media flow
- The operators did not know how to properly pulse clean the dust filters. The post filter air exhaust is directed at the operators

- The operators did not know about the pneumatic assisted screen vibrator, (not activated)

2.6 Conclusions and Recommendations From Observations at Wing Maintenance Facilities

Three issues arose from the observations made at the various Wing Maintenance Facilities:

1. New blasting cabinets are required
2. More training of personnel is required, and
3. Maintenance of the equipment needs to be improved

Aging Equipment

Almost all of the blast cabinets currently in use are over 20 years old. Many desirable features have been added to newer cabinets since that time, including explosion proof light fixtures in the cabinets, timers to monitor usage, improved dust removal filtering and lighting, improved electronic media flow control and blast pressure, and better view of work pieces.

Improved media flow control and blast pressure would alleviate some of the concerns that were noted during visits to the maintenance facilities and would also improve removal efficiency. A cabinet timer could be used to remind operators that the media is due to be changed. The improved filtering would reduce the dust in the blast cabinet and a magnet particle separator would ensure removal of metal particles (Figure 1) that can lead to surface damage to components being blasted.

If and when new equipment is purchased, the supplier should be required to install the equipment and give at least a one-day training session to any available staff.

Training

Although the staff were generally very knowledgeable, more training should be put in place to ensure that procedures to monitor nozzle pressure and media feed rate are understood and monitored, that magnetic particle separators are cleaned regularly, and that practices are standardized across the facilities.

Errors such as the observed damage to the anodized layer on a CF-18 main wheel (inexperienced operator using abrasive media meant for steel substrates) would be more readily avoided if routine training were available. This type of error could also lead to contamination of the regular media if the cabinet is not thoroughly flushed prior to refilling.

There was no evidence that the test procedures in C-12-188-SRM/VC-001 were being followed. Some of this is due to lack of training but others are due to the nature of the equipment.

Equipment is not available to carry out surface roughness, media flow rate and blasting pressure measurements. The schedule for these checks is every 50 hours of blasting time or whenever the media is replaced. New equipment will allow blast pressure and media flow to be more closely monitored but in the meantime other options should be investigated.

The current media cleanliness check requires the use of some restricted chemicals (Freon) or is more readily carried out in a laboratory setting.

A simple 'cleanliness' check could be radiography of a sample of the media taken from the cabinet (e.g. 2 Kg). If the radiograph (Figure 1) shows metal contamination then it is time to change out the media and clean out the cabinet (and check the magnetic particle separator). This procedure was carried out during the visit to CFB Bagotville and back at the laboratory for CFB Comox. In both cases there was considerable metallic contamination in the Type V media being removed for the Type VII trial.

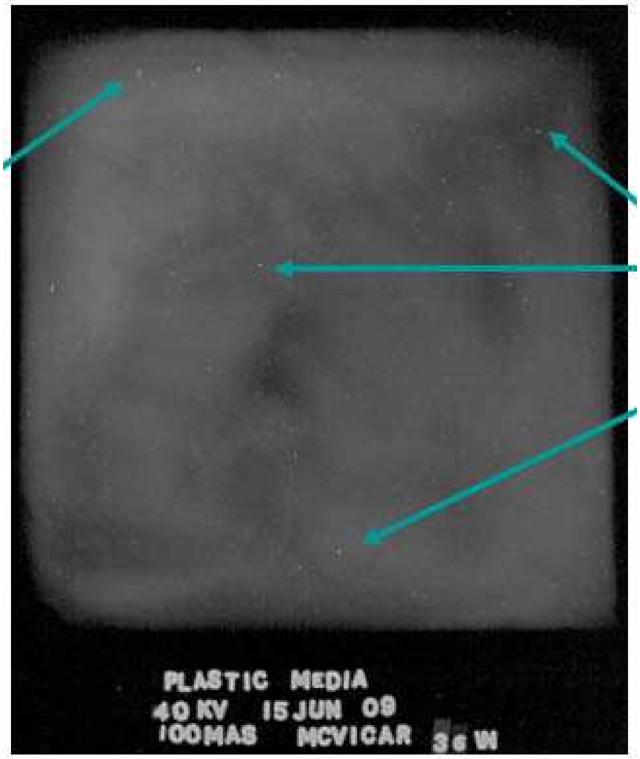

Figure 1: Radiograph of used media indicating metal particles (bright spots).

Maintenance

Improved maintenance of the equipment goes along with more frequent training. The purchase of any new equipment should include a service contract under which an acknowledged expert would routinely visit the facilities and ensure that the equipment was working at an optimum capacity. This might also help with training of new personnel.

A radiograph (Figure 1) of the used Type V media that was being removed from the blast cabinet before the Type VII could be evaluated indicated that there were metal particles in the used media. These dense metal particles can significantly affect the surface stress induced during blasting and can create small pits on the blasted surface that could be sites for fatigue crack initiation or cause accelerated corrosion from galvanic interaction of the metal particle (ferrous particle embedded in aluminum or damaged anodized layer). The presence of the metal particles is an indication that the magnetic particle separator and/or the cyclone filtering systems are not being maintained on a regular basis.

3 Results of Evaluation of Type VII Media at Wing Maintenance Facilities

Overall, blast operators at the facilities had a positive view of the Type VII media. Although the stripping rate for some items was lower for the Type VII compared to Type V, the scope of the surfaces that could be blasted was much wider.

Some problems were encountered in stripping wheels when the coating had undergone excessive heating that made the coating much more difficult to remove. On the other hand, composite, fibreglass and clad surfaces could be stripped with the Type VII media, which would improve overall productivity and reduce the amount of time consumed and the amount of hazardous dust produced by hand sanding.

3.1 CFB Bagotville

The effectiveness of the Type VII media was examined on coated aluminum and composite panels and compared with Type V media.

Type VII was not aggressive enough to remove all coatings from overheated brake wheels.

There was a significant increase in stripping rate of the Type VII media as the media was used and cycled through the cabinet. This was observed at all Wings.

This is normally the case with Type VII, as the media becomes more aggressive with cycling, whereas the Type V media tends to become less efficient with time. The Type VII media fractures on impact with the surface and retains it sharp edges whereas the Type V media softens and the edges become blunt and less effective.

3.2 CFB Cold Lake

Many trials were carried out on aluminum and composite panels. Alclad 2024 -T3, 0.71 mil panels were used to compare the roughness of the stripped surface between Type V at 20 psi and Type VII at 25 psi. A much smoother surface was obtained with Type VII even with a higher pressure. Composite panels and fiberglass antenna covers were stripped with no adverse deterioration of the surface or exposure of the fiber, leaving a smooth surface with the resin still intact.

During stripping of overheated main landing gear wheels, the polyurethane top coat was removed easily but the epoxy primer was baked on the surface and was not removed by the Type VII.

Selective stripping on fibreglass antenna covers with Type VII was demonstrated to the staff. Similar selective stripping was not possible using the Type V.

The stripping rate with Type VII was slightly slower than Type V. The technicians were pleased with the absence of the strong smell and static powder built up inside cabinet walls that occurs with Type V.

Stripping of Ion Vapour Deposited (IVD) and Cadmium plated parts (shrink arm connector link, bell crank brackets and axle arm lever) was demonstrated with Type VII at 25 psi. Some small particles of IVD coating were removed with Type V media where there was no previous damage. Type VII did not remove any IVD or cadmium plating. Defects in the IVD were observed through the coated surface prior to stripping with Type VII; these defects were exposed after the part was stripped with Type VII and there was no change in defects sizes.

3.3 CFB Shearwater

The author was not present for this demonstration and has used the notes from WO Coté and Mr. Monette.

Trials were carried out on aluminum and fibreglass panels. Alclad 2024 -T3, 0.50 mil panels were used to compare the roughness of the stripped surface between Type V at 20 psi and Type VII at 25 psi. A much smoother surface was obtained with Type VII even with a higher pressure. Fibreglass panels and antenna covers were stripped with adverse deterioration only on doubled or supported fibreglass layers, leaving a smooth surface with the resin still showing. We observed deterioration on single-layer fibreglass panel.

Selective stripping was demonstrated to the technicians on fibreglass antenna covers with Type VII. The same selective stripping process was attempted with Type V, but the resulting surface was uneven and down to substrate.

Although the stripping rate of Type VII was slightly less than Type V, technicians were pleased that Type VII did not have a strong odour or a static powder built up inside cabinet walls normally associated with Type V. After only two days experience, the technicians' comments on Type VII media ranged from good to excellent.

Stripping of a fibreglass cover with fastener holes was demonstrated with Type VII media. There was no elongation of the fastener holes. Using Type V media on the same component would have resulted in fibre damage and elongation of the fastener holes.

4 Battelle Demonstration/Evaluation of Type VII Media

No lab scale evaluation of the Type VII media was carried out for this report. While this tasking was underway, Battelle was tasked by Fleet Readiness Center Southwest North Island, San Diego (FRCSW NI) to carry out an evaluation of the Type VII media in comparison with the Type V media, including an unbiased demonstration and evaluation of the application of Type VII. The author and WO Coté were invited to participate in the demonstration at North Island and invited to examine the results of this demonstration. Samples of condemned parts from Canadian aircraft were also stripped during this evaluation.

The objectives of the Battelle study were to compare the performance of the Type V media (Acrylic) and Type VII in side-by-side tests on similar parts. This study included the following:

- Conduct comparative testing of Type V and Type VII media and related processes (bench-scale)
- Conduct demonstration and validation testing of Type V and Type VII media/processes on condemned aircraft component parts and coated test panels at FRCSW NI

Prior to the FRCSW NI demonstration a comparison of Type V and Type VII media was conducted by Battelle at the ADM Test Facility in Montreal. The following tests were carried out according to various military or SAE specifications:

- Coating removal efficiency
- Residual stress measurements
- Post blast residues
- Clad erosion and removal
- Surface roughness and profile
- Composite damage
- Media aggressiveness
- Crack closure

4.1 Summary of Battelle Laboratory Study

The following conclusions from the work carried out at ADM Test Facility in Montreal were presented in San Diego:

- Stripping rate for Type VII was comparable or slightly better than that for Type V (Acrylic)

- The Almen test results, which give an indication of the amount of surface stress induced by blasting, for Type VII were significantly lower than for Type V. The deflection was in the range of 0.002 in for Type VII and it reached a steady state while that for Type V was 0.006 or higher and had not reached a steady state level after 60 seconds of blast time.

- There was no blast residue on the surface of stripped aluminum panels using Type VII, thus no solvent wash was required after stripping. This is compared to Type V where a solvent wash is required to remove residual acrylic from the stripped surface.

- There was no damage to aluminum clad surfaces and no embedded media when stripping with Type VII.

- Fibreglass and Kevlar surfaces could be stripped using Type VII.

- Microscopic examination of the used media indicated that the Type VII retained its sharp edges while the Type V showed rounded edges resulting in reduced removal efficiency as the media is reused.

- The results of the crack closure test indicate that both Type V and Type VII media did not have any significant detrimental effect on crack length measurements.

- The Type VII is a drop-in replacement for Type V media and can be used in the same equipment.

4.2 Summary of Type VII Demonstration - FRCSW NI

The demonstration consisted of stripping various unusable pieces from several aircraft as test pieces to do a side-by-side comparison of Type V and Type VII. Several panels coated by Dockyard Laboratory Pacific were stripped, as were composite samples supplied from CF-18 parts by NRC. The demonstration also showed that selective stripping with Type VII is easily accomplished. An aluminum surface was selectively stripped of just the topcoat, leaving the primer surface intact, and also with the topcoat and primer removed, leaving Alodine treatment still in place.

On the second day, several of the blasting technicians tried the Type VII in the blast room. They all seemed to be quite impressed with the process and the ease of use. A roto dome was brought into the blast chamber for a test of the Type VII on fibreglass. The blasting technicians were impressed with the ability to remove the paint from the fibreglass with no apparent damage to the fibre surface. They commented that the coating from the rotor dome would normally be removed by hand sanding and that the Type VII would reduce the time to strip a dome considerably as well as being a cleaner process.

Some examples of parts stripped with Type VII media are shown in Figures 2 to 5. Figure 2 shows selective stripping of just the topcoat with Type VII leaving the primer intact. This is extremely difficult using Type V media. In Figure 3, all of the coating has been removed from a graphite epoxy panel with no exposure of the fibres.

Figure 2: Stripped part showing selective removal of polyurethane topcoat leaving epoxy primer intact

Figure 3: Graphite Epoxy panel showing no signs of fibre damage with complete paint removal.

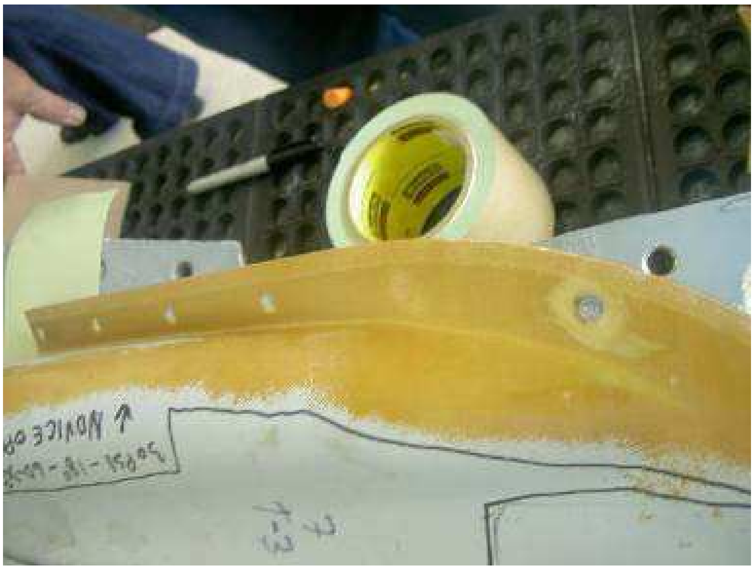

Figure 4: Stripped fibreglass part showing removal of coating and no fibre or fastener hole damage.

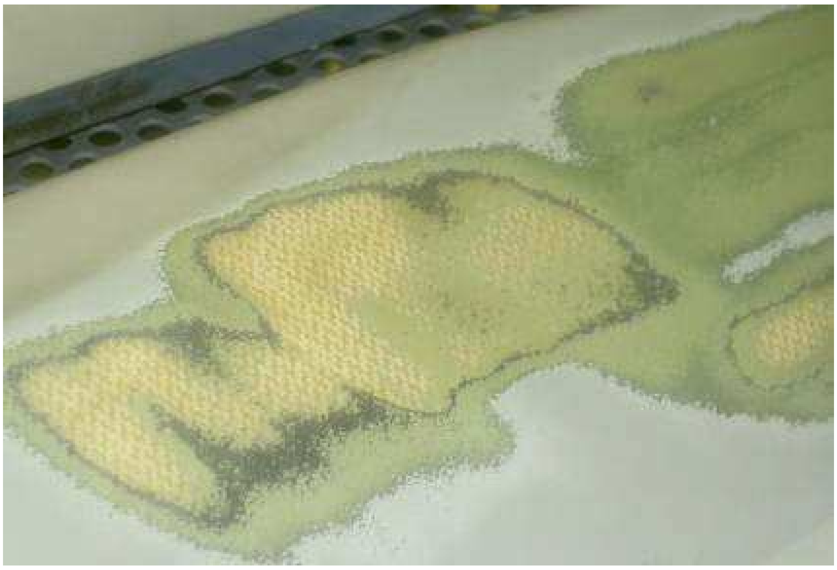

Figure 5: Kevlar surface stripped with Type VII, on the lower left all the coating was removed and in the upper right just the topcoat was removed. There was no indication of broken or exposed fibres.

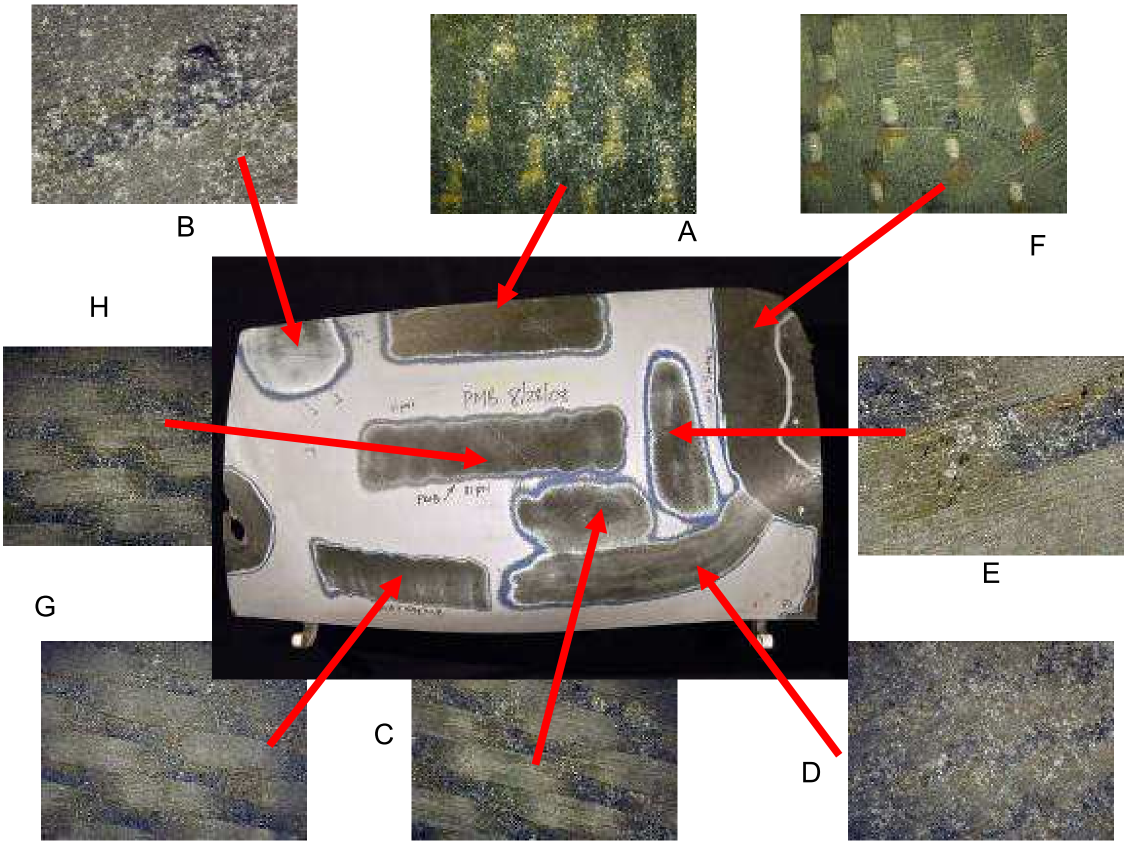

Figure 6: Blast Areas of an F18 Carbon Fibre Composite Panel using Type V and VII media as well as hand sanding. A – Type VII, B – Type VII, C – Type VII, D - Type VII, E – Hand Sanded, F – Type VII, G – Type VII, Flat Nozzle, H – Type V, 31 psi.

Figure 4 shows a fibreglass panel stripped with Type VII media; no damage was done to the fibre surface or to the fastener holes. Figure 5 shows a Kevlar part with selective stripping of the topcoat and complete removal of the coating system using Type VII media.

Figure 6 shows a carbon fibre composite part stripped with both Type V and Type VII media and hand sanded. Microscopic examination revealed no damage to the resin or fibres using Type VII media (C, D and F). The effect of hand sanding showing exposed and broken fibres can be readily seen in area E. Evidence of the coating remaining after selective stripping with Type VII can be seen in areas A and B. Exposed fibres can be seen in area H after stripping with Type VII media.

4.3 Conclusions and Recommendations From Battelle Study

From everything that was demonstrated and observed on these two days, it would appear that Type VII is a very good product and an easy drop-in replacement for Type V media. The Type VII could also be used on surfaces that are not currently stripped using Type V media. The only differences would be in the blast pressure, standoff distance and media flow rates used for the Type VII.

An economic study cited in the Battelle report [3] shows that switching to Type VII for complete aircraft (rotor and fixed wing) would reduce the paint stripping costs by 30-50%.

5 Conclusions

The following are the conclusions as a result of this study.

1. The current equipment is very old and near the end of its useful life

2. In many instances the operators were not familiar with the current blasting specification and maintenance procedures for the equipment

3. In most cases technical staff found the Type VII to be as good as or better than Type V

4. Some wheels were not being prepared for painting correctly and the anodized layer of a CF-18 main wheel had been damaged by previous coating removal procedures

5. The US Airforce, Lockheed Martin, Coast Guard, and US Army have adopted Type VII media for use on both aluminum and composite components

6. The Battelle evaluation showed that the Type VII media is as good or better than Type V media

7. The Type VII media has several advantages over Type V including lower Almen Test results, no residual media left on the blasted surface, can be used to strip graphite epoxy composites, IVD coated surfaces and fibreglass and is a drop in substitute in equipment currently used for Type V media

8. US studies have shown that there is also a cost saving in replacing Type V with Type VII

9. Type VII media could replace paint strippers and hand sanding for paint removal from composites and fiberglass

6 Recommendations

From the observations at the Wing facilities and at FRCSW NI as well as the Battelle study the Type VII media can be readily substituted for the Type V media in the current blast cabinets.

It is recommended that DTAES start using Type VII media as soon as possible. No changes to equipment are required and the cost of the media is similar to Type V. This will allow for a wider range of parts to be stripped. At least five Wings have had experience with this media and found it to be as good as or better than Type V media for their applications.

If the final decision is to change to Type VII media then the recommended blast parameters are listed in Table 6.

Table 6: Proposed Blast Parameters for Type VII Media

	Composites > 0.060”	**Aluminum/Steel** > 0.032”	**Aluminum/Steel** 0.016 - 0.032”
Nozzle Pressure	20 – 30 psi	35 psi	20 - 30 psi
Media Flow (1/2” Nozzle)	10 – 16 lb/min	10 – 16 lb/min	10 – 16 lb/min
Media Flow (3/8” Nozzle)	6 – 10 lbs	6 – 10 lbs	6 – 10 lbs
Nozzle Distance From Surface	8 – 18 inches	4 – 12 inches	8 – 18 inches
Impingement Angle	20 – 40 degrees	40 – 60 degrees	40 – 60 degrees

Note: Special care must be taken by technicians when blasting titanium which is known to spark when blasted with different types of Media. To prevent an explosion in the cabinet, excessive concentration of dust must be kept to the lowest level as possible by ensuring that the media particle size does not degrade to less than 125 micron (120 mesh) in size. Only a well ventilated cabinet or blast room shall be used when blasting A/C parts or equipment to be stripped via any type of Media.

Over the longer term, the aging blast equipment should be replaced due to ‘rust out’ of the current equipment. Additionally, features available on the new equipment will enhance productivity.

New training procedures should be implemented concurrently with the new equipment. This could be part of the project to purchase this equipment. Over the long term the Air Force should set up its own training program.

A routine maintenance program should be set up to ensure such things as the magnetic separator and the filter system are routinely inspected and cleaned.

7 References

[1] C-12-188-SRM/VC-001, Dry Media Stripping

[2] *"Comparative Assessment of Dry Blast Media for FRCSW NI"*, John T. Stropki (Battelle), Vinay Gadkari (Battelle) and Ray Paulson (FRCSW NI), Presented at the 2009 Air Force Corrosion Conference, Perry, GA, March 26, 2009

[3] John T. Stropki and Vinay Gadkari , "Demonstration and Optimization of a Bio-based Coating Removal Process at the Fleet Readiness Center Southwest – North Island (FRCSW NI"), Battelle Memorial Institute Report, prepared for United States Navy Fleet Readiness Center Southwest – North Island San Diego, CA. June 2009.

List of symbols/abbreviations/acronyms/initialisms

DND	Department of National Defence
DRDC	Defence Research and Development Canada
DRDKIM	Director Research and Development Knowledge and Information Management
R&D	Research & Development
DTAES	Directorate of Technical Airworthiness and Engineering Support
FRCSW NI	Fleet Readiness Center Southwest North Island, San Diego
DGAEPM	Director General Aerospace Equipment Program Management
ADM	Archer Midland Daniels
IVD	Ion Vapour Deposited
PMB	Plastic Media Blasting
SMB	Starch Media Blasting
AEO	Aircraft Engineering Officer
DCM	Dichloromethane
CEPA	Canadian Environment Protection Agency

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Five Airforce Wing Maintenance Facilities were visited to determine the current practices used to dry strip aircraft components using plastic media. It was observed that the current equipment is old (over 20 years) and is in need of replacement and that some of the blasting practices used by the technicians were not compliant with the current CF dry media blasting specification. A new non-toxic, biodegradable cornstarch dry stripping media (Type VII) was demonstrated to the technical staff. The use of Type VII media at other facilities (US Army, Airforce, Navy and Coast Guard) was examined to determine what would be required to introduce this media into fleet operations. The Type VII media has several advantages over the current media, such as no surface residue after blasting, odourless, can be used on composite and fibreglass surfaces and imparts less residual stress to the blasted surface. The Type VII media is a drop in replacement for the current media and no equipment changes are required if the Type VII media is specified for use by the Wing Facilities.

Cinq installations de maintenance des escadres de la Force aérienne ont été visitées dans le but de connaître les pratiques utilisées pour le décapage par projection d'un abrasif plastique sec des pièces d'aéronef. On a observé que l'équipement actuel avait déjà plus de vingt ans et qu'il devait être remplacé. De plus, les méthodes de décapage par projection d'un abrasif sec appliquées par certains techniciens n'étaient pas conformes aux normes des FC relatives à ce procédé et actuellement en vigueur. Une démonstration de décapage à sec a été faite devant le personnel technique avec de l'amidon de maïs, un nouveau matériau de décapage à sec, non toxique et biodégradable (Type VII). Une étude sur l'utilisation de ce matériau de décapage de type VII a été menée auprès d'autres installations, notamment celles de l'armée, de la force aérienne, de la marine et de la garde côtière des États-Unis, afin de déterminer ce qu'il faudrait pour intégrer l'utilisation de ce matériau à l'exploitation de la flotte. Cet abrasif conforme aux spécifications de type VII présente plusieurs avantages par rapport à celui qui est utilisé actuellement. En effet, propulsé par jet d'air, cet abrasif, qui ne laisse aucun résidu sur la surface, est inodore et peut être utilisé sur les surfaces en composites ou en fibre de verre. De plus, la contrainte résiduelle produite sur la surface traitée est nettement inférieure. Ce matériau de type VII est un substitut direct pour celui qui est utilisé actuellement et la prescription de son utilisation dans les installations de l'escadre ne nécessiterait aucun changement d'équipement.

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media blasting, plastic media stripping, Type VII media

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