Effective RN Decontamination of Sensitive Equipment Method Formulation Using Non-Radiological Contaminants

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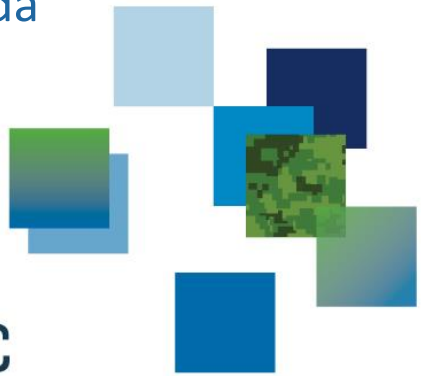

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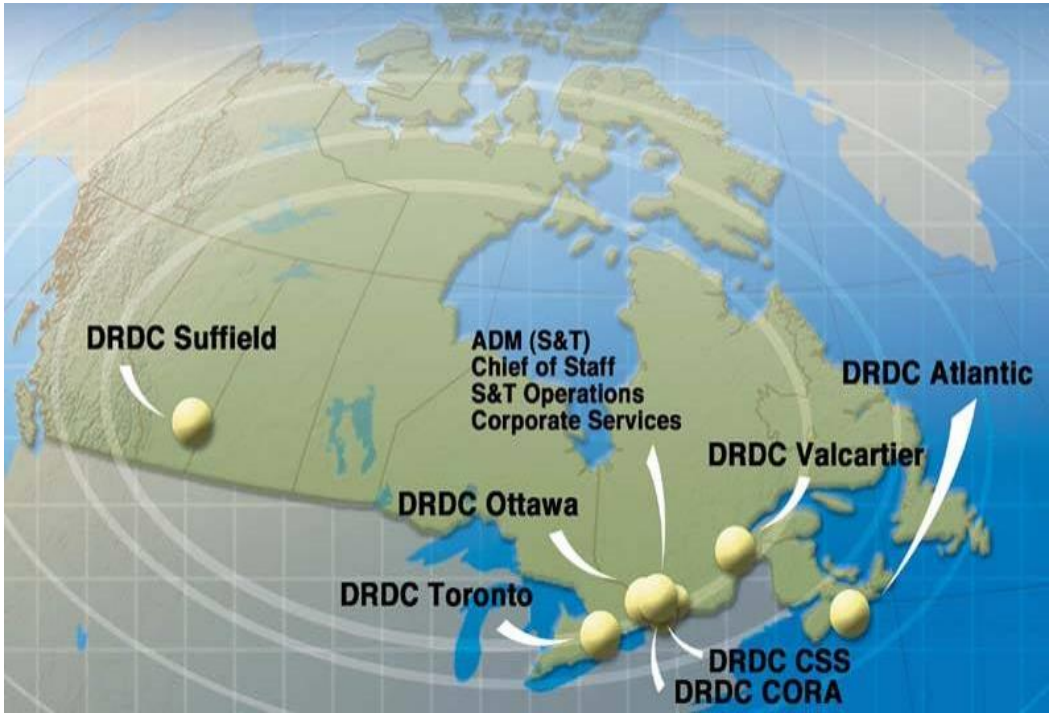
Outline

- DRDC Radiation and Nuclear (RN) Research Capability
  - *Transition*
- Decontamination of Sensitive Equipment (DOSE) Research
  - *Significance*
- DOSE Method Formulation
  - *Approach: Use of Non-Radiological Contaminants*
- Future Outlook
  - *Efficiency Testing*

Who are we?



DND

DRDC

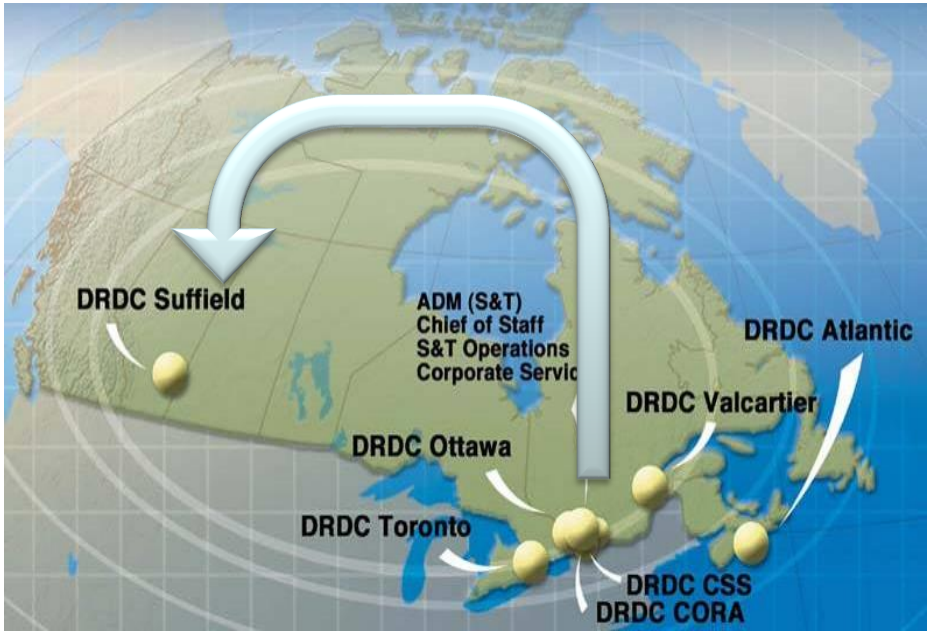
DRDC Ottawa/ Suffield

RNTG/Suffield

RNTG = Radiation and Nuclear Technologies Group

Transition

- DND has carried out RN Research at Ottawa Research Centre (ORC) for over six decades
- February 2017 - ADM(S&T) announced movement of RN Research program from ORC to Suffield Research Centre
  - Mandated to pursue the DOSE work



Radiological Decontamination

- Sensitive Equipment
  - Small individual equipment such as masks, helmets, electronics, optics and the interior of equipment
  - Essential for mission accomplishment
  - **Enabling Safety and Security**
- Hard problem faced by military:

  "How do you decontaminate something that would not survive the traditional military decontamination procedure?"
- Establishing RN Decon Program at SRC: DOSE work
  - Survivability/ functionality testing of representative sensitive equipment (e.g.; electronic and gun parts)

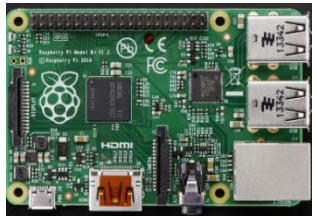
Objective

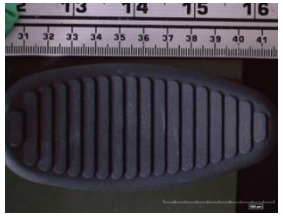
- Find formulations to decontaminate to allow reuse of RN-contaminated sensitive equipment
  - Reproducing a field situation, critical challenges are as follows:
    - Consider potential contaminants/ rad isotopes in play
    - Level of contamination (radioactivity)
    - Environmental conditions (Temperature, Humidity)
    - Effective decontamination procedures using commercial off-the-shelf (COTS) products
  - Use of non-rad contaminants to look at possible chemical reaction and the physical interaction of the contaminants onto the test pieces

Experimental Design

- Non-rad Contaminants
  - Ir and Co (powder) for ^{192}Ir and ^{60}Co, respectively
  - CsCl, (powder) for ^{137}Cs
  - $SrTiO_3$ (in solution) for $^{85,90}Sr$
  - Sand mixture with $NaNO_3$, $SrTiO_3$ and La_2O_3 for ^{24}Na, $^{85,90}Sr$ and ^{140}La, respectively for Nuclear fallout simulant (Sim NF): *Developed in collaboration with US EPA*
- Sensitive Equipment being examined
  - Electronic (Raspberry Pi™)
  - Gun Parts: Barrel, Butt Stock
- Environmental conditions: Ambient temperature; RH = Relative humidity
  - Ambient: ~ 60% RH; dwelling time, 1 hour
  - Dry : < 50 % RH; time, 7 days
  - Humid: > 60 % RH; time, 7 days
    - *Contaminants, contamination methods, environmental conditions are based on the SOPs from the CBR MOU*


Environ Chamber


Raspberry Pi


Butt Stock

Experimental Design (continued)

- Work Flow
  - Contamination
  - Dwelling/ conditioning
  - Decon approach
  - Inspection
- Contamination Methods
  - Shake n Bake (powder, dust)
  - Microspray (liquid)
- Decontamination Methods
  - Mostly mechanical removal from the surface
    - Vacuuming
    - Duct Tape
    - Compressed Air
    - Wet Wipes
    - Water
    - Cyber Putty (Cyber Clean™)

Experimental Design (continued)

- Equipment Damage Inspection
  - Visual & Microscopic (Hirox System) Inspection
    - Dry coupon
    - Takes 1-2 h for coupons to dry from Wet Wipes & Water Decon
- Functionality Testing
  - Raspberry Pi™

Contaminants on Gun Barrel

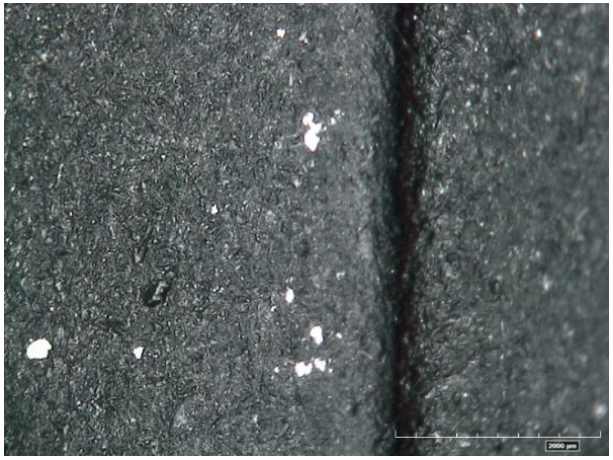
Raspberry Pi Testing

Hirox System

Results/ Discussion

- Gun Parts (Barrel, Butt Stock) Decon
  - CsCl and Ir- powder react with gun barrel; rust is observed on barrel coupon in humid condition, and using Wet Wipes and Water decon methods
  - Contaminants (e.g.; Sim NF, $SrTiO_3$ and Ir-powder) stick on butt stock coupons using Vacuum and Duct Tape methods
  - Decon using aqueous media is not an ideal option for gun parts

Humid, CsCl: Rusted Gun Barrel



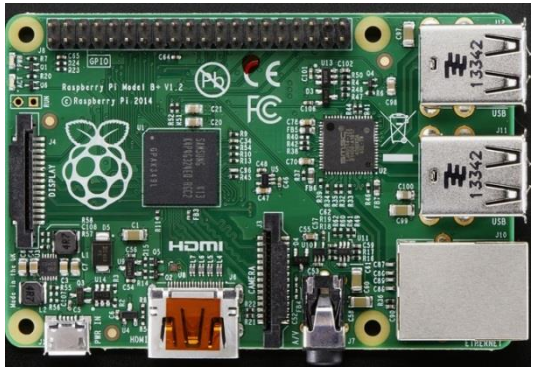
Contaminants on Butt Stock

Table: Comparison - Gun Parts Decon

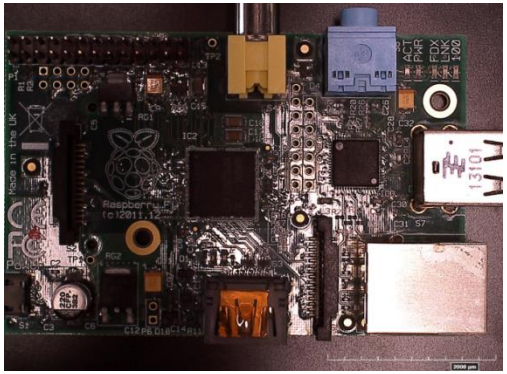
Methods	Observations/Hirox images	Prospect	Merit Rating
Vacuum	Vacuum does not remove much of any contaminants	Poor performance	**5**
Duct Tape	Tape does very little for the SimNF, Ir-powder and $SrTiO_3$	Poor performance	**4**
Wet Wipes	On order to use the wet wipes effectively, needed to hold both wipes and gun part in hands. It leaves clumpy fibers behind	Cumbersome	**3**
Water (Milli-Q)	$SrTiO_3$ and Ir-powder stick on the coupons, rust due to CsCl	Not a preferred method	**6**
Compressed Air	Works fine for most contaminants; requires a lot of effort and handling	Potential method but cumbersome	**2**
Cyber Putty (Cyber Clean™)	All contaminants are removed to a much greater extent compared to the other decon methods tested	Easy and convenient, best results	**1**

Results/ Discussion (continued)

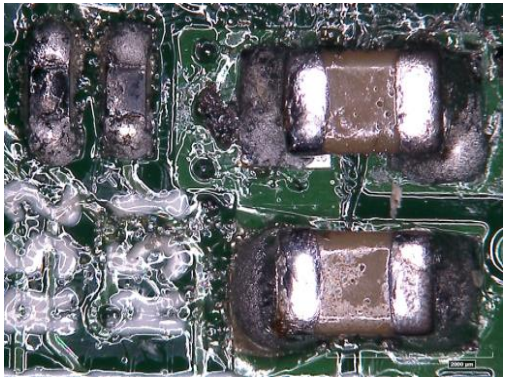
- Raspberry Pi™ Decon
  - Like gun barrel coupons, CsCl react with the Pi components resulting discoloration, corrosion and rust in humid condition and using the Wet Wipes and Water decon methods
  - Overall high retention of functionality of the Pis is observed from all the methods tested



Before contamination



Component discoloration



Component damaged

Table: Comparison - Raspberry Pi™ Decon

Methods	Observations/ Hirox images	Prospect	Functionality (%), n=24	Merit Rating
Vacuum	Works well, sometimes Sim NF sands stuck in components	Potential method	100	**2**
Duct Tape	Tape does very little for CsCl, Ir-powder and $SrTiO_3$, pin damaged	Cumbersome	75	**4**
Wet Wipes	Lots of fibers and residues are left behind, discoloration	Poor performance	100	**5**
Water (Milli-Q)	Cobalt powder sticks, CsCl reacts with components, rust is observed	Poor performance	96	**6**
Compressed Air	Works quite well with most contaminants, requires a lot of effort and handling	Potential method	100	**3**
Cyber Putty (Cyber Clean™)	Cyber Putty takes off most and sometimes all of the contaminants, no rust or damage is observed	Easy and convenient, best results	96	**1**

Conclusions

- Several decon approaches are examined in order to define a logistically and operationally simple method for sensitive equipment. The following recommendations are proposed:
  - Aqueous methods have deleterious effect on the equipment
  - Compressed Air is a promising method though it is a bit cumbersome
  - Use of Cyber Clean™ scores the highest caliber for both the gun parts and the Raspberry Pi™
  - Consider exploring the effectiveness of Cyber Putty using some other putties with different viscosities
- Future Outlook
  - Apply the Putty Method for decon efficiency estimation using short- and long-lived rad isotopes

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