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Cold Rapid Airfield Damage Repair (CRADR) Final Report

U.S. Army Engineer Research and Development Center U.S.
Air Force Civil Engineer Center

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This cover page has been added to the final report for this Coalition Warfare Program project to conform to current policy that requires science and technical information (STI) created or acquired in the execution of research and engineering activities to be documented and sent to Defense Technical Information Center (DTIC) in accordance with DoD Instruction 3200.12 (Reference (a)). DTIC's mission focuses on the dissemination of science and serves as a library to the community.

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Executive Summary

Original Project Goals and Objectives

The original project goals for the Cold Rapid Airfield Damage Repair (CRADR) project consisted of characterizing existing solutions in the laboratory at extremely cold temperatures, developing new repair materials, evaluating the performance of cold weather repair equipment, and completing a technology integration experiment in an extreme cold weather environment.

Final Project Tasks List and Schedule

(Insert from monthly report)

Final Funding Summary

Funding Summary	FY19	FY20	Total
CWP	\$ 100,000	\$ 300,000	\$ 400,000
US Financial	\$ 400,000	\$ 0	\$ 400,000
US Non-Financial	\$ 0	\$ 0	\$ 0
Foreign Financial	\$ 0	\$ 0	\$ 0
Foreign Non-Financial	\$ 800,000	\$	\$ 800,000
Total	\$ 1,300,000	\$ 300,000	\$ 1,600,000

Overall Project Performance:

Actual Project Accomplishments

Existing solutions were successfully evaluated and documented in the laboratory, new repair materials and methods were developed, and cold weather repair equipment and processes were successfully tested during a technology integration experiment in January 2020. Repairs conducted using new and existing materials all sustained the target number of simulated aircraft passes.

To what level were the original goals met?

The existing goals were fully met. Laboratory characterization was successfully documented, and new repair materials and methods were evaluated during the technology integration experiment along with cold weather equipment.

Outcome of Related Demonstrations and Tests

The technology integration experiment was successfully conducted on Goose Bay Air Base, Canada in January 2020. The full-scale experiment validated results obtained from the laboratory. Repairs were able to sustain the target number of simulated aircraft passes and no serious equipment issues were observed in an actual cold weather environment with an ambient temperature of approximately 0°F.

Operational Feedback

Troop feedback from the demonstration was positive. The Canadian airmen indicated the new repair technologies tested were easily trained and implementable. They also reported no serious equipment issues in the extremely cold environment.

Technology Readiness Levels (TRLs):

Identify the TRLs at the start and end of the CWP project. List the technologies that will be matured in the box below. Use the letters generated by the list to indicate the TRL for each at the start/end of the project. CWP FAQs contain more detail on the TRL definitions.

Technologies:			A. Extreme Cold Weather Materials B. Extreme Cold Weather Equipment C. Extreme Cold Weather Repair Processes
Start	End	TRL	TRL Definition
		1	Basic principles observed and reported
		2	Technology concept and/or application formulated
		3	Analytical and experimental critical function and/or characteristic proof of concept
A, C		4	Component and/or breadboard validation in a laboratory environment
B		5	Component and/or breadboard validation in a relevant environment
		6	System/subsystem model/prototype demonstration in a relevant environment
	A, C	7	System prototype demonstration in an operational environment
	B	8	Actual system completed and qualified through test and demonstration
		9	Actual system proven through successful mission operations

Development of associated Doctrine Development

(Includes Concept of Employment, Concepts of Operations, and Tactics, Technique and Procedure)

Recommended procedures for crater repair in extreme cold temperatures developed from CRADR project will be recommended for inclusion into the existing U.S. Air Force Rapid Airfield Damage Recovery (RADR) Tactics, Techniques, and Procedures document. The same recommendations will be provided to Canadian representatives so they can incorporate the findings into their guidance documents as necessary.

Related Forums and Initiatives

Future Plans

Transition Goal:

What was the transition aim? Double click to check. Select one that best fits the follow-on activity for this effort.

- Inform DoD decisions on new or existing programs
- Further development by lab
- Transition to a program manager for integration or further development of a system
- Transition technology to a program manager for stand-up of a new program
- Transition to a program manager for procurement
- Other: Explain

Transition Plan:

Describe what transitioned from this project (current or in current planning).

The procedures for conducting crater repairs in extreme cold temperatures using a variety of methods are the primary items being transitioned. Some of the methods do require supplies and equipment in excess of currently fielded repair kits, so specifications for those items will be developed in the procurement stage. Specifically a snow blower attachment for compact track loaders (CTLs) is required to distribute snow properly before it can be blended with additives and compacted as a backfill. Specifications for the cellulose additive will also be developed as necessary.

Partner Transition:

What is the partner transitioning from this project?

Canadian officials are considering incorporation of the cold weather repair procedures and materials into their guidance documents, as well as procurement of the proper equipment.

Next Phases:

What are the planned future engagements? Will it involve any other DoD funding programs?

- JCTD
- FCT
- DAC
- SBIR
- Service Intl Funds (Nunn, ICR&D)
- Other

AFCEC is sponsoring a similar experiment planned for March 2022 with the 773rd Civil Engineer Squadron on Joint Base Elmendorf-Richardson, Alaska in conjunction with the Arctic EDGE exercise.

Technologies and procedures developed from the CRADR demonstration plan to be introduced to U.S. Airmen, along with evaluation of technologies developed during the Expedient and Expeditionary Airfield Damage Repair (E-ADR) JCTD in a cold weather environment.

Future Partner Engagement:

Will future efforts involve current or other foreign partners?

Foreign partners will be invited to future engagements to observe future tests and demonstrations. Data and information collected will be shared with the foreign nation as allowed. Technical support concerning the new procedures and materials developed from the CRADR project will also be provided as needed.

Summary

Overall, the CRADR project was very successful. The goals and objectives were achieved and new technologies were demonstrated in an extremely cold environment with great cooperation from our Canadian partners. Three backfill and two capping methods for crater repairs were demonstrated in extremely cold temperatures (approximately 0°F). Repairs withstood the target number of simulated aircraft passes, and all pertinent characterization data was obtained. No serious equipment issues were reported, even when operating in the extremely cold temperatures. The new compacted snow and ice technologies are being recommended for consideration into both U.S. and Canadian guidance documents for crater repair in cold temperatures.

Tips for Success: Please share with us anything you found helpful in your efforts that may help future project managers.

Logistics is a critical factor when tests are conducted in a foreign country. Ensure adequate lead time is available for shipping, internal travel paperwork, and other similar tasks.

APPENDIX A –Architecture / Graphics



Pavement cutting



Breaking



Excavating



Snow-water slurry backfill

or



Sand-filled geocell
backfill

or



Rapid-setting flowable fill
backfill



Rapid-setting concrete
cap placement

or



Fiber reinforced polymer
(FRP) matting installation

Acronym Appendix

Add the acronyms you used in the nomination form in the table below. Also, spell out the acronyms in the form when first used.

<i>ADR</i>	<i>Airfield Damage Repair</i>
<i>AFCEC</i>	<i>Air Force Civil Engineer Center</i>
<i>AFRL</i>	<i>Air Force Research Laboratory</i>
<i>AIP</i>	<i>Approval in Principle</i>
<i>AT&L</i>	<i>Acquisition, Technology and Logistics</i>
<i>AS</i>	<i>Air Superiority</i>
<i>CONOPS</i>	<i>Concept of Operations</i>
<i>COCOM</i>	<i>Combatant Commander</i>
<i>CRREL</i>	<i>Cold Regions Research and Engineering Laboratory</i>
<i>CWP</i>	<i>Coalition Warfare Program</i>
<i>DISA</i>	<i>Defense Information Systems Agency</i>
<i>DND</i>	<i>Department of National Defense (Canada)</i>
<i>DoD</i>	<i>Department of Defense</i>
<i>EAR</i>	<i>Export Administration Regulations</i>
<i>ECT</i>	<i>Enterprise Capability Collaboration Team</i>
<i>ERDC</i>	<i>Engineer Research and Development Center</i>
<i>EUCOM</i>	<i>European Command</i>
<i>FDO</i>	<i>Foreign Disclosure Office</i>

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GSL	<i>Geotechnical and Structures Laboratory</i>
IPL	<i>Integrated Priority List</i>
IPO	<i>International Programs Office</i>
ITAR	<i>International Traffic in Arms Regulation</i>
JCTD	<i>Joint Capability Technology Demonstration</i>
MOA	<i>Memorandum for Agreement</i>
NATO	<i>North Atlantic Treaty Organization</i>
NORTHCOM	<i>Northern Command</i>
NSA	<i>National Security Agency</i>
OSD	<i>Office of the Secretary of Defense</i>
PACOM	<i>Pacific Command</i>
RADR	<i>Rapid Airfield Damage Recovery</i>
RDT&E	<i>Research, Development, Test, and Evaluation</i>
SIGINT	<i>Signals Intelligence</i>
SME	<i>Subject Matter Expert</i>
STANAG	<i>Standardization Agreement</i>
STIPL	<i>Science and Technology Integrated Priority List</i>
TRL	<i>Technology Readiness Level</i>
TTP	<i>Tactics, Techniques and Procedures</i>
WRM	<i>War Reserve Materials</i>

Points of Contact

Fill out POC information for all organizations that involved in the project and the supporting sponsors. List at least two POCs per nation involved. *Add or remove rows and tables as necessary. Can be copied from Annex F: Quarterly Report.*

	Name	Organization	Location (City, State)	Phone	Email
US Project Team					
U.S. Lead (DoD)	Will Carruth	ERDC-GSL	Vicksburg, MS	601-634-2492	William.D.Carruth@usace.army.mil
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Other Government Members					
Team Member (Industry)					
Team Member (Academia)					
Support Team <i>List POCs that have helped you with the project nomination and reviewed for executability</i>					
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Country Desk Officer					
IPO Agreements Negotiator					
Information Assurance		NSA			
Accreditation		DISA			
COCOM S&T Advocates					
Project Endorsers					



Director Coordination

Final Report must include final coordination with the GO/FO-Level Laboratory Director/Deputy Director.

NAME	TITLE	ORGNAIZATION	DATE	DIGITAL SIGNATURE