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Integrated Multispectral Camouflage for Mobile Weapon Systems (an effectiveness evaluation)

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ABSTRACT

The surveillance capabilities of armed forces throughout the world have increased tremendously during the past few years. The threat to military assets is multispectral and Camouflage, Concealment and Deception (CCD) measures must be provided in all the proper spectral regions in order to counter this threat. At the end of 1997, Director Soldier Systems Program Management (DSSPM) tasked Defence Research Establishment Valcartier (DREV) to determine the overall effectiveness of new mobile camouflage equipment against modern imaging systems from the ultraviolet (UV) to the thermal infrared (IR) spectral regions. An Integrated Multispectral CAMouflage for Vehicle Systems (IMCAVS) was designed by Barracuda Technologies of Sweden for the newly introduced Canadian Forces (CF) reconnaissance vehicle: the Coyote. To verify the enhanced characteristics of this new generation of camouflage equipment, a trial, under the umbrella of NATO, was conducted at CFB Valcartier in August 1998.

This paper presents results and comments on the specially designed concealment suite for the Coyote vehicle. This experimental concealment suite is designed to reduce the signature of the vehicle in the UV, visible and in both infrared spectral bands. It describes the design and characteristics of the Coyote concealment suite, a description of the experimental conditions and the instrumentation deployed during this trial. An indication of the results of a human perception experiment on the performance of the concealment suite in the visible band and electro-optical measurements taken in the UV and the two infrared (IR) bands are presented. Additionally, FLIR over flights conducted by CF188 aircraft are referenced. Finally, some conclusions and recommendations are tabled.

PROGRAMME OF WORK

The following milestones were established for the planned field trial:

- a. Jan 98 – Signature analysis and design of camouflage suite;
- b. Apr 98 – Plan of field trial;
- c. Jun 98 – Production of hardware;
- d. Aug 98 – Field trial;
- e. Jan 99 – Review of data collected at field trial;
- f. Oct 99 – National data evaluations (CA, GE, NL, IT, UK);
- g. Mar 00 – Comparisons of national results; and,
- h. Nov 00 – Final report to NATO RTO SCI (NATO CONFIDENTIAL).

TECHNICAL REQUIREMENTS FOR THE CAMOUFLAGE SUITE

A series of meetings were held between the Canadian Forces equipment users, the department of National Defence technical authorities and the camouflage producers to determine the requirements of the camouflage suite. The following requirements evolved:

- a. to be designed for in-service combat vehicles;
- b. to be for use in all tactical situations;

- c. to be able to counter widely used sensors;
- d. to be able to counter recognition and identification;
- e. to be able to reduce the multispectral signature;
- f. for use on moving combat vehicles;
- g. enable rapid deployment and striking; and,
- h. be a low cost add-on (not active or stealth)

APPLICATION OF SUITE WITH RESPECT TO COYOTE

The Coyote reconnaissance vehicle is a wheeled armoured vehicle that moves and stops frequently. It is fielded in two versions; one equipped with mast mounted sensors and the other with tripod mounted sensors having a remote capability. The stipulated technical requirements applicable to Coyote led to the development of a three stage camouflage suite (see Figures 1, 2, 3, and 4), as follows:

- a. a permanent on board camouflage kit, (S1);
- b. a permanent, onboard rapidly deployable short halt kit, (S2); and,
- c. a long halt kit, (S3).



Figure 1 – The bare Coyote



Figure 2 – The permanent camouflage (S1)

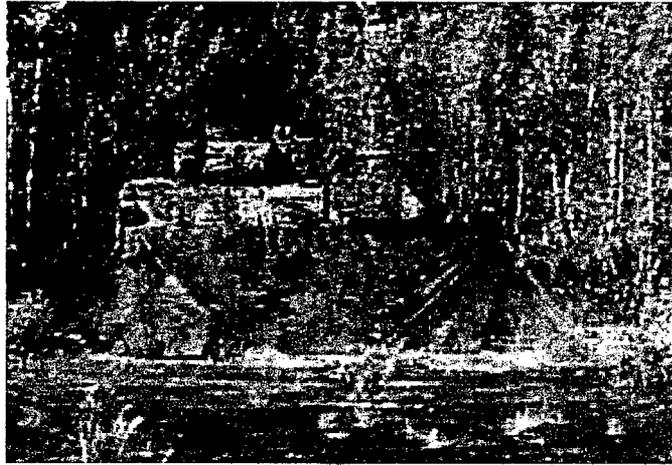


Figure 3 – The short halt kit (S2)



Figure 4 – The long halt kit (S3)

FIELD TRIAL BACKGROUNDS AND COYOTE DEPLOYMENT

The backgrounds selected into which the target vehicle was to be deployed were considered typical of the temperate northern hemisphere. The Coyote was deployed into what could be considered the most difficult of camouflage positions. As depicted in Fig. 4, one background was the front edge of a low wood line while the second background selected was in the middle of an open grassland plain interspersed with sandy patches.

DATA COLLECTION AND ANALYSIS

The data collections for the field trial consisted of:

- a. imagery from helicopters;
 - (1) 35 mm slides;
 - (2) video (moving and still)
 - (3) FLIR
- b. calibrated imagery for ground truthing (UV, VIS, NIR, M & L Wave IR)
- c. over flights from tactical aircraft with FLIR targeting systems

The analysis of the data sets was conducted by Canada, Germany, Italy the Netherlands and the United Kingdom. In several cases selected data sets were subjected to a round-robin analysis conducted in different countries. Several sets were analyzed using different models based on the same spectral domain.

TYPES OF ANALYSIS

The following figures (Figures 5 – 11) illustrate the types of analysis conducted and show unclassified comparative results:

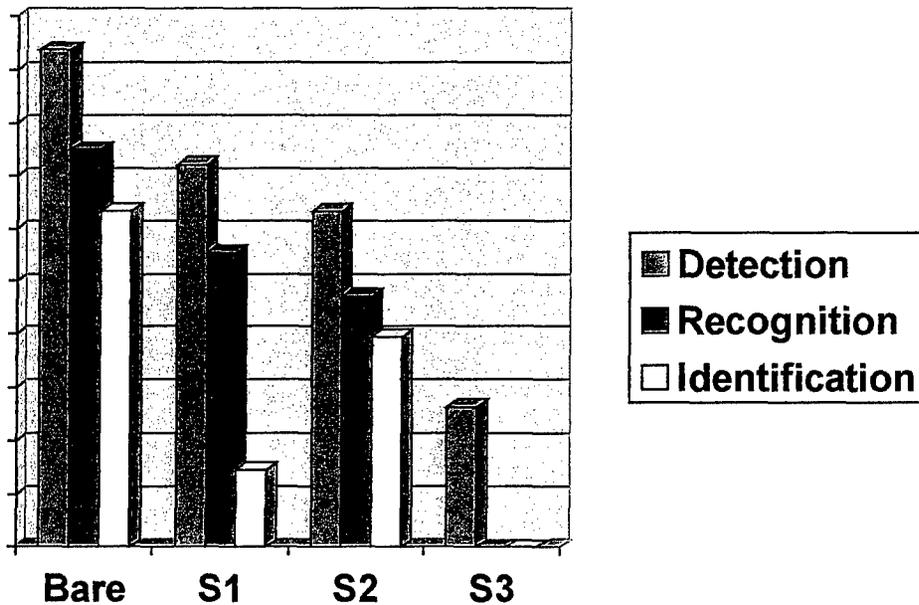


Figure 5 – Visual observation ranges in Metres

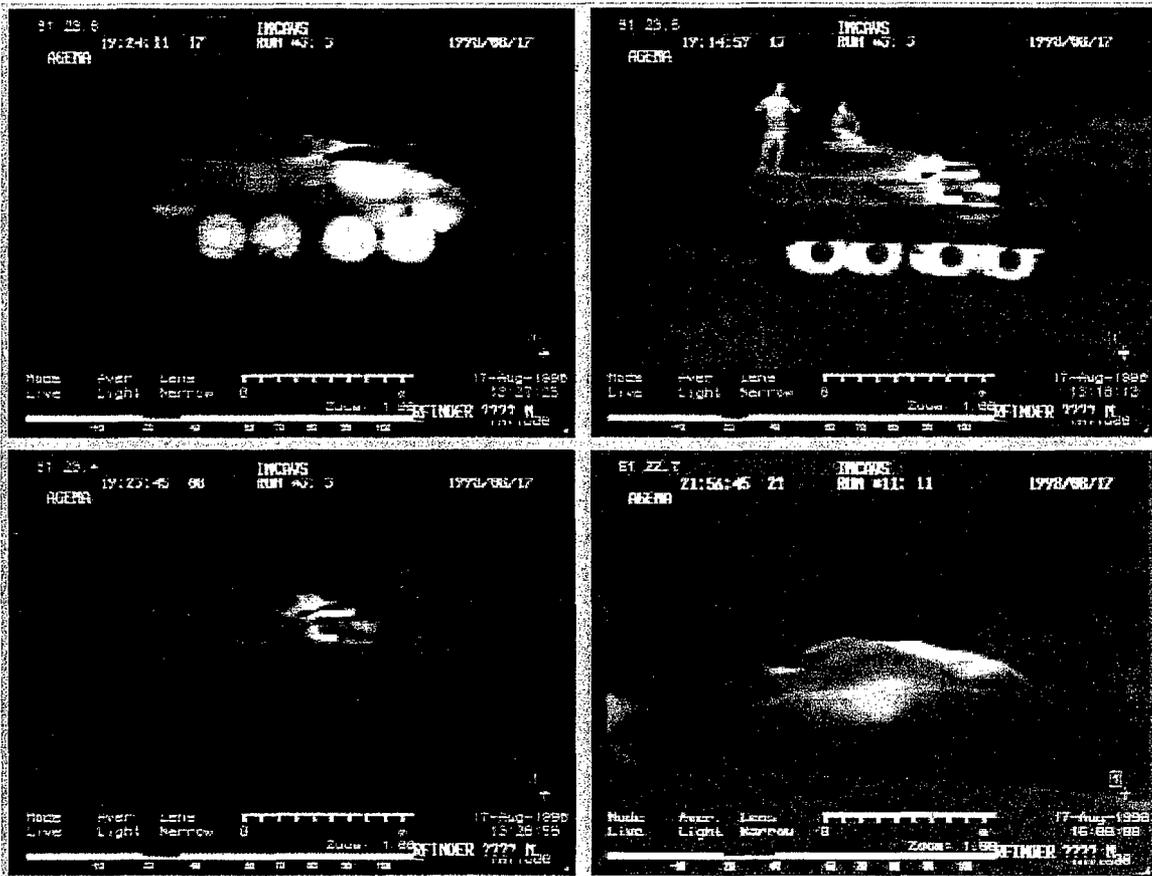


Figure 6 – LWIR ground truth imagery
(UL – Bare / UR – S1 / LL – S2 / LR – S3)

**Simulated attacks by helicopter using thermal imager:
nighttime flights**

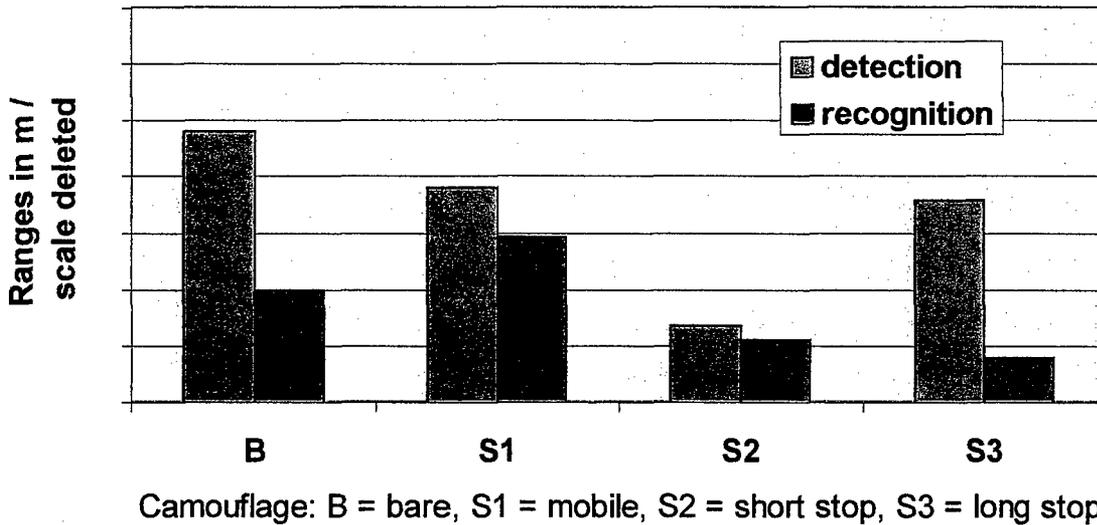


Figure 7 – Simulated attacks by FLIR equipped helicopter



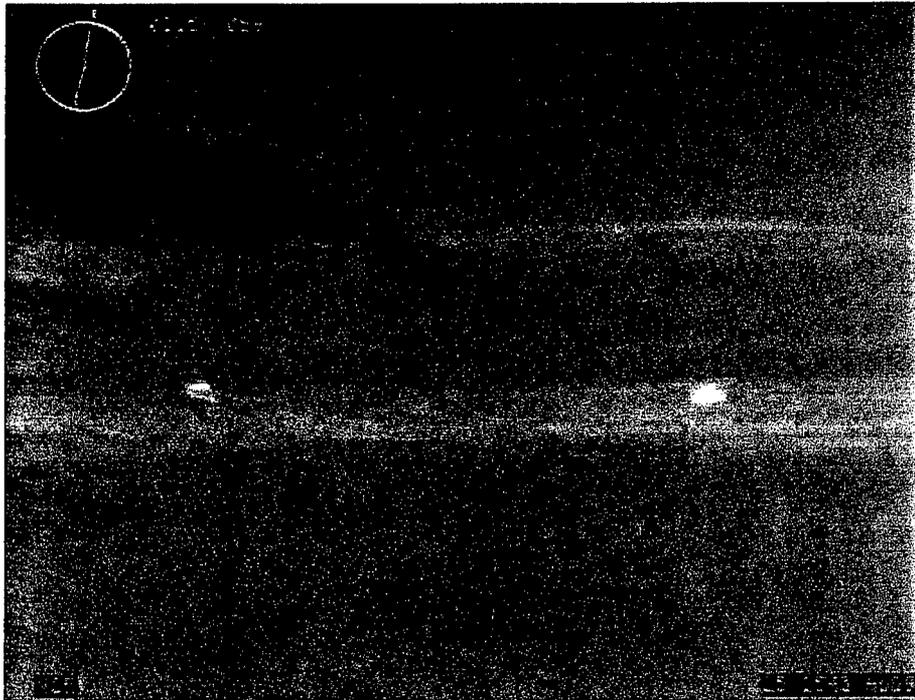


Figure 8 – Tactical MICROFLIR LWIR image of moving Coyote targets at 1 Km
RIGHT SIDE OF VEHICLES
(COYOTE LEFT - S1 / COYOTE RIGHT – Bare)



Figure 9 – Tactical MICROFLIR LWIR image of moving Coyote targets at 1Km
LEFT SIDE OF VEHICLES
(COYOTE LEFT – S1 / COYOTE RIGHT – Bare)

FLIR observation of moving targets in open terrain

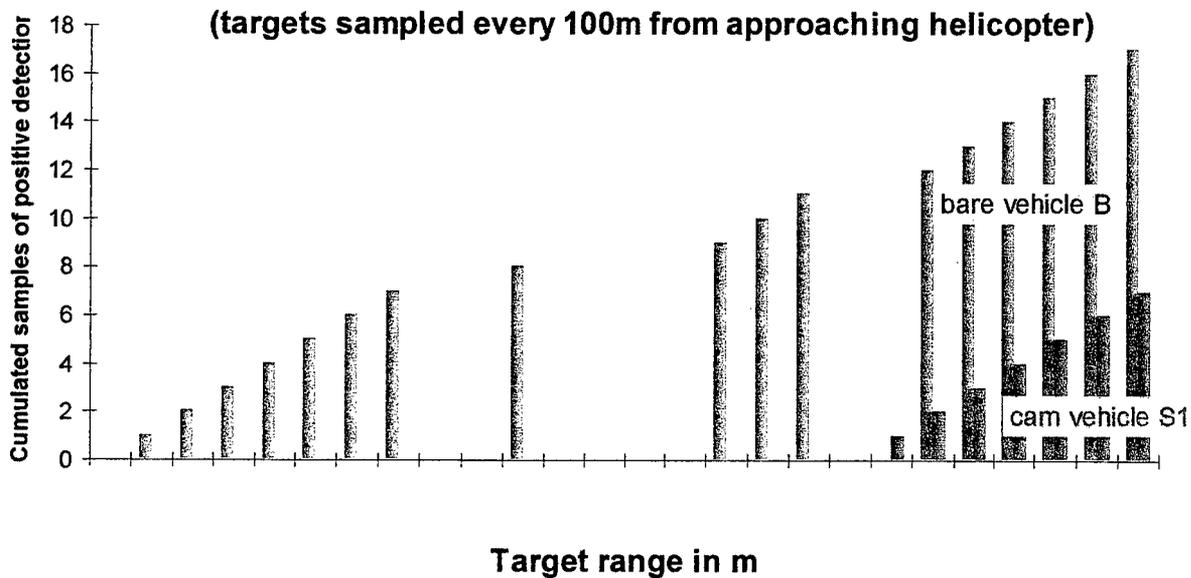


Figure 10 – FLIR observations from LONG to SHORT ranges (LONG ranges L)



Figure 11 – Targeting FLIR image (BLACK hot) of Coyote targets (engines running / 21:19 hrs local)

CUMULATIVE RESULTS OF THE ANALYSIS EXPRESSED AS CAMOUFLAGE GAIN

Figure 12 (below) represents the accumulated results of all of the analysis pertaining to the field trial. When used with judgment it is a useful tool for requirements staff in attempting to decide the “worth” of camouflage and signature reduction.

% REDUCTION IN DETECTION RANGE			
CONDITION	PERMANENT	SHORT HALT	LONG HALT
Day - Visual	20%	38%	66%
Night - Thermal	32%	72%	25%

Figure 12 – Accumulated results of field trial
(LONG HALT M&LWIR is a result of warm exhaust gases being trapped under the S3 kit)

SOME CONCLUSIONS FROM THE FIELD TRIAL

The design concept and engineering implementation of stages of camouflage proved beneficial in that:

- a. various tactical situations could be addressed individually through the use of modules;
- b. there was reduced workload for the soldiers;
- c. a significant degree of multispectral signature reduction was achieved; and,
- d. a basis for establishing the fiscal “worth” of signature reduction was achieved.

SOME RECOMMENDATIONS FROM THE FIELD TRIAL

The following general concealment considerations were documented:

- a. Signature management must be addressed as an integral part of project management and be part of all initial engineering activities associated with new equipment procurement;
- b. In-service vehicles considered to be high value assets should be retrofitted with customized camouflage kits appropriate to their role;
- c. Vehicles that move rapidly and at short notice should be equipped with a suite of multispectral camouflage kits to facilitate concealment appropriate to their role and particular operational exigencies;
- d. Means to direct and duct exhaust gases and to conceal equipment exhaust systems must be permanently installed;
- e. The effectiveness of concealment suites must be tested in all climatic regions; and,
- f. The lack of truly robust and cost efficient evaluation tools to measure camouflage effectiveness must be further considered.

OTHER RELATED NATIONAL PROJECTS



Figure 13 – QUICKCAM Kit for UK MBT CHALLENGER II



Figure 14 – Modular kit for GE MBT LEOPARD 2A4

REFERENCES

- [1] Multiple authors, 2001, "Integrated Camouflage for Mobile Weapons Systems – An Effectiveness Study", NATO RTO – TM 019AC/323-005)TP/30 NATO CONFIDENTIAL, Paris, France.