Defence Research and Development Canada
Recherche et développement pour la défense Canada

DEFENCE R&D DÉFENSE

SAREX 2007 search event data analysis

G. Toussaint
DRDC Valcartier

Defence R&D Canada – Valcartier
Technical Memorandum
DRDC Valcartier TM 2008-329
February 2009

Canada

SAREX 2007 search event data analysis

G. Toussaint
DRDC Valcartier

Defence R&D Canada – Valcartier

Technical Memorandum
DRDC Valcartier TM 2008-329
February 2009

Principal Author

Geneviève Toussaint

Defence Scientist

Approved by

Dennis Nandlall

Section Head

Approved for release by

Christian Carrier

Chief Section

Abstract

The Advanced Integrated Multi-sensing Surveillance (AIMS) system technology demonstration program (TDP) was designed to improve the surveillance and reconnaissance capabilities of the Canadian Forces (CF), particularly at night and in degraded weather conditions. Thereby, to evaluate the utility of this system for Search and Rescue (SAR) operations, evaluation criteria were developed and presented in previous publications. Also, to improve the previous published database, this memorandum presents the analysis of the data collected at SAREX 2007 using the same evaluation criteria.

The first part of this memorandum presents a short description of the SAREX 2007 search event. Then, SAREX 2007 results are presented and the analysis of the data is made using different evaluation criteria such as: target location accuracy, target identification, number of call-arounds, false detection rate, probability of detection and number of targets. Finally, a discussion is presented and recommendations are provided.

Résumé

Le programme de démonstration de technologies (PDT) du système perfectionné de surveillance multi-capteurs intégré (AIMS) a été conçu pour améliorer les capacités de surveillance et de reconnaissance des Forces canadiennes (FC), particulièrement la nuit et dans des conditions météorologiques dégradées. Ainsi, pour évaluer l'utilité du système lors des opérations de recherche et sauvetage (SAR), des critères d'évaluation ont été développés et présentés dans des publications précédentes. Aussi, pour augmenter l'étendue des données publiées précédemment, ce mémorandum présente l'analyse des données recueillies lors du SAREX 2007 en utilisant les mêmes critères d'évaluation.

La première partie du mémorandum présente une courte description de l'événement de recherche du SAREX 2007. Ensuite, les données du SAREX 2007 sont présentées et l'analyse des données est effectuée à l'aide de critères d'évaluation tels que : précision de la position d'une cible, identification d'une cible, nombre de retours en arrière, taux de fausses détections, probabilité de détection et nombre de cibles. Finalement, une discussion et des recommandations sont formulées.

This page intentionally left blank.

Executive summary

SAREX 2007 search event data analysis

G. Toussaint; DRDC Valcartier TM 2008-329; Defence R&D Canada – Valcartier; February 2009.

The Advanced Integrated Multi-sensing Surveillance (AIMS) system technology demonstration program (TDP) was designed to improve the surveillance and reconnaissance capabilities of the Canadian Forces (CF), particularly at night and in degraded weather conditions. Since the intent is that AIMS participate in the SAREX 2009, it was considered useful for the operational research (OR) analyst attached to the project to attend previous SAREX exercises to collect data from experienced crews flying on different platforms. The analysis of the data collected will help evaluate the utility for the CF to use the AIMS system during search and rescue (SAR) operations. Thus, by using some of the evaluation criteria developed in previous publications, this memorandum presents the analysis of the data collected at SAREX 2007, which improves the database presented in these publications.

The main conclusions drawn from the data analysis of this memorandum are:

1. **Target location accuracy**: As expected, few targets were detected under the aircraft since part of this area is out of reach for SAR technicians (techs)/spotters. Also, all the targets were detected within 0.8 nautical miles (NM), which is within the 1 NM expected.

2. **Target identification**: It was not possible to demonstrate which one, between colour and shape, was the most useful parameter to detect an object from its background. Therefore, it could be suitable for AIMS to be equipped with a high definition colour screen to maximize the chances of detecting a target.

3. **Number of call-arounds**: The majority of call-arounds were made for nothing. It would be preferable to evaluate this criterion during a search when there would be sufficient time to perform a good search.

4. **False detection rate**: It was not possible to draw any conclusion from the false detection rate. It is suggested to compare only the false detection rate obtained using AIMS to that obtained without AIMS for the same SAREX event.

5. **Probability of detection**: It was not sufficient to use only the data obtained from SAREX 2007 to reach a conclusion on the probability of detection (POD). However, combining the data from 1988 to 1991, 1993 and 2004 to 2007, we can confirm that the POD for passive targets is significantly less than that for cooperative targets.

6. **Number of targets**: Past search events data were compiled to determine the number of targets that were necessary to demonstrate, with 95% confidence, an improvement in the POD. Since we do not know yet the POD of the SAREX search event in which AIMS will participate, these results can only be used as an indication of the number of targets required.

Nevertheless, as many targets as possible should be employed for the SAREX search event in which AIMS will participate.

The analyst on the AIMS TD (technology demonstration) should gather data at SAREX 2008 and should be ready for the AIMS flight trials in SAREX 2009. Also, as discussed in a previous memorandum, it is important to mention, that if the use of AIMS at the search event shows an equal or a better performance than not using it, then it will be possible to state that the use of this system will be very useful for SAR operations. However, the opposite would not necessarily be true since some factors present in a SAREX search event would be absent in a real SAR incident and could influence negatively the performance of the AIMS system. Some of these factors are: AIMS will be flying with a different type of aircraft than the other teams and they will have fewer SAR techs/spotters than what is normally prescribed for a SAREX search event. Also, after the AIMS trials at the SAREX, only one set of data will be used for comparison purposes and no search will take place at night time and in bad weather, conditions for which the system was especially designed to improve search efficiency. Finally, in a SAREX search event, there are usually more cooperative targets than passive targets whereas the AIMS system has sensors that could help finding passive targets.

Sommaire

SAREX 2007 search event data analysis

G. Toussaint; DRDC Valcartier TM 2008-329; R & D pour la défense Canada – Valcartier; Février 2009.

Le programme de démonstration de technologies (PDT) du système perfectionné de surveillance multi-capteurs intégré (AIMS) a été conçu pour améliorer les capacités de surveillance et de reconnaissance des Forces canadiennes (FC), particulièrement la nuit et dans des conditions météorologiques dégradées. Étant donné que l'intention est qu'AIMS participe au SAREX 2009, on a jugé utile que l'analyste en recherche opérationnelle (OR) affecté au projet assiste aux exercices précédents du SAREX pour recueillir des données d'équipages expérimentés volant sur différentes plates-formes. L'analyse des données récoltées va contribuer à évaluer l'utilité du système AIMS pour les FC durant les opérations de recherche et sauvetage (SAR). Donc, en utilisant plusieurs critères d'évaluation développés dans des publications précédentes, ce mémorandum présente l'analyse des données recueillies au SAREX 2007, ce qui augmente l'étendue des données de ces publications.

Les conclusions principales tirées de l'analyse des données de ce mémorandum sont:

1. **Précision de la position d'une cible** : Tel que prévu, moins de cibles ont été détectées directement sous l'avion puisqu'une partie de cette zone est invisible aux techniciens (techs) SAR/observateurs. Également, toutes les cibles ont été détectées à l'intérieur de 0.8 mille nautique (NM), ce qui est à l'intérieur du 1 NM attendu.

2. **Identification d'une cible** : Il n'a pas été possible de démontrer entre la couleur et la forme quel était le paramètre le plus important pour détecter un objet dans son arrière-plan. Donc, il serait avantageux pour AIMS d'être équipé d'un écran couleur à haute définition pour maximiser les chances de détecter une cible.

3. **Nombre de retours en arrière** : La majorité des retours en arrière ont été effectués pour rien. Il serait préférable d'évaluer ce critère durant une recherche où il y aurait suffisamment de temps pour effectuer une bonne recherche.

4. **Taux de fausses détections** : Il n'a pas été possible de tirer de conclusion à partir du taux de fausses détections. Toutefois, on suggère de comparer seulement le taux de fausses détections obtenu avec AIMS à celui obtenu sans AIMS pour le même événement SAREX.

5. **Probabilité de détection** : Il n'a pas été suffisant d'utiliser les données du SAREX 2007 pour tirer une conclusion sur la probabilité de détection (POD). Par contre, en combinant les résultats des SAREX de 1988 à 1991, 1993 et 2004 à 2007, on peut affirmer que la POD des cibles passives est beaucoup moindre que celle des cibles coopératives.

6. **Nombre de cibles** : Les résultats obtenus lors d'événements de recherche passés ont été compilés pour déterminer le nombre de cibles nécessaires pour démontrer avec 95% de confiance une amélioration des POD. Étant donné qu'on ne connaît pas encore la POD de

l'événement de recherche du SAREX auquel AIMS participera, ces résultats peuvent seulement être utilisés comme une indication du nombre de cibles à utiliser. Néanmoins, autant de cibles que possible devraient être utilisées pour l'événement de recherche du SAREX auquel AIMS participera.

L'analyste du projet AIMS DT (démonstration de technologies) devrait recueillir des données au SAREX 2008 et être prêt pour les essais en vol avec AIMS du SAREX 2009. Également, tel que discuté dans un mémorandum précédent, il est important de mentionner que si l'utilisation d'AIMS lors de l'événement de recherche démontre une performance égale ou supérieure à celle lorsqu'on ne l'utilise pas, il est alors possible de dire que le système sera très utile aux opérations SAR. Par contre, l'inverse ne serait pas nécessairement vrai puisque plusieurs facteurs présents durant le SAREX seraient absents lors d'un incident réel et pourraient influencer négativement la performance du système AIMS. Certains de ces facteurs sont : AIMS ne volera pas avec le même type d'avion que les autres équipes et il y aura moins de techs SAR/observateurs à bord que d'habitude lors d'un événement de recherche du SAREX. Aussi, après les essais avec AIMS au SAREX, une seule série de données sera recueillie pour comparaison et aucune recherche n'aura lieu la nuit et dans des conditions météorologiques dégradées, conditions pour lesquelles le système a été spécialement conçu afin d'améliorer l'efficacité de la recherche. Finalement, habituellement lors de l'événement de recherche du SAREX, il y a plus de cibles coopératives que de cibles passives, alors que le système AIMS possède des capteurs qui pourraient aider à trouver des cibles passives.

Table of contents

List of figures

List of tables

Acknowledgements

The author would like to acknowledge the SAR community and the organizers of SAREX 2007, in particular, Major Struthers, Capt. Poitras and Sgt. Mackinnon. Also, special thanks are addressed to Sgt. André Hotton for is ongoing support on the permanent targets project. Finally, the author would like to acknowledge the contribution of Messrs. David Taylor and Paul Saunders for providing the global positioning system (GPS) maps.

This page intentionally left blank.

1 Introduction

The Advanced Integrated Multi-sensing Surveillance (AIMS) system technology demonstration program (TDP) was designed to improve the surveillance and reconnaissance capabilities of the Canadian Forces (CF), particularly at night and in degraded weather conditions. These enhanced capabilities for search and rescue is possible due to its integrated multi-sensors, such as an active imaging system, a thermal imager, an advanced operator-machine interface, an auto-tracker and a laser rangefinder [1].

Since AIMS intent is to participate in the Search and Rescue Exercise (SAREX) 2009, it was considered useful for the operational research (OR) analyst attached to the AIMS project to attend previous SAREX exercises to collect data from experienced crews flying on different platforms. The analysis of these data will help evaluate the utility for the CF to use the AIMS system for Search and Rescue (SAR) operations. Therefore, it was essential to develop a set of evaluation criteria (see Annex A for the description) as reported in previous publications to analyze the data that were gathered during these SAREX exercises (see publications [2][3][4][5]). Thus, the aim of this memorandum is to improve the previously published data collected during the past SAREX events.

The first part of this memorandum presents a short description of the SAREX 2007 search event. Then, a summary of the SAREX 2007 data analysis is presented. The data were analyzed using the following evaluation criteria: target location accuracy, target identification, number of call-arounds, false detection rate, probability of detection and number of targets. Finally, a discussion is presented and recommendations are provided.

This page intentionally left blank.

2 SAREX 2007 event

This chapter presents the SAREX 2007 search event organised by 444 Squadron (SQN) (Goose Bay) that took place in Goose Bay (Labrador) from October 2 to 6, 2007 [6]. Also, the data collected at this SAREX are analyzed and the results are provided.

2.1 SAREX 2007 search event

Table 1 lists the teams who took part in the SAREX 2007 and provides the name of squadron and aircraft used by each team. Unfortunately, during this yearly event, SAREX 2 had to go back to its base and therefore, this team did not participate in the search event.

Table 1: SAREX 2007 search event teams

TEAM	SQUADRON	HOME BASE	AIRCRAFT
SAREX 1	435	Winnipeg	CC-130 (Hercules)
SAREX 2	103	Gander	CH-149 (Cormorant)
SAREX 3	417 – 439 – 444	Goose Bay – Bagotville – Cold Lake	CH-146 (Griffon)
SAREX4	442	Comox	CC-130 (Hercules)
SAREX 5	424	Trenton	CC-130 (Hercules)
SAREX 6	413	Greewood	CC-130 (Hercules)

For the search event, before the crews took off for their search, each team received a Joint Rescue Coordination Center (JRCC) tasking, as provided in Annex B, with the mission to find specific targets in a defined area of search, as shown in Figure 1. On this search map, the corners of the search area are indicated with red flags and the position of the targets is indicated with yellow flags. Notice that all targets were previously ground-truthed[1] and that all teams were doing visual detection only, which implies that no external means (like sensors) other than the eyes were used to spot targets.

[1] In this context, a target ground-truthed is a target placed on the ground with a known GPS position.

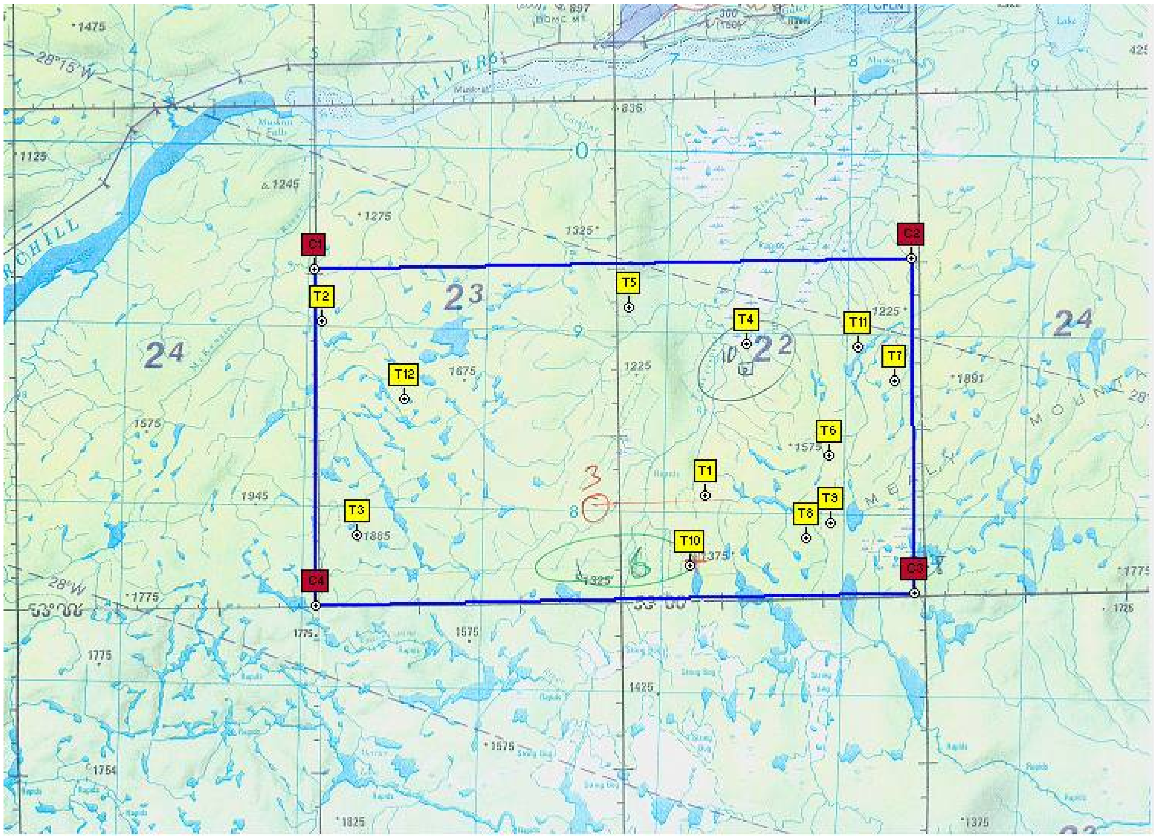

Figure 1: Map of the search [7]

The description of the targets is presented in Table 2 and the corresponding pictures are provided in Annex C (targets 1 to 11). In a previous memorandum [5], it was explained that a set of permanent targets would be implemented for each future SAREX. These targets correspond to targets 1, 4, 5, 6 and 7 in Table 2 .

Table 2: Description of the targets (SAREX 2007) [7]

TARGET #	LAT (N) / LONG (W) (DD,MM.M)	DESCRIPTION	COOPERATIVE TARGET[2,3]
1	(53°, 3.030'),(-60°, 25.450')	Full Aircraft (C-JETA)	YES
2	(53°, 8.460'),(-60°, 44.650')	Red Letter "L"	NO
3	(53°, 2.050'),(-60°, 42.930')	Orange parachute	YES
4	(53°, 7.550'),(-60°, 23.330')	White, yellow and orange floating debris	NO
5	(53°, 8.680'),(-60°, 29.270')	Floater (dummy with blue swim suit)	NO
6	(53°, 4.170'),(-60°, 19.230')	Parts of plane	NO
7	(53°, 6.360'),(-60°, 15.930')	Boating stuff	YES
8	(53°, 1.740'),(-60°, 20.360')	Orange parachute	YES
9	(53°, 2.180'),(-60°, 19.150')	Yellow parachute	YES
10	(53°, 0.950'),(-60°, 26.230')	Yellow arrow	YES
11	(53°, 7.374'),(-60°, 17.721')	White Lancaster wreck	YES
12	(53°, 6.100'),(-60°, 40.560')	B36 wreck	YES

To determine if a target is cooperative or passive is sometimes biased because the decision can be influenced by the analyst's subjectivity. This decision is usually based on the type of target, the facility to see the target from an airborne platform and its contrast with the background environment.

2.2 Target location accuracy

As done in [4][5], a comparison between the sighting and the actual GPS position is made to evaluate the target location accuracy. Figure 2 presents the data collected at the SAREX 2007.

[2] A cooperative target is a target placed by survivors in an effort to be seen; it could also be a target easily detected from the air [5].
[3] Passive target can be defined as a target that results directly from a SAR incident [5].

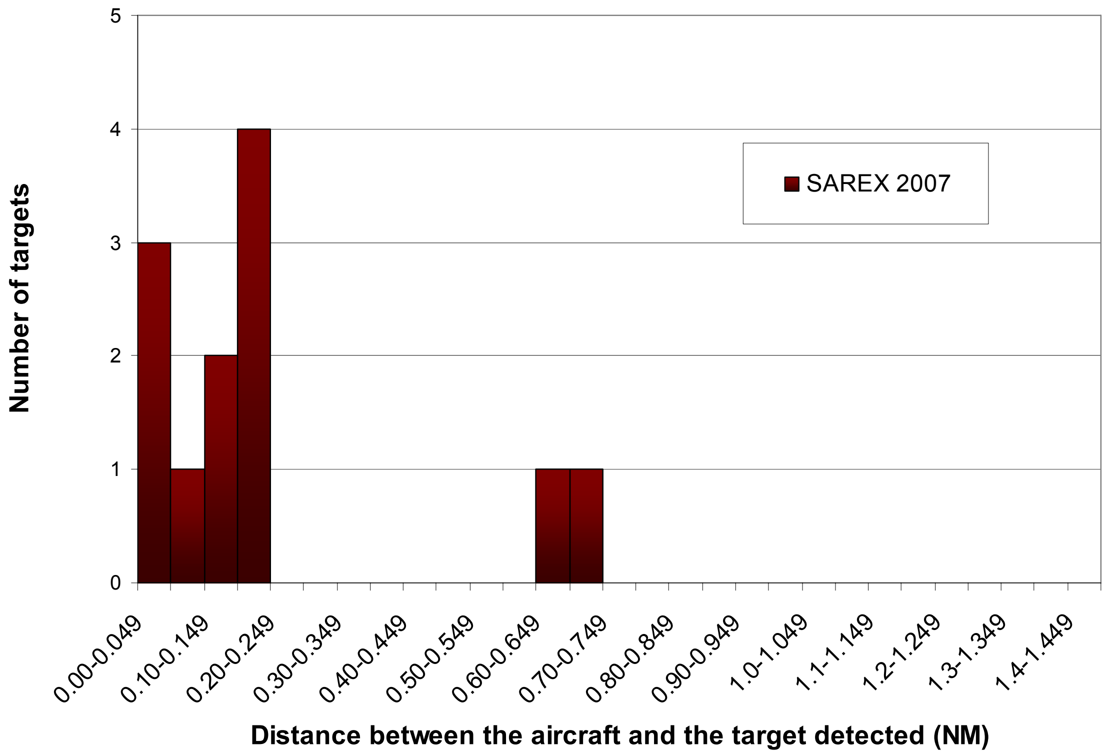

Figure 2: Number of targets detected within 1.5 NM of their exact position - SAREX 2007

In Figure 2, the data of the first column corresponds to the number of targets detected in the area directly beneath the aircraft and the subsequent intervals contains the number of targets detected at a certain distance from the aircraft (here the aircraft is located at 0 NM). It was expected that the majority of the targets would be found inside 1 NM of sight and this is observed in Figure 2.

Unfortunately, the number of targets detected at SAREX 2007 was not very high. This could be explained by several factors like the bad weather during the week and the possibility that too many targets where present in the search area for the time given to perform the search. In fact, even if one of the target was large (a B36 wreck), surprisingly, most of the teams did not see it. Also, significant time was lost by the first teams to identify white ″Y″ poles that were not part of the scenario. All the subsequent teams were then advised not to loose time to give position and description of these poles. Finally, some of the targets, like the floater, even if they were representing a real SAR scenario, were probably too small to be detected.

To increase the sample size on location accuracy, Figure 3 shows the compilation of SAREX 2006 and 2007 data.

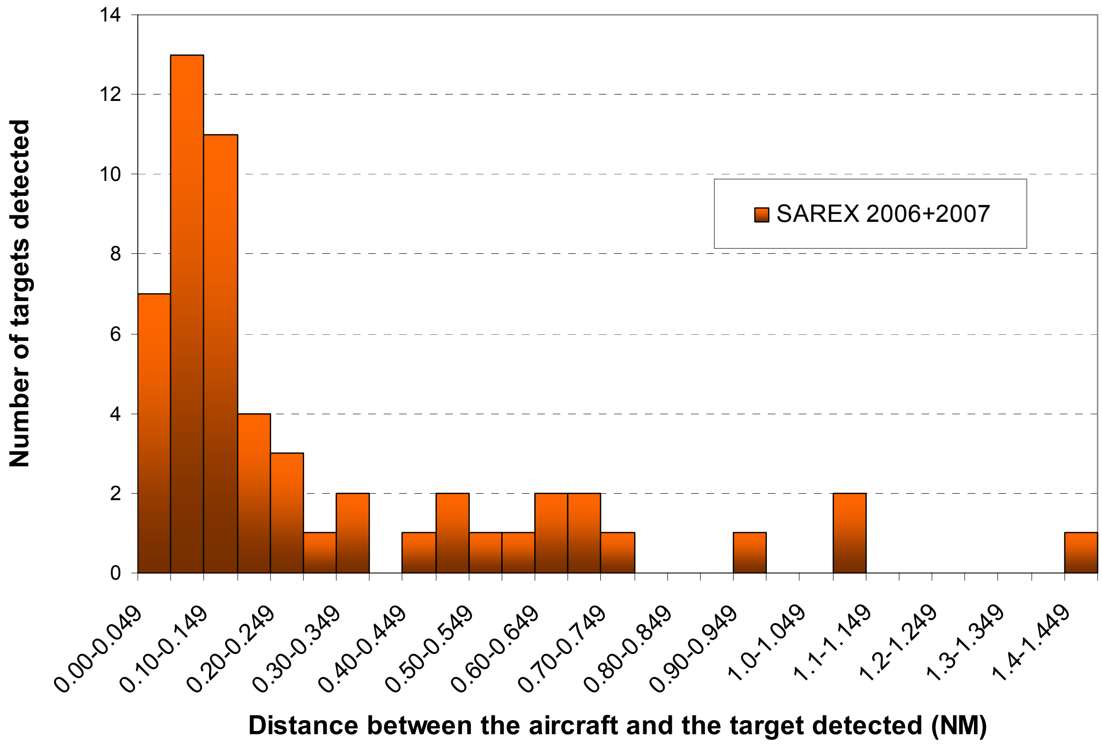

Figure 3: Number of targets detected within 1.5 NM of their exact position - SAREX 2006 and 2007

In Figure 3, one can see that fewer targets were detected in the area directly under the aircraft. This was expected since the search area directly beneath the aircraft is out of reach for SAR technicians (techs)/spotters. Also, the majority of the targets were detected within 1 NM of their exact position.

2.3 Target identification

As suggested in a previous document [5], the ability to see colours and to identify shapes was also evaluated using SAREX 2007 data[4]. Table 3 was used to evaluate the accuracy of the description of the targets given by the teams. Five points were given for each object detected and another five points if at least one of the colours was identified. No points were granted for a wrong identification or bad colour. White and silver were assumed to be the same colour and orange, yellow, red and pink were also considered to be the same colour.

[4] As suggested in [5], no distinction is made between the terms ″identification″ and ″recognition″.

Table 3: Chart of points

TARGET #	OBJECT (5pts)	COLOUR (5pts)	POINTS
1	Full aircraft	White - black	10
2	L	Red	10
3	Parachute	Orange	10
4	Debris field (tarp)	Orange	10
	Life preserver	Orange	10
	Ice box	White	10
5	Dummy	Blue - beige	10
6	Parts of plane	White - black	10
7	Floating debris: 2 paddles	Beige	10
	Square panel	White - blue - red	10
	Life jacket (tarp)	Orange - yellow	10
8	Parachute	White - yellow - orange	10
9	Parachute	Yellow	10
10	Arrow	Yellow	10
11	Lancaster (Wing)	White - black	10
	Wheel (or debris)	White - black	10
12	B36	Silver – white – black	5
TOTAL			**165**

Table 4 shows the results of the evaluation of the accuracy of the description of the targets given by the teams.

Table 4: Evaluation of the accuracy of the description of the targets given by the teams at the SAREX 2007 search event

TARGET #	**SAREX 1**		**SAREX 3**		**SAREX 4**		**SAREX 5**		**SAREX 6**	
	SHAPE/ COLOUR		**SHAPE/ COLOUR**		**SHAPE/ COLOUR**		**SHAPE/ COLOUR**		**SHAPE/ COLOUR**	
1	5	0	-	-	5	0	5	5	-	-
2	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	0	5
4	0	5	-	-	-	-	5	5	-	-
5	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	5	5
7	-	-	-	-	-	-	-	-		
8	-	-	-	-	-	-	-	-	0	5
9	-	-	-	-	-	-	-	-	-	-
10	5	5	-	-	5	5	5	5	-	-
11	-	-	10	5	5	0	-	-	-	-
12	-	-	-	-	-	-	-	-	5	5
TOTAL: # PTS	10	10	10	5	15	5	15	15	10	20
% (max=)	**6.1**	**6.1**	**6.1**	**3**	**9.1**	**3**	**9.1**	**9.1**	**6.1**	**12.2**

Since there were not many data available to perform this analysis, we should be careful in interpreting the results. An example of how to complete this table is explained below.

Let us take the results of SAREX 1 indicated in Table 4. Target 1 was detected and since in the sheet results it was specified that it was a fuselage, five points were given for the recognition of the fuselage shape, but no point was awarded for the colour. On the other hand, target 10 was detected and identified by a red arrow pointing east; therefore, five points could be given for the identification of the shape and five points for the good colour. Once this procedure was applied for all the targets detected by each team, the points were summed in each category (colour and shape) and were divided by the maximum total of points possible (165). The percentage obtained (in this case SAREX 1 scored 6.1% for shape and 6.1% for colour) was then reported in Figure 4.

Figure 4 shows the percentage obtained by each team for a good identification of colour versus the percentage obtained for a good identification of shape.

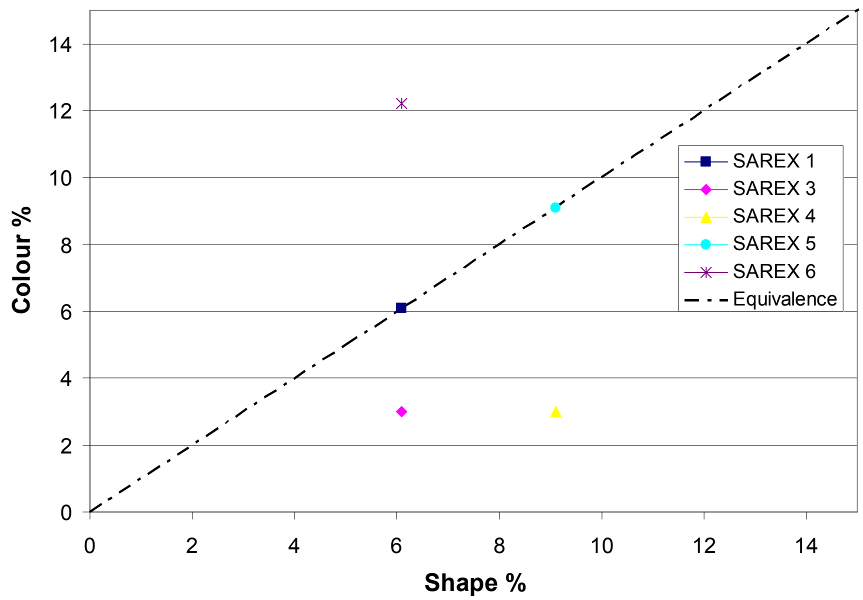

Figure 4: Percentage obtained for good identification of shape versus percentage obtained for identification of at least one good colour - SAREX 2007

In Figure 4, the low percentage obtained in each category is simply reflecting the fact that only a few targets were detected at this search event. Also, the results above the doted line (equivalence line) would mean that the colour parameter helped more than the shape parameter to identify a target and that would mean the opposite for the results below this line. In this case, due to the small number of data collected at the SAREX 2007, it is not possible to conclude which one of the shape or colour is the most important discrimination parameter.

It is important to mention that several factors may have influenced the results. Firstly, when SAR techs/spotters provide information about a potential target, the colour or the shape is not necessarily noted on the sheet results. From what have been seen, SAR techs/spotters will only describe the aspect that will help others to identify the object as soon as possible. If, for example, a white fuselage is crashed in a snow background, the white colour will probably not be the turning point. However, in the case of an orange parachute found on the ground, the orange colour will be more attractive in the middle of the woods than the type of object. Secondly, the initial choice of targets could also influence the results in the sense that if we have four targets to find and three of them are orange parachutes and if only one is a white fuselage, the colour parameter in this search will probably appear to be more important.

To increase the number of data, a combination of SAREX 2006 and SAREX 2007 analysis of shape and colour is presented in Figure 5.

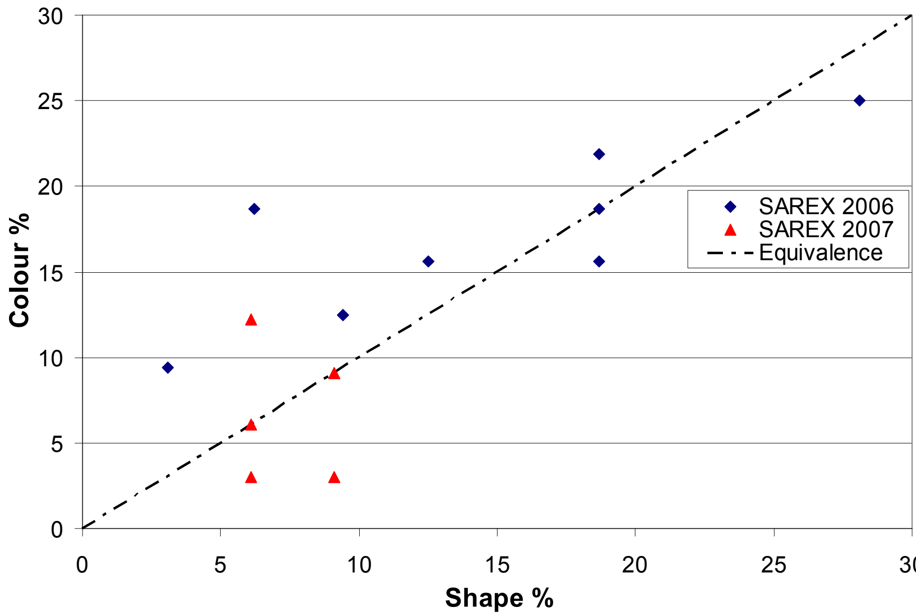

Figure 5: Percentage obtained for good identification of shape versus percentage obtained for identification of at least one good colour - SAREX 2006 and 2007

In Figure 5, the colour parameter seems to be more important than the shape for the identification of a target, but again, due to the small number of data, it is not possible to conclude on which one of the shape or colour is the most important discrimination parameter. Therefore, since we cannot conclude for the moment with these results, it could be suitable for AIMS to be equipped of a high definition colour screen to maximize the chances of detecting a target.

2.4 Number of call-arounds

During SAREX 2007, search paths were recorded and provided by Messrs. Taylor and Saunders [8]. Using the free trial version of OziExplorer [9], a visual map was generated for each aerial track flown. An example of GPS track of SAREX 1 is shown in Figure 6. To lighten this section, the search paths recorded for SAREX 3-4-5 and 6 are presented in Annex D.

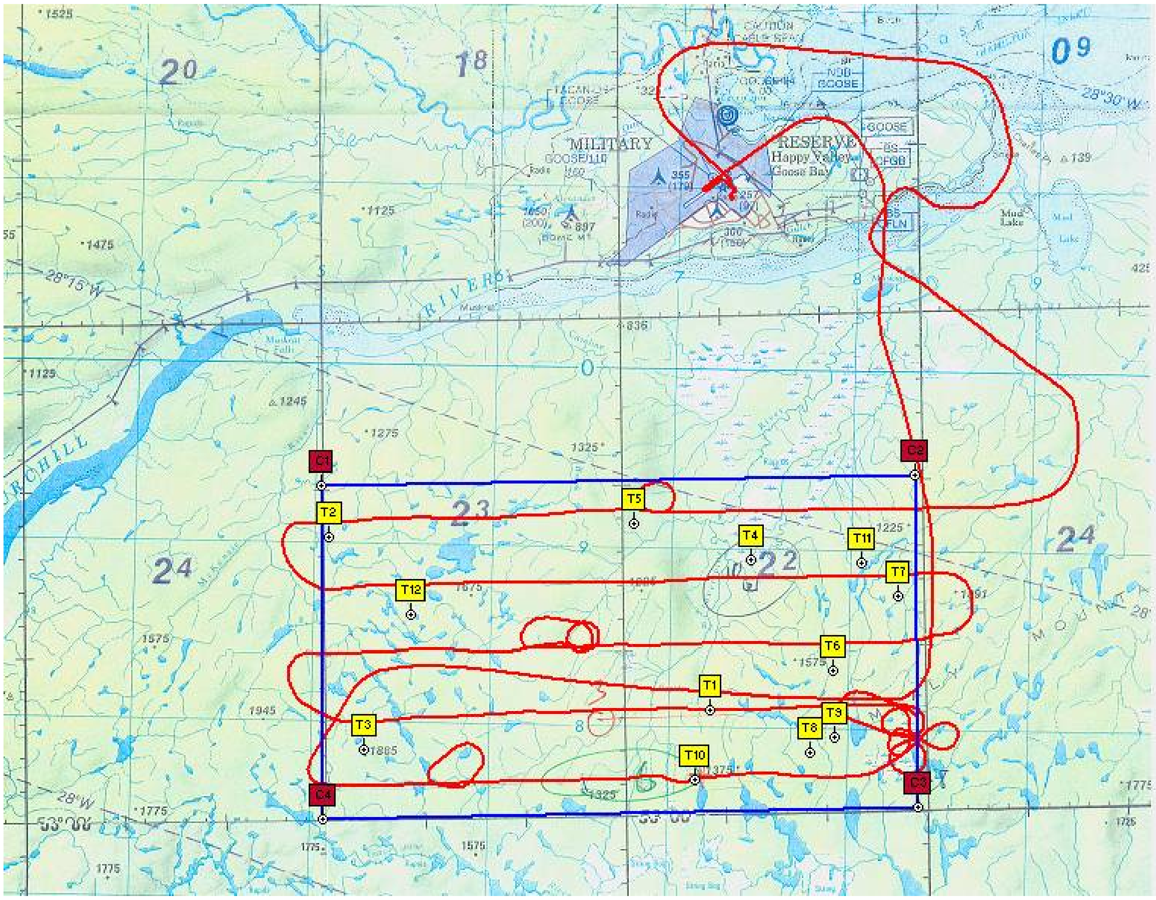

Figure 6: SAREX 1 GPS track [8]

In Figure 6, one can observe that a call-around is made each time the aircraft is doing a circle over a particular area. It is necessary to perform a call-around when SAR techs/spotters think they have seen something but cannot confirm what it is. In that case, the aircraft turns around and performs circles around the potential target until it is possible for the SAR techs/spotters to confirm if it is or not a target.

The number of call-arounds compiled during SAREX 2007 is provided in Table 5.

Table 5: Number of call-arounds

TEAM	ON DETECTED TARGETS	ON MISSED TARGETS	FOR NOTHING	TOTAL
SAREX 1	0	0	8	8
SAREX 3	1	0	11	12
SAREX 4	1	0	6	7
SAREX 5	1	0	3	4
SAREX 6	4	0	4	8
TOTAL	**7**	**0**	**32**	**39**

In a previous publication [5], 2/3 of call-arounds were made for nothing, in SAREX 2008, 4/5 of call-arounds were made for nothing. Different factors could be given:

- SAREX 3 did not have the time to fly the entire area.
- SAREX 5 experienced very bad weather, both times they flew.
- SAREX 6 started their path on the perimeter of the search instead of being 1NM inside the parameters of search. Consequently, the last 1 NM was not monitored.

Also, as previously mentioned in [5], it would be preferable to perform the evaluation of this criterion during a search where there would be sufficient time to perform a good search so that call-arounds can be made more frequently, if needed.

2.5 False detection rate

Table 6 summarizes the false detection rates obtained at the SAREX 2007 search event. Considering that the SAR techs/spotters could cover approximately 1 NM on each side of the aircraft, the area to search was divided into five corridors. To be able to determine the dimensions of the area of search in NM, first, the coordinates were obtained in decimal using the converter given in [10]. Then, using another method provided in [11], it was possible to calculate the distance. The area of search was:

$$18.072[NM]\times 10.012[NM]=180.937[NM^{2}] \qquad (1)$$

Table 6: SAREX 2007 false detections rates

TEAM	#FALSE TARGETS REPORTED	FALSE DETECTION RATES (#FALSE TARGETS / NM^2)
SAREX 1	15	0.0829
SAREX 3	4	0.0221
SAREX 4	19	0.1050
SAREX 5	6	0.0332
SAREX 6	14	0.0774
AVERAGE	**11.6**	**0.0641**

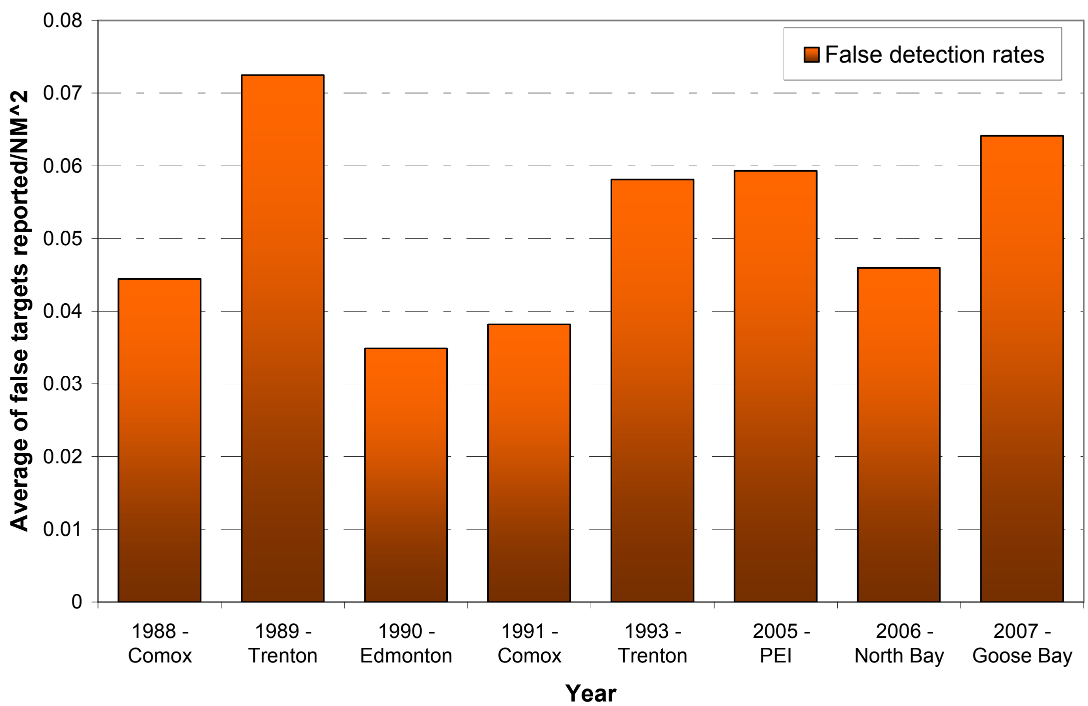

Figure 7: False detection rates

In Figure 7, one can observe that the false detection rates do not follow any particular trend.

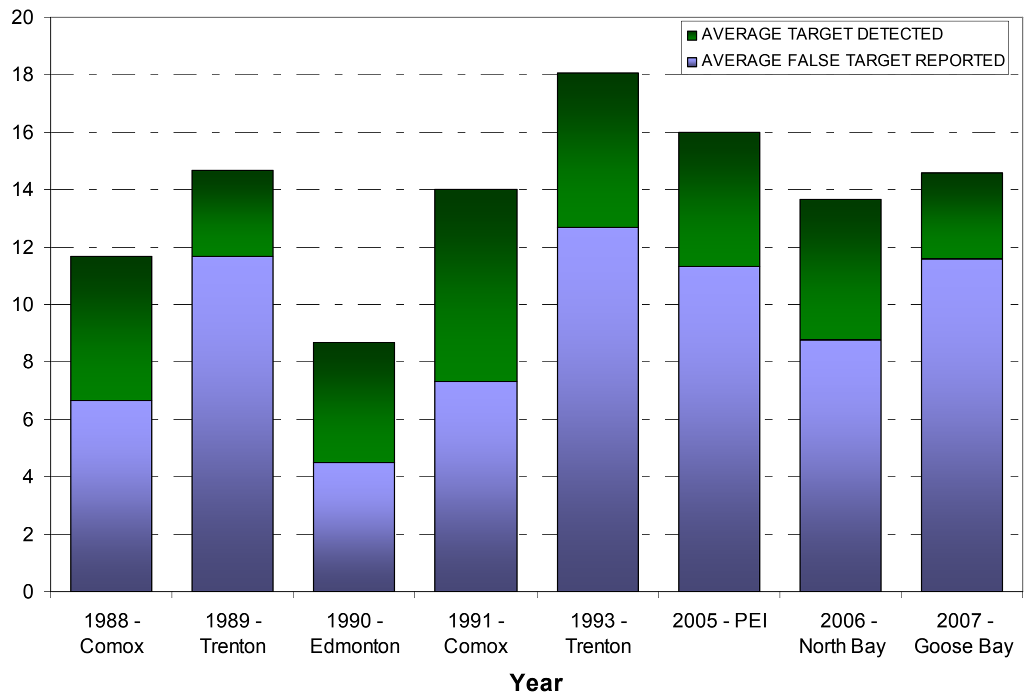

Figure 8: Comparison between real target detected and false target reported

Figure 8 does not show any relationship between the average number of targets detected and the average number of false targets reported. As discussed in [5], the false detection rate obtained using AIMS should only be compared to that obtained without AIMS for the same SAREX event.

2.6 Probability of detection

This section provides results on the probability of detection (POD) and presents many factors that could influence those POD.

Table 7 summarizes the POD of different targets at SAREX 2007.

Table 7: Estimated POD of SAREX 2007

	TARGET	ATTEMPTS	DETECTIONS	FRACTION DETECTED
1	Full Aircraft, white (C-JETA)	5	3	0.6
2	Red L	5	0	0
3	Para	5	1	0.2
4	Debris	5	2	0.4
5	Floaters	5	0	0
6	Parts of plane	5	1	0.2
7	Boating stuff	5	1	0.2
8	Chute	5	1	0.2
9	Chute 2	5	0	0
10	Arrow	5	3	0.6
11	Lancaster	5	2	0.4
12	B36	5	1	0.2
All cooperative targets		40	12	**0.30**
All passive targets		20	3	**0.15**

In a previous publication [5], it was suggested to introduce a new set of targets of reference during the SAREX search event until the flight trials with AIMS. The description of these targets is provided in Annex E. During SAREX 2007, these targets corresponded to targets 1, 4, 5, 6 and 7 in Table 2. Some modifications were done to the previous list due to material availability and the feasibility of placing the targets on site. Amongst other things, the panel with letters was replaced by a red L and the floating debris were combined with the panel with reflective strips submerged.

Previous analysis of SAREX data [3][4][5][12][13][14] demonstrated that the POD for passive targets is significantly less than that for cooperative targets. In Figure 9, one can observe the POD for SAREX 2007 with confidence intervals of 90%, 95% and 99% and, in Figure 10, the estimated POD for cooperative and passive targets with confidence intervals of 90%, 95% and 99% for SAREX 1988 to 1991, 1993 and 2004 to 2007.

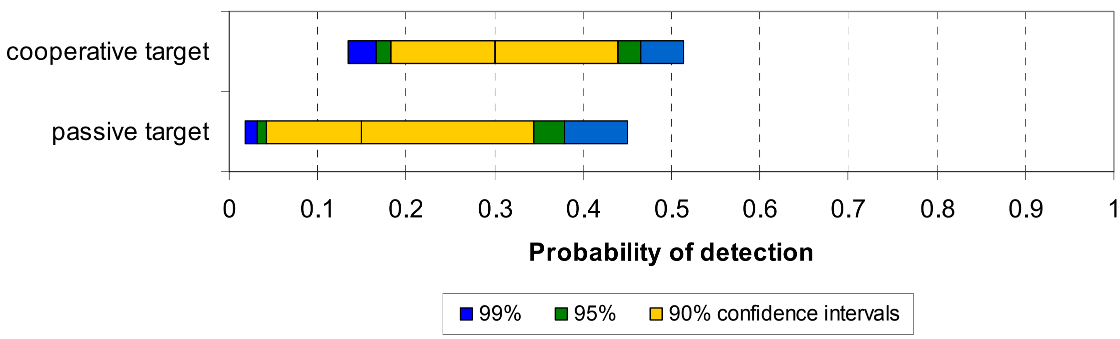

Figure 9: Estimated POD for cooperative and passive targets for SAREX 2007

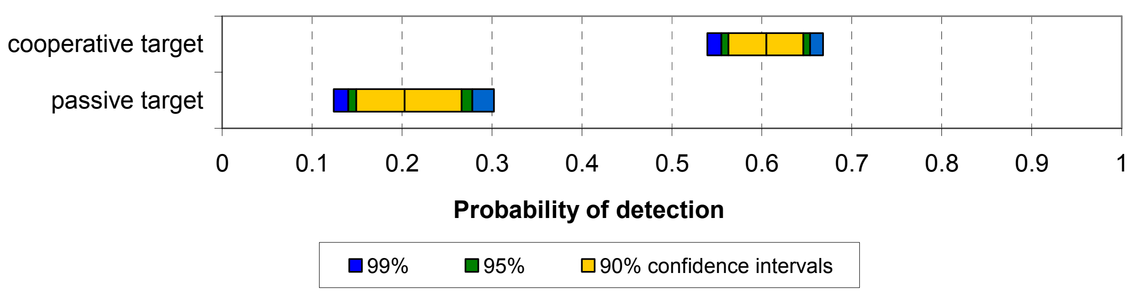

Figure 10: Estimated POD for cooperative and passive targets for past SAREX (1988 to 1991, 1993, 2004 to 2007)

In Figure 9, only the data obtained in SAREX 2007 are presented. As one can see, the confidence intervals intersect. However, if a sufficient number of data is combined, one can observe in Figure 10 that we support the following conclusion: passive targets are significantly harder to find than cooperative targets.

In a previous memorandum [5], a summary of the factors that could influence the POD were brought together:

- Weather and time of day (clouds, lighting, fog, precipitation); the weather might be different each year and might be different for different teams.
- The event location where the searches take place is different each year, therefore, the background contrast and the environment also change.
- Search and aircraft parameters (size of the area to search, type of aircraft, airspeed, altitude, track spacing, sweep width, time flying).
- Condition of the crew (crew fatigue, crew motivation, experience of crew members is not constant within a team and between the teams).
- Number of SAR techs/spotters might change between aircraft; there are usually more SAR techs/spotters during SAREX searches than there are during real SAR incidents and SAR techs/spotters search for the entire hour during the search rather than alternate every 20-30 minutes as is standard practice.
- Target characteristics: each year the number and type of targets change. Thus, it is difficult to establish a solid baseline for comparison purposes.
- Subjectivity of the scientist to class a target as passive or cooperative when calculating the POD.
- Ability of the sensor to sweep the entire area as the aircraft flies over.
- Familiarity with the environment.

2.7 Number of targets

A method was developed to determine the number of targets that are necessary to demonstrate with a certain level of statistical confidence an increase in POD [3][4]. A FORTRAN program was used to determine the confidence rate of SAREX 2007 data and is provided in Annex F. This program is equivalent to the Matlab program provided by [15] and that was presented in [5]. The results obtained using SAREX 2007 are given in Figure 11 and for comparison purposes, the data compiled using past SAREX are also presented. The results from past SAREX were extracted from [5] and exclude SAREX 2007 results.

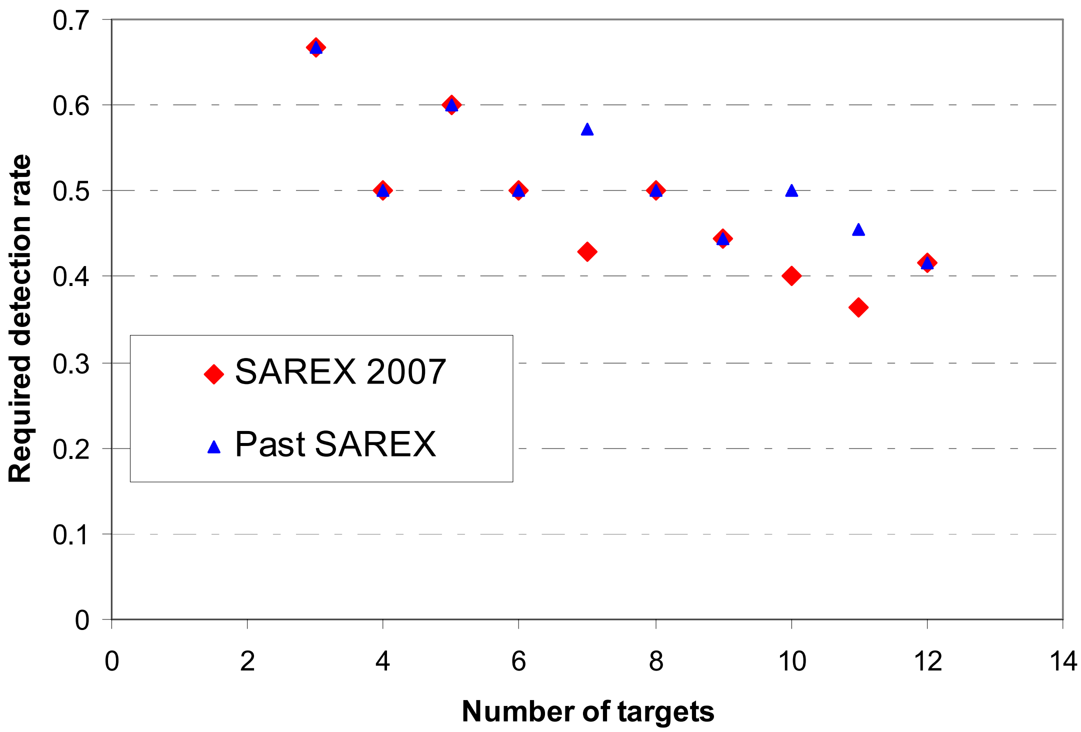

Figure 11: Detection rate required to demonstrate improvements with 95% confidence using SAREX 2007 and using past SAREX search event data

As explained in [3], Figure 11 shows "the proportion of targets that must be detected by AIMS in order to demonstrate improvements in performance with 95% confidence as a function of the number of targets used".

SAREX 2007 POD for passive targets was 0.15 and that of past SAREX (excluding SAREX 2007) was 0.21. The curves of Figure 11 were built using the POD and the Bayesian/Monte-Carlo approach [3][4]. An example of how to read this figure is explained below.

If AIMS is expected, for example, to have a POD for passive targets of 65%, the SAREX search event would be appropriate to show its superiority if at least three or more passive targets were used (using SAREX 2007 data in this example). Note that this figure is only an indication of the detection rate versus the number of targets since we do not know yet the POD of the search event in which AIMS will be participating. Of course, for this search event as many targets as possible should be employed.

This page intentionally left blank.

3 Conclusion

Since AIMS intent is to participate in the Search and Rescue Exercise (SAREX) 2009, it was considered useful for the operational research (OR) analyst attached to the AIMS project to attend previous SAREX exercises to collect data from experienced crews flying on different platforms.

The aim of this memorandum was to analyze the data collected at the SAREX search event 2007 and to improve the previous published database. The evaluation criteria provided in [5] were used to analyze the data. The main conclusions drawn from this analysis are:

1. **Target location accuracy**: As expected, few targets were detected under the aircraft since part of this area is out of reach for SAR technicians (techs)/spotters. Also, all the targets were detected within 0.8 nautical miles (NM), which is within the 1 NM expected.

2. **Target identification**: It was not possible to demonstrate which one, between colour and shape, was the most useful parameter to detect an object from its background. Therefore, it could be suitable for AIMS to be equipped with a high definition colour screen to maximize the chances of detecting a target.

3. **Number of call-arounds**: The majority of call-arounds were made for nothing. It would be preferable to evaluate this criterion during a search when there would be sufficient time to perform a good search.

4. **False detection rate**: It was not possible to draw any conclusion from the false detection rate. It is suggested to compare only the false detection rate obtained using AIMS to that obtained without AIMS for the same SAREX event.

5. **Probability of detection**: It was not sufficient to use only the data obtained from SAREX 2007 to reach a conclusion on the probability of detection (POD). However, combining the data from 1988 to 1991, 1993 and 2004 to 2007, we can confirm that the POD for passive targets is significantly less than that for cooperative targets.

6. **Number of targets**: Past search events data were compiled to determine the number of targets that were necessary to demonstrate, with 95% confidence, an improvement in the POD. Since we do not know yet the POD of the SAREX search event in which AIMS will participate, these results can only be used as an indication of the number of targets required. Nevertheless, as many targets as possible should be employed for the SAREX search event in which AIMS will participate.

For SAREX 2007, not many data were collected. This is mainly due to the fact that 1) the weather was not good during almost all the week and 2) the area of search was too large for the time given.

It was possible to include the targets provided in the reference set. It is strongly recommended to include these targets for SAREX 2008 and for SAREX 2009 when AIMS will be flying.

It was also observed at SAREX 2006 (North Bay) and SAREX 2007 (Goose Bay) that the end of September and the beginning of October might not be the best time for SAREX events. Holding the event earlier in the season (for example at the beginning of September) could probably increase the chances of good weather.

References

[1] Larochelle, V. (2007), AIMS TD - Advanced Integrated Multi-sensing Surveillance Technology Demonstration, Defence R&D Canada - Valcartier.

[2] Vincent, E. (2006), Measures of effectiveness of airborne search and rescue imaging sensors, (DRDC Valcartier TM 2005-301) Defence R&D Canada - Valcartier.

[3] Vincent, E. (2005), Using SAREX Search Events to measure searching performance, (DRDC Valcartier TN 2005-302) Defence R&D Canada - Valcartier.

[4] Vincent, E. (2006), Searching performance at the 2005 National SAREX, (DRDC Valcartier TM 2006-110) Defence R&D Canada - Valcartier.

[5] Toussaint, G., Larochelle, V. (2008), Guidelines for the SAR operational evaluation of the AIMS system, (DRDC Valcartier TM 2007-516).

[6] SAREX 2007 5 Wing Goose Bay "book" (2007), Goose Bay.

[7] SAREX Coordinating Committee (2007), 5 Wing Goose Bay, Private Communications.

[8] Saunders P. and Taylor D., CASARA, Private Communications.

[9] Des Newman's OziExplorer GPS Mapping Software, Newman, D. and L., www.oziexplorer.com (Access Date: March 25th, 2008).

[10] Copyright © 2005 Satellite Signals Ltd, Degrees, Minutes, Seconds to Decimal Degrees calculator (online), Johnston E., http://www.satsig.net/degrees-minutes-seconds-calculator.htm (Access date: 2008).

[11] This lat, long, bearing and range calculator is copyright © 1999, 2004 Satellite Signals Ltd, Great circle azimuth bearing and range calculator (with magnetic north) (online), Johnston E., http://www.satsig.net/ssazran.htm (Access date: 2008).

[12] Taylor, I. W. and Mack, I. C. (1988), A study of probability of detection using the 1988 search and rescue exercise, ATGOR Staff Note 6/88, Operational Research Branch, Air Transport Group Headquarters, CFB Trenton.

[13] Vigneault, M. and Frank, G. (1990), Probability of detection analysis from SAREX 1990, ATGOR Internal Working Paper 2/90, Operational Research Branch, Air Transport Group Headquarters, CFB Trenton.

[14] Vigneault, M. and Gammon, M. (1992), A study of probability of detection using the 1991 search and rescue exercise, ATGOR Working Paper 10/92, Operational Research Branch, Air Transport Group Headquarters, CFB Trenton.

[15] Vincent E. (2006), CEFCOM, Private Communications.

This page intentionally left blank.

Annex A Measures of effectiveness

Evaluation criteria (which include MOEs and additional criteria that are not MOEs) were developed to evaluate the AIMS TD utility for the CF in SAR operations. The MOEs proposed in [5] are:

1. The alignment error between the actual location of the target and the one given by the tracking device.
2. The maximum time that the sensor is able to stay on the target.
3. The average time it takes for the sensor to recover the target when loosing it.
4. The time from fly-over to detection.
5. The time necessary to plan an optimal search.
6. The number of hours of experience as a SAR tech/spotter (spotting with naked eyes) and as an operator using the sensor suite.
7. The maximum time that the sensor suite can be used without significant operator fatigue.
8. The maximum flight velocity for the operator to be able to analyze effectively the data in real time.
9. The precision of the geo-location system.
10. The average time required between the detection and the identification/recognition of a target.
11. The number of call-arounds.
12. The average number of false positives per unit of area.
13. The probability of detection.
14. The maximum detection range of the sensor suite.

And the other criteria proposed in [5] are:

15. The presence of a capability to store captured images.
16. The ability of the sensor suite to see colours and identify shapes.
17. The ability or effectiveness of the sensor suite to remain effective during different visibility and illumination conditions.
18. The presence of a reasonable image transmission capability.

This page intentionally left blank.

Annex B JRCC tasking

The SAREX 2007 search event is detailed in B.1 and B.2 [7].

B.1 Search event scenario

Overdue Cessna 172, G-CFOX departed Goose Bay on a VFR flight plan and headed south of the airport to conduct some aerial photography. Two persons on board, both male, mid 20's with no health problems. Last transmission to Goose Bay tower indicated they were experiencing engine problems and could not maintain altitude.

B.2 JRCC tasking

Complete a visual search in area bounded by the following coordinates; 5300N 06045W, 5310N 06045W, 5310N 06015W, 5300N 06015W. You have one hour to complete a search of the area. Mark suspicious sightings on map and put lat/long and description on form below.

Target #	LAT/LONG	DESCRIPTION
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

This page intentionally left blank.

Annex C Targets pictures

Annex C contains a series of pictures of the targets that were taken at the SAREX 2007 by members of the SAREX committee [7] and by the author of this memorandum. Figure B-1 and B-2 represent a crashed aircraft. For comparison purposes, two persons are shown in Figure B-1.

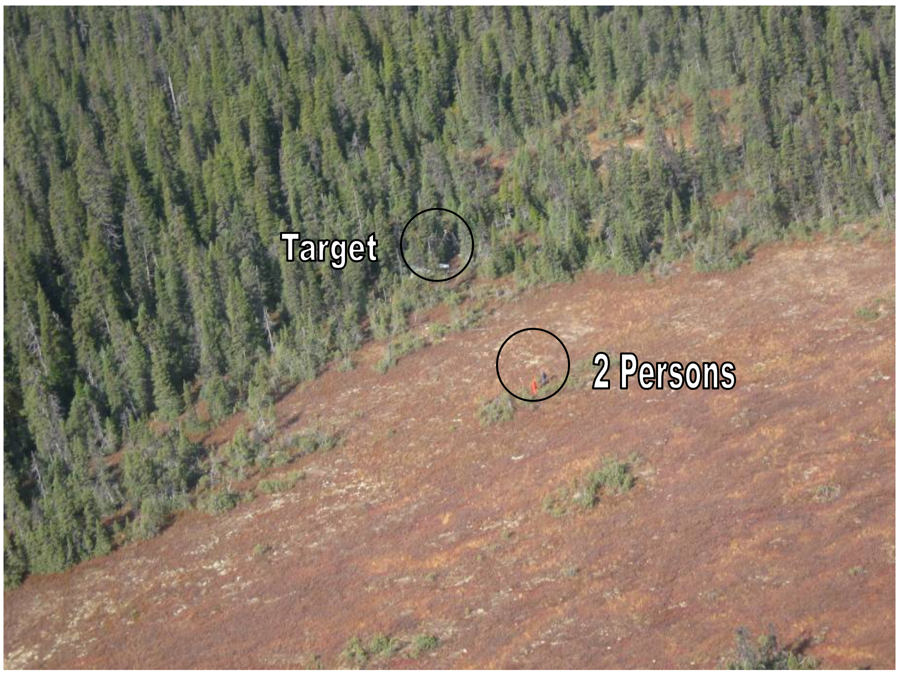

Figure B-1: Target 1 - Full aircraft - View A

Figure B-2: Target 1 - Full aircraft - View B

Figure B-3 shows a red L hidden in a very small open area.

Figure B-3: Target 2 - Red L

Figure B-4: Target 3 - Parachute 1

Figure B-5: Target 4 - Debris field

Figure B-6: Target 5 - Floater - View A

Figure B-7: Target 5 - Floater - View B

Figure B-8 shows parts of a burned fuselage.

Figure B-8: Target 6 - Debris field

Figure B-9 shows floating debris (paddle, life jacket, square plate with circle).

Figure B-9: Target 7 - Floating debris

Figure B-10: Target 8 - Parachute 2

Figure B-11: Target 9 - Parachute 3

Figure B-12: Target 10 - Yellow arrow

Figure B-13: Target 11 - Lancaster wreck - View A

Figure B-14: Target 11 - Lancaster wreck - View B

No picture was provided for target 12 (B36 wreck).

Annex D Examples of GPS tracks

The map of the search was provided by [7] and SAREX 2007 GPS tracks were provided by [8] and are shown below.

Figure D-1 shows the GPS tracks on the search map for the SAREX 3 team.

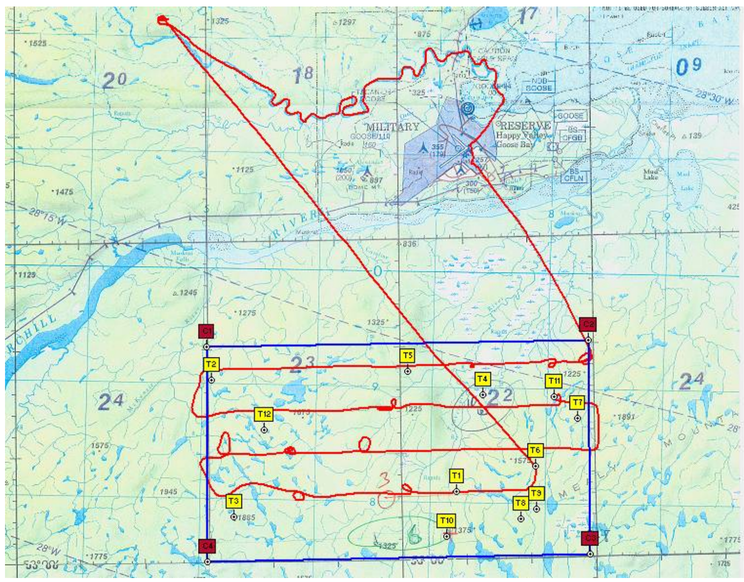

Figure D-1: SAREX 3 GPS track

Figure D-2 shows the GPS tracks on the search map for the SAREX 4 team.

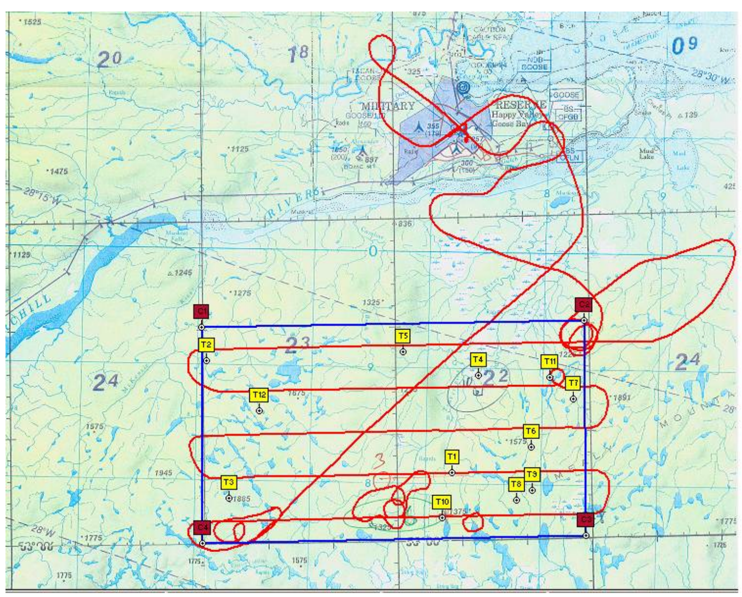

Figure D-2: SAREX 4 GPS track

Figure D-3 shows the GPS tracks on the search map for the SAREX 5 team (first flight of two).

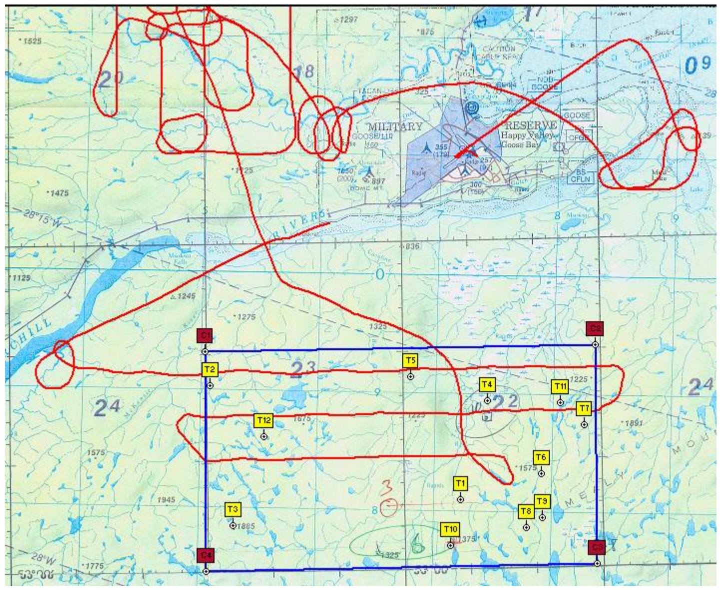

Figure D-3: SAREX 5 GPS track - Flight 1

Figure D-4 shows the GPS tracks on the search map for the SAREX 5 team (flight two).

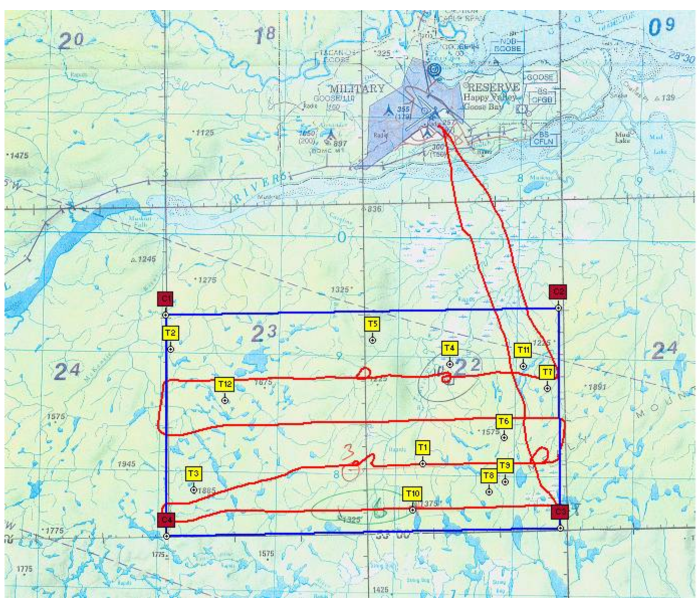

Figure D-4: SAREX 5 GPS track - Flight 2

Figure D-5 shows the GPS tracks on the search map for the SAREX 6 team.

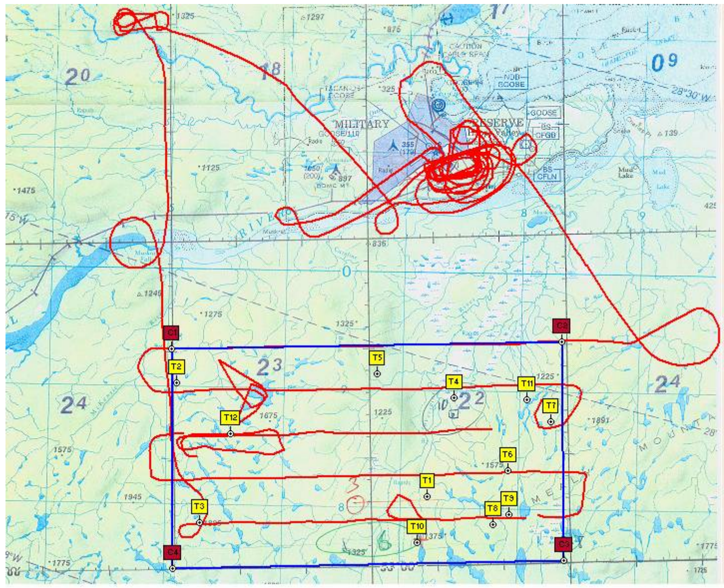

Figure D-5: SAREX 6 GPS track

This page intentionally left blank.

Annex E Description of reference targets

The following targets were chosen as a set of reference for future SAREX [5]:

- **TARGET 1:** Panel with letters on it (for example: SOS) with a reasonable height.
- **TARGET 2:** Intact fuselage with identification through trees (target smaller than a real fuselage but will have the same coating as a real one; target has to be small since it is carried by helicopter).
- **TARGET 3:** Fuselage ruined/burned (it will be a matte black frame with pipes, maybe one or two small panels to represent a seat). It happened in the past that a crash caused only a flash of fire, leaving no trace of the accident except a bundle of pipes.
- **TARGET 4:** Bundle of small targets (parachute, dummy, reflective tape, icebox) dispersed in either a swamp area, open area, or where trees are cut (to simulate the action of wild animals dispersing objects).
- **TARGET 5:** Floating debris (for example, floating life preserver, reflective strip with letters, geometric shapes).
- **TARGET 6:** Object under the surface of the water (panel with reflective strips submerged at 1 foot or 2 feet with 4 life buoys to maintain its level of floatability).
- **TARGET 7:** Drowned person (a person in t-shirt and jeans floating in the water).

This page intentionally left blank.

Annex F FORTRAN program

The FORTRAN program used to determine the confidence rate that a particular method is better than another one is equivalent to the Matlab program provided by [15] and that was presented in [5].

```
program test3
use dflib
      implicit none
integer n1, n2, k1, k2, i, it
integer y, n, jj, nsets
character b
real res, invres
      real*8 bayesian
      write(*,*) 'enter i, it'
      read(*,*) i,it
      write(*,*) 'enter number of sets'
      read(*,*) nsets
      do jj=1,nsets
        write(*,*) 'enter n1,n2,k1,k2'
        read(*,*) n1,n2,k1,k2
  res = bayesian(n1, k1, n2, k2, i, it)
        invres = (1.-res)*100
        do while (invres .LT. 95.)
    k2=k2+1
          write(*,*) 'n1, n2, k1, k2=',n1,n2,k1,k2
    res = bayesian(n1, k1, n2, k2, i, it)
          invres = (1.-res)*100
        end do
        write(*,*) 'bayesian=', k2, res*100., (1.-res)*100.
C THE FUNCTION RETURNS THE CONFIDENCE RATE THAT THE DETECTION RATE
C OF METHOD 1 (n1 detections, k1 independent trials) IS BETTER THAN
C THE DETECTION RATE OF METHOD 2 (n2 detections, k2 independent trials)
end do
```

```
      b=getcharQQ()
      end
      real*8 function bayesian(n1,k1,n2,k2,i,it)
   implicit none
   integer n1, n2, k1, k2, i, it
   integer j, y, n, z, k, m, kk1, kk2, w1, w2, w3
   integer n1kk1, n2kk2
   real*8 ps(2,i)
   real*8 s, d, ss, c, nc1, nc2, mm, kn2
   real*8 p (it)
   real*8 pp (2,it)
   real*8 nchoosek
   do j=1,i
       ps(1,j)=0.
       ps(2,j)=0.
      end do
   n=n1+n2
   y=k1+k2
   do j=1,i
    ps(1,j)=j*1.0/i-1.0/(2*i)
    ps(2,j)=(ps(1,j)**(y-0.5))*((1-ps(1,j))**(n-y-0.5))
   end do
   s = 0
   do 10 m=1,i
    s = s + ps(2,m)
10  continue
   do j=1,i
    ps(2,j)=ps(2,j)*1.0/s
   end do
   do j=2,i
    ps(2,j) = ps(2,j)+ps(2,j-1);
   end do
   call random_seed ()
```

```
      call random_number (p)
      do z=1,it
        pp(1,z)=0.
             pp(2,z)=0.
           end do
      d=k2*1.0/n2-k1*1.0/n1
      do j=1,it
        k=1
        do while (p(j) .GT. ps(2,k))
          k=k+1
        end do
        pp(1,j) = ps(1,k)
        pp(2,j) = 0
        do kk2=0,n2
          kn2=kk2*1.0/n2
          mm=n1*(kn2+d)
          kk1 = ceiling(mm)
          ss = 0
            do while (kk1 .LE. n1)
              nc1=nchoosek(n1,kk1)
              ss = ss + nc1*(pp(1,j)**kk1)*((1-pp(1,j))**(n1-kk1))
              kk1 = kk1 + 1
            end do
          nc2=nchoosek(n2,kk2)
          pp(2,j) = pp(2,j) + ss*nc2*(pp(1,j)**kk2)*
     &((1-pp(1,j))**(n2-kk2))
        end do
      end do
C DETERMINE THE SUM OF C
      c = 0
      do 11 j=1,it
        c=c+pp(2,j)
11    continue
```

```
C DIVIDE THE SUM OF C BY THE NUMBER OF ELEMENTS IT
      bayesian = c/it
          return
      end
C THIS FUNCTION IS SIMILAR TO THE FUNCTION NCHOOSEK IN MATLAB
      real*8 function nchoosek(n1,kk1)
      implicit none
      integer n1, kk1, j, n1kk1
      real*8 w1, w2, w3

C DETERMINE n1!/((n1-kk1)!kk1!)
C DETERMINE n1!
      w1=1
      do 13 j=1,n1
        w1=w1*j
13    continue
C DETERMINE kk1!
      w2=1
      do 14 j=1,kk1
        w2=w2*j
14    continue
C DETERMINE (n1-kk1)!
      n1kk1=n1-kk1
      w3=1
      do 15 j=1,n1kk1
        w3=w3*j
15    continue
C RETURN THE VALUE OF nchoosek
      nchoosek = w1*1.0/(w2*w3)
      return
      end
```

List of abbreviations/acronyms

AIMS	Advanced Integrated Multi-sensing Surveillance / Système perfectionné de surveillance multi-capteurs intégré
CF	Canadian Forces
DND	Department of National Defence
DRDC	Defence Research and Development Canada
DRDKIM	Director Research and Development Knowledge and Information Management
DT	Démonstration de technologies
FC	Forces canadiennes
JRCC	Joint Rescue Coordination Center
MOE	Measure of Effectiveness / Mesure d’efficacité
NM	Nautical miles / Mille nautique
PDT	Programme de démonstration de technologies
POD	Probability of Detection / Probabilité de détection
R&D	Research and Development
RDDC	Recherche et développement pour la défense Canada
SAR	Search and Rescue / Recherche et sauvetage
SAREX	Search and Rescue Exercise / Exercice de recherche et sauvetage
SQN	Squadron
Tech	Technician / Technicien
TD	Technology demonstration
TDP	Technology demonstration program

This page intentionally left blank.

Distribution list

Document No.: DRDC Valcartier TM 2008-329

LIST PART 1: Internal Distribution by Centre

1 Guy Vézina
Director General

1 Dennis Nandall
Section Head / Weapons Effects and Protection

3 Document Library

1 Geneviève Toussaint (Author)

1 Vincent Larochelle

1 Gilbert Tardif

1 Luc Forand

9 TOTAL LIST PART 1

LIST PART 2: External Distribution by DRDKIM

1 Director Research & Development, Knowledge and Information Management (PDF FILE)

1 Library and Archives Canada

1 Capt. Jean-François Gaudreau
Directorate Aerospace Equipment Program Management (Radar & Communications System) 6-4-4
National Defence Headquarters
Ottawa, Ontario K1A 0K2

1 Dave Dempster
Directorate Aerospace Equipment Program Management (Radar & Communications System) 6-4-3-C1
400 Cumberland 6B18
Ottawa, Ontario K1A 0K2

1 Terry Rea
Engarde! Consulting Inc.
94, Rue Raymond
St-Denis-sur-mer, Québec G0L 2R0

1 Jacqui Crebolder
Defence Research & Development Canada – Atlantic
Darmouth, Nova Scotia B2Y 3Z7

1 Jocelyn Keillor
Defence Research & Development Canada – Toronto
Toronto, Ontario M3M 3B9

1 Katrina Newman
Directorate Aerospace Equipment Program Management (Radar & Communications System)
National Defence Headquarters
Ottawa, Ontario K1A 0K2

1 Martin Mackinnon
DRDC/DSTA-5
Constitution Building
101 Colonel By Drive
Ottawa, Ontario K1A 0K2

1 Maj. Gordon Ireland
Directorate of Air Requirements
2-4
National Defence Headquarters
Ottawa, Ontario K1A 0K2

1 Sgt. Andre Hotton
14 Wing
PO Box 5000 Station Main
Greenwood, Nova Scotia BOP 1NO

11 TOTAL LIST PART 2

20 TOTAL COPIES REQUIRED

DOCUMENT CONTROL DATA

(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1. ORIGINATOR (The name and address of the organization preparing the document. Organizations for whom the document was prepared, e.g. Centre sponsoring a contractor's report, or tasking agency, are entered in section 8.) Defence R&D Canada – Valcartier 2459 Pie-XI Blvd North Quebec (Quebec) G3J 1X5 Canada	2. SECURITY CLASSIFICATION (Overall security classification of the document including special warning terms if applicable.) UNCLASSIFIED

3. TITLE (The complete document title as indicated on the title page. Its classification should be indicated by the appropriate abbreviation (S, C or U) in parentheses after the title.)

SAREX 2007 search event data analysis

4. AUTHORS (last name, followed by initials – ranks, titles, etc. not to be used)

Toussaint, G.

5. DATE OF PUBLICATION (Month and year of publication of document.) February 2009	6a. NO. OF PAGES (Total containing information, including Annexes, Appendices, etc.) 66	6b. NO. OF REFS (Total cited in document.) 15

7. DESCRIPTIVE NOTES (The category of the document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.)

Technical Memorandum

8. SPONSORING ACTIVITY (The name of the department project office or laboratory sponsoring the research and development – include address.)

Defence R&D Canada – Valcartier
2459 Pie-XI Blvd North
Quebec (Quebec)
G3J 1X5 Canada

9a. PROJECT OR GRANT NO. (If appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant.) 13dx04	9b. CONTRACT NO. (If appropriate, the applicable number under which the document was written.)
10a. ORIGINATOR'S DOCUMENT NUMBER (The official document number by which the document is identified by the originating activity. This number must be unique to this document.) DRDC Valcartier TM 2008-329	10b. OTHER DOCUMENT NO(s). (Any other numbers which may be assigned this document either by the originator or by the sponsor.)

11. DOCUMENT AVAILABILITY (Any limitations on further dissemination of the document, other than those imposed by security classification.)

UNLIMITED

12. DOCUMENT ANNOUNCEMENT (Any limitation to the bibliographic announcement of this document. This will normally correspond to the Document Availability (11). However, where further distribution (beyond the audience specified in (11) is possible, a wider announcement audience may be selected.))

UNLIMITED

13. ABSTRACT (A brief and factual summary of the document. It may also appear elsewhere in the body of the document itself. It is highly desirable that the abstract of classified documents be unclassified. Each paragraph of the abstract shall begin with an indication of the security classification of the information in the paragraph (unless the document itself is unclassified) represented as (S), (C), (R), or (U). It is not necessary to include here abstracts in both official languages unless the text is bilingual.)

The Advanced Integrated Multi-sensing Surveillance (AIMS) system technology demonstration program (TDP) was designed to improve the surveillance and reconnaissance capabilities of the Canadian Forces (CF), particularly at night and in degraded weather conditions. Thereby, to evaluate the utility of this system for Search and Rescue (SAR) operations, evaluation criteria were developed and presented in previous publications. Also, to improve the previous published database, this memorandum presents the analysis of the data collected at SAREX 2007 using the same evaluation criteria.

The first part of this memorandum presents a short description of the SAREX 2007 search event. Then, SAREX 2007 results are presented and the analysis of the data is made using different evaluation criteria such as: target location accuracy, target identification, number of call-arounds, false detection rate, probability of detection and number of targets. Finally, a discussion is presented and recommendations are provided.

Le programme de démonstration de technologies (PDT) du système perfectionné de surveillance multi-capteurs intégré (AIMS) a été conçu pour améliorer les capacités de surveillance et de reconnaissance des Forces canadiennes (FC), particulièrement la nuit et dans des conditions météorologiques dégradées. Ainsi, pour évaluer l'utilité du système lors des opérations de recherche et sauvetage (SAR), des critères d'évaluation ont été développés et présentés dans des publications précédentes. Aussi, pour augmenter l'étendue des données publiées précédemment, ce mémorandum présente l'analyse des données recueillies lors du SAREX 2007 en utilisant les mêmes critères d'évaluation.

La première partie du mémorandum présente une courte description de l'événement de recherche du SAREX 2007. Ensuite, les données du SAREX 2007 sont présentées et l'analyse des données est effectuée à l'aide de critères d'évaluation tels que : précision de la position d'une cible, identification d'une cible, nombre de retours en arrière, taux de fausses détections, probabilité de détection et nombre de cibles. Finalement, une discussion et des recommandations sont formulées.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (Technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus, e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

Advanced Integrated Multi-sensing Surveillance, AIMS, Search and Rescue, SAR, Search and Rescue Exercise, SAREX, MOE, POD

Defence R&D Canada

Canada's Leader in Defence
and National Security
Science and Technology

R & D pour la défense Canada

Chef de file au Canada en matière
de science et de technologie pour
la défense et la sécurité nationale

DEFENCE DÉFENSE

www.drdc-rddc.gc.ca