Testing of the Irvin Canada Sea Rescue Kit (SRK)

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BACKGROUND

1. The current MA-1 Kit has been in service for many years and suffers from several critical deficiencies. The inflation of the 10 Man life raft during descent has been the source of significant problems with the system. The life raft often ended up upside down on the surface of the water making it very difficult for survivors to right and board the raft. In high wind conditions, the life raft would tumble across the surface of the water ending up far from survivors and making it difficult for them to access the life raft at all. With the life raft acting as a sail during descent, delivery accuracy has also been problematic in certain situations. Other limitations have also been identified: survival equipment in the MA-1 kit is provided in a separate bundle from the life raft. In some cases, the equipment has gone unused or lost (cut-away).

2. In response, a Search and Rescue initiative was raised by NDHQ/Irvin personnel to develop solutions to these deficiencies. This paper outlines the development and testing conducted on the Sea Rescue Kit (SRK) for the Canadian Forces.

Irvin SRK Development and General Description

3. The design of the system focused on addressing the deficiencies with the existing system while maintaining the concept of operations of the MA-1 kits to facilitate field acceptance and minimize training impact. As such, the Irvin SRK system was designed to be a hand launched system capable of both ramp and side door deployments. Flexibility of the system was achieved by making all kits the same (and therefore interchangeable) by including a 6-man life raft and survival kit in each unit. This resulted in a 20% increase in life saving capacity for the same number of bundles deployed. The system was designed to allow 2, 3 or 4 modules to be delivered in one drop. Also, rope-to-rope connections of the

modules ensured a wide area could be covered with a single drop to maximize the chances of successful delivery of the equipment to survivors. The bundles descend to the water under a drogue parachute that keeps the life raft and contents contained until impact with the water. Initially, a mechanical timer was used to delay life raft deployment until water immersion. Subsequently, Irvin designed a patented Water Activated Inflation Device (WAID) to initiate life raft inflation once the kit entered the water. This provided a system that could be dropped from a variety of altitudes while still achieving life raft inflation upon water entry. The inflation of the life raft opens the valise and frees the drogue and valise from the interconnected life raft system. This helps to avoid possible entanglement of the survivors with these components. Water pockets on the life raft, together with an automatically deployed weighted sea anchor and specific life raft folding techniques help to stabilize the deployment and ensure an upright life raft in the majority of cases. The survival contents are secured inside the life raft in water-resistant containers.

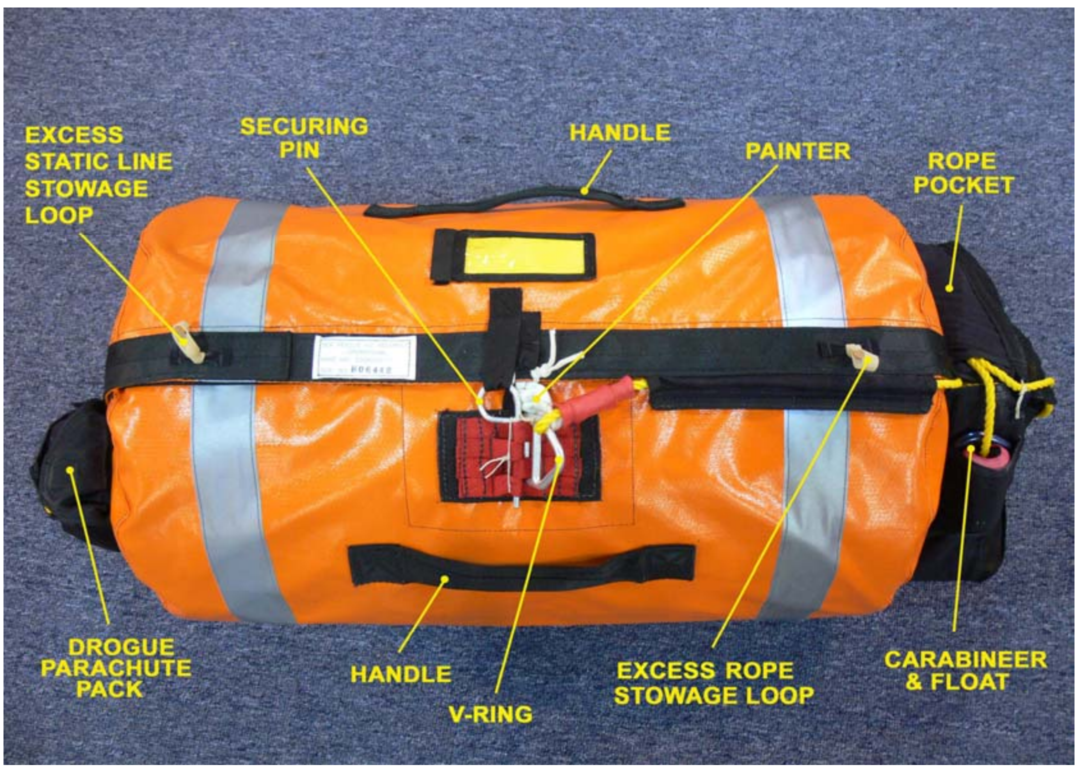

Figure 1 – Irvin Sea Rescue Kit (SRK, Operational)

4. A training system was also designed to allow users to validate and practice drop techniques without expending operational assets. The training system replicated the size and weight of the operational kits and carried ballast instead of a life raft and survival contents. The intent was to provide training systems that acted just like operational systems up to the point of water impact. These systems are easily dried and re-used over and over again.

Figure 2. Sea Rescue Training Kit

5. Two sets of flight tests were conducted to validate and qualify the SRK design for use by the Canadian Forces. This paper summarizes the findings from those tests.

OBJECTIVES

6. The aim of the flight tests was to evaluate the suitability of the SRK for SAR operations and training in support of operational airworthiness clearances.

7. The specific objectives of the flight tests were as follows:

a. To evaluate system deployments of the SAR Sea Rescue Kit when launched from the ramp and side doors of the CC130 Hercules aircraft;
b. To evaluate system deployments of the SAR Sea Rescue Kit when launched from the ramp and side doors of the CC115 Buffalo aircraft;
c. To assess the structural suitability of the modules (both operational and training) in all tested conditions;
d. To assess the visibility of the deployed kits at search pattern altitudes;
e. To assess the operational suitability of the design through review and evaluation of the following;
   i. documentation and procedures provided;
   ii. the maintainability of the system;
   iii. the interoperability between platforms;
   iv. the reliability of the system;
   v. the safety of the system; and,
   vi. the operational effectiveness of the system.

TEST METHODS

8. The test method was to deploy both operational and training modules from the CC115 Buffalo and CC130 Hercules aircraft (ramp and side door) at speeds ranging from 130 to 150 Kts using documented procedures. Data collection included a video record of the drops and limited time, space, and position information of the modules.

9. All tests were conducted in daytime visual meteorological conditions (VMC) in low to moderate winds and sea states ranging from 1 to 4 on the Beaufort scale.

10. Test drops were separated into two sessions. A total of 26 drops (9 operational) were conducted in the first series of tests with 12 drops (5 operational) conducted in the second series of tests.

RESULTS AND DISCUSSION

Preliminary Flight Tests

11. The first series of test were completed off the east coast of Halifax, Nova Scotia. All the drops were performed using a CC130 Hercules aircraft. Qualified CF SAR technicians were employed in the tests to assess system performance and to ensure normal guidelines for SAR drops were respected. Drops were conducted with both training and operational kits at target release points of 300 ft AWL and from 130 to 150 KIAS. All operational SRKs used in these tests were configured with Mk10B mechanisms to initiate life raft inflation.

12. Two Bundle Drops. A total of 9 two bundle drops were made 3 of which were completed with fully operational modules. The release altitudes for all drops were between 290 and 328 ft AWL. The target airspeeds were 130 KIAS, 140 KIAS, and 150 KIAS and were achieved within ± 3 kts.

13. No anomalies were noted in the first 2 operational drops. Winds varied between 16 and 20kts on these drops and crews noted some accuracy issues attributed to SRK drift. Two of the 3 operational drops were successful with the system deploying the life rafts upright. On the third drop, one of the life rafts was inverted after inflation.

14. The visibility of the deployed life rafts was good. In contrast, the olive drab valises used in these trials for the training units was poor and aircrew stated that the training units were very difficult to see from an altitude of 300 ft AWL.

15. Several structural failures on the SRK system occurred during these drops including drogues departing the valise upon inflation and rope to valise failures at rope stretch. The damaged units were repaired and reinforced on-site and used for the remaining drops in the preliminary flight test trials.

16. Three Bundle Drops. A total of 8 three bundle drops were completed, 2 of which were completed with fully operational modules. The release altitudes for all drops were between 300 and 320 ft AWL. The target airspeeds were 130 KIAS, 140 KIAS, and 150 KIAS and were achieved within ± 4 kts.

17. No anomalies were noted in the deployment of the 2 operational drops. One life raft of the 6 deployed, inflated in an inverted position. Winds reached a maximum of 23 kts on test day.

18. As with the 2 bundle drops, the visibility of the deployed life rafts was good while the training modules were very difficult to spot from the air. The structural failures observed in the 2 bundles tests were reduced although the rope to valise attachment was problematic. As was done previously, damaged units were repaired to allow testing to continue.

19. Four Bundle Drops. A total of 7 four bundle drops were completed in these preliminary flight tests including 4 drops using operational modules. The release altitudes for all drops were between 290 and 330 ft AWL. The target airspeeds were 130 KIAS, 140 KIAS, and 150 KIAS and were achieved within ±3 kts.

20. No anomalies were noted in the deployment of the operational kits. One life raft of the 24 deployed inflated in an inverted position while another failed to inflate at all.

21. Summary of Preliminary Flight Tests. Aircrew conducting these preliminary trials reported that although there were several deficiencies to be addressed, the units would significantly improve SAR operations once certain improvements to the system were implemented. These changes included improving the structural integrity of several critical areas (rope and drogue connections), and improving training system visibility. Some SAR technicians felt that the system was subject to excessive drift under the drogue parachute and suggested this be addressed.

22. Based on these initial trials, the deployment speed was recommended to be 130 KIAS. Deployment procedures were validated although it was noted that breakaway static lines would improve aircrew safety after system deployment.

Follow-On Flight Tests

23. After the preliminary flight tests were completed, Irvin examined the results to assess how to improve system performance. One of the key objectives of the program was to address the accessibility of the life raft for survivors in the water. One important component to achieving this objective was to provide survivors with an upright life raft to board. While the majority of the life rafts deployed in the preliminary tests were successful, a few were inverted after inflation (3 of 28 deployments). To address this, Irvin modified the packing procedures of the life raft in the SRK to improve the deployment characteristics of the life raft and the weighted sea anchor.

24. It was recognized in the preliminary tests that using a mechanical timer to control life raft inflation was limited and could not address the fact that the time delay setting on different drops would need to be different if the life raft was to inflate just after water entry. A water activated inflation device (WAID) was designed and patented to ensure life raft inflation occurred at the desired time. The device was based on the water-soluble capsules used in life preservers to initiate a spring-loaded cable attached to the operating head of the life raft's CO2 bottle. The SRK was changed to accommodate the device and associated plumbing to ensure an unimpeded path for the water needed to activate the system. Extensive tests were conducted on the system to ensure reliability including immersion tests in fresh and salt water and environmental testing.

25. The valises and attachments for the rope and drogue were beefed up to address structural failures which occurred in the first round of tests. Moreover, the training module material was changed to a more durable bright yellow material to facilitate locating the module in the water for recovery operations. The operational units were made bright orange to distinguish them from the training units. For the second round of flight tests, 10 operational modules were manufactured. Six of these used the new WAID while the remaining 4 modules used the mechanical timer for life raft inflation. Nine training kits were manufactured for these trials.

26. The follow-on trials were conducted near Comox off Vancouver Island in British Columbia. Tests were conducted from both the CC115 Buffalo aircraft and the CC130 Hercules. Test conditions were VMC with light to moderate winds (up to 30 kts) and sea states ranging from 1 to 4 on the Beaufort scale. Test points included both ramp and door deployments from both aircraft platforms with target release altitude of 300 ft AWL and release speeds of 110 KIAS for the CC115 and 137 KIAS ($\pm$ 5 KIAS) for the CC130. A total of 12 multiple bundle drops were conducted in these tests.

27. Deployment Characteristics. During some drops the static lines were considered to be a hazard to crews due to the whipping motion of the lines after deployment. The configuration was changed to break way static lines. This eliminated problems with the flailing static lines. No significant impact was noted on system deployment or operation with this modification. It was recommended that the system be modified to require only one static line per drop rather than one per module.

28. While timing and technique significantly affected drop accuracy, the bundles displayed consistent descent characteristics. Using the dispatch procedures developed and a 1 second deployment delay between modules,

delivery accuracy was good and considered much better than that of the MA1 kits.

29. Life Raft Deployment. A total of 17 operational modules were dropped from both aircraft platforms in light to moderate winds and sea states up to 4 on the Beaufort scale. Upon landing in the water, each life raft inflated successfully in an upright position. Both the mechanical timer and water activated devices performed without any problems. Test members preferred the water activated device over the mechanical timer due to its ruggedness and flexibility to accommodate drops from virtually any altitude without impacting life raft inflation characteristics. It was noted that tests need to be conducted in heavy seas and in stronger winds to evaluate the system in more challenging conditions. Within the scope of these tests, life raft deployment was satisfactory and represented a significant improvement over the current system.

30. Structural Integrity. Only one event was noted as a structural issue in the deployment of 38 modules during these tests. During the side door deployment of a module from the CC130 aircraft, one v-ring attachment failed. This was attributed to a delayed dispatch of a kit during a side door deployment. Apart from this event, all other attachments remained intact and no significant damage was noted on the drogue, static line, or rope attachment points. As such the structural integrity of both the operational and training modules was satisfactory.

31. Human Factors. Test crews assessed the handling properties of the SRK and determined that the smaller size of the modules, the layout of the end and side mounted handles, along with the colour coding on the valises to distinguish training systems from operational systems made the kits easy to load and handle. No configuration changes were required between aircraft platforms and the modules were considered to be fully compatible and suitable for use on either the CC130 or CC115 aircraft.

32. Once dispatched and in the water, the bright yellow colour of the training valises made spotting these modules much easier than the previous versions. Again, retrieval from the water was facilitated by the layout of the handles. The auto activated light distress marker on the life raft for operational SRKs was tested during daytime and was visible against the dark background of the water. The ergonomics of the modules and visibility of the units once dispatched was satisfactory.

33. Training Kit Suitability. The training modules were effective in providing kits that accurately matched the size, weight, and deployment characteristics of operational units. Descent characteristics were also very similar to operational systems. It was noted that the shape of the training system combined with the more rigid core resulted in a tendency for the training modules to roll about on the cabin floor. It was recommended that the bottom of these kits be modified to reduce this tendency. Overall, the training kits were considered to be highly valuable in that they allow crews to employ the exact loading, rigging, and deployment techniques and procedures required for proper use of the operational systems. Moreover, this positive training will lead to improved crew proficiency and improved drop accuracy.

CONCLUSIONS AND RECOMMENDATIONS

34. The Irvin SRK (operational and training) was tested from both CC130 Hercules and CC115 Buffalo aircraft with satisfactory results observed with ramp and side door deployments. The SRK units represent a significant improvement over the MA-1 kits for SAR crews in both handling and operation. In the final configuration, operational units using the Irvin water activated inflation device provided reliable deployment of life rafts in an upright position. Further testing is recommended to evaluate system performance in more severe conditions than those tested. The positive training provided by the training kits was an excellent way to practice SRK drops under realistic conditions without expending operational assets. Based on these tests, operational clearance was recommended for the Irvin SRK system for use by Canadian Forces SAR personnel. The SRK system is expected to enter service with the CF in April 2006.