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MANIKIN TESTING ON LASA SUIT

by

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On behalf of

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ABSTRACT

The CORD Group Limited was asked by DRDC Toronto to provide the facilities to allow them to conduct in waves human subject trials on the new LASA NBC immersion suit with water and air temperature the same. In conjunction with the human subject trials, a thermal manikin was used to collect data about the thermal resistance properties of the new LASA NBC immersion suit in still air as well as in waves.

During the trials, thermal resistance data was also collected on an extreme cold weather garment ensemble as well as the modified current flyer's coverall immersion suit in a still air and waves.

The data presented in this report will be compared to the data collected by the human subjects at a later date for each test garment ensemble.

EXECUTIVE SUMMARY

As part of a BL2 with the directorate of Aerospace Engineering Support DAES, DRDC Toronto required testing to be conducted on a thermal immersion manikin to evaluate the thermal resistance of the NBC immersion suit LASA in a wave pool. Parallel to the manikin testing, human testing was performed using the same test facilities.

In conjunction with this evaluation, the thermal resistance of the ACE extreme cold weather garments and the modified current flyer's coverall immersion suit was also measured. This report details the thermal resistance results of the ACE extreme cold weather garments, LASA immersion suit, and modified current flyer's coverall immersion suit in still air and in 40 cm waves. These results will be compared to values recorded from human subjects using the same wave height tested at the same test facility (wave tank).

1.0 INTRODUCTION

1.1 BACKGROUND:

As part of a BL2 with the directorate of Aerospace Engineering Support DAES, DRDC Toronto requires testing to be conducted on a thermal immersion manikin to evaluate the thermal resistance of the NBC immersion suit LASA in a wave pool. In conjunction with this evaluation, the thermal resistance of the ACE extreme cold weather garments and the modified current flyer's coverall immersion suit in still air and in 40 cm waves would also be evaluated.

1.2 AIM:

To measure the thermal performance of the ACE extreme cold weather garments, LASA immersion suit, and the modified current flyer's coverall immersion suit in still air and 40 cm waves.

1.3 STATEMENT OF WORK:

The project will determine, utilizing a standardized, validated and reliable protocol (formally agreed upon between contractor and scientific authorities), the thermal performance in still air and 40 cm waves on the LASA immersion suit as well as the ACE extreme cold weather garments and the modified current flyer's coverall immersion suit. The details of the manikin test conditions are as follows:

1. ACE extreme weather garment system in 10^{O} C still air;
2. LASA immersion suit system in still air;
3. Modified current flyer's coverall immersion suit system in still air;
4. LASA immersion suit system in 40 cm waves;
5. Modified current flyer's coverall immersion suit in 40 cm waves; and
6. Modified current flyer's coverall immersion suit in 40 cm waves with 2 liters of leakage added to suit system.

DRDC Toronto will provide all the clothing and equipment required for the manikin tests. The contractor will make available the same test facilities used for the manikin testing for the human testing, i.e. wave pool and dressing area.

2.0 REFERENCES

2.1 CORD Document No. R95-018 (1995). Implementation of Test Protocol of Thermal Manikin Test System. The CORD Group Limited, Dartmouth: May 1995.

3.0 METHOD

3.1 METHODOLOGY:

The thermal performance of the ACE extreme cold weather garments, LASA immersion suit, and the modified current flyer's immersion suit in still air and 40 cm waves was determined using a Thermal Instrumented Manikin Test System. During each test, environment, temperature, skin temperature and power consumption was recorded.

3.2 THERMAL MANIKIN TEST SYSTEM:

The Thermal Manikin Test System is a means for evaluating the thermal insulation of thermal protective clothing. In particular, this refers to survival suits for ocean emergencies and, in general, it refers to any human-use apparel. The system consists of a hollow aluminum manikin equipped with temperature sensors and electric heaters connected to a computer system.

In operation, the manikin is dressed in the human-use apparel to be tested and placed in an appropriate environment. The computing equipment then controls the heaters to maintain the skin of the manikin at a set temperature and measures the electrical power required to do so. This power is equivalent to the heat that escaped through the clothing due to the temperature difference across it. The power and temperature differences are then used, along with the known surface area of the manikin to calculate the thermal resistance offered by the apparel.

The system is designed for flexibility and ease of operation. To allow for different types of clothing, different sections of the manikin can be included or eliminated from the test as required.

The basic philosophy on which the design is based is that the thermal performance of a garment can be evaluated by unmanned tests on the whole garment under conditions identical or similar to actual operating conditions. This philosophy dictates that the system employs a life-sized watertight manikin capable of being heated to and maintained at a selected temperature.

Figure 1 gives a total view of the system. The visible components are the Thermally Instrumented Manikin (TIM), the control module, the computer, the environmental temperature sensors and the cables connecting these components. Basically, the manikin provides a shape of human proportions to fit inside the test garment. The combinations of the aluminum shell of the manikin and the output of heaters inside it provide for an approximately uniform temperature over the manikin surface. This temperature is sensed by sensors embedded in the manikin's shell and passed to the control module. The control module houses the programmed data acquisition system, the heater relays and other circuit components. The data acquisition system receives data from the

3.2 THERMAL MANIKIN TEST SYSTEM (Contd.):

temperature sensors on the manikin and controls the heater relays so that the manikin surface temperature remains constant. It also measures the Environment temperature and the power applied to the manikin and is programmed with the surface area of the manikin. With this temperature, power, and area data, it calculates the insulation value of the garment and passes this, along with other pertinent data to the computer. The computer acts as a control and display terminal and post-processor.

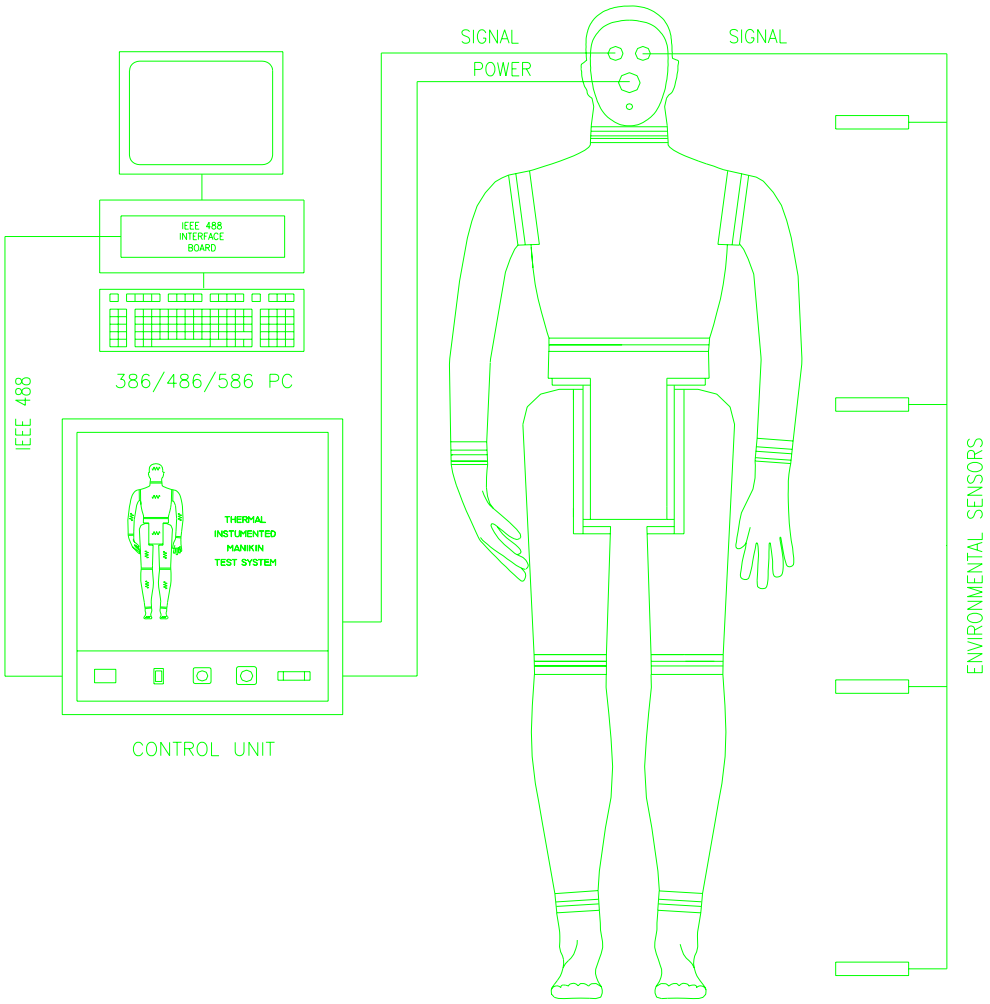


FIGURE 1

4.0 TEST EQUIPMENT

4.1 Control Module.
Model #: Micro-Mac 5000. Serial #: 98-9109404-001.
Last Calibration Date: January 26, 2006.
Calibration Due Date: January 26, 2007.

4.2 Instrumented Manikin.
Model #: TIM 1.
Last Calibration Date: January 26, 2006.
Calibration Due Date: January 26, 2007.

4.3 Desktop Computer.
Model #: MID-MSI 2600 ATX.
Calibration not required.

5.0 TEST CONDITIONS

5.1 Testing was conducted in water and still air with an air and water temperature recorded at:

5.1.1 Ambient Air:	8.72 – 12.12	|	N/A
5.1.2 Water temperature:	9.49 – 9.95	|	10.2 – 10.5

Despite the unintentional changes in the ambient air and water temperature, the conditions are not critical to the results rather it is the difference between the air/water temperature and body temperature, and that the latter was maintained constant across all conditions.

6.0 TEST ITEMS

6.1 Thermal Instrumented Manikin dressed in test garment and undergarment ensembles described in table 6.2.1 and 6.3.1.

6.2 Table 6.2.1 illustrates the garments requested.

6.3 Table 6.3.1 illustrates the undergarments requested.

Run #	Garments
1	(ACE) extreme weather garment system; current flyer's gloves (brown), balaclava (black), mod. 9183 JKT outer jacket size 7342, mod 9187 size 7334 bib pant, prototype extreme cold weather boots (black).
2	LASA suit size 10, Event gloves (black), helmet, LPSV lifejacket, anti-G pant, and prototype extreme cold weather boots (black).
3	Modified current flyer's coverall size 6, current flyer's gloves with liner (brown), helmet, LPSV lifejacket, and prototype extreme cold weather boots (black).
4 - 5	LASA immersion suit size 10, neoprene hood/boots, LPSV lifejacket, left hand (Event glove) right hand (neoprene 3 finger mitt), and LASA anti-G pant.
6 - 7	Modified current flyer's coverall size 6, neoprene hood/ boots/3 finger mitts, and LPSV lifejacket.

Table 6.2.1

Run #	Undergarments
1	Light weight 2 piece long sleeved/legged underwear, sock liner, wool socks, mod. 9186 flight coverall size 7342, and mod. 9184 JKT jacket liner size 7342.
2	LASA 2 piece long sleeved/legged underwear and thin socks.
3	FQH foam liner size 5 and heavy weight socks.
4 -5	LASA 2 piece long sleeved/legged underwater, thin sock liner, and heavy weight sock.
6 - 7	FQH foam liner size 5 and heavy weight socks.

Table 6.3.1

7.0 TEST PROCEDURE

The ACE extreme cold weather garment system, LASA immersion suit, and modified current flyer's coverall immersion suit were tested using the procedures as directed in CORD Document No. R95-018 Implementation of Test Protocol of Thermal Manikin Test System May 1995. The manikin was lifted using an overhead hoist. The manikin was dressed in the above undergarment and garment ensembles and secured. Auxiliary components were added over the garments as described in Section 6.0 Test Items. The manikin was positioned into the prescribed test environments by lowering it onto steel hooks under each arm and into the water and positioned in the centre of the test tank in the natural flotation position. The environmental sensors were either attached to a hanging frame or the flotation frame to provide the environmental temperature. A wave generator consisting of a hydraulic ram connected to a paddle board located a one of the test tank provided a 40 cm wave with a wave period of 2.5 seconds environment for testing.

Entering all pertinent information into the system's computer started a warm up period, while all sections of the manikin were warming up to the selected skin temperature. During that time, the conditions for the prescribed tests were implemented. Once all sections of the manikin reached the set point, the test automatically commenced. The test duration was four (4) hours or until the manikin achieved steady state condition.

8.0 RESULTS

8.1 Table 8.1.1 illustrates final results of the thermal resistance testing rounded to four decimal points.

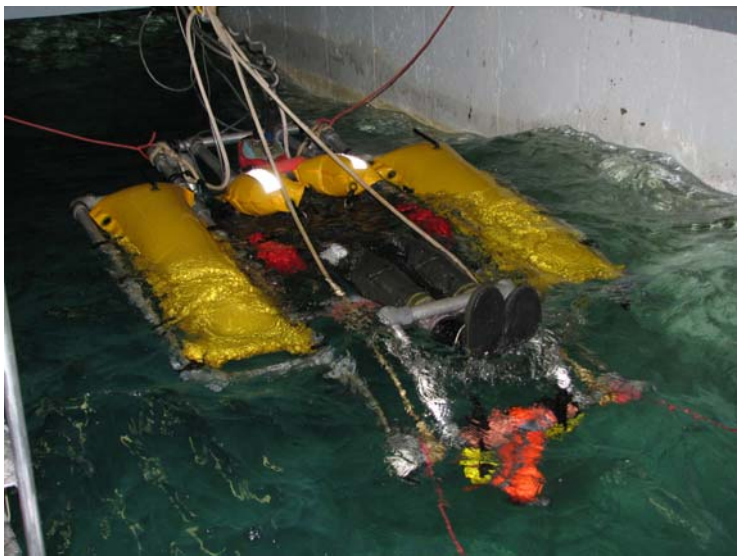
Run #	Description	Condition	Result CLO
1	ACE extreme cold weather garments	Still air	3.2094
2	LASA immersion suit system with helmet	Still air	2.4117
3	Modified current flyer's coverall immersion suit system with helmet	Still air	2.1595
4	LASA immersion suit system with left hand with Event glove and right hand with neoprene 3 finger mitt	40 cm wave	0.3805
5	LASA immersion suit system with neoprene hood/boots/3 finger mitts, anti-G compression pant, re-test with vent valves taped, neck taped	40 cm wave	0.7995
6	Modified current flyer's coverall immersion suit system *	40 cm wave	0.5980
7	Modified current flyer's coverall immersion suit system with 2 litres of leakage added to the suit system	40 cm wave	0.3160

* Test ended early because of accidental leakage in the suit system

Table 8.1.1

9.0 TESTING PHOTOGRAPHS

Modified Current flyer's coverall undergarments



Modified Current Flyer's coverall in 40 cm waves

ACE extreme cold weather garments

LASA immersion suit

ANNEX “A”
RAW DATA

TEST NUMBER:
TEST TITLE: AIR CREW EXTREME WEATHER GARMENT EVALUATION.
FILE NAME: c:\Documents and Settings\Test Lab\Desktop\Tim_2005\NEW PROGRAM\M06003SA2.TM1

DATE OF TEST: 02-21-2006
START TIME: 16:20:07
DESCRIPTION OF SUIT TESTED: (ACE) EXTREME WEATHER GARMENT SYSTEM;CURRENT FLYER'S GLOVES (BROWN), BALACLAVA (BLACK), MOD. 9183 JKT OUTER JACKET SIZE 7342, MOD. 9187 SIZE 7334 BIB PANT, PROTOTYPE EXTREME COLD WEATHER BOOTS (BLACK).
UNDERGARMENTS: LIGHT WEIGHT 2 PIECE LONG SLEEVED/LEGGED UNDERWEAR, SOCK LINER, WOOL SOCKS, MOD. 9186 FLIGHT COVERALL SIZE 7342, MOD. 9184 JKT JACKET LINER SIZE 7342.
ENVIRONMENT: STILL AIR
  POSITION: HANGING VERTICAL
  HUMIDITY: 58
  ENV. FLOW SPEED:
  DIRECTION: From Front
CABLE LENGTH: Short (50ft)
ADDITIONAL INFORMATION:

STOP TIME: 20:20:04 MINUTES SINCE START OF TEST: 239.95
ENVIRONMENT TEMPERATURE:
  INSTANTANEOUS: 11.71 AVERAGE OVER TEST TIME: 12.11

SECTION	SETPOINT (Deg C)	SKINTEMP (Deg C)	TEMP DIFF(Deg C) INSTANT	TEMP DIFF(Deg C) AVERAGE	POWER (WATTS) ST	POWER (WATTS) LT	INSULATION (CLO) ST	INSULATION (CLO) LT
Head	39.00	39.00	27.29	26.89	17.34	16.93	1.3780	1.3908
Chest	39.00	39.06	27.36	26.96	3.66	3.74	7.5008	7.2338
Back	39.00	39.01	27.30	26.91	4.61	4.75	6.3592	6.0791
Abdomen	39.00	39.01	27.30	26.90	2.25	2.34	4.3024	4.0649
Buttocks	39.00	39.00	27.30	26.90	2.37	2.33	6.3928	6.4223
Right Arm	39.00	39.00	27.30	26.89	6.48	6.40	3.0851	3.0787
Left Arm	39.00	39.00	27.30	26.90	5.71	5.56	3.1460	3.1853
Right Hand	39.00	39.11	27.41	27.02	10.10	8.72	0.8594	0.9820
Left Hand	39.00	39.18	27.47	27.07	7.30	6.89	1.1707	1.2215
Right Leg	39.00	39.00	27.30	26.90	14.36	15.42	4.3703	4.0099
Left Leg	39.00	39.00	27.30	26.90	13.93	13.86	4.1945	4.1552
Right Foot	39.00	39.04	27.33	26.93	3.24	3.49	3.7301	3.4147
Left Foot	39.00	39.04	27.33	26.94	3.58	3.53	3.3197	3.3232
Overall					94.93	93.95	3.2233	3.2094

   Total Power (W) For All Sections: 93.949
   Total Area (Square Meters): 1.736
   Overall Insulation Resistance (CLO): 3.2094

TEST NUMBER:
TEST TITLE: DRDC SUIT EVALUATION
FILE NAME: c:\Documents and Settings\Test Lab\Desktop\Tim_2005\NEW PROGRAM\M06003SA4.TM1

DATE OF TEST: 02-23-2006
START TIME: 10:39:51
DESCRIPTION OF SUIT TESTED: LASA SUIT SIZE 10,EVENT GLOVES,COLD WEATHER LEATHER FLIGHT BOOTS,HELMET,LPSV LIFEJACKET,ANTI-G COMPRESSION PANT.
UNDERGARMENTS: LASA 2 PIECE LONG UNDERWEAR,THIN SOCKS.
ENVIRONMENT: STILL AIR.
  POSITION: STANDING VERTICAL SUSPENDED FROM STEEL HOOKS.
  HUMIDITY: 68
  ENV. FLOW SPEED:
  DIRECTION: From Front
CABLE LENGTH: Short (50ft)
ADDITIONAL INFORMATION:

STOP TIME: 18:39:47 MINUTES SINCE START OF TEST: 479.95
ENVIRONMENT TEMPERATURE:
  INSTANTANEOUS: 12.14 AVERAGE OVER TEST TIME: 12.12

SECTION	SETPOINT (Deg C)	SKINTEMP (Deg C)	TEMP DIFF(Deg C) INSTANT	TEMP DIFF(Deg C) AVERAGE	POWER (WATTS) ST	POWER (WATTS) LT	INSULATION (CLO) ST	INSULATION (CLO) LT
Head	39.00	39.00	26.86	26.89	13.01	13.03	1.8082	1.8062
Chest	39.00	39.07	26.93	26.96	5.80	5.75	4.6614	4.7124
Back	39.00	39.01	26.87	26.89	7.46	8.12	3.8647	3.5517
Abdomen	39.00	39.01	26.86	26.89	3.88	4.21	2.4518	2.2602
Buttocks	39.00	39.00	26.86	26.89	4.15	4.65	3.5920	3.2112
Right Arm	39.00	39.00	26.86	26.88	10.05	10.03	1.9588	1.9636
Left Arm	39.00	39.00	26.86	26.89	9.02	9.18	1.9597	1.9265
Right Hand	39.00	39.12	26.98	27.01	3.37	3.64	2.5370	2.3494
Left Hand	39.00	39.16	27.02	27.05	4.09	3.82	2.0549	2.2052
Right Leg	39.00	39.01	26.86	26.89	24.80	27.63	2.4899	2.2368
Left Leg	39.00	39.00	26.86	26.88	24.31	24.91	2.3653	2.3108
Right Foot	39.00	39.04	26.90	26.93	5.23	4.84	2.2731	2.4599
Left Foot	39.00	39.06	26.92	26.94	4.79	5.09	2.4462	2.3009
Overall					119.96	124.92	2.5090	2.4117

   Total Power (W) For All Sections: 124.917
   Total Area (Square Meters): 1.736
   Overall Insulation Resistance (CLO): 2.4117

TEST NUMBER:
TEST TITLE: DRDC CURRENT FLYER'S SUIT EVALUATION
FILE NAME: c:\Documents and Settings\Test Lab\Desktop\Tim_2005\NEW PROGRAM\M06003SA5.TM1

DATE OF TEST: 02-27-2006
START TIME: 15:18:49
DESCRIPTION OF SUIT TESTED: MODIFIED CURRENT FLYER'S COVERALL,LPSV LIFEJACKET,FLYER'S GLOVE WITH LINER,HELMET,COLD WEATHER LEATHER FLIGHT BOOTS.
UNDERGARMENTS: FQH FOAM LINER, HEAVY WEIGHT SOCKS.
ENVIRONMENT: STILL AIR.
  POSITION: STANDING VERTICAL SUSPENDED ON STEEL HOOKS.
  HUMIDITY: 65
  ENV. FLOW SPEED:
  DIRECTION: From Front
CABLE LENGTH: Short (50ft)
ADDITIONAL INFORMATION:

STOP TIME: 23:18:45 MINUTES SINCE START OF TEST: 479.95
ENVIRONMENT TEMPERATURE:
INSTANTANEOUS: 7.54 AVERAGE OVER TEST TIME: 8.72

SECTION	SETPOINT (Deg C)	SKINTEMP (Deg C)	TEMP DIFF(Deg C) INSTANT	TEMP DIFF(Deg C) AVERAGE	POWER (WATTS) ST	POWER (WATTS) LT	INSULATION (CLO) ST	INSULATION (CLO) LT
Head	39.00	39.00	31.45	30.28	18.35	16.77	1.5009	1.5811
Chest	39.00	39.10	31.56	30.38	7.75	8.27	4.0914	3.6884
Back	39.00	39.01	31.46	30.29	8.63	9.06	3.9136	3.5868
Abdomen	39.00	39.00	31.46	30.28	5.61	5.64	1.9861	1.9030
Buttocks	39.00	39.00	31.45	30.28	6.05	6.00	2.8880	2.8053
Right Arm	39.00	39.00	31.45	30.28	13.72	13.02	1.6801	1.7043
Left Arm	39.00	39.00	31.45	30.28	12.61	11.74	1.6416	1.6976
Right Hand	39.00	39.14	31.59	30.42	7.12	6.71	1.4065	1.4358
Left Hand	39.00	39.17	31.63	30.46	7.96	7.12	1.2362	1.3298
Right Leg	39.00	39.00	31.45	30.28	37.86	32.64	1.9097	2.1326
Left Leg	39.00	39.00	31.46	30.28	30.32	29.86	2.2216	2.1717
Right Foot	39.00	39.05	31.50	30.33	5.01	5.08	2.7814	2.6366
Left Foot	39.00	39.07	31.52	30.35	5.56	5.24	2.4666	2.5191
Overall					166.52	157.15	2.1167	2.1595

Total Power (W) For All Sections: 157.151
Total Area (Square Meters): 1.736
Overall Insulation Resistance (CLO): 2.1595

TEST NUMBER:
TEST TITLE: DRDC LASA SUIT EVALUATION.
FILE NAME: c:\Documents and Settings\Test Lab\Desktop\Tim_2005\NEW PROGRAM\M06003WT1.TM1

DATE OF TEST: 02-22-2006
START TIME: 16:24:37
DESCRIPTION OF SUIT TESTED: LASA IMMERSION SUIT,NEOPRENE HOOD/BOOTS,INFLATED LPSV LIFEJACKET,LEFT HAND EVENT FIVE FINGER GLOVE,RIGHT HAND NEOPRENE 3 FINGER MITT.
UNDERGARMENTS: LASA 2 PIECE UNDERWEAR,THIN SOCK LINER,HEAVY WEIGHT SOCK.
ENVIRONMENT: 40 CM WAVE.
  POSITION: NATURAL FLOTATION POSITION.
  HUMIDITY: 78
  ENV. FLOW SPEED:
  DIRECTION: From Front
CABLE LENGTH: Short (50ft)
ADDITIONAL INFORMATION:

STOP TIME: 18:47:37 MINUTES SINCE START OF TEST: 143.00
ENVIRONMENT TEMPERATURE:
  INSTANTANEOUS: 9.97 AVERAGE OVER TEST TIME: 9.95

SECTION	SETPOINT (Deg C)	SKINTEMP (Deg C)	TEMP DIFF(Deg C) INSTANT	TEMP DIFF(Deg C) AVERAGE	POWER (WATTS) ST	POWER (WATTS) LT	INSULATION (CLO) ST	INSULATION (CLO) LT
Head	30.00	30.01	20.04	20.03	47.25	51.34	0.3713	0.3416
Chest	30.00	30.06	20.08	20.10	17.59	21.92	1.1468	0.9210
Back	30.00	29.60	19.63	20.02	76.91	60.96	0.2738	0.3523
Abdomen	30.00	30.01	20.03	20.04	23.13	15.94	0.3067	0.4454
Buttocks	30.00	22.70	12.73	16.23	43.30	43.49	0.1633	0.2073
Right Arm	30.00	30.00	20.02	20.05	37.90	36.52	0.3872	0.4023
Left Arm	30.00	29.99	20.02	20.05	23.44	18.43	0.5619	0.7160
Right Hand	30.00	29.93	19.95	19.99	30.49	29.51	0.2073	0.2146
Left Hand	30.00	19.65	9.67	10.46	30.74	31.33	0.0979	0.1038
Right Leg	30.00	29.97	19.99	20.04	161.88	123.51	0.2839	0.3730
Left Leg	30.00	29.98	20.01	20.04	132.81	99.11	0.3226	0.4330
Right Foot	30.00	30.03	20.06	20.08	7.79	8.97	1.1382	0.9894
Left Foot	30.00	30.04	20.07	20.09	9.23	9.78	0.9451	0.8931
Overall					642.46	550.80	0.3194	0.3805

Total Power (W) For All Sections: 550.797
Total Area (Square Meters): 1.736
Overall Insulation Resistance (CLO): 0.3805

TEST NUMBER:
TEST TITLE: DRDC LASA SUIT EVALUATION
FILE NAME: c:\Documents and Settings\Test Lab\Desktop\Tim_2005\NEW PROGRAM\M06003WT2.TM1

DATE OF TEST: 02-27-2006
START TIME: 11:28:34
DESCRIPTION OF SUIT TESTED: LASA IMMERSION SUIT,LPSV LIFEJACKET,NEOPRENE HOOD/GLOVES/BOOTS,ANTI-G COMPRESSION PANT.
UNDERGARMENTS: LASA 2 PIECE UNDERWEAR,THIN SOCK LINER,HEAVY WEIGHT SOCK.
ENVIRONMENT: 40 CM WAVE.
  POSITION: NATURAL FLOTATION POSITION.
  HUMIDITY: 70
  ENV. FLOW SPEED:
  DIRECTION: From Front
CABLE LENGTH: Short (50ft)
ADDITIONAL INFORMATION: RE-TEST OF M06003WT2 WITH VALVES TAPED, NECK TAPED.

STOP TIME: 13:28:34 MINUTES SINCE START OF TEST: 120.00
ENVIRONMENT TEMPERATURE:
  INSTANTANEOUS: 9.49 AVERAGE OVER TEST TIME: 9.49

SECTION	SETPOINT (Deg C)	SKINTEMP (Deg C)	TEMP DIFF(Deg C) INSTANT	TEMP DIFF(Deg C) AVERAGE	POWER (WATTS) ST	POWER (WATTS) LT	INSULATION (CLO) ST	INSULATION (CLO) LT
Head	30.00	30.00	20.51	20.51	42.08	41.05	0.4268	0.4373
Chest	30.00	30.09	20.60	20.58	17.63	19.16	1.1736	1.0794
Back	30.00	30.03	20.54	20.52	20.20	21.66	1.0912	1.0164
Abdomen	30.00	30.00	20.52	20.52	7.29	7.47	0.9962	0.9734
Buttocks	30.00	30.00	20.51	20.52	8.82	8.89	1.2916	1.2821
Right Arm	30.00	30.00	20.52	20.51	18.58	18.65	0.8094	0.8059
Left Arm	30.00	30.00	20.51	20.51	17.11	16.30	0.7891	0.8280
Right Hand	30.00	29.95	20.46	20.46	21.53	21.15	0.3011	0.3064
Left Hand	30.00	29.95	20.46	20.46	19.98	19.65	0.3185	0.3237
Right Leg	30.00	30.00	20.51	20.50	48.85	48.09	0.9652	0.9800
Left Leg	30.00	30.00	20.51	20.51	40.96	40.30	1.0724	1.0897
Right Foot	30.00	30.04	20.55	20.54	10.28	10.24	0.8837	0.8865
Left Foot	30.00	30.03	20.55	20.54	14.67	14.65	0.6092	0.6098
Overall					287.97	287.26	0.7978	0.7995

Total Power (W) For All Sections: 287.255
Total Area (Square Meters): 1.736
Overall Insulation Resistance (CLO): 0.7995

TEST NUMBER:
TEST TITLE: DRDC CURRENT FLYER'S COVERALL EVALUATION
FILE NAME: c:\Documents and Settings\Test Lab\Desktop\Tim_2005\NEW PROGRAM\M06003WT3.TM1

DATE OF TEST: 02-28-2006
START TIME: 10:04:34
DESCRIPTION OF SUIT TESTED: MODIFIED CURRENT FLYER'S COVERALL, NEOPRENE HOOD/MITTS/BOOTS,LPSV VEST.
UNDERGARMENTS: FQH LOAM LINER, HEAVY WEIGHT SOCKS.
ENVIRONMENT: 40 CM WAVE
  POSITION: NATURAL FLOTATION POSITION.
  HUMIDITY: 65
  ENV. FLOW SPEED:
  DIRECTION: From Front
CABLE LENGTH: Short (50ft)
ADDITIONAL INFORMATION: TEST ENDED EARLY DUE TO LEAKAGE IN THE SUIT

STOP TIME: 10:24:34 MINUTES SINCE START OF TEST: 20.00
ENVIRONMENT TEMPERATURE:
INSTANTANEOUS: 9.30 AVERAGE OVER TEST TIME: 9.30

SECTION	SETPOINT (Deg C)	SKINTEMP (Deg C)	TEMP DIFF (Deg C) INSTANT	TEMP DIFF (Deg C) AVERAGE	POWER (WATTS) ST	POWER (WATTS) LT	INSULATION (CLO) ST	INSULATION (CLO) LT
Head	30.00	29.99	20.68	20.68	38.20	38.20	0.4740	0.4740
Chest	30.00	30.02	20.71	20.71	27.27	27.27	0.7629	0.7629
Back	30.00	29.99	20.69	20.69	37.95	37.95	0.5849	0.5849
Abdomen	30.00	30.03	20.72	20.72	14.02	14.02	0.5236	0.5236
Buttocks	30.00	30.05	20.74	20.74	10.27	10.27	1.1216	1.1216
Right Arm	30.00	29.99	20.69	20.69	24.02	24.02	0.6313	0.6313
Left Arm	30.00	29.99	20.69	20.69	21.46	21.46	0.6343	0.6343
Right Hand	30.00	29.94	20.63	20.63	20.23	20.23	0.3230	0.3230
Left Hand	30.00	30.03	20.73	20.73	14.67	14.67	0.4392	0.4392
Right Leg	30.00	29.97	20.66	20.66	78.00	78.00	0.6090	0.6090
Left Leg	30.00	29.99	20.69	20.69	54.84	54.84	0.8079	0.8079
Right Foot	30.00	30.03	20.73	20.73	9.86	9.86	0.9288	0.9288
Left Foot	30.00	30.03	20.72	20.72	14.59	14.59	0.6175	0.6175
Overall					365.41	365.41	0.6340	0.6340

Total Power (W) For All Sections: 365.405
Total Area (Square Meters): 1.736
Overall Insulation Resistance (CLO): 0.6340

STOP TIME: 11:34:34 MINUTES SINCE START OF TEST: 90.00
ENVIRONMENT TEMPERATURE:
INSTANTANEOUS: 9.27 AVERAGE OVER TEST TIME: 9.29

SECTION	SETPOINT (Deg C)	SKINTEMP (Deg C)	TEMP DIFF (Deg C) INSTANT	TEMP DIFF (Deg C) AVERAGE	POWER (WATTS) ST	POWER (WATTS) LT	INSULATION (CLO) ST	INSULATION (CLO) LT
Head	30.00	30.00	20.72	20.70	45.13	42.17	0.4019	0.4299
Chest	30.00	29.98	20.70	20.71	41.42	32.32	0.5021	0.6438
Back	30.00	29.99	20.72	20.71	48.56	42.72	0.4577	0.5201
Abdomen	30.00	30.00	20.73	20.72	13.00	13.83	0.5650	0.5308
Buttocks	30.00	30.00	20.72	20.72	12.05	11.15	0.9551	1.0322
Right Arm	30.00	30.00	20.72	20.71	32.74	27.93	0.4639	0.5434
Left Arm	30.00	30.00	20.73	20.71	27.96	25.50	0.4878	0.5344
Right Hand	30.00	29.96	20.68	20.66	20.32	20.64	0.3223	0.3171
Left Hand	30.00	30.03	20.75	20.74	14.83	14.74	0.4352	0.4375
Right Leg	30.00	30.01	20.74	20.71	65.66	72.32	0.7260	0.6581
Left Leg	30.00	30.00	20.72	20.71	60.49	58.14	0.7336	0.7628
Right Foot	30.00	30.02	20.74	20.74	13.14	11.05	0.6978	0.8297
Left Foot	30.00	30.01	20.73	20.74	16.68	15.28	0.5405	0.5901
Overall					411.98	387.78	0.5633	0.5980

Total Power (W) For All Sections: 387.783
Total Area (Square Meters): 1.736
Overall Insulation Resistance (CLO): 0.5980

TEST NUMBER:
TEST TITLE: DRDC SUIT EVALUATION
FILE NAME: c:\Documents and Settings\Default\Desktop\Tim_2005\NEW PROGRAM\M06003WT5.TM1

DATE OF TEST: 03-16-2006
START TIME: 12:25:29
DESCRIPTION OF SUIT TESTED: MODIFIED CURRENT FLYER'S COVERALL, NEOPRENE HOOD/MITTS/BOOTS, LPSV LIFEJACKET.
UNDERGARMENTS: FQH FOAM LINER, HEAVY WEIGHT SOCKS.
ENVIRONMENT: 40 CM WAVE.
  POSITION: NATURAL FLOTATION POSITION
  HUMIDITY: 65
  ENV. FLOW SPEED:
  DIRECTION: From Front
CABLE LENGTH: Short (50ft)
ADDITIONAL INFORMATION: 2 LITRES OF LEAKAGE ADDED TO THE SUIT SYSTEM.

STOP TIME: 14:55:28 MINUTES SINCE START OF TEST: 150.00
ENVIRONMENT TEMPERATURE:
  INSTANTANEOUS: 9.52 AVERAGE OVER TEST TIME: 9.51

SECTION	SETPOINT (Deg C)	SKINTEMP (Deg C)	TEMP DIFF(Deg C) INSTANT	TEMP DIFF(Deg C) AVERAGE	POWER (WATTS) ST	POWER (WATTS) LT	INSULATION (CLO) ST	INSULATION (CLO) LT
Head	26.00	25.96	16.45	16.48	59.09	56.40	0.2437	0.2558
Chest	26.00	25.91	16.39	16.38	62.97	59.01	0.2615	0.2788
Back	26.00	26.00	16.49	16.49	56.08	58.62	0.3154	0.3018
Abdomen	26.00	25.99	16.48	16.49	22.13	21.45	0.2637	0.2722
Buttocks	26.00	25.99	16.47	16.49	31.97	32.79	0.2863	0.2794
Right Arm	26.00	26.00	16.48	16.49	30.70	27.70	0.3935	0.4363
Left Arm	26.00	26.00	16.48	16.49	29.41	27.98	0.3689	0.3878
Right Hand	26.00	26.02	16.50	16.52	13.73	13.11	0.3805	0.3993
Left Hand	26.00	26.01	16.49	16.49	14.74	15.46	0.3478	0.3317
Right Leg	26.00	26.00	16.48	16.49	138.77	137.02	0.2730	0.2767
Left Leg	26.00	26.00	16.48	16.49	120.55	117.10	0.2927	0.3016
Right Foot	26.00	26.03	16.52	16.53	8.64	8.32	0.8449	0.8779
Left Foot	26.00	26.01	16.49	16.54	10.98	8.99	0.6530	0.7994
Overall					599.76	583.95	0.3075	0.3160

   Total Power (W) For All Sections: 583.948
   Total Area (Square Meters): 1.736
   Overall Insulation Resistance (CLO): 0.3160

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Manikin testing on LASA suit (U)

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W. Durnford, P. Potter

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(U) As part of a BL2 with the Directorate of Aerospace Engineering Support DAES, DRDC Toronto required testing to be conducted on a thermal immersion manikin to evaluate the thermal resistance of the NBC immersion suit LASA in a wave pool. Parallel to the manikin testing, human testing was performed using the same test facilities.

In conjunction with this evaluation, the thermal resistance of the ACE extreme cold weather garments and the modified current flyer's coverall immersion suit was also measured. This report details the thermal resistance results of the ACE extreme cold weather garments, LASA immersion suit, and modified current flyer's coverall immersion suit in stil air and 40 cm waves. These results will be compared to values recorded from human subjects using the same wave height tested at the same test facility (wave tank).

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(U) immersion suit insulation, winter boots insulation, thermal manikin