HEATED OIL AND UNDER-REPORTED DISPERSANT VOLUMES MAR MMS/EXXON COLD WATER DISPERSANT TESTS AT OHMSETT

Prepared by the Prince William Sound Regional Citizens' Advisory Council
July 14, 2004

Executive Summary

The Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) has recently discovered that the ANS crude oil used in most of the 2002 Dispersant Effectiveness Tests in Cold Water conducted at Ohmsett was heated far above ambient water temperature (32 degrees F) immediately before being dispersed with Corexit 9527 and 9500. This heating (as high as 115 degrees F) was not identified in the Final Report but was only recently discovered in handwritten daily test logs.

The 2003 Final Report and daily test logs do not record any oil temperatures whatsoever. However, in a video clip, weathered ANS crude oil is shown being distributed at a viscosity that indicates that it is far above ambient water temperature.

In addition to the unreported oil heating, the Dispersant-to-Oil Ratios (DORs) reported in the 2002 Final Report account for only 40% of the dispersant shown in the daily test logs to actually have been used in the tests. This underreporting of dispersant volumes continued in the 2003 Cold Water Tests.

Currently, MMS is using these same protocols to correlate "indirect" observations of dispersant effectiveness in field trials with "direct" observations in their test tank.

Background

In 2000, PWSRCAC commissioned NOAA's Auke Bay Laboratory to rerun the standard Swirling Flask Laboratory Test, used in the National Contingency Plan, at 3, 10, and 22 degrees C with salinities of 22% and 32% with ANS crude and Corexit 9527. This test showed that Corexit 9527 was ineffective at dispersing ANS in cold water. PWSRCAC began a campaign to develop a more realistic test to determine if Corexit 9527, the dispersant stockpiled in Alaska, was, in fact, effective on ANS at Prince William Sound temperatures and salinities.

In 2000, Exxon/Mobil began to develop test protocols for a wave tank test in cold water at the S.L. Ross Environmental Research Lab in Ontario, Canada. In March of 2002, S.L. Ross, working for the Minerals Management Service and Exxon/Mobil, conducted the 2002 Dispersant Effectiveness Tests in Cold Water at the large MMS Testing Facility in New Jersey (Ohmsett). The Final Report was released in August 2002, and was presented at the 2003 International Oil Spill Conference by Randy Balore of S.L. Ross. While PWSRCAC had decided not to participate in this test, due to lack of opportunity to modify the S.L. Ross testing protocols, we did send an observer to photograph several of the tests.

The report of the PWSRCAC observer led to an article in the Oil Spill Intelligence Report (OSIR) that was focused on limitations of the methodologies and the testing facilities (June 5, 2003). A response by MMS was published in August 2003.

Exxon/Mobil, although originally planning on supporting the 2003 Ohmsett tests, withdrew its financial support. MMS proceeded to conduct a new series of coldwater tests in March of 2003. PWSRCAC again sent an observer. The Final Report on these tests was completed in August of 2003.

In March 2004, MMS sent to PWSRCAC two CD-R disks. The first disk contained the 2002 Final Report, a series of video clips showing the spraying of the dispersant and the apparent dispersion of the various oils, and a file containing the daily test logs and bridge operator's logs in handwritten form. The second disk contained the 2003 Final Report, a series of video clips from the 2003 tests again showing the spraying of the dispersant, the apparent dispersion of the various oils, and on this disk, a single video of 17% evaporated ANS crude oil being distributed into the top few centimeters of the water column just ahead of the dispersant spray. Recently, PWSRCAC obtained the 2003 Daily Test Logs and Bridge Operator's Logs.

2002 Cold Water Tests at Ohmsett

Temperature

The Ohmsett test facility is a large (2 million gallon) wave tank with a powered bridge spanning the tank, which travels up and down its length. The test protocols include distributing the test oil into the top few centimeters of the water column through an array of pipes hung from the leading side of the bridge as the bridge travels down the length of the tank. A few seconds later, this oil is sprayed with dispersant from an array of nozzles hung from the trailing side of the bridge. The wave machine is turned on, and after an hour or so what oil remains on the surface is collected and compared to the original volume.

From the beginning, PWSRCAC has had serious reservations about this protocol. It has always seemed extremely unrealistic to distribute artificially "weathered" oil directly in front of the dispersant spray. S.L. Ross and MMS have answered that wind could rapidly move the oil slick to one side of the tank if the oil is left for any time on the surface of the tank. PWSRCAC's concern has to do with whether or not S.L. Ross's "weathering" accurately captures all the critical changes that oil undergoes as it weathers on the surface of cold seawater.

In addition to ANS crude, the 2002 tests also looked at Hibernia crude from Newfoundland. One of the tests on Hibernia crude was a hot oil test. This test was clearly distinguished from the other tests throughout the Final Report.

In the following page taken from the 2002 Final Report, note that the hot Hibernia test is clearly labeled, as well as air and water temperatures for all the tests. There is no column for oil temperatures.

Page 11 of the August 2002 Final Report by SL Ross

Test Results

A total of twelve tests were completed with various combinations of oil type, dispersant type, and dispersant-to-oil ratios (DORs). Table 1 summarizes the tests that were completed, arranged by oil and dispersant type rather than by order of test completion.

Table 1. Cold Water Dispersant Effectiveness Test Results Summary

Oil Type	***% Evap. By Volume***	***Air Temp °C am pm***	***Water Temp °C am pm***	***Oil Volume (liters)***	***Oil Thickness (mm)***	***Dispersant Type***	***DOR***	***Max DE (%)***	***Links to Video Segments***	***Test #***
Hibernia	*0.0*	*5.6 6.1*	*1.6 2.4*	*86*	*1.17*	*none*	*0*	*84**	*1.initial slick 2. breaking waves*	*1*
	0.0	*5.6 6.1*	*1.6 2.4*	*82*	*1.21*	*Corexit 9500*	*1:33*	*>90*	*1.early dispersion 2.breaking waves 3.full dispersion*	*2*
	7.9	*0.6 6.7*	*0.3 0.8*	*88*	*1.47*	*Corexit 9500*	*1:38*	*82*	*1.early dispersion 2.dispersed oil cloud 3.oil after dispersion*	*3*
	10.3	*0.6 10.0*	*-0.5 0.4*	*68*	*1.76*	*Corexit 9500*	*1:14*	*95*	*1.dispersant spraying 2.initial oil slick 3.early dispersion 4.dispersed oil cloud 5.dispersed oil & ice*	*5*
Hot Hibernia	*0.0*	*0.6 10.0*	*-0.5 0.4*	*69*	*1.80*	*Corexit 9500*	*1:14*	*98*	*1.dispersant spray 2.main dispersion 3. oil at end*	*7*
ANS Crude	*0.0*	*0.6 10.0*	*-0.5 0.4*	*20*	*n/a*	*none*	*0*	*n/a*	*1.oil discharge 2.breaking wave*	*6*
	0.0	*-5.0 2.8*	*-0.4 0.0*	*71*	*1.15*	*Corexit 9527*	*1:32*	*98*	*1.initial slick 2.major dispersion 3.more dispersed oil 4.oil at end*	*9*
	10	*1.7 3.9*	*0.2 2.0*	*79*	*1.28*	*Corexit 9527*	*1:48*	*99*	*1.dispersant spraying 2.initial slick 3.wave cresting 4.dispersed cloud 5.oil at end*	*8*
	20	*-5.0 2.8*	*-0.4 0.0*	*77*	*1.25*	*Corexit 9527*	*1:44*	*99*	*1.initial slick 2.early dispersion 3.dispersed cloud 4.dispersed cloud*	*10*
	0.0	*0.6 6.7*	*0.3 0.8*	*71*	*1.14*	*Corexit 9500*	*1:34*	*97*	*1.dispersant spraying 2.initial slick 3.early dispersion 4.breaking waves 5.oil at end*	*4*
	0.0	*3.3 16.7*	*-0.3 0.9*	*74*	*1.20*	*Corexit 9500*	*1:81*	*93**	*1.oil herding 2.oil collection*	*11*
	20	*3.3 16.7*	*-0.3 0.9*	*76*	*1.23*	*Corexit 9500*	*1:38*	*96*	*1.dispersant spray 2.mid test video 3. oil at end*	*12*

** considerable quantity of black, non-dispersing oil escaped the containment area in these tests*

Later in the Final Report, there is a section where each individual test is discussed in depth. Here are the two pages on the Hot Hibernia test:

<u>Pages 21of the August 2002 Final Report by SL Ross</u>

“Test #7: Hot, Fresh Hibernia

In this test, fresh Hibernia crude was heated to 45°C and discharged onto the cold water. Previous tests (SL Ross 2001) have shown that hot, fresh Hibernia crude will gel when quickly cooled to 1°C. Hibernia crude is stored offshore and shipped at temperatures in the 35 to 45 °C range, so the behavior and dispersibility of this oil spilled under these conditions is of interest. The spilled oil formed patches of non-fluid oil similar to the 10.3 % evaporated oil shown in the first photo of Figure 15. As with the evaporated oil, the slick became more fluid after the onset of waves. The first photo in Figure 16 shows the slick herded to the north east corner of the containment area shortly after being laid down and sprayed. The other three photos show the slick 5, 10 and 20 minutes after the onset of cresting waves. Click on the following link for a short video clip of this test (main dispersion). A total of 1.4 liters of emulsion with a water content of 27% (1.0 liter of oil) was collected after the one-hour test period. A total of 70 liters of oil was used in the test. If all of the oil lost from the containment area is assumed to have dispersed, the dispersant effectiveness in this test would be about 98%. Some dispersed oil and water splashed over the north boom segment but this oil quickly dispersed into the water column and did not re-surface.”

In only one other place in the 2002 Final Report is there any mention of oil being heated. This occurs in the section on test procedures. Initially PWSRCAC interpreted this to be a reference to the Hot Hibernia test only. See procedure #2

Page 7 of the August 2002 Final Report by SL Ross

"Test Procedure

The following steps, specified in the 2001 test protocol, were completed for each test.

1. Position a rectangle of containment boom in the tank.
2. Load desired test oil into Main Bridge oil distribution system. Start re-circulating. Measure oil temperature periodically. When oil warm enough, set position of oil pump re-circulating valve by calibrating flow from discharge hose with bucket and stopwatch. Connect discharge hose to oil distribution system.
3. Start dispersant pump re-circulating.
4. Position Main Bridge towards north end of rectangle of boom.
5. Spray dispersant over north boom until good spray pattern established. Shut solenoid valve.
6. Turn on videos, data acquisition.
7. Accelerate bridge to specified speed.
8. When Main Bridge oil distribution system is 5 m south of north end of rectangle of boom, begin laying down test slick by opening air-actuators. When oil appears from nozzles start stopwatch.
9. Lay oil for 20 m travel distance. Close air actuators when specified oil discharge time reached.
10. When dispersant spray bar is 1 m from beginning of test slick, activate solenoid valve to begin spray – hold open until spray bar is 1 m past end of test slick.
11. Turn on waves at desired setting.
12. Turn off and secure oil and dispersant pumps.
13. Visually observe dispersion.
14. One hour after first waves hit slick, stop waves and allow surface to calm.
15. Herd remaining surface oil to downwind end of rectangle of boom for recovery and volumetric/water content measurements."

It has been very disconcerting to see the Daily Test Logs from the 2002 disk and to realize that they clearly show that the ANS crude oil was heated above ambient air and water temperatures in all of the ANS crude oil tests. This is especially troubling in the three tests using weathered ANS. This paper will focus on the weathered ANS tests, tests number 8, 10, and 12.

Following are the complete Daily Test Logs for all the 2002 cold water tests from the disk.

DAILY TEST LOG DATE 2/27/02 PAGE 1 OF ____

T.# 401

TEST#	1	2
File Name		
Time of Day	9:33 am	2:20 pm
Type	CONTROL - OIL ONLY	DISPERSANT ≈ 1:50 DOR
Oil Drum Initial(inches)	13 3/8"	5 3/4"
Oil Drum Final(inches)	28 5/8"	19 3/4
Oil Pump Time(sec)	36 sec	35 sec.
Bridge Speed	1.0	1.0
Test Duration(sec)	1hr – (22.39 Dia)	1hr
Test Oil	Hibernia (1.7) (Drum)	Hibernia / Fresh.
Oil Dist. Total(gal)	25.0 (~~1.64~~ gal/inch)	24.4 gal.
Nominal Oil Coverage (mm)	1mm × 20' × 60'	1mm × 20' × 60'
Volume Recovered Oil (gallons)	4 gallons.	None –
Dispersant Type	NONE	9500 / 68°F
Dispersant Initial	"	7 1/2" Depth (1.5 lb/inch)
Dispersant Final	"	6"
Dispersant Elapsed Time	"	~~57~~ 41 sec.
COMMENTS Spray bar nozzles.	Oil Temp 37° immediately after Distribution WAVES STARTED immediately After Distribution – 3:32 Lowered from 35 – they broke waves over boom. LOST A Little oil over boom.	Dist. Oil Temp 33° STARTED at 2:26 pm – there were no breakers INCREASED TO 35 cpm. Observed – by Dan Spree WIND – blew dispersant away from oil – OIL TOTALLY dispersed IN ≈ ~~10~~ 5 min Maybe ≈ 1 gal on surface TEST ENDED AT 2:55 pm.

DAILY TEST LOG DATE 2/28/02 PAGE 2. OF ___
T.# 401

TEST#	3	4
File Name		
Time of Day	10:19 Bridge stopped	1:43 pm Bridge stops.
Type	Disperse weathered oil	Fresh. ANS
Oil Drum Initial(inches)	12 7/8"	5 1/4"
Oil Drum Final(inches)	28 3/8	17 3/4
Oil Pump Time(sec)	35.8	30.1
Bridge Speed	1.0	1.0.
Test Duration(sec)	1hr.	1hr.
Test Oil	Hibernia / 7.5% weathered	ANS Fresh
Oil Dist. Total(gal)	26.4	21.3
Nominal Oil Coverage (mm)	1mm X 20' X 60'	1mm x 20' x 60'
Volume Recovered Oil (gallons)	5 gallons/samples	~~5 gal~~ / 2 1/2" in 5 gal pail / samples
Dispersant Type	9500	9500
Dispersant Initial	6 5/8" 1.5 hr/cm	6 5/8"
Dispersant Final	5 11/16"	5 1/4"
Dispersant Elapsed Time	/ volume: 5.95 LTR.	50 sec
COMMENTS	Oil Temp in Drum 47°F water Temp 32 1/2°F waves down 11:21 WINDS from West waves @ 35 → increased to 37.	Oil Temp in Drum 53°F water Temp 31°F 9 - 98% (visual) dispersed after at 1:55 pm → waves at 35 cpm - 3"

DAILY TEST LOG **DATE** 3/1/02 **PAGE** 3 **OF** ____

T.# 401

TEST#	5	~~6~~ 7
File Name		
Time of Day	9:01 am Bridge stops.	1:14 pm. Bridge stops
Type	Dispersant/oil	Dispersant on oil
Oil Drum Initial(inches)	14 1/2" / 53°F in	16 1/4"
Oil Drum Final(inches)	~~5 1/2"~~ 26 1/2" Drum	28 1/2"
Oil Pump Time(sec)	30 sec	30. sec.
Bridge Speed	1.0	1.0.
Test Duration(sec)	1hr	1hr.
Test Oil	Hibernia 9% weathered	Hibernia fresh/heated
Oil Dist. Total(gal)	20.4	20.4
Nominal Oil Coverage (mm)	1mm X 20' X 60'	1mm X 20' X 60'
Volume Recovered Oil (gallons)	3 1/4" in 5 gal pail X 1.42 l/in = 4.6 l	1" in A 5 gal pail
Dispersant Type	9500.	9500.
Dispersant Initial	10" / 62°F	9 1/2"
Dispersant Final	5 1/2"	5 3/16
Dispersant Elapsed Time	45 sec.	41 sec / 42 psi
COMMENTS T-6 was 5 gal oil in open water - no dispersant - to document if there is natural dispersion, with 3"-35 cpm waves.	Nozzles - changed to 4008 Waves - 3"-35. at 9:40 am - Majority estimate - 90% appeared dispersed.	water temp - 29°F oil temp 97°F in Drum Some dispersion apparent at 1:22 pm At 1:28 pm ≅ 40→50% Dispersion Waves 3"-35 cpm.

DAILY TEST LOG **DATE** 3/4/02 **PAGE** 4 **OF** ___

T.# 401

TEST#	8	9 (3/5/02)
File Name		
Time of Day	Bridge stopped at 1:26 pm	Bridge stopped 9:34 am
Type	Dispersant on oil 10% weathered ANS	Fresh ANS - Dispersant
Oil Drum Initial(inches)	10 1/2"	4 7/8"
Oil Drum Final(inches)	24 3/8	17 3/4
Oil Pump Time(sec)	30 sec	30 sec.
Bridge Speed Kt.	1.0	1 Kt
Test Duration(sec)	1 hr.	1 hr
Test Oil	10% weathered ANS.	ANS fresh
Oil Dist. Total(gal)	23.6	21.9
Nominal Oil Coverage (mm)	1 mm x 20' x 60'	1 mm x 20' x 60'
Volume Recovered Oil (gallons)	≃ ~~gt~~ qt 1" in Pail	1" in pail
Dispersant Type	9527	9527.
Dispersant Initial	8 9/16"	~~9 5/8"~~ 9 1/16" (1.3 ltr)
Dispersant Final	7 3/4"	7 5/8"
Dispersant Elapsed Time	38 sec.	49 sec.
COMMENTS	Nozzles 8005 → ; WINDS - ~~westerly~~ OUT of WEST	OIL TEMP 41°F IN Drum; 2.2

DAILY TEST LOG **DATE** 3/5/02 **PAGE** 5 **OF** ____
T.# 401

TEST#	10	11 (3/6/02)
File Name		
Time of Day	Bridge stopped at 1:33pm	Bridge stopped at 8:45am
Type	20% weathered ANS	Fresh ANS / Dispersant
Oil Drum Initial(inches)	11"	27/8"
Oil Drum Final(inches)	24 5/8"	15 7/8"
Oil Pump Time(sec)	30 sec	30 sec
Bridge Speed	1 Kt.	1 Kt.
Test Duration(sec)	1 hr.	1 hr.
Test Oil	ANS weathered 20%	Fresh ANS,
Oil Dist. Total(gal)	23.2	22.1
Nominal Oil Coverage (mm)	1 mm x 20' x 60'	1 mm x 20' x 60'
Volume Recovered Oil (gallons)	≃ 500 mL (Sample Jar)	4" in 5 gal pail
Dispersant Type	9527 — 50 psi 65°F	9500
Dispersant Initial	9 1/2"	7 5/16"
Dispersant Final	8 5/16	~~5~~ 7 7/16"
Dispersant Elapsed Time	49.5	~~47.5~~ sec 42 sec
COMMENTS	Oil temp in drum 55°F	Nozzle - 80010 Oil - 50°F in drum - waves started when Bridge started moving

DAILY TEST LOG **DATE** 3/6/02 **PAGE** 6 **OF** ___

T.# 4101

TEST#	12	
File Name		
Time of Day	Bridge stopped at 12:50 pm	
Type	Disperse - ANS.	
Oil Drum Initial(inches)	18"	
Oil Drum Final(inches)	31 1/2"	
Oil Pump Time(sec)	30sec.	
Bridge Speed	1Kt	
Test Duration(sec)	1hr.	
Test Oil	ANS 20% weathered	
Oil Dist. Total(gal)		
Nominal Oil Coverage (mm)	1mm x 20'x60'	
Volume Recovered Oil (gallons)	3 1/2" in 5 gal pail	
Dispersant Type	9500	
Dispersant Initial	7"	
Dispersant Final	5 11/16"	
Dispersant Elapsed Time	47.5	
COMMENTS	Drum oil Temp. 115F	

The Daily Test Logs show oil-in-drum temperatures for all dispersant tests except for numbers 2 and 8. Test number 2 shows Hibernia oil temperature "immediately after distribution". Test number 8, weathered ANS, is the only dispersal test for which the Daily Test Logs show no temperature readings. In the future, the researchers need to take the oil temperature as the dispersant is applied to determine how "realistic" the test is. We will not have the luxury to attempt to disperse hot oil in the Prince William Sound region.

Following is the spreadsheet from the 2002 Final Report, as modified by PWSRCAC to include the temperature data from the Daily Test Logs (and a column for the Hibernia temperature). PWSRCAC has as well dropped the video links, moved the test numbers to the left side, and identified the three weathered ANS tests in bold.

2002 Temperature

From 2002 Final Report										PWSRCAC Generated Columns	
Test #	**Oil Type**	**% Evap. By Volume**	**Air Temp °C am pm**	**Water Temp °C am pm**	**Oil Volume (liters)**	**Oil Thickness (mm)**	**Dispersant Type**	**DOR**	**Max DE (%)**	**Oil Temp from final August 2002 report °C**	**Oil Temp from Daily Log °F**
1	Hibernia	0.0	5.6 6.1	1.6 2.4	86	1.17	none	0	87*		33[1]
2		0.0	5.6 6.1	1.6 2.4	82	1.21	Corexit 9500	1:33	>90		37[2]
3		7.9	0.6 6.7	0.3 0.8	88	1.47	Corexit 9500	1:38	82		47
5		10.3	0.6 10.0	-0.5 0.4	68	1.76	Corexit 9500	1:14	95		53
7	Hot Hibernia	0.0	0.6 10.0	-0.5 0.4	69	1.80	Corexit 9500	1:14	98	45	97
6	ANS Crude	0.0	0.6 10.0	-0.5 0.4	20	n/a	none	0	n/a		
9		0.0	-5.0 2.8	-0.4 0.0	71	1.15	Corexit 9527	1:32	98		41
8	***Weathered***	**10**	**1.7 3.9**	**0.2 2.0**	**79**	**1.28**	**Corexit 9527**	**1:48**	**99**		
10	***Weathered***	**20**	**-5.0 2.8**	**-0.4 0.0**	**77**	**1.25**	**Corexit 9527**	**1:44**	**99**		**85**
4		0.0	0.6 6.7	0.3 0.8	71	1.14	Corexit 9500	1:34	97		58
11		0.0	3.3 16.7	-0.3 0.9	74	1.20	Corexit 9500	1:81	93*		50
12	***Weathered***	**20**	**3.3 16.7**	**-0.3 0.9**	**76**	**1.23**	**Corexit 9500**	**1:38**	**96**		**115**

[1]Immediately after distribution (daily log)
[2]Dist. oil temperature (daily log)

The most severely elevated temperatures are associated with the weathered ANS tests. For test number eight, we have no temperature; however, the similar dispersant efficiency and DOR suggest similar oil viscosity to that in tests 10 and 12. Oil viscosity is temperature dependent. In both the other weathered ANS tests the temperatures are quite elevated and in test number 12 the temperature is actually 18 degrees F hotter than even the Hot Hibernia test. Below are the sections of the 2002 Final Report that discuss these two tests individually.

Page 27 of the 2002 Final Report

"Test #10: Corexit 9527 on 20% Evaporated ANS Crude, DOR = 1:44

Corexit 9527 was applied to the 20% evaporated ANS crude oil at a dose rate of about 1:44 in this test. Wind herded the oil to the east side of the containment boom shortly after the application of dispersant, as seen in the first photo of Figure 20. At the time of the test, the clarity of the tank was poor from earlier tests, the weather was overcast, and it was difficult to see the dispersed oil cloud that formed. This is evident from the second photo in Figure 20. A small amount of oil, seen in the third photo of Figure 20 was collected at the end of the test. The fourth photo shows a siphon being used to remove the free water from the collection bucket. Click on the following link for a short video clip of this test (test #10 Video Clip). A total of 0.5 liters of emulsion, with a water content of 27% (0.36 liters of oil), was collected after the one-hour test period. A total of 79 liters of oil was used in the test. If all of the oil lost from the containment area is assumed to have dispersed, the dispersant effectiveness in this test would be about 99%. Some dispersed oil and water splashed over the north boom segment but this oil was observed to quickly dispersed into the water column and did not re-surface."

Page 31 from the 2002 Final Report

"Test #12: Corexit 9500 on 20% Evaporated ANS Crude, DOR = 1:38

Twenty percent evaporated ANS crude oil was treated with Corexit 9500 with a DOR of 1:38. The tank water was not clear in this test and the development of the dispersed oil cloud was not as visible as in earlier tests. Click on the following link for a short video clip of this test (mid test behavior). The first photo in Figure 23 shows the slick shortly after the application of dispersants. The second photo shows the containment zone about 10 minutes later. A small amount of surface oil remains in the north-east corner of the boom at this time and the water has a darker hue due to additional dispersed oil. A total of 5 liters of emulsion, with a water content of 43% (2.9 liters of oil), was collected after the one-hour test period. A total of 76 liters of oil was used in the test. If the loss of surface oil out the north end of this boom is ignored, the estimate of dispersant effectiveness in this test is about 96%. It was difficult to visually confirm the formation of a dispersed oil cloud in this test due to the poor water clarity at the start of the test. There was no visual evidence of oil escaping the boomed area that remained as a surface slick."

Nowhere in the 2002 Final Report, nor in any other publication associated with the 2002 Cold Water Tests, have the elevated temperatures of the weathered ANS been reported. Only in the handwritten Daily Test Logs is this vital information revealed.

These temperatures are critical to the tests because of the very short interval between the time when the oil hits the cold water and the time when the dispersant is applied. How many seconds is it? We are not told, but any reasonable assumption (3 to 6 seconds) leads to doubts that the oil has had time to drop to ambient temperature before the dispersant hits it – and where does any escaping heat go? It must go into the surrounding water. In the first few seconds this heat must raise the temperature of the water immediately surrounding the oil. That heat is therefore very much still available to the reaction.

The Daily Test Logs indicate that all of the weathered ANS tests in the 2002 Cold Water Tests were actually warm oil, warm water tests.

Dispersant to Oil Ratios (DOR)

The 2002 Daily Test Logs list the amount of dispersant used in each test in inches, the difference between "initial" and "final." Fortunately, the Daily Test Log for test number 3 gives more information. It lists both the total volume of dispersant used in this test, and a value for dispersant volume in liters per centimeter (1.5 liters/cm). Using this key we can determine the actual volume of dispersant used in each test.

While the spreadsheet from the 2002 Final Report does not list a value for the volume of total dispersant used, it does give a volume figure for the oil used in each test, and a DOR. Simple arithmetic produces the Calculated Volume by DOR column shown below. In addition PWSRCAC has added three more columns to the spreadsheet – Inches in Daily Log, Dispersant Volume by Daily Log, and Percentage of Dispersant contained in DOR.

2002 DOR

From 2002 Final Report										PWSRCAC Generated Columns				
Test #	**Oil Type**	**% Evap. By Volume**	**Air Temp °C am pm**	**Water Temp °C am pm**	**Oil Volume (liters)**	**Oil Thickness (mm)**	**Dispersant Type**	**DOR**	**Max DE (%)**	**Calculated Volume by DOR (liters)**	**Inches in Daily Log**	**Disp. Volume by Daily Log**	**Calculated from inches**	**% Disp. counted in DOR**
1	Hibernia	0.0	5.6 6.1	1.6 2.4	86	1.17	none	0	87*	0				
2		0.0	5.6 6.1	1.6 2.4	82	1.21	Corexit 9500	1:33	>90	2.6	$1\ ^{8}/_{16}$		5.72	45
3		7.9	0.6 6.7	0.3 0.8	88	1.47	Corexit 9500	1:38	82	2.32	$1\ ^{9}/_{16}$	5.95		39
5		10.3	0.6 10.0	-0.5 0.4	68	1.76	Corexit 9500	1:14	95	4.9	$4\ ^{8}/_{16}$		17.15	29
7	Hot Hibernia	0.0	0.6 10.0	-0.5 0.4	69	1.80	Corexit 9500	1:14	98	4.9	$4\ ^{1}/_{16}$		15.48	32
6	ANS Crude	0.0	0.6 10.0	-0.5 0.4	20	n/a	none	0	n/a	0				
9		0.0	-5.0 2.8	-0.4 0.0	71	1.15	Corexit 9527	1:32	98	2.2	$1\ ^{7}/_{16}$		5.48	40
8		10	1.7 3.9	0.2 2.0	79	1.28	Corexit 9527	1:48	99	1.65	$^{13}/_{16}$		3.094	53
10		20	-5.0 2.8	-0.4 0.0	77	1.25	Corexit 9527	1:44	99	1.75	$1\ ^{3}/_{16}$		4.52	39
4		0.0	0.6 6.7	0.3 0.8	71	1.14	Corexit 9500	1:34	97		$1\ ^{6}/_{16}$		5.24	40
11		0.0	3.3 16.7	-0.3 0.9	74	1.20	Corexit 9500	1:81	93*	0.9	$^{8}/_{16}$		1.9	47
12		20	3.3 16.7	-0.3 0.9	76	1.23	Corexit 9500	1:38	96	2.0	$1\ ^{15}/_{16}$		5.0	40

Average % of dispersants accounted for in DOR = 40.4%.

While there may be a good argument for discounting the actual amount of dispersant used before calculating the DOR, it is difficult to imagine sufficient reason to discount it by 60% - and surely any such argument should be presented in the Final Report so that it can be judged on its merits.

2003 Cold Water Tests at Ohmsett

In March of 2003, MMS again ran a series of cold water tests using Corexit 9527, this time on four different Prudhoe crude oils, and one from Cook Inlet (MGS). There is no mention of any oil temperatures anywhere in the 2003 Final Report. There is however, on the disk, a video clip showing 17% evaporated ANS crude oil being distributed into the top few centimeters of the water in the test tank during test #1 (1R1.mpg). From the apparent low viscosity of the oil, it is unlikely that this oil is close to ambient water temperature.

Once again, there is absolutely no discussion on how the DOR figures in the 2003 Final Report were reached. PWSRCAC has recently received copies of the 2003 Daily Test Logs and Bridge Operator's Reports. These documents show that, once again, the DOR's stated in the Final Report account for only a fraction of the total amount of dispersant that was sprayed.

Table S1. Cold-Water Dispersant Effectiveness Test Results Summary

From August 2003 SL Ross Environmental Research Report to MMS, columns added by PWSRCAC as indicated

From 2003 Final Report									PWSRCAC Generated Columns			
Oil	**Test #**	**% Evap. By Weight**	**Average Air Temp °C**	**Average Water Temp °C**	**Oil Volume Spilled (liters)**	**Approx. Oil Thickness**	**DOR**	**Max. Dispersant Effectivenes s (%)**	**Calculated Volume by DOR**	**Inches in Daily Log**	**Disp. Volume by Daily Log**	**% Disp. counted in DOR**
ANS	1	17	-3.1	-0.6	107	0.92	24	85	4.46	$1\frac{7}{8}$	7.154	62
ANS	9	17	-1.7	-0.4	1001 * (94.8)	0.97	25	86	3.8	$4\frac{5}{16}$	15.26	25
Endicott	8	0	-2.1	-0.4	113	1.1	31	74	3.65	$1\frac{7}{8}$	7.154	51
Endicott	14	11	-1.9	-0.6	94	0.91	22	3	4.27	$1\frac{15}{16}$	7.39	58
Northstar	2	0	-4.4	-0.4	78	0.75	18	~100	4.33	$2\frac{1}{8}$	8.11	53
Northstar	10	29	-7.4	-0.7	105	1.1	19	8	5.53	$3\frac{1}{4}$	12.4	45
MGS	11	0	-6.1	-0.5	98	0.95	24	82	4.08	$2\frac{1}{16}$	7.87	52
MGS	3	20	-5.3	-1.1	105	0.90	27	80	3.89	$1\frac{5}{8}$	6.18	63
Pt. McIntyre	12	0	-5.6	-0.5	103	1.0	29	77	3.55	$1\frac{11}{16}$	6.44	55

**Apparent error in oil volume shown in Final Report. Daily Log indicates 94.8 liters.*

Average % of Dispersants accounted for in DOR = 51.6%.

Current Dispersant Tests at Ohmsett

In October 2003, MMS released a paper entitled "Correlating Ohmsett Dispersant Testing Results with UK SEA TRIALS". This document is especially troubling in light of what we have discovered about the temperature of the oils tested using the Ohmsett protocols.

The following is a quote from the October 2003 paper listed above (page 3):

> "1. Introduction and Study Objectives
>
> A number of research initiatives are currently in progress aimed at resolving two important questions facing oil spill responders, planners and researchers. The questions are:
> 1. What is the actual limiting viscosity of oil for dispersant use; and
> 2. How well do results of dispersant effectiveness tests conducted in the laboratory and in experimental tanks correlate with dispersant performance under real-world conditions at sea?"

Viscosity is a measure of the resistance to flow of a liquid. In oil it varies directly with evaporation and *inversely* with temperature. Viscosity is commonly recognized as a measure of how difficult a particular oil will be to disperse. In other words, as an oil slick gets older and colder, it also gets harder to disperse. How can measuring viscosity be the number one objective of a protocol which does not measure oil temperature? Viscosity is a function of temperature. The Ohmsett Test Plan on page 4 of the above paper lists several conditions to be controlled, "identical oils, dispersants, dispersant dosages, water temperature." Once again, there is no mention of oil temperatures in the Ohmsett Test Plan

The issue becomes clearer in section 1.1 (p.3) where the field trials are referred to as "semi-quantitative methods of monitoring dispersant effectiveness," while "direct measurement of effectiveness" will be done at Ohmsett.

Conclusion

In the two areas of oil temperature and DOR calculation, the Final Reports for both the 2002 and 2003 cold water tests at Ohmsett withheld critical information that would have severely undermined the efficiency ratings given for Corexit 9527 on ANS spilled in cold seawater. The protocol for dispersant testing used at Ohmsett must be changed to insure that realistic weathering effects are captured, that ambient temperatures are achieved for all fluids, and that acceptable DOR calculations are used.