“Development, Production and Testing of Coated \textsuperscript{patent pending} Skimmer Technology”
OHMSETT SKIMMER TESTING –

TANKER OWNERS OPERATING IN ALASKA
OBJECTIVES

- INVESTIGATE THE POSSIBILITY OF UTILIZING OLEOPHILIC SKIMMERS IN PLACE OF THE EXISTING WEIR SKIMMERS

- INCREASE EFFICIENCY OF OIL RECOVERY DURING SPILL RESPONSE TO 360 GPM PURE OIL
PRINCE WILLIAM SOUND OPERATES WITH A SERIES OF LARGE BARGES EQUIPPED WITH A PAIR OF TRANSREC SKIMMERS WHICH ARE DEPLOYED FROM THE STERN OF EACH OF THE BARGES.

ONCE DEPLOYED, THE WEIR SKIMMERS ARE FLOATED TO THE APEX OF THE “U” BOOM
TEST METHOD
- BASED ON F2709 ASTM APPROVED SKIMMER TEST STANDARD
- 3” OIL SLICK DECLINING TO 2” TO MEASURE RECOVERY RATE AND EFFICIENCY

TEST OILS
- ANS CRUDE USED:
  * FRESH
  * WEATHERED
TO REPLICATE 72-HOUR SPILL CLEANUP Sceanriomandated by State of Alaska
CRUCIAL COATED SKIMMER DESIGN & BUILDING
DECEMBER 2007
MARINE GRADE ALUMINUM CATAMARAN WITH DUAL HYDRAULICALLY DRIVEN DISC BANKS, POSITIVE DISPLACEMENT PUMP
COATING APPLIED TO 2 EA. TEST DISCS
COATEDDpatent pending TEST DISCS INSTALLED
OHMSETT TESTING

MARCH, 2008
ORIGINAL SKIMMER DESIGN:

- 56 EACH 30-INCH DIAMETER ALUMINUM DISCS
- 2 EACH COATED TEST DISCS
- ALUMINUM DISCS REPLACED WITH 44 FIBER COATED DISCS
RECOVERY RATES OBSERVED SHOWED GREATLY INCREASED RECOVERY RATE ON THE 2 EA. TEST COATED\textsuperscript{patent pending} DISCS AS OPPOSED TO SMOOTH DISCS
ALL ALUMINUM DISCS WERE REPLACED WITH 44 EA. FIBER COATED patent pending DISCS. RECOVERY RATES REACHED OVER 200 GPM.
Summary of Results
March 2008 Tests

<table>
<thead>
<tr>
<th>Skimmer</th>
<th>ORR, gpm</th>
<th>ORE, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh Oil</td>
<td>128</td>
<td>67</td>
</tr>
<tr>
<td>Weathered Oil</td>
<td>150</td>
<td>81</td>
</tr>
<tr>
<td>Semi-weathered Oil</td>
<td>234</td>
<td>74</td>
</tr>
</tbody>
</table>
HOWEVER, IT WAS OBSERVED THAT A CONSIDERABLE AMOUNT OF OIL REMAINED ON THE DISCS AFTER SCRAPING.
IT WAS ALSO OBSERVED THAT IF THE DISCS WERE SCRAPED MORE, THE INCREASED VOLUME OF OIL WOULD HAVE TO BE DRAINED FROM THE FINGERS FASTER.
MODIFY / REDESIGN
MARCH - JULY, 2008
A small test unit was used to evaluate modified scraper designs.

Double scraper blades were tested.

Angled scraper finger along with a more rigid scraper blade solved both conditions noted in the March testing.
OHMSETT
DISC SKIMMER
TESTING
JULY, 2008
SKIMMER DESIGN:
- 52 ALL FIBER COATED DISCS
- THICKER GAUGE SCRAPERS
- ANGLED SCRAPER FINGER FOR FASTER DRAINING OF OIL
NEW SCRAPER DESIGN TESTED WELL AND RESULTED IN HIGHER RECOVERY EFFICIENCY. RECOVERY RATE OF APPROX. 400 GPM @ 85% EFFICIENT WERE ACHIEVED.
Summary of Results (new scrapers) July 2008 Tests

<table>
<thead>
<tr>
<th>Skimmer</th>
<th>ORR, gpm</th>
<th>ORE, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh Oil</td>
<td>386</td>
<td>77</td>
</tr>
<tr>
<td>Weathered Oil</td>
<td>402</td>
<td>87</td>
</tr>
</tbody>
</table>
OHMSETT TESTING

NOVEMBER, 2008

& MARCH, 2009
SKIMMER DESIGN

(200 CU.M/HR.):

- 88 EACH ALL FIBER COATED *patent pending* DISCS (4 BANKS OF 22 EA.)

- REDESIGNED SCRAPER BLADES

- DUAL POSITIVE DISPLACEMENT LOBE PUMPS
88-DISC SKIMMER CAPABLE OF RECOVERY OF APPROX. 880 GPM (200 CU.M/HR.) OF PURE OIL!
## Summary of Result
### March 2009 Tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Speed rpm</th>
<th>Test oil</th>
<th>ORR, gpm</th>
<th>ORE, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>31</td>
<td>Fresh</td>
<td>828</td>
<td>88</td>
</tr>
<tr>
<td>6</td>
<td>34</td>
<td>Fresh</td>
<td>874</td>
<td>77</td>
</tr>
<tr>
<td>7</td>
<td>32</td>
<td>Fresh</td>
<td>949</td>
<td>80</td>
</tr>
</tbody>
</table>
March, 2010
24-Hour Test &
Seaweed Test
88-Disc Skimmer
at Ohmsett
VISCROUS OIL BEING DRAWN INTO DISCS
EVEN EMULSIFIED OIL AFTER BEING SKIMMED & PUMPED ALL NIGHT LONG ARE EASILY RECOVERED BY THE FUZZY DISCS
SEAWEED WAS ADDED TO THE TEST TANK TO EVALUATE THE SKIMMER WITH DEBRIS PRESENT
July 2009
Deployment Tests
By CISPRI
Homer, Alaska
C-DISC 88/30 SKIMMER
WITH "V"-SWEEP
DEPLOYMENT
C-DISC 88/30
SKIMMER WITH
OCEAN BUSTER
DEPLOYMENT
C-DISC 88/30 SKIMMER TESTING WITH BOOM VANE DEPLOYMENT
DESIGNING & TESTING COMPLETE LINE OF COATED DISC SKIMMERS
CRUSHED ICE TEST - AUGUST, 2010

ALASKA CLEAN SEAS C-DISC 13/24 IN TEST TANK
85 GPM (19 CU.M/HR.) @ 97% EFFICIENCY
CISPRI UTILIZING LOCAL FISHERMAN AND CURRENT BUSTER FOR TRAINING WITH MODEL C-DISC 13/30
CISPRI – MODEL C-DISC 56/30 IN TEST TANK
MSRC OPERATING C-DISC 88/30
DURING DEEPWATER HORIZON 2010
2010
MSRC ordered 12 each
CRUCIAL Model 88/30
Coated
Disc Skimmer Systems
MSRC UNITS WERE COMPLETED IN 2011 AND DELIVERED TO VARIOUS LOCATIONS
2011
MSRC ordered 6 each
CRUCIAL Model 56/30
Coated
Disc Skimmer Systems
MSRC UNITS WERE COMPLETED IN 2011 AND DELIVERED TO VARIOUS LOCATIONS
2011 CRUCIAL ENTERED THE Wendy Schmidt Oil Cleanup X CHALLENGE AND MADE THE TOP 10 FINALIST
TWO OF CRUCIAL’s 88-DISC MODULES WERE MOUNTED IN A TRIMARAN HULL FOR THE Wendy Schmidt Oil Cleanup X CHALLENGE

4 BANKS OF DISCS HAD NEW FABRIC COATING AND 4 BANKS OF DISCS HAD FABRIC PREVIOUSLY USED IN TESTING / SPILLS
C-DISC 13/30 with optional eductor
CISPRI December 2011

<table>
<thead>
<tr>
<th>Skimmer</th>
<th>ORR, gpm</th>
<th>ORE, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>With eductor</td>
<td>138/129</td>
<td>91/94</td>
</tr>
<tr>
<td>Without eductor</td>
<td>123/121</td>
<td>92/94</td>
</tr>
</tbody>
</table>
IN ADDITION TO RECOVERY TESTS, CISPRI PERFORMED DEPLOYMENT TESTS WITH FISHING VESSELS

CRUCIAL MODEL C-DISC 13/30 TESTING DECEMBER, 2011
MODIFICATIONS INCORPORATED IN THESE UNITS:

- ROLLED ALUMINUM GUARD ALONG TOP OF PONTOON TO PROTECT PONTOON AND CONTAINMENT BOOM
- SINGLE POINT LIFT WELDED TO FRAME
- BULLNOSE DESIGN AT BOTH ENDS OF PONTOONS FOR SKIMMING IN BOTH DIRECTIONS
Model 88/30 deployment testing by Alyeska-SERVS in Alaska
AUGUST, 2012
CRUCIAL COATED DRUM SKIMMERS
DRUM SKIMMER DESIGN:

- COATEDDrum (VARIOUS Diameters AND LENGTHS)
- HEAVY GAUGE SCRAPERS
- OIL TRANSFER PUMP
CRUCIAL HAS OPENED A NEW DOOR TO INCREASED OIL SPILL RECOVERY RATES WITH OUR INNOVATIVE DESIGN.
CLEAN HARBORS COOP –
36 INCH COATED DRUM SKIMMER ON SPILL
CLEAN HARBORS QUICK DEPLOYMENT RACKS – 2 SKIMMERS PER RACK FOR EFFICIENT LOADING ONTO TRUCKS OR TRAILERS
CLEAN RIVERS COOP – PORTLAND, OR

SELECTED 2 MODELS OF COATED DRUM:
- MINI CD
- 1CD18H-36”
CISPRI TESTING – AUGUST 2012

MODEL 1CD18H-36 COATED DRUM SKIMMER

<table>
<thead>
<tr>
<th>Skimmer</th>
<th>ORR, gpm</th>
<th>ORE, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANS Crude</td>
<td>54</td>
<td>99</td>
</tr>
<tr>
<td>ULSD#2</td>
<td>50</td>
<td>96</td>
</tr>
</tbody>
</table>
CRUCIAL’S MODEL
1CD18-36 DRUM
SKIMMER IN ICE CONDITIONS

CRREL TESTING FACILITY
JANUARY, 2013
CRUCIAL’S COATING CAN BE RETROFITTED TO DISC AND DRUM SKIMMERS MANUFACTURED BY OTHERS.
THIS IS AN AQUA-GUARD DISC SKIMMER WHERE THE DISCS ARE MODIFIED WITH CRUCIAL’S UNIQUE FABRIC COATING
WE CAN ALSO RETROFIT DRUM SKIMMERS MANUFACTURED BY OTHER WITH THIS COATING TO INCREASE THE RECOVERY RATE UP TO 10 TIMES OVER SMOOTH DISCS & DRUMS.

THIS DOUBLE DRUM SKIMMER FROM CANATEC WAS CONVERTED FROM SMOOTH DRUMS USING OUR UNIQUE FABRIC COATING