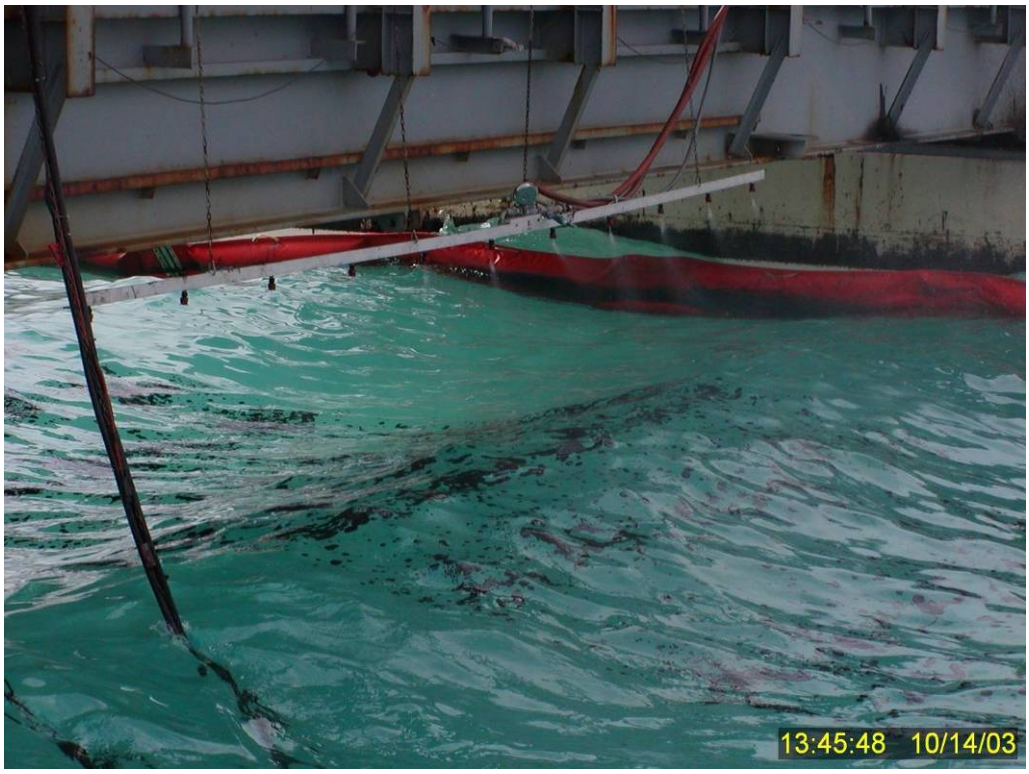

Figure 98 Passing wave moving under the dispersant spray bar 14 seconds after initiation of Test No. 15.

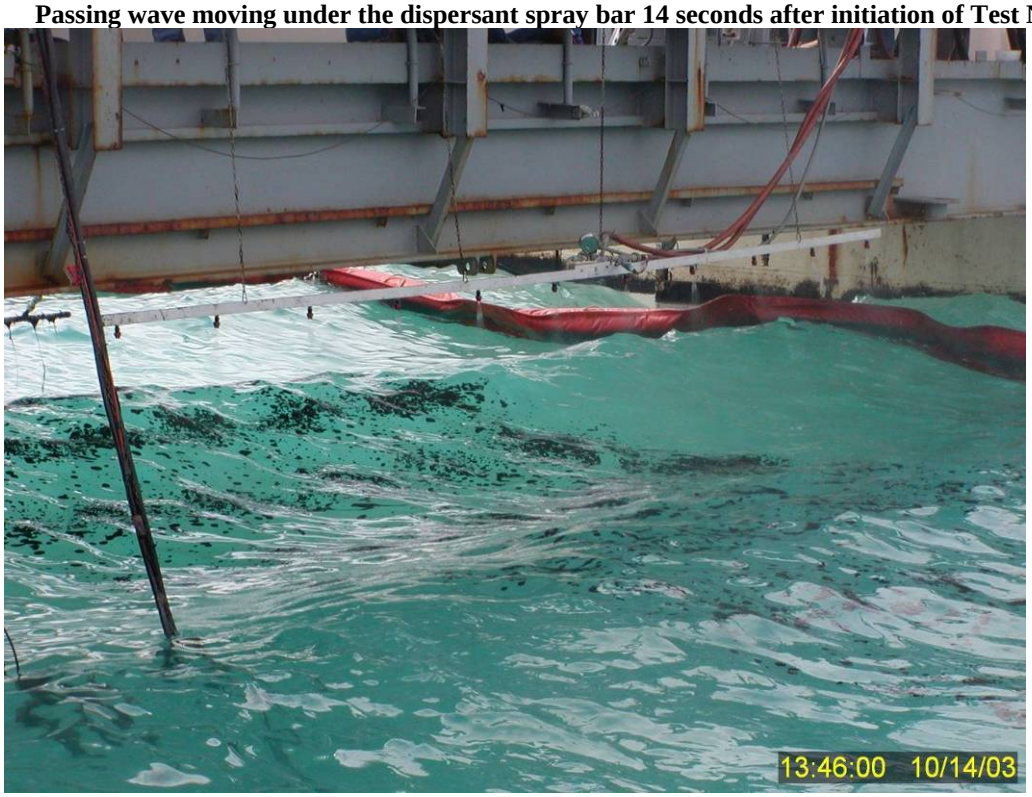

Figure 99 Application of Superdispersant 25 to spreading oil patches beneath the movable bridge 25 seconds into Test No. 15. Note the patchy oil distribution on the water surface resulting in "under dosing" of the slick (an estimated 50% of the dispersant is sprayed directly into the water and not onto the oil).

Figure 100 Close up of water surface and IFO 180 fuel oil directly under the dispersant spray bar in Figure 98. Note the dispersant spray velocity is not sufficient to force the oil into or under the water surface.

Figure 101 Appearance of dispersant-treated slick in center of the wave tank two and one-half minutes after Test No. 15 dispersant application. Note the absence of any breaking or cresting waves.

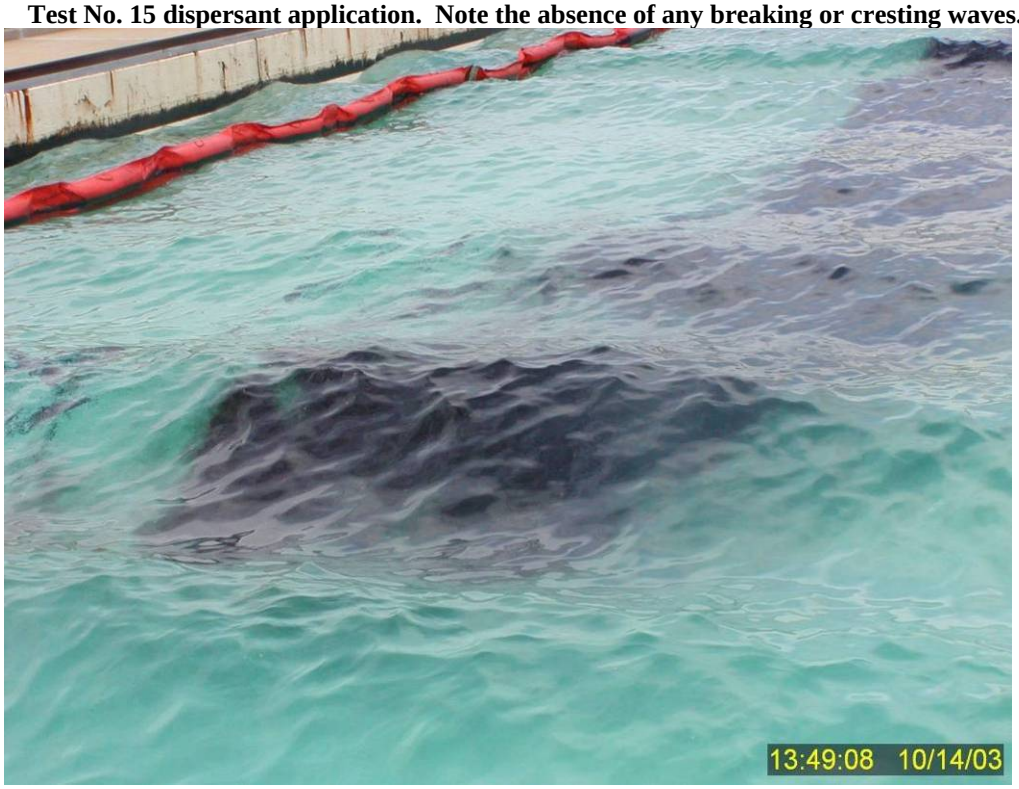

Figure 102 Closer view of dispersant-treated oil as it continues to spread three and one-half minutes into Test No. 15.

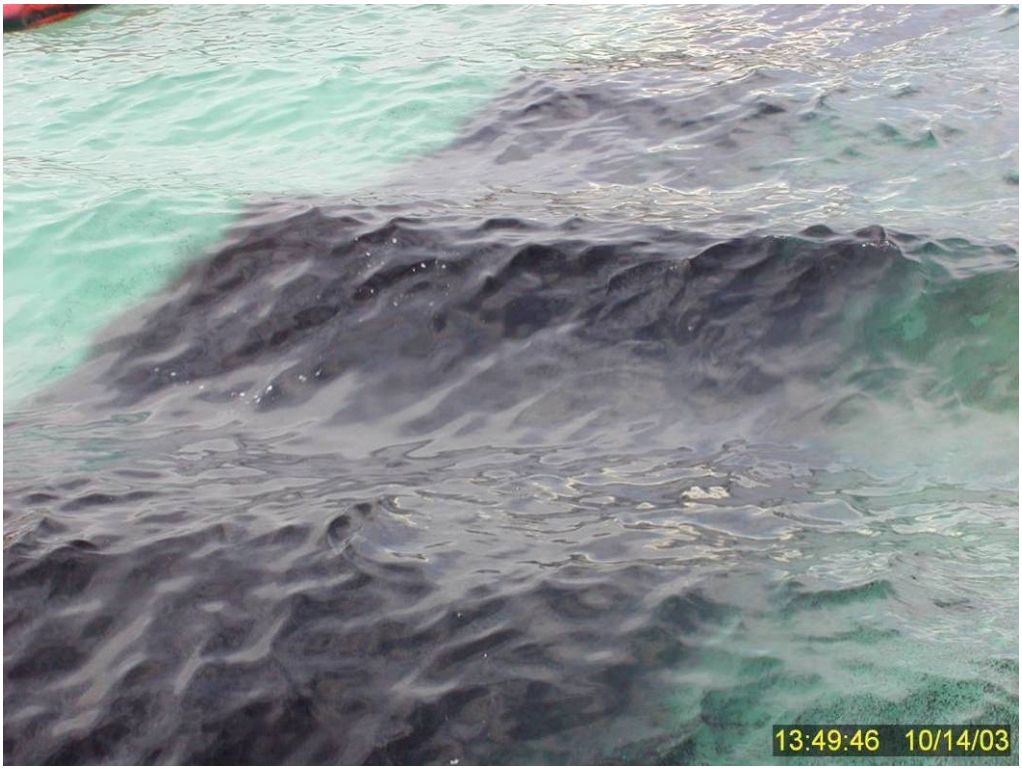

Figure 103 Overhead view of dispersant treated oil actually beginning to be entrained below the water surface. Note, this is being facilitated by the stretching and pulling of the slick by the passing waves, not by cresting of breaking whitecaps per se.

Figure 104 Close up of oil and water surface four and one-half minutes into Test No. 15 showing the beginning evidence of a fringing subsurface dispersed oil cloud along the upper edge of the slick. Compare the appearance of the oil to that from Figure 80 where no dispersion occurred following a similar time interval after dispersant application but lower wave energy.

Figure 105 Surface and slightly entrained subsurface oil in contact with the containment boom at the north end of the test tank four and one-half minutes into Test No. 15.

Figure 106 Surface and slightly entrained oil at north end of containment boom five minutes into Test No. 15. Note the clean water in the secondary containment boom showing the lack of any oil "splash over" and only limited diffusion of subsurface dispersed oil up to this time (compare to Figure 107 taken 22 seconds later).

Figure 107 Initial diffusion of subsurface dispersed oil plume into secondary containment boom five and one-half minutes into Test No. 15 (compare to Figure 106 taken 22 seconds earlier).

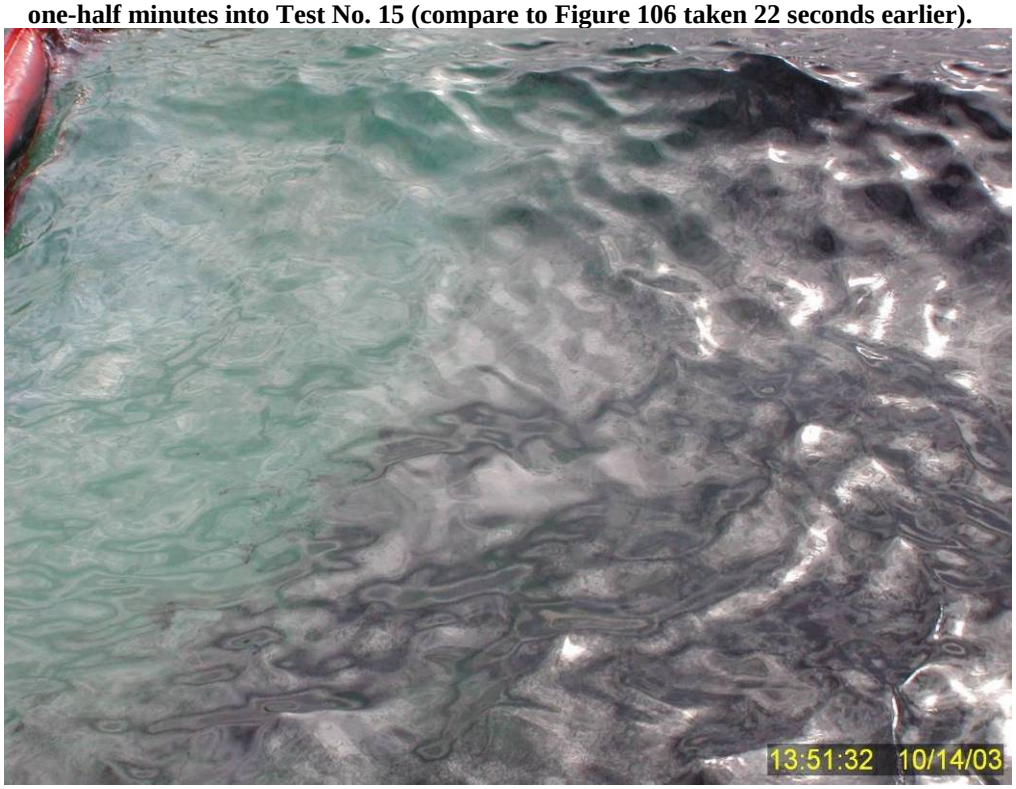

Figure 108 Slightly subsurface dispersed oil plume and surface sheen in center of test tank but near western containment boom six minutes into Test No. 15.

Figure 109 Dispersed oil plume diffusing toward eastern containment boom in center of test area six and one-half minutes into Test No. 15.

Figure 110 Residual (nondispersed) surface oil against the northern containment boom and slowly diffusing subsurface dispersed oil within secondary containment area and in water at the bottom of the figure seven minutes into Test No. 15.

Figure 111 Laterally spreading subsurface dispersed oil plume near north end of test area eight minutes into Test No. 15.

Figure 112 Subsurface dispersed oil plume throughout center of test tank ~ nine minutes into Test No. 15.

Figure 113 Subsurface dispersed oil plume throughout test tank 10 minutes into Test No. 15. Note the subsurface oil is not subject to wind drift and it is not driven by the waves into the north end of the test enclosure. Compare to surface slick appearance for non-dispersed oil in Figure 66.

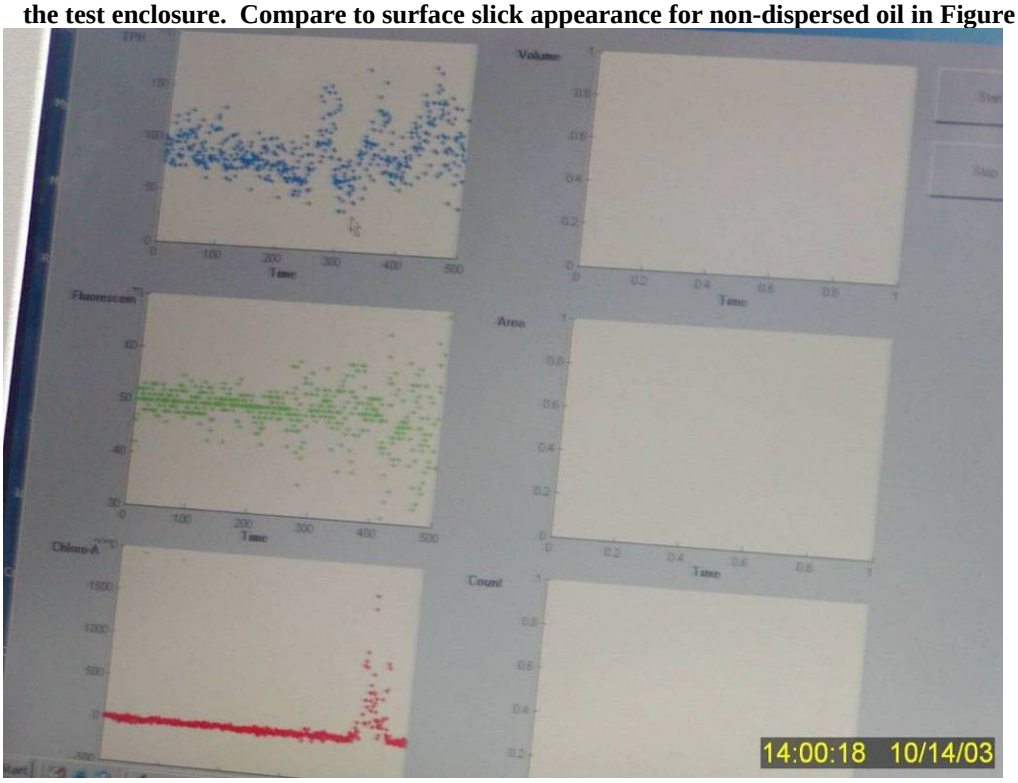

Figure 114 Computer display showing evidence of subsurface dispersed oil plume after completing a transect through the test area with the in situ towed fluorometer. In control and previous runs where no dispersion was observed, these readouts yielded flat lines showing no subsurface oil.

Figure 115 Real-time readout of measured dispersed oil concentrations from the 1- and 2-meter sampling lines (20.4 and 26.4 ppm, respectively) attached to the Turner 10-AU fluorometers on the movable bridge. In previous tests where no dispersion occurred these instruments both consistently read 0.0 ppm.

Figure 116 Diffusion-controlled advance of dispersed oil plume into secondary containment boom 23 minutes into Test No. 15. Note the minimal residual surface oil (smoother water) immediately adjacent to the edge of the primary containment boom on the right side of the figure.

Figure 117 View from the northern-most underwater window 15 minutes after the wave turbulence was stopped at the termination of Test No. 15. Compare to the photograph in Figure 93.

Figure 118 The water throughout the test tank (both inside and outside the containment booms) was still jet black twenty minutes after the wave turbulence was terminated at the end of Test No. 15. Note there was some silver sheen observed on the water surface, but there was no evidence of massive oil resurfacing like that observed at the end of Test No. 12 with a poorer performing dispersant (see Figures 55 and 56 for comparison).

Figure 119 Residual nondispersed oil within the test area being herded for recovery after Test No. 15.

Figure 120 Residual nondispersed oil within the primary containment boom being herded in preparation for vacuum recovery.

Figure 121 Vacuum recovery of residual surface oil remaining inside the primary containment boom at the termination of Test No. 15.

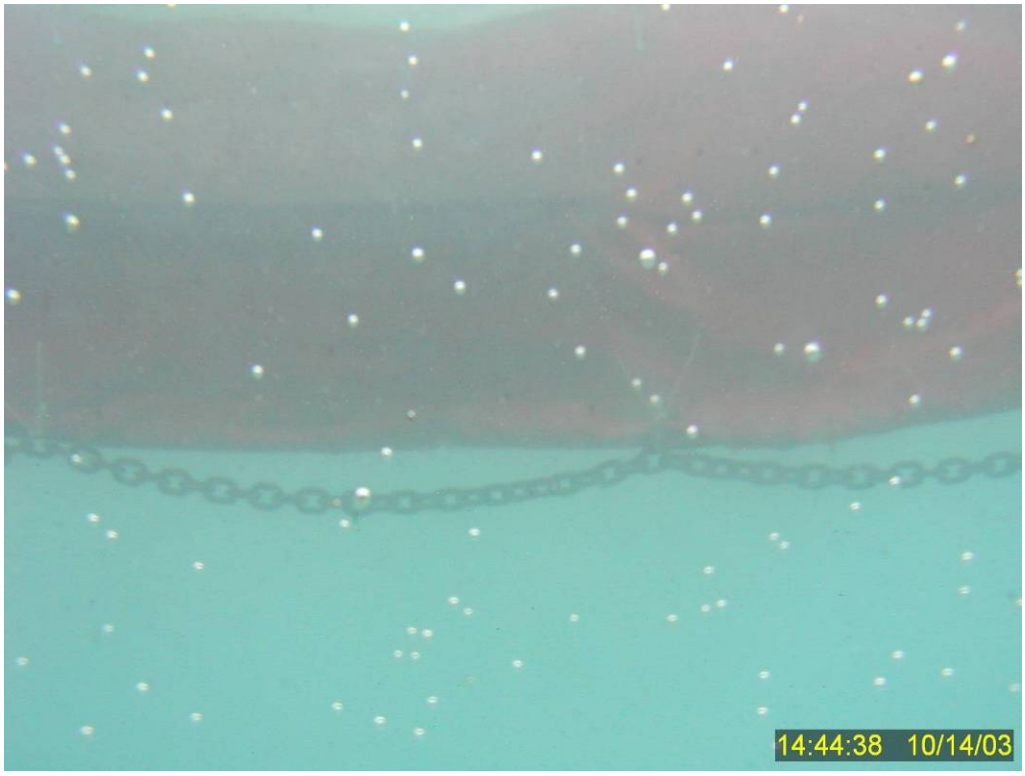

Figure 122 Water clarity as observed from the southern-most under water window (closest to the wave generator) where the containment boom and anchor chain 8-10 feet from the window can still be observed 23 minutes after terminating the wave turbulence for Test No. 15.

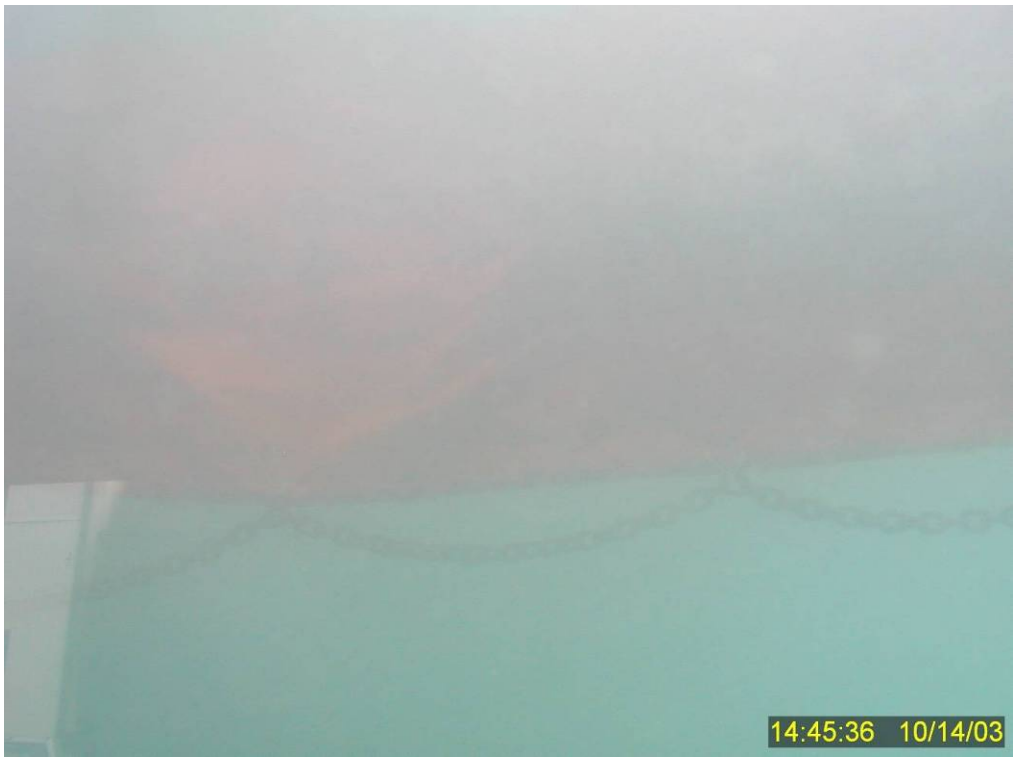

Figure 123 Water clarity as observed from the middle under water window (center of the tank) where the containment boom and anchor chain 8-10 feet from the window are partially obscured 30 minutes after terminating the wave turbulence for Test No. 15

Figure 124 View from the northern-most underwater window where the containment boom and anchor chain 8-10 feet from the window are still completely obscured 31 minutes after terminating the wave turbulence for Test No. 15.

Figure 125 Subsurface dispersed oil discoloration of the tank water 38 minutes after stopping the wave turbulence and sweeping the tank to remove residual surface oil at the end of Test No. 15. Note there is some minor sheen adjacent to the primary containment boom near the top of the figure, but massive dispersed-oil resurfacing like that observed after Test No. 12 did not occur.

Figure 126 Set up for Test No. 16: IFO 180 treated with Corexit 9500 (nominal DOR 1:50) at intermediate wave energy (33 cpm).

Figure 127 Discolored water and residual surface sheen from previous test (No. 15) terminated an hour earlier.

Figure 128 Wave train established for Test No. 16 just before oil addition. Note single cresting wave passing under movable bridge.

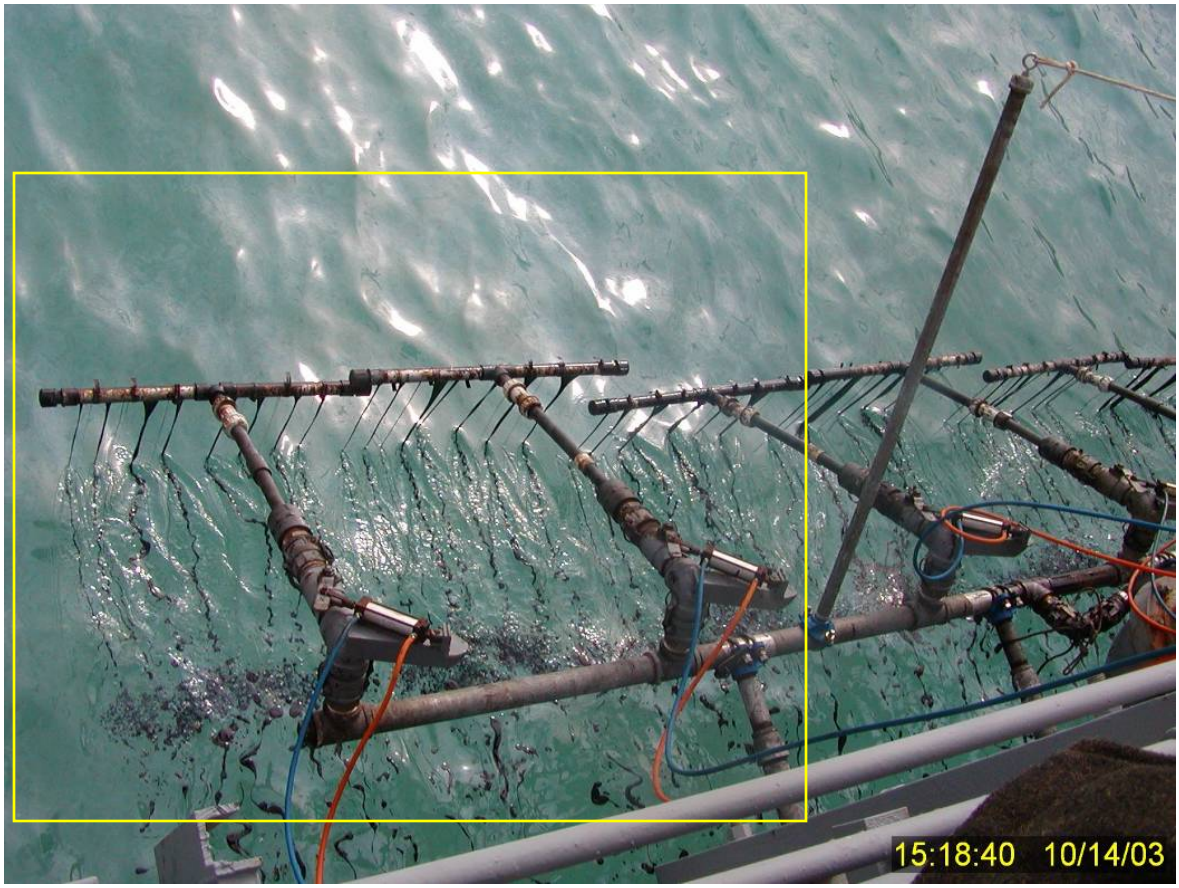

Figure 129 Application of IFO 180 fuel oil from the movable bridge to the water surface at the initiation of Test No. 16. During the oil addition the bridge is advanced to the south (toward the wave generator) at ~ ½ knot. The dispersant is sprayed onto the oil approximately 8-10 seconds later after it has passed under the bridge by a spray boom mounted ~3 feet above the water. Note the lack of oil penetration into the water as it is applied and the residual silver sheen on the water surface from the previous test. Also see Figure 130, which is a close up of the area within the yellow rectangle.

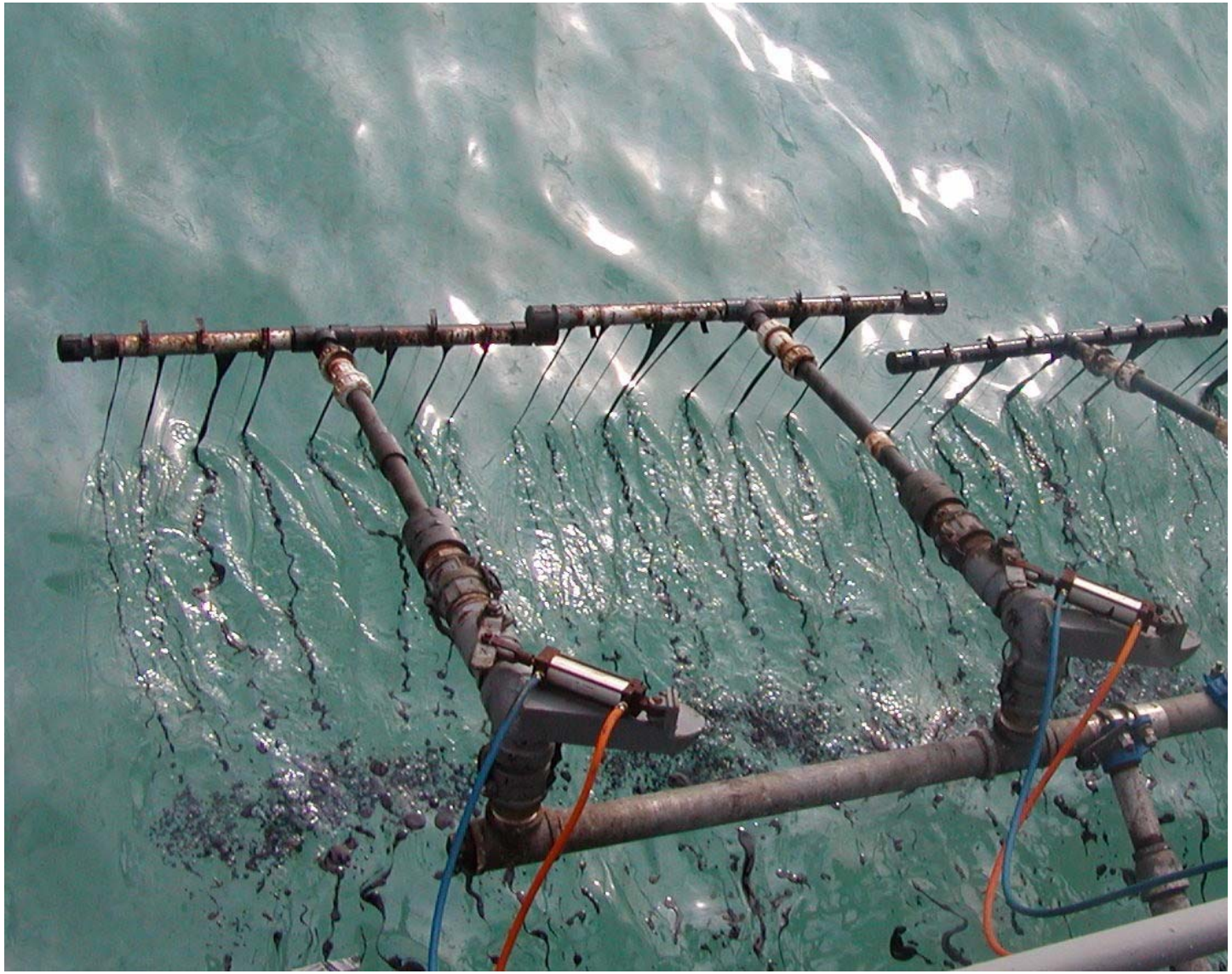

Figure 130 Close up of IFO 180 fuel oil being dribbled onto water surface at initiation of Test No. 16. Note the lack of oil penetration into the water at this low application rate and the presence of broken silver sheen from Test No. 15 on the water surface at the top of the photograph.

Figure 131 **Appearance of the IFO 180 immediately after passing under the dispersant spray boom 20 seconds into Test No. 16. Note the uneven distribution of the oil on the water surface resulting in under dosing by the dispersant spray. Also note the water color before any significant dispersion begins.**

Figure 132 **Appearance of the IFO 180 fuel oil approximately 30-45 seconds after treatment with Corexit 9500. Note the water clarity appears better from this angle (looking north) compared to the view toward the south just before the initiation of the test (Figures 127 and 128).**

Figure 133 Dispersant-treated slick in the center of the tank one minute after initiation of Test No. 16.

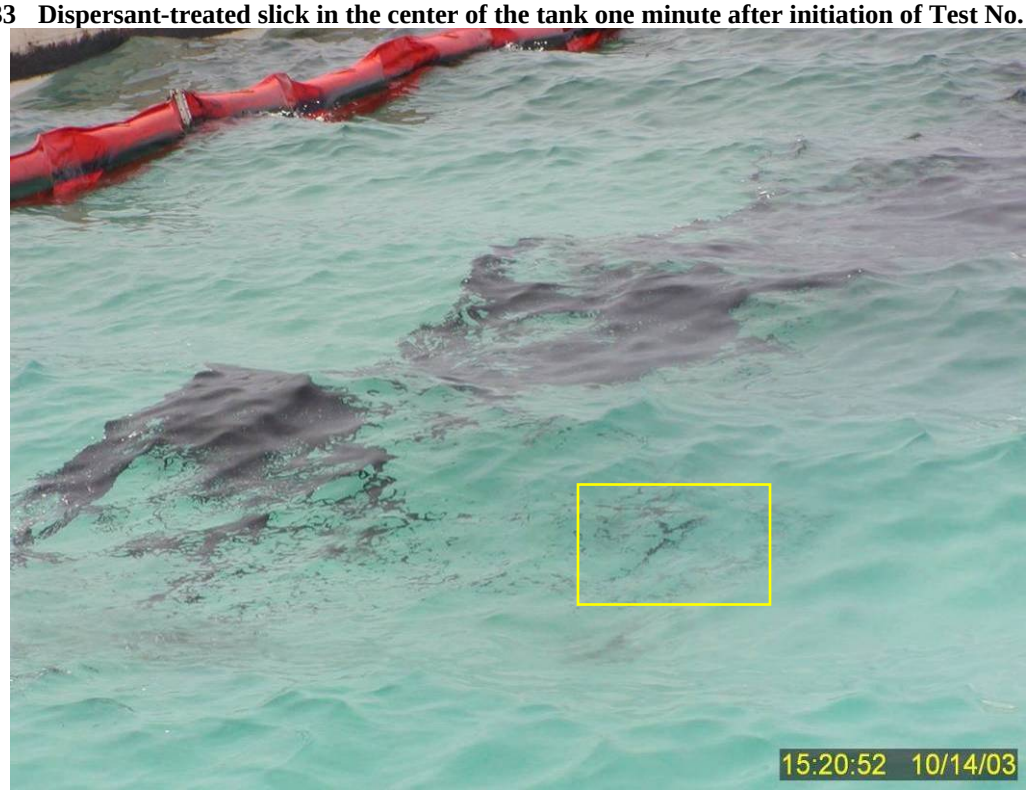

Figure 134 Overhead view of dispersant-treated surface slick approximately two and one-half minutes after dispersant application. See Figure 135 for a close up of the area in the yellow rectangle as it begins to break up and become dispersed.

Figure 135 Close up of the yellow rectangle in Figure 134 as it begins to disperse into the water column two and one-half minutes after dispersant treatment. Note the water color before the majority of the oil begins to disperse.

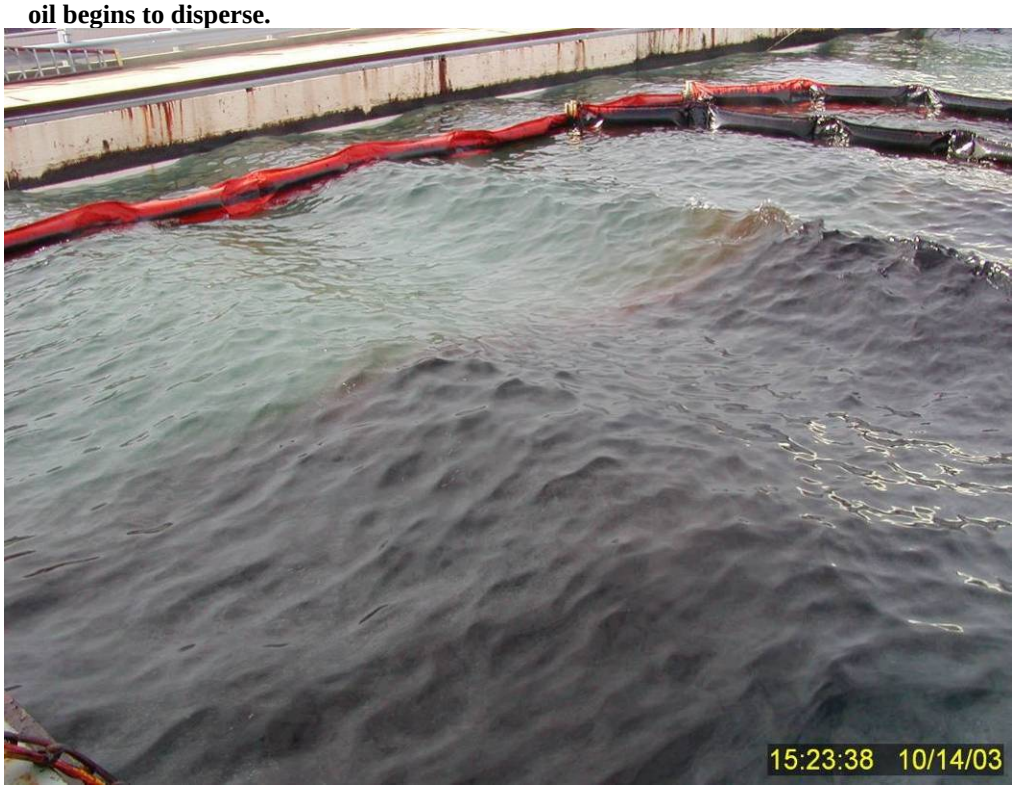

Figure 136 Bulk oil in center of tank beginning to disperse approximately five minutes after dispersant treatment.

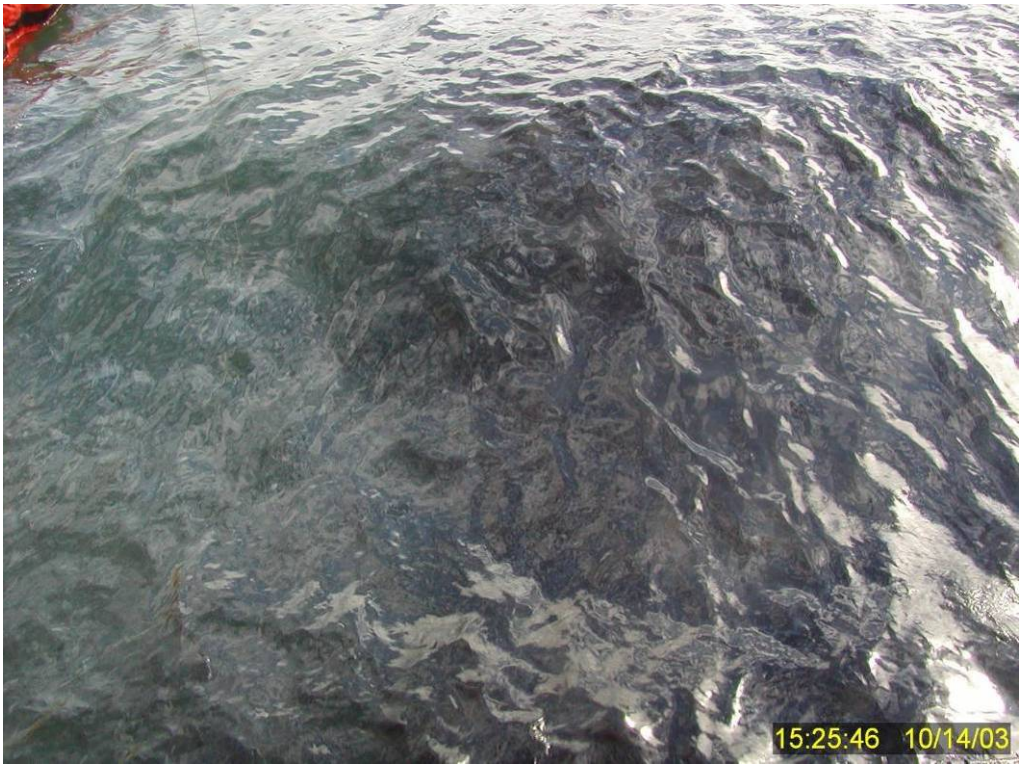

Figure 137 Subsurface oil plume approximately in the middle of the tank and 6-7 feet from the western containment boom. Photo was taken looking to the north seven minutes after dispersant treatment in Test No. 16.

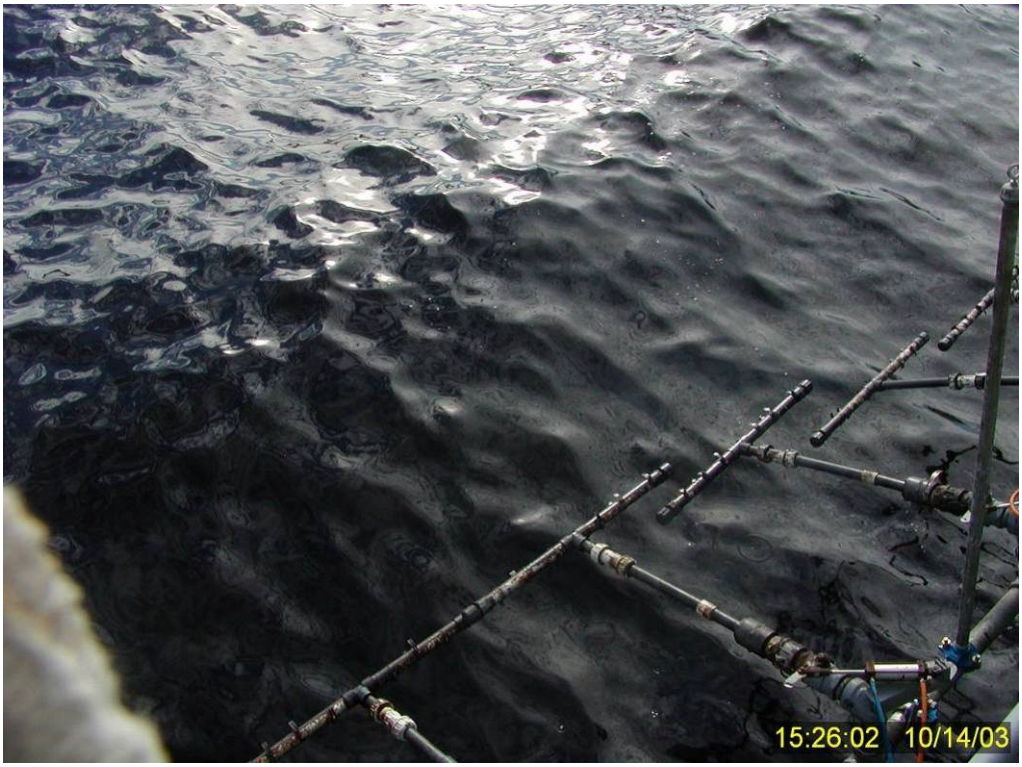

Figure 138 Subsurface oil plume looking to the south seven and one-half minutes after dispersant treatment in Test No. 16.

Figure 139 More traditional lighter brown plume of subsurface dispersed oil plume nine minutes after dispersant treatment in Test No. 16. It is believed that the lighter color may be due to smaller dispersed oil droplets, but droplet size data are not available to confirm this hypothesis.

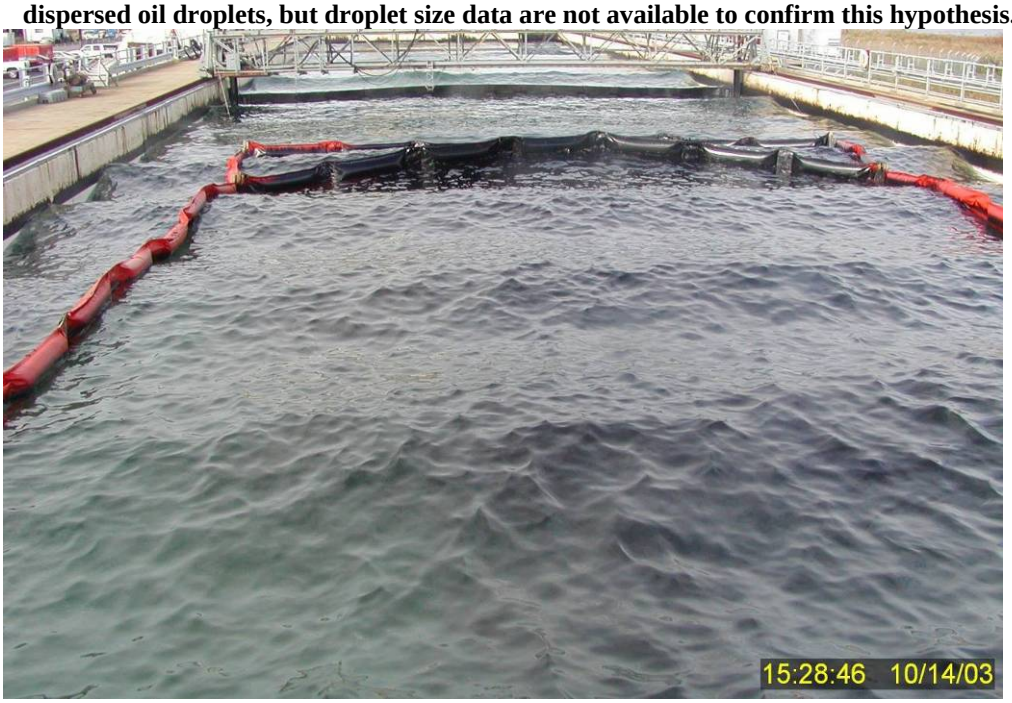

Figure 140 Overview of subsurface dispersed oil plume in center of the tank ten minutes after treatment in Test No. 16. Note the lack of any whitecaps at this wave frequency setting and the gradual lateral spread (diffusion) of the black subsurface oil outside the containment boom on the western (left) side of the tank. Compare the water color to Figures 132 and 133.

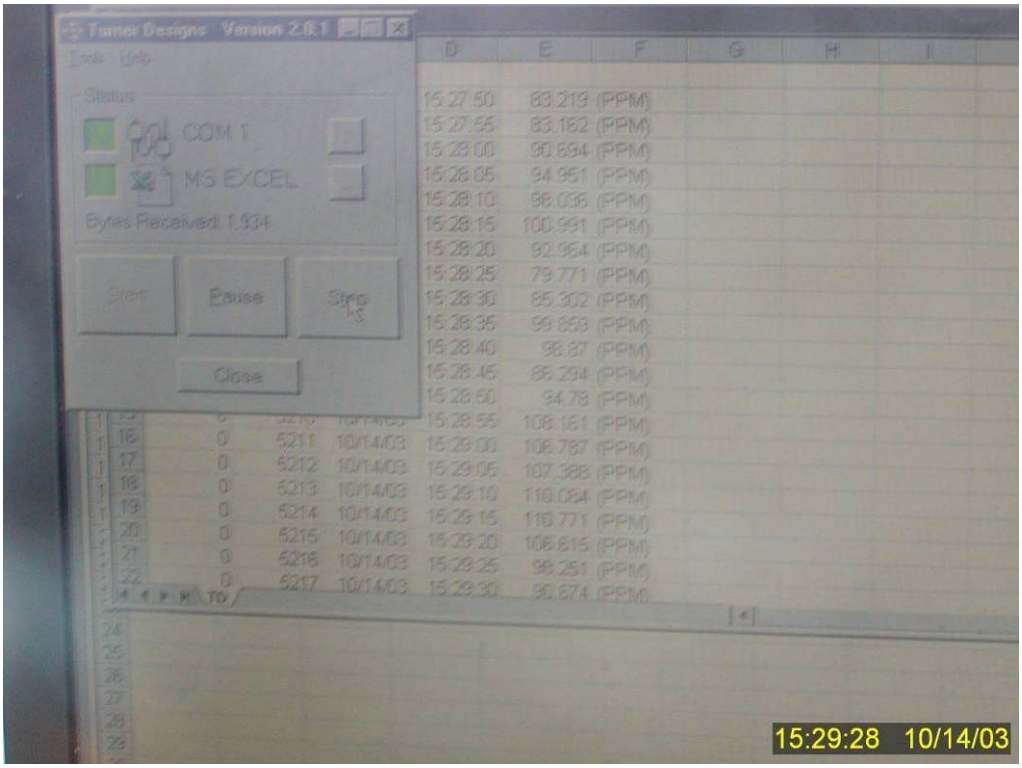

Figure 141 Computer readout of 1-meter Turner 10 AU fluorometer read out showing peak dispersed oil concentrations around 110 ppm during a longitudinal (north-south) transect approximately eleven minutes into Test No. 16. Background readings in the 30-40 ppm range from residual dispersed oil remaining from Test No. 15 were obtained immediately before Test No. 16 was initiated.

Figure 142 Grab sample of water tapped from the discharge line of the 1-meter Turner AU-10 fluorometer. This sample was collected after approximately eleven and one-half minutes for detailed chemical analysis of oil content for direct comparison to the fluorometer reading. Note the visible dispersed oil droplets throughout the sample.

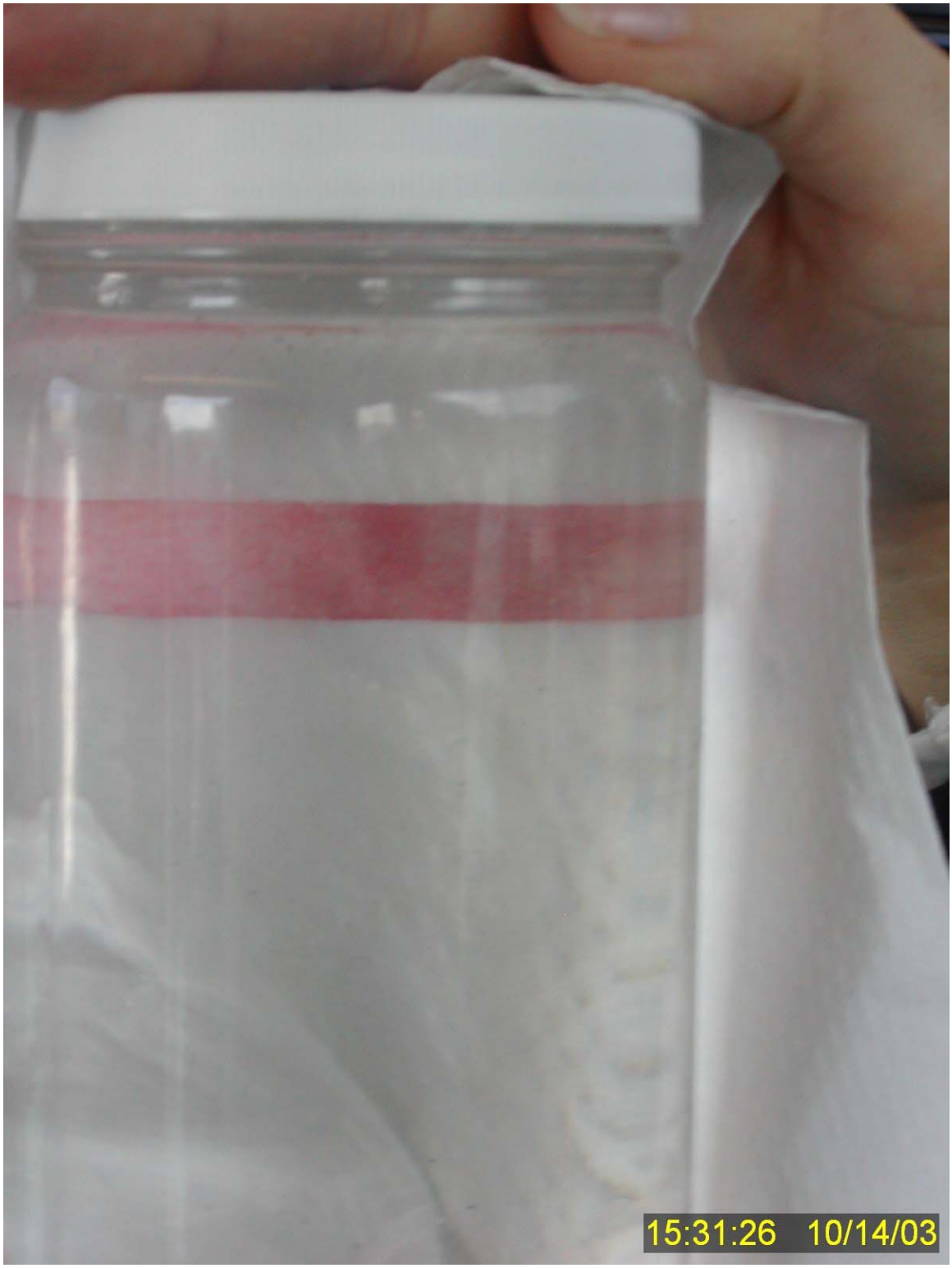

Figure 143 Grab sample of water tapped from the discharge line of the 2-meter Turner AU-10 fluorometer. This sample was collected at the same time as the 1-meter deep sample (after approximately eleven and one-half minutes) but it was not photographed until the time-stamp shown on the figure. Note the 2-meter deep sample is considerably cleaner than the corresponding 1-meter sample.

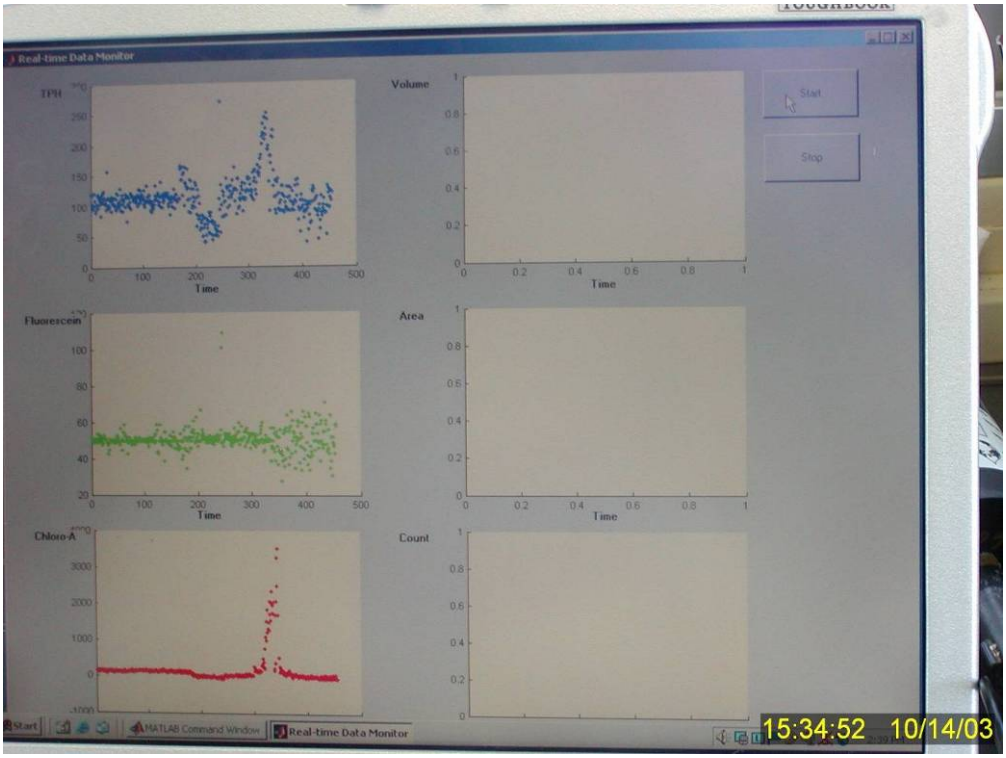

Figure 144 Computer readout from the WET-Labs in situ fluorometer following a south-to-north transect through the dispersed oil plume approximately 16 minutes after Test No. 16 dispersant treatment.

Figure 145 Overview of the water surface and dispersed oil plume 20 minutes into Test No. 16. Note the virtual absence of any surface oil and the lateral diffusion of the dispersed oil plume outside (to the left of) the containment zone.

Figure 146 North end of the experimental test zone 23 minutes into Test No. 16. There is little or no visible surface oil, and the dispersed oil plume can be seen outside the containment boom on the top of the figure.

Figure 147 Primary and secondary containment boom showing little or no surface oil and the distribution of dispersed subsurface oil across the tank 23 minutes after dispersant treatment.

Figure 148 Silver oil sheen and small patch of residual surface oil adjacent to the primary containment boom 25 minutes into Test No. 16.

Figure 149 Overview of test tank 32 minutes into Test No. 16 showing dispersed oil plume diffusing laterally and longitudinally throughout the tank.

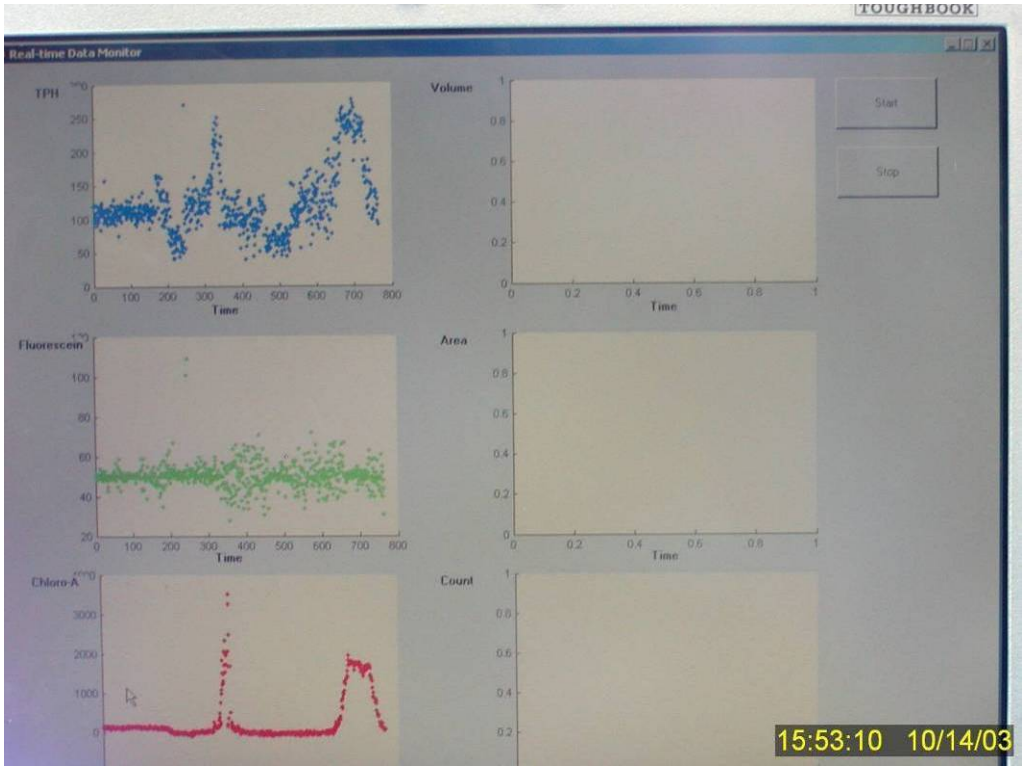

Figure 150 Computer readout from the WET-Labs in situ fluorometer following a south-to-north transect through the dispersed oil plume approximately 35 minutes after dispersant treatment.

Figure 151 Water surface and green-black subsurface dispersed oil plume approximately six minutes after the wave turbulence for Test No. 16 was stopped (41 minutes after dispersant addition).

Figure 152 Subsurface dispersed oil plume along western edge of containment boom and tank wall approximately seven minutes after cessation of wave turbulence for Test No. 16.

Figure 153 Center of tank test area showing dispersed oil cloud and absence of any significant surface oil before tank cleaning operations were initiated at the end of Test No. 16.

Figure 154 Close up of minor residual surface oil remaining within the primary containment boom at the termination of Test No. 16.

Figure 155 Residual surface oil and subsurface dispersed oil plume within primary and secondary containment booms at the end of Test No. 16.

Figure 156 Squeegee/vacuum recovery of residual surface oil within the primary containment boom at the termination of Test No. 16. Only 16 percent of the original oil was recovered (Table 1).

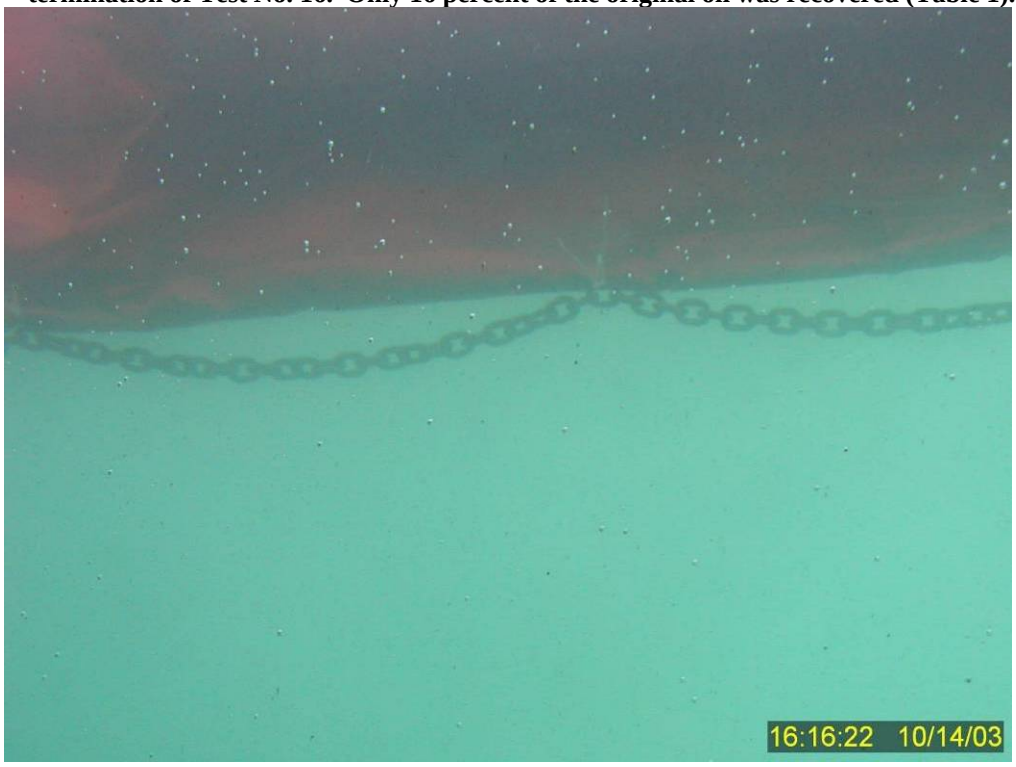

Figure 157 Water clarity as observed from the southern-most under water window (closest to the wave generator) where the containment boom and anchor chain 8-10 feet from the window can still be observed 23 minutes after terminating the wave turbulence for Test No. 16.

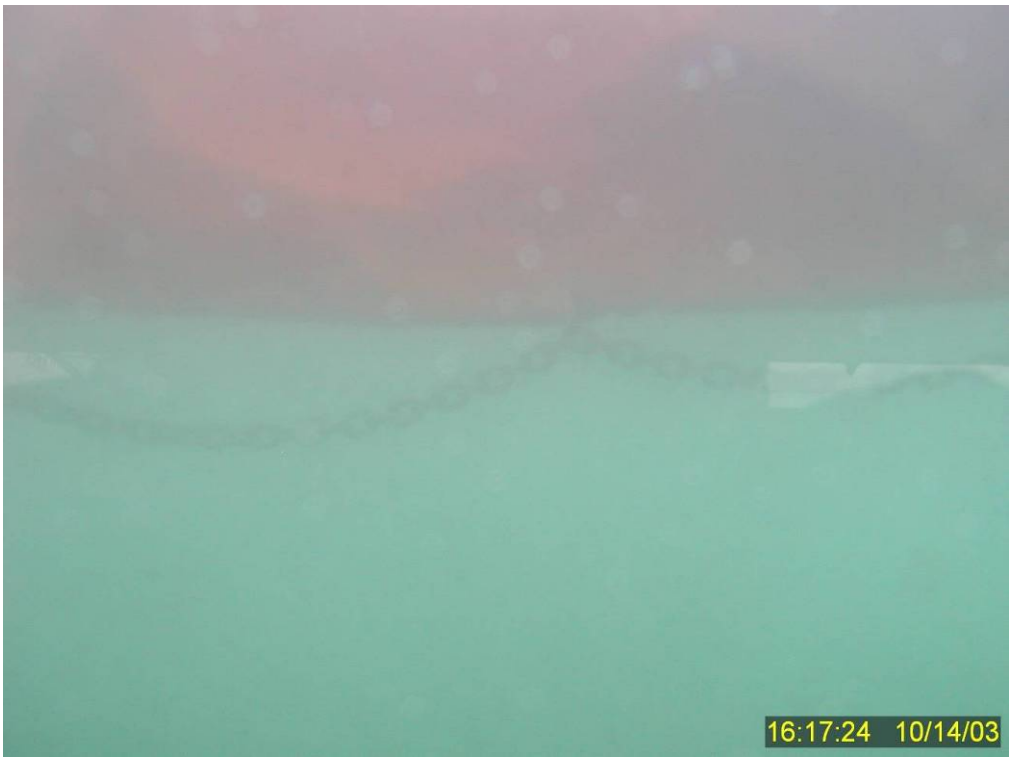

Figure 158 Water clarity as observed from the middle under water window (center of the tank) where the containment boom and anchor chain 8-10 feet from the window are partially obscured 24 minutes after terminating the wave turbulence for Test No. 16.

Figure 159 View from the northern-most underwater window where the containment boom and anchor chain 8-10 feet from the window are still completely obscured 25 minutes after terminating the wave turbulence for Test No. 16.

Figure 160 **Surface water and dispersed oil plume to the north of the primary and secondary containment booms 19 minutes after the wave turbulence was stopped at the termination of Test No. 16. No significant resurfacing of dispersed oil was observed after this test like it was with the poorer performing dispersant at the termination of Test No. 12 (see Figure 56). At this time, the water column was jet black, but there was no surface slick observed anywhere throughout the tank.**

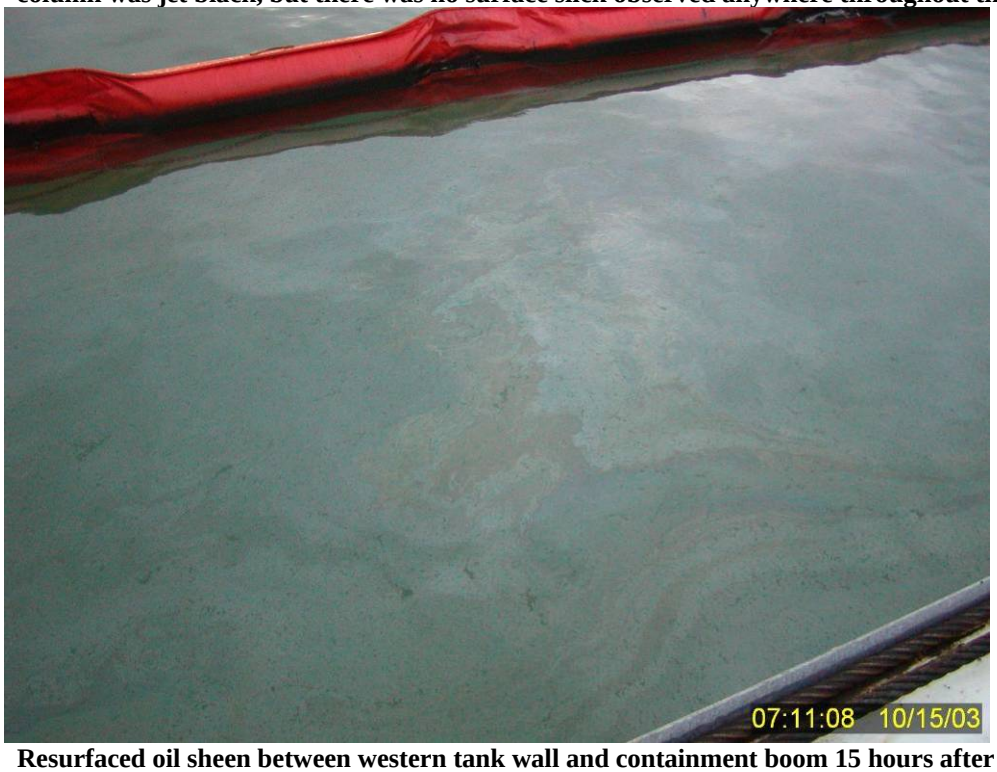

Figure 161 **Resurfaced oil sheen between western tank wall and containment boom 15 hours after cessation of turbulence at the end of Test to. 16. Photo taken early the next morning before any tank cleaning operations had been initiated.**

Figure 162 Resurfaced oil sheen and droplets outside of secondary containment boom 15 hours after Test No. 16. The tank had been allowed to stand undisturbed overnight, and this photograph was taken before any OHMSETT personnel had arrived to initiate additional clean up operations.

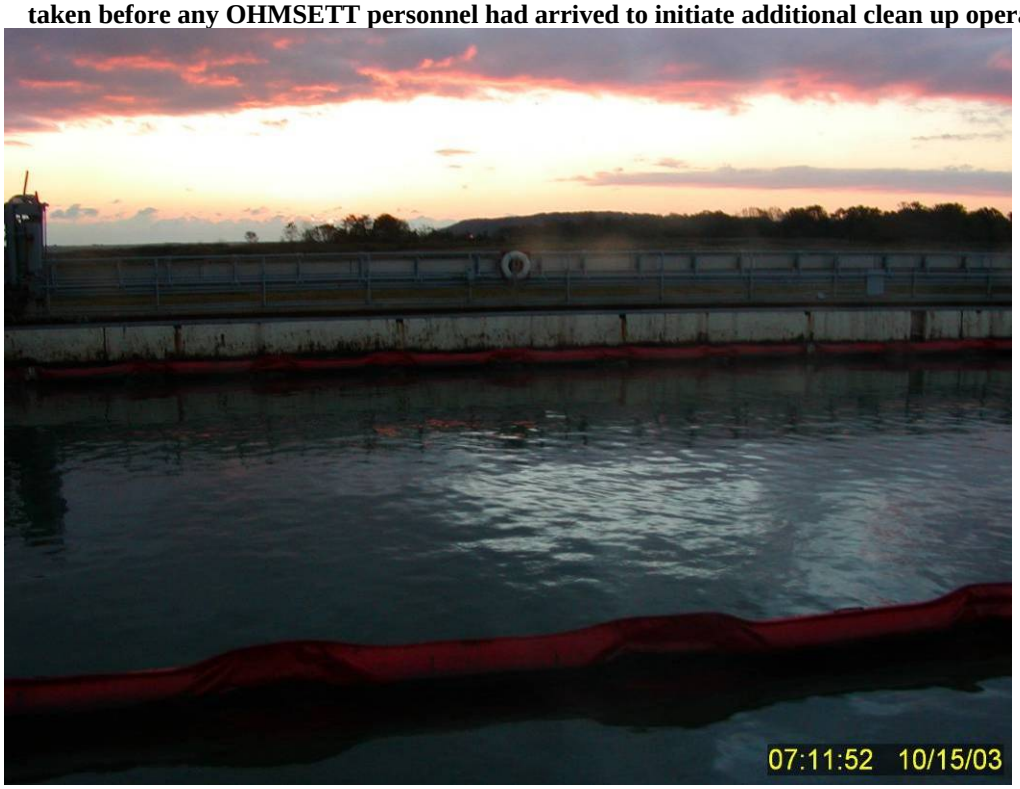

Figure 163 Undisturbed test tank 15 hours after termination of Test No. 16 and before any additional clean up operations.

Figure 164 Undisturbed test tank surface near secondary containment boom and under movable bridge 15 hours after termination of Test No. 16. Note the absence of significant resurfaced oil accumulations like those observed after Test No. 12 (see Figure 56).

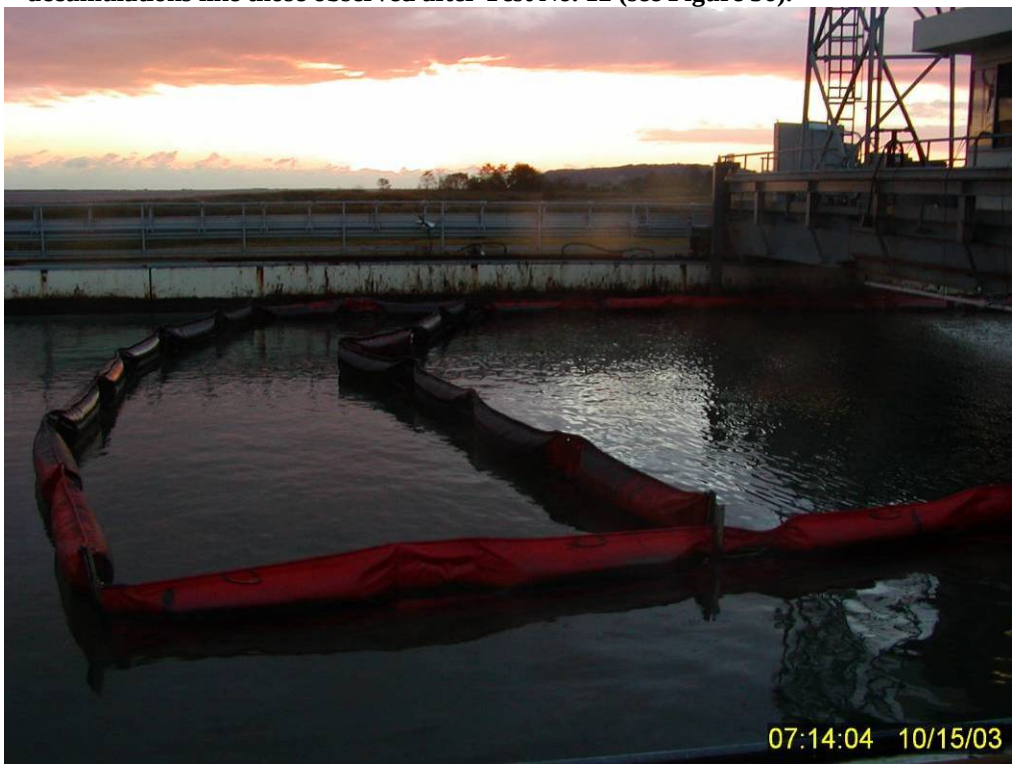

Figure 165 Undisturbed water surface inside secondary containment boom and north end of test zone 15 hours after termination of Test No. 16.

Figure 166 Undisturbed water surface between western tank wall and containment boom in center of tank after standing quite for ~15.5 hours following the termination of Test No. 16.

Figure 167 Oblique photograph of silver oil sheen on water surface from Figure 166 (photographed at a 90 degree angle to the containment boom).

Figure 168 **View from southern-most under water window (closest to wave generator) 15.5 hours after cessation of wave turbulence at the end of Test No. 16. Compare to Figure 156 taken 23 minutes after the turbulence was terminated. The boom and anchor chain are now completely obscured by subsurface dispersed oil droplets that had diffused throughout the (quite) tank overnight.**

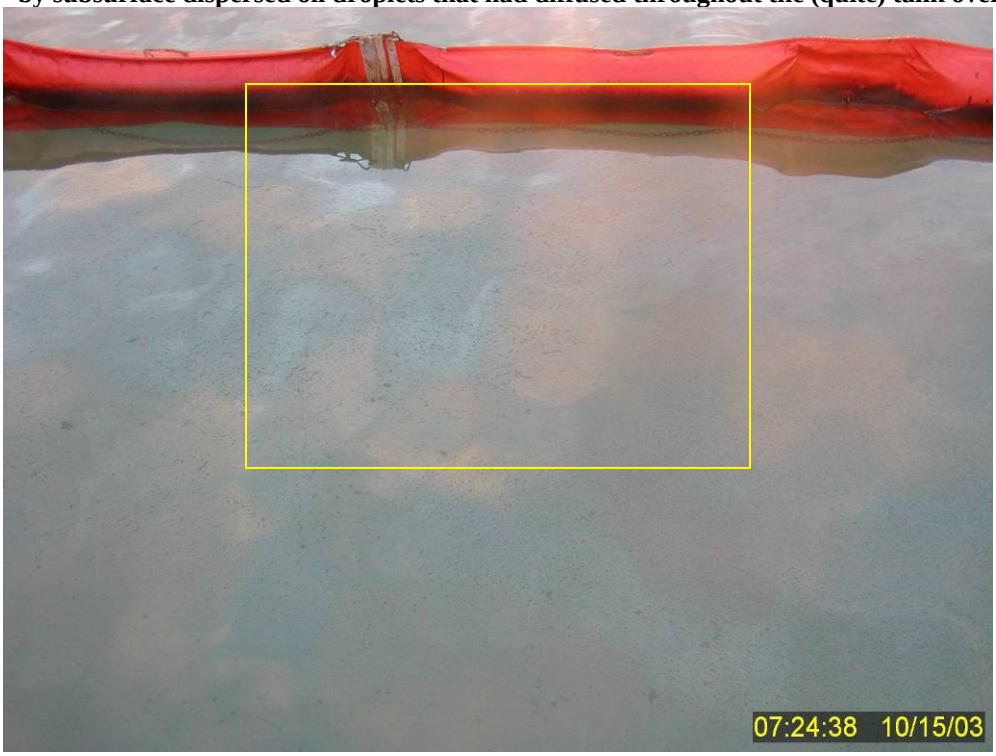

Figure 169 **Finite 0.5 – 1 cm sized agglomerations of resurface oil between the western tank wall and containment boom above the southernmost under-water window after 15.5 hours of calm conditions. The area within the yellow rectangle is blown up in Figure 170.**

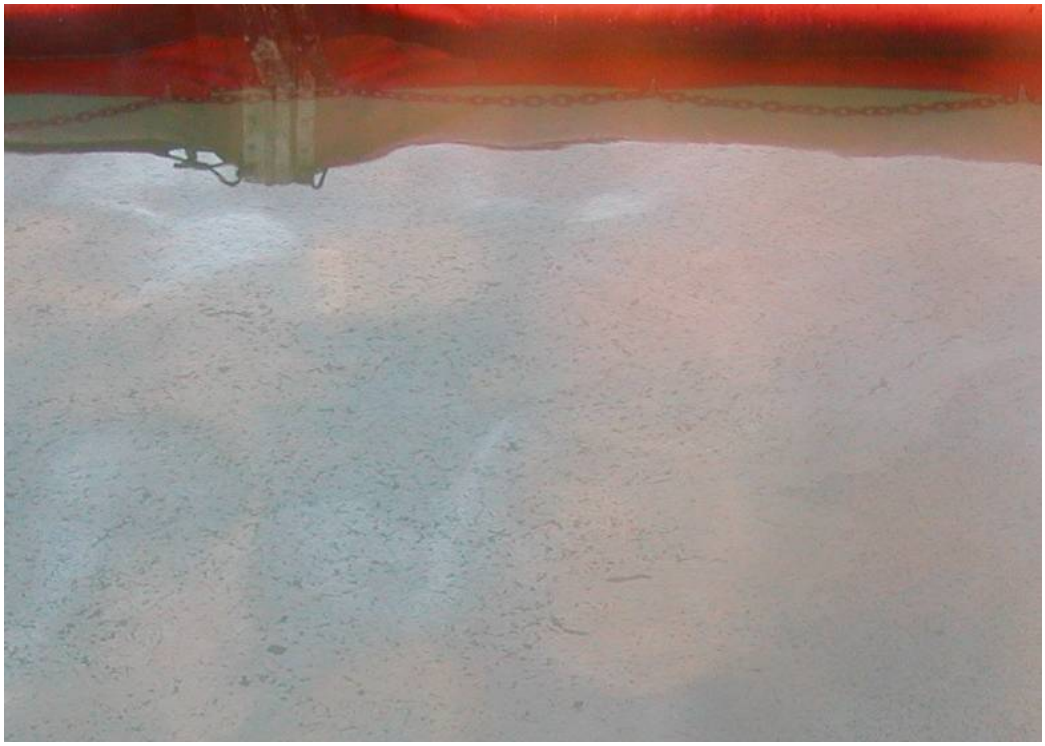

Figure 170 **Close up of silver sheen and 0.5 – 1 cm sized surface oil agglomerates between the containment boom and western tank wall from area outlined by the yellow rectangle in Figure 169. The colors are from the reflections of the clouds at sunrise and not thicker colored oil films.**

Figure 171 **Northwestern corners of primary and secondary containment booms 15.5 hours after the termination of wave turbulence at the end of Test No. 16.**

Figure 172 Residual oil from within the experimental test area that had resurfaced overnight and been blown by the southwesterly wind into northeastern corner of primary containment boom.

Figure 173 Close up of the accumulated silver sheen and re-surfaced oil that had been blown overnight into the northeast corner of the primary and secondary containment boom.

Figure 174 Resurfaced oil in the northeast corner of the containment boom photographed from the eastern tank wall 15.5 hours after cessation of turbulence at the end of Test No. 16.

Figure 175 View of the primary containment zone looking toward the southwest approximately 15.5 hours after the wave generator was turned off at the end of Test No. 16. The water surface was relatively free of oil (it had all been blown into the northeast corner by the prevailing winds), but the subsurface was still very dark due to the dispersed oil that remained in suspension overnight.

Figure 176 **Subsurface dispersed oil imparting a dark green/black hue to the water column after 16.5 hours of relative calm and removal or the residual surface oil by OHMSETT personnel in preparation for additional tests scheduled for October 15, 2003. Photographed an hour after Figures 174 and 175 from the movable bridge looking north northeast.**

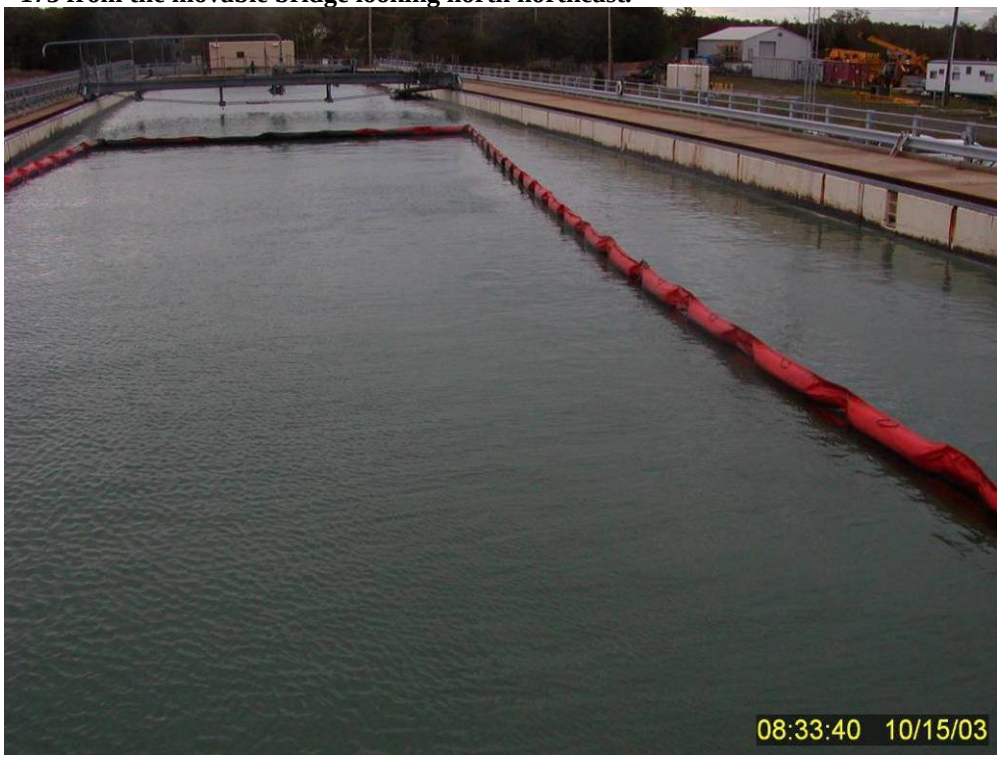

Figure 177 **View of the containment boom (looking towards the south from the movable bridge) after the tank had been cleaned of residual resurfaced oil in preparation for additional tests on October 15, 2003. Although the wind blowing from the west (right to left) has bowed the primary containment boom, it does not impart a lot of wave energy to the tank.**

Figure 178 Completing final preparations for Test No. 17: Lower viscosity IFO 120 fuel oil, Corexit 9500 (nominal DOR 1:50), and low wave energy (30 cpm).

Figure 179 Application of lower viscosity IFO 120 fuel oil to water surface at beginning of Test No. 17.

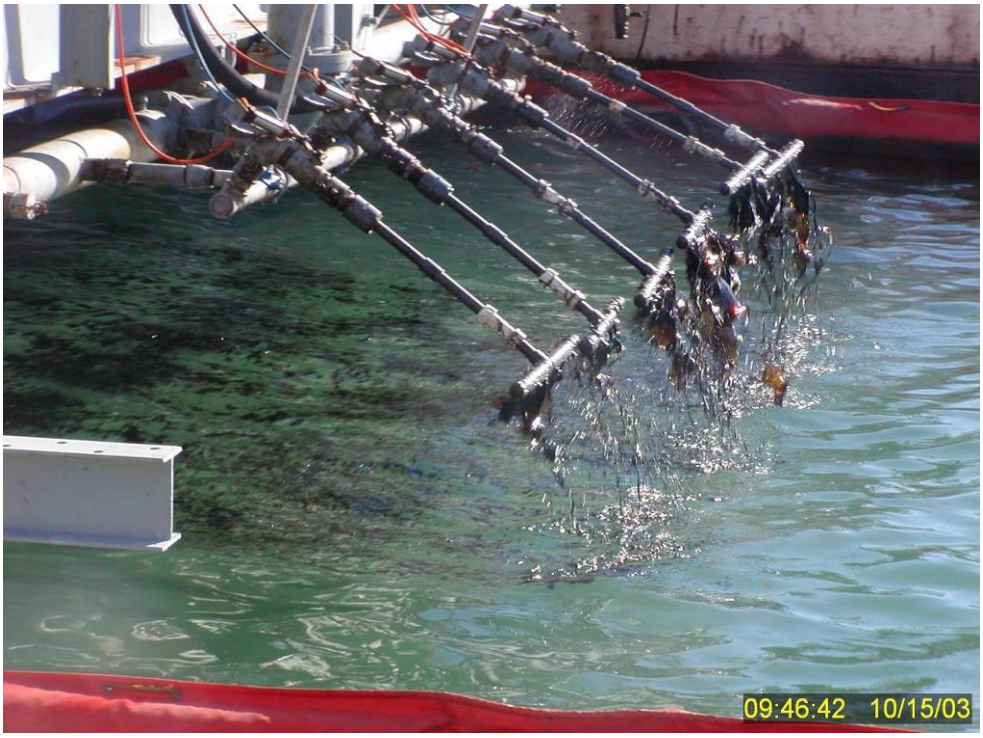

Figure 180 **IFO 120 fuel oil application to water surface at initiation of Test No. 17. Note the lighter, less viscous oil spreads more rapidly than the heavier IFO 180 fuel oil used in earlier tests.**

Figure 181 **Spray boom application of Corexit 9500 at initiation of Test No. 17. Note there was considerable wind drift of the dispersant away from the oil target (westerly winds were measured at 20-30 mph with gusts to 40 mph). These wind conditions are normally considered to be outside the nominal operating window for OHMSETT dispersant testing, but it was day two of "visitor's day" and there was a strong desire to demonstrate another successful dispersant test for additional NOAA, USCG, and US Navy personnel who were not present the day before.**

Figure 182 IFO 120 fuel oil two minutes after dispersant treatment. With the strong westerly winds, the surface oil quickly drifted toward the east (note the containment boom is being pressed hard against the tank wall); however, the dispersed oil remained more in the center of the tank.

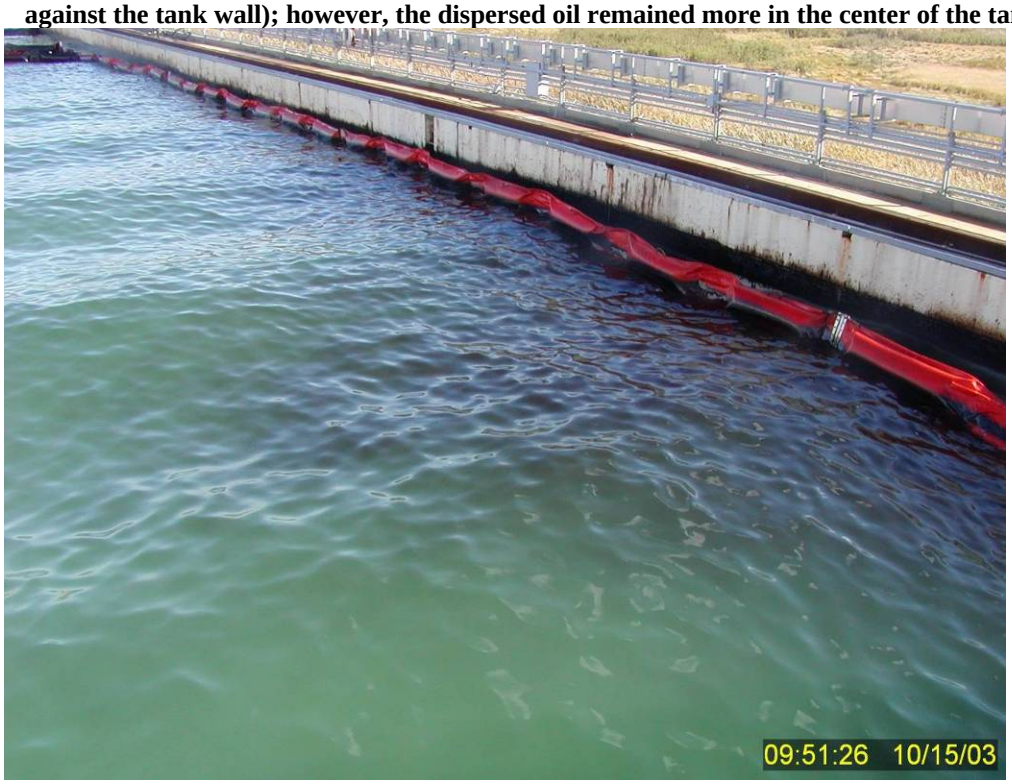

Figure 183 Dispersed oil plume and residual non-dispersed surface oil (immediately adjacent to the boom) approximately four minutes after dispersant treatment in Test No. 17.

Figure 184 Subsurface dispersed oil plume approximately four and one-half minutes after dispersant treatment in Test No. 17. Note this lighter IFO 120 oil (viscosity = 1,145 cP @ 16° C) dispersed much more readily than the IFO 180 oil (2,075 cP @ 16° C) treated with the same dispersant, DOR, and wave energy during Test No. 14. See Table 1 and Figures 72 through 91.

Figure 185 Residual non-dispersed surface oil blown against the containment boom along the eastern side of the tank approximately 6 minutes after the initiation of Test No. 17.

Figure 186 Residual non-dispersed surface oil blown against the containment boom along the eastern wall of the test tank approximately 9 minutes after the initiation of Test No. 17. Photographed from just above the secondary containment boom looking south. Note: there is considerably less surface oil than in Figure 185 taken 3 minutes earlier; however, it is believed (and acknowledged by SL Ross and OHMSETT personnel) that the additional turbulence introduced by the interaction of the boom with the passing waves enhanced dispersion in this test.

Figure 187 Dispersed IFO 120 oil plume over eastern half of the tank approximately 15 minutes after initiation of Test No. 17.