



OVERVIEW

Florida Power and Light (FPL) applied for regulatory approval to combust Orimulsion™ as an alternative to Fuel Oil #6 at the Manatee power plant facility located near Tampa Bay in Parrish, FL. Orimulsion™ is an emulsion of bitumen in water developed by the Venezuelan oil industry, formulated to have a viscosity comparable to that of fuel oil, so that Orimulsion™ could be used in oil-burning power plants with minimal conversion costs. This product consists of a bitumen that is extracted from an underground deposit in the Orinoco River basin and that is emulsified in such a way as to facilitate three attributes: 1) maintain product stability; 2) provide for ease of extraction and transportation; and 3) allow direct combustion. The resultant product consists of approximately 70% bitumen and 30% water, with the individual particles of bitumen coated with the surfactant nonylphenol polyethoxylate, consisting of <0.2% of the total mass. Because the product does not require refinement before it can be combusted, there is the potential for considerable savings in the cost of fuel in FPL's fossil fuel plants. However, this product has not yet been licensed as the complete fuel in any major power plant facility in the US. The Manatee facility was selected by FPL as the first power plant to convert to Orimulsion™ combustion.

Under FPL sponsorship, a project led by Drs. Harwell and Gentile was established at the Center for Marine and Environmental Analyses (CMEA) at the University of Miami Rosenstiel School of Marine and Atmospheric Science (RSMAS) to conduct a comparative ecological risk assessment (CERA) to evaluate the relative risks of Orimulsion™ in comparison to Fuel Oil #6, the present fuel used at the Manatee facility and many other FPL facilities in Florida. The role of Drs. Harwell and Gentile was to coordinate the CERA research, to provide liaison with the other research and licensing elements of FPL and its contractors, and to develop the final comparative ecological risk assessment based on information, data, and analyses developed under their leadership at the University of Miami and collaborating universities. These institutions include Florida International University, University of South Florida, University of North Texas, and University of Massachusetts.

The need for the CERA was clear: there is an increased recognition that the most central issues relating to resource damages resulting from oil spills are environmental impacts. Enhanced public awareness as well as the increasing environmental objectives of the nation require the ability to assess ecological, economic, and societal consequences of oil spills. Examples of potential ecological effects from oil spills in Florida's subtropical coastal ecosystems are immediate mortality to fishes, invertebrates, seagrasses, corals, and mangroves caused by toxic stress, as well as potential longer-term changes in coastal ecosystem structure, function, and dynamics. Because of their complex functioning and the nexus of inter-relationships, ecosystem effects are difficult to quantify. Ecosystem effects from anthropogenic activities often result from harm to key components that are critical for environmental sustainability and that are

beneficial to humans. For example, many fishes and macro-invertebrates are key, ecologically important ecosystem trophic links, and they often comprise economically (commercially and recreationally) important species. It is imperative to determine the fate, transport, and biological effects of oil once it enters the environment, and to determine if biological populations are sufficiently resilient to recover to a sustainable state.

Under direction of Drs. Harwell and Gentile, the Center for Marine and Environmental Analyses, with several collaborating academic and research institutions, conducted a 2-year study comparing the ecological risks to the Tampa Bay ecosystem from large spills of Fuel Oil #6 and Orimulsion™. That research was sponsored by Florida Power & Light (FPL) in support of its application to the State of Florida Power Plant Siting Board for a permit to convert its existing Manatee power plant, located near the shore of Tampa Bay, from Fuel Oil #6 to Orimulsion™. The comparative ecological risk assessment (CERA) conducted by CMEA was published as a two-volume document submitted for the licensing hearing. The first volume detailed the elements of the comparative ecological risk assessments, including: a) the ecological risk assessment framework used; b) the scenarios developed for major spills in Tampa Bay under adverse conditions; c) the laboratory studies conducted on the physical, chemical, and toxicological characteristics of Fuel Oil #6 and Orimulsion™; d) the hydrodynamic and fate-and-transport models used to simulate spill movement in the Bay; e) the spatially explicit exposures that would ensue from spills in Tampa Bay; f) the expected ecological consequences from those exposures; and g) the conclusions from the comparative risk assessment. Volume II was the technical support document, with experimental and modeling data and outputs.

Subsequent to the publication of the CERA report, Harwell Gentile & Associates, LC, was contracted to provide the technical support to FPL through its prime contractor Golder and Associates, through the licensing process. HGA provided the expert witness testimony to the Florida Administrative Judicial Process. A second round of evidentiary hearings were conducted in response to a request by the Florida Siting Board for additional studies on the shallow waters and other sensitive areas of the Tampa Bay ecosystem. Harwell Gentile & Associates conducted additional risk assessment analyses and expert testimony on the ecological risks to those aspects to Tampa Bay from Orimulsion™ in comparison with Fuel Oil #6.

PROJECT SCOPE

The scope of this multi-year project was trans-disciplinary and multi-institutional, and extensive in terms of spatial scale, modeling, data base management, and graphical analysis (GIS). Basically it was comprised of the following activities: 1) development of sophisticated modeling tools to simulate dynamically the physical environment of Tampa Bay; 2) the establishment of geographical information and scientific data visualization systems to collate an extensive database on the ecology of Tampa Bay and its biological resources into a spatially distributed, graphically appealing system; 3) the conduct of experiments to test toxicological responses of biological resources to Fuel Oil #6 and Orimulsion™ 100 in addition to the survey of existing toxicological data; 4) the application of stochastic models of population-level toxicological effects; 5) the development of scenarios for hypothetical conditions that might occur at the time of a spill of Fuel Oil #6 or Orimulsion™ 100; 6) the application of models for developing maps of estimated concentrations and exposures of toxicologically important constituents of each fuel type; 7) the analysis of the co-occurrence of exposures with distributional data of selected fish

and invertebrate species of Tampa bay; 8) the determination of the fate and shoreline impacts of the slick that would ensue from a spill of Fuel Oil #6; 9) the estimation of the risk of ecological effect from the water and shoreline exposures to the two fuel types; and 10) the synthesis and analyses of data into an overall judgment of the comparative ecological risks of Fuel Oil #6 and Orimulsion™ 100 spill in Tampa Bay.

PROJECT APPROACH

The approach used in these studies have the following characteristics: a) conservatively protective by choosing parameters that were plausibly conservative for the scenarios used; b) studied species and life stages that were sensitive to the stress and important to society; c) examined potential effects to populations and critical habitats; emphasize cumulative exposures to ecotoxicological endpoints using plausibly conservative assumptions; and d) utilized sensitivity analysis to evaluate changes in key factors on the magnitude of the ecological effects.

PHASE I CONCLUSIONS

The overall conclusions of the comparative risk assessment are that the ecological risks from Fuel Oil #6 and Orimulsion™ 100 to the Tampa Bay ecological system are essentially similar. The assessment demonstrated that while the materials have the likelihood to impact individual ecological endpoints differently (e.g. spotted seatrout versus coastal systems), the overall risks were judged to be comparable. If Fuel Oil #6 risks are assumed to be socially acceptable, since a power plant is currently utilizing Fuel Oil #6, then the overall ecological risks from Orimulsion™ 100 would not be significantly greater. There is greater uncertainty about some of the effects on aquatic systems from Orimulsion™ 100 because it does not have as extensive a data base as Fuel Oil #6.

The conclusions from the original comparative ecological risk assessments of Orimulsion™ 100 and Fuel Oil #6 depended on the ecosystems, habitats, and ecological endpoints. In the comparative risk assessment the risks of the two materials to biota in the water column, coastal systems and avian species were evaluated. Water column risks from Orimulsion™ 100 exceed those from Fuel Oil #6. The lower amount of Fuel Oil #6 that enters the water column, combined with a shorter residence time, results in a lower cumulative exposure. After a spill Orimulsion™ 100 will be dispersed into the sea water column and it will therefore have a longer cumulative exposure. However, Fuel Oil #6 contains much higher levels of dissolved aromatics than does Orimulsion™ 100. These dissolved aromatics are orders of magnitude more toxic to aquatic life. Therefore when ecological effects in the water column are compared Orimulsion™ 100 has only a slightly higher toxicity. The ecological impacts from the fuel oil slick on coastal systems and avian species will be significant for some spill scenarios of Fuel Oil #6 whereas Orimulsion™ 100 spills will have limited effects on these endpoints because the Orimulsion™ does not form a slick, thus moving with currents rather than wind.

EVIDENTIARY HEARING-I

At the initial evidentiary hearing for the licensing request in the fall of 1995, the bases, results, and conclusions from the CERA were presented by the CMEA team of scientists through documents and sworn testimony. The administrative law judge (Judge Johnston) found these studies to be appropriate and adequate for his findings of fact concerning the relative risks of the two fuels in Tampa Bay, and he found the major conclusion of the CERA study was correct,

specifically that the relative risks to the entirety of Tampa Bay of the two fuels are essentially the same. Based on this and other findings, Judge Johnston recommended approval of the permit. Following several subsequent legal steps, the Florida Power Plant Siting Board (which consisted of the Governor and Cabinet) remanded back to the administrative law judge to determine the facts on further specified issues. With respect to the ecological risks of spills, the Siting Board remanded a determination of the relative risks to the shallow water and critical habitats of Tampa Bay, rather than the whole of the Bay. The Board also remanded the issue of the potential ecological risks from the surfactant then used in Orimulsion™ (Intan-100), especially with respect to potential endocrine disruption effects.

PHASE II CONCLUSIONS

The central conclusions of the subsequent research conducted for the comparative ecological risk assessment of Tampa Bay were: 1) the risks to the shallow water, critical habitats of Tampa Bay from a major spill of Orimulsion™ are one or two orders-of-magnitude lower than the risks from a comparable spill of Fuel Oil #6; this is because the routes and magnitude of exposures for Fuel Oil #6 are much greater than the routes and magnitude of exposures for Orimulsion™; 2) the yolk sac larval stage of the seatrout remained the most sensitive life stage and most sensitive species, and the toxicity levels for the other tested species were quite consistent with the initial set of toxicity tests; 3) the laboratory and modeling studies indicated that the vertical settling velocities of Orimulsion™ particles, including when in contact with actual Tampa Bay particulates, were much lower than the normal vertical velocities of water movement in Tampa Bay, suggesting that there would not be a significant accumulation of Orimulsion™ onto the sediments and resulting in low exposures to benthic organisms from settling; 4) the potential risks to marine mammals, turtles, aquatic birds, and other air-breathing animals of Tampa Bay would be much greater for Fuel Oil #6 than for Orimulsion™ because of the oil slick that would result from a spill of fuel oil but not from Orimulsion™; air-breathing vertebrates would have to pass through this oil slick and thus would have exceedingly high exposures to Fuel Oil #6, but very low exposures to Orimulsion™; and 5) the exposures to the surfactant in Orimulsion™ 100 would be many orders-of-magnitude lower than required to cause any potential endocrine disruption, even to the most sensitive indicator of effects.

EVIDENTIARY HEARING - II

Based on the new ecological risk studies, Dr. Harwell testified that the comparative risk assessment clearly demonstrated significantly reduced risks from Orimulsion™ compared to the extant risks from Fuel Oil #6, when focused on the shallow waters and other sensitive areas of the Tampa Bay ecosystem. Judge Johnston again recommended on technical grounds that the Siting Board approve FPL's licensing request, as he found that conversion to Orimulsion™ would be a significant contributor to pollution prevention and risk reduction in Tampa Bay and the rest of the State of Florida. The Siting Board specifically accepted the technical studies and conclusions of the ecological risk assessments and other supporting technical studies, but denied the permit based on policy grounds. FPL subsequently decided not to pursue the license application appeals process, and there is no further consideration of the use of Orimulsion™ as an alternative fuel for electric generating plants in the State of Florida.