Assessment of Oil Spill Risk due to Potential Increased Vessel Traffic at Cherry Point, Washington

A Draft Proposal Submitted to

Ms. Christine Butenschoen
Contracts Administrator
BP Cherry Point Refinery
4519 Grandview Road
Blaine, WA 98230

Submitted by:

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Institute for Crisis, Disaster, and Risk Management

ICDRM

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Introduction

The attorneys for BP (Matthew Cohn, Esq., Heller, Ehrman, White, and McAuliffe, LLP 701 Fifth Avenue, Suite 6100, Seattle, Washington 98104-7098) and Ocean Advocates (John Arum, Esq. (Attorney for Ocean Advocates), Ziontz, Chestnut, Varnell, Berley, & Slonim 2101 Fourth Avenue, Suite 1230 Seattle, Washington, 98122) have requested a proposal from GWU for a study that will analyze vessel traffic and evaluate risk designed for incorporation into the Section 10 permit Environmental Impact Assessment (EIS) for the expansion of the Cherry Point terminal. The study will analyze the effects on oil spill risk of the incremental increase in vessel traffic projected to call at the Cherry Point facility over the next twenty years and evaluate potential mitigation measures applicable to BP to address such impacts. The proposal and cost budget will be submitted to BP (Ms. Christine Butenschoen, Contracts Administrator BP Cherry Point Refinery, 4519 Grandview Road, Blaine, WA 98230) for approval. The work described in this proposal will be performed in close coordination with a contractor (still to be selected) preparing an EIS (EIS contractor hereafter) for the Army Corps of Engineers (Corps hereafter).

Scope

The Scope of Work shown below was provided to GWU by the attorneys for BP and Ocean Advocates. The following sections provide a project plan consisting of a description of tasks required to comply with this Scope of Work and a preliminary budget assessment.

- The study will evaluate the routes used by marine vessels to carry crude oil and petroleum products between the Cherry Point Refinery and Buoy J offshore of Cape Flattery.
- The study will evaluate the incremental risk of (1) an accident (collision, grounding or other scenario) involving a tank vessel, (2) resulting in a discharge of crude oil or petroleum products, (3) associated with reasonably foreseeable increases in vessel traffic through calendar year 2025 to and from both wings of the Cherry Point Refinery Pier, (4) as compared with the baseline traffic that the pre-North Wing pier could accommodate.
- In evaluating these risks the study will model all vessel traffic (not just vessels carrying crude oil and petroleum products) and reasonably foreseeable increases and decreases in vessel traffic along the entire pathway followed by vessels between Cherry Point and Buoy J, including but not limited to vessels calling in British Columbia, and vessels calling at the Cherry Point Refinery Pier, Conoco-Phillips, Intalco and reasonably foreseeable future marine terminal facilities in the Cherry Point area, including the proposed Gateway facility.
- The study will account for non-VTS reporting vessels (fishing vessels and recreation traffic) using methods developed in the modeling of traffic in San Francisco Bay as far as data or expert judgment is available to model this traffic in a reasonable manner.
- The study will evaluate low, medium and high traffic scenarios.
- The study will consider the impact of human and organizational error on the likelihood of accidents and the effectiveness of risk reduction interventions.
- The study will not evaluate vessel traffic risks at locations other than the routes used by vessels traveling between Cherry Point and Buoy J.

- The study will cover risks associated with the Haro Strait and Huckleberry-Saddlebag approaches to and from Cherry Point.
- The study will include identification and evaluation of potential vessel traffic management protocols that would reduce the risk of an accident and that can be instituted consistent with existing law. At a minimum, the vessel traffic management protocols studied will include: (1) use of Rosario Strait and Guemes Channel instead of the Huckleberry-Saddlebag traverse; (2) stationing a year-round prevention and response tug (of the kind currently stationed in Prince William Sound) in Neah Bay, Washington; (3) a single tug escort requirement for the Western reaches of Juan de Fuca Strait with hand-off between prevention and response tugs stationed in Neah Bay and Port Angeles; and (4) any additional vessel traffic management protocols or other mitigation measures selected for analysis during the scoping stage of the EIS.
- The study will include an impact analysis that will describe the outcomes of an accident as described by the location and size of oil outflows, but will stop short of examining the fate and effects of an oil spill.
- The study will use, but not be constrained by, the results of prior studies that examined various aspects of maritime risk in Washington State waters. The study will be directed by Jack Harrald and Martha Grabowski.

The project team (Study Team hereafter) from The George Washington University Institute for Crisis, Disaster and Risk Management, The Virginia Commonwealth University (VCU) and Rensselaer Polytechnic Institute (RPI) proposes to develop a maritime risk simulation to conduct the vessel traffic study above. The simulation will be based on the methodology developed for the dynamic risk simulation of tanker operations in Prince William Sound, Alaska (1995-96), for the Washington State Ferries (WSF) Risk Assessment (1998-1999) and for the San Francisco Bay Exposure Assessment (2002). This methodology is described in:

- J.R.W. Merrick, J.R. van Dorp, J.P. Blackford, G.L. Shaw, T.A. Mazzuchi and J.R. Harrald (2003). "A Traffic Density Analysis of Proposed Ferry Service Expansion in San Francisco Bay Using a Maritime Simulation Model", *Reliability Engineering and System Safety*, Vol. 81 (2): pp. 119-132.
- J.R.W. Merrick, J. R. van Dorp, T. Mazzuchi, J. Harrald, J. Spahn and M. Grabowski (2002). "The Prince William Sound Risk Assessment". *Interfaces*, Vol. 32 (6): pp.25-40.
- J.R. van Dorp J.R.W. Merrick , J.R. Harrald, T.A. Mazzuchi, and M. Grabowski (2001). "A Risk Management procedure for the Washington State Ferries", *Journal of Risk Analysis*, Vol. 21 (1): pp. 127-142
- J. R. W. Merrick, J. R. van Dorp and A. Singh (2005). "Analysis of Correlated Expert Judgments from Pairwise Comparisons". *Decision Analysis*, Vol. 2 (1), pp. 17-29
- P. Szwed, J. R. van Dorp, J.R.W.Merrick, T.A. Mazzuchi and A. Singh (2006). "A Bayesian Paired Comparison Approach for Relative Accident Probability Assessment with Covariate Information", *European Journal of Operations Research*, Vol. 169 (1), pp. 157-177.

In this project, the Study Team proposes to use the methodologies and approaches they have developed during previous studies. While there is significant cost savings through the use of computer code and analysis developed in previous studies, to fulfill the scope listed above the Study Team must create specific models for this project using the most recent data sources and up to date expert judgment elicitations. The tasks involved are described in the next section.

Proposed Work

The Study Team anticipates a project kickoff meeting and final report review meeting, as well as periodic progress meetings as requested by the project team and approved by the Corps. All project meetings will need to be coordinated with the EIS Contractor who will ensure that all appropriate EIS protocols are followed. Members of the Study Team also may meet with individuals approved by the Corps who have substantive expertise about maritime safety issues or the geographic area under study, as described in Task 7 below.

The projected project anticipated start date is May 1, 2006 with an approximate completion of all tasks at 22 months after receipt of order (ARO). Figure 1, at the end of this section, illustrates a Gantt chart of activities along an estimated timeline. The specific tasks to be performed by the Study Team include:

Task 1: Definition of System Requirements. In this task, earlier risk analysis work can be reviewed, and the domain, context and environment for the study, along with key constructs of the risk assessment—people, organizations, roles, technology and equipment, organizational and system culture, organizational and system structure, as well as key definitions and assumptions—can be defined. The Study Team will participate in the EIS scoping process to ensure that system definitions are consistent between the EIS study and the proposed vessel risk analysis. Vessel rides on vessels in the system will be undertaken, and background questionnaires[1] may be administered in order to assess procedures, practices and assumptions aboard the vessels. In addition, as part of this task, future scenarios of traffic load for the next 20 years need to be developed in consultation with BP to provide predictions of future Cherry Point dock utilization and of all other vessel traffic predictions to be researched/developed by the Study Team. Construction of these scenarios will use as input traffic increases that have occurred over the past years. Agreement on the layout of these scenarios will have to be reached at the completion of Task 4. **Anticipated task start and completion time: 1-9 months ARO.**

Task 2: Identification of Potential Risk Intervention Measures. A preliminary list of risk intervention measures will be developed based on those specified in the Scope of Work and those that emerge during the EIS scoping process. Input to the list of possible risk intervention measures will need to be limited to those identified by the Study Team and those identified during the public scoping process. These potential interventions will be considered for risk intervention effectiveness evaluation and their early identification will ensure that adequate models will be developed. The structure of the set of risk intervention measures will be determined following a causal chain approach. Scenarios of combinations of risk intervention measure will be developed as directed by the Corps for further effectiveness analysis. The development of these scenarios will continue until the system

[1] Specific questions and protocols will be developed during the start of the scoping task and will be subject to the participating Universities' Institutional Review Board review and approval process prior to being implemented.

simulation (Task 4) has reached completion. **Anticipated task start and completion time: 1 - 12 months ARO**.

Task 3: Data Assessment. The necessary data for a maritime risk assessment includes information on traffic patterns, the environment (weather, sea conditions, visibility), historical and current operational performance data, and human performance data. Traffic and environmental data patterns are used to develop the traffic simulation model. Operational data is also used in the system simulation, along with human performance data[2], as available. While we have data prior to 1998 from previous studies, these data sources must be updated and integrated to perform this study with any level of accuracy. A more complete list of data required to conduct the study is:

- Geographic data for the area under study to provide the baseline geographical representation for the simulation;
- Vessel traffic data for all vessels in the system, including tanker, escorts, ferries, tugs and barges, passenger vessels, container ships, and fishing vessel traffic over a period of several years (we assume access to necessary USCG VTS Data);
- Weather, visibility, and other environmental data over a several year period;
- Historical accident, incident, and near miss data for all vessels in the system—TAPS and non-TAPS tankers, escort vessels, container ships, ferries, tugs and barges, passenger ships, and fishing vessels over a several year period;
- Ship visit and survey data;
- TAPS tanker, non-TAPS tanker, and escort vessel failure rates over a several year period (propulsion failures, steering failures, navigational equipment failures, electrical failures, etc.);
- Human bridge and tug performance and response data over a several year period;
- Expert judgment data[3] to supplement missing or inadequate human factors data;
- Oil outflow, consequence data;
- New TAPS trade tanker vessel performance and reliability data;
- New TAPS trade tanker vessel data characteristics; and
- Pilot and master human performance data over a several year period.

A sparse database and a relatively large difference between real experience in Puget Sound and the data used for the study can influence the credibility of a risk assessment's results. Thus, even with an extensive list of required data, the inherent limitations of available data place limits on the accuracy, completeness, and uncertainty in the risk assessment results and this data must be augmented with expert judgment as described in Task 7. **Anticipated task start and completion time: 1 – 12 months ARO.**

[2] To be obtained through records research and supplemented by interviews/questionnaires --specific questions and protocols will be developed during the start of the data assessment task and will be subject to the participating Universities' Institutional Review Board review and approval process prior to being implemented.
[3] Specific questions and protocols to elicit expert judgment will be developed during the start of the data assessment task and will be subject to the participating Universities' Institutional Review Board review and approval process prior to being implemented.

Task 4: The development of a base maritime system simulation. A system simulation of a scope similar to that of the simulation part of the models developed for the PWS Risk Assessment and the WSF Risk Assessment will be developed. The maritime simulation dynamically imitates the current operation of the vessels in the study area, and the environmental conditions (to be called Base Simulation hereafter). The computer code from previous studies will be used and improved to develop this simulation, but each of the inputs to the model must be built with the latest data sources. Maritime traffic that participates in the VTS in the study area will be modeled. Traffic data will be collected from the Coast Guard (CG) and from VTS arrival and departure data. Environmental data (weather, wind, visibility) will be collected from NOAA and CG sources and formatted for the simulation by the Study Team. **Anticipated task start and completion time: 2 – 8 months ARO.**

Task 5: The development of a geographic baseline exposure profile. With the completion of Task 4 the Study Team can generate a traffic density profile across the study area. This is an important milestone for the development of a geographic accident profile that integrates traffic density with accident probabilities to arrive at accident frequencies per year. **Anticipated task start and completion time: 8 – 9 months ARO.**

Task 6: Human Factors Modeling. Many potential risk reduction interventions will involve reducing human and organizational error in the system. In order to fully identify the causal factors and the effectiveness of risk reduction interventions human factors must be understood better than in previous studies. Initially, a task analysis of the escort system can be developed. At the same time, a safety culture questionnaire[4] which assesses organizational and vessel safety culture and climate, can be administered to provide quantitative and qualitative input to the safety culture analysis. Finally, in order to develop the empirical human factors data so critical to risk assessments involving human performance, a human factors analysis task will be performed to evaluate historical accident, incident and human performance in the system. **Anticipated task start and completion time: 4 – 12 months ARO.**

Task 7: Elicitation of Expert Judgment. The methodology used in this study will use all available data (see Task 3 above), but this data will be inadequate to support the calculation of conditional probabilities required to link causal factors with outcomes. The Study Team will conduct expert judgment elicitation[5] to supplement existing data following the techniques described in Szwed et al. (2006) and Merrick et al. (2005). This approach will be used to perform expert elicitation designed specifically for the scope of this project and the set of risk intervention measures identified for modeling through the scoping process. The result of this analysis will be relative accident probabilities given a combination of organizational and situational factors as well as human error relative incident probabilities.

While the Study Team's time and effort to conduct the expert judgment elicitation is contained within our budget, BP will provide whatever assistance in this elicitation process

[4] Specific questions and protocols will be developed during the start of the human factor modeling task and will be subject to the participating Universities' Institutional Review Board review and approval process prior to being implemented

[5] Specific questions and protocols to elicit expert judgment will be developed during the start of the elicitation of expert judgment task and will be subject to the participating Universities' Institutional Review Board review and approval process prior to being implemented.

that is deemed appropriate by the Corps. We expect to need at least 8 hours of time for each individual expert for elicitation purposes. In past studies we have used over 20 experts within a given study for elicitation. This is typically driven by availability of experts and the actual number of experts in this study may thus differ. Expert interviews may be conducted with representatives of the U.S. Coast Guard, Washington State agencies, and other key domain experts, e.g. the Puget Sound Pilots Association and environmental groups with substantive expertise about maritime safety issues or the geographic area under study. We anticipate the expert judgment elicitation development, expert judgment elicitation and subsequent analysis to be completed also in a 6 months time frame running in part concurrently with the human factors modeling. **Anticipated task start and completion time: 8 – 14 months ARO.**

Task 8: Calculation of baseline accident frequencies. Completion of Tasks 1-8 will allow us to develop a baseline risk profile in terms of projected accident frequencies, integrating both the maritime traffic simulation model, the relative accident probability and incident models with available accident and incident data. **Anticipated task start and completion time: 12 – 15 months ARO.**

Task 9: Development/adaption of Consequence (oil outflow) model). An oil outflow model will have to be adapted or developed to address the consequences part of accident risk. The Study Team will build on experiences with oil outflow models obtained in the PWS Risk Assessment and naval architect collision analysis conducted in the Washington State Ferry Risk Assessment. This process shall benefit from recent advances in oil outflow modeling including available casualty/oil outflow models for BP owned and operated vessels to be provided by BP. Outflow modeling will start after the completion of the maritime simulation model, but will run concurrently with the expert judgment elicitation analysis. Completion of this task will allow us to integrate the baseline risk analysis in terms of accident frequencies under Task 8 with an outflow analysis to produce a baseline risk profile in terms of expected oil outflow. **Anticipated task start and completion time: 11 – 17 months ARO.**

Task 10: Evaluation of risk reduction interventions. With a complete analysis model, a baseline risk profile, the risk intervention combination scenarios identified under Task 2 and future traffic scenarios under Task 1, the Study Team will complete a battery of simulation runs followed by risk profile development associated with each scenario. The results will be compared to the baseline risk scenario determined under Task 8 and 9. **Anticipated task start and completion time: 12 – 19 months ARO.**

Task 11: Preparation of Draft Final Reports and Briefings. A draft final report will be written synthesizing the analysis results developed. The draft report will be provided to the EIS Contractor for inclusion in the draft EIS that will be issued by the Corps. An executive briefing will be prepared at the direction of the Corps. A draft final report will be delivered to the EIS Contractor as agreed upon by the Study Team and the EIS Contractor at a timing that is consistent with the proposed Scope of Work. **Anticipated start and completion time draft final report: 19 – 20 months ARO.**

Task 12: Review of Draft Final Reports and Preparation of Final Report. A one month final report review and revision period is envisioned and the revised final report will be issued approximately 22 months ARO. However, timing between the draft and final reports will be per the schedule set forth by the EIS Contractor as necessary to meet the public review obligations dictated by NEPA, as directed by the Corps. **Anticipated review period and completion revision final report: 21 – 22 months ARO.**

Task 13: Project Briefings, Project Team Meetings, Travel, Project Management.
At the request of the Study Team and as approved by the EIS Contractor, the Study Team will meet periodically with interested parties for project updates and reviews, and will meet as required with members of the Puget Sound maritime community for data gathering and expert elicitation sessions. The Study Team will work with the EIS Contractor to obtain the necessary approvals from the Corps. Travel and project management as required will be undertaken to meet the project schedule. <u>Travel expenses of the Study Team members will be reimbursed directly to them by BP and not through their respective Universities. BP shall set-up the administrative procedures for travel approval, travel documentation and travel reimbursement of travel expenses incurred by the Study Team members prior to their first travel.</u> Deliverables will be provided by the Study Team as identified in the task descriptions and on the Gantt chart in close coordination with the EIS contractor and/or the Corps. **Anticipated task start and completion time: 1 – 22 months ARO.**

Project Team

The Study Team developed the dynamic system simulation methodology for Maritime Transportation System (MTS) risk assessment utilized in PWS Risk Assessment, the Washington State Ferry Risk Assessment and the San Francisco Bay Exposure Assessment. Prior maritime risk projects are described on the web site:

http://www.seas.gwu.edu/~dorpjr/tab3/NSFProject_GWU_VCU/NSFMain.html.

The Study Team includes 6 senior personnel and four highly qualified doctoral research assistants from GWU, RPI and VCU.

JOHN R. HARRALD, D.Sc. – Study Research Director is a Professor of Engineering Management and Systems Engineering at The George Washington University and the director of the Crisis, Disaster and Risk Management Institute:

http://www.gwu.edu/~icdrm/.

His professional interests concentrate in maritime safety and security, emergency, disaster and risk management. Dr. Harrald is a retired USCG Captain and has served as a USCG Captain of the Port. His email address is: jharrald@gwu.edu.

MARTHA GRABOWKSI, Ph.D. – Study Research Director is a Professor and Director of the Information Systems program at LeMoyne College in Syracuse, New York and Research Professor of Decision Sciences and Engineering Systems at Rensselaer Polytechnic Institute in Troy, New York:

http://web.lemoyne.edu/~grabowsk/.

She is Vice Chair and Chair-elect of the National Research Council's Transportation Research Board/Marine Board and a member of the American Bureau of Shipping. Her research interests focus on the impact of technology in large-scale systems, human and organizational error, and risk assessment in safety-critical systems. Her email address is: grabowsk@lemoyne.edu.

J. RENÉ VAN DORP, D.Sc. – PI GWU is an Associate Professor of Engineering Management and Systems Engineering at The George Washington University:

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THOMAS A. MAZZUCHI, D.Sc. – GWU is a Professor of Engineering Management and Systems Engineering at The George Washington University. His professional interests concentrate in human reliability modeling, quality control, reliability and risk assessment. His email address is: mazzu@gwu.edu.

GREGORY L. SHAW, D.Sc. is Managing Director of the Institute of Crisis Disaster and Risk Management. His professional interests concentrate in maritime safety and security, emergency, disaster and risk management. He is a Certified Disaster Recovery Planner through Disaster Research Institute International. .Dr. Shaw is a retired USCG Captain and commanded four USCG cutters. His email address is: glshaw@gwu.edu.

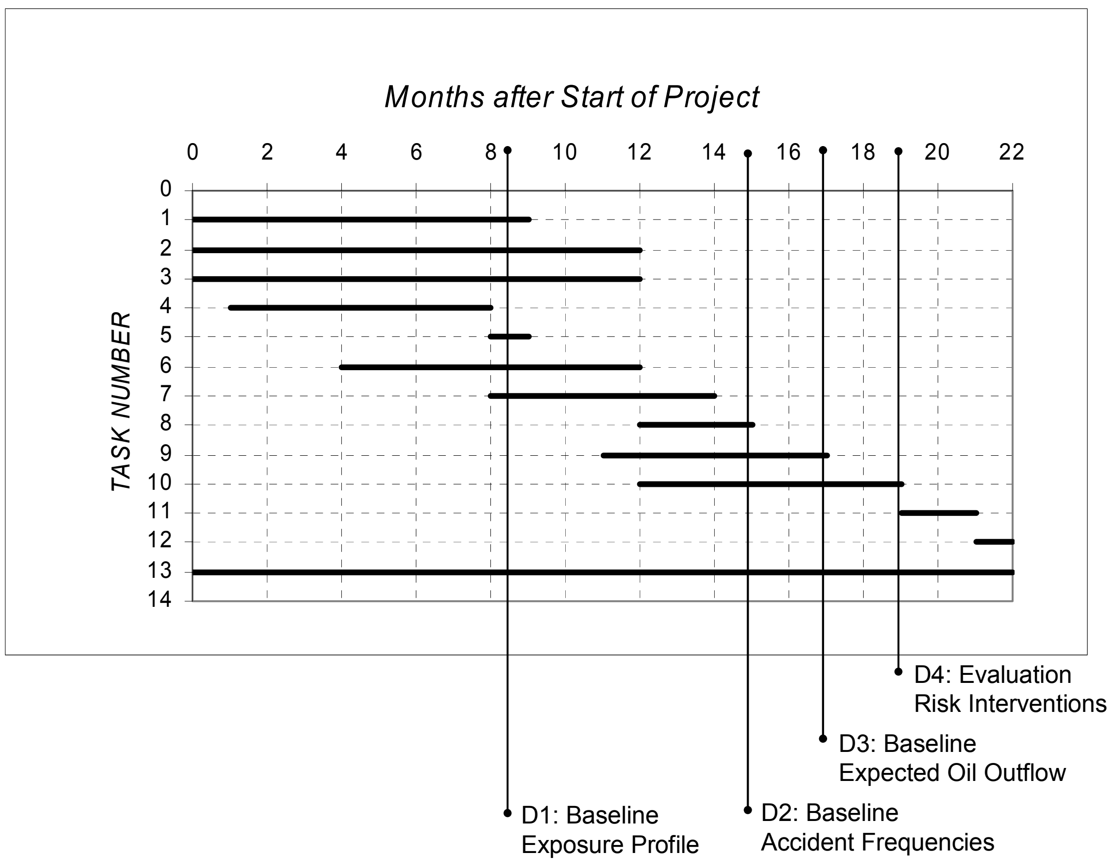
Graduate Assistants-- GWU, VCU and RPI will each use one graduate research assistant for data gathering, data analysis, modeling support, and project support. These students are doctoral students in Systems Engineering (GWU), Operations Research and Statistics (VCU), and Decision Sciences and Engineering Systems (RPI).

Dr. Harrald and Dr. Grabowski will serve as research directors, and Dr. Merrick and Dr. van Dorp will conduct the main tasks of maritime simulation development, expert judgment elicitation design and analysis. Dr. Shaw will provide maritime expertise, administrative project support and conduct expert judgment elicitation support. Dr. Mazzuchi was the lead scientist of the PWS and WSF risk assessment and will assist Dr. Merrick and Dr. van Dorp in accident probability model development and expert judgment elicitation by providing quality control and oversight.

Project Schedule and Budget

A summary of the sequencing of the tasks above is presented in Figure 1 together with four intermediate deliverables D1, D2, D3 and D4. The first deliverable D1 (9 months ARO) is a baseline exposure profile that highlights traffic density across the study area. This profile is generated from the maritime simulation. Following the human factor modeling and expert judgment elicitation baseline accident frequencies can be evaluated which identifies the second deliverable D2 (15 months ARO). A geographic profile of expected oil outflow constitutes the third deliverable D3 (17 months ARO) and finally completion of the fourth intermediate deliverable D4 (19 months ARO) coincides with the evaluation of proposes risk intervention measures. Deliverable and their ultimate schedule will need to be negotiated between the Study Team and the EIS Contractor while keeping in mind the Scope of Work.

Figure 1. Proposed Risk Assessment Plan



Task 1: Definition of System Requirements
Task 2: Identification of Potential Risk Intervention Measures
Task 3: Data Assessment
Task 4: The development of a base maritime system simulation
Task 5: Calculation of baseline exposure profile
Task 6: Human Factors Modeling
Task 7: Elicitation of Expert Judgment
Task 8 : Calculation of baseline accident frequencies.
Task 9: Development of Consequence (oil outflow) model)
Task 10: Evaluation of risk reduction interventions
Task 11: Preparation of Draft Final Reports and Briefings
Task 12: Review of Draft Final Reports and Preparation of Final Report
Task 13: Communication, Project Briefings, Project Team Meetings, Travel, Project Management.

Such changes to the Study Schedule serve to align the EIS schedule and the Study Schedule. The proposed budget is $885,750. <u>This budget amount $885,750 does not include travel expenses. Travel expenses of the Study Team members will be reimbursed directly to them by BP and not through their respective Universities. BP shall set-up the administrative procedures for travel approval, travel documentation and travel reimbursement of travel expenses incurred by the Study Team members prior to their first travel.</u>