Ensuring Resilience of the Petroleum Supply Chain for the Hawaiian Islands
M.S. Thesis in Operations Research (completion date: March 2011)
LT Jason Ileto, USN  jvileto@nps.edu
last update: November 2010

Background:

In 2009, Hawaii imported nearly 41 million barrels of crude oil that was primarily refined into jet fuel for aviation services, fuel oil for electricity generation, and gasoline and diesel for automobiles. While options such as natural gas, coal, wind, hydro and solar energy have been implemented, the primary method of electricity generation comes from burning fuel oil. In 2009, 8.6 million barrels of fuel oil were consumed for this purpose, of which 78,000 barrels of refined fuel oil were imported while the rest was refined locally. Furthermore, the primary method of travel to Hawaii is via aviation. Thus there is a heavy reliance on aviation fuel. Of the 4.6 million barrels of jet fuel consumed in 2009, 3.6 million was refined locally from imported crude oil and the rest was imported having already undergone the refining process. Regarding surface transportation on the islands, over 445 million gallons of gasoline and 176 million gallons of diesel for highway use were consumed in 2009.

The current infrastructure of transporting petroleum is historically reliable but aging. It consists of Marine and Land terminals to receive the petroleum products, refineries to process crude oil into usable products, storage facilities to hold crude oil and refined products, and a distribution system.

If the petroleum infrastructure system is disrupted, then there could be a significant impact on the state’s economy, quality of life and security. The consequences could be exacerbated if the time it takes to restore the system is significant. The principle operators of the system are responsible to reconstitute their part of the system (e.g. repairing pipelines, importing refined products if refineries go down).

Objective:

This thesis will analyze how this petroleum infrastructure system will respond in the face of major disruptions, whether caused by deliberate threat (e.g., sabotage, vandalism, terrorism) or non-deliberate hazard (e.g., accident, failure, natural disaster). In addition, this thesis will investigate how to invest limited defensive resources (e.g., for hardening, redundancy, or capacity expansion) to make these systems resilient to such disruptions.

Success can be measured by a clearer picture of vulnerability of systems that provide fuel to the Hawaiian Islands. In addition, investment solutions can be compared to current investment plans to see if there can be a more effective return on investment.

Scope:

The geographic scope of the project will be the Hawaiian Islands. The analysis scope will encompass the maritime transport of fuels between islands and from the mainland United States as well as the various types of commodities refined on Oahu and their respective distribution system. Interdependencies in production and distribution will be taken into account. The scope will be further defined by the specific data made available.
Method:

The analysis will be accomplished by developing a mathematical model that captures the day-to-day operating realities. This “Operator’s model” will depict the movement of petroleum goods via barges, pipelines and trucks and how one decides how much product to produce, import, store, and distribute. The objective of the operator is to satisfy the demands of all customers. There is recognition that sometimes not all demand can be met (this is called a shortfall) and there are costs associated with not satisfying demand. In this model, the operator uses domain-specific knowledge to manage system activities in an intelligent way, even if the infrastructure has been subjected to extreme disruption.

Once the Operator’s model is completed, one can assess the consequence of any disruption and see how system performance is affected. Then an “Attacker’s model” can be constructed where an intelligent adversary can attack the infrastructure that would cause the greatest effect on system performance. Once these possibilities are explored, a “Defender’s model” can be constructed where the defender can choose candidate defense plans to make the infrastructure more resilient.

In Partnership with State and Local Officials:

This project is being conducted in partnership with the US Coast Guard Captain of the Port (COTP) for Honolulu, the Department of Homeland Security Protective Security Advisor (PSA), and the local fuel companies: Chevron and Tesoro. We are working in coordination with Hawaii State Civil Defense, Hawaii State Harbors, the University of Hawaii DHS Science and Technology Center of Excellence, the Pacific Disaster Center, and Department of Defense Pacific Command.

Project Time Line:

Oct 2010-Jan 2011 Model refinement and analysis.
Feb 2011 Presentation of final FOUO report to stakeholders.
Mar 2011 Thesis completion and graduation.

For more information contact:
• LT Jason Ileto, jvileto@nps.edu
• Dr. David Alderson, Director, Center for Infrastructure Defense, dlalders@nps.edu

About the Researcher: LT Jason Ileto, SC, USN is a student of the Joint Operational Logistics curriculum in the Department of Operations Research at the Naval Postgraduate School.

About the NPS Center for Infrastructure Defense (CID): The mission of the CID is to develop, review and promote science of the highest quality in the service of defending critical infrastructure systems affecting our homeland at the national, state, and local levels.

About the Naval Postgraduate School (NPS): NPS is a fully accredited technical university with a highly motivated student body consisting of military officers and government employees from the U.S. and its global partners. The Operations Research Department offers MS and PhD degrees and is one of the largest in the country with its 250 students, 25 tenure-track faculty, and 19 full-time adjunct faculty, including three members of the National Academy of Engineering and fellows from many professional societies. NPS is located on the Pacific coast in Monterey, California, about 120 miles south of San Francisco.