ECA Implementation Strategies for the Cruise Industry

In 2010, the U.S. Environmental Protection Agency (EPA) released new air pollution regulations for ocean ships and large vessels (EPA, 2020). By 2015, the EPA required ships within 200 miles of shore in the North American Emission Control Area (ECA) to emit no more than 0.1 percent sulfur when burning fuel. By 2016, the nitrogen oxide (NOx) emission standards rose from Tier II (Engine-based controls) to Tier III (After-treatment forcing).

Figure 1: North American Emission Control Area (EPA, 2020)

Here is a brief review of the implementation strategies available to the cruise industry when these new regulations went into effect.

1. Shore Based Power

Cruise ships normally use their engines to produce electric energy while in port, releasing a substantial portion of their air emissions. Shore based power systems can replace the energy from the ship's diesel engines with clean, electric energy from the local power grid. Switching to local power can reduce air emissions by over 95% per vessel port call (EPA, 2020).

Cruise ships plug directly into shore-side electrical power in a process known as Cold Ironing. Princess Cruises established shore based power in Juneau, Alaska in 2004 (Spalding, 2011). Other west coast ports soon followed and installed systems including San Diego, San Francisco, Los Angeles and Seattle. In 2011, Brooklyn, NY committed to become the first east coast port to provide shore based power (Collins, 2011) while Los Angeles became the first port to provide electricity to two ships simultaneously for a total power delivery of 40 megawatts (Owen, 2011).

The diesel ship engines will produce more particulate matter and air emissions than shore based power although the net gain is dependent on the local power source (Goldsworthy, 2010). Local power is generally clean compared to the diesel engines and priced competitively for the cruise industry, especially when compared to the costs for low sulfur fuel and Selective Catalytic Reduction equipment.

2. Low Sulfur Fuel

Switching to low sulfur is the most direct and effective way to reduce sulfur emissions and comply with the ECA standards (Burgel, 2009). However, this strategy is the most cost prohibitive as low sulfur fuel can run as much as 50% higher than conventional diesel fuel currently used by cruise ships. This implementation strategy is better suited for newer ships where the costs are already mitigated by the ship's designs. Existing ships will need to combine with other strategies in order to achieve the desired cost reductions.

3. Liquefied Natural Gas

Liquefied Natural Gas (LGS) is a compressed natural gas primarily composed of methane and contains virtually no sulfur (Goldsworthy, 2010). LNG engines produce negligible sulfur emissions and 20% less nitrogen oxide emissions than diesel engines. The *MV Accolade* cruise ship has been operating in the Australian market on LNG for twenty years.

The cruise industry, though, has built very few LNG powered cruise ships due to the lack of available LNG infrastructure worldwide. Converting existing cruise ships to LNG engines would be a very expensive refit even if the infrastructure was available. With the recent discoveries of vast natural gas reserves in the United States, LNG infrastructure development should make steady progress and eventually be readily available for the Alaskan cruise industry. However, LNG is more of a long term implementation strategy for new cruise ships when the infrastructure is in place.

4. Emissions Control Technologies

Emissions control technologies consist of the on-board controls for After-treatment forcing (Tier III) used to reduce gas emissions as required under the ECA standards. Selective Catalytic Reduction (SCR) is the most direct and proven way to reduce nitrogen oxide emissions and comply with these standards (Fournier, 2006). However, SCR is the most cost prohibitive technology as installation of this equipment on a cruise ship requires a substantial investment for the cruise line.

5. Energy Efficient Engine, Propulsion and Hull Designs

Energy efficient engine, propulsion and hull designs in new cruise ships comprise the below deck strategy to increase energy efficiency and reduce emissions. These state-of-are designs include energy efficient engines, propulsion and hull design optimization, full saving hull coatings, highly sophisticated and optimized power management systems, and improved fuel injection. The energy efficient engines on new cruise ships like Royal Caribbean's *Oasis of the Seas* use 20% less fuel than conventional diesel engines while significantly reducing nitrogen oxide emissions (Spalding, 2011). Hydro-dynamically efficient hull design and hull coats reduce friction, producing energy savings up to 20% as well. Celebrity Cruises installed the first smokeless gas turbines on the *Millennium*, reducing visible air emissions by over 90%. Through energy savings, these new designs can help mitigate the implementation costs for the ECA standards.

6. Onboard Energy Savings

Onboard energy savings comprise the above deck strategy to increase energy efficiency and reduce emissions. These state-of-art technologies include high-efficient heating, ventilation and air condition systems, LED and compact fluorescent lighting, automatic lighting and air conditioning control systems, window-coatings to reduce sun penetration and AC use, high-efficiency appliances, co-generated energy and heating, and renewal energy options including wind and solar. Carnival cruises uses the co-generated heat from their ship engines to heat hot water instead of using boilers and expects to save up to $ 100,000 per ship through the installation of LED and compact fluorescent lighting (Spalding, 2011). The Celebrity Millennium-class and the Royal Caribbean Radiance-class ships use Alaskan seawater to chill water instead of running air conditioning compressors. These onboard energy savings technologies can be suitable for both new and existing cruise ships and can help mitigate the implementation costs for the ECA standards.

7. Speed Reduction

Propulsion consumes the most energy on a cruise ship. A small speed reduction of 10% produces a 20% reduction in fuel consumption and air emissions (Goldsworthy, 2010). Since the ECA standards extend 200 miles from the shore, cruise ships will need to reduce emissions at sea where shore based power is obviously not available. Speed reduction should be the most cost effective strategy to reduce emissions as savings in fuel consumption can offset some of the costs associated with low sulfur fuel and After-treatment forcing.

8. Emissions Taxes and Trading

Regulatory change could allow some cruise ships to opt out of complying with the ECA standards and simply pay emissions taxes instead. For older, existing ships, this may be more cost effective strategy. Norway and Sweden currently impose emissions taxes on shipping for sulfur and nitrogen oxides while the Port of Vancouver charges differentiated harbor dues based on fuel sulfur content (Goldsworthy, 2010). An emissions trading program could also be regulated to allow cruise lines to purchase credits in order to achieve compliance.

References

Burgel, A. (2009). Air Pollution from Ships: Recent Developments. World Maritime University Journal of Maritime Affairs. Volume: 6, Number: 2, Pages: 217 – 224.

Collins, S. (2011). Brooklyn Wins Pollution Deal. *South Brooklyn Post.* Issue: April 13, 2011. URL: http://southbrooklynpost.com/news-views/brooklyn-wins-cruise-pollution-deal/

EPA. (2020). Designation of North American Emission Control Area for Marine Vessels URL: https://www.epa.gov/regulations-emissions-vehicles-and-engines/designation-north-american-emission-control-area-marine

Fournier, A. (2006). Controlling air emissions from marine vessels. Santa Barbara: Donald Bren School of Environmental Science and Management University of California Santa Barbara. Pages 1-91.

Goldsworthy, L. (2010). Exhaust Emissions from Ship Engines – Significance, Regulations, Control Technologies. *Australian and New Zealand Maritime Journal.* Volume: 24, Pages: 21-30

Owen, C. (2011). Port of Los Angeles plugs in cruise ships to help environment. *Huffington Post.* Issue: February 25, 2011. URL: http://www.gadling.com/2011/02/25/port-of-los-angeles-plugs-in-cruise-ships-to-help-environment/

Spalding, D. (2011). New and advancing technologies, International cruise lines. *BC Shipping News.* Issue: October 2011, Pages: 26 – 28.