Review of Pacific NorthWest LNG NOx Emissions

1.0 Background

Genesis Engineering was requested by Luanne Roth (T. Buck Suzuki Environmental Foundation) to investigate the NOx emissions from the proposed Pacific NorthWest LNG plant to be located on Island south of Prince Rupert, BC. Of concern is the magnitude of these emissions and methods to reduce these emissions. A link to the LNG project environmental assessment, prepared by Stantec, was provided: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_396.html

2.0 NOx Emission Inventory

The proposed project will increase NOx emissions in the local assessment area (LAA) by **over 700%:**

1. Existing land-based and marine NOx emissions from terminal and ferry operations of 492 tonnes/year (TPY).
2. Estimated NOx emissions from City of Prince Rupert (transportation, heating, light industry and commercial) of 168 TPY.
3. Total existing NOx emissions = 660 TPY
4. Long-term NOx emissions from proposed project of 4,033 TPY.
5. Total long-term emissions in the LAA of 4,700 TPY.
6. NOx emission increase = 100 x 4,700/660 = 711%.

Most (81.1%) of the NOx emissions from proposed project are from aero-derivative gas turbine drivers that will be used to drive compressors and electrical generators. It is assumed by the proponent that the gas turbines will meet BC Ministry of Environment Emission Criteria for Gas Turbines of 48 milligrams per cubic meter (mg/m^3). The Canadian Council of Environmental Ministers (CCME) has an equivalent 1992 guideline of 140 grams NOx per Gigajoule of energy output. These guidelines both correspond to 25 parts per million (volume basis) of NOx in the exhaust gas and was consistent with best available control technology in 1992.

3.0 Reducing Gas Turbine Emissions

Stationary gas turbines are often used to generate electricity close to large urban centers. Hence their smog-forming NOx emissions are of concern and gas turbine manufacturers have responded to this concern by designing turbines to minimize NOx emissions. Older, existing gas turbines can be retrofitted with SCR (selective catalytic reduction) scrubbers to similarly reduce emissions.

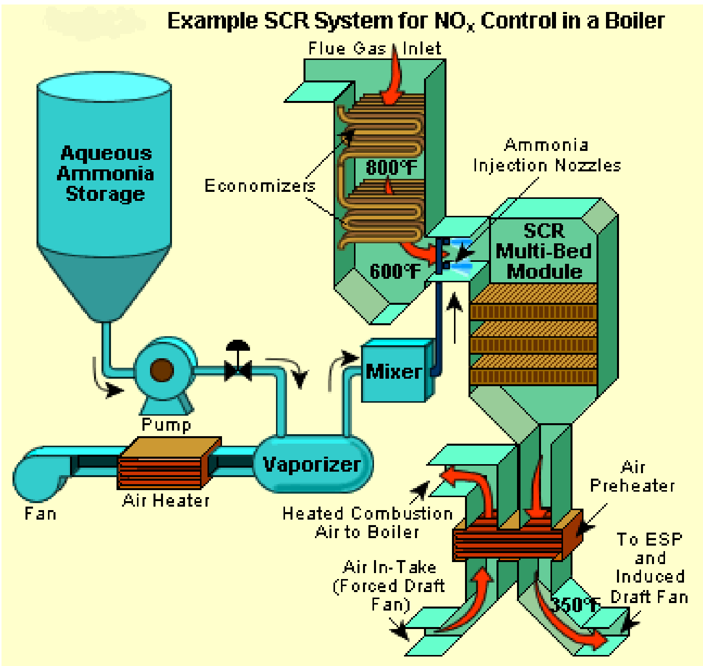
1. NOx reduction through improved burner design.

   Older gas turbines emitted 100 – 200 ppm of NOx in their exhaust. When the guidelines were being crafted in the early 1990's technology was at that time becoming available to reduce these emissions down to 25 ppm. Modern burner design can reduce these emissions even further, down to 3 – 5 ppm.

   For example, General Electric supplies their 6B, 7E and 7EA heavy-duty stationary turbines with *Dry Low NOx* (*DLN 1+)* burner technology and are guaranteed to emit less than 5 ppm of NOX, and typically 3 – 5 ppm NOx. Siemens-Westinghouse has similar capabilities.

2. NOx reduction through SCR scrubbing.

   SCR is retrofitted to existing gas turbines to meet local regulatory requirements. SCR reduces NOx to nitrogen gas by reacting NOx with ammonia within a bed of catalyst particles, similar to that shown in the figure below for a boiler.



The gases entering the catalyst beds must be within a certain temperature range, in the order of 300 – 500 deg. C, for efficient NOx reduction to occur. And there is a trade-off between NOx reduction and ammonia "slip" (unreacted ammonia present in the exhaust gases). Excessive ammonia slip is undesirable because in the atmosphere ammonia reacts with NOx and SOx to form ammonium nitrate and ammonium sulphate, which are often significant components of urban smog. Excessive ammonia in the atmosphere may contribute to watershed eutrophication, as it is efficiently washed out of the atmosphere by rainfall and transferred to down-wind watersheds. Hence it is not feasible to use SCR to completely remove NOx from turbine exhaust gases. SCR could be used, for example, to reduce the NOx from 25 ppm down to 3 ppm, resulting in an ammonia slip in the order of 2-3 ppm.

For the proposed LNG plant the capital cost for SCR would be in the order of $50 - $100 million. The cost-effectiveness of SCR is approximately $20,000 per tonne of NOx reduction. This can be compared with the cost-effectiveness of dry low-NOx technology of approximately $500 per tonne of NOx reduction. (*EPA-453/R-93-007: "Alternative Control Techniques Document – NOx Emissions from Stationary Gas Turbines"*)

Clearly it would be better to use modern dry low-NOx burner technology than to resort to SCR, both for economic and for environmental reasons.

3. Environmental Effects of Reduced NOx Emissions

If the proposed LNG project uses gas turbines whose NOx emissions are guaranteed to be less than 5 ppm, then the long-term increase in existing NOx emissions will be decreased from over 700% down to about 310% (a reduction of 2, 600 TPY of NOx emissions). Hence the environmental effects from these reduced emissions should be less than those identified in the project's Environmental Assessment (EA).

1. Acid Rain: Acid rain concerns go back to the days when the NOx and SOx emissions from coal-fired power plants caused damage to watersheds in eastern North America. Surface geology in eastern North America provides little buffering to acidic inputs. The surface geology in the Prince Rupert area also provides little buffering to acidic inputs. The project's EA (Section 7.6) reports that the projected sulphate and nitrogen PAI input, immediately adjacent to the project site, will be similar to a "critical load" of 150 equivalents per hectare per year. A reduction in gas turbine emissions from 25 down to less than 5 ppm NOx would provide a safety margin and therefore help to prevent acid rain related damage to the ecosystem. Acid rain effects are further mitigated because of the heavy rainfall in the Prince Rupert area. The additional precipitation dilutes and flushes acidic inputs.

2. Interaction of NOx Emissions with Coal and Petroleum Coke Dust from Ridley Island: Coal dust consists of mainly carbon with minor inorganic ash content (aluminum silicates, etc.). Coke dust is similar but with elevated levels of vanadium and nickel that may be of concern. However, a US EPA study (*Screening-Level Hazard Characterization for Petroleum Coke, June 2011*) investigated the toxicity of this product to aquatic species, as well as to mammalian lungs, and concluded that there was no toxicity.

   Perhaps of more concern would be the further acidification of freshwater bodies and the release of tri-valent aluminum, which is toxic to marine species. This concern can be addressed by reducing NOx emissions as stated above, by monitoring the freshwater bodies for pH, alkalinity and the presence of tri-valent aluminum, and if necessary by adding alkalinity. If alkalinity is added it should be done so moderately in the form of powdered limestone.

4 Conclusions and Recommendations

This study found that the projected NOx emissions from the proposed LNG plant can be reduced from 4,033 TPY down to 1,415 TPY by using gas turbines that employ the latest lean low-NOx burner technology. This solution would be less expensive and more environmentally acceptable than using SCR scrubbing. The resulting impacts upon the receiving environment should be within government guidelines.

Therefore it is recommended that the proponent use gas turbine technology that guarantees NOx emissions of less than 5 ppm. It is further recommended that the water chemistry of downwind freshwater bodies be periodically monitored to ascertain their health.

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