



APTECH Engineering Services, Inc. Petrochemical Group



Economic Remaining Useful Life Strategies For Cryogenic Gas Ships



Stringent Demands for LNG/LPG Ships

Aptech Engineering Services, Inc. (APTECH) provides an independent engineering and economic Remaining Useful Life (RUL®) assessment program for many types of merchant ships. However, the RUL program for liquefied gas ships is especially valuable to ship owners, port authorities and safety regulatory agencies, insurance companies, and charterers. Vessel carriers of liquefied natural gas (LNG) and petroleum gases (LPG), ammonia, vinylchloride monomer (VCN), propylene, ethylene, and other chemical gases are subject to special low-temperature loads and resulting stresses, fatigue cycles and fractures. Further, most of the products transported are explosive, flammable toxic, or corrosive, and therefore are very high hazards. Prudence mandates the highest degree of maintenance and care of these liquid gas carriers, and demonstrated skills of the ship crew and terminal operators.



Financial Rewards

The shipyard price for a new building LNG vessel is about four times the price of a conventional tanker of the same size, and a LPG vessel costs over twice as much for the same cargo volume. At prices over 200 million dollars for a 130,000 cubic meter LNG, and an LPG ship of one-tenth that size priced at about 40 million dollars, new replacements are unaffordable at current charter hire rates. However, the charter hire is attractive and able to support existing ships, even those needing expensive rehabilitation.



Structural Problems

The tank and piping containment for cryogenic gases must remain leak-tight through a range of temperatures from 25°C down to as low as -162°C, and lower for nitrogen or other elements. Alternating loaded and ballast, and large temperature contractions and alternating expansions result in severe loads and stresses. Special metals resistant to low temperature brittleness and with low coefficients of expansion are difficult to form and weld. Minute cargo and cleaning contaminants can react with tank and piping metals and gaskets, causing accelerated deterioration. Extreme measures to protect the cargo system are generally employed.

The conventional portions of the ship, especially warm fuel and salt water ballast tanks, also corrode and erode normally, as do exposed decks and fittings. Stress from low temperature leaks through thermal insulation can cause brittleness problems.



Operational Problems

Containment of cargo vapors, cleansers, and inert gas is essential on an LNG or LPG ship. Cargo transfer and cleaning mishaps are dangerous. Methane, propane, butane, and other gases are explosive in small concentrations in air. Numerous instruments and controls can easily malfunction, requiring frequent checks to achieve high reliability. The tendency cryogenic ships to last longer than conventional tankers results, in turn, in extended years of machinery operations with better than average reliability sought for safety.

The APTECH RUL Program

The overall objective of the economic RUL program is to identify the best time and cost of major life extension projects to rehabilitate the ship and postpone acquisition of a replacement vessel. Principal analyses include hull structure, cargo tanks and piping, propulsion and steering, cargo pumping and blanketing, and major deck machinery. Sophisticated engineering methods for creep, fatigue life, corrosion and protection, stress concentrations at weak points, acceptable flaws, and crack growth are the major part of the APTECH program. Cost estimates of forecast repair needs for continuing LNG/LPG service are fed into calculations to find the economic ship life that meets the ship owner's financial goals.

Owner's Benefits

Completion of the APTECH RUL program provides a vessel owner with scientific estimates of what major physical problems to expect, and how to avoid them at minimum long-term cost. Planning for major replacements and budgeting of repair expenditures improved.

The numerous regulatory agencies for cryogenic gas transport can be presented with documented evidence of continuing safety of the hazardous liquefied gas ship. Making these analyses in advance will demonstrate that no better method of engineering is available to ascertain reliability and safety. Charterers and insurance companies may improve their rates with APTECH's RUL documentation.

APTECH's Qualifications for Low Temperature Structures

APTECH has developed similar life assessment, component analysis, and extension programs for cycling power plants subject to greater scrutiny, United States Navy ships, pressure vessels, and offshore platforms. APTECH offers specialized services in the following areas:

- ◆ Stress analysis and integrity analysis of proposed and existing structures, pipelines, and vessels
- ◆ Fracture mechanics-based fatigue design and analysis of brittle fractures
- ◆ Integrity analysis of damaged structures and design of repairs
- ◆ Development of procedures and standards for welding and weld inspection
- ◆ Materials selection and design practice for low temperature service
- ◆ Corrosion and corrosion fatigue monitoring and control
- ◆ Inspection signal enhancement using digital computer techniques

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