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Without worldwide standards it will be difficult for ships to get connected ashore, explains a team that has been examining the issue

California has a reputation for tackling environmental issues and one of the targets of the latest round of initatives is pollution from ports. Dockside equipment is being changed over to more ecologically-friendly fuel, but the real target in the eye of authorities is emissions from ships.

The most obvious drawback is cost. The California Air Resources Board estimates it would cost ports in the state at least $90M to supply alternative maritime power (AMP). In addition, retrofiting vessels is expected to cost in the region of $500,000 to $1.5M. On the plus side, the board says that emissions could be reduced by 18 tonnes a day, or 70%, if every vessel calling three or more times a year to California's ports was able to receive shoreside power. Long Beach and Los Angles have long-term plans to supply power to vessels making frequent calls and are putting serious efforts into persuading other ports on these vessels' itineraries to do the same.

Current rules and standards need to be revised and new ones developed to ensure systems are compatible at ports around the world. Naval architects, shipowners, and port authorities should be involved in the development of these standards to ensure safe, cost-effective methods are developed for powering ships on shore power.

The following issues should be addressed: Modern container ship operations at berth present many challenges when connecting shore power to the ships. Wharf space is limited and container cranes operate near the edge of the wharf. Shore side connections need to be located away from cranes at the edge of the berth at locations flexible enough to accommodate different ships.

If ships are retrofitted for the connection to shore power, standards are needed to simplify connection methods, establish voltage level, and connection capacity.

If a plug or receptacle connection is used for shore power connections, an international standard for compatibility should be developed to allow ships to connect at different ports throughout the world.

Standards need to be developed to identify acceptable ranges for shore side voltage level and system frequency.

On-board generator emissions during docking periods has become an important air pollution issue and vessel power demands have increased dramatically, reaching tens of MW. AMP, provided from the shore, should make use of near-zero or zero emissions technology to provide cleaner power to docked ships. Several ports throughout the world, including Los Angeles in the USA and Gothenburg, , have already implemented shoreside power measures.

Specifically, these measures call for ports to: require shore-side power as a condition of new terminal leases

> Many ship operators and port authorities are struggling with the absence of standards for connecting ships

or renewals; invest in infrastructure for electrical power; redevelop shoreside power for port-operated facilities; subsidise development of shoreside power for harbor craft; and provide funding to offset costs of retrofitting ships to accommodate shoreside power.

On the shore side, an appropriate special power system is required to hook up the power delivery cabling system via power receptacles and power plugs. Power may be delivered at 6.6 kV or 440 V, depending upon the rating of the vessel's on-board normal power supply equipment.

Many ship operators and port authorities are struggling with the absence of appropriate standards and specifications for interconnecting the ship service loads to on-shore power distribution systems, especially the grounding of the shoreside power system.

For AMP to be successful, sufficient power must be available for use at the berths for substation development, and cable-laying rights-of-way must be available close to the terminals. Ships in service may not have the correct electrical hookups to allow proper connection.

At present, there are no industry standards for cold ironing connection and power system design, especially the grounding of the shore side power to a floating ungrounded ship's electrical infrastructure.

Based on its economic analysis studies, the Port of Los Angeles has fitted two terminals with shore power and plans are being developed for seven other terminals. Nearby, the Port of Long Beach is planning to provide shore power to every berth. These ports have planned and selected a 6.6 kV supply voltage infrastructure with power delivery up to 7.5 MVA per berth. Specific shore side power supply system grounding requirements are still under discussion with ships interests.

Other USA ports investigating the possibility of cold ironing projects are Houston, Richmond, Norfolk, Seattle, Tacoma, Oakland and San Francisco. Ports surrounding the Baltic Sea are incorporating shoreside power as part of their environmental programmes and Lubeck port started tests in August 2005.

Ports considering container or cruise terminal AMP need to upgrade existing shore side power system infrastructures, since these ships demand power in the range of three to 15 megawatts. This demand requires new substations with step down power transformers with medium voltage secondaries to match with shipside voltage requirements.

In addition, appropriate medium voltage switchgear, flexible power cable connections, and power plug or receptacle assemblies are needed for ships loading or off-loading at dock. The emissions associated with the electrical generation supplied by the substation must be significantly lower than the emissions generated by on-board generators of receiving ships to ensure significant air pollution emissions reductions. Shore side power generation must make the use of renewable energy sources or appropriate natural gas. Any port-operated substation should explore the best available control technology to reduce pollution impacts.

The second option is the installation of one or two fuel cell units (200 to 250 kW) at berths where smaller ships (tugboats, commercial fishing boats, and crew/supply boats, for example) are hoteling, and where natural gas is available as a fuel source.

The third option is a power barge equipped with fuel cells to supply power at multiple locations. The fuel cell application may be particularly well suited for berthed cargo ships where diesel generators producing auxiliary loads are in the one to two megawatt range. Fuel cell technology offers significant enhancements over existing diesel generators including very low exhaust emissions, inherently low vibration and sound levels, and improved thermal efficiency (particularly at low-load levels).

Much work needs to be done to develop recommended practices for AMP, and we would recommend this be conducted together with the USA-based Institute of Electrical and Electronics Engineers, Inc (IEEE) A group with international participation could be formed to work with the IEEE standard 45 working group to study and develop recommendations. PH

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Los Angeles port (left) has opted for barges to supply shore side power for ships

Barges (above right) can supply power all over a port (bottom right).