Attachment on ZEAT Requirements: Zero-Emission Capable Hybrid Vessels

FAQ on Zero-Emission Capable Hybrid Vessels

I. What is meant by "30 percent vessel power required for main propulsion and auxiliary power operation with zero tailpipe emissions when averaged over a calendar year"?

This means that a minimum of 30 percent of total annual vessel power for both propulsion and auxiliary vessel-systems power must come from a zero-emission tailpipe power source, such as battery-electric propulsion charged by grid-power or hydrogen fuel cells.

II. How do I calculate the 30 percent zero-emission power and provide supporting data to CARB for compliance?

For grid power:

a) Use average engine load factors or values provided in Table H-9 of *Appendix H of the Initial Statement of Reasons (ISOR)*
b) Calculate the annual kilowatt hours of diesel-powered propulsion and auxiliary system work.
c) Calculate the annual kilowatt hours of electric power used by vessel hybrid system (This may be determined using your hybrid control system data logging or by using a power bill if the power for the vessel hybrid system is separately metered).
d) Divide annual kilowatt hours of electric power by the total annual kilowatt hours used (diesel + electric).

For example:

A zero-emission capable hybrid excursion vessel has two 400 kW main engines and two 60 kW auxiliary engines. The excursion vessel operator follows steps a.-d. above to check that 30% of power is coming from grid power.

a) The excursion vessel operator uses *Appendix H of the ISOR* to determine engine load factors for excursion vessels are 0.27 for main engines and 0.40 for auxiliary engines.
b) The operator uses annual operating hours for each engine to determine the total number of kilowatt hours worked by the diesel engines. Multiplying the engine's power rating, the annual operating hours, and the load factor gives the total energy coming from diesel power.

Engines	Rated Engine Power (kWh)	Annual Operating Hours	Load Factor	Multiply Engine Power by Operating Hours and Load Factor	Work (kWh)
Main Engine 1	400	1,500	0.27	$400\ kW \times 1500\ h \times 0.27 =$	162,000
Main Engine 2	400	1,500	0.27	$400\ kW \times 1500\ h \times 0.27 =$	162,000
Auxiliary Engine 1	60	600	0.40	$60\ kW \times 600\ h \times 0.40 =$	14,400
Auxiliary Engine 2	60	100	0.40	$60\ kW \times 100\ h \times 0.40 =$	2,400
				Total Energy from Diesel Power	**340,800 kWh**

c) The same excursion vessel operator has collected 12 months of electric utility bills generated by charging the battery on the excursion vessel. The operator gets the total electricity usage for the year by adding up the electric bill from each month.

Month	Electric Utility Bill (kWh)
January	12,000
February	13,000
March	12,000
April	13,000
May	12,000
June	14,000
July	14,000
August	14,000
September	12,000
October	12,000
November	11,000
December	11,000

Total Electricity Usage	**150,000 kWh**

d) The excursion vessel operator now knows how much energy is coming from electricity and how much is coming from diesel. Adding those two values together gives the total energy usage for the year.

$$340{,}800\ kWh \text{ from diesel} + 150{,}000\ kWh \text{ from electric} = 490{,}800\ kWh \text{ total}$$

To determine the percent of power that was from the electric grid, the excursion vessel operator divides the annual energy from electric by the total energy used.

This comes out to 31%, complying with the 30% zero-emission requirements.

$$150{,}000\ kWh / 490{,}800\ kWh = 31\%$$

A fillable spreadsheet to assist in these calculations is available on the *CARB website*.