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# C1Or2A-03: Cold compressor performance and energy consumption improvements at Jefferson Lab's Central Helium Liquefiers

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Jefferson Lab operates two large (18 kW at 4.2 K equivalent) central helium liquefiers (CHLs) in support of its upgraded 12 GeV electron beam accelerator. Both machines utilize full cold compression from the saturation pressure at operating temperature (approximately 2.1 K) to just over atmospheric pressure. The original plant, CHL1, was recently outfitted with a replacement subatmospheric cold box (SC1R) containing state-of-the-art cold compressor technology. The 12 GeV upgrade plant, CHL2, uses older cold compressors that were originally installed to provide redundancy for CHL1. In both cases, the heat of compression is absorbed at low temperature at the expense of electrical power consumed by the warm compressors. Due to the superior efficiency and turndown capabilities of SC1R, a new operating mode has been identified for CHL1 in which the required number of operating warm compressors is reduced by one. A cost-based method for optimizing cold compressor stability and efficiency has been developed and applied to CHL2, improving its turndown and lowering the warm compressor discharge pressure. As a result of these efforts, power consumption of the combined CHLs during normal 12 GeV operations has been reduced by 10%, or a total of 690 kW. The observed performance of CHL1 with SC1R, as well as the cold compressor optimization method, leading to this improved energy consumption rate will be discussed in detail. Though many installations already utilize the more efficient modern cold compressors, the optimization could still be applied to other large-scale subatmospheric helium liquefiers to improve turndown and efficiency and ultimately reduce operating costs.

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