In cold spray additive manufacturing, the evolution of temperature and residual stresses have an impact on the quality and service life of the final products. Conventionally, the finite element method has been used to simulate the temperature and residual stress distributions. However, conducting finite element simulations for large-scale or complex applications often demands substantial computational time and resources. It is essential to develop a rapid alternative for thermal and residual stress predictions to shorten the design and optimization cycles. In this work, physics-enabled machine learning models were developed to predict the temperature and residual stress fields in the cold spray additive manufacturing process. Finite element simulations were performed to generate datasets for training and testing the surrogate model, the physical features were extracted and used as inputs to the machine learning models. The baseline performance and generalization ability of the surrogate models were validated, demonstrating a high accuracy for both temperature and residual stress distributions.