HS-ETS1-4

Students who demonstrate understanding can:

HS-ETS1-4. **Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.**

The performance expectation above was developed using the following elements from *A Framework for K-12 Science Education*:

Science and Engineering Practices

Using Mathematics and Computational Thinking

Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems.

Disciplinary Core Ideas

ETS1.B: Developing Possible Solutions

- Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs.

Crosscutting Concepts

Systems and System Models

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions — including energy, matter, and information flows — within and between systems at different scales.

Observable features of the student performance by the end of the course:

1	Representation		
	a	Students identify the following components from a given computer simulation:	
		i.	The complex real-world problem with numerous criteria and constraints;
		ii.	The system that is being modeled by the computational simulation, including the boundaries of the systems;
		iii.	What variables can be changed by the user to evaluate the proposed solutions, tradeoffs, or other decisions; and
		iv.	The scientific principle(s) and/or relationship(s) being used by the model.
2	Computational Modeling		
	a	Students use the given computer simulation to model the proposed solutions by:	
		i.	Selecting logical and realistic inputs; and
		ii.	Using the model to simulate the effects of different solutions, tradeoffs, or other decisions.
3	Analysis		
	a	Students compare the simulated results to the expected results.	
	b	Students interpret the results of the simulation and predict the effects of the proposed solutions within and between systems relevant to the problem based on the interpretation.	
	c	Students identify the possible negative consequences of solutions that outweigh their benefits.	
	d	Students identify the simulation's limitations.	