**Engineering, Technology, and Applications of Science**

**MS-ETS1 Engineering Design**

**MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.**

Further explanation: To solve a problem it needs to have clearly defined set goals and limits. The more limitations applied to a problem, the more elegant and successful the solution is likely to be. Limitations would take into account potential impacts on the environment, social/cultural norms, and allowable interactions. The application of science principles is to be used as a tool to verify solutions. Examples could include hydroelectric dams as a viable, cost effective and ecologically friendly way to generate electrical power. However, the dam holds fish populations from traveling freely through the environment. There is a need to provide a safe way for aquatic life to pass by the hydroelectric turbine in a way that does not impact the electrical generation, the original water flow of the river dammed, is cost effective to existing dam models, and has no negative impact on human populations.

Asking questions and defining problems, defining and delimiting engineering problems, influence of science, engineering, and technology on society and the natural world

**MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.**

Further explanation: When designing a solution to a problem, there need to be many possible solutions explored, tested, verified, and compared, and the use of some tool to determine the validity of competing designs in meeting the design criteria. These tools would be used to make testing data understandable, comparable, and accessible.

Engaging in argument from evidence, developing possible solutions

**MS-ETS1-3 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.**

Further explanation: Testing and data is used to evaluate the solutions or part of the solutions that best solve the given problem. The data needs to be assessed and then used to modify, combine, and deny solutions and then retested to arrive at the best possible solution within the constraints of the problem. Examples could include tables, graphs, matrices, check lists, spreadsheets, public polls, Venn diagrams, mathematical models, etc.

Analyzing and interpreting data, developing possible solutions, optimizing design solution

**MS-ETS1-4 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.**

Further explanation: Developing the proper test to verify which solutions meet and which excel when applied against the constraints. That test is then applied to a prototype or model to allow faults to be identified and then corrected, frequently the combination of two or more solutions can produce a better solution and then retest it to see if it is the best solution. Examples could include materials science testing (shear strength, compression testing, tension testing, etc.), weather testing (temperature, rain, snow, wind, sun exposure), wind tunnel, failure or destructive testing, mathematical models, etc.

Developing and using models, developing possible solutions, optimizing design solution