Washington Office of Superintendent of
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Statewide Framework Document for:

470616 Core Plus Maritime

Standards may be added to this document prior to submission but may not be removed from the framework to meet state credit equivalency requirements. Performance assessments may be developed at the local level. To earn state approval, performance assessments must be submitted within this framework.

This course is eligible for one credit of ELA, Mathematics, and Science.

The Washington State Science Standards performance expectations for high school blend core ideas (Disciplinary Core Ideas, or DCIs) with scientific and engineering practices (SEPs) and crosscutting concepts (CCCs) to support students in developing usable knowledge that can be applied across the science disciplines. These courses are to be taught in a three-dimensional manner. The details about each performance expectation can be found at Next Generation Science Standards.

Washington Mathematics Standards (Common Core State Standards) support foundational mathematical knowledge and reasoning. While it is important to develop a conceptual understanding of mathematical topics and fluency in numeracy and procedural skills, teachers should also focus on the application of mathematics to career fields to support the three (3) key shifts of CCSS. The Standards for Mathematical Practice develop mathematical habits of mind and are to be modeled and integrated throughout the course. The details about each mathematical standard can be found at Common Core Mathematics Standards.

Washington English Language Arts Standards (Common Core State Standards) establish guidelines for literacy in history/social studies, science, and technical subjects. The College and Career Readiness Anchor Standards form the backbone of the ELA/literacy standards by articulating core knowledge and skills, while grade-specific standards provide additional specificity. The Anchor Standards are:

Anchor Standards for College and Career Readiness for Reading

Key Ideas and Details:

CCSS.ELA-LITERACY.CCRA.R.1
Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

CCSS.ELA-LITERACY.CCRA.R.2
Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

CCSS.ELA-LITERACY.CCRA.R.3
Analyze how and why individuals, events, or ideas develop and interact over the course of a text.

Craft and Structure:

CCSS.ELA-LITERACY.CCRA.R.4

Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

CCSS.ELA-LITERACY.CCRA.R.5

Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.

CCSS.ELA-LITERACY.CCRA.R.6

Assess how point of view or purpose shapes the content and style of a text.

Integration of Knowledge and Ideas:

CCSS.ELA-LITERACY.CCRA.R.7

Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.1

CCSS.ELA-LITERACY.CCRA.R.8

Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.

CCSS.ELA-LITERACY.CCRA.R.9

Analyze how two or more texts address similar themes or topics to build knowledge or to compare the approaches the authors take.

Range of Reading and Level of Text Complexity:

CCSS.ELA-LITERACY.CCRA.R.10

Read and comprehend complex literary and informational texts independently and proficiently.

Anchor Standards for College and Career Readiness for Writing

Text Types and Purposes:

CCSS.ELA-LITERACY.CCRA.W.1

Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.

CCSS.ELA-LITERACY.CCRA.W.2

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

CCSS.ELA-LITERACY.CCRA.W.3

Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

Production and Distribution of Writing:

CCSS.ELA-LITERACY.CCRA.W.4

Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

CCSS.ELA-LITERACY.CCRA.W.5

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

CCSS.ELA-LITERACY.CCRA.W.6

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

Research to Build and Present Knowledge:

CCSS.ELA-LITERACY.CCRA.W.7

Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

CCSS.ELA-LITERACY.CCRA.W.8

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

CCSS.ELA-LITERACY.CCRA.W.9

Draw evidence from literary or informational texts to support analysis, reflection, and research.

Range of Writing:

CCSS.ELA-LITERACY.CCRA.W.10

Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

Anchor Standards for College and Career Readiness for Speaking and Listening

Comprehension and Collaboration:

CCSS.ELA-LITERACY.CCRA.SL.1

Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

CCSS.ELA-LITERACY.CCRA.SL.2

Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

CCSS.ELA-LITERACY.CCRA.SL.3

Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric.

Presentation of Knowledge and Ideas:

CCSS.ELA-LITERACY.CCRA.SL.4

Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.

CCSS.ELA-LITERACY.CCRA.SL.5
Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.
CCSS.ELA-LITERACY.CCRA.SL.6
Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate.

Anchor Standards for College and Career Readiness for Language

Conventions of Standard English:
CCSS.ELA-LITERACY.CCRA.L.1
Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
CCSS.ELA-LITERACY.CCRA.L.2
Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

Knowledge of Language:
CCSS.ELA-LITERACY.CCRA.L.3
Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.

Vocabulary Acquisition and Use:
CCSS.ELA-LITERACY.CCRA.L.4
Determine or clarify the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts, and consulting general and specialized reference materials, as appropriate.
CCSS.ELA-LITERACY.CCRA.L.5
Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
CCSS.ELA-LITERACY.CCRA.L.6
Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when encountering an unknown term important to comprehension or expression.

The details about English Language Arts Standards can be found at Common Core English Language Arts Standards.

***In this framework, *standards that are addressed but not specifically assessed are in italics*. All other standards are assessed as part of the student's achievement.**

Core Plus Maritime – 540-hour Framework

School District Name		
Course Title: Core Plus Maritime		**Total Framework Hours:** Up to 540
CIP Code: 470616	☐ Exploratory ☒ Preparatory	**Date Last Modified:** March 12, 2021
Career Cluster: Manufacturing	**Cluster Pathway:** All Pathways within the Cluster	

Course Summary:

The **Core Plus Maritime** program consists of frameworks and curricular materials that are designed to incorporate academic learning into maritime manufacturing.

The units are designed to be taught during the design, manufacture, and testing of the Capstone Project, helping students recognize where each unit's information is important to the maritime and manufacturing industries, and how that information is best utilized during the various manufacturing processes. Due to the fact that communities are different in the ways that the maritime industry might be seen, and how the many disciplines of maritime might be implemented, it is strongly recommended that teachers look to their Advisory Committees for direct implementations and identifications of local impacts as students proceed through this Career Pathway.

Eligible for Equivalent Credit: 3rd Credit of Math, Science and ELA	**Total Number of Units:** 22

Total Number of Units: 22 Total Units

Mapping Maritime	Pacific Northwest Maritime Resources, Careers, and Sectors
Navigation/Washington Boater's Safety Card	Materials Science
Hand and Power Tools	Safety/OSHA-10
Standard Operating Procedures	Precision Measurement
Print Reading	Applied Physics
Math for Industry	Rigging
Hydraulics and Pneumatics	Electrical Systems
Corrosion	Welding
Buoyancy	Propulsion
Quality Control and Assurance	Fasteners
Career Readiness and Employment	Capstone Project

Unit 1 – Mapping Maritime	**Total Learning Hours for Unit:** 20

Unit Summary:

The beginning units of Mapping Maritime (***part of the initial 180 hours of Core Plus Maritime***) help students see the size, scope, and the scientific realities and influences the maritime industry has on world commerce and economies. Those realities might help students understand how the maritime industry has become a major contributor to the Washington State maritime economy, and how science and mathematics aspects of seawater and freshwater are foundational to successful employment and growth of the industry.

The intermediate units of Mapping Maritime (***part of the remining 360-hour program in Core Plus Maritime***) continue to help students see the size, scope, and the scientific realities and influences the maritime industry has on world commerce and economies. These units help students see how fluid dynamics, fluid mechanics, buoyancy, density and other scientific aspects of seawater and freshwater are foundational to the Washington State economy and the maritime industry.

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

General

- Students identify and understand the functions of various portions of a ship.
- Students articulate and understand the purposes of the hierarchy of ship personnel ("Chain of Command").
- Students identify ship safety systems.
- Students learn and use maritime vocabulary.
- Practice tying basic knots used in maritime applications.
- Students identify industry protocols related to various maritime pathways and exhibit that understanding throughout the course.
- Students understand and articulate how and why native cultures have been impacted over time.
- Students explain how cultural changes impact current maritime-related decisions and practices.
- Students explain how geography and environmental resources play roles in today's maritime industry.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Making short classroom presentations describing how literature has influenced maritime beliefs and practices.
- Examining the cultural impacts of Sea Tales ("The Art of the Yarn")
- Identifying and composing what they have learned by creating, maintaining, and reviewing a Student Journal.
- Understanding and correctly incorporating maritime and nautical vocabulary into their classroom responses, both orally and written, through conversation and classroom presentations.
- Describing how maritime technology and resources impacted first contacts in the New World between Native Americans, Europeans, and Americans.
- Identifying and explaining various maritime connections that the Puget Sound maritime industry has with the State of Alaska and neighboring states, and the impact this has on the economy of these regions.
- Describing how Native Americans developed technologies and cultures based on the national environment resources and geography of the Pacific Northwest.
- Understanding how lives and maritime career prospects today reflect the region's history and marine resources.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Students use tools, technologies, and/or models to analyze the data and identify relationships within the datasets, including:

- A more massive object experiencing the same net force as a less massive object has a smaller acceleration, and a larger net force on a given object produces a correspondingly larger acceleration; and
- The result of gravitation is a constant acceleration on macroscopic objects as evidenced by the fact that the ratio of net force to mass remains constant.

- Students use the data as empirical evidence to distinguish between causal and correlational relationships linking force, mass, and acceleration.
- Students use the mathematical representations to model and describe the physical interaction of the two objects in terms of the change in the momentum of each object because of the interaction.
- Students use the analysis of the motion of the objects before the interaction to identify a system with essentially no net force on it.
- Students identify that the analysis of the momentum of each object in the system indicates that any change in momentum of one object is balanced by a change in the momentum of the other object, so that the total momentum is constant.
- Students gain an understanding of how various cultures and beliefs can potentially impact the environment.
- Students understand how various cultures and civilizations have and will interact with other cultures and then identify specific environmental issues and impacts on various species of animals and fish created through those interactions (ex. fishing rights, land ownership, international travel).
- Students identify the responsibilities that maritime careers have on communities and people from various backgrounds and heritage and how impacts on the environment and animal species might be prevented and/or managed for the benefit of all.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Interpreting and calculating GPS coordinates and weather information to determine how speed, distance, load, and time may influence international shipping.
- Analyzing the influences and impacts weather systems can have on speed, direction, and time during maritime travel and fuel needed for cargo delivery.
- Understand environmental conditions (oil spills, impacts that Sea Lions have on salmon migration, how dams on the Columbia and Snake Rivers impacts Salmon migration, etc.)
- Helping students understand various tribal fishing rights, harvest quotas for commercial and recreational fishing, crabbing, clamming, hunting, and other maritime species.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

Through team-based activities relating to Mapping Maritime, students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).

- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Leadership Skills:
1.A Think Creatively.
1.B Work Creatively with Others
2.A Reason Effectively
2.B Use Systems Thinking
2.C Make Judgments and Decisions
2.D Solve Problems.
4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- Maritime Vocabulary - Understand the influences and impacts that various civilizations and cultures have had on the development of the maritime industry.
- Navigation - Use online resources (https://www.aquaplot.com/) to calculate distances between ports.
- Global Positioning - Understand Latitude and Longitude and how they are used to identify location (coordinates, Global Positioning Satellites (GPS)).
- Speed and Distance - Understanding distance and speed using Nautical Miles and Knots.
- Weather Impacts - Understand how weather may impact maritime commerce.
- PNW Cultural Impacts - Understand how impacts and interactions between explorers and natives have shaped the maritime industry in the Pacific Northwest.
- Commercial and Environmental Issues - Describe the differences between Ownership and Freedom of the Seas and how these working relationships can create commercial and environmental tensions.

Aligned Washington State Academic Standards	
English Language Arts: Common Core	*RI.11-12.1 - Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.* RI.11-12.2 - Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text. RI.11-12.3 - Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text. RI.11-12.4 - Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the

	meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10). *RI.11-12.5 - Analyze and evaluate the effectiveness of the structure an author uses in his or her exposition or argument, including whether the structure makes points clear, convincing, and engaging.* *RI.11-12.6 - Determine an author's point of view or purpose in a text in which the rhetoric is particularly effective, analyzing how style and content contribute to the power, persuasiveness, or beauty of the text.* RI.11-12.7 - Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words to address a question or solve a problem. *RI.11-12.8 - Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning (e.g., in U.S. Supreme Court majority opinions and dissents) and the premises, purposes, and arguments in works of public advocacy (e.g.,* The Federalist*, presidential addresses).* SL.11-12.1 - Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. SL.11-12.1.A - Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas. SL.11-12.1.B - Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed. SL.11-12.1.C - Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives. SL.11-12.4 - Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks. SL.11-12.5 - Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

	SL.11-12.6 - Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate. L.11-12.1 - Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. *L.11-12.1.A - Apply the understanding that usage is a matter of convention, can change over time, and is sometimes contested.* L.11-12.2 - Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. *L.11-12.2.A - Observe hyphenation conventions.* L.11-12.2.B - Spell correctly. L.11-12.4 - Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on *grades 11-12 reading and content*, choosing flexibly from a range of strategies. L.11-12.4.A - Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word's position or function in a sentence) as a clue to the meaning of a word or phrase. L.11-12.4.B - Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., *conceive, conception, conceivable*). L.11-12.4.C - Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, its etymology, or its standard usage. L.11-12.4.D - Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary) L.11-12.5 - Demonstrate understanding of figurative language, word relationships, and nuances in word meanings. L.11-12.5.A - Interpret figures of speech (e.g., hyperbole, paradox) in context and analyze their role in the text. *L.11-12.5.B - Analyze nuances in the meaning of words with similar denotations.* L.11-12.6 - Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression. RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

	RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. RST.11-12.4 - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*. *RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.* *RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.* RST.11-12.8 - Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. RST.11-12.9 - Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently. Write arguments focused on *discipline-specific content*. WHST.11-12.1.A - Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence. Write arguments focused on *discipline-specific content*. WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. *WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.*

	WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information. WHST.11-12.7 - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.
Environment and Sustainability	Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels. Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments. Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.
Mathematics: Common Core	HSN.VM.A.1 **-** Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, v). HSN.VM.A.2 **-** Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point. HSN.VM.A.3 **-** Solve problems involving velocity and other quantities that can be represented by vectors.

	HSN.VM.B.4 - Add and subtract vectors. HSN.VM.B.4.A - Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes. HSN.VM.B.4.B - Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum
Mathematical Practices	MP1 - Make sense of problems and persevere in solving them. MP2 - Reason abstractly and quantitatively. MP3 - Construct viable arguments and critique the reasoning of others. MP4 - Model with mathematics.
Science	HS-PS2-1 - Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-2 - Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system. HS-LS2-1 - Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. HS-LS2-2 - Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. HS-LS2-6 - Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions but changing conditions may result in a new ecosystem. HS-LS2-7 - Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. HS-LS2-8 - Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. HS-LS4-6 - Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

	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.	
Science and Engineering Practice	**Disciplinary Core Idea**	**Crosscutting Concept**
Analyzing and Interpreting Data Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions *Connections to Nature of Science* Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena	PS2.A: Forces and Motion PS2.B: Types of Interactions LS2.A: Interdependent Relationships in Ecosystems LS2.C: Ecosystem Dynamics, Functioning, and Resilience LS4.D: Biodiversity and Humans ETS1.B: Developing Possible Solutions	Patterns Cause and Effect Systems and System Models Stability and Change *Connections to Engineering, Technology, and Applications of Science* Influence of Science, Engineering, and Technology on Society and the Natural World *Connections to Nature of Science* Science Addresses Questions About the Natural and Material World

Unit 2 – Pacific Northwest Maritime Resources, Careers, and Sectors	**Total Learning Hours for Unit:** 20

Unit Summary:

The introductory units of Pacific Northwest Maritime Resources, Careers, and Sectors (***part of the initial 180 hours of Core Plus Maritime***) help students see that the maritime economy is larger than most people know and understand. Opportunities are available in our region to learn and identify valuable entry-level skills, and how the Pacific Ocean, Puget Sound, Columbia River, and available resources help anchor our maritime economy.

The intermediate units of Pacific Northwest Maritime Resources, Careers, and Sectors (***part of the remaining 360-hour program in Core Plus Maritime***) continue to help students understand how numerous marine career paths follow some of the oldest footprints in the New World and how strategic and regulatory issues can impact maritime careers. Pathways may include cargo handling and logistics, commercial fishing and seafood processing, ship and boat building, repair and maintenance, passenger vessel operations, recreational boating and sport fishing, military, and federal activities – US Navy, US Coast Guard and NOAA, support industries and activities – engineering, consulting, education, and training.
It is important that teachers emphasize to students that there are multiple maritime pathways so that students can more easily recognize the knowledge, skills, and abilities that are necessary and/or required in those various pathways. Students should also investigate what additional knowledge, skills, and abilities are necessary to advance in multiple pathways, and where additional education and/or training

might be necessary to advance within or change pathways. Incorporation of Career Counselors in this unit would be extremely advantageous.

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

General

- Students describe various career opportunities in the maritime industry.
- Students describe the differences between inland and marine sector careers.
- Students identify and describe job skills that enable people to enter maritime careers, including military opportunities.
- Students describe the four marine resources that are the cornerstones of our maritime job base.
- Students describe how each of the four main resources impact maritime careers and career opportunities.
- Students describe how environmental, economic, and cultural influences impact local, regional, and federal decisions and legislation.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Researching and presenting information in various formats that pertain to the current and potential career opportunities available in the Pacific Northwest relating to the maritime industry. Students will incorporate into these presentations social, environmental, and economic impacts of various careers and identify the skills and experience needed for various certifications and advancement in these career opportunities.
- Creating and presenting classroom and community presentations.
- Explaining how and why the Columbia River and the Snake River are valuable financially to numerous maritime enterprises.
- Describing how society might balance the value of Columbia River and the Snake River hydro resources, fish runs, and shipping in the inland waterways.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Students construct an explanation that includes:
    - Specific cause and effect relationships between environmental factors (natural hazards, changes in climate, and the availability of natural resources) and features of human societies including population size and migration patterns; and
    - How technology in modern civilization has mitigated some of the effects of natural hazards, climate, and the availability of natural resources on human activity.
- Students identify and describe the evidence to construct their explanation, including:
    - Natural hazard occurrences that can affect human activity and have significantly altered the sizes and distributions of human populations in particular regions.
    - Changes in climate that affect human activity (e.g., agriculture) and human populations, and that can drive mass migrations.
    - Features of human societies that have been affected by the availability of natural resources.

- Evidence of the dependence of human populations on technological systems to acquire natural resources and to modify physical settings.
- Students utilize a variety of valid and reliable sources for the evidence, potentially including theories, simulations, peer review, or students' own investigations.
- Students use reasoning that connects the evidence, along with the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future, to describe:
  - The effect of natural hazards, changes in climate, and the availability of natural resources on features of human societies, including population size and migration patterns.
  - How technology has changed the cause-and-effect relationship between the development of human society and natural hazards, climate, and natural resources.
- Students describe reasoning for how the evidence allows for the distinction between causal and correlational relationships between environmental factors and human activity.
- Reporting/presenting information as to why and how the four main resources available in the Pacific Northwest influence maritime development and public policy regarding development and species utilization and protection.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Analyzing the influences and impacts weather systems can have on maritime career opportunities and requirements for those careers.
- Utilize mathematical formulas and interpret data to predict impacts associated with human interaction in the marine environments.
- Identifying, organizing, and connecting evidence and assumptions regarding theories and laws that describe how the natural world operates today based on how it did in the past.
- Collecting and organizing data to better understand trends and to predict future results.
- Using information to make conclusions regarding causal and correlational relationships between environmental factors and human activity.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

Through team-based activities relating to maritime careers, students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Leadership Skills:

1.A Think Creatively.

1.B Work Creatively with Others

2.A Reason Effectively
2.B Use Systems Thinking
2.C Make Judgments and Decisions
2.D Solve Problems.
4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- Career Opportunities - Understand the scale and scope of career opportunities.
- Career Resources - Identify and utilize career resources and training entities.
- Maritime Certification - Understand numerous maritime certifications and requirements.
- Geographic Impacts on Maritime Commerce - Articulate impacts and opportunities that the Pacific Ocean, Puget Sound, the Columbia River and Pacific Salmon and other seafood resources provide.
- Environmental Impacts – Understand and identify environmental conditions, both natural and man-made, have on the maritime economy.
- Historical Impacts - Understand and identify historical events that have shaped and continue to influence the maritime industry.

Aligned Washington State Academic Standards	
English Language Arts: Common Core	CCRA.SL.1 - Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively. CCRA.SL.2 - Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. CCRA.SL.4 - Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience. CCRA.SL.5 - Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. RST.11-12.1 -Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. RST.11-12.4 - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*.

	RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas. RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem. RST.11-12.8 - Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. RST.11-12.9 - Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently. Write arguments focused on *discipline-specific content*. WHST.11-12.1.A - Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence. WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. *WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.* WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information. WHST.11-12.7 - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in

	terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research. WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Environment and Sustainability	Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels. Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments. Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.
Mathematics – Common Core	HSN.RN.A.1 - Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. HSN.RN.A.2 - Rewrite expressions involving radicals and rational exponents using the properties of exponents. Use properties of rational and irrational numbers. HSN.RN.B.3 - Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational. HSA.SSE.A.1 - Interpret expressions that represent a quantity in terms of its context. HSA.SSE.A.1.A - Interpret parts of an expression, such as terms, factors, and coefficients. HSA.SSE.A.1. - Interpret complicated expressions by viewing one or more of their parts as a single entity.

	HSA.SSE.A.2 - Use the structure of an expression to identify ways to rewrite it. HSS.ID.A.1 - Represent data with plots on the real number line (dot plots, histograms, and box plots). HSS.ID.A.2 - Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.
Mathematical Practices	MP1 **-** Make sense of problems and persevere in solving them. MP2 **-** Reason abstractly and quantitatively. MP3 **-** Construct viable arguments and critique the reasoning of others. MP4 - Model with mathematics.

Science	HS-LS2-1 **-** Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. HS-LS2-2 **-** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. HS-LS2-6 **-** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions but changing conditions may result in a new ecosystem. HS-LS2-7 **-** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. HS-LS2-8 **-** Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. HS-LS4-6 **-** Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. HS-ESS3-1 - Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. HS-ESS3-3 - Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. HS-ESS3-4 - Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. HS-ESS3-6 - Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. HS-ETS1-1 **-** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2 **-** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3 **-** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. 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.

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept

Analyzing and Interpreting Data Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions *Connections to Nature of Science* Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena	PS2.A: Forces and Motion PS2.B: Types of Interactions LS2.A: Interdependent Relationships in Ecosystems LS2.C: Ecosystem Dynamics, Functioning, and Resilience LS4.D: Biodiversity and Humans ETS1.B: Developing Possible Solutions	Patterns Cause and Effect Systems and System Models Stability and Change *Connections to Engineering, Technology, and Applications of Science* Influence of Science, Engineering, and Technology on Society and the Natural World *Connections to Nature of Science* Science Addresses Questions About the Natural and Material World

Unit 3 – Navigation	**Total Learning Hours for Unit:** 25

Unit Summary:
Marine navigation is the art and science of finding your way on the water. It has been used by sailors for centuries to get from point A on the vast globe of the world's oceans and waterways, to point B. Historically, sailors navigated by the stars and constellations and followed the winds and ocean currents. Learning to navigate today includes knowing how to read a nautical chart, knowing the various Aids to Navigation, plotting a course on a nautical chart, following a plotted course, and learning to obtain a fix on a nautical chart using marine electronics.

It is strongly recommended that as part this unit students will be working to achieve Washington State Boater Education Safety Certification.

Performance Assessments: (Districts to complete for each unit)
Example assessments for this unit include:

General

Students expected to:

- Learn and understand the criteria of the Washington State Boater Education Safety Certification and prepare to qualify for that certification.
- Describe and explain various types of marine navigation methods.
- Identify and use the terms and language and resources used in basic piloting and navigation, including charting, GPS, Compass use, and navigational aids.
- Discuss the earth's shape, its rotation, and magnetic characteristics and how these impact vessel navigations.
- Identify key elements of the navigational earth, including latitude, longitude, great circles, meridian distance, rhumb lines and how they are used in navigation.
- Interpret the information found in various types of chart projections and use that information to plot a course to a specified port from a predetermined location.

- Identity the parts of a magnetic compass, describe their purpose, and how they might affect magnetic compass accuracy.
- Demonstrate and use various navigation plotting instruments used for distance and bearing measurement.
- Describe and demonstrate basic skills in practical chartwork and basic piloting.
- Utilizing the Global Navigation Satellite System (GNSS) and other methods, calculate vessel position (latitude/longitude).
- Using web-based resources and other technologies, develop a course from a location in Washington State to a major shipping terminal outside of Washington State.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Researching and presenting real-life perspectives of marine navigation methods.
- Reading to understand and interpret the principles of basic piloting and navigation.
- Recognize the terms and units to measure speed, distance, and direction and how they influence navigation planning and execution.
- Researching and creating real-life perspectives of the derivation of navigation terms and definitions.
- Creating and organizing classroom presentations on maritime shipping routes, ocean currents, geography, global trade, and commerce.
- Researching and creating presentations on maritime casualties (collisions, groundings, etc.) and their causes and how they might have been avoided.
- Creating and presenting classroom and community presentations relating to the various types of chart projections and how they are used in navigation.
- Understanding and interpreting Visual Aids to Navigation (Buoyage systems, Beacons, and Lights).
- Understanding Time Zones and how they are used in navigation.
- Identifying, understanding, and meeting the Washington State Boater Education Safety Certification standards.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Analyzing data using computational models to make valid and reliable scientific claims relating to the changing of the Earth's position due to the changing of the seasons and how this might affect the determination of location.
- Identifying and demonstrating the basic principles of magnetism, magnetic compasses and determining magnetic deviation and how they influence compass readings and how to adjust for those potential deviations.
- Recognizing the different types of electronic charts and understanding the differences between raster digital chats and vector charts.
- Identifying the interaction of electronic positioning devices and the navigation techniques used in electronic charts.
- Demonstrating the hazards of over-reliance and the limitations of electronic charts for navigation.
- Presenting an overview of the scientific and mathematical algorithms used to create electronic charts.
- Providing a mechanistic account of the relationship between energy flow in Earth's systems and changes in climate, including:
    - The specific cause and effect relationships between the factors and the effect on energy flow into and out of Earth's systems; and
    - The net effect of all the competing factors in changing the climate.
- Demonstrating an understanding and use of required navigation publications regarding tides, tidal currents, ocean currents, weather routing, charts and radio and navigation aids.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Identifying and presenting information and drawing conclusions regarding the uses of:
  - Geometry and Trigonometry.
  - Time, speed, and distance calculations.
  - Bearing and course angle measurements.
  - Practical chart work and the use of navigation instruments.
  - Chart projection and chart scale.
  - How electronic navigation equipment might assist in navigation work.
  - Navigating across a curved surface versus navigation on a plane surface; introduction to spherical trigonometry and celestial navigation techniques.
- Determining Position, Direction, Time, Speed, and Distance.
- Determining the geographic range of an object based upon height of eye.
- Determining the range of visibility of a lighted aid based upon meteorological conditions.
- Identifying the causes of magnetic deviation and calculating compass error.
- Understanding Dead Reckoning and using vector analysis to determine tidal current set and drift, leeway caused by wind.
- Applying graphical or mathematical techniques to determine the distance of a charted object when course and speed are known.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

Through team-based activities relating to navigation study and presentations students will:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Leadership Skills:

1.A Think Creatively.

1.B Work Creatively with Others

2.A Reason Effectively

2.B Use Systems Thinking

2.C Make Judgments and Decisions

2.D Solve Problems.

4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- This framework contains content related to the minimum requirements for the knowledge, understanding and proficiency in Table A-II/5 of the STCW Code at the Support Level for *Function 1 - Navigation at the Support Level*. This Navigation element provides the background knowledge to support the training outcomes related to the following competencies:
  - 1.1 Contribute to a safe navigation watch.
    - 1.1.1 Ability to understand orders and to communicate with the officer of the watch on matters relevant to watchkeeping duties.
      - .1 basic knowledge of the English language both written and spoken.
      - .2 familiar use of important nautical and technical shipboard terms
- This Navigation framework contains content related to 46 CFR Subpart I- Subjects of Examination and Practical Demonstrations of Competence, Table 11.910-2; column 17 – Master or Mate-Inland 100 gross tons.
- Navigation – Become familiar with and use online resources (https://www.aquaplot.com/) to calculate distances between ports.
- Global Positioning - Understand Latitude and Longitude and how they are used to identify location (coordinates, Global Positioning Satellites (GPS)).
- Speed and Distance - Understanding distance and speed using Nautical Miles and Knots.
- Weather Impacts - Understand how weather may impact maritime commerce.
- Maritime Vocabulary - Understand the influences and impacts that various civilizations and cultures have had on the development and use of communication terms and methods of the maritime industry.

Aligned Washington State Academic Standards	
English Language Arts: Common Core	RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. RST.11-12.4 - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*. *RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.* RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem. RST.11-12.8 - Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

	RST.11-12.9 - Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently. Write arguments focused on *discipline-specific content*. WHST.11-12.1.A - Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence. WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. *WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience*. WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information. WHST.11-12.7 - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research. WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Environment and Sustainability	Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels. Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments. Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.
Mathematics: Common Core	HSN-Q.A.1 - Use units to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. HSN-Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. HSN.VM.A.1 **-** Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, $\vec{v}$). HSN.VM.A.2 **-** Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point. HSN.VM.A.3 **-** Solve problems involving velocity and other quantities that can be represented by vectors. HSN.VM.B.4 **-** Add and subtract vectors. HSN.VM.B.4.A **-** Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes. HSN.VM.B.4.B - Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.
Mathematical Practices	MP1 **-** Make sense of problems and persevere in solving them.

	MP2 - Reason abstractly and quantitatively. MP3 - Construct viable arguments and critique the reasoning of others. MP4 - Model with mathematics. MP5 - Use appropriate tools strategically. MP6 - Attend to precision. MP7 - Look for and make use of structure. MP8 - Look for and express regularity in repeated reasoning.
Science	HS-PS2-1 **-** Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-2 **-** Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system. HS-PS2-3 **-** Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. HS-PS2-4 **-** Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. HS-ESS2-2 **-** Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. HS-ESS2-3 **-** Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. HS-ESS2-5 **-** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. HS-ESS2-6 **-** Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. HS-ESS2-7 **-** Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. HS-ESS2-4 **-** Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. HS-ESS3-5 **-** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. HS-ESS3-1 **-** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

	HS-ESS3-2 **-** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. HS-ESS3-3 **-** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. HS-ESS3-4 **-** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. HS-ESS3-6 **-** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. HS-ETS1-1 **-** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2 **-** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3 **-** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. 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.	
Science and Engineering Practice	**Disciplinary Core Idea**	**Crosscutting Concept**
Developing and Using Models Analyzing and Interpreting Data *Connections to Nature of Science* Scientific Investigations Use a Variety of Methods Scientific Knowledge is Based on Empirical Evidence Asking Questions and Defining Problems. Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	ESS1.B: Earth and the Solar System ESS2.A: Earth Materials and Systems ESS2.D: Weather and Climate ESS3.D: Global Climate Change ETS1.A: Defining and Delimiting Engineering Problems. ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Systems and System Models *Connections to Engineering, Technology, and Applications of Science* Influence of Science, Engineering, and Technology on Society and the Natural World

Unit 4 - Material Science	**Total Learning Hours for Unit:** 60

Unit Summary:
The information found in this unit has been designed to help students identify and understand why and how the various materials utilized in systems and applications in the maritime industry are selected and how they react to various manufacturing processes, what tools and equipment are used on those materials, including specialized tools, what finishes are recommended on those materials, how those materials impact manufacturing, assembly, and how they are impacted and/or changed by various environments.

Classroom and laboratory activities and experiences will be systems-based, where material science-related information is delivered during manufacturing procedures and maritime applications, by having students defend why one material is used instead of another and how the selection of that material impacts manufacturing processes, tool selection, and equipment.

The materials that will be examined and the systems those materials effect throughout this course include:

- Ferrous and Non-ferrous Metals
    - Steel – structural systems, propulsion, fasteners, welding
    - Aluminum – structural systems, fasteners, welding
    - Copper – electrical systems, hydraulics/pneumatics/fluid lines, fasteners
- Gases and Fluids – hydraulic and pneumatic systems
- Nylon and Rope – (natural fiber, nylon, synthetics, wire) – rigging systems.
- Plastics/PVC/CPVC/PEX//Fiberglass/Epoxy/Composites/Carbon Fiber – structural systems, fluid lines

It is recommended that during this unit that students will be manufacturing a Capstone project, and that pertinent Material Science information be included during the planning, execution, and evaluation of that project.

To meet English Language Arts standards, journaling and other writing and student presentations are embedded into all Core Plus Maritime units and materials.

Performance Assessments: (Districts to complete for each unit)
Example assessments for this unit include:

General

- Students interpret and speak in language relating to Materials Science.
- Students demonstrate knowledge of materials science concepts as they relate to maritime applications and systems.
- Compare and contrast the different materials:
    - metallic bonded maritime materials rusts and corrode.
    - wood and some polymers rot and degrade.
    - ceramics work great and are difficult or impossible to apply.

    - there are no perfect materials, and all products are designed taking cost and lifespan into consideration .
        - Example: A platinum boat would be the ideal material the only problem is the weight (mass) and the fact it cost 32,000 times as much as iron.
- Select and defend correct and accurate applications of materials science concepts in the performance of classroom and laboratory activities.
- Use technology-based tools, printed documentation, and other media sources to research and make presentations of materials science solutions in marine-related applications.
- Students will be able to list several common materials used in the design and manufacture of marine products, identify simple properties of materials, such as strength, flexibility, and transparency, and describe advantages and limitations of those materials.
- Student develop and understand working knowledge of how the bonding in thermoplastics vs thermoset effect mechanical properties, cost, working time, and service life.
- Students journal information that can be shared and interpreted at later times during the manufacturing of the Capstone Project and/or laboratory activities.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Outlining pertinent information relating to material properties.
- Create material profiles for three common marine materials, including applications, structural strength, composition, relative cost, and availability.
- For a given marine application, create a presentation that analyzes the advantages/disadvantages of three competing materials available for that purpose.
- Produce a procedure for a selected material, including installation techniques, tools and equipment required, fastening approach, and safety procedures that must be observed.
- Select a material that fosters sustainable principles and justify its use in a project.
- Creating narratives that can be used to generate manufacturing process documents.
- Creating and presenting classroom and community presentations relating to their results of research projects, identifying manufacturing processes, and steps used to evaluate materials used and the quality of the Capstone Project.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Understanding and sharing information related to the physical and chemical properties of various materials used in the maritime industry, including:
    - Glues, Adhesives, and Finishes
    - Wood glue or Epoxy?
    - Types of Caulking
    - Paint
    - Gelcoat

- How do they work?
- How does temperature or other environmental conditions impact their effectiveness in maritime applications?

- Identifying the strengths and weaknesses of various materials used in maritime environments and selecting appropriate materials and processes for the application.
- Justifying the criteria used to select various materials to be used in the Capstone Project and explain their reasoning in their journals and during the design, manufacturing, and evaluation processes.
- Understanding and sharing information related to how various metal properties change due to the addition of other materials.
- Explaining how the physical and chemical properties of metals dictate how they might be used in maritime manufacturing.
- Identifying how the different materials react to changes in the environment.
- Recognizing how various materials bond and how those bonds react in maritime conditions.
- Modifying or changing various materials by adding other materials (composites).
- Identifying various physical characteristics of various composite materials.
- Predicting the types of physical and chemical reactions due to the addition of other materials (epoxy, adhesives, color pigments. etc.).

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Analyzing the influences and impacts weather systems can have on maritime career opportunities and requirements for those careers.
- Interpreting and manipulating information related to individual parts of a system and then how those component parts impact the entire system.
- Identifying distances, velocity, and force.
- Demonstrating knowledge and understanding of amounts, forces, and direction as they are presented in various quantities and utilized in laboratory and/or manufacturing applications.
- Interpreting written and spoken information relating to Materials Science. Journaling that information into forms that can be shared and interpreted the same at various times during the course.
- Applying geometric applications related to digital programs that utilize computer-aided design, and layout and the utilization of CNC equipment (laser cutter/engraver, plasma cutter, or milling equipment) to create drawings and then converting those drawings into 2D and 3D manufacturing files.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

Through team-based activities relating to maritime careers students will:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.

- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Leadership Skills:
1.A Think Creatively.
1.B Work Creatively with Others
2.A Reason Effectively
2.B Use Systems Thinking
2.C Make Judgments and Decisions
2.D Solve Problems.
4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- Properties of Materials - Understand and articulate the properties of various materials.
- Types of Bonding - Show how various materials are created at the atomic and molecular levels and how types of bonding impacts maritime manufacturing processes (adhesives, buoyancy, weight, etc.).
- Journaling and Documentation - Put their ideas and understanding into writing and review the impacts and changes that various materials and manufacturing processes that are utilized affect the maritime industry.
- Identification of Material Structure - Articulate how the crystalline structure on various materials impacts their uses in maritime manufacturing and how the structure might be modified or changed by various manufacturing processes.
- Manufacturing Processes and Procedures - Apply various manufacturing process to complete a Capstone Project.

Aligned Washington State Academic Standards	
	RST.11-12.4 - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*. *RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.* RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem. RST.11-12.8 - Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. RST.11-12.9 - Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently. Write arguments focused on *discipline-specific content*.

English Language Arts: Common Core	WHST.11-12.1.A - Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence. WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. *WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.* WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information. WHST.11-12.7 - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research. WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Environment and Sustainability	Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels. Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments. Standard 3: Sustainability and Civic Responsibility

	Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.
Mathematics: Common Core	HSN-Q.A.1 - Use units to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. HSN-Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling. HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. HSN.VM.A.1 **-** (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, v). HSN.VM.A.2 **-** (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point. HSN.VM.A.3 - (+) Solve problems involving velocity and other quantities that can be represented by vectors. HSA.SSE.A.1 - Interpret expressions that represent a quantity in terms of its context. HSA.SSE.A.1.A - Interpret parts of an expression, such as terms, factors, and coefficients
Mathematical Practices	MP1 **-** Make sense of problems and persevere in solving them. MP2 - Reason abstractly and quantitatively. MP3 - Construct viable arguments and critique the reasoning of others. MP4 **-** Model with mathematics. MP5 - Use appropriate tools strategically. MP6 **-** Attend to precision MP7 **-** Look for and make use of structure. MP8 **-** Look for and express regularity in repeated reasoning.
Science	HS-PS1-1 **-** Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. HS-PS1-3 **-** Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. HS-PS1-8 **-** Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. HS-PS2-6 **-** Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

	HS-PS1-1 - Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. HS-PS1-3 - Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. HS-PS1-8 - Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. HS-PS2-6 - Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. HS-PS2-1 - Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-3 - Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. HS-ESS3-1 - Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. HS-ESS3-2 - Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. HS-ESS3-4 - Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. 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.	
Science and Engineering Practice	**Disciplinary Core Idea**	**Crosscutting Concept**

Developing and Using Models Planning and Carrying Out Investigations Obtaining, Evaluating, and Communicating Information Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions Asking Questions and Defining Problems.	PS1.A: Structure and Properties of Matter PS1.B: Chemical Reactions PS1.C: Nuclear Processes PS2.B: Types of Interactions ETS1.A: Defining and Delimiting Engineering Problems. ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Patterns Energy and Matter Structure and Function *Connections to Nature of Science* Scientific Knowledge Assumes an Order and Consistency in Natural Systems Systems and System Models *Connections to Engineering, Technology, and Applications of Science* Influence of Science, Engineering, and Technology on Society and the Natural World

Unit 5 – Shop Tools	**Total Learning Hours for Unit:** 20

Unit Summary:
This unit is designed to be taught while completing lab activities or manufacturing a project. As new tools are needed to complete the project, instruction on safe and proper use, and care of those shop tools will occur. Tools will vary depending upon the lab activity or the project being manufactured.

Performance Assessments: (Districts to complete for each unit)
Example assessments for this unit include:

General

- Students understand and apply the criteria to inspect Shop Tools and implement appropriate procedures to notify supervisors of equipment maintenance needs.
- Explain and demonstrate knowledge of the hand tools, power tools, and stationary equipment found in the classroom and laboratory.
- Observation of correct and safe applications of hand tools, power tools, and stationary equipment concepts in the performance of activities in the classroom and laboratory.
- Explain and demonstrate safety practices related to tool operation, maintenance, and storage.
- Demonstrate through written tasks and examinations the concepts and skills in using hand tools, power tools, and stationary equipment.
- Work in groups to safely use hand tools, power tools, and stationary equipment.
- Use available technology-based tools, printed documentation, and other media sources to research and make presentations of hand tools and power tools.
- Students understand and articulate how to safely handle waste from projects and classroom activities.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Classroom presentations relating to the steps in safe and appropriate use of tools, and how to handle changes to materials (heat, material construction, chemical and/or physical reactions, fumes, handling and disposing of waste materials, fuels, and lubricants, etc. and how their use could impact the environment.
- Reading information from commonly available sources and then creating an Operator's Manual for various construction tools. Students will include concepts, and information clearly and accurately through the selection, organization, and analysis of content.
- Developing an informative presentation on the safe operation of a power tool. The presentation will fully evaluate the usefulness of the power tool and identify potential hazards of improper tool use.
- Evaluating other written products and presentations' point of view, reasoning, and use of terminology when using the power tools.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Presenting the safe use of tools to include instruction on the human and machinery force required for the use of the tools. Students will need to understand how much force can safely be used to ensure shop tools are functional as well as safe.
- Identifying the materials that tools are made from and how those tools might safely be used (ex. "Can I use a tool made from aluminum to cut or shape a piece of steel? If so, how can it be done?")
- Analyzing real-world situations by presenting solutions based on specific criteria and limitations.
- Communicating technical information or ideas in multiple formats.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Understanding the correct use of shop tools requires an in-depth knowledge of units. It necessitates fluency in the English and Metric system and of the tool - just because the tool provides a measurement, one cannot assume it's correct. There are many examples where incorrect units were recorded resulting in safety issues and wasted resources. In this unit, students will practice hands-on skills with a variety of shop tools – being challenged each time, what units to use, why, and what factors go into selecting the appropriate tool.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

Through team-based activities relating to maritime careers students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Leadership Skills:

1.A Think Creatively.
1.B Work Creatively with Others
2.A Reason Effectively
2.B Use Systems Thinking
2.C Make Judgments and Decisions
2.D Solve Problems.
4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- Safe Use of Hand Tools - Demonstrate an understanding of Hand Tool Safety and Care.
- Safe Use of Power Tools - Demonstrate an understanding of Power Tool Safety and Care.
- Proper Tag-Out Procedures - Inspect Shop Tools and implement appropriate procedures to notify supervisors of equipment maintenance needs.
- Environmental Safety - Understand how to safely handle waste related to Shop Tool use

Aligned Washington State Academic Standards	
English Language Arts: Common Core	RL.11-12.1 - Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain. RL.11-12.2 - Determine two or more themes or central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to produce a complex account; provide an objective summary of the text. SL.11-12.1 - Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. SL.11-12.1.A - Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas. SL.11-12.1.B - Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed. RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. RST.11-12.4 - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*.

	RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas. RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem. RST.11-12.8 - Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. RST.11-12.9 - Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently. Write arguments focused on *discipline-specific content*. WHST.11-12.1.A - Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence. WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. *WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.* WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information. WHST.11-12.7 - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.

	WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Environment and Sustainability	Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels. Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments. Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.
Mathematics: Common Core	HSN-Q.A.1 - Use units to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. HSN-Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling. HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. HSA.SSE.A.1 **-** Interpret expressions that represent a quantity in terms of its context. HSA.SSE.A.1.A **-** Interpret parts of an expression, such as terms, factors, and coefficients
Mathematical Practices	MP2 **-** Reason abstractly and quantitatively. MP4 **-** Model with mathematics. MP5 **-** Use appropriate tools strategically. MP6 **-** Attend to precision. MP8 - Look for and express regularity in repeated reasoning.
Science	HS-PS2-1 **-** Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-2 **-** Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system. HS-PS2-3 **-** Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.

	HS-ETS1-1. **-** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2 **-** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3. **-** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Developing and Using Models Planning and Carrying Out Investigations Obtaining, Evaluating, and Communicating Information Asking Questions and Defining Problems. Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	PS1.A: Structure and Properties of Matter PS1.C: Nuclear Processes PS2.B: Types of Interactions ETS1.A: Defining and Delimiting Engineering Problems. ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Patterns Energy and Matter Structure and Function Systems and System Models *Connections to Engineering, Technology, and Applications of Science* Influence of Science, Engineering, and Technology on Society and the Natural World

Unit 6 – Safety	**Total Learning Hours for Unit:** 20

Unit Summary:

This unit covers:

- Covers OSHA and Environmental Health & Safety (EH&S) program design in Washington State including goals and practices. Topics include hazardous communication, ergonomics, safety regulations, human factors, and standard operating procedures as they relate to safety, personal protective equipment, and lockout-tag out, hand and power tool safety, industrial housekeeping, and environmental safety.
- Recreational safety on the water and shoreside. *It is strongly recommended that before teaching this unit that students will have received their Washington State Boater Education Safety Certification.*

It is also recommended that teachers investigate the feasibility of having an outside agency provide First Aid Training and Certification as part of this unit.

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

General

Students:

- Discuss the benefits of an effective environment, health, and safety program.
- Describe and apply the four elements of an effective environment, health, and safety program.
- Describe and provide examples for each of the three methods to prevent and control workplace hazards.
- Explain the term "safety culture."
- Observation of correct and accurate applications of safety concepts in the performance of activities in the classroom and laboratory.
- Classroom presentations relating to the safe use and appropriate use of tools, and how to handle changes to materials (heat, material construction, chemical and/or physical reactions, fumes, handling and disposing of waste materials, fuels, and lubricants, etc.) and how their use could impact the environment.
- Demonstrate through written tasks and examinations the concepts and skills and understanding of safety awareness.
- Use various technology-based tools, printed documentation, and other information sources to create maritime-related presentations related to safety at the workplace and on the water.
- Describe the safety requirements for working on shipboard and shoreside electrical systems.
- Describe the application of safe working practices in the workshop environment.
- Explain how the safety knowledge learned is applied to the operation of a recreational vessels under their control.
- Recognize how safety is applied to the unique environment(s) where work and living spaces coexist.
- Donn a personal floatation device (PFD) .
- Show knowledge of basic water and land survival skills, heat exposure, summing help, navigation, and rescue.
- Complete a Float plan in accordance with the WA State Boater's Education Program and USCG recommendations.
- Cite the required equipment to be onboard prior to getting underway in a recreational vessel (Boater's Education Card).
- Cite the safety precautions associated with the operation of Personal Watercraft (WA State Boater's Education Program).
- Complete a job safety analysis for a critical work assignment or a Hot Work Permit for welding.
- Demonstrate the use of personal protective equipment (PPE) in shop activities such as grinding, cutting, brazing, etc.
- Explain the difference between respirators and self-contained breathing apparatus (SCBA).
- Demonstrate the proper selection and use of tools during shop activities.
- Explain the emergency and safety signals used aboard ships (Fire, man Overboard, Abandon ship).
- Explain the process and procedures required for Enclosed Space Entry.
- Describe inhalation hazards and effects of petroleum.
- Describe toxicity and the terms used to describe the toxicity of a substance.
- Describe the hazards associated with Benzene and Hydrogen Sulfide
- Explain the use of oxygen meters and combustible gas indicator aboard ships.
- Describe the signs of oxygen deficiency and where these hazards may exist onboard ships (chain locker, drying paints, enclosed spaces, etc.).
- Identifying and explaining safety as it relates to terminal operations.
- Identify and explain a Fire Suppression system and its components, and what to do in a fire emergency.

- Examining and interpreting various case studies of sea disasters and near-miss reporting and developing potential solutions that would have prevented these incidents.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Describe the four main employer responsibilities under the HazCom standard.
- Describe the five basic components of an appropriate HazCom program.
- Compare and contrast the various HazCom labeling requirements.
- Locate, select, and interpret Material Safety Data Sheets (MSDS) for various materials found in the lab or shop.
- Explain and interpret a "fire diamond."
- Compare and contrast federal, state, and local government safety regulations.
- Locate appropriate safety regulations that affect the individuals and employers.
- Interpret the uniform numbering system for the code of federal regulations and name at least 3 different disciplines from which human factors draws its base of study.
- Creating safety posters and cartoons.
- Review accident investigations and develop an accident investigation process.
- Prepare presentation on the various impacts of human factors.
- Research studies on sleep patterns, safety, and circadian rhythms, how is sleep adjusted on ships or businesses operating 24 hours?
- Research on human behavior and psychology used in the creation of safety programs but studying Near Miss Reports.
- Prepare a discussion on Industrial Hygiene and the scope of work of an industrial hygienist.
- Research maritime accidents due to hot work, static electricity, or the use of PVC piping in cargo lines.
- Research major maritime safety and environment treaties, SOLAS, MARPOL, STCW, OPA'90.
- Prepare presentation on application or lack thereof of OSHA onboard ships.
- Prepare discussion on Harbor Safety Act – longshore workers.
- Research and prepare discussion on the origins of STCW, and other major international safety legislation.
- Discussion on airborne contaminants, benzene, chemical hazards
- Prepare an oil spill response plan for local area. Research and present state plan for same clean up.
- Research oil spill plans for railcars.
- Research responsibilities for recreational boater and oil spill cleanup and effective ways to mitigate the spill.
- Writing a Safety or Incident Report.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Understanding the MSDS is an individual or pair's activity which reviews the MSDS for Clorox, or other common household items students would be familiar.
- Explaining an Environmental Management System and the goals of the EPA for a facility EMS.

- Utilizing the safe and appropriate use of tools, and how to handle changes to materials (heat, material construction, chemical and/or physical reactions, fumes, handling and disposing of waste materials, etc.
- Analyzing real-world situations by identifying criteria and limits for successful solutions.
- Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- Communicate technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).
- Researching and developing to skim oil or contain it.
- Researching how dispersants work and the impacts to the marine environment.
- Research the firefighting techniques for various noxious liquid substances and how are they contained if spilled.
- Explaining the layers of oil and water, thieving a tank, interface and settling out. API gravity, specific gravity density and flammability.
- Research and prepare a presentation on how the oil rig Deep Water Horizon was capped.
- Describe the terms oxygen deficiency, flammable ranges and limits, static electricity, inert gas, threshold limit values (TLV).

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Interpreting Occupational Injury and Illness Data.
- Conduct a short research project to evaluate statistical data sets related to various maritime-related safety accidents, frequencies, and causes. Organize the results to ensure comprehension by target audience, and present findings.
- Determine the impact of personal protective equipment on productivity by collecting evidence and compiling data.
- Locating and practicing the excavation safety plan for the classroom and laboratory established to ensure safe evacuation in case of emergency.
- Describe how ergonomics plays into the manufacture of safety equipment and equipment used in the workplace.
- Demonstrate the mathematical logic used in the injury pyramid (# of near misses leads to lost time injury).
- Calculating loss time injury rates.
- Calculating the cost of safety versus injury or death.
- Calculating the cost of safety equipment procurement.
- Calculating flammability limits for various chemical or petroleum products.
- Calculating toxicity limits, PPM, percentage of hydrocarbon by volume.
- Determining the increase in PPM of H2S in a liquid state and then the amount of H2S (PPM) as it evolves into a vapor state.
- Calculating the percentage of oxygen in a compartment containing a specific amount of hydrocarbon vapor.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

Throughout this unit, students are being taught and encouraged to use 21st Century Skills such as Leadership and Accountability, Flexibility and Adaptability, Communication and Collaboration, Critical Thinking and Problem Solving as well as Productivity.

Through team-based activities relating to the safe use of shop tools, and personal responsibility for safety students will:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).
- Determination of whether to enter a tank with hazardous material.
- Articulate what to do in an injury or medical emergency, fire, missing person, active shooter.
- Sounding the alarm and taking immediate response to emergencies.
- As part of an emergency drill, mustering groups and accounting for personnel.
- Creating rescue teams and response teams.
- Demonstrating the initiative and courage to shut down or Stop work!
- Preparing requests for proper personal protective equipment (PPE).
- Developing ways to motivate people to comply with the safety policies.
- Demonstrating key elements of Basic First Aid and CPR to peers
- Leadership Skills:

1.A Think Creatively.
1.B Work Creatively with Others
2.A Reason Effectively
2.B Use Systems Thinking
2.C Make Judgments and Decisions
2.D Solve Problems.
4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- EHS Program - Identify and understand the components of and reasons for an effective environment, health, and safety program.
- Understanding MSDS - Locate, select, and interpret Material Safety Data Sheets (MSDS) and/or Safety Data Sheets (SDS) for various materials found in the lab or shop.
- *PEAR* Model - Understand how People, Environment, Actions, and Resources (PEAR) can help in the development of a safety management system.
- Safety "Dirty Dozen" - Identify and minimize the 12 common causes of mistakes in manufacturing and maritime.
- Standard Operating Procedures (SOP) - Understand and implement Standard Operating Procedures as they relate to safety and daily operations.
- Personal Protective Equipment (PPE) - Students demonstrate and use PPE.

- Lockout/Tagout - Students identify and implement appropriate lockout/tagout procedures.
- Lean Manufacturing and 5S - Apply Lean Manufacturing and 5S principles.
- Environmental Management System - Students practice environmental safety.
- Standards for Training Certification and Watchkeeping (STCW) :: Standard of Competence for Officers in Charge of an Engineering Watch (OICEW) - Marine engineering at an Operational Level: STCW Table A-III/1
    - Use of appropriate tools for fabrication and repair operations typically performed on ships.
    - Use of hand tools and measuring equipment for dismantling, maintenance, repair and reassembly of shipboard plant and equipment.
    - Use of English in written and oral form.
- Safe Working Practices for Seaman – Students identify key safety behaviors and practices of seamen.
- Shipyard safety programs – Students identify and describe the safety programs found in shipyards and boat building.
- Enclosed Space Entry – Students identify and implement appropriate enclosed space entry precautions.
- Hot Work permits – Students prepare a Hot Work permit.
- Behavior Based Safety Programs – Students identify the key elements of a Behavior Based Safety Program

Aligned Washington State Academic Standards

English Language Arts: Common Core	RL.11-12.1 - Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain. *RL.11-12.2 - Determine two or more themes or central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to produce a complex account; provide an objective summary of the text.* SL.11-12.1 - Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. SL.11-12.1.A - Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas. SL.11-12.1.B - Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed. RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

	RST.11-12.4 - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*. *RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.* RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem. RST.11-12.8 - Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. RST.11-12.9 - Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently. Write arguments focused on *discipline-specific content*. WHST.11-12.1.A - Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence. WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. *WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.* WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information. WHST.11-12.7 - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the

	flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research. WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Environment and Sustainability	Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels. Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments. Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.
Mathematics: Common Core	HSS.IC.B.3 **-** Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. HSS.ID.A.1 - Represent data with plots on the real number line (dot plots, histograms, and box plots). HSS.ID.A.2 - Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets. HSS.ID.A.3 - Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). HSS.ID.A.4 - Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve. HSS.IC.A.1 - Understand statistics as a process for making inferences about population parameters based on a random sample from that population. HSS.IC.A.2 - Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation.
Mathematical Practices	MP2 Reason abstractly and quantitatively.

Science	HS-PS2-1 - Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-2 **-** Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system. HS-PS2-3 **-** Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. HS-ETS1-1. **-** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2 **-** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3. **-** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Developing and Using Models Planning and Carrying Out Investigations Obtaining, Evaluating, and Communicating Information Asking Questions and Defining Problems. Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	PS1.A: Structure and Properties of Matter PS1.C: Nuclear Processes PS2.B: Types of Interactions	Patterns Energy and Matter. Structure and Function

Unit 7 – Standard Operating Procedures (SOP)	**Total Learning Hours for Unit:** 20

Unit Summary:

Standard Operating procedures or SOP's are a set of clearly written instructions which outline the steps or tasks needed to complete a job, operation or operate a piece of machinery or plant. The instructions must be written in a brief manner in simple language that all operators and employees required to perform the task are able to read and understand.

In this unit students will identify and practice the culture of Quality Management Systems (QMS) and will focus on writing and analyzing the Standard Operating Procedures necessary to promote efficiency, quality, safety, and customer satisfaction.

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

General

Students:

- Define QMS.
- Describe Enterprise Level QMS.
- Explain the hierarchy of a Production (new construction or repair) Work Order.
- Identify a standardized process in their environment.
- Demonstrate knowledge of SOP and identify revisions required for increase/effective Enterprise QMS.
- Define Root Cause Analysis in fundamental terms.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Articulating thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Reporting and presenting information and drawing conclusions regarding why and how the geographic features of the Pacific Northwest has influenced native culture, exploration, and maritime development; past, present, and future.
- Create and present a standard process for identifying the materials that will be used for an identified purpose, how those materials are selected, and how those selected materials influence the manufacturing process of that identified purpose.

Mathematics

Students demonstrate mathematics understanding be:

- Data collection and organization relating to root cause analysis to create and implement potential solutions.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

Through team-based activities relating to maritime careers students will:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).

- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Leadership Skills:
1.A Think Creatively.
1.B Work Creatively with Others
2.A Reason Effectively
2.B Use Systems Thinking
2.C Make Judgments and Decisions
2.D Solve Problems.
4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- **Quality Management Systems (QMS)** - Understand how quality standards for production and operation positively impact companies.
- **Root Cause Analysis** - Identify current and potential problems and create solutions.
- **International Standards (ISO)-** Identify and implement international standards that are used in the maritime industry.

Aligned Washington State Academic Standards	
English Language Arts: Common Core	*RI.11-12.1 - Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.* RI.11-12.3 - Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text. RI.11-12.4 - Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10). *RI.11-12.5 - Analyze and evaluate the effectiveness of the structure an author uses in his or her exposition or argument, including whether the structure makes points clear, convincing, and engaging.* SL.11-12.1 - Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. SL.11-12.1.A - Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas. SL.11-12.1.B - Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.

	SL.11-12.1.C - Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives. SL.11-12.4 - Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks. SL.11-12.5 - Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. SL.11-12.6 - Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate. L.11-12.1 - Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. L.11-12.1.A - Apply the understanding that usage is a matter of convention, can change over time, and is sometimes contested. L.11-12.2 - Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. *L.11-12.2.A - Observe hyphenation conventions*. L.11-12.2.B - Spell correctly. L.11-12.4 - Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on *grades 11-12 reading and content*, choosing flexibly from a range of strategies. L.11-12.4.A - Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word's position or function in a sentence) as a clue to the meaning of a word or phrase. L.11-12.4.B - Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., *conceive, conception, conceivable*). L.11-12.4.C - Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, its etymology, or its standard usage. L.11-12.4.D - Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary) L.11-12.5 - Demonstrate understanding of figurative language, word relationships, and nuances in word meanings. L.11-12.5.A - Interpret figures of speech (e.g., hyperbole, paradox) in context and analyze their role in the text. L.11-12.5.B - Analyze nuances in the meaning of words with similar denotations.

	L.11-12.6 - Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression. *RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.* RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. RST.11-12.4 - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*. *RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.* RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem. RST.11-12.8 - Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. RST.11-12.9 - Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently. Write arguments focused on *discipline-specific content*. *WHST.11-12.1.A - Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.* WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. *WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.* WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

	WHST.11-12.7 - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research. WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Environment and Sustainability	Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels. Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments. Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.
Mathematics: Common Core	CCSS. Math.Content.HSS.ID.A.3 **-** Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). CCSS. Math.Content.HSS.IC.B.3 **-** Make inferences and justify conclusions from sample surveys, experiments, and observational studies: Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.
Mathematical Practices	MP2 - Reason abstractly and quantitatively MP4 - Model with mathematics.
Science	HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2 **-** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

	HS-ETS1-3 **-** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.	
Science and Engineering Practice	**Disciplinary Core Idea**	**Crosscutting Concept**
Asking Questions and Defining Problems. Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	ETS1.A: Defining and Delimiting Engineering Problems. ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Systems and System Models *Connections to Engineering, Technology, and Applications of Science* Influence of Science, Engineering, and Technology on Society and the Natural World

Unit 8 – Precision Measurement	**Total Learning Hours for Unit:** 10

Unit Summary:

Semi Precision and Precision Measurement is an essential overview of measurement techniques commonly found in manufacturing. Topics include precision measurement vs. semi-precision measurement, units, an introduction to geometric dimensioning and tolerances, and the use, care, and calibration of precision measurement tools. This lesson includes a variety of hands-on activities with several types of precision measurement tools, including English rules (machinist scales), gage blocks, different types of gages, Vernier tools, dial calipers, micrometers, and more. Following successful completion of this unit, students will be able to select and apply the appropriate measurement tool for an assigned task.

It is recommended that the precision measurement tools be taught in relation to the materials being utilized during the unit. Since the primary measurement tool for wood is a tape measure, framing squares, or other measurement tools that are calibrated in fractions, it is recommended that instruction regarding fractions is taught while wood is the primary material. If metal is the material being utilized, the addition of micrometers and calipers, where the tools are calibrated in decimals, is recommended.

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

General

- Students properly document, use and maintain semi-precision and precision measurement tools.
- Students describe the differences between inland and marine sector careers.
- Students identify and describe job skills that enable people to enter maritime careers, including military opportunities.
- Students demonstrate how to calibrate and read a Vernier scale and/or a dial caliper, and Micrometers.
- Students will recognize, interpret, and make recommended adjustments based on reading taken from various meters and gauges.
- Students identify and explain the uses of precision measuring tools that are pertinent to the students' career interests.
- Students understand basic instrumentation.

English/Language Arts

Students will demonstrate ELA competencies through several classroom and laboratory activities like:

- Identifying the **Geometric Dimensioning and Tolerancing** (**GD&T**) symbols that represent specific tolerances.
- Read and interpret a **Feature Control Frame**.
- Explaining care and handling procedures of Precision Measurement tools, and the need for calibration
- Identifying and interpreting information found on various instruments and gauges found on dashboards and instrument panels.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Successfully completing the Student Booklet as well as the application of the learning during the design, manufacturing, and testing during laboratory and/or manufacturing activities. Use mathematical representations of phenomena to describe explanations.
- Creating a computational model or simulation of a phenomenon, designed device, process, or system.
- Designing, evaluating, and/or refining a solution to a complex real-world construction problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
- Identifying and interpreting the information found on a **feature control frame** that is required to describe the conditions and tolerances of a geometric control on a part's feature.
- Creating and using a model based on evidence to predict the relationships between systems or between components of a system.
- Communicating technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Applying math to calculate measurement and tolerances found in industrial manufacturing and repair environments.
- Interpreting a set of geometric dimensioning symbols used to define relationships between a feature and a measurement reference.
- Accurately measuring using semi-precision and precision measurement tools.
- Choosing the appropriate semi-precision and precision measurement tool for an assigned task.
- Selecting appropriate units and level of precision as defined by industry standards.
- Comprehending and applying the concept of scale when reading construction drawings and prints, and when designing projects.
- Performing measurement and layout activities for various marine applications. Tasks will include dimensional mathematics, manipulating fractions, and extrapolating values from two-dimension representations to three dimensional products.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

Through team-based activities relating to maritime careers students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.

- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Leadership Skills:
1.A Think Creatively.
1.B Work Creatively with Others
2.A Reason Effectively
2.B Use Systems Thinking
2.C Make Judgments and Decisions
2.D Solve Problems.
4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- **Reading Prints and Drawings -** Identify lines, symbols, abbreviations, and nomenclature within prints.
- **Precision, Accuracy, and Tolerance** - Understand the differences between precision, accuracy, and tolerance and how these terms relate to Precision Measurement.
- **Calibration** - Understand calibration and be able to make appropriate adjustments when using precision measurement tools.
- **Geometric Dimensioning and Tolerancing** - Understand the term related to Geometric Dimensioning and Tolerancing and how to interpret them on drawings.
- **Feature Control Frame** - Interpret information found in Feature Control Frames and apply those criteria in Precision Measurement.

Aligned Washington State Academic Standards	
English Language Arts: Common Core	RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. RST.11-12.4 - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*. *RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.* RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem. RST.11-12.8 - Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

	RST.11-12.9 - Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently. Write arguments focused on *discipline-specific content*. WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. WHST.11-12.7 - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research. WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Environment and Sustainability	Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments. Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.
Mathematics: Common Core	HSN-Q.A.1 - Use units to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. HSN-Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.

	HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. HSA.SSE.A.1 **-** Interpret expressions that represent a quantity in terms of its context. HSA.SSE.A.1.A **-** Interpret parts of an expression, such as terms, factors, and coefficients
Mathematical Practices	MP 2 **-** Reason abstractly and quantitatively. MP 4 **-** Model with mathematics. MP 5 **-** Use appropriate tools strategically. MP 6 **-** Attend to precision. MP 8 **-** Look for and express regularity in repeated reasoning.
Science	HS-ETS1-2 **-** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3. **-** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Asking Questions and Defining Problems. Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	ETS1.A: Defining and Delimiting Engineering Problems. ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Systems and System Models *Connections to Engineering, Technology, and Applications of Science* Influence of Science, Engineering, and Technology on Society and the Natural World

Unit 9 – Print Reading	**Total Learning Hours for Unit:** 30

Unit Summary:

This unit includes basic terminology, drawing categories and authorities, all about the picture sheet, including the title block, the geometric elements found in a drawing and the Alphabet of Lines. Students will also learn to interpret different pictorial views of print readings, and then they will practice drawing and constructing these views. These include the most common views, isometric and orthographic, but also include detail, section, auxiliary and cutting views. In addition, students will learn to identify the many drawing symbols found in industry. The more commonly used symbols are included in this lesson: flag notes, holes, materials, shapes, and electric symbols. Special attention might be paid to Emergency Distress Symbols Publication 102 (Flags).

This unit includes reading plans and diagrams commonly used in the maritime industry. This includes boat building plans (half-breadth, body, sheer, sail), construction plans, the techniques used in lofting, ship arrangement plans, fire control plans, fire and foam system drawings, fire and emergency symbols, cargo and fuel oil piping diagrams, pump room diagrams, instructional schematics used on shipboard equipment, engine room diagrams, HVAC systems, plumbing drawings, engineering prints, repair/maintenance drawings, and electrical drawings.

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

General

Students:

- Understand fundamental terminology related to prints and drawings.
- Recognize different drawing categories.
- Recognize and apply different drawing authorities.
- Recognize the purpose and interpret the various elements found on a picture sheet.
- Locate the Title Block on a drawing and identify the name, purpose of a drawing, and other fields depicted.
- Interpret geometric elements in a drawing.
- Identify the Alphabet of Lines.
- Identify the location of safety equipment on a fire control plan.
- Identify key symbols used in specific schematics and drawings.
- Compare a print/drawing to its real-world installation.
- Simulate a procedure/operation which requires reading a print or schematic.
- Creating a print/drawing for their Capstone project (if applicable).
- Compare the reading of print/schematics to reading maps and nautical charts.
- Recognizing how the principles of quality assurance applies to the procedures for making changes/corrections to a print/schematic.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Understanding fundamental terminology related to sketches, blueprints, and drawings.
- Recognizing drawing categories.
- Translate a simple construction drawing from its symbolic and dimensional representation into a written description that presents the form and function of each element.
- Given a set of specifications, sketch a representation using correct symbols and dimensions, then present your project to the class.
- Apply drawing authorities.
- Recognizing and interpret the elements found on a picture sheet.
- Locating the Title Block on a drawing and identify the name, purpose of a drawing, and other fields depicted.

- Given a drawing, correctly prepare a Request for Information (RFI) that accurately describes the problem and the specifics of the information being sought.
- Researching the "who, what, where, when, why and how" about CAD drawings and their applications in the maritime industry.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Describing the safe use of tools, including instruction on the human and machinery force required for the use of the tools.
- Including mathematical representations of events to describe explanations and potential solutions.
- Creating a computational model or simulation of an event, device, process, or system.
- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.
- Use a model based on evidence to predict the relationships between systems or between components of a system.
- Communicate technical information or ideas (e.g., about events and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).
- Reading a print/schematic identifying the equipment and process that is occurring (cargo flows through a pipe to a pump and pressure is increased).
- Reading a print/schematic and using knowledge of the function being performed; locate and identify critical points for diagnostic solutions and problem solving i.e., closed/open valves, faulty pressure sensors, bypass valves/lines, etc.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Creating and using drawings and prints that exhibit perspective, multiple planes, two and three dimensions, blown-up and enlarged views, and details of the drawing.
- Using drawings and blueprints to determine material quantities, convert units of measure, place orders, and construct budgets.
- Consistently and accurately converting measurement values between imperial and metric units and decimals when calculating values.
- Using the Pythagorean Theorem to determine and verify square and plumb layout.
- Creating full size or scaled models from prints/schematics used for their Capstone projects.
- Estimating the volume of cargo or fuel oil piping and other fluid lines from prints and schematics.
- Estimating the changes in electrical resistance, amperes, etc. from reading a print/schematic drawing.
- Redrawing print/schematic is a different scale or redrawing a specific portion of the schematic.
- Estimating the increase/decrease in pressure at points in a cargo piping system through reading prints/schematics.
- The use of "lofting" techniques and/or application to their Capstone Project.
- Estimating the vessel's tonnage, displacement, capacities of tanks, cofferdams and other or vessel spaces from reading prints/schematics.
- Researching the computer programming and mathematics behind CAD drawings and their applications in the maritime industry.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.
Example:
Through team-based activities relating to maritime careers students will:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).
- Working within a team to solve a problem which requires reading a print/schematic (high pressure in a system line).
- Assisting teammates to better understand the reading of prints/schematics.
- Building confidence in the ability to read prints/schematics for diagnostic or trouble shooting purposes.
- Using print/schematics to build their Capstone project.

Leadership Skills:
1.A Think Creatively.
1.B Work Creatively with Others
2.A Reason Effectively
2.B Use Systems Thinking
2.C Make Judgments and Decisions
2.D Solve Problems.
4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- Drawing Categories - Understand and use Detail Drawings, Assembly Drawings, and Installation Drawings.
- Picture Sheets - Interpret and implement information found on Picture Sheets.
- Title Block - Locate and interpret the information found on Title Blocks.
- Geometric Elements - Understand how straight, parallel, and curved lines are used to show a 3-dimensional object in two dimensions.
- Interpreting Perspective, Isometric, and Orthographic Views - Understand how Perspective Drawings, Isometric Drawings, and Orthographic Drawings are different and identify instances where each are used.
- Scale Reading - Use different scales to measure items in fractions, decimals, and metric units.
- Angle Dimensioning - Use different protractors and angle gauges to measure six common angles, arcs, and cylinders in degrees inches, and metric units.
- Base Line Dimensioning - Interpreting drawing information as it relates to a Point of Origin.
- Tolerancing - Understanding the limits of acceptable variation for an item are specified by the designer on various drawings.
- General and Specific Tolerances - Understand how Perspective Drawings, Isometric Drawings, and Orthographic Drawings are used to identify where Specific Tolerances are called for and where General Tolerances do not apply.

• Standards for Training Certification and Watchkeeping (STCW) and USCG examinations: practical knowledge in the use of prints/schematics found aboard ships and marine vessels. For example, the use of fire control plans, the recognition of fire and emergency symbols, symbols for hazardous materials, safety symbols on equipment (lifeboat/life raft), the use of shipboard general arrangement plans, piping diagrams, etc. • Communicating with Flags, Publication 102 (flags).	
Aligned Washington State Academic Standards	
English Language Arts: Common Core	RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. RST.11-12.4 - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*. *RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.* *RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.* RST.11-12.8 - Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. *RST.11-12.9 - Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.* RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently. Write arguments focused on *discipline-specific content*. WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. WHST.11-12.7 - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

	WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research. WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Environment and Sustainability	Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels. Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments. Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.
Mathematics: Common Core	HSG.GMD.B.4 **-** Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects. HSG.CO.A.5 **-** Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another. HSG.MG.A.1 **-** Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder) HSG.SRT.C.8 - Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems
Mathematical Practices	MP 2 **-** Reason abstractly and quantitatively. MP 4 **-** Model with mathematics. MP 5 **-** Use appropriate tools strategically. MP 6 **-** Attend to precision. MP 8 **-** Look for and express regularity in repeated reasoning.

Science	HS-PS2-1 **-** Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-2 **-** Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system. HS-ETS1-1. **-** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2 **-** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3. **-** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Science and Engineering Practice	**Disciplinary Core Idea**	**Crosscutting Concept**
Developing and Using Models Planning and Carrying Out Investigations Obtaining, Evaluating, and Communicating Information Asking Questions and Defining Problems. Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	PS1.A: Structure and Properties of Matter PS1.C: Nuclear Processes PS2.B: Types of Interactions ETS1.A: Defining and Delimiting Engineering Problems. ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Patterns Energy and Matter Structure and Function Systems and System Models *Connections to Engineering, Technology, and Applications of Science* Influence of Science, Engineering, and Technology on Society and the Natural World

Unit 10 - Applied Physics	**Total Learning Hours for Unit:** 30

Unit Summary:

Students will be given the guiding principles of physics. Its purpose is to help students understand why things move and how machines operate based on these principles. Students will gain the knowledge of the primary laws of physics and how they apply to the design and construction of marine vessels, the operations conducted aboard, and the operation and manufacturing of the equipment found thereon.

This includes the primary laws of physics related to mass and measurement, liquid pressure, Archimedes' principle, density and specific gravity, air pressure and the atmosphere, the effects of concurrent or parallel forces, Newton's laws of motion, the motion of celestial bodies, mechanical and electromechanical waves, the principles of work, power and energy, simple machines, the principles of heat and expansion, transmission of heat, the nature and propagation of light, reflection of light, refraction or light, optical instruments, magnetism, static electricity, electrical current and magnetic effects, electrical energy and power, radio and electromagnetic waves, and the principles of physics on a ship`.

It is recommended that during this unit that students will be manufacturing a Capstone project, and this information will be continually instructed throughout the manufacturing process. It is recommended that this information be covered during manufacturing steps where the specific Applied Physics information is pertinent.

To meet English Language Arts standards, journaling and other writing and student presentations are embedded into all Core Plus Maritime units and materials.

Performance Assessments: (Districts to complete for each unit)
Example assessments for this unit include:

General

- Students understand and explain the guiding principles of physics related to mass, weight, gravity, force, power, work, machines, heat, pressure, gas laws, fluid mechanics and waves.
- Students explain why things move and how machines operate based on these principles.
- Students understand and explain the guiding principles of physics related to kinetic energy, thermal properties, gas laws, and how to solve for pressure, temperature, or volume.
- Students identify the various components of water and other maritime fluids.
- Students share their knowledge of buoyancy and how to determine if something will float using the buoyancy formula.
- Students share their knowledge of the primary laws of physics and how they apply to manufacturing.
- Students understand and explain the properties of optical instruments.
- Students understand the fundamental units of measurement.
- Students understand and explain the molecular forces in solids and liquids.
- Students understand and explain the transmission of pressure.
- Students understand center of gravity and stability.
- Students understand the operation of a simple electrical circuit.
- Students understand how a simple battery works.
- Students understand the basic characteristics of sound.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Explaining the relationship between matter and mass and name the three states of matter.
- Defining weight and gravity, how weight relates to mass, and how that impacts buoyancy.
- Defining Specific Gravity and calculate a Specific Gravity ratio given density or weight of an object.
- Defining energy and name the two types of energy in objects.
- Explaining the differences between force, work, and power, and where those forces are found in maritime environments.
- Describing the force of friction and how it can be measured and/or identified.

- Explaining the relationship between heat, and kinetic energy.
- Describing various forms of energy and their capacity to be converted to heat and how that heat is controlled or used.
- Comparing methods of heat transfer and their uses in maritime applications.
- Explaining the significance of the phrase "The Art of the Yarn" as it relates to seafarers.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Defining machines and identifying simple machines.
- Distinguishing between different types of levers and inclined planes, and how they can be utilized advantageously.
- Defining mechanical advantage and calculate it using force/distance variables.
- Solving for mechanical work using effort and resistance variables, and what type of equipment might be used to take in those situations (ex., ropes, pulleys, chains, gears, hydraulics, etc.).
- Defining stress and its effects.
- Distinguishing between speed and velocity; explain how they are related to acceleration.
- Defining heat, its relation to kinetic energy, and its units in both English and Metric.
- Listing and describing forms of energy which can be converted to heat.
- Explaining how heat is transferred and list three methods of heat transfer.
- Defining Thermal Efficiency and how it is measured.
- Defining Specific Heat and solve for Thermal Expansion.
- Defining pressure, list different pressure gauges, and practice solving for psi.
- Explain wave phenomena.
- Define wave vocabulary, including units.
- Identify the classifications of waves.
- Explain the electromagnetic spectrum in terms of why some waves are visible and others are not visible by the naked eye.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Explaining the relationship between matter and mass and name the three states of matter.
- Defining weight and gravity, and how weight relates to mass.
- Solving for weight, mass and gravity using the given formula(s) and using appropriate units.
- Defining density and solve for density, mass, volume using the given formula(s) and using appropriate units.
- Defining Specific Gravity and calculate a Specific Gravity ratio given density or weight of an object.
- Explaining how to determine if something will float using the buoyancy formula.
- Calculating conversion problems relating to:
    - **Amplitude**: Maximum distance the wave vibrates from the rest position.
    - **Wavelength**: The distance between any adjacent crests or troughs in a series of waves.

- **Crest and Trough**: The high point and the low point of each wavelength.
- **Period**: The time it takes to complete a cycle or wave oscillation.
- **Graphing Wave Frequency** as it relates to the number of waves in a given amount of time.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

Through team-based activities relating to maritime careers students will:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Leadership Skills:

1.A Think Creatively.

1.B Work Creatively with Others

2.A Reason Effectively

2.B Use Systems Thinking

2.C Make Judgments and Decisions

2.D Solve Problems.

4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- Specific Gravity - Calculate a Specific Gravity ratio given density or weight of an object.
- Energy - Explain the differences between force, work, and power.
- Mechanical Advantage - Understand and calculate the ratio of the force produced by a machine to the force applied to it, and how this is used in assessing the performance of a machine.
- Torque - Articulate how the forces applied in a twisting motion are measured.
- Amplitude - Maximum distance the wave vibrates from the rest position.
- Wavelength - The distance between any adjacent crests or troughs in a series of waves.
- Crest and Trough - The high point and the low point of each wavelength.
- Period - The time it takes to complete a cycle or wave oscillation.
- Graphing Wave Frequency - the number of waves in a given amount of time.

Aligned Washington State Academic Standards

English Language Arts: Common Core	RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. RST.11-12.4 - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*. *RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.* RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. RST.11-12.8 - Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. RST.11-12.9 - Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently. Write arguments focused on *discipline-specific content*. WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. WHST.11-12.7 - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

	WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Environment and Sustainability	Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels. Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments. Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability
Mathematics: Common Core	HSN.Q.A.1 **-** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. HSN.Q.A.2 **-** Define appropriate quantities for the purpose of descriptive modeling. HSN.Q.A.3 **-** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. HSA.CED.A.1 **-** Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions. HSA.CED.A.4 **-** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R. HSA.REI.B.3 **-** Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters
Mathematical Practices	MP5 **-** Use appropriate tools strategically. MP6 - Attend to precision. MP7 **-** Look for and make use of structure. MP8 **-** Look for and express regularity in repeated reasoning.
Science	HS-PS2-3 - Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. HS-PS2-4 - Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

	HS-PS3-1 - Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. HS-PS3-2 - Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects) HS-PS3-3 - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. HS-PS3-4 - Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). HS-PS3-5 - Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. 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.	
Science and Engineering Practice	**Disciplinary Core Idea**	**Crosscutting Concept**

Developing and Using Models Planning and Carrying Out Investigations Obtaining, Evaluating, and Communicating Information Asking Questions and Defining Problems. Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	PS1.A: Structure and Properties of Matter PS1.C: Nuclear Processes PS2.B: Types of Interactions ETS1.A: Defining and Delimiting Engineering Problems. ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution.	Patterns Energy and Matter Structure and Function Systems and System Models *Connections to Engineering, Technology, and Applications of Science* Influence of Science, Engineering, and Technology on Society and the Natural World

Unit 11 – Math for Industry	**Total Learning Hours for Unit:** 20

Unit Summary:

This unit helps students recognize where and how mathematics has been and is used in the maritime industry. This unit has been designed to help students see where and how mathematics is used, not only as a process for making various calculations and decisions, but as a means of communication with and between similar disciplines in maritime and manufacturing applications.

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

General

Students:

- Explain and demonstrate knowledge of mathematical concepts of as they relate to maritime activities.
- Observation of correct and accurate applications of mathematic concepts in the performance of practical activities in the classroom and laboratory.
- Demonstrate through written tasks and examinations the concepts and skills in using mathematics.
- Work in groups to apply mathematics principles to concepts such as Load Plans and Safe Working Loads, the Economics of Shipping (ton-mile, freight weight), Stored Energy Devices (batteries, hydraulic and pneumatic systems, estimating, scheduling, and budgeting).
- Using data to compute the environmental impact of operations.
- Using the scale of operations to show how small changes and improvements add up over millions of TEUs.
- Explaining and adjusting for how a degree of difference in a ship's navigation does not make a big difference in the short run but it sure does after 1000 miles.
- Use technology-based tools, printed documentation, and other media sources to research and make presentations of mathematical solutions to various marine-related activities.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Synthesizing into coherent written products the culmination of mathematical activities related to manufacturing operations such as estimating, scheduling, or budgeting.
- Participating in collaborative activities to solve maritime-related problems with mathematical techniques and present findings to the larger group.
- Writing reports on the biographies of inventors, physicists, chemist, mathematicians, naturals scientist, philosophers whose contributions led to the discoveries and principles applied in the classroom, laboratory, and real-world activities.
- Synthesizing into coherent written products the culmination of mathematical activities related to marine and aerial navigation applications.
- Synthesizing into coherent written products the culmination of mathematical activities related to marine engineering operations.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Analyzing complex real-world problems by specifying criteria and constraints for successful solutions.
- Designing, evaluating, and/or refining a solution to a complex real-world maritime or manufacturing problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
- Using a model based on evidence to predict the relationships between systems or between components of a system.
- Using mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations.
- Communicating technical information or ideas (e.g., about events and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Mathematics

Math is essential and necessary to be successfully employed in the maritime and manufacturing industries, and thus has application throughout the Core Plus Maritime program. Specific "math" performance assessments are included in all units that are part of the Core Plus Maritime frameworks and curricular materials.

Students demonstrate Math competencies through several classroom and laboratory activities like:

- Mathematical activities related to marine navigation applications such as compass correction, set, drift and leeway, air temperature, pressure and altitude, tides, and tidal currents, landing distances and basic piloting.
- Mathematical activities related to marine engineering operations such as work, horsepower, and speed.
- Creating a project/job estimation, identifying criteria that would impact manufacturing and profitability.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

Through team-based activities relating to maritime careers students will:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).

- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).
- Working within a team to provide mathematical solutions and interpretations.
- Sharing with teammates their diverse knowledge to better understand mathematical equations.
- Helping others and building team spirit.
- Show continuous improvement and gain confidence in providing mathematical solutions in real time in real world applications.

Leadership Skills:
1.A Think Creatively.
1.B Work Creatively with Others
2.A Reason Effectively
2.B Use Systems Thinking
2.C Make Judgments and Decisions
2.D Solve Problems.
4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- Equations and Inequalities
  - Apply properties of real numbers.
  - Evaluate and simplify algebraic expressions.
  - Solve linear equations.
  - Rewrite formulas and equations.
  - Use problem solving strategies and models.
  - Solve linear inequalities.
  - Solve absolute values.
- Linear Equations and Functions
  - Represent relations and functions.
  - Find slope and rate of change.
  - Graph equations of lines.
  - Write equations of lines.
  - Model direct variation.
  - Draw scatter plots and best fitting lines.
- Linear Systems and Matrices
  - Solve linear systems graphically.
  - Solve linear systems algebraically.
- Quadratic Functions

- Write quadratic functions and models and use to solve problems.
- Attributes and Relationships of Geometric Objects
  - Define Pythagorean Theorem and solve problems involving right triangles.
  - Understand and apply theorems about circles.
  - Explain volume formulas and use them in solving problems.
  - Apply geometric concepts in modeling situations.
- Counting Methods and Probability
  - Apply counting principles and permutations.
  - Define and use probability.
  - Determine expected values.
- Data Analysis and Statistics
  - Collect and interpret quantitative data.
  - Use normal distributions.
  - Draw conclusions from samples.
- Trigonometric Functions
  - Apply right triangle trigonometry.
  - Write and apply trigonometric functions and models.

Aligned Washington State Academic Standards	
English Language Arts: Common Core	*RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.* RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. RST.11-12.4 - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*. *RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.* *RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.* RST.11-12.8 - Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. RST.11-12.9 - Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

	RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently. Write arguments focused on *discipline-specific content*. WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). *WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.* WHST.11-12.7 - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. *WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.* WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Mathematics: Common Core	HSN.Q.A.1 - Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. HSN.Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling. HSN.Q.A.3 **-** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. HSA.CED.A.1 **-** Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions. HSA.CED.A.2 **-** Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. HSA.REI.AEl. - Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method. HSA.REI.A.2 **-** Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

	HSA.REI.B.3 - Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. HSA.REI.B.4 - Solve quadratic equations in one variable. HSA.REI.D.10 - Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line). HSF.IF.C.7 - Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. HSG.CO.B.6 - Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent. HSG.CO.D.12 - Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line. HSG.SRT.A.1 - Verify experimentally the properties of dilations given by a center and a scale factor: HSG.SRT.A.2 - Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides. HSG.C.A.1 - Prove that all circles are similar. HSG.C.A.2 - Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle. HSG.GPE.A.1 - Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation. HSG.GPE.B.6 - Find the point on a directed line segment between two given points that partitions the segment in a given ratio. HSG.GPE.B.7 - Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula. HSS.ID.A.1 - Represent data with plots on the real number line (dot plots, histograms, and box plots). HSS.ID.A.2 - Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.

	HSS.ID.A.3 - Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). HSS.IC.A.1 - Understand statistics as a process for making inferences about population parameters based on a random sample from that population. HSS.IC.B.6 - Evaluate reports based on data.
Mathematical Practices	MP1 - Make sense of problems and persevere in solving them. MP2 - Reason abstractly and quantitatively. MP3 - Construct viable arguments and critique the reasoning of others. MP4 - Model with mathematics. MP5 - Use appropriate tools strategically. MP6 - Attend to precision. MP7 - Look for and make use of structure. MP8 - Look for and express regularity in repeated reasoning.
Science	HS-ETS1-2. - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3. - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. 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.

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Constructing Explanations and Designing Solutions Developing and Using Models Using Mathematics and Computational Thinking Analyzing and Interpreting Data Obtaining, Evaluating, and Communicating Information	ETS1.A: Defining and Delimiting an Engineering Problem ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Patterns Systems and System Models

Unit 12 – Rigging	**Total Learning Hours for Unit:** 20
Unit Summary:	

The Rigging unit is designed to provide students with information needed to prepare for and carry out a hands-on skill practice for rigging, lifting, and moving a load. Lesson content includes determining lifting task and job-site requirements, characterization of the load (volume, weight, and center of gravity), selection of rigging equipment, and techniques and procedures for lifting, maneuvering, and moving the load. Utilization of scale models in some instances is recommended.

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

General

After completing this unit students will be able to:

- Identify specific rigging skills that are necessary for various maritime Career Pathways and identify various skills needed to move or advance in different pathways.
- Given a set of circumstances, predict whether a proposed load movement would be classified as a critical lift, pre-engineered lift, or ordinary lift.
- State the four major steps in planning a move, including two elements of what to look for in each step.
- Recall the four major steps in planning a move.
- Identify types of rigging, describe their features, and explain uses and inspection criteria.
- Distinguish between the various types of cranes, hoists and lifting devices encountered at worksites.
- State and describe the last of the four major steps in planning a move.
- Demonstrate how to tie all the knots and hitches (15+) identified in the USCG practical examination for Able Seafarer.
- Demonstrate how to make an eye splice and perform splices in various types of line.
- Calculate the safe working load (SWL) and select the proper size lifting gear, block, line, or wire.
- Determine the mechanical advantage for common block and tackle arrangements used in the maritime industry.
- How to reeve a block and tackle arrangement.
- Identify the various types of lines used in the maritime industry (manila, Dacron, Spectra, nylon, etc.).
- How to maintain the integrity of lifting gear, routine maintenance, and overall blocks.
- Demonstrate how to sew canvas using the most common methods (baseball stich, herringbone stitch).
- Demonstrate how to put a temporary seizing on a wire rope.
- Demonstrate how to put a whipping on a line.
- Demonstrate how to put clamps on wire rope.
- Demonstrate how to coil and throw a heaving line.
- Demonstrate how to rig a line through fairleads to a winch head.
- Demonstrate knowledge of the various methods for securing cargo on a moving object like a ship, boat, truck, airplane.
- How to measure the dimensions of wire rope
- How to lash various types of cargo using chain, wire strops and/or fabric straps.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Listing, explaining, and answering the four questions that must be asked before planning a lift or move.
- Identifying types of rigging, describe their features, and explain uses and inspection criteria.
- Formulate a written rigging plan by evaluating the relevant lift factors and selecting the appropriate hardware and rigging configurations.
- For a given lift scenario, assess the proposed lift options and explain/defend the best plan for the operation. Present the rationale and the relevant supporting data to persuade the audience of the decision.
- Distinguishing between the various types of cranes, hoists and lifting devices encountered at worksites.
- Stating and describing the last of the four major steps in planning a move.
- Presentation of the techniques and methods used to raise a mast on a sailing ship.
- Identify and discuss the terms used to describe rigging and its use aboard sailing ships (jury-rigged, mizzen mast, etc.).
- Research and make a presentation on the different of sailing ships and their rigging.
- Research on the advances in rigging and their connection to increase trade and commerce.
- Research on historical vessels and how repairs were made to rigging and masts during their voyages.
- Research on the voyages and routes of a sailing ship transiting Cape Horn. (Her rigging limits the wind angle on a broad reach to within 60° of the wind.)
- Research and make a presentation on how sailing ships turn around? What was the procedure?
- Research and presentation on the various methods of transporting cargo. The improvements to cargo handling which lead to containerization.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Developing and using models to predict and show relationships among variables between systems and their components.
- Planning and carrying out simulations of rigging applications.
- Obtaining, evaluating, and communicating information related to securing, lifting, and moving loads.
- Designing new systems or structures including detailed examination of the properties of different materials, the structures of different components, and connections of components to solve problems.
- Demonstrating various methods used to reduce friction in rigging operations (chafing gear, grease, lubricants).
- Research the construction and manufacture of ultra- high-density polypropylene lines.
- Research the design and construction of modern shipboard cranes and shipyard cranes.
- Demonstrate the stresses on the cargo boom at different angles of elevation from the horizontal.
- Demonstrate the effects of torsional resistance on a load.
- Research and discuss the buoyancy changes (shifting of ballast water) that occur when performing a heavy lift aboard a heavy lift barge.
- Research the change in the angle of heel when performing a heavy lift of cargo from dock to ship.
- Research and demonstrate the effects of a such stop (dynamic load) has on cargo gear.
- Research the dynamic loads on cargo containers located at the top of the stack.
- Research how hooks, shackles, straps, and other lifting gear is manufactured and tested.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Measuring and determining the volume of a load.
- Converting measurements expressed in different units into common units.
- Calculating the weight of a load.
- Determining the Center of Gravity(C/G) for a symmetrical load.
- Determining the Center of Gravity (C/G) for an asymmetric load.
- Determine the appropriate material (rope, strap, cable, etc.) needed to lift designated loads.
- Calculate the safe working load and stresses on a lifting arrangement (ship's cargo gear).
- Calculate the forces at each critical part of the lifting arrangement (head block, heel block, strain at winch).
- Calculate acceleration rate of cargo containers stored high above the deck.
- Calculate stresses on lashing gear used on container ships.
- Calculate the change in angle of heel when lifting cargo aboard ship.
- Calculating turning radius of older sailing ships based upon rigging.
- Calculate the proper size wire rope (diameter)or line (circumference) to be used to provide proper breaking stress and SWL.
- Calculating the SWL of hooks and shackles, other lifting devices.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

Through team-based activities relating to maritime careers students will:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).
- Organize a lift using techniques learned and instruction to persons about their duties.
- Perform a root cause analysis to determine the failure of a lift.
- Stop work instruction when critical items of lift preparation omitted.
- Demonstrating to another student the techniques for reeving blocks or splicing lines or tying a knot.
- When given a list of lift parameters, picking the proper equipment for the job.
- When given an inoperative lifting arrangement or gear, develop a solution to make it operational.
- Demonstrate how to perform routine maintenance on lifting equipment.

Leadership Skills:

1.A Think Creatively.

1.B Work Creatively with Others
2.A Reason Effectively
2.B Use Systems Thinking
2.C Make Judgments and Decisions
2.D Solve Problems.
4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- ANSI/ASME Standards – Identify and implement the standards regarding lifting and moving loads.
- Classifications of Lifts – Explain how various loads would be classified as a critical lifts, pre-engineered lifts, or ordinary lifts.
- Volume of a Load – Measure and then determine the volume of loads and articulating the requirements and/or constraints of that load.
- Center of Gravity – Determine the Center of Gravity (C/G) for symmetrical and asymmetrical loads.
- Steel Rigging vs. Synthetic Rigging – Differentiate in detail between steel and synthetic rigging materials.
- Hand Signaling - Perform hand signals to direct the load movement.
- USCG Practical Examination for Able Seafarer (knots, splices, rigging).
- Washington State Labor and Industries Maritime Crane Safety program (see WA L&I website for more info.)
- Washington State Construction Crane Certification and Crane Operator Certification (see WA L&I website for more info.)
- General Industry Cranes – General Safety and Health Standard (see WA L&I website for more info.)
- Safety Standards for longshore, stevedores and other related waterfront activities (see WA L&I website for more info.)

Aligned Washington State Academic Standards	
English Language Arts: Common Core	RST.11-12.1 **-** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. RST.11-12.3 **-** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. RST.11-12.4 **-** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*. *RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas*. RST.11-12.7 **-** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem. RST.11-12.8 **-** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

	RST.11-12.9 - Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. *WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.* WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information. WHST.11-12.7 - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. *WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.* *WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.* WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Environment and Sustainability	Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels. Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments. Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.

Mathematics: Common Core	HSN.Q.A.1 **-** Use units to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. HSN.Q.A.2 **-** Define appropriate quantities for the purpose of descriptive modeling. HSN.Q.A.3 **-** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. HSA.CED.A.1 **-** Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions. HSA.CED.A.4 **-** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R HSA.REI.B.3 **-** Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters
Mathematical Practices	MP5 **-** Use appropriate tools strategically. MP6 **-** Attend to precision. MP7 **-** Look for and make use of structure. MP8 **-** Look for and express regularity in repeated reasoning.
Science	HS-PS2-1 **-** Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-3 **-** Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. HS-PS2-4 **-** Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. HS-PS3-1 **-** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. HS-PS3-2 **-** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects) HS-PS3-3 **-** Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. HS-PS3-4 **-** Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). HS-PS3-5 **-** Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

	HS-ETS1-1 **-** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2 **-** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3 **-** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. 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.	
Science and Engineering Practice	**Disciplinary Core Idea**	**Crosscutting Concept**
Developing and Using Models Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions Constructing Explanations and Designing Solutions Analyzing and Interpreting Data Obtaining, Evaluating, and Communicating Information	PS3.A: Definitions of Energy PS3.B: Conservation of Energy and Energy Transfer PS3.C: Relationship Between Energy and Forces PS3.D: Energy in Chemical Processes ETS1.A: Defining and Delimiting an Engineering Problem ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Cause and Effect Systems and System Models Energy and Matter Patterns Systems and System Models *Connections to Engineering, Technology, and Applications of Science* Influence of Science, Engineering and Technology on Society and the Natural World *Connections to Nature of Science* Scientific Knowledge Assumes an Order and Consistency in Natural Systems

Unit 13 – Hydraulics, Pneumatics, Fluid Lines, and Fittings	**Total Learning Hours for Unit:** 30

Unit Summary:

In this unit students learn the physics guiding hydraulics, solve problems using the Pascal's Law, the history of the science of fluids, the terminology common in hydraulics, and safe handling procedures of hydraulic systems, and then learn the fundamentals of a pneumatics system and how it compares to a hydraulics system. Students will learn about basic components, how pneumatic systems work, terminology, and proper safety procedures related to pneumatics.

Students learn the essentials of metal (rigid fluid lines) tubing and what rigid tubing is used for and where they may be used on vessels and shoreside. Students will learn proper installation techniques, including how to repair and replace rigid tubing. The repair and replacement process includes cutting, deburring, bending, and flaring/beading. Students will explore how different fittings are used depending on the type and use of the tubing and inspection techniques and what is and what is not acceptable. Students will also learn how flexible hosing can fail, the repercussions of failure, and the functions of flexible hosing. Students will also learn about proper and improper installation of hoses and fittings, what to look for in a hose inspection, and the importance of hose testing. At the end, students will be given a hands-on activity working with flexible hosing.

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

General

Students:

- Identify and explain the factors to consider when setting up a hydraulic system.
- Define terminology common to hydraulics.
- List the typical components of a basic hydraulics system.
- Identify systems in marine applications where hydraulics and pneumatics are found (sanitation, fuel, HVAC, mechanical systems, etc.), and explain how hydraulics and pneumatics are utilized in those systems.
- Recognize the fluid power components from schematics.
- Define pneumatics.
- Describe air compression, air receivers and air preparation.
- Identify typical components of pneumatics.
- Compare and contrast rigid tubing and flexible tubing.
- Build a rigid tubing system using proper cutting, bending, and flaring techniques.
- Discuss how to professionally cut, bend, flare/bead, and fit rigid tubing.
- Examine the differences between flaring, double-flaring, and beading.
- Design a flexible hosing system with multiple outputs.
- Build a flexible hosing system with multiple outputs.
- Using correct tools to install the appropriate fittings as stated in installation/repair documents.
- Explain why hoses and piping systems are tested at 1.5 times the working pressure.
- Understand Nominal Pipe Size (NPS) and how they are used to select appropriate sizes of fluid lines.
- Understand the need for flushing and cleaning piping systems.
- Determine whether fluid lines should be repaired or replaced.
- Identifying the need for and procedure to “pickle” a hydraulic system.
- Explaining why and where to use chafing gear on fluid lines.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Identifying the major historical events (and figures) behind the science of fluids.
- Compare and contrast pneumatics to hydraulics.
- Explaining Open and Closed Circuits.
- Compare and contrast flow rate and velocity of compressed air.
- Explain how a pneumatics system works.
- Explain series parallel rules regarding fluid flow.
- Describe where fluid lines are used on vessels and shoreside.
- Explain the factors to be considered when inspecting and testing rigid tubing.
- Summarize what may cause tubing to burst, crack or leak.
- Compare and contrast pipe threads to machine threads.
- Summarize the repair process, including removing dents and scratches.
- Explain the different options to join metal tubing.
- Describe where flexible hosing is used on vessels and shoreside.
- Summarize what factors should be considered when inspecting and testing flexible hose.
- Explain how to correctly fit flexible hoses and what to avoid (e.g., twisting).
- Comparing and contrasting how and when flexible and/or flexible tubing is used in various manufacturing systems (maritime, maritime, construction, etc.).

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Explaining the physics guiding hydraulics systems.
- Describing the advantages and disadvantages of fluid power systems, including the type of fluid used (water, oil, and oil viscosity, etc. (Material Science)).
- Practicing safe handling procedures of hydraulics and hydraulics equipment.
- Understanding, calculating, and explaining how to utilize Mechanical Advantage.
- Describe vacuum system types used in pneumatic systems.
- Demonstrate safety when handling and using pneumatics components and systems.
- Identifying environmental conditions that influence pressure.
- Selecting proper fluid line materials for various purposes (air, team, oil, water, fuel, cooling, firefighting systems, HVAC, etc.)
- Explain why Teflon™ is a preferred material in hydraulic and fluid systems.
- Discuss and demonstrate how to professionally install a hose clamp.
- Selecting appropriate flexible tubing and various solutions using tubing reactivity and breakdown as criteria.
- Explaining why hydraulic systems use heated oil (usually 140-165 degrees F) during flushing and maintenance.
- Discussing the need for using pressure (and identifying the pressure range) when testing hard tubing systems.
- Investigating and describing how and why vessels separate oil and water before discharge at sea.

- Understand and develop management and safety plans pertaining to Stored Energy Devices (pressure systems, fire extinguishers, steam systems, etc.) for positive uses and prevent negative situations (accident-related).

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Calculating problems related to fluid and pneumatic power using Pascal's Law, force, work, and power equations.
- Explaining and calculating transmission and multiplication of Force.
- Explaining and calculating for how pressure is influenced by method of transmission and distance of transmission.
- Calculating Mechanical Advantage.
- Solving problems relating to pressure, compression, and vacuum.
- Calculating Absolute Pressure as it relates to air pressure and vacuum pressure.
- Identifying and calculate the inside diameter of rigid tubing.
- Measuring and identifying the wall thickness of various fluid lines.
- Calculating and executing the correct angles of bending rigid tubing.
- Calculating the pressure inside of a line to select the appropriate type and material of the lines and select the appropriate type of fittings.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

Through team-based activities relating to maritime careers students will:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Leadership Skills:

1.A Think Creatively.
1.B Work Creatively with Others
2.A Reason Effectively
2.B Use Systems Thinking
2.C Make Judgments and Decisions
2.D Solve Problems.
4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- Hydraulic Terminology – Understand and use terminology common to hydraulics.
- Pneumatic Terminology – Understand and use terminology common to pneumatics.

• Compression – Articulate how compression is created and utilized in hydraulics and pneumatics. • Vacuum – Understand and articulate how vacuum is created and manipulated in manufacturing and the maritime industry. • Pressure – Understand and articulate how pressure is created and manipulated in manufacturing and the maritime industry. • Mechanical Advantage – Understand and calculate the ratio of the force that performs the useful work to the force that is applied. • Rigid tubing and flexible tubing – Characteristics and appropriate uses. • Cut, bend, flare/bead, and fit rigid tubing – Correctly performing repair tasks. • Understand Nominal Pipe Size (NPS) - Used to select appropriate sizes of fluid lines. • Repair or Replace – Making the correct determination and performing the task.	
Aligned Washington State Academic Standards	
English Language Arts: Common Core	RI.11-12.7 **-** Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words to address a question or solve a problem. SL.11-12.1 **-** Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. SL.11-12.2 **-** Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data. *RST.11-12.1* **-** *Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.* RST.11-12.3 **-** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. RST.11-12.4 **-** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*. *RST.11-12.7* **-** *Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.* RST.11-12.8 **-** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. *RST.11-12.9 - Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.* WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

	WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. *WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.* WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information. WHST.11-12.7 - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. *WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.* WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Environment and Sustainability	Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels. Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments. Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.
Mathematics: Common Core	HSN.Q.A.1 **-** Use units to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data HSN.Q.A.2 **-** Define appropriate quantities for the purpose of descriptive modeling. HSN.Q.A.3 **-** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

	HSA.CED.A.1 - Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions. HSA.CED.A.4 - Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. HSA.REI.A.1 - Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method. HSA.REI.A.2 - Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. HSA.REI.B.3 - Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. HSA.REI.C.6 - Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. HSA.REI.C.7 - Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. HSF.IF.B.4 - For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity. HSF.IF.B.6 - Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph. HSF.IF.C.7 - Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.* HSF.IF.C.7.A - Graph linear and quadratic functions and show intercepts, maxima, and minima. HSS.IC.B.6 - Evaluate reports based on data.
Mathematical Practices	MP1 - Make sense of problems and persevere in solving them. MP2 - Reason abstractly and quantitatively. MP3 - Construct viable arguments and critique the reasoning of others. MP4 - Model with mathematics. MP5 - Use appropriate tools strategically. MP6 - Attend to precision. MP7 - Look for and make use of structure. MP8 - Look for and express regularity in repeated reasoning.

Science	HS-PS3-1 - Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. HS-PS3-2 - Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects) HS-PS3-3 - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. HS-PS3-4 - Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). HS-PS3-5 - Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. 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.	
Science and Engineering Practice	**Disciplinary Core Idea**	**Crosscutting Concept**
Developing and Using Models Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions Analyzing and Interpreting Data Obtaining, Evaluating, and Communicating Information	PS3.A: Definitions of Energy PS3.B: Conservation of Energy and Energy Transfer PS3.C: Relationship Between Energy and Forces PS3.D: Energy in Chemical Processes ETS1.A: Defining and Delimiting an Engineering Problem ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Cause and Effect Systems and System Models Energy and Matter Patterns Systems and System Models *Connections to Engineering, Technology, and Applications of Science* Influence of Science, Engineering and Technology on Society and the Natural World

		Connections to Nature of Science Scientific Knowledge Assumes an Order and Consistency in Natural Systems

Unit 14 - Electrical Systems	**Total Learning Hours for Unit:** 30

Unit Summary:
The purpose of this unit is to provide students with the basics of electrical theory, so that those that proceed into careers that are mechanically focused can understand the related electrical circuits and assist electricians and electronics technicians with troubleshooting.

Performance Assessments: (Districts to complete for each unit)
Example assessments for this unit include:

General

Students:

- State the difference between electricity and electronics.
- List the parts of a molecule and explain how these sperate parts are used in an electrical circuit.
- State the meanings of and the relationship between matter, element, nucleus, compound, molecule, mixture, atom, electron, proton, neutron, energy, valence, valence shell, and ion.
- Identify advantages and disadvantages of different battery technologies.
- Provide a basic AC & DC electrical systems overview.
- Describe the importance of observing electrical safety.
- Describe the fundamental concepts of electricity.
- Define open and short circuits and describe their effects on a circuit.
- Demonstrate knowledge and proper use of electricity-based Stored Energy Systems (Batteries, new battery technology, power generation systems, etc.)

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Describing the laws of magnetic attraction and repulsion.
- Define the terms: retentivity, reluctance, permeability, ferromagnetism, natural magnet, and artificial magnet as used to describe magnetic materials.
- Describing how voltage polarities are assigned to the voltage drops across resistors when Kirchhoff's voltage law is used.
- Stating the meaning of the term source resistance and describe its effect on a circuit.
- Describing in terms of circuit values the circuit condition needed for maximum power transfer.

- Developing a power management system for a vessel (Remember, at sea, the ship must generate and manage its own power!)

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Stating, in terms of valence, the differences between a conductor, an insulator, and a semiconductor, and list some materials which make the best conductors and insulators.
- Identifying the term power, and state three formulas for computing power.
- Drawing a sketch that depicts magnetic fields and lines of force.
- Identifying the characteristics of magnetic lines of force (magnetic flux), including their relation to magnetic induction, and shielding.
- Describing why electrical safety hazards occur.
- Defining and describing electrical bonding or grounding.
- Describing how different current levels affect the human body.
- Describing the ways in which electric shock can be received.
- Identifying the term schematic diagram and identify the components in a circuit from a simple schematic diagram.
- Measuring the voltage at the reference point in a circuit.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Stating the equation for Ohm's law and describe the effects on current caused by changes in a circuit.
- Calculating resistance values, voltage and wattage using Ohm's Law.
- Given simple graphs of current versus power and voltage versus power, determining the value of circuit power for a given current and voltage.
- Computing circuit and component power in series, parallel, and combination circuits.
- Calculating the efficiency of an electrical device.
- Solving for unknown quantities of resistance, current, and voltage in a series circuit.
- Calculating efficiency of power transfer in a circuit.
- Solving for unknown quantities of resistance, current, and voltage in a parallel circuit.
- Computing resistance, current, voltage, and power in voltage dividers.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

Through team-based activities relating to maritime careers students will:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Leadership Skills:
1.A Think Creatively.
1.B Work Creatively with Others
2.A Reason Effectively
2.B Use Systems Thinking
2.C Make Judgments and Decisions
2.D Solve Problems.
4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- Science of Basic Electricity – Understanding how electrical current is created and used in maritime and manufacturing environments.
- Voltage, Current, and Resistance – How each is measured and utilized in electrical circuits.
- Electrical Circuits – How do design, install, and protect circuits and devices.
- Electrical Safety – Identifying potential hazards and protecting the circuit, devices, and people working on and/or using the electrical devices.

Aligned Washington State Academic Standards	
English Language Arts: Common Core	RI.11-12.7 **-** Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words to address a question or solve a problem. SL.11-12.1 **-** Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. SL.11-12.2 **-** Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data. *RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.* RST.11-12.3 **-** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. RST.11-12.4 **-** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*. RST.11-12.7 **-** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem. RST.11-12.8 **-** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

	RST.11-12.9 - Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. *WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.* WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information. WHST.11-12.7 - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. *WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.* WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Environment and Sustainability	Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels. Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments. Standard 3: Sustainability and Civic Responsibility

	Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.
Mathematics: Common Core	HSN.Q.A.1 - Use units to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. HSN.Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling. HSN.Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. HSA.CED.A.1 - Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions. HSA.CED.A.4 - Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. HSA.REI.A.1 - Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method. HSA.REI.A.2 - Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. HSA.REI.B.3 - Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. HSA.REI.C.6 - Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. HSS.IC.B.6 - Evaluate reports based on data.
Mathematical Practices	MP1 - Make sense of problems and persevere in solving them. MP2 - Reason abstractly and quantitatively. MP3 - Construct viable arguments and critique the reasoning of others. MP4 - Model with mathematics. MP5 - Use appropriate tools strategically. MP6 - Attend to precision. MP7 - Look for and make use of structure. MP8 - Look for and express regularity in repeated reasoning.
Science	HS-PS3-1 - Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

	HS-PS3-2 - Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects) HS-PS3-3 - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. HS-PS3-4 - Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). HS-PS3-5 - Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. 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.	
Science and Engineering Practice	**Disciplinary Core Idea**	**Crosscutting Concept**
Developing and Using Models Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions Analyzing and Interpreting Data Obtaining, Evaluating, and Communicating Information	PS3.A: Definitions of Energy PS3.B: Conservation of Energy and Energy Transfer PS3.C: Relationship Between Energy and Forces PS3.D: Energy in Chemical Processes ETS1.A: Defining and Delimiting an Engineering Problem ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Cause and Effect Systems and System Models Energy and Matter Patterns Systems and System Models *Connections to Engineering, Technology, and Applications of Science* Influence of Science, Engineering and Technology on Society and the Natural World *Connections to Nature of Science* Scientific Knowledge Assumes an Order and

		Consistency in Natural Systems

Unit 15 – Corrosion	**Total Learning Hours for Unit:** 20

Unit Summary:
In this unit students will gain an understanding of how corrosion happens, why it happens and how to prevent it from happening. They will also learn about the different types of corrosion and why it can happen both on land and underwater.

Performance Assessments: (Districts to complete for each unit)
Example assessments for this unit include:

General

Students:

- Document what conditions are present for corrosion to take place in various manufacturing and maritime situations.
- Determine what factors will slow or accelerate corrosion in mechanical and electrical situations.
- Identify and observe evidence of corrosion and calculate potential financial implications of remedies, repair, and/or replacement.
- Relate what will affect the rate of corrosion in real world applications, including financial, structural, and maintenance implications.
- Explain corrosion control by:
    - Proper design
    - Materials Selection
    - Protective Coatings
    - Cathodic and Anodic Protection
- Understanding that corrosion is industry-standard controlled and must be managed and controlled by on-board standard practices.
- Describing what corrosion is, what causes it, and suggesting various methods of controlling corrosion on various marine systems, such as external components, electrical systems, pressure systems, freight-handling systems, etc.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Describing what corrosion is, what causes it, and suggesting various methods of controlling corrosion on various marine systems, such as external components, electrical systems, pressure systems, freight-handling systems, etc.
- Describing the "roles' that anodes, cathodes, metallic paths, and electrolytes play in corrosion reactions.
- Sharing a series of simple steps that are involved in and that are a driving force needed to achieve them in corrosive reactions.
- Preparing and sharing a short classroom presentation about four methods of slowing and/or stopping uniform corrosion.
- Identifying and describing various types of localized corrosion.
- Reporting on a corrosion-related issue that is specific to marine environments.
- Studying and interpreting accident reports and case studies related to "Why Ships Sink".

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Understanding what corrosion is, what causes it, and suggesting various methods of controlling corrosion.
- Explaining how and why saltwater increases the rate of corrosion in maritime environments.
- Describing the differences and similarities in problems that corrosion causes to plastics, metals, concrete, and wood products.
- Identifying and describing four things that need to be present for corrosion to occur.
- Understand and describe how a negatively charged material that can combine with the iron and electrons, which are produced in the first reaction are used up.
- Describing the impact that oxygen has on corrosion reactions.
- Explaining how heat and other environmental forces has on corrosion reactions.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Explaining and predicting the rate of uniform corrosion in various situations, such as dockside corrosion on loading and logistical equipment, ship-board navigation equipment, vessel construction and maintenance situations, material selection during vessel construction, etc.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

Through team-based activities relating to maritime careers students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Leadership Skills:

1.A Think Creatively.
1.B Work Creatively with Others
2.A Reason Effectively
2.B Use Systems Thinking
2.C Make Judgments and Decisions
2.D Solve Problems.
4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- Corrosion Reactions – Understanding how and where corrosion occurs.
- Corrosion Control Methods – Identifying and implementing various methods of controlling corrosion.
- Impacts of Corrosion – Recognizing and managing the impacts that various types of corrosion in marine environments.

Aligned Washington State Academic Standards	
English Language Arts: Common Core	RI.11-12.7 **-** Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words to address a question or solve a problem. SL.11-12.1 **-** Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. SL.11-12.2 **-** Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data. RST.11-12.1 **-** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. RST.11-12.3 **-** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. RST.11-12.4 **-** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*. RST.11-12.7 **-** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem. *RST.11-12.8 **-** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.* *RST.11-12.9 - Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.* WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. *WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.* WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information. WHST.11-12.7 - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate;

	synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. *WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.* WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Environment and Sustainability	Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels. Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments. Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.
Mathematics: Common Core	HSN.Q.A.1 **-** Use units to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. HSN.Q.A.2 **-** Define appropriate quantities for the purpose of descriptive modeling. HSN.Q.A.3 **-** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. HSF.IF.C.7 **-** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.* HSF.IF.C.7.A **-** Graph linear and quadratic functions and show intercepts, maxima, and minima. HSS.ID.A.2 **-** Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.

	HSS.ID.A.3 - Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). HSS.ID.A.4 - Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve. HSS.IC.A.1 - Understand statistics as a process for making inferences about population parameters based on a random sample from that population. HSS.IC.B.3 - Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. HSS.IC.B.4 - Use data from a sample survey to estimate a population mean or proportion; develop a margin of error using simulation models for random sampling. HSS.IC.B.6 - Evaluate reports based on data.
Mathematical Practices	MP1 - Make sense of problems and persevere in solving them. MP2 - Reason abstractly and quantitatively. MP3 - Construct viable arguments and critique the reasoning of others. MP4 - Model with mathematics. MP5 - Use appropriate tools strategically. MP6 - Attend to precision. MP7 - Look for and make use of structure. MP8 - Look for and express regularity in repeated reasoning.
Science	HS-PS1-1 - Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. HS-PS2-6 - Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. HS-PS1-2 - Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. HS-PS1-5 - Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

	HS-ETS1-3 **-** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. 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.	
Science and Engineering Practice	**Disciplinary Core Idea**	**Crosscutting Concept**
Developing and Using Models Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions Analyzing and Interpreting Data Obtaining, Evaluating, and Communicating Information	PS3.A: Definitions of Energy PS3.B: Conservation of Energy and Energy Transfer PS3.C: Relationship Between Energy and Forces PS3.D: Energy in Chemical Processes ETS1.A: Defining and Delimiting an Engineering Problem ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Cause and Effect Systems and System Models Energy and Matter Patterns Systems and System Models *Connections to Engineering, Technology, and Applications of Science* Influence of Science, Engineering and Technology on Society and the Natural World *Connections to Nature of Science* Scientific Knowledge Assumes an Order and Consistency in Natural Systems

Unit 16 – Welding	**Total Learning Hours for Unit:** 40

Unit Summary:

This unit provides students with knowledge and skills relating to the safety, equipment, and procedures necessary to be successful in Arc Welding. Students will demonstrate these skills through a variety of shop projects that use each of these tools, and in a final exercise that uses a combination of these skills. It is recommended that, before beginning this unit, students complete the following units:

- Materials Science
- Hand and Power Tools
- Safety
- Standard Operating Procedures
- Precision Measurement
- Print Reading
- Applied Physics

At the completion of this unit students should be able to describe the required qualifications, safety, equipment, procedures, and work environment associated with Arc Welding. Students will also understand that they will need to get additional education and training to become certified to weld on ships, what the Coast Guard regulations are regarding welding on vessels, and where to get that additional education and training.

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

General

- Before starting a machining operation, the student will be able to determine the safety and fitness of tools and materials and report defects and malfunctions to appropriate personnel.
- The student safely operates, use, and maintain the tool and perform the tasks according to manufacturer's guidelines.
- The student demonstrates the operation, use, and maintenance according to manufacturer's guidelines.
- The student states and demonstrates safe movement and the use of personal protective equipment such as safety shoes, goggles, and hard hats, and the shop's safety procedures with 100% accuracy and consistency.
- The student identifies the safety features and demonstrates the safe use of all available shop hand tools according to manufacturers' guidelines.
- Stating the meaning of the term source resistance and describe its effect on a circuit.
- Describing in terms of circuit values the circuit condition needed for maximum power transfer.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Understanding, interpreting, and demonstrating both the manufacturer's safety procedures and the shop's safety procedures with 100% accuracy and consistency.
- Identifying all safety features of the machine, discuss characteristic tool wear and failure, and state how this information can protect the user and others in the shop.
- Given an assembly drawing, the student will be able to use number symbols to match part descriptions on the parts list with the detail of that part on the drawing.
- Defining and describing electrical bonding or grounding and how it impacts the welding process.
- Describing how different current levels affect the human body.
- Describing the ways in which electric shock can be received and prevented.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Stating the differences between a conductor, an insulator, and a semiconductor, and list some materials which make the best conductors and insulators.
- Drawing a sketch that depicts magnetic fields and lines of force.
- Identifying the characteristics of magnetic lines of force (magnetic flux), including their relation to magnetic induction, and shielding.
- Describing why electrical safety hazards occur.
- Defining and describing electrical bonding or grounding.

- Describing how different current levels affect the human body.
- Describing the ways in which electric shock can be received.
- Defining the changes that occur in metals during and after the welding process and these changes affect the welded materials in marine and manufacturing applications.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Interpreting and, subsequently, laying out a part to within ± .015" of drawing specifications.
- Stating the equation for Ohm's law and describe the effects on current caused by changes in a circuit.
- Calculating resistance values, voltage and wattage using Ohm's Law.
- Given simple graphs of current versus power and voltage versus power, determining the value of circuit power for a given current and voltage.
- Calculating the efficiency of an arc welder.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

Through team-based activities relating to maritime careers students will:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Leadership Skills:

1.A Think Creatively.
1.B Work Creatively with Others
2.A Reason Effectively
2.B Use Systems Thinking
2.C Make Judgments and Decisions
2.D Solve Problems.
4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- Personal Safety Measures - Explain importance, define types, and explain safe maintenance of Personal Protective Equipment (PPE).
- Workplace Safety Measures - Explain Importance of safety at workplace and its implications.
- Shielded Metal Arc Welding (SMAW) - Determine the specifications and/or classification of electrode required for the job and demonstrate welding operation as stated in documents or from instruction.

• Gas Metal Arc Welding (GMAW) - Describe how to adjust welding parameters and their effects on welds and demonstrate welding operation as stated in documents or from instruction. • Gas Tungsten Arc Welding (GTAW) - Describe how to adjust welding parameters and their effects on welds and demonstrate welding operation as stated in documents or from instruction**.**	
Aligned Washington State Academic Standards	
English Language Arts: Common Core	RI.11-12.7 **-** Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words to address a question or solve a problem. *SL.11-12.1* **-** *Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.* *SL.11-12.2* **-** *Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.* RST.11-12.1 **-** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. RST.11-12.3 **-** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. RST.11-12.4 **-** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*. *RST.11-12.7* **-** *Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.* RST.11-12.8 **-** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. RST.11-12.9 - Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. *WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.*

	WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information. WHST.11-12.7 - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. *WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.* WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Environment and Sustainability	Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels. Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments. Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.
	HSN.Q.A.1 **-** Use units to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. HSN.Q.A.2 **-** Define appropriate quantities for the purpose of descriptive modeling. HSN.Q.A.3 **-** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. HSA.CED.A.1 **-** Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

Mathematics: Common Core	HSA.CED.A.4 - Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. HSA.REI.A.1 - Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method. HSA.REI.A.2 - Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. HSA.REI.B.3 - Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. HSA.REI.C.6 - Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. HSF.IF.B.4 - For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity. HSF.IF.B.6 - Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph. HSS.IC.B.6 - Evaluate reports based on data.
Mathematical Practices	MP 1 - Make sense of problems and persevere in solving them. MP 2 - Reason abstractly and quantitatively. MP 4 - Model with mathematics. MP 5 - Use appropriate tools strategically. MP 6 - Attend to precision. MP 8 - Look for and express regularity in repeated reasoning.
Science	HS-PS1-5 - Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. HS-PS2-5. - Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. HS-PS3-4 - Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). HS-PS3-5 - Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

	HS-ETS1-1 **-** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2 **-** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3 **-** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. 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.

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Constructing Explanations and Designing Solutions Planning and Carrying Out Investigations Developing and Using Models Using Mathematics and Computational Thinking Analyzing and Interpreting Data Obtaining, Evaluating, and Communicating Information	PS1.B: Chemical Reactions PS2.B: Types of Interactions PS3.A: Definitions of Energy PS3.B: Conservation of Energy and Energy Transfer PS3.C: Relationship Between Energy and Forces ETS1.A: Defining and Delimiting an Engineering Problem ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Patterns Cause and Effect Systems and System Models Energy and Matter *Connections to Engineering, Technology, and Applications of Science* Influence of Science, Engineering and Technology on Society and the Natural World

Unit 17 – Buoyancy	**Total Learning Hours for Unit:** 20

Unit Summary:
How can we make steel float? How about other materials?
This unit is designed to help students understand various materials and how they are utilized to impact their ability to float in water or other liquids. Students will learn how buoyancy or upthrust is an upward force exerted by a fluid that opposes the weight of a partially or fully immersed object. They will also study the various shapes of ship hulls and why different shapes might be more desirable.

Performance Assessments: (Districts to complete for each unit)
Example assessments for this unit include:
General
Students:

- Describe Archimedes' Principle and how it is used to calculate buoyancy.

- Define Density.
- Explain how a ship can float.
- Explain the importance of the Plimsoll line in shipping.
- Explain why floating bridges made of concrete.
- Describe differences in naval architecture between types of vessels regarding buoyancy (recreational craft, shipping, transportation, cruise-related vessels, etc.).

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Identifying what caused the sinking of the ship Vasa and proposing solutions that would have prevented the accident.
- Articulating Archimedes' "Eureka" moment and how it relates to buoyancy.
- Understanding and describing relationship between gravity and buoyancy.
- Explaining how a ship can float in water.
- Understand the "Plimsoll Line" on a ship and describe how it is used to load cargo on a ship at different locations and times of the year.

Science

Students will demonstrate Science competencies through several classroom and laboratory activities like:

- Describing how the weight of the fluid displaced is the force which acts against gravity.
- Understanding and calculating displacement.
- Describing how a force equal to the weight of the displaced water (buoyant force) pushes upward on the bottom of the boat, and therefore, keeps it afloat.
- Defining "density" and discussing how an object's density affects whether it will float and/or at what level.
- Understanding and explaining how the shape of a ship's hull causes the ship to displace a greater volume of water than a solid piece of steel with the same mass.
- Explaining how and why floating bridges are made of concrete and how this concept can be applied to vessel buoyancy.
- Understanding what the differences are between Flat Bottom, V-hulls, Tri-hulls, Catamarans, and SWATH hulls, and how each might be the preferred hull shape for various vessels, based on vessel use, stability, ease of navigation and handling, and different sea conditions and marine environments.

Mathematics

Students will demonstrate mathematics competencies through several classroom and laboratory activities like:

- Identifying the data involved in calculating buoyancy.
- Calculating how much water is displaced when an object is placed in water.
- Calculating how much water is displaced by the same object when it is floated in a boat.
- Calculating where in water various items float (at the top, submerged, at the bottom, etc.).
- Understanding how and why weight and other forces impacting buoyancy are drawn as vectors.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.
Example:
Through team-based activities relating to maritime careers students will:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Leadership Skills:
1.A Think Creatively.
1.B Work Creatively with Others
2.A Reason Effectively
2.B Use Systems Thinking
2.C Make Judgments and Decisions
2.D Solve Problems.
4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- Buoyancy – the ability or tendency to float in water or air or some other fluid.
- Density - the degree of compactness of a substance.
- Volume **-** the measurement of the amount of space that a liquid, solid or gas occupies in a contained space.
- Mass - the amount of matter contained in an object.
- Gravity - the force that is required to change the speed or direction of a moving object.
- Displacement - the act of moving something from one position to another or the measurement of the volume replaced by something else.

Aligned Washington State Academic Standards	
	SL.11-12.1 **-** Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. SL.11-12.2 **-** Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data. RST.11-12.1 **-** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

English Language Arts: Common Core	RST.11-12.3 **-** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. RST.11-12.4 **-** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*. RST.11-12.7 **-** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem. RST.11-12.8 **-** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. RST.11-12.9 **-** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. *WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.* WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information. WHST.11-12.7 - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. *WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.* WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Environment and Sustainability	Standard 1: Ecological, Social, and Economic Systems

	Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels. Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments. Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.
Mathematics: Common Core	HSN.Q.A.1 **-** Use units to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. HSN.Q.A.2 **-** Define appropriate quantities for the purpose of descriptive modeling. HSN.Q.A.3 **-** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. HSA.CED.A.1 **-** Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions. HSA.CED.A.4 **-** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. HSA.REI.A.1 **-** Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method. HSA.REI.A.2 **-** Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. HSA.REI.B.3 **-** Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. HSA.REI.C.6 **-** Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. HSA.REI.C.7 **-** Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. HSF.IF.B.4 **-** For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.

	HSF.IF.B.6 - Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph. HSF.IF.C.7 - Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. HSF.IF.C.7.A - Graph linear and quadratic functions and show intercepts, maxima, and minima. HSS.IC.B.6 - Evaluate reports based on data.
Mathematical Practices	MP 1 - Make sense of problems and persevere in solving them. MP 2 - Reason abstractly and quantitatively. MP 3 - Construct viable arguments and critique the reasoning of others. MP 4 - Model with mathematics. MP 5 - Use appropriate tools strategically. MP 6 - Attend to precision. MP 7 - Look for and make use of structure. MP 8 - Look for and express regularity in repeated reasoning.
Science	HS-PS2-1 - Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-3 - Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. HS-PS2-4 - Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. HS-PS3-1 - Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. HS-PS3-2 - Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects) HS-PS3-3 - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. HS-PS3-4 - Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). HS-PS3-5 - Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

	HS-ETS1-1 **-** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2 **-** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3 **-** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. 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.	
Science and Engineering Practice	**Disciplinary Core Idea**	**Crosscutting Concept**
Developing and Using Models Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions Analyzing and Interpreting Data Obtaining, Evaluating, and Communicating Information	PS3.A: Definitions of Energy PS3.B: Conservation of Energy and Energy Transfer PS3.C: Relationship Between Energy and Forces PS3.D: Energy in Chemical Processes ETS1.A: Defining and Delimiting an Engineering Problem ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Patterns Cause and Effect Systems and System Models Energy and Matter *Connections to Engineering, Technology, and Applications of Science* Influence of Science, Engineering and Technology on Society and the Natural World *Connections to Nature of Science* Scientific Knowledge Assumes an Order and Consistency in Natural Systems

Unit 18 – Propulsion	**Total Learning Hours for Unit:** 20
Unit Summary: Propulsion is the mechanism or system used to generate thrust to move a vehicle across water or through the air. While paddles and sails are still used on some smaller boats, most modern ships are propelled by mechanical systems consisting of an electric motor or engine turning a propeller, or less frequently, in pump-jets, an impeller. Marine engineering is the discipline concerned with the engineering design process of marine propulsion systems.	
Performance Assessments: (Districts to complete for each unit) *Example assessments for this unit include:* **General**	

Students will be able to:

- Provide an overview of the different marine engine types and attendant systems.
- Explain the advantages and disadvantages of outboard, gasoline, and diesel engines.
- Provide an overview of propulsion systems (i.e. diesel, wind, nuclear, gas turbine, fuel cell, solar steam, diesel-electric, waterjet, LNG, etc.)
- Explain the differences between right-hand and left-hand propellers and how they impact direction when traveling forward and reverse.
- Define "Propeller Walk" and what effects this has on vessel movement, forward and reverse.
- Understand and explain the term "free surface effect" and how it impacts boat stabilization and buoyancy.
- Identify various methods of controlling "free surface effect" and maintaining vessel stabilization.
- Compare fixed and controllable pitch propeller systems.
- Describe how these propulsion systems work and identify benefits and drawbacks of each:
    - Water Jets
    - Z drives
    - Voith Systems
    - Reduction gears
    - Diesel electric propulsion
    - Thrusters
- Understanding fresh and saltwater cooling.
- Determine how and why heat is transferred between engine and water.
- Determine how pumps and impellors work.
- Understanding systems, investigating problems, and identifying solutions.

English/Language Arts

Students will demonstrate ELA competencies through several classroom and laboratory activities like:

- Identifying and describing methods of maritime propulsion throughout history.
- Comparing and contrasting how oar design has changed over time, how they are used to propel the boat, and how they differ from oars made today.
- Describing the "Age of Sail" , how civilization changed, and what lead to its decline.
- Describing how the Bernoulli Principle, which states that an increase in a liquid's speed creates a pressure decrease and a decrease in a liquid's speed creates a pressure increase occurs and is utilized in various methods of propulsion.
- Explaining the dynamics of sails and sailing.
- Explain the differences between right-hand and left-hand propellers and how they impact direction when traveling forward and reverse and how ship handlers correct for this phenomenon.
- Identifying the effects that direction of movement has on the Pivot Point of a vessel.
- Using Newton's Third Law of Physics to explain how air and water are the same but different.

- Describing the advantages and disadvantages of pitch control when selecting propellers.
- Defining cavitation, how it is created, and how it affects the operation of the propeller and a centrifugal cargo pump.
- Investigating and presenting the benefits and drawbacks of outboard motors, inboard engines, stern drives, and jet drives.
- Comparing how the action of a twin-screw vessel different from that of a single screw vessel.
- Explaining how the triple screws of the icebreakers *USCG Polar Sea* and *USCG Polar Star are* configured, and why?

Science

Students will demonstrate Science competencies through several classroom and laboratory activities like:

- Investigating the differences in propulsion that exist in freshwater and saltwater.
- Explaining how fluid flow can be used over a curved surface to produce mechanical energy (sail or turbine blade).
- Describing how changes in force can be used to create momentum.
- Articulating how mechanical energy can be used to produce a low-and high-pressure surfaces to move a plane or boat propeller).
- Describing how and why heat is transferred between the engine and water.
- Describing how a Sea Chest if utilized in engine cooling.
- Investigating and comparing Sea Chests and Keel Cooling systems and how they affect vessel propulsion.
- Explaining how the Venturi Effect can be used in propulsion.
- Explaining how steam turbines function.
- Explain how and why Liquified Natural Gas Propulsion is being introduced in the Cruise Ship industry.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Calculating the differences in power and speed between various propeller with different pitches.
- Calculating the distance run by engine revolutions or the pitch of the propeller combined with the ship's RPM for a given period when compared to the actual miles travelled yields efficiency.
- Using one of the provided formulas calculate the Wetted Surface Area (WSA) of specifically identified vessels from blueprints or provided data.
- Calculating Propeller Slip.
- Estimating how the Pivot Point changes based on direction of travel.
- Calculating the changes in fluid pressure as the fluid velocity increases and how this is used to select optimal and efficient pipe sizes when designing pipelines and transport systems.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

Through team-based activities relating to maritime careers students will:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Leadership Skills:
1.A Think Creatively.
1.B Work Creatively with Others
2.A Reason Effectively
2.B Use Systems Thinking
2.C Make Judgments and Decisions
2.D Solve Problems.
4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- Propeller Pitch – **the distance a propeller would move forward in a substance,** without slipping (propeller slip), in one revolution.
- Power - energy that is produced by mechanical, electrical, or other means and used to operate a device.
- Speed - the rate at which someone or something can move or operate.
- Momentum - the quantity of motion of a moving body, measured as a product of its mass and velocity.
- Cavitation - the formation of partial vacuums in a liquid by a swiftly moving solid body, such as a propeller.

Aligned Washington State Academic Standards	
English Language Arts: Common Core	*RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.* RST.11-12.8 **-** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. *RST.11-12.9 - Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.* WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. *WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.* SL.11-12.5 **-** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.
Environment and Sustainability	Standard 1: Ecological, Social, and Economic Systems

	Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels. Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments. Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.
Mathematics: Common Core	HSN.Q.A.1 **-** Use units to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. HSN.Q.A.2 **-** Define appropriate quantities for the purpose of descriptive modeling. HSN.Q.A.3 **-** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities
Mathematical Practices	MP 1 **-** Make sense of problems and persevere in solving them. MP 2 **-** Reason abstractly and quantitatively. MP 4 **-** Model with mathematics.
Science	HS-PS2-1 **-** Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-3 **-** Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. HS-PS2-4 **-** Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. HS-PS3-1 **-** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. HS-PS3-2 **-** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects) HS-PS3-3 **-** Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. HS-ETS1-1 **-** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

	HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. 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.

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Developing and Using Models Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions Analyzing and Interpreting Data Obtaining, Evaluating, and Communicating Information	PS3.A: Definitions of Energy PS3.B: Conservation of Energy and Energy Transfer PS3.C: Relationship Between Energy and Forces PS3.D: Energy in Chemical Processes ETS1.A: Defining and Delimiting an Engineering Problem ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Patterns Cause and Effect Systems and System Models Energy and Matter *Connections to Engineering, Technology, and Applications of Science* Influence of Science, Engineering and Technology on Society and the Natural World *Connections to Nature of Science* Scientific Knowledge Assumes an Order and Consistency in Natural Systems

Unit 19 – Fasteners	**Total Learning Hours for Unit:** 10
Unit Summary: This unit will show students the various types of fasteners used in many manufacturing processes. The unit includes information about materials, types of threads, shapes of threads, how they are made, thread-related terms, various types of fasteners, advantages and disadvantages, materials fasteners are made from, and possible production problems associated with the manufacturing of fasteners.	
Performance Assessments: (Districts to complete for each unit) *Example assessments for this unit include:* **General** At the completion of the unit students will be able to:	

- Identify reasons why and when fasteners are the preferred method of joining materials.
- Identify fastener threads by type.
- Define the term **helix** and explain why it is important in understanding fasteners.
- Understand how threads are cut, internally and externally.
- Converse using appropriate Thread Terms.
- Identify various fasteners by type and usefulness.
- Recognize that fasteners made in different countries might meet different standards.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Using online resources, students will create and share classroom presentations regarding fasteners.
- Articulating the various standards regarding fasteners.
- Interpreting what type of fastener is a **½"-13UNC-2A-RH** bolt is and explaining a typical situation this bolt would be appropriately used.
- Explaining applications where self-locking fasteners might be used.
- Identify and explain the differences between standard Thread Systems.
- Describe and explain some of the differences between the Indian, German, Japanese, American, and British Standards of fasteners.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Selecting the appropriate fasteners for various uses based on materials, environment, application, and cost.
- Describing tensile strength and explaining why it is an important consideration in selecting fasteners.
- Explaining various processes that some fasteners go through during the coating-application process.
- Presenting potential problems and solutions when joining two or more different objects made from different materials (rate of corrosion, abrasive wear, etc.).
- Explaining what an anti-seize remedy is made of and how/when it should be used.
- Understanding how to effectively use a torque wrench.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Explaining how and why screw sizes are determined.
- Explaining how diameter, depth, angle of thread, and pitch are utilized in describing threads.
- Describe chamfer and explain why it is important in understanding fasteners.
- Explaining the differences between inch and metric fasteners.
- Graphing the impacts of increasing torque on various fasteners

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

Through team-based activities relating to maritime careers students will:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Leadership Skills:
1.A Think Creatively.
1.B Work Creatively with Others
2.A Reason Effectively
2.B Use Systems Thinking
2.C Make Judgments and Decisions
2.D Solve Problems.
4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- Fastener Thread Type - External vs. internal threads, coarse threads vs. fine threads, etc.
- Tap and Die – Using appropriate tools to cut internal and external threads.
- Thread Terminology – Utilizing appropriate terms to describe fasteners.
- Fastener Standards – International vs domestic standards.

Aligned Washington State Academic Standards	
English Language Arts: Common Core	RI.11-12.7 **-** Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words to address a question or solve a problem. SL.11-12.1 **-** Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. SL.11-12.2 **-** Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data. RST.11-12.3 **-** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. RST.11-12.4 **-** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*.

	RST.11-12.7 **-** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem. *RST.11-12.8 - Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.* *RST.11-12.9 - Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.* WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. *WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.* WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information. WHST.11-12.7 - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. *WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.* WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Environment and Sustainability	Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels. Standard 2: The Natural and Built Environment

	Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments. Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.
Mathematics: Common Core	HSN.Q.A.1 **-** Use units to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. HSN.Q.A.2 **-** Define appropriate quantities for the purpose of descriptive modeling. HSN.Q.A.3 **-** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. HSA.CED.A.1 **-** Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions. HSA.CED.A.2 **-** Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. HSA.CED.A.3 **-** Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. HSA.CED.A.4 **-** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. HSF.IF.B.4 **-** For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.* HSF.IF.B.5 **-** Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. HSF.IF.B.6 **-** Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.
Mathematical Practices	MP 1 **-** Make sense of problems and persevere in solving them. MP 2 **-** Reason abstractly and quantitatively. MP 3 **-** Construct viable arguments and critique the reasoning of others. MP 4 **-** Model with mathematics. MP 5 **-** Use appropriate tools strategically.

	MP 6 - Attend to precision. MP 7 - Look for and make use of structure. MP 8 - Look for and express regularity in repeated reasoning.
Science	HS-PS2-3 - Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. 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.

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Asking Questions and Defining Problems. Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	ETS1.A: Defining and Delimiting Engineering Problems. ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Systems and System Models *Connections to Engineering, Technology, and Applications of Science* Influence of Science, Engineering, and Technology on Society and the Natural World

Unit 20 – Quality Control and Quality Assurance	**Total Learning Hours for Unit:** 20

Unit Summary:
This unit will examine the importance of Quality Assurance, the role a Quality Inspector plays to ensure quality, and about the tools and techniques used to ensure quality. Quality assurance is applied to design and manufacturing, safety, and environmental protection. The student will be introduced to the quality management systems such as the ISO-9000 series, ISO-14000 series, OHSAS-18001, the International Management Code for Safe operation of ships and Pollution Prevention (ISM code) and various Health, Safety, Quality and Environment (HSQE) that are required in the maritime industry. In addition, the student will identify the role of the recognized associations responsible for approval, certification, and auditing of quality management system.

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

General

Students will be able to show knowledge by completing activities like:

- Understanding and applying appropriate boat classification certifications (Coast Guard/CFRs, ABS, SOLAS, Bravo Veritas).
- Be able to conduct a proper safety and pollution prevention compliance inspection of a recreational boat (owned or rented); in accordance with USCG and Washington State Boating laws.
- Understand the difference between Quality Control and Quality Assurance and who is responsible for each.
- Define Quality Inspection.
- Define Policy, Procedure and Specification.
- List the skills that make up a good Quality Inspector.
- State the Quality Inspector motto and explain what it means.
- List examples of why product safety is important.
- Why is quality important (do you want to keep an employee that produces low quality work, and do you want to do business with a company that produces low- or high-quality work?)
- How does quality affect the work you do and or the product you produce?
- How does Quality relate to retaining continuing business or reputation?
- Explain how FME would be used to prevent system and Tank contamination.
- Explain the importance of when and how FME is used during repair, new construction, and testing.
- Explain the importance of record keeping as it relates to recording when and where FME was installed and removed.
- Creating and presenting information on how to create a culture of quality, safety, and environmental protection.
- Understand the role quality management systems play in the maritime industry.
- Understand the structure and required content of a quality management system.
- Identify the various inspection programs in the maritime industry (USCG, American Bureau of shipping (ABS), port state control, state and local.
- Understand the process for reporting and submitting a nonconformity.
- Understand the process for corrective action(s).
- Understand the purpose of a safety and environment mission statement and policy.
- Understand the role of the Designated Person as stated in the International safety Management Code (ISM).
- Understand how quality management systems are applied to health, safety, and environmental protection.
- Understand the role of the individual in continuous improvement of quality management systems.
- Identify a safety or environment concern, report a non-conformity, and provide suggested corrective action.
- Understand the responsibility of the ship's Master in implementing the safety management system and motivating person to participate.
- Review and identify the key elements of a quality management system.
- Create a working procedure for a fictional quality management system.

- Understand terms and definitions used in safety and environmental management systems.
- Understand the company's role and responsibility in a safety and environmental management system.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Comparing Quality Control and Quality Assurance.
- Defining Quality Inspection.
- Describing the roles and responsibilities of a Quality Inspector.
- Defining Policy, Procedure and Specification.
- Listing the skills that make up a good Quality Inspector.
- Stating the Quality Inspector motto and explain what it means.
- Defending the importance of Quality and Safety.
- Identifying and describe the four elements of an effective Environmental Health and Safety program.
- Listing examples of why product safety is important.
- Explaining how Quality Inspection improves product safety.
- Identifying Inspection criteria.
    - What are the requirements you are inspecting to?
    - What are the differences between contract requirements and regulatory requirement?
    - What inspection requirements take precedence? For example: which requirements do you inspect to and why? (company policies, contract requirements ABS, CG or SOLA)S. Which one do you inspect to?
- Time management during inspections.
- Inspection reporting and conflict resolution. (How do you tell someone that has been doing the job for 20+ that they failed an inspection because their work does not meet the requirements?)
- Compare and contrast the two types of Inspection techniques and the tools used for both.
- Discussing Non-Destructive Inspection and the tools used.
- Identifying Foreign Material Exclusion (FME) and explain how to prevent it.
- Writing a procedure for a quality management system.
- Researching and proposing the corrective action for a non-conformity within the quality management system.
- Research accident information of maritime casualties to cite the recommended corrective actions.
- Develop a safety and environmental management system for their school.
- Create a safety and environmental policy and mission statement.
- Create a safety and environmental slogan.
- Reviewing their school's emergency response procedure for continuous improvement
- Create ideas to motivate students (employees) in adhering to the policies of a safety management system.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Evaluating various products and samples of work based on specific criteria to determine and identify specific examples of how specifications were or were not met.
- Conducting a systematic analysis (why-tree) to determine root cause for why specifications were not met.
- Conducting various tests to determine product or sample limitations through destructive and non-destructive testing.
- Students restating the original product parameters into a diagram or flow chart.
- For at least one of the parameters, students proposing two or more solutions that are based on student-generated data and/or scientific information from other sources.
- Students describing how solutions to the parameters are interconnected to solve all or part of the larger problem.
- Students describing the rationale for the sequence of how parameters are to be met, and which criteria should be given highest priority if tradeoffs must be made.
- Generating a list of three or more realistic criteria and two or more constraints, including such relevant factors as cost, safety, reliability, and aesthetics that specifies an acceptable solution to a complex real-world problem.
- Assigning priorities for each criterion and constraint that allows for a logical and systematic evaluation of alternative solution proposals.
- Analyzing and describing the strengths and weaknesses of the solution with respect to each criterion and constraint, as well as social and cultural acceptability and environmental impacts.
- Describing possible barriers to implementing each solution, such as cultural, economic, or other sources of resistance to potential solutions.
- Provide an evidence-based decision of which solution is optimum, based on prioritized criteria, analysis of the strengths and weaknesses (costs and benefits) of each solution, and barriers to be overcome.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Identifying the inputs and constraints of the product or sample to be evaluated.
- Designing, creating, or selecting the model to evaluate the effects of different solutions to identify compliance, tradeoffs, or to make other decisions.
- Predicting expected results.
- Comparing predicted results to actual results.
- Identifying possible negative consequences of solutions that outweigh their benefits.
- Calculating the estimated cleanup cost of a pollution incident.
- Estimating the legal costs and payments associated with a workplace injury.
- Calculate the estimated cost associated with the loss of human lives versus the cost of remanufacturing.
- Using the frequency of a specific type of near miss to predict the potential of a serious marine casualty.
- Calculating the estimated loss in business income due to a serious marine casualty (grounding, stranding, collision)
- Calculating the cost of a safety program.
- Calculating the estimated cost fines associated with failure to adhere to federal, state, or local regulations.

- Estimate the cost to "re-tool" or re-manufacture a product.
- Estimate the recall costs for a defective, unsafe, or non-compliant product.
- Estimate the costs associated with quality inspections of petroleum products transported on tank barges or tank ships

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

Through team-based activities relating to maritime careers students will:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).
- Set the objectives of a safety management system and motivate persons in the observance of that policy and objective(s).
- Verifying that specific requirements are being observed in student created quality management system.
- Implementing the safety and environmental policies of their school and local communities.
- Identifying and implementing methods for continuous improvement to their school activities.
- Providing innovative ways to inform school officials of opportunities for continuous improvement of education outcomes.
- Improving the effectiveness of teacher evaluations thereby contributing to improved teacher performance and improved education outcomes.
- Provide continuous improvement feedback to educators on poor performing educational programs through greater by participation and improved documentation.
- Creating documented health.
- Safety Quality and Environment management system implemented by the Student Governing body.
- Demand a quality education in a safe working environment.

Leadership Skills:

1.A Think Creatively.
1.B Work Creatively with Others
2.A Reason Effectively
2.B Use Systems Thinking
2.C Make Judgments and Decisions
2.D Solve Problems.
4.A Access and Evaluate Information

Industry Standards and/or Competencies:

Quality Inspection - Measures or processes aimed at checking, measuring, or testing one or more product characteristics, and to relate the results to compliance requirements.

Policy - A course or principle of action adopted or proposed by a government, party, business, or individual. Procedure - An established or official way of doing something. Specification - An act of describing or identifying something precisely or stating a precise requirement. "Trust but Verify" – Believe people do things correctly but make sure to double-check the work. Rework vs Repair – identifying when to change methods or to fix mistakes. Structure of Marine Health, Safety , Quality and Environmental Management Systems - the key elements of the International Management Code for the Safe Operation of Ships and for Pollution prevention (International Safety Management Code (ISM).	
Aligned Washington State Academic Standards	
English Language Arts: Common Core	RI.11-12.7 **-** Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words to address a question or solve a problem. SL.11-12.1 **-** Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. SL.11-12.2 **-** Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data. RST.11-12.1 **-** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. RST.11-12.3 **-** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. RST.11-12.4 **-** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*. RST.11-12.7 **-** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem. RST.11-12.8 **-** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. RST.11-12.9 **-** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

	WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information. WHST.11-12.7 - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. *WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.* WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Environment and Sustainability	Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels. Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments. Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.
Mathematics: Common Core	HSN.Q.A.1 **-** Use units to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. HSN.Q.A.2 **-** Define appropriate quantities for the purpose of descriptive modeling. HSN.Q.A.3 **-** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. HSA.CED.A.1 **-** Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

	HSA.CED.A.2 - Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. HSA.CED.A.3 - Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. HSA.CED.A.4 - Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. HSF.IF.B.4 - For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.* HSF.IF.B.5 - Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. HSF.IF.B.6 - Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.
Mathematical Practices	MP 1 - Make sense of problems and persevere in solving them. MP 2 - Reason abstractly and quantitatively. MP 3 - Construct viable arguments and critique the reasoning of others. MP 4 - Model with mathematics. MP 5 - Use appropriate tools strategically. MP 6 - Attend to precision. MP 7 - Look for and make use of structure. MP 8 - Look for and express regularity in repeated reasoning.
Science	HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. 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.

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept

Asking Questions and Defining Problems. Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	ETS1.A: Defining and Delimiting Engineering Problems. ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Systems and System Models *Connections to Engineering, Technology, and Applications of Science* Influence of Science, Engineering, and Technology on Society and the Natural World

Unit 21 – Career Readiness and Employment	**Total Learning Hours for Unit:** 20

Unit Summary:

This unit includes careers, pathways and industries that relate to Core Plus training. Students will learn how to:

- find jobs, training, and certificate programs.
- write resumes, cover letters, and effectively communicate with employers.

Students will also learn what to expect in the "real world" before they graduate, learn how to increase their value as an employee, and leave with the Core Plus Employability Certificate to serve as evidence as they apply for employment.

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

General

At the end of this unit students will be able to:

- Be the employee your employer cannot live without.
- Understand types of career pathways.
- Know the differences and similarities between internships, jobs, and apprenticeships.
- Understand the importance of transferrable skills.
- Find certificate and technical college programs.
- Understand the types of jobs they qualify for.
- Know the right jobs and terms to look for in job postings.
- Know how to find an employer that suites their career pathway needs.
- Present yourself well in a professional setting.
- Know what to wear for a job interview.
- Know how to prepare for a job interview.
- Have reasonable expectations of what to expect when they first enter the workforce.
- Use the Employability Certificate as a letter of recommendation.

English/Language Arts

Students will demonstrate ELA competencies through several classroom and laboratory activities like:

- Understanding the job application process.
- Writing a resume.
- Writing a cover letter.
- Completing a job application.
- Knowing how to respond to interview questions and what to ask the interviewer.
- Properly responding to an employer by email or phone.
- Understanding and articulating the current perception of youth.
- Identifying employability skills they might need to improve.
- Understand what behaviors are expected in a classroom and workplace.
- Comparing the differences between union and nonunion positions.

Mathematics

Students will demonstrate mathematics competencies through several classroom and laboratory activities like:

- Analyzing and understanding Washington's starting wage.
- Calculating compensation packages.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

Through team-based activities relating to maritime careers students will:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Leadership Skills:

1.A Think Creatively.
1.B Work Creatively with Others
2.A Reason Effectively
2.B Use Systems Thinking
2.C Make Judgments and Decisions
2.D Solve Problems.
4.A Access and Evaluate Information

Industry Standards and/or Competencies:

Career Pathways – Organized approach to career planning for anyone wanting to land a first job or to improve skills for different or better job opportunities**.**

Internships - Short-term periods of temporary work experience, typically lasting for a few weeks or months.

Apprenticeships - Formal employment program that trains you to do a specific job.

Transferrable Skills – An ability or expertise which may be used in a variety of roles or occupations.

Employability Certificate – An authorization issued by school authorities for a child of school age to work at a job paying wages or salary.

Resume – Formal document that job hopefuls submit to hiring managers and employment recruiters as a means of itemizing their work experience, educational background, and special skills.

Cover Letter – One-page document that introduces a job seeker's work history, professional skills, and personal interest in applying for a job**.**

Compensation Packages - Combination of benefits that an employer offers to employees that may include wages, insurance, vacation days, guaranteed raises, and other perks.

Aligned Washington State Academic Standards	
English Language Arts: Common Core	RI.11-12.1 **-** Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain. *RI.11-12.2 - Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text.* RI.11-12.4 **-** Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10). RI.11-12.7 **-** Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words to address a question or solve a problem. SL.11-12.1 **-** Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. SL.11-12.1.A **-** Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas. SL.11-12.1.C **-** Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives. SL.11-12.2 **-** Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

	SL.11-12.3 **-** Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used. SL.11-12.4 **-** Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks. SL.11-12.5 **-** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. SL.11-12.6 Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate. WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. *WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.* WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information. *WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.* *WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.* WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Environment and Sustainability	Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels. Standard 2: The Natural and Built Environment

	Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments. Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.
Mathematics: Common Core	HSN.Q.A.1 **-** Use units to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. HSN.Q.A.2 **-** Define appropriate quantities for the purpose of descriptive modeling. HSN.Q.A.3 **-** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. HSA.SSE.A.1 **-** Interpret expressions that represent a quantity in terms of its context. HSA.SSE.A.1.A **-** Interpret parts of an expression, such as terms, factors, and coefficients. HSA.SSE.A.1.B **-** Interpret complicated expressions by viewing one or more of their parts as a single entity. HSA.SSE.A.2 - Use the structure of an expression to identify ways to rewrite it. HSA.SSE.B.3 **-** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. HSA.REI.A.1 **-** Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method. HSA.REI.A.2 **-** Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.
Mathematical Practices	MP 4 **-** Model with mathematics. MP 5 **-** Use appropriate tools strategically. MP 6 **-** Attend to precision. MP 7 **-** Look for and make use of structure. MP 8 **-** Look for and express regularity in repeated reasoning.
Science	None

Unit 22 - Capstone Project	**Total Learning Hours for Unit:** 40
Unit Summary:	

It is recommended that to complete this unit, students will be manufacturing a Capstone project, and the project will include information that students have learned from the previous units. *It is recommended that this information be covered during manufacturing steps where the specific information is pertinent.*

To help meet English Language Arts standards, journaling, other writing (lab reports, manufacturing documentation, etc.), and student presentations are embedded into all Core Plus Maritime units and materials.

Capstone project ideas may include individual student projects, group projects, community-based projects, presentations, preparation for and participation in CTSO events, and the manufacture of teaching aids for various units that may be used during the instruction of maritime units in the future.

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

General

- Students understand and explain the guiding principles of marine-related manufacturing.
- Students understand and implement The Design Process to complete their Capstone Project.
- Students design and manufacture a marine-related project, including design, cost analysis, manufacturing, testing, and quality assurance documentation.
- Students explain why things move and operate based on design, cost analysis, manufacturing, testing, and quality assurance documentation principles.
- Students understand and explain the guiding principles of physics and mathematics and manufacturing related to marine applications.
- Students share their knowledge of marine manufacturing processes and procedures.
- Students share their knowledge of the primary laws of science and mathematics and how they apply to manufacturing.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Creating a Quality Assurance checklist as part of the project evaluation process.
- Presenting their Capstone Project, including identifying the process they used to problem solve issues.
- Creating an Employment Plan describing the knowledge and skills they demonstrated during the design, manufacture, and testing of their Capstone Project.
- Creating clear and coherent written or multimedia training/instruction and operation manuals for their Capstone project.
- Presenting arguments for design changes, improvements, or changes in manufacturing process.
- Presentations using multimedia documentation of the lessons learned while creating their Capstone project.
- Written, oral or multimedia informative/explanatory presentations on the safety and environmental concerns of their Capstone project.
- Written and oral arguments incorporating multimedia on the scientific theories and/or mathematically explanations of their Capstone project.
- Creating written and multimedia workplace safety bulletins, posters, safety checklists, and guidelines.

- Short written or multimedia biographies about the inventor, physicist, astronomer, or discoverer, whomever or whatever servers as the cornerstone of their Capstone project.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Designing a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- Evaluating a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
- Providing a practical demonstration or documentation supporting the scientific aspects of their Capstone project.
- Selecting as their Capstone project to manufacture something based upon scientific theories i.e., a magnetic compass.
- Applying scientific principles to design and construction of their Capstone project.
- Working within a team to develop and defend arguments based upon scientific reasoning and deduction.
- Apply the principles of simple machines and the laws of physics in the rigging or physical construction of their Capstone project.
- Selecting the appropriate construction materials relevant to their Capstone project (wood, aluminum, steel, non-magnetic, etc.).
- Reading of schematics and print drawings of electrical circuits, pipelines, fluid lines, etc.).

Mathematic

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Evaluating a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
- Appling appropriate precision during the design, manufacturing, and testing of the Capstone Project.
- Using appropriate formulas and performing required mathematical calculations to support the physics of their Capstone project.
- Performing material cost analysis, cost of ancillary equipment and calculation of production time of their Capstone project.
- Mathematical calculations related to measurements required in their Capstone project.
- Evaluating and calculating the energy or power requirements of their Capstone project.
- Performing a market analysis for the subsequent distribution of their Capstone project.
- Evaluating and calculating the cost of revisions/alterations from the original design of their Capstone project.
- Calculating disposal costs of their Capstone project.

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

Through team-based activities relating to maritime careers students will:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).

- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).
- Apply the principles of good teamwork and to make success attainable for all.
- Develop a sense of team spirit and work within the team to support common goals.
- Develop and show initiative and the confidence to make decisions.
- Apply the principles of continuous improvement to their Capstone project.
- Solicit diverse thoughts or proposals from others and diverse fields when looking for solutions to problems,
- Develop and show industriousness and the willingness to do hard work.

Leadership Skills:
1.A Think Creatively.
1.B Work Creatively with Others
2.A Reason Effectively
2.B Use Systems Thinking
2.C Make Judgments and Decisions
2.D Solve Problems.
4.A Access and Evaluate Information

Industry Standards and/or Competencies:

The Design Process - Design, cost analysis, manufacturing, testing, and quality assurance documentation.
Metacognition – Applying knowledge based on awareness and understanding of one's own thought processes.
Safety – Knowledge and understanding of safe conditions and procedures.
Standard Operating Procedures – Understanding and applying standard procedures.
Precision Measurement – Using correct tools and standards to manufacture within appropriate precision, accuracy, and tolerance.
Print Reading – Creating and/or interpreting design specifications.
Applied Physics – Understanding and planning for the influences that forces, energy, and environmental conditions have on the manufacturing process.
Material Science – Selection of appropriate materials to be used in the manufacturing of the Capstone Project.

Aligned Washington State Academic Standards	
English Language Arts: Common Core	*RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.* RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. RST.11-12.4 - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*.

	RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas. *RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.* RST.11-12.8 - Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. RST.11-12.9 - Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently. Write arguments focused on *discipline-specific content*. WHST.11-12.1.A - Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence. WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. *WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.* WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information. WHST.11-12.7 - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. *WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.*

	WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Environment and Sustainability	Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels. Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments. Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.
Mathematics: Common Core	HSN.Q.A.1 **-** Use units to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. HSN.Q.A.2 **-** Define appropriate quantities for the purpose of descriptive modeling. HSN.Q.A.3 **-** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. HSA.CED.A **-** Create equations that describe numbers or relationships. HSA.CED.A.1 **-** Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions. HSA.CED.A.4 **-** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R. HSA.REI.A **-** Understand solving equations as a process of reasoning and explain the reasoning. HSA.REI.B **-** Solve equations and inequalities in one variable. HSA.REI.B.3 **-** Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters
Mathematical Practices	MP 5 **-** Use appropriate tools strategically. MP 6 - Attend to precision. MP 7 **-** Look for and make use of structure. MP 8 **-** Look for and express regularity in repeated reasoning.

Science	HS-ETS1-1 **-** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2 **-** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3 **-** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. 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.

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Asking Questions and Defining Problems. Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	ETS1.A: Defining and Delimiting Engineering Problems. ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Systems and System Models *Connections to Engineering, Technology, and Applications of Science* Influence of Science, Engineering, and Technology on Society and the Natural World