

Virtual meeting 2026

NIST Standards Coordination Office Curricula Development Cooperative Agreement Program

Title: Develop, Implement, and Integrate Standard Education Modules in Mechanical, Chemical, and Industrial Management and Technology Curricula (2023)

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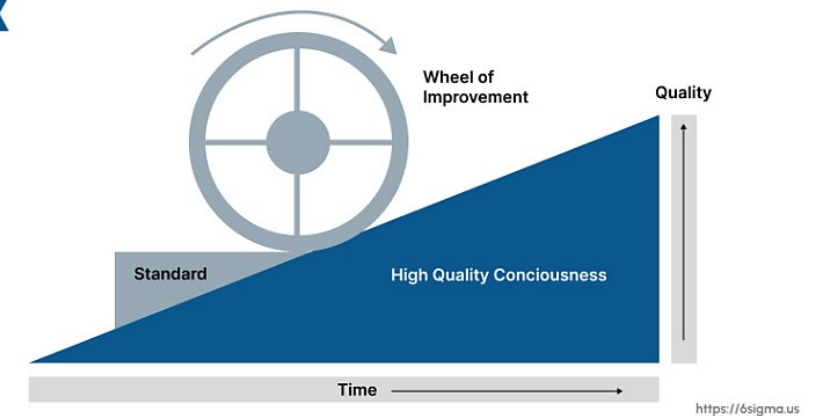
Date: September 10, 2026

Motivation for the Project

- Standardization ensures **uniformity, efficiency, quality, safety, and performance**.
- **Consistency** is critical for operational excellence: it **minimizes** performance **variations**, reduces errors, and enhances quality control.
- Process standardization is a **continuous journey**, requiring commitment and ongoing improvement.
- Engineering **graduates** often face challenges when applying standards-based design in practice.



SIX



Link: <https://www.6sigma.us/business-process-management-articles/process-standardization-for-operational-excellence/>

Project Goal and Objectives

Project Goal:

Improve Mechanical, Chemical, and Industrial Management & Technology curricula by developing course modules that:

- Integrate standards and standardization knowledge
- Prepare students to understand the impact and value of standards in engineering
- Strengthen students' ability to apply engineering standards to real-world problems and case studies.



Objective

Description

O1: Familiarize

Introduce students to the standardization process

O2: Guide

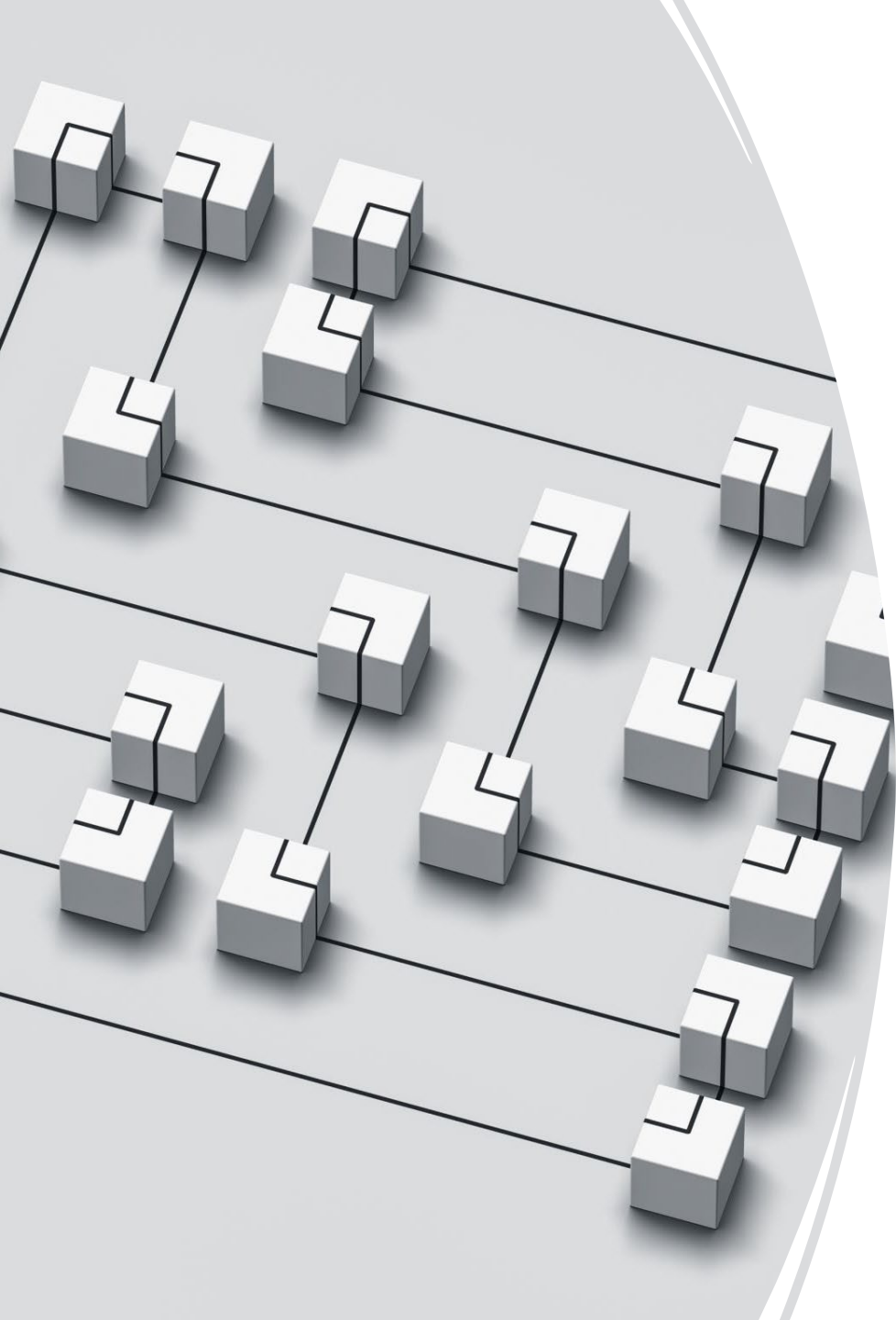
Help students identify relevant standards for design, manufacturing, and testing

O3: Educate

Teach students to apply standards in component/system design

O4: Inspire

Encourage future use of standards in professional practice



Scope of Work

- Develop 14 sustainable modules integrated across Mechanical, Chemical, and Industrial Management & Applied Engineering Technology courses.
- Organize 5 webinars on standards and their applications with industry experts.
- Integrate modules into existing courses without disrupting curricula.
- Evaluate effectiveness through assessments.
- Disseminate modules through TAMUK website, professional networks, and conferences (ASEE, ASME, IEEE)

Implemented Course Modules

Integration of Industry Standards into Curriculum

*Bridging Academic Learning
with Industry Standards*

Discipline	Level	Standards / Codes (Implemented in Module)	Module No.	Course Number
 Mechanical Engineering	Junior	1. ASME Boiler and Pressure Vessel Code, Section VIII, Div. 2. 2. ASME Boiler and Pressure Vessel Code, Section II, part D. 3. DNV 2.7-1 Standard for Certification Offshore Containers.	Module 1	MEEN 3350
			Module 10	MEEN 3360
	Senior	4. AISC Steel Construction Manual, American Institute of Steel Construction.	Module 2	MEEN 4351
	Graduate	6. ASTM test method for tensile properties of fiber-resin composites (D3039) 7. ASTM test method for flexural properties of fiber-resin composites (D7264)	Module 15	MEEN 5316
		8. AGMA Gear Standard 1012-H23 for Gear Tooth Design	Module 13	MEEN 3352
 Chemical Engineering	Junior	9. ASTM B543 Heat exchanger tubing	Module 4	CHEN 3310
	Senior	10. ASTM E3027 Sustainable Chemicals Selection 10. NFPA 36-17 Solvent Extraction Plants	Module 5	CHEN 4317
		11. ASTM C1274 Ceramic Materials Surface Area Determination	Module 6	CHEN 4317
		12. NFPA 30 Flammable and Combustible Liquids Code	Module 14	CHEN 4317
		13. ASTM E2535 Safe Handling of Engineered Nanoparticles 14. NFPA 53-16 Oxygen Enriched Atmospheres	Module 9	CHEN 4316
 Industrial Management and Technology	Sophomore	15. IEEE 516-2009: Guide for Maintenance Methods on Energized Power Lines 16. NFPA 170, Standard for Fire Safety and Emergency Symbols	Module 7	ITEN 2330
	Junior	17. IEEE Std 1562™-2021: Practice for Sizing of Stand-Alone Photovoltaic (PV) Systems 18. IEEE 2030.9-2019: Practice for the Planning and Design of the Microgrid	Module 3	ITEN 3313
		19. IEEE 519-2022: Standard for Harmonic Control in Electric Power Systems	Module 12	ITEN 3313
		20. IEEE Standard for Smart Energy Profile Application Protocol	Module 16	ITEN 3313
	Graduate	19. ISO 28000:2022 Security and resilience – Security management systems Requirements 20. GS1-128 (formerly known as EAN-128 or UCC-128): Linear Barcode Symbology Specification	Module 11	IMEN 5350
		21. ISO 45001:2018 Occupational health and safety management systems 22. ISO 45001:2018 Occupational health and safety management systems	Module 8	IMEN 5340

What makes a Module?



What standards and standardization are.



Importance and applications of standards.



Development and modification process of standards.



Major engineering standards (ASME, IEEE, ASTM, ISO, NFPA, etc.).



Standard databases and search methods.



Includes real-world examples (e.g., accidents due to noncompliance, design of pressure vessels, layout of chemical plants).



Integrated webinars with industry experts; recorded content embedded in module

Students' Learning Outcomes and Evaluations

- **Assessment Aspects**
 - Students' ability to **identify the correct standard** for a specific design
 - Students' **understanding of the standardization process**
 - Students' ability to **apply appropriate standards** to components
 - Students' **interest in using standards** in their future career
 - Students' **familiarity with a variety of standards**
- **Assessment Instruments**
 - **Homework & Project Assignments** – measure application of standards
 - **Quizzes & Exams** – test comprehension and accuracy
 - **Pre- & Post-Course Surveys** – capture growth in awareness, interest, and familiarity





Project Timeline and Tasks

- **Year 1: September 2023 – August 2024**

Goal: Develop 14 modules and integrate 6 modules into courses

- **Task 1.1:** Collect standards & develop 6 modules – by Dec 2023
- **Task 1.2:** Organize 5 webinars & implement 5 modules – by May 2024
- **Task 1.3:** Develop 5 additional modules – by May 2024
- **Task 1.4:** Develop 5 additional modules – by Sept 2024
- **Task 1.5:** Collect data for evaluation – by Aug 2024

- **Year 2: September 2024 – August 2025**

Goal: Integrate 8 modules into 8 courses

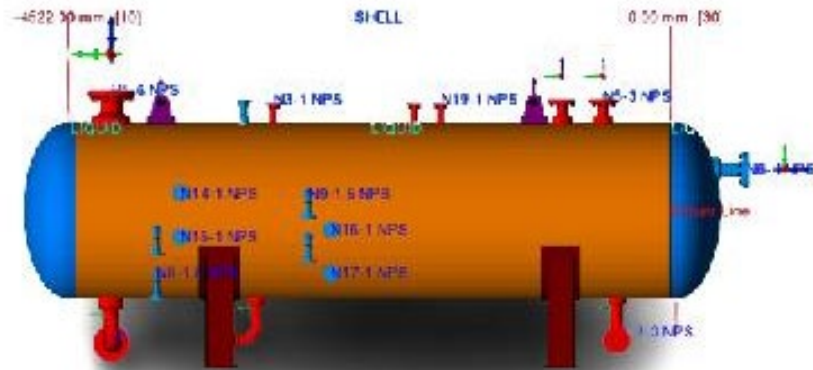
- **Task 2.1:** Integrate 5 modules – by Dec 2024
- **Task 2.2:** Integrate 5 modules – by May 2025
- **Task 2.3:** Collect evaluation data – by May 2025
- **Task 2.4:** Final reporting, assessment & dissemination (TAMUK site, NIST site, conferences) – by Sep 2025

- **Year 3: September 2025 – August 2026**

Goal: Develop 2 modules and integrate then into courses

- **Task 3.1:** Develop 2 modules – by Dec 2025
- **Task 2.2:** Integrate 2 modules – by May 2026
- **Task 2.3:** Collect evaluation data – by May 2026
- **Task 2.4:** Final reporting, assessment & dissemination (TAMUK site, NIST site, conferences) – by Sep 2026

Example Standard 1: Design a pressure vessel according to ASME boiler and pressure vessel code



1. Code Selection

- **ASME VIII (Division 2): Construction of Pressure Vessel Codes**

2. Material Selection

- Based on Appendix B requirements
- **SA-106 B** for Head, Shell, Nozzle, PG, Drain, Inlet, Outlet

3. Design Temperature

- Max: **300°F**
- MDMT = lowest expected service temperature

4. Corrosion Allowance

- **1.5 mm** allowance for air receivers (condensation expected)

5. Shell Design

- Thickness based on circumferential & longitudinal stress formulas
- Uses allowable stress (S) & weld joint efficiency (E)

6. Closure & Head Design

- Ellipsoidal, torispherical, hemispherical per UG-16 & UG-22

- Required thickness $\geq$ hemispherical equivalent

7. Ellipsoidal Head Design

- Required thickness $\approx 57.4 - 59.7$ mm

8. Nozzle & Reinforcement

- Openings circular/elliptical
- Flow-rate based dimensions:
Inlet = 100 mm, Outlet = 80 mm

9. Prototype Modeling

- 3D model created in **SolidWorks**

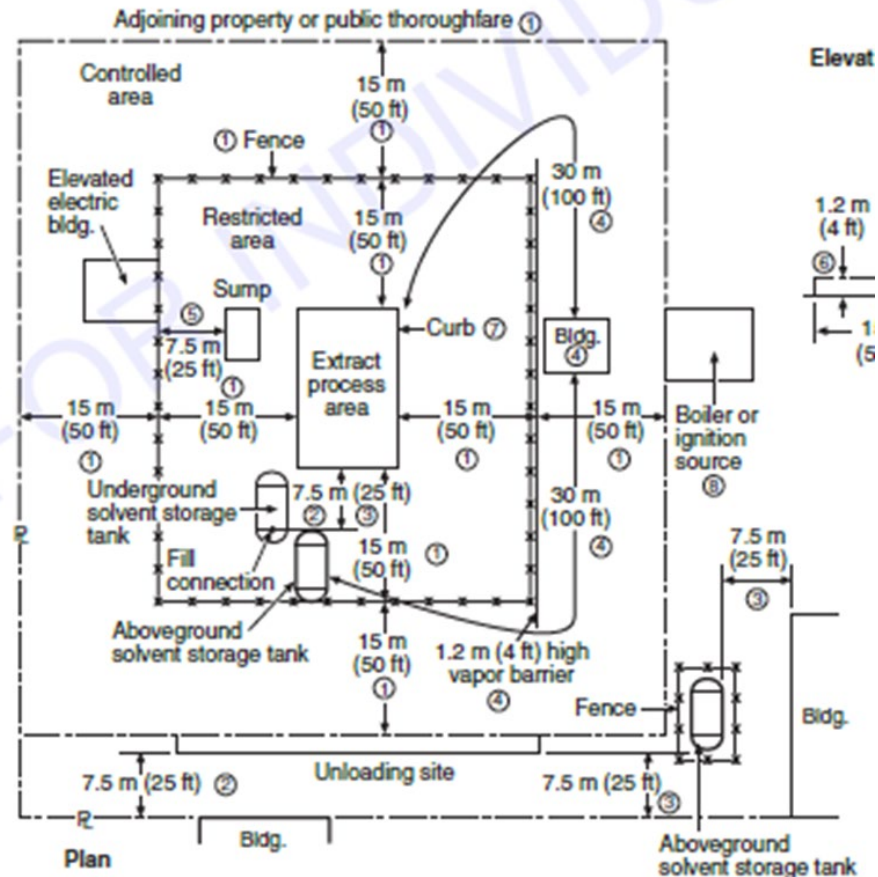
10. Simulation & Analysis

- Finite element analysis (FEA)
- Compare von Mises stresses with allowable stress (S)

10. Modification & Finalization

- Adjust thickness or material grade if stress > allowable
- Finalize optimized design

Example Standard 2: NFPA 36-17 Standard for Solvent Extraction Plants



1. Code Selection

- NFPA 36 provides code for safety of solvent extraction plants using hexane and similar solvents

2. Objectives

- Fire prevention
- Structure design requirements
- Hazardous materials handling
- Emergency response

3. Siting

- Extraction process using flammable solvents should be located in the open or specially designed buildings.

4. Fencing / Access

- Industrial fencing shall be installed at least 15 m from the extraction equipment.
- The area from 15 to 30 m from the unit shall be controlled with posted signs.
- Basements and tunnels shall be prohibited within 30 m.

5. Design and Construction

- Building containing extraction equipment must be open air.
- Must be constructed of fire-resistant and non-combustible materials.

6. Drainage and Spill Control

- Must design site drainage so as to prevent the introduction of any released solvent into sewer or storm sewer system.

7. Ignition Source

- Ignition sources not allowed in the extraction building or within 30 m of extraction process unit
- Heating or steam tracing equipment shall not exceed 120 C temperature.

Example Standard 3: IEEE 516-2009: IEEE Guide for Maintenance Methods on Energized Power Lines



1. Pre-Job Planning & Setup

- Safety briefing, equipment check
- Calculate MAD (e.g., 5 m @ 500 kV)
- Verify tool insulation distance (e.g., 6 m @ 500 kV)

2. Installation of Protective Equipment

- Apply temporary grounding on de-energized sections
- Use cover-up equipment for adjacent energized parts

3. Aerial Work & Barehand Procedures

- Access line via helicopter or insulated aerial device
- Workers bonded to line potential using gloving/barehand techniques

4. Monitoring During Maintenance

- Track leakage & capacitive currents (safe < 1 mA leakage)
- Ensure sparkover ratings exceed possible surges

5. Post-Job Procedures

- Remove grounding & cover-up equipment
- Document MAD, parameters, incidents, and lessons learned

• Illustrative Example: 500 kV Transmission Line Maintenance

- **Setup:** MAD = 5 m; insulated tools = 6 m; grounding rated 40 kA
- **Access:** Workers lifted by helicopter, bonded at line potential, gloves rated 500 kV
- **Monitoring:** Leakage current = 0.8 mA; capacitive current = 15 mA; surge = 600 kV (tools rated 700 kV)
- **Post-Job:** Safe removal of equipment; final report with surge and current data
- **Critical factors that can change the measurement**
- Work Techniques: Aerial Work, Barehand Work, Helicopter Work, etc.
- Protective Measures: Cover-up Equipment, Insulated Tools/Device
- Electrical Currents: Conduction Current, Capacitive Current, Leakage Current

Learning Progression: From Standards Awareness to Application



Recognize

Awareness: Recognize the purpose, value, and professional relevance of standards.



Identify

Identification: Locate or select the appropriate standard for an engineering problem.



Explain

Interpretation: Explain how and why specific requirements affect engineering outcomes.



Use

Application: Use requirements, limits, test methods, or decision rules to guide an engineering action.

Evaluation Approach: Assessment of Student Learning

- Evaluated using anonymous response
- Pre- and Post-course surveys based on 8 questions
- Survey items were mapped to the four learning stages:
 - I. Awareness — Q1, Q7
 - II. Identification — Q2, Q4
 - III. Interpretation — Q3
 - IV. Application — Q5, Q6
- Responses were analyzed as independent groups because individual responses were anonymous and unlinked

Survey Questions (Q1 – Q8)		Item Mapping to Learning Stages
Q1	I understand the importance of engineering standards in professional practice.	Awareness Q1, Q7
Q2	I can identify an appropriate standard for a given engineering problem.	
Q3	I can interpret the requirements of a standard (e.g., limits, test methods, or specifications).	Identification Q2, Q4
Q4	I am confident in finding and accessing the full text of a relevant standard.	Interpretation Q3
Q5	I can apply standard requirements to an engineering design or analysis.	
Q6	I can explain how a specific standard applies to a real engineering system.	Application Q5, Q6
Q7	I am likely to use engineering standards in my future career.	
Q8	In your own words, explain the role of engineering standards in the design, analysis, or operation of engineering systems.	Written Evidence Q8
5-Point Likert Scale: 1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree		

Evaluation Results

- Post responses were higher on **Q1–Q7**.
- The largest difference occurred in **Q6**, which focused on explaining how a standard applies to a real engineering system.
- **Identification** showed the largest stage-level increase: **+1.21**
- **Application** increased by **+1.04**
- **Interpretation** increased by **+0.74**
- **Awareness** was already relatively high before instruction and increased by **+0.36**.



KEEPING POWER CLEAN

Understanding IEEE 519 Harmonic Limits Made Simple

01 Introduction

- A guide to limit electrical noise (harmonics)
- Harmonics can overheat machines, cause malfunctions, and waste energy
- It sets limits at the Point of Common Coupling (PCC) to keep electricity clean

02 Objective

The main goal of IEEE Std 519-2014 is to protect electrical systems by limiting harmonics.

- Minimize the effects of harmonic distortion on equipment, reduce efficiency, and distort power quality.
- Clear limits for how much harmonic distortion is allowed in voltage and current
- A way to measure these limits at the Point of Common Coupling (PCC) when a building or system connects to the grid
- Guidelines to help engineers design systems that operate safely and efficiently

03 Key Definitions

- THD:** % of all harmonic content in voltage/current
- TDD:** Harmonics as % of max demand current (IL)
- IL:** Max current used in a year
- ISC:** Short-circuit current (from utility)
- ISC/IL Ratio** used to set harmonic limit

04 Numerical Example

We want to check if a machine follows the IEEE 519 harmonic rules.

- Load current: 100 A
- Max demand current (IL): 300 A
- Measured THD: 12%
- ISC = 9000 A, which is common for small to mid-size commercial transformers

To know the ISC/IL range and limit

ISC = The short-circuit current at the Point of Common Coupling (PCC) is usually given by the utility or calculated based on transformer size and impedance.

IL = The maximum load current of your system

$$\frac{ISC}{IL} = \frac{\text{Short-circuit current}}{\text{Load current (IL)}}$$
$$\frac{ISC}{IL} = \frac{9000}{300} = 30$$

Now to calculate the limit use the formula:

$$TDD = THD \times \left(\frac{ISC}{IL} \right)$$

05 Harmonic limits

Dangers of excessive harmonic distortion include overheating of equipment and

VCRB Range (TDD Limit %)	
< 25	5.0
25 - 50	8.0

06 Conclusion

Practical Application: VFDs

- VFDs create harmonics in factories
- Use 12-pulse rectifiers + harmonic filters
- Measure/simulate to confirm TDD < 5%

Publication in Progress

Seminars were given by the following industry representatives & experts

- Brian McFall (Army Corps of Engineers – Coastal & Hydraulics Laboratory): Developing the International Guidelines for Application of Natural Sed Features (NNBF)
- Mark Roetzel (CDS Muery Engineers) TITLE: Effective Use of Plans Design Definition
- Richard M. Berry (CDS Muery) TITLE: Standards and Codes in Construction
- Matthew Alexander (TAMUK) TITLE: Application of Engineering Standards in Environmental Engineering Design

ISO 28000:2022

SAFEGUARDING THE SUPPLY CHAIN

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ISO 28000:2022

SAFEGUARDING THE SUPPLY CHAIN

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ISO 28000:2022 To Mitigate Counterfeit Component

Manufacturing Satellite Phone Company

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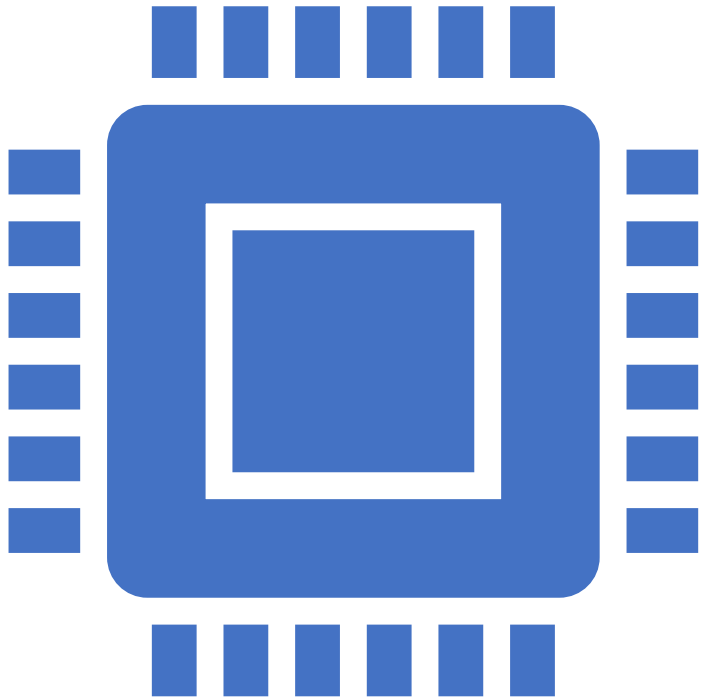
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Highlights from Accomplishments

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“Standards are the silent architects of innovation.” – ISO

Thank you NIST!