

## Virtual meeting 2025

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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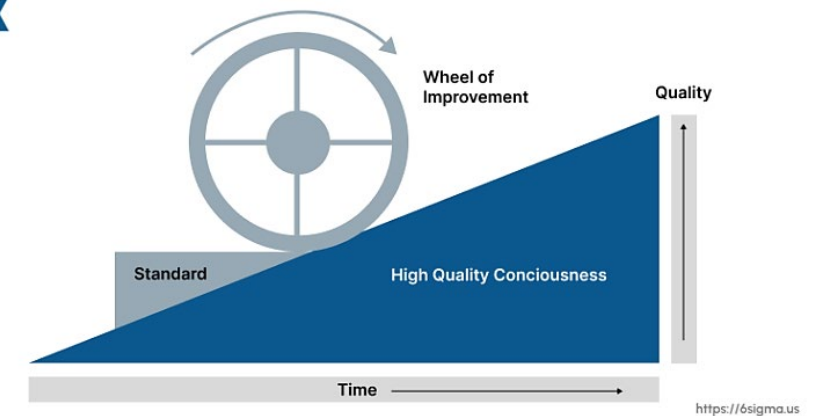
Date: September 10, 2025

## 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



### Objective

### Description

O1: Familiarize

Introduce students to the standardization process

O2: Guide

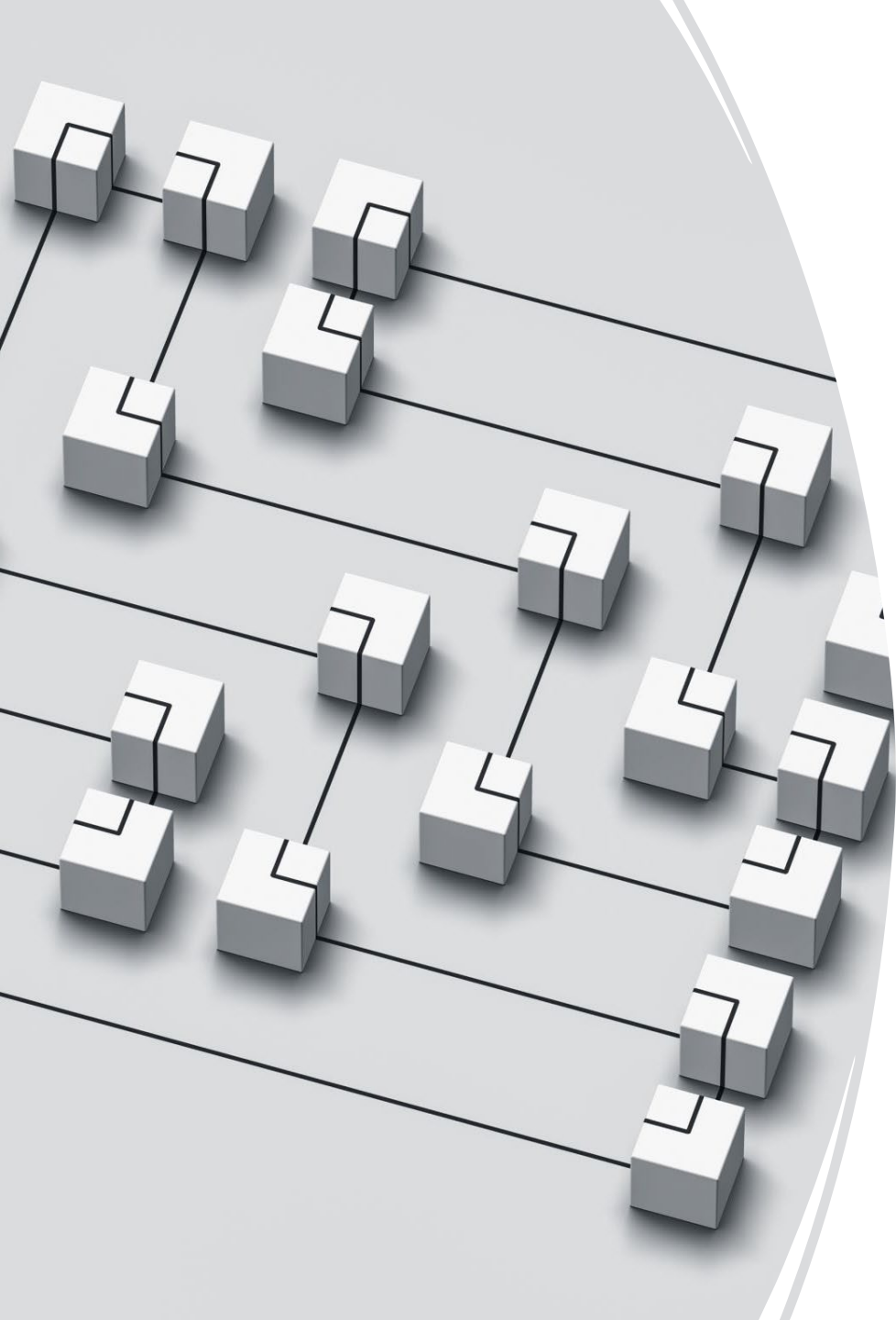
Help students identify relevant standards for design, manufacturing, and testing

O3: Educate

Teach students to apply standards in component/system design

O4: Inspire

Encourage future use of standards in professional practice



## Scope of Work

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- 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

| Discipline                                               | Level     | Targeted Codes / Standards                                                                                                                                                          | Course Number |
|----------------------------------------------------------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Mechanical Engineering                                   | Junior    | 1. ASME Boiler and Pressure Vessel Code, Section VIII, Div. 2.<br>2. ASME Boiler and Pressure Vessel Code, Section II, part D.                                                      | MEEN 3350     |
|                                                          |           | 3. API 2C Specification for Offshore Pedestal Mounted Cranes.                                                                                                                       | MEEN 3360     |
|                                                          | Senior    | 4. ANSI/AISC 303-16 Code of Standards Practice for Steel Buildings and Bridges<br>5. Steel Construction Manual, American Institute of Steel Construction.                           | MEEN 4351     |
|                                                          | Graduate  | 6. ASTM test method for tensile properties of fiber-resin composites (D3039)<br>7. ASTM test method for flexural properties of fiber-resin composites (D7264)                       | MEEN 5316     |
|                                                          |           | 8. DNV-GL Rule for classification -Submarine                                                                                                                                        | MEEN 5314     |
| Chemical Engineering                                     | Junior    | 9. ASTM B543 Heat exchanger tubing                                                                                                                                                  | CHEN 3310     |
|                                                          | Senior    | 10. NFPA 36-17 Solvent Extraction Plants<br>11. ASTM E3027 Sustainable Chemicals Selection                                                                                          | CHEN 4317     |
|                                                          |           | 12. ASTM C1274 Ceramic Materials Surface Area Determination                                                                                                                         | CHEN 4373     |
|                                                          |           | 13. ASTM E2535 Safe Handling of Engineered Nanoparticles<br>14. NFPA 53-16 Oxygen Enriched Atmospheres                                                                              | CHEN 4341     |
| Industrial Management and Applied Engineering Technology | Sophomore | 15. IEEE 516-2009: IEEE Guide for Maintenance Methods on Energized Power Lines<br>16. IEEE 2030.9-2019: IEEE Recommended Practice for the Planning and Design of the Microgrid      | ITEN 2330     |
|                                                          | Junior    | 17. IEEE Std 1562™-2021: IEEE Recommended Practice for Sizing of Stand-Alone Photovoltaic (PV) Systems<br>18. NFPA 170 Standard for Fire Safety and Emergency Symbols               | ITEN 3313     |
|                                                          | Graduate  | 19. ISO 28000:2022 Security and resilience - Security management systems Requirements<br>20. GS1-128 (formerly known as EAN-128 or UCC-128): Linear Barcode Symbology Specification | IMEN 5350     |
|                                                          |           | 21. ISO 45001:2018 Occupational health and safety management systems<br>22. ISO/IEC 31010:2019 Risk management — Risk assessment techniques                                         | IMEN 5340     |

# What makes a Module?

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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



# Evaluation Metric

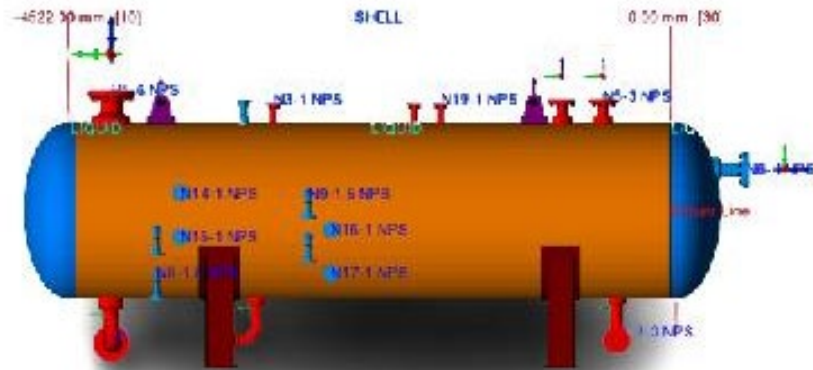
| CRITERIA (INSTRUMENT)                                                                         | UNSATISFACTORY (1)               | DEVELOPING (2)                      | SATISFACTORY (3)                 | EXEMPLARY (4)              | SCORE |
|-----------------------------------------------------------------------------------------------|----------------------------------|-------------------------------------|----------------------------------|----------------------------|-------|
| <b>Identify proper standard for a particular design problem (homework and course project)</b> | Not identify the proper standard | Identified partial correct standard | Identified near correct standard | Identified proper standard |       |
| <b>Students' comprehension on standardization process (quiz)</b>                              | Wrong answer                     | Partial correct answer              | Near correct answer              | Full answer with example   |       |
| <b>Student's familiarity with various standards (quiz and exam)</b>                           | Wrong answer                     | Partial correct answer              | Near correct answer              | Full answer with example   |       |
| <b>Student's interest on using standards in future career (Survey)</b>                        | No interest                      | Partial interest                    | Strong interest                  | Very strong interest       |       |
| <b>Use of standard properly (homework and course project)</b>                                 | Not use standard                 | Somehow used standard               | Satisfactory used standard       | Excellent used standard    |       |
| <b>Average Score</b>                                                                          |                                  |                                     |                                  |                            |       |



# 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 Aug 2025

# 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**

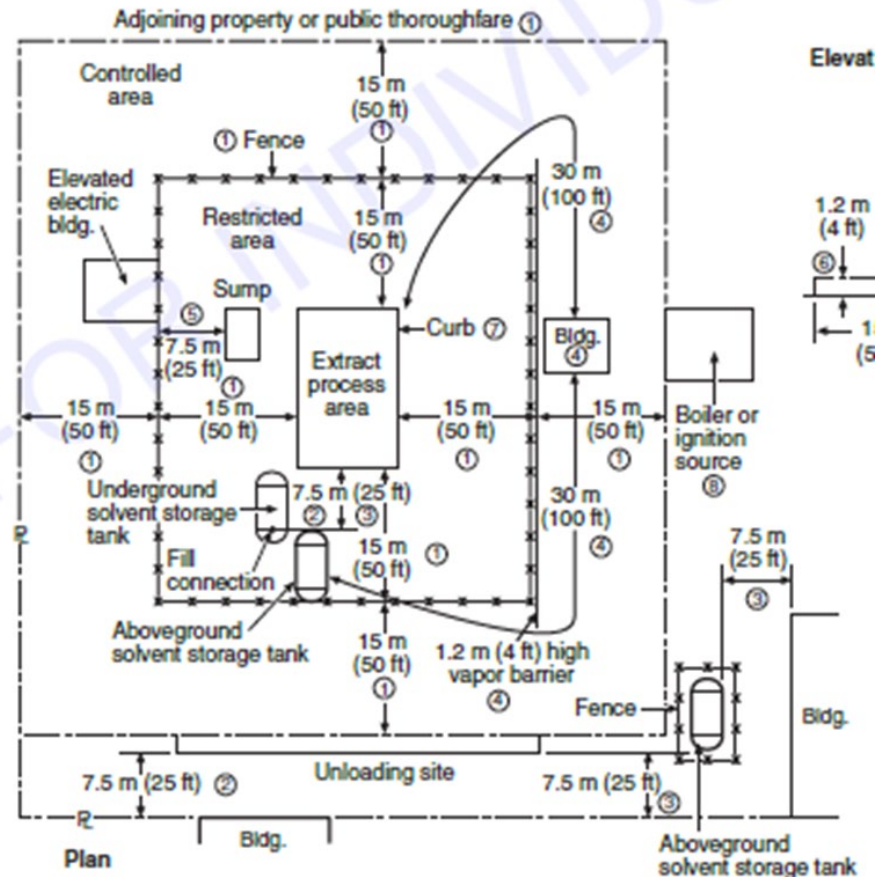
## 10. Simulation & Analysis

- 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

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 voltage and current distortion
- 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)

IL = 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 Limits (%) |     |
|---------------------------|-----|
| < 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%

Authors



Acknowledge  
Md. Monirul Islam



# 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

**ISO 28000:2022** is a new standard for supply chain management. It provides a framework for organizations to manage their supply chain risks and ensure the quality and integrity of their products and services.

**Key Features:**

- Focuses on the entire supply chain, from raw materials to finished products.
- Provides a framework for managing supply chain risks, including financial, operational, and reputational risks.
- Emphasizes the importance of transparency and traceability in the supply chain.
- Requires organizations to establish clear policies and procedures for supply chain management.
- Provides a framework for monitoring and measuring supply chain performance.

**Application of ISO 28000:2022**

- Manufacturing: Ensuring the quality and integrity of products.
- Logistics: Managing the flow of goods and services.
- Procurement: Managing the procurement process.
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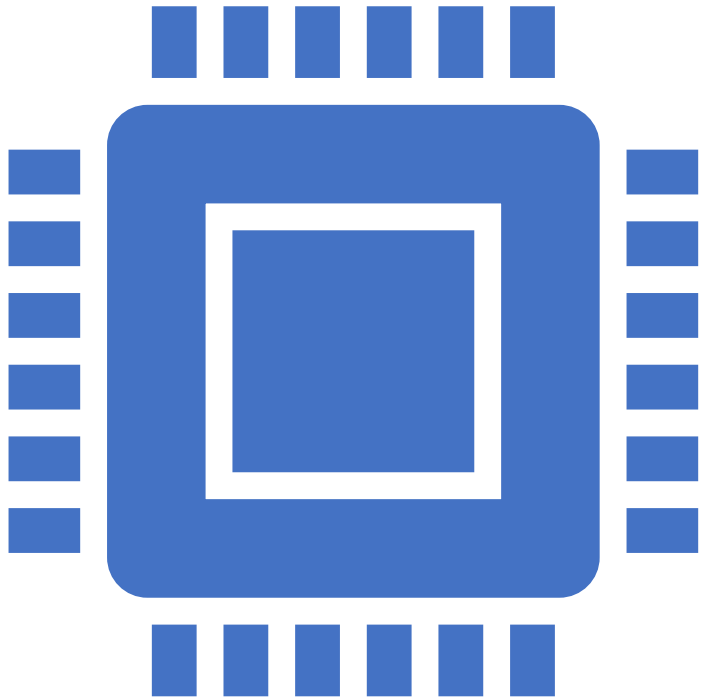
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Highlights from Accomplishments

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

Thank you NIST!