ASC Software Quality Engineering Program

Advancing Software Code Credibility and Pedigree Using SQE

Exceptional service in the national interest

Sandia National Laboratories

ASC SQE

ASC Software Quality Engineering

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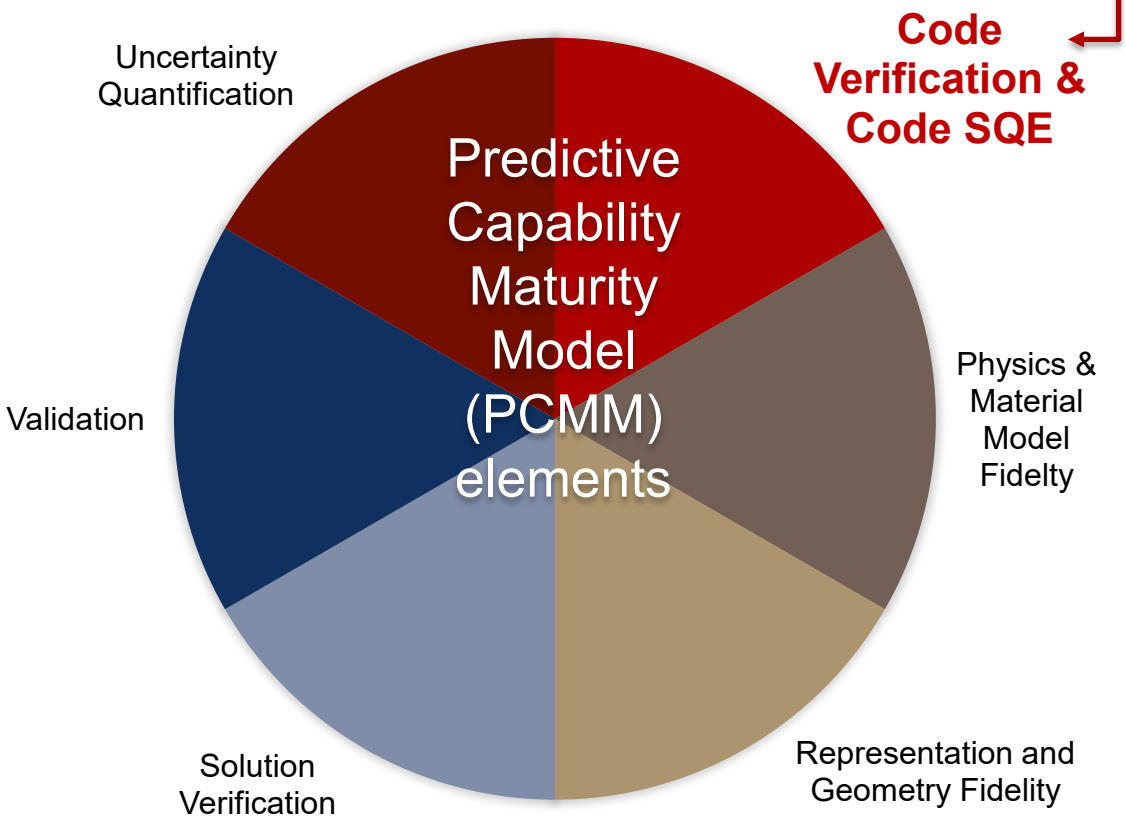
ASC Software Quality Engineering (SQE) Program

- Program formally established in 2007
- Provides an engineering framework for software development that includes independent appraisals
- One of the elements within the Predictive Capability Maturity Model (PCMM)
- Facilitates development of evidence to support code credibility and pedigree

PCMM & SQE



The SQE Element for Code Credibility & Pedigree

ASC Software Quality Plan Implementation

- Establishes code credibility
- Includes 30 ASC SQE Practices (project management, software engineering, software verification, training)

Independent SQE appraisals

- Provides ongoing code pedigree along with code team artifacts that implement the *ASC SQE Plan*
- Used to facilitate continual process improvement
- Ensures that verification testing is tied to the intended use of the code as defined in software requirements
- Ensures that acceptance testing is conducted to maintain capability through continual end user acceptance

Code Credibility & Pedigree Using SQE

1. **Software Quality Plan**
   30 SQE practices

   Tailored implementation of the ASC Software Quality Plan on all ASC-funded codes

2. **ASC Appraisal Methodology**
   Tailored reviews

   Tailored, continuous review of ASC codes using ASC Program target ratings

3. **ASC SQE Use Cases**
   Transition codes from R&D to Production or Qualification Readiness

   Established SQE Use Cases to facilitate quick transition of codes from R&D to Production or to Qualification Readiness (for ND codes use)

Code Credibility & Code Pedigree Established over Time ✓

Software Quality Plan

Category	Practice Numbers
Project Management	PR1 – PR12
Software Engineering	PR13 – PR25
Software Verification	PR26 – PR28
Training	PR29 – PR30

PR #	Practice Description	
	SPG#	Supplemental Practice Guidance (Note: not all practices have supplemental practice guidance.)
	AR #	Artifact Description
PR1	Document and maintain a strategic plan.	
	AR1	Strategic plan [project's mission, management, stakeholders, stakeholder roles and responsibilities, team operating procedures]
PR2	Perform a risk based assessment, determine level of formality and applicable practices, and obtain approvals.	
	SPG2a	Risk-based assessment procedure to determine LOF (template): ASC Risk-Based Assessment Procedure
	SPG2b	ASC safety software guidance: Instructions for Determining Whether an ASC Software Product Should be Categorized as DOE Order 414.1c Safety Software
	AR2	Approved level of formality and applicable practices [tailoring and/or waivers]

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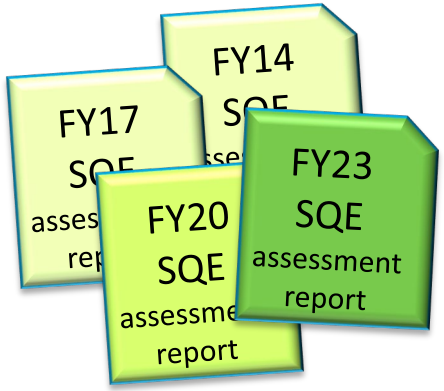
The ASC Software Quality Plan

covers the complete lifecycle:

development, testing, delivery & support

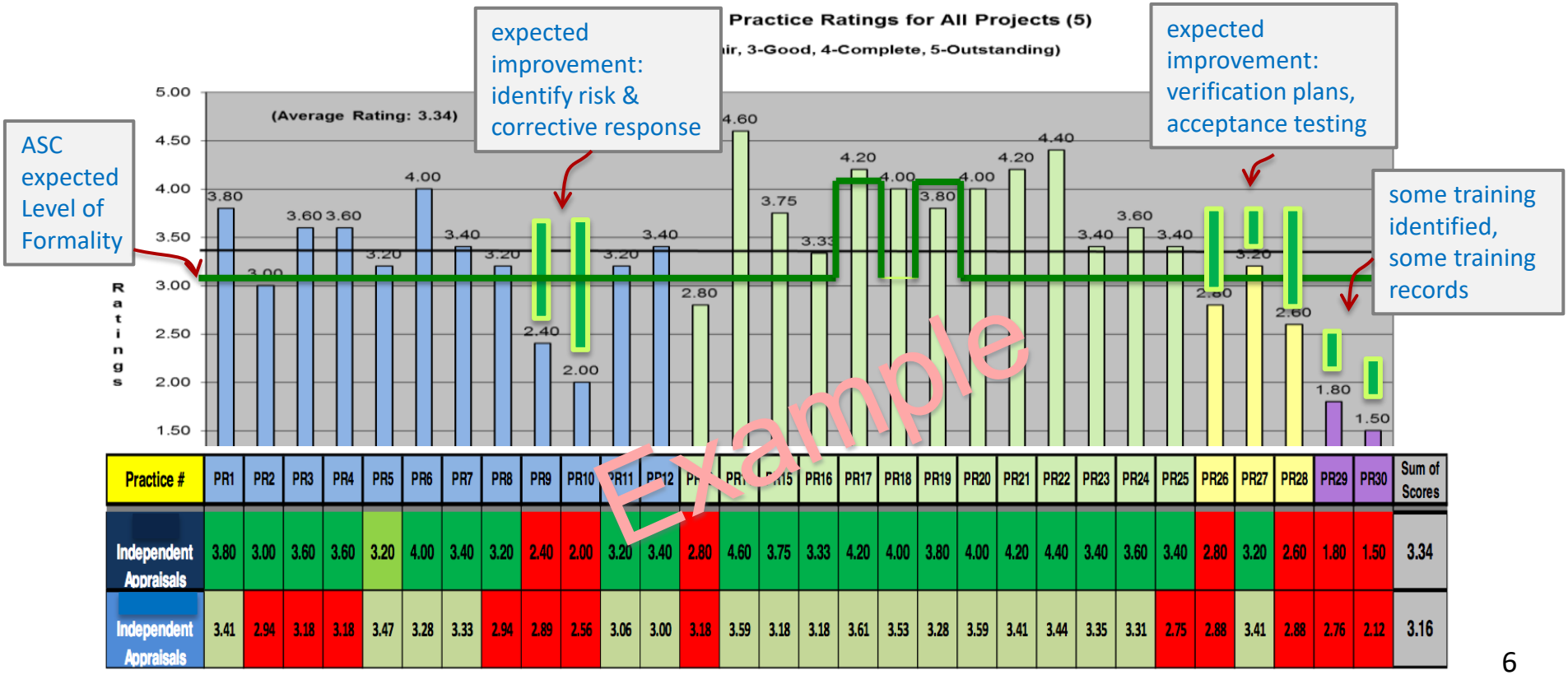
Independent SQE Appraisals



ASC codes are appraised every 3 years

Independent SQE Appraisals

Appraisal reports are used to demonstrate improvements over time.



Practice #	PR1	PR2	PR3	PR4	PR5	PR6	PR7	PR8	PR9	PR10	PR11	PR12	PR13	PR14	PR15	PR16	PR17	PR18	PR19	PR20	PR21	PR22	PR23	PR24	PR25	PR26	PR27	PR28	PR29	PR30	Sum of Scores
Independent Appraisals	3.80	3.00	3.60	3.60	3.20	4.00	3.40	3.20	2.40	2.00	3.20	3.40	2.80	4.60	3.75	3.33	4.20	4.00	3.80	4.00	4.20	4.40	3.40	3.60	3.40	2.80	3.20	2.60	1.80	1.50	3.34
Independent Appraisals	3.41	2.94	3.18	3.18	3.47	3.28	3.33	2.94	2.89	2.56	3.06	3.00	3.18	3.59	3.18	3.18	3.61	3.53	3.28	3.59	3.41	3.44	3.35	3.31	2.75	2.88	3.41	2.88	2.76	2.12	3.16

Drop | Better | Below

Use Case Types transition codes from R&D to Qualification Ready for ND codes

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ASC SQE Practices	R&D	Production Ready	Production	Qualification Ready
	Level of Formality (LOF) Target Rating by Use Case			
Project Management				
1. Integrated Teaming Process Area	1	3	3	4
2. Graded Level of Formality Process Area	3	3	3	4
3. Measurement and Analysis Process Area	1	7	9	15
4. Requirements Development and Management Process Area	6	9	9	15
5. Risk Management Process Area	2	4	6	8
6. Project Planning and Oversight	4	6	6	8
Software Engineering				
7. Technical Solution Process Area	8	12	12	20
8. Configuration Management Process Area	10	11	11	14
9. Integrated Product Process Area		4	6	10
10. Deployment and Lifecycle Support Process Area		8	12	17
Software Verification				
11. Software Verification Process Area	7	9	9	15
Training				
12. Training Process Area		6	6	8
Total Target Rating (Sum)	42	82	92	138
Total Target Rating (Average) per Practice (30)	2.10	2.73	3.07	4.53

SQE implementation starts early in a code's development

Increased rigor in SQE implementation over time

ASC SQE Code Use Case Types

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ASC SQE Practices	R&D Codes	Production Ready Codes	Production Codes	Qualification Ready Codes
	Level of Formality (LOF) Target Rating by Use Case			
1. Integrated Teaming Process Area				
PR1. Document and maintain a strategic plan.	1	3	3	4
2. Graded Level of Formality Process Area				
PR2. Perform a risk-based assessment, determine level of formality and applicable practices, and obtain approvals.	3	3	3	4
3. Measurement and Analysis Process Area				
PR3. Document, monitor, and control lifecycle processes and their interdependencies and obtain approvals.		2	3	5
PR4. Define, collect, and monitor appropriate process metrics.		2	3	5
PR5. Periodically evaluate quality issues and implement process improvements.	1	3	3	5
4. Requirements Development and Management Process Area				
PR6. Identify stakeholders and other requirements sources.	2	3	3	5
PR7. Gather and manage stakeholders' expectations, requirements, and constraints.	2	3	3	5
PR8. Derive, negotiate, manage, and trace requirements.	2	3	3	5
5. Risk Management Process Area				
PR9. Identify and analyze risk events.	1	2	3	4
PR10. Define, monitor, and implement the risk response.	1	2	3	4
6. Project Planning and Oversight				
PR11. Create and manage the project plan.	2	3	3	4
PR12. Track project performance versus project plan and implement needed (corrective) actions.	2	3	3	4
7. Technical Solution Process Area				
PR13. Communicate and review design.	2	3	3	5
PR14. Create required software and product documentation.	2	3	3	5
PR15. Identify and track third party software products and follow applicable agreements.	2	3	3	5
PR16. Identify, accept ownership, and manage assimilation of other software products.	2	3	3	5
8. Configuration Management Process Area				
PR17. Perform version control of identified software product artifacts.	4	4	4	5
PR18. Record and track issues associated with the software product.	2	3	3	5
PR19. Ensure backup and disaster recovery of software product artifacts.	4	4	4	4
9. Integrated Product Process Area				
PR20. Plan and generate the release package.		2	3	5
PR21. Certify that the software product (code and its related artifacts) is ready for release and distribution.		2	3	5
10. Deployment and Lifecycle Support Process Area				
PR22. Distribute release to customers.		2	3	5
PR23. Define and implement a customer support plan.		2	3	4
PR24. Implement the training identified in the customer support plan.		2	3	4
PR25. Evaluate customer feedback to determine customer satisfaction.		2	3	4
11. Software Verification Process Area				
PR26. Develop and maintain a software verification plan.	2	3	3	5
PR27. Conduct tests to demonstrate that acceptance criteria are met and to ensure that previously tested capabilities continue to perform as expected.	3	3	3	5
PR28. Conduct independent technical reviews to evaluate adequacy with respect to requirements.	2	3	3	5
12. Training Process Area				
PR29. Determine project team training needed to fulfill assigned roles and responsibilities.		3	3	4
PR30. Track training undertaken by project team.		3	3	4
Total Target Rating (Sum)	42	82	92	138
Total Target Rating (Average)	2.10	2.73	3.07	4.53

ASC SQE Code Use Case Type Details

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ASC SQE Practices	R&D Codes	Production Ready Codes	Production Codes	Qualification Ready Codes
	Level of Formality (LOF) Target Rating by Use Case			
10. Deployment and Lifecycle Support Process Area				
PR22. Distribute release to customers.		2	3	5
PR23. Define and implement a customer support plan.		2	3	4
PR24. Implement the training identified in the customer support plan.		2	3	4
PR25. Evaluate customer feedback to determine customer satisfaction.		2	3	4
11. Software Verification Process Area				
PR26. Develop and maintain a software verification plan.	2	3	3	5
PR27. Conduct tests to demonstrate that acceptance criteria are met and to ensure that previously tested capabilities continue to perform as expected.	3	3	3	5
PR28. Conduct independent technical reviews to evaluate adequacy with respect to requirements.	2	3	3	5

SQE implementation starts early in a code's development

Increased rigor in SQE implementation over time

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Use Cases Facilitate Code Readiness

- Encourages SQE early in a code's life cycle (R&D phase)
- Provides documented code maturity improvements over time
- Allows for gradual, cost-efficient progression to high rigor SQE
- Manages consistent formality of SQE across different codes
- Stages the pedigree & credibility process
- Documents due diligence

Code Credibility Principles

- **Ensure due diligence**
  - Ask and follow up on concerns SQE (correctness, sensitivity, robustness)
- **Generate confidence that ModSim produces reliable, trusted results**
  - Analyses being attempted are known to provide trusted, consistent results
- **Invest in continuous improvement**
  - in software development, quality practices & verification
- **Create and maintain code credibility evidence**
  - **Software Quality Plan Implementation**
    - ASC codes accept practices defined in the ASC software quality plan.
  - **Usage-based verification**
    - Verification testing is tied to the intended use of the code.
  - **Acceptance testing**
    - Maintain capability by continuously accepting/updating with hardware, compiler, code changes.

Code Pedigree Principles

- **Demonstrated progression**
  - Codes can demonstrate that SQE has been implemented from as far back as initial R&D experimentation
- **Successful code releases**
  - Each release, including those conducted during R&D are progressions towards readiness for rigorous use within ND; documentation maturity improves with each release
- **Configuration management**
  - Codes can support more than one software release for end users and can revert to a previous release as well. Releases can be associated with SQE implementation levels from SQE appraisals
- **Compiled evidence**
  - With the implementation of Use Case Types, codes are able to provide quality evidence early in development and demonstrate improvements over time