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Applying Software Quality Engineering to Research & Development Software

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April 2021

Energy Facility Contractors Group (EFCOG) Spring 2021 Virtual Meeting

Software Quality Assurance Subgroup

Sandia Advanced Simulation and Computing (ASC) Program

- The Sandia ASC program provides state-of-the-art computing, modeling, and simulation tools used by a variety of national security programs

- The Sandia ASC Software Quality Engineering (SQE) program ensures that ASC codes are developed using well-defined software engineering practices

- The ASC SQE program also includes an Appraisal Methodology that ensures that all Sandia ASC-funded codes (identified by management) are appraised to determine SQE implementation levels

Sandia Advanced Simulation & Computing (ASC) Software Quality Engineering (SQE) Plan

- The ASC SQE Plan is comprised of 30 SQE practices (PR), grouped by 4 categories and 12 process areas

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

- Suggested artifacts (AR) are provided for each SQE practice

PR = Practice
AR = Artifact
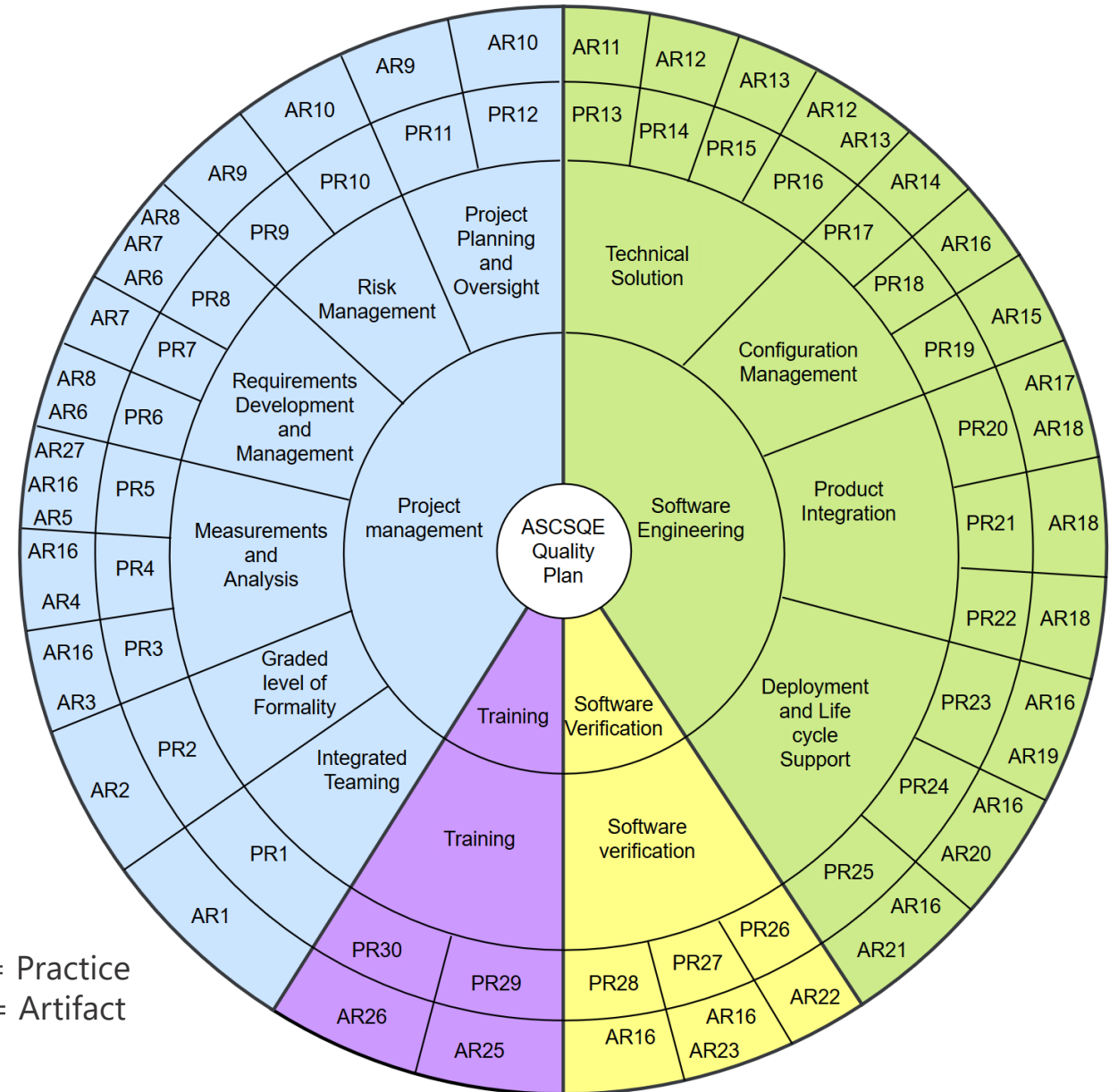
Sandia ASC SQE Graded Approach

- Sandia ASC codes use a graded approach to implementation of the 30 ASC Practices
- The graded approach is called the Level of Formality, or LOF, and results in three levels: high, medium, or low
- LOF is determined by considering both likelihood and consequence of software failure

		Likelihood Tier (Undesirable Event Due To Software Product Failure)				
		Negligible (L0)	Low (L1)	Moderate (L2)	High (L3)	Very High (L4)
Consequence Tier (Undesirable Event)	**Catastrophic (C4)**	Medium Formality	Medium Formality	Medium Formality	High Formality	High Formality
	Severe (C3)	Medium Formality	Medium Formality	Medium Formality	Medium Formality	High Formality
	Moderate (C2)	Medium Formality	Medium Formality	Medium Formality	Medium Formality	Medium Formality
	Low (C1)	Low Formality	Medium Formality	Medium Formality	Medium Formality	Medium Formality
	Negligible (C0)	Low Formality	Low Formality	Medium Formality	Medium Formality	Medium Formality

Sandia ASC Appraisal Method

- Sandia ASC-funded codes selected by management are appraised at least every 3 years
- Rating scale of 0 – 5 (5 is the highest rating) is used for each practice

Rating	NOTE: *Descriptions below are provided to allow for further clarification on typical expectations at each rating level. These are not intended to be all-inclusive; thus, projects may or may not exhibit all characteristics identified in the following descriptions.*
5	***Outstanding*** – the software project team has fully implemented this practice; meaning that a documented process exists for the practice, all team members are fully trained on the process, work products have been produced and managed, and practice plans and results have been shared with all appropriate stakeholders. The team's implementation of the practice is a candidate for a best practice to be shared with other teams and/or institutionalized across multiple teams or the program.
4	***Complete*** – the software project team has implemented a final (not draft) process for conducting the practice and work products are in place supporting this practice. Most project team members have been trained in the process implementation. Practice results have been shared with appropriate stakeholders.
3	***Good*** – the software project team has implemented this practice; however, there are still a few activities that need to be addressed (e.g., training, finalizing work products). For example, a draft of the process for conducting the practice exists or a completed documented process exists with most of the team (but not all) complying with the process. The team has made significant progress in rolling-out an implementation for the process, and draft work products that contain significant content exist.
2	***Fair*** – the software project team has a preliminary process (e.g., a detailed outline, a well-understood ad hoc team process that is not documented) for implementing this practice. There may be a preliminary plan about how to proceed with the process, and implementation and preliminary work products exist.
1	***Limited*** – the software project team has proposed that this practice be implemented and activities and resources for the practice are in the planning stages. It is evident that the project is committed to implementing this practice. At this level, it is typical that resources have not yet been allocated for fulfillment of the practice.
0	***Absent*** – the software project team has not yet addressed the implementation of this practice.
NA	**Not Applicable** – the software project team has determined that this practice is not applicable to its code development environment. A value of NA must be accompanied by an explanation from the team describing why the practice will not be followed.

Sandia ASC Use Case Types with Target Ratings

ASC SQE Practices	Work with Others/COTS	Maintenance	Small Production Code	R&D	Production Ready	Qualified Engineering Release (QER) Codes	Production Codes Low LOF	Med LOF	High LOF
1. Integrated Teaming Process Area									
PR1. Document and maintain a strategic plan.		1	2	1	3	4		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	3	3	4	3	3	4
3. Measurement and Analysis Process Area									
PR3. Document, monitor, and control lifecycle processes and their interdependencies and obtain approvals.					2	5		3	4
PR4. Define, collect, and monitor appropriate process metrics.					2	5		3	4
PR5. Periodically evaluate quality issues and implement process improvements.	3	1	2	1	3	5		3	4
4. Requirements Development and Management Process Area									
PR6. Identify stakeholders and other requirements sources.	3	3	3	2	3	5	3	3	4
PR7. Gather and manage stakeholders' expectations, requirements, and constraints.	3	3	3	2	3	5	3	3	4
PR8. Derive, negotiate, manage, and trace requirements.		3	3	2	3	5	3	3	4
5. Risk Management Process Area									
PR9. Identify and analyze risk events.		1	2	1	2	4	3	3	4
PR10. Define, monitor, and implement the risk response.			2	1	2	4	3	3	4
6. Project Planning and Oversight									
PR11. Create and manage the project plan.	3	2	2	2	3	4	3	3	4
PR12. Track project performance versus project plan and implement needed (corrective) actions.			2	2	3	4	3	3	4
7. Technical Solution Process Area									
PR13. Communicate and review design.		3	3	2	3	5		3	4
PR14. Create required software and product documentation.	3	3	2	2	3	5		3	4
PR15. Identify and track third party software products and follow applicable agreements.	3	3	3	2	3	5		3	4
PR16. Identify, accept ownership, and manage assimilation of other software products.	3	3	3	2	3	5		3	4
8. Configuration Management Process Area									
PR17. Perform version control of identified software product artifacts.	4	4	4	4	4	5	4	4	4
PR18. Record and track issues associated with the software product.	3	2	2	2	3	5		3	4
PR19. Ensure backup and disaster recovery of software product artifacts.		4	4	4	4	4	4	4	4
9. Integrated Product Process Area									
PR20. Plan and generate the release package.	3	3	2		2	5		3	4
PR21. Certify that the software product (code and its related artifacts) is ready for release and distribution.	3	3	2		2	5		3	4
10. Deployment and Lifecycle Support Process Area									
PR22. Distribute release to customers.	3	3	2		2	5		3	4
PR23. Define and implement a customer support plan.		2	2		2	4		3	4
PR24. Implement the training identified in the customer support plan.			2		2	4		3	4
PR25. Evaluate customer feedback to determine customer satisfaction.			2		2	4		3	4
11. Software Verification Process Area									
PR26. Develop and maintain a software verification plan.		3	3	2	3	5		3	4
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	3	3	5		3	4
PR28. Conduct independent technical reviews to evaluate adequacy with respect to requirements.		3	3	2	3	5		3	4
12. Training Process Area									
PR29. Determine project team training needed to fulfill assigned roles and responsibilities.					3	4		3	4
PR30. Track training undertaken by project team.					3	4		3	4
Total Target Rating (Sum)	46	59	66	42	82	136	30	92	120
Total Target Rating (Average)	3.07	2.68	2.54	2.10	2.73	4.53	1.00	3.07	4.00

Level of Formality (LOF) Target Ratings by Use Case

- Target ratings are set for each practice based upon use case type
- Use case types other than Production and QER assume a Medium LOF
- Use case types intentionally progress R&D codes to higher levels of rigor as they evolve towards Production
- R&D codes transition as follows
  - R&D
  - Production Ready
  - Production
  - Qualified Engineering Release (QER)
    - For codes used in support of defined rigorous qualification processes

This is a work in progress!

SQE for R&D – Project Management

ASC SQE Practices	R&D	Production Ready	Qualified Engineering Release (QER) Codes	Production Codes		
				Low LOF	Med LOF	High LOF
1. Integrated Teaming Process Area						
PR1. Document and maintain a strategic plan.	1	3	4		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	4	3	3	4
3. Measurement and Analysis Process Area						
PR3. Document, monitor, and control lifecycle processes and their interdependencies and obtain approvals.		2	5		3	4
PR4. Define, collect, and monitor appropriate process metrics.		2	5		3	4
PR5. Periodically evaluate quality issues and implement process improvements.	1	3	5		3	4
4. Requirements Development and Management Process Area						
PR6. Identify stakeholders and other requirements sources.	2	3	5	3	3	4
PR7. Gather and manage stakeholders' expectations, requirements, and constraints.	2	3	5	3	3	4
PR8. Derive, negotiate, manage, and trace requirements.	2	3	5	3	3	4
5. Risk Management Process Area						
PR9. Identify and analyze risk events.	1	2	4	3	3	4
PR10. Define, monitor, and implement the risk response.	1	2	4	3	3	4
6. Project Planning and Oversight						
PR11. Create and manage the project plan.	2	3	4	3	3	4
PR12. Track project performance versus project plan and implement needed (corrective) actions.	2	3	4	3	3	4

SQE for R&D – Software Engineering

ASC SQE Practices	R&D	Production Ready	Qualified Engineering Release (QER) Codes	Production Codes		
				Low LOF	Med LOF	High LOF
7. Technical Solution Process Area						
PR13. Communicate and review design.	2	3	5		3	4
PR14. Create required software and product documentation.	2	3	5		3	4
PR15. Identify and track third party software products and follow applicable agreements.	2	3	5		3	4
PR16. Identify, accept ownership, and manage assimilation of other software products.	2	3	5		3	4
8. Configuration Management Process Area						
PR17. Perform version control of identified software product artifacts.	4	4	5	4	4	4
PR18. Record and track issues associated with the software product.	2	3	5		3	4
PR19. Ensure backup and disaster recovery of software product artifacts.	4	4	4	4	4	4
9. Integrated Product Process Area						
PR20. Plan and generate the release package.		2	5		3	4
PR21. Certify that the software product (code and its related artifacts) is ready for release and distribution.		2	5		3	4
10. Deployment and Lifecycle Support Process Area						
PR22. Distribute release to customers.		2	5		3	4
PR23. Define and implement a customer support plan.		2	4		3	4
PR24. Implement the training identified in the customer support plan.		2	4		3	4
PR25. Evaluate customer feedback to determine customer satisfaction.		2	4		3	4

SQE for R&D – Software Verification & Training

ASC SQE Practices	R&D	Production Ready	Qualified Engineering Release (QER) Codes	Production Codes		
				Low LOF	Med LOF	High LOF
11. Software Verification Process Area						
PR26. Develop and maintain a software verification plan.	2	3	5		3	4
PR27. Conduct tests to demonstrate that acceptance criteria are met and to ensure that previously tested capabilities continue to perform as expected.	3	3	5		3	4
PR28. Conduct independent technical reviews to evaluate adequacy with respect to requirements.	2	3	5		3	4
12. Training Process Area						
PR29. Determine project team training needed to fulfill assigned roles and responsibilities.		3	4		3	4
PR30. Track training undertaken by project team.		3	4		3	4

SQE for R&D – Next Steps

- Revisit the Low LOF for Production Codes and better align with expectations for R&D

- Determine the need for the "Small Production Code" use case type versus the Low LOF for Production Code use case

- Revisit Target Ratings for all use cases

Questions/Comments?

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