



# **Governor's Office of Innovation & Technology**

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## **Software Independent Verification and Validation (IV&V)/ Independent Assessment (IA) Criteria**

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## 1. Introduction

Independent Verification and Validation (IV&V) is a proven method of obtaining a high level of confidence in the operation of new systems prior to their deployment. IV&V offers a formal and structured process to identify potential system/process problems before they arise. IV&V is particularly useful if employed during the requirements analysis phase of a project, in that poor or omitted requirements account for a large percentage of eventual cost or schedule overruns. Poor requirements can also lead to systems being delivered without key functionality.

The purpose of this document is to provide quantifiable criteria for determining whether IV&V should be applied to a given software development project. All projects containing software shall evaluate themselves against these criteria to determine if a software IV&V or Independent Assessment (IA) is required. An IA is a review and analysis of the project/program's software development lifecycle plan and existing products. The IA differs in scope from a fully software IV&V program in that IV&V is applied over the lifecycle of the system whereas an IA is usually a one-time review of the existing products and plans. The IA maybe initiated as needed and can be part of a risk mitigation effort or as a technical assessment.

## 2. Risk Factors and Consequences

### 2.1 Risk Factors

Software IV&V is intended to assist the project team in mitigating risk; hence, the decision to employ software IV&V should be risk-based. Risk can be defined as the possibility of an event occurring that would have an adverse effect on an organization or its systems. If risk is not properly mitigated, the results could be in the form of cost overruns, schedule slippage, safety mishaps, or failure to achieve a critical business need due to an inadequacy of the technology solution. The exact probability of occurrence and consequences of a given software failure is difficult to quantify early in the software lifecycle. However, there are metrics available that provide general approximations of the consequences, as well as the likelihood of failures.

The use of IV&V depends on the project's cost, size, complexity, life span, risk, and consequences of failure. Table 1 contains simple metrics on the software, the project team, and the development environment, which have proven to be indicators of the potential for future software problems. While these indicators are not precise, they can provide order of magnitude estimates that are adequate for assessing the need for software IV&V.

Risk Factor	Possible Score					Weight Factor	Assigned Score
	1	2	3	4	5		
Project Team Size/Complexity	Small (less than 20) dedicated, experienced staff, centralized	Average size (20-50), dedicated, experienced staff	Average size, experienced staff, multiple projects	Average-Large, mostly centralized, multiple projects	Large (more than 50), mixed experienced	X3	15
Size of the system	Small number of programs, for 1 department	Moderate number of programs for 1 department	Large number of programs for multiple departments	Moderate number of programs for statewide usage	Large number of programs for statewide usage	X2	10
Contractor Support	None	Contractors with minor tasks		Contractors with major tasks	Contractor with major tasks critical to project success	X1	5
Contract Type	Firm Fixed Price	Fixed Level of Effort	Cost-Reimbursement	Cost plus/Fixed Fee/Incentive Fee	Time & Materials	X1	5
Duration of development cycle	Less than 3 months	3 – 6 months	6 – 12 months	12 – 18 months	Greater than 18 months	X2	10
Schedule Pressure	No deadline		Deadline is negotiable		Non-negotiable deadline (mandate)	X1	5
Independent Assessment of PM Experience/ Process Maturity of Software Provider	CMMI <sup>1</sup> (or equivalent) Level 4, 5	CMMI Level 3	CMMI Level 2	CMMI Level 1 with record of repeated success	CMMI Level 1 or equivalent	X2	10
Degree of Innovation	Proven and accepted		Proven but new to organization		Cutting edge	X3	15
Level of Integration	Simple, Stand alone		Moderate		Extensive Integration	X1	5
Requirements maturity	Well defined objectives	Well defined objectives – Few unknowns		Preliminary objectives	Changing ambiguous or untestable objectives	X2	10
Project Budget	Less than \$100K	Less than \$500K	\$500,000 – 1m	1m – 10m	Greater than \$10m	X2	10
<b>Total risk score</b>							100

<sup>1</sup> – Capability Maturity Model® Integration (more information on CMMI can be found at <http://www.sei.cmu.edu/cmmi/models/ss-staged-v1.1.doc>)

**Table 1 – Risk Evaluation Matrix**

## 2.2 Consequences of Failure

The consequences and impact of a software failure must also be considered. Factors include, but not limited to, the following:

- a) Business/ Operational Impact – The potential to interrupt the day-to-day operations of the State or agency
- b) Financial Impact – Negative effect on financial performance or loss of revenue
- c) Safety/Public Health Impact – Potential for loss of life or serious injury
- d) Legal/Statutory Compliance – Direct effect on the organization's ability to comply with statutory obligations

## 2.3 Failure Rating

Consequences of failure are considered **Catastrophic** when *any* of the following conditions are met:

a.	Potential disruption on business/routine operations	Work stoppage to multiple agencies
b.	Potential for financial loss	Greater than \$5,000,000
c.	Potential for safety/public health incidence	Loss of life
d.	Potential for legal/statutory non-compliance	Yes

Consequences of failure are considered **Critical** when *any* of the following conditions are met:

a.	Potential disruption on business/routine operations	Partial work stoppage to agency or department
b.	Potential for financial loss	Greater than \$1,000,000
c.	Potential for safety/public health incidence	Serious injury
d.	Potential for legal/statutory non-compliance	Yes

Consequences of failure are considered **Marginal** when *any* of the following conditions are met:

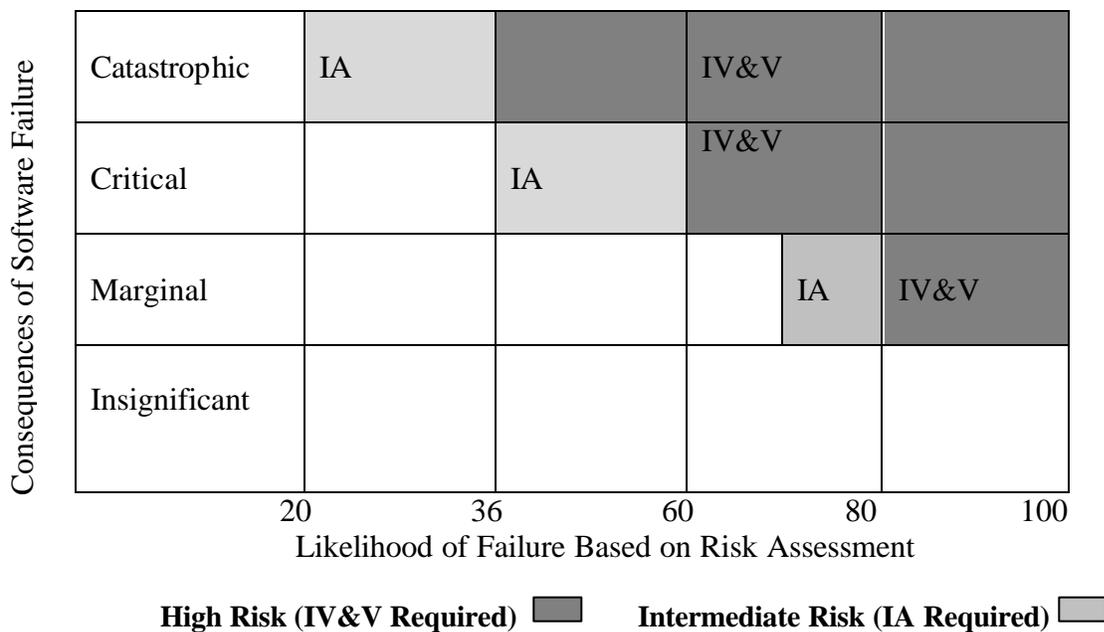
a.	Potential disruption on business/routine operations	No more than an inconvenience to multiple departments
b.	Potential for financial loss	Greater than \$500,000
c.	Potential for safety/public health incidence	No
d.	Potential for legal/statutory non-compliance	No

Consequences of failure are considered **Insignificant** when *all* of the following conditions are met:

a.	Potential disruption on business/routine operations	No more than a department inconvenience
b.	Potential for financial loss	Less than \$500,000
c.	Potential for safety/public health incidence	No
d.	Potential for legal/statutory non-compliance	No

### 3. Risk Assessment

Combining the software consequences of failure referenced above and the likelihood of failure rating from Table 1, yields a risk assessment that can be used to identify the need for software IV&V. The indication of whether software IV&V is required can be obtained by plotting in Figure 1 the intersection of the Consequences of Software Failure determination and the Total Likelihood of Failure determination. Application of these criteria simply determines that a project is a candidate for software IV&V – not the level of software IV&V or the resources associated with the software IV&V effort. These will be determined as a result of discussions between the project, statewide PMO, and the Commission on Information Management (IMC) Risk Management Subcommittee.



**Figure 1 – Software Risk**

Figure 1 shows a dark region of high risk where software consequences, likelihood of failure, or both are high. Projects having software that falls into this high-risk area shall undergo software IV&V. The exception would be those projects that have already done hardware/software integration. A software IV&V would not be productive that late in the development cycle. These projects shall undergo a Software Independent Assessment (IA).

Figure 1 shows three gray regions of intermediate risk. Projects having software that falls into these areas shall undergo a Software IA. An independent agency or contractor shall conduct the Software IA. One purpose of the Software IA is to ensure that the software development does not have project-specific risk characteristics that would warrant software IV&V versus an IA. Should such characteristics be identified, the IMC Risk Management Subcommittee would make a recommendation for software IV&V performance.

## 4. IV&V Reporting Structure

An independent organization or contractor to provide impartial oversight of the overall project and the prime contractor's performance should conduct IV&V. IV&V activities may include but are not limited to:

- Monitor contractor and project office activities
- Evaluate contractor's proposal for technical feasibility
- Evaluate contractor's deliverables for correctness and completeness
- Assess formal/informal design reviews and code inspections
- Monitor contractor's test program
- Validate adequacy and appropriateness of test procedures
- Verify requirements traceability
- Provide monthly IV&V status reports

IV&V shall report directly to OIT or the department's Executive Steering Committee. Exceptions to this reporting structure must be approved by the IMC. All projects with IV&V shall provide monthly status reports to the IMC via the statewide PMO.

## 5. Initiating the IV&V Evaluation

The IV&V evaluation should occur at the Concept Definition phase of the life cycle management process. Once the project scope and technical approach are defined, the next step would be to determine the need for IV&V.

Contact OIT to receive electronic copies of the IV&V evaluation spreadsheets by sending an e-mail request to: [OITPMO@state.co.us](mailto:OITPMO@state.co.us)