

# Quantitative Risk Analysis of Deficient Contractor Business Systems

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# Research Issue

- Request from Director of the Earned Value Management Division of the Defense Contract Management Agency (DCMA)
- Asked for assistance in developing a method that Administrative Contracting Officers (ACO) can use to assess risk associated with non-compliant contractor business systems
- A recent rule change in the Defense Supplement to the Federal Acquisition Regulation (DFARS) permits an ACO to withhold up to 10% of contract payments for a “significant deficiency” in a contractor’s business system that creates risk to the government.
- The research issue is how to objectively and quantitatively portray that risk in a way that supports a monetary withhold decision and can withstand push-back (to include litigation) from the defense contractor.

# Definition of Terms

## Contractor Business Systems

### Section 893, NDAA for FY2011

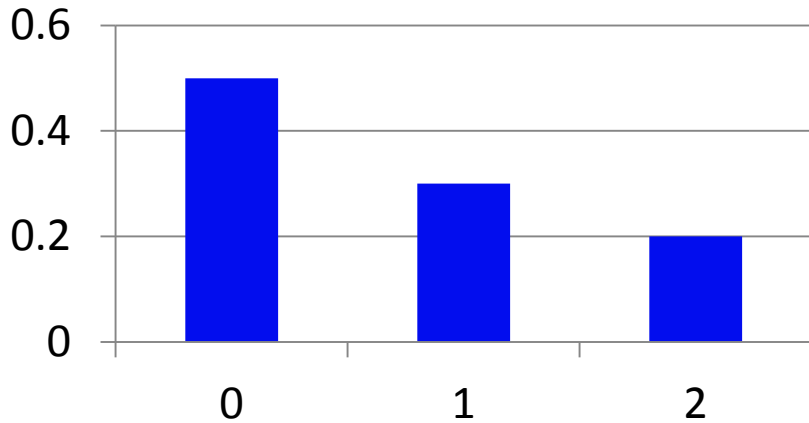
Term	Definition
Contractor Business System	<ul style="list-style-type: none"> <li>• accounting system</li> <li>• estimating system</li> <li>• purchasing system</li> <li>• earned value management system</li> <li>• material management and accounting system</li> <li>• property management system</li> </ul>
Covered Contractor	A contractor that is subject to the cost accounting standards under section 26 of the Office of Federal Procurement Policy Act (41 U.S.C. 422)
Covered Contract	<ul style="list-style-type: none"> <li>• cost-reimbursement contract</li> <li>• incentive-type contract</li> <li>• time-and-materials contract</li> <li>• labor-hour contract</li> </ul>
Significant Deficiency	“...shortcoming in the system that materially affects the ability of officials of the Department of Defense and the contractor to rely upon information produced by the system that is needed for management purposes.”

# Feedback on December 2010 Draft Rule

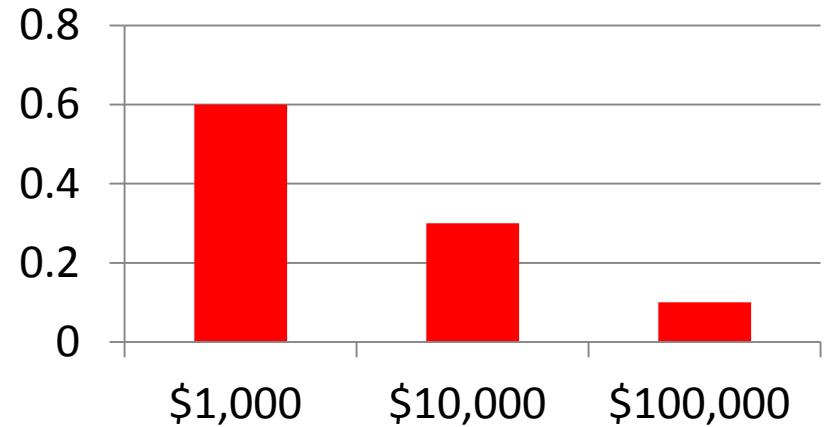
- The rule fails to offer any guidance to the contracting officer for describing a “significant deficiency.”
- There is the potential for inconsistent application of business system criteria when determining a “significant deficiency.”
- The Defense Contract Management Agency (DCMA) and the Defense Contract Audit Agency (DCAA) are under-resourced to implement the rule.

# Constructing the Loss Distribution\*

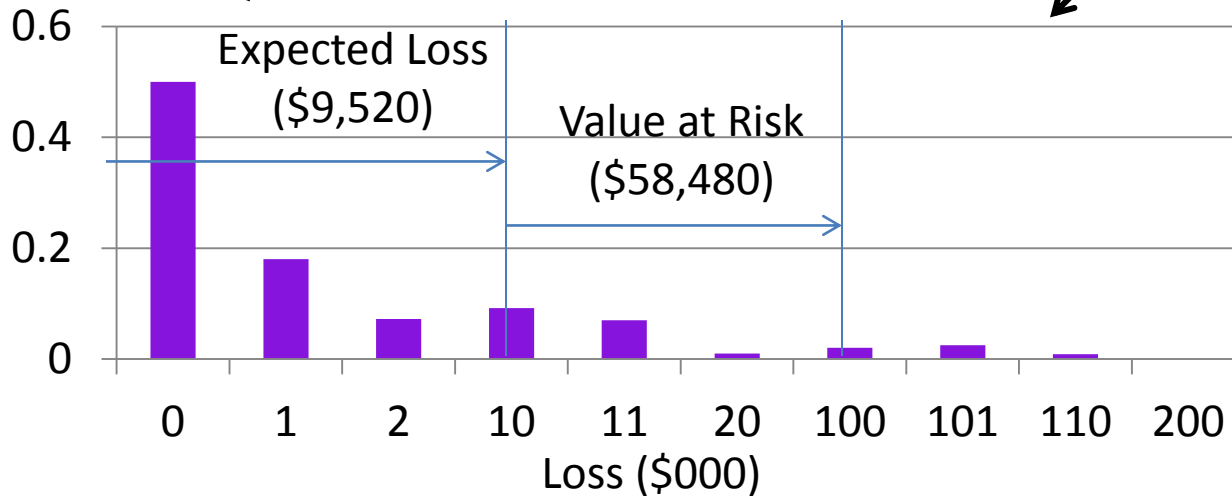
## Frequency Distribution



## Severity Distribution



## Loss Distribution



\*Notional, see Jorion (2007), Value at Risk, Chapter 19, Operational Risk

# Earned Value Management

## 32 Guidelines

### Accounting Processes

1. Define the Project Work Scope
2. Define the Project Organization
3. Integrate Subsidiary Processes
4. Identify Overhead Management
5. Integrate WBS/OBS to Create Control Accounts
6. Schedule with network logic
7. Set measurement indicators
8. Establish the CBB/PMB
9. Budget by cost elements
10. Create work/planning packages
11. Sum WP/PP budgets to the Control Account
12. Level of Effort planning
13. Set overhead budgets
14. Identify Management Reserve and Undistributed Budget
15. Reconcile CBB to target values
- 16. Record direct costs**
17. Summarize direct costs by WBS elements
18. Summarize direct costs by OBS elements
19. Record/allocate indirect costs
20. Identify unit and lot costs as needed
21. Track and report material costs/quantities
22. Calculate Schedule Variance & Cost Variance
23. Identify significant variances for analysis
24. Analyze indirect Cost Variance
25. Summarize information for management
26. Implement corrective actions
27. Revise Estimate At Completion
28. Incorporate changes in a timely manner
29. Reconcile current to prior budgets
30. Control retroactive changes
31. Prevent unauthorized revisions
32. Document PMB changes

# Contract Performance Report Validity Checks

## GAO Cost Estimating and Assessment Guide\*

Definitive  
Measure?

			Definitive Measure?
Sanity Checks (Anomalies)	negative values for ACWP, BAC, BCWP, BCWS, or EAC		Y
	unusually large performance swings (BCWP) from month to month		N
	BCWP and BCWS data with no corresponding ACWP		Y
	BCWP with no BCWS		Y
	BCWP with no ACWP		Y
	ACWP with no BCWP	p. 257	Y
	Inconsistency between EAC and BAC, such as no BAC but an EAC and vice versa		Y
	BCWP or BCWS exceeds BAC		Y
	ACWP that is way above or below the planned value		N
ACWP exceeds EAC		Y	

\*Similar definitive sanity checks are found in the SCEA CEBoK, p. 57

# Two Validity Checks Selected

## BCWP with no ACWP

- Indicates that budgeted and authorized work performed in a particular Work Breakdown Structure (WBS) element was recorded in EVM system, but no labor or material costs were recorded in company's accounting system for that work.
- The effect of this error is to understate the actual cost of work that has been performed.

## ACWP with no BCWP

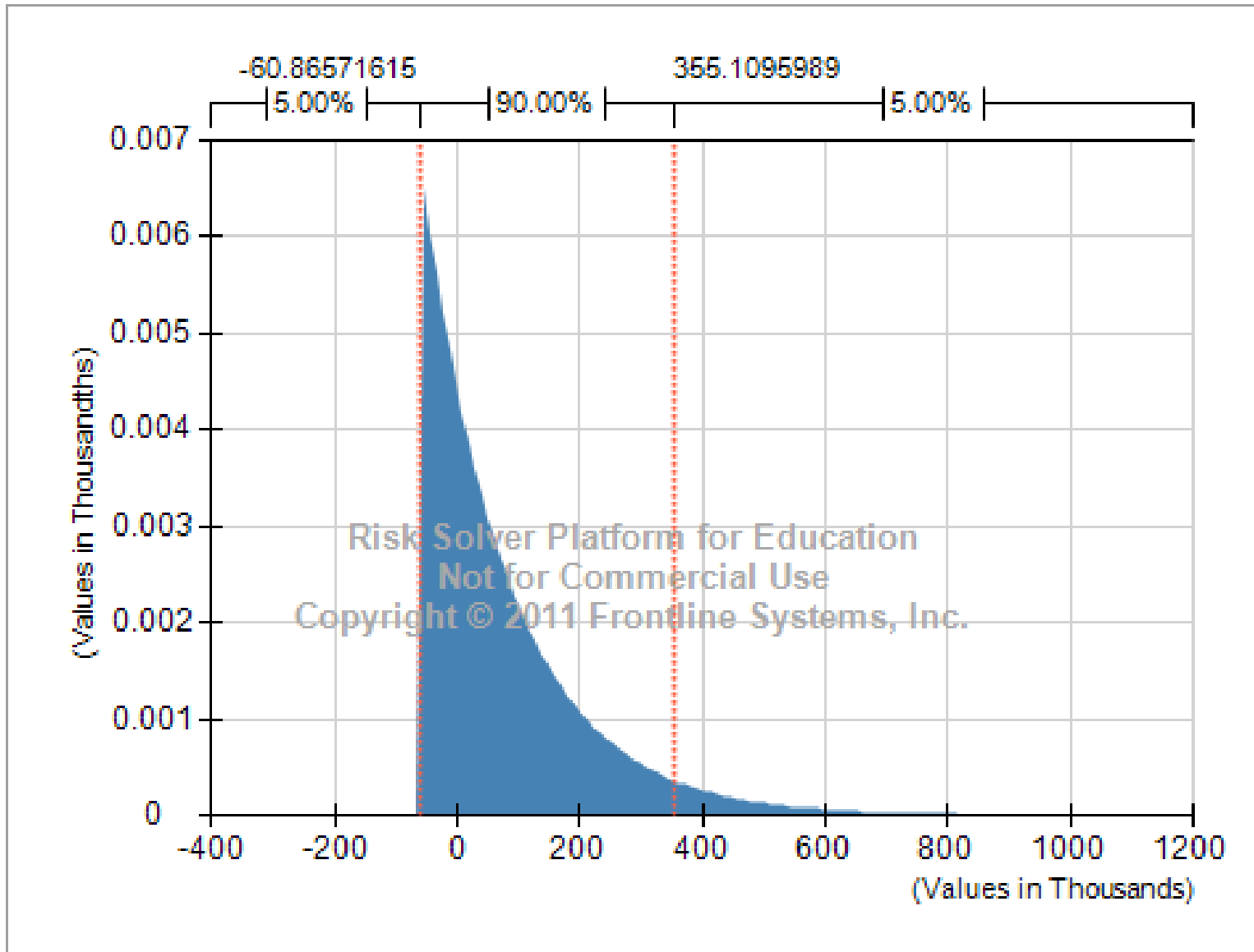
- Reveals that actual labor and material costs (ACWP) were recorded against a particular WBS in the accounting system, but no earned value (BCWP) was credited in the EVM system of the company.
- The effect of this error is to overstate the actual cost of work that has been performed.



# Research Results

Program	CPR Date	BCWP w/no ACWP	Dollar Value of Errors	% of WBS elements w/errors	ACWP w/no BCWP	Dollar Value of Errors	% of WBS elements w/errors	Number of WBS Elements
1	Feb-12	6	47443	0.01	13	2359780	0.02	719
1	Nov-11	7	80043	0.01	10	25000	0.01	719
1	Aug-11	9	114269	0.01	10	33269	0.01	716
2	Feb-12	30	175295	0.01	324	5722147	0.15	2216
2	Dec-11	40	272495	0.02	242	6004275	0.12	2012
2	Aug-11	24	445108	0.01	217	15931175	0.13	1635
3	Jan-12	82	1228323	0.10	30	58140	0.04	820
3	Oct-11	84	1363864	0.11	22	90663	0.03	779
3	Jul-11	49	1086391	0.07	11	35545	0.02	710

# Research Results



Gamma Loss Distribution, Program 2, CPR Aug 11, ACWP with no BCWP

# Research Conclusions

- Distributions were best fit by Exponential (2), Gamma (4), Weibull (5), and LogLogistics (6) loss distributions.
- An Operational Value at Risk (VaR) method (Jorion, 2007) could be used to estimate the risk to the government of deficient information from contractor EVM systems.
- Use of the VaR model would benefit the government contracting officer by providing a more defensible risk value as the basis for withholding contractor payments.

# Future Research

## Research Topic 1

Similar risk management problems exist in industry, including: insurance, banking, and investment portfolio management. In the insurance industry, actuarial data is applied to model risk and risk capital reserves are maintained to cover the expected values for claims. Banks hold cash reserves to maintain liquidity and cover the expected values of depositor withdrawals, based on regulatory requirements for capital (risk) reserves. Investment portfolio managers evaluate value at risk across the portfolio and adjust holdings as necessary to maintain the risk value below acceptable levels. In all three of these examples the risk environment is characterized by probabilistic behavior, expected dollar values, and risk management objectives that are governed by regulation and statutory law.

- Can any of these risk management models (or others) be extrapolated to the business system rule implementation?
- What quantitative methods can be developed to quantify material financial risk to government when a business system produces “unreliable and inaccurate data”?
- How do other regulatory activities manage risk that is caused by business system deficiencies?

# Future Research

## Research Topic 2

Under ANSI/EIA-748, Earned Value Management Systems (EVMS) must comply with 32 guidelines. When a significant deficiency exists in one of the critical guidelines the EVMS is non-compliant and will be disapproved by the Administrative Contracting Officer. The following research questions apply specifically to EVMS:

- Is there any rank or natural order to the potential severity of the deficiency posed by these guidelines? To what degree is there inter-dependence or causality across these guidelines? Can they be grouped with respect to causality of risk?
- What quantitative method(s) can be used to calculate risk value with respect to non-compliance of critical guidelines, or non-critical guidelines?
- What quantitative definition of “significant deficiency” is applicable?
- Is it possible to develop a deterministic rule set that yields a consistent and repeatable finding of significant deficiency?
- What should be the relationship of risk value calculations and findings of EVMS non-compliance, with: 1) probability of error; 2) magnitude of errors; and, 3) adverse impact of errors?

# Future Research

## Research Topic 3

Other business systems (accounting, estimating, material management and accounting, purchasing, and property management) are also within the scope of the contractor business system rule and the following questions apply:

- What is the standard of compliance that applies to the non-EVMS business systems? Do these standards have clearly defined compliance criteria?
- Can an extensible method be developed for all business systems with respect to the calculation of risk value?

## Research Topic 4

Instead of measuring business system compliance with various guidelines and standards, is there a better approach to risk management, when there is potential harm to the government?