Integrated Regulatory Framework Mathematical Model Deciphered and the Interface with the Regulatory Compliance Scale and the Equal Interval and Relative Weighting Risk Assessment Matrix

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April 2026

This research abstract will build upon and explain more fully the implications of the Integrated Regulatory Framework (IRF) as outlined in an earlier publication (Fiene, 2026) focusing on the results of using the mathematical modeling suggested in that earlier publication. The IRF has been introduced as a companion piece to the Child Care Early Education Heart Monitor (CCEEHM) as a twin domain dealing with the macro and micro assessment of early care and education (ECE) settings in which the IRF is the macro assessment while the CCEEHM is the micro assessment. The CCEEHM modeling has been addressed previously (Fiene, 2025) so it will not be presented here. But the IRF modeling of results has not been addressed as of this writing. Hopefully this research abstract will update that scenario.

The reason for the IRF is to continue to introduce the use of regulatory science methods into human care licensing so that it is driven by empirical evidence. The IRF is the resultant methodology born out of the Theory of Regulatory Compliance (Fiene, 2025). The IRF clearly demonstrates in a mathematical model how best to utilize the twin methodologies of differential monitoring: key indicator predictors and risk assessment rules. By taking the results of these methodologies it provides policy makers with a data driven approach to program monitoring which goes beyond the typical one size fits all paradigm. IRF provides a more targeted or focused type of assessment.

However, before sharing the actual results of the IRF Math Model, there are some elementary principles that need addressing that are critical in making this assessment approach work as it should.

First, the IRF and the recommended differential monitoring approach is only meant to be used with the most compliant and high quality ECE programs. It is not meant to be used on the majority of ECE programs. The majority of programs will continue to receive a full-scale licensing review and inspection. If this is not done, the number of false positive results in which programs do not pass the validation phase of predictor rule assessments will increase and will invalidate the use of the differential monitoring approach.

Second, the Theory of Regulatory Compliance predicts the relationship between regulatory compliance and program quality and asserts that substantial compliance is equivalent to full 100% compliance with all rules and regulations. However, the theory is very helpful in dealing with the upper ends of the regulatory compliance scale but is not really needed when we compare high regulatory compliance (Full and Substantial compliance) with low regulatory compliance. It is clearly evident from previous studies (Fiene, 2019) that there are significant differences between the two groups. The theory is very useful when comparing the upper end of regulatory compliance and distinguishing between full vs substantial regulatory compliance. The theory has ushered in the use of differential monitoring as an alternative to uniform program monitoring. In fact, if the major result of the Theory of Regulatory Compliance regarding substantial compliance was not discovered, there would be no need for the differential monitoring approach and its associated methodologies of key indicators and risk assessment.

The mathematical model for the Integrated Regulatory Framework (IRF) is the following:

$$\mathbf{IRF = (FC = .90V + .75Q + .50L) - (F- = 0) - (F+ = 1 \times 3)}$$

In the Fiene (2026) publication a theoretical plotting of the data was proposed which ranged from -3 to +3 in a parabola curve and in a 2 x 2 Matrix. In the above formula, FC can be measured at three levels: V = Validation that the key indicator predictor system is working; Q = coefficient at the quality initiative level, generally within a QRIS system; and L = coefficient at the licensing level. F- = False Negative in which there is no non-compliance with highly risk rules. F+ =

this measures the substantial compliance level in which there is two or fewer non-compliances of low-risk rules allowed. The following table presents potential results based upon this formula.

IRF Formula Results

FC	F-	F+	Result	F+	Result	Correction	Result	Theory
+.90V	0	0	+.90	-1	-.10	**V+L+Q**	+.40	+.90/-2.10
+.75Q	0	0	+.75	-1	-.25	**Q**+L+V	+.25	+.75/-2.25
+.50L	0	0	+.50	-1	-.50	L+**Q**+V	+.25	+.50/-2.50
			+.90	-2	-1.10	**L+Q+V**	+.15	Total
Total	100%	100%	+.75	-2	-1.25	**L+Q+V**	+.15	+2.15
+2.15	Compliance	Compliance	+.50	-2	-1.50	**L+Q+V**	+.15	+/-3.00

In the above IRF Formula Results table, FC ranges from +.50 for licensing indicators to +.90 for validation results comparing key indicators to a comprehensive assessment. +.75 is for quality indicators threshold. F- represents high risk rules which in the above table are always in 100% compliance. If there is any non-compliance for F-, the program would fail the IRF and there would be no need to proceed with any other calculations. F+ represents low risk rules and in the third column there is no non-compliance. Column 4 gives the IRF final score for these scenarios in which all the programs would pass since the results are greater than zero. In column 5 the F+ False Positives change now to either one (-1) or two (-2) low risk rules being out of compliance. Column 6 demonstrates the change to the scores based upon this. The scores range from -.10 to -1.50 which indicate failing IRF scores in each case. However, the program can correct this result by engaging in additional development of quality indicators (Q) or in completing validation of their key indicator system (V). If a respective program were to do that as indicated in Column 7 where the additions are highlighted the results in column 8 change into the positive range and the program could pass on the IRF score. The last column, Column 9, contains the theoretical results based upon the mathematical model's parabolic curve (Fiene, 2026).

It is perfectly clear from the above table that the IRF Scoring is rather robust and it will be difficult for most programs to consistently obtain passing scores. But that is the intent of using a differential monitoring approach, it is a reward system for those ECE programs that have consistently maintained a high level of quality and a safe environment for young children. It is not intended as a screening tool or for the majority of ECE programs in a particular jurisdiction.

Let's switch our focus from the IRF to the Regulatory Compliance Scale to demonstrate how the two scoring and scale innovations can be used in interpreting results one from the other.

Interface with the Regulatory Compliance Scale

The other major proposal that has evolved from the Theory of Regulatory Compliance and regulatory compliance measurement is the Regulatory Compliance Scale (RCS)(Fiene, 2025). In this section of this research abstract, I will do a cross-walk from the IRF to the RCS for those who may be wanting to use the RCS instead of the IRF in reporting back to programs. The RCS has certain advantages in that it is more of an ordinal scale which is more commonplace in the ECE research literature than introducing a new measurement scale which occurs if one were to use the IRF Formula and results.

Let's revisit the RCS and how it is constructed. The reasoning behind the RCS is to move human care licensing measurement from a nominal (frequency violation counts) to an ordinal scale. The following table provides that initial crosswalk between violation count data and the resultant ordinal scale.

Regulatory Compliance Scale (RCS)

Scale	Result	Compliance	Violations	Risk to Child	License
7	Full	100%	0	Not Applicable	Full
5	Substantial	99-98%	1-2	Low Risk	Full
3	Medium	97-90%	3-10	Low-Mid Risk	Provisional
1	Low	89% or less	11+	Mid-High Risk	Denial

If we take the above Regulatory Compliance Scale table and apply it to the Integrated Regulatory Framework, this is potentially how it gets translated in moving from one (RCS) to the other (IRF) in the following table.

Crosswalk between Integrated Regulatory Framework (IRF) and the Regulatory Compliance Scale (RCS)

Scale	Result	FC Averages/Range	F- False Negative	F+ False Positive
7	Full	+2.15	0	0
5	Substantial	+1.15 to +.15	0	1-2
3	Medium	-.75	0	3+
1	Low	-3.00+	1	10+

In this Crosswalk between Integrated Regulatory Framework (IRF) and the Regulatory Compliance Scale (RCS) table the progressive nature of the decision making is parallel to the previous Regulatory Compliance Scale table when it comes to risk to the child as well as the licensing decision making. By utilizing the IRF, it takes into account measurement biases, certainty and uncertainty in decision making, as well as relative risk level and prediction. Licensing administrators can utilize the IRF as is or do the above crosswalk to the RCS. In either case, it provides a data driven and empirically based decision-making protocol. In the above two tables, relative weighting will be a bit more sensitive to making distinctions than absolute equal-interval weighting by introducing medium risk a bit earlier in the above tables. And weighting in general is superior to doing just violation counts.

But the bottom line with the IRF formula is the following: there should be no high risk rules out of compliance; there should be 2 or fewer low risk rules out of compliance; and if key indicators are used for licensing, only those rules with a FC of .50 should be utilized with no non-compliances in the selected key indicator rules, for quality, only those rules/standards with a FC of .75 should be utilized, and if validation studies are completed only those results of .90 should be utilized. One also has the added benefit of detecting assessor bias in regulatory compliance decision making as well as tracking the regulatory compliance history of specific programs. To make this as simple as possible, <u>key indicators are all in full 100% compliance, high risk rules are all in full 100% compliance, and low risk rules are in substantial compliance.</u>

Another way of thinking about this is to utilize the Risk Assessment Matrix (RAM) template and to interface with the IRF. The following table demonstrates how the IRF Formula distributes within the RAM template. The IRF Interface with RAM Template tables for relative weighting and equal interval weighting clearly depict how based upon the above parameters the RAM Template is impacted by the use of the IRF Formula. No high-risk rules are present; medium risk rules constitute the KIM: Key Indicator Rule generation; and the low-risk rules have very little non-compliance. The weights of 1 through 100 indicate increasing risk and prevalence as the weight increases. This could be depicted in the following color scheme in moving from green to red where green are low risk weights and red are high risk weights.

IRF Interface with Relative Weighting RAM Template

100	40	20	High Risk Rules = 0 (F-)
13	8	5	Medium Risk Rules = KIM (FC) 0 NC
3	2	1	Low Risk Rules = -2 (Substantial RC (F+)
High Prevalence	Medium Prevalence	Low Prevalence	IRF = KIM + RAM

IRF Interface with Equal Interval Weighting RAM Template

9	8	7	High Risk Rules = 0 (F-)
6	5	4	Medium Risk Rules = KIM (FC) 0 NC
3	2	1	Low Risk Rules = -2 (Substantial RC (F+)
High Prevalence	Medium Prevalence	Low Prevalence	IRF = KIM + RAM

References:

Fiene (2019). A treatise on the theory of regulatory compliance, *Journal of Regulatory Science, 7, 1-3.*

Fiene (2025). Finding the rules that work, *American Scientist, Volume 113*, 16-21.

Fiene (2026). *An integrated regulatory framework: The psychology of compliance*, Research Institute for Key Indicators Data Laboratory and the National Association for Regulatory Administration, Fredericksburg, VA. Unpublished manuscript.