

Crop *Revenue* Coverage Continuous Rating Premium Rate Calculation Guide

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Introduction

This document establishes the procedure for calculating Crop *Revenue* Coverage (*CRC*) premium rates using the Continuous Rating model. This procedure is effective beginning with the 2001 crop year and applies **only** to crops insured under insurance plan code 44.

Continuous Rating for *CRC* uses eight basic components. The first four: Reference Yield, Reference Rate, Exponent and Fixed Rate Load are the same as those found in the Continuous Rating model for Actual Production History (APH) yield based crops. The last four: Exponential Factor, Probability Variable, Standard Deviation and “T-Factor” are defined below and their use outlined in the steps that follow.

Continuous Rating is a different method of rate presentation, which allows rates to be calculated for any producer’s APH Yield. Prior to the introduction of the Continuous Rating model, RMA published Base Premium Rates and *CRC* Base Rates for *CRC* crops using a fixed rate for a span of yields, which was typically nine rate spans (R-span) per crop. The Continuous Rating model develops a rate for each yield rather than for a range of yields. The rates change only incrementally for a small difference in yield. Since the Continuous Rating method would result in too many rates to publish in a small document, RMA will publish a single Base Premium Rate (the Reference Rate) at the 75% coverage level for the established county average yield (the Reference Yield) for each type and practice combination. Rates for all other possible yields are computed from this single published rate using the Continuous Rating computations outlined in this procedure.

A worksheet is provided within this procedure to assist in the computation of a Base Premium Rate and the *CRC* Base Rate. The worksheet requires the current and previous year’s Actuarial Tables. A second worksheet is then provided within this procedure to assist in the computation of a *CRC* Premium.

The following definitions and calculation instructions should be consulted for an explanation of the necessary components within each step of the calculations. Rounding rules for final and intermediate values are described in each step of the calculations.

Automated rate calculation and premium quoting software must follow the rate calculation instructions as described here. The Actuarial Table information required for rating can be obtained from the Actuarial Data Master (ADM) for the current crop year. See the applicable RO Server Bulletin for the ADM record layouts. See the Data Acceptance System Handbook (FCIC-M13) for the reporting and validation instructions for the Base Premium Rate, *CRC* Base Rate and the premium calculation.

Conflicts between this procedure and FCIC-M13 will be governed by this procedure. Conflicts between this procedure and the FCIC 18010 Crop Insurance Handbook (CIH), will be governed by this procedure.

Any questions regarding this procedure should be addressed to:

Office of the Assistant Manager for Research and Development, Actuarial Division
Rates and Prices Branch
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Definitions

Actuarial Table	The FCI-35 Coverage and Rates document for the state / county / crop / insurance plan / type / practice for the appropriate year.
Additional Coverage Rate	One or more rates that are added to the Preliminary Base Rate to account for the risk of certain specified elected options and any high-risk surcharge. This is the sum of the applicable items annotated with an "A" in the "Additional Coverage and High-Risk Rates" section of the Actuarial Table.
Adjusted Base Rate	The Preliminary Base Rate with adjustments made for additional coverage options/endorsements and/or high-risk land.
Approved APH Yield	This is the amount of production per acre computed and approved by the verifier (based on up to ten years of history), including any applicable adjustments, as defined in the Crop Insurance Handbook.
Average APH Yield	The simple average of the per-acre yields in the APH database (before any yield adjustment), as defined in the Crop Insurance Handbook.
APH Yield	The APH yield for the current year that is used to determine the applicable rate, as defined in the Crop Insurance Handbook. Generally this is the Approved APH Yield, unless the yield floor applies, in which case this is the Average APH Yield.
Base Premium Rate	The Adjusted Base Rate multiplied by the Coverage Level Rate Differential. The rate used in the calculation of the yield and price portion of the CRC Premium.
Continuous Rating Base Rate	The base rate calculated from the APH Yield and appropriate year's set of rate variables: Reference Yield, Reference Rate, Exponent and Fixed Rate Load.
CRC Base Rate	The rate used in the calculation of the revenue

portion of the CRC Premium.

Designated Rate	A fixed rate that is used in the calculation of the Adjusted Base Rate. The Designated Rate is annotated with an “F” in the “Additional Coverage and High-Risk Rates” section of the Actuarial Table.
Exponent	A rate component used in calculating the Continuous Rating Base Rate. The Exponent is listed on the Actuarial Table for the appropriate year.
Exponential Factor	A rate component used in calculating the CRC Base Rate. This component shows the relationship between price and yield.
Fixed Rate Load	A rate component used in calculating the Continuous Rating Base Rate. The Fixed Rate Load is listed on the Actuarial Table for the appropriate year.
Multiplicative Factor	One or more factors that are multiplied against the Preliminary Base Rate (after the Additional Coverage Rate is applied) to account for the risk of certain specified elected options and any high-risk surcharge. This is the product of the applicable items annotated with an “M” in the “Additional Coverage and High-Risk Rates” section of the Actuarial Table.
Probability Variable (T)	In the calculation of the CRC Base Rate, an approximation of the area under the normal APH yield curve is used. This is the variable for that approximation. It is a function of the standard deviation for this curve given the level that the insured has chosen.
Preliminary Base Rate	The lowest of: (1) the current year’s Continuous Rating Base Rate, (2) 120% of the Yield Span Base Rate, and (3) 120% of the prior year’s Continuous Rating Base Rate.
Reference Rate	A rate component used in calculating the Continuous Rating Base Rate. The Reference Rate is listed on the Actuarial Table for the appropriate year.

Reference Yield	A rate component used in calculating the Continuous Rating Base Rate. The Reference Yield is listed on the Actuarial Table for the appropriate year.
Standard Deviation (s)	The Standard Deviation, "s", is a variable. It is a derived approximation to the usual standard deviation for the normal APH yield curves.
"T-Factor"	A rate component in the calculation of the CRC Base Rate. It is an approximation of the area under the APH yield curve at the insured's guaranteed number of bushels.
Yield Ratio	The ratio of the APH Yield to the Reference Yield.
Yield Span Base Rate	Initially, the R-span rate at the 75% coverage level the insured would have paid for the same APH yield in crop year 2000. In future years, these yield spans and associated base rates will be determined by RMA and the values will be found on the applicable ADM record.

Sample Actuarial Table Document

Examples throughout this document refer to the following sample Actuarial Table. All examples use the following assumptions:

Crop	Wheat (0011)
Insurance Plan	CropRevenueCoverage (44)
State	Nebraska (31)
County	Box Butte (013)
Type	NTS (997)
Practice	Summerfallow (005)
APH Yield	35 bushels
Elected coverage level	60%

FCI-35 COVERAGE AND RATES
xxxx AND SUCCEEDING CROP YEARS

ST: NEBRASKA (31)
CO: Box Butte (013)

CROP: WHEAT (0011)
PLAN: Crop Revenue Coverage (44)

TYPE		PRACTICE
(997)NTS -- No Type Specified		Irrigated -- I (002)
(997)NTS -- No Type Specified		Continuous Cropping -- CC (004)
(997)NTS -- No Type Specified		Summer fallow -- SF (005)

TYPE PRACTICE	(997) NTS (002) I	(997) NTS (004) CC	(997) NTS (005) SF
REFERENCE YIELD(BU)	51.5	24.5	31.5
REFERENCE RATE	0.073	0.289	0.128
EXPONENT	-1.955	-1.867	-1.924
FIXED RATE LOAD	0.023	0.023	0.023

ADDITIONAL COVERAGE AND HIGH RISK RATES

(AAA) HIGH RISK AREA	A	0.098	0.300	0.151
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COVERAGE LEVEL RATE DIFFERENTIALS

50%	0.47	0.47	0.47
55%	0.51	0.51	0.51
60%	0.57	0.57	0.57
65%	0.65	0.65	0.65
70%	0.79	0.79	0.79
75%	1.00	1.00	1.00

UNIT FACTORS

(OU) OPTIONAL UNITS	1.00	1.00	1.00
(BU) BASIC UNIT	0.90	0.90	0.90
(EU) ENTERPRISE UNITS (50-499 ACRES)	0.93	0.93	0.93
(EU) ENTERPRISE UNITS (500-999 ACRES)	0.87	0.87	0.87
(EU) ENTERPRISE UNITS (>999 ACRES)	0.83	0.83	0.83

OPTIONAL COVERAGE FACTORS

(PF) PREVENTED PLANTING +5%	1.01	1.01	1.01
(PT) PREVENTED PLANTING +10%	1.02	1.02	1.02
(SR) SHORT RATE ADJUSTMENT	0.35	0.35	0.35

TRANSITIONAL YIELDS (BU)

	57.0	27.0	31.0
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CRC PRICE FACTORS TABLE BY TYPE

	997	
LOW PRICE FACTOR	*	* - To Be Announced Prior to the Sales Closing Date
HIGH PRICE FACTOR	*	

CONTINUOUS RATING CALCULATION

Step 1: Calculate Current Year's Yield Ratio:

Calculate the current year's Yield Ratio based on the APH Yield and the current year's Reference Yield.

$$\text{Current Year's Yield Ratio} = \frac{\text{APH Yield}}{\text{Current Year's Reference Yield}}$$

- Round the Yield Ratio to the nearest hundredth
- Minimum Yield Ratio equal to 0.50
- Maximum Yield Ratio equal to 1.50

For example, we are given the APH Yield of 35 bushels per acre and we find that the Reference Yield on the Actuarial Table for Summerfallow Wheat is 31.5 bushels; therefore, the Yield Ratio is: 1.11 ($35.0 / 31.5 = 1.1111111 \dots$).

Step 2: Calculate Current Year's Continuous Rating Base Rate:

Calculate the current year's Continuous Rating Base Rate based on the current year's Yield Ratio, Exponent, Reference Rate and Fixed Rate Load.

$$((\text{Current Year Yield Ratio})^{\text{Current Year Exponent}}) \times \text{Current Year Reference Rate} + \text{Current Year Fixed Rate Load}$$

- Round to 8 decimal places, including each interim step

The first calculation is to raise the result of step 1 (Yield Ratio) by the power function (Exponent). For example, we determined the Yield Ratio to be 1.11 in step 1 and the Exponent for Summerfallow Wheat on the Actuarial Table is -1.924. This results in a factor of 0.81808530 (0.818085299...). The second calculation is to take that result 0.81808530 and multiply it by the Reference Rate for Summerfallow Wheat (0.128) from the Actuarial Table, which results in a value of 0.10471492 (0.104714918....). The third calculation is to take that result (0.10471492) and add the Fixed Rate Load for Summerfallow Wheat (0.023) from the Actuarial Table. This results in a Continuous Rating Base Rate of 0.12771492.

Step 3: Calculate 120% of Yield Span Base Rate:

Calculate 120% of the Yield Span Base Rate based on the APH Yield. If the applicable state / county / crop / insurance plan / type / practice did not exist in the prior crop year, the yield and rate elements used in determining the Yield Span Base Rate of this calculation will be blank. If blank, the Yield Span Base Rate should be considered to be equal to 0.999 for processing purposes.

Yield Span Base Rate x 1.20

- Round to 8 decimal places

For example, the 75% coverage level Yield Span Base Rate for APH Yields of 35 through 38, Summerfallow Wheat in Box Butte County for crop year 2000 was 0.122 (R06).

This Yield Span Base Rate of 0.122 is multiplied by 1.20 for a result of 0.1464.

Note: In certain circumstances, the Yield Span Base Rate used in the rating formula may need to be modified (lowered) in order to ensure that no rate increase exceeds 20%. This situation can arise in the year or years following a revision to the components of the Continuous Rating formula.

For example, in the event that a revision to the components of the Continuous Rating formula for cropyear 2004 results in a rate increase in excess of 20% for some APH Yield, the Preliminary Base Rate will be less than the current year's Continuous Rating Base Rate. This creates the possibility that some producer may receive a rate increase of more than 20% the following year unless the Yield Span Base Rate is modified the following year. To address this problem, RMA will identify the restrained yields and selectively override values for the Yield Span Base Rates to ensure that the rate increase will not exceed 20%.

Step 4: Calculate Prior Year's Yield Ratio:

NOTE: Whenever the applicable state / county / crop / insurance plan / type / practice did not exist in the prior crop year, the prior year's Continuous Rating Base Rate components will be the same as the current year's components.

For the 2001 crop year, the computation of the prior year's Continuous Rating Base Rate is not applicable, as continuous rating did not exist in 2000. However, to ensure uniformity of the calculations in future years, the 2000 crop year Continuous Rating Base Rate components (Reference Yield, Reference Rate, Exponent, Fixed Rate Load) will be the same as the 2001 crop year components.

Calculate the prior year's Yield Ratio based on the APH Yield and the prior year's Reference Yield.

$$\text{Prior Year's Yield Ratio} = \frac{\text{APH Yield}}{\text{Prior Year's Reference Yield}}$$

- Round the Yield Ratio to the nearest hundredth
- Minimum Yield Ratio equal to 0.50
- Maximum Yield Ratio equal to 1.50

Step 5: Calculate 120% of Prior Year's Continuous Rating Base Rate:

Calculate 120% of the prior year's Continuous Rating Base Rate determined from the prior year's Yield Ratio, Exponent, Reference Rate, and Fixed Rate Load.

$$\left(((\text{Prior Year Yield Ratio})^{\text{Prior Year Exponent}}) \times \text{Prior Year Reference Rate} + \text{Prior Year Fixed Rate Load} \right) \times 1.20$$

- Round to 8 decimal places, including each interim step

For example, in 2001 the prior year's Continuous Rating Base Rate components will be identical to the current year values. The prior year's Yield Ratio is the APH Yield of 35 bushels divided by the prior year's Reference Yield of 31 bushels, for a result of 1.11. The prior year's Continuous Rating Base Rate is:

$$1.11^{-1.924} \times 0.128 + 0.023 = 0.12771492$$

This is multiplied by 1.20, for a result of 0.15325790.

Step 6: Determine Preliminary Base Rate:

The Preliminary Base Rate is the lowest result of Step 2, Step 3 and Step 5.

$$\text{Preliminary Base Rate} = \text{Lowest result of Steps 2, 3, and 5}$$

The purpose of this step is to limit the annual rate increase to no more than 20%, in accordance with federal statute.

For example, the result in Step 2 was 0.12771492; in Step 3 was 0.14640000; and Step 5 was 0.15325790. The lowest of the three results is 0.12771492 from Step 2.

Step 7: Determine Adjusted Base Rate:

The Adjusted Base Rate is the greater of: (1) the Preliminary Base Rate (Step 6) plus any Additional Coverage Rate, with the sum multiplied by the Multiplicative Factor; or (2) the Designated Rate.

Adjusted Base Rate = Greater of:

$$[\text{Preliminary Base Rate} + \text{Additional Coverage Rate}] \times \text{Multiplicative Factor}$$

OR

Designated Rate

- Round to 8 decimal places

For example, if the insured acreage is in map area AAA, there is an additive rate of 0.151 shown on the Actuarial Table for Summerfallow Wheat. The Adjusted Base Rate in this example would equal 0.27871492 (0.12771492 + 0.151).

The above adjustments to the Preliminary Base Rate are intended to reflect the added risk of high-risk areas and certain coverage endorsements. The default for the Additional Coverage Rate is 0.000, the default for the Multiplicative Factor is 1.000 and the default for the Designated Rate is 0.000.

Current additive endorsements are:

- WA Wheat: Winter Coverage Endorsement - Option A
- WB Wheat: Winter Coverage Endorsement - Option B

If multiple adjustments are needed, they must be combined before being entered into the formula. For example, an add-on high-risk rate surcharge would need to be combined with the winter coverage endorsement rate before being added to the Preliminary Base Rate.

Step 8: Calculate Base Premium Rate:

Calculate the Base Premium Rate by multiplying the Adjusted Base Rate (Step 7) by the elected Coverage Level Rate Differential found on the Actuarial Table.

$$\text{Base Premium Rate} = \text{Adjusted Base Rate} \times \text{Coverage Level Rate Differential}$$

- Round to 8 decimal places
- Cap rate at 0.999

For example, if the insured elected the 60% coverage level, the Adjusted Base Rate of 0.27871492 from step 7 would be multiplied by the 60% Coverage Level Rate Differential of 0.57 as shown on the Actuarial Table, which equals 0.15886750.

The Base Premium Rate calculated in this step is the “Base Premium Rate” entered on line C) of the “Crop Revenue Coverage Premium Calculation Worksheet”. It is utilized to calculate the CRC Base Rate.

Step 9: Calculate Standard Deviation (s):

Calculate the standard deviation by inserting the Base Premium Rate found above into the appropriate formula below.

- Level 50:** $s = (1.44434394 \times \text{Base Premium Rate}) + 0.40198673$
- Level 55:** $s = (1.54650547 \times \text{Base Premium Rate}) + 0.37456110$
- Level 60:** $s = (1.64841058 \times \text{Base Premium Rate}) + 0.34460749$
- Level 65:** $s = (1.75040141 \times \text{Base Premium Rate}) + 0.31214948$
- Level 70:** $s = (1.85281979 \times \text{Base Premium Rate}) + 0.27715584$

Level 75: $s = (1.95603215 \times \text{Base Premium Rate}) + 0.23953590$

Level 80: $s = (2.06046206 \times \text{Base Premium Rate}) + 0.19912558$

Level 85: $s = (2.16664218 \times \text{Base Premium Rate}) + 0.15565713$

- Round to 8 decimal places

Continuing the example from above, the insured has elected the 60 percent coverage level and has a base premium rate of 0.15886750. Inserting this into the formula for the 60 percent coverage level results in 0.60648636 $[(1.64841058 \times 0.15886750) + 0.34460749]$.

Step 10: Preliminary Calculations for CRC Base Rates:

Before we get to the final rate calculation, there are some preliminary factors that need to be calculated. These are the “T-Factor” and the “Exponential Factor”.

Part A: Calculating the Probability Variable “T”:

Before calculating the “T-Factor” we must first find the Probability Variable “T”. “T” is given by the Standard Deviation from Step 9 divided by the quantity of the Standard Deviation plus 0.33267 times the quantity of one minus the level. (Here the level is expressed as a decimal, thus the 60 percent level is expressed as 0.60.) The formula looks like this:

$$T = \text{StandardDeviation} / (\text{StandardDeviation} + (0.33267 \times (1 - \text{Level})))$$

- Round to 8 decimal places

For our example, T equals 0.82007002.

$$0.60648636 / (0.60648636 + (0.33267 \times (1 - 0.60)))$$

Part B: Calculating the “T-Factor”:

The value “T” is inserted into the following formula to give the “T-factor”:

$$\text{T-Factor} = (0.4361836 \times T) - (0.1201676 \times (T^{**2})) + (0.937298 \times (T^{**3}))$$

- Round to 8 decimal places

In our example the “T-factor” is 0.79381512.

$$\text{T-Factor} = (0.4361836 \times 0.82007002) - (0.1201676 \times ((0.82007002)^{**2})) + (0.937298 \times ((0.82007002)^{**3}))$$

Part C: Calculating the Exponential Factor:

This is given by the formula:

$$\text{Exponential Factor} = 2.71828183^{(-0.5 \times (((1-\text{Level})/\text{Standard Deviation})^2))}$$

- Round to 8 decimal places

The example gives us the value of 0.80453218 for the Exponential Factor.

$$\text{Exponential Factor} = 2.71828183^{(-0.5 \times (((1-0.60)/0.60648636)^2))}$$

Step 11: Calculating CRC Base Rates:

Complete the final step in calculating the CRC Base Rate by inserting the “T-Factor” and the “Exponential Factor” into the following formula:

$$0.39894228 \times \text{Level} \times (1 - \text{Base Premium Rate}) \times \text{Exponential Factor} \times \text{T-Factor}$$

Completing the example, the CRC base rate is 0.12858447.

$$0.39894228 \times 0.60 \times (1 - 0.15886750) \times 0.80453218 \times 0.79381512$$

This value is the “CRC Base Rate” that is entered on line E) of the “Crop Revenue Coverage Premium Calculation Worksheet”.

CRC Continuous Rating Worksheet

1. Calculate the current year's **Yield Ratio**:
 APH Yield / Current Year Reference Yield.
 _____ / _____ = _____
(1)

2. Calculate the current year's **Continuous Rating Base Rate**:
 (Current Year Yield Ratio **Current Year Exponent) x Current Year Reference Rate + Current Year Fixed Rate Load
 [_____ ** _____] x _____ + _____ = _____
(2)

3. Calculate 120% of the **Yield Span Base Rate**:
 Yield Span Base Rate x 1.20
 _____ x 1.20 = _____
(2)

4. Calculate the prior year's **Yield Ratio**:
 APH Yield / Prior Year Reference Yield
 _____ / _____ = _____
(1)

5. Calculate 120% of the prior year's **Continuous Rating Base Rate**:
 ((Prior Year Yield Ratio**Prior Year Exponent) x Prior Year Reference Rate + Prior Year Fixed Rate Load) x 1.20
 [[_____ ** _____] x _____ + _____] x 1.20 = _____
(2)

6. Determine the **Preliminary Base Rate**:
 Enter the lowest result of steps 2, 3 and 5.

7. Determine the **Adjusted Base Rate**:
 Greater of:
 [Preliminary Base Rate + Additional Coverage Rate] x Multiplicative Factor OR Designated Rate
 [_____ + _____] x _____ = _____ OR _____
(2) (2)

8. Calculate the **Base Premium Rate**:
 Adjusted Base Rate x Coverage Level Rate Differential
 _____ x _____ = _____
(2) (3)

9. For the appropriate level below, calculate the **Standard Deviation** :

Level 50:	(1.44434394 x Base Premium Rate) + 0.40198673
Level 55:	(1.54650547 x Base Premium Rate) + 0.37456110
Level 60:	(1.64841058 x Base Premium Rate) + 0.34460749
Level 65:	(1.75040141 x Base Premium Rate) + 0.31214948
Level 70:	(1.85281979 x Base Premium Rate) + 0.27715584
Level 75:	(1.95603215 x Base Premium Rate) + 0.23953590
Level 80:	(2.06046206 x Base Premium Rate) + 0.19912558
Level 85:	(2.16664218 x Base Premium Rate) + 0.15565713

 (_____ x _____) + _____ = _____
(5)

10. Preliminary calculations for CRC Base Rates:

A) Calculate the *Probability Variable (T)*:

Standard Deviation/(Standard Deviation +(0.33267 x (1 - Level)))

$$\frac{\text{Standard Deviation}}{\text{Standard Deviation} + (0.33267 \times (1 - \text{Level}))} = \text{_____}$$

(4) (5)

B) Calculate the *T-Factor*:

(0.4361836 x T) - (0.1201676 x T**2) + (0.937298 x T**3)

$$(0.4361836 \times \text{_____}) - (0.1201676 \times \text{_____}^{**2}) + (0.937298 \times \text{_____}^{**3})$$

$$= \text{_____}$$

(5)

C) Calculate the *Exponential Factor*:

2.71828183**(-0.5 x ((1 - Level)/Standard Deviation)**2)

$$2.71828183^{**(-0.5 \times ((1 - \text{Level}) / \text{Standard Deviation}))^{**2}} = \text{_____}$$

(4) (5)

11. Calculate the CRC Base Rates:

0.39894228 x Level x (1 - Base Premium Rate) x Exponential Factor x T-Factor

$$0.39894228 \times \text{_____} \times (1 - \text{_____}) \times \text{_____} \times \text{_____} = \text{_____}$$

(4) (5)

- (1) Round to nearest hundredth, minimum value = 0.50, maximum value = 1.50
- (2) Round to 8 decimal places including each interim step
- (3) Maximum value 0.999
- (4) Level is expressed as a decimal (i.e. Level 60 is calculated using 0.60)
- (5) Round to 8 decimal places.