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Generation of the LHS Samples for the CRA-2014 (AP-164) Revision 0 PA Calculations

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I. Introduction

The Waste Isolation Pilot Plant (WIPP), located in southeastern New Mexico, has been developed by the U.S. Department of Energy (DOE) for the geologic (deep underground) disposal of transuranic (TRU) waste. Containment of TRU waste at the WIPP is regulated by the U.S. Environmental Protection Agency (EPA) according to the regulations set forth in Title 40 of the Code of Federal Regulations (CFR), Part 191. The DOE demonstrates compliance with the containment requirements according to the Certification Criteria in Title 40 CFR Part 194 by means of performance assessment (PA) calculations performed by Sandia National Laboratories (SNL). WIPP PA calculations estimate the probability and consequence of potential radionuclide releases from the repository to the accessible environment for a regulatory period of 10,000 years after facility closure. The models used in PA are maintained and updated with new information as part of an ongoing process. Improved information regarding important WIPP features, events, and processes typically results in refinements and modifications to PA models and the parameters used in them. Planned changes to the repository and/or the components therein also result in updates to WIPP PA models. WIPP PA models are used to support the repository recertification process that occurs at five-year intervals following the receipt of the first waste shipment at the site in 1999.

PA calculations were included in the 1996 Compliance Certification Application (CCA) (U.S. DOE 1996), and in a subsequent Performance Assessment Verification Test (PAVT) (MacKinnon and Freeze 1997a, 1997b and 1997c). Based in part on the CCA and PAVT PA calculations, the EPA certified that the WIPP met the regulatory containment criteria. The facility was approved for disposal of transuranic waste in May 1998 (U.S. EPA 1998). PA calculations were an integral part of the 2004 Compliance Recertification Application (CRA-2004) (U.S. DOE 2004). During their review of the CRA-2004, the EPA requested an additional PA calculation, referred to as the CRA-2004 Performance Assessment Baseline Calculation (PABC) (Leigh et al. 2005), be conducted with modified assumptions and parameter values (Cotsworth 2005). Following review of the CRA-2004 and the CRA-2004 PABC, the EPA recertified the WIPP in March 2006 (U.S. EPA 2006).

PA calculations were completed for the second WIPP recertification and documented in the 2009 Compliance Recertification Application (CRA-2009). The CRA-2009 PA resulted from continued review of the CRA-2004 PABC, including a number of technical changes and corrections, as well as updates to parameters and improvements to the PA computer codes (Clayton et al. 2008). To incorporate additional information which was received after the CRA-2009 PA was completed, but before the submittal of the CRA-2009, the EPA requested an additional PA calculation, referred to as the 2009 Compliance Recertification Application Performance Assessment Baseline Calculation (PABC-2009) (Clayton et al. 2010), be

undertaken which included updated information (Cotsworth 2009). Following the completion and submission of the PABC-2009, the WIPP was recertified in 2010 (U.S. EPA 2010).

The Land Withdrawal Act (U.S. Congress 1992) requires that the DOE apply for WIPP recertification every five years following the initial 1999 waste shipment. The 2014 Compliance Recertification Application (CRA-2014) is the third WIPP recertification application submitted by the DOE for EPA approval. The PA executed by SNL in support of the CRA-2014 is detailed in AP-164 (Camphouse 2013). The CRA-2014 PA includes a number of technical changes and parameter refinements, as well as a redesigned WIPP panel closure system. Results found in the CRA-2014 PA are compared to those obtained in the PABC-2009 in order to assess repository performance in terms of the current regulatory baseline. This analysis package documents the LHS component of the CRA-2014 PA analysis.

The program LHS is used to sample the distributions of parameters having epistemic uncertainty using a Latin Hypercube sampling design. Epistemic uncertainty represents lack of knowledge about parameters that are considered constants, hence represents a distribution of confidence rather than of variability. However, LHS is also used to sample variables that represent model uncertainty rather than parameter uncertainty. In two cases (SOLMOD3:SOLVAR and SOLMOD4:SOLVAR) LHS samples distributions that represent prediction error (logarithm of observed/predicted) in the EQ3/6 model as the uncertainty on solubility projections (Brush and Domski 2013). These two parameters not only introduce uncertainty into the computed solubilities but correct for bias in the predictions of EQ3/6. S_MB139:RELPMOD is used to select one of two relative permeability models for use in anhydrite. WAS_AREA:PROBDEG is the probability of biodegradation of plastics and rubber and it takes on only one of two values, either 1 for microbial degradation of cellulose only, or 2 for microbial degradation of cellulose, plastic and rubber.

PRELHS is run prior to LHS and is used to obtain from the WIPP Parameter Database the data describing the distributions and to create an input file to LHS based on that data. PRELHS Version 2.40 was used in this analysis. The user creates an input file for PRELHS that specifies which parameters are to be sampled using their "material" and "property" identifiers. PRELHS performs limited error checking on the data extracted from the database.

LHS can reorder sampled data to induce or restrict correlations among the parameters. However, other conditional relationships were specified by the code analysts for three parameters. These conditional relationships restricted the value for one parameter to be less than the sampled value of another parameter. This conditional relationship was enforced using the utility LHS_EDIT Version 1.0 (Appendix VIII) to modify the output file generated by LHS. This report documents the use of PRELHS Version 2.40, LHS Version 2.42 and LHS_EDIT to provide three sets of sampled data for use in the CRA-2014 CRA PA (Camphouse 2013). These three sets represent

three replicates of one hundred samples for each of 75 variables. Sixty-three of these variables are associated with model parameters (Table 1). However, there are also 12 "placeholder" variables sampled. These placeholders are included to enable users to add additional parameters and run LHS while preserving the ability to regenerate the values previously sampled for the model parameters.

Table 1. Parameters sampled by LHS for the CRA-2014 PA.

Parameter	Description
AM+3:MKD_AM	Americium III, matrix partition coefficient for americium
BH_SAND:PRMX_LOG	Borehole filled with silty sand, log of intrinsic permeability, x-direction
BOREHOLE:DOMEGA	Borehole and fill, drill string angular velocity (0)
BOREHOLE:TAUFAIL	Borehole and fill, effective shear strength for erosion
CASTILER:COMP_RCK	Castile brine reservoir, bulk compressibility
CASTILER:PRESSURE	Castile brine reservoir, brine far-field pore pressure
CASTILER:PRMX_LOG	Castile brine reservoir, log of intrinsic permeability, x-direction
CONC_PLG:PRMX_LOG	Concrete plug, surface and rustler, log of intrinsic permeability, x-direction
CULEBRA:APOROS	Culebra member of the rustler formation, Culebra advective porosity
CULEBRA:DPOROS	Culebra member of the rustler formation, diffusive porosity for Culebra dolomite
CULEBRA:HMBLKLT	Culebra member of the rustler formation, Culebra half matrix-block length
CULEBRA:MINP_FAC	Culebra member of the rustler formation, mining transmissivity multiplier
DRZ_1:PRMX_LOG	Disturbed rock zone during the time period that begins with facility closure (0 years) and ends when drz healing is complete, log of intrinsic permeability, x-direction
DRZ_PCS:PRMX_LOG	DRZ directly above the panel closure system, log of intrinsic permeability, x-direction
GLOBAL:CLIMTIDX	Information that applies globally, climate index
GLOBAL:OXSTAT	Information that applies globally, index for the oxidation state
GLOBAL:PBRINE	Information that applies globally, prob. that drilling intrusion in excavated area encounteres pressurized brine
GLOBAL:TRANSIDX	Information that applies globally, index for selecting realizations of the transmissivity field
PCS_T1:PORE_DIS	Panel closure system for an initial time duration, Brooks-Corey pore distribution parameter
PCS_T1:POROSITY	Panel closure system for an initial time duration, effective porosity
PCS_T1:PRMX_LOG	Panel closure system for an initial time duration, log of intrinsic permeability, x-direction
PCS_T1:SAT_RBRN	Panel closure system for an initial time duration, residual brine saturation
PCS_T1:SAT_RGAS	Panel closure system for an initial time duration, residual gas saturation
PCS_T2:POR2PERM	Panel closure system for a secondary time duration, distribution used to calculate permeability from sampled porosity values
PCS_T2:POROSITY	Panel closure system for a secondary time duration, effective porosity
PCS_T3:POROSITY	Run-of-mine panel closure system, tertiary time period, effective porosity

Parameter	Description
PHUMOX3:PHUMCIM	Proportionality constant with humic colloids for actinides in oxidation state III, Castile brine, MgO controlls ph
PU+3:MKD_PU	Plutonium III, matrix partition coefficient for plutonium
PU+4:MKD_PU	Plutonium iv, matrix partition coefficient for plutonium
S_HALITE:COMP_RCK	Salado halite, intact, bulk compressibility
S_HALITE:POROSITY	Salado halite, intact, effective porosity
S_HALITE:PRESSURE	Salado halite, intact, brine far-field pore pressure
S_HALITE:PRMX_LOG	Salado halite, intact, log of intrinsic permeability, x-direction
S_MB139:PORE_DIS	Salado marker bed 139, intact and fractured, Brooks-Corey pore distribution parameter
S_MB139:PRMX_LOG	Salado marker bed 139, intact and fractured, log of intrinsic permeability, x-direction
S_MB139:RELP_MOD	Salado marker bed 139, intact and fractured, model number, relative permeability model
S_MB139:SAT_RBRN	Salado marker bed 139, intact and fractured, residual brine saturation
SHFTL_T1:PRMX_LOG	Lower portion of simplified shaft from 0 - 200 years, log of intrinsic permeability, x-direction
SHFTL_T2:PRMX_LOG	Lower portion of simplified shaft from 200 - 10,000 years, log of intrinsic permeability, x-direction
SHFTU:PRMX_LOG	Upper portion of simplified shaft, log of intrinsic permeability, x-direction
SHFTU:SAT_RBRN	Upper portion of simplified shaft, residual brine saturation
SHFTU:SAT_RGAS	Upper portion of simplified shaft, residual gas saturation
SOLMOD3:SOLVAR	Oxidation state III model, solubility multiplier
SOLMOD4:SOLVAR	Oxidation state IV model, solubility multiplier
SPALLMOD:PARTDIAM	Material developed for DRSPALL, particle diameter of disaggregated waste
SPALLMOD:REPIPERM	Material developed for DRSPALL, waste permeability to gas local to intrusion borehole
SPALLMOD:REPIPOR	Material developed for DRSPALL, waste porosity at time of drilling intrusion
SPALLMOD:TENSLSTR	Material developed for DRSPALL, tensile strength of waste
STEEL:CORRMCO2	Generic steel in waste, inundated corrosion rate for steel without CO2 present
TH+4:MKD_TH	Thorium IV, matrix partition coefficient for thorium
U+4:MKD_U	Uranium IV, matrix partition coefficient for uranium
U+6:MKD_U	Uranium IV, matrix partition coefficient for uranium
WAS_AREA:BIOGENFC	Waste emplacement area and waste, probability of attaining sampled microbial-gas-generation rates
WAS_AREA:BRUCITEC	Waste emplacement area and waste, MgO inundated hydration rate in ERDA-6 brine
WAS_AREA:BRUCITEH	Waste emplacement area and waste, MgO humid hydration rate
WAS_AREA:BRUCITES	Waste emplacement area and waste, MgO inundated hydration rate in GWB brine
WAS_AREA:GRATMICH	Waste emplacement area and waste, humid biodegradation rate for cellulose
WAS_AREA:GRATMICI	Waste emplacement area and waste, inundated biodegradation rate for cellulose

Parameter	Description
WAS_AREA:HYMAGCON	Waste emplacement area and waste, rate of conversion of hydromagnesite to magnesite
WAS_AREA:PROBDEG	Waste emplacement area and waste, probability of plastics and rubber biodegradation in event of microbial gas generation
WAS_AREA:SAT_RBRN	Waste emplacement area and waste, residual brine saturation
WAS_AREA:SAT_RGAS	Waste emplacement area and waste, residual gas saturation
WAS_AREA:SAT_WICK	Waste emplacement area and waste, index for computing wicking

The execution of LHS was verified by:

1. Checking the LHS input files to ensure that the headers properly document the analysis and that the random number seeds were correct (Section III and Appendices I to III).
2. Verifying that the proper set of parameters was sampled. This was done by comparing the set to the specifications of the analysis plan (AP) for the analysis (AP-164). The proper variables were sampled.
3. Checking the EVAL script input files to ensure that any conditional relationships imposed using LHS_EDIT.EXE were properly specified. These were correct.
4. Examining the LHS log files for any obvious errors or failures. No errors or failure were noted.
5. Examining the PRELHS transfer (output) file to verify that the data were properly extracted from the database (Section IV and Appendices IV to VI).
6. Examining the correlation matrices for "significant" values and to verify that non-zero correlations specified in the input file were properly generated (Section IV).
7. Checking the values generated to ensure that they did not exceed the specified range (Appendix VII).
8. Checking that the distributions match those specified in the parameter database. No errors were found.
9. Plotting the empirical Cumulative Distribution Function (CDF) against the expected CDF and looking for anomalies (Section IV).

II. Run Control

The script EVAL_LHS.COM was used to execute PRELHS, LHS and LHS_EDIT. This script processes an input file which lists the specific information required to run these codes. The details of run control are documented in Long (2013). The script and its input files are stored in LIBCRA14_EVAL (PACMS2:[CMS_CRA14.CRA14_EVAL]).

III. PRELHS Input Files

AP-164 specifies that the analyses be run as four cases where each case adds features not represented in the previous case and the last case includes all changes required for the CRA-2014 analysis. Only one replicate was run for the first 3 cases and LHS was run only for the first two cases (CRA14BL and CRA14TP) and the fourth and final case (CRA14). The fourth case was run using three replicates. This report focusses on the fourth case since it includes the sampled parameters of all previous cases but shows comparisons to distributions used in the PABC09, CRA14BL or CRA14TP analyses when they are different from the CRA14 case.

The two input files for PRELHS for the CRA14 BL and CRA14TP cases are called LHS1_CRA14BL_R1.INP and LHS1_CRA14TP_R1.INP , respectively. The three input files for PRELHS for the CRA14 case are listed in appendices I to III. These files are named LHS1_CRA14_R1.INP, LHS1_ CRA14_R2.INP and LHS1_ CRA14_R3.INP, respectively for replicates 1 to 3. Except for the title and random seed these three files are identical. Different random seeds are assigned in each input file to cause LHS to generate three unique sets of values. The random seeds used were those used in the PABC09, as specified in AP-164. This sampling design facilitates the comparison of results from one analysis to the next by ensuring that identically numbered vectors have, to the greatest extent possible, the same collection of parameter values.

The output files for the CRA14BL and CRA14TP cases are named LHS1_CRA14BL_R1.TRN and CRA14TP_R1.TRN, respectively. The corresponding output (transfer) files from PRELHS for the three replicates of the CRA14 case are listed in appendices IV to VI. These files are named LHS1_ CRA14_R1.TRN, LHS1_ CRA14_R2.TRN and LHS1_ CRA14_R3.TRN, respectively for replicates 1 to 3. The three transfer files are also identical except for titles and the random seed values. All input and output files were inspected to verify that the data used to construct the distributions were properly extracted from the library.

IV. LHS Output files

The LHS output files were examined for errors. The ranges of the sampled variables were compared to the range specified as input for the distribution (Appendix VII). No values were found to exceed the specified ranges of the distributions although a few were found to cover less than 90% of the specified range, e.g. 77.4 % of the range was covered by the samples for S_MB139:PRMX_LOG (*material:property*) in replicate 3 (Fig. 162). These low coverage values are undoubtedly due to the shape of the distribution; the tails of the CDF curves are nearly horizontal, so that the width of 1 % and 99 % quantiles sampled by LHS are relatively wide. The width of the quantiles (each covering 1 % of the probability) is set by the number of LHS samples in the replicate (100).

The LHS output file lists the correlation coefficients between the sampled variables. The sampled data for those variables for which a correlation matrix was entered showed correlations that were close to those specified (Table 2). No significant ($\alpha = 0.01$) spurious correlations were observed among the uncorrelated variables, although in replicate 2 the correlation between the ranks of the variables CASTILER:PRESSURE and WAS_AREA:PROBDEG was -0.234 which is significant at $\alpha = 0.05$. However, WAS_AREA:PROBDEG is a discrete user-specified distribution (Delta distribution) having only 2 possible values (Figure 61). This restriction undoubtedly limits the ability of LHS to shuffle the values to enforce a correlation near zero. In addition, the significance test on the correlation coefficient is questionable in any case because the data fails to even come close to meeting the assumptions of normality of the data.

To evaluate the frequency with which high correlation coefficients would be expected in such variables, a test was conducted (Kirchner 2009). In the test, 1000 LHS samples were generated and the correlation coefficients greater than 0.197 (the test statistic for the correlation coefficient for n=100) were tabulated. To generate these values, the LHS2_LHS.FOR code was modified to 1) run 1000 iterations of LHS sampling and 2) to output the data that exceeded 0.197. The modified code was named LHS2_LHS_TEST.FOR and stored with the executable and input files in library LIBCRA09_LHSCORR (PACMS2:[CMS_CRA09.CRA09_LHSCORR). For this informal test, all correlations were specified to be zero. Out of the 1000 samples, 502 ($\alpha = 0.05$) and 2 ($\alpha = 0.01$) "significant" correlations were generated. All of these correlations involved either WAS_AREA:PROBDEG or S_MB139:RELP_MOD, both of which have discrete distributions having only two possible values. These results suggest that the number of values exceeding the standard test statistics for correlation coefficients may be relatively high when LHS samples discrete distributions having few possible values.

Table 2. Significant correlations between parameters.

Replicate	Between		Expected Correlation	Observed Correlation	Significance[2]
1	CASTILER:COMP_RCK	CASTILER:PRMX_LOG	-0.75	-0.7281	**
	S_HALITE:COMP_RCK	S_HALITE:PRMX_LOG	-0.99	-0.9869	**
2	CASTILER:COMP_RCK	CASTILER:PRMX_LOG	-0.75	-0.7242	**
	CASTILER:PRESSURE[1]	WAS_AREA:PROBDEG	0.00	-0.234	*
	S_HALITE:COMP_RCK	S_HALITE:PRMX_LOG	-0.99	-0.9907	**
3	CASTILER:COMP_RCK	CASTILER:PRMX_LOG	-0.75	-0.7252	**
	S_HALITE:COMP_RCK	S_HALITE:PRMX_LOG	-0.99	-0.9834	**

1 This correlation is spurious.

2 * = Significant at $p<0.05$, ** = Significant at $p<0.01$

The sampled distributions were compared to the expected distributions. Cumulative distribution functions for the sampled data were constructed by ordering the data from smallest to largest value and assigning the probability $i/100-0.005$ to the i^{th} ordered value, i.e. the midpoint of the interval containing the value based on order statistics (Figures 2 through 190). With the exception of the variables modified using LHS_EDIT (Figures 26, 27 and 58 for replicate 1, Figures 89, 90 and 121 for replicate 2 and Figures 152,153 and 184 for replicate 3), the differences between the CDFs of the sampled values and the CDFs of the expected distributions are due to the differences between the estimated probability assigned to the values and the true probability associated with the data.

AP-164 (Camphouse 2013) called for a phased set of computations to help identify the cause of the expected changes among the predominant differences from the PABC09. Changes in the set of sampled parameters occurred in three of the four cases that were run. The baseline (BL) case had new parameter values for PCS_T1:PRMX_LOG (Camphouse 2010), SOLMOD3:SOLVAR, and SOLMOD4:SOLVAR (Brush and Domski 2013). The PCS_T1: PRMX_LOG parameter was not used in the PABC09 although it was used in previous PAs related to analyses of the panel closure system. The new distributions for SOLMOD3:SOLVAR and SOLMOD4:SOLVAR are compared to the distributions used in PABC09 in Figures 44, 45, 107, 108, 170 and 171.

The second case, TP, was run using new distributions for BOREHOLE:TAUFAIL (Herrick and Kirchner, 2013) and GLOBAL:PBRINE (Kirchner, Kirkes and Zeitler, 2013). These new distributions are compared to those used in the BL case (and the PABC09) in Figures 5, 68 and 131 (TAUFAIL) and 18, 81, and 144 (PBRINE).

LHS didn't need to be run again for the third case, but was run again for the fourth case which incorporated all the changes for the CRA-2014 PA. The parameters WAS:AREA:BRUCITEC. WAS:AREA:BRUCITEH and WAS:AREA:BRUCITES were previously treated as constants but were assigned distributions in this analysis (Clayton 2013). The distribution of uncertainty on these parameters should be a Student-t distribution because the parameters represent the slopes of lines from linear regressions. However, the Student distribution of LHS could not be parameterized using a mean, standard error and degrees of freedom and so a normal distribution was substituted. Figure 1 represents BRUCITES which, having the fewest degrees of freedom of the three parameters, shows the greatest difference between the Student and normal distributions. The differences between the normal and student distributions are inconsequential. LHS will be modified to allow this alternative specification of its parameters. LHS STEEL:CORRMCO2 was assigned a Student-t distribution whereas previously it had a uniform distribution, reflecting its basis on new experimental results (Roselle 2013). It is compared to the BL (and PABC09) distribution in Figures 50, 113 and 176.

Three parameters having distributions were assigned new values in the parameter database but were not subsequently sampled. New values were assigned to PCS_T1:PRMY_LOG and PCS_T1:PRMZ_LOG in the parameter database but the sampled values of PCS_T1:PRMX_LOG were assigned to the Y and Z versions of the parameter to assure that they had identical values within each vector. DRZ_PCS:RELP_MOD was not sampled for this PA but it was assigned a new default value, 4, because the previous default value, 0, was in error. BRAGFLO would fail if it received a value of 0 and previously the default value from the database was overridden in MATSET to avoid this failure.

V. Imposing Additional Limits on Some Variables

LHS_EDIT was used to enforce a conditional relationship between three pairs of variables. The relationships were WAS_AREA:GRATMICH ≤ WAS_AREA:GRATMICI (Clayton 2008, Nemer and Stein 2005) and PCS_T3: POROSITY ≤ PCS_T2: POROSITY ≤ PCS_T1:POROSITY (Camphouse 2013). The relationships were enforced by modifying values in the LHS transfer file, thus making the conditioned values available for use in the sensitivity analysis. For each pair of variables LHS_EDIT rescales the sampled value of the parameter to the left of the ≤ symbol to the new "controlled" value using the equation

$$v_i' = \frac{v_i - U_{V,lower}}{U_{V,upper} - U_{V,lower}} \times \left(Min(x_i, U_{V,upper}) - U_{V,lower} \right) + U_{V,lower} \qquad (1)$$

Where v_i' is the conditioned value of left hand variable, v_i is the sampled value of that variable, x_i is the sampled value of the right hand variable, and $U_{V,lower}$ and $U_{V,upper}$ are the bounds of the distribution assigned to the left hand variable. This method preserves the probability associated with the value of the left hand variable. The CDFs for the original sampled values and the conditioned values are shown in Figures 26, 27 and 58 for replicate 1, Figures 89, 90 and 121 for replicate 2 and Figures 152,153 and 184 for replicate 3. This conditional relationship results in a positive correlation between the pairs of variables. For example, the correlation between WAS_AREA:GRATMICH and WAS_AREA:GRATMICI was computed for Replicate 1 using Excel and found to be 0.74 (Figure 191). The nature of these correlations is fundamentally different than that which LHS could induce between the variables. LHS achieves correlations between variables by reordering the sampled data whereas LHS_EDIT changes the range of the left hand sampled variable. If instead of limiting the value of the left hand variable an equivalent correlation had been specified between the variables in the input file to LHS then LHS would have generated values for the left hand variable that could have exceeded the corresponding value for the right hand variable.

VI. Summary and Conclusions

LHS was used to generate one hundred vectors of sampled parameter values for each of three replicates. LHS was also used to generate one hundred vectors for the first replicate of cases BL and TP, which had fewer new distributions than the final CRA-2014 case. A unique random number seed was assigned to each of the three replicates. These seed values were identical to those used in the PABC09 analysis. The resulting sampled data had the expected correlation structure and the values fell within the expected ranges. The LHS results were subsequently modified to enforce a conditional relationship between WAS_AREA:GRATMICH and WAS_AREA:GRATMICI, PCS_T3: POROSITY and PCS_T2: POROSITY, and PCS_T2: POROSITY and PCS_T1:POROSITY. The distributions of sampled values matched the expected CDFs.

VII. References

Brush, L. and P. Domski. 2013. Uncertainty Analysis of Actinide Solubilities for the WIPP CRA-2014 PA, Rev. 1 Supersedes ERMS 559278. PA. Sandia National Laboratories, Carlsbad. ERMS # 559712

Camphouse, C. 2010. Recommendation and Justification of Parameter Values Required for the WIPP Panel Closure Redesign and Repository Reconfiguration Performance Assessment, Sandia National Laboratories, Carlsbad. ERMS #554614

Camphouse, R.C. 2013. Analysis Plan for the 2014 WIPP Compliance Recertification Application Performance Assessment. Sandia National Laboratories, Carlsbad, NM. ERMS #559198.

Clayton, D. J. 2008. Analysis Plan for the Performance Assessment for the 2009 Compliance Recertification Application. Sandia National Laboratories, Carlsbad, N.M. ERMS #547515.

Clayton, D.J., S. Dunagan, J.W. Garner, A.E. Ismail, T.B. Kirchner, G.R. Kirkes, M.B. Nemer. 2008. Summary Report of the 2009 Compliance Recertification Application Performance Assessment. Sandia National Laboratories, Carlsbad, NM. ERMS 548862.

Clayton, D.J., Camphouse, R. C., Garner, J. W., Ismail, A. E., Kirchner, T. B., Kuhlman, K. L., and Nemer, M. B.. 2010. Summary Report of the CRA-2009 Performance Assessment Baseline Calculation, Revision 1. Sandia National Laboratories. Carlsbad, New Mexico, ERMS 553039.

Clayton, D. 2013. Justification of Chemistry Parameters for Use in BRAGFLO for AP-164, Rev. 1, Sandia National Laboratories, Carlsbad. ERMS #559466]

Cotsworth, E. 2005. EPA Letter on Conducting the Performance Assessment Baseline Change (PABC) Verification Test. U.S. EPA, Office of Radiation and Indoor Air, Washington, D.C. ERMS 538858.

Cotsworth, E. 2009. EPA Letter on CRA-2009 First Set of Completeness Comments. U.S. EPA, Office of Radiation and Indoor Air, Washington, D.C. ERMS 551444.

Herrick, C. and T. Kirchner. 2013. Follow-up Questions Concerning TAUFAIL Flume Testing Raised during the November 14-15, 2012 Technical Exchange between the DOE and EPA. Sandia National Laboratories, Carlsbad. ERMS # 559081

Kirchner, T. 2009. Generation of the LHS Samples for the AP-137 Revision 0 (CRA09) PA Calculations. Carlsbad, NM: Sandia National Laboratories. ERMS #547971

Kirchner, T., R. Kirkes and T. Zeitler. 2013. Evaluating the data in order to derive a value for GLOBAL:PBRINE. Sandia National Laboratories, Carlsbad. ERMS #558724

Leigh, C.D., J.F. Kanney, L.H. Brush, J.W. Garner, G.R. Kirkes, T. Lowry, M.B. Nemer, J.S. Stein, E.D. Vugrin, S. Wagner, and T.B. Kirchner. 2005. 2004 Compliance Recertification Application Performance Assessment Baseline Calculation, Revision 0. Sandia National Laboratories, Carlsbad, NM. ERMS 541521.

Long, J.J. 2013. Execution of Performance Assessment Codes for the CRA-2014 Performance Assessment. Sandia National Laboratories, Carlsbad, NM.

MacKinnon, R.J., and G. Freeze. 1997a. Summary of EPA-Mandated Performance Assessment Verification Test (Replicate 1) and Comparison With the Compliance Certification Application Calculations, Revision 1. Sandia National Laboratories, Carlsbad, NM. ERMS 422595.

MacKinnon, R.J., and G. Freeze. 1997b. Summary of Uncertainty and Sensitivity Analysis Results for the EPA-Mandated Performance Assessment Verification Test, Rev. 1. Sandia National Laboratories, Carlsbad, NM. ERMS 420669.

MacKinnon, R.J., and G. Freeze. 1997c. Supplemental Summary of EPA-Mandated Performance Assessment Verification Test (All Replicates) and Comparison With the Compliance Certification Application Calculations, Revision 1. Sandia National Laboratories, Carlsbad, NM. ERMS 414880.

Nemer, M. B. and J. S. Stein. 2005. "Analysis Package for BRAGFLO: 2004 Compliance Recertification Application Performance Assessment Baseline Calculation." Analysis Report, June 28, 2005. Carlsbad, NM: Sandia National Laboratories. ERMS 540527.

Roselle, G. 2013. Determination of Corrosion Rates from Iron/Lead Corrosion Experiments to be used for Gas Generation Calculations. Sandia National Laboratories, Carlsbad. ERMS #559077

U.S. Congress. 1992. WIPP Land Withdrawal Act, Public Law 102-579, 106 Stat. 4777, 1992; as amended by Public Law 104-201, 110 Stat. 2422, 1996.

U.S. Department of Energy (DOE) 1996. Title 40 CFR Part 191 Compliance Certification Application for the Waste Isolation Pilot. U.S. Department of Energy Waste Isolation Pilot Plant, Carlsbad Area Office, Carlsbad, NM. DOE/CAO-1996-2184.

U.S. Department of Energy (DOE) 2004. Title 40 CFR Part 191 Compliance Recertification Application for the Waste Isolation Pilot Plant, , 10 vols., U.S. Department of Energy Waste Isolation Pilot Plant, Carlsbad Area Office, Carlsbad, NM. DOE/WIPP 2004-3231.

U.S. Environmental Protection Agency (EPA). 1998. 40 CFR 194, Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the Disposal Regulations: Certification Decision: Final Rule, Federal Register. Vol. 63, 27354-27406.

U.S. Environmental Protection Agency (EPA). 2006. 40 CFR 194, Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the Disposal Regulations: Certification Decision: Final Rule, Federal Register. Vol. 71, 18010-18021.

U.S. Environmental Protection Agency (EPA). 2010. 40 CFR Part 194 Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance With the Disposal Regulations: Recertification Decision, Federal Register No. 222, Vol. 75, pp. 70584-70595, November 18, 2010.

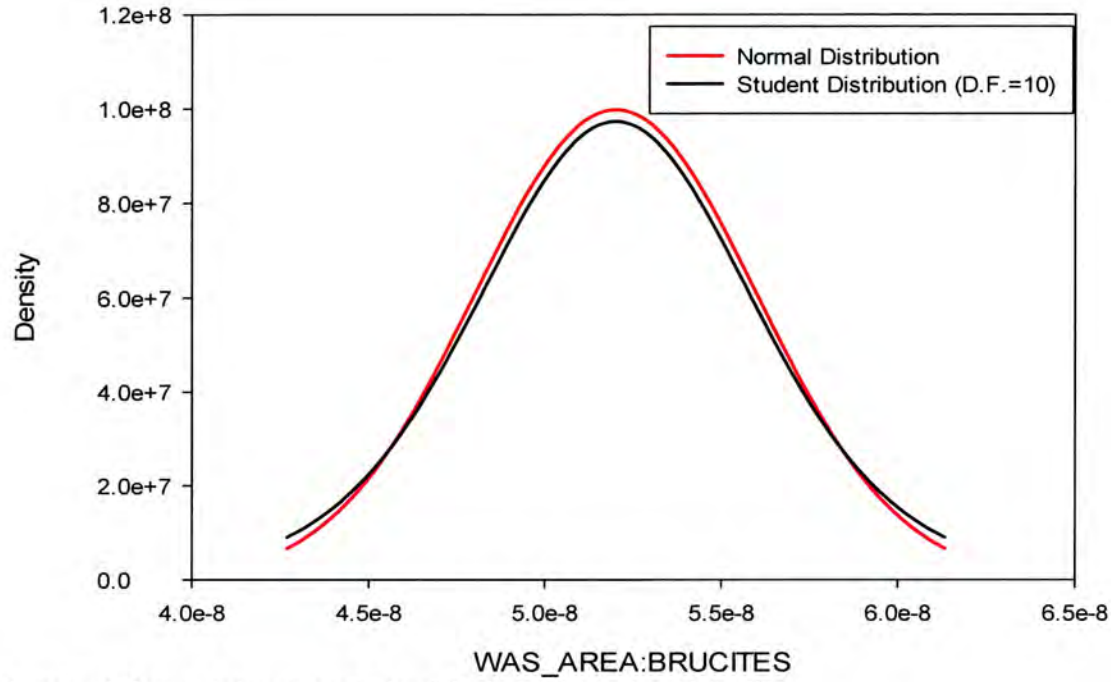

Figure 1. Difference between a normal and Student-t distribution (d.f. = 10).

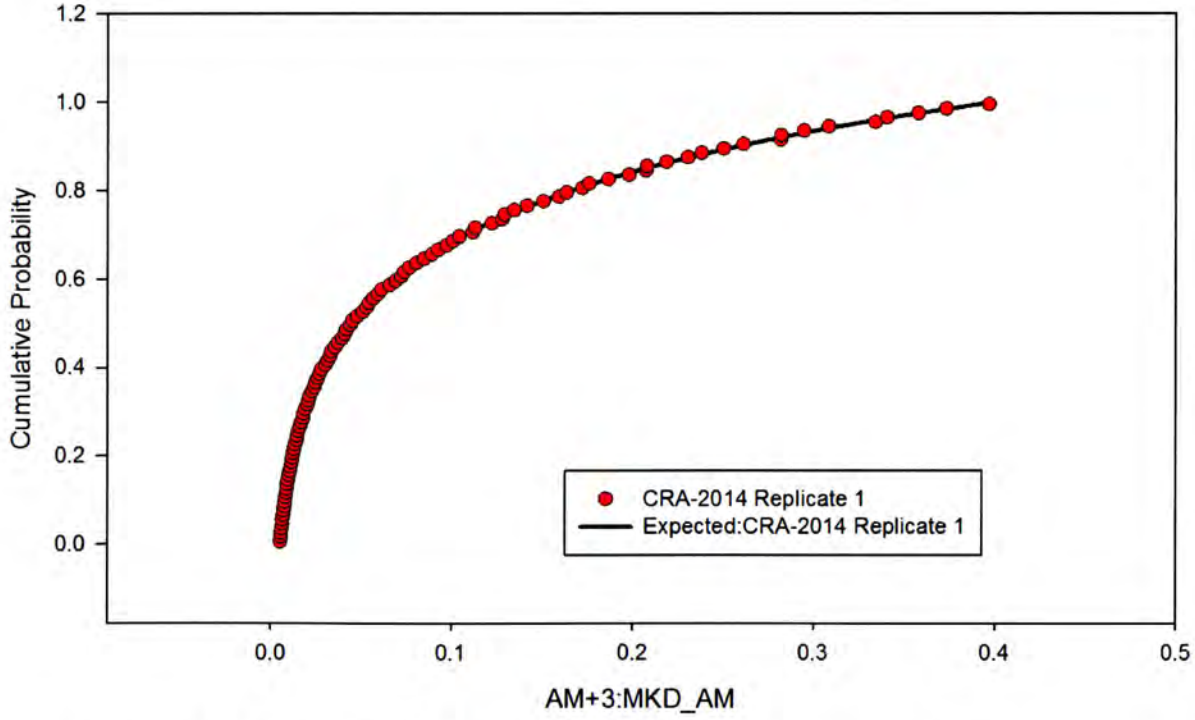

Figure 2. Observed and Expected CDFs for AM+3:MKD_AM (Loguniform Distribution) Replicate 1.

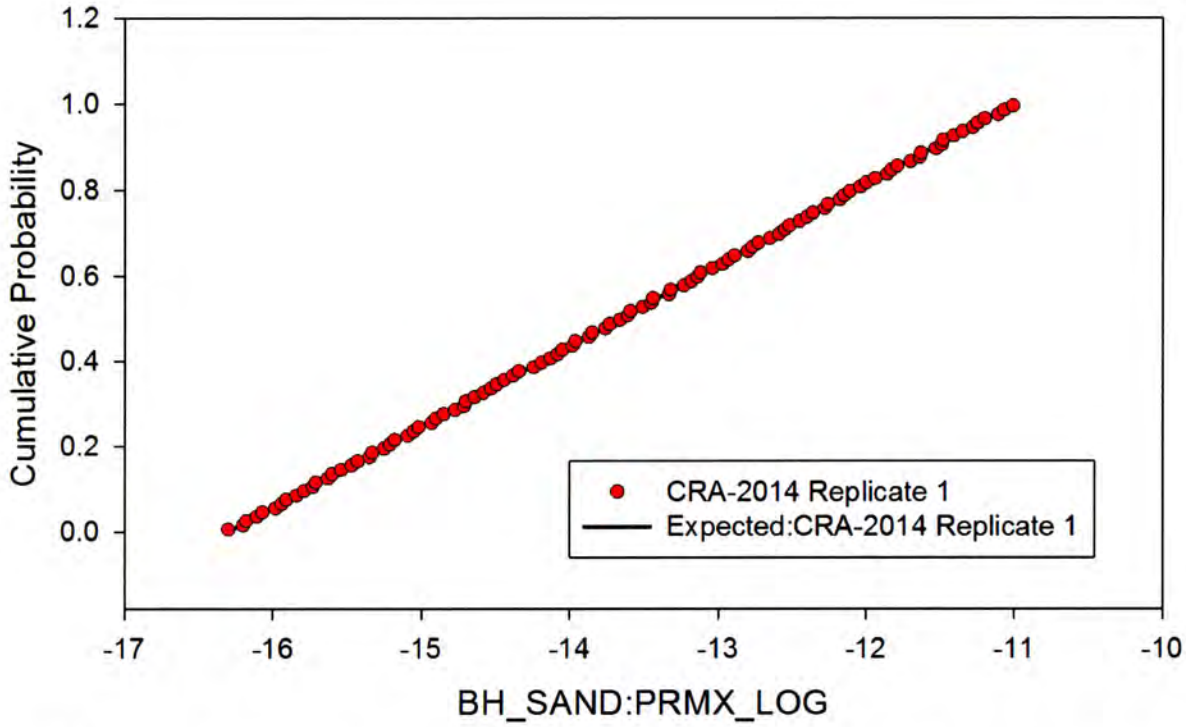

Figure 3. Observed and Expected CDFs for BH_SAND:PRMX_LOG (Uniform Distribution) Replicate 1.

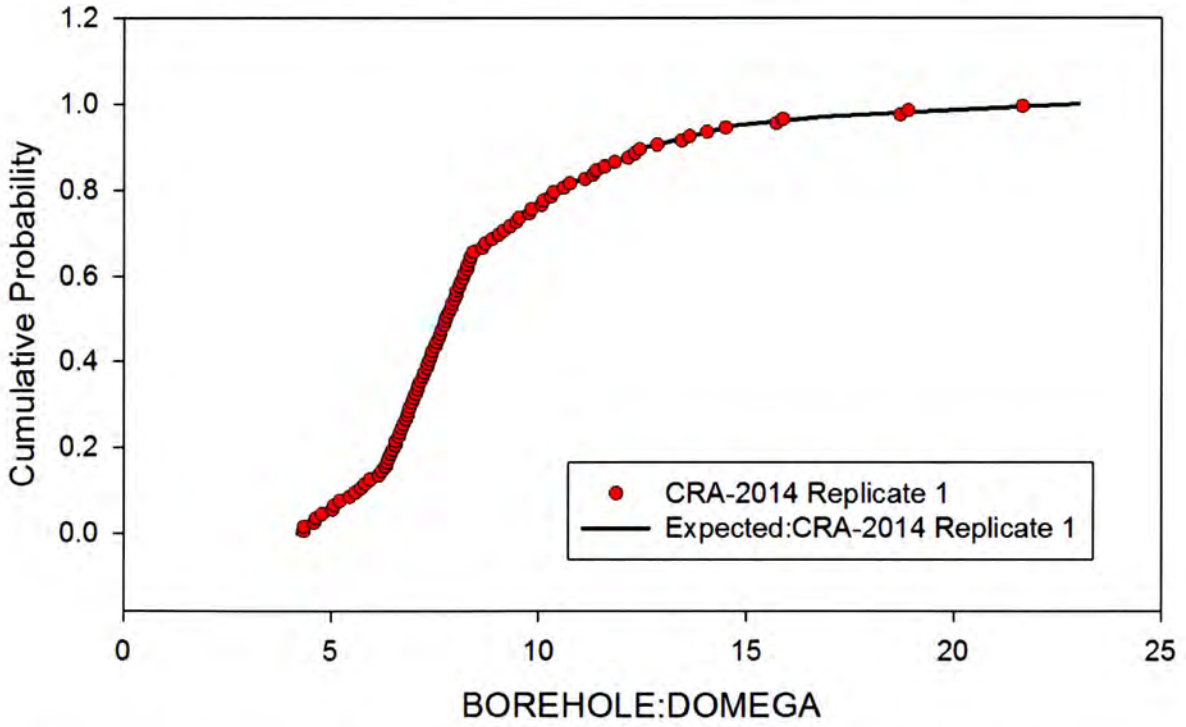

Figure 4. Observed and Expected CDFs for BOREHOLE:DOMEGA (User Continuous Distribution) Replicate 1.

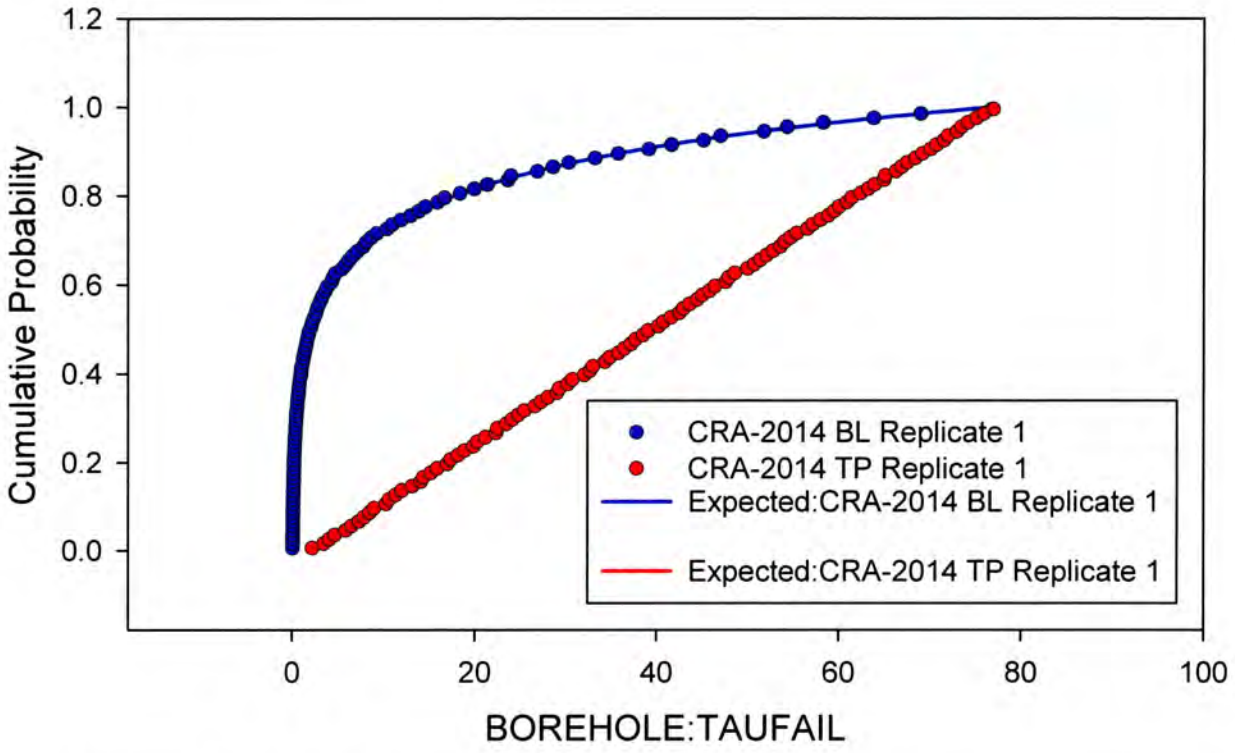

Figure 5. Observed Distribution for BOREHOLE:TAUFAIL Replicate 1, case BL (Loguniform Distribution) and TP (Uniform Distribution).

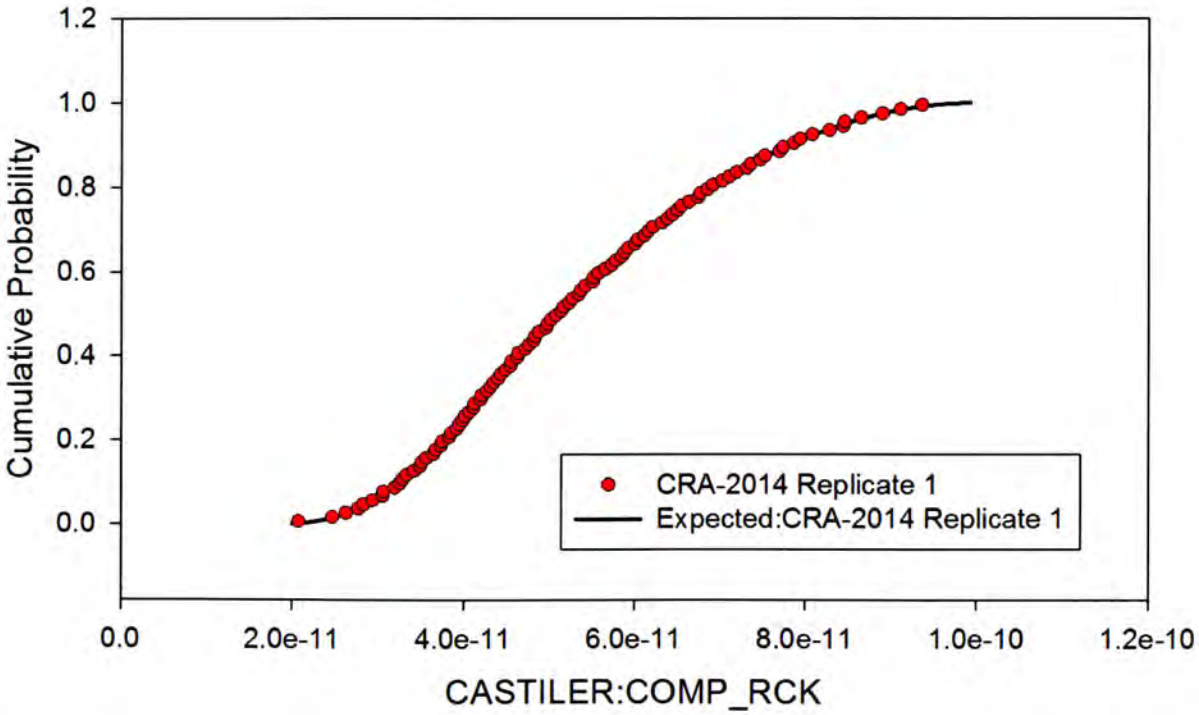

Figure 6. Observed and Expected CDFs for CASTILER:COMP_RCK (Triangular Distribution) Replicate 1.

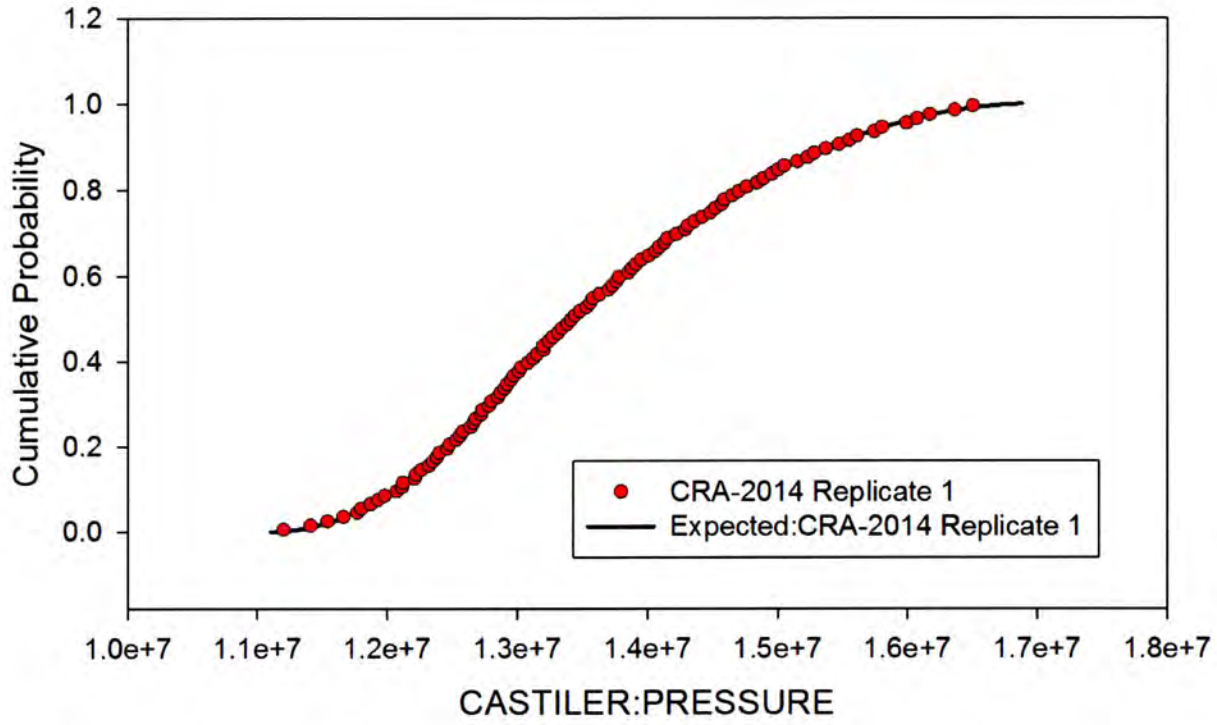

Figure 7. Observed and Expected CDFs for CASTILER:PRESSURE (Triangular Distribution) Replicate 1.

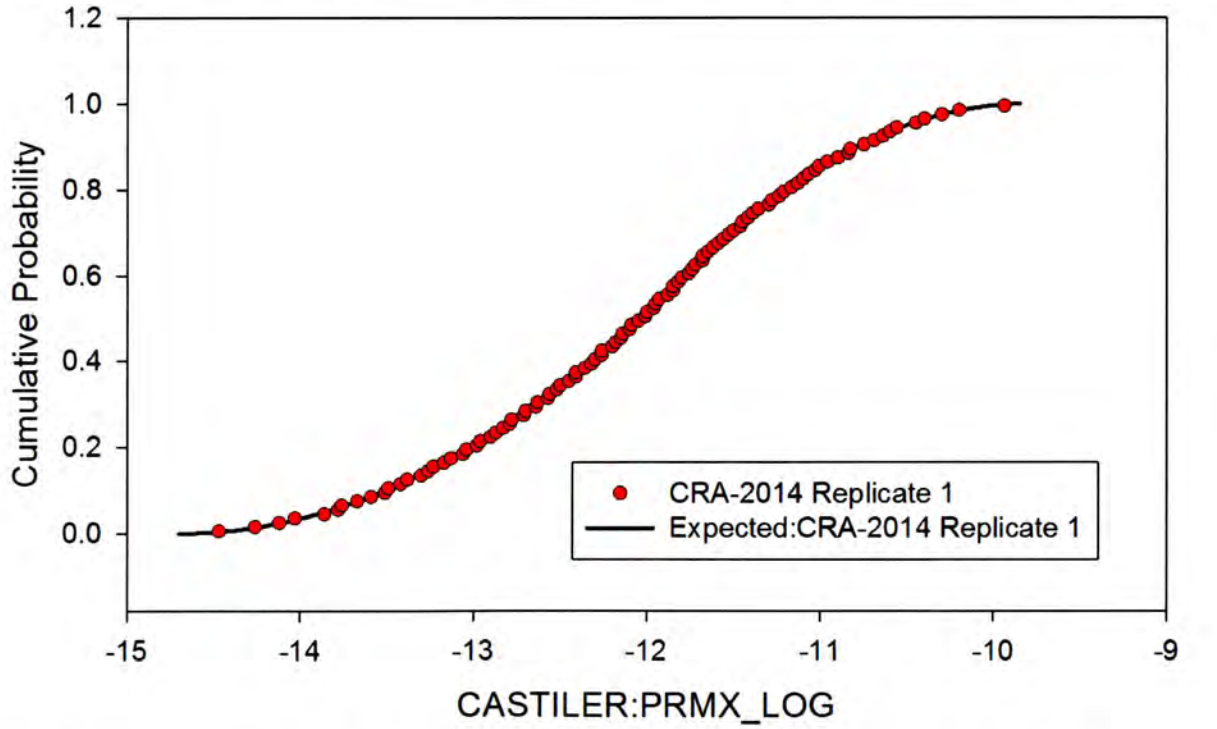

Figure 8. Observed and Expected CDFs for CASTILER:PRMX_LOG (Triangular Distribution) Replicate 1.

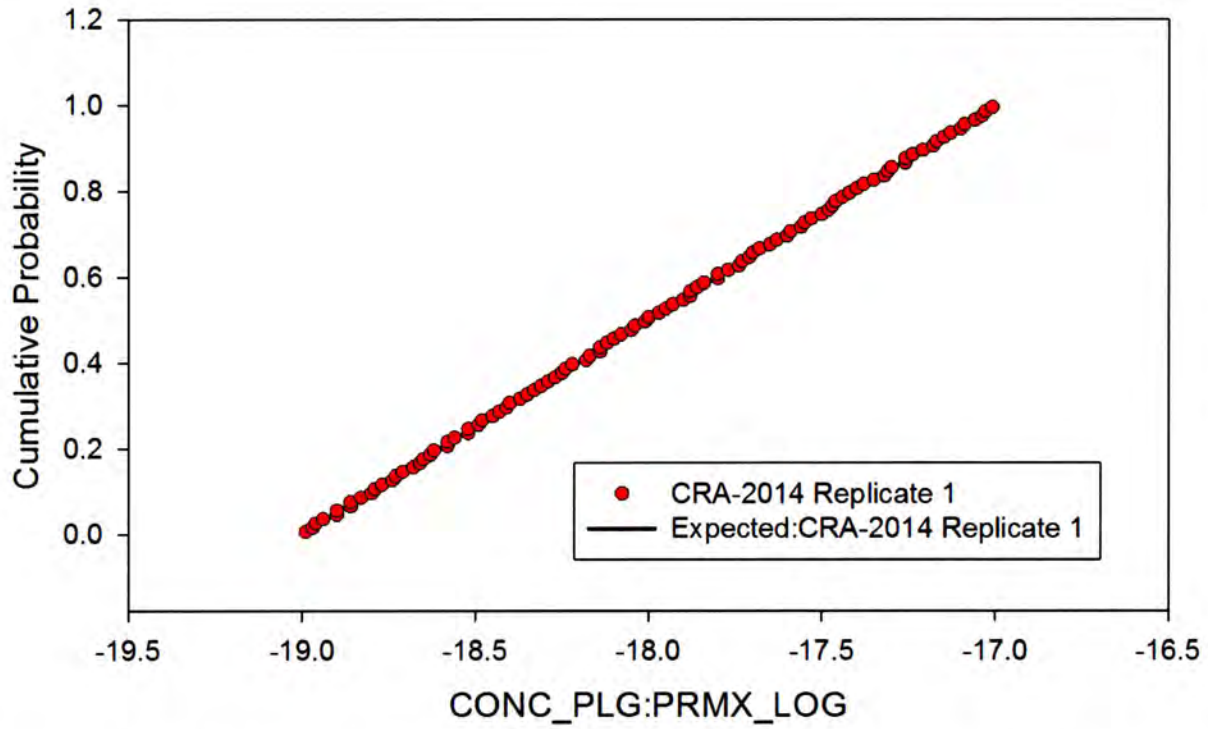

Figure 9. Observed and Expected CDFs for CONC_PLG:PRMX_LOG (Uniform Distribution) Replicate 1.

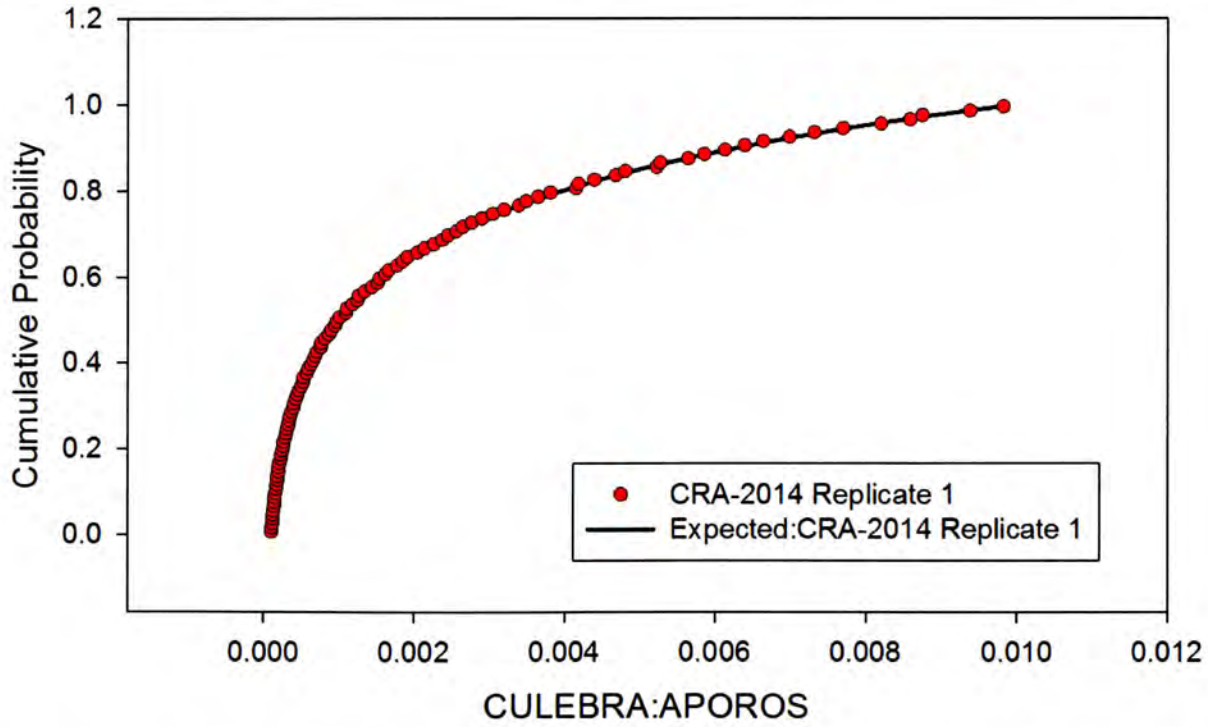

Figure 10. Observed and Expected CDFs for CULEBRA:APOROS (Loguniform Distribution) Replicate 1.

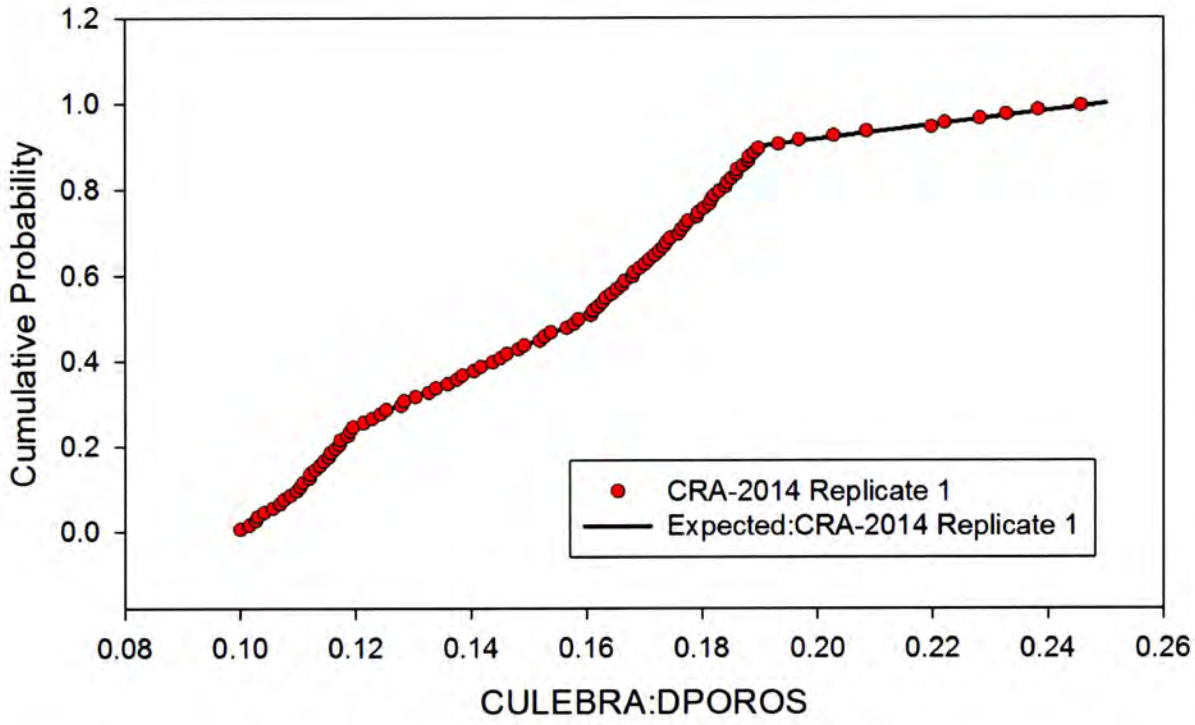

Figure 11. Observed and Expected CDFs for CULEBRA:DPOROS (User Continuous Distribution) Replicate 1.

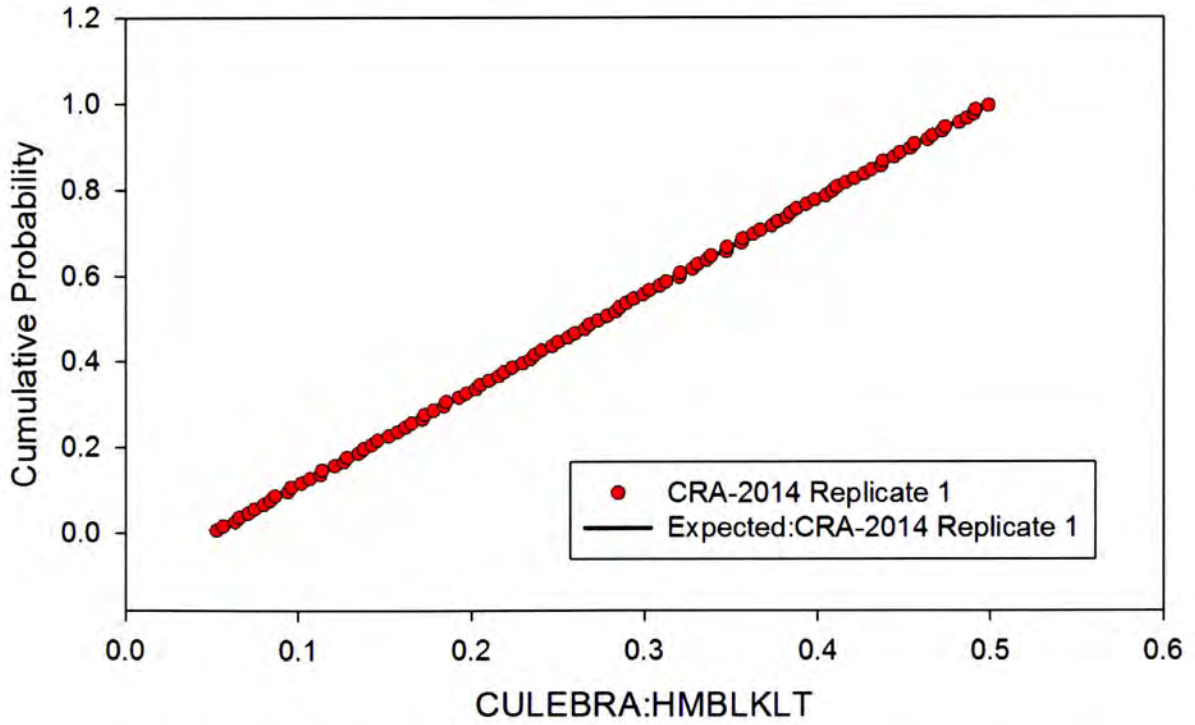

Figure 12. Observed and Expected CDFs for CULEBRA:HMBLKLT (Uniform Distribution) Replicate 1.

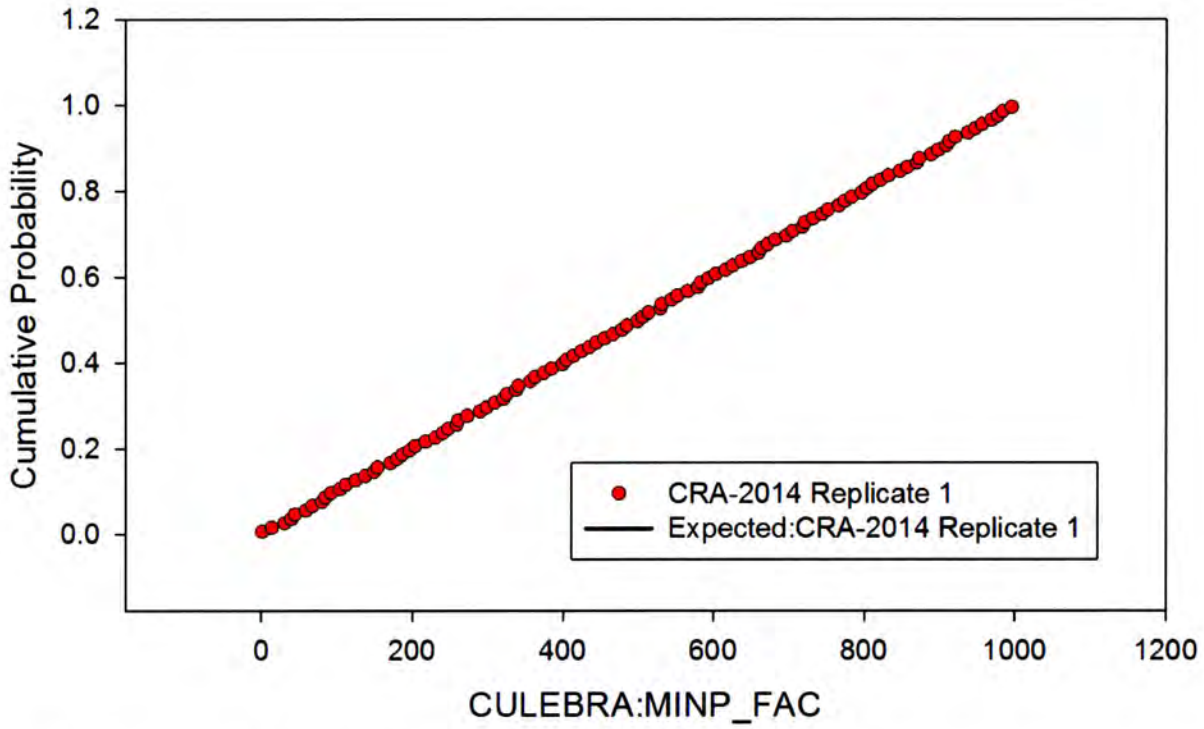

Figure 13. Observed and Expected CDFs for CULEBRA:MINP_FAC (Uniform Distribution) Replicate 1.

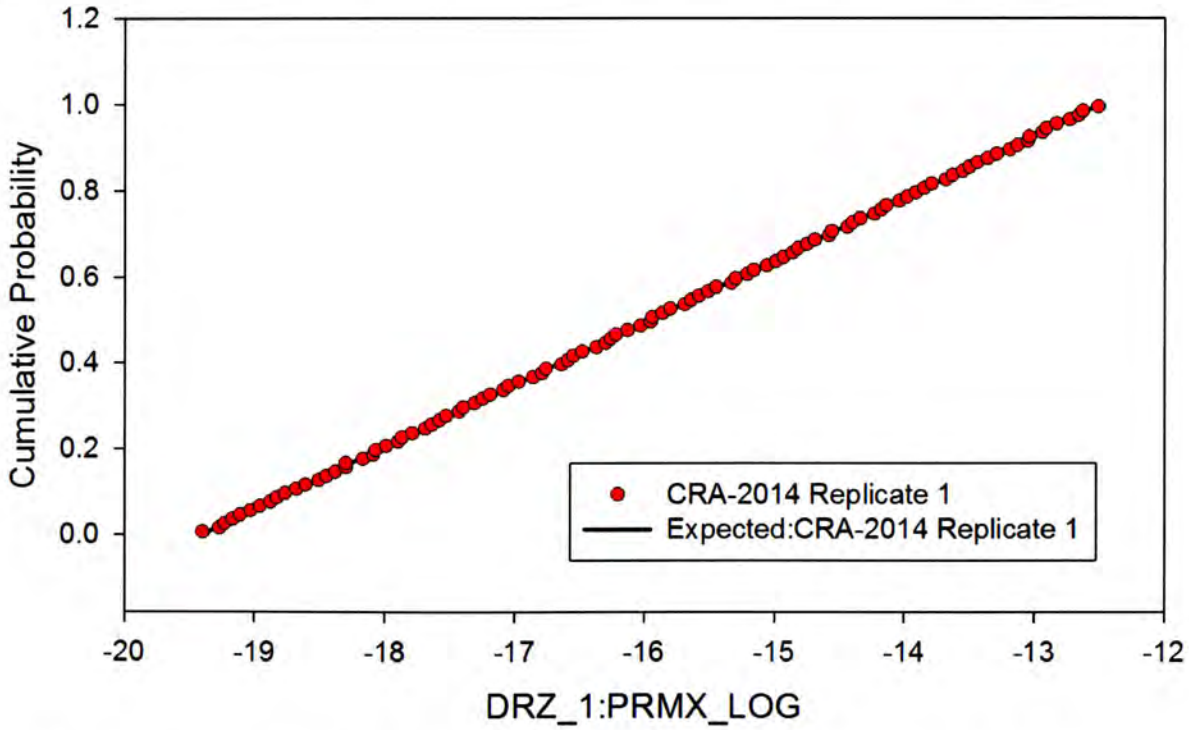

Figure 14. Observed and Expected CDFs for DRZ_1:PRMX_LOG (Uniform Distribution) Replicate 1.

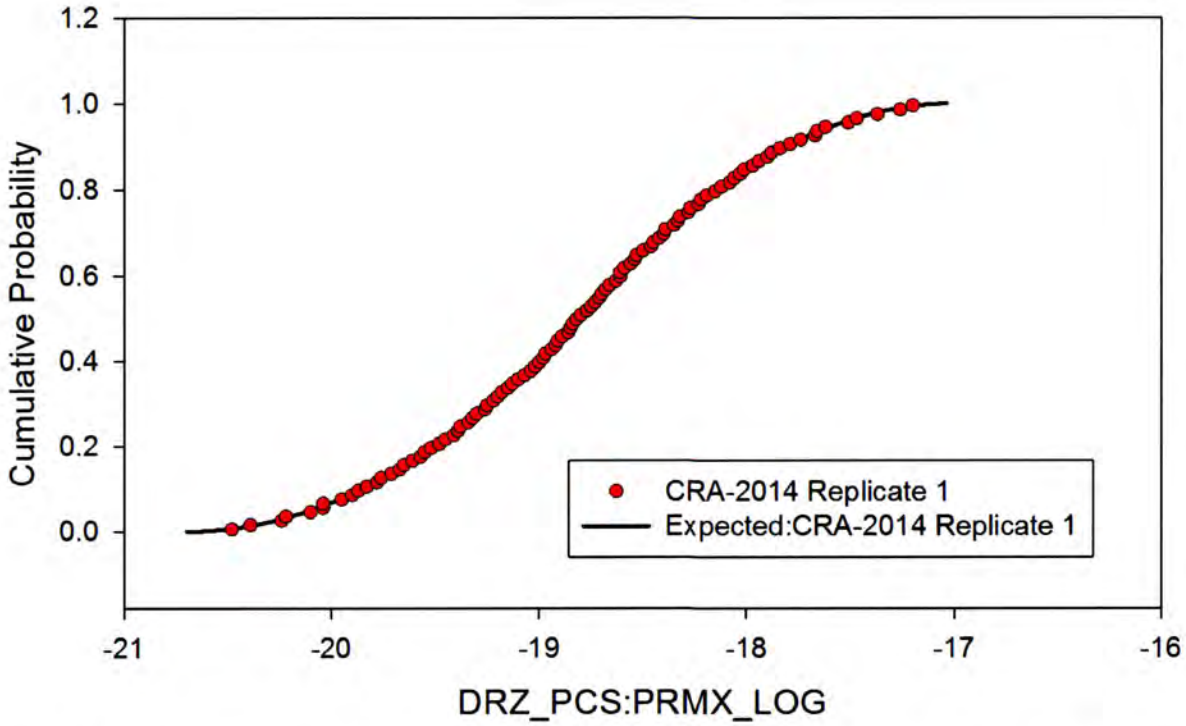

Figure 15. Observed and Expected CDFs for DRZ_PCS:PRMX_LOG (Triangular Distribution) Replicate 1.

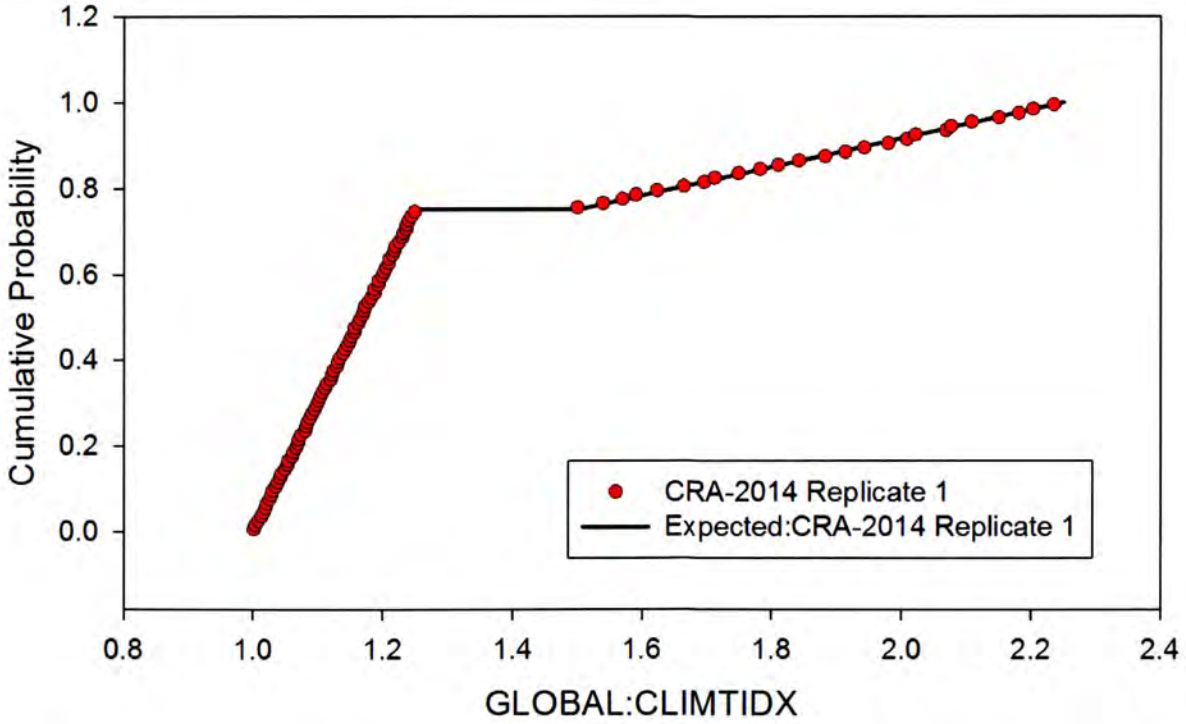

Figure 16. Observed and Expected CDFs for GLOBAL:CLIMTIDX (User Continuous Distribution) Replicate 1.

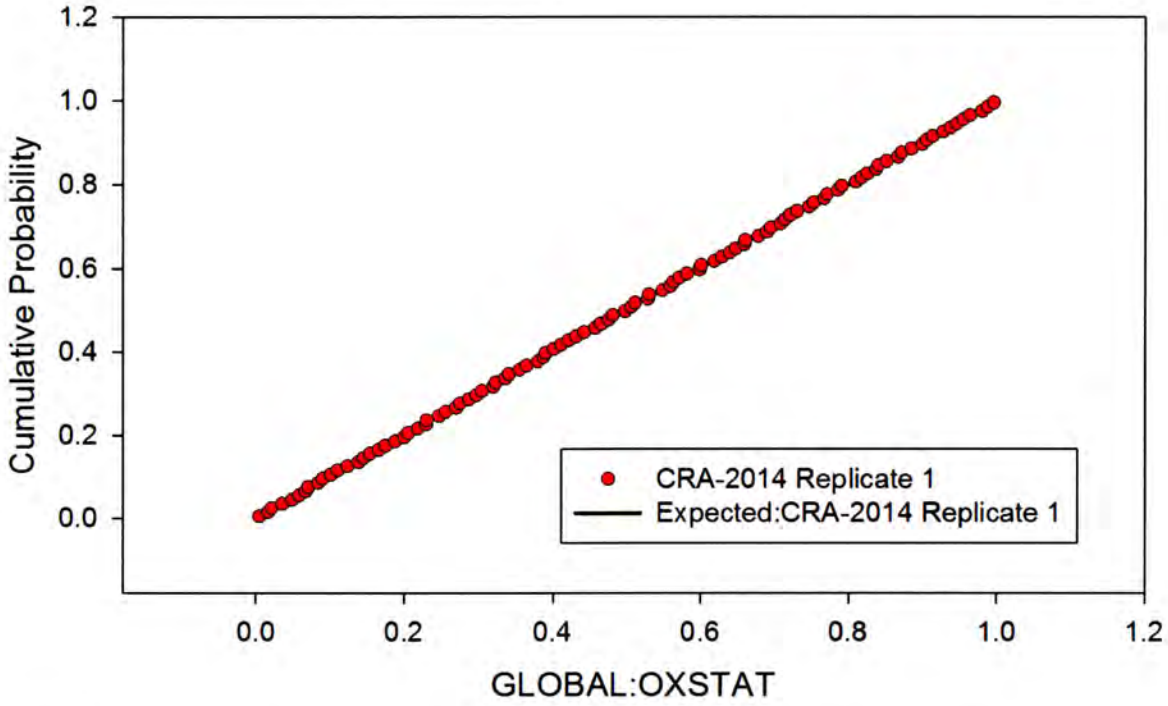

Figure 17. Observed and Expected CDFs for GLOBAL:OXSTAT (Uniform Distribution) Replicate 1.

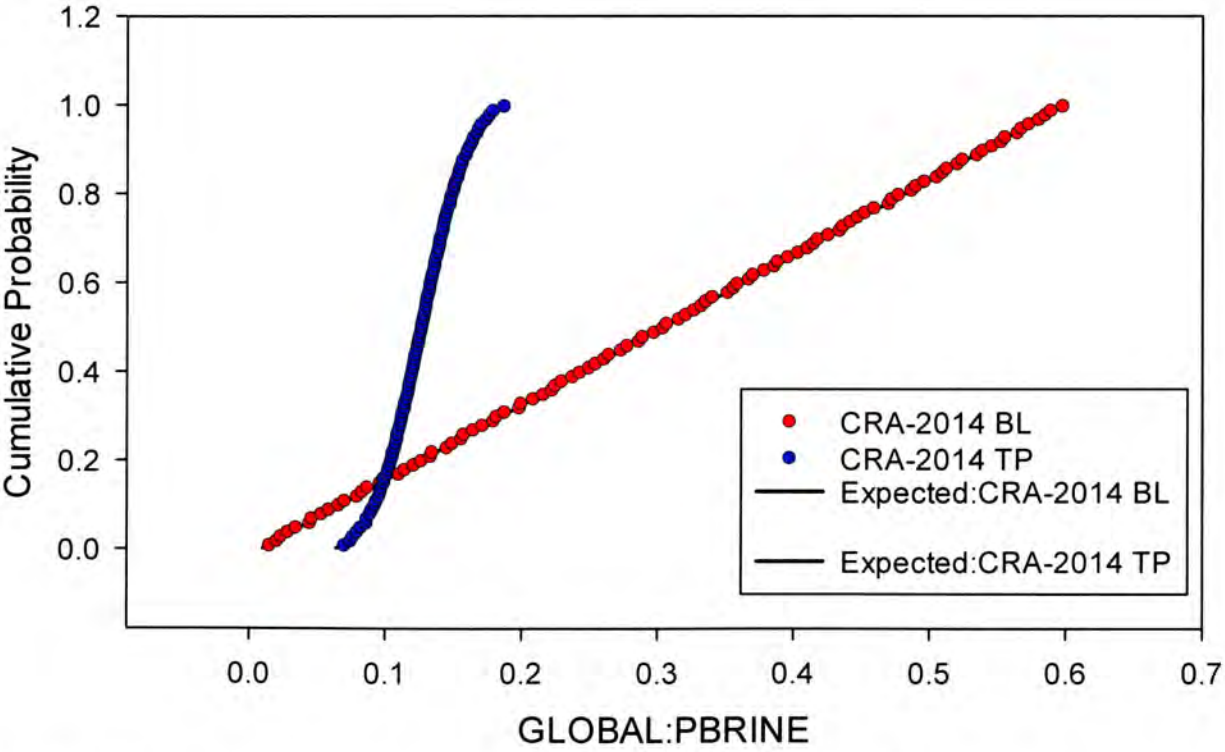

Figure 18. Observed Distribution for GLOBAL:PBRINE Replicate 1, case BL (Uniform Distribution) and TP (Normal Distribution).

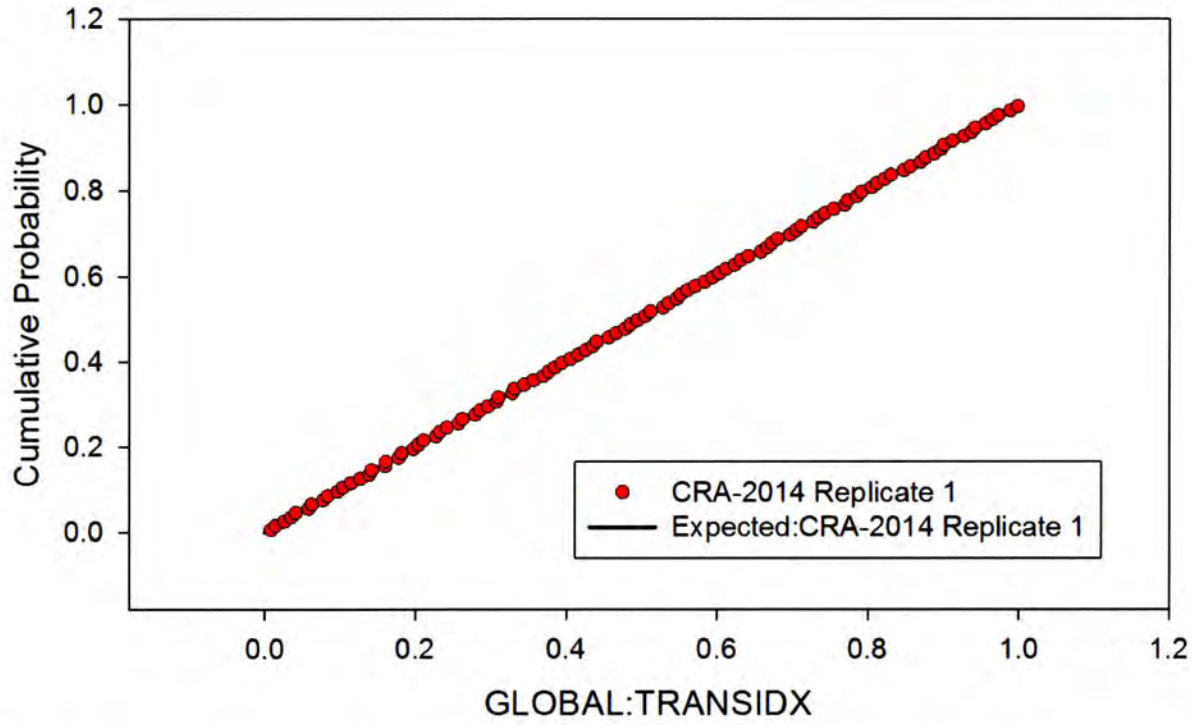

Figure 19. Observed and Expected CDFs for GLOBAL:TRANSIDX (Uniform Distribution) Replicate 1.

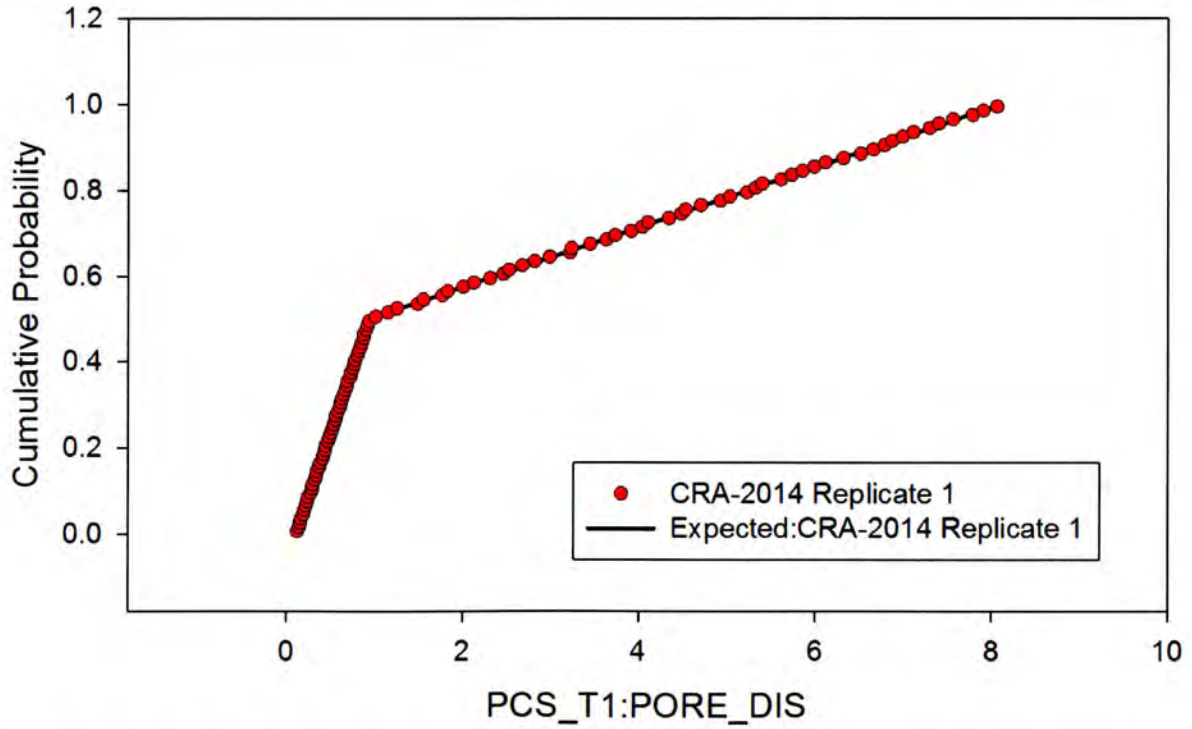

Figure 20. Observed and Expected CDFs for PCS_T1:PORE_DIS (User Continuous Distribution) Replicate 1.

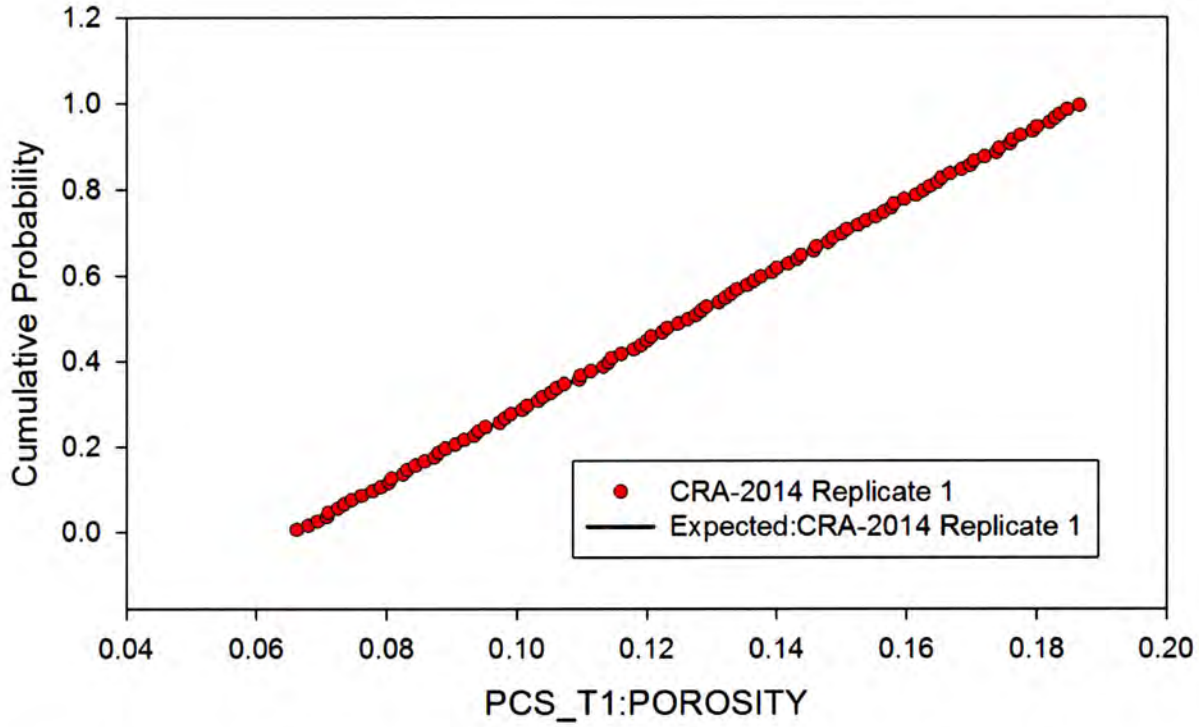

Figure 21. Observed and Expected CDFs for PCS_T1:POROSITY (Uniform Distribution) Replicate 1.

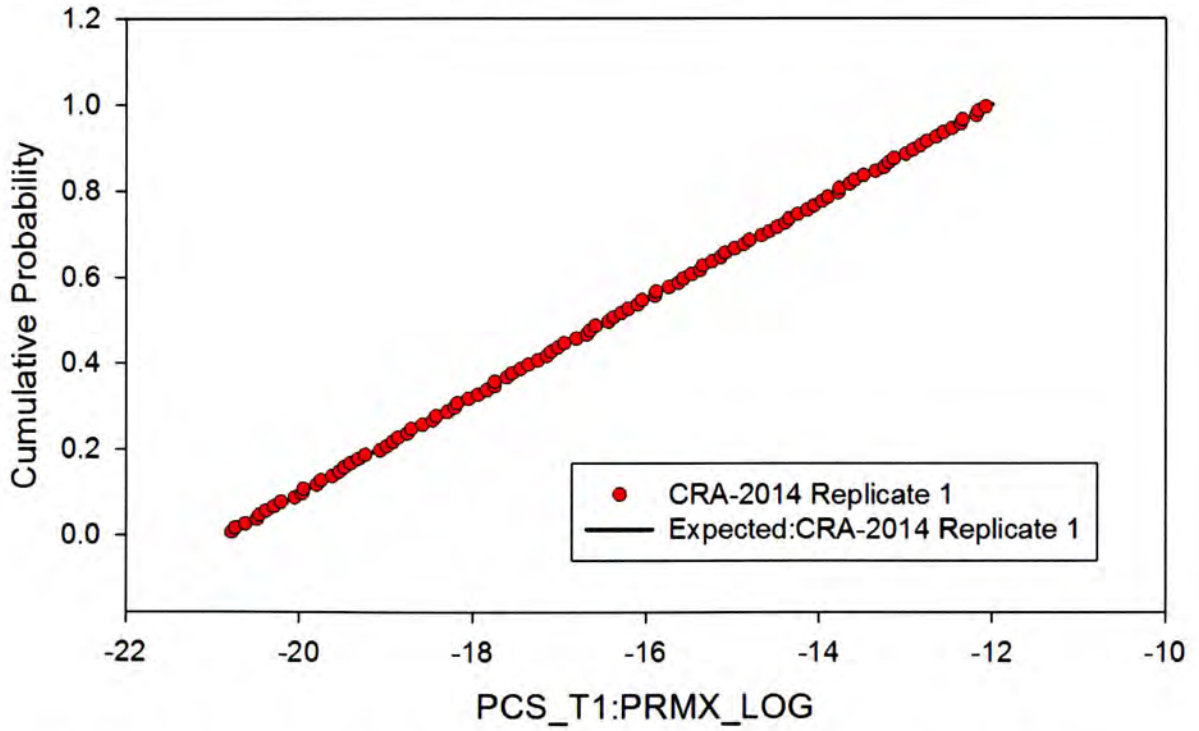

Figure 22. Observed and Expected CDFs for PCS_T1:PRMX_LOG (Uniform Distribution) Replicate 1.

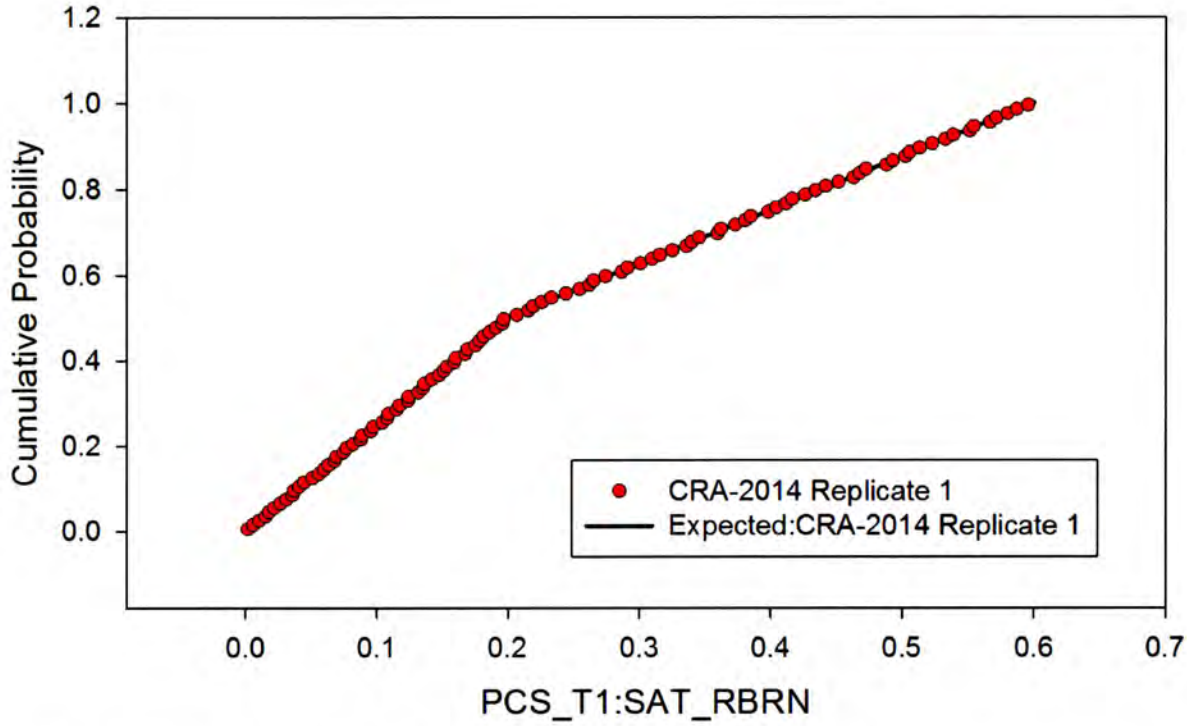

Figure 23. Observed and Expected CDFs for PCS_T1:SAT_RBRN (User Continuous Distribution) Replicate 1.

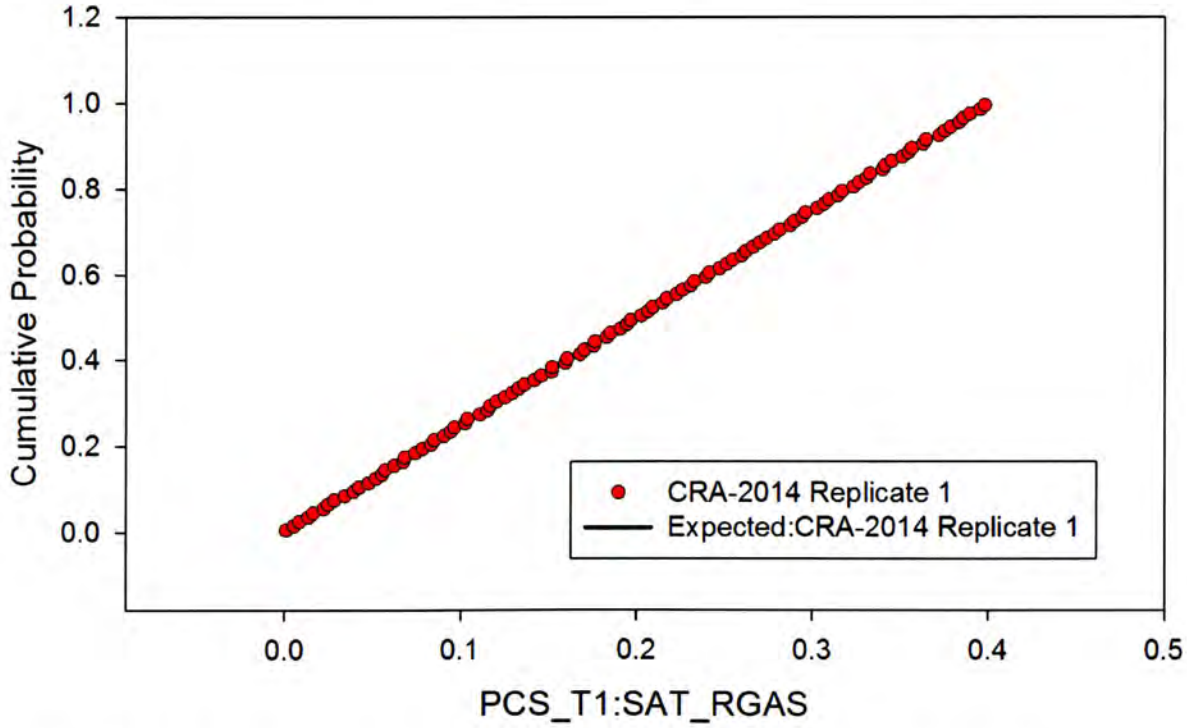

Figure 24. Observed and Expected CDFs for PCS_T1:SAT_RGAS (Uniform Distribution) Replicate 1.

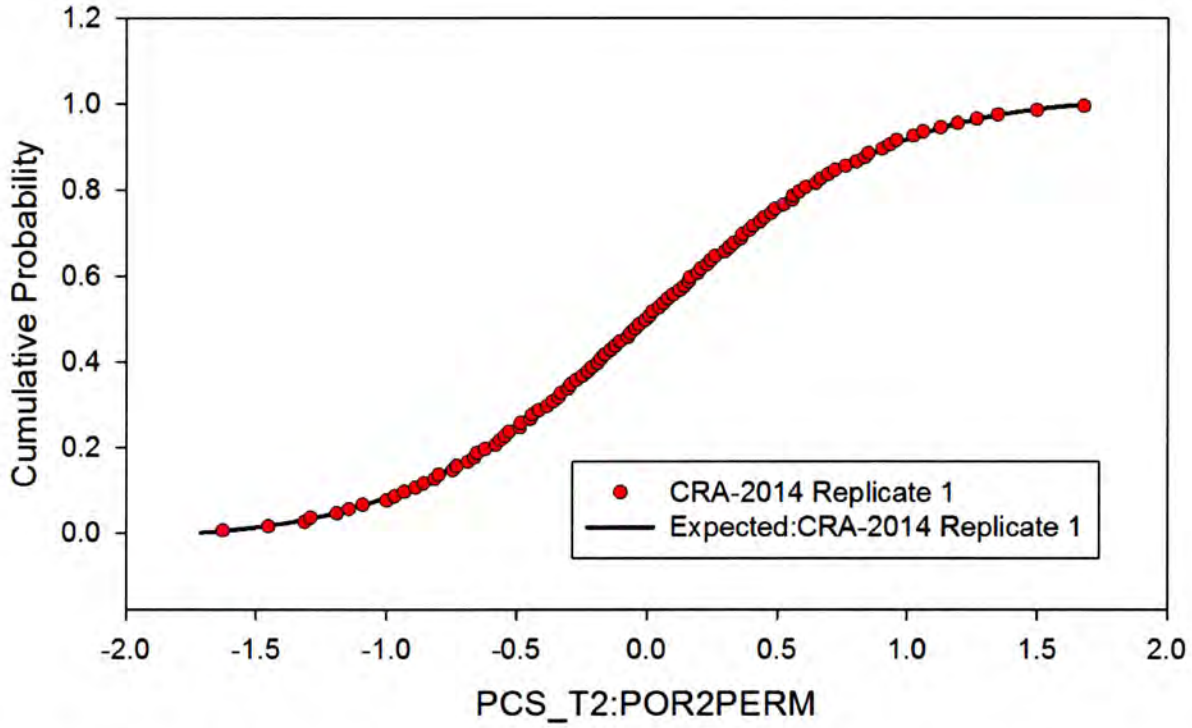

Figure 25. Observed and Expected CDFs for PCS_T2:POR2PERM (Normal Distribution) Replicate 1.

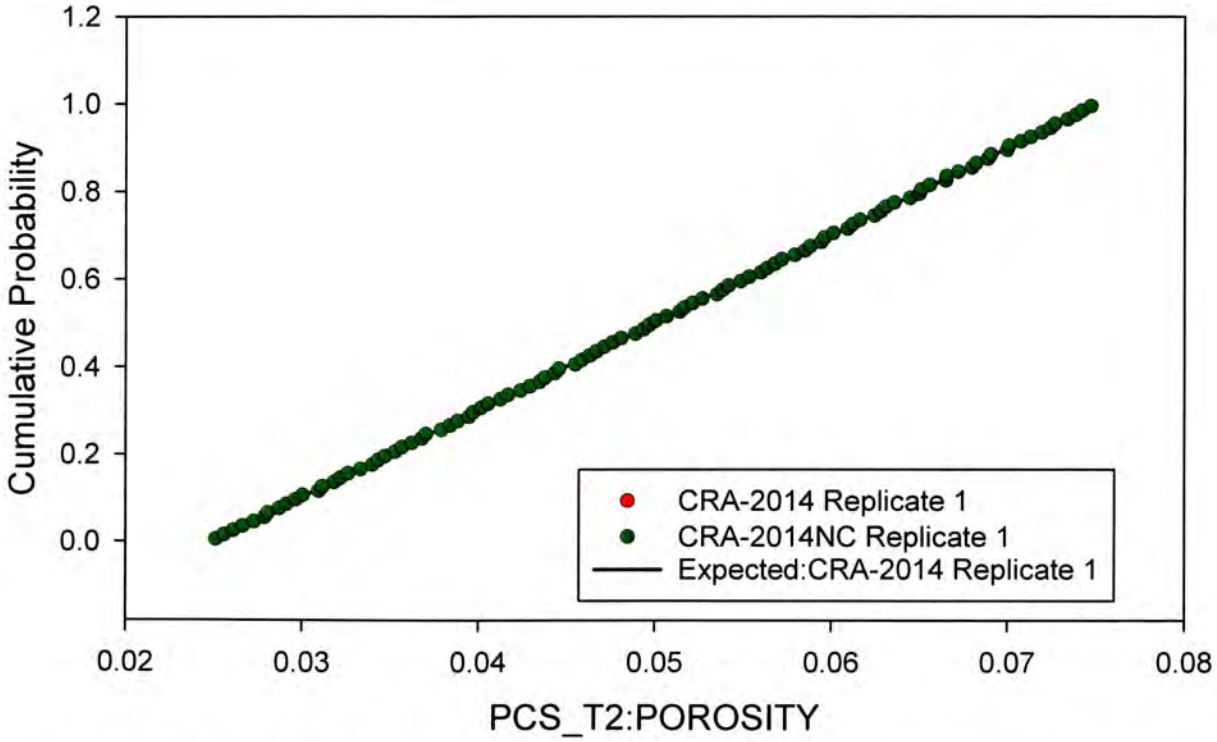

Figure 26. Observed and Expected CDFs for PCS_T2:POROSITY (Uniform Distribution) Replicate 1 also showing the data prior to conditioning (NC).

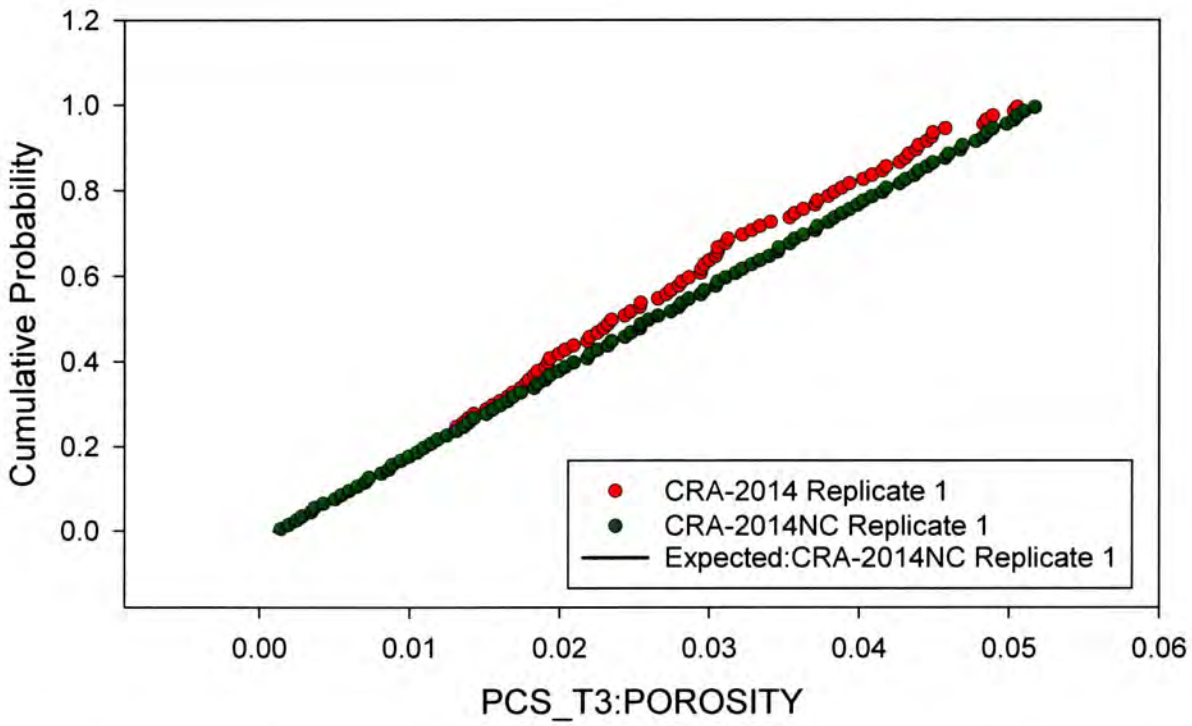

Figure 27. Observed and Expected CDFs for PCS_T3:POROSITY (Uniform Distribution) Replicate 1 also showing the data prior to conditioning (NC).

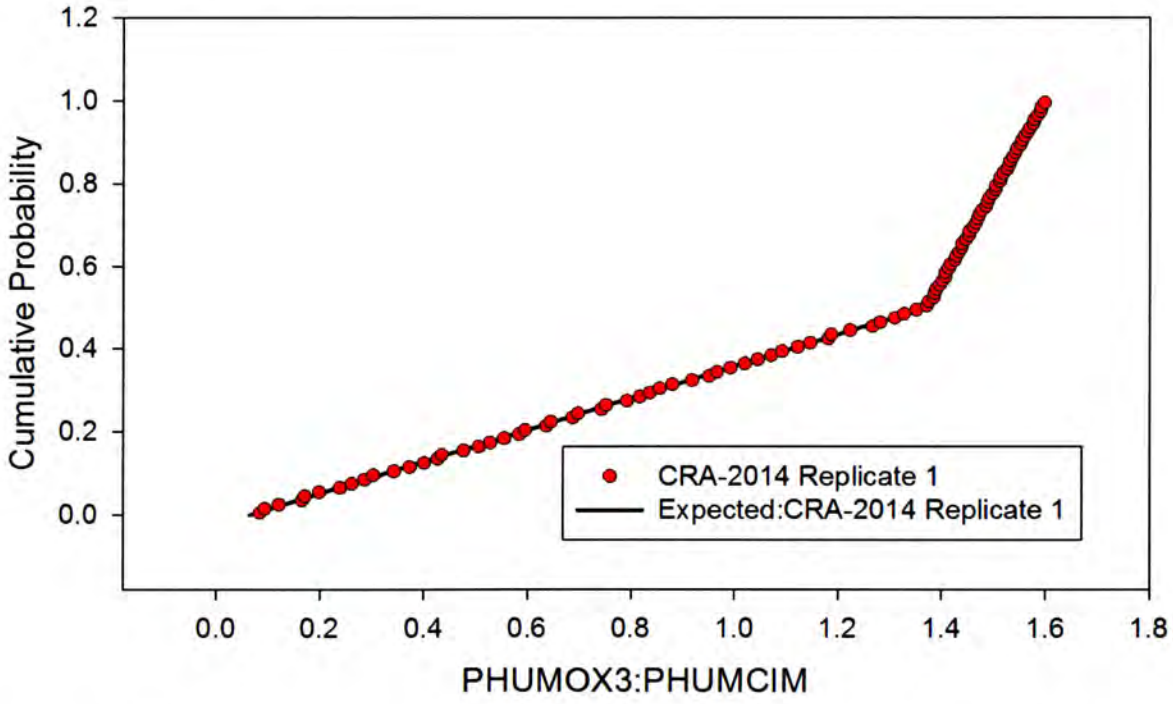

Figure 28. Observed and Expected CDFs for PHUMOX3:PHUMCIM (User Continuous Distribution) Replicate 1.

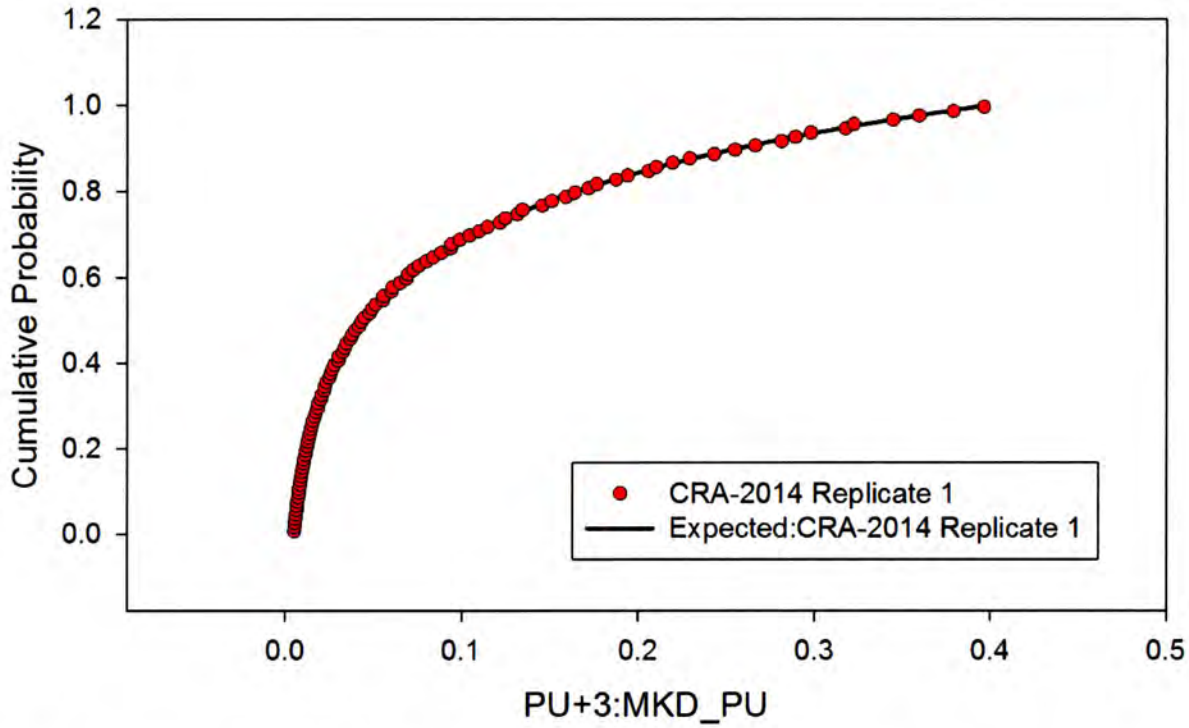

Figure 29. Observed and Expected CDFs for PU+3:MKD_PU (Loguniform Distribution) Replicate 1.

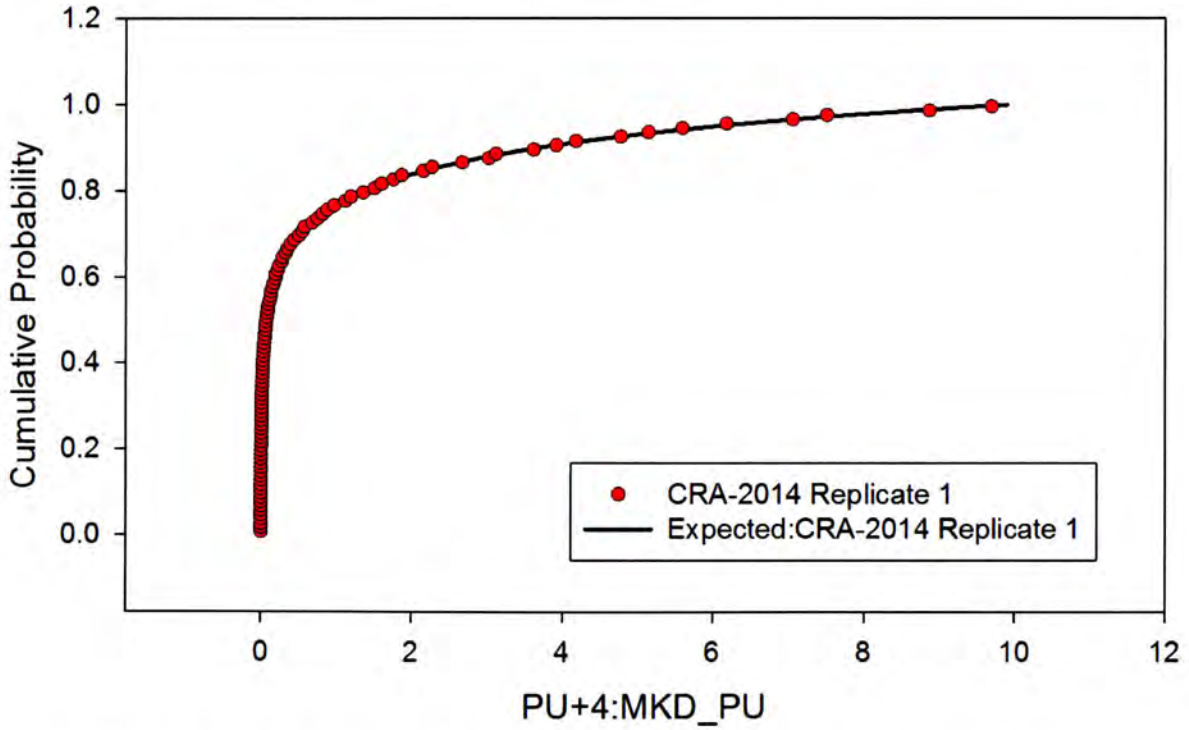

Figure 30. Observed and Expected CDFs for PU+4:MKD_PU (Loguniform Distribution) Replicate 1.

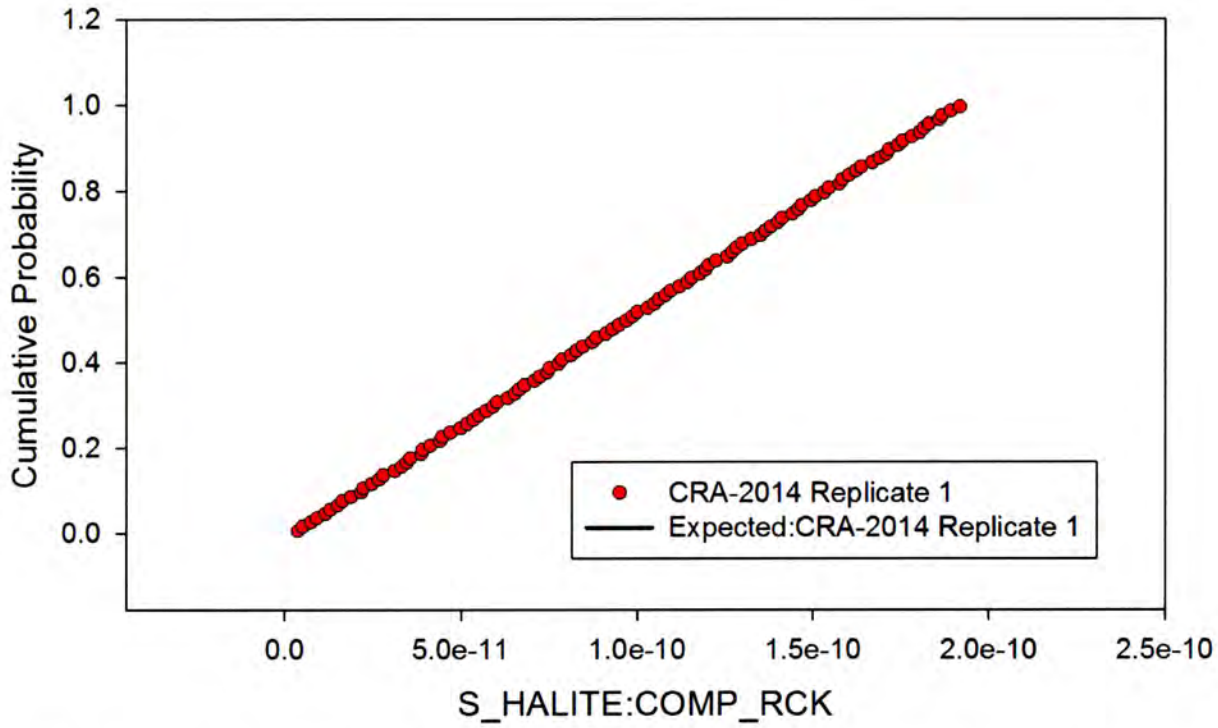

Figure 31. Observed and Expected CDFs for S_HALITE:COMP_RCK (Uniform Distribution) Replicate 1.

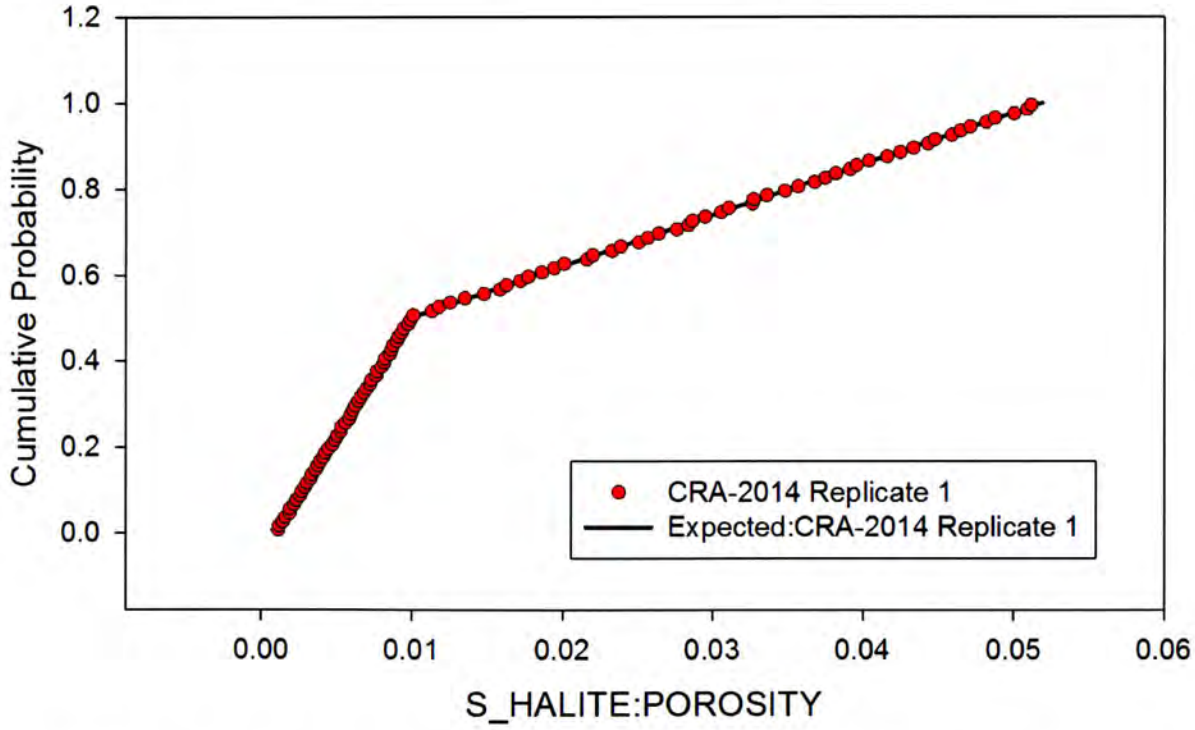

Figure 32. Observed and Expected CDFs for S_HALITE:POROSITY (User Continuous Distribution) Replicate 1.

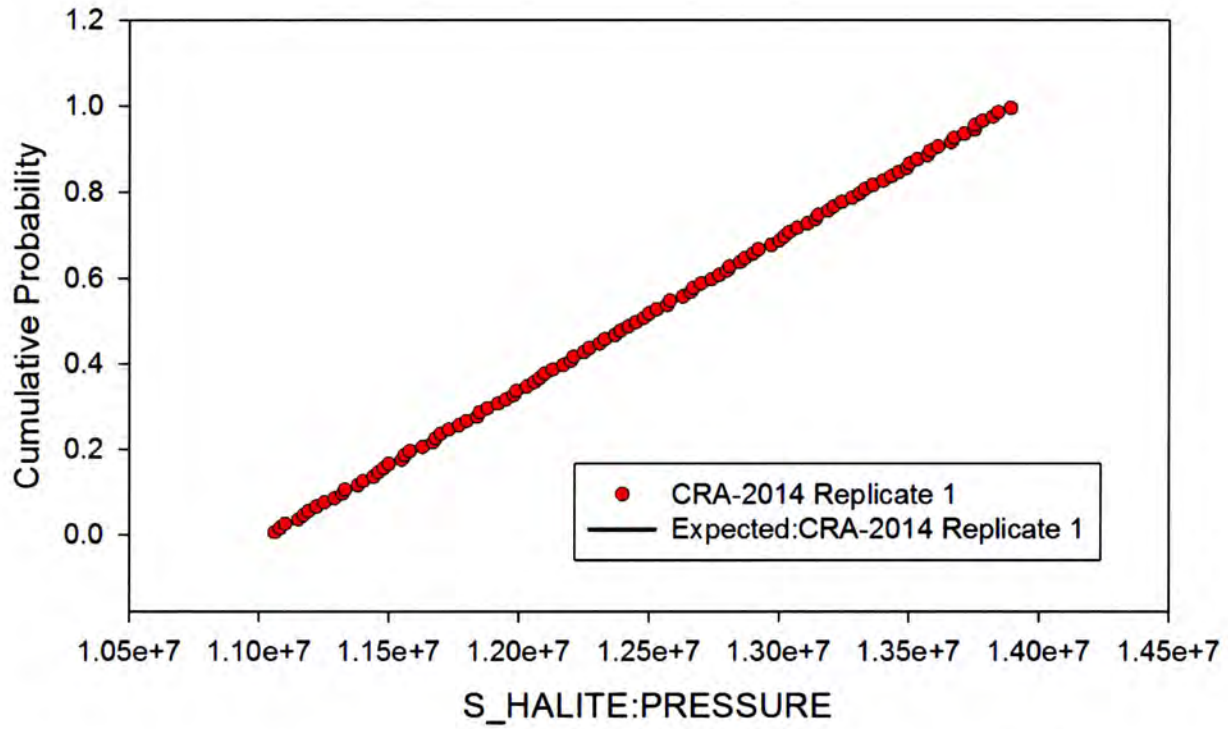

Figure 33. Observed and Expected CDFs for S_HALITE:PRESSURE (Uniform Distribution) Replicate 1.

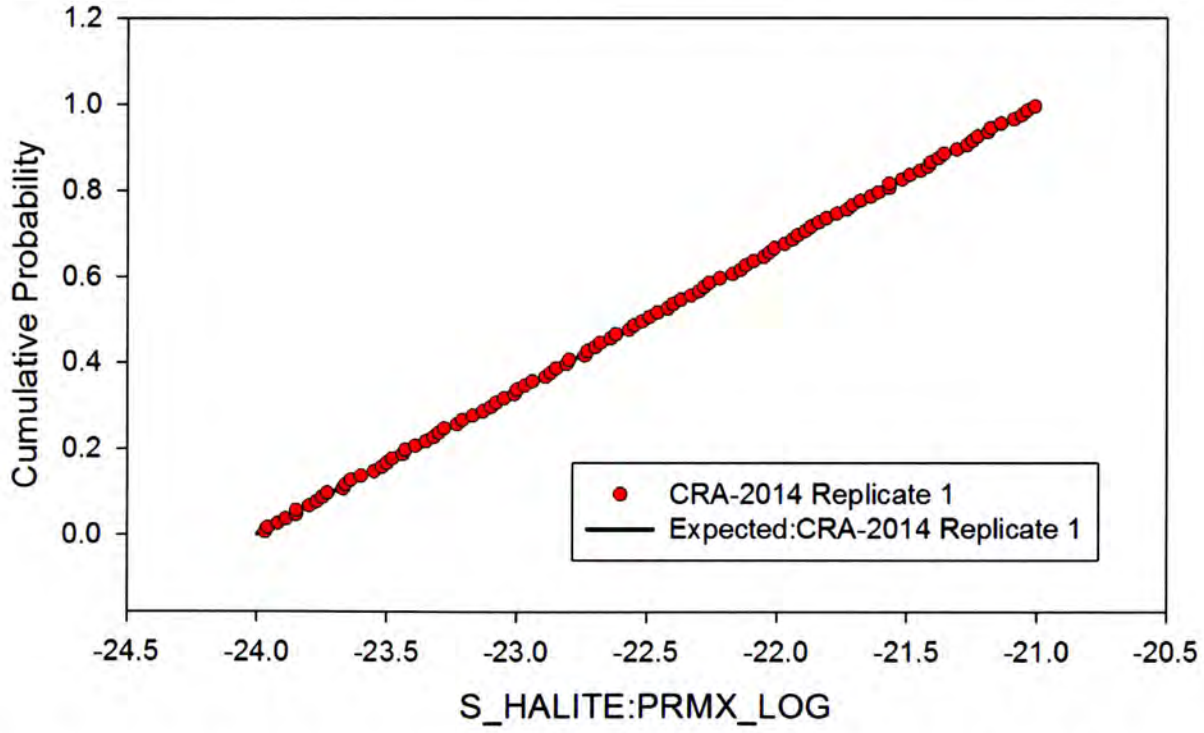

Figure 34. Observed and Expected CDFs for S_HALITE:PRMX_LOG (Uniform Distribution) Replicate 1.

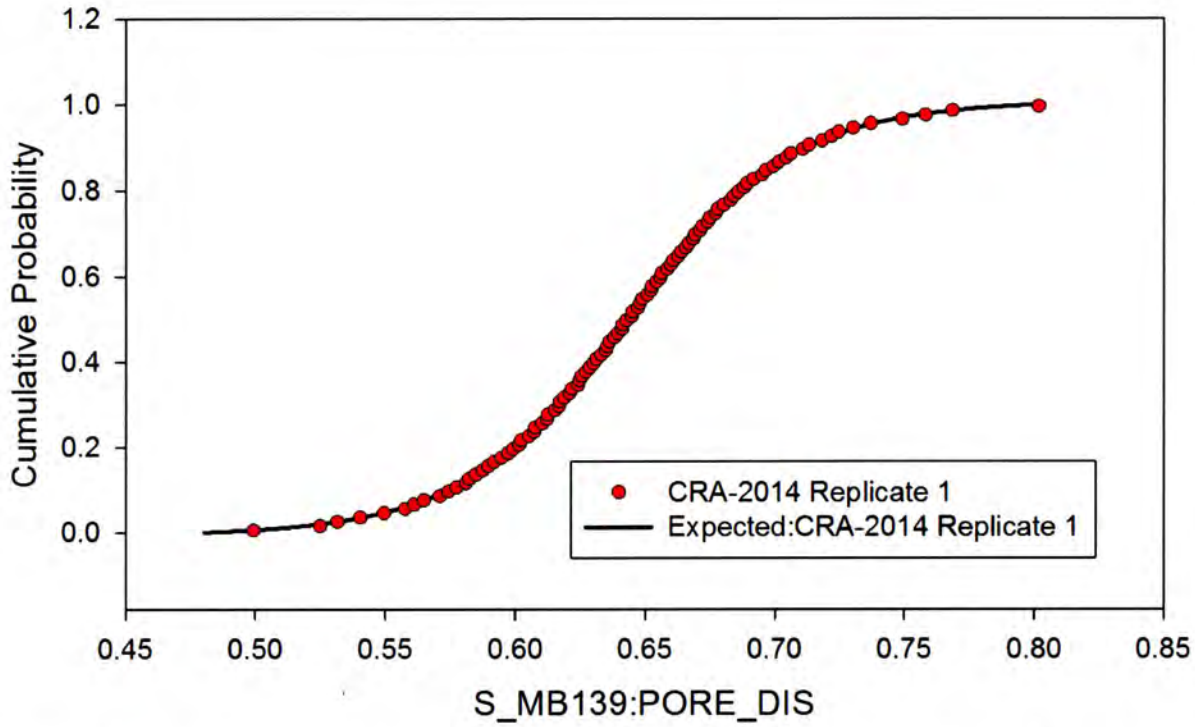

Figure 35. Observed and Expected CDFs for S_MB139:PORE_DIS (Student Distribution) Replicate 1.

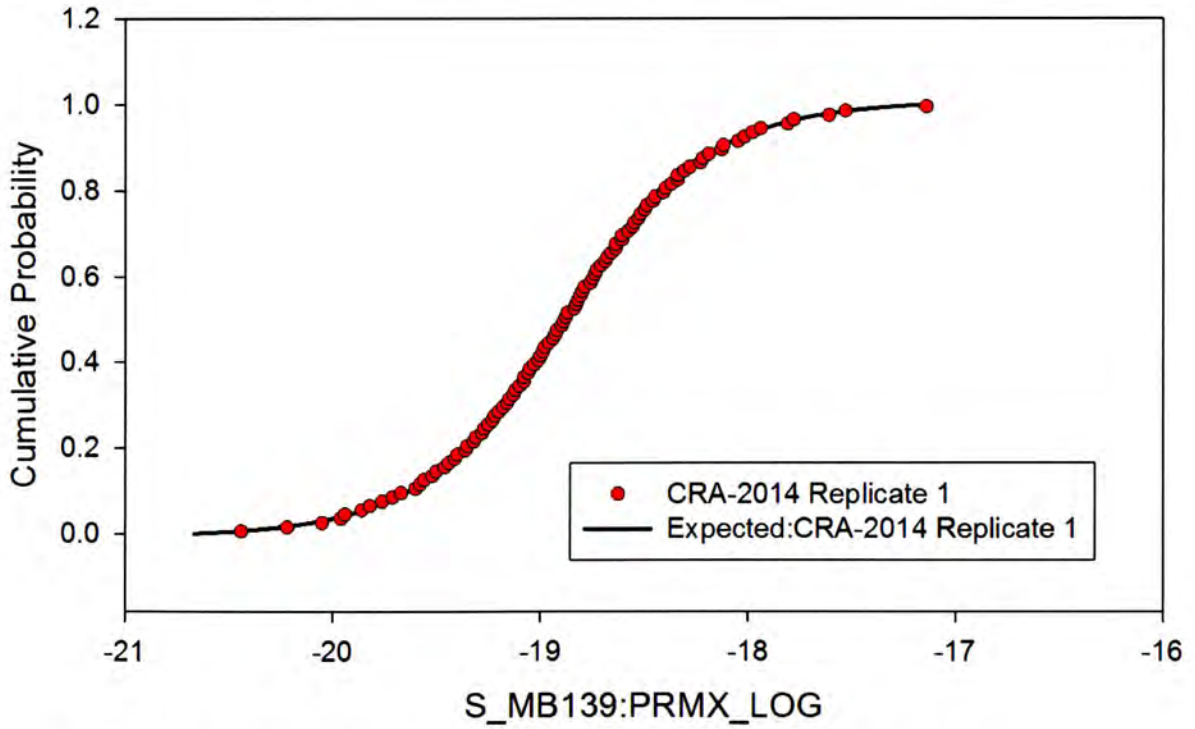

Figure 36. Observed and Expected CDFs for S_MB139:PRMX_LOG (Student Distribution) Replicate 1.

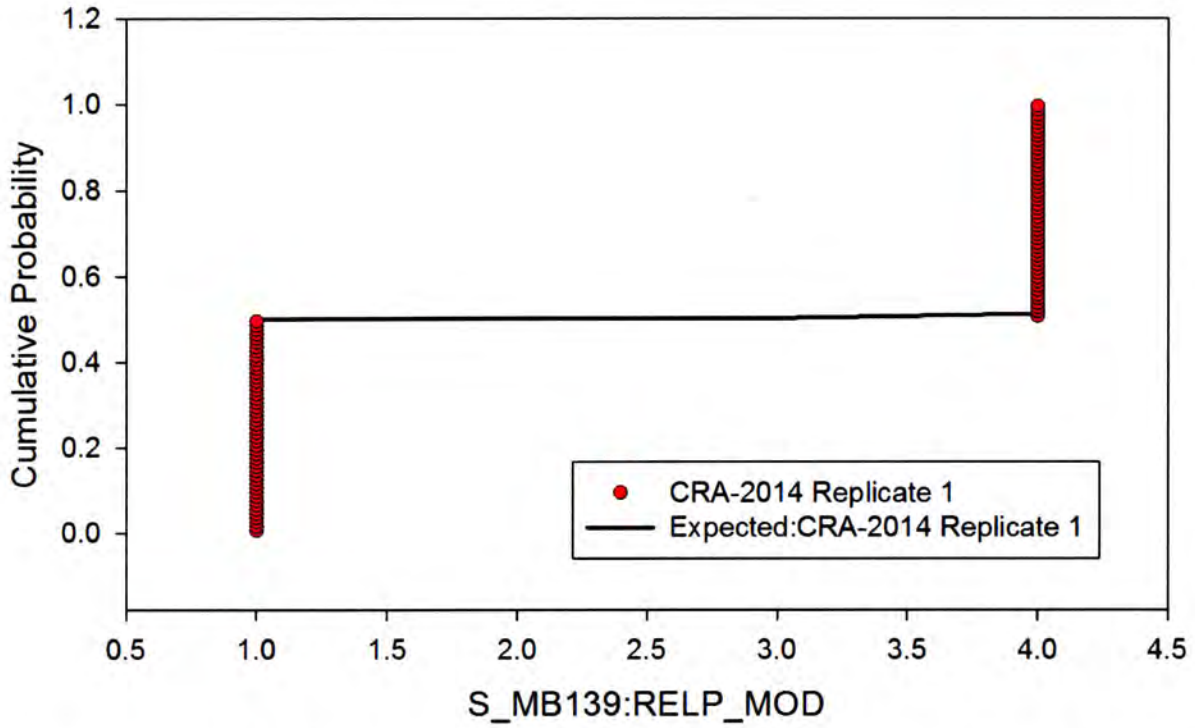

Figure 37. Observed and Expected CDFs for S_MB139:RELP_MOD (User Discrete (Delta) Distribution) Replicate 1.

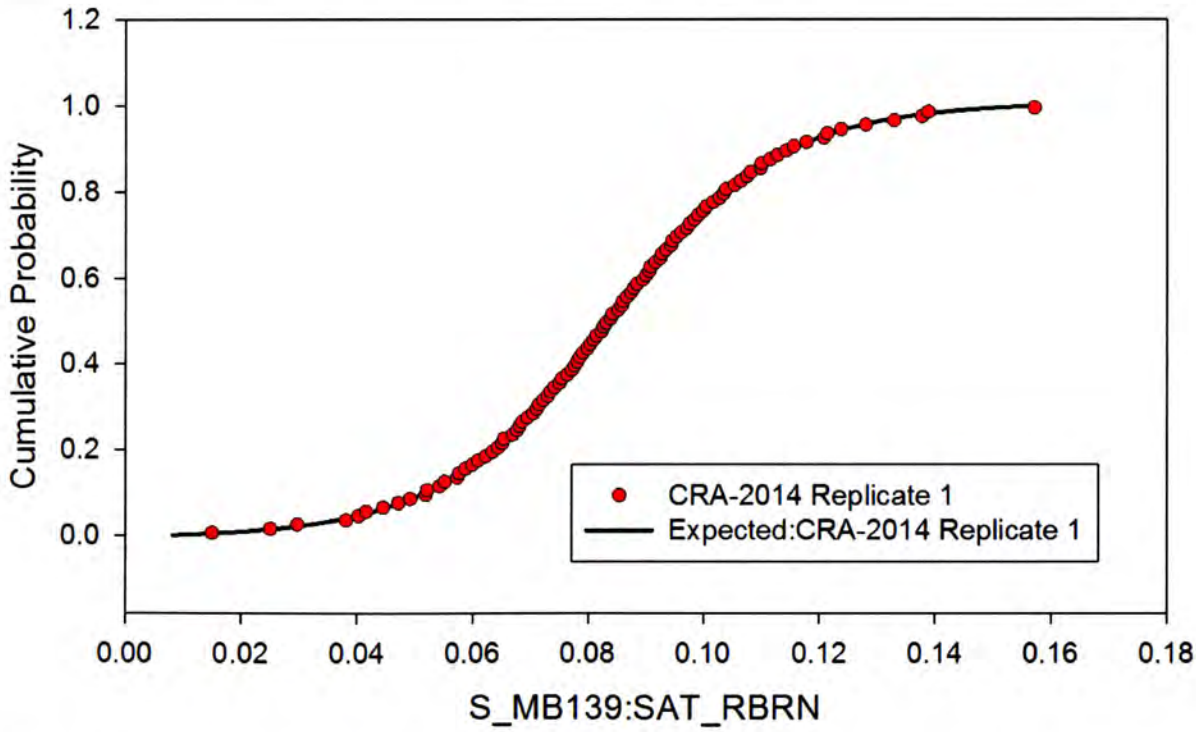

Figure 38. Observed and Expected CDFs for S_MB139:SAT_RBRN (Student Distribution) Replicate 1.

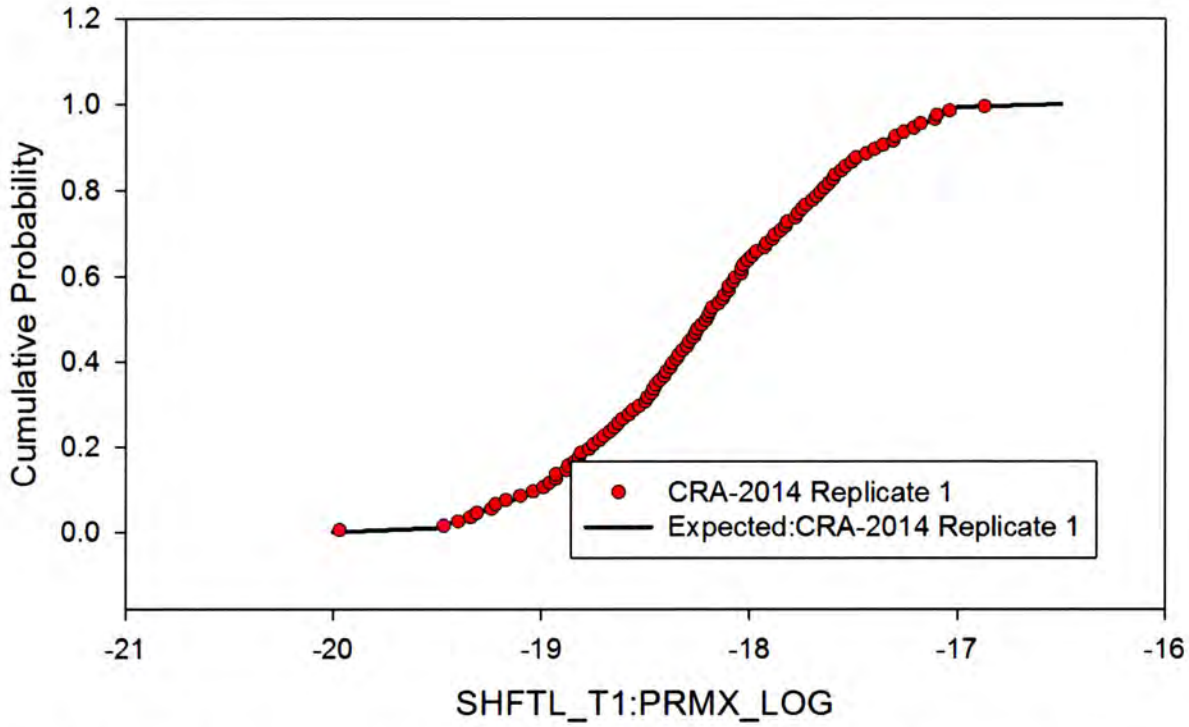

Figure 39. Observed and Expected CDFs for SHFTL_T1:PRMX_LOG (User Continuous Distribution) Replicate 1.

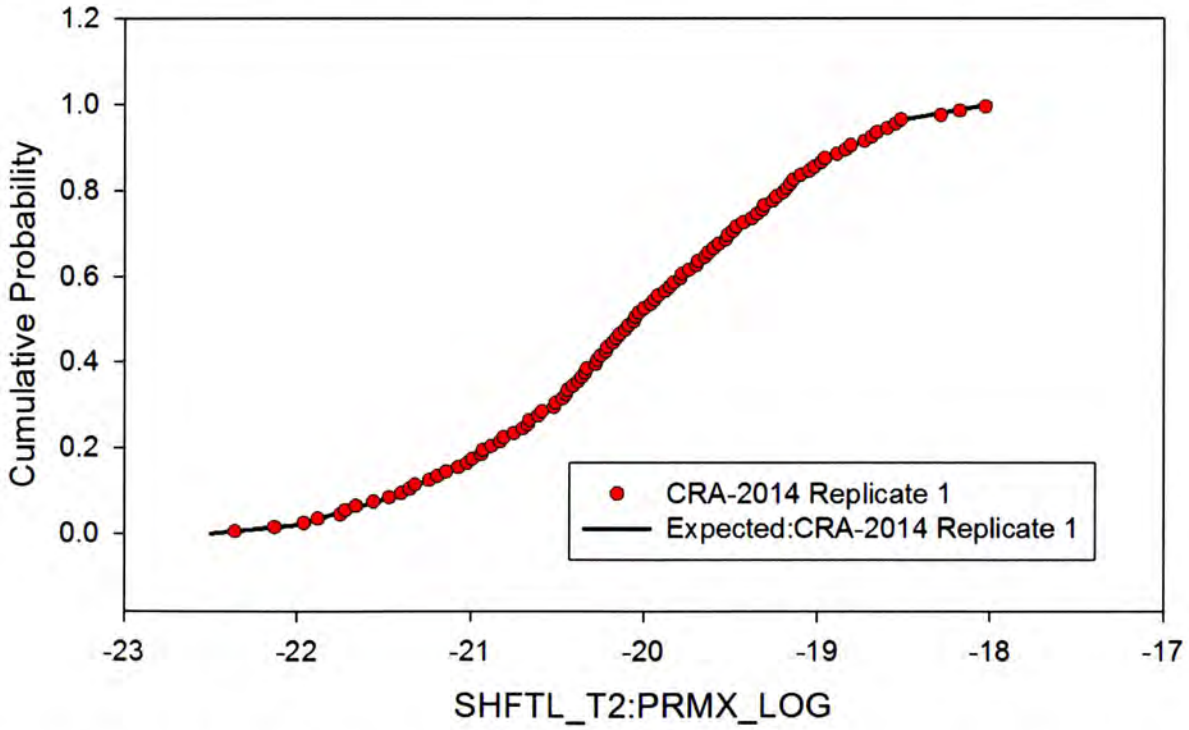

Figure 40. Observed and Expected CDFs for SHFTL_T2:PRMX_LOG (User Continuous Distribution) Replicate 1.

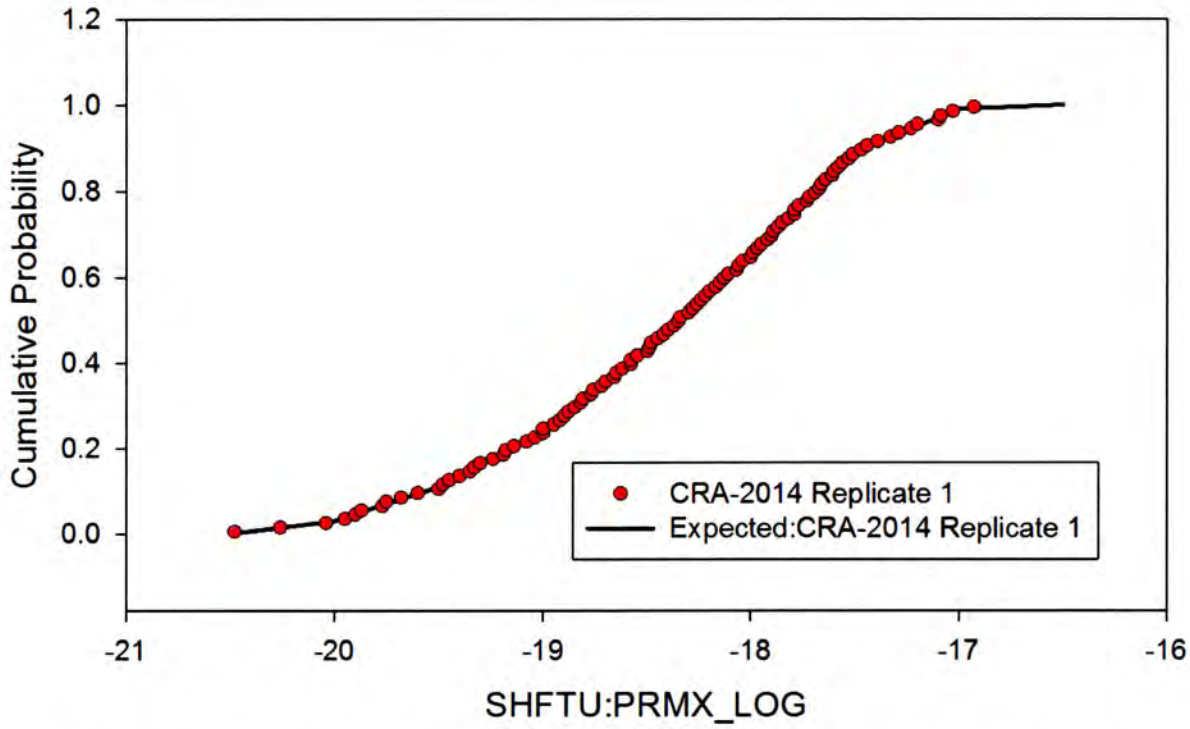

Figure 41. Observed and Expected CDFs for SHFTU:PRMX_LOG (User Continuous Distribution) Replicate 1.

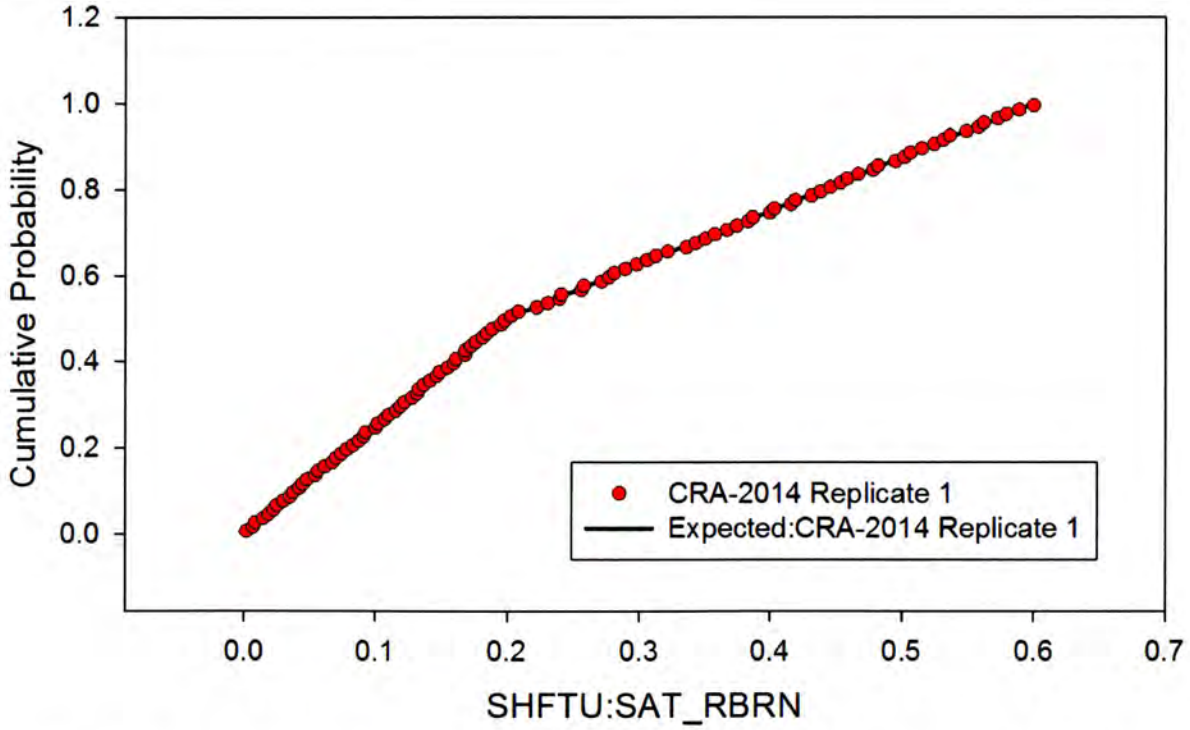

Figure 42. Observed and Expected CDFs for SHFTU:SAT_RBRN (User Continuous Distribution) Replicate 1.

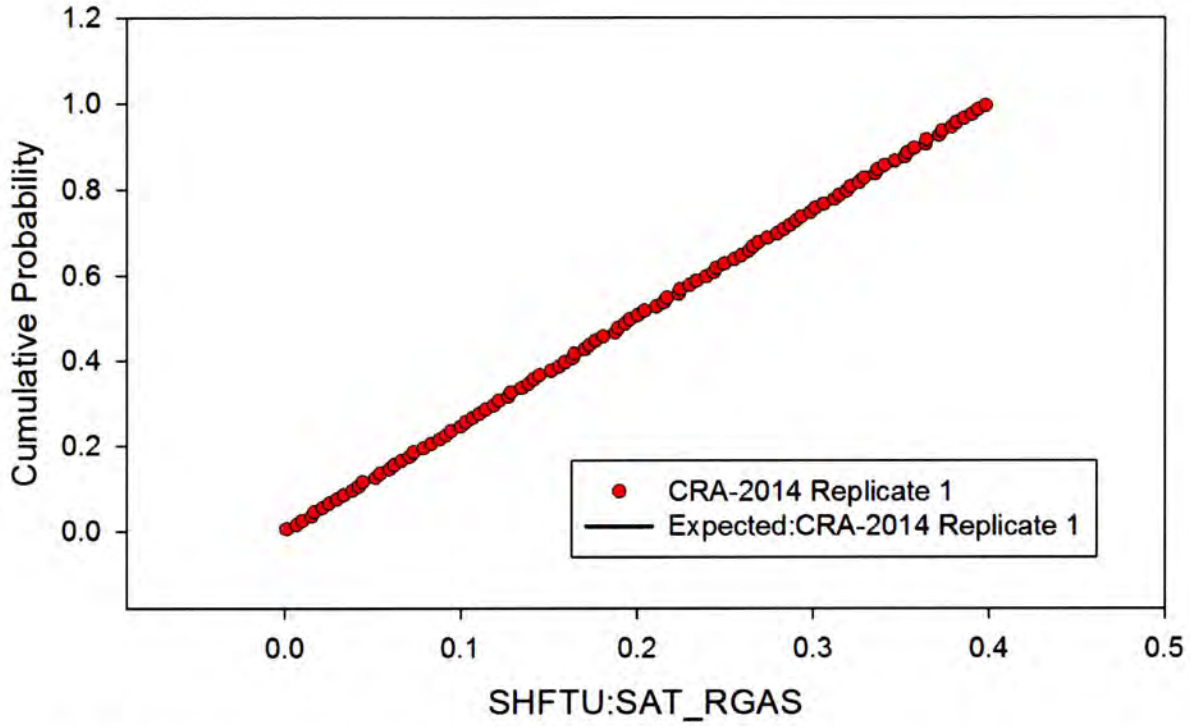

Figure 43. Observed and Expected CDFs for SHFTU:SAT_RGAS (Uniform Distribution) Replicate 1.

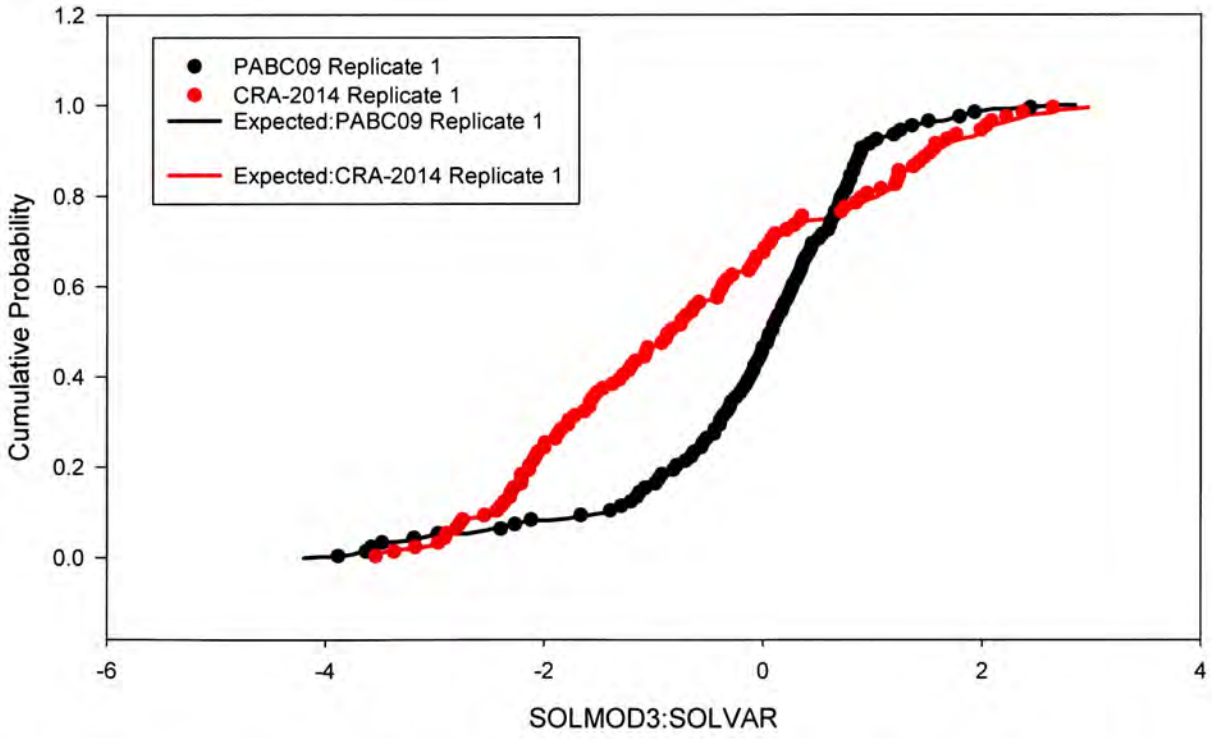

Figure 44. Observed and Expected CDFs for SOLMOD3:SOLVAR (User Continuous Distribution) Replicate 1.

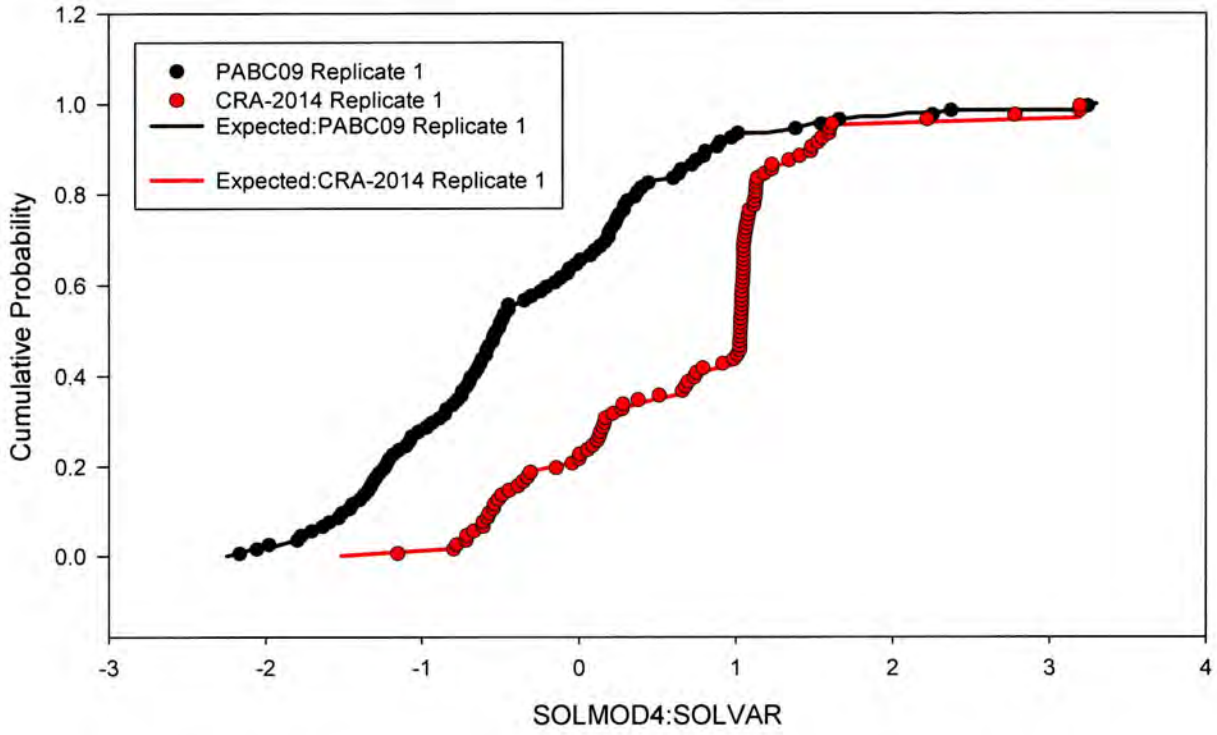

Figure 45. Observed and Expected CDFs for SOLMOD4:SOLVAR (User Continuous Distribution) Replicate 1 for PABC09 and CRA-2014.

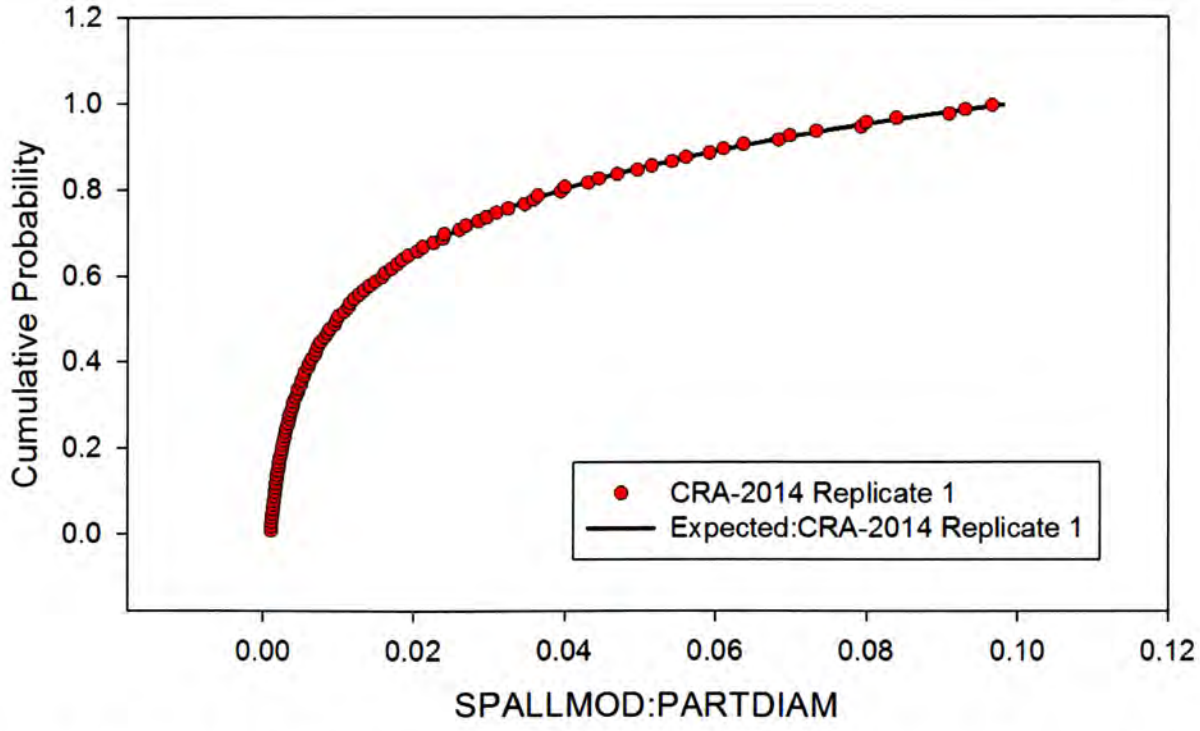

Figure 46. Observed and Expected CDFs for SPALLMOD:PARTDIAM (Loguniform Distribution) Replicate 1.

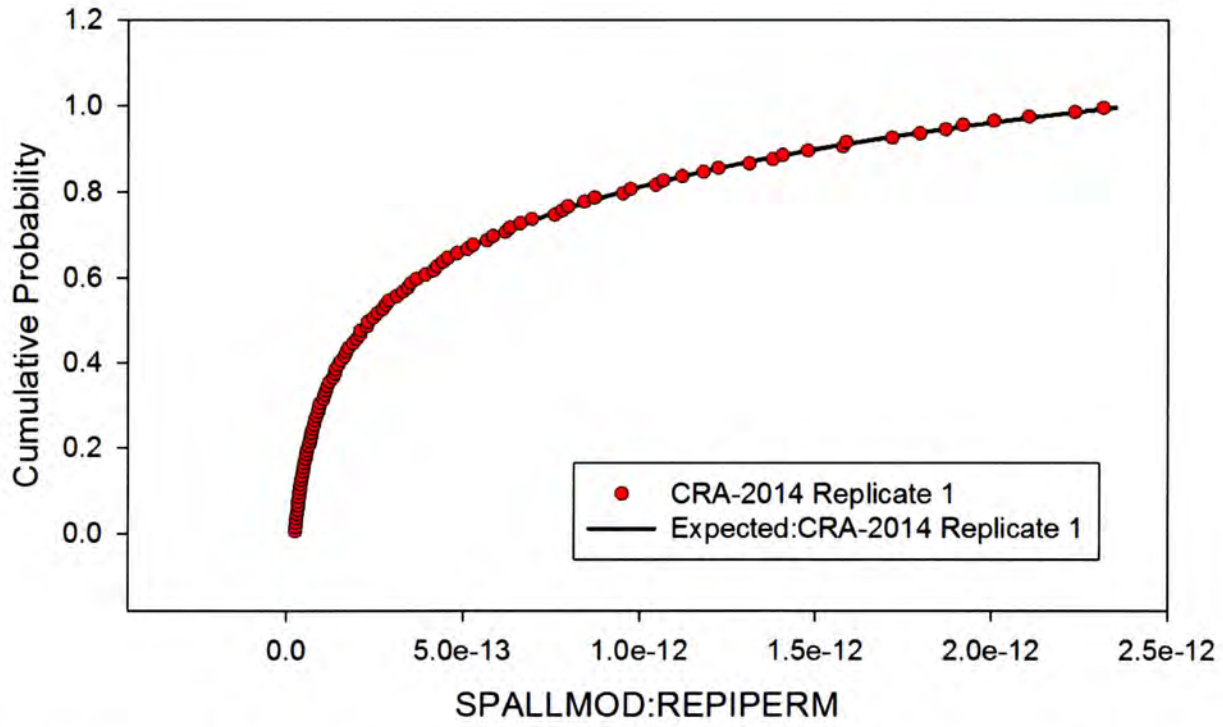

Figure 47. Observed and Expected CDFs for SPALLMOD:REPIPERM (Loguniform Distribution) Replicate 1.

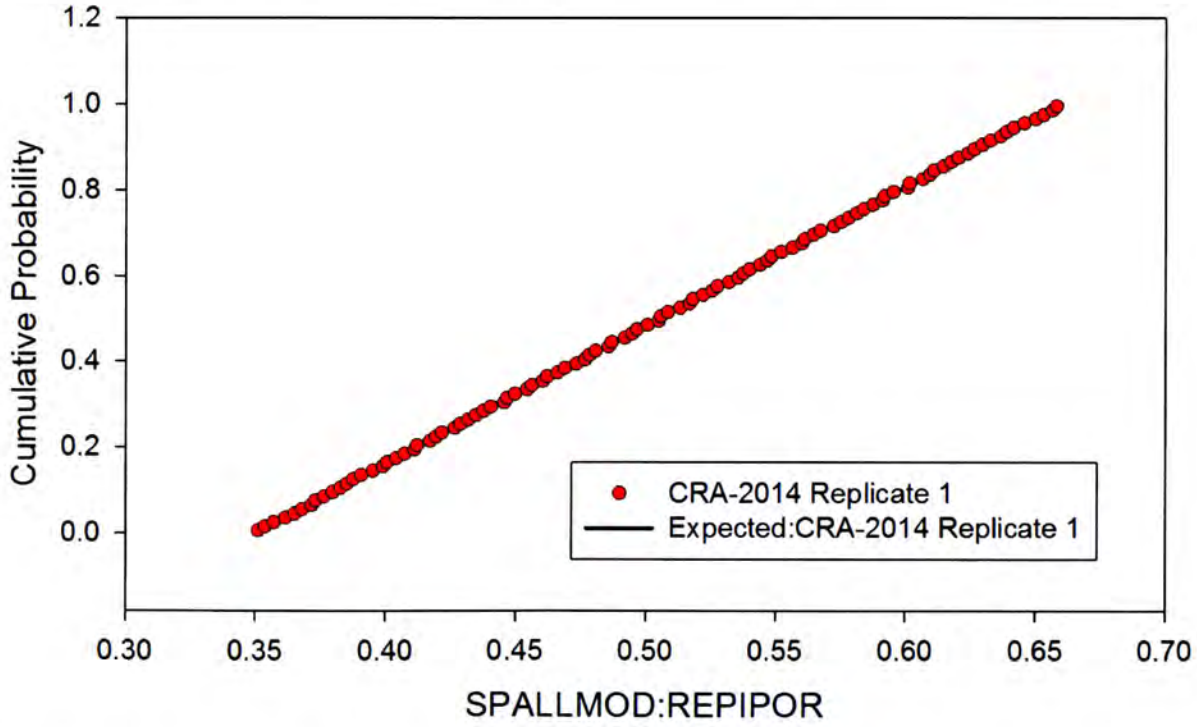

Figure 48. Observed and Expected CDFs for SPALLMOD:REPIPOR (Uniform Distribution) Replicate 1.

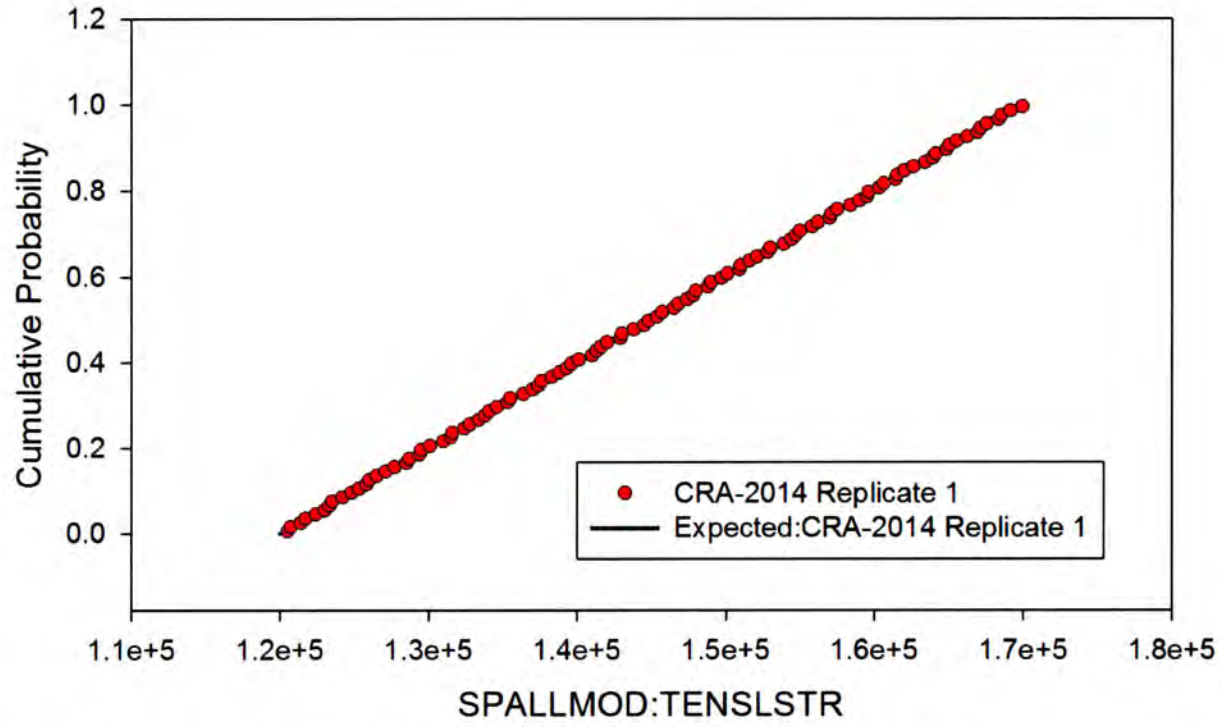

Figure 49. Observed and Expected CDFs for SPALLMOD:TENSLSTR (Uniform Distribution) Replicate 1.

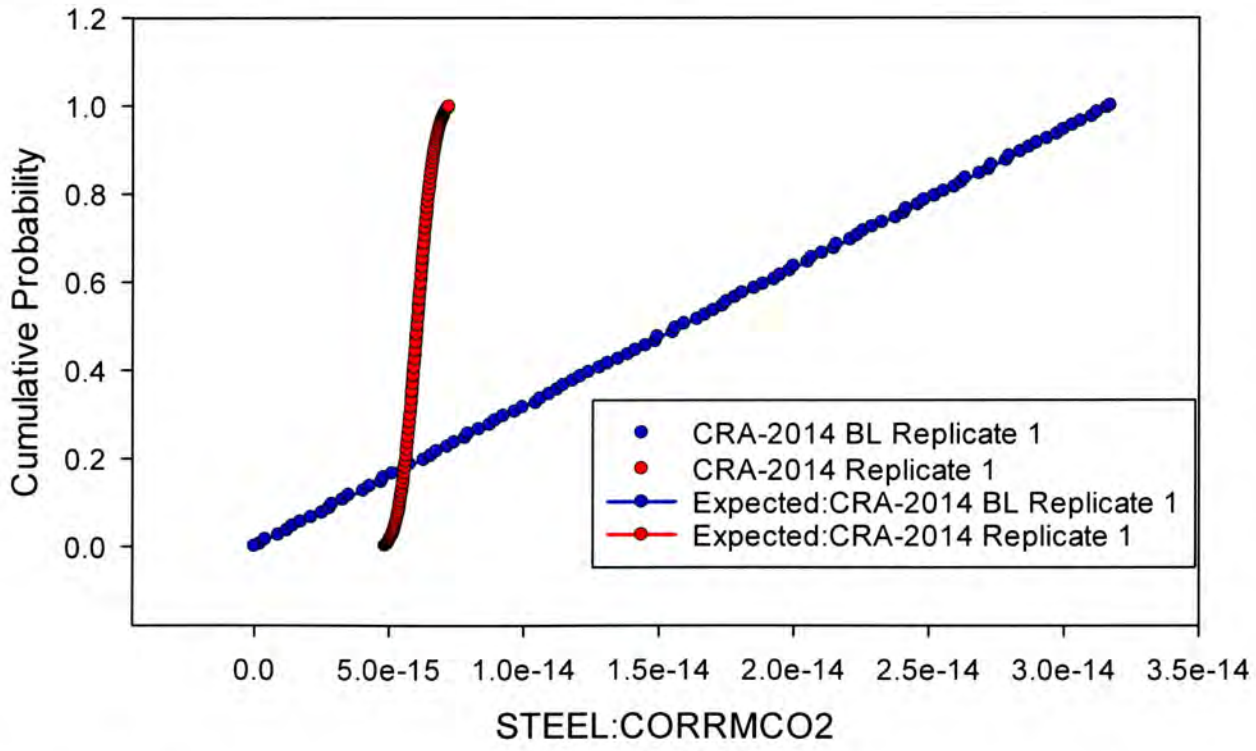

Figure 50. Observed Distribution for STEEL:CORRMCO2 Replicate 1, case BL(Uniform) and CRA-2014 (Student Distribution) Replicate 1.

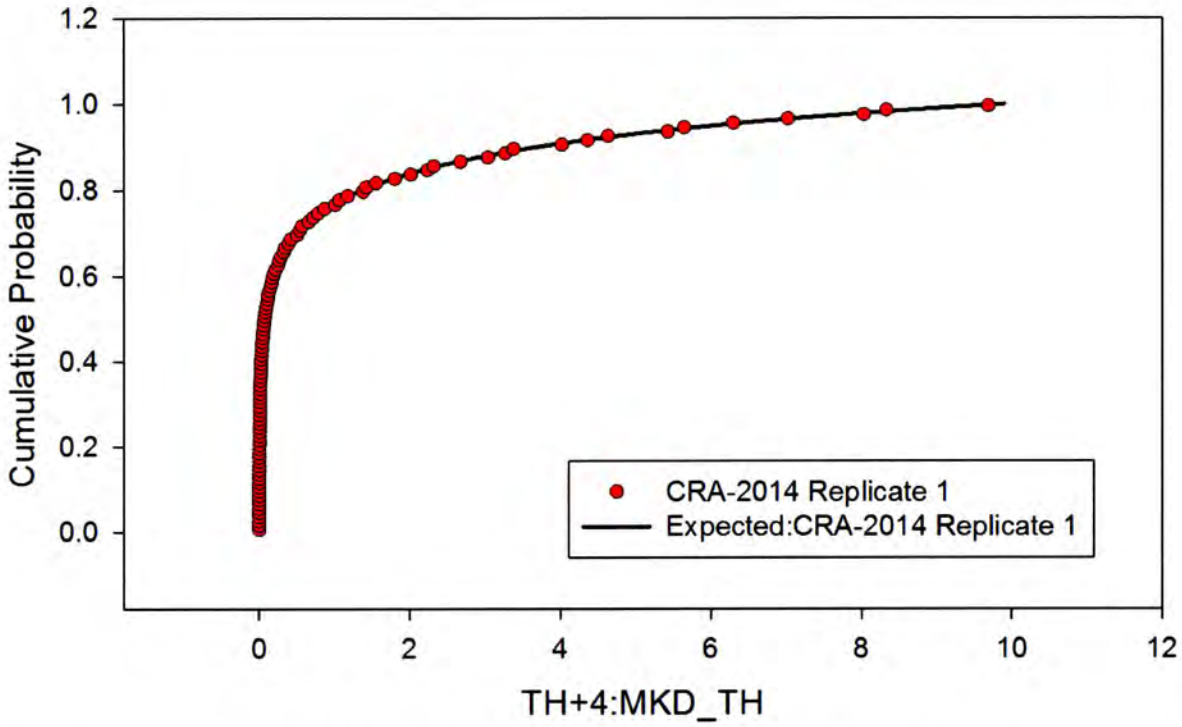

Figure 51. Observed and Expected CDFs for TH+4:MKD_TH (Loguniform Distribution) Replicate 1.

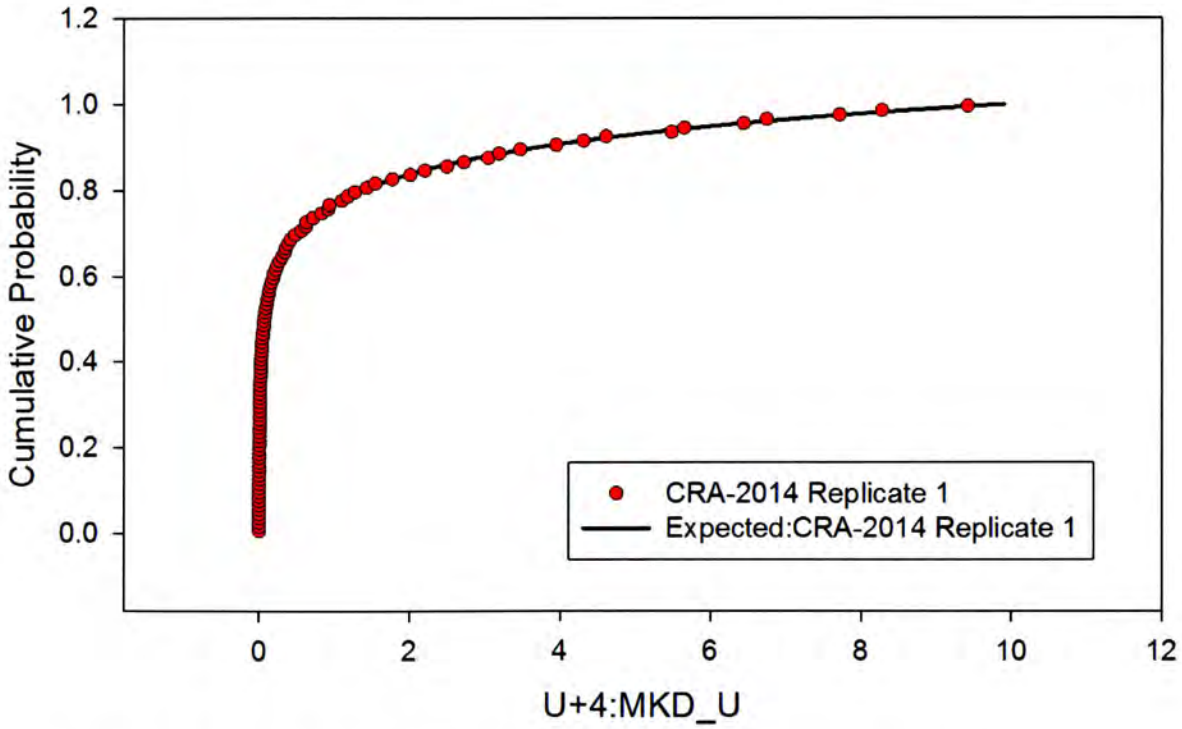

Figure 52. Observed and Expected CDFs for U+4:MKD_U (Loguniform Distribution) Replicate 1.

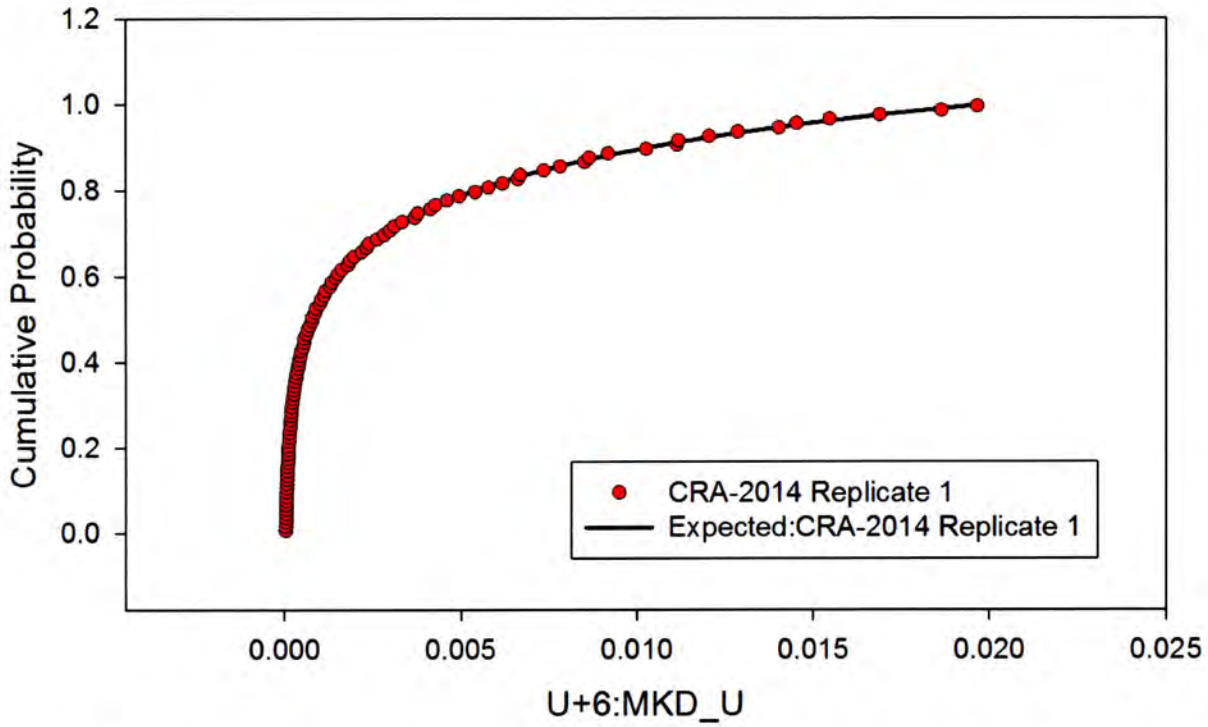

Figure 53. Observed and Expected CDFs for U+6:MKD_U (Loguniform Distribution) Replicate 1.

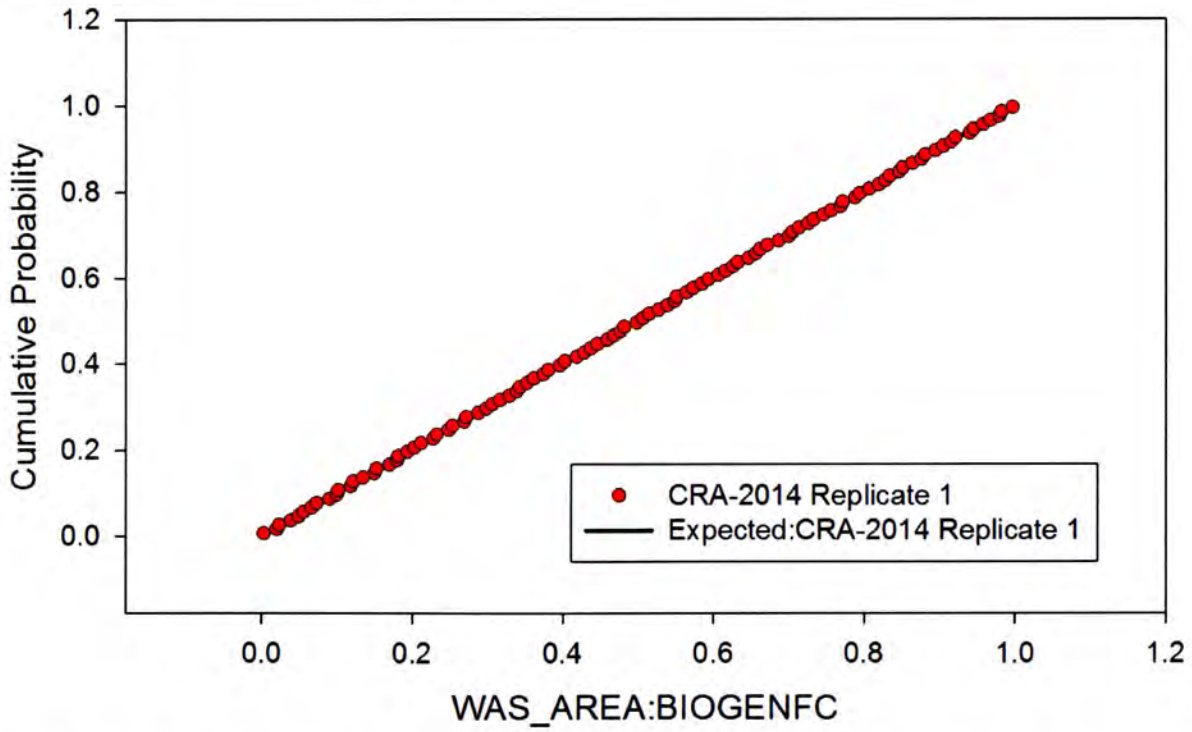

Figure 54. Observed and Expected CDFs for WAS_AREA:BIOGENFC (Uniform Distribution) Replicate 1.

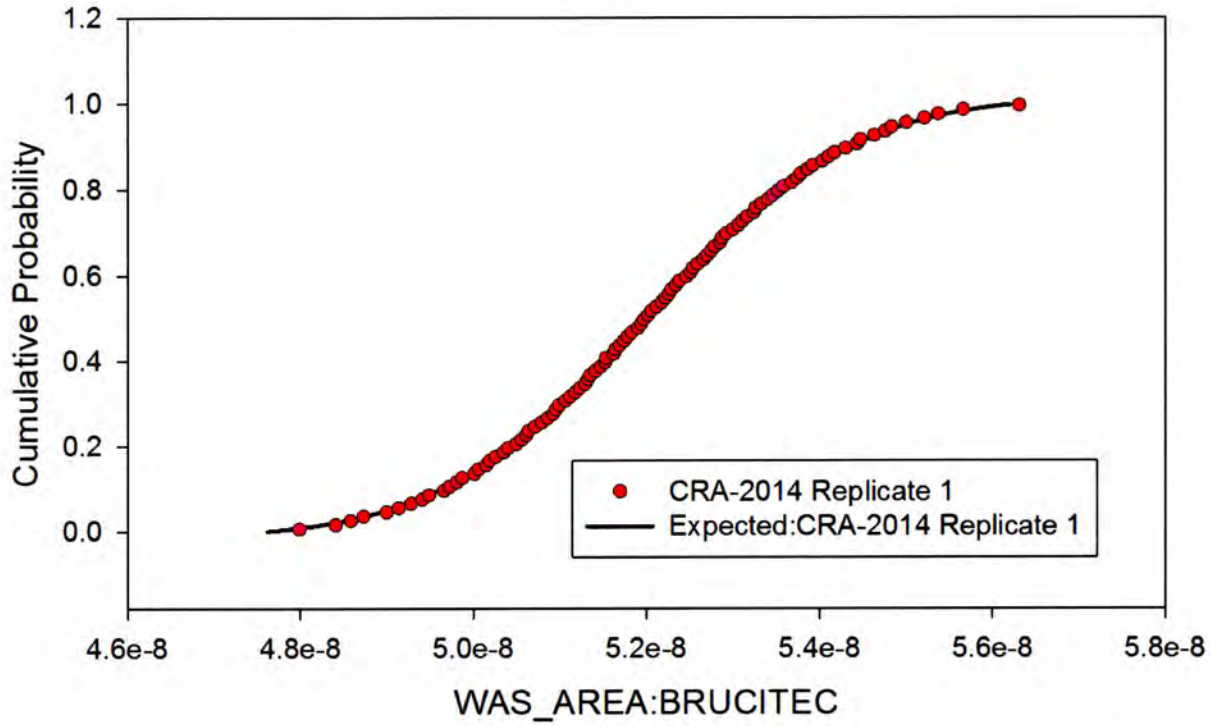

Figure 55. Observed and Expected CDFs for WAS_AREA:BRUCITEC (Normal Distribution) Replicate 1.

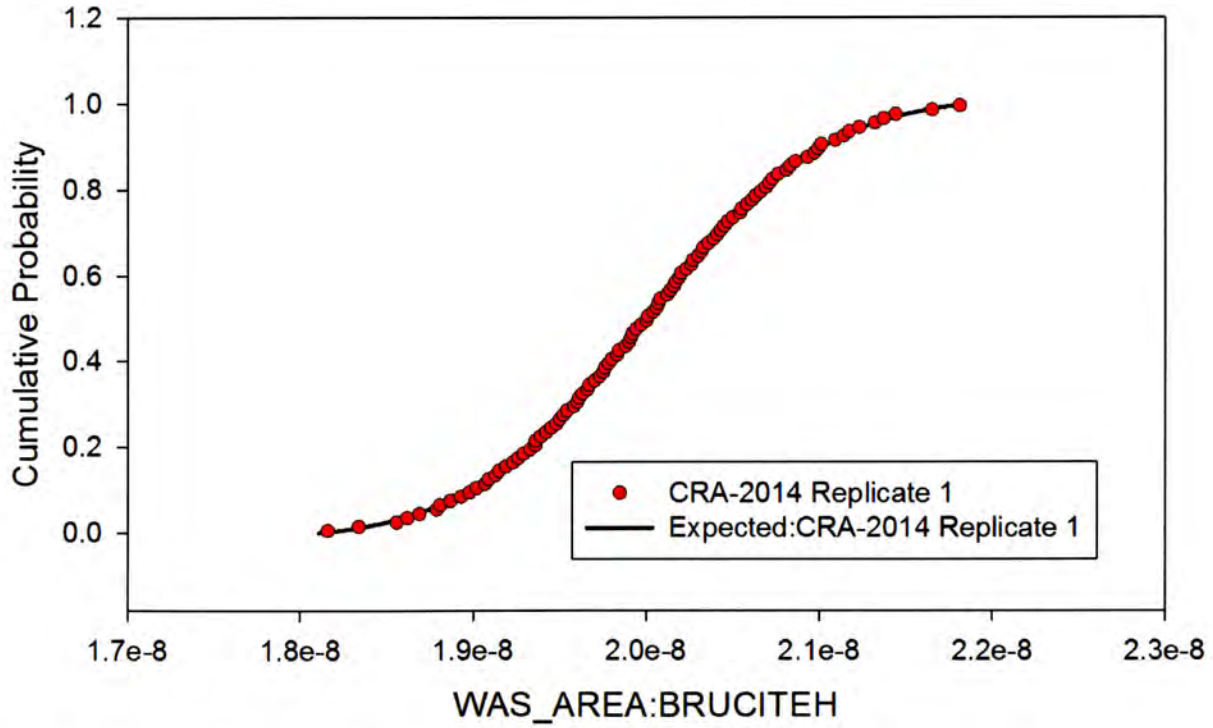

Figure 56. Observed and Expected CDFs for WAS_AREA:BRUCITEH (Normal Distribution) Replicate 1.

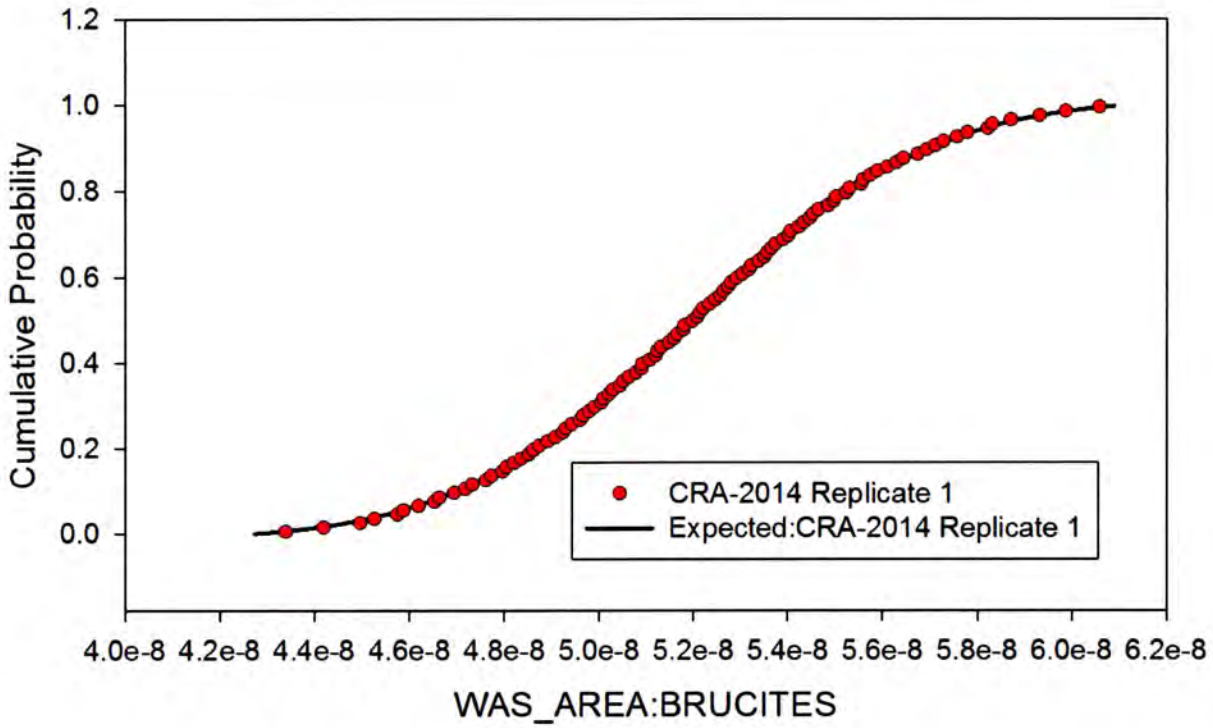

Figure 57. Observed and Expected CDFs for WAS_AREA:BRUCITES (Normal Distribution) Replicate 1.

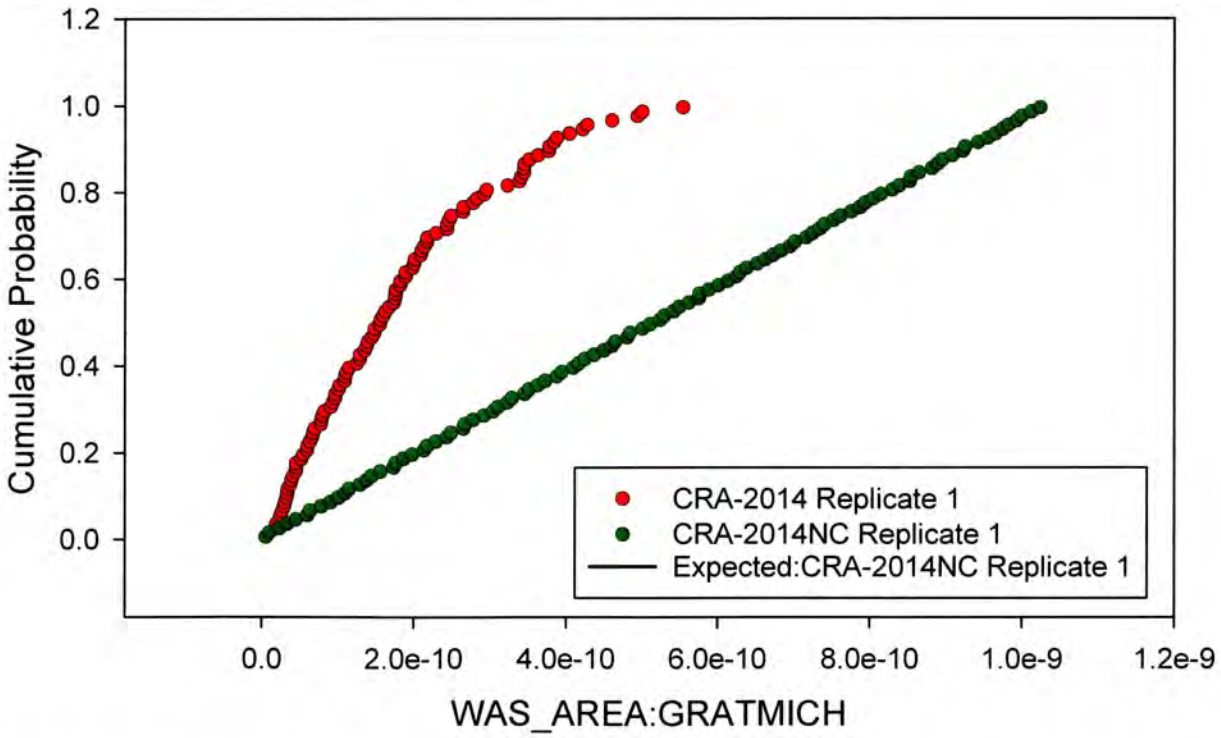

Figure 58. Observed and Expected CDFs for WAS_AREA:GRATMICH (Uniform Distribution) Replicate 1 also showing the data prior to conditioning (NC).

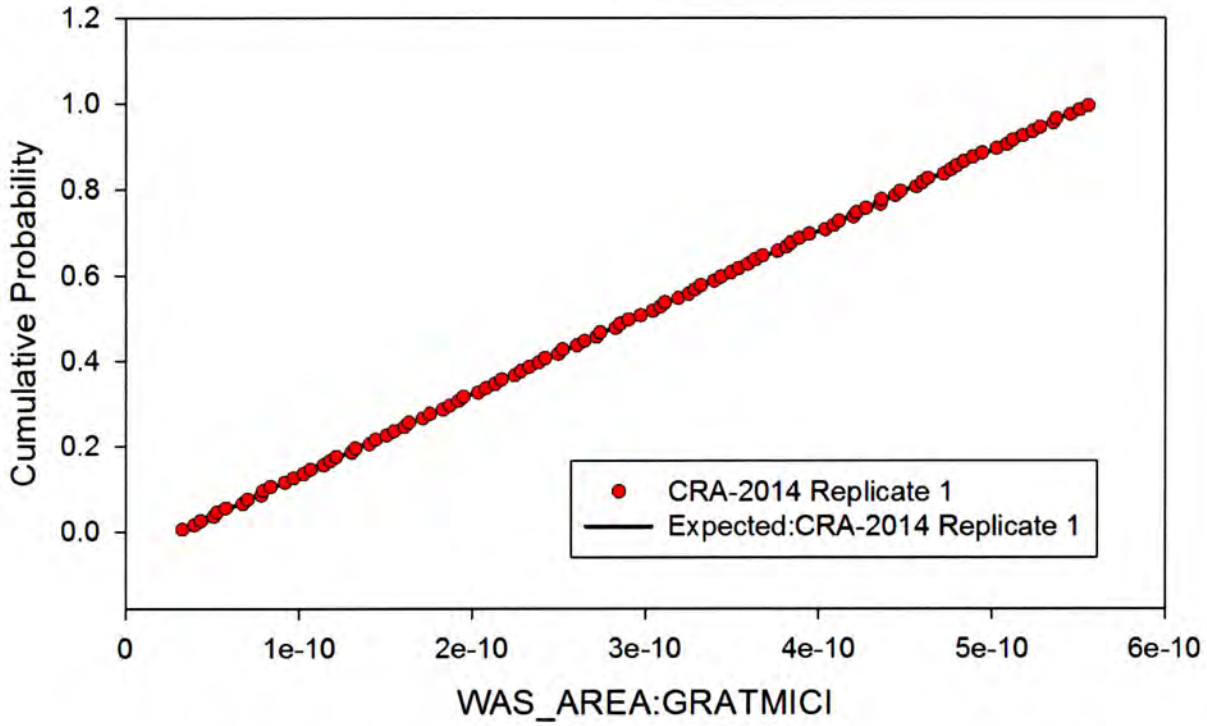

Figure 59. Observed and Expected CDFs for WAS_AREA:GRATMICI (Uniform Distribution) Replicate 1.

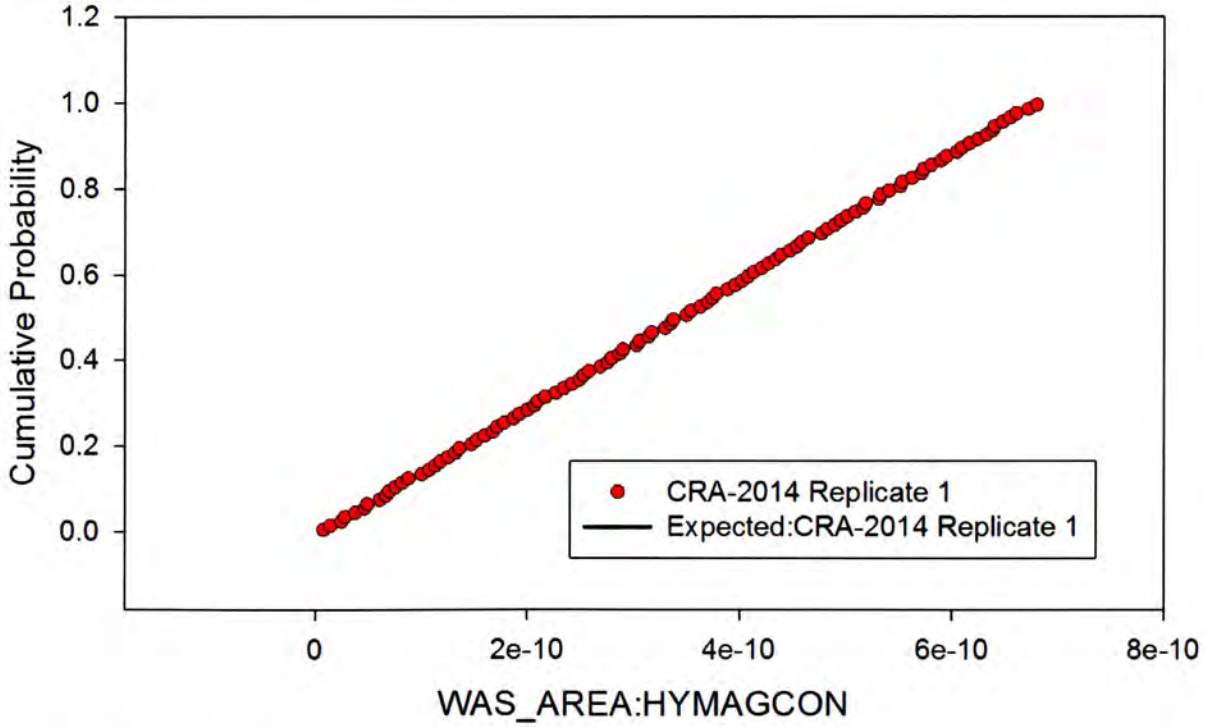

Figure 60. Observed and Expected CDFs for WAS_AREA:HYMAGCON (Uniform Distribution) Replicate 1.

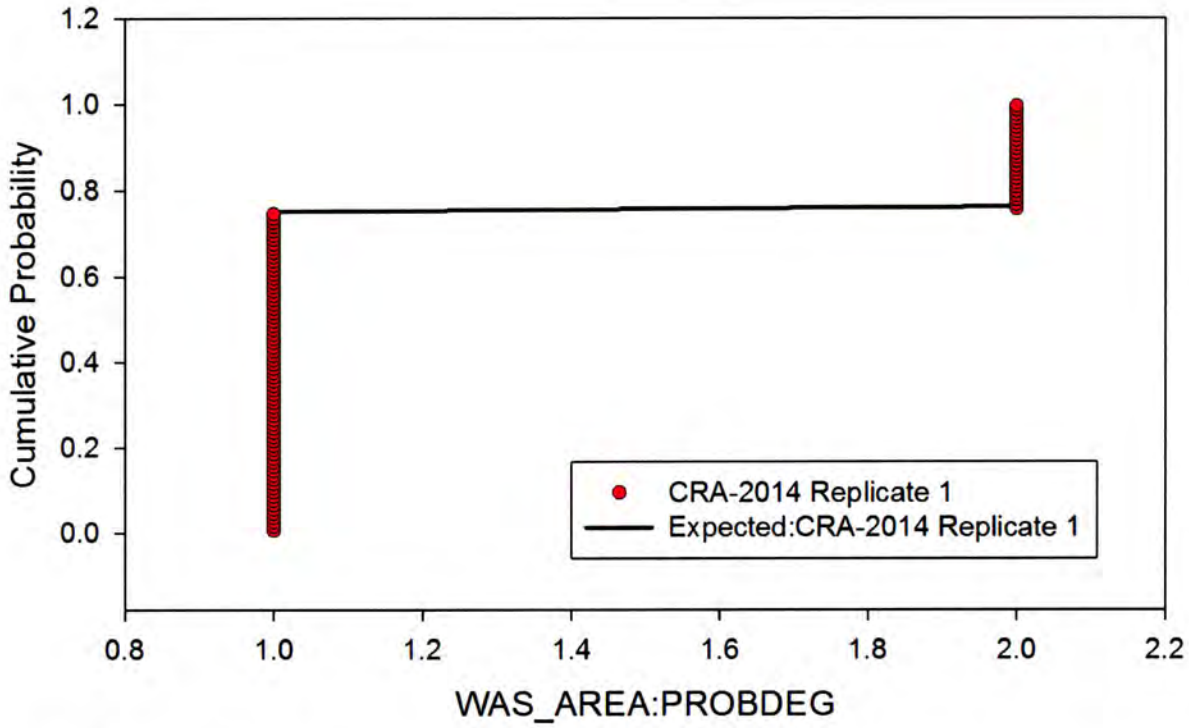

Figure 61. Observed and Expected CDFs for WAS_AREA:PROBDEG (User Discrete (Delta) Distribution) Replicate 1.

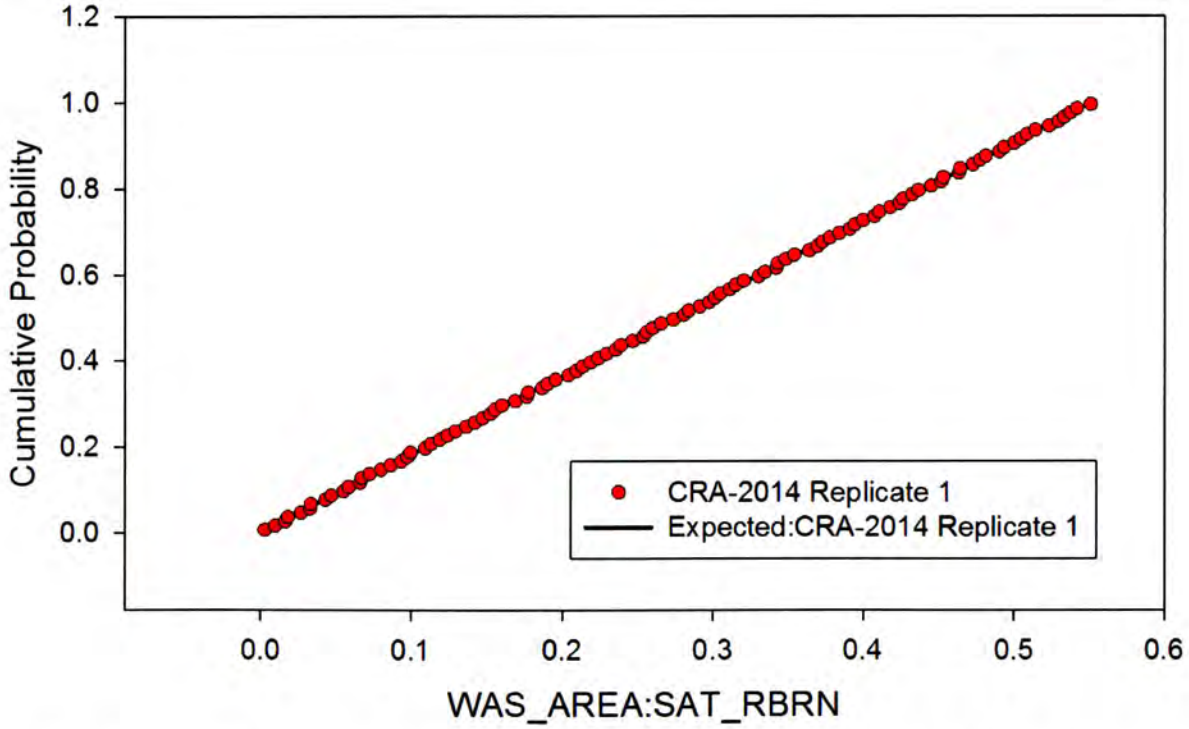

Figure 62. Observed and Expected CDFs for WAS_AREA:SAT_RBRN (Uniform Distribution) Replicate 1.

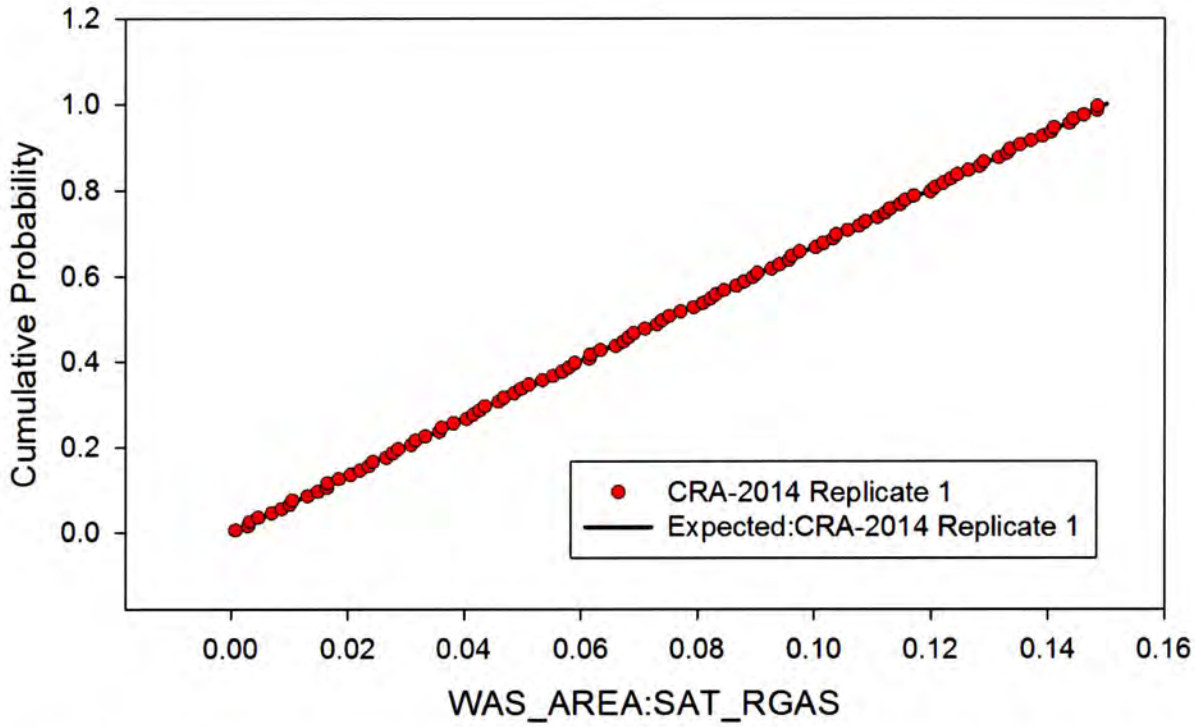

Figure 63. Observed and Expected CDFs for WAS_AREA:SAT_RGAS (Uniform Distribution) Replicate 1.

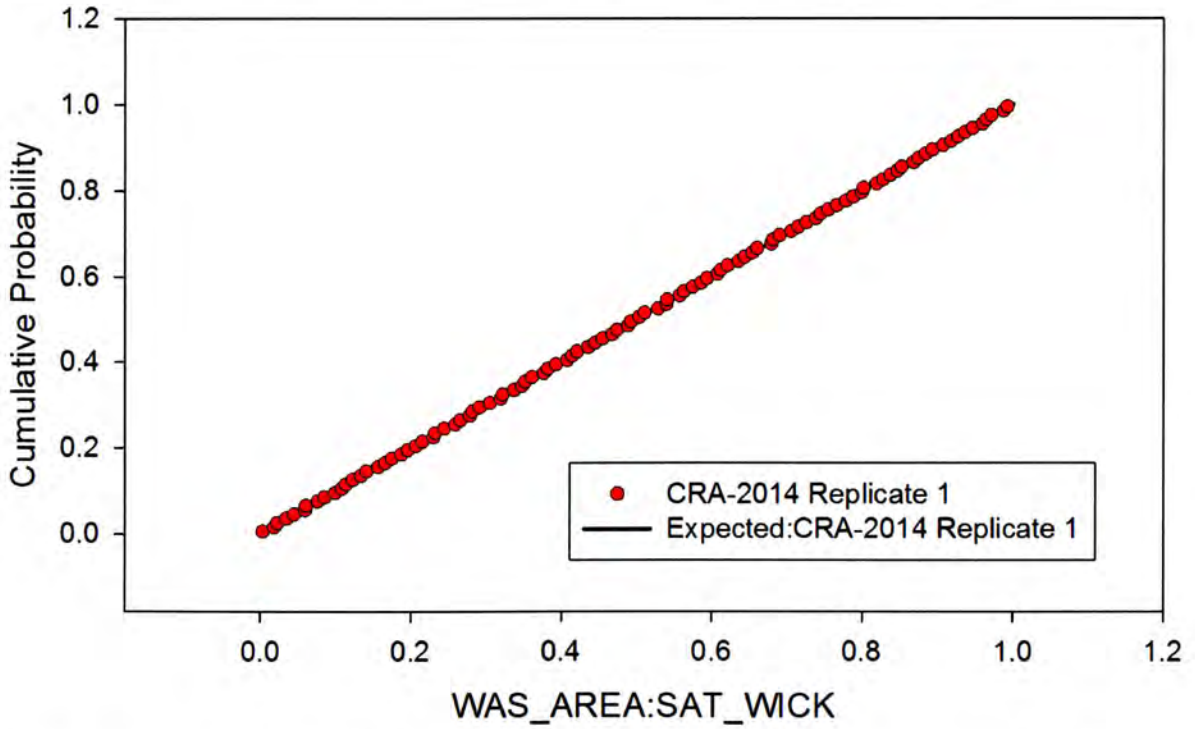

Figure 64. Observed and Expected CDFs for WAS_AREA:SAT_WICK (Uniform Distribution) Replicate 1.

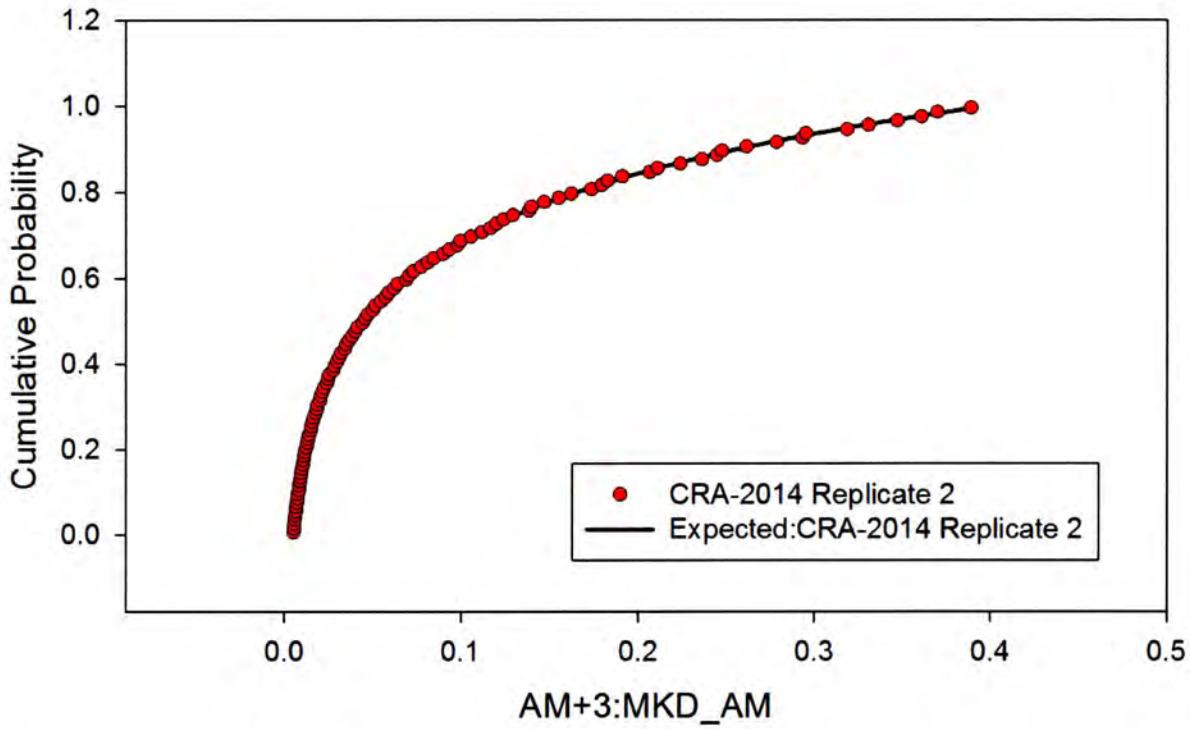

Figure 65. Observed and Expected CDFs for AM+3:MKD_AM (Loguniform Distribution) Replicate 2.

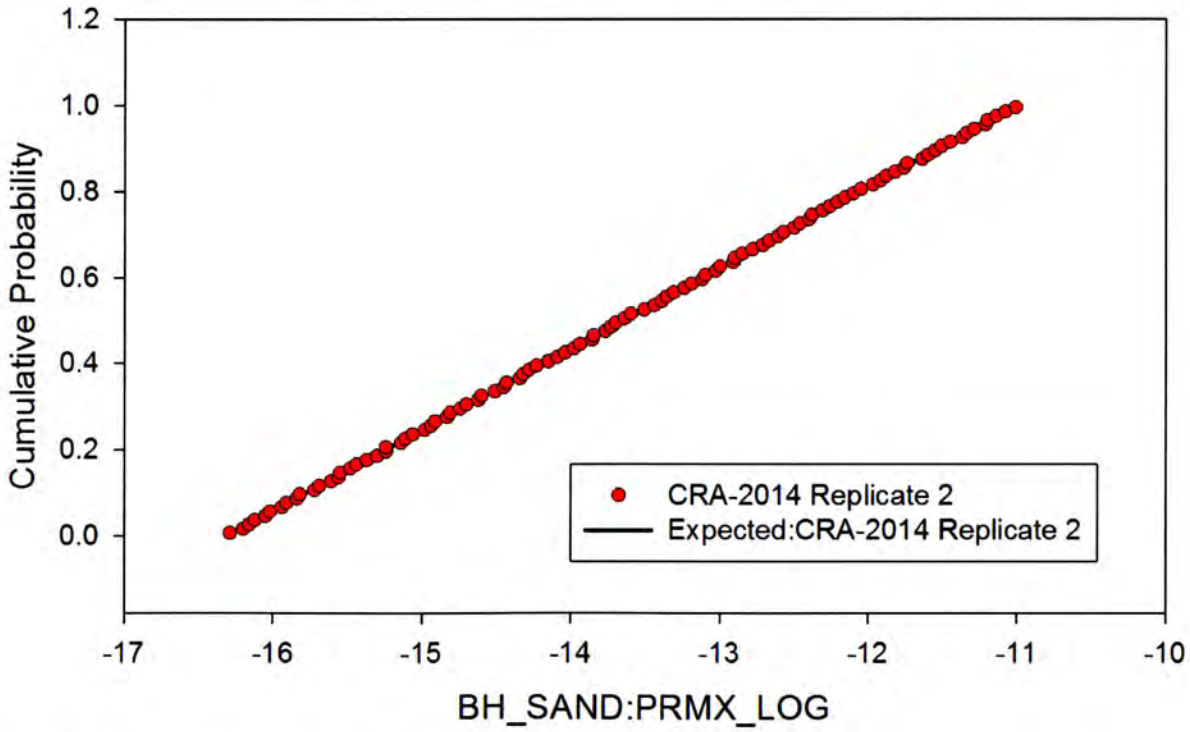

Figure 66. Observed and Expected CDFs for BH_SAND:PRMX_LOG (Uniform Distribution) Replicate 2.

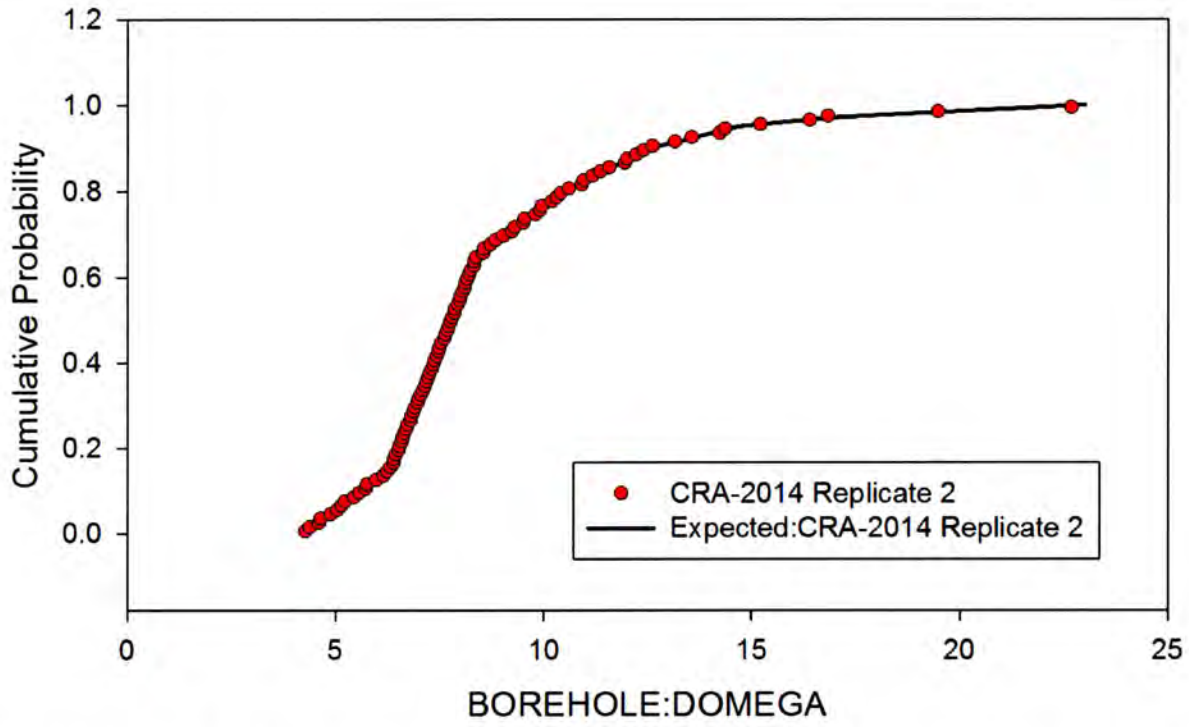

Figure 67. Observed and Expected CDFs for BOREHOLE:DOMEGA (User Continuous Distribution) Replicate 2.

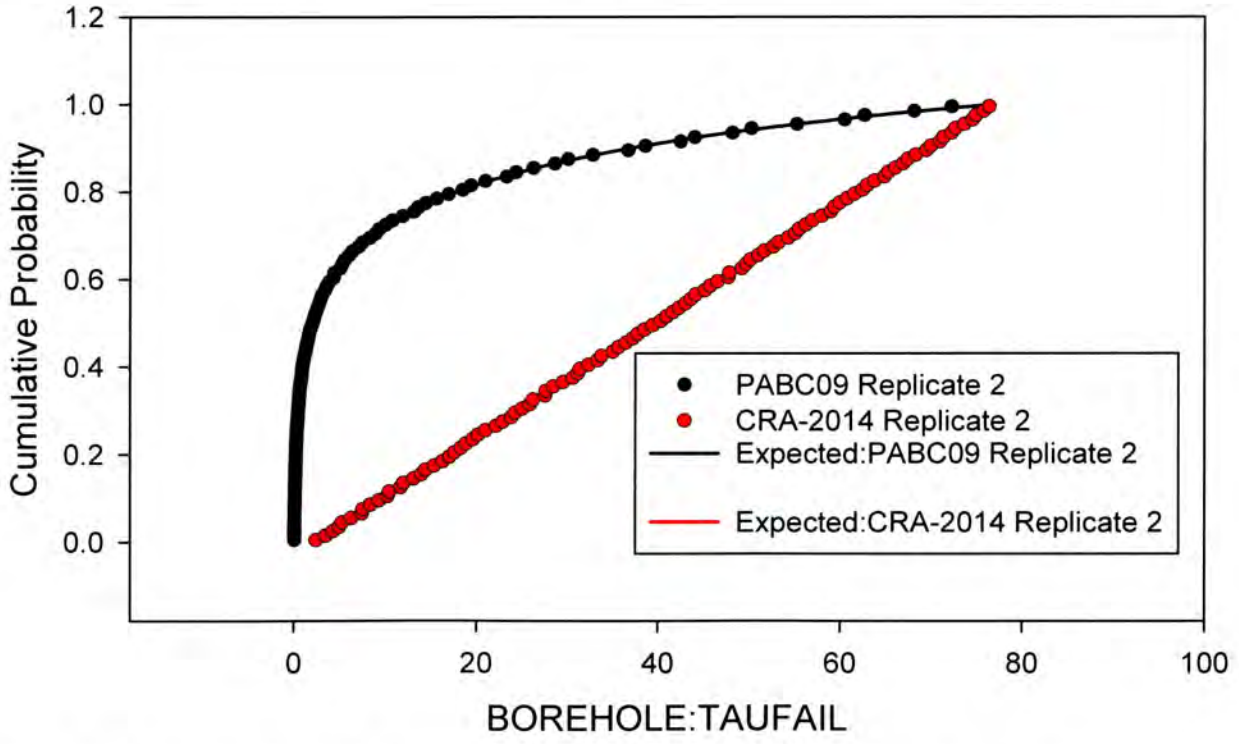

Figure 68. Observed Distribution for BOREHOLE:TAUFAIL Replicate 2, PABC09 (Loguniform Distribution) and CRA-2014 (Uniform Distribution).

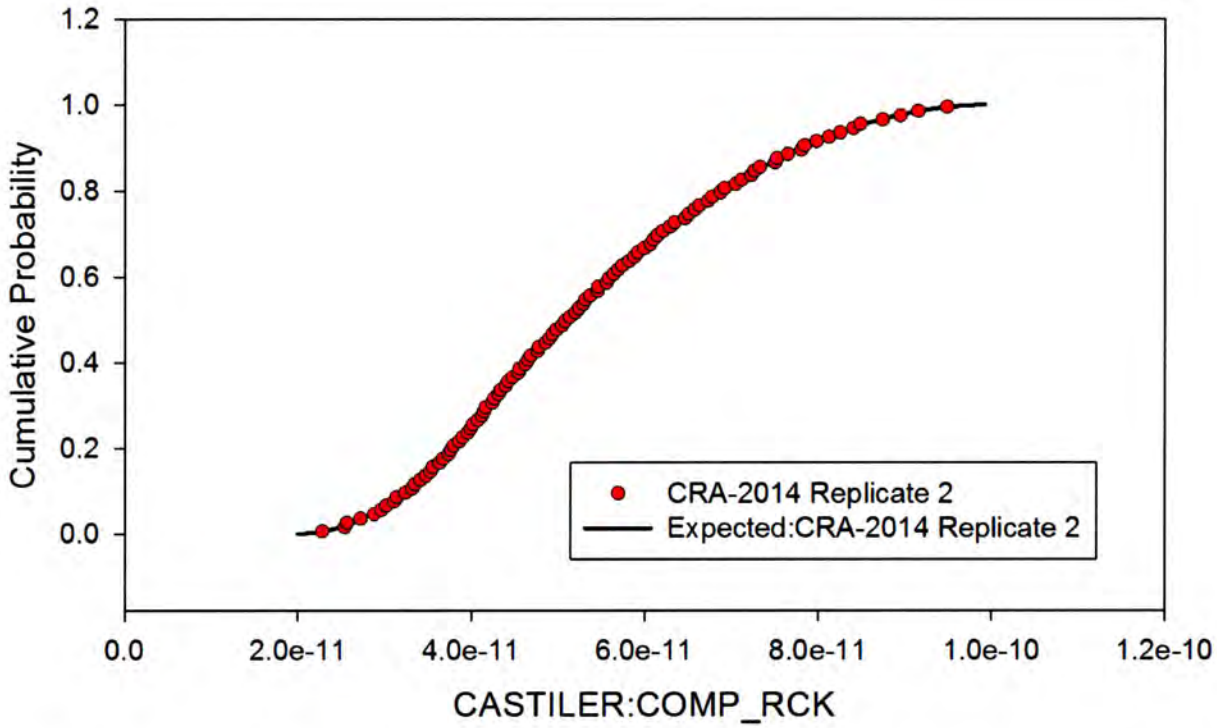

Figure 69. Observed and Expected CDFs for CASTILER:COMP_RCK (Triangular Distribution) Replicate 2.

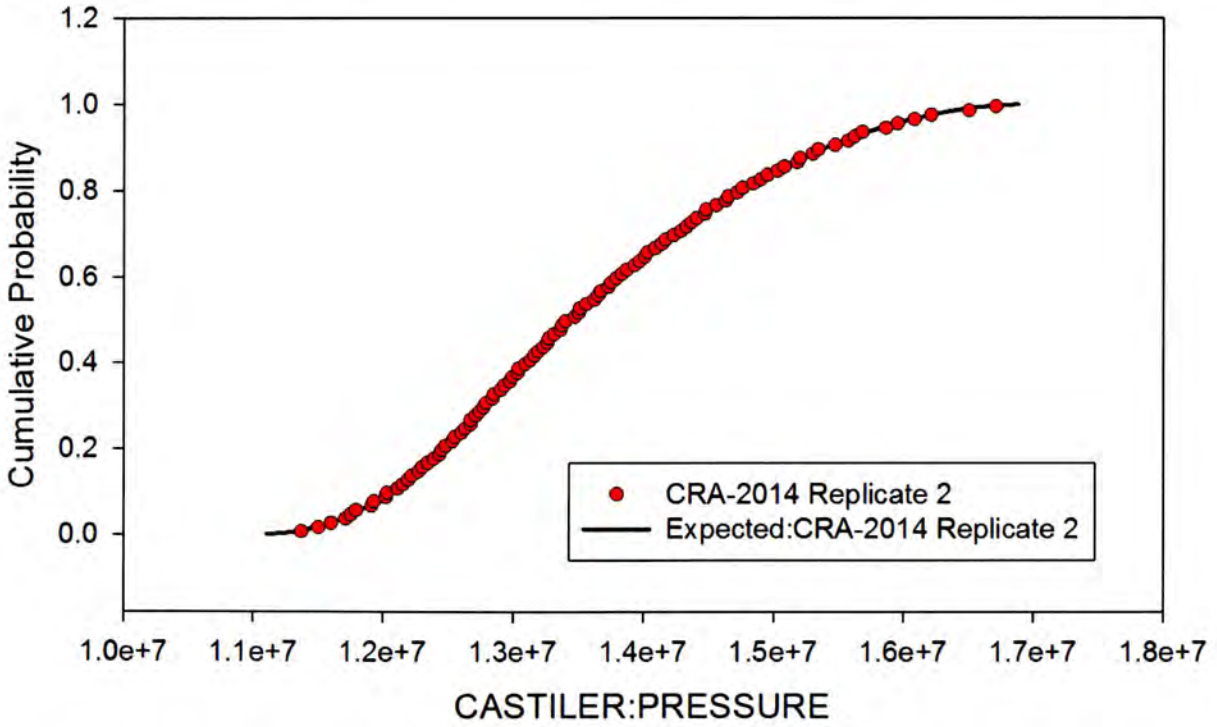

Figure 70. Observed and Expected CDFs for CASTILER:PRESSURE (Triangular Distribution) Replicate 2.

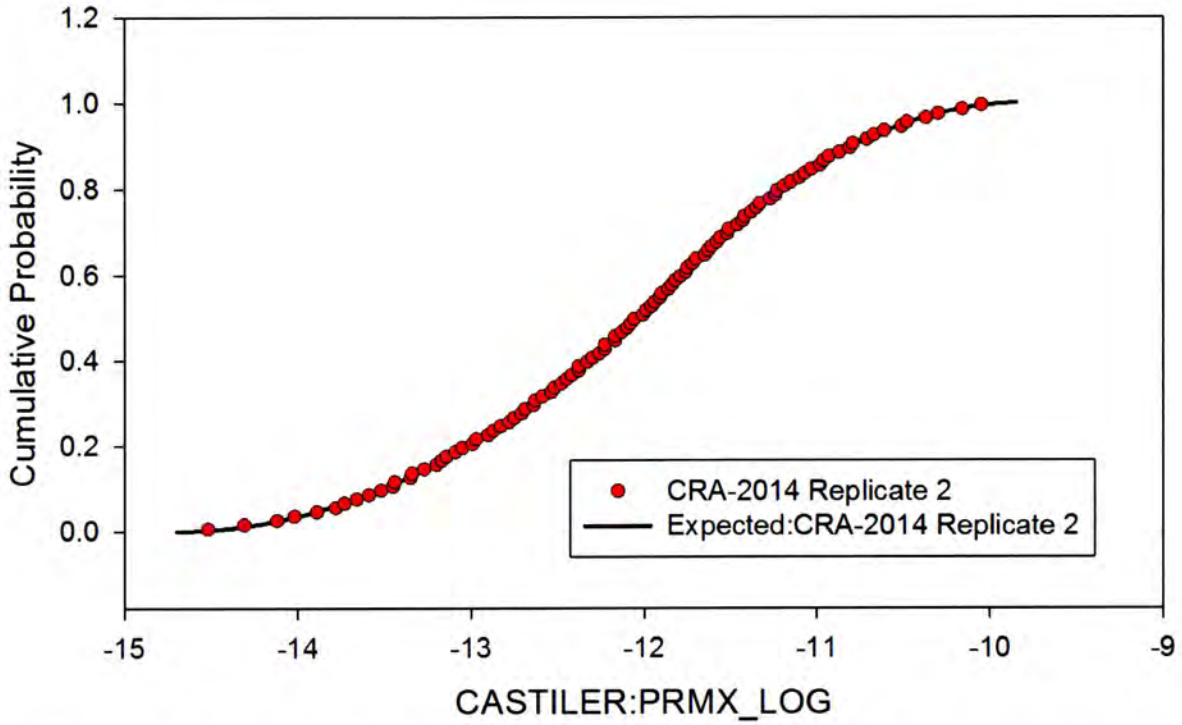

Figure 71. Observed and Expected CDFs for CASTILER:PRMX_LOG (Triangular Distribution) Replicate 2.

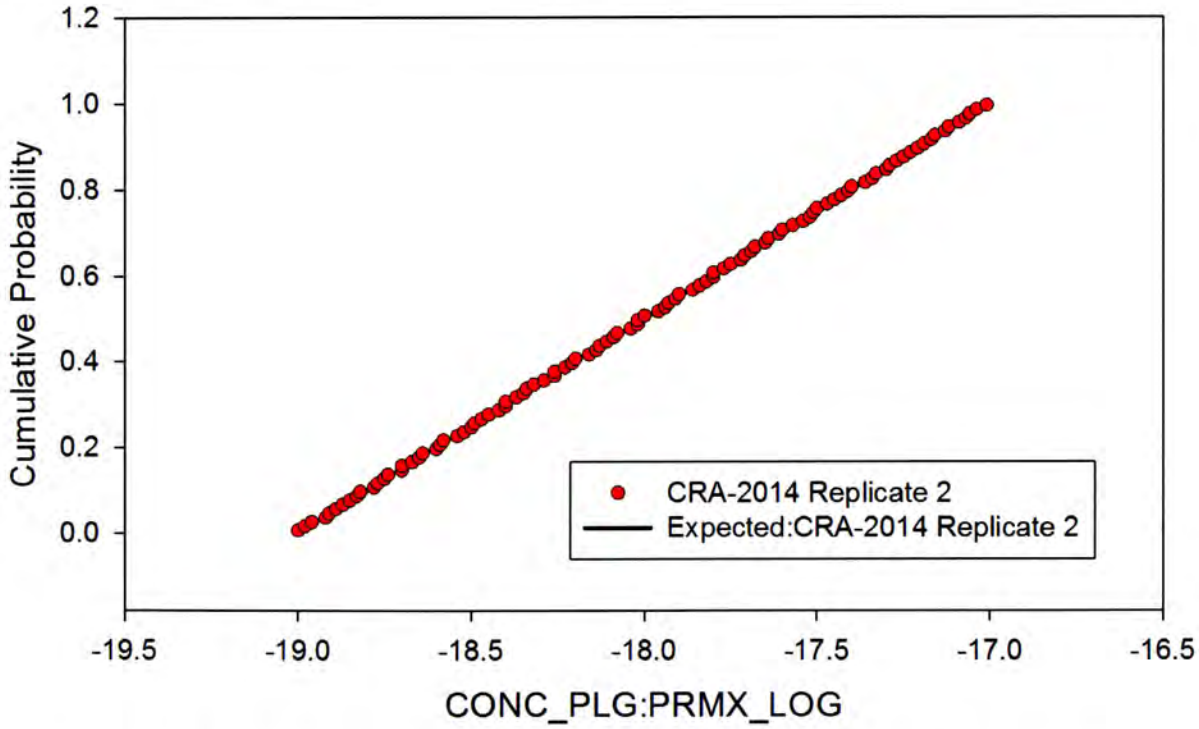

Figure 72. Observed and Expected CDFs for CONC_PLG:PRMX_LOG (Uniform Distribution) Replicate 2.

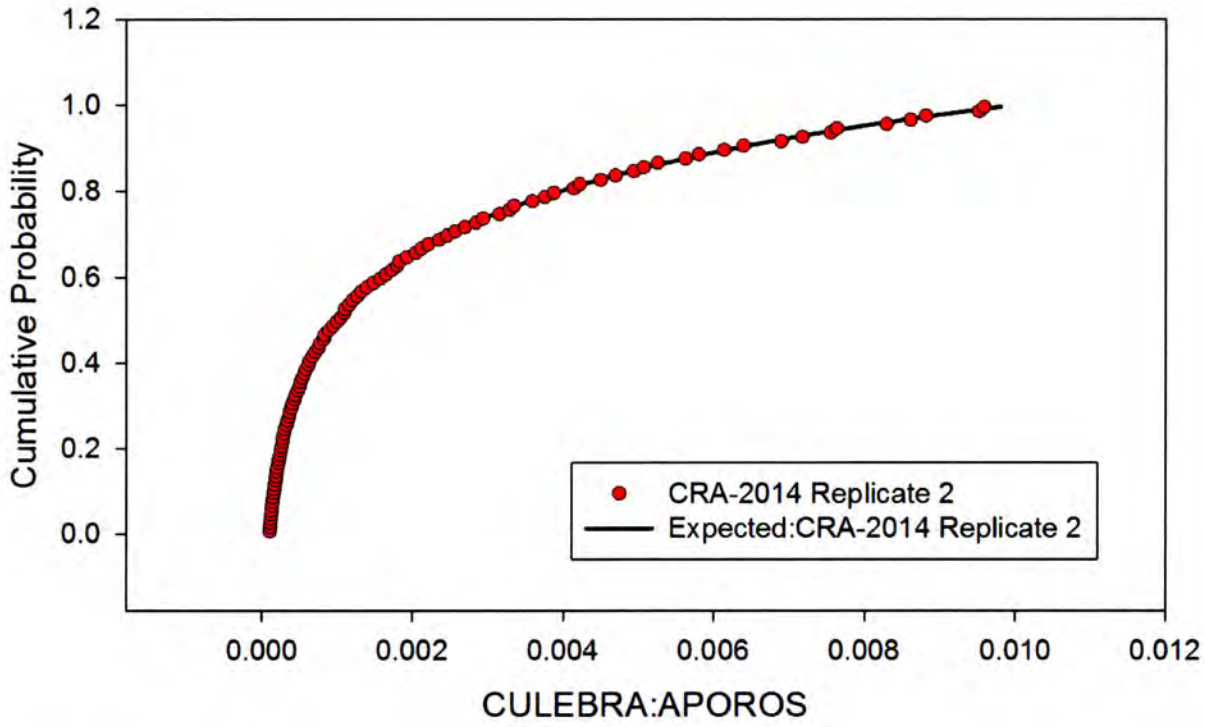

Figure 73. Observed and Expected CDFs for CULEBRA:APOROS (Loguniform Distribution) Replicate 2.

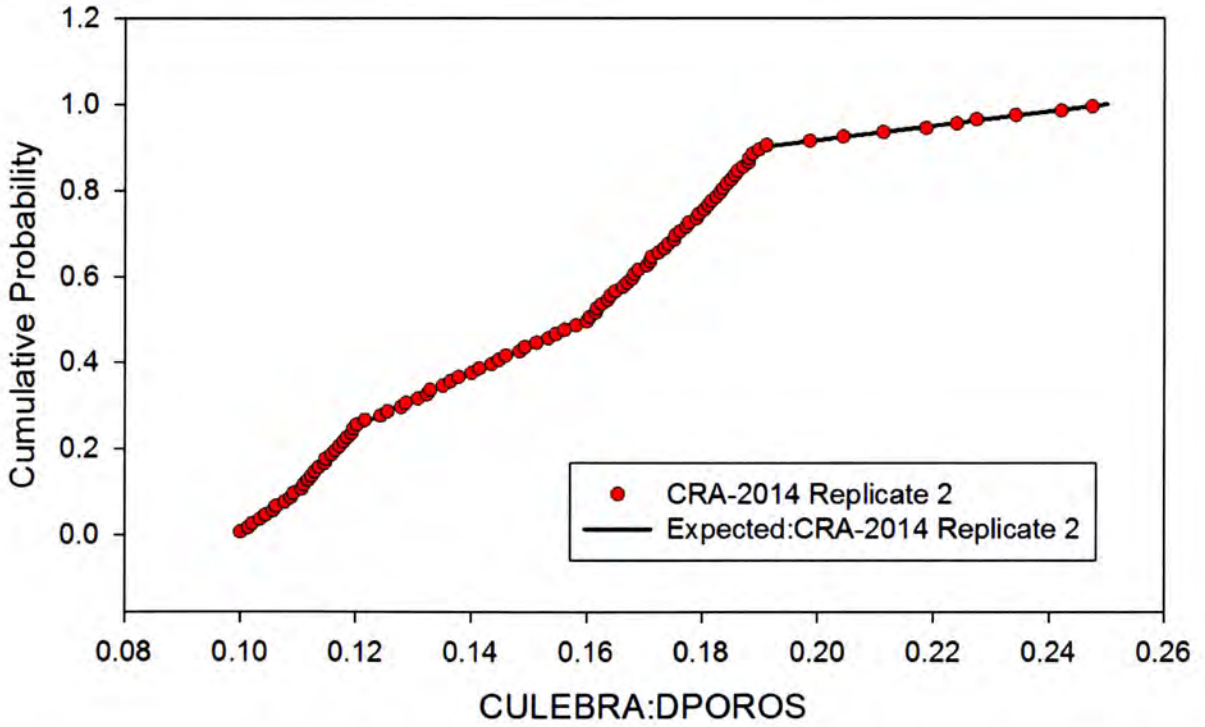

Figure 74. Observed and Expected CDFs for CULEBRA:DPOROS (User Continuous Distribution) Replicate 2.

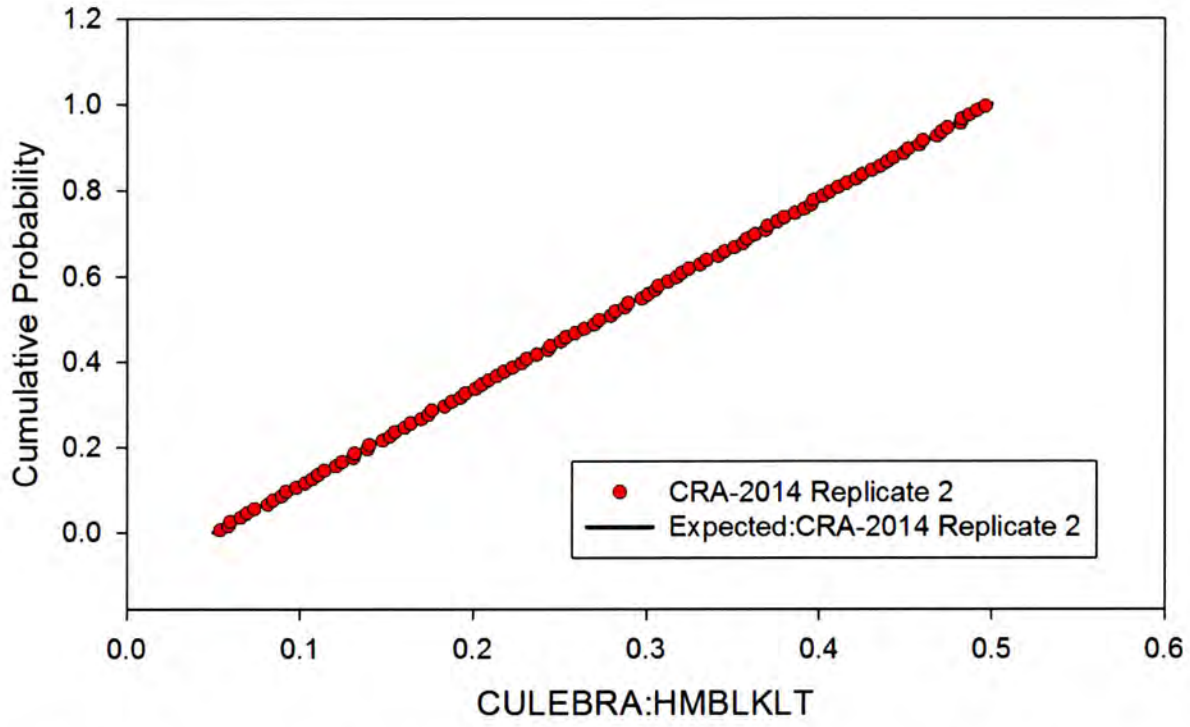

Figure 75. Observed and Expected CDFs for CULEBRA:HMBLKLT (Uniform Distribution) Replicate 2.

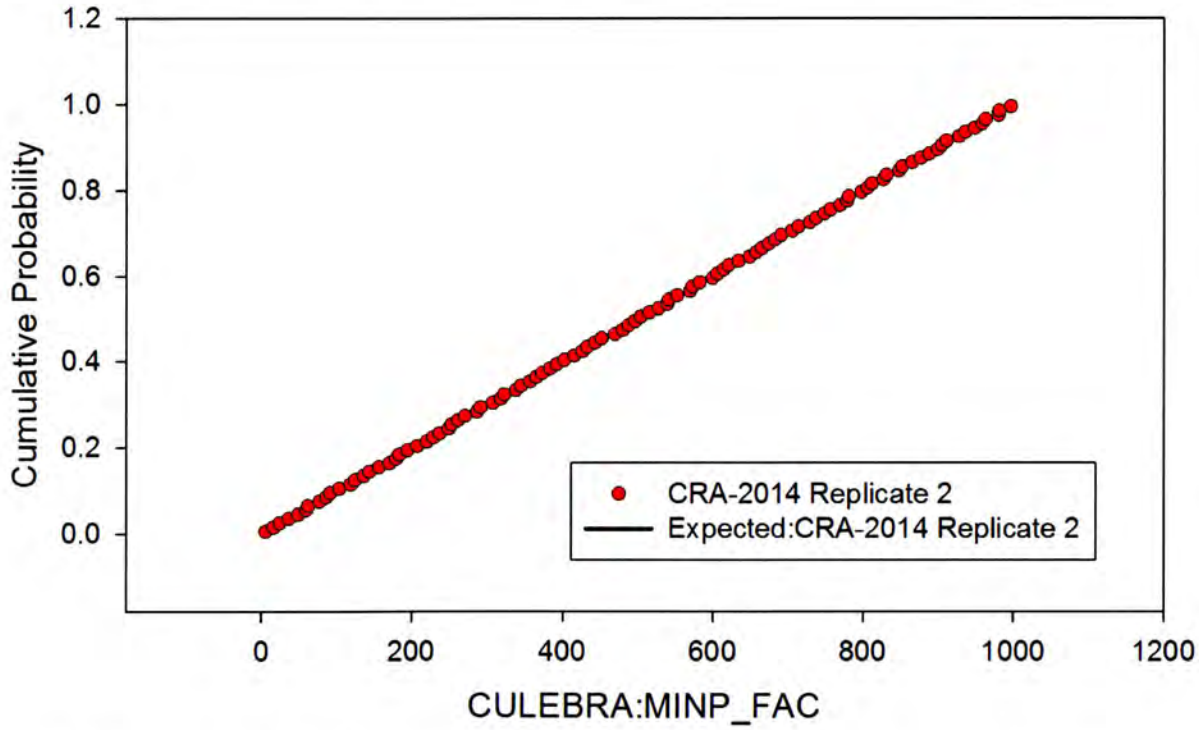

Figure 76. Observed and Expected CDFs for CULEBRA:MINP_FAC (Uniform Distribution) Replicate 2.

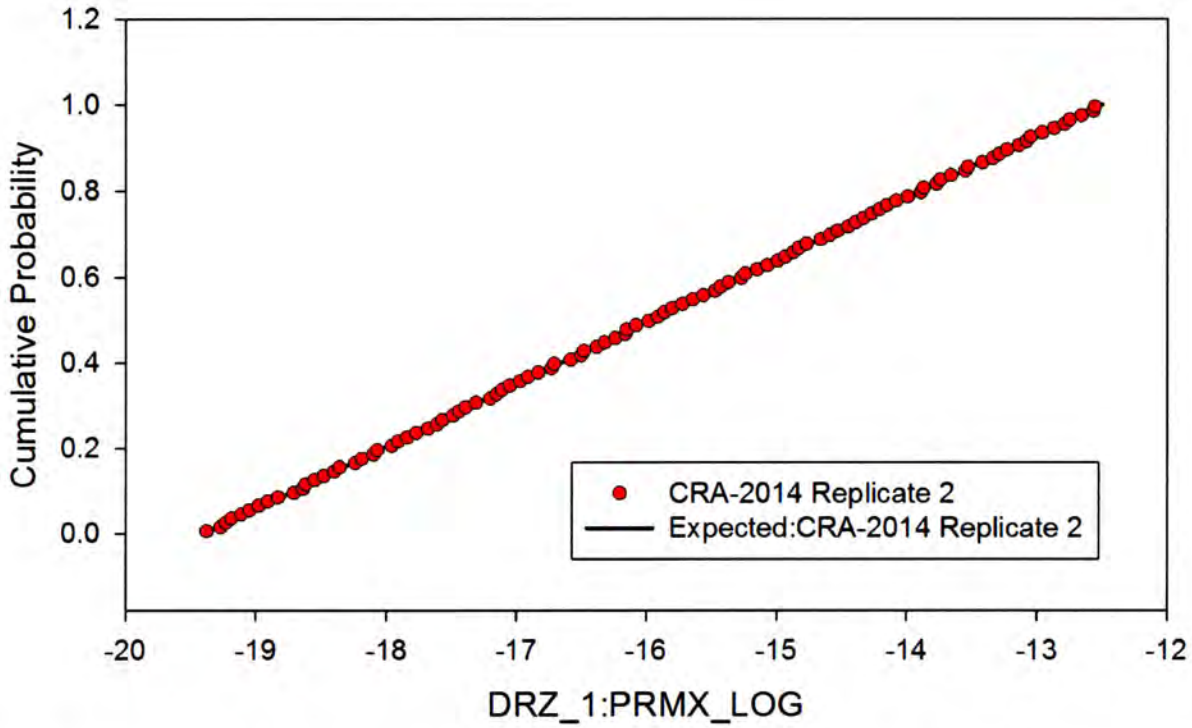

Figure 77. Observed and Expected CDFs for DRZ_1:PRMX_LOG (Uniform Distribution) Replicate 2.

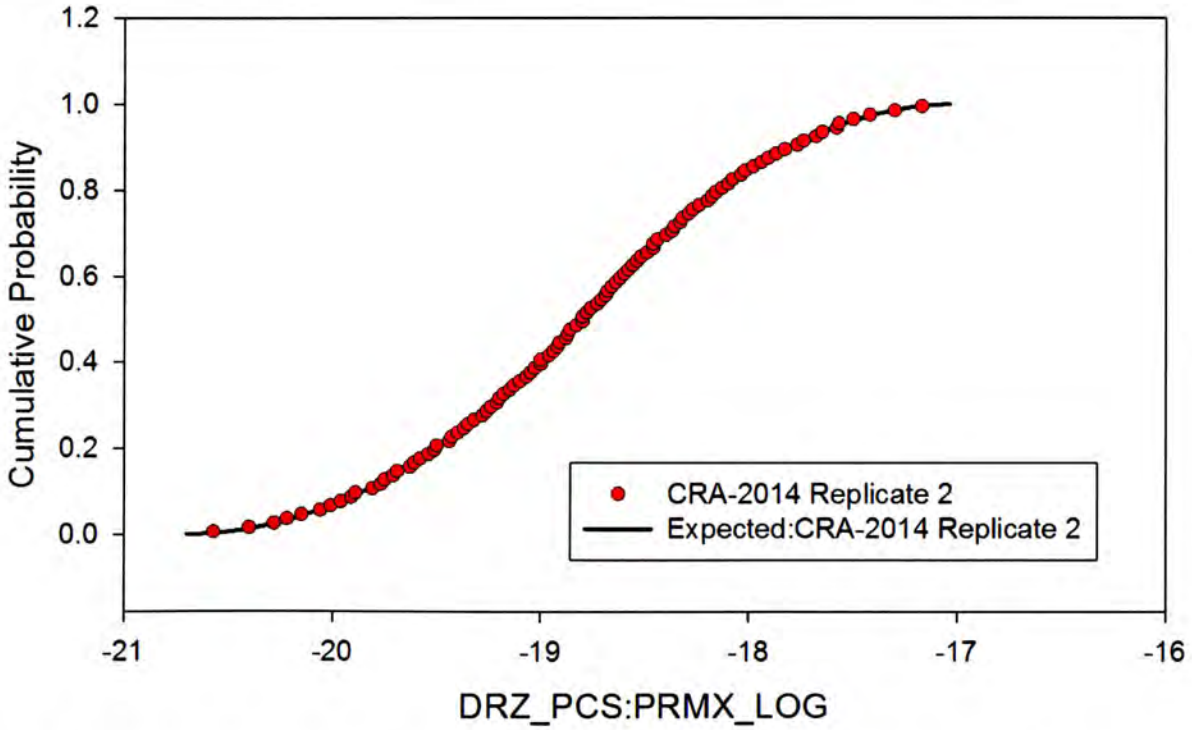

Figure 78. Observed and Expected CDFs for DRZ_PCS:PRMX_LOG (Triangular Distribution) Replicate 2.

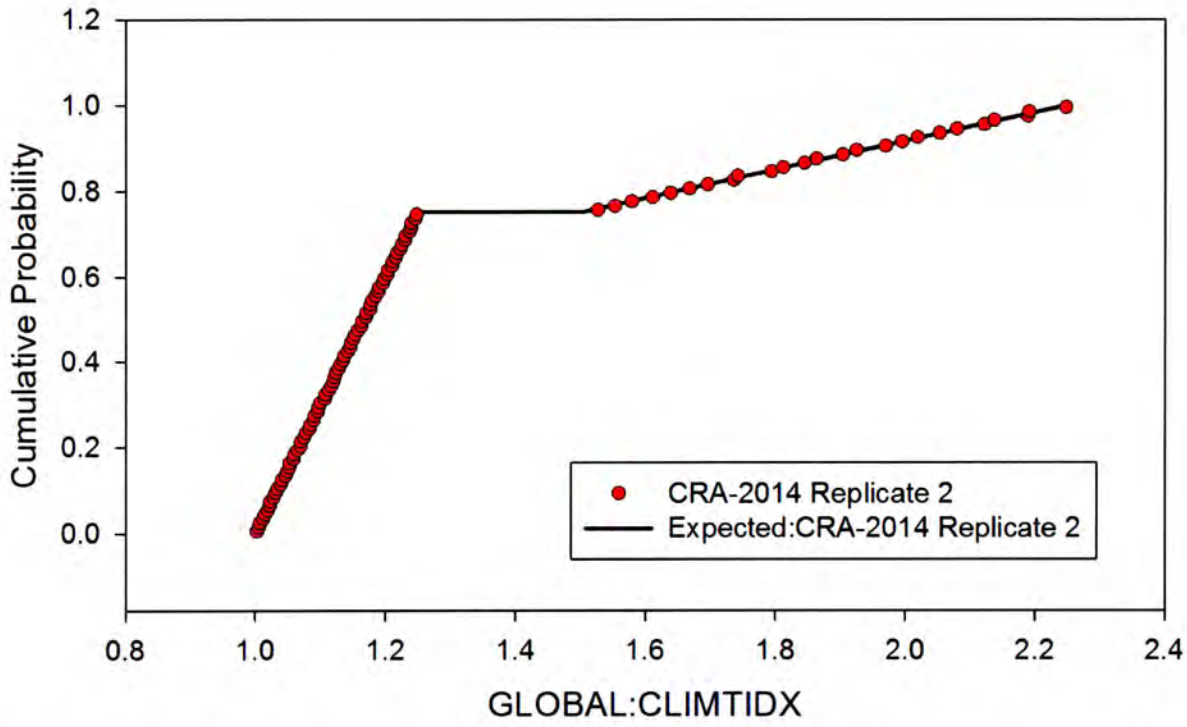

Figure 79. Observed and Expected CDFs for GLOBAL:CLIMTIDX (User Continuous Distribution) Replicate 2.

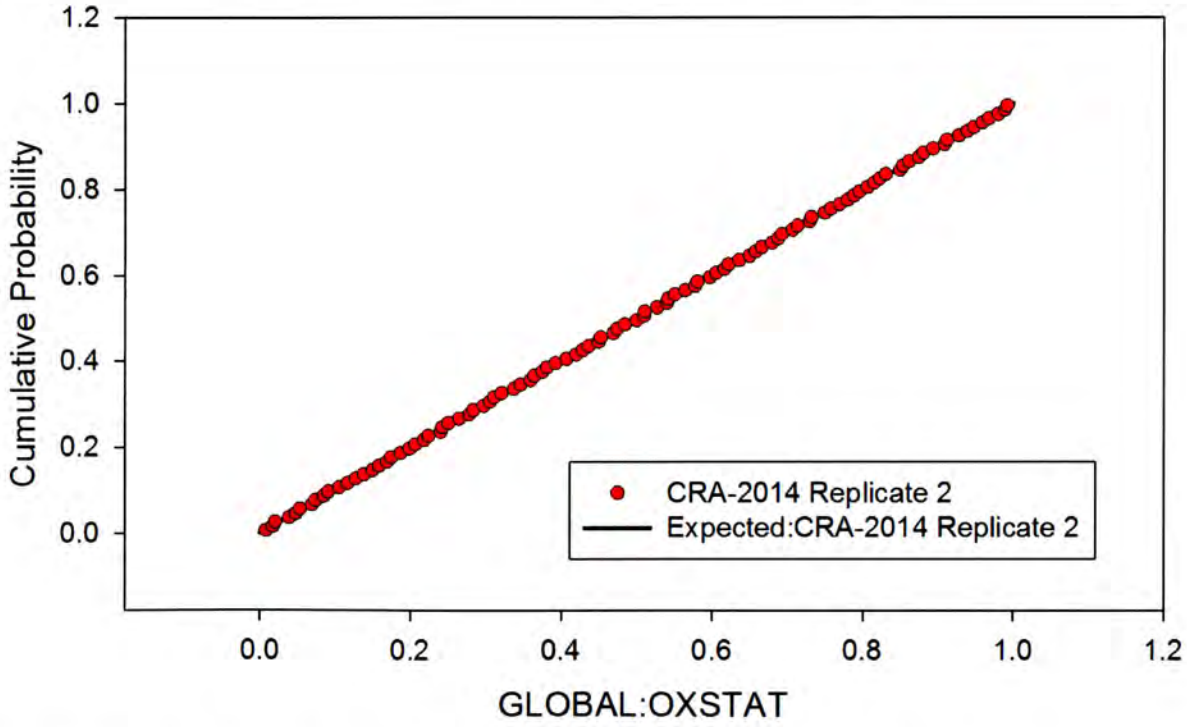

Figure 80. Observed and Expected CDFs for GLOBAL:OXSTAT (Uniform Distribution) Replicate 2.

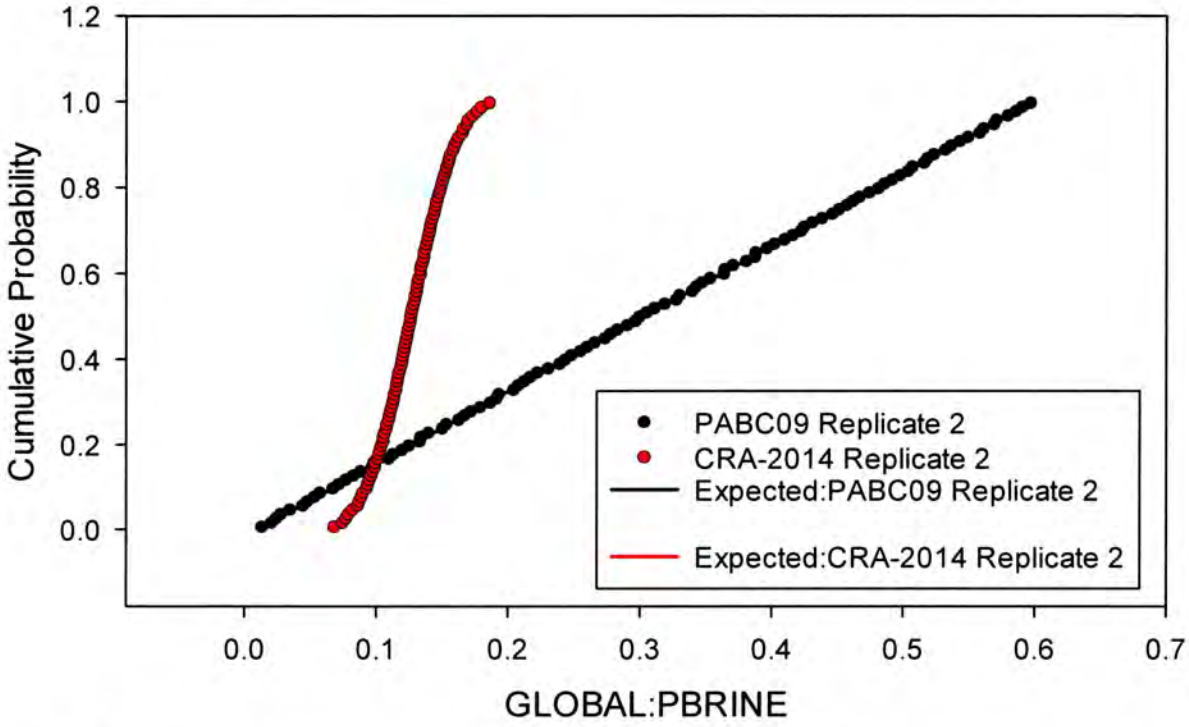

Figure 81. Observed and Expected CDFs for GLOBAL:PBRINE Replicate 2 for PABC09 (Uniform Distribution) and CRA-2014 (Normal Distribution).

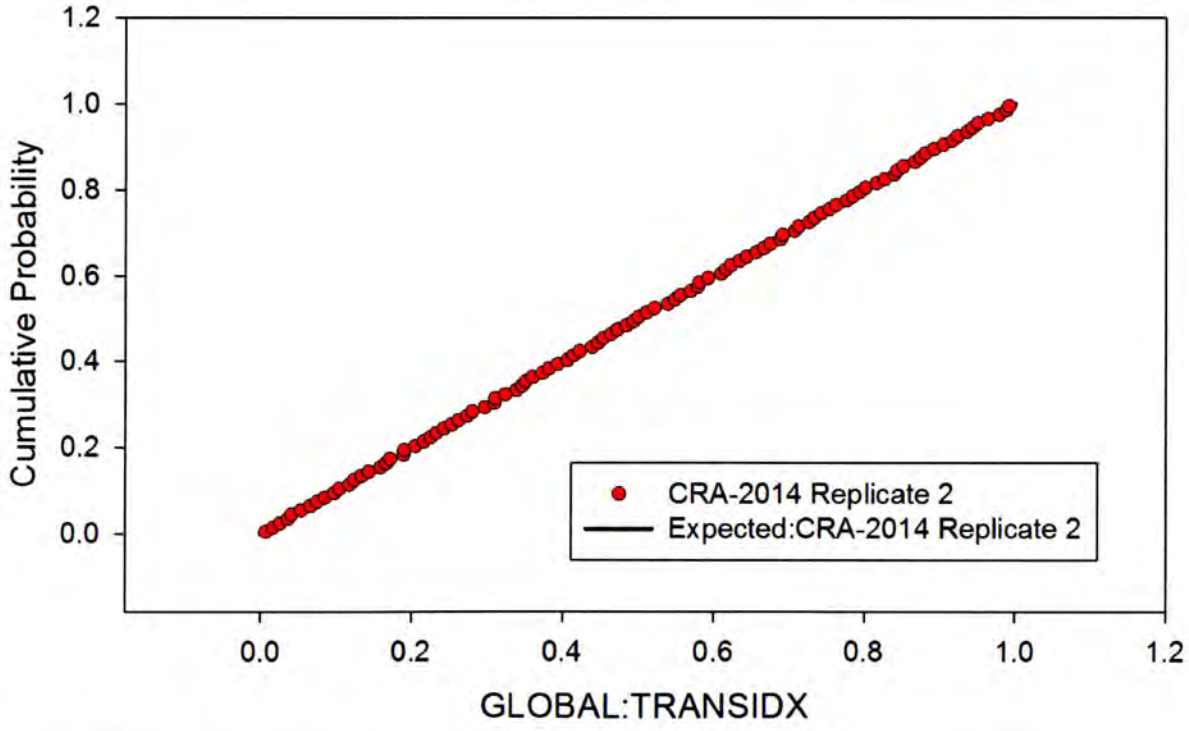

Figure 82. Observed and Expected CDFs for GLOBAL:TRANSIDX (Uniform Distribution) Replicate 2.

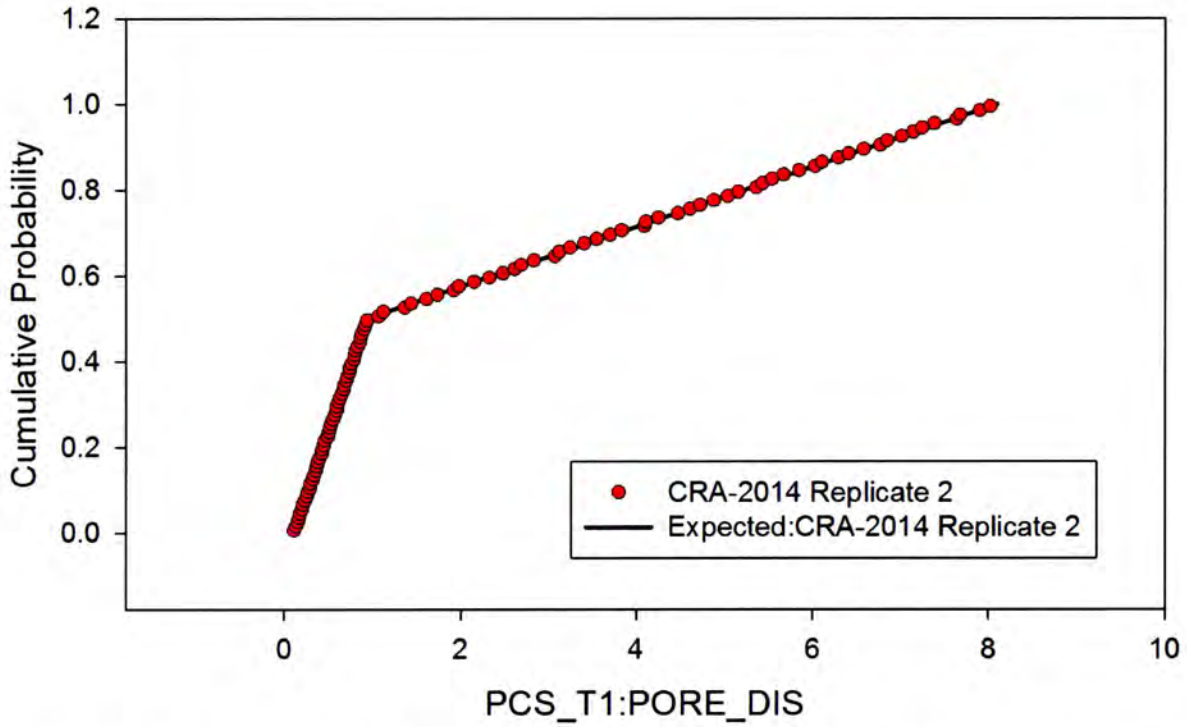

Figure 83. Observed and Expected CDFs for PCS_T1:PORE_DIS (User Continuous Distribution) Replicate 2.

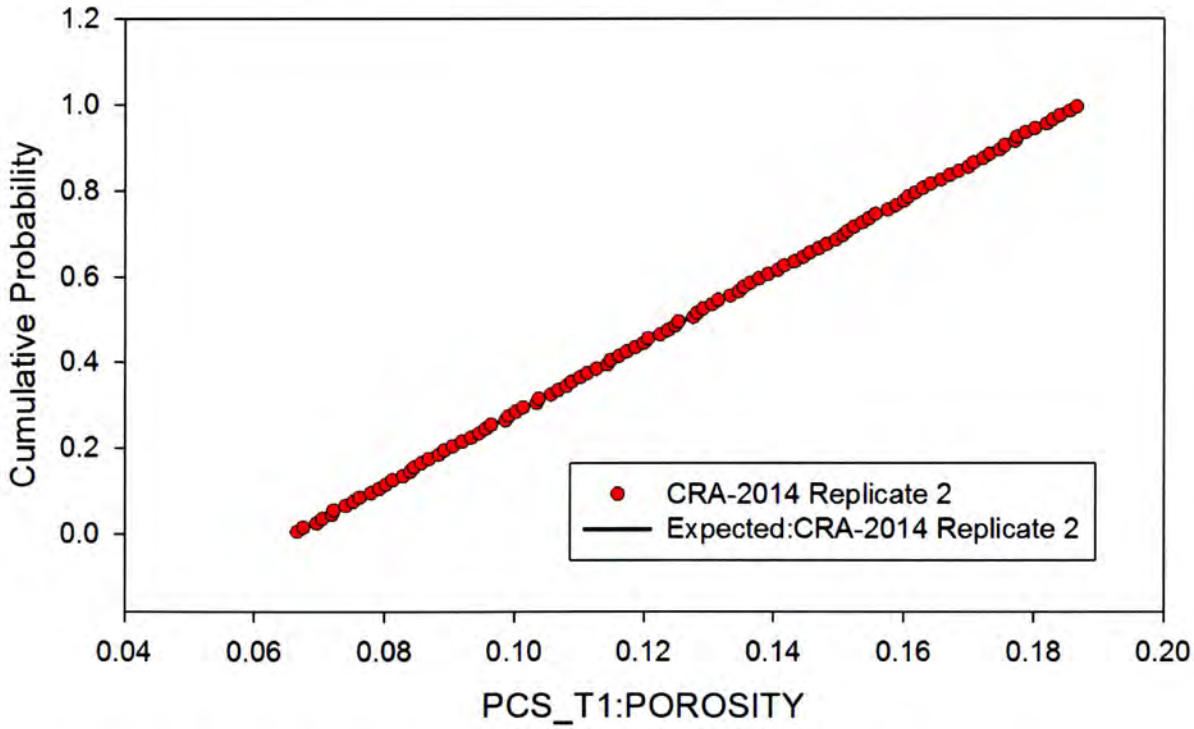

Figure 84. Observed and Expected CDFs for PCS_T1:POROSITY (Uniform Distribution) Replicate 2.

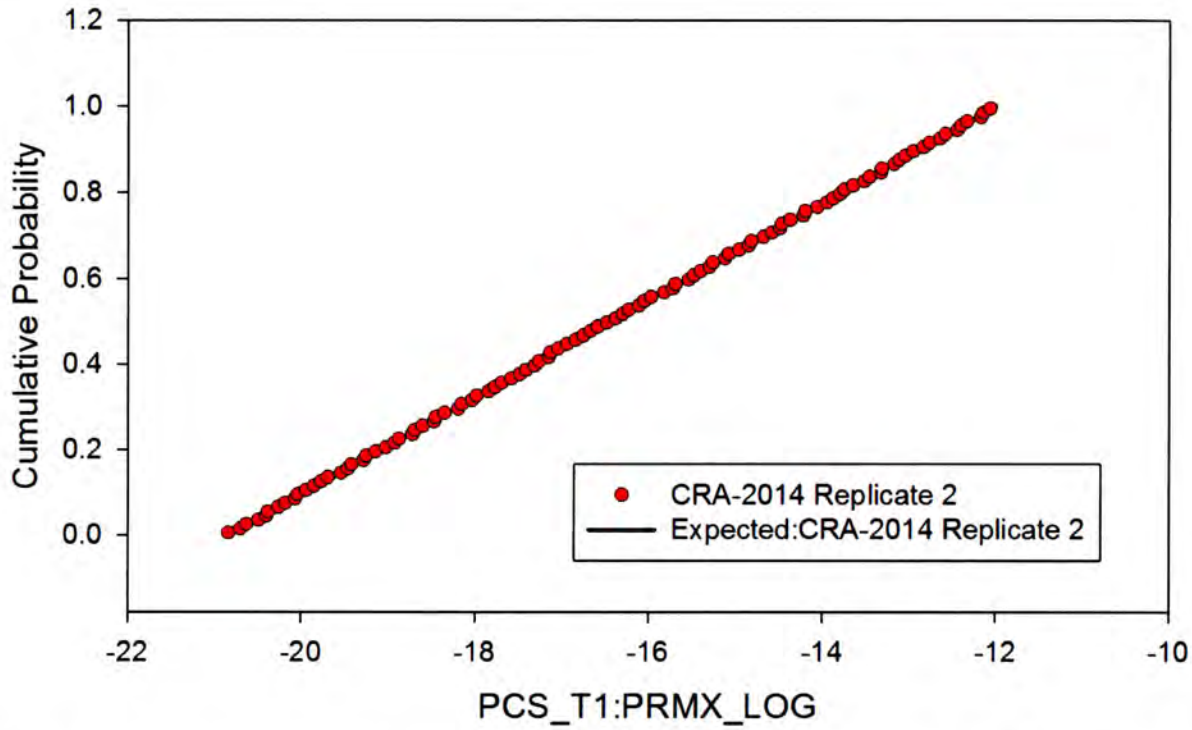

Figure 85. Observed and Expected CDFs for PCS_T1:PRMX_LOG (Uniform Distribution) Replicate 2.

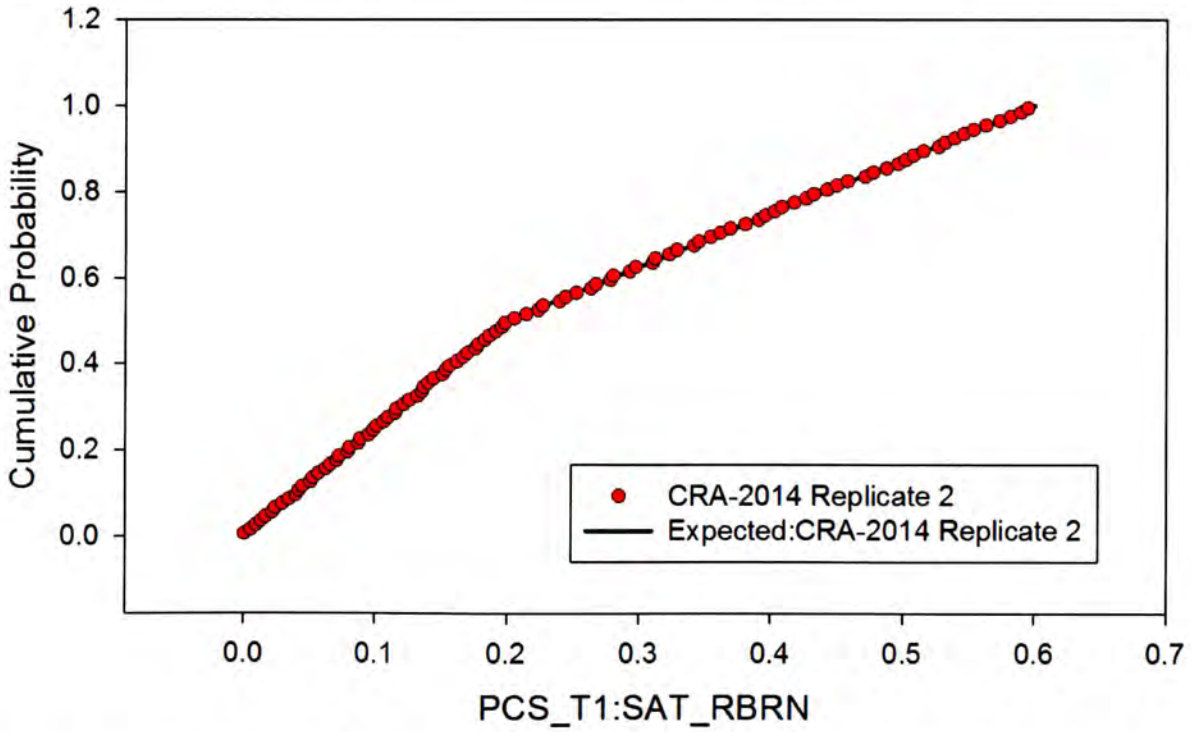

Figure 86. Observed and Expected CDFs for PCS_T1:SAT_RBRN (User Continuous Distribution) Replicate 2.

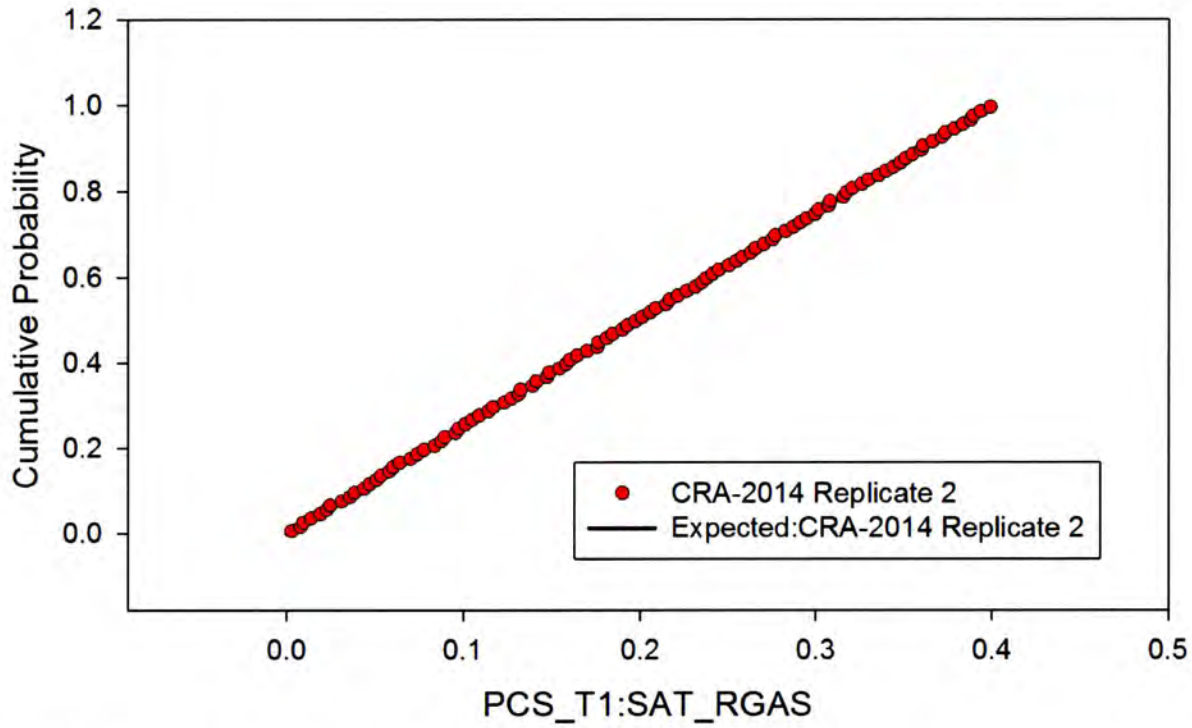

Figure 87. Observed and Expected CDFs for PCS_T1:SAT_RGAS (Uniform Distribution) Replicate 2.

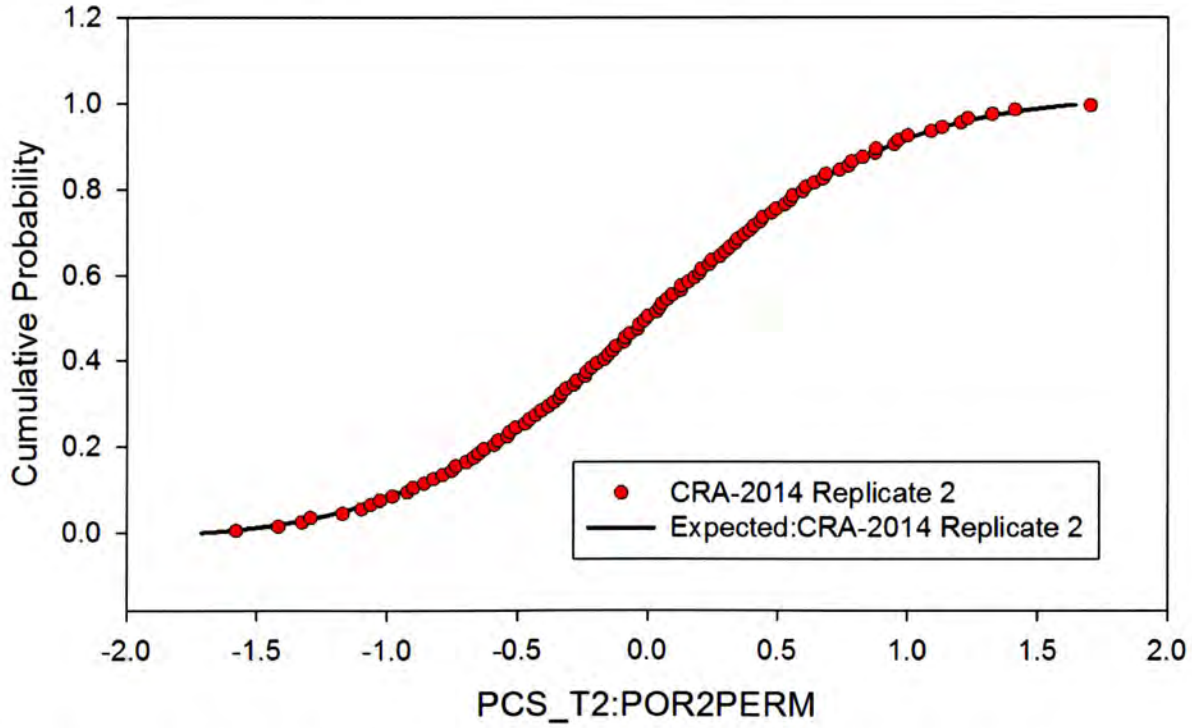

Figure 88. Observed and Expected CDFs for PCS_T2:POR2PERM (Normal Distribution) Replicate 2.

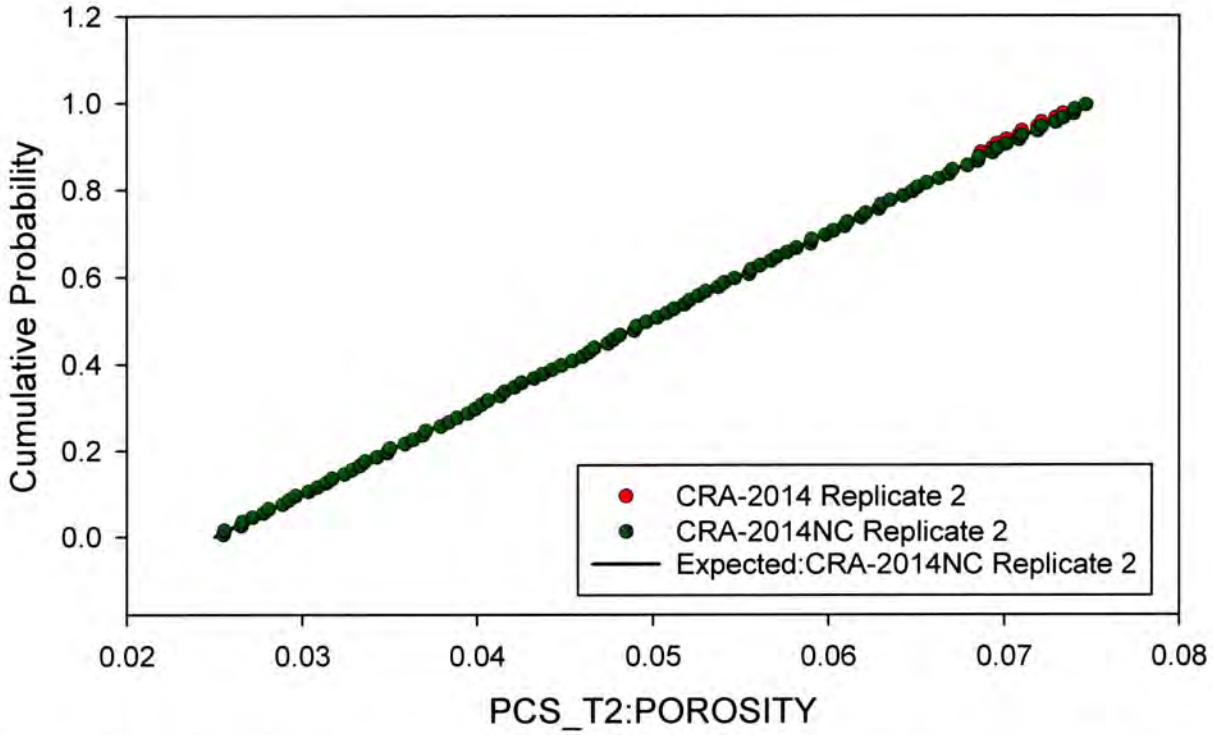

Figure 89. Observed and Expected CDFs for PCS_T2:POROSITY (Uniform Distribution) Replicate 2 also showing the data prior to conditioning (NC)

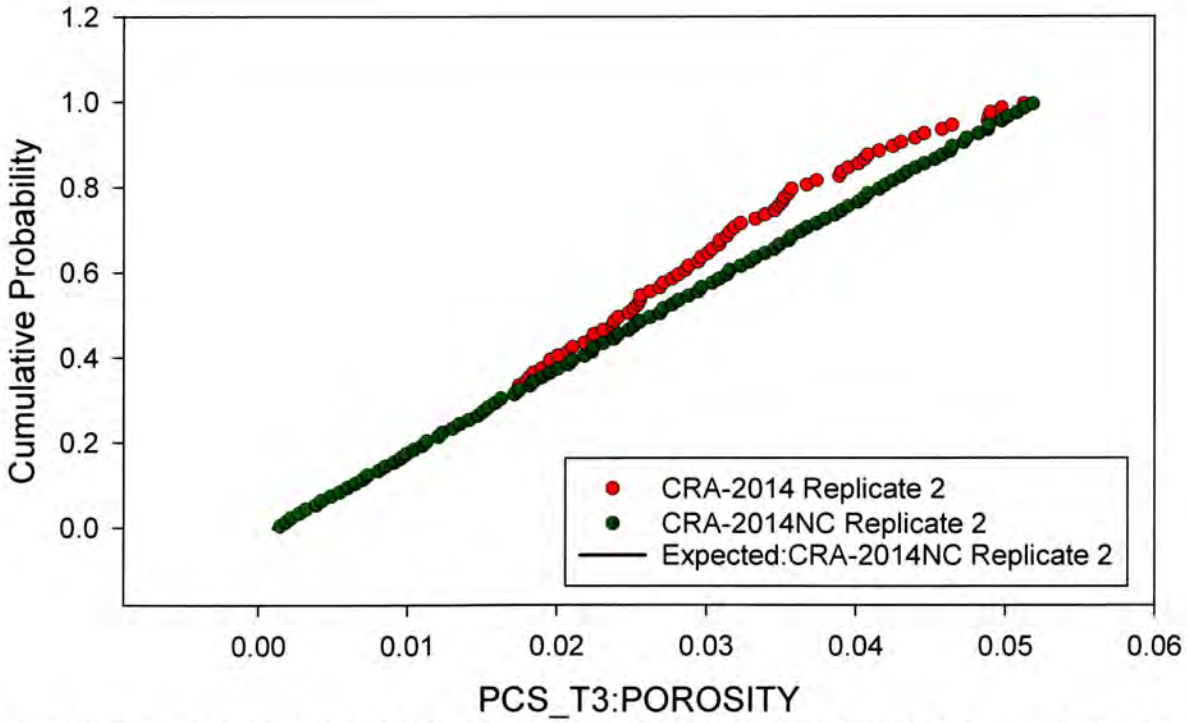

Figure 90. Observed and Expected CDFs for PCS_T3:POROSITY (Uniform Distribution) Replicate 2 also showing the data prior to conditioning (NC).

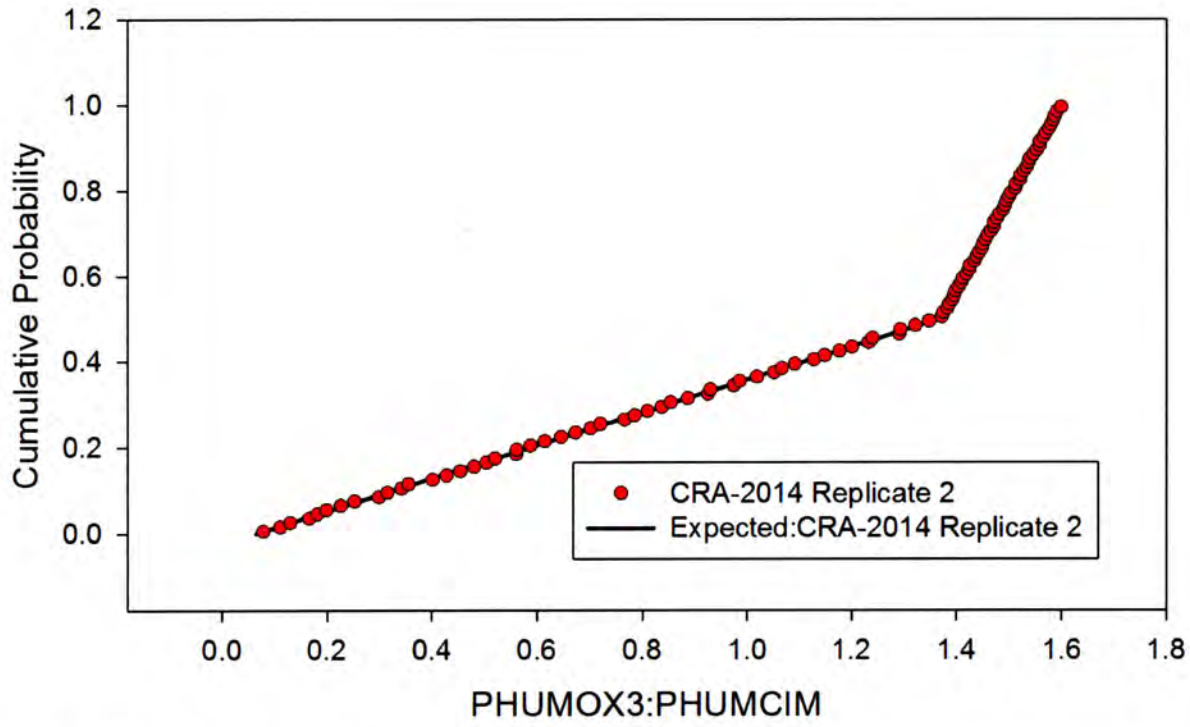

Figure 91. Observed and Expected CDFs for PHUMOX3:PHUMCIM (User Continuous Distribution) Replicate 2.

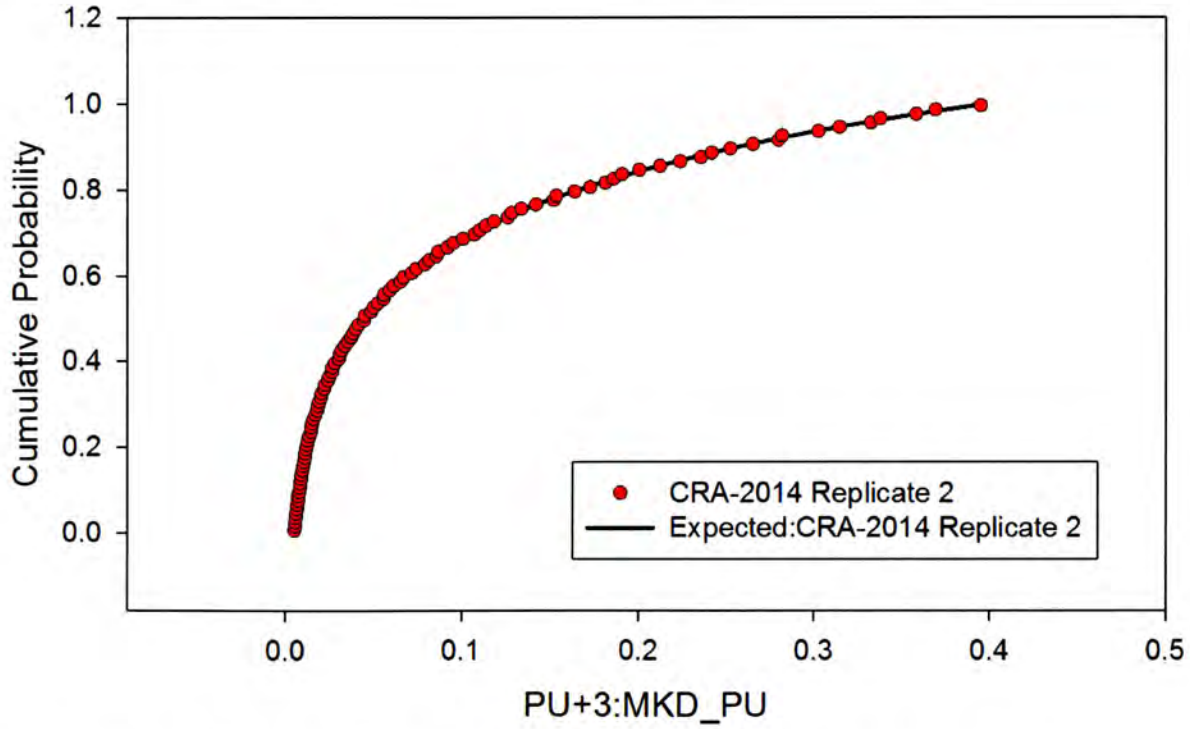

Figure 92. Observed and Expected CDFs for PU+3:MKD_PU (Loguniform Distribution) Replicate 2.

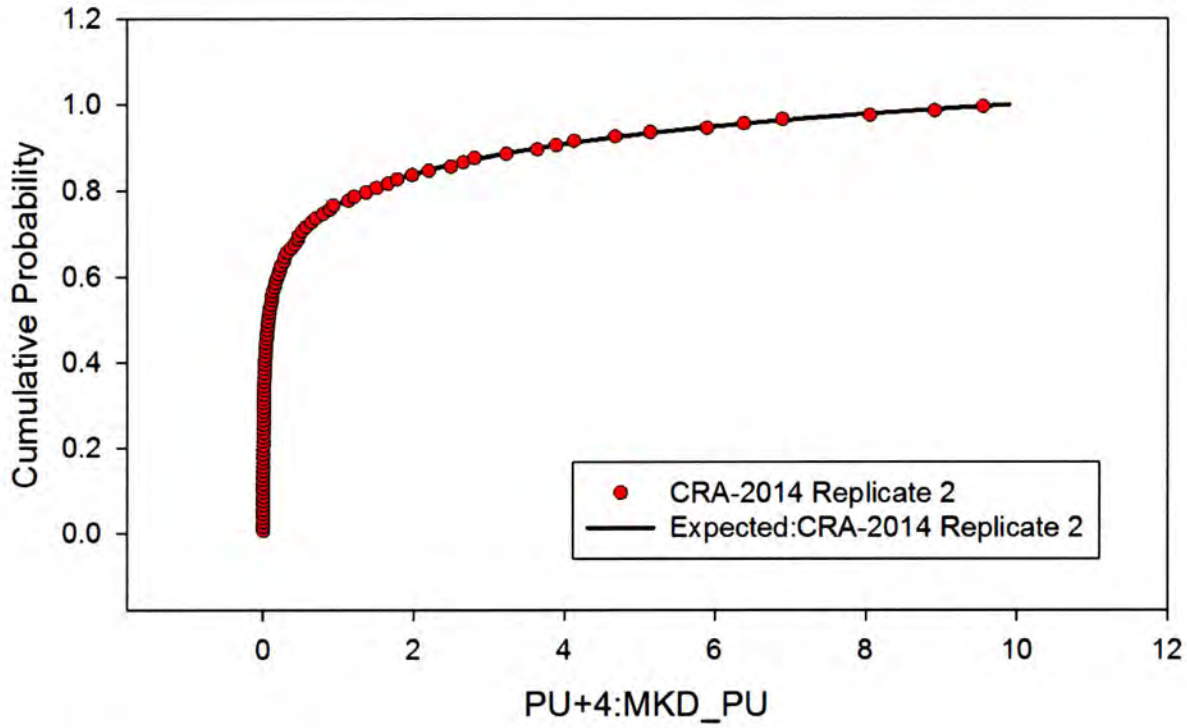

Figure 93. Observed and Expected CDFs for PU+4:MKD_PU (Loguniform Distribution) Replicate 2.

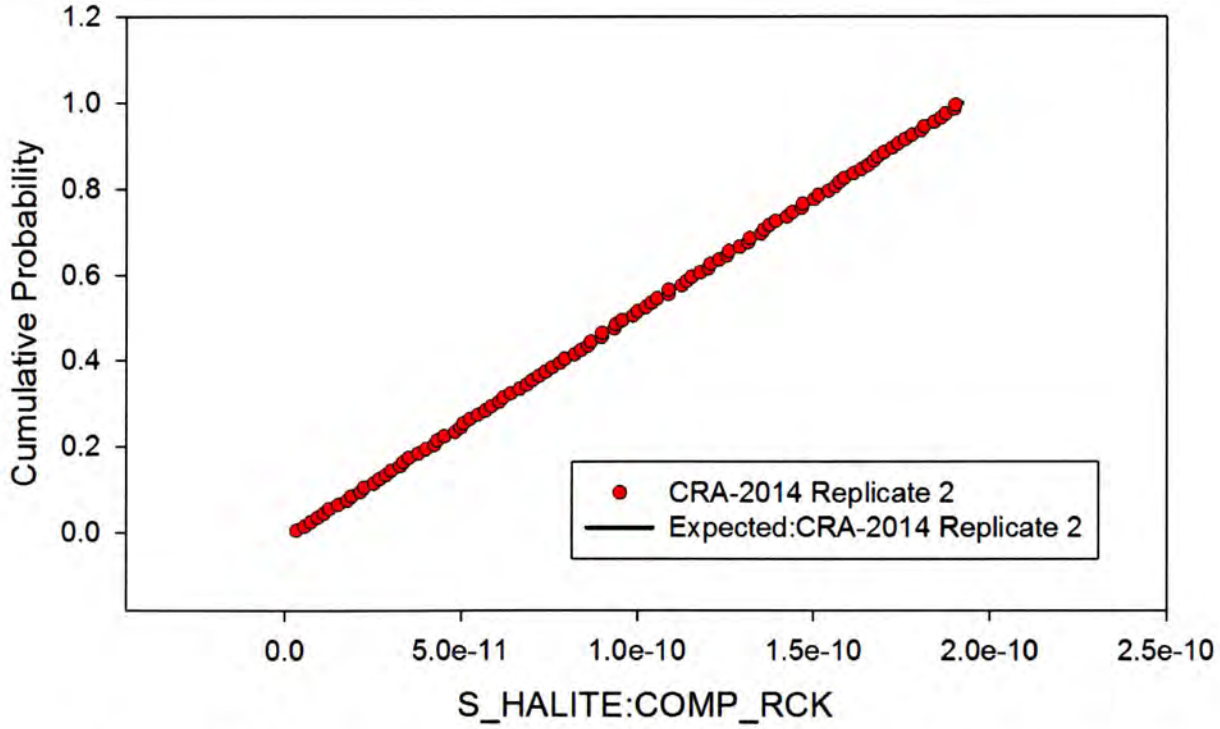

Figure 94. Observed and Expected CDFs for S_HALITE:COMP_RCK (Uniform Distribution) Replicate 2.

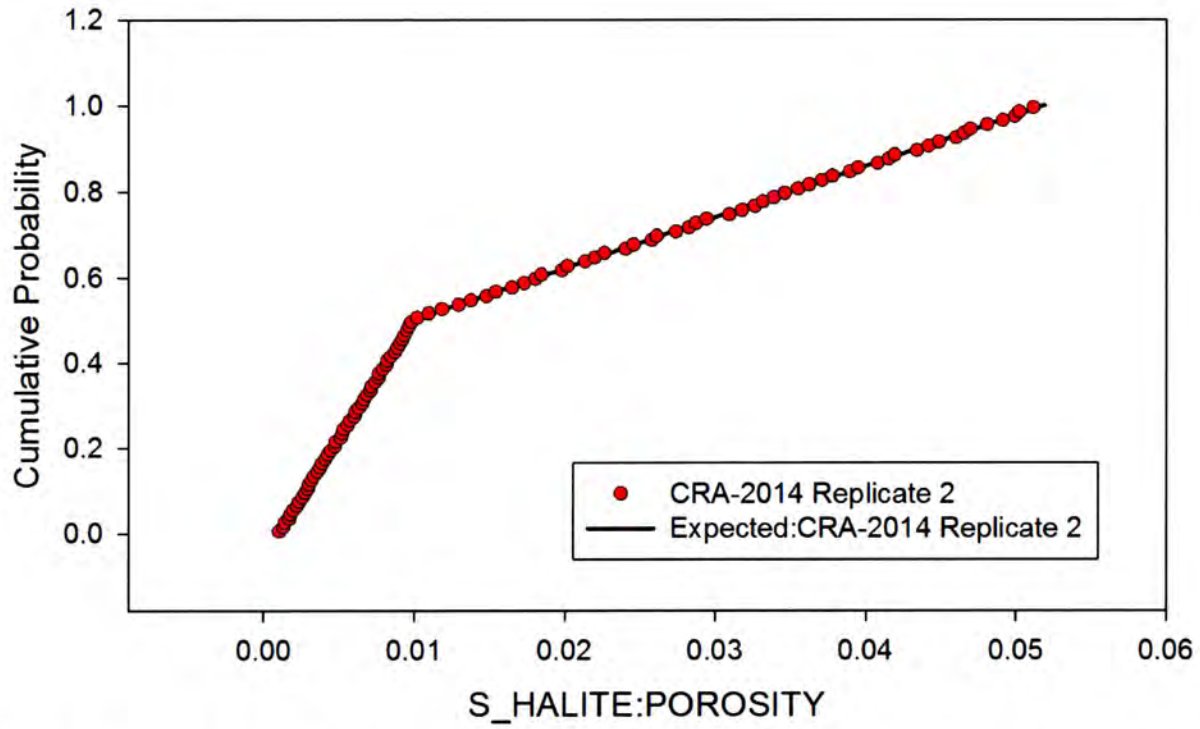

Figure 95. Observed and Expected CDFs for S_HALITE:POROSITY (User Continuous Distribution) Replicate 2.

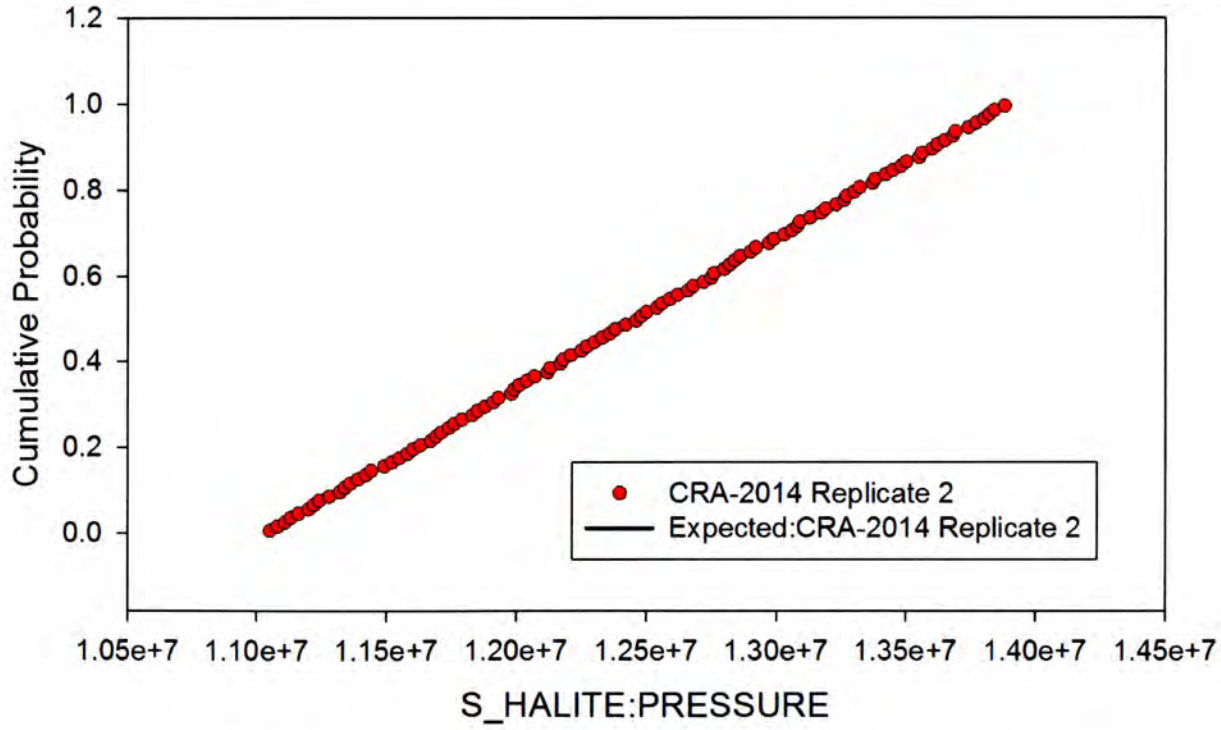

Figure 96. Observed and Expected CDFs for S_HALITE:PRESSURE (Uniform Distribution) Replicate 2.

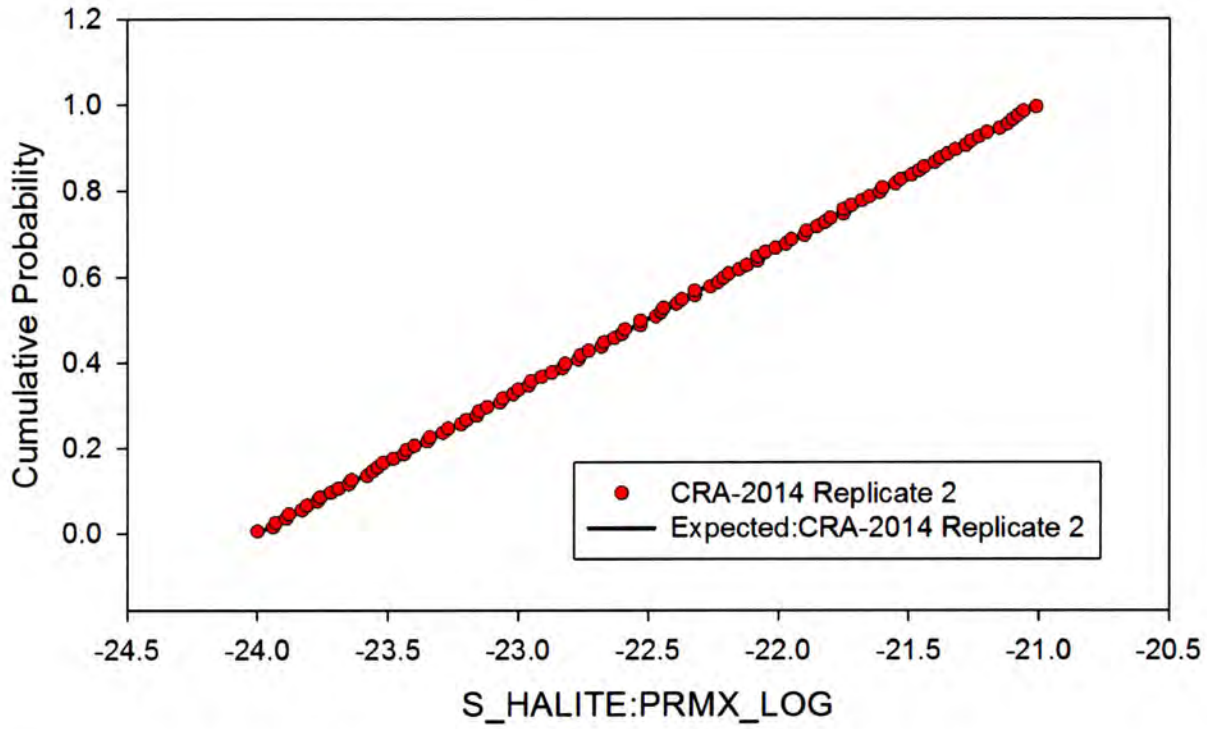

Figure 97. Observed and Expected CDFs for S_HALITE:PRMX_LOG (Uniform Distribution) Replicate 2.

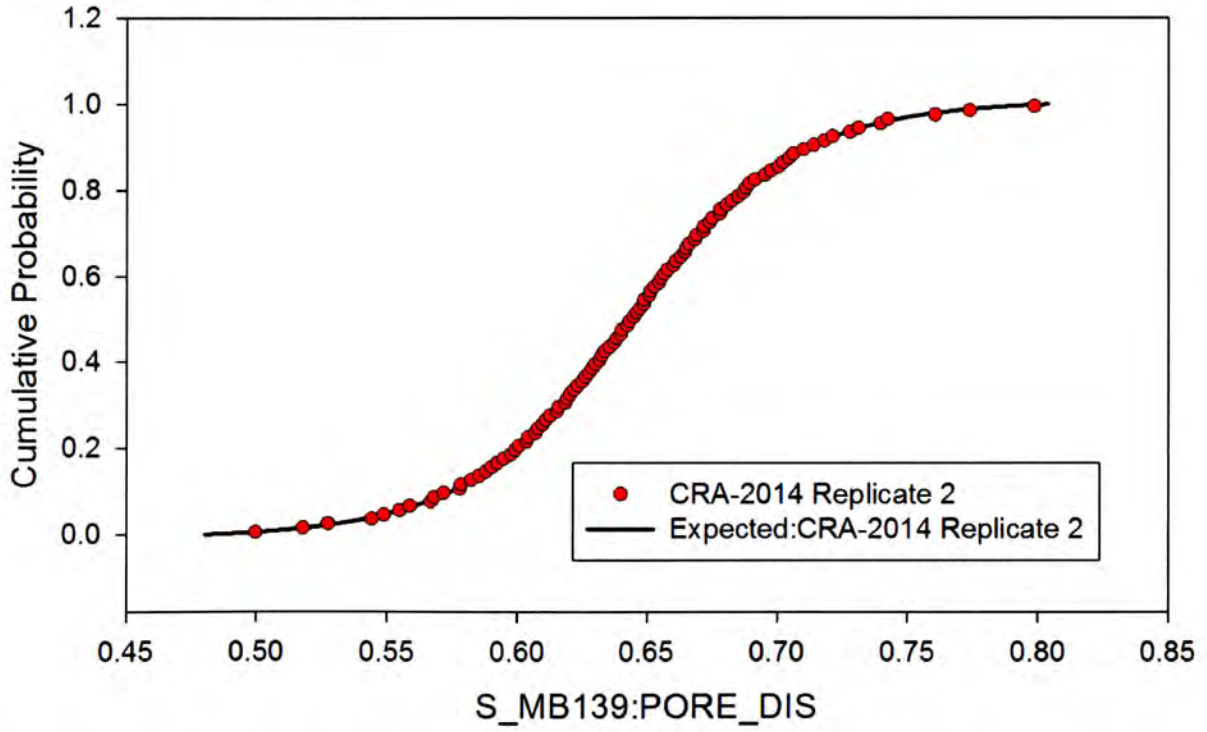

Figure 98. Observed and Expected CDFs for S_MB139:PORE_DIS (Student Distribution) Replicate 2.

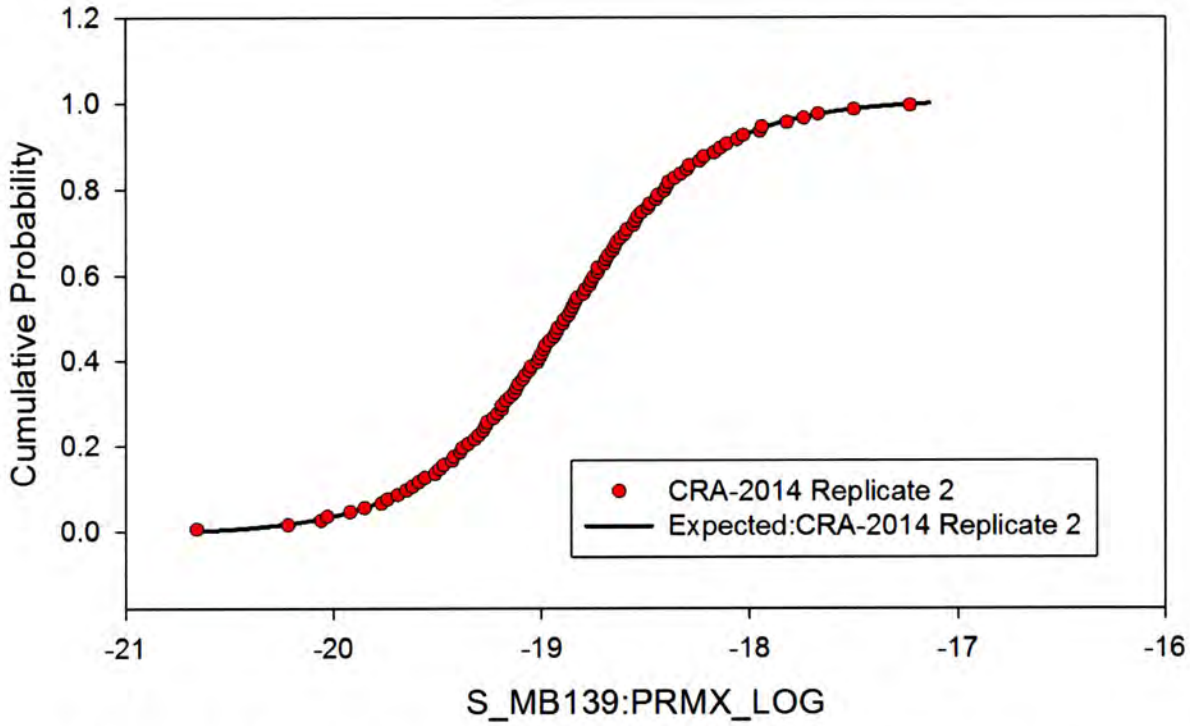

Figure 99. Observed and Expected CDFs for S_MB139:PRMX_LOG (Student Distribution) Replicate 2.

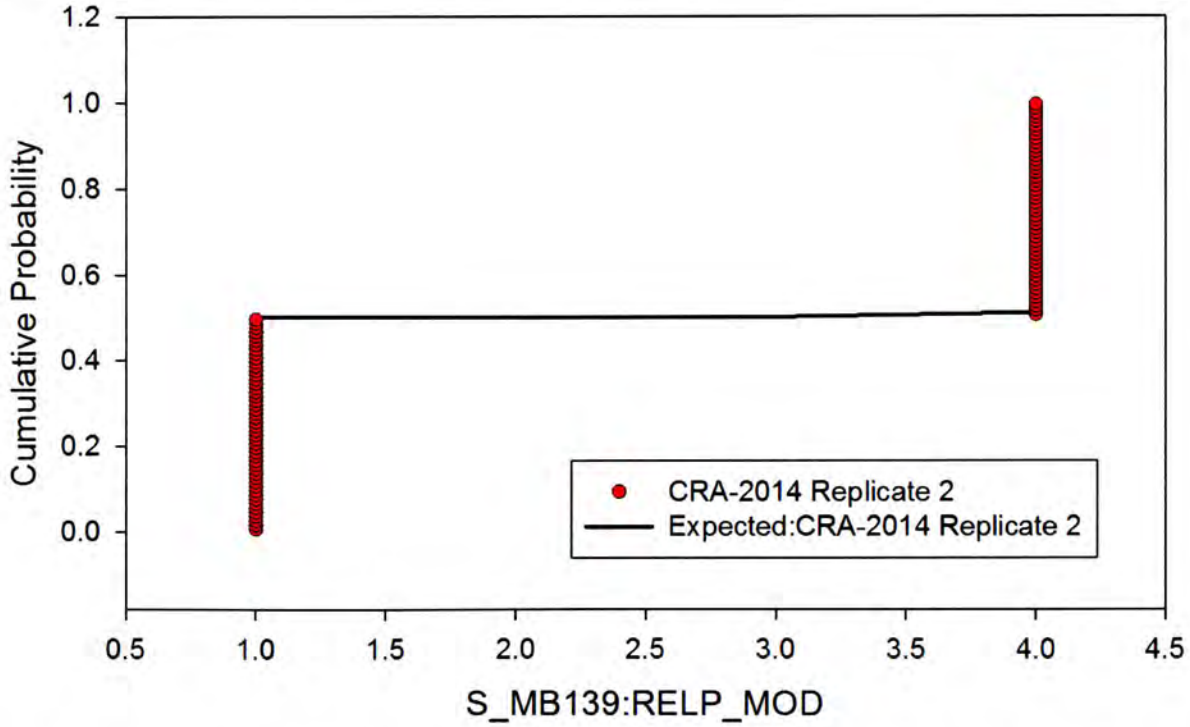

Figure 100. Observed and Expected CDFs for S_MB139:RELP_MOD (User Discrete (Delta) Distribution) Replicate 2.

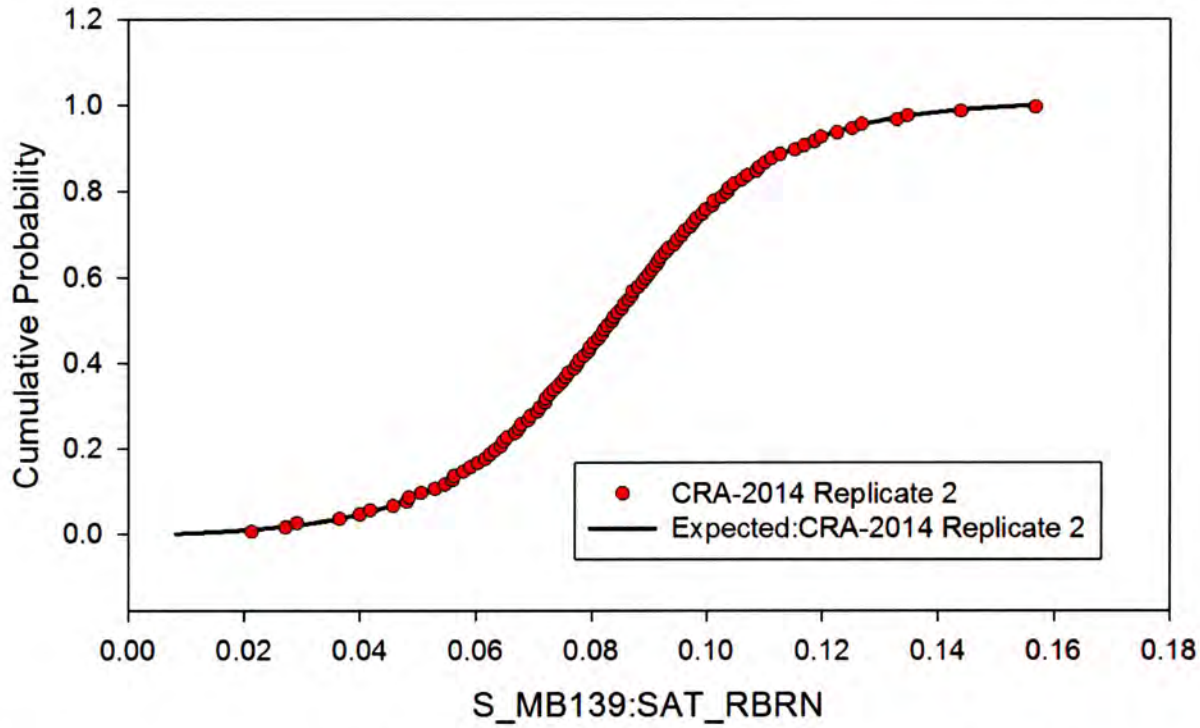

Figure 101. Observed and Expected CDFs for S_MB139:SAT_RBRN (Student Distribution) Replicate 2.

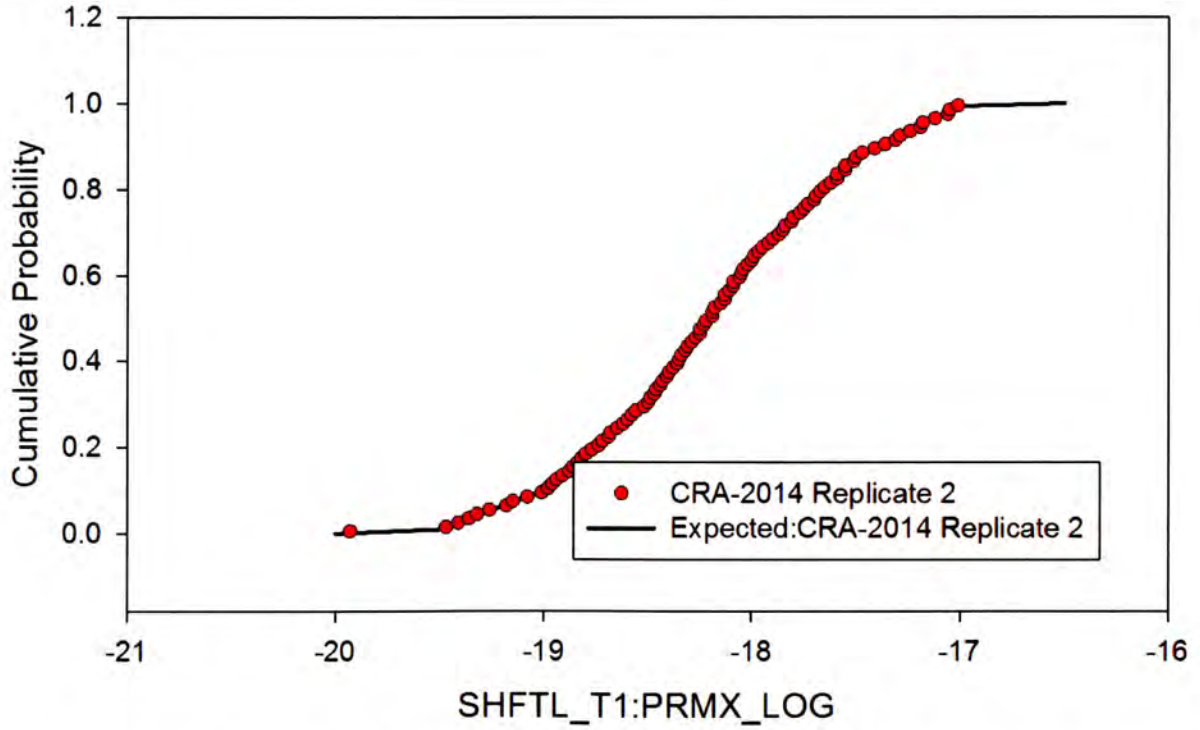

Figure 102. Observed and Expected CDFs for SHFTL_T1:PRMX_LOG (User Continuous Distribution) Replicate 2.

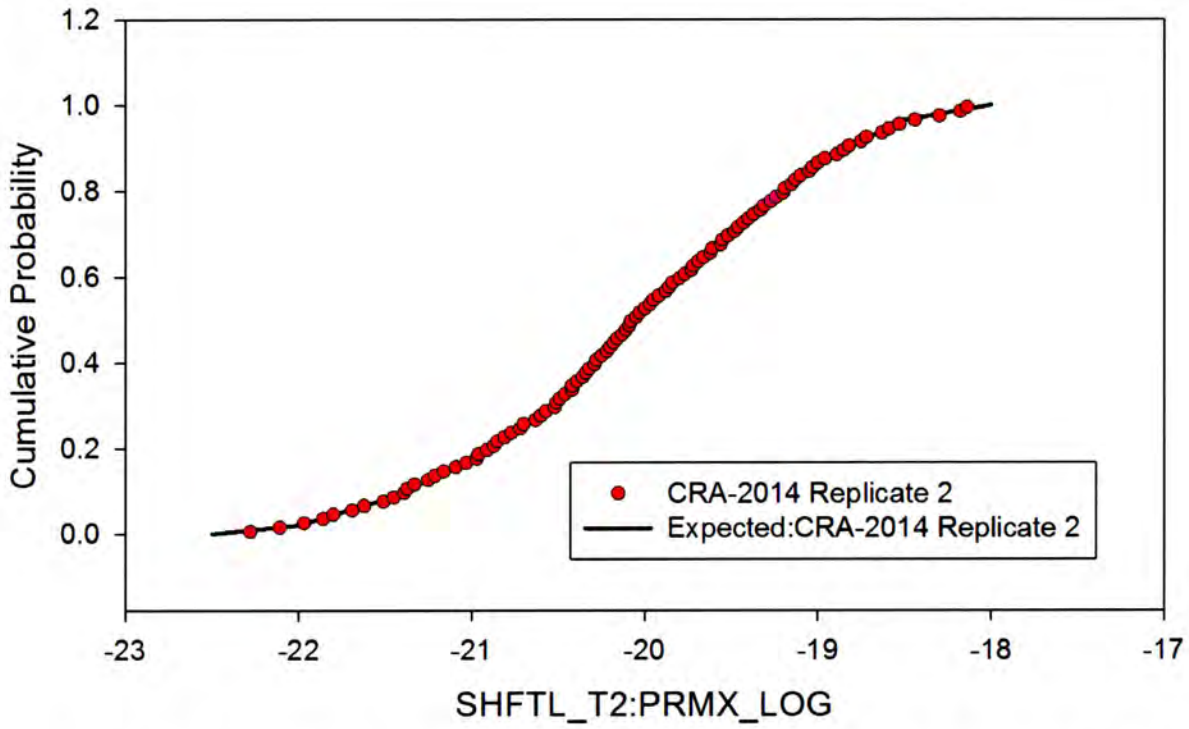

Figure 103. Observed and Expected CDFs for SHFTL_T2:PRMX_LOG (User Continuous Distribution) Replicate 2.

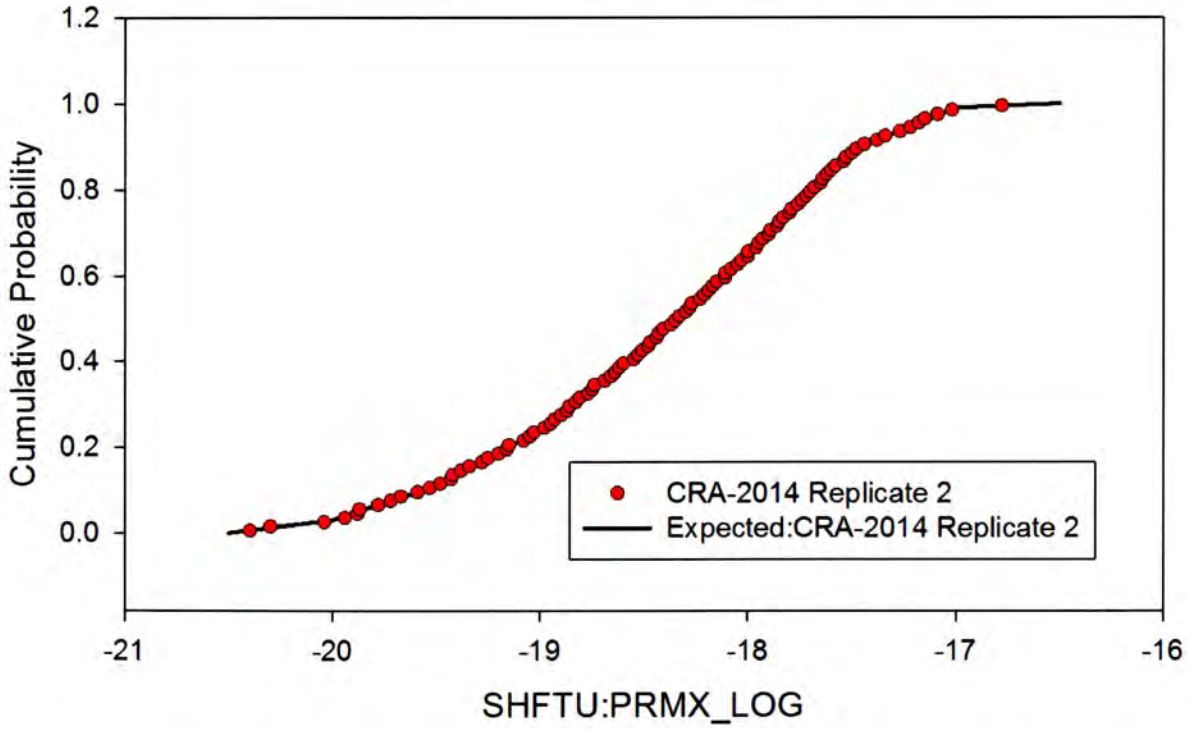

Figure 104. Observed and Expected CDFs for SHFTU:PRMX_LOG (User Continuous Distribution) Replicate 2.

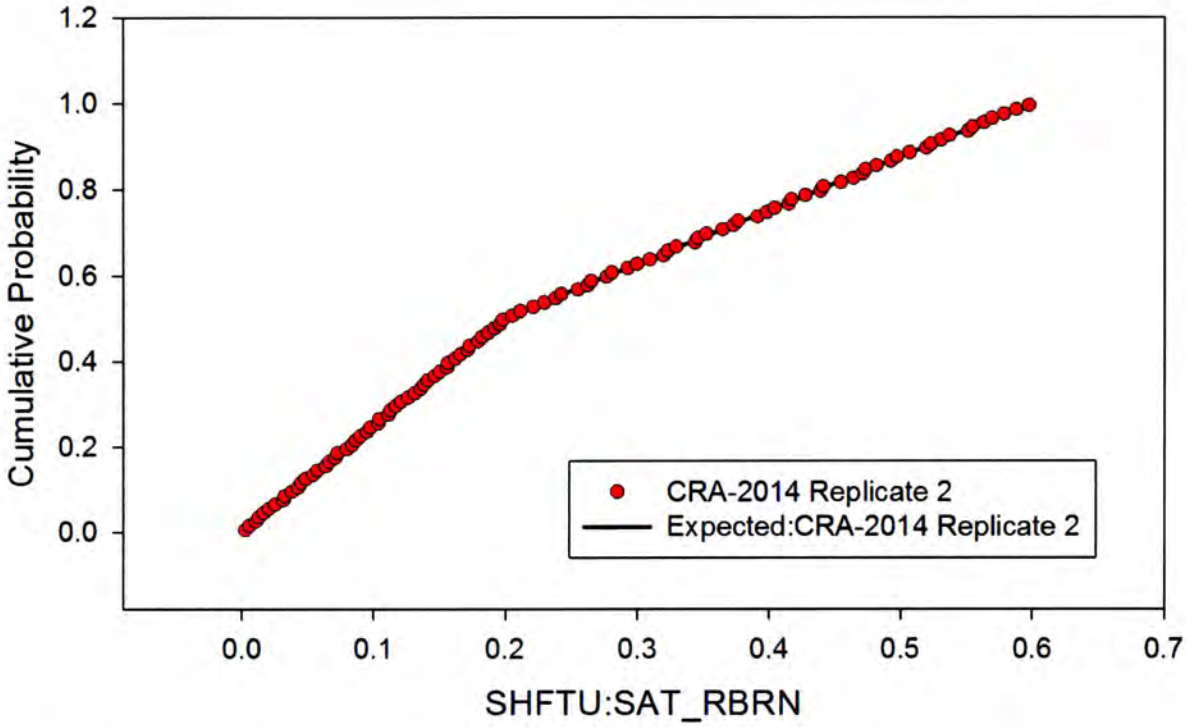

Figure 105. Observed and Expected CDFs for SHFTU:SAT_RBRN (User Continuous Distribution) Replicate 2.

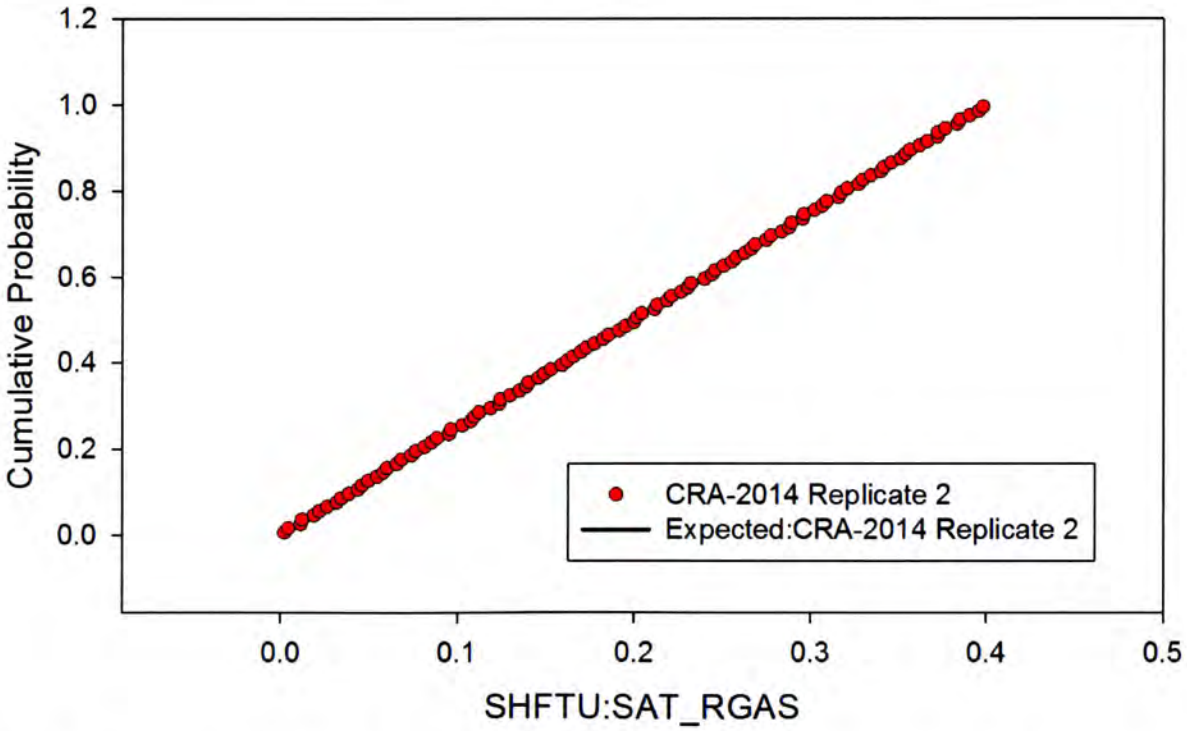

Figure 106. Observed and Expected CDFs for SHFTU:SAT_RGAS (Uniform Distribution) Replicate 2.

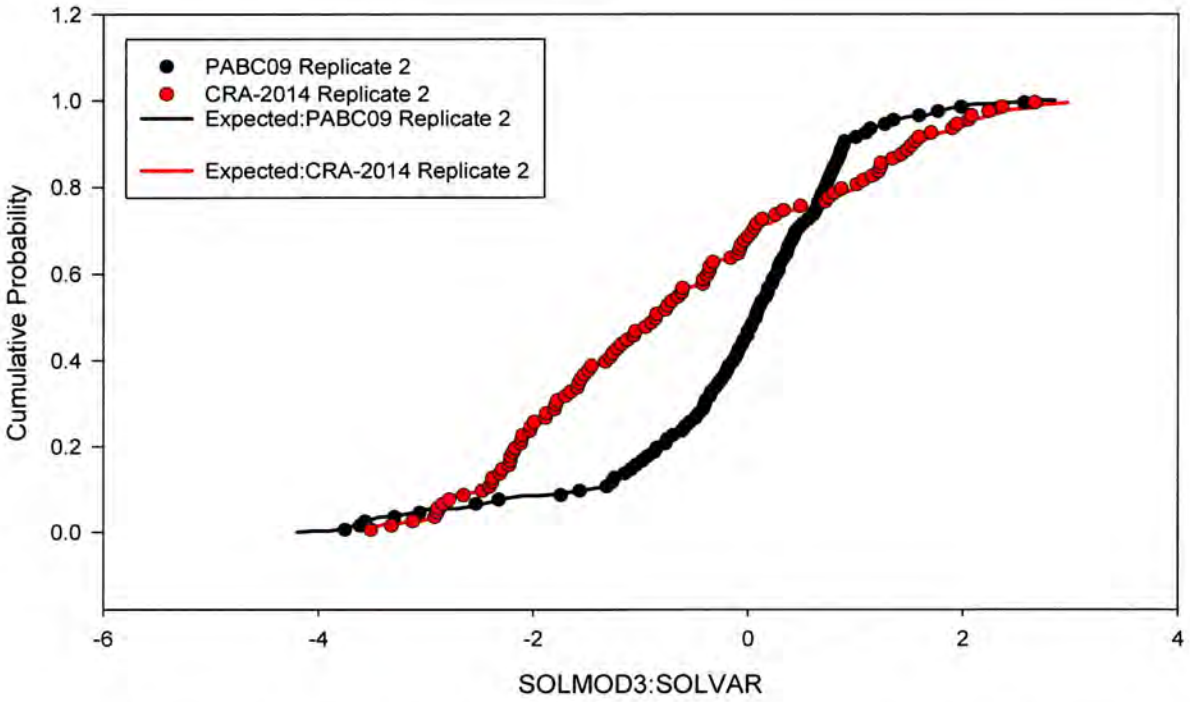

Figure 107. Observed and Expected CDFs for SOLMOD3:SOLVAR (User Continuous Distribution) Replicate 2 for PABC09 and CRA-2014.

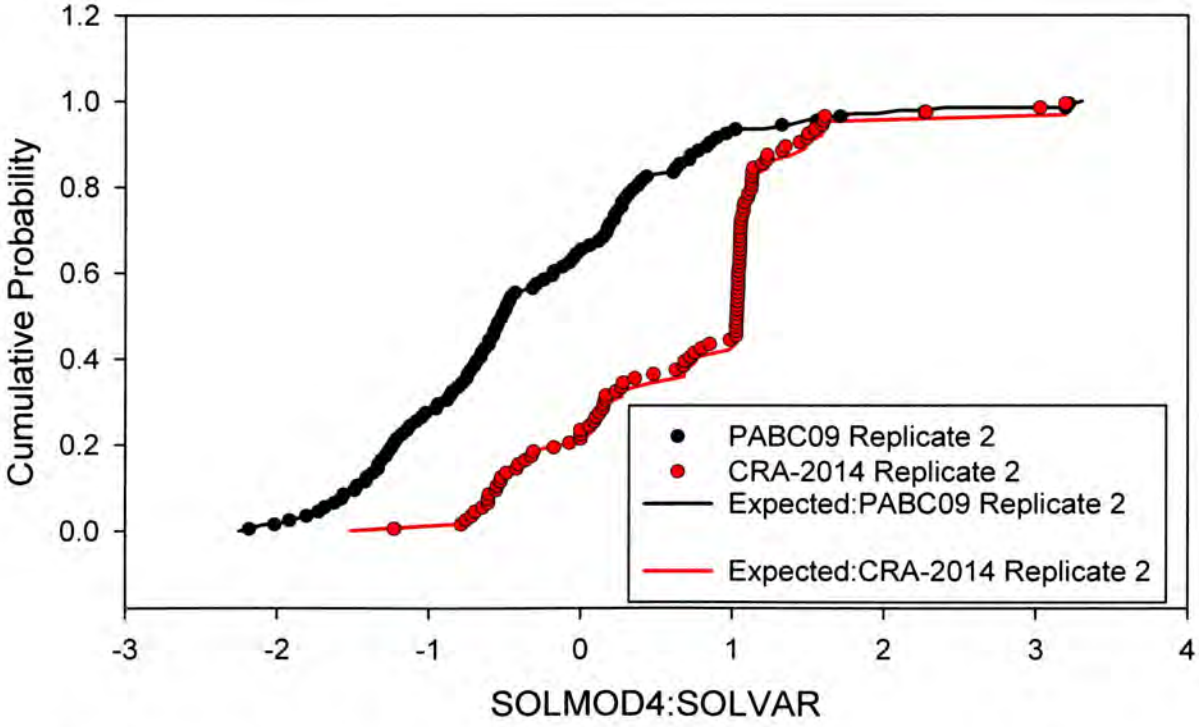

Figure 108. Observed and Expected CDFs for SOLMOD4:SOLVAR (User Continuous Distribution) Replicate 2 for PABC09 and CRA-2014.

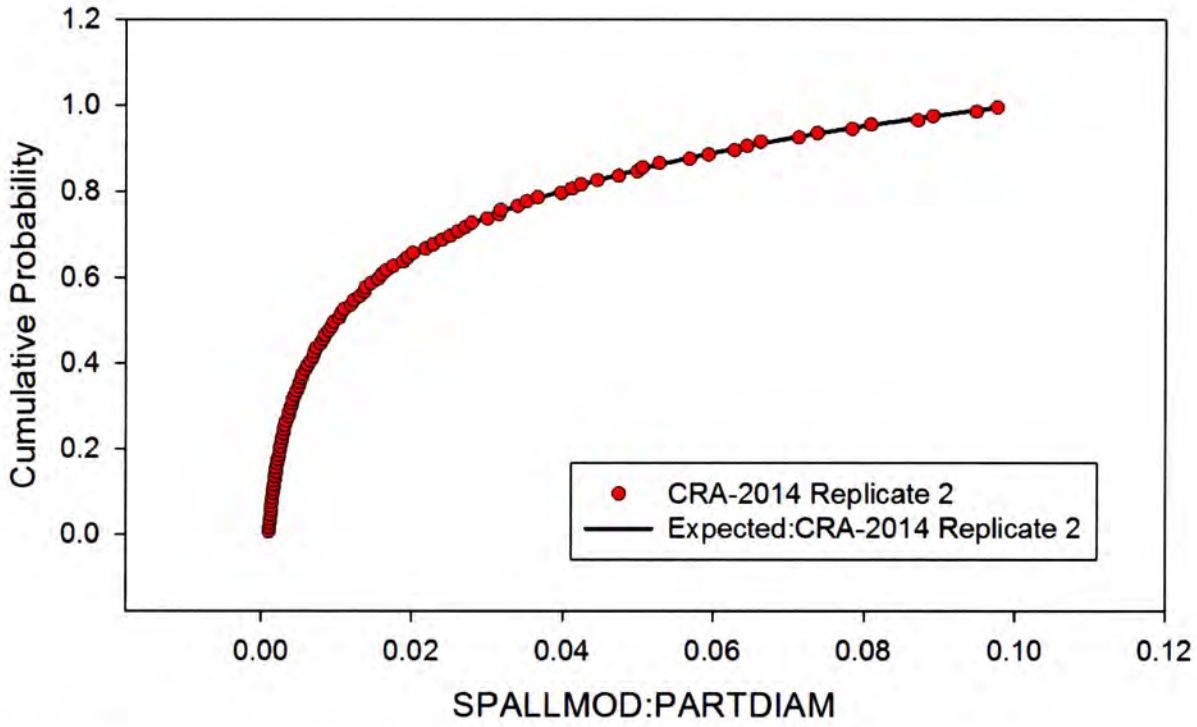

Figure 109. Observed and Expected CDFs for SPALLMOD:PARTDIAM (Loguniform Distribution) Replicate 2.

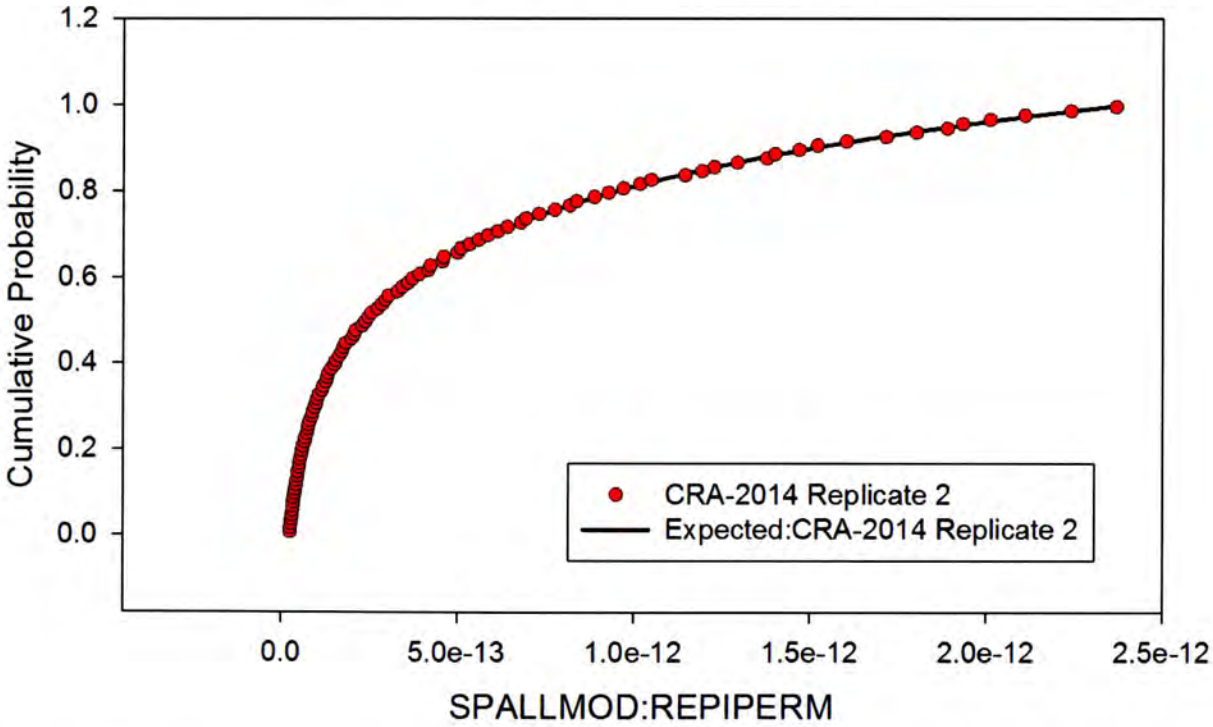

Figure 110. Observed and Expected CDFs for SPALLMOD:REPIPERM (Loguniform Distribution) Replicate 2.

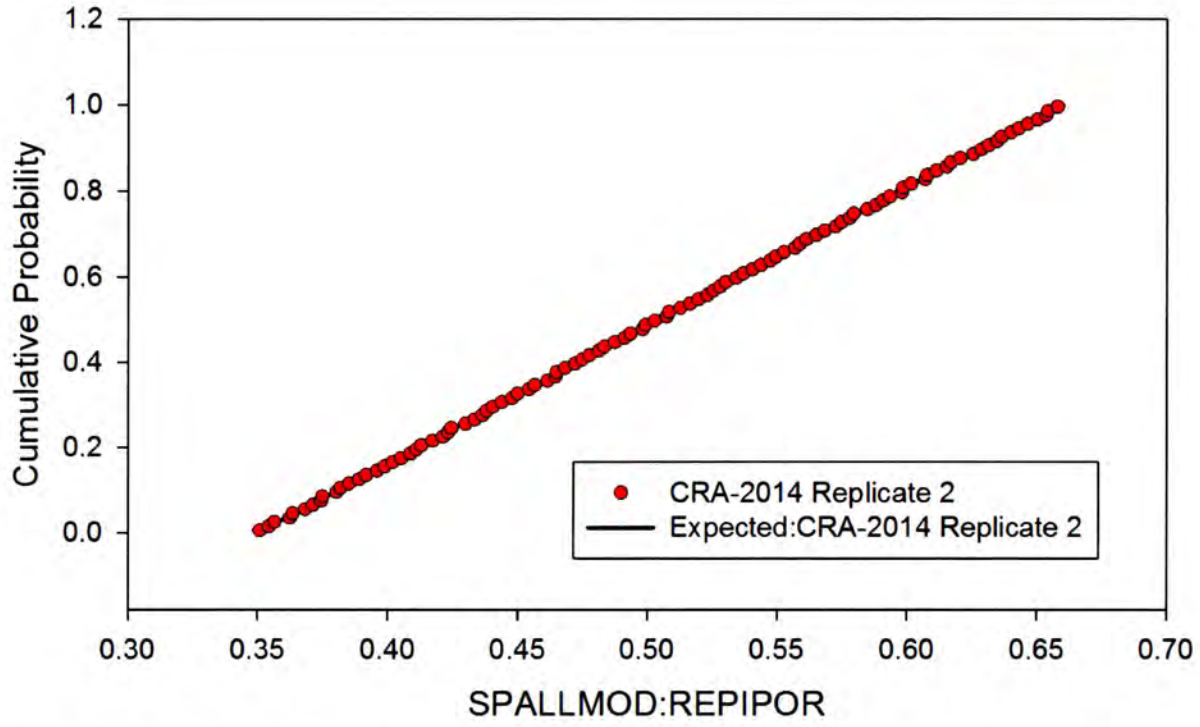

Figure 111. Observed and Expected CDFs for SPALLMOD:REPIPOR (Uniform Distribution) Replicate 2.

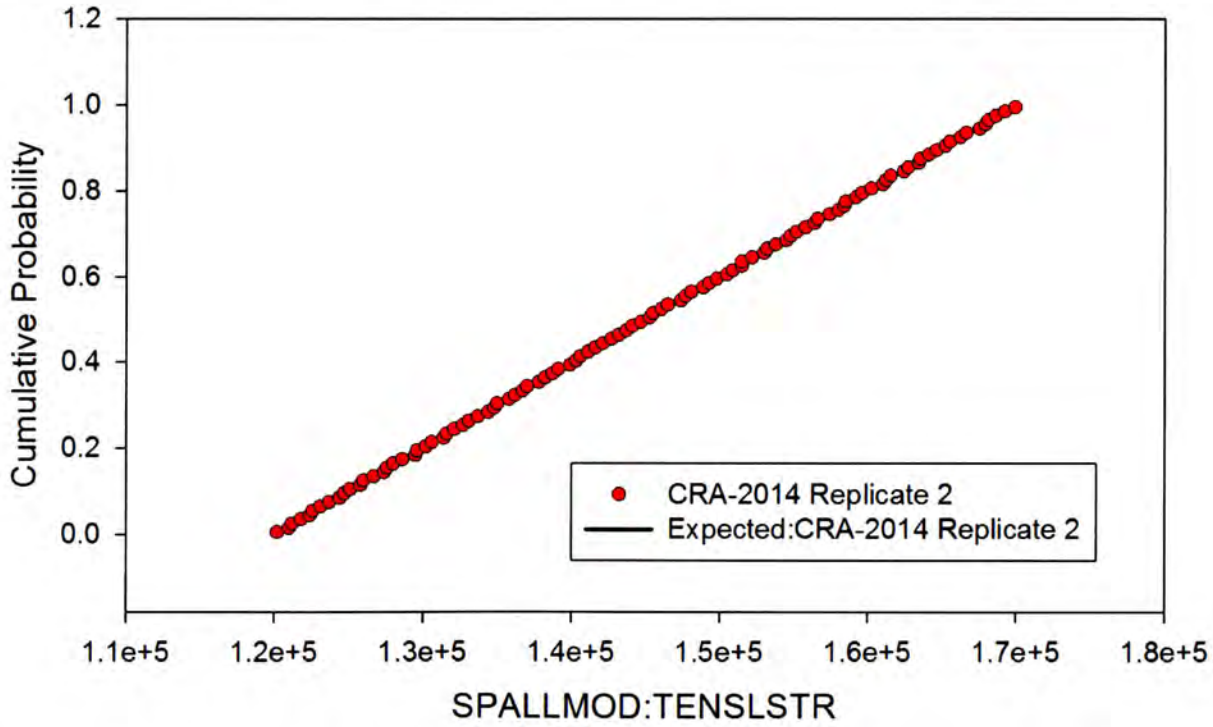

Figure 112. Observed and Expected CDFs for SPALLMOD:TENSLSTR (Uniform Distribution) Replicate 2.

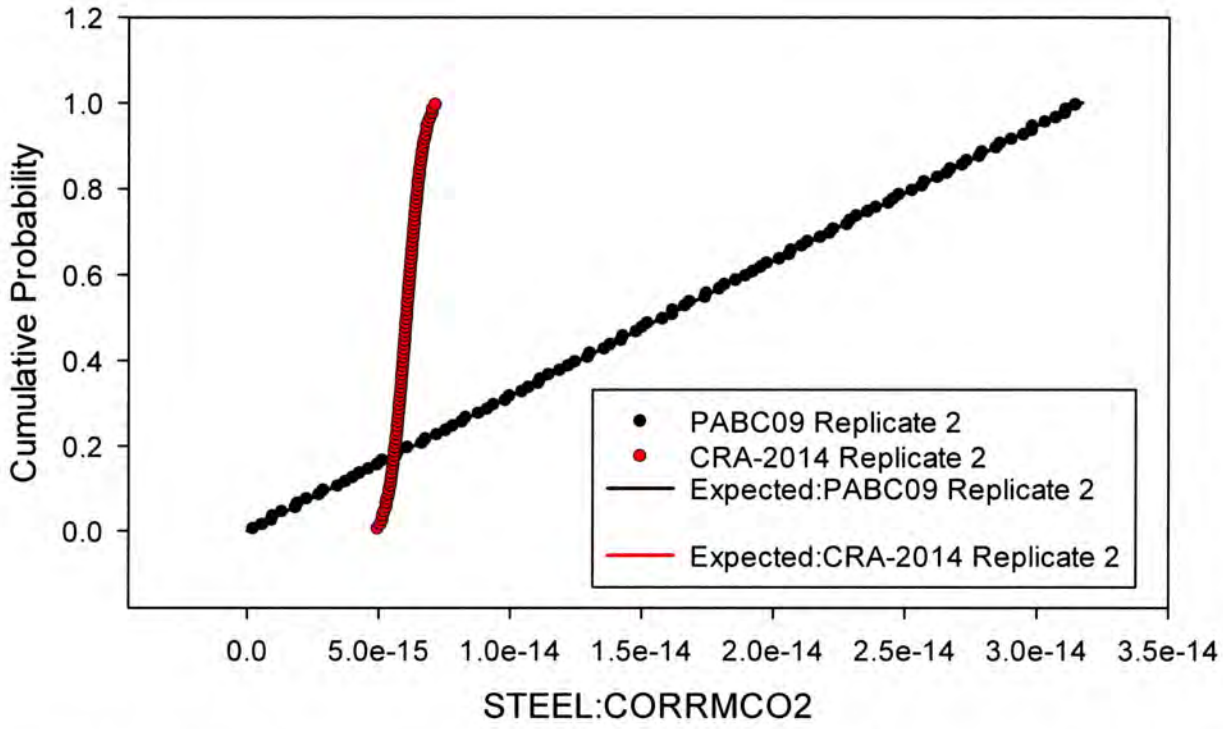

Figure 113. Observed and Expected CDFs for STEEL:CORRMCO2 Replicate 2 for CRA-2014 (Student Distribution) and PABC09 (Uniform Distribution).

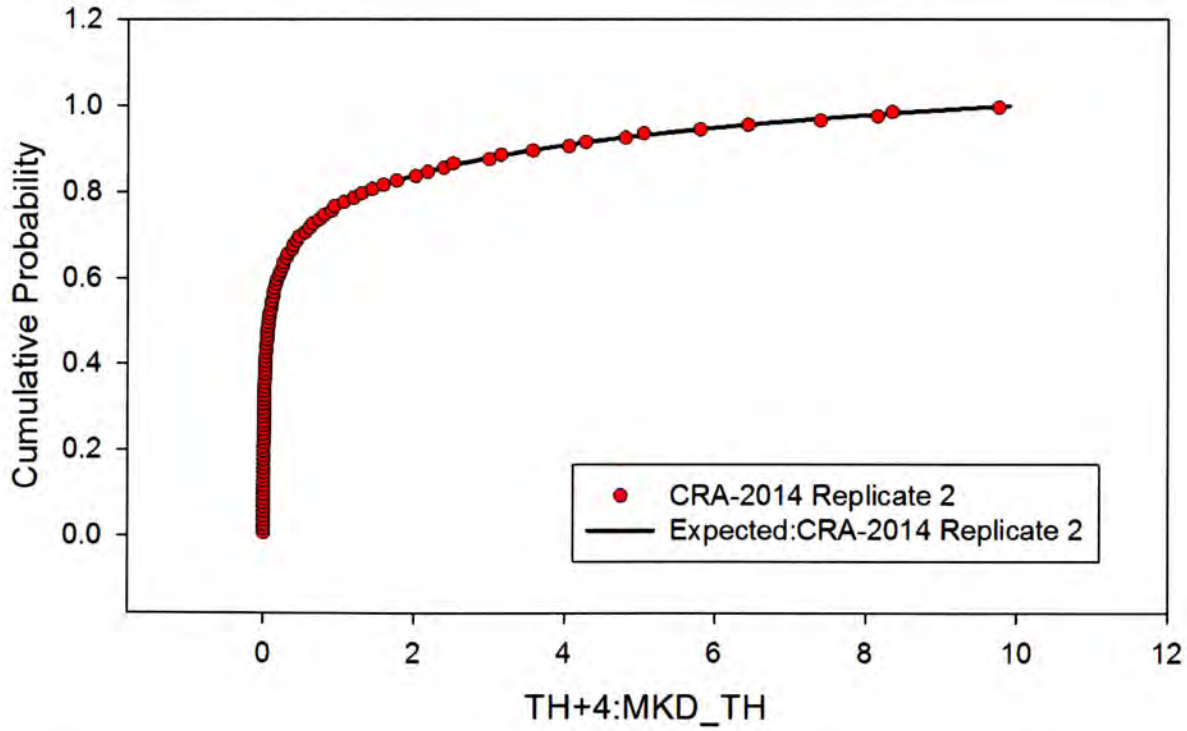

Figure 114. Observed and Expected CDFs for TH+4:MKD_TH (Loguniform Distribution) Replicate 2.

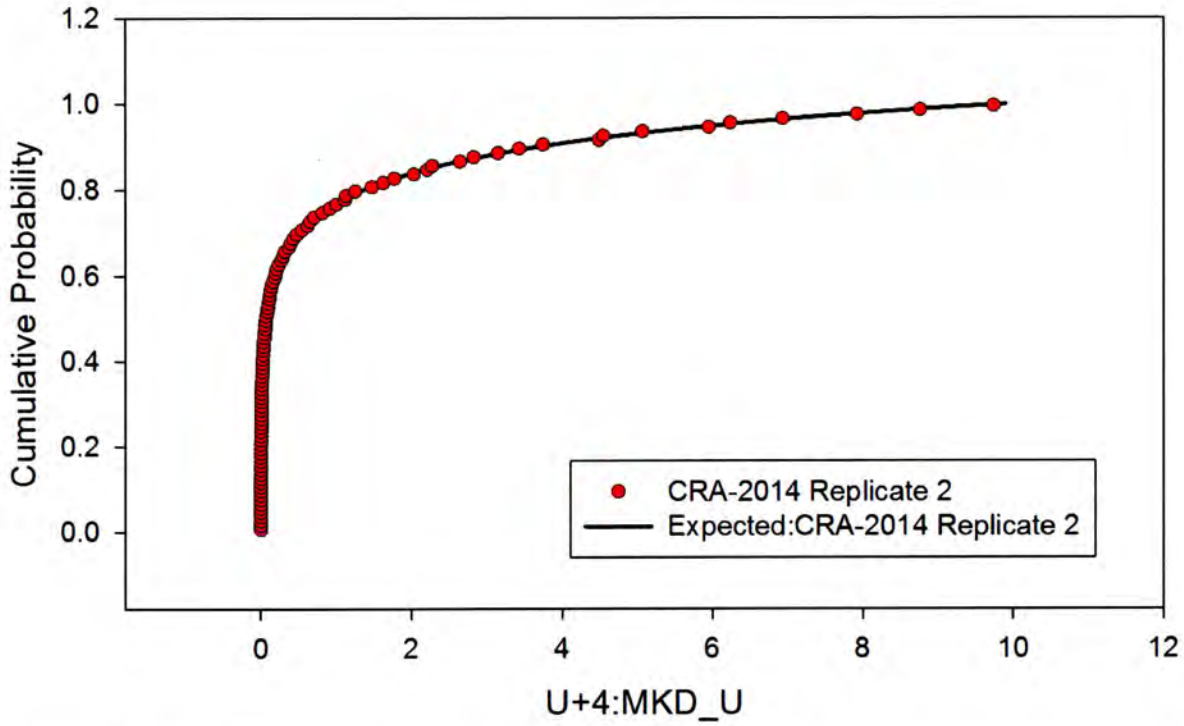

Figure 115. Observed and Expected CDFs for U+4:MKD_U (Loguniform Distribution) Replicate 2.

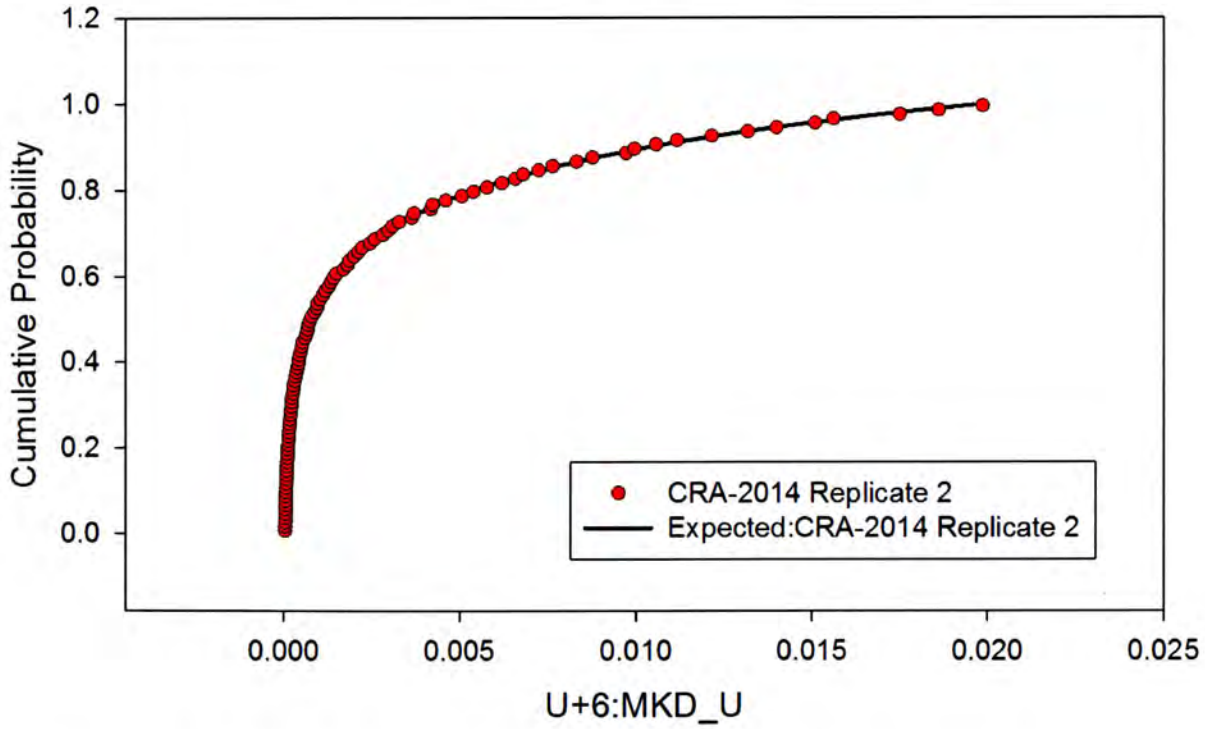

Figure 116. Observed and Expected CDFs for U+6:MKD_U (Loguniform Distribution) Replicate 2.

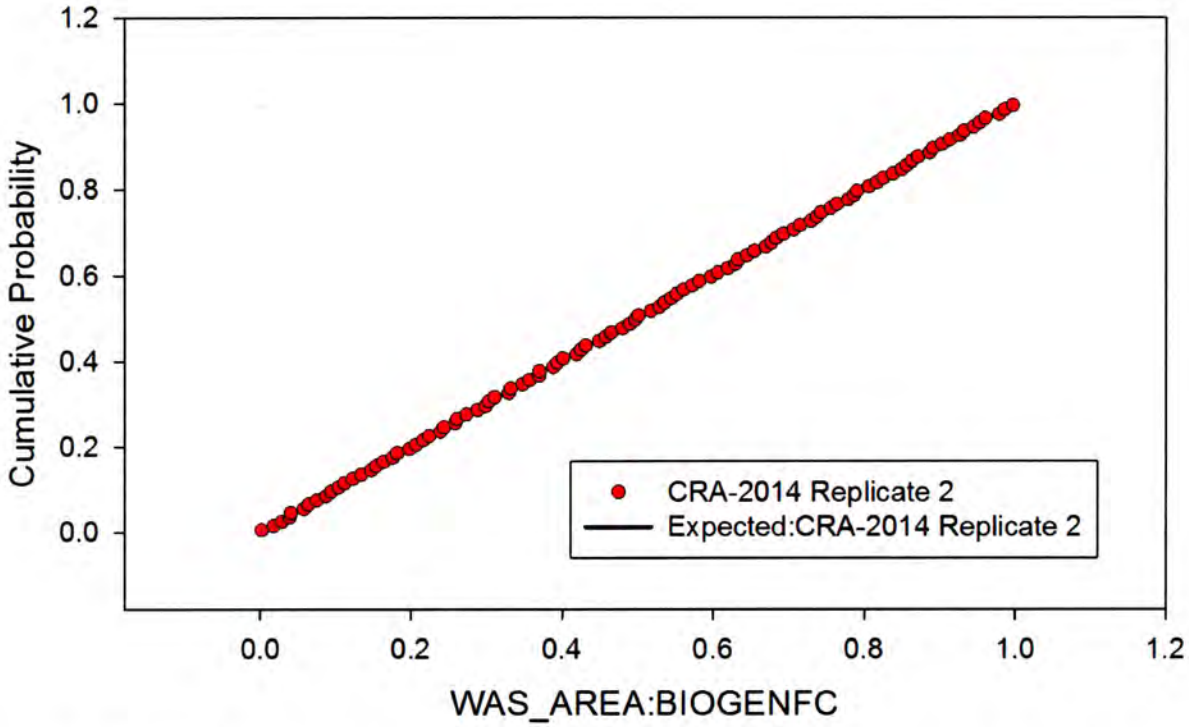

Figure 117. Observed and Expected CDFs for WAS_AREA:BIOGENFC (Uniform Distribution) Replicate 2.

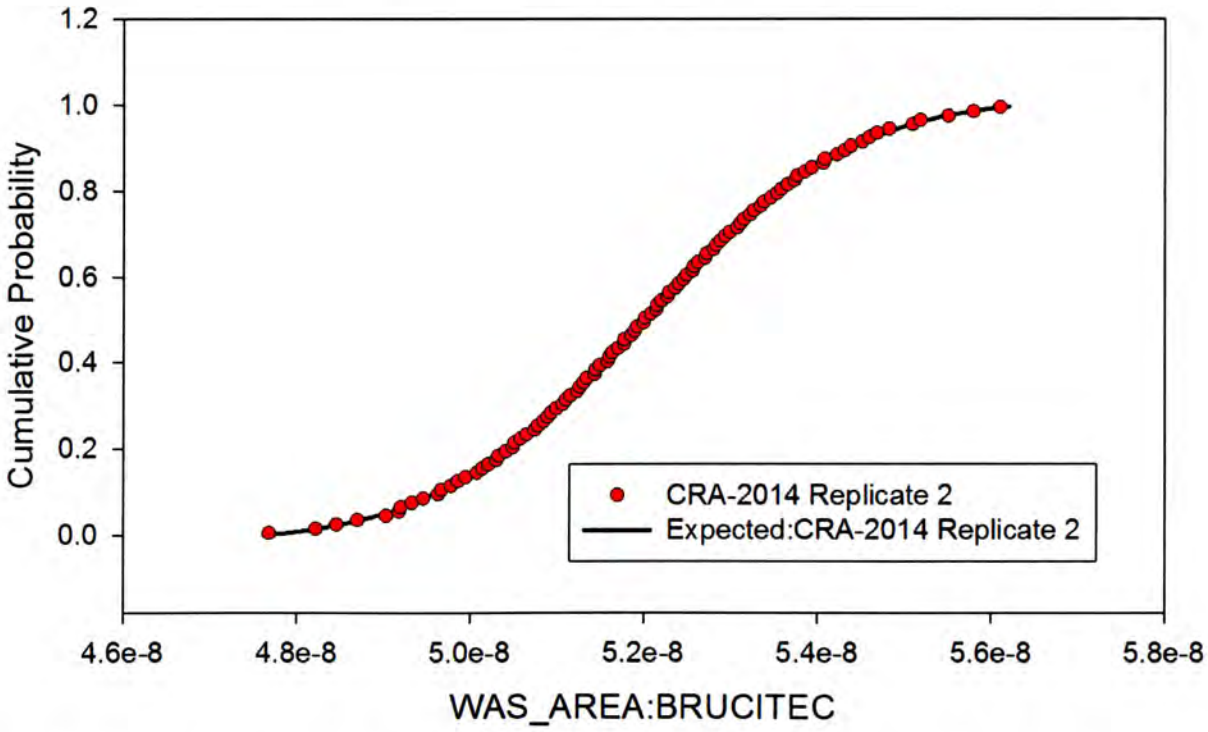

Figure 118. Observed and Expected CDFs for WAS_AREA:BRUCITEC (Normal Distribution) Replicate 2.

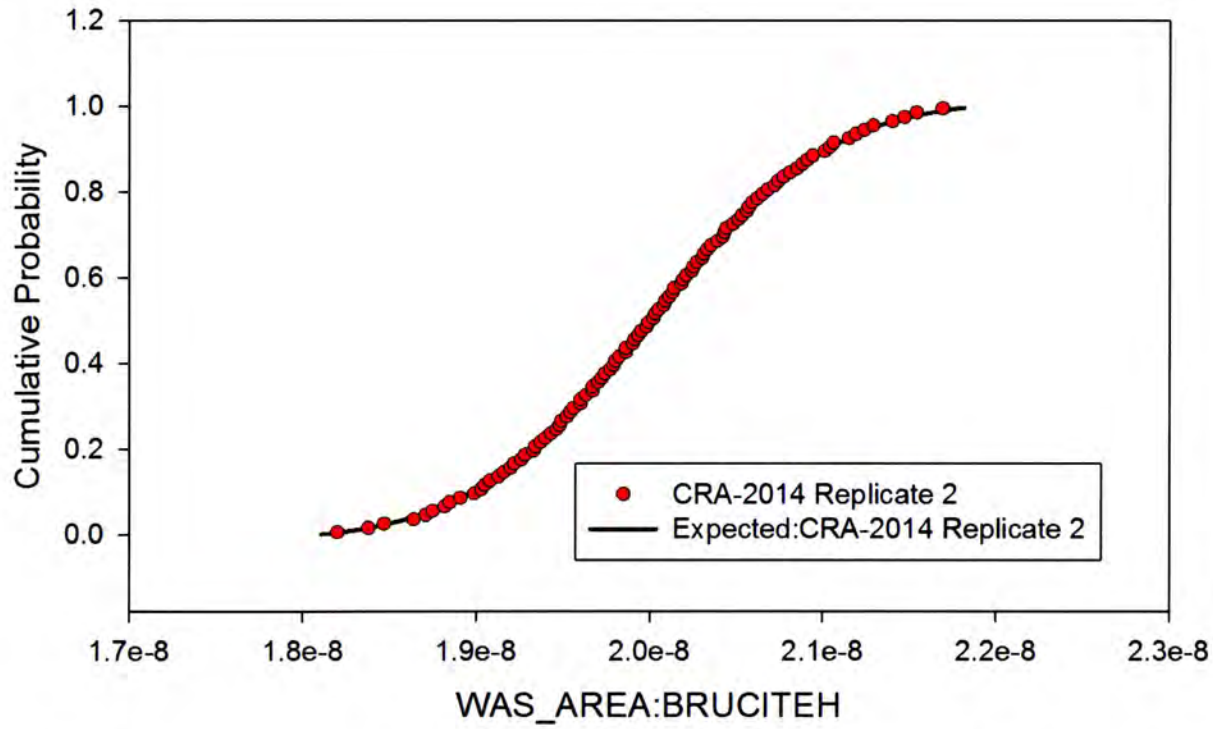

Figure 119. Observed and Expected CDFs for WAS_AREA:BRUCITEH (Normal Distribution) Replicate 2.

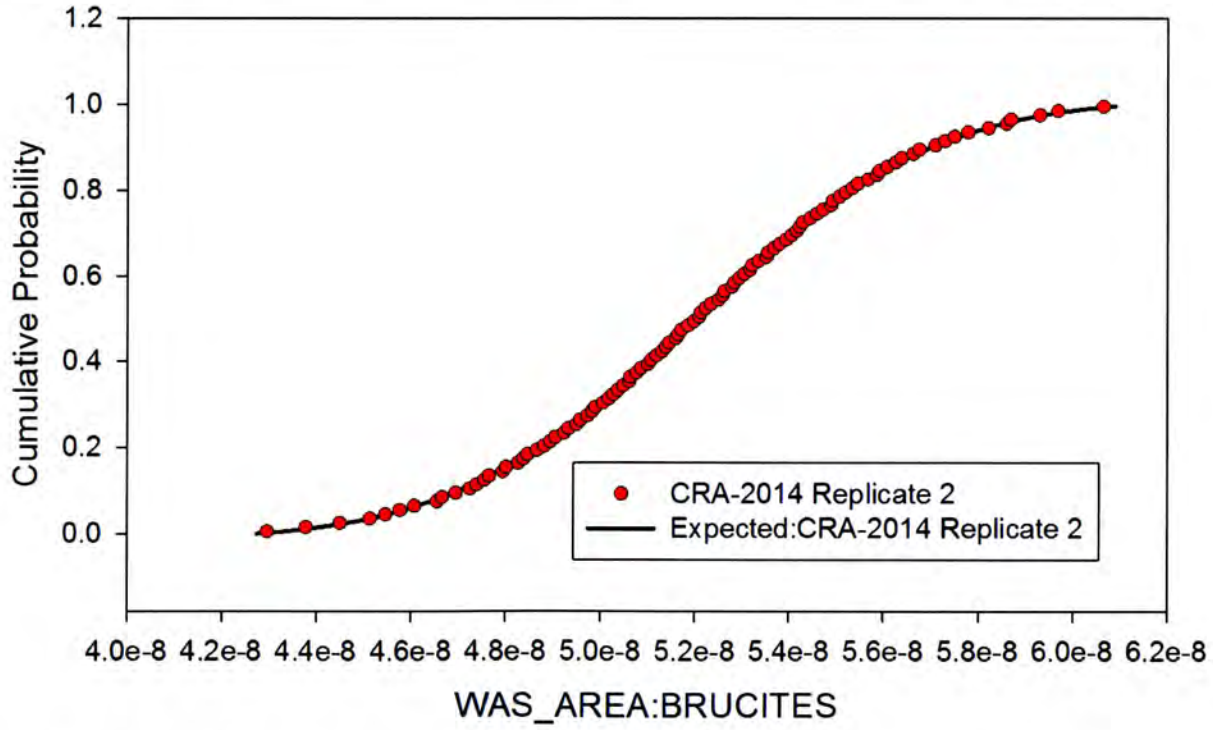

Figure 120. Observed and Expected CDFs for WAS_AREA:BRUCITES (Normal Distribution) Replicate 2.

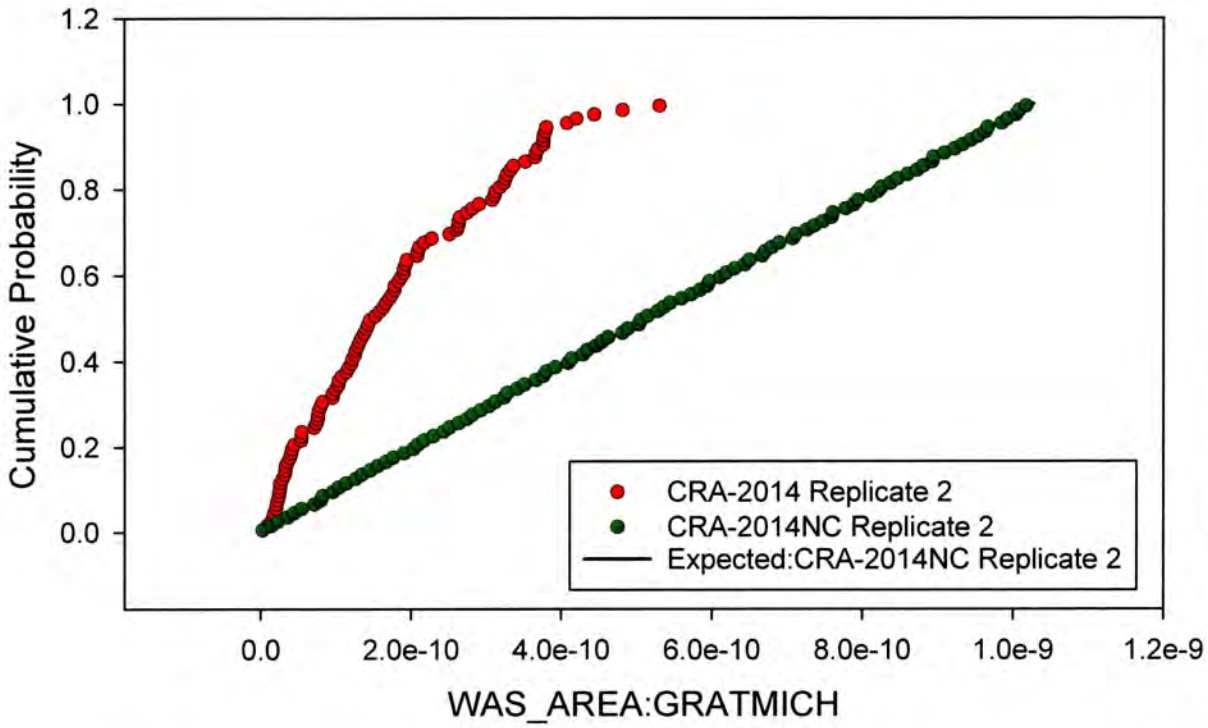

Figure 121. Observed and Expected CDFs for WAS_AREA:GRATMICH (Uniform Distribution) Replicate 2 also showing the data prior to conditioning (NC).

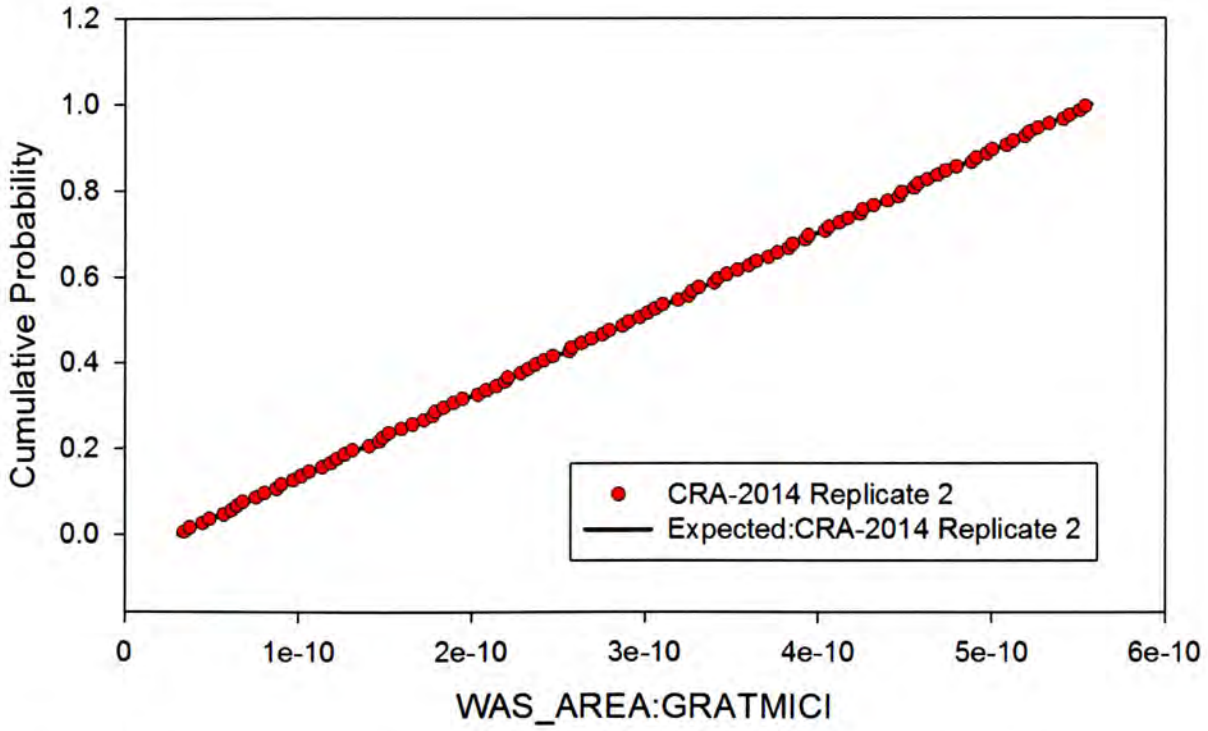

Figure 122. Observed and Expected CDFs for WAS_AREA:GRATMICI (Uniform Distribution) Replicate 2.

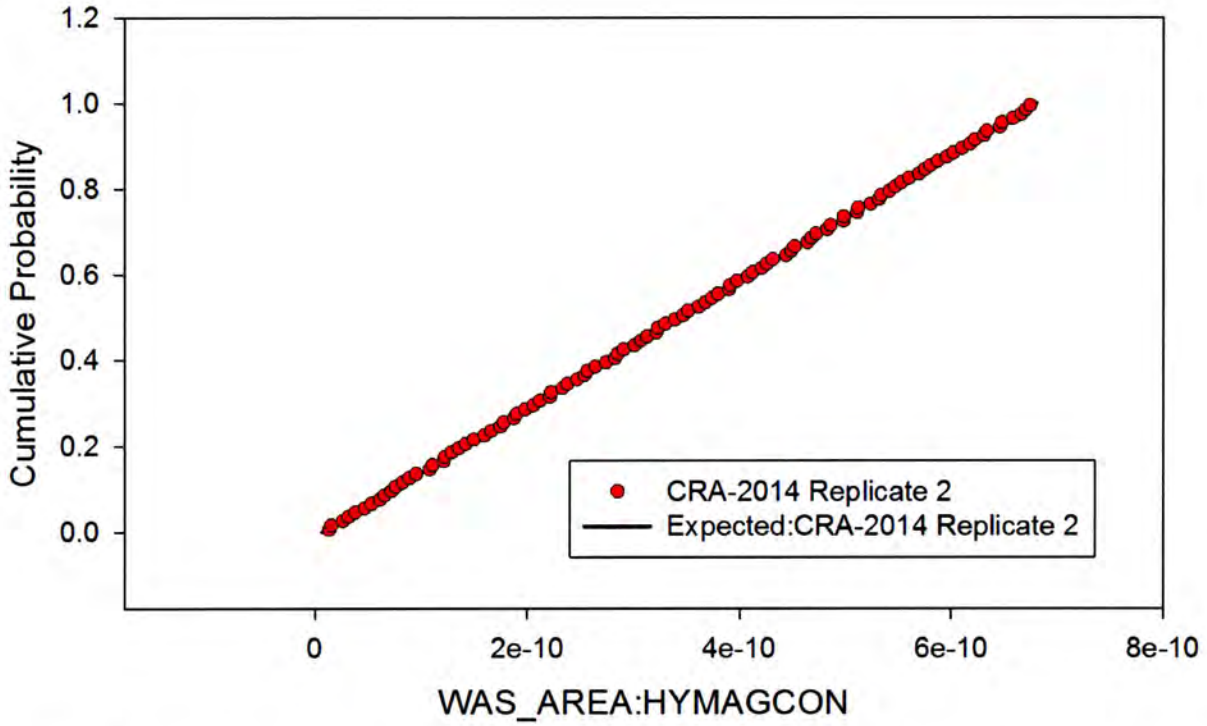

Figure 123. Observed and Expected CDFs for WAS_AREA:HYMAGCON (Uniform Distribution) Replicate 2.

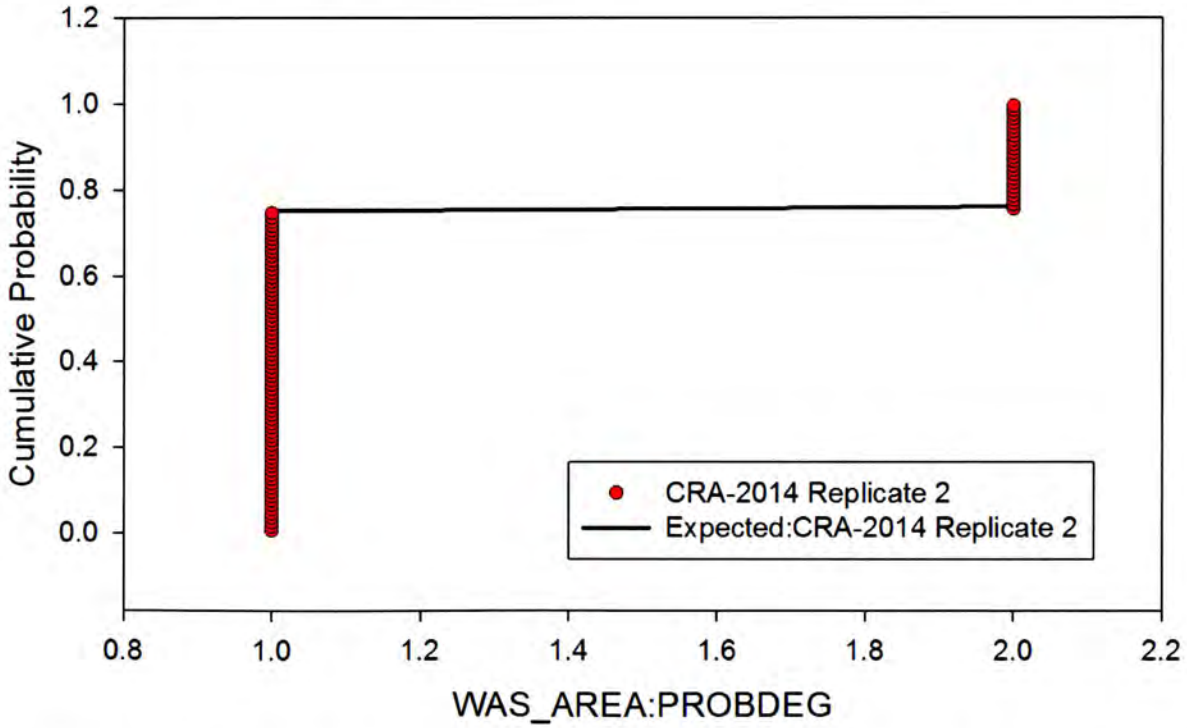

Figure 124. Observed and Expected CDFs for WAS_AREA:PROBDEG (User Discrete (Delta) Distribution) Replicate 2.

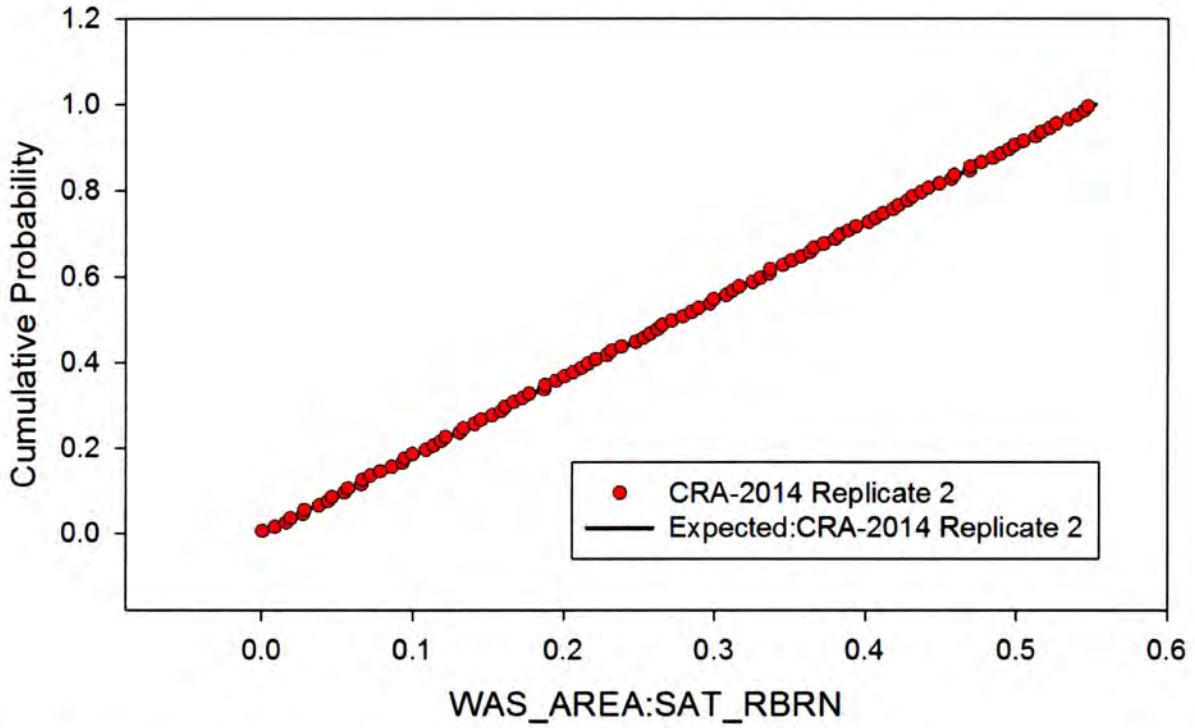

Figure 125. Observed and Expected CDFs for WAS_AREA:SAT_RBRN (Uniform Distribution) Replicate 2.

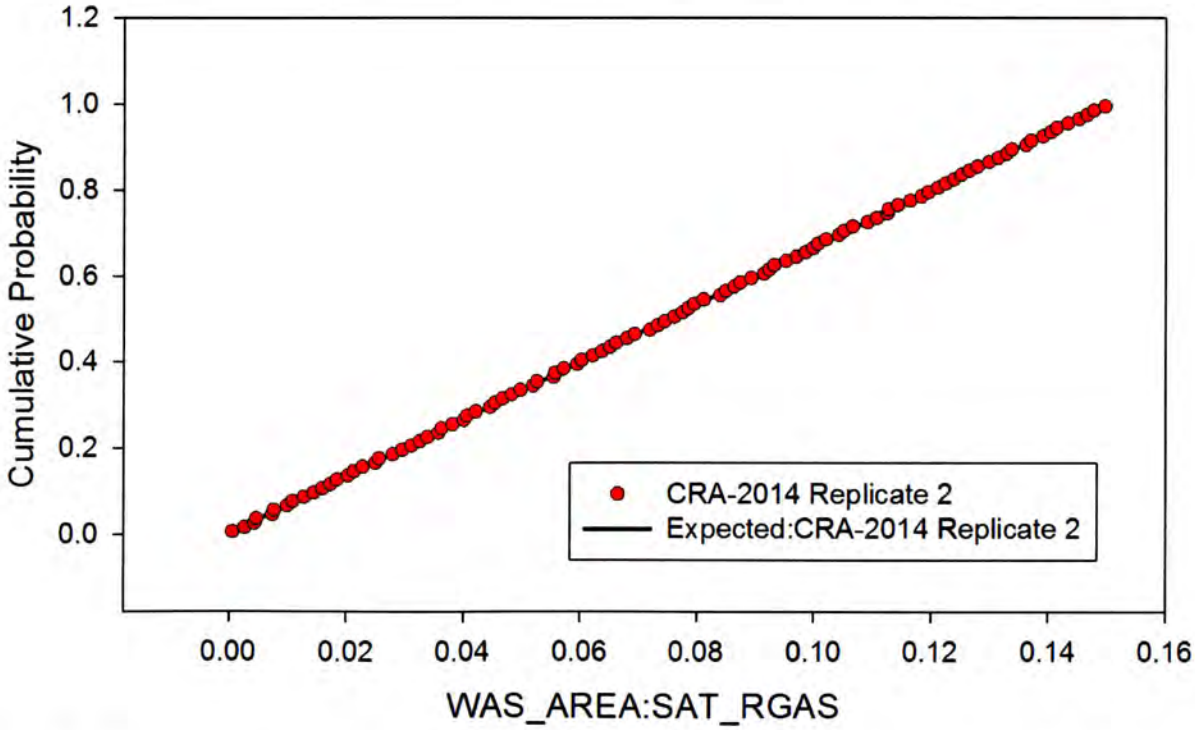

Figure 126. Observed and Expected CDFs for WAS_AREA:SAT_RGAS (Uniform Distribution) Replicate 2.

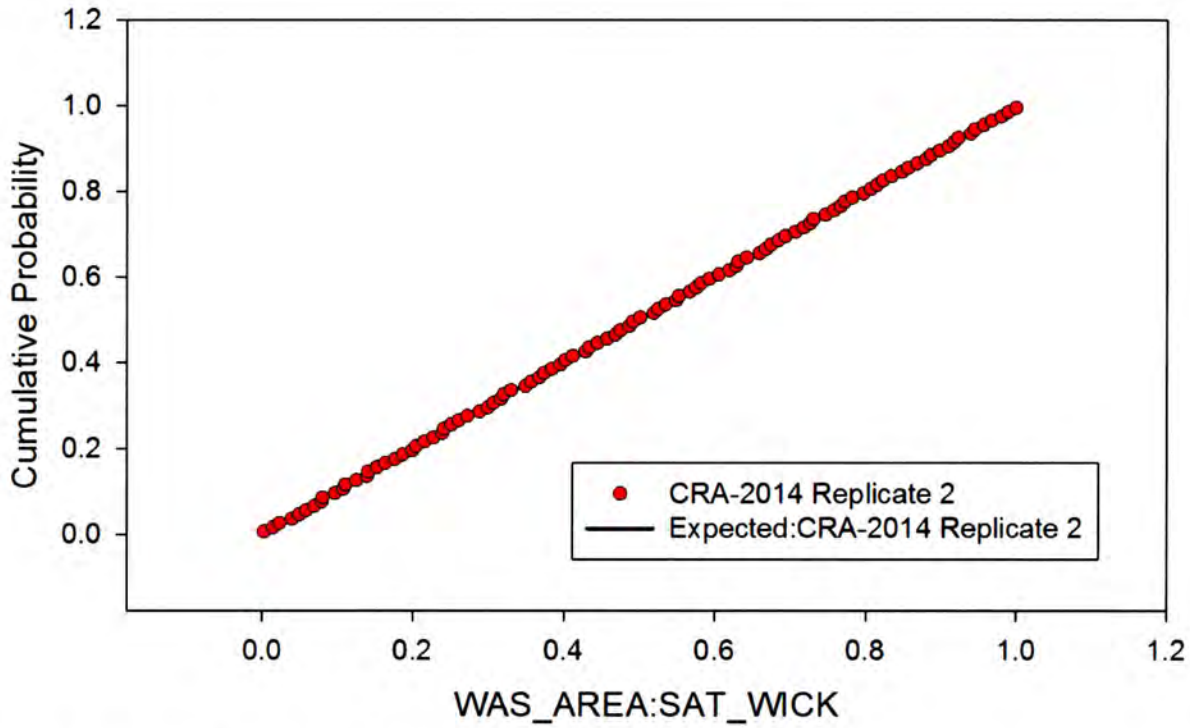

Figure 127. Observed and Expected CDFs for WAS_AREA:SAT_WICK (Uniform Distribution) Replicate 2.

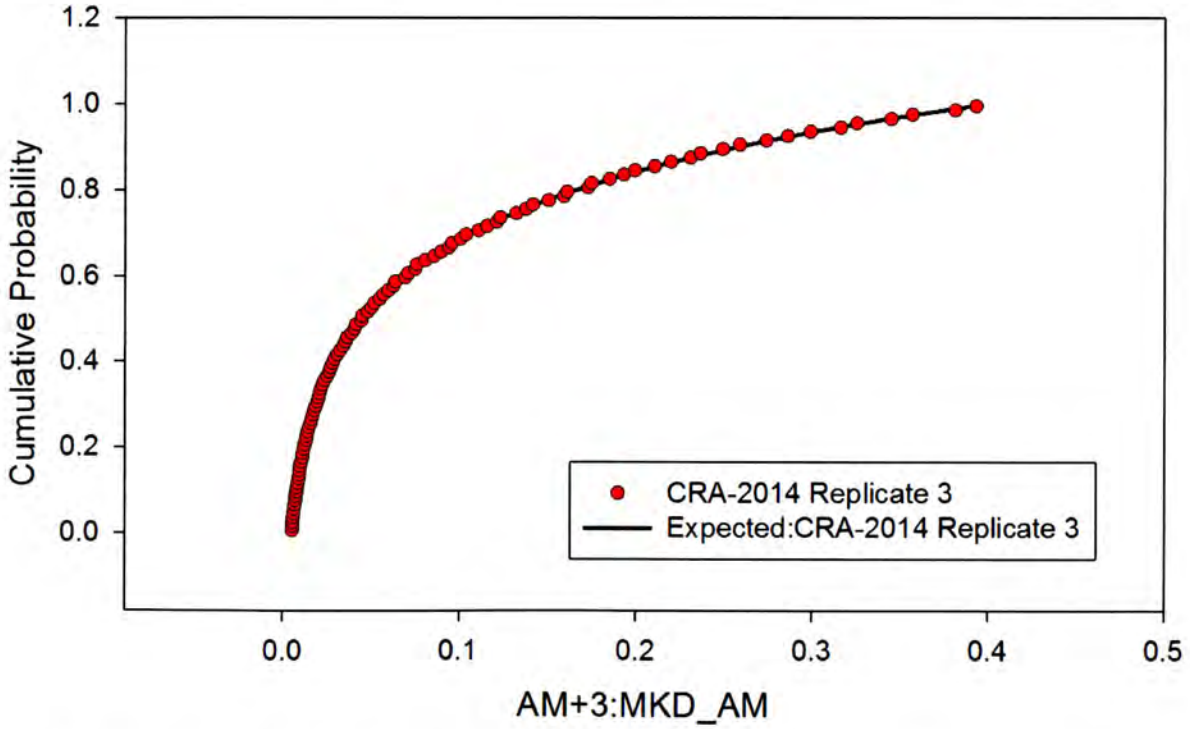

Figure 128. Observed and Expected CDFs for AM+3:MKD_AM (Loguniform Distribution) Replicate 3.

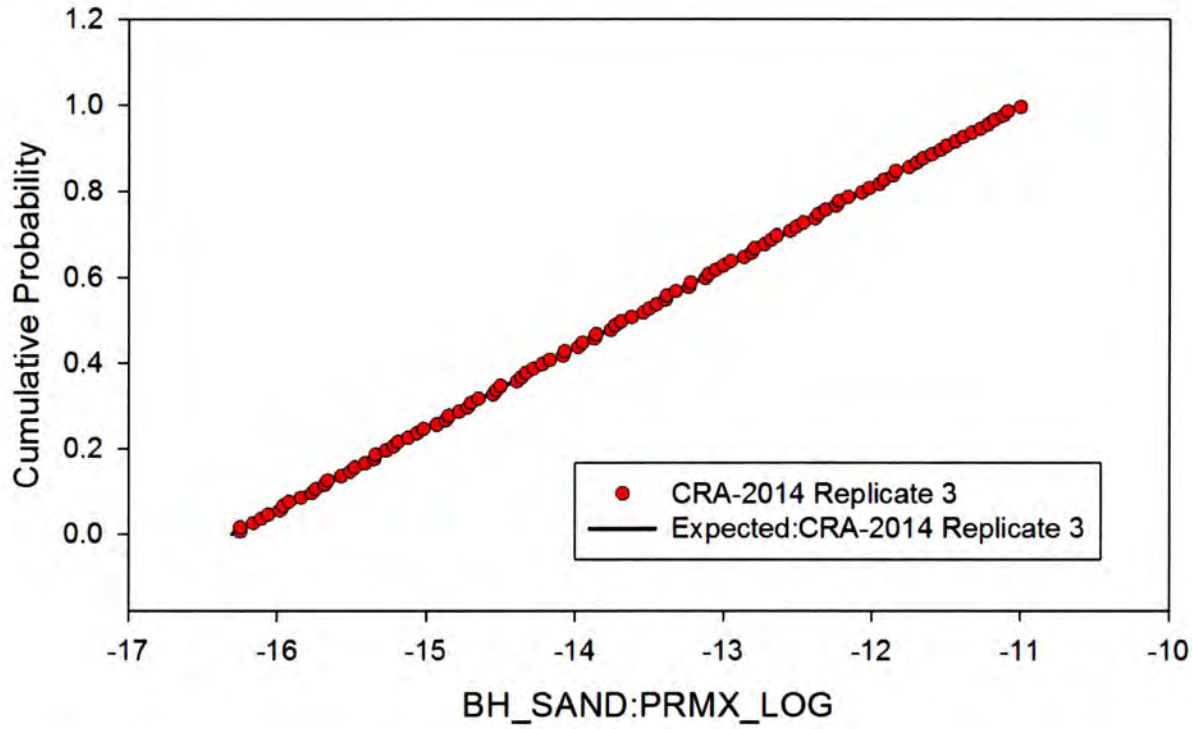

Figure 129. Observed and Expected CDFs for BH_SAND:PRMX_LOG (Uniform Distribution) Replicate 3.

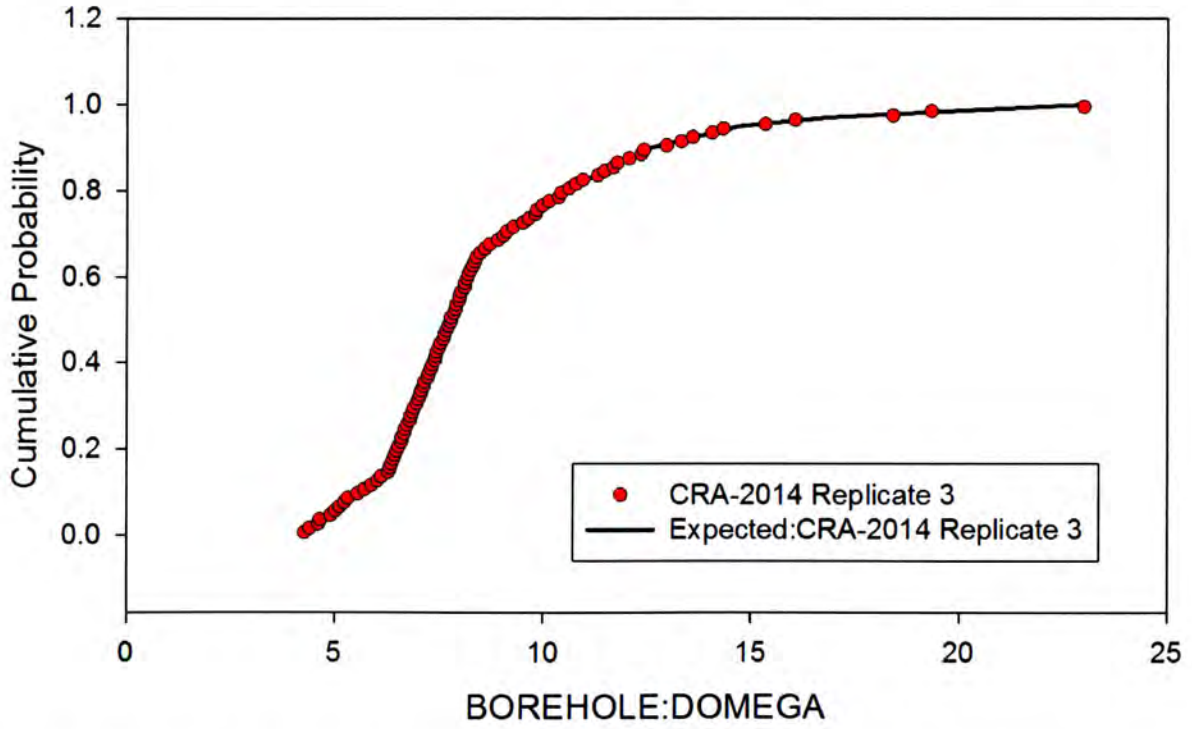

Figure 130. Observed and Expected CDFs for BOREHOLE:DOMEGA (User Continuous Distribution) Replicate 3.

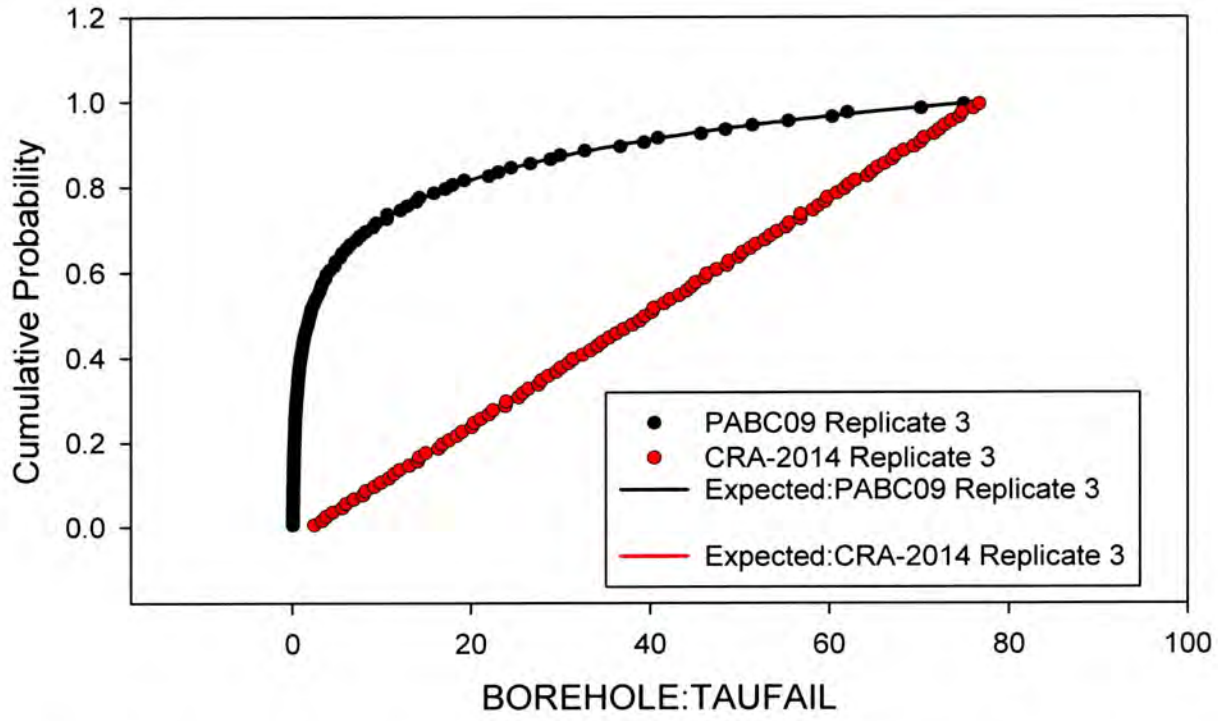

Figure 131. Observed Distribution for BOREHOLE:TAUFAIL Replicate 3, PABC09 (Loguniform Distribution) and CRA-2014 (Uniform Distribution).

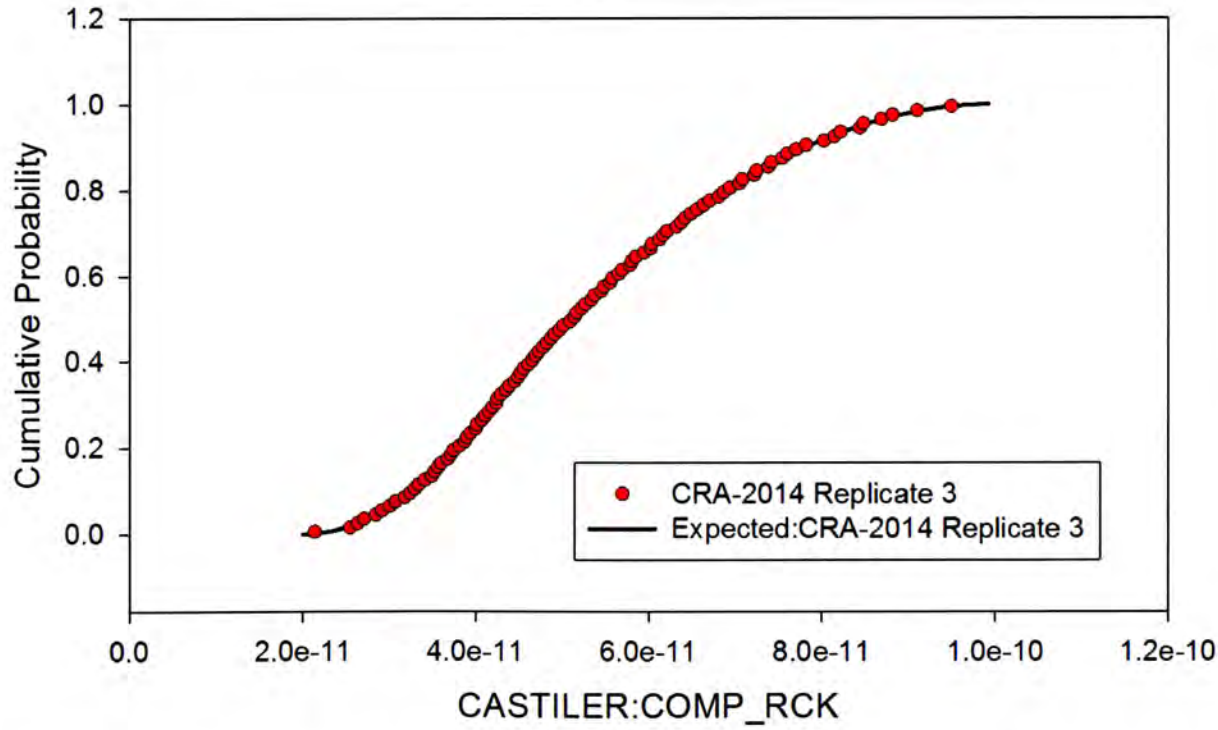

Figure 132. Observed and Expected CDFs for CASTILER:COMP_RCK (Triangular Distribution) Replicate 3.

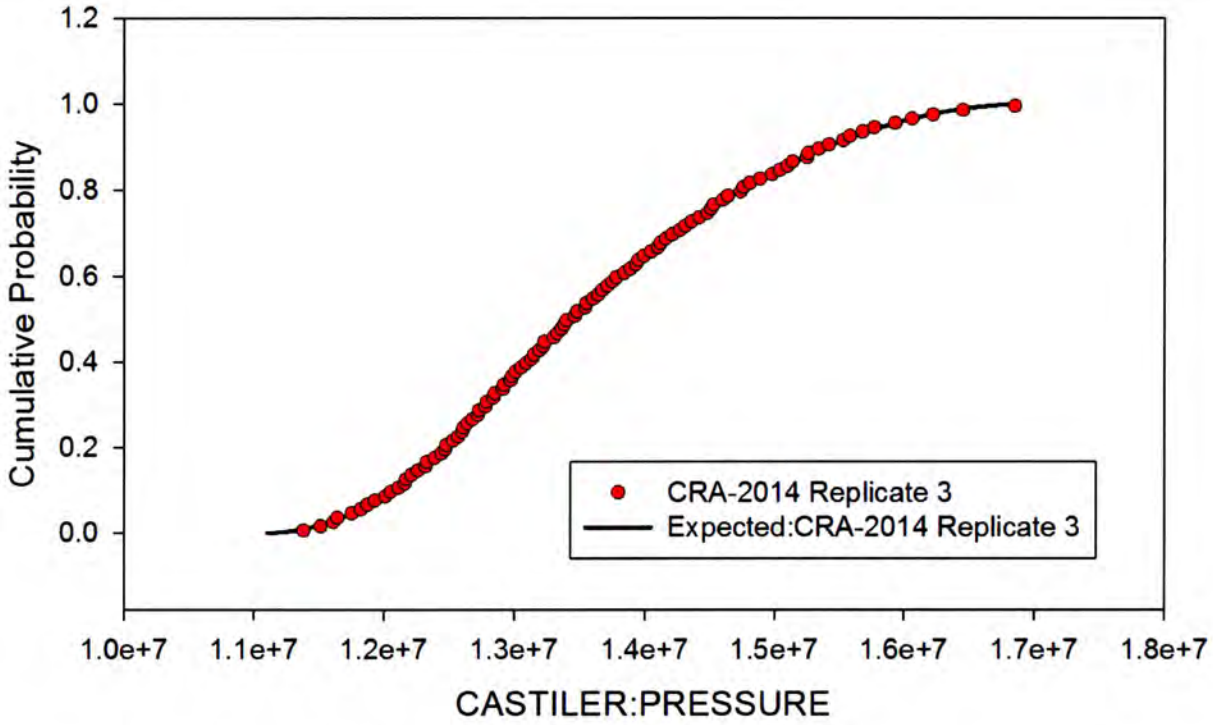

Figure 133. Observed and Expected CDFs for CASTILER:PRESSURE (Triangular Distribution) Replicate 3.

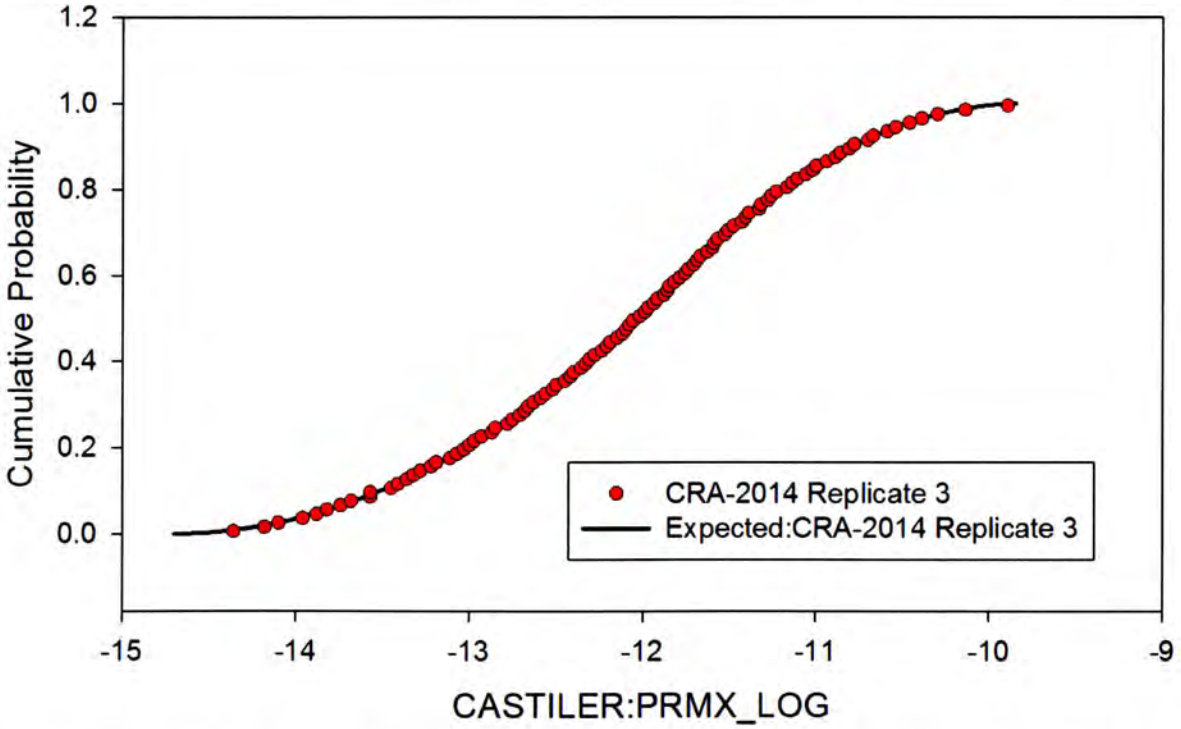

Figure 134. Observed and Expected CDFs for CASTILER:PRMX_LOG (Triangular Distribution) Replicate 3.

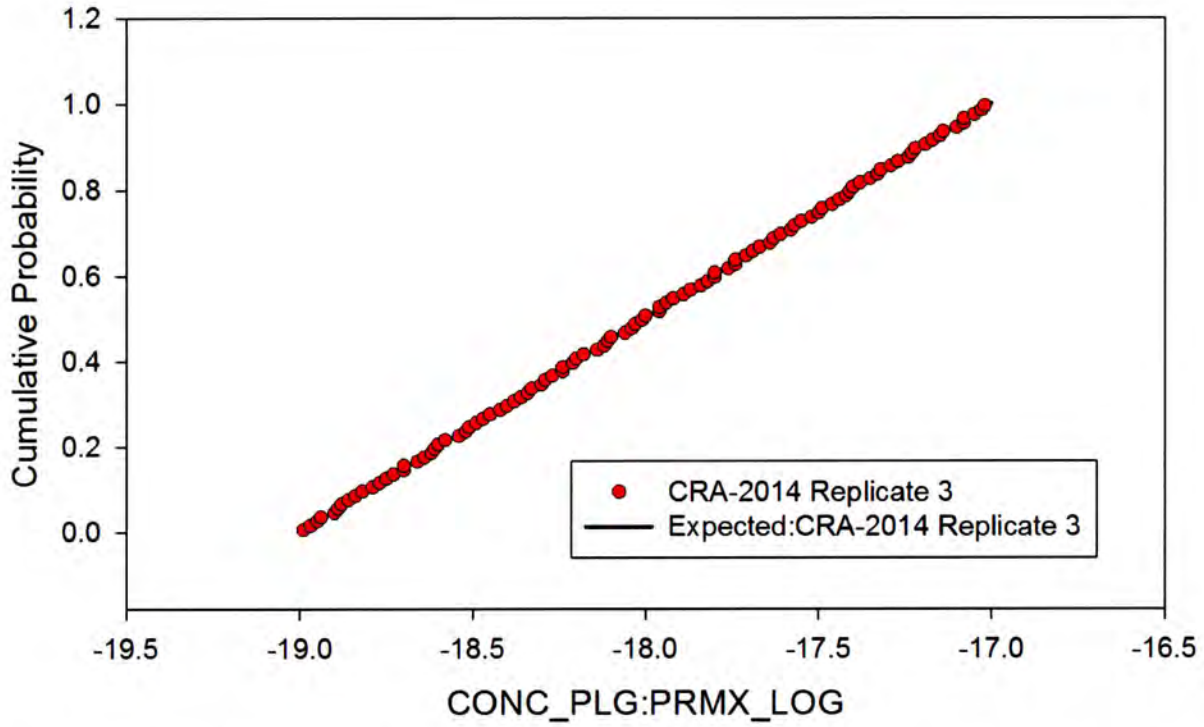

Figure 135. Observed and Expected CDFs for CONC_PLG:PRMX_LOG (Uniform Distribution) Replicate 3.

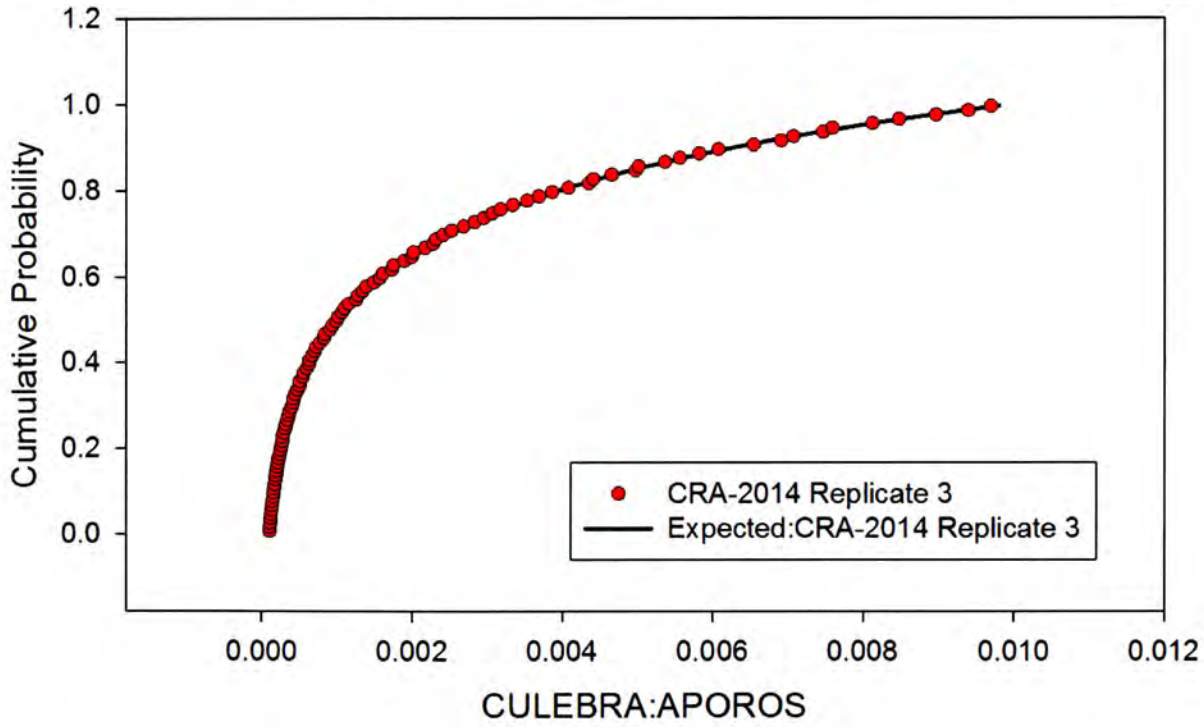

Figure 136. Observed and Expected CDFs for CULEBRA:APOROS (Loguniform Distribution) Replicate 3.

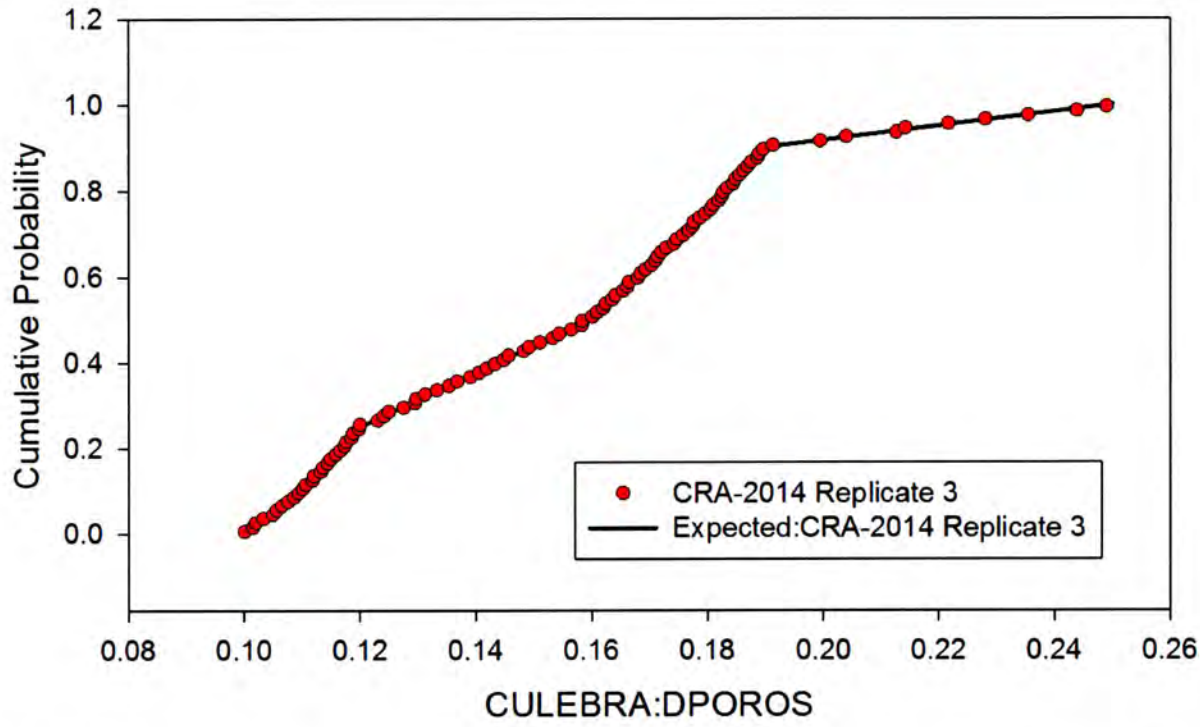

Figure 137. Observed and Expected CDFs for CULEBRA:DPOROS (User Continuous Distribution) Replicate 3.

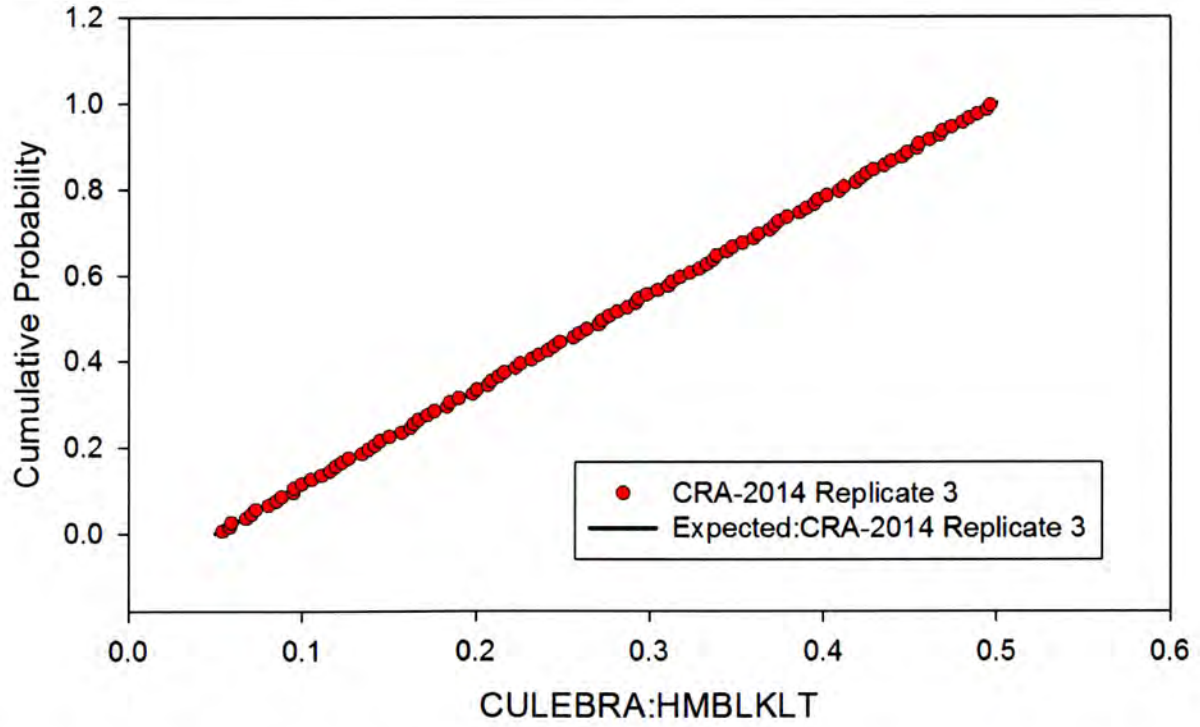

Figure 138. Observed and Expected CDFs for CULEBRA:HMBLKLT (Uniform Distribution) Replicate 3.

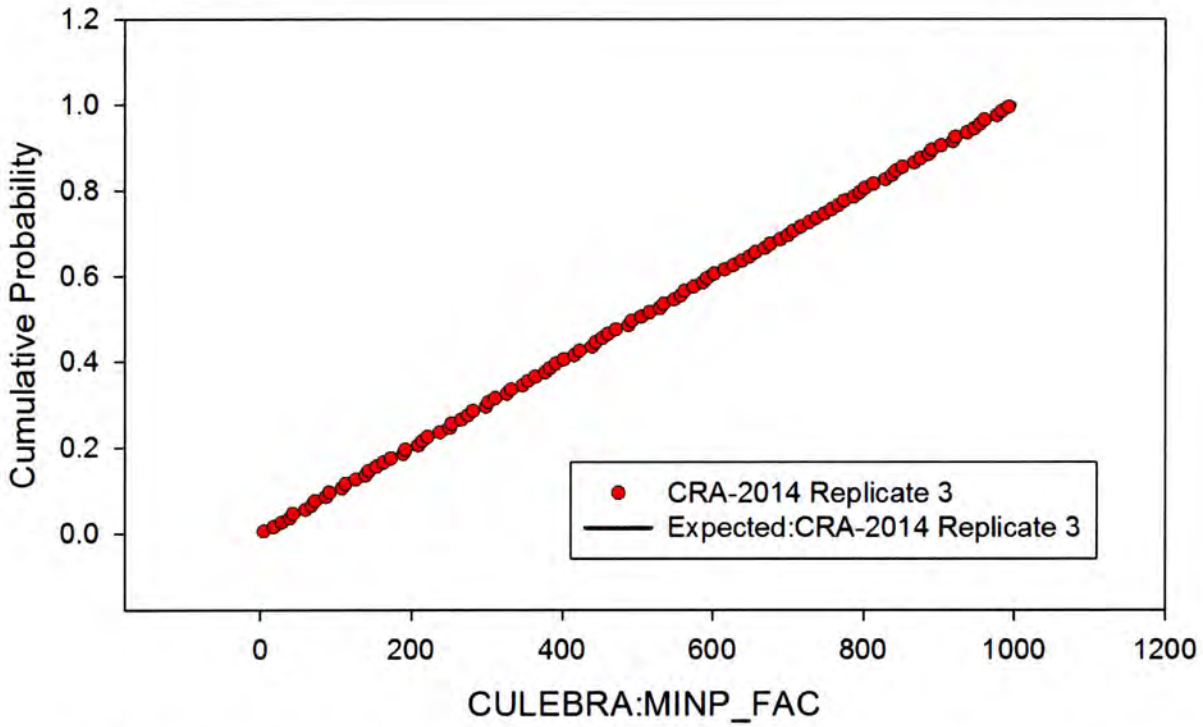

Figure 139. Observed and Expected CDFs for CULEBRA:MINP_FAC (Uniform Distribution) Replicate 3.

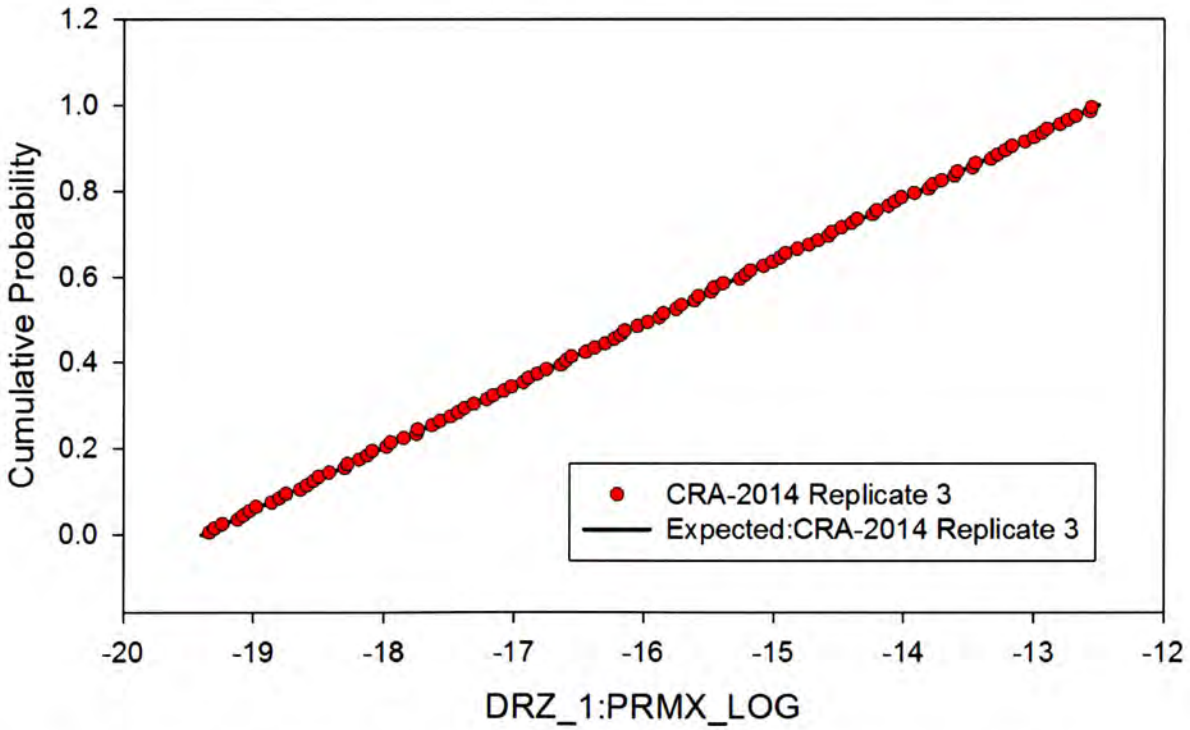

Figure 140. Observed and Expected CDFs for DRZ_1:PRMX_LOG (Uniform Distribution) Replicate 3.

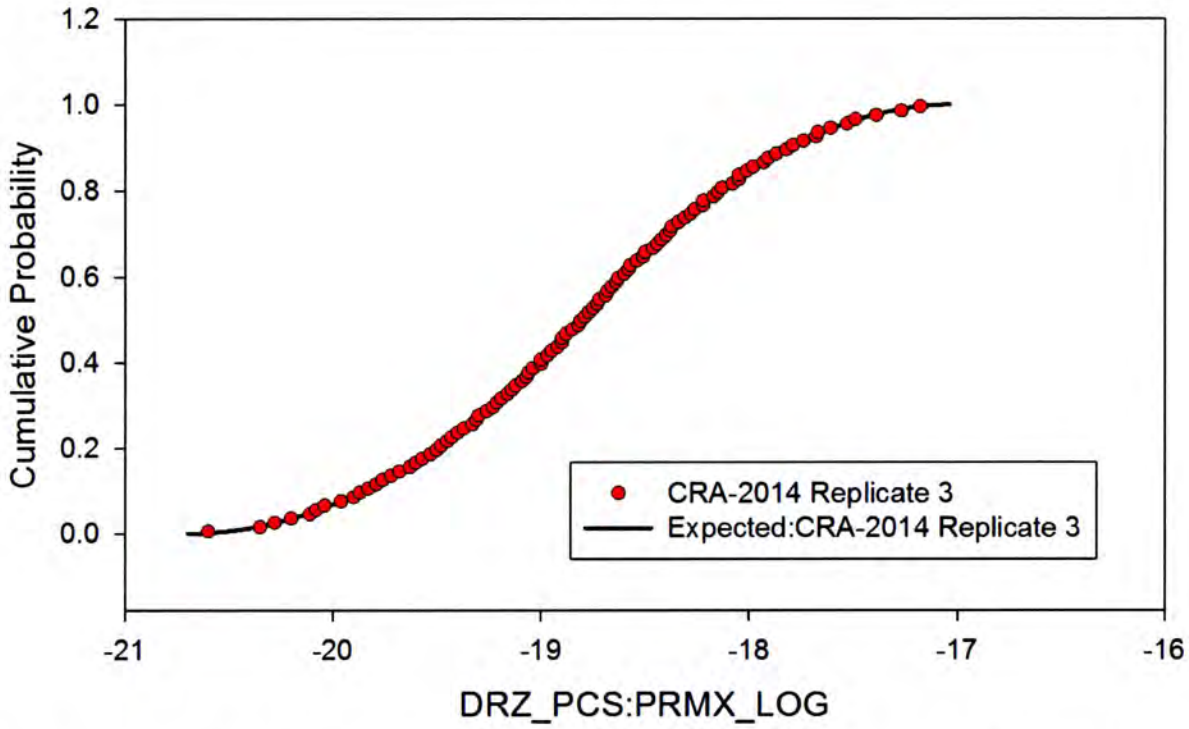

Figure 141. Observed and Expected CDFs for DRZ_PCS:PRMX_LOG (Triangular Distribution) Replicate 3.

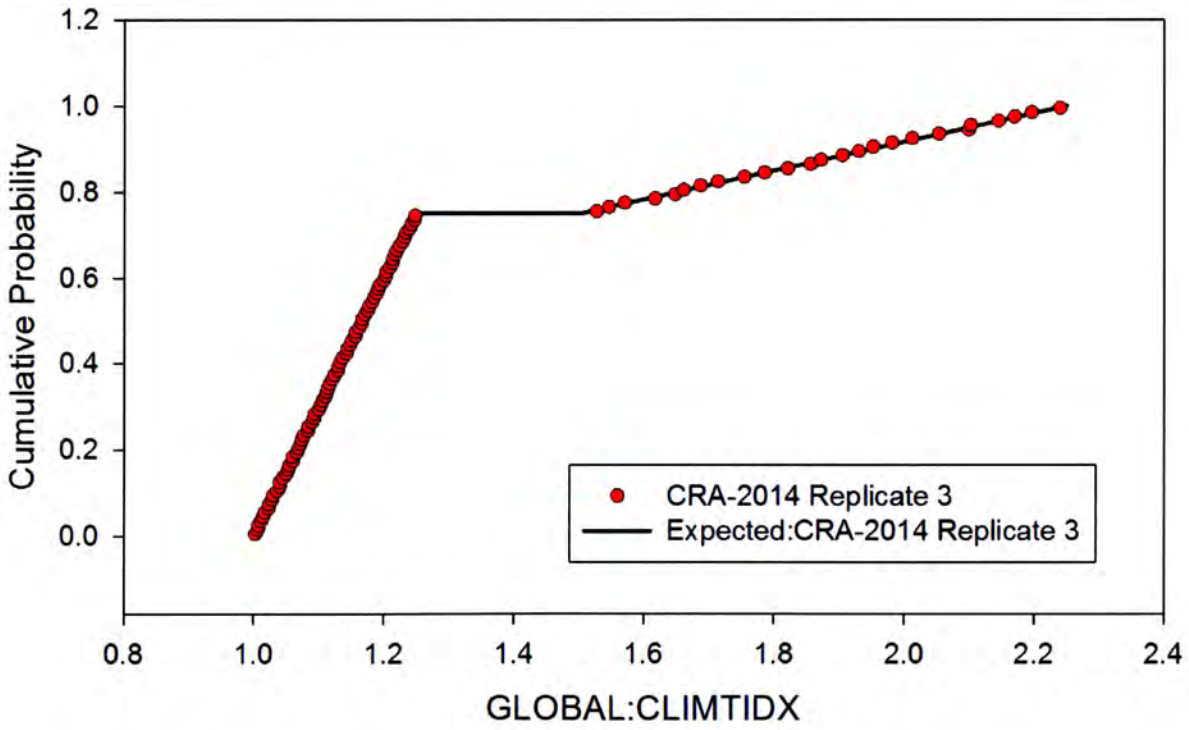

Figure 142. Observed and Expected CDFs for GLOBAL:CLIMTIDX (User Continuous Distribution) Replicate 3.

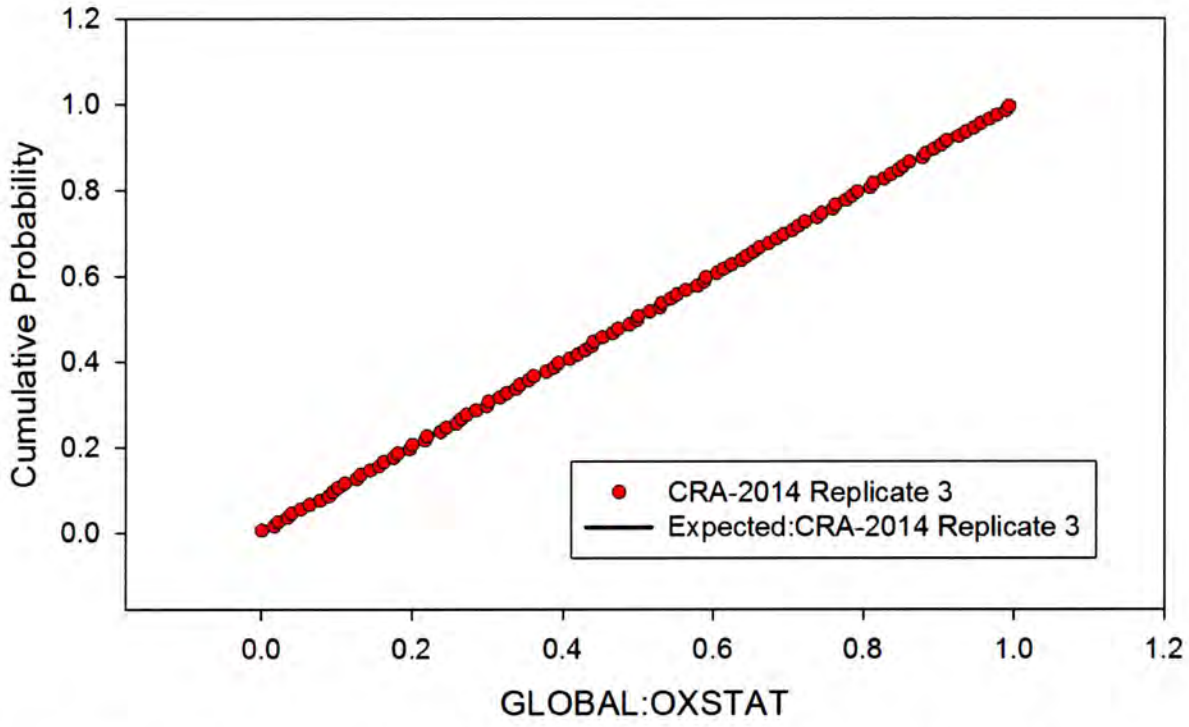

Figure 143. Observed and Expected CDFs for GLOBAL:OXSTAT (Uniform Distribution) Replicate 3.

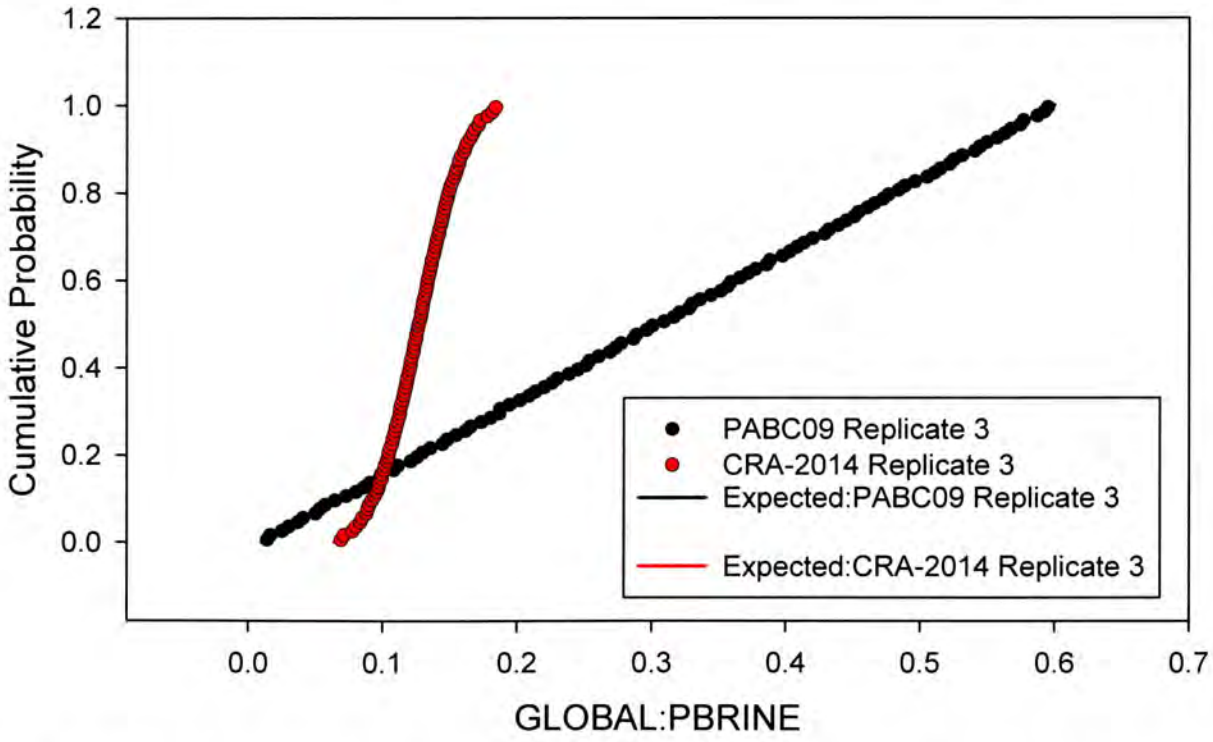

Figure 144. Observed and Expected CDFs for GLOBAL:PBRINE Replicate 3 for PABC09 (Uniform Distribution) and CRA-2014 (Normal Distribution).

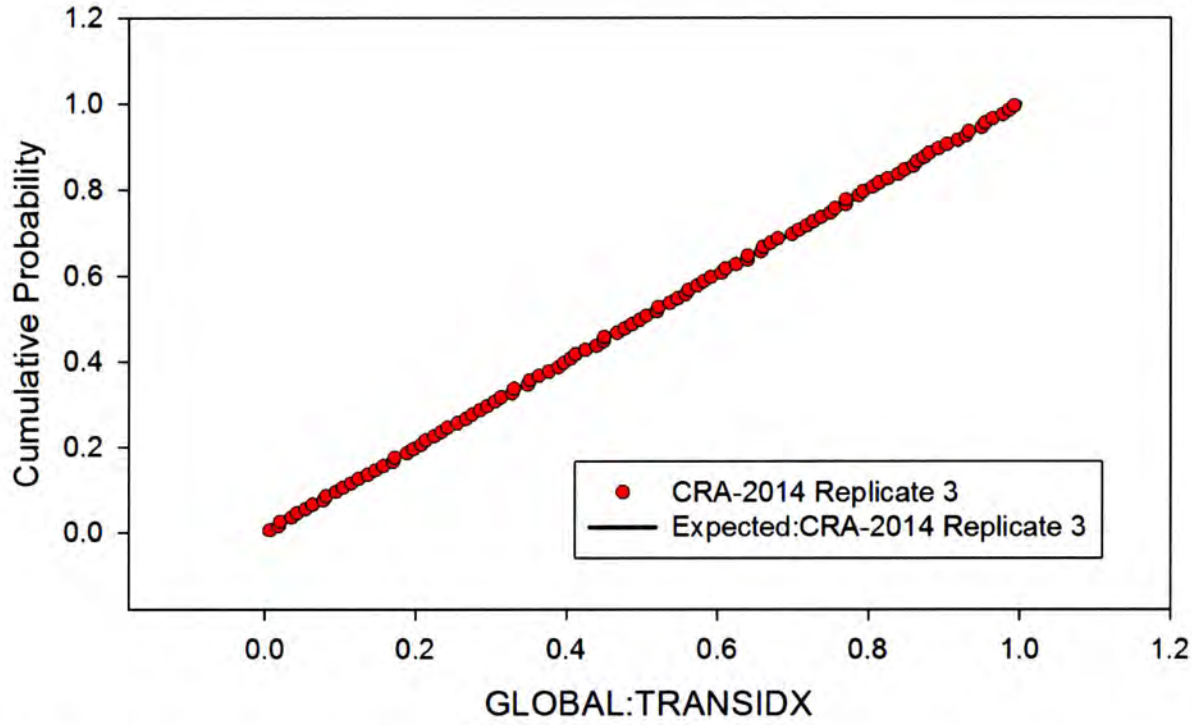

Figure 145. Observed and Expected CDFs for GLOBAL:TRANSIDX (Uniform Distribution) Replicate 3.

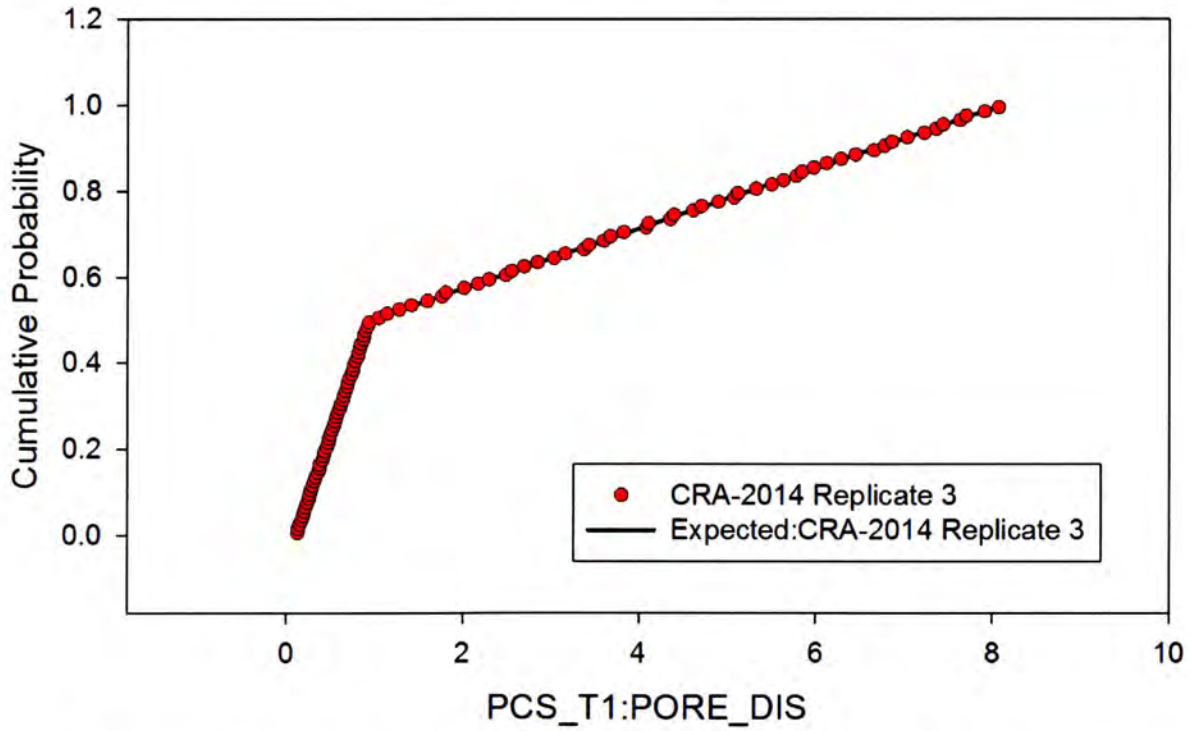

Figure 146. Observed and Expected CDFs for PCS_T1:PORE_DIS (User Continuous Distribution) Replicate 3.

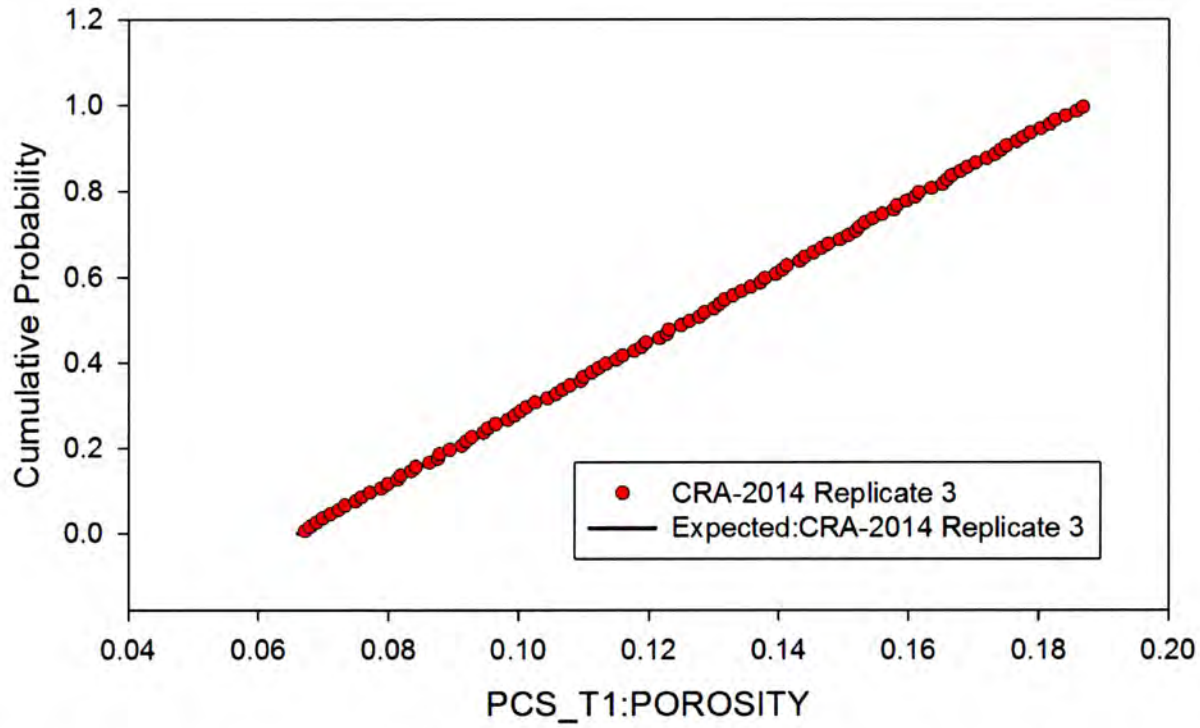

Figure 147. Observed and Expected CDFs for PCS_T1:POROSITY (Uniform Distribution) Replicate 3.

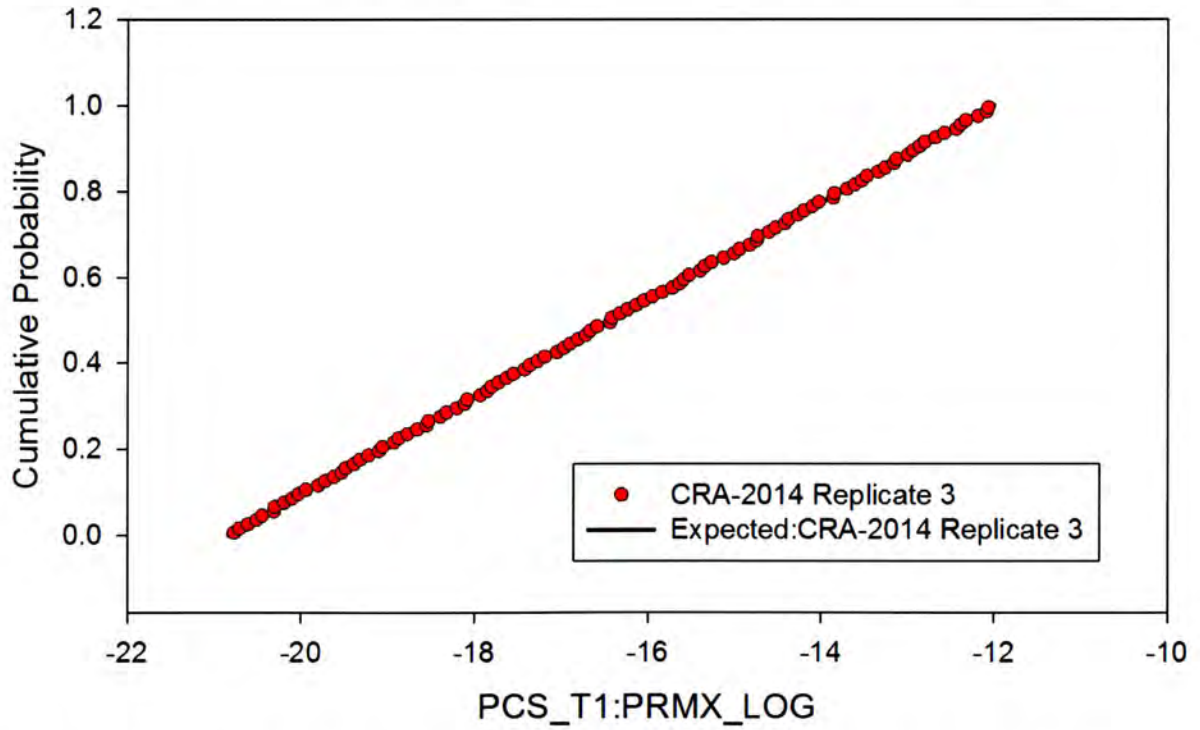

Figure 148. Observed and Expected CDFs for PCS_T1:PRMX_LOG (Uniform Distribution) Replicate 3.

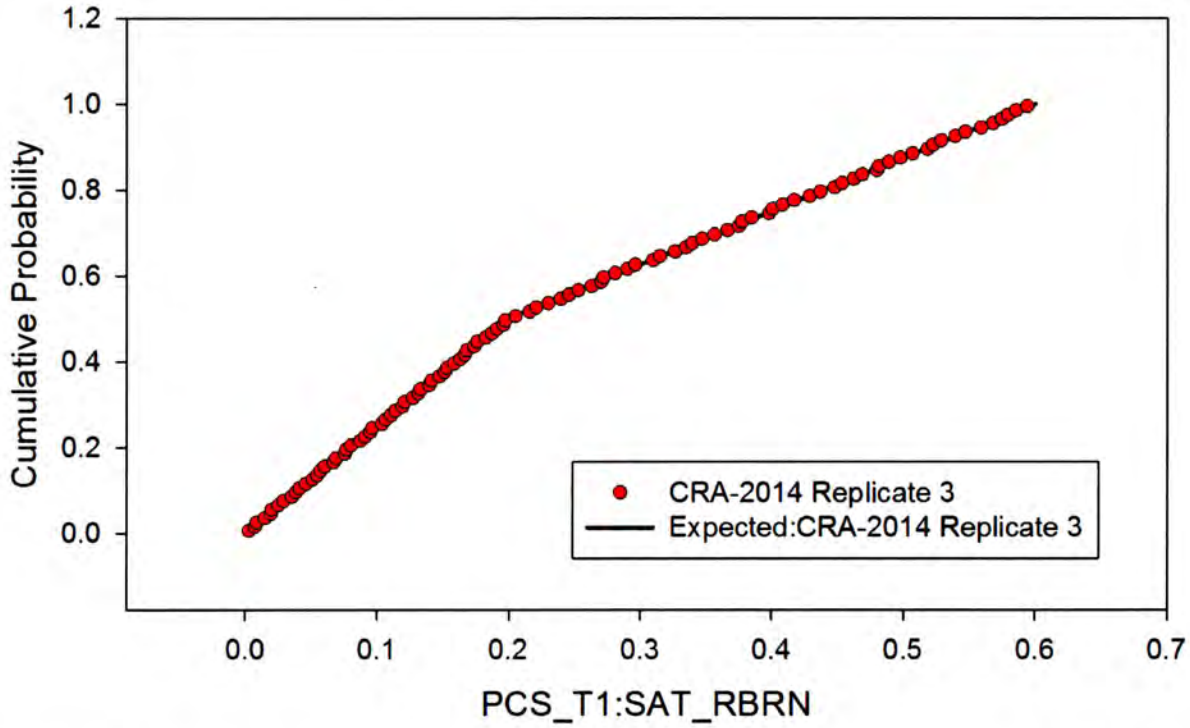

Figure 149. Observed and Expected CDFs for PCS_T1:SAT_RBRN (User Continuous Distribution) Replicate 3.

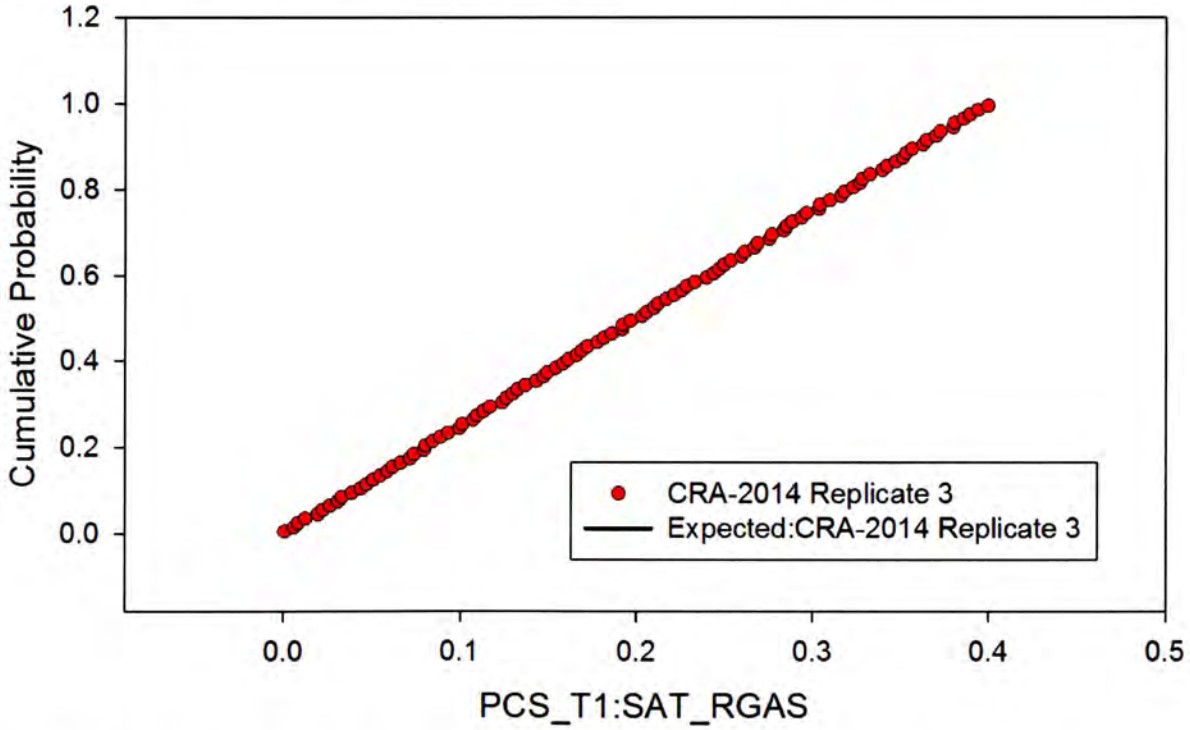

Figure 150. Observed and Expected CDFs for PCS_T1:SAT_RGAS (Uniform Distribution) Replicate 3.

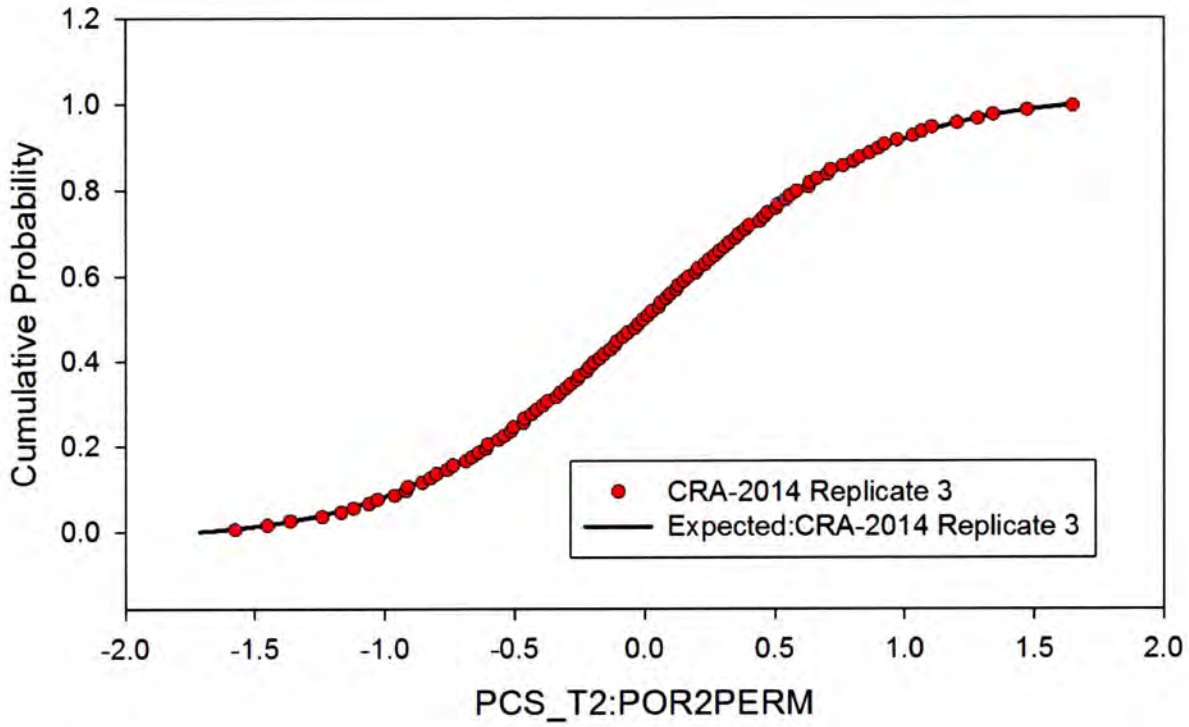

Figure 151. Observed and Expected CDFs for PCS_T2:POR2PERM (Normal Distribution) Replicate 3.

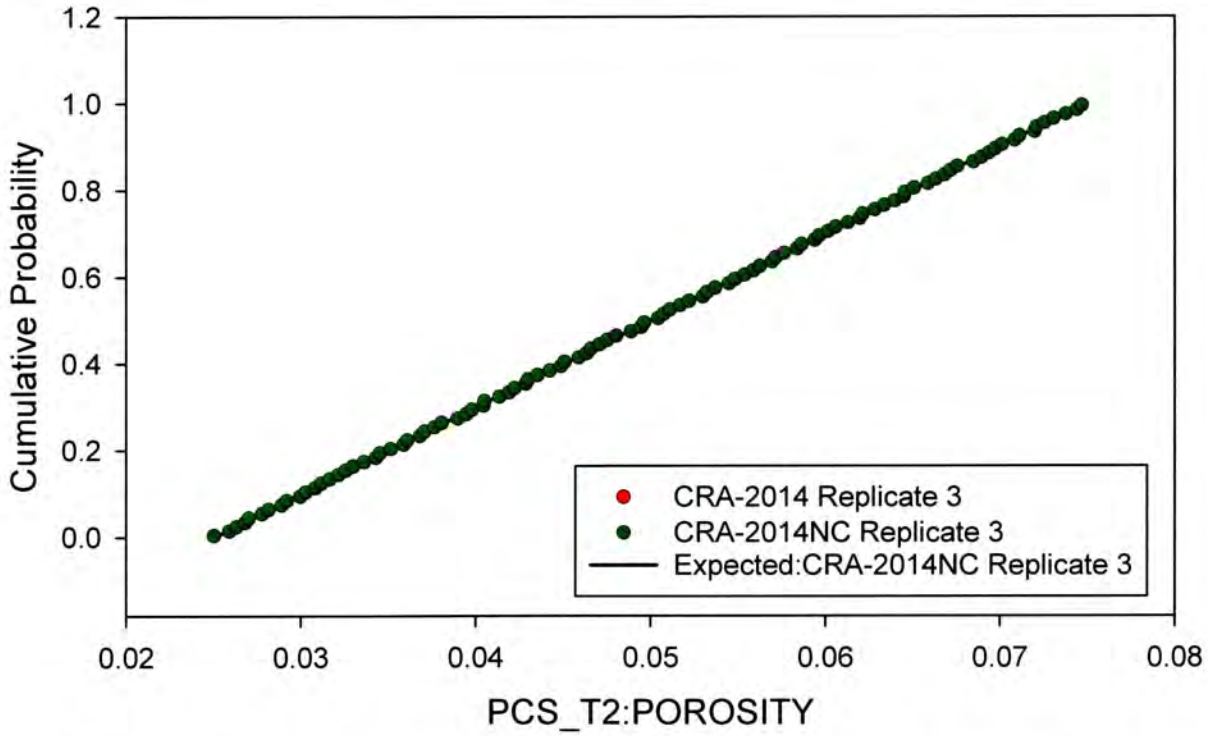

Figure 152. Observed and Expected CDFs for PCS_T2:POROSITY (Uniform Distribution) Replicate 3 also showing the data prior to conditioning (NC).

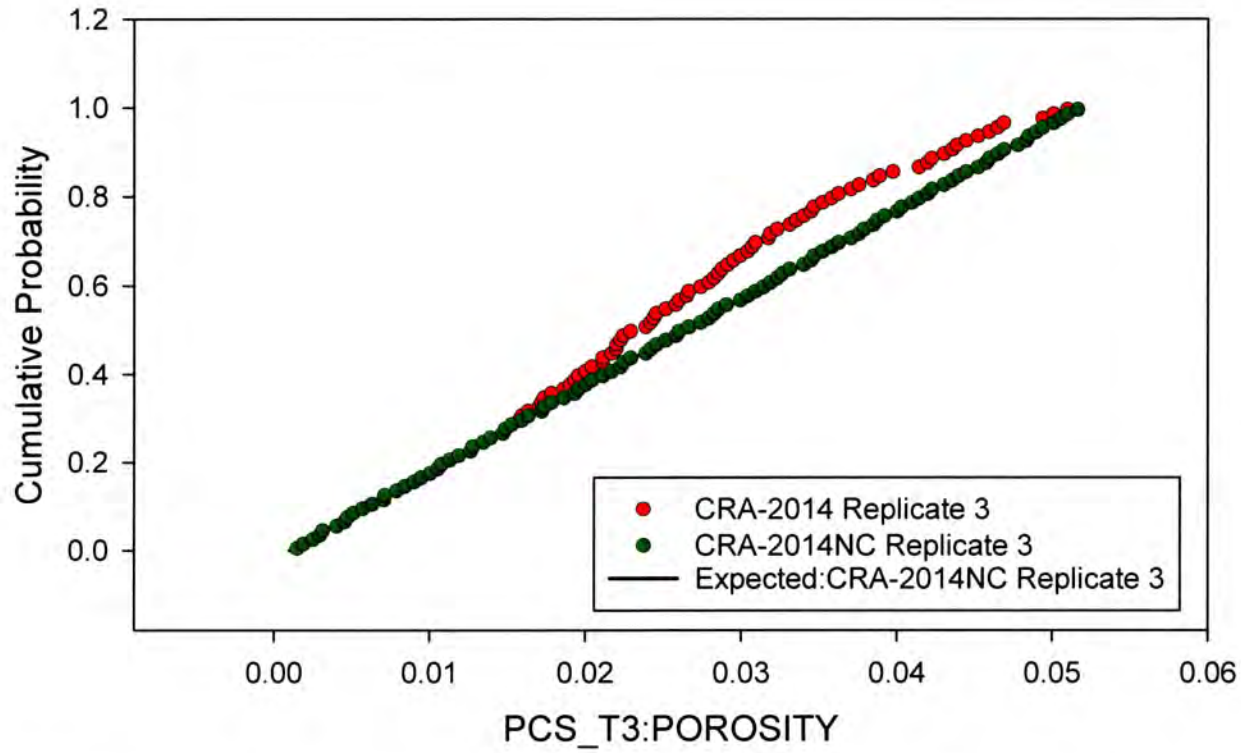

Figure 153. Observed and Expected CDFs for PCS_T3:POROSITY (Uniform Distribution) Replicate 3 also showing the data prior to conditioning (NC).

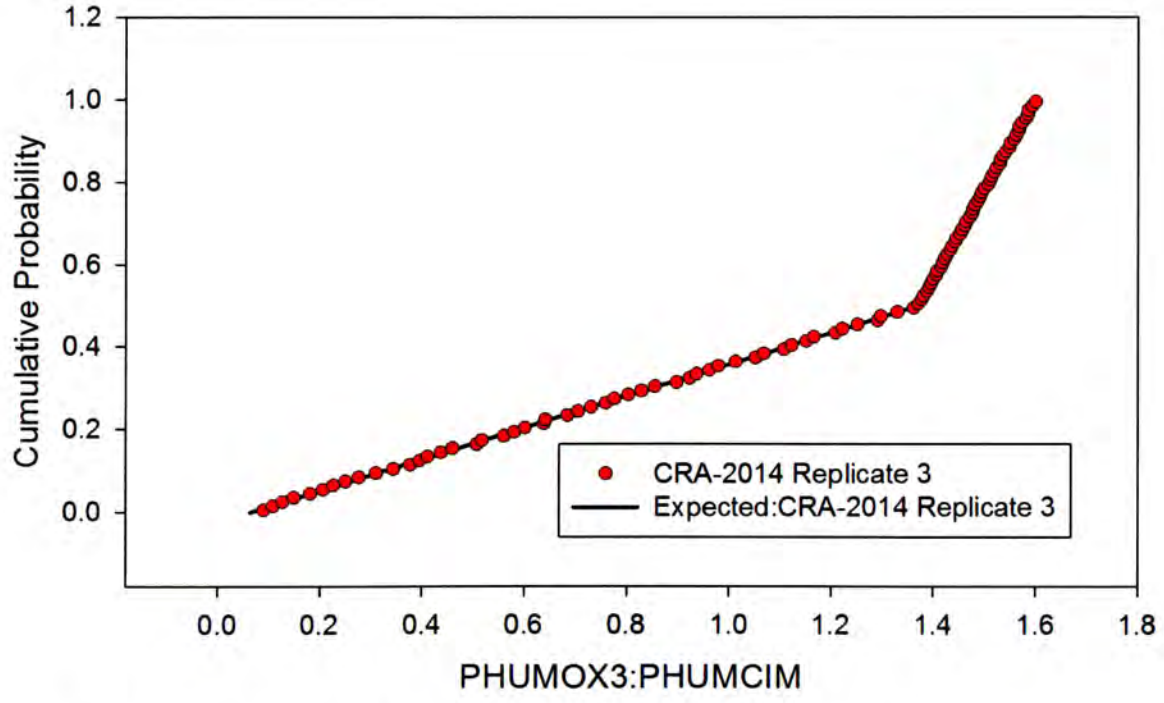

Figure 154. Observed and Expected CDFs for PHUMOX3:PHUMCIM (User Continuous Distribution) Replicate 3.

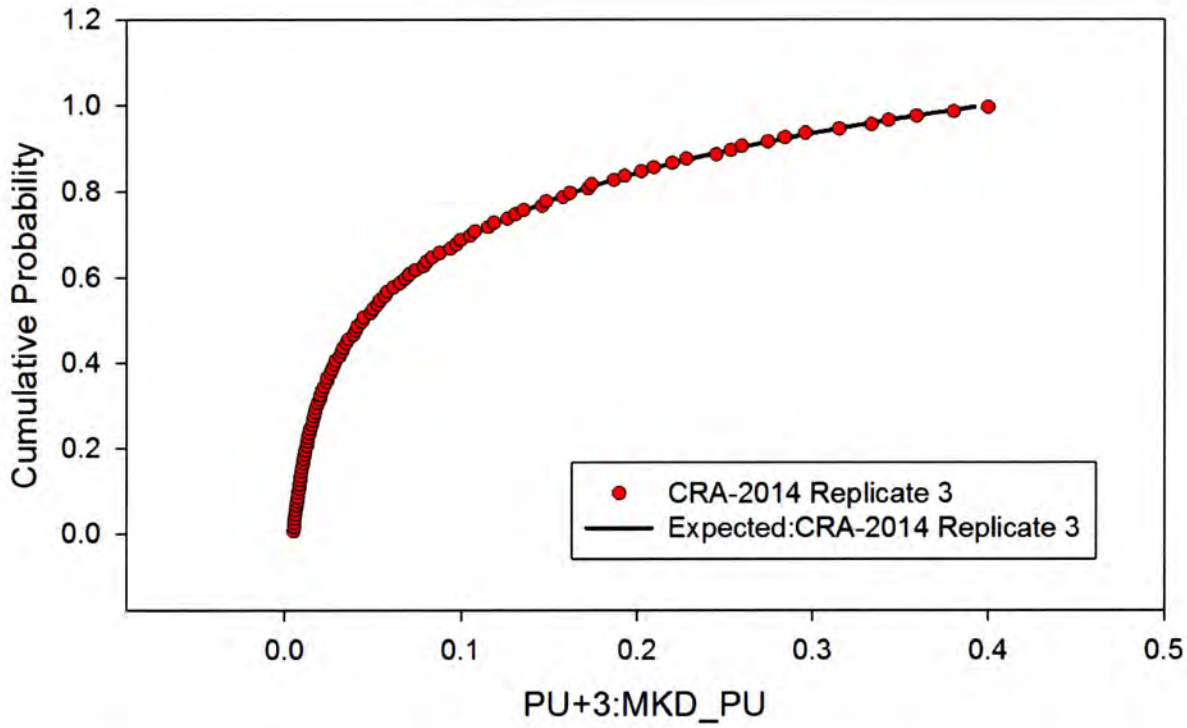

Figure 155. Observed and Expected CDFs for PU+3:MKD_PU (Loguniform Distribution) Replicate 3.

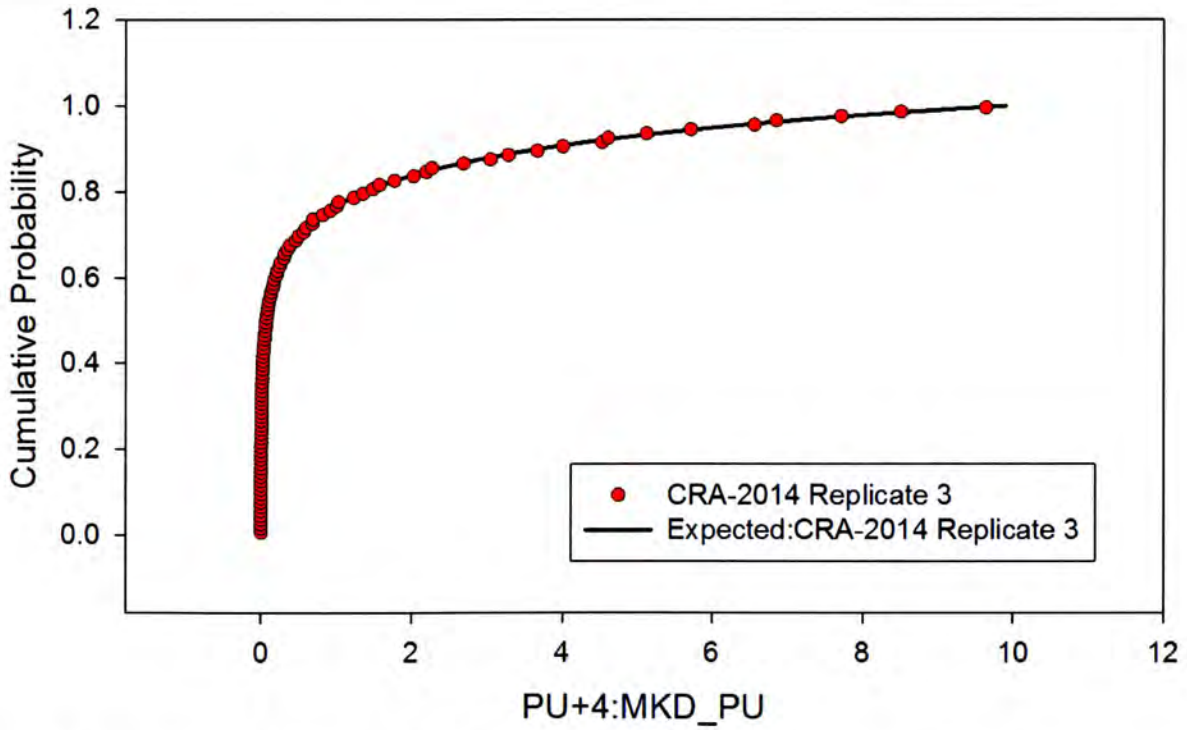

Figure 156. Observed and Expected CDFs for PU+4:MKD_PU (Loguniform Distribution) Replicate 3.

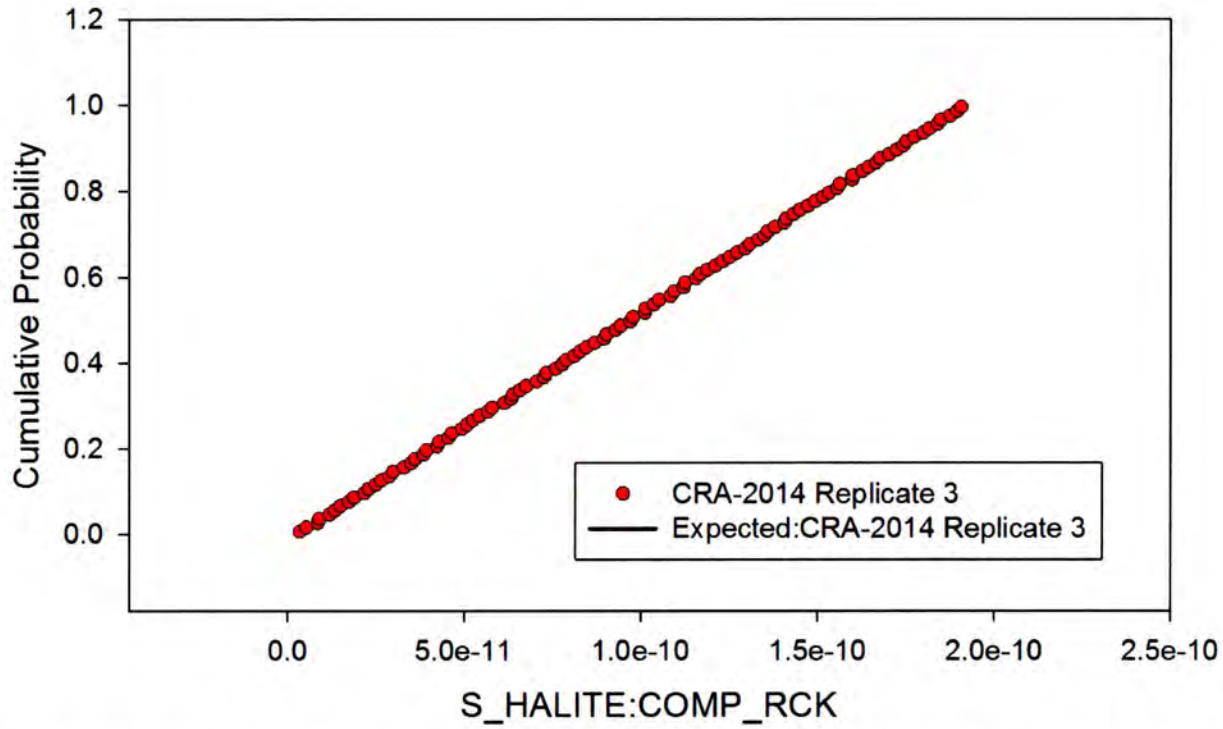

Figure 157. Observed and Expected CDFs for S_HALITE:COMP_RCK (Uniform Distribution) Replicate 3.

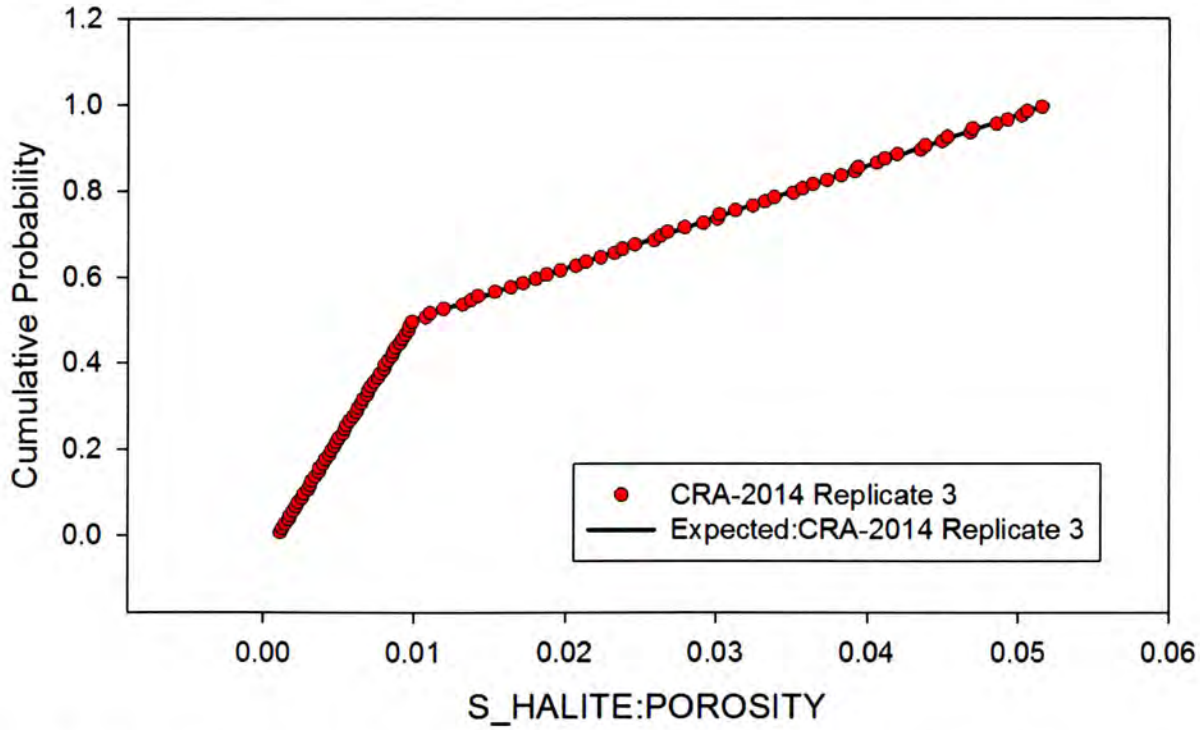

Figure 158. Observed and Expected CDFs for S_HALITE:POROSITY (User Continuous Distribution) Replicate 3.

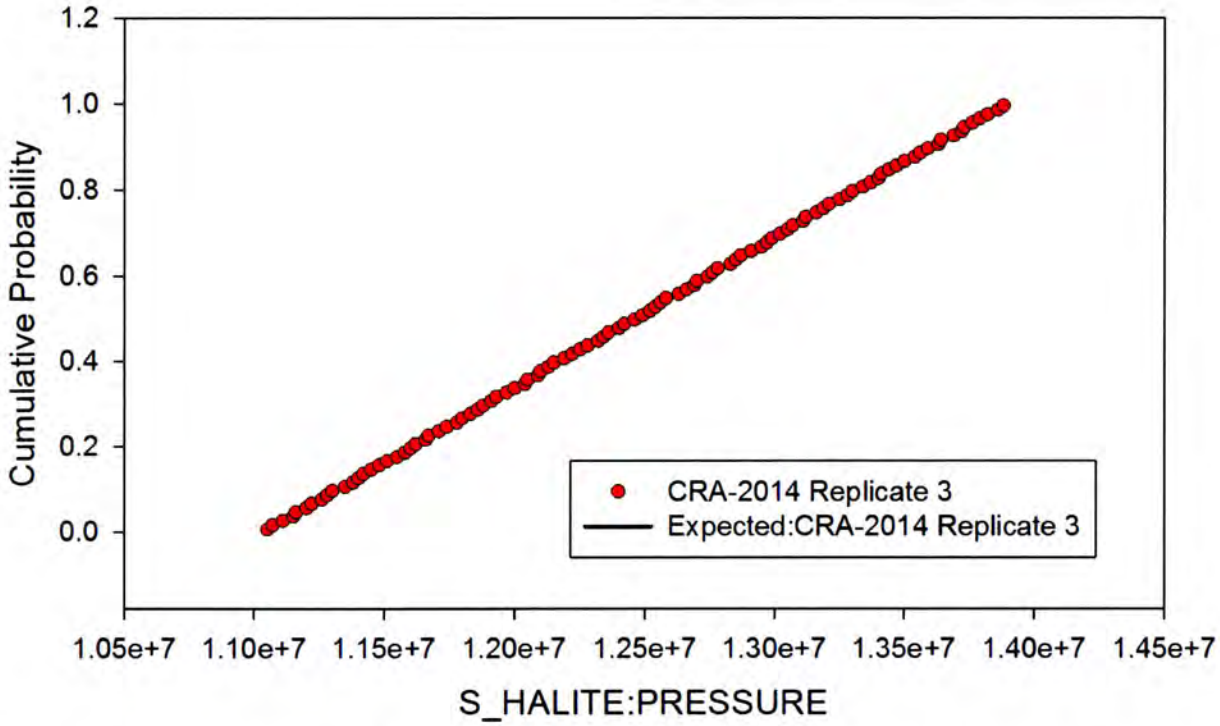

Figure 159. Observed and Expected CDFs for S_HALITE:PRESSURE (Uniform Distribution) Replicate 3.

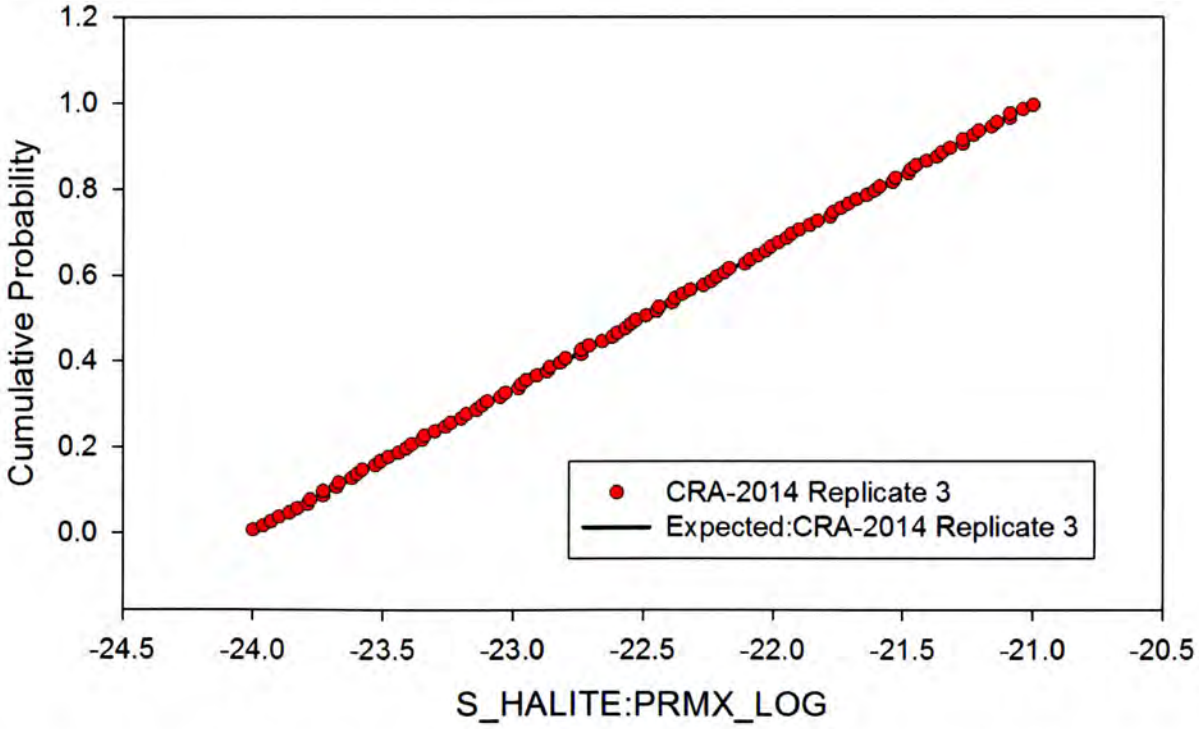

Figure 160. Observed and Expected CDFs for S_HALITE:PRMX_LOG (Uniform Distribution) Replicate 3.

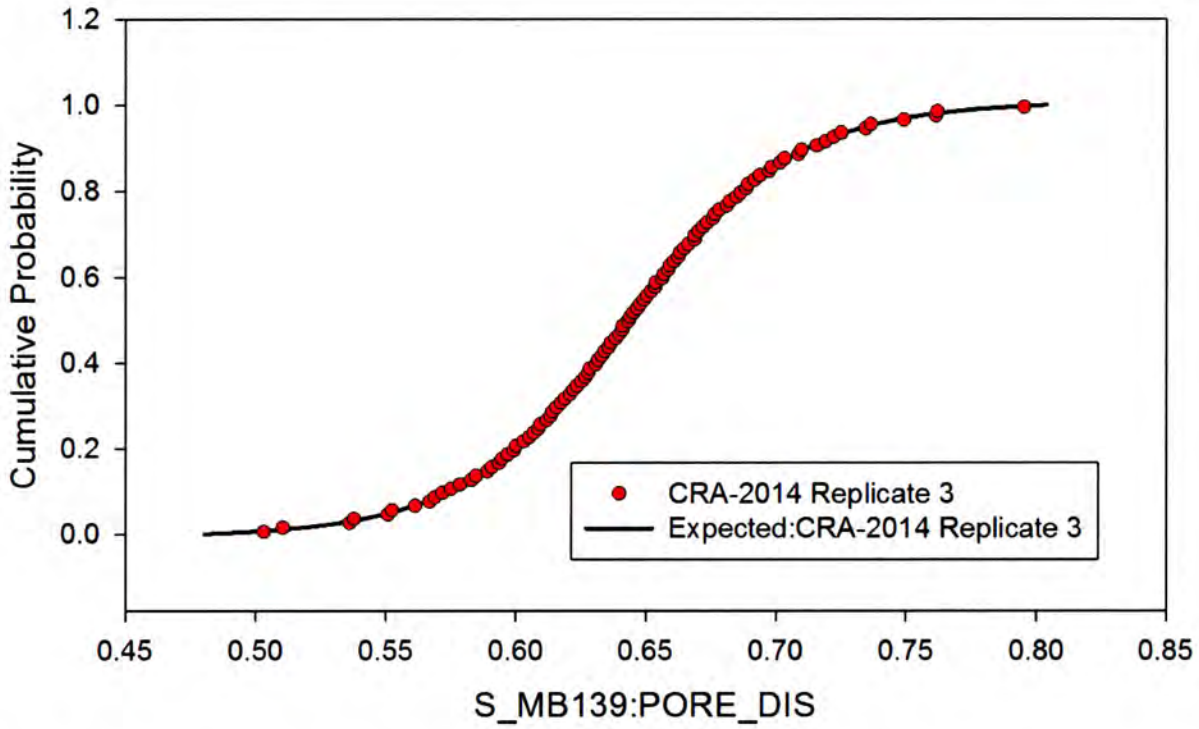

Figure 161. Observed and Expected CDFs for S_MB139:PORE_DIS (Student Distribution) Replicate 3.

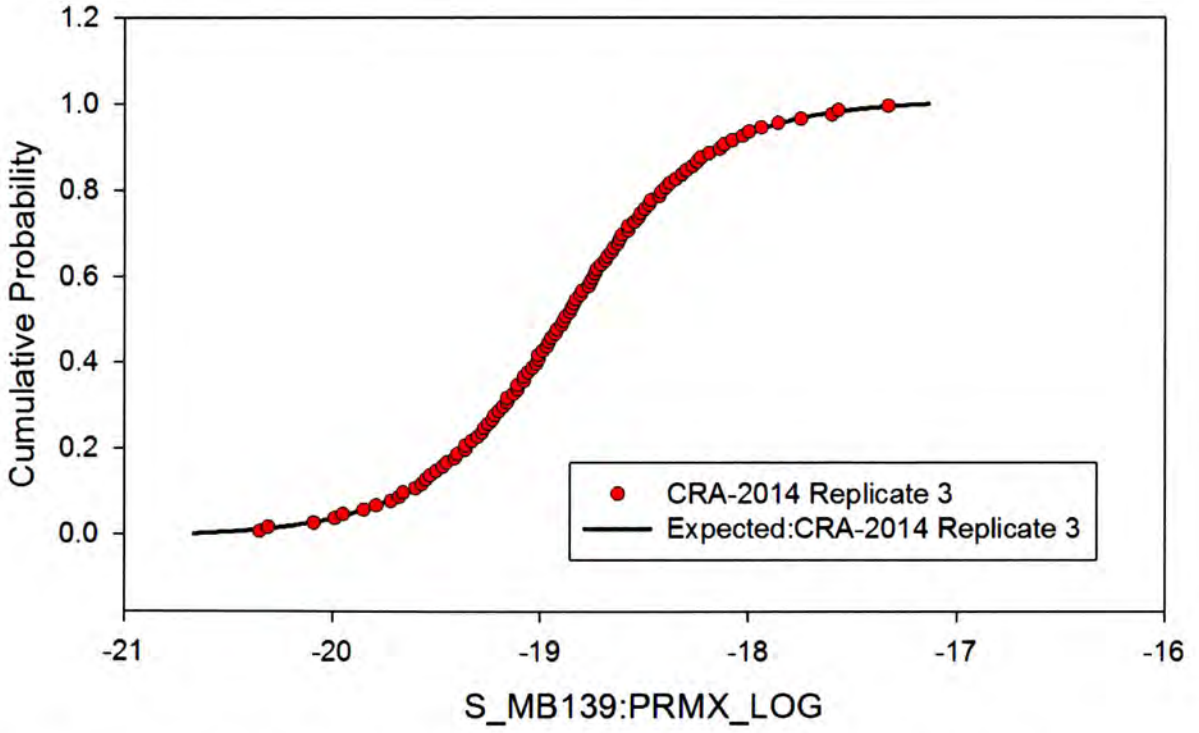

Figure 162. Observed and Expected CDFs for S_MB139:PRMX_LOG (Student Distribution) Replicate 3.

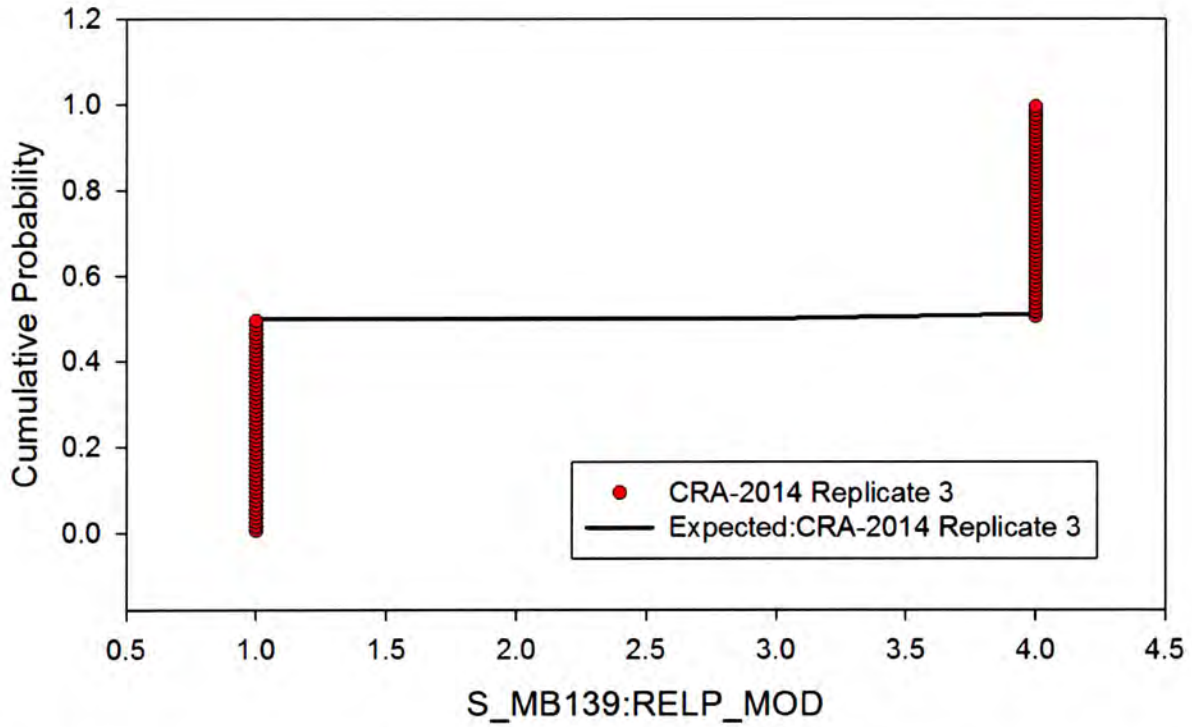

Figure 163. Observed and Expected CDFs for S_MB139:RELP_MOD (User Discrete (Delta) Distribution) Replicate 3.

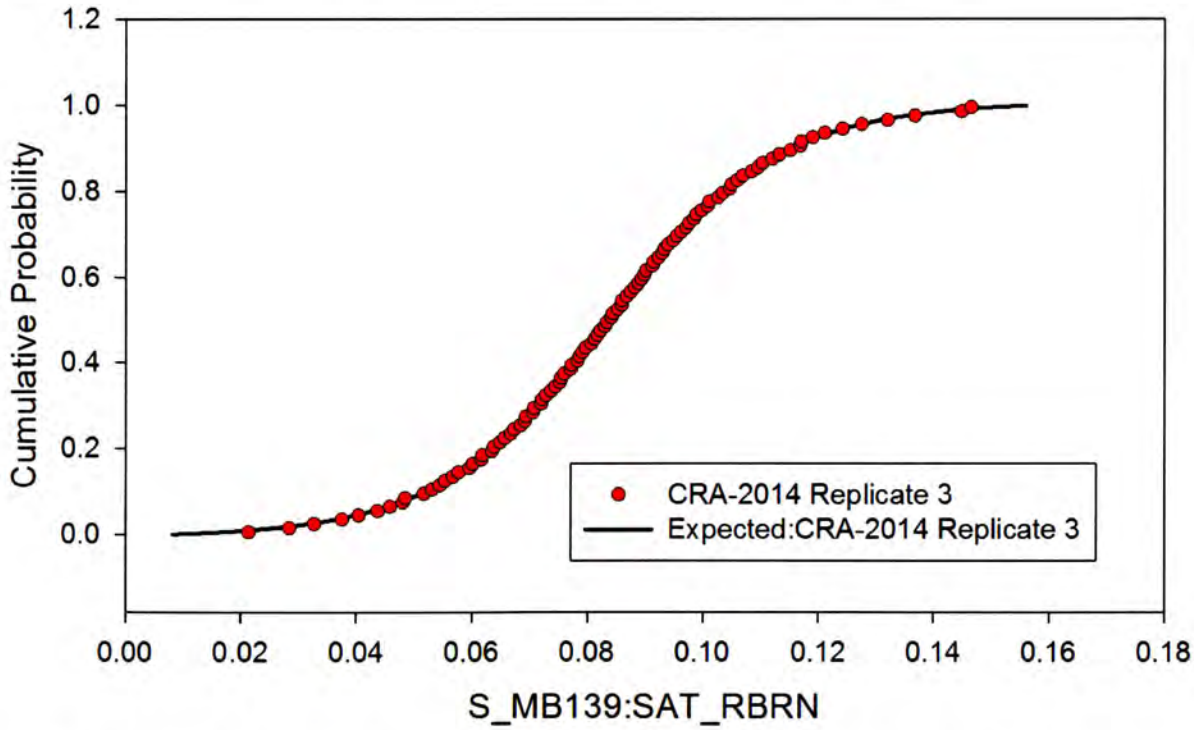

Figure 164. Observed and Expected CDFs for S_MB139:SAT_RBRN (Student Distribution) Replicate 3.

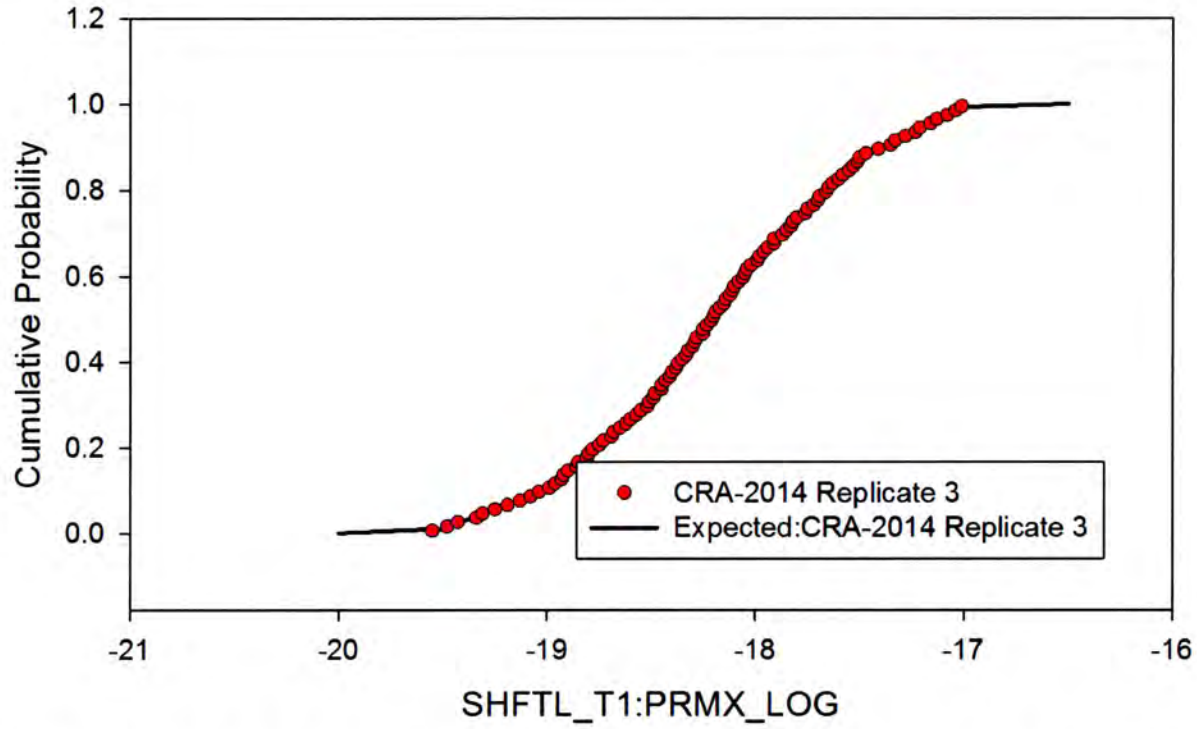

Figure 165. Observed and Expected CDFs for SHFTL_T1:PRMX_LOG (User Continuous Distribution) Replicate 3.

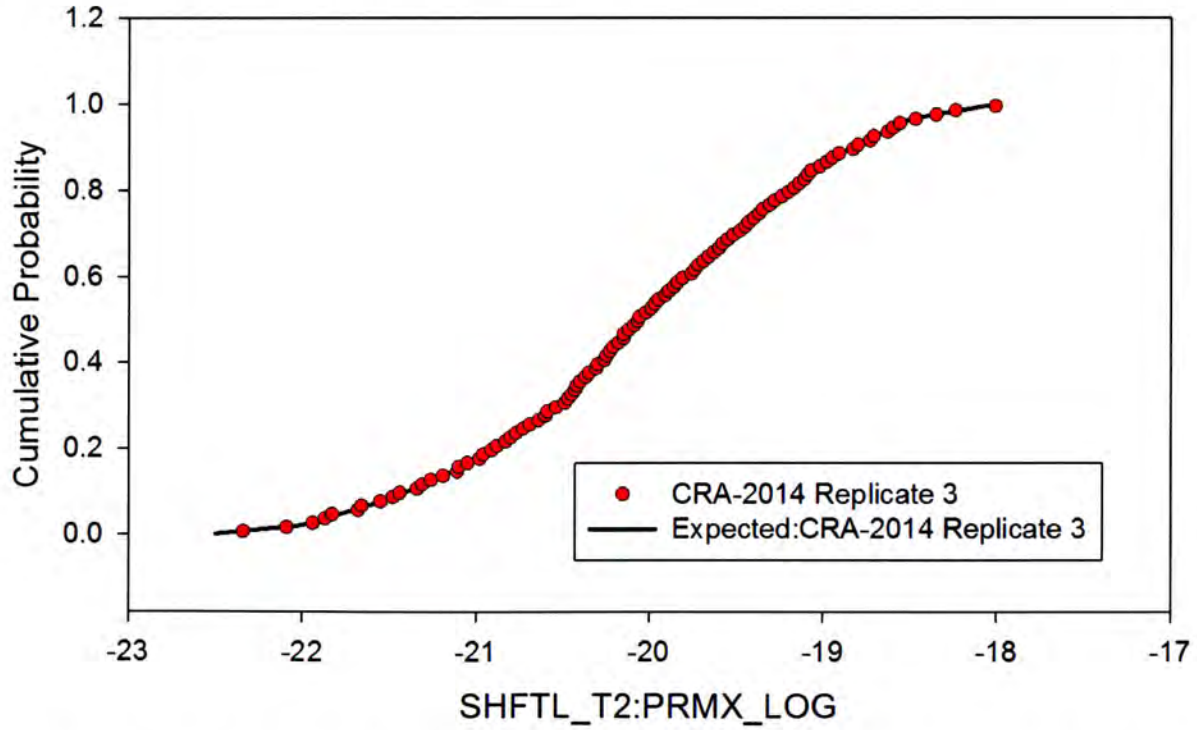

Figure 166. Observed and Expected CDFs for SHFTL_T2:PRMX_LOG (User Continuous Distribution) Replicate 3.

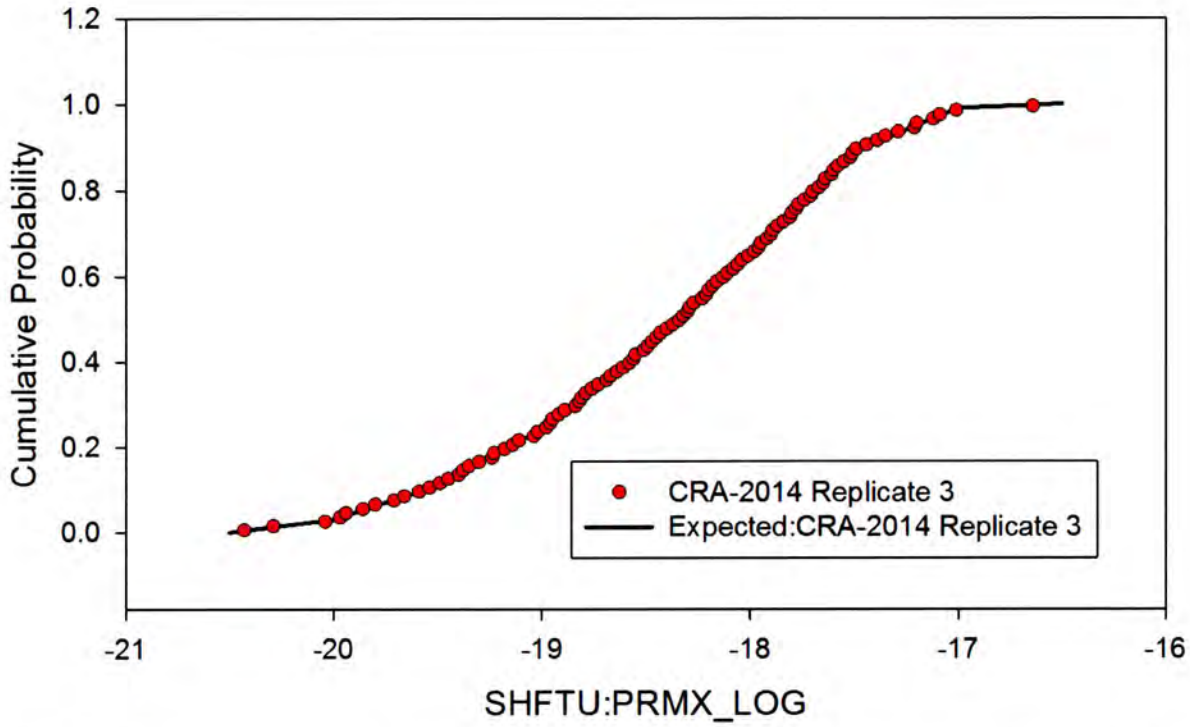

Figure 167. Observed and Expected CDFs for SHFTU:PRMX_LOG (User Continuous Distribution) Replicate 3.

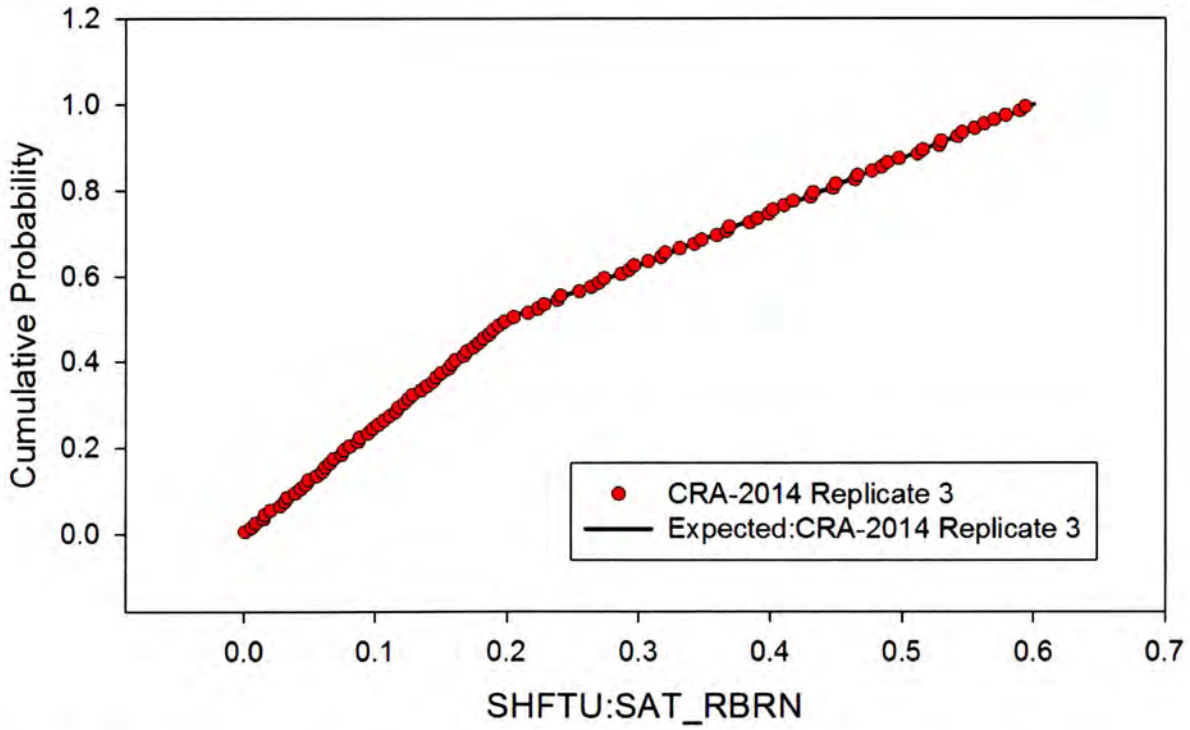

Figure 168. Observed and Expected CDFs for SHFTU:SAT_RBRN (User Continuous Distribution) Replicate 3.

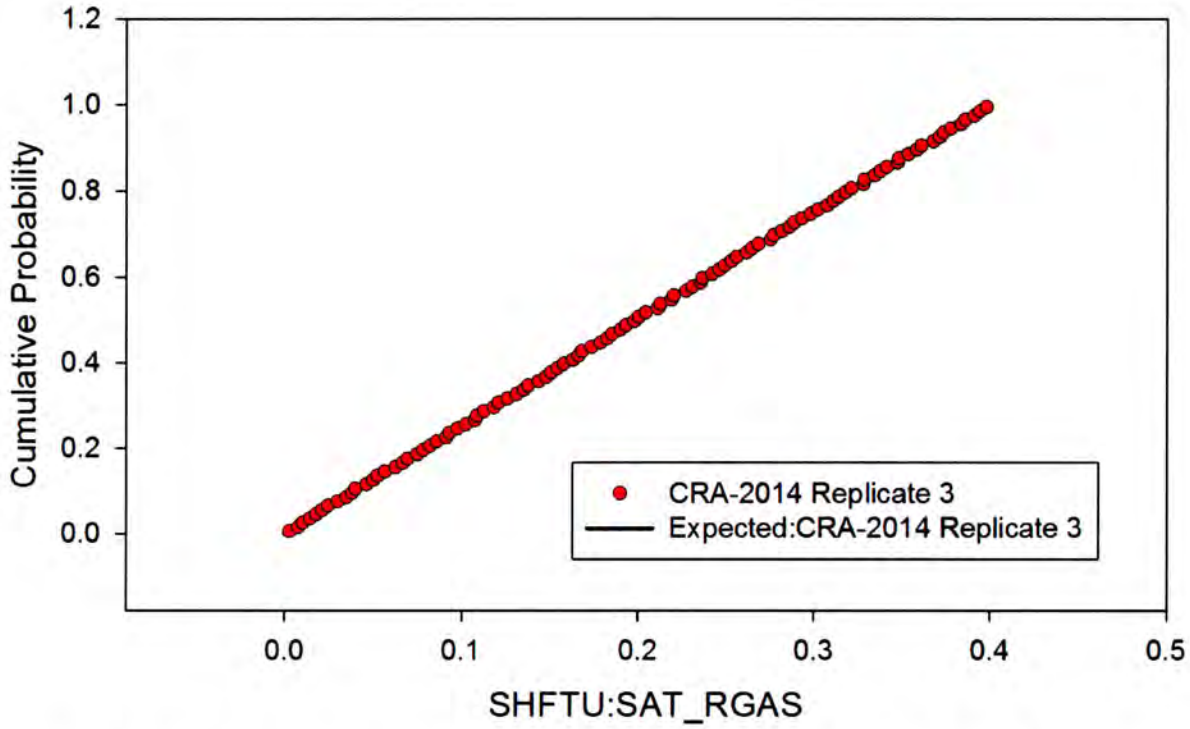

Figure 169. Observed and Expected CDFs for SHFTU:SAT_RGAS (Uniform Distribution) Replicate 3.

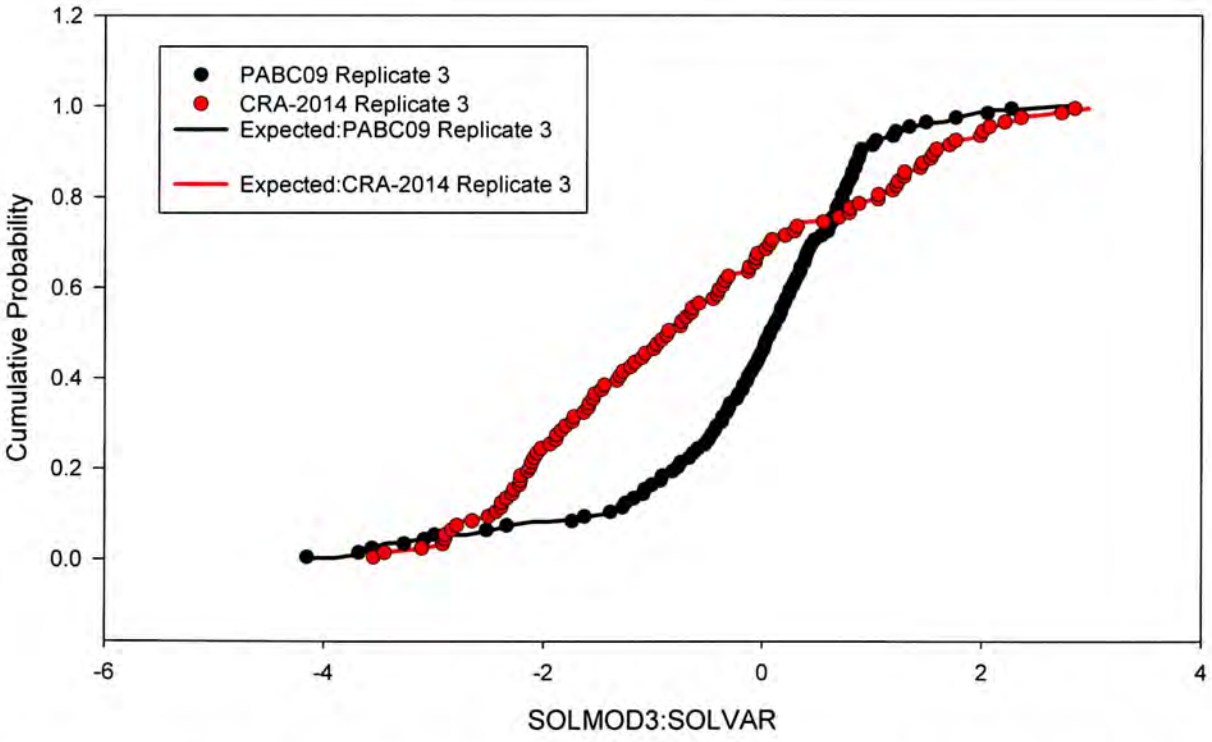

Figure 170. Observed and Expected CDFs for SOLMOD3:SOLVAR (User Continuous Distribution) Replicate 3 for PABC09 and CRA-2014.

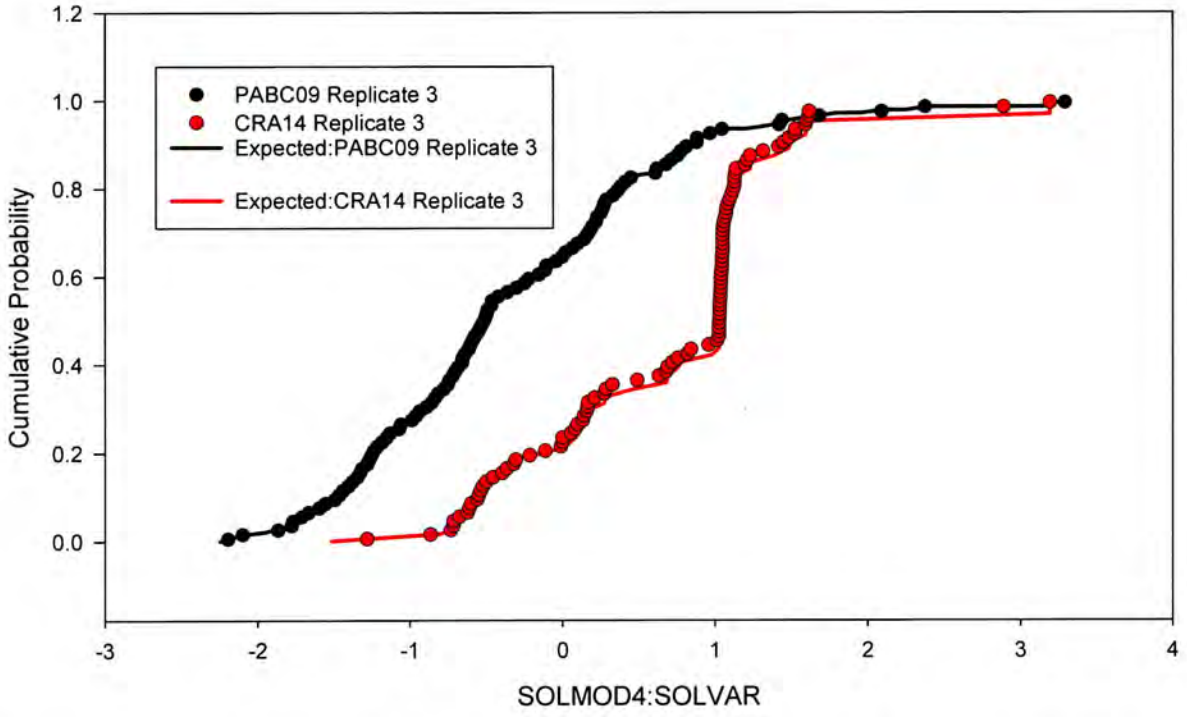

Figure 171. Observed and Expected CDFs for SOLMOD4:SOLVAR (User Continuous Distribution) Replicate 3 for PABC09 and CRA-2014.

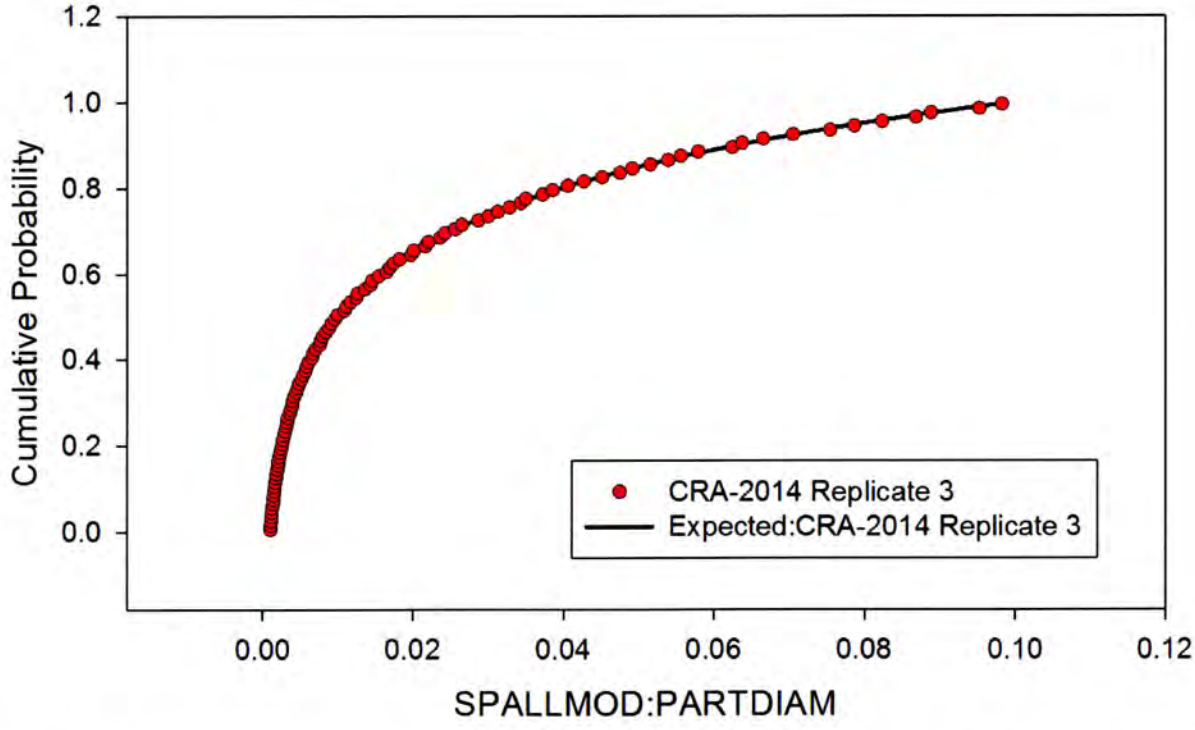

Figure 172. Observed and Expected CDFs for SPALLMOD:PARTDIAM (Loguniform Distribution) Replicate 3.

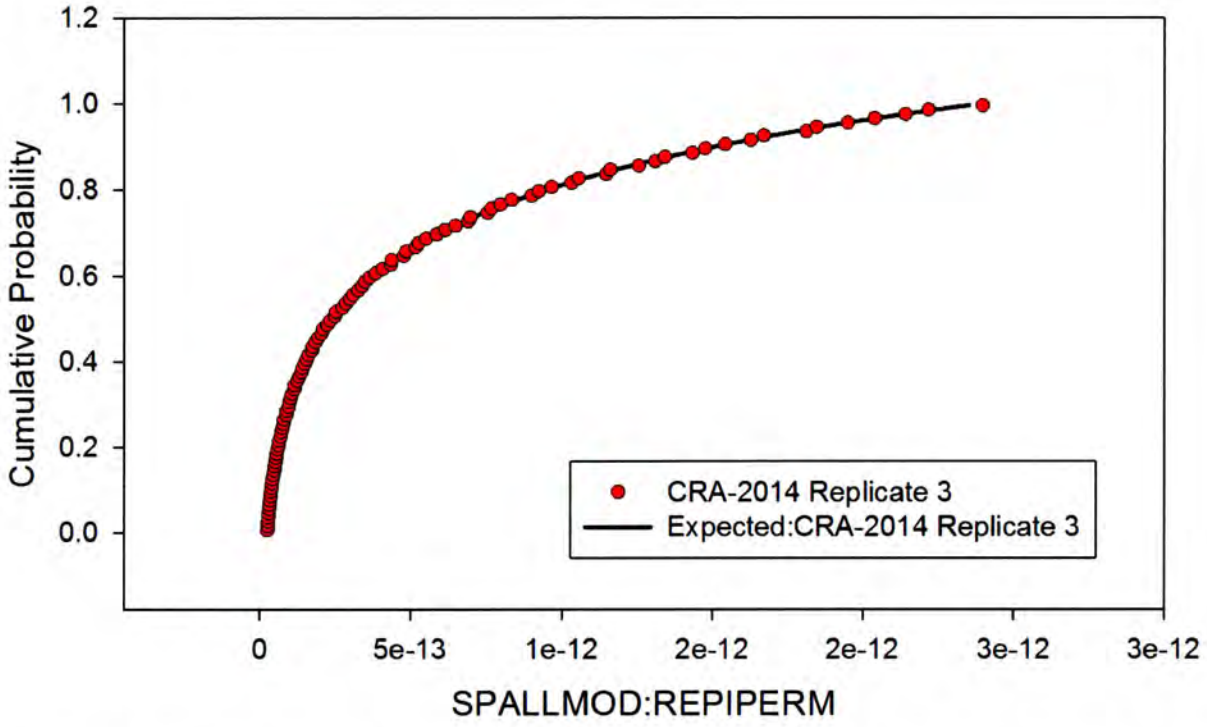

Figure 173. Observed and Expected CDFs for SPALLMOD:REPIPERM (Loguniform Distribution) Replicate 3.

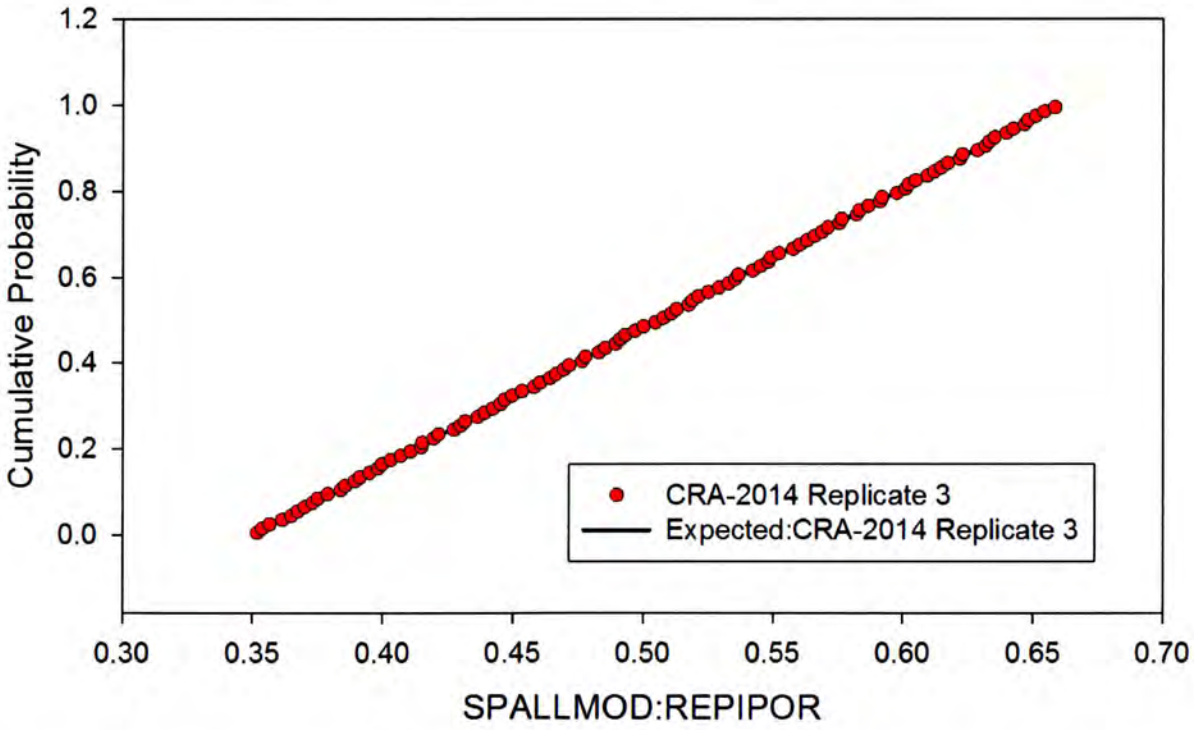

Figure 174. Observed and Expected CDFs for SPALLMOD:REPIPOR (Uniform Distribution) Replicate 3.

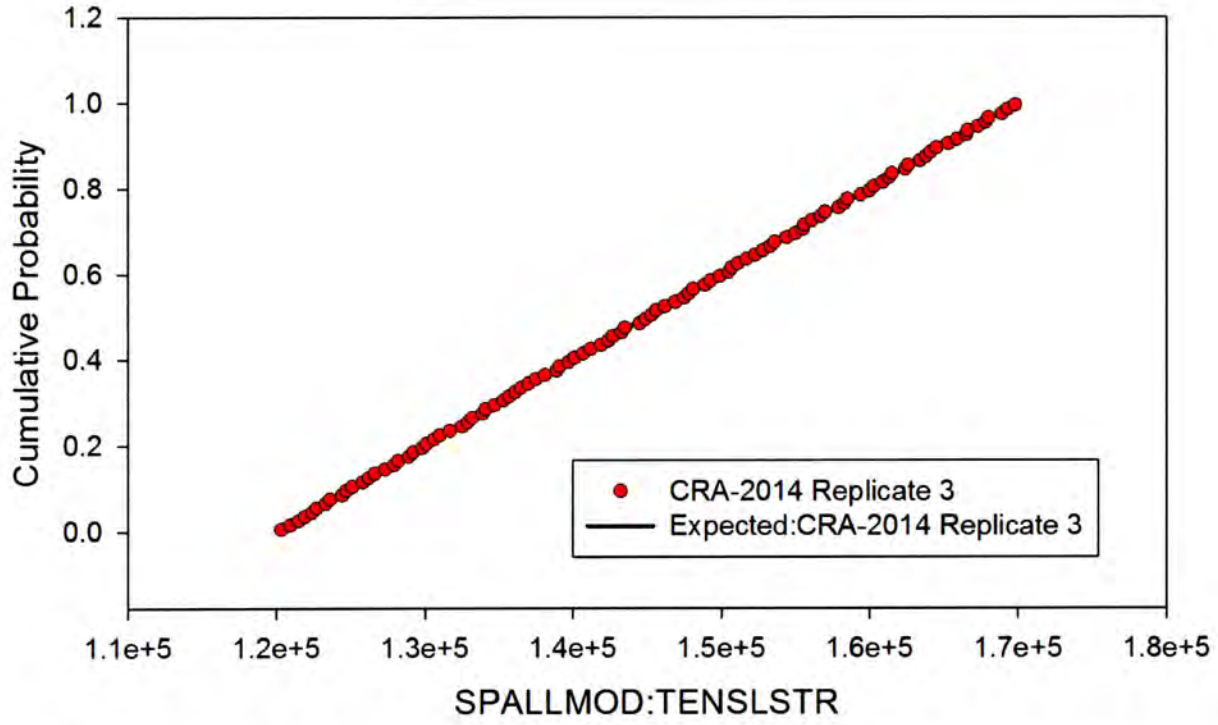

Figure 175. Observed and Expected CDFs for SPALLMOD:TENSLSTR (Uniform Distribution) Replicate 3.

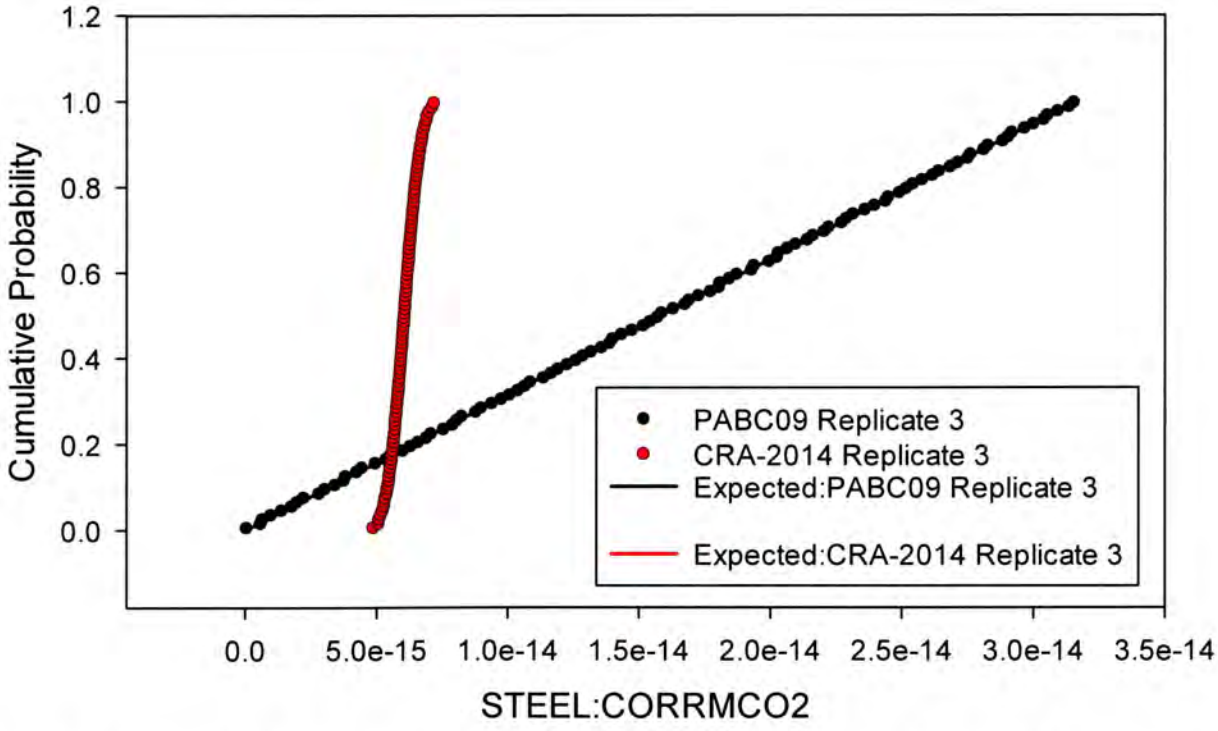

Figure 176. Observed and Expected CDFs for STEEL:CORRMCO2 Replicate 3 for PABC09 (Uniform Distribution) and CRA-2014 (Student Distribution).

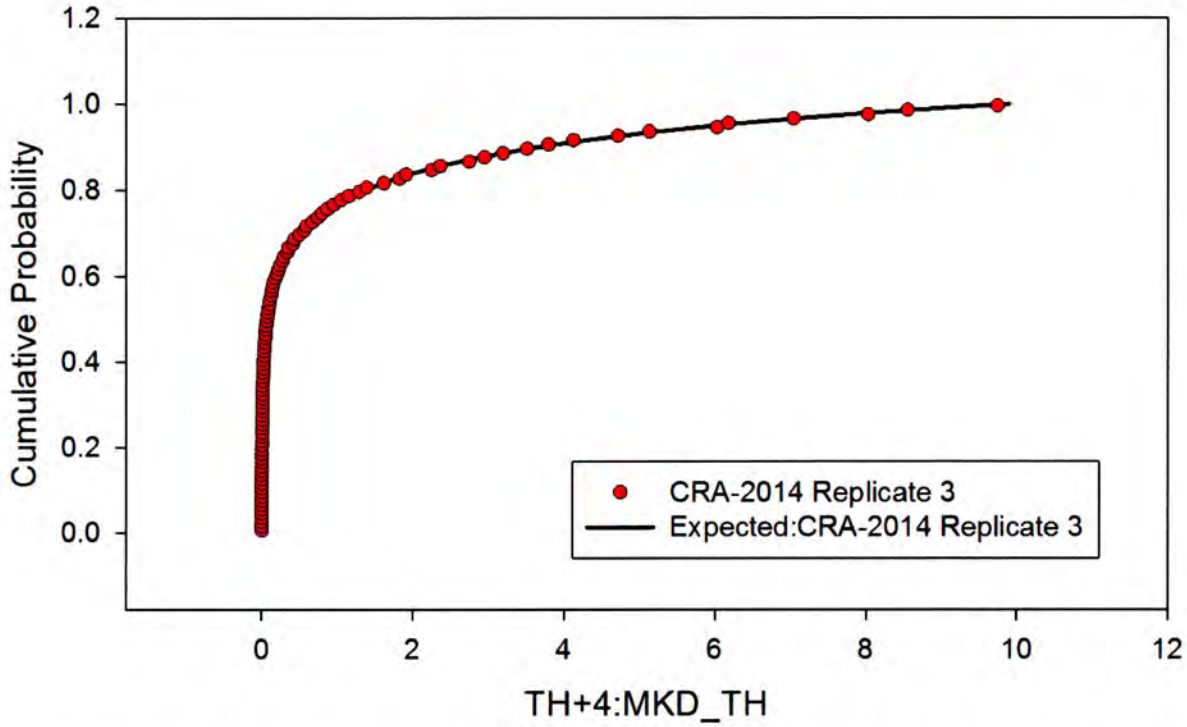

Figure 177. Observed and Expected CDFs for TH+4:MKD_TH (Loguniform Distribution) Replicate 3.

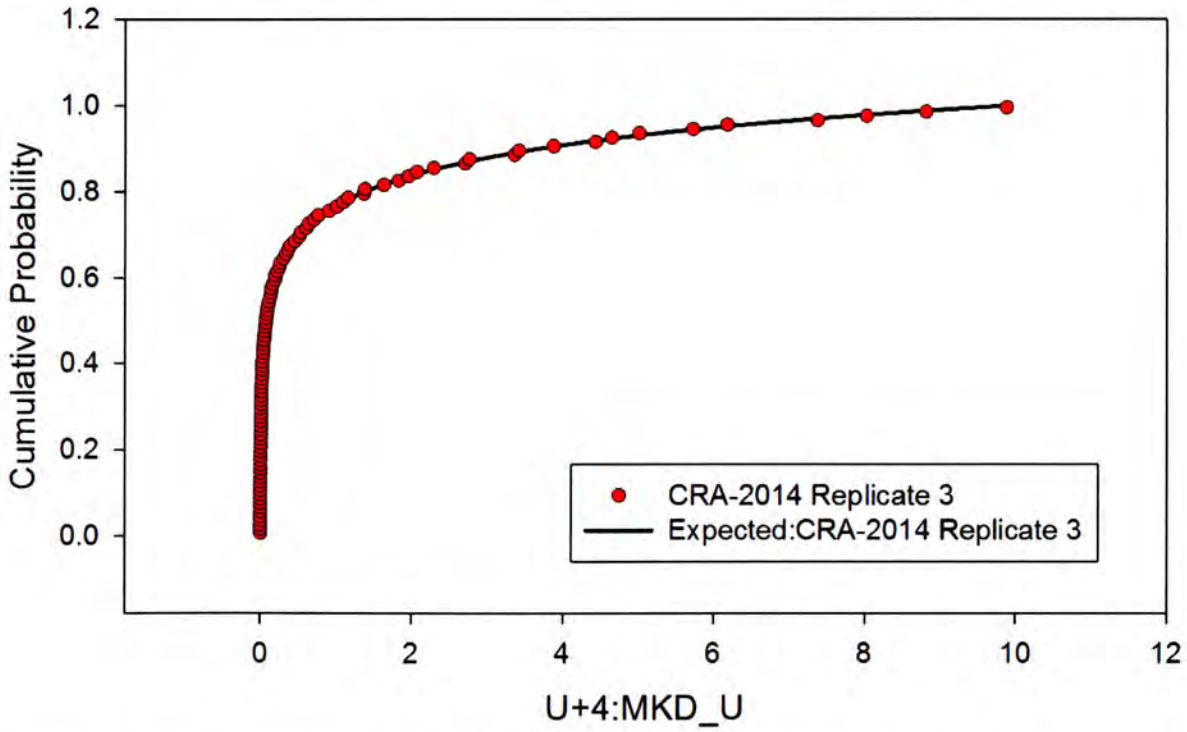

Figure 178. Observed and Expected CDFs for U+4:MKD_U (Loguniform Distribution) Replicate 3.

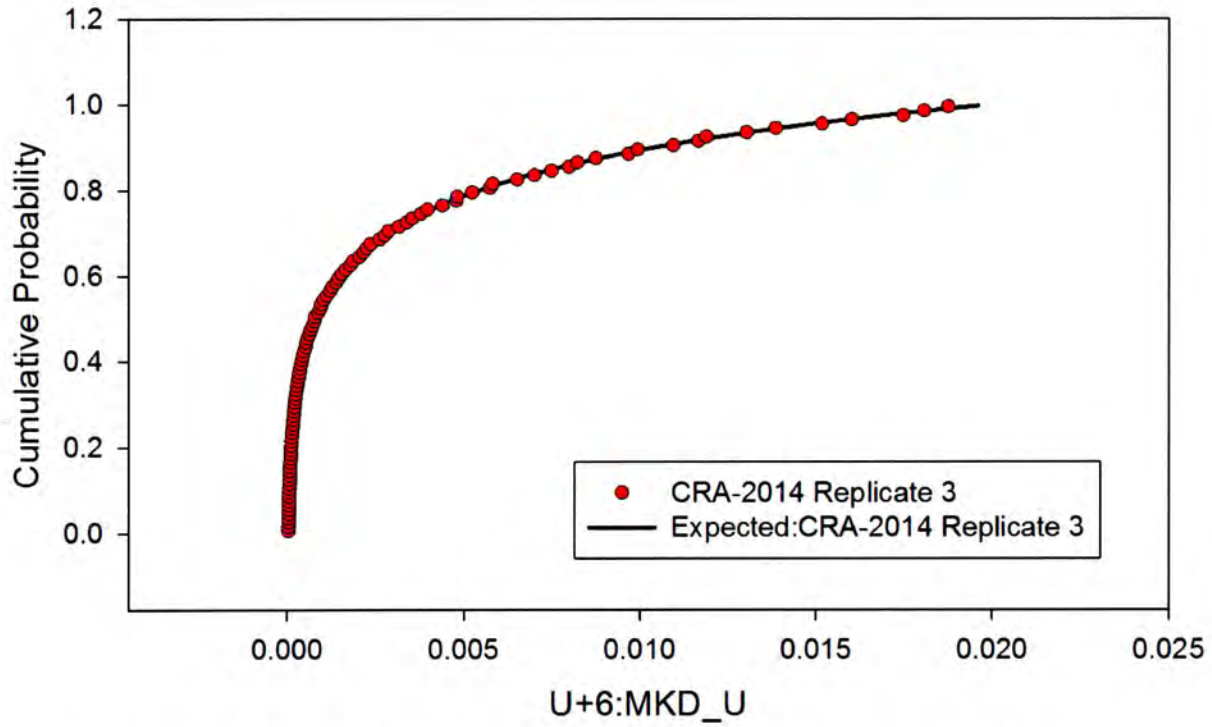

Figure 179. Observed and Expected CDFs for U+6:MKD_U (Loguniform Distribution) Replicate 3.

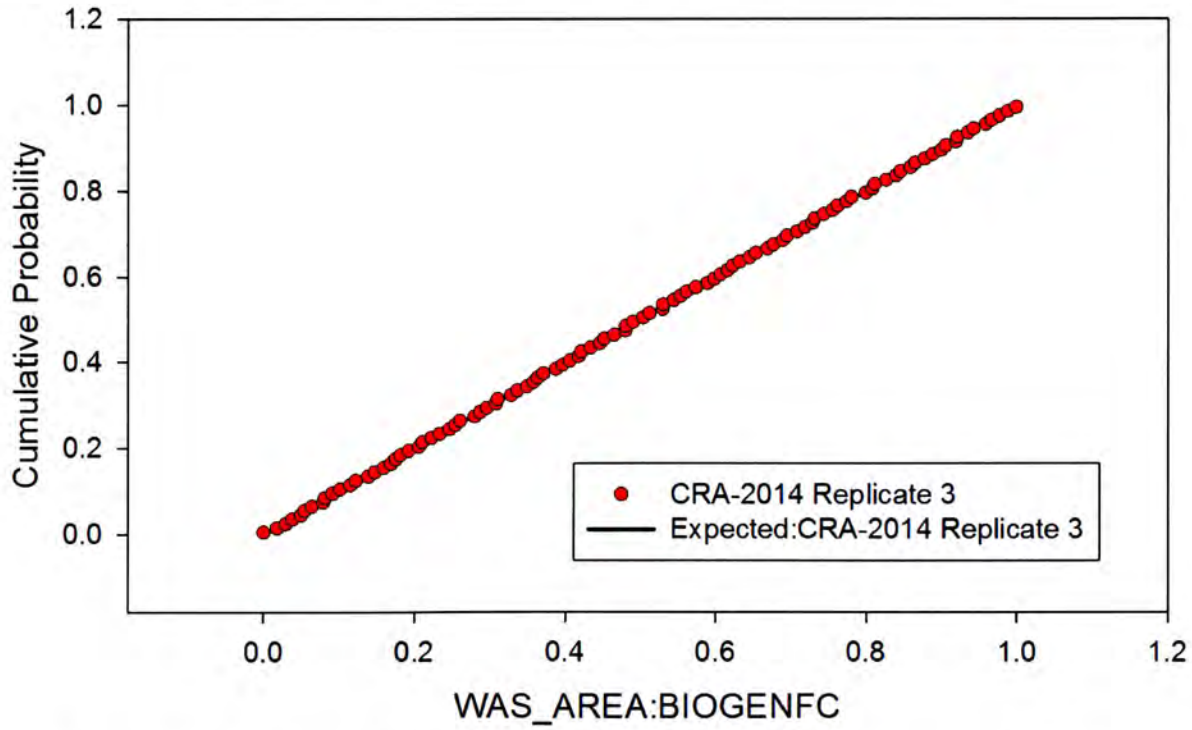

Figure 180. Observed and Expected CDFs for WAS_AREA:BIOGENFC (Uniform Distribution) Replicate 3.

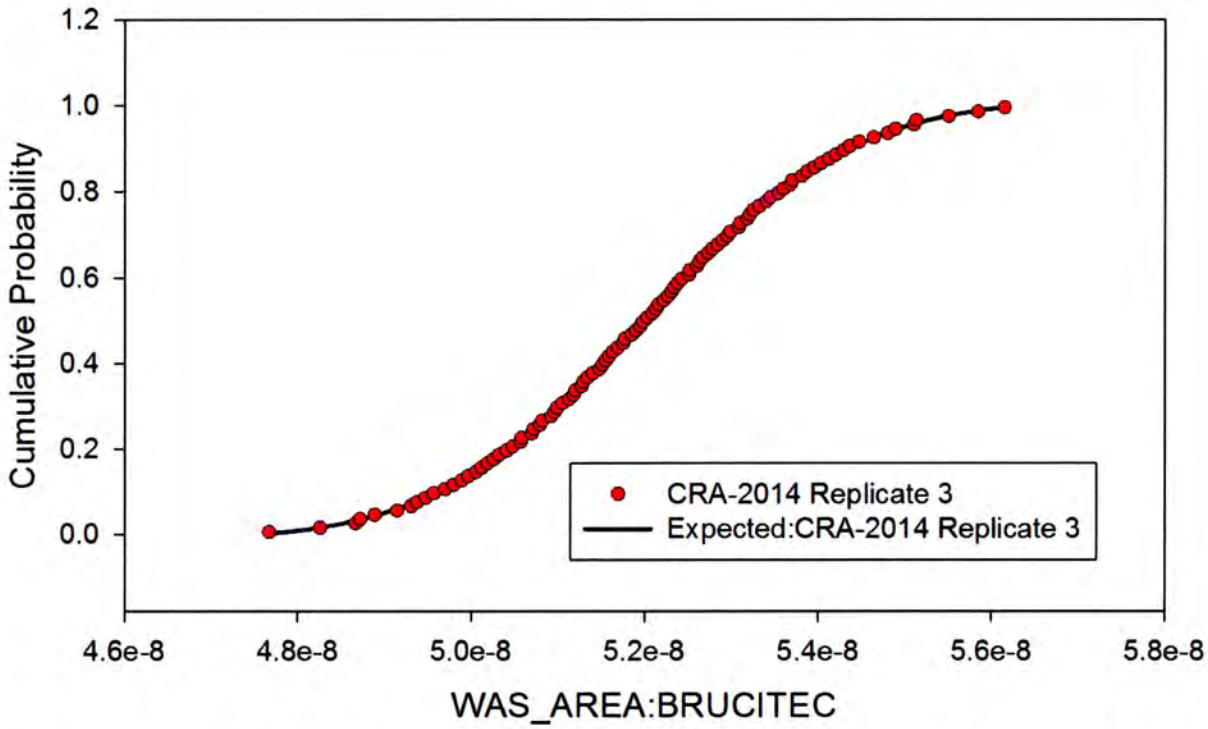

Figure 181. Observed and Expected CDFs for WAS_AREA:BRUCITEC (Normal Distribution) Replicate 3.

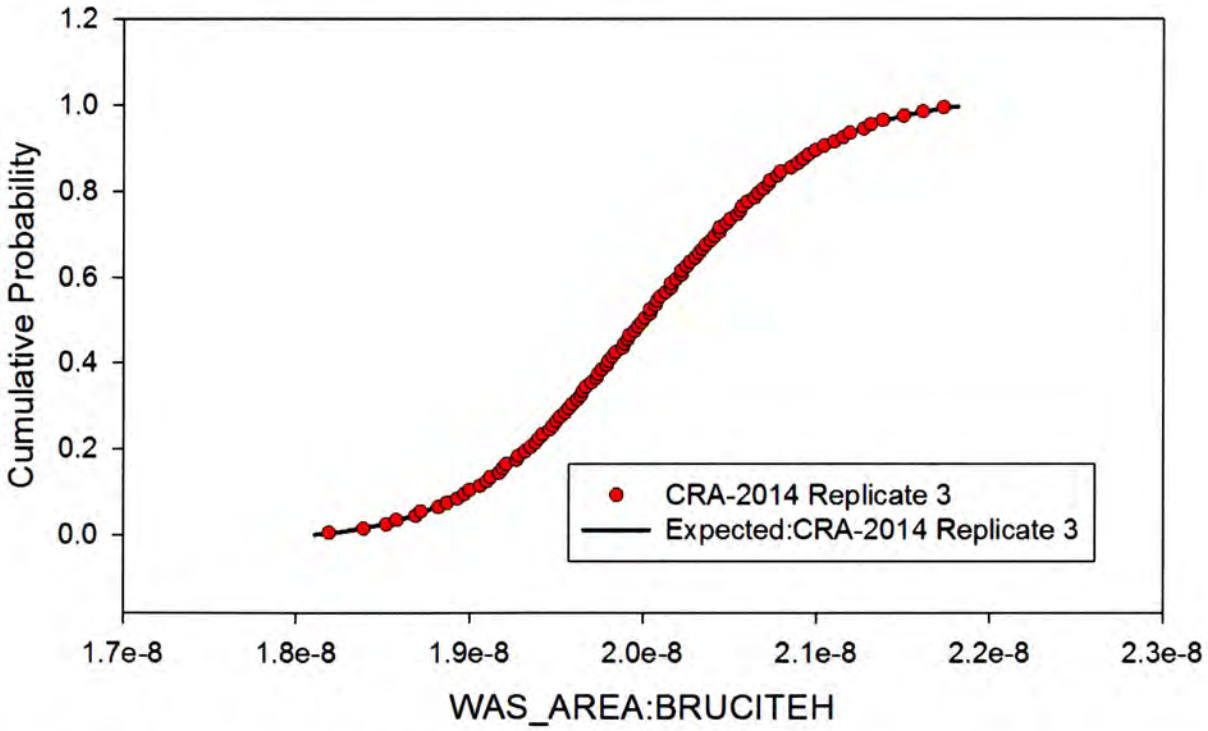

Figure 182. Observed and Expected CDFs for WAS_AREA:BRUCITEH (Normal Distribution) Replicate 3.

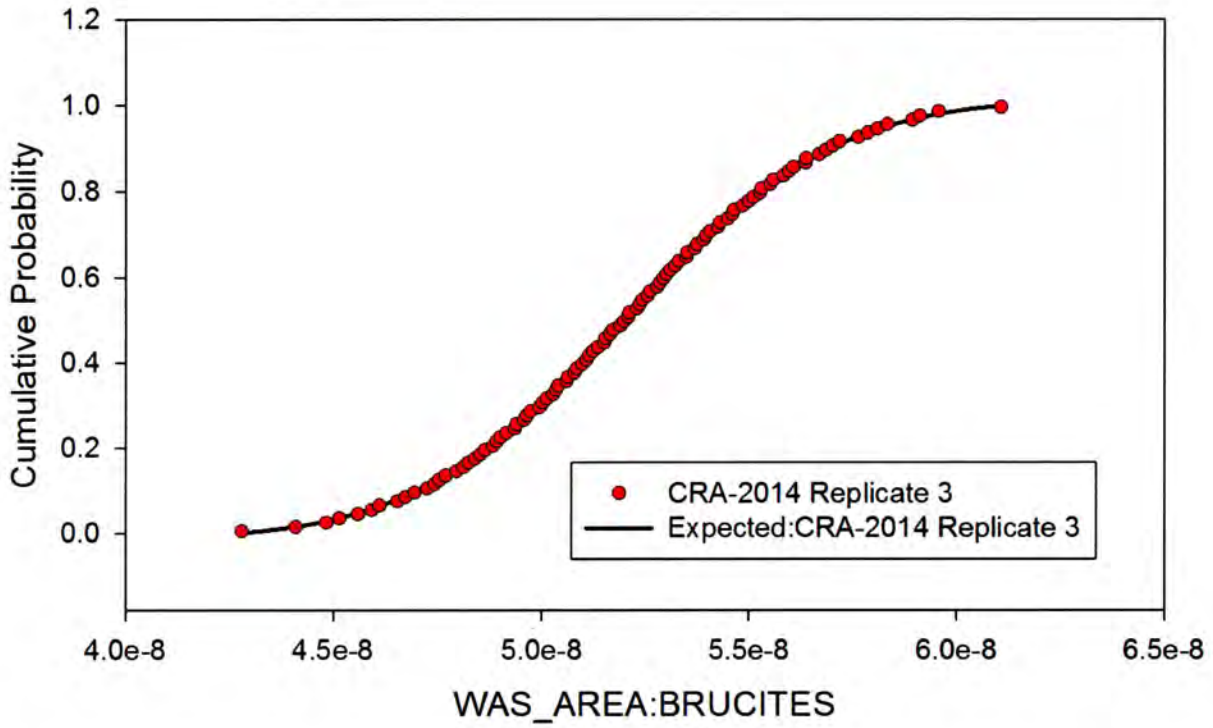

Figure 183. Observed and Expected CDFs for WAS_AREA:BRUCITES (Normal Distribution) Replicate 3.

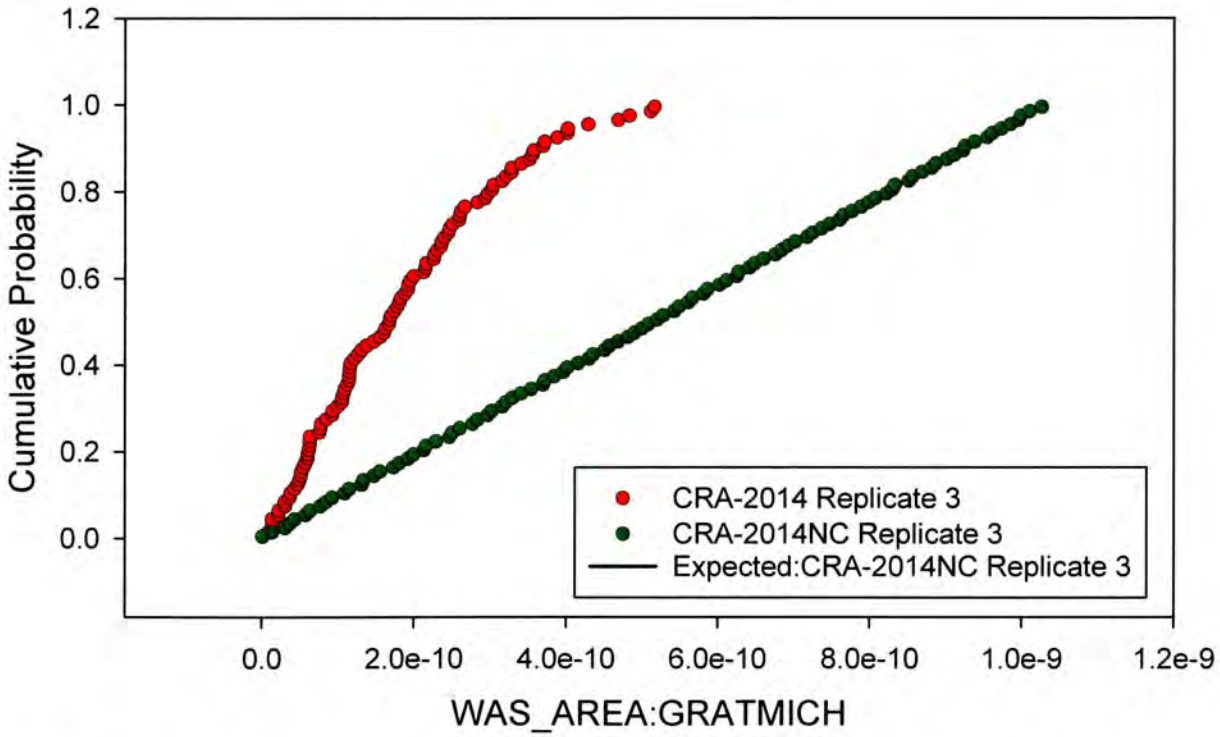

Figure 184. Observed and Expected CDFs for WAS_AREA:GRATMICH (Uniform Distribution) Replicate 3 also showing the data prior to conditioning (NC).

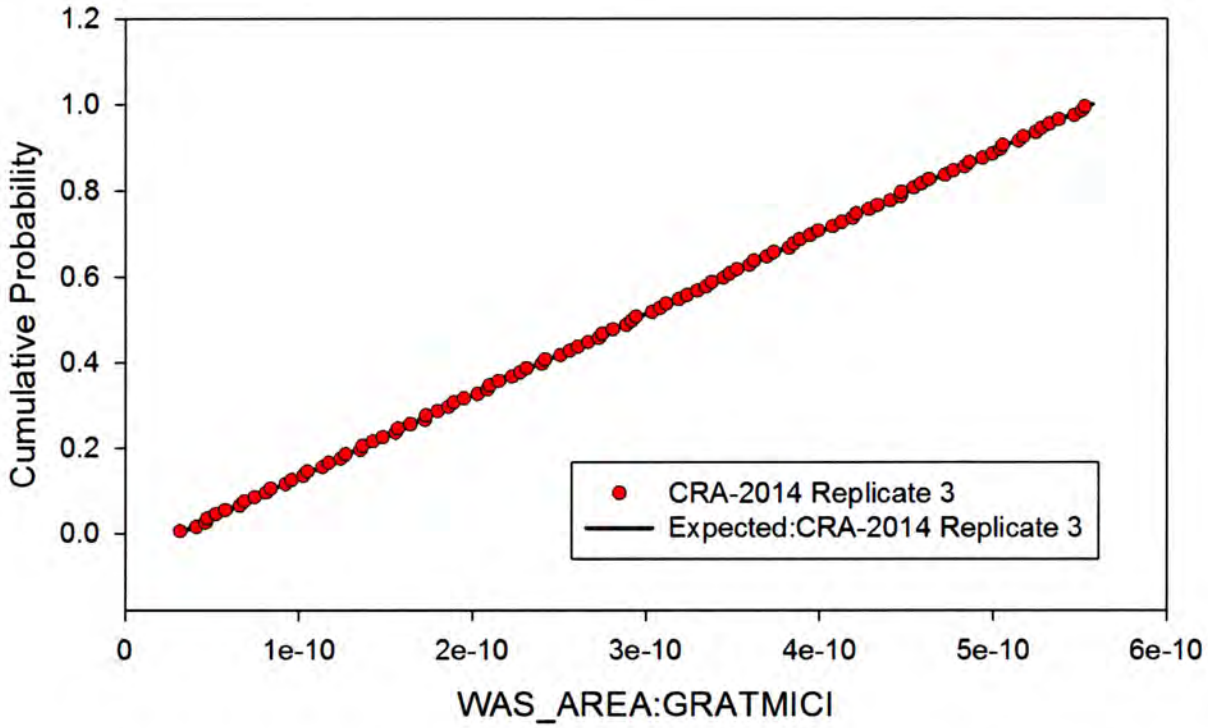

Figure 185. Observed and Expected CDFs for WAS_AREA:GRATMICI (Uniform Distribution) Replicate 3.

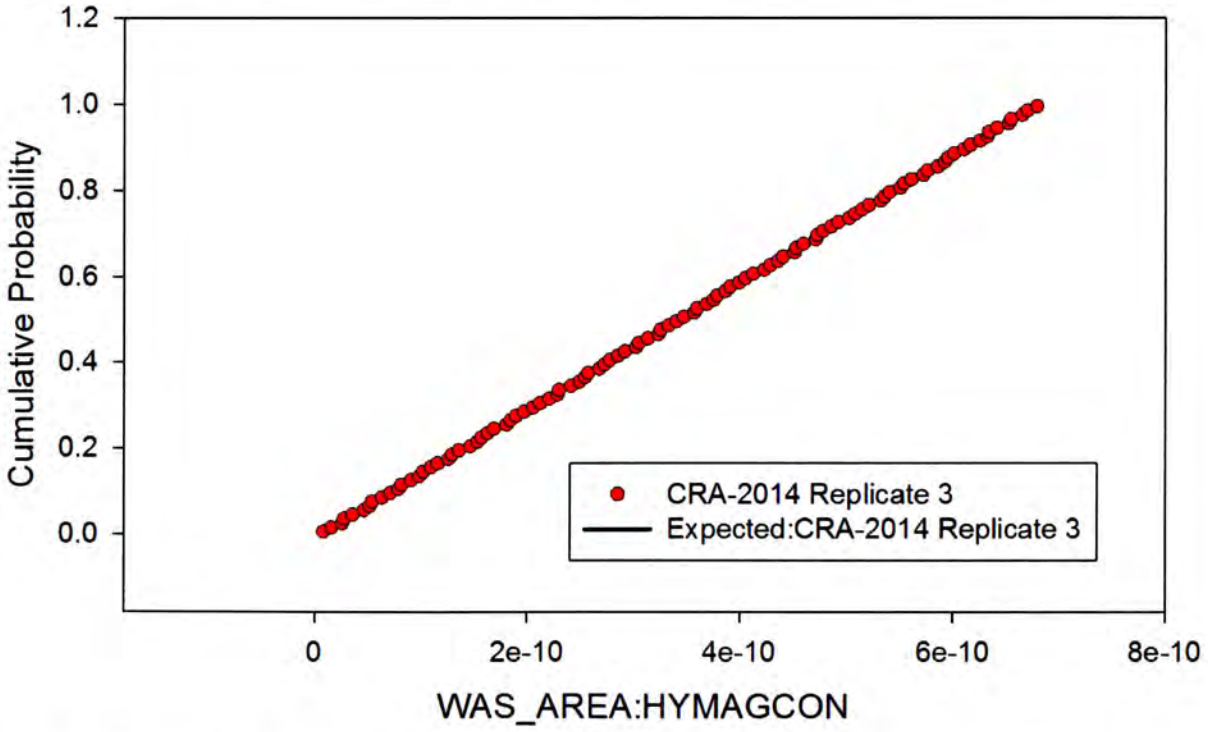

Figure 186. Observed and Expected CDFs for WAS_AREA:HYMAGCON (Uniform Distribution) Replicate 3.

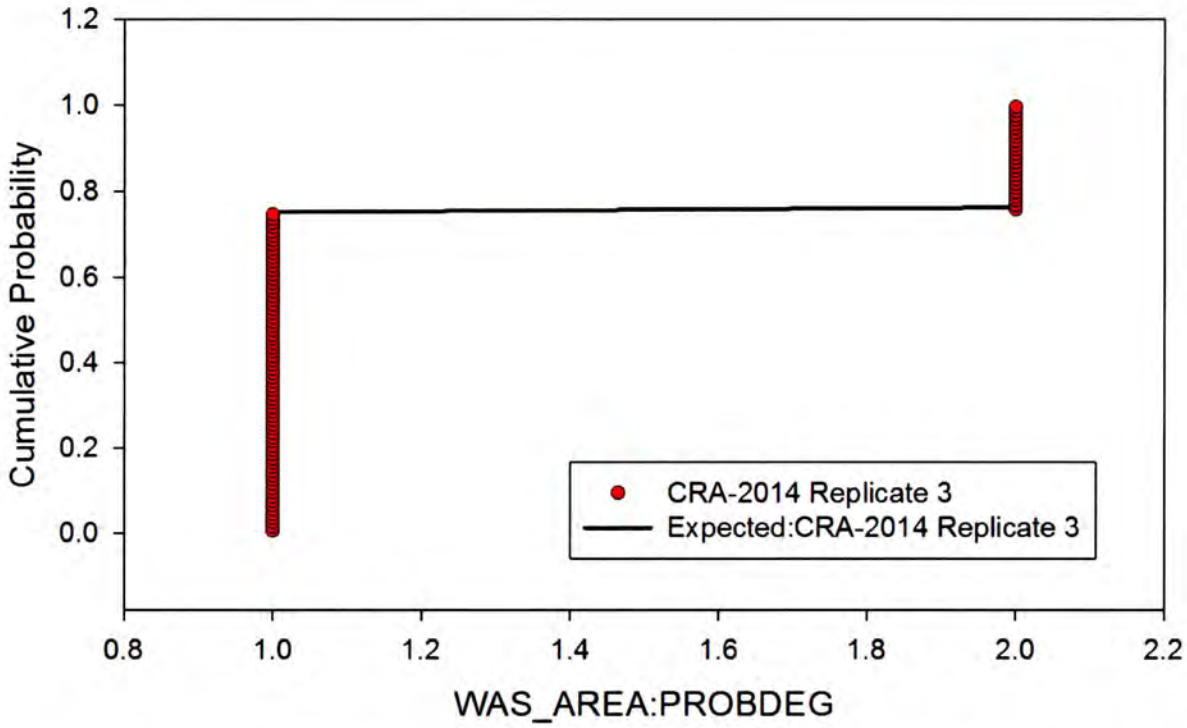

Figure 187. Observed and Expected CDFs for WAS_AREA:PROBDEG (User Discrete (Delta) Distribution) Replicate 3.

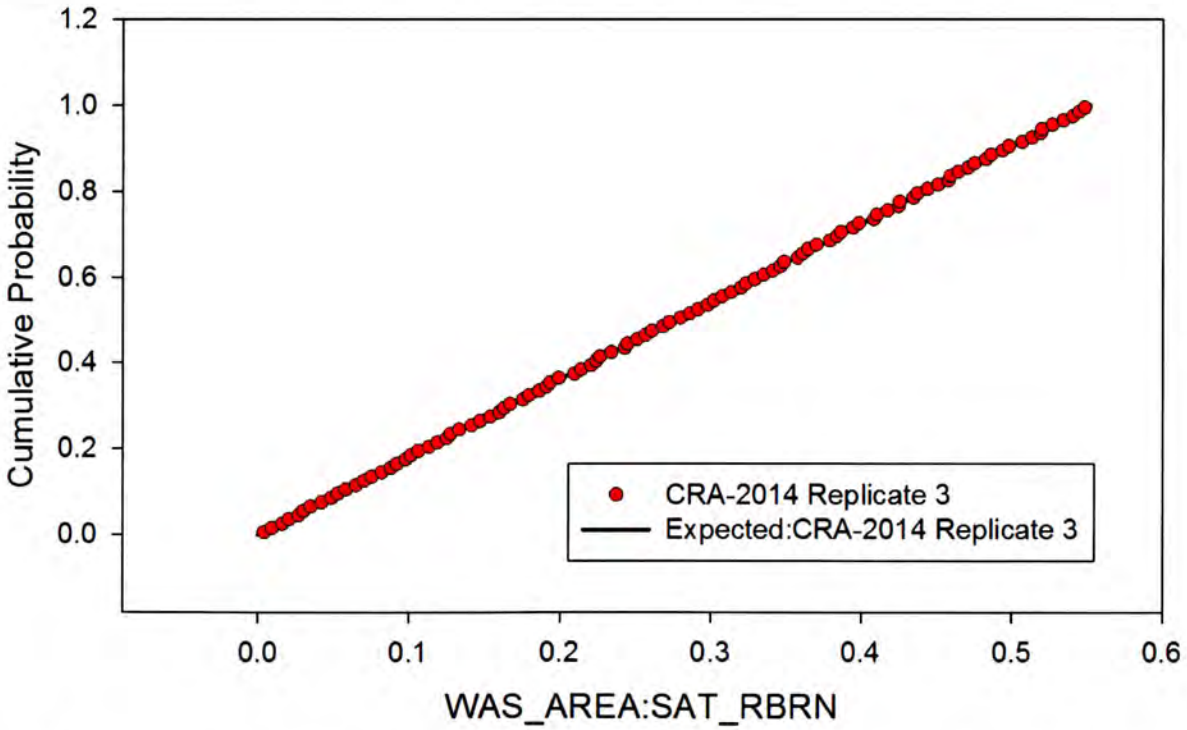

Figure 188. Observed and Expected CDFs for WAS_AREA:SAT_RBRN (Uniform Distribution) Replicate 3.

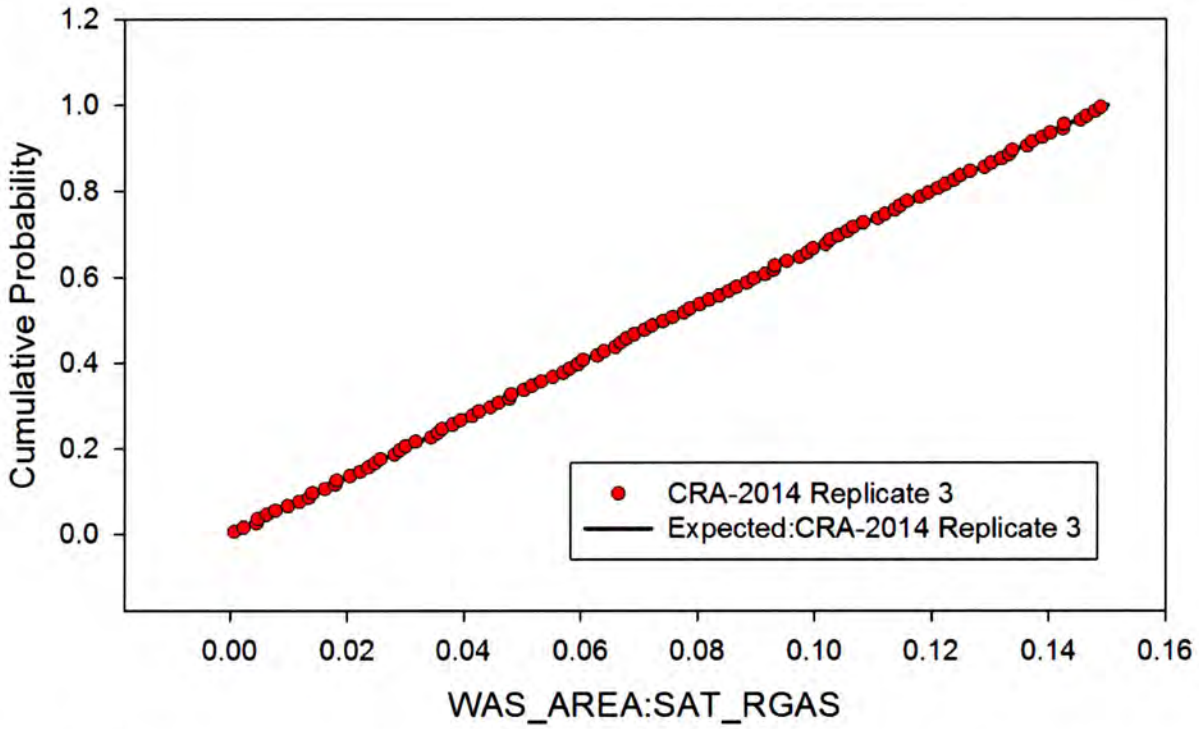

Figure 189. Observed and Expected CDFs for WAS_AREA:SAT_RGAS (Uniform Distribution) Replicate 3.

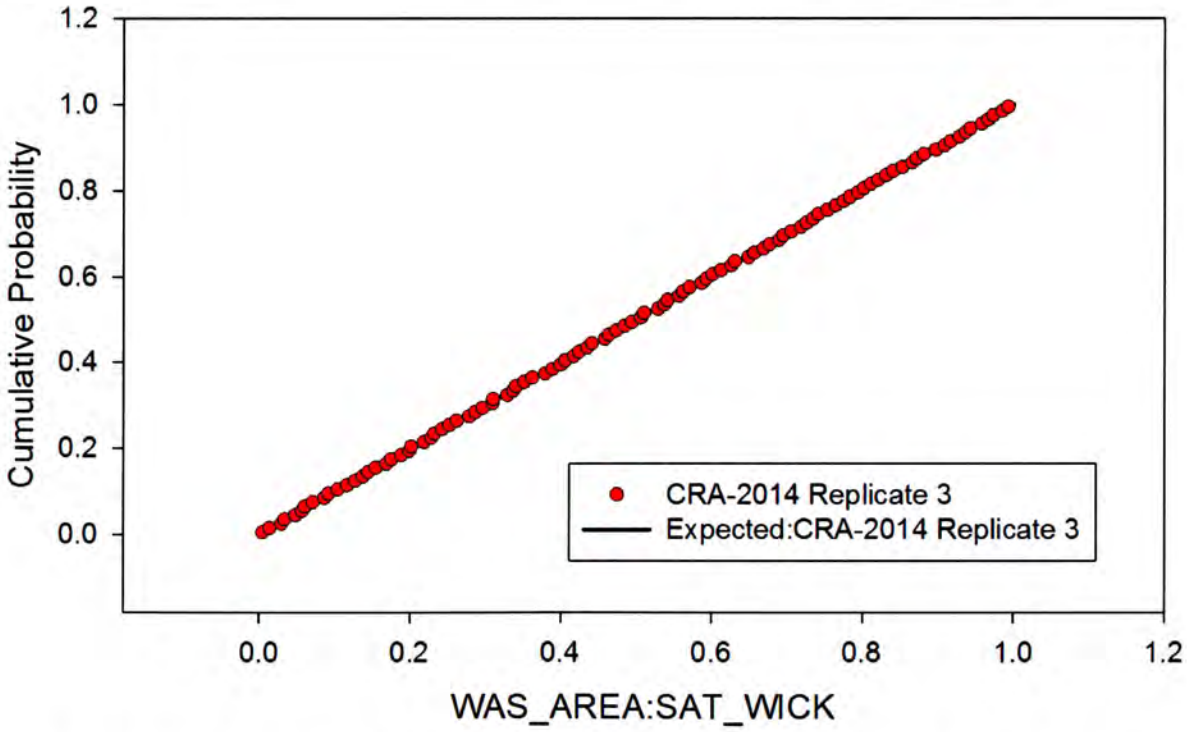

Figure 190. Observed and Expected CDFs for WAS_AREA:SAT_WICK (Uniform Distribution) Replicate 3.

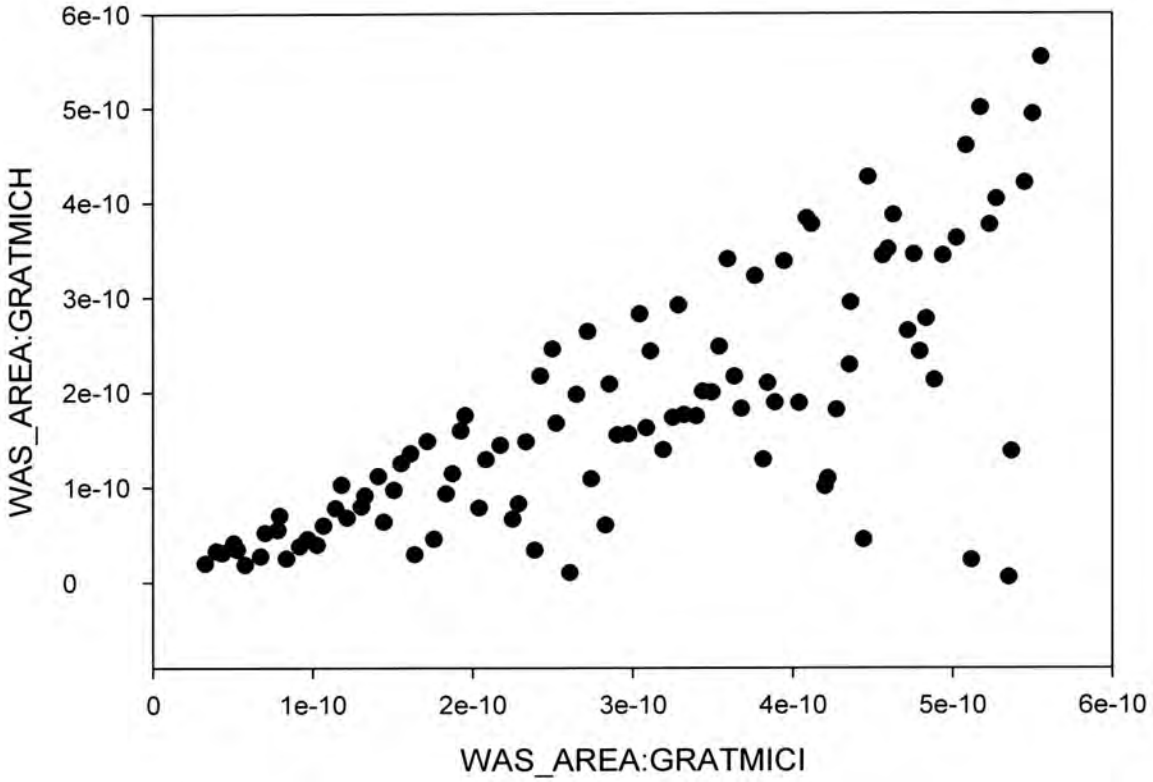

Figure 191. The conditional relationship introduced between WAS_AREA:GRATMICI and WAS_AREA:GRATMICH also produces a correlation between the variables.

Appendix I. Input file to PRELHS for Replicate 1

Note that there is an error in the comments of the header of the file. The comment "!Also, LHS_EDIT should control 41<42, and 74<73<72 WAS_AREA:GRATMICI < WAS_AREA:GRATMICH and" should have stated "!Also, LHS_EDIT should control 42<41, and 74<73<72 (WAS_AREA:GRATMICH < WAS_AREA:GRATMICI and".

```
! TITLE:          CRA-2014 PRELHS (LHS1) Input File
! ANALYSIS PLAN: AP-164
! ANALYST:       Tom Kirchner
! CREATED:       February 2013
!
!  LHSCALC = CRA-2014 REALIZATION 1
!=========================================================================
!
!  DESCRIPTION:
!
!  WIPP CRA-2014 Performance Assessment Baseline Calculation,
!  aka  (AP164)
!
!  This input file to PRELHS is used to generate, as an output file, an
LHS
!  input file containing all distribution information and execution
options
!  required to create a sample for Replicate R1 for the WIPP CRA-2014 PA
!
!  Changes from PABC09 analyses: CELLULS:FBETA removed
!                                Material CONC_PCS replaced by PCS_T1 for
4 properties
!                                     (PRMX_LOG, SAT_RBRN, SAT_RGAS, and
POR_DIS)
!                                PCS_T1:POROSITY added
!                                PCS_T2:POROSITY added
!                                PCS_T3:POROSITY added
!                                PCS_T2:POR2PERM added
!
!Also, LHS_EDIT should control 41<42, and 74<73<72 (WAS_AREA:GRATMICI <
WAS_AREA:GRATMICH and
!    PCS_T3:POROSITY < PCS_T2:POROSITY < PCS_T1:POROSITY)
!
!========= No Comments Allowed between *ECHOLHS and *ENDECHO
===============
!
*ECHOLHS
TITLE CRA-2014, AP164, Replicate R1 Input File for the LHS Code
NOBS           100
RANDOM SEED    582592385
CORRELATION MATRIX
    2
```

```
    53  54 -0.99
    61  62 -0.75
OUTPUT CORR HIST DATA
*ENDECHO
!
!== PROPERTIES TO BE RETRIEVED FROM WIPP PA CALCULATION DATABASE ==
!
*RETRIEVE
!1    CCDFGF
      MATERIALS,  GLOBAL
      PROPERTIES, PBRINE
!2
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!3
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!4    CUTTINGS_S
      MATERIALS,  BOREHOLE
      PROPERTIES, DOMEGA
!5    CUTTINGS_S
      MATERIALS,  BOREHOLE
      PROPERTIES, TAUFAIL
!6
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!7
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!8    DRSPALL
      MATERIALS,  SPALLMOD
      PROPERTIES, REPIPERM
!9    DRSPALL
      MATERIALS,  SPALLMOD
      PROPERTIES, TENSLSTR
!10   DRSPALL
      MATERIALS,  SPALLMOD
      PROPERTIES, PARTDIAM
!11   DRSPALL
      MATERIALS,  SPALLMOD
      PROPERTIES, REPIPOR
!12
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!13
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!14
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!15   PANEL
```

```
        MATERIALS,      SOLMOD3
        PROPERTIES,     SOLVAR
!16   PANEL
        MATERIALS,      SOLMOD4
        PROPERTIES,     SOLVAR
!17   PANEL
      MATERIALS,  PHUMOX3
      PROPERTIES, PHUMCIM
!18   PANEL/SECOTP2D
      MATERIALS,  GLOBAL
      PROPERTIES, OXSTAT
!19
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!20
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!21
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!22
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!23   SECOTP2D
      MATERIALS,  CULEBRA
      PROPERTIES, MINP_FAC
!24   SECOTP2D
      MATERIALS,  GLOBAL
      PROPERTIES, TRANSIDX
!25   SECOTP2D
      MATERIALS,  GLOBAL
      PROPERTIES, CLIMTIDX
!26   SECOTP2D
      MATERIALS,  CULEBRA
      PROPERTIES, HMBLKLT
!27   SECOTP2D
      MATERIALS,  CULEBRA
      PROPERTIES, APOROS
!28   SECOTP2D
      MATERIALS,  CULEBRA
      PROPERTIES, DPOROS
!29   SECOTP2D
      MATERIALS,  U+6
      PROPERTIES, MKD_U
!30   SECOTP2D
      MATERIALS,  U+4
      PROPERTIES, MKD_U
!31   SECOTP2D
      MATERIALS,  PU+3
      PROPERTIES, MKD_PU
!32   SECOTP2D
```

```
      MATERIALS,  PU+4
      PROPERTIES, MKD_PU
!33   SECOTP2D
      MATERIALS,  TH+4
      PROPERTIES, MKD_TH
!34   SECOTP2D
      MATERIALS,  AM+3
      PROPERTIES, MKD_AM
!35
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!36   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, BRUCITEC
!37   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, BRUCITES
!38
      MATERIALS,  WAS_AREA
      PROPERTIES, BRUCITEH
!39   BRAGFLO
      MATERIALS,  STEEL
      PROPERTIES, CORRMCO2
!40   BRAGFLO/PANEL
      MATERIALS,  WAS_AREA
      PROPERTIES, PROBDEG
!41   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, GRATMICI
!42   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, GRATMICH
!43   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, HYMAGCON
!44   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, SAT_RGAS
!45   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, SAT_RBRN
!46   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, SAT_WICK
!47   BRAGFLO
      MATERIALS,  DRZ_PCS
      PROPERTIES, PRMX_LOG
!48   BRAGFLO
      MATERIALS,  PCS_T1
      PROPERTIES, PRMX_LOG
!49   BRAGFLO
```

```
      MATERIALS,  PCS_T1
      PROPERTIES, SAT_RGAS
!50   BRAGFLO
      MATERIALS,  PCS_T1
      PROPERTIES, SAT_RBRN
!51   BRAGFLO
      MATERIALS,  PCS_T1
      PROPERTIES, PORE_DIS
!52   BRAGFLO
      MATERIALS,  S_HALITE
      PROPERTIES, POROSITY
!53   BRAGFLO
      MATERIALS,  S_HALITE
      PROPERTIES, PRMX_LOG
!54   BRAGFLO
      MATERIALS,  S_HALITE
      PROPERTIES, COMP_RCK
!55   BRAGFLO
      MATERIALS,  S_MB139
      PROPERTIES, PRMX_LOG
!56   BRAGFLO
      MATERIALS,  S_MB139
      PROPERTIES, RELP_MOD
!57   BRAGFLO
      MATERIALS,  S_MB139
      PROPERTIES, SAT_RBRN
!58   BRAGFLO
      MATERIALS,  S_MB139
      PROPERTIES, PORE_DIS
!59   BRAGFLO
      MATERIALS,  S_HALITE
      PROPERTIES, PRESSURE
!60   BRAGFLO
      MATERIALS,  CASTILER
      PROPERTIES, PRESSURE
!61   BRAGFLO
      MATERIALS,  CASTILER
      PROPERTIES, PRMX_LOG
!62   BRAGFLO
      MATERIALS,  CASTILER
      PROPERTIES, COMP_RCK
!63   BRAGFLO
      MATERIALS,  BH_SAND
      PROPERTIES, PRMX_LOG
!64   BRAGFLO
      MATERIALS,  DRZ_1
      PROPERTIES, PRMX_LOG
!65   BRAGFLO
      MATERIALS,  CONC_PLG
      PROPERTIES, PRMX_LOG
!66   BRAGFLO
```

```
      MATERIALS,  SHFTU
      PROPERTIES, SAT_RBRN
!67   BRAGFLO
      MATERIALS,  SHFTU
      PROPERTIES, SAT_RGAS
!68   BRAGFLO
      MATERIALS,  SHFTU
      PROPERTIES, PRMX_LOG
!69   BRAGFLO
      MATERIALS,  SHFTL_T1
      PROPERTIES, PRMX_LOG
!70   BRAGFLO
      MATERIALS,  SHFTL_T2
      PROPERTIES, PRMX_LOG
!71   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, BIOGENFC
!72
      MATERIALS,  PCS_T1
      PROPERTIES, POROSITY
!73
      MATERIALS,  PCS_T2
      PROPERTIES, POROSITY
!74
      MATERIALS,  PCS_T3
      PROPERTIES, POROSITY
!75
      MATERIALS,  PCS_T2
      PROPERTIES, POR2PERM
!
!=============================================================================
!
*END
```

Appendix II. Input file to PRELHS for Replicate 2

Note that there is an error in the comments of the header of the file. The comment "!Also, LHS_EDIT should control 41<42, and 74<73<72 WAS_AREA:GRATMICI < WAS_AREA:GRATMICH and" should have stated "!Also, LHS_EDIT should control 42<41, and 74<73<72 (WAS_AREA:GRATMICH < WAS_AREA:GRATMICI and".

```
! TITLE:          CRA-2014 PRELHS (LHS1) Input File
! ANALYSIS PLAN: AP-164
! ANALYST:       Tom Kirchner
! CREATED:       February 2013
!
!  LHSCALC = CRA-2014 REALIZATION 2
!=======================================================================
!
!  DESCRIPTION:
!
!  WIPP CRA-2014 Performance Assessment Baseline Calculation,
!  aka  (AP164)
!
!  This input file to PRELHS is used to generate, as an output file, an
LHS
!  input file containing all distribution information and execution
options
!  required to create a sample for Replicate R2 for the WIPP CRA-2014 PA
!
!  Changes from PABC09 analyses: CELLULS:FBETA removed
!                                Material CONC_PCS replaced by PCS_T1 for
4 properties
!                                     (PRMX_LOG, SAT_RBRN, SAT_RGAS, and
POR_DIS)
!                                PCS_T1:POROSITY added
!                                PCS_T2:POROSITY added
!                                PCS_T3:POROSITY added
!                                PCS_T2:POR2PERM added
!
!Also, LHS_EDIT should control 41<42, and 74<73<72 (WAS_AREA:GRATMICI <
WAS_AREA:GRATMICH and
!    PCS_T3:POROSITY < PCS_T2:POROSITY < PCS_T1:POROSITY)
!
!========= No Comments Allowed between *ECHOLHS and *ENDECHO
================
!
*ECHOLHS
TITLE CRA-2014, AP164, Replicate R2 Input File for the LHS Code
NOBS            100
RANDOM SEED     168866235
CORRELATION MATRIX
    2
    53  54 -0.99
```

```
    61  62 -0.75
OUTPUT CORR HIST DATA
*ENDECHO
!
!== PROPERTIES TO BE RETRIEVED FROM WIPP PA CALCULATION DATABASE ==
!
*RETRIEVE
!1    CCDFGF
      MATERIALS,  GLOBAL
      PROPERTIES, PBRINE
!2
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!3
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!4    CUTTINGS_S
      MATERIALS,  BOREHOLE
      PROPERTIES, DOMEGA
!5    CUTTINGS_S
      MATERIALS,  BOREHOLE
      PROPERTIES, TAUFAIL
!6
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!7
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!8    DRSPALL
      MATERIALS,  SPALLMOD
      PROPERTIES, REPIPERM
!9    DRSPALL
      MATERIALS,  SPALLMOD
      PROPERTIES, TENSLSTR
!10   DRSPALL
      MATERIALS,  SPALLMOD
      PROPERTIES, PARTDIAM
!11   DRSPALL
      MATERIALS,  SPALLMOD
      PROPERTIES, REPIPOR
!12
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!13
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!14
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!15   PANEL
        MATERIALS,      SOLMOD3
```

```
        PROPERTIES,     SOLVAR
!16   PANEL
        MATERIALS,      SOLMOD4
        PROPERTIES,     SOLVAR
!17   PANEL
      MATERIALS,  PHUMOX3
      PROPERTIES, PHUMCIM
!18   PANEL/SECOTP2D
      MATERIALS,  GLOBAL
      PROPERTIES, OXSTAT
!19
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!20
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!21
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!22
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!23   SECOTP2D
      MATERIALS,  CULEBRA
      PROPERTIES, MINP_FAC
!24   SECOTP2D
      MATERIALS,  GLOBAL
      PROPERTIES, TRANSIDX
!25   SECOTP2D
      MATERIALS,  GLOBAL
      PROPERTIES, CLIMTIDX
!26   SECOTP2D
      MATERIALS,  CULEBRA
      PROPERTIES, HMBLKLT
!27   SECOTP2D
      MATERIALS,  CULEBRA
      PROPERTIES, APOROS
!28   SECOTP2D
      MATERIALS,  CULEBRA
      PROPERTIES, DPOROS
!29   SECOTP2D
      MATERIALS,  U+6
      PROPERTIES, MKD_U
!30   SECOTP2D
      MATERIALS,  U+4
      PROPERTIES, MKD_U
!31   SECOTP2D
      MATERIALS,  PU+3
      PROPERTIES, MKD_PU
!32   SECOTP2D
      MATERIALS,  PU+4
```

```
      PROPERTIES, MKD_PU
!33   SECOTP2D
      MATERIALS,  TH+4
      PROPERTIES, MKD_TH
!34   SECOTP2D
      MATERIALS,  AM+3
      PROPERTIES, MKD_AM
!35
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!36   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, BRUCITEC
!37   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, BRUCITES
!38
      MATERIALS,  WAS_AREA
      PROPERTIES, BRUCITEH
!39   BRAGFLO
      MATERIALS,  STEEL
      PROPERTIES, CORRMCO2
!40   BRAGFLO/PANEL
      MATERIALS,  WAS_AREA
      PROPERTIES, PROBDEG
!41   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, GRATMICI
!42   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, GRATMICH
!43   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, HYMAGCON
!44   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, SAT_RGAS
!45   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, SAT_RBRN
!46   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, SAT_WICK
!47   BRAGFLO
      MATERIALS,  DRZ_PCS
      PROPERTIES, PRMX_LOG
!48   BRAGFLO
      MATERIALS,  PCS_T1
      PROPERTIES, PRMX_LOG
!49   BRAGFLO
      MATERIALS,  PCS_T1
```

```
      PROPERTIES, SAT_RGAS
!50   BRAGFLO
      MATERIALS,  PCS_T1
      PROPERTIES, SAT_RBRN
!51   BRAGFLO
      MATERIALS,  PCS_T1
      PROPERTIES, PORE_DIS
!52   BRAGFLO
      MATERIALS,  S_HALITE
      PROPERTIES, POROSITY
!53   BRAGFLO
      MATERIALS,  S_HALITE
      PROPERTIES, PRMX_LOG
!54   BRAGFLO
      MATERIALS,  S_HALITE
      PROPERTIES, COMP_RCK
!55   BRAGFLO
      MATERIALS,  S_MB139
      PROPERTIES, PRMX_LOG
!56   BRAGFLO
      MATERIALS,  S_MB139
      PROPERTIES, RELP_MOD
!57   BRAGFLO
      MATERIALS,  S_MB139
      PROPERTIES, SAT_RBRN
!58   BRAGFLO
      MATERIALS,  S_MB139
      PROPERTIES, PORE_DIS
!59   BRAGFLO
      MATERIALS,  S_HALITE
      PROPERTIES, PRESSURE
!60   BRAGFLO
      MATERIALS,  CASTILER
      PROPERTIES, PRESSURE
!61   BRAGFLO
      MATERIALS,  CASTILER
      PROPERTIES, PRMX_LOG
!62   BRAGFLO
      MATERIALS,  CASTILER
      PROPERTIES, COMP_RCK
!63   BRAGFLO
      MATERIALS,  BH_SAND
      PROPERTIES, PRMX_LOG
!64   BRAGFLO
      MATERIALS,  DRZ_1
      PROPERTIES, PRMX_LOG
!65   BRAGFLO
      MATERIALS,  CONC_PLG
      PROPERTIES, PRMX_LOG
!66   BRAGFLO
      MATERIALS,  SHFTU
```

```
      PROPERTIES, SAT_RBRN
!67   BRAGFLO
      MATERIALS,  SHFTU
      PROPERTIES, SAT_RGAS
!68   BRAGFLO
      MATERIALS,  SHFTU
      PROPERTIES, PRMX_LOG
!69   BRAGFLO
      MATERIALS,  SHFTL_T1
      PROPERTIES, PRMX_LOG
!70   BRAGFLO
      MATERIALS,  SHFTL_T2
      PROPERTIES, PRMX_LOG
!71   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, BIOGENFC
!72
      MATERIALS,  PCS_T1
      PROPERTIES, POROSITY
!73
      MATERIALS,  PCS_T2
      PROPERTIES, POROSITY
!74
      MATERIALS,  PCS_T3
      PROPERTIES, POROSITY
!75
      MATERIALS,  PCS_T2
      PROPERTIES, POR2PERM
!
!=============================================================================
!
*END
```

Appendix III. Input file to PRELHS for Replicate 3

Note that there is an error in the comments of the header of the file. The comment "!Also, LHS_EDIT should control 41<42, and 74<73<72 WAS_AREA:GRATMICI < WAS_AREA:GRATMICH and" should have stated "!Also, LHS_EDIT should control 42<41, and 74<73<72 (WAS_AREA:GRATMICH < WAS_AREA:GRATMICI and".

```
! TITLE:          CRA-2014 PRELHS (LHS1) Input File
! ANALYSIS PLAN: AP-164
! ANALYST:       Tom Kirchner
! CREATED:       February 2013
!
!  LHSCALC = CRA-2014 REALIZATION 3
!=======================================================================
!
!  DESCRIPTION:
!
!  WIPP CRA-2014 Performance Assessment Baseline Calculation,
!  aka  (AP164)
!
!  This input file to PRELHS is used to generate, as an output file, an
LHS
!  input file containing all distribution information and execution
options
!  required to create a sample for Replicate R3 for the WIPP CRA-2014 PA
!
!  Changes from PABC09 analyses: CELLULS:FBETA removed
!                                Material CONC_PCS replaced by PCS_T1 for
4 properties
!                                     (PRMX_LOG, SAT_RBRN, SAT_RGAS, and
POR_DIS)
!                                PCS_T1:POROSITY added
!                                PCS_T2:POROSITY added
!                                PCS_T3:POROSITY added
!                                PCS_T2:POR2PERM added
!
!Also, LHS_EDIT should control 41<42, and 74<73<72 (WAS_AREA:GRATMICI <
WAS_AREA:GRATMICH and
!    PCS_T3:POROSITY < PCS_T2:POROSITY < PCS_T1:POROSITY)
!
!========= No Comments Allowed between *ECHOLHS and *ENDECHO
===============
!
*ECHOLHS
TITLE CRA-2014, AP164, Replicate R3 Input File for the LHS Code
NOBS           100
RANDOM SEED    292058223
CORRELATION MATRIX
    2
    53  54 -0.99
```

```
    61   62 -0.75
OUTPUT CORR HIST DATA
*ENDECHO
!
!== PROPERTIES TO BE RETRIEVED FROM WIPP PA CALCULATION DATABASE ==
!
*RETRIEVE
!1    CCDFGF
      MATERIALS,  GLOBAL
      PROPERTIES, PBRINE
!2
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!3
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!4    CUTTINGS_S
      MATERIALS,  BOREHOLE
      PROPERTIES, DOMEGA
!5    CUTTINGS_S
      MATERIALS,  BOREHOLE
      PROPERTIES, TAUFAIL
!6
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!7
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!8    DRSPALL
      MATERIALS,  SPALLMOD
      PROPERTIES, REPIPERM
!9    DRSPALL
      MATERIALS,  SPALLMOD
      PROPERTIES, TENSLSTR
!10   DRSPALL
      MATERIALS,  SPALLMOD
      PROPERTIES, PARTDIAM
!11   DRSPALL
      MATERIALS,  SPALLMOD
      PROPERTIES, REPIPOR
!12
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!13
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!14
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!15   PANEL
        MATERIALS,      SOLMOD3
```

```
        PROPERTIES,     SOLVAR
!16   PANEL
        MATERIALS,      SOLMOD4
        PROPERTIES,     SOLVAR
!17   PANEL
      MATERIALS,  PHUMOX3
      PROPERTIES, PHUMCIM
!18   PANEL/SECOTP2D
      MATERIALS,  GLOBAL
      PROPERTIES, OXSTAT
!19
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!20
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!21
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!22
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!23   SECOTP2D
      MATERIALS,  CULEBRA
      PROPERTIES, MINP_FAC
!24   SECOTP2D
      MATERIALS,  GLOBAL
      PROPERTIES, TRANSIDX
!25   SECOTP2D
      MATERIALS,  GLOBAL
      PROPERTIES, CLIMTIDX
!26   SECOTP2D
      MATERIALS,  CULEBRA
      PROPERTIES, HMBLKLT
!27   SECOTP2D
      MATERIALS,  CULEBRA
      PROPERTIES, APOROS
!28   SECOTP2D
      MATERIALS,  CULEBRA
      PROPERTIES, DPOROS
!29   SECOTP2D
      MATERIALS,  U+6
      PROPERTIES, MKD_U
!30   SECOTP2D
      MATERIALS,  U+4
      PROPERTIES, MKD_U
!31   SECOTP2D
      MATERIALS,  PU+3
      PROPERTIES, MKD_PU
!32   SECOTP2D
      MATERIALS,  PU+4
```

```
      PROPERTIES, MKD_PU
!33   SECOTP2D
      MATERIALS,  TH+4
      PROPERTIES, MKD_TH
!34   SECOTP2D
      MATERIALS,  AM+3
      PROPERTIES, MKD_AM
!35
      MATERIALS,  REFCON
      PROPERTIES, LHSBLANK
!36   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, BRUCITEC
!37   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, BRUCITES
!38
      MATERIALS,  WAS_AREA
      PROPERTIES, BRUCITEH
!39   BRAGFLO
      MATERIALS,  STEEL
      PROPERTIES, CORRMCO2
!40   BRAGFLO/PANEL
      MATERIALS,  WAS_AREA
      PROPERTIES, PROBDEG
!41   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, GRATMICI
!42   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, GRATMICH
!43   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, HYMAGCON
!44   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, SAT_RGAS
!45   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, SAT_RBRN
!46   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, SAT_WICK
!47   BRAGFLO
      MATERIALS,  DRZ_PCS
      PROPERTIES, PRMX_LOG
!48   BRAGFLO
      MATERIALS,  PCS_T1
      PROPERTIES, PRMX_LOG
!49   BRAGFLO
      MATERIALS,  PCS_T1
```

```
      PROPERTIES, SAT_RGAS
!50   BRAGFLO
      MATERIALS,  PCS_T1
      PROPERTIES, SAT_RBRN
!51   BRAGFLO
      MATERIALS,  PCS_T1
      PROPERTIES, PORE_DIS
!52   BRAGFLO
      MATERIALS,  S_HALITE
      PROPERTIES, POROSITY
!53   BRAGFLO
      MATERIALS,  S_HALITE
      PROPERTIES, PRMX_LOG
!54   BRAGFLO
      MATERIALS,  S_HALITE
      PROPERTIES, COMP_RCK
!55   BRAGFLO
      MATERIALS,  S_MB139
      PROPERTIES, PRMX_LOG
!56   BRAGFLO
      MATERIALS,  S_MB139
      PROPERTIES, RELP_MOD
!57   BRAGFLO
      MATERIALS,  S_MB139
      PROPERTIES, SAT_RBRN
!58   BRAGFLO
      MATERIALS,  S_MB139
      PROPERTIES, PORE_DIS
!59   BRAGFLO
      MATERIALS,  S_HALITE
      PROPERTIES, PRESSURE
!60   BRAGFLO
      MATERIALS,  CASTILER
      PROPERTIES, PRESSURE
!61   BRAGFLO
      MATERIALS,  CASTILER
      PROPERTIES, PRMX_LOG
!62   BRAGFLO
      MATERIALS,  CASTILER
      PROPERTIES, COMP_RCK
!63   BRAGFLO
      MATERIALS,  BH_SAND
      PROPERTIES, PRMX_LOG
!64   BRAGFLO
      MATERIALS,  DRZ_1
      PROPERTIES, PRMX_LOG
!65   BRAGFLO
      MATERIALS,  CONC_PLG
      PROPERTIES, PRMX_LOG
!66   BRAGFLO
      MATERIALS,  SHFTU
```

```
      PROPERTIES, SAT_RBRN
!67   BRAGFLO
      MATERIALS,  SHFTU
      PROPERTIES, SAT_RGAS
!68   BRAGFLO
      MATERIALS,  SHFTU
      PROPERTIES, PRMX_LOG
!69   BRAGFLO
      MATERIALS,  SHFTL_T1
      PROPERTIES, PRMX_LOG
!70   BRAGFLO
      MATERIALS,  SHFTL_T2
      PROPERTIES, PRMX_LOG
!71   BRAGFLO
      MATERIALS,  WAS_AREA
      PROPERTIES, BIOGENFC
!72
      MATERIALS,  PCS_T1
      PROPERTIES, POROSITY
!73
      MATERIALS,  PCS_T2
      PROPERTIES, POROSITY
!74
      MATERIALS,  PCS_T3
      PROPERTIES, POROSITY
!75
      MATERIALS,  PCS_T2
      PROPERTIES, POR2PERM
!
!=============================================================================
!
*END
```

Appendix IV. PRELHS Output (Transfer) File for Replicate 1

```
TITLE SDB: ParamDB            Calc: CRA14        Ver: 2.00     04/05/13
16:12:20
TITLE CRA-2014, AP164, Replicate R1 Input File for the LHS Code
NOBS           100
RANDOM SEED    582592385
NORMAL                  GLOBAL    PBRINE
    6.36240E-02    1.90376E-01
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
USER DISTRIBUTION  (CUMULATIVE)       BOREHOLE  DOMEGA
        10          SPECIFIED    CONTINUOUS
    4.20000E+00   0.15000
    6.30000E+00   0.50000
    8.40000E+00   0.15000
    1.05000E+01   0.10000
    1.26000E+01   0.05000
    1.47000E+01   0.02000
    1.68000E+01   0.01000
    1.88000E+01   0.01000
    2.09000E+01   0.01000
    2.30000E+01   0.00000
UNIFORM                 BOREHOLE  TAUFAIL
    2.22000E+00    7.70000E+01
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
LOGUNIFORM              SPALLMOD  REPIPERM
    2.40000E-14    2.40000E-12
UNIFORM                 SPALLMOD  TENSLSTR
    1.20000E+05    1.70000E+05
LOGUNIFORM              SPALLMOD  PARTDIAM
    1.00000E-03    1.00000E-01
UNIFORM                 SPALLMOD  REPIPOR
    3.50000E-01    6.60000E-01
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
USER DISTRIBUTION  (CUMULATIVE)       SOLMOD3   SOLVAR
       172          SPECIFIED    CONTINUOUS
   -3.54668E+00   0.00582
   -3.53804E+00   0.00581
   -3.48624E+00   0.00582
   -3.39484E+00   0.00581
   -3.12625E+00   0.00581
```

-2.99787E+00	0.00582
-2.92819E+00	0.00581
-2.90889E+00	0.00582
-2.89789E+00	0.00581
-2.89417E+00	0.00581
-2.88167E+00	0.00582
-2.81960E+00	0.00581
-2.80340E+00	0.00582
-2.77909E+00	0.00581
-2.75392E+00	0.00581
-2.71310E+00	0.00582
-2.50363E+00	0.00586
-2.44562E+00	0.00580
-2.42524E+00	0.00580
-2.40328E+00	0.00580
-2.38528E+00	0.00580
-2.38125E+00	0.00580
-2.36584E+00	0.00580
-2.34077E+00	0.00580
-2.30728E+00	0.00590
-2.30370E+00	0.00580
-2.28221E+00	0.00580
-2.22527E+00	0.00580
-2.21692E+00	0.00580
-2.21193E+00	0.00580
-2.21057E+00	0.00580
-2.21035E+00	0.00590
-2.19890E+00	0.00580
-2.17941E+00	0.00580
-2.14466E+00	0.00580
-2.14017E+00	0.00580
-2.11004E+00	0.00580
-2.10131E+00	0.00580
-2.10044E+00	0.00590
-2.08652E+00	0.00580
-2.06574E+00	0.00580
-2.02624E+00	0.00580
-2.02078E+00	0.00580
-1.99435E+00	0.00580
-1.99094E+00	0.00580
-1.89183E+00	0.00590
-1.88602E+00	0.00580
-1.88082E+00	0.00580
-1.87526E+00	0.00580
-1.81645E+00	0.00580
-1.79857E+00	0.00580
-1.79072E+00	0.00580
-1.77062E+00	0.00590
-1.73992E+00	0.00580
-1.71789E+00	0.00580
-1.65342E+00	0.00580

-1.64679E+00	0.00580
-1.60274E+00	0.00580
-1.58665E+00	0.00580
-1.57875E+00	0.00590
-1.57686E+00	0.00580
-1.55805E+00	0.00580
-1.54605E+00	0.00580
-1.53335E+00	0.00580
-1.50332E+00	0.00580
-1.47121E+00	0.00580
-1.43567E+00	0.00580
-1.35594E+00	0.00590
-1.32260E+00	0.00580
-1.29978E+00	0.00580
-1.28158E+00	0.00580
-1.27820E+00	0.00580
-1.23176E+00	0.00580
-1.20372E+00	0.00580
-1.17824E+00	0.00590
-1.17469E+00	0.00580
-1.13616E+00	0.00580
-1.08408E+00	0.00580
-1.07590E+00	0.00580
-1.06288E+00	0.00580
-1.01740E+00	0.00580
-9.69620E-01	0.00590
-9.44130E-01	0.00580
-9.04860E-01	0.00580
-8.78900E-01	0.00580
-8.74340E-01	0.00580
-8.58310E-01	0.00580
-8.42840E-01	0.00580
-7.55150E-01	0.00590
-7.47140E-01	0.00580
-7.46500E-01	0.00580
-7.10440E-01	0.00580
-6.99130E-01	0.00580
-6.94680E-01	0.00580
-6.60580E-01	0.00580
-6.35820E-01	0.00590
-6.17060E-01	0.00580
-5.93350E-01	0.00580
-4.86970E-01	0.00580
-4.24470E-01	0.00580
-4.16450E-01	0.00580
-4.10480E-01	0.00580
-3.92890E-01	0.00590
-3.76830E-01	0.00580
-3.62740E-01	0.00580
-3.59140E-01	0.00580
-3.33710E-01	0.00580

-3.23410E-01	0.00580
-3.08070E-01	0.00580
-1.60530E-01	0.00580
-1.28860E-01	0.00590
-1.08350E-01	0.00580
-7.91900E-02	0.00580
-6.93600E-02	0.00580
-6.42200E-02	0.00580
-5.86200E-02	0.00580
-2.52000E-02	0.00580
2.19500E-02	0.00590
4.98100E-02	0.01160
7.41400E-02	-0.00580
7.41400E-02	0.01160
8.61500E-02	0.00580
1.06090E-01	0.00580
1.98800E-01	0.00580
2.54330E-01	0.00590
2.64170E-01	0.00580
3.13030E-01	0.00580
3.46360E-01	0.00580
3.60080E-01	0.00580
6.85280E-01	0.00580
7.01580E-01	0.00580
7.49390E-01	0.00590
7.78210E-01	0.00580
8.02090E-01	0.00580
8.50270E-01	0.00580
8.89950E-01	0.00580
9.52970E-01	0.00580
1.02872E+00	0.00580
1.06857E+00	0.00590
1.09543E+00	0.00580
1.17080E+00	0.00580
1.21546E+00	0.00580
1.21768E+00	0.00580
1.23265E+00	0.00580
1.23608E+00	0.00580
1.23617E+00	0.00590
1.28595E+00	0.00580
1.29523E+00	0.00580
1.41886E+00	0.00580
1.41967E+00	0.00580
1.45195E+00	0.00580
1.47603E+00	0.00580
1.51897E+00	0.00580
1.53738E+00	0.00590
1.55726E+00	0.00580
1.57030E+00	0.00580
1.64380E+00	0.00580
1.67223E+00	0.00580

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    1.70369E+00   0.00580
    1.79257E+00   0.00580
    1.91679E+00   0.00590
    1.96394E+00   0.00580
    2.02303E+00   0.00580
    2.05965E+00   0.00580
    2.06862E+00   0.00580
    2.17544E+00   0.00580
    2.25179E+00   0.00580
    2.34368E+00   0.00590
    2.37300E+00   0.00580
    2.62793E+00   0.00580
    2.68349E+00   0.00580
    2.97147E+00   0.00000
USER DISTRIBUTION  (CUMULATIVE)        SOLMOD4   SOLVAR
        64           SPECIFIED    CONTINUOUS
   -1.51771E+00   0.01570
   -8.00330E-01   0.01560
   -7.20330E-01   0.01560
   -7.10320E-01   0.01560
   -6.10330E-01   0.01570
   -6.10330E-01   0.01560
   -5.60330E-01   0.01560
   -5.40320E-01   0.01560
   -5.20330E-01   0.01570
   -4.77680E-01   0.01560
   -3.76990E-01   0.01560
   -3.30320E-01   0.01560
   -3.03270E-01   0.01570
   -8.03200E-02   0.01560
    2.96700E-02   0.01560
    8.50900E-02   0.01560
    1.15650E-01   0.01570
    1.49610E-01   0.01560
    1.59670E-01   0.01560
    1.72370E-01   0.01560
    2.69670E-01   0.01570
    2.89670E-01   0.01560
    4.59670E-01   0.01560
    6.79670E-01   0.01560
    6.89670E-01   0.01570
    7.49670E-01   0.01560
    7.77830E-01   0.01560
    9.77830E-01   0.01560
    1.02567E+00   0.01570
    1.02571E+00   0.01560
    1.02653E+00   0.01560
    1.02863E+00   0.01560
    1.03036E+00   0.01570
    1.03252E+00   0.01560
    1.03516E+00   0.01560
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    1.03730E+00   0.01560
    1.03736E+00   0.01570
    1.03798E+00   0.01560
    1.04386E+00   0.01560
    1.04576E+00   0.01560
    1.04779E+00   0.01570
    1.04922E+00   0.01560
    1.04986E+00   0.01560
    1.04993E+00   0.01560
    1.05263E+00   0.01570
    1.05670E+00   0.01560
    1.07033E+00   0.01560
    1.07537E+00   0.01560
    1.08572E+00   0.01570
    1.11229E+00   0.01560
    1.12607E+00   0.01560
    1.12659E+00   0.01560
    1.13123E+00   0.01570
    1.13919E+00   0.01560
    1.22809E+00   0.01560
    1.23038E+00   0.01560
    1.39185E+00   0.01570
    1.48279E+00   0.01560
    1.50341E+00   0.01560
    1.59187E+00   0.01560
    1.60342E+00   0.01570
    1.61913E+00   0.01560
    3.19246E+00   0.01560
    3.19268E+00   0.00000
USER DISTRIBUTION  (CUMULATIVE)       PHUMOX3    PHUMCIM
         3          SPECIFIED    CONTINUOUS
    6.50000E-02   0.50000
    1.37000E+00   0.50000
    1.60000E+00   0.00000
UNIFORM                GLOBAL    OXSTAT
    0.00000E+00    1.00000E+00
UNIFORM                REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                CULEBRA   MINP_FAC
    1.00000E+00    1.00000E+03
UNIFORM                GLOBAL    TRANSIDX
    0.00000E+00    1.00000E+00
USER DISTRIBUTION  (CUMULATIVE)       GLOBAL    CLIMTIDX
         4          SPECIFIED    CONTINUOUS
    1.00000E+00   0.75000
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    1.25000E+00   0.00000
    1.50000E+00   0.25000
    2.25000E+00   0.00000
UNIFORM                CULEBRA   HMBLKLT
    5.00000E-02    5.00000E-01
LOGUNIFORM             CULEBRA   APOROS
    1.00000E-04    1.00000E-02
USER DISTRIBUTION  (CUMULATIVE)      CULEBRA   DPOROS
         7          SPECIFIED    CONTINUOUS
    1.00000E-01   0.10000
    1.10000E-01   0.15000
    1.20000E-01   0.25000
    1.60000E-01   0.25000
    1.80000E-01   0.15000
    1.90000E-01   0.10000
    2.50000E-01   0.00000
LOGUNIFORM             U+6       MKD_U
    3.00000E-05    2.00000E-02
LOGUNIFORM             U+4       MKD_U
    5.00000E-04    1.00000E+01
LOGUNIFORM             PU+3      MKD_PU
    5.00000E-03    4.00000E-01
LOGUNIFORM             PU+4      MKD_PU
    5.00000E-04    1.00000E+01
LOGUNIFORM             TH+4      MKD_TH
    5.00000E-04    1.00000E+01
LOGUNIFORM             AM+3      MKD_AM
    5.00000E-03    4.00000E-01
UNIFORM                REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
NORMAL                 WAS_AREA  BRUCITEC
    4.76000E-08    5.64000E-08
NORMAL                 WAS_AREA  BRUCITES
    4.27000E-08    6.13000E-08
NORMAL                 WAS_AREA  BRUCITEH
    1.81000E-08    2.19000E-08
STUDENT                STEEL     CORRMCO2
        64
  3.28700E-16  3.77000E-16  1.63600E-15  1.88900E-15  2.25700E-15
2.26500E-15
  2.45900E-15  2.82000E-15  2.84400E-15  2.86800E-15  2.88500E-15
2.94200E-15
  3.21000E-15  3.22500E-15  3.24700E-15  3.28400E-15  3.36900E-15
3.38800E-15
  3.39300E-15  3.49100E-15  3.61200E-15  3.69800E-15  3.77300E-15
3.90900E-15
  4.02300E-15  4.02400E-15  4.21000E-15  4.40800E-15  4.51900E-15
4.70400E-15
  4.86700E-15  5.31100E-15  5.31200E-15  5.59400E-15  5.62800E-15
5.64800E-15
```

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  5.65400E-15  5.76300E-15  5.85600E-15  5.91600E-15  6.02000E-15
6.37400E-15
  6.38200E-15  6.39200E-15  6.55100E-15  6.65800E-15  6.78000E-15
6.93000E-15
  7.11900E-15  7.37700E-15  7.67700E-15  7.95600E-15  8.23900E-15
8.61800E-15
  8.92400E-15  9.31700E-15  1.29200E-14  1.39200E-14  1.46600E-14
1.47500E-14
  1.50800E-14  1.55300E-14  1.66300E-14  1.83500E-14
USER DISTRIBUTION  (DELTA)           WAS_AREA  PROBDEG
         2          SPECIFIED    DISCRETE
    1.00000E+00   0.75000
    2.00000E+00   0.25000
UNIFORM                WAS_AREA  GRATMICI
    3.08269E-11    5.56921E-10
UNIFORM                WAS_AREA  GRATMICH
    0.00000E+00    1.02717E-09
UNIFORM                WAS_AREA  HYMAGCON
    6.80000E-12    6.80000E-10
UNIFORM                WAS_AREA  SAT_RGAS
    0.00000E+00    1.50000E-01
UNIFORM                WAS_AREA  SAT_RBRN
    0.00000E+00    5.52000E-01
UNIFORM                WAS_AREA  SAT_WICK
    0.00000E+00    1.00000E+00
TRIANGULAR             DRZ_PCS   PRMX_LOG
   -2.06990E+01   -1.87496E+01   -1.70000E+01
UNIFORM                PCS_T1    PRMX_LOG
   -2.08400E+01   -1.20000E+01
UNIFORM                PCS_T1    SAT_RGAS
    0.00000E+00    4.00000E-01
USER DISTRIBUTION  (CUMULATIVE)       PCS_T1    SAT_RBRN
         3          SPECIFIED    CONTINUOUS
    0.00000E+00   0.50000
    2.00000E-01   0.50000
    6.00000E-01   0.00000
USER DISTRIBUTION  (CUMULATIVE)       PCS_T1    PORE_DIS
         3          SPECIFIED    CONTINUOUS
    1.10000E-01   0.50000
    9.40000E-01   0.50000
    8.10000E+00   0.00000
USER DISTRIBUTION  (CUMULATIVE)       S_HALITE  POROSITY
         3          SPECIFIED    CONTINUOUS
    1.00000E-03   0.50000
    1.00000E-02   0.50000
    5.19000E-02   0.00000
UNIFORM                S_HALITE  PRMX_LOG
   -2.40000E+01   -2.10000E+01
UNIFORM                S_HALITE  COMP_RCK
    2.94000E-12    1.92000E-10
STUDENT                S_MB139   PRMX_LOG
```

```
         6
 -2.10000E+01 -1.92000E+01 -1.91000E+01 -1.88000E+01 -1.81000E+01 -
1.71000E+01
USER DISTRIBUTION  (DELTA)           S_MB139    RELP_MOD
         4          SPECIFIED    DISCRETE
    1.00000E+00   0.50000
    2.00000E+00   0.00000
    3.00000E+00   0.00000
    4.00000E+00   0.50000
STUDENT                 S_MB139    SAT_RBRN
         6
  7.78460E-03  6.88420E-02  6.98600E-02  7.26200E-02  1.08610E-01
1.74010E-01
STUDENT                 S_MB139    PORE_DIS
         6
  4.90530E-01  5.57750E-01  6.52000E-01  6.55000E-01  6.64520E-01
8.41780E-01
UNIFORM                 S_HALITE   PRESSURE
    1.10400E+07    1.38900E+07
TRIANGULAR              CASTILER   PRESSURE
    1.11000E+07    1.27000E+07    1.70000E+07
TRIANGULAR              CASTILER   PRMX_LOG
   -1.47000E+01   -1.18000E+01   -9.80000E+00
TRIANGULAR              CASTILER   COMP_RCK
    2.00000E-11    4.00000E-11    1.00000E-10
UNIFORM                 BH_SAND    PRMX_LOG
   -1.63000E+01   -1.10000E+01
UNIFORM                 DRZ_1      PRMX_LOG
   -1.94000E+01   -1.25000E+01
UNIFORM                 CONC_PLG   PRMX_LOG
   -1.90000E+01   -1.70000E+01
USER DISTRIBUTION  (CUMULATIVE)        SHFTU      SAT_RBRN
         3          SPECIFIED    CONTINUOUS
    0.00000E+00   0.50000
    2.00000E-01   0.50000
    6.00000E-01   0.00000
UNIFORM                 SHFTU      SAT_RGAS
    0.00000E+00    4.00000E-01
USER DISTRIBUTION  (CUMULATIVE)        SHFTU      PRMX_LOG
         9          SPECIFIED    CONTINUOUS
   -2.05000E+01   0.03000
   -2.00000E+01   0.08000
   -1.95000E+01   0.13000
   -1.90000E+01   0.19000
   -1.85000E+01   0.22000
   -1.80000E+01   0.24000
   -1.75000E+01   0.10000
   -1.70000E+01   0.01000
   -1.65000E+01   0.00000
USER DISTRIBUTION  (CUMULATIVE)        SHFTL_T1   PRMX_LOG
         8          SPECIFIED    CONTINUOUS
```

```
   -2.00000E+01   0.01000
   -1.95000E+01   0.09000
   -1.90000E+01   0.20700
   -1.85000E+01   0.33000
   -1.80000E+01   0.23600
   -1.75000E+01   0.12000
   -1.70000E+01   0.00700
   -1.65000E+01   0.00000
USER DISTRIBUTION  (CUMULATIVE)        SHFTL_T2  PRMX_LOG
        10          SPECIFIED    CONTINUOUS
   -2.25000E+01   0.02000
   -2.20000E+01   0.06000
   -2.15000E+01   0.09000
   -2.10000E+01   0.13500
   -2.05000E+01   0.22000
   -2.00000E+01   0.17500
   -1.95000E+01   0.16500
   -1.90000E+01   0.10000
   -1.85000E+01   0.03500
   -1.80000E+01   0.00000
UNIFORM                 WAS_AREA  BIOGENFC
    0.00000E+00    1.00000E+00
UNIFORM                 PCS_T1    POROSITY
    6.60000E-02    1.87000E-01
UNIFORM                 PCS_T2    POROSITY
    2.50000E-02    7.50000E-02
UNIFORM                 PCS_T3    POROSITY
    1.00000E-03    5.19000E-02
NORMAL                  PCS_T2    POR2PERM
   -1.72000E+00    1.72000E+00
CORRELATION MATRIX
    2
    53  54 -0.99
    61  62 -0.75
OUTPUT CORR HIST DATA
TITLE SDB: ParamDB           Calc: CRA14        Ver: 2.00     04/05/13
16:12:20
```

Appendix V. PRELHS Output (Transfer) File for Replicate 2

```
TITLE SDB: ParamDB            Calc: CRA14        Ver: 2.00     04/05/13
16:12:43
TITLE CRA-2014, AP164, Replicate R2 Input File for the LHS Code
NOBS           100
RANDOM SEED    168866235
NORMAL                  GLOBAL    PBRINE
    6.36240E-02    1.90376E-01
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
USER DISTRIBUTION  (CUMULATIVE)       BOREHOLE  DOMEGA
        10          SPECIFIED    CONTINUOUS
    4.20000E+00   0.15000
    6.30000E+00   0.50000
    8.40000E+00   0.15000
    1.05000E+01   0.10000
    1.26000E+01   0.05000
    1.47000E+01   0.02000
    1.68000E+01   0.01000
    1.88000E+01   0.01000
    2.09000E+01   0.01000
    2.30000E+01   0.00000
UNIFORM                 BOREHOLE  TAUFAIL
    2.22000E+00    7.70000E+01
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
LOGUNIFORM              SPALLMOD  REPIPERM
    2.40000E-14    2.40000E-12
UNIFORM                 SPALLMOD  TENSLSTR
    1.20000E+05    1.70000E+05
LOGUNIFORM              SPALLMOD  PARTDIAM
    1.00000E-03    1.00000E-01
UNIFORM                 SPALLMOD  REPIPOR
    3.50000E-01    6.60000E-01
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
USER DISTRIBUTION  (CUMULATIVE)       SOLMOD3   SOLVAR
       172          SPECIFIED    CONTINUOUS
   -3.54668E+00   0.00582
   -3.53804E+00   0.00581
   -3.48624E+00   0.00582
   -3.39484E+00   0.00581
   -3.12625E+00   0.00581
```

-2.99787E+00	0.00582
-2.92819E+00	0.00581
-2.90889E+00	0.00582
-2.89789E+00	0.00581
-2.89417E+00	0.00581
-2.88167E+00	0.00582
-2.81960E+00	0.00581
-2.80340E+00	0.00582
-2.77909E+00	0.00581
-2.75392E+00	0.00581
-2.71310E+00	0.00582
-2.50363E+00	0.00586
-2.44562E+00	0.00580
-2.42524E+00	0.00580
-2.40328E+00	0.00580
-2.38528E+00	0.00580
-2.38125E+00	0.00580
-2.36584E+00	0.00580
-2.34077E+00	0.00580
-2.30728E+00	0.00590
-2.30370E+00	0.00580
-2.28221E+00	0.00580
-2.22527E+00	0.00580
-2.21692E+00	0.00580
-2.21193E+00	0.00580
-2.21057E+00	0.00580
-2.21035E+00	0.00590
-2.19890E+00	0.00580
-2.17941E+00	0.00580
-2.14466E+00	0.00580
-2.14017E+00	0.00580
-2.11004E+00	0.00580
-2.10131E+00	0.00580
-2.10044E+00	0.00590
-2.08652E+00	0.00580
-2.06574E+00	0.00580
-2.02624E+00	0.00580
-2.02078E+00	0.00580
-1.99435E+00	0.00580
-1.99094E+00	0.00580
-1.89183E+00	0.00590
-1.88602E+00	0.00580
-1.88082E+00	0.00580
-1.87526E+00	0.00580
-1.81645E+00	0.00580
-1.79857E+00	0.00580
-1.79072E+00	0.00580
-1.77062E+00	0.00590
-1.73992E+00	0.00580
-1.71789E+00	0.00580
-1.65342E+00	0.00580

-1.64679E+00	0.00580
-1.60274E+00	0.00580
-1.58665E+00	0.00580
-1.57875E+00	0.00590
-1.57686E+00	0.00580
-1.55805E+00	0.00580
-1.54605E+00	0.00580
-1.53335E+00	0.00580
-1.50332E+00	0.00580
-1.47121E+00	0.00580
-1.43567E+00	0.00580
-1.35594E+00	0.00590
-1.32260E+00	0.00580
-1.29978E+00	0.00580
-1.28158E+00	0.00580
-1.27820E+00	0.00580
-1.23176E+00	0.00580
-1.20372E+00	0.00580
-1.17824E+00	0.00590
-1.17469E+00	0.00580
-1.13616E+00	0.00580
-1.08408E+00	0.00580
-1.07590E+00	0.00580
-1.06288E+00	0.00580
-1.01740E+00	0.00580
-9.69620E-01	0.00590
-9.44130E-01	0.00580
-9.04860E-01	0.00580
-8.78900E-01	0.00580
-8.74340E-01	0.00580
-8.58310E-01	0.00580
-8.42840E-01	0.00580
-7.55150E-01	0.00590
-7.47140E-01	0.00580
-7.46500E-01	0.00580
-7.10440E-01	0.00580
-6.99130E-01	0.00580
-6.94680E-01	0.00580
-6.60580E-01	0.00580
-6.35820E-01	0.00590
-6.17060E-01	0.00580
-5.93350E-01	0.00580
-4.86970E-01	0.00580
-4.24470E-01	0.00580
-4.16450E-01	0.00580
-4.10480E-01	0.00580
-3.92890E-01	0.00590
-3.76830E-01	0.00580
-3.62740E-01	0.00580
-3.59140E-01	0.00580
-3.33710E-01	0.00580

-3.23410E-01	0.00580
-3.08070E-01	0.00580
-1.60530E-01	0.00580
-1.28860E-01	0.00590
-1.08350E-01	0.00580
-7.91900E-02	0.00580
-6.93600E-02	0.00580
-6.42200E-02	0.00580
-5.86200E-02	0.00580
-2.52000E-02	0.00580
2.19500E-02	0.00590
4.98100E-02	0.01160
7.41400E-02	-0.00580
7.41400E-02	0.01160
8.61500E-02	0.00580
1.06090E-01	0.00580
1.98800E-01	0.00580
2.54330E-01	0.00590
2.64170E-01	0.00580
3.13030E-01	0.00580
3.46360E-01	0.00580
3.60080E-01	0.00580
6.85280E-01	0.00580
7.01580E-01	0.00580
7.49390E-01	0.00590
7.78210E-01	0.00580
8.02090E-01	0.00580
8.50270E-01	0.00580
8.89950E-01	0.00580
9.52970E-01	0.00580
1.02872E+00	0.00580
1.06857E+00	0.00590
1.09543E+00	0.00580
1.17080E+00	0.00580
1.21546E+00	0.00580
1.21768E+00	0.00580
1.23265E+00	0.00580
1.23608E+00	0.00580
1.23617E+00	0.00590
1.28595E+00	0.00580
1.29523E+00	0.00580
1.41886E+00	0.00580
1.41967E+00	0.00580
1.45195E+00	0.00580
1.47603E+00	0.00580
1.51897E+00	0.00580
1.53738E+00	0.00590
1.55726E+00	0.00580
1.57030E+00	0.00580
1.64380E+00	0.00580
1.67223E+00	0.00580

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    1.70369E+00   0.00580
    1.79257E+00   0.00580
    1.91679E+00   0.00590
    1.96394E+00   0.00580
    2.02303E+00   0.00580
    2.05965E+00   0.00580
    2.06862E+00   0.00580
    2.17544E+00   0.00580
    2.25179E+00   0.00580
    2.34368E+00   0.00590
    2.37300E+00   0.00580
    2.62793E+00   0.00580
    2.68349E+00   0.00580
    2.97147E+00   0.00000
USER DISTRIBUTION  (CUMULATIVE)       SOLMOD4   SOLVAR
        64           SPECIFIED    CONTINUOUS
   -1.51771E+00   0.01570
   -8.00330E-01   0.01560
   -7.20330E-01   0.01560
   -7.10320E-01   0.01560
   -6.10330E-01   0.01570
   -6.10330E-01   0.01560
   -5.60330E-01   0.01560
   -5.40320E-01   0.01560
   -5.20330E-01   0.01570
   -4.77680E-01   0.01560
   -3.76990E-01   0.01560
   -3.30320E-01   0.01560
   -3.03270E-01   0.01570
   -8.03200E-02   0.01560
    2.96700E-02   0.01560
    8.50900E-02   0.01560
    1.15650E-01   0.01570
    1.49610E-01   0.01560
    1.59670E-01   0.01560
    1.72370E-01   0.01560
    2.69670E-01   0.01570
    2.89670E-01   0.01560
    4.59670E-01   0.01560
    6.79670E-01   0.01560
    6.89670E-01   0.01570
    7.49670E-01   0.01560
    7.77830E-01   0.01560
    9.77830E-01   0.01560
    1.02567E+00   0.01570
    1.02571E+00   0.01560
    1.02653E+00   0.01560
    1.02863E+00   0.01560
    1.03036E+00   0.01570
    1.03252E+00   0.01560
    1.03516E+00   0.01560
```

```
    1.03730E+00   0.01560
    1.03736E+00   0.01570
    1.03798E+00   0.01560
    1.04386E+00   0.01560
    1.04576E+00   0.01560
    1.04779E+00   0.01570
    1.04922E+00   0.01560
    1.04986E+00   0.01560
    1.04993E+00   0.01560
    1.05263E+00   0.01570
    1.05670E+00   0.01560
    1.07033E+00   0.01560
    1.07537E+00   0.01560
    1.08572E+00   0.01570
    1.11229E+00   0.01560
    1.12607E+00   0.01560
    1.12659E+00   0.01560
    1.13123E+00   0.01570
    1.13919E+00   0.01560
    1.22809E+00   0.01560
    1.23038E+00   0.01560
    1.39185E+00   0.01570
    1.48279E+00   0.01560
    1.50341E+00   0.01560
    1.59187E+00   0.01560
    1.60342E+00   0.01570
    1.61913E+00   0.01560
    3.19246E+00   0.01560
    3.19268E+00   0.00000
USER DISTRIBUTION  (CUMULATIVE)       PHUMOX3    PHUMCIM
         3          SPECIFIED    CONTINUOUS
    6.50000E-02   0.50000
    1.37000E+00   0.50000
    1.60000E+00   0.00000
UNIFORM                GLOBAL    OXSTAT
    0.00000E+00    1.00000E+00
UNIFORM                REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                CULEBRA   MINP_FAC
    1.00000E+00    1.00000E+03
UNIFORM                GLOBAL    TRANSIDX
    0.00000E+00    1.00000E+00
USER DISTRIBUTION  (CUMULATIVE)       GLOBAL    CLIMTIDX
         4          SPECIFIED    CONTINUOUS
    1.00000E+00   0.75000
```

```
    1.25000E+00   0.00000
    1.50000E+00   0.25000
    2.25000E+00   0.00000
UNIFORM                CULEBRA   HMBLKLT
    5.00000E-02    5.00000E-01
LOGUNIFORM             CULEBRA   APOROS
    1.00000E-04    1.00000E-02
USER DISTRIBUTION  (CUMULATIVE)       CULEBRA   DPOROS
         7          SPECIFIED    CONTINUOUS
    1.00000E-01   0.10000
    1.10000E-01   0.15000
    1.20000E-01   0.25000
    1.60000E-01   0.25000
    1.80000E-01   0.15000
    1.90000E-01   0.10000
    2.50000E-01   0.00000
LOGUNIFORM             U+6       MKD_U
    3.00000E-05    2.00000E-02
LOGUNIFORM             U+4       MKD_U
    5.00000E-04    1.00000E+01
LOGUNIFORM             PU+3      MKD_PU
    5.00000E-03    4.00000E-01
LOGUNIFORM             PU+4      MKD_PU
    5.00000E-04    1.00000E+01
LOGUNIFORM             TH+4      MKD_TH
    5.00000E-04    1.00000E+01
LOGUNIFORM             AM+3      MKD_AM
    5.00000E-03    4.00000E-01
UNIFORM                REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
NORMAL                 WAS_AREA  BRUCITEC
    4.76000E-08    5.64000E-08
NORMAL                 WAS_AREA  BRUCITES
    4.27000E-08    6.13000E-08
NORMAL                 WAS_AREA  BRUCITEH
    1.81000E-08    2.19000E-08
STUDENT                STEEL     CORRMCO2
       64
  3.28700E-16  3.77000E-16  1.63600E-15  1.88900E-15  2.25700E-15
2.26500E-15
  2.45900E-15  2.82000E-15  2.84400E-15  2.86800E-15  2.88500E-15
2.94200E-15
  3.21000E-15  3.22500E-15  3.24700E-15  3.28400E-15  3.36900E-15
3.38800E-15
  3.39300E-15  3.49100E-15  3.61200E-15  3.69800E-15  3.77300E-15
3.90900E-15
  4.02300E-15  4.02400E-15  4.21000E-15  4.40800E-15  4.51900E-15
4.70400E-15
  4.86700E-15  5.31100E-15  5.31200E-15  5.59400E-15  5.62800E-15
5.64800E-15
```

```
  5.65400E-15  5.76300E-15  5.85600E-15  5.91600E-15  6.02000E-15
6.37400E-15
  6.38200E-15  6.39200E-15  6.55100E-15  6.65800E-15  6.78000E-15
6.93000E-15
  7.11900E-15  7.37700E-15  7.67700E-15  7.95600E-15  8.23900E-15
8.61800E-15
  8.92400E-15  9.31700E-15  1.29200E-14  1.39200E-14  1.46600E-14
1.47500E-14
  1.50800E-14  1.55300E-14  1.66300E-14  1.83500E-14
USER DISTRIBUTION  (DELTA)           WAS_AREA  PROBDEG
         2          SPECIFIED    DISCRETE
    1.00000E+00   0.75000
    2.00000E+00   0.25000
UNIFORM                 WAS_AREA  GRATMICI
    3.08269E-11    5.56921E-10
UNIFORM                 WAS_AREA  GRATMICH
    0.00000E+00    1.02717E-09
UNIFORM                 WAS_AREA  HYMAGCON
    6.80000E-12    6.80000E-10
UNIFORM                 WAS_AREA  SAT_RGAS
    0.00000E+00    1.50000E-01
UNIFORM                 WAS_AREA  SAT_RBRN
    0.00000E+00    5.52000E-01
UNIFORM                 WAS_AREA  SAT_WICK
    0.00000E+00    1.00000E+00
TRIANGULAR              DRZ_PCS   PRMX_LOG
   -2.06990E+01   -1.87496E+01   -1.70000E+01
UNIFORM                 PCS_T1    PRMX_LOG
   -2.08400E+01   -1.20000E+01
UNIFORM                 PCS_T1    SAT_RGAS
    0.00000E+00    4.00000E-01
USER DISTRIBUTION  (CUMULATIVE)       PCS_T1    SAT_RBRN
         3          SPECIFIED    CONTINUOUS
    0.00000E+00   0.50000
    2.00000E-01   0.50000
    6.00000E-01   0.00000
USER DISTRIBUTION  (CUMULATIVE)       PCS_T1    PORE_DIS
         3          SPECIFIED    CONTINUOUS
    1.10000E-01   0.50000
    9.40000E-01   0.50000
    8.10000E+00   0.00000
USER DISTRIBUTION  (CUMULATIVE)       S_HALITE  POROSITY
         3          SPECIFIED    CONTINUOUS
    1.00000E-03   0.50000
    1.00000E-02   0.50000
    5.19000E-02   0.00000
UNIFORM                 S_HALITE  PRMX_LOG
   -2.40000E+01   -2.10000E+01
UNIFORM                 S_HALITE  COMP_RCK
    2.94000E-12    1.92000E-10
STUDENT                 S_MB139   PRMX_LOG
```

```
         6
 -2.10000E+01 -1.92000E+01 -1.91000E+01 -1.88000E+01 -1.81000E+01 -
1.71000E+01
USER DISTRIBUTION  (DELTA)           S_MB139   RELP_MOD
         4          SPECIFIED    DISCRETE
    1.00000E+00   0.50000
    2.00000E+00   0.00000
    3.00000E+00   0.00000
    4.00000E+00   0.50000
STUDENT                 S_MB139   SAT_RBRN
         6
  7.78460E-03  6.88420E-02  6.98600E-02  7.26200E-02  1.08610E-01
1.74010E-01
STUDENT                 S_MB139   PORE_DIS
         6
  4.90530E-01  5.57750E-01  6.52000E-01  6.55000E-01  6.64520E-01
8.41780E-01
UNIFORM                 S_HALITE  PRESSURE
    1.10400E+07    1.38900E+07
TRIANGULAR              CASTILER  PRESSURE
    1.11000E+07    1.27000E+07    1.70000E+07
TRIANGULAR              CASTILER  PRMX_LOG
   -1.47000E+01   -1.18000E+01   -9.80000E+00
TRIANGULAR              CASTILER  COMP_RCK
    2.00000E-11    4.00000E-11    1.00000E-10
UNIFORM                 BH_SAND   PRMX_LOG
   -1.63000E+01   -1.10000E+01
UNIFORM                 DRZ_1     PRMX_LOG
   -1.94000E+01   -1.25000E+01
UNIFORM                 CONC_PLG  PRMX_LOG
   -1.90000E+01   -1.70000E+01
USER DISTRIBUTION  (CUMULATIVE)       SHFTU     SAT_RBRN
         3          SPECIFIED    CONTINUOUS
    0.00000E+00   0.50000
    2.00000E-01   0.50000
    6.00000E-01   0.00000
UNIFORM                 SHFTU     SAT_RGAS
    0.00000E+00    4.00000E-01
USER DISTRIBUTION  (CUMULATIVE)       SHFTU     PRMX_LOG
         9          SPECIFIED    CONTINUOUS
   -2.05000E+01   0.03000
   -2.00000E+01   0.08000
   -1.95000E+01   0.13000
   -1.90000E+01   0.19000
   -1.85000E+01   0.22000
   -1.80000E+01   0.24000
   -1.75000E+01   0.10000
   -1.70000E+01   0.01000
   -1.65000E+01   0.00000
USER DISTRIBUTION  (CUMULATIVE)       SHFTL_T1  PRMX_LOG
         8          SPECIFIED    CONTINUOUS
```

```
   -2.00000E+01   0.01000
   -1.95000E+01   0.09000
   -1.90000E+01   0.20700
   -1.85000E+01   0.33000
   -1.80000E+01   0.23600
   -1.75000E+01   0.12000
   -1.70000E+01   0.00700
   -1.65000E+01   0.00000
USER DISTRIBUTION  (CUMULATIVE)        SHFTL_T2  PRMX_LOG
        10          SPECIFIED    CONTINUOUS
   -2.25000E+01   0.02000
   -2.20000E+01   0.06000
   -2.15000E+01   0.09000
   -2.10000E+01   0.13500
   -2.05000E+01   0.22000
   -2.00000E+01   0.17500
   -1.95000E+01   0.16500
   -1.90000E+01   0.10000
   -1.85000E+01   0.03500
   -1.80000E+01   0.00000
UNIFORM                 WAS_AREA  BIOGENFC
    0.00000E+00    1.00000E+00
UNIFORM                 PCS_T1    POROSITY
    6.60000E-02    1.87000E-01
UNIFORM                 PCS_T2    POROSITY
    2.50000E-02    7.50000E-02
UNIFORM                 PCS_T3    POROSITY
    1.00000E-03    5.19000E-02
NORMAL                  PCS_T2    POR2PERM
   -1.72000E+00    1.72000E+00
CORRELATION MATRIX
    2
    53  54 -0.99
    61  62 -0.75
OUTPUT CORR HIST DATA
TITLE SDB: ParamDB            Calc: CRA14        Ver: 2.00     04/05/13
16:12:43
```

Appendix VI. PRELHS Output (Transfer) File for Replicate 3

```
TITLE SDB: ParamDB            Calc: CRA14        Ver: 2.00     04/05/13
16:13:05
TITLE CRA-2014, AP164, Replicate R3 Input File for the LHS Code
NOBS           100
RANDOM SEED    292058223
NORMAL                  GLOBAL    PBRINE
    6.36240E-02    1.90376E-01
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
USER DISTRIBUTION  (CUMULATIVE)       BOREHOLE  DOMEGA
        10          SPECIFIED    CONTINUOUS
    4.20000E+00   0.15000
    6.30000E+00   0.50000
    8.40000E+00   0.15000
    1.05000E+01   0.10000
    1.26000E+01   0.05000
    1.47000E+01   0.02000
    1.68000E+01   0.01000
    1.88000E+01   0.01000
    2.09000E+01   0.01000
    2.30000E+01   0.00000
UNIFORM                 BOREHOLE  TAUFAIL
    2.22000E+00    7.70000E+01
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
LOGUNIFORM              SPALLMOD  REPIPERM
    2.40000E-14    2.40000E-12
UNIFORM                 SPALLMOD  TENSLSTR
    1.20000E+05    1.70000E+05
LOGUNIFORM              SPALLMOD  PARTDIAM
    1.00000E-03    1.00000E-01
UNIFORM                 SPALLMOD  REPIPOR
    3.50000E-01    6.60000E-01
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
USER DISTRIBUTION  (CUMULATIVE)       SOLMOD3   SOLVAR
       172          SPECIFIED    CONTINUOUS
   -3.54668E+00   0.00582
   -3.53804E+00   0.00581
   -3.48624E+00   0.00582
   -3.39484E+00   0.00581
   -3.12625E+00   0.00581
```

-2.99787E+00	0.00582
-2.92819E+00	0.00581
-2.90889E+00	0.00582
-2.89789E+00	0.00581
-2.89417E+00	0.00581
-2.88167E+00	0.00582
-2.81960E+00	0.00581
-2.80340E+00	0.00582
-2.77909E+00	0.00581
-2.75392E+00	0.00581
-2.71310E+00	0.00582
-2.50363E+00	0.00586
-2.44562E+00	0.00580
-2.42524E+00	0.00580
-2.40328E+00	0.00580
-2.38528E+00	0.00580
-2.38125E+00	0.00580
-2.36584E+00	0.00580
-2.34077E+00	0.00580
-2.30728E+00	0.00590
-2.30370E+00	0.00580
-2.28221E+00	0.00580
-2.22527E+00	0.00580
-2.21692E+00	0.00580
-2.21193E+00	0.00580
-2.21057E+00	0.00580
-2.21035E+00	0.00590
-2.19890E+00	0.00580
-2.17941E+00	0.00580
-2.14466E+00	0.00580
-2.14017E+00	0.00580
-2.11004E+00	0.00580
-2.10131E+00	0.00580
-2.10044E+00	0.00590
-2.08652E+00	0.00580
-2.06574E+00	0.00580
-2.02624E+00	0.00580
-2.02078E+00	0.00580
-1.99435E+00	0.00580
-1.99094E+00	0.00580
-1.89183E+00	0.00590
-1.88602E+00	0.00580
-1.88082E+00	0.00580
-1.87526E+00	0.00580
-1.81645E+00	0.00580
-1.79857E+00	0.00580
-1.79072E+00	0.00580
-1.77062E+00	0.00590
-1.73992E+00	0.00580
-1.71789E+00	0.00580
-1.65342E+00	0.00580

-1.64679E+00	0.00580
-1.60274E+00	0.00580
-1.58665E+00	0.00580
-1.57875E+00	0.00590
-1.57686E+00	0.00580
-1.55805E+00	0.00580
-1.54605E+00	0.00580
-1.53335E+00	0.00580
-1.50332E+00	0.00580
-1.47121E+00	0.00580
-1.43567E+00	0.00580
-1.35594E+00	0.00590
-1.32260E+00	0.00580
-1.29978E+00	0.00580
-1.28158E+00	0.00580
-1.27820E+00	0.00580
-1.23176E+00	0.00580
-1.20372E+00	0.00580
-1.17824E+00	0.00590
-1.17469E+00	0.00580
-1.13616E+00	0.00580
-1.08408E+00	0.00580
-1.07590E+00	0.00580
-1.06288E+00	0.00580
-1.01740E+00	0.00580
-9.69620E-01	0.00590
-9.44130E-01	0.00580
-9.04860E-01	0.00580
-8.78900E-01	0.00580
-8.74340E-01	0.00580
-8.58310E-01	0.00580
-8.42840E-01	0.00580
-7.55150E-01	0.00590
-7.47140E-01	0.00580
-7.46500E-01	0.00580
-7.10440E-01	0.00580
-6.99130E-01	0.00580
-6.94680E-01	0.00580
-6.60580E-01	0.00580
-6.35820E-01	0.00590
-6.17060E-01	0.00580
-5.93350E-01	0.00580
-4.86970E-01	0.00580
-4.24470E-01	0.00580
-4.16450E-01	0.00580
-4.10480E-01	0.00580
-3.92890E-01	0.00590
-3.76830E-01	0.00580
-3.62740E-01	0.00580
-3.59140E-01	0.00580
-3.33710E-01	0.00580

-3.23410E-01	0.00580
-3.08070E-01	0.00580
-1.60530E-01	0.00580
-1.28860E-01	0.00590
-1.08350E-01	0.00580
-7.91900E-02	0.00580
-6.93600E-02	0.00580
-6.42200E-02	0.00580
-5.86200E-02	0.00580
-2.52000E-02	0.00580
2.19500E-02	0.00590
4.98100E-02	0.01160
7.41400E-02	-0.00580
7.41400E-02	0.01160
8.61500E-02	0.00580
1.06090E-01	0.00580
1.98800E-01	0.00580
2.54330E-01	0.00590
2.64170E-01	0.00580
3.13030E-01	0.00580
3.46360E-01	0.00580
3.60080E-01	0.00580
6.85280E-01	0.00580
7.01580E-01	0.00580
7.49390E-01	0.00590
7.78210E-01	0.00580
8.02090E-01	0.00580
8.50270E-01	0.00580
8.89950E-01	0.00580
9.52970E-01	0.00580
1.02872E+00	0.00580
1.06857E+00	0.00590
1.09543E+00	0.00580
1.17080E+00	0.00580
1.21546E+00	0.00580
1.21768E+00	0.00580
1.23265E+00	0.00580
1.23608E+00	0.00580
1.23617E+00	0.00590
1.28595E+00	0.00580
1.29523E+00	0.00580
1.41886E+00	0.00580
1.41967E+00	0.00580
1.45195E+00	0.00580
1.47603E+00	0.00580
1.51897E+00	0.00580
1.53738E+00	0.00590
1.55726E+00	0.00580
1.57030E+00	0.00580
1.64380E+00	0.00580
1.67223E+00	0.00580

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    1.70369E+00   0.00580
    1.79257E+00   0.00580
    1.91679E+00   0.00590
    1.96394E+00   0.00580
    2.02303E+00   0.00580
    2.05965E+00   0.00580
    2.06862E+00   0.00580
    2.17544E+00   0.00580
    2.25179E+00   0.00580
    2.34368E+00   0.00590
    2.37300E+00   0.00580
    2.62793E+00   0.00580
    2.68349E+00   0.00580
    2.97147E+00   0.00000
USER DISTRIBUTION  (CUMULATIVE)        SOLMOD4    SOLVAR
       64           SPECIFIED    CONTINUOUS
   -1.51771E+00   0.01570
   -8.00330E-01   0.01560
   -7.20330E-01   0.01560
   -7.10320E-01   0.01560
   -6.10330E-01   0.01570
   -6.10330E-01   0.01560
   -5.60330E-01   0.01560
   -5.40320E-01   0.01560
   -5.20330E-01   0.01570
   -4.77680E-01   0.01560
   -3.76990E-01   0.01560
   -3.30320E-01   0.01560
   -3.03270E-01   0.01570
   -8.03200E-02   0.01560
    2.96700E-02   0.01560
    8.50900E-02   0.01560
    1.15650E-01   0.01570
    1.49610E-01   0.01560
    1.59670E-01   0.01560
    1.72370E-01   0.01560
    2.69670E-01   0.01570
    2.89670E-01   0.01560
    4.59670E-01   0.01560
    6.79670E-01   0.01560
    6.89670E-01   0.01570
    7.49670E-01   0.01560
    7.77830E-01   0.01560
    9.77830E-01   0.01560
    1.02567E+00   0.01570
    1.02571E+00   0.01560
    1.02653E+00   0.01560
    1.02863E+00   0.01560
    1.03036E+00   0.01570
    1.03252E+00   0.01560
    1.03516E+00   0.01560
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    1.03730E+00   0.01560
    1.03736E+00   0.01570
    1.03798E+00   0.01560
    1.04386E+00   0.01560
    1.04576E+00   0.01560
    1.04779E+00   0.01570
    1.04922E+00   0.01560
    1.04986E+00   0.01560
    1.04993E+00   0.01560
    1.05263E+00   0.01570
    1.05670E+00   0.01560
    1.07033E+00   0.01560
    1.07537E+00   0.01560
    1.08572E+00   0.01570
    1.11229E+00   0.01560
    1.12607E+00   0.01560
    1.12659E+00   0.01560
    1.13123E+00   0.01570
    1.13919E+00   0.01560
    1.22809E+00   0.01560
    1.23038E+00   0.01560
    1.39185E+00   0.01570
    1.48279E+00   0.01560
    1.50341E+00   0.01560
    1.59187E+00   0.01560
    1.60342E+00   0.01570
    1.61913E+00   0.01560
    3.19246E+00   0.01560
    3.19268E+00   0.00000
USER DISTRIBUTION  (CUMULATIVE)        PHUMOX3    PHUMCIM
         3          SPECIFIED    CONTINUOUS
    6.50000E-02   0.50000
    1.37000E+00   0.50000
    1.60000E+00   0.00000
UNIFORM                 GLOBAL    OXSTAT
    0.00000E+00    1.00000E+00
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                 REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
UNIFORM                 CULEBRA   MINP_FAC
    1.00000E+00    1.00000E+03
UNIFORM                 GLOBAL    TRANSIDX
    0.00000E+00    1.00000E+00
USER DISTRIBUTION  (CUMULATIVE)        GLOBAL    CLIMTIDX
         4          SPECIFIED    CONTINUOUS
    1.00000E+00   0.75000
```

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    1.25000E+00   0.00000
    1.50000E+00   0.25000
    2.25000E+00   0.00000
UNIFORM                CULEBRA   HMBLKLT
    5.00000E-02    5.00000E-01
LOGUNIFORM             CULEBRA   APOROS
    1.00000E-04    1.00000E-02
USER DISTRIBUTION  (CUMULATIVE)       CULEBRA   DPOROS
         7          SPECIFIED    CONTINUOUS
    1.00000E-01   0.10000
    1.10000E-01   0.15000
    1.20000E-01   0.25000
    1.60000E-01   0.25000
    1.80000E-01   0.15000
    1.90000E-01   0.10000
    2.50000E-01   0.00000
LOGUNIFORM             U+6       MKD_U
    3.00000E-05    2.00000E-02
LOGUNIFORM             U+4       MKD_U
    5.00000E-04    1.00000E+01
LOGUNIFORM             PU+3      MKD_PU
    5.00000E-03    4.00000E-01
LOGUNIFORM             PU+4      MKD_PU
    5.00000E-04    1.00000E+01
LOGUNIFORM             TH+4      MKD_TH
    5.00000E-04    1.00000E+01
LOGUNIFORM             AM+3      MKD_AM
    5.00000E-03    4.00000E-01
UNIFORM                REFCON    LHSBLANK
    0.00000E+00    1.00000E+00
NORMAL                 WAS_AREA  BRUCITEC
    4.76000E-08    5.64000E-08
NORMAL                 WAS_AREA  BRUCITES
    4.27000E-08    6.13000E-08
NORMAL                 WAS_AREA  BRUCITEH
    1.81000E-08    2.19000E-08
STUDENT                STEEL     CORRMCO2
       64
  3.28700E-16  3.77000E-16  1.63600E-15  1.88900E-15  2.25700E-15
2.26500E-15
  2.45900E-15  2.82000E-15  2.84400E-15  2.86800E-15  2.88500E-15
2.94200E-15
  3.21000E-15  3.22500E-15  3.24700E-15  3.28400E-15  3.36900E-15
3.38800E-15
  3.39300E-15  3.49100E-15  3.61200E-15  3.69800E-15  3.77300E-15
3.90900E-15
  4.02300E-15  4.02400E-15  4.21000E-15  4.40800E-15  4.51900E-15
4.70400E-15
  4.86700E-15  5.31100E-15  5.31200E-15  5.59400E-15  5.62800E-15
5.64800E-15
```

```
  5.65400E-15  5.76300E-15  5.85600E-15  5.91600E-15  6.02000E-15
6.37400E-15
  6.38200E-15  6.39200E-15  6.55100E-15  6.65800E-15  6.78000E-15
6.93000E-15
  7.11900E-15  7.37700E-15  7.67700E-15  7.95600E-15  8.23900E-15
8.61800E-15
  8.92400E-15  9.31700E-15  1.29200E-14  1.39200E-14  1.46600E-14
1.47500E-14
  1.50800E-14  1.55300E-14  1.66300E-14  1.83500E-14
USER DISTRIBUTION  (DELTA)           WAS_AREA  PROBDEG
         2          SPECIFIED    DISCRETE
    1.00000E+00   0.75000
    2.00000E+00   0.25000
UNIFORM                WAS_AREA  GRATMICI
    3.08269E-11    5.56921E-10
UNIFORM                WAS_AREA  GRATMICH
    0.00000E+00    1.02717E-09
UNIFORM                WAS_AREA  HYMAGCON
    6.80000E-12    6.80000E-10
UNIFORM                WAS_AREA  SAT_RGAS
    0.00000E+00    1.50000E-01
UNIFORM                WAS_AREA  SAT_RBRN
    0.00000E+00    5.52000E-01
UNIFORM                WAS_AREA  SAT_WICK
    0.00000E+00    1.00000E+00
TRIANGULAR             DRZ_PCS   PRMX_LOG
   -2.06990E+01   -1.87496E+01   -1.70000E+01
UNIFORM                PCS_T1    PRMX_LOG
   -2.08400E+01   -1.20000E+01
UNIFORM                PCS_T1    SAT_RGAS
    0.00000E+00    4.00000E-01
USER DISTRIBUTION  (CUMULATIVE)       PCS_T1    SAT_RBRN
         3          SPECIFIED    CONTINUOUS
    0.00000E+00   0.50000
    2.00000E-01   0.50000
    6.00000E-01   0.00000
USER DISTRIBUTION  (CUMULATIVE)       PCS_T1    PORE_DIS
         3          SPECIFIED    CONTINUOUS
    1.10000E-01   0.50000
    9.40000E-01   0.50000
    8.10000E+00   0.00000
USER DISTRIBUTION  (CUMULATIVE)       S_HALITE  POROSITY
         3          SPECIFIED    CONTINUOUS
    1.00000E-03   0.50000
    1.00000E-02   0.50000
    5.19000E-02   0.00000
UNIFORM                S_HALITE  PRMX_LOG
   -2.40000E+01   -2.10000E+01
UNIFORM                S_HALITE  COMP_RCK
    2.94000E-12    1.92000E-10
STUDENT                S_MB139   PRMX_LOG
```

```
         6
 -2.10000E+01 -1.92000E+01 -1.91000E+01 -1.88000E+01 -1.81000E+01 -
1.71000E+01
USER DISTRIBUTION  (DELTA)           S_MB139   RELP_MOD
         4          SPECIFIED    DISCRETE
    1.00000E+00   0.50000
    2.00000E+00   0.00000
    3.00000E+00   0.00000
    4.00000E+00   0.50000
STUDENT                 S_MB139   SAT_RBRN
         6
  7.78460E-03  6.88420E-02  6.98600E-02  7.26200E-02  1.08610E-01
1.74010E-01
STUDENT                 S_MB139   PORE_DIS
         6
  4.90530E-01  5.57750E-01  6.52000E-01  6.55000E-01  6.64520E-01
8.41780E-01
UNIFORM                 S_HALITE  PRESSURE
    1.10400E+07    1.38900E+07
TRIANGULAR              CASTILER  PRESSURE
    1.11000E+07    1.27000E+07    1.70000E+07
TRIANGULAR              CASTILER  PRMX_LOG
   -1.47000E+01   -1.18000E+01   -9.80000E+00
TRIANGULAR              CASTILER  COMP_RCK
    2.00000E-11    4.00000E-11    1.00000E-10
UNIFORM                 BH_SAND   PRMX_LOG
   -1.63000E+01   -1.10000E+01
UNIFORM                 DRZ_1     PRMX_LOG
   -1.94000E+01   -1.25000E+01
UNIFORM                 CONC_PLG  PRMX_LOG
   -1.90000E+01   -1.70000E+01
USER DISTRIBUTION  (CUMULATIVE)       SHFTU     SAT_RBRN
         3          SPECIFIED    CONTINUOUS
    0.00000E+00   0.50000
    2.00000E-01   0.50000
    6.00000E-01   0.00000
UNIFORM                 SHFTU     SAT_RGAS
    0.00000E+00    4.00000E-01
USER DISTRIBUTION  (CUMULATIVE)       SHFTU     PRMX_LOG
         9          SPECIFIED    CONTINUOUS
   -2.05000E+01   0.03000
   -2.00000E+01   0.08000
   -1.95000E+01   0.13000
   -1.90000E+01   0.19000
   -1.85000E+01   0.22000
   -1.80000E+01   0.24000
   -1.75000E+01   0.10000
   -1.70000E+01   0.01000
   -1.65000E+01   0.00000
USER DISTRIBUTION  (CUMULATIVE)       SHFTL_T1  PRMX_LOG
         8          SPECIFIED    CONTINUOUS
```

```
   -2.00000E+01   0.01000
   -1.95000E+01   0.09000
   -1.90000E+01   0.20700
   -1.85000E+01   0.33000
   -1.80000E+01   0.23600
   -1.75000E+01   0.12000
   -1.70000E+01   0.00700
   -1.65000E+01   0.00000
USER DISTRIBUTION  (CUMULATIVE)        SHFTL_T2  PRMX_LOG
        10          SPECIFIED    CONTINUOUS
   -2.25000E+01   0.02000
   -2.20000E+01   0.06000
   -2.15000E+01   0.09000
   -2.10000E+01   0.13500
   -2.05000E+01   0.22000
   -2.00000E+01   0.17500
   -1.95000E+01   0.16500
   -1.90000E+01   0.10000
   -1.85000E+01   0.03500
   -1.80000E+01   0.00000
UNIFORM                 WAS_AREA  BIOGENFC
    0.00000E+00    1.00000E+00
UNIFORM                 PCS_T1    POROSITY
    6.60000E-02    1.87000E-01
UNIFORM                 PCS_T2    POROSITY
    2.50000E-02    7.50000E-02
UNIFORM                 PCS_T3    POROSITY
    1.00000E-03    5.19000E-02
NORMAL                  PCS_T2    POR2PERM
   -1.72000E+00    1.72000E+00
CORRELATION MATRIX
    2
    53  54 -0.99
    61  62 -0.75
OUTPUT CORR HIST DATA
TITLE SDB: ParamDB           Calc: CRA14        Ver: 2.00     04/05/13
16:13:05
```

Appendix VII. Comparison of Sampled Data to Expected Range

The following table compares the mean and range observed in the unconditioned sampled data for the final case (all changes implemented) to the mean and range specified in the parameter database. The table also shows the relative percent difference (RPD) in the means and the percent of the range covered by the sampled values. In general, the samples ranges matched the expected ranges within a few percent. The observed range of the sampled data for Student distributions is much smaller than the range specified in the parameter database because the minimum and maximum values in the database are the extremes of the data whereas the sampled values represent the uncertainty on the mean. The uncertainty on the mean is based on the standard error of the data and that range will always be smaller than the range of the data. PCS_T2:POR2PRM shows a RPD of 200% because the expected mean is 0 and the RPD formula becomes $RPD = \frac{\overline{X}_1 - \overline{X}_2}{\left(\overline{X}_1 + \overline{X}_2\right)/2} = \frac{2\overline{X}_1}{\overline{X}_1} = 2$.

S_MB139:RELP_MOD has a large RPD because there are only two possible values, 1 and 4, so the observed mean lies between these two values whereas the mean from the database was assigned to 4 because previously the mean also represented the default value. WAS_AREA:GRATMICH shows a large RPD because its distribution was controlled after sampling to ensure the sampled value in each vector did not exceed the sampled value for WAS_AREA:GRATMICI, hence the observed mean is reduced compared to the expected mean. PCS_T3:POROSITY also shows elevated RPDs because it is controlled by PCS_T2:POROSITY. PCS_T2:POROSITY was controlled by PCS_T1:POROSITY but the overlap was small and the control never had to modify the sampled values.

Compare Observed To PAPDB

Tuesday, April 09, 2013
4:53:27 PM

				Observed			Parameter Database					
Analysis	Material	Property	Rep	Minimum	Maximum	Mean	Minimum	Maximum	Mean	RPD of Means	% Range Covered	Distribution
CRA-2014	AM+3	MKD_AM	1	5.02E-03	3.97E-01	9.00E-02	5.00E-03	4.00E-01	9.00E-02	0.04%	99.1%	Loguniform
CRA-2014	AM+3	MKD_AM	2	5.17E-03	3.89E-01	9.03E-02	5.00E-03	4.00E-01	9.00E-02	0.31%	97.1%	Loguniform
CRA-2014	AM+3	MKD_AM	3	5.21E-03	3.93E-01	9.00E-02	5.00E-03	4.00E-01	9.00E-02	0.03%	98.1%	Loguniform
CRA-2014	BH_SAND	PRMX_LOG	1	-1.63E+01	-1.10E+01	-1.36E+01	-1.63E+01	-1.10E+01	-1.37E+01	0.01%	99.8%	Uniform
CRA-2014	BH_SAND	PRMX_LOG	2	-1.63E+01	-1.10E+01	-1.36E+01	-1.63E+01	-1.10E+01	-1.37E+01	0.01%	99.6%	Uniform
CRA-2014	BH_SAND	PRMX_LOG	3	-1.63E+01	-1.10E+01	-1.36E+01	-1.63E+01	-1.10E+01	-1.37E+01	0.02%	99.1%	Uniform
CRA-2014	BOREHOLE	DOMEGA	1	4.34E+00	2.16E+01	8.63E+00	4.20E+00	2.30E+01	8.63E+00	0.05%	92.1%	Cumulative
CRA-2014	BOREHOLE	DOMEGA	2	4.27E+00	2.27E+01	8.62E+00	4.20E+00	2.30E+01	8.63E+00	0.14%	97.9%	Cumulative
CRA-2014	BOREHOLE	DOMEGA	3	4.27E+00	2.30E+01	8.64E+00	4.20E+00	2.30E+01	8.63E+00	0.12%	99.6%	Cumulative
CRA-2014	BOREHOLE	TAUFAIL	1	2.23E+00	7.70E+01	3.96E+01	2.22E+00	7.70E+01	3.96E+01	0.01%	99.9%	Uniform
CRA-2014	BOREHOLE	TAUFAIL	2	2.43E+00	7.63E+01	3.96E+01	2.22E+00	7.70E+01	3.96E+01	0.06%	98.8%	Uniform
CRA-2014	BOREHOLE	TAUFAIL	3	2.46E+00	7.67E+01	3.96E+01	2.22E+00	7.70E+01	3.96E+01	0.02%	99.3%	Uniform
CRA-2014	CASTILER	COMP_RCK	1	2.07E-11	9.36E-11	5.33E-11	2.00E-11	1.00E-10	5.30E-11	0.54%	91.1%	Triangular
CRA-2014	CASTILER	COMP_RCK	2	2.28E-11	9.48E-11	5.33E-11	2.00E-11	1.00E-10	5.30E-11	0.66%	90.0%	Triangular
CRA-2014	CASTILER	COMP_RCK	3	2.14E-11	9.49E-11	5.33E-11	2.00E-11	1.00E-10	5.30E-11	0.51%	91.9%	Triangular
CRA-2014	CASTILER	PRESSURE	1	1.12E+07	1.65E+07	1.36E+07	1.11E+07	1.70E+07	1.36E+07	0.03%	89.8%	Triangular
CRA-2014	CASTILER	PRESSURE	2	1.14E+07	1.67E+07	1.36E+07	1.11E+07	1.70E+07	1.36E+07	0.04%	90.5%	Triangular
CRA-2014	CASTILER	PRESSURE	3	1.14E+07	1.69E+07	1.36E+07	1.11E+07	1.70E+07	1.36E+07	0.02%	92.7%	Triangular
CRA-2014	CASTILER	PRMX_LOG	1	-1.45E+01	-9.94E+00	-1.21E+01	-1.47E+01	-9.80E+00	-1.21E+01	0.01%	92.5%	Triangular
CRA-2014	CASTILER	PRMX_LOG	2	-1.45E+01	-1.01E+01	-1.21E+01	-1.47E+01	-9.80E+00	-1.21E+01	0.01%	91.2%	Triangular
CRA-2014	CASTILER	PRMX_LOG	3	-1.44E+01	-9.89E+00	-1.21E+01	-1.47E+01	-9.80E+00	-1.21E+01	0.03%	91.1%	Triangular
CRA-2014	CONC_PLG	PRMX_LOG	1	-1.90E+01	-1.70E+01	-1.80E+01	-1.90E+01	-1.70E+01	-1.80E+01	0.00%	99.0%	Uniform
CRA-2014	CONC_PLG	PRMX_LOG	2	-1.90E+01	-1.70E+01	-1.80E+01	-1.90E+01	-1.70E+01	-1.80E+01	0.00%	99.5%	Uniform

				Observed			Parameter Database					
Analysis	Material	Property	Rep	Minimum	Maximum	Mean	Minimum	Maximum	Mean	RPD of Means	% Range Covered	Distribution
CRA-2014	CONC_PLG	PRMX_LOG	3	-1.90E+01	-1.70E+01	-1.80E+01	-1.90E+01	-1.70E+01	-1.80E+01	0.01%	98.5%	Uniform
CRA-2014	CULEBRA	APOROS	1	1.01E-04	9.82E-03	2.14E-03	1.00E-04	1.00E-02	2.10E-03	1.79%	98.1%	Loguniform
CRA-2014	CULEBRA	APOROS	2	1.02E-04	9.58E-03	2.15E-03	1.00E-04	1.00E-02	2.10E-03	2.46%	95.7%	Loguniform
CRA-2014	CULEBRA	APOROS	3	1.01E-04	9.70E-03	2.14E-03	1.00E-04	1.00E-02	2.10E-03	2.11%	96.9%	Loguniform
CRA-2014	CULEBRA	DPOROS	1	1.00E-01	2.46E-01	1.55E-01	1.00E-01	2.50E-01	1.60E-01	3.21%	97.1%	Cumulative
CRA-2014	CULEBRA	DPOROS	2	1.00E-01	2.48E-01	1.55E-01	1.00E-01	2.50E-01	1.60E-01	3.18%	98.3%	Cumulative
CRA-2014	CULEBRA	DPOROS	3	1.00E-01	2.49E-01	1.55E-01	1.00E-01	2.50E-01	1.60E-01	3.19%	99.3%	Cumulative
CRA-2014	CULEBRA	HMBLKLT	1	5.26E-02	4.99E-01	2.75E-01	5.00E-02	5.00E-01	2.75E-01	0.09%	99.2%	Uniform
CRA-2014	CULEBRA	HMBLKLT	2	5.39E-02	4.96E-01	2.75E-01	5.00E-02	5.00E-01	2.75E-01	0.01%	98.3%	Uniform
CRA-2014	CULEBRA	HMBLKLT	3	5.41E-02	4.96E-01	2.75E-01	5.00E-02	5.00E-01	2.75E-01	0.06%	98.3%	Uniform
CRA-2014	CULEBRA	MINP_FAC	1	1.02E+00	9.95E+02	5.01E+02	1.00E+00	1.00E+03	5.01E+02	0.04%	99.5%	Uniform
CRA-2014	CULEBRA	MINP_FAC	2	5.56E+00	9.96E+02	5.01E+02	1.00E+00	1.00E+03	5.01E+02	0.00%	99.2%	Uniform
CRA-2014	CULEBRA	MINP_FAC	3	4.34E+00	9.92E+02	5.00E+02	1.00E+00	1.00E+03	5.01E+02	0.03%	98.9%	Uniform
CRA-2014	DRZ_1	PRMX_LOG	1	-1.94E+01	-1.25E+01	-1.59E+01	-1.94E+01	-1.25E+01	-1.60E+01	0.32%	99.9%	Uniform
CRA-2014	DRZ_1	PRMX_LOG	2	-1.94E+01	-1.26E+01	-1.60E+01	-1.94E+01	-1.25E+01	-1.60E+01	0.31%	98.8%	Uniform
CRA-2014	DRZ_1	PRMX_LOG	3	-1.93E+01	-1.26E+01	-1.59E+01	-1.94E+01	-1.25E+01	-1.60E+01	0.33%	98.3%	Uniform
CRA-2014	DRZ_PCS	PRMX_LOG	1	-2.05E+01	-1.72E+01	-1.88E+01	-2.07E+01	-1.70E+01	-1.88E+01	0.01%	88.7%	Triangular
CRA-2014	DRZ_PCS	PRMX_LOG	2	-2.06E+01	-1.72E+01	-1.88E+01	-2.07E+01	-1.70E+01	-1.88E+01	0.01%	91.9%	Triangular
CRA-2014	DRZ_PCS	PRMX_LOG	3	-2.06E+01	-1.72E+01	-1.88E+01	-2.07E+01	-1.70E+01	-1.88E+01	0.00%	92.5%	Triangular
CRA-2014	GLOBAL	CLIMTIDX	1	1.00E+00	2.23E+00	1.31E+00	1.00E+00	2.25E+00	1.31E+00	0.16%	98.7%	Cumulative
CRA-2014	GLOBAL	CLIMTIDX	2	1.00E+00	2.25E+00	1.31E+00	1.00E+00	2.25E+00	1.31E+00	0.21%	99.7%	Cumulative
CRA-2014	GLOBAL	CLIMTIDX	3	1.00E+00	2.24E+00	1.31E+00	1.00E+00	2.25E+00	1.31E+00	0.16%	99.0%	Cumulative
CRA-2014	GLOBAL	OXSTAT	1	4.38E-03	9.95E-01	5.00E-01	0.00E+00	1.00E+00	5.00E-01	0.02%	99.1%	Uniform
CRA-2014	GLOBAL	OXSTAT	2	7.89E-03	9.92E-01	5.01E-01	0.00E+00	1.00E+00	5.00E-01	0.14%	98.4%	Uniform
CRA-2014	GLOBAL	OXSTAT	3	8.11E-04	9.94E-01	5.00E-01	0.00E+00	1.00E+00	5.00E-01	0.03%	99.3%	Uniform
CRA-2014	GLOBAL	PBRINE	1	7.03E-02	1.87E-01	1.27E-01	6.36E-02	1.90E-01	1.27E-01	0.01%	92.1%	Normal

				Observed			Parameter Database					
Analysis	Material	Property	Rep	Minimum	Maximum	Mean	Minimum	Maximum	Mean	RPD of Means	% Range Covered	Distribution
CRA-2014	GLOBAL	PBRINE	2	6.85E-02	1.86E-01	1.27E-01	6.36E-02	1.90E-01	1.27E-01	0.01%	92.9%	Normal
CRA-2014	GLOBAL	PBRINE	3	6.92E-02	1.84E-01	1.27E-01	6.36E-02	1.90E-01	1.27E-01	0.02%	90.5%	Normal
CRA-2014	GLOBAL	TRANSIDX	1	7.95E-03	9.98E-01	5.00E-01	0.00E+00	1.00E+00	5.00E-01	0.05%	99.0%	Uniform
CRA-2014	GLOBAL	TRANSIDX	2	6.83E-03	9.92E-01	5.00E-01	0.00E+00	1.00E+00	5.00E-01	0.07%	98.5%	Uniform
CRA-2014	GLOBAL	TRANSIDX	3	6.61E-03	9.92E-01	5.00E-01	0.00E+00	1.00E+00	5.00E-01	0.05%	98.6%	Uniform
CRA-2014	PCS_T1	PORE_DIS	1	1.20E-01	8.06E+00	2.52E+00	1.10E-01	8.10E+00	2.52E+00	0.01%	99.3%	Cumulative
CRA-2014	PCS_T1	PORE_DIS	2	1.10E-01	8.02E+00	2.52E+00	1.10E-01	8.10E+00	2.52E+00	0.12%	99.0%	Cumulative
CRA-2014	PCS_T1	PORE_DIS	3	1.26E-01	8.06E+00	2.52E+00	1.10E-01	8.10E+00	2.52E+00	0.12%	99.4%	Cumulative
CRA-2014	PCS_T1	POROSITY	1	6.62E-02	1.87E-01	1.26E-01	6.60E-02	1.87E-01	1.27E-01	0.05%	99.4%	Uniform
CRA-2014	PCS_T1	POROSITY	2	6.65E-02	1.87E-01	1.27E-01	6.60E-02	1.87E-01	1.27E-01	0.01%	99.2%	Uniform
CRA-2014	PCS_T1	POROSITY	3	6.71E-02	1.87E-01	1.26E-01	6.60E-02	1.87E-01	1.27E-01	0.03%	98.9%	Uniform
CRA-2014	PCS_T1	PRMX_LOG	1	-2.08E+01	-1.21E+01	-1.64E+01	-2.08E+01	-1.20E+01	-1.64E+01	0.00%	98.4%	Uniform
CRA-2014	PCS_T1	PRMX_LOG	2	-2.08E+01	-1.21E+01	-1.64E+01	-2.08E+01	-1.20E+01	-1.64E+01	0.02%	99.2%	Uniform
CRA-2014	PCS_T1	PRMX_LOG	3	-2.08E+01	-1.21E+01	-1.64E+01	-2.08E+01	-1.20E+01	-1.64E+01	0.01%	98.4%	Uniform
CRA-2014	PCS_T1	SAT_RBRN	1	1.96E-03	5.95E-01	2.50E-01	0.00E+00	6.00E-01	2.50E-01	0.04%	98.9%	Cumulative
CRA-2014	PCS_T1	SAT_RBRN	2	6.93E-04	5.95E-01	2.50E-01	0.00E+00	6.00E-01	2.50E-01	0.09%	99.0%	Cumulative
CRA-2014	PCS_T1	SAT_RBRN	3	2.91E-03	5.94E-01	2.50E-01	0.00E+00	6.00E-01	2.50E-01	0.05%	98.5%	Cumulative
CRA-2014	PCS_T1	SAT_RGAS	1	9.61E-04	3.98E-01	2.00E-01	0.00E+00	4.00E-01	2.00E-01	0.05%	99.2%	Uniform
CRA-2014	PCS_T1	SAT_RGAS	2	2.78E-03	3.99E-01	2.00E-01	0.00E+00	4.00E-01	2.00E-01	0.09%	99.1%	Uniform
CRA-2014	PCS_T1	SAT_RGAS	3	5.95E-04	3.99E-01	2.00E-01	0.00E+00	4.00E-01	2.00E-01	0.09%	99.7%	Uniform
CRA-2014	PCS_T2	POR2PERM	1	-1.63E+00	1.68E+00	5.65E-04	-1.72E+00	1.72E+00	0.00E+00	200.00%	96.1%	Normal
CRA-2014	PCS_T2	POR2PERM	2	-1.58E+00	1.70E+00	1.14E-03	-1.72E+00	1.72E+00	0.00E+00	200.00%	95.5%	Normal
CRA-2014	PCS_T2	POR2PERM	3	-1.58E+00	1.65E+00	1.18E-03	-1.72E+00	1.72E+00	0.00E+00	200.00%	93.8%	Normal
CRA-2014	PCS_T2	POROSITY	1	2.51E-02	7.47E-02	5.00E-02	2.50E-02	7.50E-02	5.00E-02	0.00%	99.1%	Uniform
CRA-2014	PCS_T2	POROSITY	2	2.55E-02	7.47E-02	4.99E-02	2.50E-02	7.50E-02	5.00E-02	0.13%	98.4%	Uniform
CRA-2014	PCS_T2	POROSITY	3	2.50E-02	7.47E-02	5.00E-02	2.50E-02	7.50E-02	5.00E-02	0.01%	99.3%	Uniform

				Observed			Parameter Database					
Analysis	Material	Property	Rep	Minimum	Maximum	Mean	Minimum	Maximum	Mean	RPD of Means	% Range Covered	Distribution
CRA-2014	PCS_T3	POROSITY	1	1.44E-03	5.05E-02	2.47E-02	1.00E-03	5.19E-02	2.65E-02	7.12%	96.5%	Uniform
CRA-2014	PCS_T3	POROSITY	2	1.46E-03	5.12E-02	2.44E-02	1.00E-03	5.19E-02	2.65E-02	8.24%	97.8%	Uniform
CRA-2014	PCS_T3	POROSITY	3	1.49E-03	5.10E-02	2.40E-02	1.00E-03	5.19E-02	2.65E-02	9.80%	97.2%	Uniform
CRA-2014	PHUMOX3	PHUMCIM	1	8.48E-02	1.60E+00	1.10E+00	6.50E-02	1.60E+00	1.10E+00	0.17%	98.6%	Cumulative
CRA-2014	PHUMOX3	PHUMCIM	2	7.88E-02	1.60E+00	1.10E+00	6.50E-02	1.60E+00	1.10E+00	0.11%	99.0%	Cumulative
CRA-2014	PHUMOX3	PHUMCIM	3	9.04E-02	1.60E+00	1.10E+00	6.50E-02	1.60E+00	1.10E+00	0.11%	98.3%	Cumulative
CRA-2014	PU+3	MKD_PU	1	5.02E-03	3.96E-01	9.03E-02	5.00E-03	4.00E-01	9.00E-02	0.30%	99.0%	Loguniform
CRA-2014	PU+3	MKD_PU	2	5.06E-03	3.95E-01	9.02E-02	5.00E-03	4.00E-01	9.00E-02	0.18%	98.7%	Loguniform
CRA-2014	PU+3	MKD_PU	3	5.04E-03	4.00E-01	9.01E-02	5.00E-03	4.00E-01	9.00E-02	0.16%	99.9%	Loguniform
CRA-2014	PU+4	MKD_PU	1	5.20E-04	9.69E+00	1.01E+00	5.00E-04	1.00E+01	1.00E+00	0.51%	96.9%	Loguniform
CRA-2014	PU+4	MKD_PU	2	5.21E-04	9.55E+00	1.01E+00	5.00E-04	1.00E+01	1.00E+00	1.40%	95.5%	Loguniform
CRA-2014	PU+4	MKD_PU	3	5.38E-04	9.64E+00	1.01E+00	5.00E-04	1.00E+01	1.00E+00	1.28%	96.4%	Loguniform
CRA-2014	S_HALITE	COMP_RCK	1	3.77E-12	1.92E-10	9.75E-11	2.94E-12	1.92E-10	9.75E-11	0.04%	99.4%	Uniform
CRA-2014	S_HALITE	COMP_RCK	2	3.20E-12	1.90E-10	9.75E-11	2.94E-12	1.92E-10	9.75E-11	0.02%	98.9%	Uniform
CRA-2014	S_HALITE	COMP_RCK	3	3.46E-12	1.91E-10	9.74E-11	2.94E-12	1.92E-10	9.75E-11	0.07%	99.0%	Uniform
CRA-2014	S_HALITE	POROSITY	1	1.13E-03	5.12E-02	1.82E-02	1.00E-03	5.19E-02	1.82E-02	0.17%	98.3%	Cumulative
CRA-2014	S_HALITE	POROSITY	2	1.05E-03	5.12E-02	1.82E-02	1.00E-03	5.19E-02	1.82E-02	0.13%	98.4%	Cumulative
CRA-2014	S_HALITE	POROSITY	3	1.11E-03	5.16E-02	1.82E-02	1.00E-03	5.19E-02	1.82E-02	0.24%	99.1%	Cumulative
CRA-2014	S_HALITE	PRESSURE	1	1.11E+07	1.39E+07	1.25E+07	1.10E+07	1.39E+07	1.25E+07	0.04%	99.3%	Uniform
CRA-2014	S_HALITE	PRESSURE	2	1.11E+07	1.39E+07	1.25E+07	1.10E+07	1.39E+07	1.25E+07	0.05%	99.3%	Uniform
CRA-2014	S_HALITE	PRESSURE	3	1.11E+07	1.39E+07	1.25E+07	1.10E+07	1.39E+07	1.25E+07	0.03%	99.3%	Uniform
CRA-2014	S_HALITE	PRMX_LOG	1	-2.40E+01	-2.10E+01	-2.25E+01	-2.40E+01	-2.10E+01	-2.25E+01	0.00%	98.7%	Uniform
CRA-2014	S_HALITE	PRMX_LOG	2	-2.40E+01	-2.10E+01	-2.25E+01	-2.40E+01	-2.10E+01	-2.25E+01	0.00%	99.7%	Uniform
CRA-2014	S_HALITE	PRMX_LOG	3	-2.40E+01	-2.10E+01	-2.25E+01	-2.40E+01	-2.10E+01	-2.25E+01	0.01%	100.0%	Uniform
CRA-2014	S_MB139	PORE_DIS	1	4.99E-01	8.02E-01	6.44E-01	4.91E-01	8.42E-01	6.44E-01	0.04%	86.1%	Student
CRA-2014	S_MB139	PORE_DIS	2	5.00E-01	7.99E-01	6.44E-01	4.91E-01	8.42E-01	6.44E-01	0.01%	85.1%	Student

				Observed			Parameter Database					
Analysis	Material	Property	Rep	Minimum	Maximum	Mean	Minimum	Maximum	Mean	RPD of Means	% Range Covered	Distribution
CRA-2014	S_MB139	PORE_DIS	3	5.03E-01	7.95E-01	6.44E-01	4.91E-01	8.42E-01	6.44E-01	0.00%	83.2%	Student
CRA-2014	S_MB139	PRMX_LOG	1	-2.04E+01	-1.71E+01	-1.89E+01	-2.10E+01	-1.71E+01	-1.89E+01	0.05%	84.6%	Student
CRA-2014	S_MB139	PRMX_LOG	2	-2.07E+01	-1.72E+01	-1.89E+01	-2.10E+01	-1.71E+01	-1.89E+01	0.04%	87.9%	Student
CRA-2014	S_MB139	PRMX_LOG	3	-2.04E+01	-1.73E+01	-1.89E+01	-2.10E+01	-1.71E+01	-1.89E+01	0.03%	77.4%	Student
CRA-2014	S_MB139	RELP_MOD	1	1.00E+00	4.00E+00	2.50E+00	1.00E+00	4.00E+00	4.00E+00	46.15%	100.0%	Delta
CRA-2014	S_MB139	RELP_MOD	2	1.00E+00	4.00E+00	2.50E+00	1.00E+00	4.00E+00	4.00E+00	46.15%	100.0%	Delta
CRA-2014	S_MB139	RELP_MOD	3	1.00E+00	4.00E+00	2.50E+00	1.00E+00	4.00E+00	4.00E+00	46.15%	100.0%	Delta
CRA-2014	S_MB139	SAT_RBRN	1	1.50E-02	1.57E-01	8.36E-02	7.78E-03	1.74E-01	8.36E-02	0.01%	85.5%	Student
CRA-2014	S_MB139	SAT_RBRN	2	2.13E-02	1.57E-01	8.38E-02	7.78E-03	1.74E-01	8.36E-02	0.20%	81.5%	Student
CRA-2014	S_MB139	SAT_RBRN	3	2.14E-02	1.46E-01	8.38E-02	7.78E-03	1.74E-01	8.36E-02	0.17%	75.3%	Student
CRA-2014	SHFTL_T1	PRMX_LOG	1	-2.00E+01	-1.69E+01	-1.82E+01	-2.00E+01	-1.65E+01	-1.80E+01	1.18%	88.6%	Cumulative
CRA-2014	SHFTL_T1	PRMX_LOG	2	-1.99E+01	-1.70E+01	-1.82E+01	-2.00E+01	-1.65E+01	-1.80E+01	1.18%	83.4%	Cumulative
CRA-2014	SHFTL_T1	PRMX_LOG	3	-1.96E+01	-1.70E+01	-1.82E+01	-2.00E+01	-1.65E+01	-1.80E+01	1.16%	72.6%	Cumulative
CRA-2014	SHFTL_T2	PRMX_LOG	1	-2.24E+01	-1.80E+01	-2.01E+01	-2.25E+01	-1.80E+01	-1.98E+01	1.32%	96.2%	Cumulative
CRA-2014	SHFTL_T2	PRMX_LOG	2	-2.23E+01	-1.81E+01	-2.01E+01	-2.25E+01	-1.80E+01	-1.98E+01	1.32%	92.0%	Cumulative
CRA-2014	SHFTL_T2	PRMX_LOG	3	-2.23E+01	-1.80E+01	-2.01E+01	-2.25E+01	-1.80E+01	-1.98E+01	1.33%	96.2%	Cumulative
CRA-2014	SHFTU	PRMX_LOG	1	-2.05E+01	-1.69E+01	-1.84E+01	-2.05E+01	-1.65E+01	-1.82E+01	1.21%	88.8%	Cumulative
CRA-2014	SHFTU	PRMX_LOG	2	-2.04E+01	-1.68E+01	-1.84E+01	-2.05E+01	-1.65E+01	-1.82E+01	1.20%	90.5%	Cumulative
CRA-2014	SHFTU	PRMX_LOG	3	-2.04E+01	-1.66E+01	-1.84E+01	-2.05E+01	-1.65E+01	-1.82E+01	1.21%	94.8%	Cumulative
CRA-2014	SHFTU	SAT_RBRN	1	1.79E-03	6.00E-01	2.50E-01	0.00E+00	6.00E-01	2.50E-01	0.04%	99.7%	Cumulative
CRA-2014	SHFTU	SAT_RBRN	2	2.76E-03	5.97E-01	2.50E-01	0.00E+00	6.00E-01	2.50E-01	0.03%	99.1%	Cumulative
CRA-2014	SHFTU	SAT_RBRN	3	9.67E-04	5.93E-01	2.50E-01	0.00E+00	6.00E-01	2.50E-01	0.03%	98.7%	Cumulative
CRA-2014	SHFTU	SAT_RGAS	1	9.09E-04	3.98E-01	2.00E-01	0.00E+00	4.00E-01	2.00E-01	0.07%	99.2%	Uniform
CRA-2014	SHFTU	SAT_RGAS	2	2.05E-03	3.98E-01	2.00E-01	0.00E+00	4.00E-01	2.00E-01	0.00%	98.9%	Uniform
CRA-2014	SHFTU	SAT_RGAS	3	2.70E-03	3.98E-01	2.00E-01	0.00E+00	4.00E-01	2.00E-01	0.01%	98.7%	Uniform
CRA-2014	SOLMOD3	SOLVAR	1	-3.54E+00	2.64E+00	-6.90E-01	-3.55E+00	2.97E+00	-6.76E-01	2.00%	94.9%	Cumulative

				Observed			Parameter Database					
Analysis	Material	Property	Rep	Minimum	Maximum	Mean	Minimum	Maximum	Mean	RPD of Means	% Range Covered	Distribution
CRA-2014	SOLMOD3	SOLVAR	2	-3.52E+00	2.67E+00	-6.88E-01	-3.55E+00	2.97E+00	-6.76E-01	1.68%	94.8%	Cumulative
CRA-2014	SOLMOD3	SOLVAR	3	-3.54E+00	2.84E+00	-6.61E-01	-3.55E+00	2.97E+00	-6.76E-01	2.27%	98.0%	Cumulative
CRA-2014	SOLMOD4	SOLVAR	1	-1.16E+00	3.19E+00	6.85E-01	-1.52E+00	3.19E+00	6.60E-01	3.83%	92.3%	Cumulative
CRA-2014	SOLMOD4	SOLVAR	2	-1.23E+00	3.19E+00	6.53E-01	-1.52E+00	3.19E+00	6.60E-01	0.94%	93.9%	Cumulative
CRA-2014	SOLMOD4	SOLVAR	3	-1.28E+00	3.19E+00	6.43E-01	-1.52E+00	3.19E+00	6.60E-01	2.61%	95.0%	Cumulative
CRA-2014	SPALLMOD	PARTDIAM	1	1.01E-03	9.65E-02	2.15E-02	1.00E-03	1.00E-01	2.15E-02	0.10%	96.5%	Loguniform
CRA-2014	SPALLMOD	PARTDIAM	2	1.00E-03	9.76E-02	2.16E-02	1.00E-03	1.00E-01	2.15E-02	0.28%	97.6%	Loguniform
CRA-2014	SPALLMOD	PARTDIAM	3	1.04E-03	9.82E-02	2.16E-02	1.00E-03	1.00E-01	2.15E-02	0.32%	98.2%	Loguniform
CRA-2014	SPALLMOD	REPIPERM	1	2.42E-14	2.32E-12	5.15E-13	2.40E-14	2.40E-12	5.16E-13	0.26%	96.5%	Loguniform
CRA-2014	SPALLMOD	REPIPERM	2	2.49E-14	2.37E-12	5.15E-13	2.40E-14	2.40E-12	5.16E-13	0.22%	98.6%	Loguniform
CRA-2014	SPALLMOD	REPIPERM	3	2.45E-14	2.40E-12	5.16E-13	2.40E-14	2.40E-12	5.16E-13	0.01%	99.9%	Loguniform
CRA-2014	SPALLMOD	REPIPOR	1	3.51E-01	6.58E-01	5.05E-01	3.50E-01	6.60E-01	5.05E-01	0.04%	99.0%	Uniform
CRA-2014	SPALLMOD	REPIPOR	2	3.51E-01	6.58E-01	5.05E-01	3.50E-01	6.60E-01	5.05E-01	0.00%	99.1%	Uniform
CRA-2014	SPALLMOD	REPIPOR	3	3.52E-01	6.58E-01	5.05E-01	3.50E-01	6.60E-01	5.05E-01	0.02%	99.0%	Uniform
CRA-2014	SPALLMOD	TENSLSTR	1	1.21E+05	1.70E+05	1.45E+05	1.20E+05	1.70E+05	1.45E+05	0.01%	98.8%	Uniform
CRA-2014	SPALLMOD	TENSLSTR	2	1.20E+05	1.70E+05	1.45E+05	1.20E+05	1.70E+05	1.45E+05	0.02%	99.4%	Uniform
CRA-2014	SPALLMOD	TENSLSTR	3	1.20E+05	1.70E+05	1.45E+05	1.20E+05	1.70E+05	1.45E+05	0.00%	99.0%	Uniform
CRA-2014	STEEL	CORRMCO2	1	4.96E-15	7.21E-15	6.06E-15	3.29E-16	1.83E-14	6.06E-15	0.01%	12.5%	Student
CRA-2014	STEEL	CORRMCO2	2	4.97E-15	7.14E-15	6.06E-15	3.29E-16	1.83E-14	6.06E-15	0.01%	12.1%	Student
CRA-2014	STEEL	CORRMCO2	3	4.88E-15	7.18E-15	6.06E-15	3.29E-16	1.83E-14	6.06E-15	0.00%	12.8%	Student
CRA-2014	TH+4	MKD_TH	1	5.20E-04	9.69E+00	1.01E+00	5.00E-04	1.00E+01	1.00E+00	1.07%	96.9%	Loguniform
CRA-2014	TH+4	MKD_TH	2	5.25E-04	9.76E+00	1.02E+00	5.00E-04	1.00E+01	1.00E+00	1.52%	97.6%	Loguniform
CRA-2014	TH+4	MKD_TH	3	5.24E-04	9.75E+00	1.01E+00	5.00E-04	1.00E+01	1.00E+00	0.97%	97.5%	Loguniform
CRA-2014	U+4	MKD_U	1	5.45E-04	9.42E+00	1.00E+00	5.00E-04	1.00E+01	1.00E+00	0.34%	94.2%	Loguniform
CRA-2014	U+4	MKD_U	2	5.20E-04	9.74E+00	1.01E+00	5.00E-04	1.00E+01	1.00E+00	0.81%	97.4%	Loguniform
CRA-2014	U+4	MKD_U	3	5.07E-04	9.88E+00	1.01E+00	5.00E-04	1.00E+01	1.00E+00	1.38%	98.8%	Loguniform

				Observed			Parameter Database					
Analysis	Material	Property	Rep	Minimum	Maximum	Mean	Minimum	Maximum	Mean	RPD of Means	% Range Covered	Distribution
CRA-2014	U+6	MKD_U	1	3.14E-05	1.97E-02	3.07E-03	3.00E-05	2.00E-02	3.10E-03	0.92%	98.3%	Loguniform
CRA-2014	U+6	MKD_U	2	3.11E-05	1.99E-02	3.08E-03	3.00E-05	2.00E-02	3.10E-03	0.66%	99.3%	Loguniform
CRA-2014	U+6	MKD_U	3	3.07E-05	1.88E-02	3.07E-03	3.00E-05	2.00E-02	3.10E-03	0.81%	93.8%	Loguniform
CRA-2014	WAS_AREA	BIOGENFC	1	2.82E-03	9.97E-01	5.01E-01	0.00E+00	1.00E+00	5.00E-01	0.11%	99.4%	Uniform
CRA-2014	WAS_AREA	BIOGENFC	2	1.81E-03	9.97E-01	5.00E-01	0.00E+00	1.00E+00	5.00E-01	0.07%	99.5%	Uniform
CRA-2014	WAS_AREA	BIOGENFC	3	2.65E-04	9.99E-01	5.00E-01	0.00E+00	1.00E+00	5.00E-01	0.07%	99.9%	Uniform
CRA-2014	WAS_AREA	BRUCITEC	1	4.80E-08	5.63E-08	5.20E-08	4.76E-08	5.64E-08	5.20E-08	0.01%	94.5%	Normal
CRA-2014	WAS_AREA	BRUCITEC	2	4.77E-08	5.61E-08	5.20E-08	4.76E-08	5.64E-08	5.20E-08	0.01%	95.7%	Normal
CRA-2014	WAS_AREA	BRUCITEC	3	4.77E-08	5.62E-08	5.20E-08	4.76E-08	5.64E-08	5.20E-08	0.00%	96.4%	Normal
CRA-2014	WAS_AREA	BRUCITEH	1	1.82E-08	2.18E-08	2.00E-08	1.81E-08	2.19E-08	2.00E-08	0.00%	96.1%	Normal
CRA-2014	WAS_AREA	BRUCITEH	2	1.82E-08	2.17E-08	2.00E-08	1.81E-08	2.19E-08	2.00E-08	0.01%	91.8%	Normal
CRA-2014	WAS_AREA	BRUCITEH	3	1.82E-08	2.17E-08	2.00E-08	1.81E-08	2.19E-08	2.00E-08	0.00%	93.2%	Normal
CRA-2014	WAS_AREA	BRUCITES	1	4.34E-08	6.06E-08	5.20E-08	4.27E-08	6.13E-08	5.20E-08	0.01%	92.4%	Normal
CRA-2014	WAS_AREA	BRUCITES	2	4.30E-08	6.06E-08	5.20E-08	4.27E-08	6.13E-08	5.20E-08	0.02%	95.1%	Normal
CRA-2014	WAS_AREA	BRUCITES	3	4.28E-08	6.11E-08	5.20E-08	4.27E-08	6.13E-08	5.20E-08	0.00%	98.2%	Normal
CRA-2014	WAS_AREA	GRATMICH	1	5.57E-12	5.54E-10	1.80E-10	0.00E+00	1.03E-09	5.14E-10	96.34%	53.4%	Uniform
CRA-2014	WAS_AREA	GRATMICH	2	2.65E-12	5.31E-10	1.78E-10	0.00E+00	1.03E-09	5.14E-10	97.00%	51.4%	Uniform
CRA-2014	WAS_AREA	GRATMICH	3	6.73E-13	5.16E-10	1.84E-10	0.00E+00	1.03E-09	5.14E-10	94.70%	50.2%	Uniform
CRA-2014	WAS_AREA	GRATMICI	1	3.26E-11	5.55E-10	2.94E-10	3.08E-11	5.57E-10	2.94E-10	0.05%	99.4%	Uniform
CRA-2014	WAS_AREA	GRATMICI	2	3.40E-11	5.53E-10	2.94E-10	3.08E-11	5.57E-10	2.94E-10	0.08%	98.7%	Uniform
CRA-2014	WAS_AREA	GRATMICI	3	3.15E-11	5.52E-10	2.94E-10	3.08E-11	5.57E-10	2.94E-10	0.04%	99.0%	Uniform
CRA-2014	WAS_AREA	HYMAGCON	1	7.49E-12	6.80E-10	3.44E-10	6.80E-12	6.80E-10	3.43E-10	0.06%	99.9%	Uniform
CRA-2014	WAS_AREA	HYMAGCON	2	1.30E-11	6.74E-10	3.43E-10	6.80E-12	6.80E-10	3.43E-10	0.06%	98.2%	Uniform
CRA-2014	WAS_AREA	HYMAGCON	3	7.91E-12	6.79E-10	3.43E-10	6.80E-12	6.80E-10	3.43E-10	0.06%	99.7%	Uniform
CRA-2014	WAS_AREA	PROBDEG	1	1.00E+00	2.00E+00	1.25E+00	1.00E+00	2.00E+00	1.25E+00	0.00%	100.0%	Delta
CRA-2014	WAS_AREA	PROBDEG	2	1.00E+00	2.00E+00	1.25E+00	1.00E+00	2.00E+00	1.25E+00	0.00%	100.0%	Delta

				Observed			Parameter Database					
Analysis	Material	Property	Rep	Minimum	Maximum	Mean	Minimum	Maximum	Mean	RPD of Means	% Range Covered	Distribution
CRA-2014	WAS_AREA	PROBDEG	3	1.00E+00	2.00E+00	1.25E+00	1.00E+00	2.00E+00	1.25E+00	0.00%	100.0%	Delta
CRA-2014	WAS_AREA	SAT_RBRN	1	2.71E-03	5.51E-01	2.76E-01	0.00E+00	5.52E-01	2.76E-01	0.07%	99.3%	Uniform
CRA-2014	WAS_AREA	SAT_RBRN	2	6.63E-04	5.47E-01	2.76E-01	0.00E+00	5.52E-01	2.76E-01	0.05%	99.0%	Uniform
CRA-2014	WAS_AREA	SAT_RBRN	3	3.97E-03	5.48E-01	2.76E-01	0.00E+00	5.52E-01	2.76E-01	0.11%	98.6%	Uniform
CRA-2014	WAS_AREA	SAT_RGAS	1	7.72E-04	1.48E-01	7.50E-02	0.00E+00	1.50E-01	7.50E-02	0.01%	98.5%	Uniform
CRA-2014	WAS_AREA	SAT_RGAS	2	6.34E-04	1.50E-01	7.50E-02	0.00E+00	1.50E-01	7.50E-02	0.04%	99.3%	Uniform
CRA-2014	WAS_AREA	SAT_RGAS	3	7.07E-04	1.49E-01	7.51E-02	0.00E+00	1.50E-01	7.50E-02	0.10%	98.7%	Uniform
CRA-2014	WAS_AREA	SAT_WICK	1	3.06E-03	9.92E-01	5.00E-01	0.00E+00	1.00E+00	5.00E-01	0.05%	98.9%	Uniform
CRA-2014	WAS_AREA	SAT_WICK	2	2.32E-03	9.99E-01	5.00E-01	0.00E+00	1.00E+00	5.00E-01	0.09%	99.7%	Uniform
CRA-2014	WAS_AREA	SAT_WICK	3	4.40E-03	9.93E-01	5.00E-01	0.00E+00	1.00E+00	5.00E-01	0.02%	98.8%	Uniform
189 Records												

Appendix VIII. LHS_EDIT

1.1. Description and Requirements

LHS_EDIT was created to impose conditional relationships between pairs of variables for the case where 1) one variable was restricted to having values less than or equal to the other "controlling" variable and 2) the restricted, or conditioned, variable has a uniform distribution. LHS_EDIT is designed to read the LHS output (transfer) file and:

1) Extract the upper and lower bounds for the uniform distribution of the variable to be restricted,
2) Extract the sampled values for each pair of variables,
3) Compare the value of the variable to be restricted to the value of the controlling variable,
4) Rescale the restricted value if it exceeds the value of the controlling variable, and
5) Write a new transfer file containing the modified data.

The restricted value is rescaled by assuming that the distribution of the restricted value is a uniform distribution with an upper bound that is the minimum of the upper bound assigned to the parameter in the parameter data base and the sampled value of the controlling variable. The conditioned value of the restricted variable is computed using:

$$v_i' = \frac{v_i - U_{V,lower}}{U_{V,upper} - U_{V,lower}} \times \left(Min(x_i, U_{V,upper}) - U_{V,lower} \right) + U_{V,lower} \quad (2)$$

where v_i' is the conditioned value of the restricted variable, v_i is the sampled value of the restricted variable, x_i is the sampled value of the controlling variable, and $U_{V,lower}$ and $U_{V,upper}$ are the bounds of the distribution assigned to the restricted variable. This method preserves the probability associated with the value of the restricted variable but will affect the rank-order correlations with the other variables.

The format of the numbers in the listing of the distribution parameters in the LHS transfer file is limited to four digits after the decimal point, whereas the database can store more significant digits. The variables that were modified by LHS_EDIT have 1 more digit stored in the Parameter Database than can be represented by the LHS format, thus introducing a small error in the rescaling calculation. However, the error is insignificant because the rounding occurs in the fourth digit after the decimal point, i.e. the fifth significant digit.

1.2. Platform and Source Code Description

The LHS_EDIT source code was written in FORTRAN 90 and executed on OpenVMS Version 7.3-1 operating system.

1.3. Usage

Files

LHS_EDIT requires as input the LHS output (transfer) file and a control file listing the pairs of variables to be related. The control file contains a record for each pair of variables and the variables are identified by a number corresponding to the numeric sequence of the variables in the PRELHS input file. The format for the record is (I2,1x,I2). The output files for LHS_EDIT are a new transfer file having the conditioned data and a file called CHECK.TXT. CHECK.TXT lists the values of the controlling, restricted and conditioned variables in a comma-delimited format. CHECK.TXT can be used to easily check whether LHS_EDIT is functioning properly.

Execution

File names are passed to LHS_EDIT using VMS logical variables. These variables are assigned values using the define command. The logical variables are LHS_CONTROL, LHS2_TRN, and LHS_EDIT_OUT for the control, LHS transfer file and the new transfer file, respectively. For example:

```
$  define LHS_CONTROL lhs_control_R1.inp
$  define LHS2_TRN lhs2_CRA14_R1.trn
$  define LHS_EDIT_OUT lhs2_CRA14_R1_CON.trn
$  run LHS_EDIT
```

For the CRA-2014 PA LHS_EDIT was executed using the EVAL_LHS.COM script and the file names were passed to EVAL_LHS.COM through its input file (EVAL_LHS_CRA14_R*n*.INP where *n* is 1, 2 or 3 for the three replicates, EVAL_LHS_CRA14BL_R1.INP and EVAL_LHS_CRA14TP_R1.INP). The script and input files are stored in the SCMS library PACMS2:[CMS_CRA14.CRA14_EVAL]

1.4. Testing of LHS_EDIT

Test Procedure

The test of the performance of LHS_EDIT was conducted by examining the data for Replicate 1 of the LHS transfer file and the LHS_EDIT output file. There have been no changes to LHS_EDIT since the test documented in Kirchner (2009). The data for WAS_AREA:GRATMICI and WAS_AREA:GRATMICH were extracted from these files and put into tables using the "Load LHS File" function of the Access database CCDFGF_Analysis. The maximum and minimum for the distribution of WAS_AREA:GRATMICH were obtained from the PA Parameter Database (PAPDB) table ParamAttributes. The query TestLHS_EDIT was used to compare the values produced by LHS_Edit to independently computed values.

```
SELECT LHS_ParamValues.Vector, LHS_ParamValues.Value AS GRATMICI, LHS_ParamValues_1.Value AS GRATMICH,
IIf([GRATMICH]>[GRATMICI],([GRATMICH]-[Min])/([Max]-[Min])*([GRATMICI]-[Min])+[Min],[GRATMICH]) AS [Test Value],
LHS_ParamValues_2.Value AS [Conditioned GRATMICH], IIf((Abs([Conditioned GRATMICH]-[Test Value])/[Conditioned
GRATMICH]>0.001) Or [Conditioned GRATMICH]>[GRATMICI],"error","") AS ErrorFlag, ParamAttributes.value AS [Min],
ParamAttributes_1.value AS [Max]

FROM LHS_FileNames AS LHS_FileNames_1 INNER JOIN ((((LHS_ParamValues INNER JOIN LHS_FileNames ON
LHS_ParamValues.FileID = LHS_FileNames.FileID) INNER JOIN LHS_ParamValues AS LHS_ParamValues_1 ON
(LHS_FileNames.FileID = LHS_ParamValues_1.FileID) AND (LHS_ParamValues.Vector = LHS_ParamValues_1.Vector)) INNER
JOIN ((AnalysisToVersion INNER JOIN ParamAttributes ON AnalysisToVersion.VersionNumber =
ParamAttributes.VersionNumber) INNER JOIN ParamAttributes AS ParamAttributes_1 ON AnalysisToVersion.VersionNumber =
ParamAttributes_1.VersionNumber) ON (LHS_ParamValues_1.Material = ParamAttributes.Material) AND
(LHS_ParamValues_1.Property = ParamAttributes.Property) AND (LHS_ParamValues_1.Material = ParamAttributes_1.Material)
AND (LHS_ParamValues_1.Property = ParamAttributes_1.Property) AND (LHS_ParamValues_1.Material =
AnalysisToVersion.Material) AND (LHS_ParamValues_1.Property = AnalysisToVersion.Property)) INNER JOIN LHS_ParamValues
AS LHS_ParamValues_2 ON (LHS_ParamValues_1.Material = LHS_ParamValues_2.Material) AND
(LHS_ParamValues_1.Property = LHS_ParamValues_2.Property) AND (LHS_ParamValues_1.Vector =
LHS_ParamValues_2.Vector)) ON LHS_FileNames_1.FileID = LHS_ParamValues_2.FileID

WHERE (((LHS_ParamValues.Material)="WAS_AREA") AND ((LHS_ParamValues.Property)="GRATMICI") AND
((LHS_ParamValues_1.Material)="WAS_AREA") AND ((LHS_ParamValues_1.Property)="GRATMICH") AND
((LHS_FileNames.Analysis)="CRA-2014NC") AND ((LHS_FileNames.Replicate)=1) AND
((ParamAttributes.Attribute)="Minimum") AND ((AnalysisToVersion.Analysis)="CRA14") AND
((AnalysisToVersion.Code)="BRAGFLO") AND ((ParamAttributes_1.Attribute)="Maximum") AND
((LHS_FileNames_1.Analysis)="CRA-2014") AND ((LHS_FileNames_1.Replicate)=1))

ORDER BY LHS_ParamValues.Vector;
```

The SQL for the TestLHS_EDIT query.

The "Test Value" was computed using the formula "IIf([GRATMICH] > [GRATMICI],([GRATMICH]-[Min])/([Max]-[Min])*([GRATMICI]-[Min])+[Min],[GRATMICH])", where Min is the minimum and Max is the maximum for the distribution of WAS_AREA:GRATMICH. This formula is equivalent to Eq. 2. The Error Flag field was set to "Error" if the conditioned value did not equal the Test Value to within 0.1 % or if the conditioned value exceeded the value of WAS_AREA:GRATMICI. No such errors were observed. The CCDFGF_Analysis.mdb and the associated CCDFGF_Data.mdb files are contained in the CCDFGF_Analysis.zip file and stored in the library LIBCRA14_LHS.

Table 2. Results showing independently computed values (Test Value) for WAS_AREA:GRATMICH.

Vector	GRATMICI	GRATMICH	Test Value	Conditioned GRATMICH	ErrorFlag
1	2.386E-10	3.388E-11	3.388E-11	3.388E-11	

2	7.815E-11	7.244E-10	5.511E-11	5.511E-11
3	3.285E-10	2.922E-10	2.922E-10	2.922E-10
4	7.927E-11	9.082E-10	7.009E-11	7.009E-11
5	5.275E-10	7.871E-10	4.042E-10	4.042E-10
6	4.086E-10	9.649E-10	3.838E-10	3.838E-10
7	5.085E-10	4.603E-10	4.603E-10	4.603E-10
8	3.044E-10	9.548E-10	2.830E-10	2.829E-10
9	5.452E-10	7.937E-10	4.213E-10	4.213E-10
10	3.320E-10	1.764E-10	1.764E-10	1.764E-10
11	5.351E-10	5.574E-12	5.574E-12	5.574E-12
12	1.215E-10	5.749E-10	6.800E-11	6.800E-11
13	3.190E-10	4.495E-10	1.396E-10	1.396E-10
14	1.305E-10	6.290E-10	7.991E-11	7.991E-11
15	1.833E-10	5.237E-10	9.346E-11	9.345E-11
16	1.717E-10	8.889E-10	1.486E-10	1.486E-10
17	2.606E-10	1.032E-11	1.032E-11	1.032E-11
18	3.259E-11	6.244E-10	1.981E-11	1.981E-11
19	1.924E-10	8.524E-10	1.597E-10	1.597E-10
20	2.853E-10	7.522E-10	2.089E-10	2.089E-10
21	4.886E-10	2.134E-10	2.134E-10	2.134E-10
22	2.248E-10	3.043E-10	6.660E-11	6.660E-11
23	2.082E-10	6.378E-10	1.293E-10	1.293E-10
24	3.950E-11	8.538E-10	3.283E-11	3.283E-11
25	4.442E-10	4.511E-11	4.511E-11	4.511E-11
26	1.143E-10	7.013E-10	7.804E-11	7.804E-11
27	2.332E-10	6.518E-10	1.480E-10	1.480E-10
28	4.361E-10	6.953E-10	2.952E-10	2.952E-10
29	4.324E-11	7.338E-10	3.089E-11	3.089E-11
30	3.814E-10	1.294E-10	1.294E-10	1.294E-10
31	9.191E-11	4.245E-10	3.798E-11	3.798E-11
32	2.648E-10	1.980E-10	1.980E-10	1.980E-10
33	4.720E-10	2.652E-10	2.652E-10	2.652E-10
34	4.038E-10	4.806E-10	1.889E-10	1.889E-10
35	2.497E-10	1.012E-09	2.460E-10	2.460E-10
36	1.507E-10	6.626E-10	9.721E-11	9.721E-11
37	4.595E-10	3.513E-10	3.513E-10	3.513E-10
38	3.887E-10	5.004E-10	1.894E-10	1.894E-10
39	3.592E-10	9.742E-10	3.407E-10	3.407E-10
40	3.539E-10	2.486E-10	2.486E-10	2.486E-10
41	4.200E-10	1.010E-10	1.010E-10	1.010E-10

42	1.611E-10	8.643E-10	1.356E-10	1.356E-10
43	4.470E-10	9.822E-10	4.274E-10	4.274E-10
44	5.175E-10	9.931E-10	5.003E-10	5.003E-10
45	8.357E-11	3.108E-10	2.529E-11	2.529E-11
46	2.521E-10	6.831E-10	1.677E-10	1.676E-10
47	1.027E-10	3.940E-10	3.939E-11	3.939E-11
48	2.285E-10	3.723E-10	8.282E-11	8.282E-11
49	3.250E-10	1.735E-10	1.735E-10	1.735E-10
50	5.025E-10	3.628E-10	3.628E-10	3.628E-10
51	2.718E-10	9.993E-10	2.644E-10	2.644E-10
52	5.368E-10	1.380E-10	1.380E-10	1.380E-10
53	3.494E-10	5.884E-10	2.001E-10	2.001E-10
54	2.902E-10	5.489E-10	1.551E-10	1.551E-10
55	4.835E-10	2.779E-10	2.779E-10	2.779E-10
56	5.058E-11	8.385E-10	4.129E-11	4.129E-11
57	4.563E-10	7.754E-10	3.445E-10	3.444E-10
58	3.086E-10	5.417E-10	1.627E-10	1.627E-10
59	4.218E-10	1.097E-10	1.097E-10	1.097E-10
60	5.232E-10	7.400E-10	3.769E-10	3.769E-10
61	1.067E-10	5.755E-10	5.978E-11	5.978E-11
62	3.634E-10	6.134E-10	2.170E-10	2.170E-10
63	1.409E-10	8.140E-10	1.117E-10	1.117E-10
64	6.744E-11	4.164E-10	2.734E-11	2.734E-11
65	5.117E-10	2.362E-11	2.362E-11	2.362E-11
66	9.678E-11	4.838E-10	4.558E-11	4.558E-11
67	1.952E-10	9.249E-10	1.758E-10	1.758E-10
68	2.828E-10	6.035E-11	6.035E-11	6.035E-11
69	3.945E-10	8.815E-10	3.386E-10	3.385E-10
70	1.636E-10	1.862E-10	2.966E-11	2.966E-11
71	5.503E-10	9.219E-10	4.939E-10	4.939E-10
72	2.421E-10	2.177E-10	2.177E-10	2.177E-10
73	4.759E-10	3.455E-10	3.455E-10	3.455E-10
74	3.438E-10	6.009E-10	2.011E-10	2.011E-10
75	2.973E-10	1.563E-10	1.563E-10	1.563E-10
76	5.555E-10	1.024E-09	5.538E-10	5.538E-10
77	1.757E-10	2.672E-10	4.571E-11	4.570E-11
78	1.444E-10	6.379E-11	6.379E-11	6.379E-11
79	1.327E-10	9.124E-11	9.124E-11	9.124E-11
80	7.024E-11	7.611E-10	5.205E-11	5.204E-11
81	3.677E-10	5.104E-10	1.827E-10	1.827E-10

82	1.180E-10	8.947E-10	1.028E-10	1.028E-10
83	2.038E-10	7.849E-11	7.849E-11	7.849E-11
84	5.259E-11	6.730E-10	3.446E-11	3.446E-11
85	4.794E-10	2.433E-10	2.433E-10	2.433E-10
86	5.762E-11	3.288E-10	1.844E-11	1.844E-11
87	4.940E-10	7.164E-10	3.445E-10	3.445E-10
88	2.739E-10	4.093E-10	1.091E-10	1.091E-10
89	4.272E-10	4.368E-10	1.817E-10	1.817E-10
90	1.873E-10	1.148E-10	1.148E-10	1.148E-10
91	3.111E-10	8.042E-10	2.436E-10	2.436E-10
92	1.552E-10	8.290E-10	1.253E-10	1.253E-10
93	4.354E-10	2.292E-10	2.292E-10	2.292E-10
94	4.629E-10	3.874E-10	3.874E-10	3.874E-10
95	3.842E-10	5.618E-10	2.101E-10	2.101E-10
96	3.763E-10	3.229E-10	3.229E-10	3.229E-10
97	3.397E-10	5.294E-10	1.751E-10	1.751E-10
98	4.116E-10	9.420E-10	3.775E-10	3.775E-10
99	2.171E-10	1.445E-10	1.445E-10	1.445E-10
100	2.134E-10	4.645E-10	9.650E-11	9.650E-11

Acceptance Criteria

The acceptance criteria for the test is that an independent calculation of the conditioned value for WAS_AREA:GRATMICH match with the reported precision the value computed by LHS_EDIT.

Evaluation

The Test Values matched the values computed by LHS_EDIT in every case where WAS_AREA:GRATMICH exceeded WAS_AREA:GRATMICI.

1.5. Source Code

The source code for LHS_EDIT Version 1.0 can be found in the file LHS_EDIT.FOR in the SCMS library PACMS2:[CMS_AP132.AP132_LHS] (LIBAP132_LHS) in the LHS_EDIT_V1.0 class. The executable LHS_EDIT.EXE is found in the same library and class. The source code is reproduced below.

```
      Program LHSedit
!.....Purpose: Edit a LHS output file by restricting the value in column col2
to
!              to never exceed the value in col1
!     Author: Tom Kirchner
!     Version: 1.0

!.....Edit a LHS output file by restricting the value in column col2 to
!     never exceed the value in col1
      Character*160 line
      Double precision a,b    !Endpoints of the first (rightmost)
distribution
      Double precision c,d    !Endpoints of the second (leftmost)
distribution
      Integer col1, col2      !The primary and conditional variables
      Double precision current(100,75)
      Character*160 spacer(4,7)
      Common/NewData/current,spacer

!.....Load the data into value()
      Call ReadFloats(current,spacer)

!.....Open the "control" file
      OPEN(2,file='LHS_CONTROL')
      Open(3,FILE="check.txt")
    5 Read(2,'(i2,1x,i2)',END=50) col1, col2
!.........Read the distribution definition section
          Call ReadDistInfo(col1, a, b, col2, c, d)
          write(*,*) "Column 1: ", col1," Range: ",a,b
          write(*,*) "Column 2: ", col2," Range: ",c,d
          write(*,'(a,i2,2a,i2)') " Data in column ",col2," to be ",
     &             "conditioned on column ",col1

!.........Now mofify the file
          Call MakeConditional(col1,col2,a,b,c,d)
      GoTo 5
   50 Close(2)
      Close(3)

!.....Now write the new file
      Call WriteFile

      Stop
  100 Format(a160)
  110 Format(a160)
      End

      Subroutine ReadFloats(fpvalue,spacer)
!.....Read the sampled values into the fpvalue array, preserving the
!     headers between "pages" in the spacer array
      Double precision fpvalue(100,75)
      Character*160 spacer(4,7)
      Character*160 line
      Integer LineNum
```

```
      Open(1,FILE='LHS2_TRN',ERR=75)
      Do While (.not.eof(1))
          Read(1,210) line
        If (line(1:14).eq." RUN NO.  X(1)") then
              Do k=1,7
                  Do i=1,100
                    Read(1,200) LineNum,(fpvalue(i,(k-1)*10+j),j=1,10)
                End Do
                Do i=1,4
                    Read(1,210) spacer(i,k)
                End Do
               End Do

              Do i=1,100
                Read(1,200) LineNum,(fpvalue(i,70+j),j=1,5)
              End Do
              Close(1)
              Return
           End If
      End Do
      Close (1)
      Return
   75 Write(*,*) "Error opening file"
  200 Format(3x,i3,10(1x,f10.3))
  210 Format(a160)
      End

      Subroutine MakeConditional(col1,col2,a,b,c,d)
!.....Modify values in column col2
!     by 1) reading values from columns col1 and col2 of LHS2_TRN
!        2) rescaling the value in col2 so that it is alway greater than
!           that in col1
!     A new file is written which leaves all the data in LHS2_TRN above and
!     below the sampled values unchanged.
      Integer col1, col2
      Character*160 line
      Double precision current(100,75)
      Character*160 spacer(4,7)
      Common/NewData/current,spacer
      Double precision Rescale, v, a, b, c, d, upper

!..... Now replace the data
        Write(3,*) "Column 1, Column 2, Conditioned Column 2"
      Do i=1,100
          v=Rescale(i,current,col1,col2, a,b,c,d)
          Write(3,*) current(i,col1),",",current(i,col2),',',v
          current(i,col2)=v
      End Do
      Return
      End

      Subroutine WriteFile
!.......Write out the file with the modify values
```

```
!     A new file is written which leaves all the data in LHS2_TRN above and
!     below the sampled values unchanged.
      character*160 line
      Double precision current(100,75)
      character*160 spacer(4,7)
      Common/NewData/current,spacer
      Character*3 fmt

      fmt="0  "

      Open(1,FILE='LHS2_TRN')
      Open(2,FILE='LHS_EDIT_OUT',recl=160)
        Write(2,'(a)') "1"
      Do While (.not.eof(1))
          Read(1,410) line
          If (line(1:14).eq." RUN NO.  X(1)") then
              Write(2,'(a)') trim(line)
!           and write the new values out
            Do k=1,7
                Do i=1,100
                    Write(2,400)fmt,i,(current(i,(k-1)*10+j),
     &                          j=1,10)
                End Do
                Do i=1,4
                      Write(2,'(a)') trim(spacer(i,k))
                End Do
            End Do
            Do i=1,100
                Write(2,400) fmt,i,(current(i,70+j),j=1,5)
            End Do

          Else
              Write(2,'(a)') trim(line)
          End If
      End Do
      Return
  400   Format(a3,i3,10(1x,1pE10.3))
  410   Format(a160)
      End

      Double Precision Function Rescale(i,current,col1, col2, a, b, c, d)
!.....Adjust col2 so that it never exceeds col1
!     The distribution of col2 ranges from [c-d]
!     The distribution of col1 ranges from [a-b]
      Double precision current(100,75), a, b, c, d, upper
      Integer i, col1, col2
      Double precision v

      v=current(i,col2)
      If (current(i,col2).GT.current(i,col1)) then
          upper=current(i,col1)
          v=(current(i,col2)-c)/(d-c)*(upper-c)+c
      End If
```

```
      Rescale = v

      Return
      End

      Subroutine ReadDistInfo(col1, a, b, col2, c, d)
!.....Read the distribution information and save the range limits
!     for the uniform distribution for the col1 variable
      Integer col2, col1
      Integer VarNum
      Double Precision a, b, c, d
      Character*160 line
!     Open the file
      Open(1,FILE='LHS2_TRN')
!     Skip the first page of the header
      Do While (line(1:26).ne."    VARIABLE  DISTRIBUTION")
          Read(1,800) line
      End Do
!.....Now process the definitions
      Do While (line(1:1).ne."1")         !marks the end of the data
        Read(1,800) line
        If (line(11:21).eq."    UNIFORM") Then
!             Get the variable number
              Read(line,'(7x,i2)') VarNum
            If (VarNum.eq.col2) Then
!             Get the minimum and maximum
                  Read(line,'(33x,e10.4)') c
                  Read(line,'(49x,e10.4)') d
            Else if (VarNum.eq.col1) Then
!             Get the minimum and maximum
                  Read(line,'(33x,e10.4)') a
                  Read(line,'(49x,e10.4)') b
            End if
        End If
      End Do
      Close (1)
      return
  800 Format(a160)
      End
```