SANDIA NATIONAL LABORATORIES
WASTE ISOLATION PILOT PLANT

ANALYSIS REPORT FOR PARAMETER SAMPLING IN THE 2026 COMPLIANCE RECERTIFICATION APPLICATION PERFORMANCE ASSESSMENT

REVISION 0

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Executive Summary

The Waste Isolation Pilot Plant (WIPP) was initially certified as a repository consisting of 10 panels, which were excavated for the long-term storage and placement of transuranic waste (U.S. EPA 1998). However, due to operational constraints, the entire volume of the 10 panels is no longer available for waste disposal. In March 2024, the U.S. Department of Energy (DOE) submitted the Replacement Panels Planned Change Request (RPPCR) to the U.S. Environmental Protection Agency (EPA) for approval of waste emplacement in two new panels. These panels, referred to as replacement panels, are located to the west of the existing operations area. The EPA approved the RPPCR in July 2025.

The addition of the two replacement panels is not expected to provide adequate space for the disposal of the allowable waste volume designated for WIPP under the Land Withdrawal Act (LWA); thus, the 12-panel configuration is regarded as an interim state of the repository. The DOE may pursue approval for waste disposal in seven additional panels to accommodate the full allowable volume of waste. This hypothetical 19-panel configuration is considered the anticipated final state of the repository.

The DOE demonstrates compliance with containment requirements as outlined in the Certification Criteria of Title 40 CFR Part 191.13 through performance assessment (PA). PA calculations estimate the probability and consequences of potential radionuclide releases from the repository to the accessible environment over a regulatory period of 10,000 years following facility closure. WIPP PA models are utilized to support the periodic recertification of WIPP.

The 2026 Compliance Recertification Application (CRA-2026) represents the fifth recertification application submitted to the EPA. A PA has been carried out by Sandia National Laboratories to support the DOE's submission of the CRA-2026. The results presented in the CRA-2026 PA are compared to those from the RPPCR PA, the most recent regulatory submission.

This analysis report documents the parameter sampling component of the CRA-2026 PA for both the interim and final state repository realizations. The resulting sampled data had the expected correlation structure, and the values fell within the expected ranges. The distributions of sampled values matched the expected cumulative distribution functions (CDFs).

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1.0 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 disposal of transuranic (TRU) waste. The containment of TRU waste at WIPP is regulated by the U.S. Environmental Protection Agency (EPA) under Title 40 of the Code of Federal Regulations (CFR), Part 191.

The DOE demonstrates compliance with the containment requirements of 40 CFR 191.13 by means of performance assessment (PA) as described in the Certification Criteria of Title 40 CFR Part 194. Sandia National Laboratories (SNL) conducts PAs at the request of the DOE. The PA calculations estimate the probability and consequences of potential radionuclide releases from the repository to the accessible environment over a regulatory period of 10,000 years following facility closure. The PA models are continuously maintained and updated with new information, which typically leads to refinements and modifications in both the models and their parameters. Additionally, planned changes to the repository and its components necessitate updates to the WIPP PA models.

All previous WIPP certifications have been based on a repository consisting of 10 panels. In March 2024, the DOE submitted the Replacement Panels Planned Change Request (RPPCR) to seek EPA approval for waste emplacement in two new panels, referred to as replacement panels, located to the west of the existing operations area (Bollinger 2024). The EPA approved the RPPCR in July 2025 (U.S. EPA 2025).

The addition of the two replacement panels is not expected to provide sufficient space for the disposal of the allowable waste volume designated for WIPP under the Land Withdrawal Act (LWA). The 12-panel configuration is thus regarded as an interim state of the repository. The DOE may seek approval for waste disposal in up to seven additional panels to accommodate the full allowable volume of waste. This 19-panel configuration is considered the anticipated final state of the repository.

The CRA-2026 is the fifth recertification application for the WIPP submitted by the DOE for EPA approval. The PA executed by SNL in support of the CRA-2026 PA is described in AP-214 (Hansen et al. 2025). This analysis report documents the parameter sampling component of the CRA-2026 PA for both the interim and final state repository realizations.

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2.0 CHANGES SINCE THE RPPCR

Several changes are incorporated in the CRA-2026 PA relative to the RPPCR that may impact the parameter sampling results. These changes include:

- Solubility uncertainty distributions.
- MgO hydration parameters.
- Revisions to the porosity-permeability parameter distribution.

Changes listed above are discussed in more detail in the sections that follow.

2.1 Solubility Uncertainty Distributions

Actinide solubility uncertainty distributions, which are independent of the repository inventory, are updated for CRA-2026, as documented in Domski (2025). A literature review was conducted to identify relevant studies published prior to the CRA-2026 cutoff date. Based on this review, the uncertainty distribution for +III actinide solubilities (SOLMOD3:SOLVAR) is updated. No new literature was found for +IV actinide solubilities; therefore, no update to the +IV solubility uncertainty distribution is made.

2.2 MgO Hydration Parameters

The rate of hydration of MgO to form brucite, $Mg(OH)_2$, in the Salado flow model is specified for humid (WAS_AREA:BRUCITEH), Castile brine inundated (WAS_AREA:BRUCITEC), and Salado brine inundated (WAS_AREA:BRUCITES) conditions. Although changes to the MgO hydration rate parameters were not anticipated in AP-214 (Hansen et al. 2025), Nemer (2025) recommends new parameter distributions for the Castile and Salado brine inundated conditions. King (2025) redefines the recommended distributions to be compatible with the WIPP PA code LHS.

2.3 Porosity-Permeability Parameter Distribution

King (2025) redefines the distribution for the parameter representing the relationship between porosity and permeability in a run-of-mine salt panel closure system during the secondary time duration (PCS_T2:POR2PERM). Initially defined as a truncated normal distribution, this parameter is revised, along with the MgO hydration parameters (Section 2.2), to a cumulative distribution characterized by discrete data points. This change constitutes a deviation from AP-214 (Hansen et al. 2025).

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3.0 CONCEPTUAL APPROACH FOR THE CRA-2026

No changes have been made to the conceptualization of parameter sampling since the RPPCR PA. Under the standard approach, a determination is first made as to which parameters are epistemically uncertain and parameter distributions are defined for those parameters and entered into the WIPP PA Parameter Database (ParamDB) (Feng and Kicker 2025). Uncertain parameters are sampled from these defined distributions using a Latin Hypercube Sampling (LHS) design. Care is taken to ensure that distributions that have not changed since the RPPCR are sampled identically as was done for RPPCR calculations. Distributions that have changed are sampled in the same rank order as the sampling in the RPPCR. To maintain random sampling with previous WIPP PA calculations executed on the Solaris cluster, a list of random numbers (previously generated on the Solaris cluster) is used rather than use a random number seed. As a result, the random numbers used in the CRA-2026 were identical to those used in the RPPCR and identical parameter values were generated for the 60 parameters that had no change. Three sets ("replicates") of 100 samples each are assembled for use in PA calculations performed by various PA codes. The LHS code is used to perform the sampling and populate database tables from which sampled values may be accessed.

The CRA-2026 includes two PA calculations, one for the interim state repository and one for the expected final state repository. The interim state repository calculation is named CRA26_IS, while the final state repository calculation is named CRA26_FS. All epistemically uncertain parameters are the same for the interim state and the final state realizations. As a result, the parameter sampling is identical for the CRA26_IS and CRA26_FS calculations. This report will focus on the results for the CRA26_IS parameter sampling, but all results and conclusions hold true for the CRA26_FS calculation as well.

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4.0 PARAMETER SAMPLING METHODOLOGY

The LHS code is used to sample the distributions of parameters having epistemic uncertainty using a Latin Hypercube sampling design (WIPP PA 2021a). Epistemic uncertainty represents lack of knowledge about parameters that are considered constants and hence represents a distribution of confidence rather than of variability. Sampled parameters are written to the WIPP PA Results Database (PA_Results) for use by other WIPP PA codes.

However, the LHS code is also used to sample variables that represent model uncertainty rather than parameter uncertainty. The S_MB139:RELPMOD parameter is used to select one of two relative permeability models for use in anhydrite. The WAS_AREA:PROBDEG parameter is the probability of biodegradation of plastics and rubber and 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.

The PRELHS code is run prior to the LHS code and is used to obtain from ParamDB the data describing the distributions and to create an input file for the LHS code based on that data. PRELHS v2.46 was used in CRA-2026 calculations. A user-created input file for PRELHS 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.

The LHS code can reorder sampled data to induce or restrict correlations among the parameters based on specified correlation relationships. The LHS code generates a correlation matrix that can be used to help identify correlations among sampled parameters. Additionally, other conditional relationships may be user-specified. These conditional relationships restrict the value for one parameter to be less than or equal to the sampled value of another parameter. For the CRA-2026 PA calculations, conditional relationships were enforced using the LHS code in the same way as in the RPPCR.

This report documents the use of PRELHS v.2.46 and LHS v.3.00 to provide three sets of sampled data for use in the CRA-2026 (Hansen et al. 2025). These three sets represent three replicates of one hundred samples for each of 75 variables. Sixty-four of these variables are associated with model parameters (Table 1). However, there are also 11 "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. The ability to regenerate values previously sampled (e.g., for the CRA-2019 PA calculations) was ensured by maintaining identical values of random numbers used between the Solaris cluster (used for CRA-2019) and the Linux cluster (used for RPPCR and CRA-2026). This approach enables comparison of RPPCR and CRA-2026 results on a vector-by-vector basis.

4.1 Parameters Sampled for the CRA-2026

The 64 parameters sampled for the CRA-2026 are listed in Table 1; these are the same 64 parameters sampled in the RPPCR.

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Table 1. Parameters Sampled by LHS for the CRA-2026

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
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:GDEPFAC	Information that applies globally, energy deposition probability for wetted solid radionuclides
GLOBAL:OXSTAT	Information that applies globally, index for the oxidation state
GLOBAL:PBRINE	Information that applies globally, probability that drilling intrusion in excavated area encounters pressurized brine
GLOBAL:TRANSIDX	Information that applies globally, index for selecting realizations of the transmissivity field

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Parameter	Description
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
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

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Parameter	Description
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
STEEL:HUMCORR	Generic steel in waste, humid corrosion rate for steel
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 VI, 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[1]
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[2]
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

[1] ERDA-6 (Energy Research and Development Administration Well #6) is used to simulate brine from the Castile formation.

[2] GWB (Generic Weep Brine) is used to simulate brine from the Salado formation.

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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

4.2 Correlation Assignments

As was done for the RPPCR, correlations between variables are assigned in two cases. First a correlation of -0.99 is assigned between the S_HALITE:PRMX_LOG and S_HALITE:COMP_RCK parameters. Also, a correlation of -0.75 is assigned between the CASTILER:PRMX_LOG and CASTILER:COMP_RCK parameters. Rank correlations are calculated for each possible pair of variables and are written to the PA_Results; significant correlations are reported in Section 5.2.

4.3 Conditional Relationship Assignments

The LHS code is used to enforce a conditional relationship between three pairs of variables. The relationships are WAS_AREA:GRATMICH ≤ WAS_AREA:GRATMICI (Clayton 2008, Nemer and Stein 2005) and PCS_T3: POROSITY ≤ PCS_T2: POROSITY ≤ PCS_T1:POROSITY (Camphouse 2013).

For each pair of variables, the sampled value of the "restricted" variable (i.e., the parameter to the left of the ≤ symbol) is rescaled to the new, conditioned value using the equation:

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

Where v_i' is the conditioned value of the restricted parameter, v_i is the sampled value of the restricted variable, x_i is the sampled value of the "controlling" variable (i.e., the parameter to the right of the ≤ symbol), and $U_{V,lower}$ and $U_{V,upper}$ are the bounds of the distribution assigned to the restricted variable (WIPP PA 2021b). Note that this equation is only applied if the sampled value of the restricted variable is greater than the sampled value of the controlling variable.

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 the conditional relationship changes the range of the restricted variable. If instead of limiting the value of the restricted variable, an equivalent correlation had been specified between the variables in the input file to LHS, then LHS would have generated values for the restricted variable with a range that would still have overlapped the range of the controlling variable. This

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would result in the possibility of a sampled restricted variable value exceeding the sampled controlling variable value, so it is not a viable option here.

4.3.1 MgO Hydration Rates

Humid MgO hydration rates are given by the WAS_AREA:BRUCITEH parameter. Inundated hydration rates are defined by the WAS_AREA:BRUCITEC and WAS_AREA:BRUCITES parameters (BRUCITEC when Castile brine is assumed and BRUCITES when Salado brine is assumed). For a given BRAGFLO calculation, only one of the WAS_AREA:BRUCITEC and WAS_AREA:BRUCITES parameters is used. Support for the conditional relationship between the humid and inundated rates for biodegradation of cellulose (i.e., that the humid rate should not be expected to exceed the inundated rate or WAS_AREA:GRATMICH ≤ WAS_AREA:GRATMICI (Clayton 2008, Nemer and Stein 2005)) could potentially be extended to the humid and inundated rates for hydration of MgO (i.e., WAS_AREA:BRUCITEH ≤ WAS_AREA:BRUCITEC and WAS_AREA:BRUCITEH ≤ WAS_AREA:BRUCITES). Because there is no overlap between the BRUCITEH parameter distribution and the BRUCITEC parameter distributions, there is zero probability that a BRUCITEH sampled value could exceed a sampled BRUCITEC value (Table 2). However, there is an overlap between the BRUCITEH parameter distribution and the BRUCITES parameter distribution. The algorithm used to control conditional relationships in the LHS code (Equation 1) is only applicable to uniform distributions of the restricted value and the distribution defined for the WAS_AREA:BRUCITES distribution is a cumulative distribution approximating a truncated normal distribution. Therefore, a conditional relationship between WAS_AREA:BRUCITES and WAS_AREA:BRUCITEH was not enforced.

Table 2. MgO Hydration Rate Distribution Limits

Material:Property	Minimum (mol kg^{-1} sec^{-1})	Maximum (mol kg^{-1} sec^{-1})
WAS_AREA:BRUCITEH	1.81E-8	2.19E-8
WAS_AREA:BRUCITEC	7.6E-8	8.8E-8
WAS_AREA:BRUCITES	0.0	2.9E-7

Due to the small overlap between the distributions for BRUCITES and BRUCITEH, the humid MgO hydration rate exceeds the Salado brine inundated rate in one case out of 100 samples for each of the 3 replicates. Figure 1 shows the distributions and replicate 1 samples for BRUCITES and BRUCITEH; replicate 2 and replicate 3 samples are similar (see Figure 77 and Figure 78 in Appendix A). The three vectors where the humid MgO hydration rate is sampled larger than the Salado brine inundated rate are listed in Table 3.

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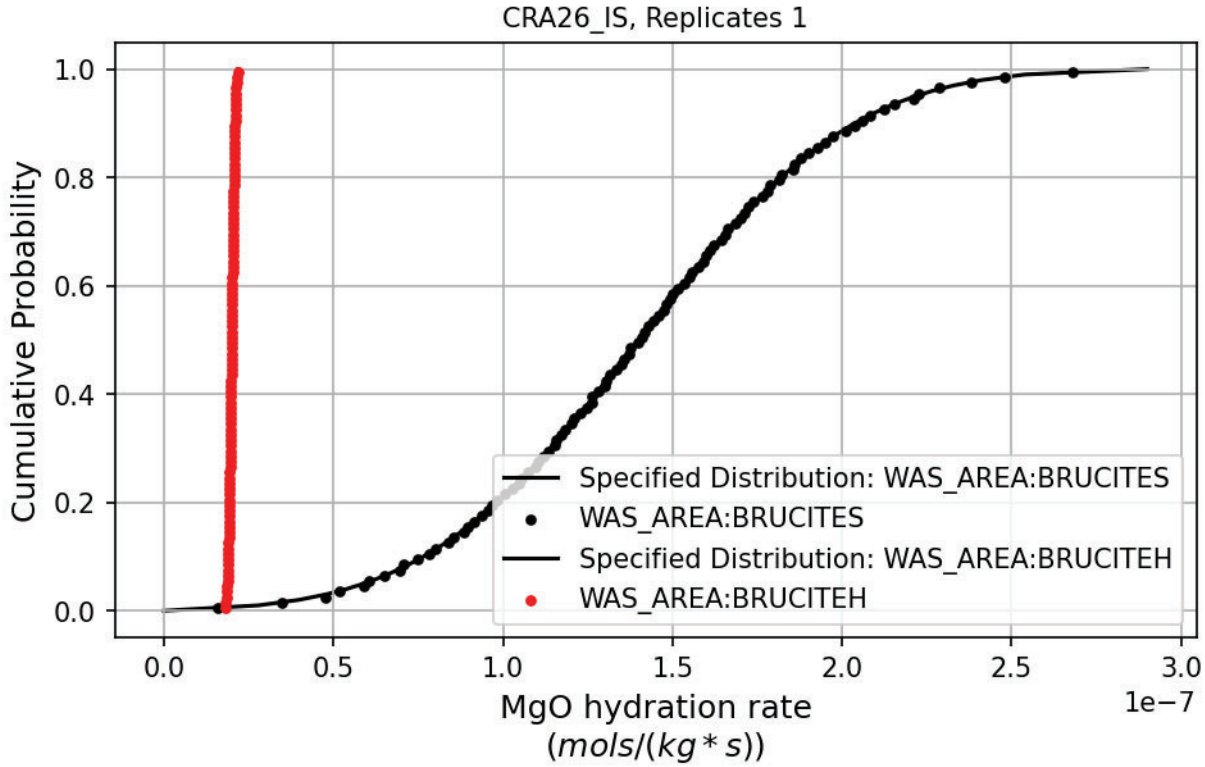

Figure 1. Comparison of WAS_AREA:BRUCITES and WAS_AREA:BRUCITEH Distributions for the CRA26_IS

Table 3. Vectors in CRA26_IS where BRUCITES < BRUCITEH

Replicate	Vector	WAS_AREA:BRUCITES (mol kg^{-1} sec^{-1})	WAS_AREA:BRUCITEH (mol kg^{-1} sec^{-1})
1	061	1.603E-08	1.939E-08
2	068	5.424E-09	2.074E-08
3	031	1.850E-09	2.025E-08

4.3.2 Steel Corrosion Rate

Humid steel corrosion rates are given by the STEEL:HUMCORR parameter. Inundated steel corrosion rates are defined by the STEEL:CORRMCO2 parameter. Support for the conditional relationship between the humid and inundated rates for biodegradation of cellulose (i.e., that the humid rate should not be expected to exceed the inundated rate or WAS_AREA:GRATMICH ≤ WAS_AREA:GRATMICI (Clayton 2008, Nemer and Stein 2005)) could potentially be extended to the humid and inundated rates for corrosion of steel (i.e.,

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STEEL:HUMCORR ≤ STEEL:CORRMCO2). However, the algorithm used to control conditional relationships in the LHS code (Equation 1) is only applicable to uniform distributions of the restricted value and the distributions defined for STEEL:HUMCORR and STEEL:CORRMCO2 are both cumulative distributions. Therefore, a conditional relationship between STEEL:HUMCORR and STEEL:CORRMCO2 was not enforced in CRA-2026 calculations (the same as for the RPPCR PA calculations).

However, there is only a small overlap in the defined distributions for the two rates and thus only a small probability of the humid rate exceeding the inundated rate (Figure 2). As a result, the humid steel corrosion exceeds the inundated rate in only one case out of the 300 sampled pairs (replicate 3, Vector 42)—in that case, the humid rate is 4.51E-16 m/s and the inundated rate is 1.39E-16 m/s. Because a conditional relationship was not enforced, the humid rate of steel corrosion for this sample is higher than it would have been had a conditional relationship been enforced.

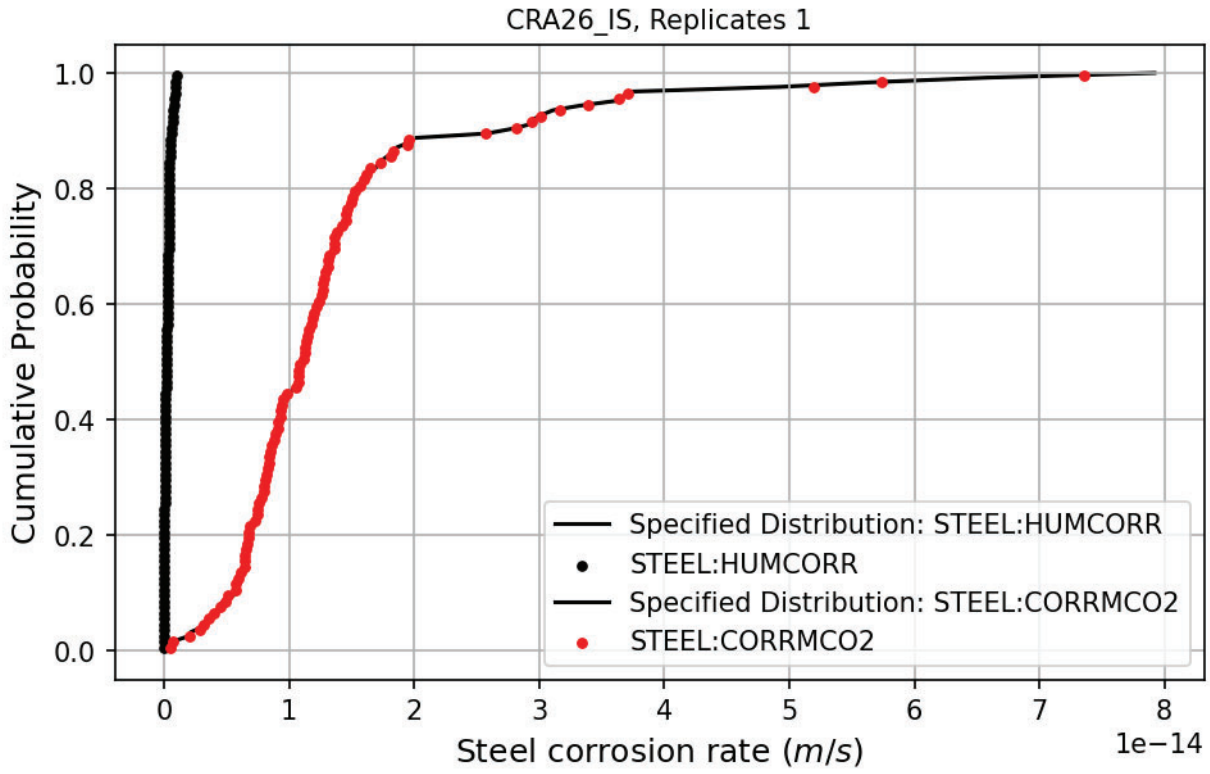

Figure 2. Comparison of STEEL:HUMCORR and STEEL:CORRMCO2 Distributions for the CRA26_IS

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5.0 RESULTS

Results of parameter sampling are presented in this section for all 64 uncertain parameters. Four parameters have updated distributions since the RPPCR PA: SOLMOD3:SOLVAR, WAS_AREA:BRUCITEC, WAS_AREA:BRUCITES, and PCS_T2:POR2PERM.

In this section, sampled distributions are compared to the expected distributions. CDFs 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 ith ordered value (i.e., the midpoint of the interval containing the value based on order statistics) (note, i varies from 1-100 for each replicate). With the exception of the variables modified based on assigned conditional relationships (Section 4.3), 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.

5.1 Parameters with Updated Sampled Values Since the RPPCR PA

Parameter distributions for four parameters have changed since the RPPCR. Parameter distributions for the CRA26_IS analysis are compared with those from the RPPCR PA for these four parameters below. Parameter sampling for the RPPCR is documented in Zeitler (2023). Sampled parameter values for all parameters in CRA-2026 are tabulated in Feng and Kicker (2025).

5.1.1 SOLMOD3:SOLVAR

The distribution for the SOLMOD3:SOLVAR parameter has been changed for the CRA-2026 calculations (Section 2.1). The distribution was updated based on newly calculated solubility uncertainty multipliers (Domski 2025). Comparison of the replicate 1 sampled values for the CRA26_IS PA against the expected distribution is shown in Figure 3, along with the same comparison for the RPPCR PA.

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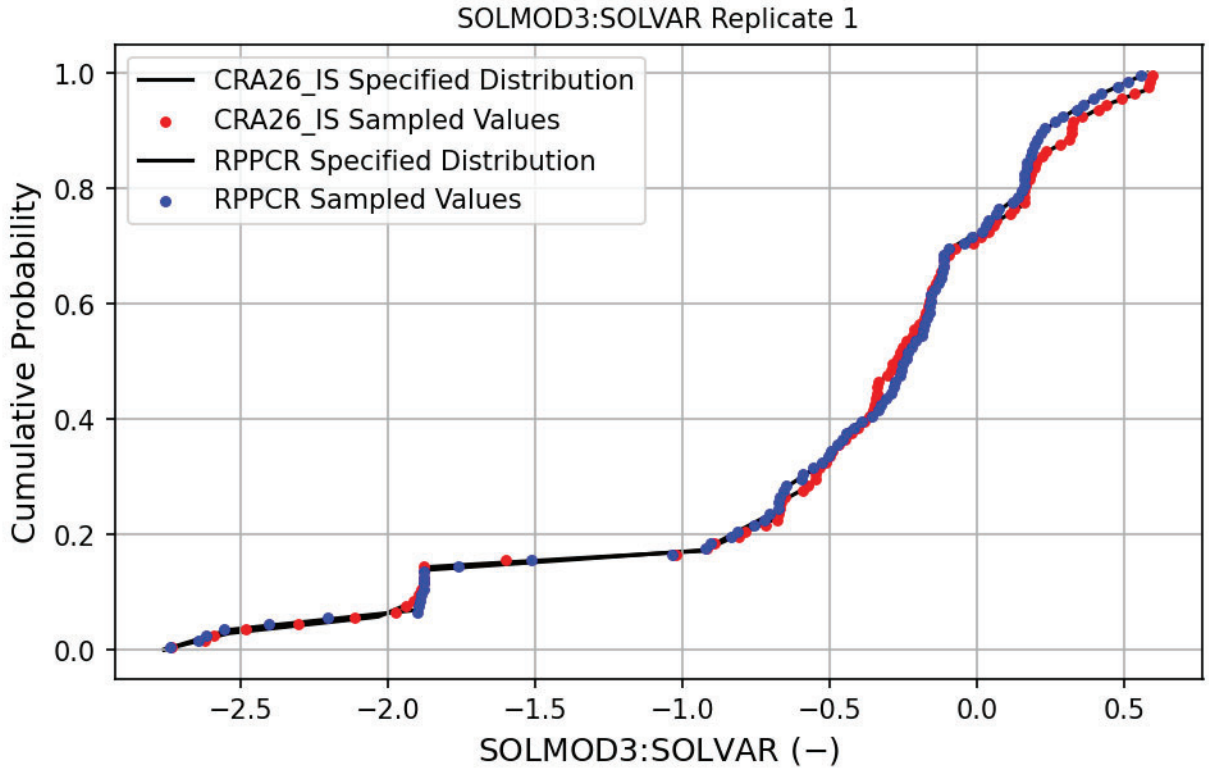

Figure 3. Observed and Expected CDFs for SOLMOD3:SOLVAR, Replicate 1 for the RPPCR and CRA26_IS Analyses

5.1.2 WAS_AREA:BRUCITEC

The distribution for the WAS_AREA:BRUCITEC parameter has been updated for the CRA-2026 calculations (Section 2.2). The WAS_AREA:BRUCITEC distribution in the RPPCR had a range of 4.76E-08 to 5.64E-08. This range increased in the CRA-2026 calculations to 7.6E-08 to 8.8E-08. Comparison of all sampled values for the CRA26_IS analysis against the expected distribution is shown in Figure 4, along with the same comparison for the RPPCR PA.

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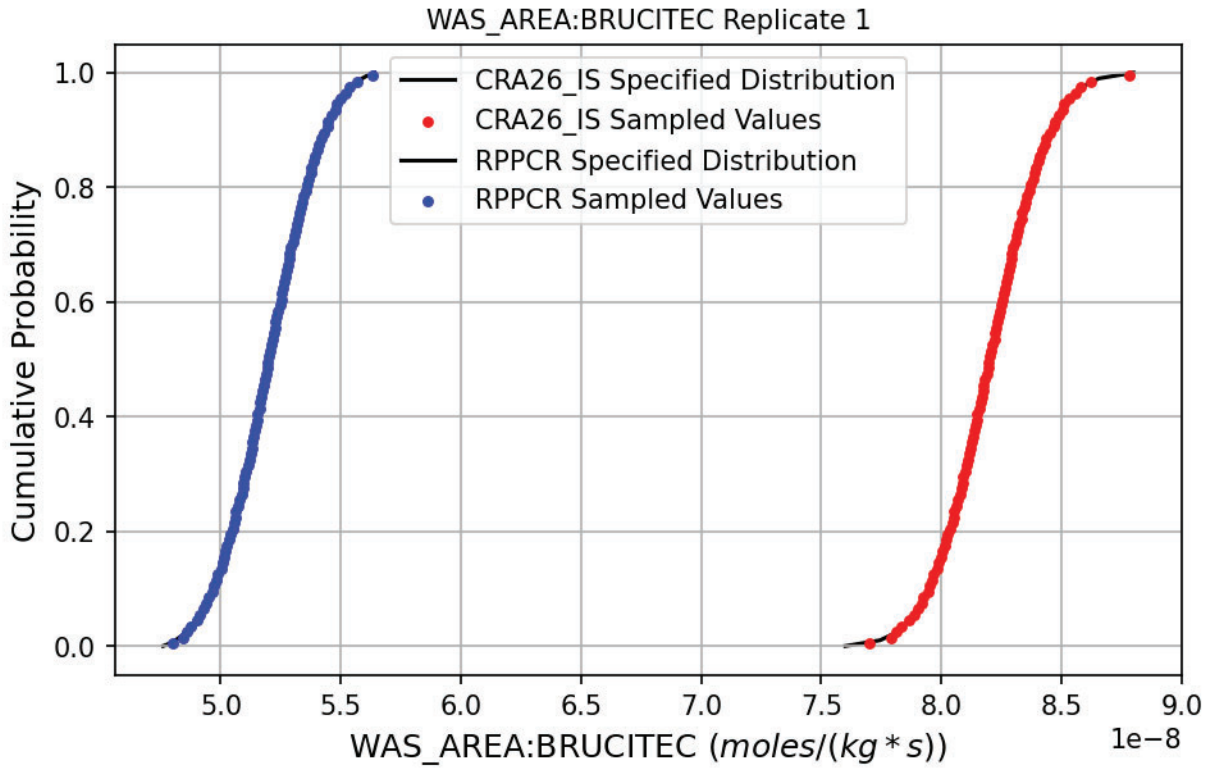

Figure 4. Observed and Expected CDFs for WAS_AREA:BRUCITEC, Replicate 1 for the RPPCR and CRA26_IS Analyses

5.1.3 WAS_AREA:BRUCITES

The distribution for the WAS_AREA:BRUCITES parameter has been updated for the CRA-2026 calculations (Section 2.2). The WAS_AREA:BRUCITES distribution in the RPPCR had a range of 4.27E-08 to 6.13E-08. This range changed in the CRA-2026 calculations to 0.0 to 2.9E-07. Comparison of all sampled values for the CRA26_IS analysis against the expected distribution is shown in Figure 5, along with the same comparison for the RPPCR PA.

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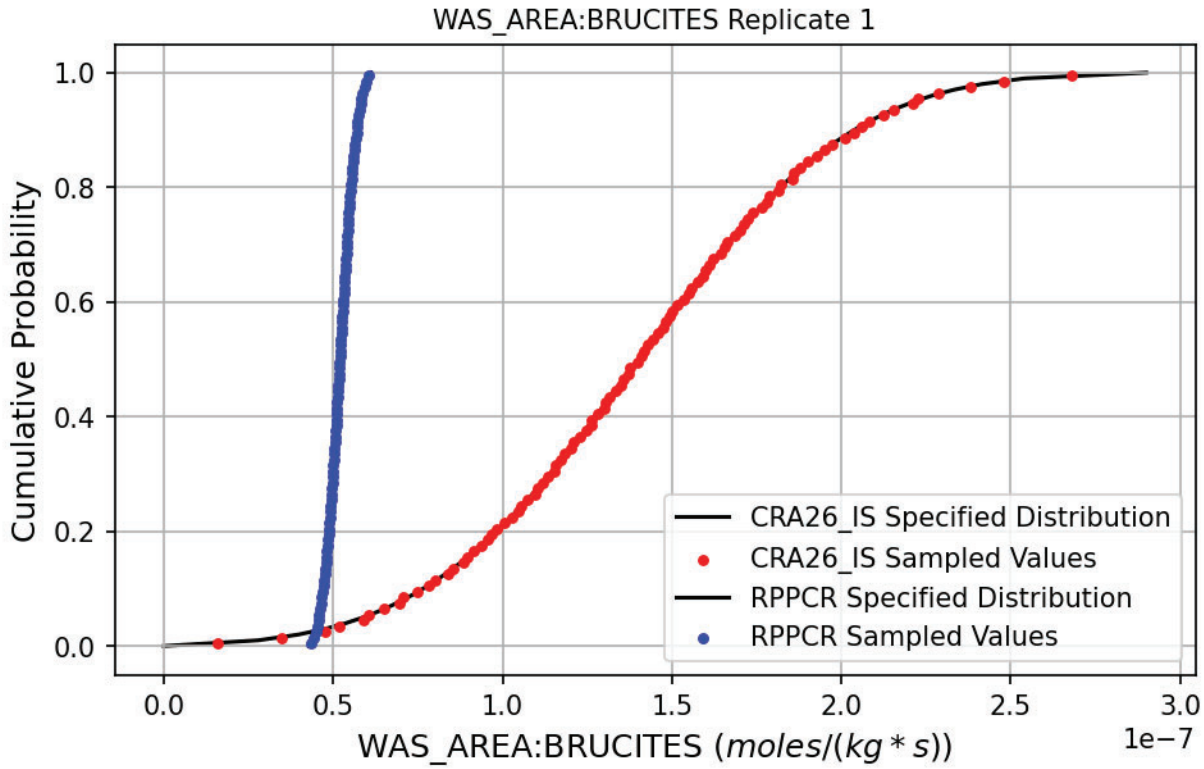

Figure 5. Observed and Expected CDFs for WAS_AREA:BRUCITES, Replicate 1 for the RPPCR and CRA26_IS Analyses

5.1.4 PCS_T2:POR2PERM

The definition for the PCS_T2:POR2PERM parameter distribution has been updated for the CRA-2026 calculations (Section 2.3). The range of the PCS_T2:POR2PERM parameter did not change however a cumulative distribution definition was used to align the sampled values with the originally derived normal distribution. Comparison of all sampled values for the CRA26_IS analysis against the expected distribution is shown in Figure 6, along with the same comparison for the RPPCR PA.

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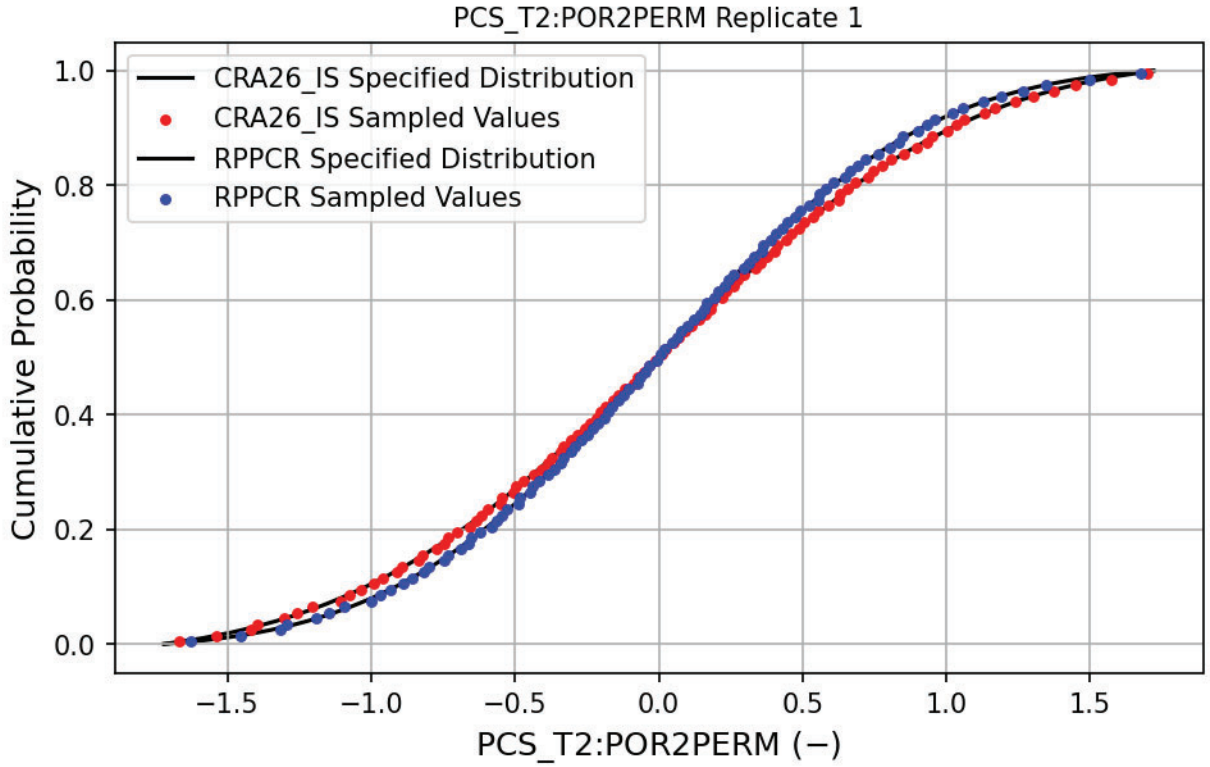

Figure 6. Observed and Expected CDFs for PCS_T2:POR2PERM, Replicate 1 for the RPPCR and CRA26_IS Analyses

5.2 Calculated Correlation Between Variables

Rank correlations between pairs of sampled variables (i.e., the strength of a linear association between the sampled values) are written directly to PA_Results and are also found in the LHS output file (e.g., lhs2_CRA26_IS_r1_con.trn) and the correlations output file (e.g., lhs2_CRA26_IS_r1_con.trn_CORR) for each replicate. The rank correlations in PA_Results were examined and those that exceeded specified test statistics are noted in Table 4.[1]

The rankings of sampled data for those variables for which a correlation relationship was assigned showed correlations that were close to those specified. Positive, significant correlations were also observed between the WAS_AREA:GRATMICH and WAS_AREA:GRATMICI parameters in all replicates, which is a result of the assigned conditional relationship (Section 4.3). No significant (at the $\alpha = 0.01$ significance level; α is the probability of a Type I error, or the probability of rejecting a null hypothesis when it is in fact true) 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 the

[1] A test statistic of 0.195 was used to determine the $\alpha = 0.05$ level of significance and a test statistic of 0.254 was used for the $\alpha = 0.01$ level of significance. These are the same values used by Kirchner (2013) and are appropriate for a sample size of 100.

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$\alpha = 0.05$ level. However, the WAS_AREA:PROBDEG parameter is a discrete user-specified distribution (delta distribution) having only 2 possible values (Figure 73). This restriction limits the ability of LHS to rearrange the sampled 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 (Kirchner 2013).

To evaluate the frequency with which high correlation coefficients would be expected in such variables, a test was conducted by Kirchner (2009), the results of which continue to be valid as no new correlations have been specified for the CRA-2026 calculations. In the test, 1000 LHS samples were generated and the correlation coefficients were tabulated. For this test, all correlations were specified to be zero. Out of the 1000 samples, "significant" correlations were generated in 502 cases at the $\alpha = 0.05$ level and 2 cases at the $\alpha = 0.01$ level. All of these correlations involved either the WAS_AREA:PROBDEG or S_MB139:RELP_MOD parameters, 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 4. Significant Correlations Between Parameters

Replicate	Parameter 1 (MAT:PROP)	Parameter 2 (MAT:PROP)	Exp. Corr.	Obs. Corr.	Sig[a]
1	CASTILER:COMP_RCK	CASTILER:PRMX_LOG	-0.75	-0.728	**
1	S_HALITE:COMP_RCK	S_HALITE:PRMX_LOG	-0.99	-0.987	**
1	WAS_AREA:GRATMICH	WAS_AREA:GRATMICI	0.00	0.735	**[b]
2	CASTILER:COMP_RCK	CASTILER:PRMX_LOG	-0.75	-0.724	**
2	CASTILER:PRESSURE	WAS_AREA:PROBDEG	0.00	-0.234	*[c]
2	S_HALITE:COMP_RCK	S_HALITE:PRMX_LOG	-0.99	-0.991	**
2	WAS_AREA:GRATMICH	WAS_AREA:GRATMICI	0.00	0.692	**[b]
3	CASTILER:COMP_RCK	CASTILER:PRMX_LOG	-0.75	-0.725	**
3	PCS_T3:POROSITY	PCS_T2:POROSITY	0.00	0.271	**[b]
3	S_HALITE:COMP_RCK	S_HALITE:PRMX_LOG	-0.99	-0.983	**
3	WAS_AREA:GRATMICH	WAS_AREA:GRATMICI	0.00	0.760	**[b]

[a] Significance level: *=Significant at p<0.05, **=Significant at p<0.01
[b] No correlation specified, but conditional relationship assigned (Section 4.3)
[c] This correlation is spurious

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5.3 Parameters with Conditional Relationships

As was done for the RPPCR PA, conditional relationships were imposed for three variables in the CRA-2026 PAs. The CDFs for the original sampled values and the conditioned values are shown in Figure 7, Figure 9, and Figure 11 for the WAS_AREA:GRATMICH, PCS_T2:POROSITY, and PCS_T3:POROSITY parameters, respectively. The correlations between variables involved in conditional relationships are shown in Table 5.

Table 5. Correlations Between Parameters With Conditional Relationships

Replicate	Restricted Parameter	Controlling Parameter	Observed Correlation
1	PCS_T2:POROSITY	PCS_T1:POROSITY	-0.051
1	PCS_T3:POROSITY	PCS_T2:POROSITY	0.123
1	WAS_AREA:GRATMICH	WAS_AREA:GRATMICI	0.735
2	PCS_T2:POROSITY	PCS_T1:POROSITY	-0.016
2	PCS_T3:POROSITY	PCS_T2:POROSITY	0.183
2	WAS_AREA:GRATMICH	WAS_AREA:GRATMICI	0.692
3	PCS_T2:POROSITY	PCS_T1:POROSITY	-0.014
3	PCS_T3:POROSITY	PCS_T2:POROSITY	0.271
3	WAS_AREA:GRATMICH	WAS_AREA:GRATMICI	0.760

5.3.1 WAS_AREA:GRATMICH

As was done for the RPPCR PA, the conditional relationship WAS_AREA:GRATMICH ≤ WAS_AREA:GRATMICI has been imposed for the CRA-2026 PAs, which ensures that the humid rate of cellulose degradation does not exceed the inundated rate by adjusting the sampled value of WAS_AREA:GRATMICH, if necessary. The values used in the CRA-2026 are input into PA_Results, while values sampled prior to conditioning are only available in the LHS output debug files (e.g., lhs2_CRA26_IS_r1_con.dbg for replicate 1). A comparison of the values for WAS_AREA:GRATMICH prior to conditioning with those used in the CRA26_IS for replicate 1 is shown in Figure 7. All values are identical to those for the RPPCR PA (not shown). The correlation between the two variables as a result of the applied conditional relationship is shown in Figure 8. Relatively strong correlations of 0.734, 0.692, and 0.760 were calculated for replicates 1, 2, and 3.

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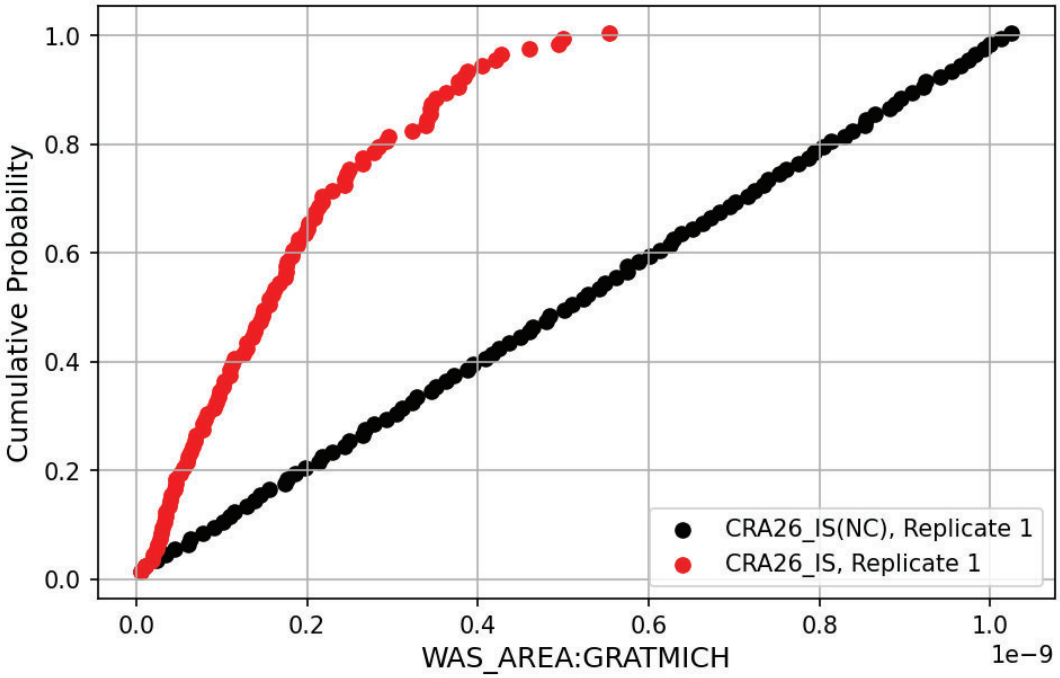

Figure 7. Conditioned and Non-Conditioned Sampled Values for WAS_AREA:GRATMICH, Replicate 1

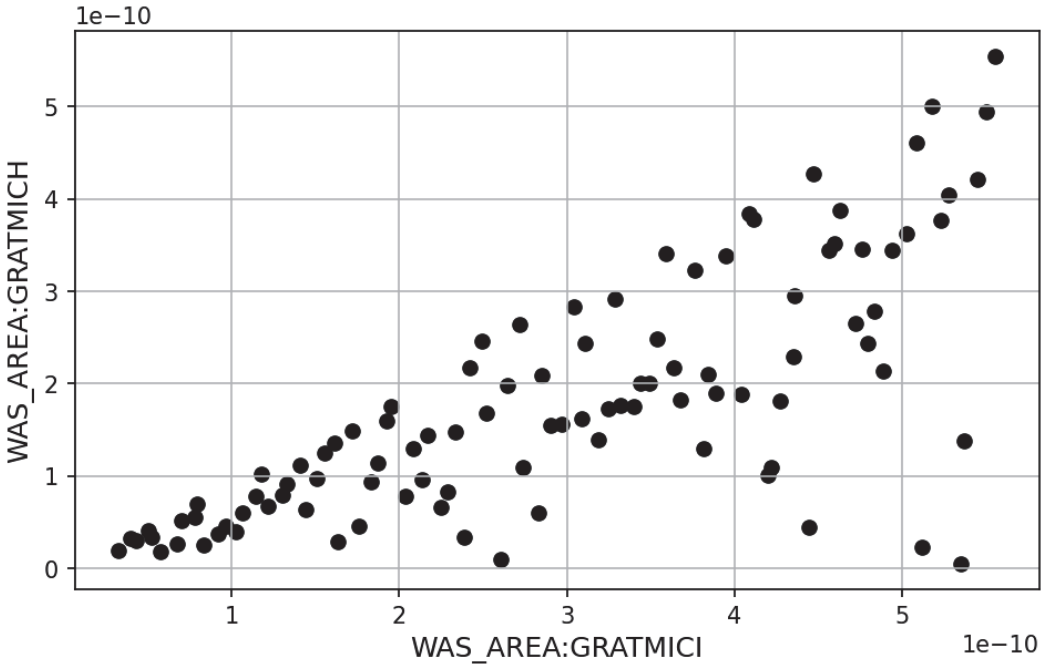

Figure 8. Correlation Between WAS_AREA:GRATMICI and WAS_AREA:GRATMICH, Replicate 1

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5.3.2 PCS_T2:POROSITY

As was done for the RPPCR PA, the conditional relationship PCS_T2:POROSITY ≤ PCS_T1:POROSITY has been imposed for the CRA-2026 PAs, which ensures that the panel closure porosity decreases with time by adjusting the sampled value of PCS_T2:POROSITY, if necessary. The values used in the RPPCR are input into PA_Results, while values sampled prior to conditioning are only available in the LHS output debug files (e.g., lhs2_CRA26_IS_r1_con.dbg for replicate 1). A comparison of the values for PCS_T2:POROSITY prior to conditioning with those used in the CRA26_IS for replicate 1 is shown in Figure 9. In only a few cases was the conditional relationship applied; therefore, the differences between values prior to and subsequent to conditioning are relatively rare and not easily discernable from the figure. All values are identical to those for the RPPCR PA. The correlation between the two variables as a result of the applied conditional relationship is shown in Figure 10. Relatively weak correlations of -0.051, -0.016, and -0.014 were calculated for replicates 1, 2, and 3.

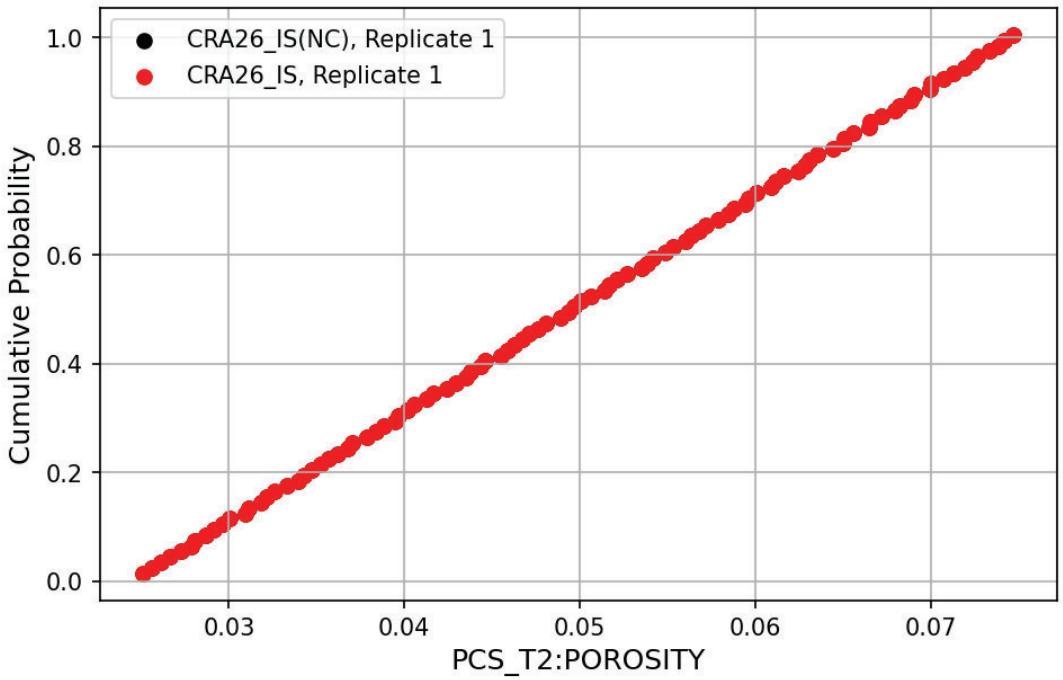

Figure 9. Conditioned and Non-Conditioned Sampled Values for PCS_T2:POROSITY, Replicate 1

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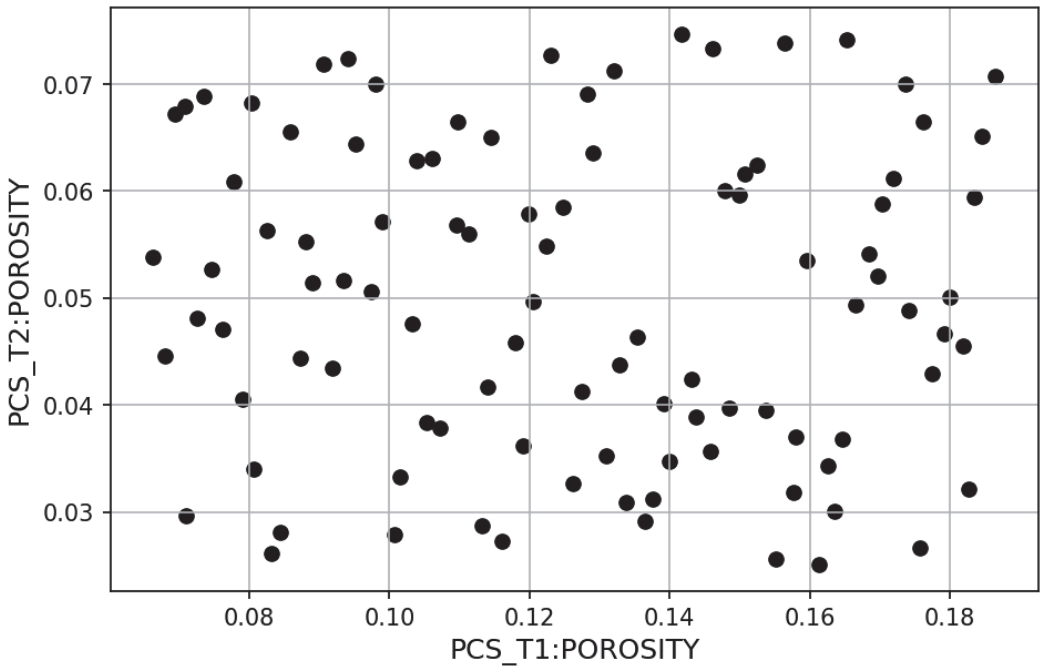

Figure 10. Correlation Between PCS_T1:POROSITY and PCS_T2:POROSITY, Replicate 1

5.3.3 PCS_T3:POROSITY

As was done for the RPPCR PA, the conditional relationship PCS_T3:POROSITY ≤ PCS_T2:POROSITY has been imposed for the CRA-2026 PAs, which ensures that the panel closure porosity decreases with time by adjusting the sampled value of PCS_T3:POROSITY, if necessary. The values used in the CRA-2026 PAs are input into PA_Results, while values sampled prior to conditioning are only available in the LHS output debug files (e.g., lhs2_CRA26_IS_r1_con.dbg for replicate 1). A comparison of the values for PCS_T3:POROSITY prior to conditioning with those used in the CRA26_IS for replicate 1 is shown in Figure 11. All values are identical to those for the RPPCR (not shown). The correlation between the two variables as a result of the applied conditional relationship is shown in Figure 12. Relatively weak correlations of 0.123, 0.183, and 0.271 were calculated for replicates 1, 2, and 3.

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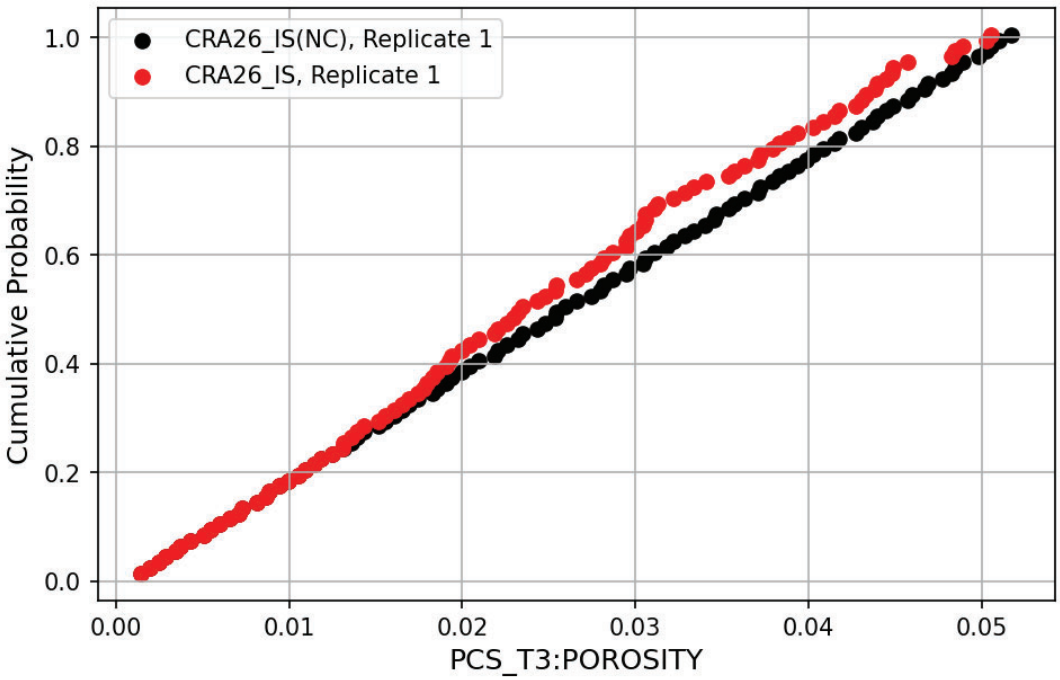

Figure 11. Conditioned and Non-Conditioned Sampled Values for PCS_T3:POROSITY, Replicate 1

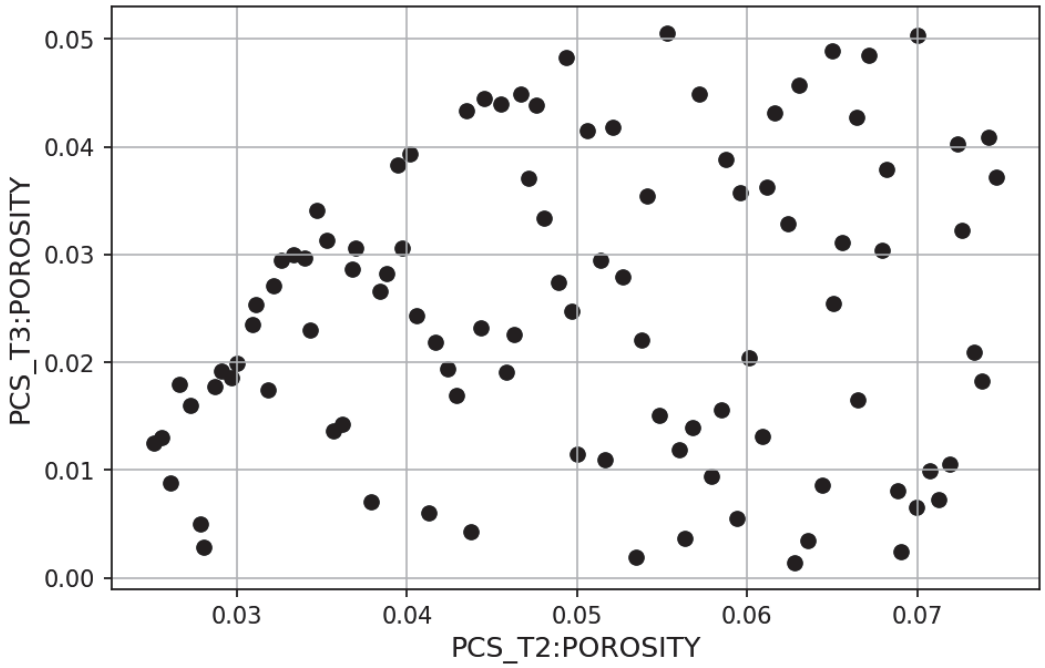

Figure 12. Correlation Between PCS_T2:POROSITY and PCS_T3:POROSITY, Replicate 1

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5.4 Sampled CDF Comparisons to Input Distributions

Comparisons between the sampled parameters and input distributions ("expected distributions") for all 64 sampled parameters are found in the CDFs plotted from Figure 13 through Figure 76 for replicate 1. Plots for replicate 2 and replicate 3 are shown in Appendix A, Section 8.4. Sampled parameter values for all parameters are tabulated in Feng and Kicker (2025).

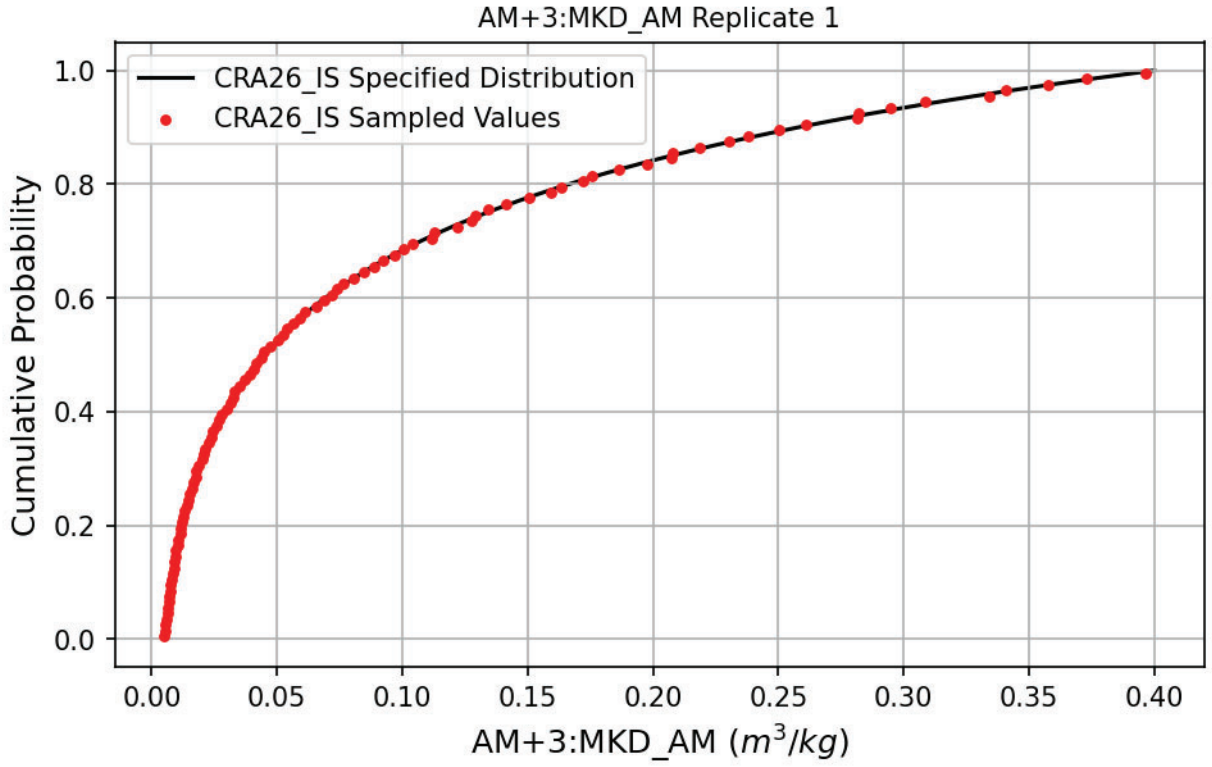

Figure 13. Observed and Expected CDFs for AM+3:MKD_AM (Loguniform Distribution) Replicate 1

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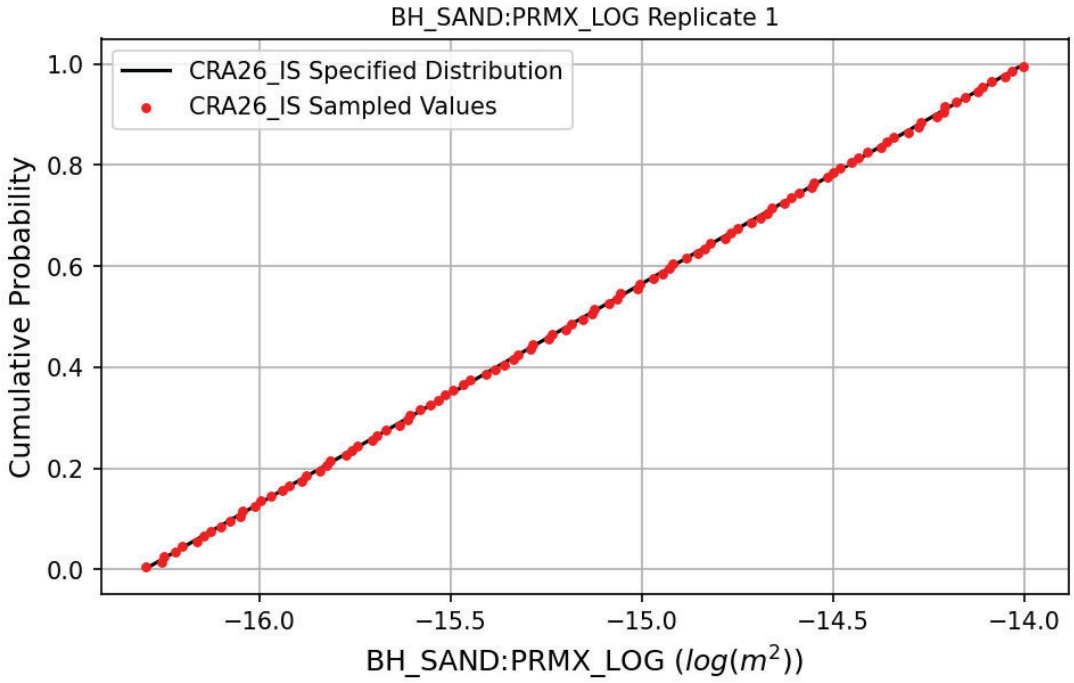

Figure 14. Observed and Expected CDFs for BH_SAND:PRMX_LOG (Uniform Distribution) Replicate 1

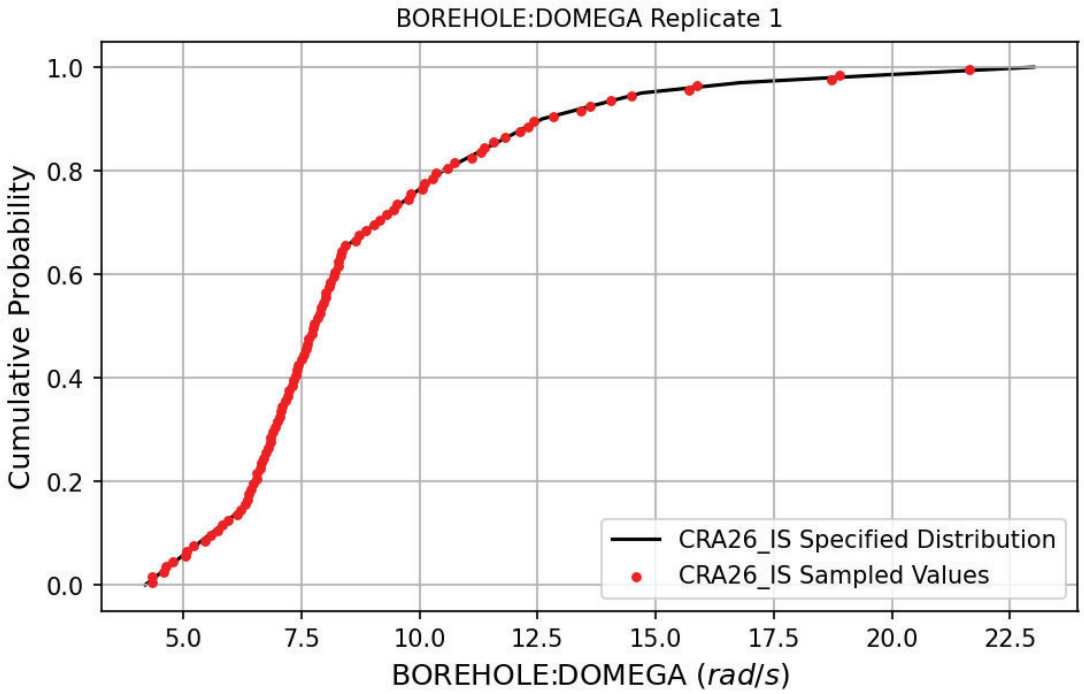

Figure 15. Observed and Expected CDFs for BOREHOLE:DOMEGA (Cumulative Distribution) Replicate 1

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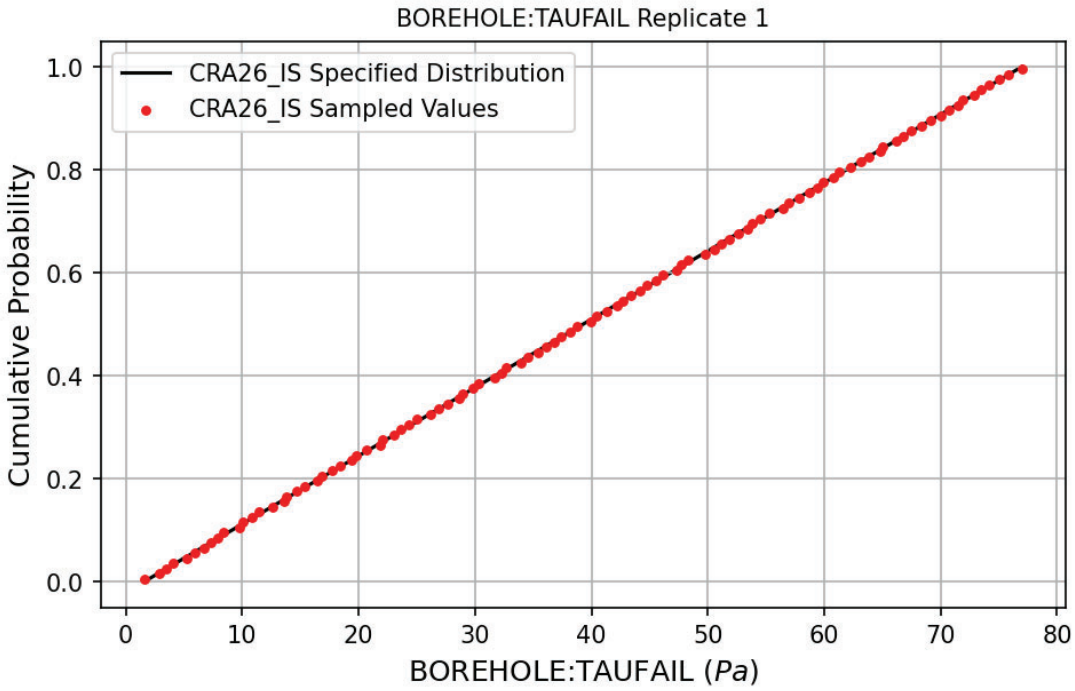

Figure 16. Observed and Expected CDFs for BOREHOLE:TAUFAIL (Uniform Distribution) Replicate 1

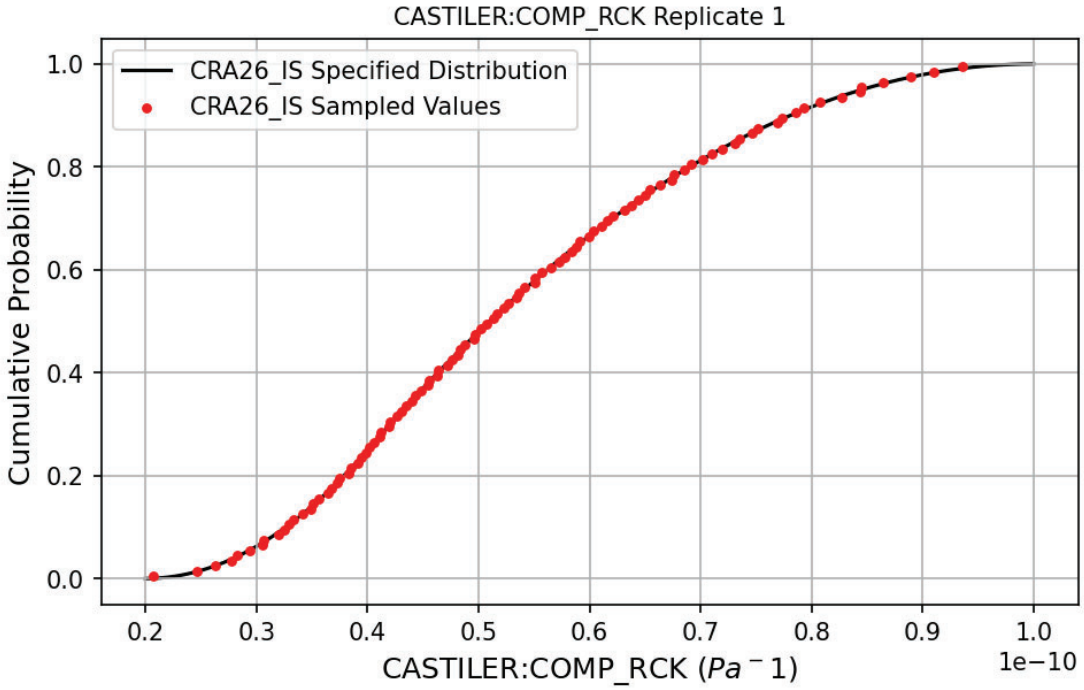

Figure 17. Observed and Expected CDFs for CASTILER:COMP_RCK (Triangular Distribution) Replicate 1

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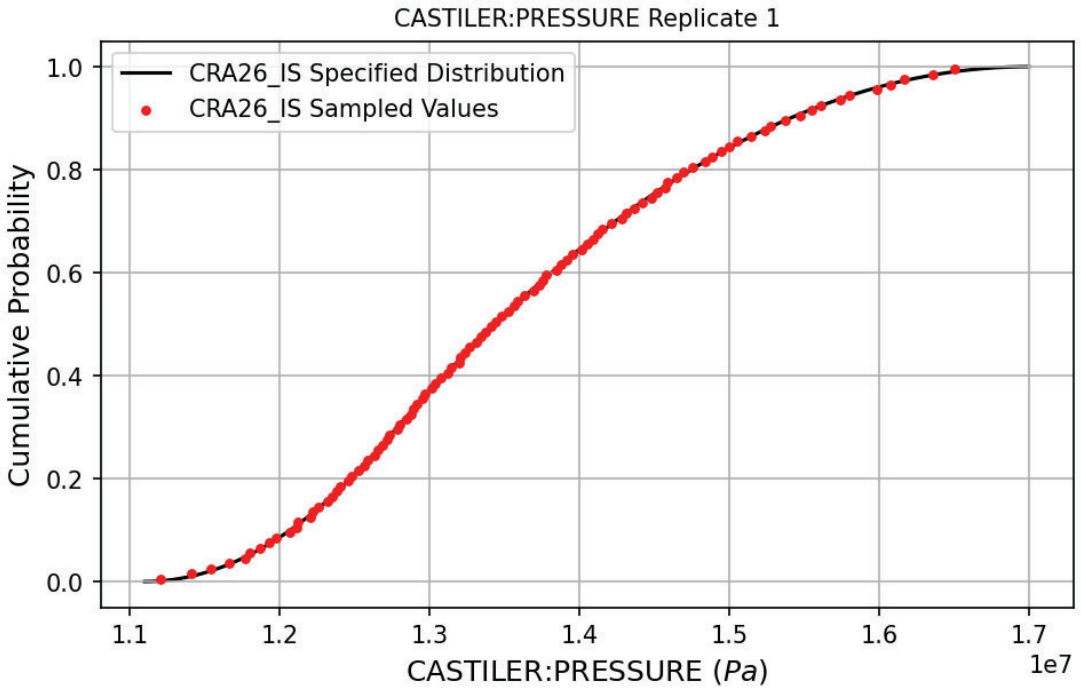

Figure 18. Observed and Expected CDFs for CASTILER:PRESSURE (Triangular Distribution) Replicate 1

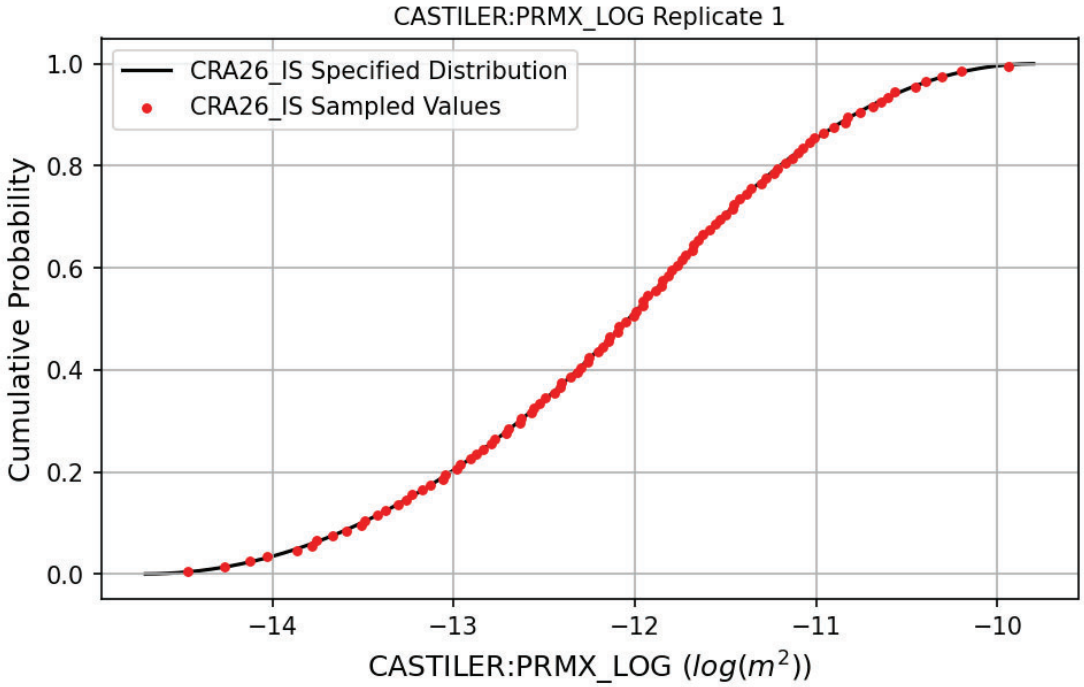

Figure 19. Observed and Expected CDFs for CASTILER:PRMX_LOG (Triangular Distribution) Replicate 1

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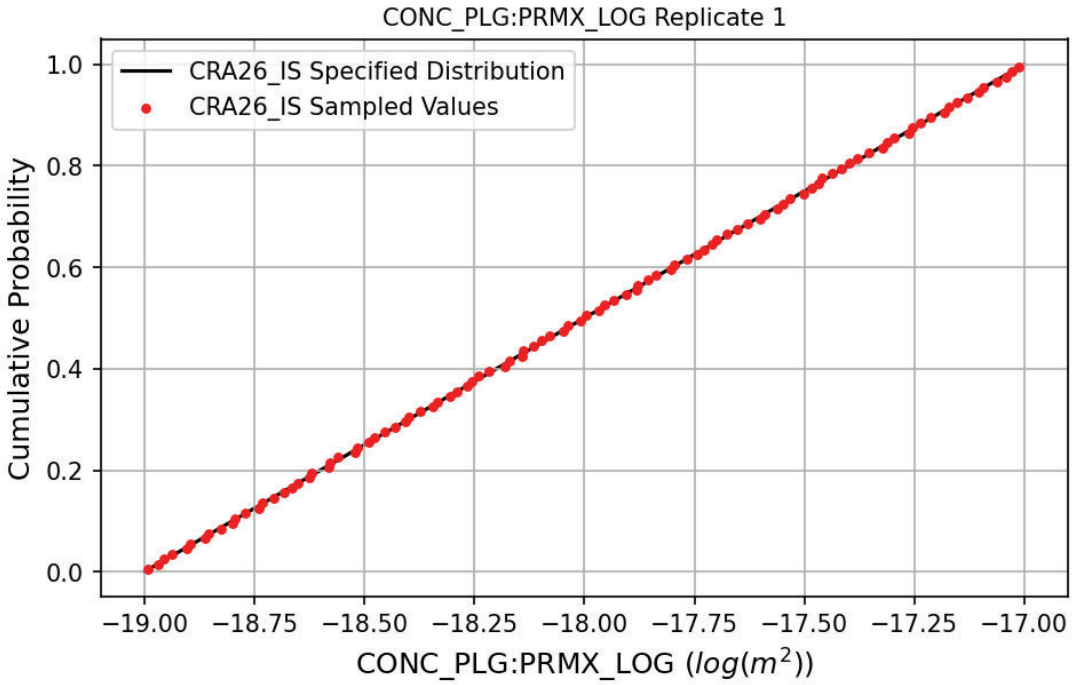

Figure 20. Observed and Expected CDFs for CONC_PLG:PRMX_LOG (Uniform Distribution) Replicate 1

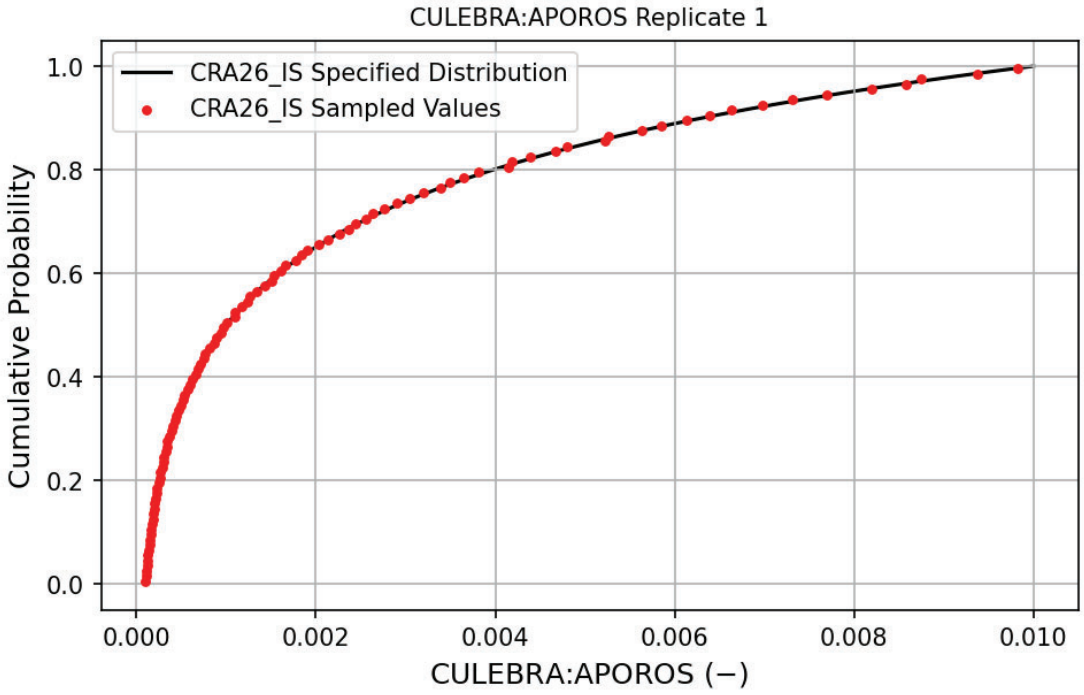

Figure 21. Observed and Expected CDFs for CULEBRA:APOROS (Loguniform Distribution) Replicate 1

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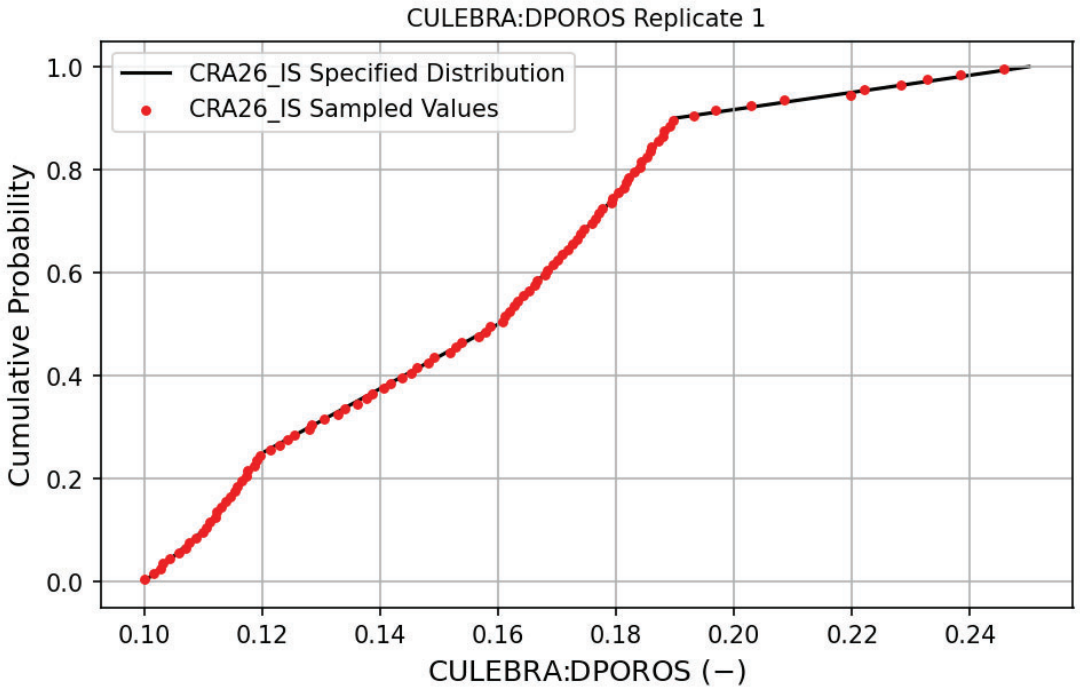

Figure 22. Observed and Expected CDFs for CULEBRA:DPOROS (Cumulative Distribution) Replicate 1

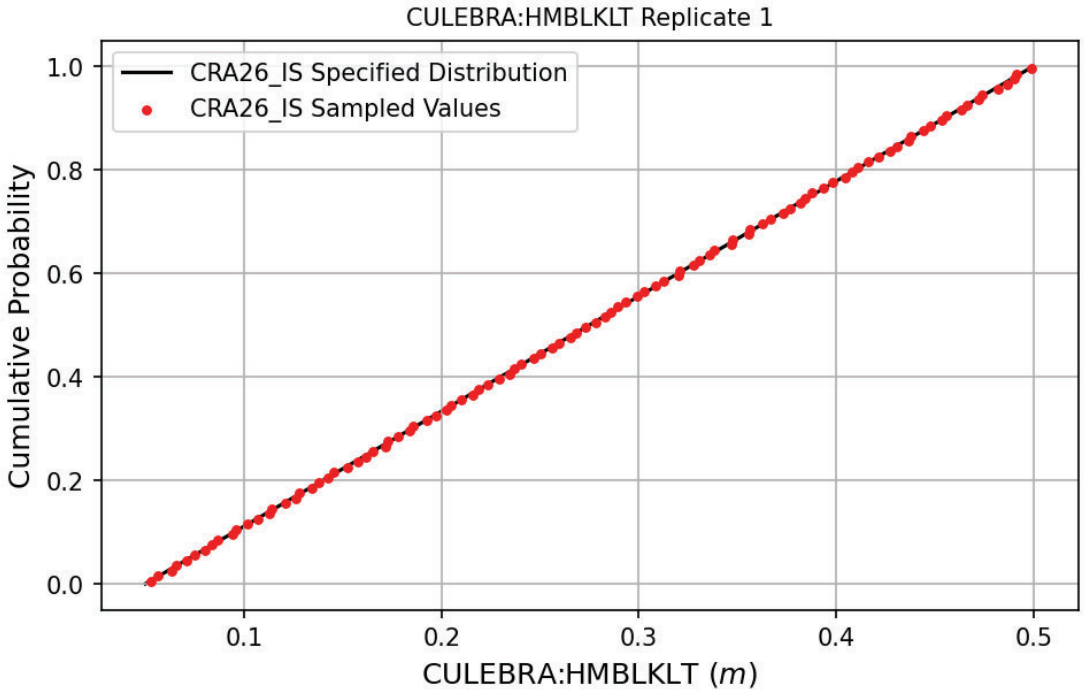

Figure 23. Observed and Expected CDFs for CULEBRA:HMBLKLT (Uniform Distribution) Replicate 1

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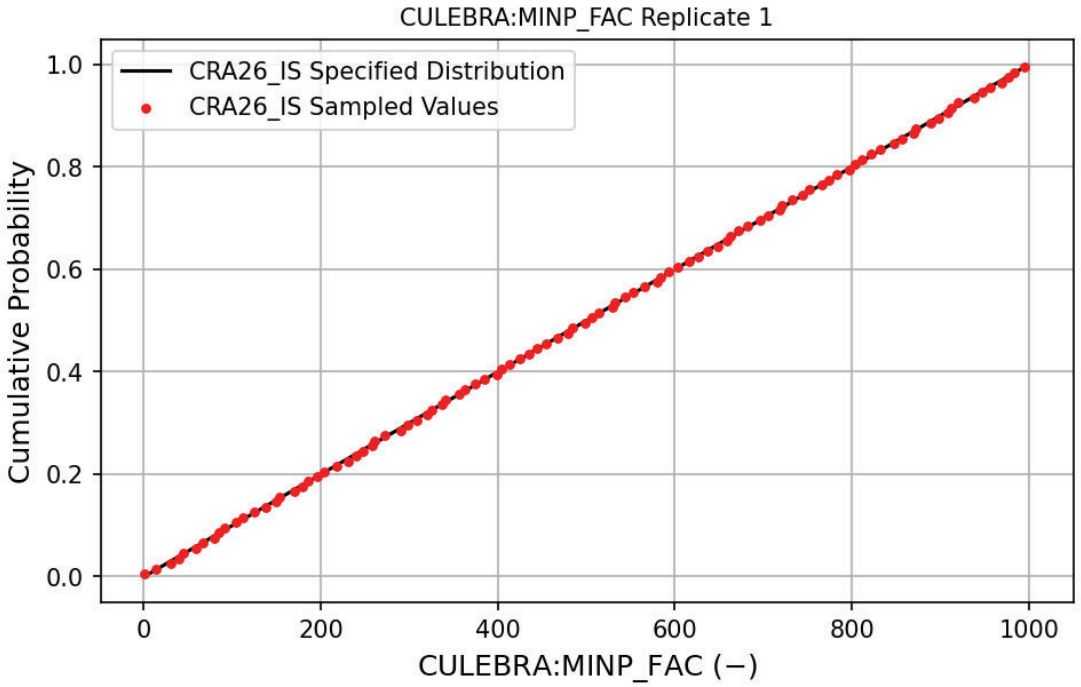

Figure 24. Observed and Expected CDFs for CULEBRA:MINP_FAC (Uniform Distribution) Replicate 1

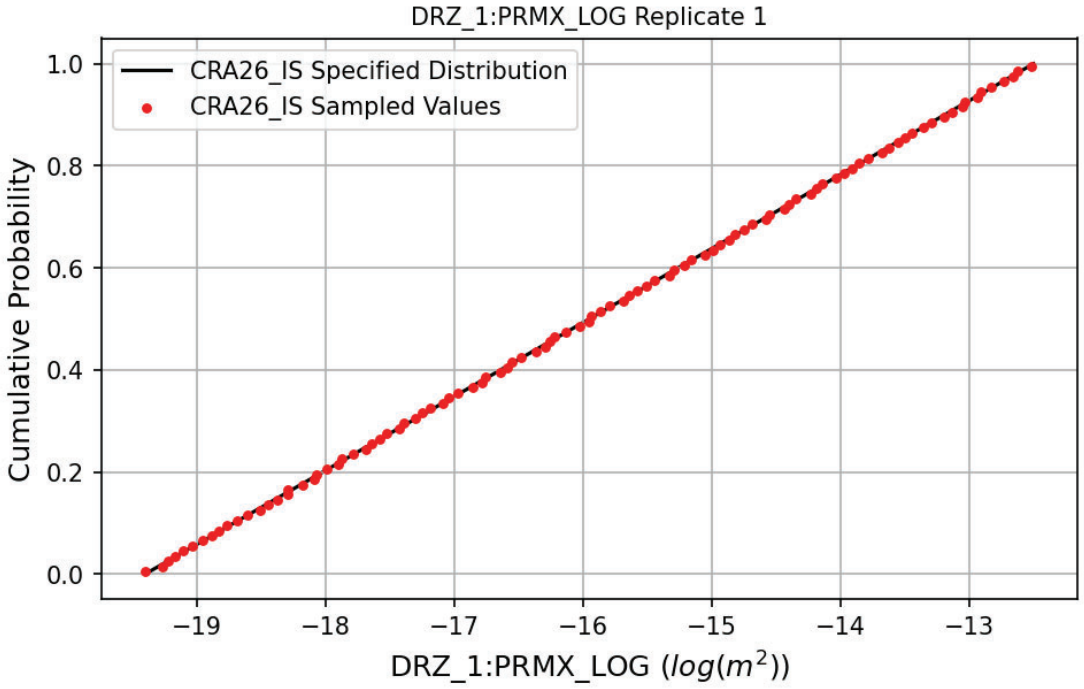

Figure 25. Observed and Expected CDFs for DRZ_1:PRMX_LOG (Uniform Distribution) Replicate 1

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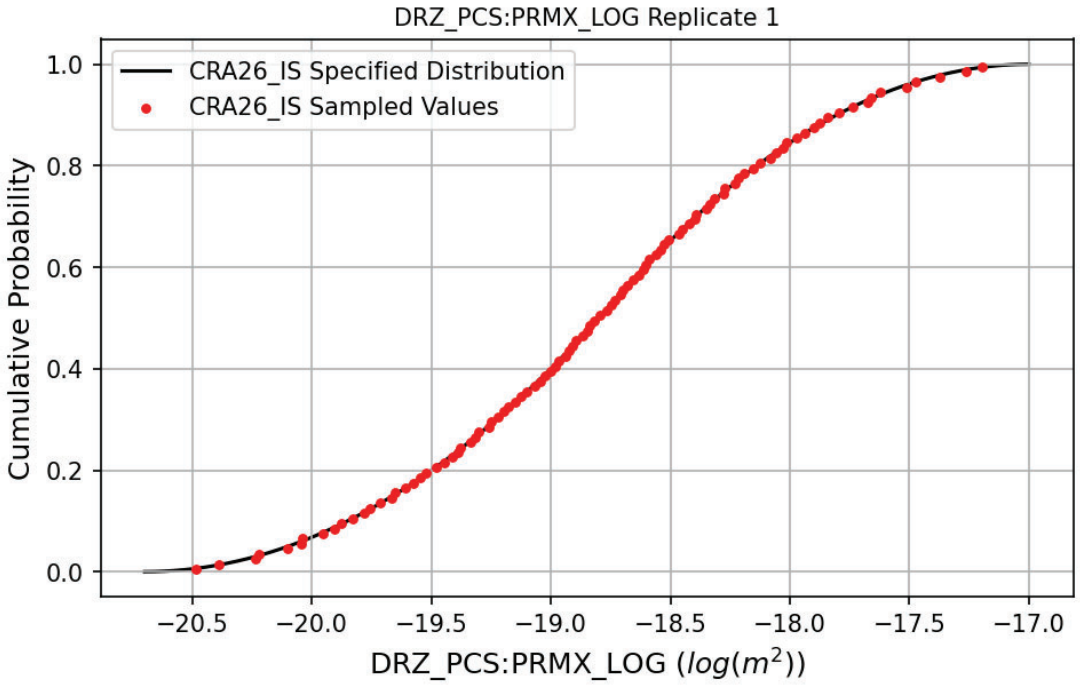

Figure 26. Observed and Expected CDFs for DRZ_PCS:PRMX_LOG (Triangular Distribution) Replicate 1

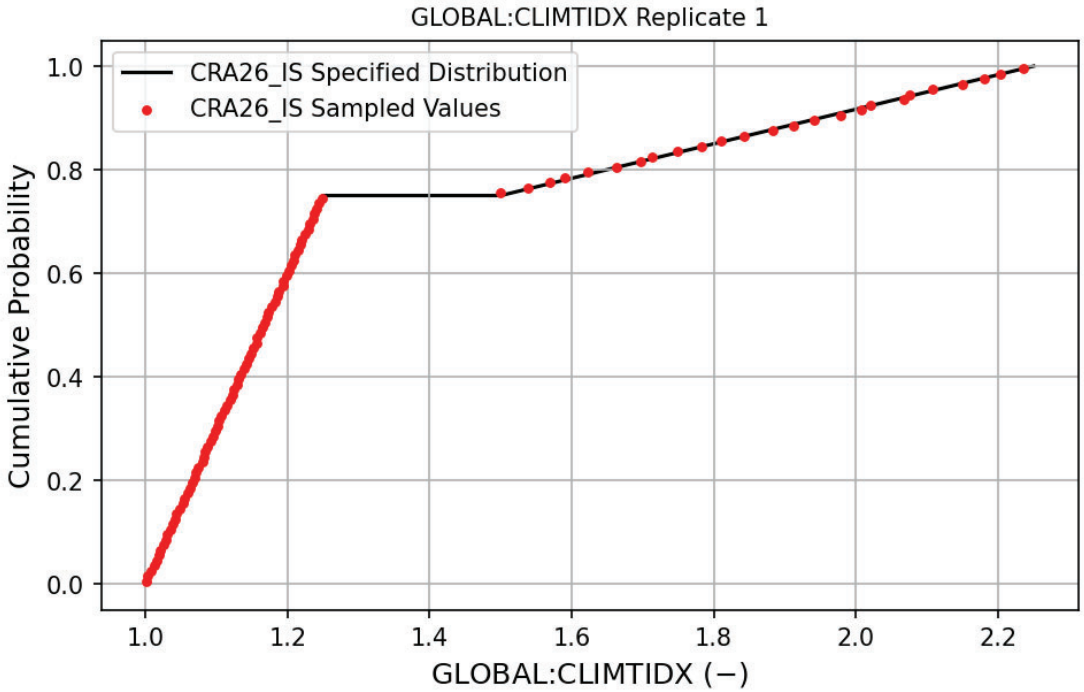

Figure 27. Observed and Expected CDFs for GLOBAL:CLIMTIDX (Cumulative Distribution) Replicate 1

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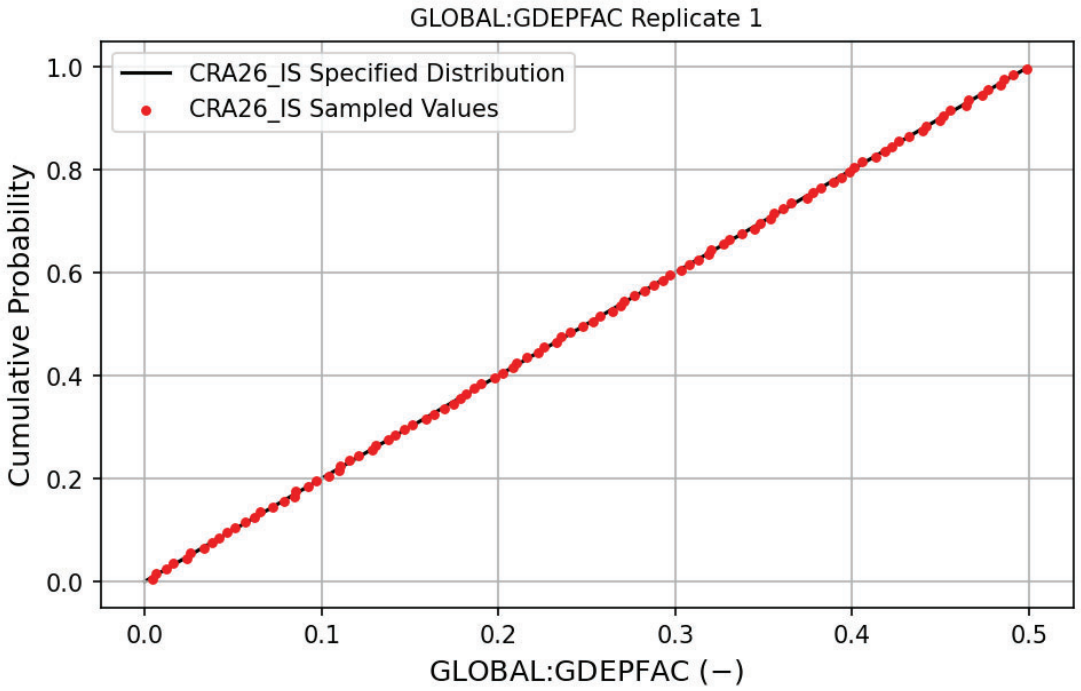

Figure 28. Observed and Expected CDFs for GLOBAL:GDEPFAC (Uniform Distribution) Replicate 1

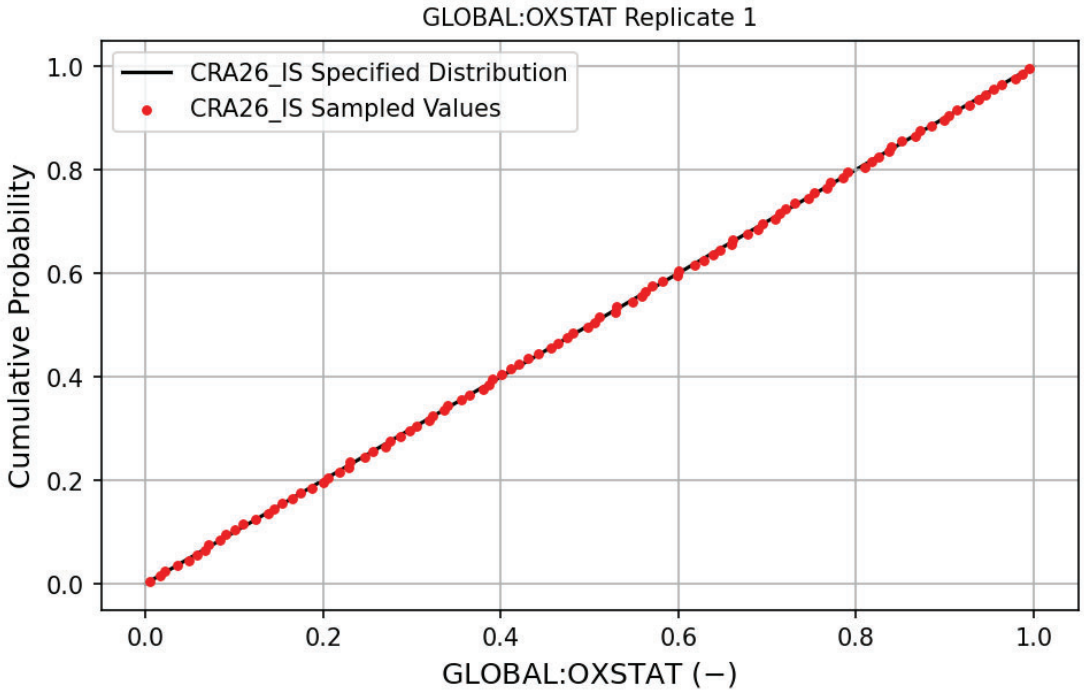

Figure 29. Observed and Expected CDFs for GLOBAL:OXSTAT (Uniform Distribution) Replicate 1

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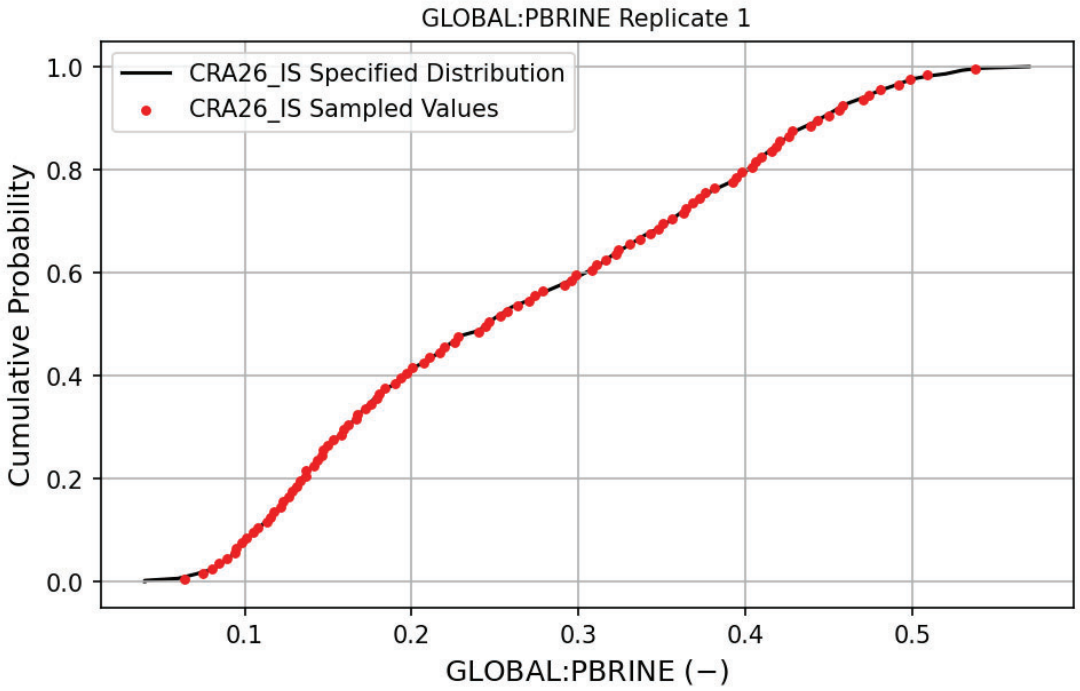

Figure 30. Observed and Expected CDFs for GLOBAL:PBRINE (Cumulative Distribution) Replicate 1

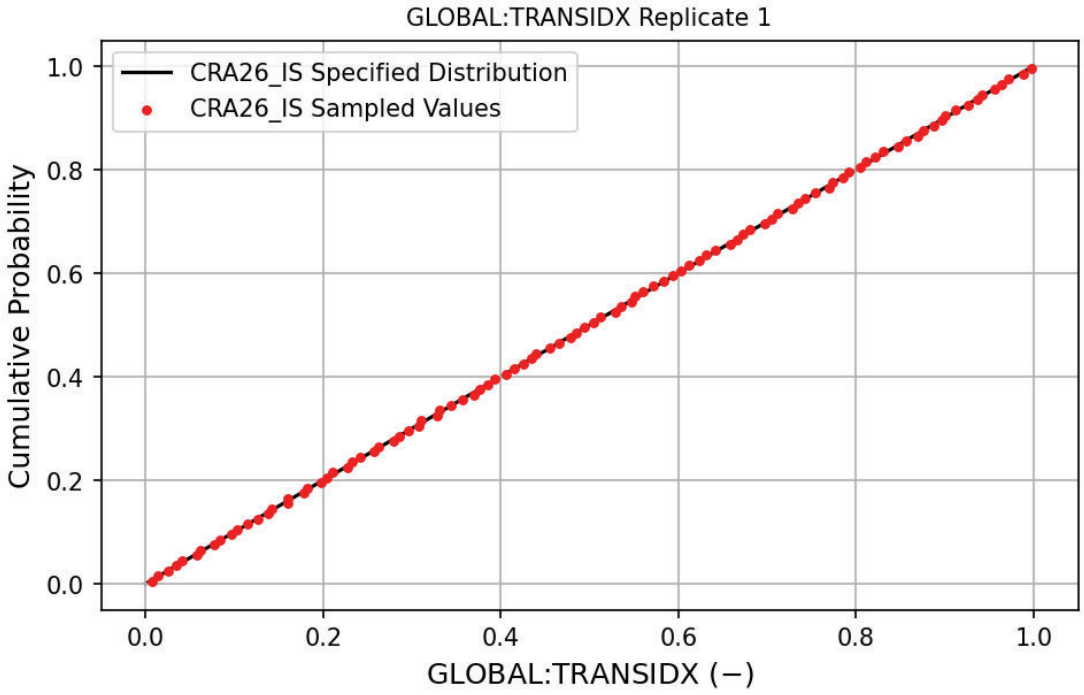

Figure 31. Observed and Expected CDFs for GLOBAL:TRANSIDX (Uniform Distribution) Replicate 1

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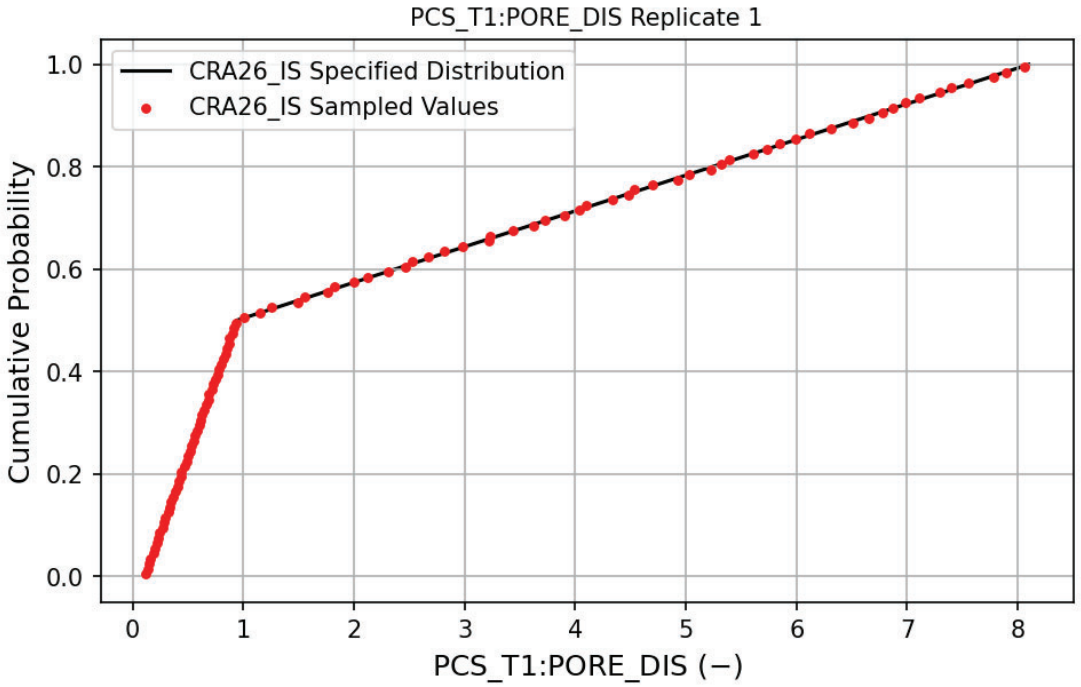

Figure 32. Observed and Expected CDFs for PCS_T1:PORE_DIS (Cumulative Distribution) Replicate 1

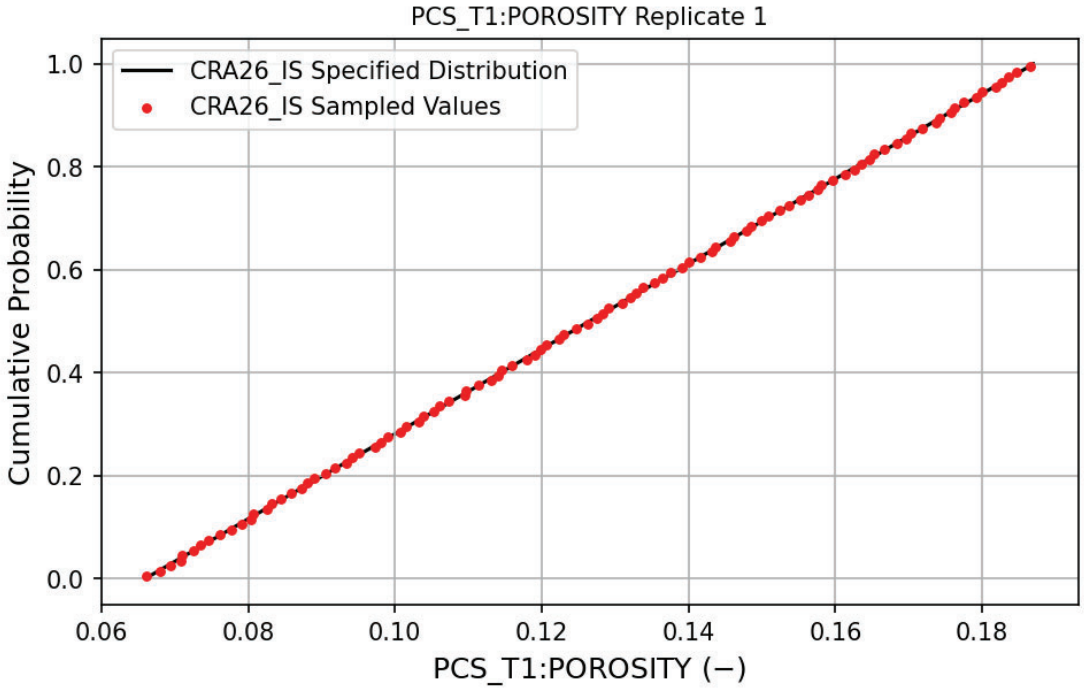

Figure 33. Observed and Expected CDFs for PCS_T1:POROSITY (Uniform Distribution) Replicate 1

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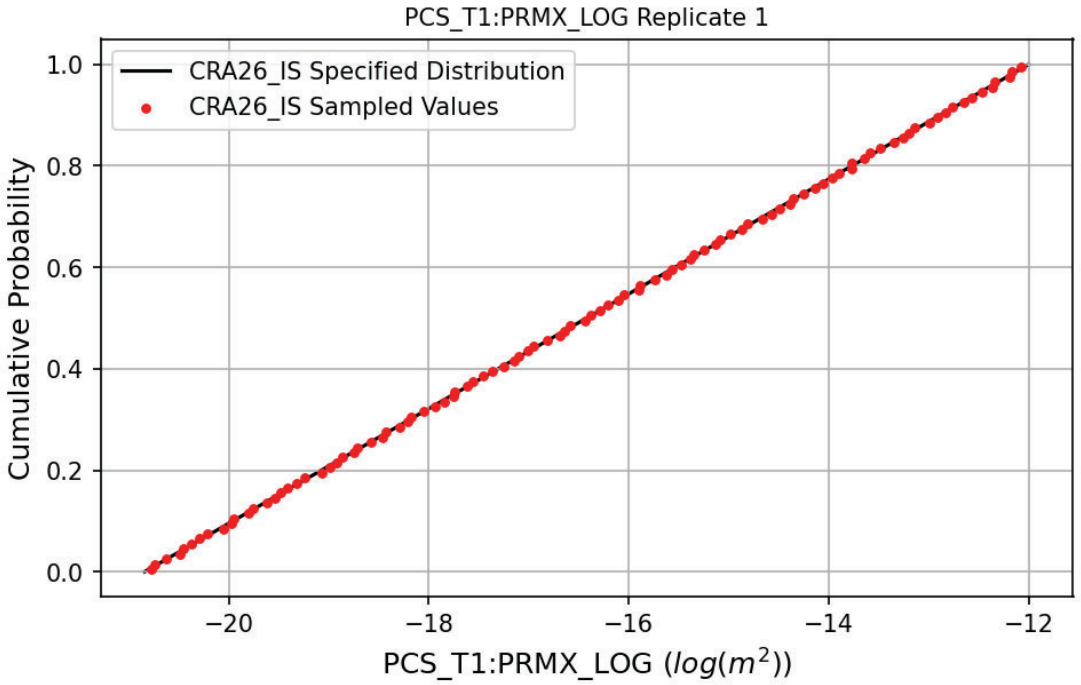

Figure 34. Observed and Expected CDFs for PCS_T1:PRMX_LOG (Uniform Distribution) Replicate 1

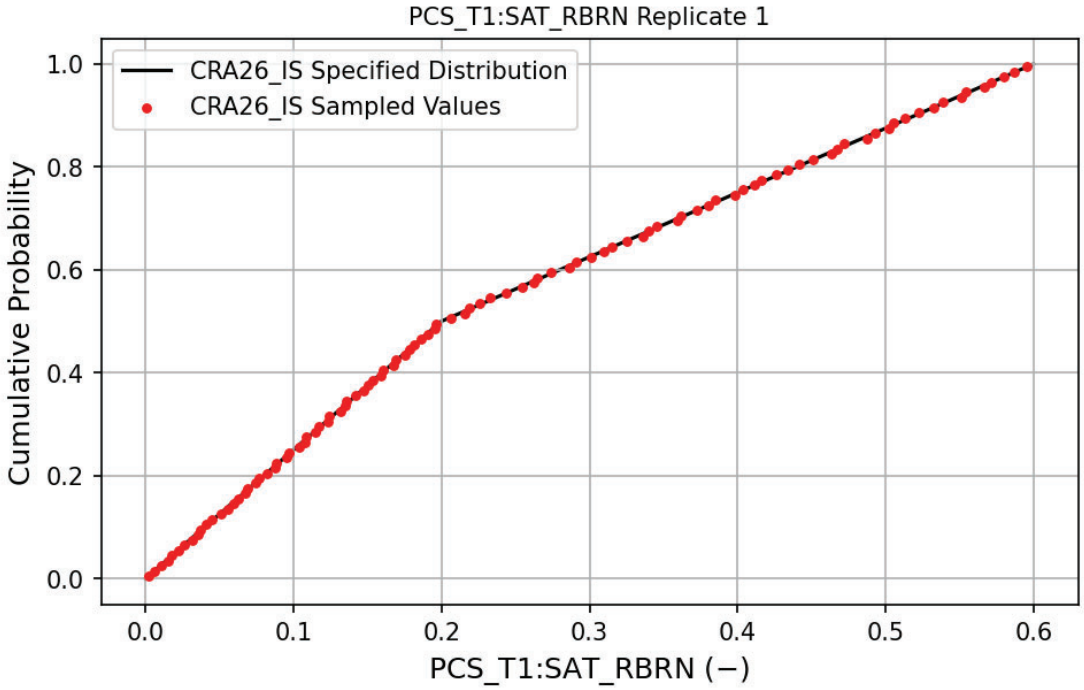

Figure 35. Observed and Expected CDFs for PCS_T1:SAT_RBRN (Cumulative Distribution) Replicate 1

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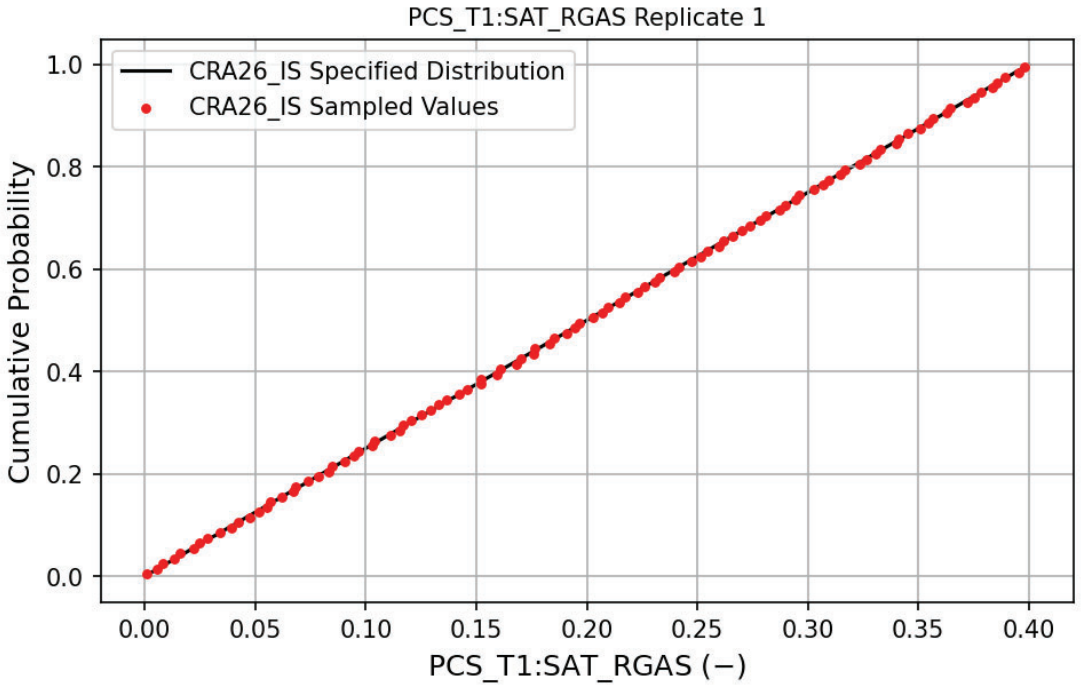

Figure 36. Observed and Expected CDFs for PCS_T1:SAT_RGAS (Uniform Distribution) Replicate 1

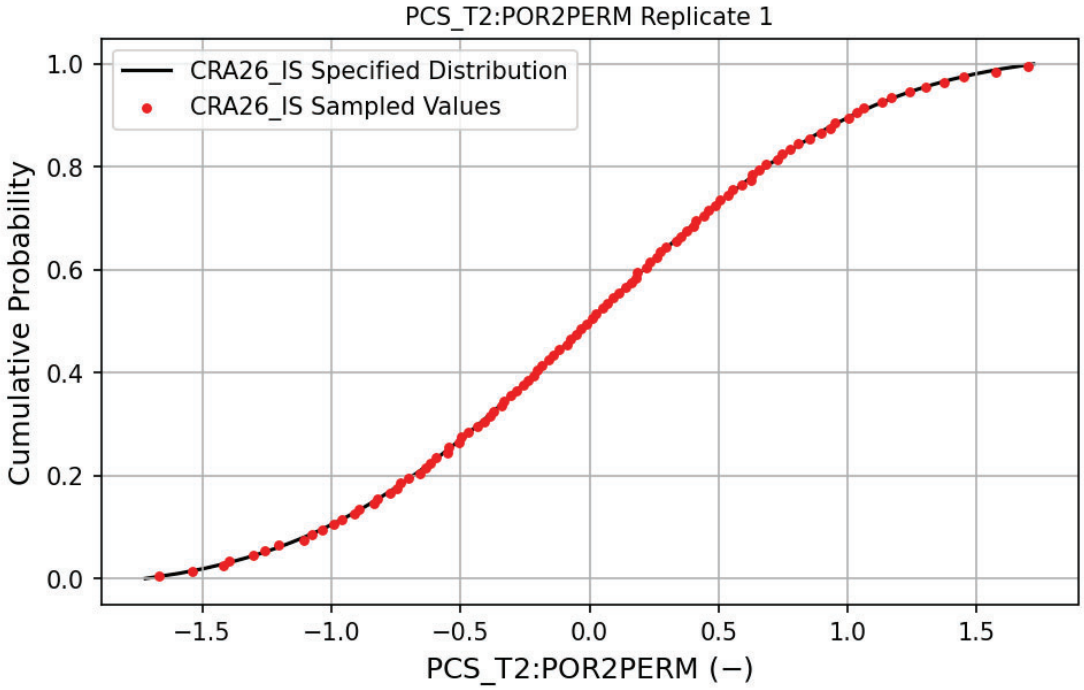

Figure 37. Observed and Expected CDFs for PCS_T2:POR2PERM (Cumulative Distribution) Replicate 1

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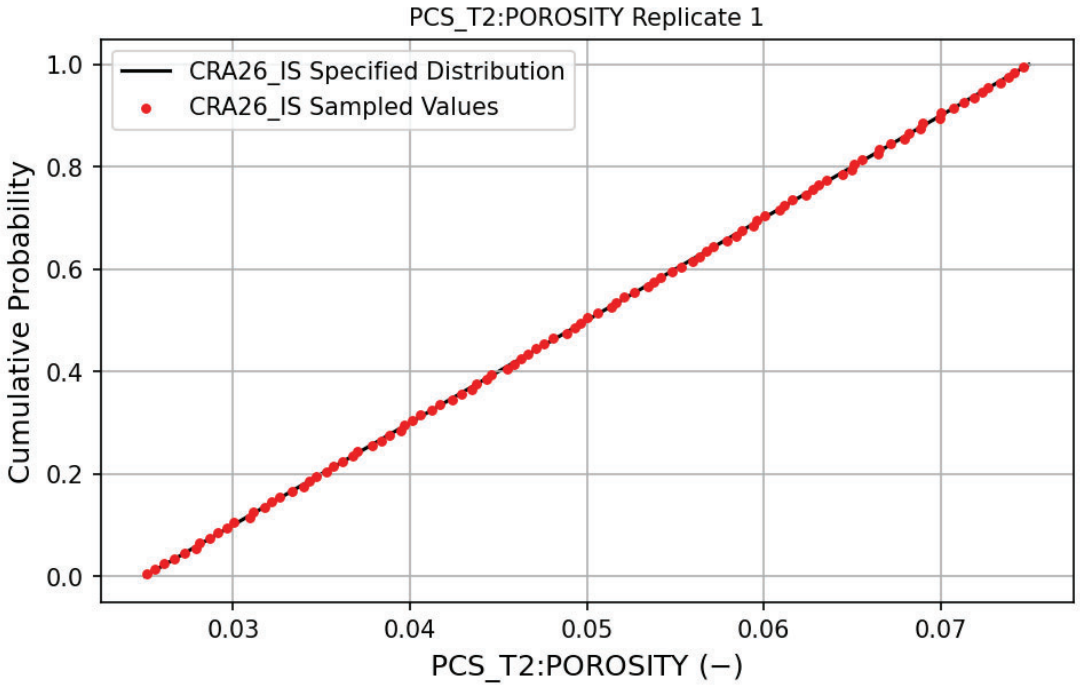

Figure 38. Observed and Expected CDFs for PCS_T2:POROSITY (Uniform Distribution) Replicate 1

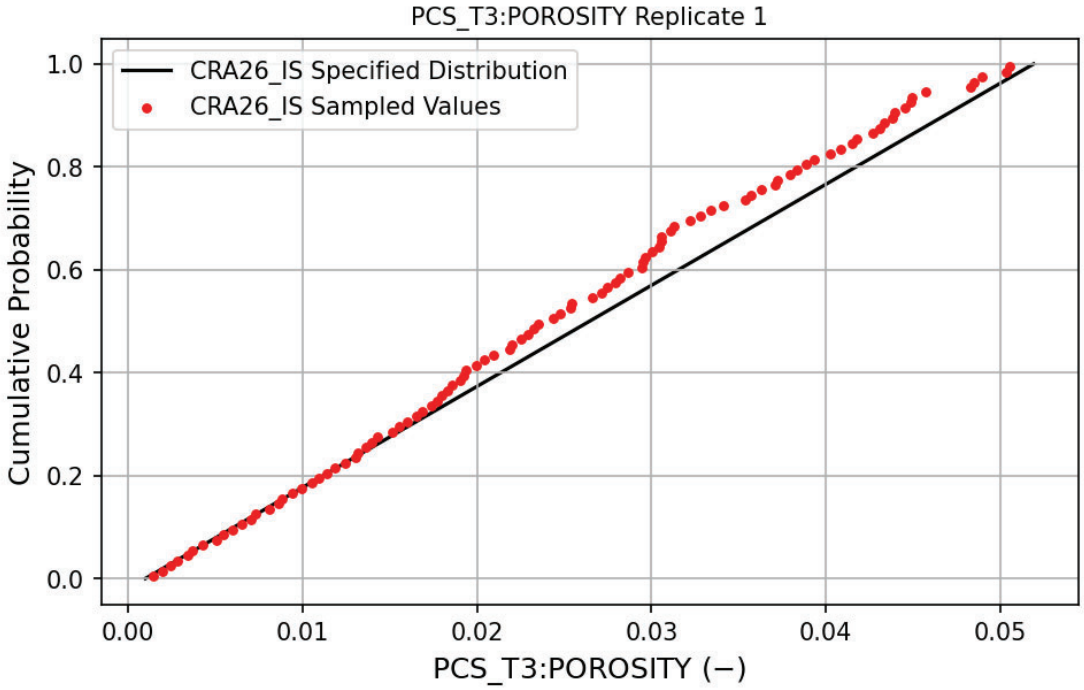

Figure 39. Observed and Expected CDFs for PCS_T3:POROSITY (Uniform Distribution) Replicate 1

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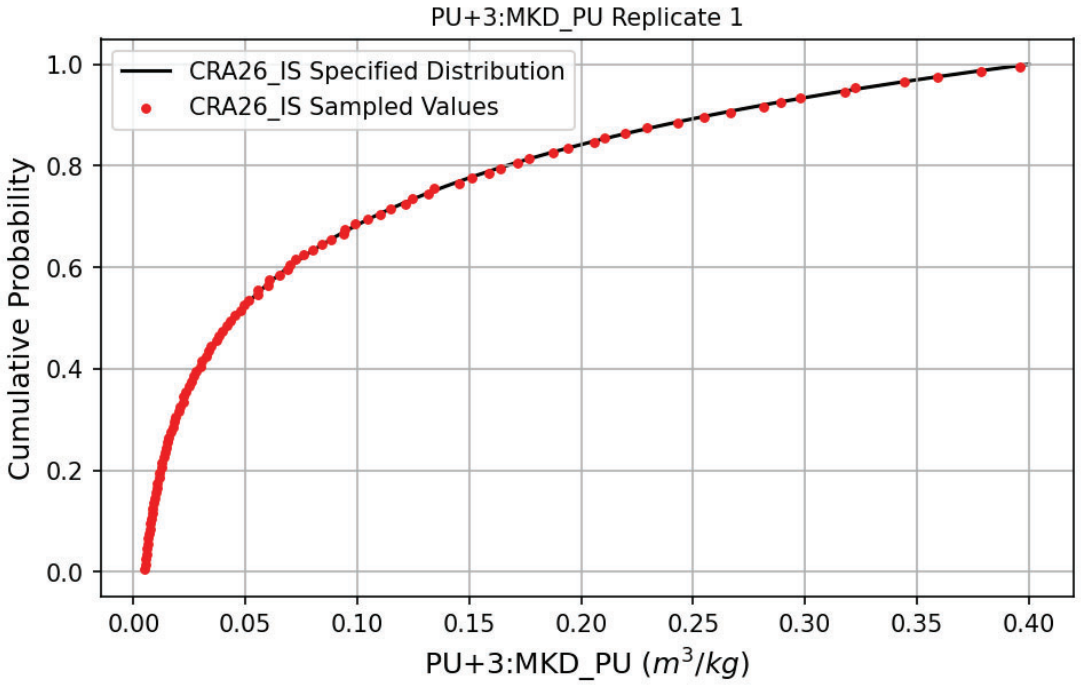

Figure 40. Observed and Expected CDFs for PU+3:MKD_PU (Loguniform Distribution) Replicate 1

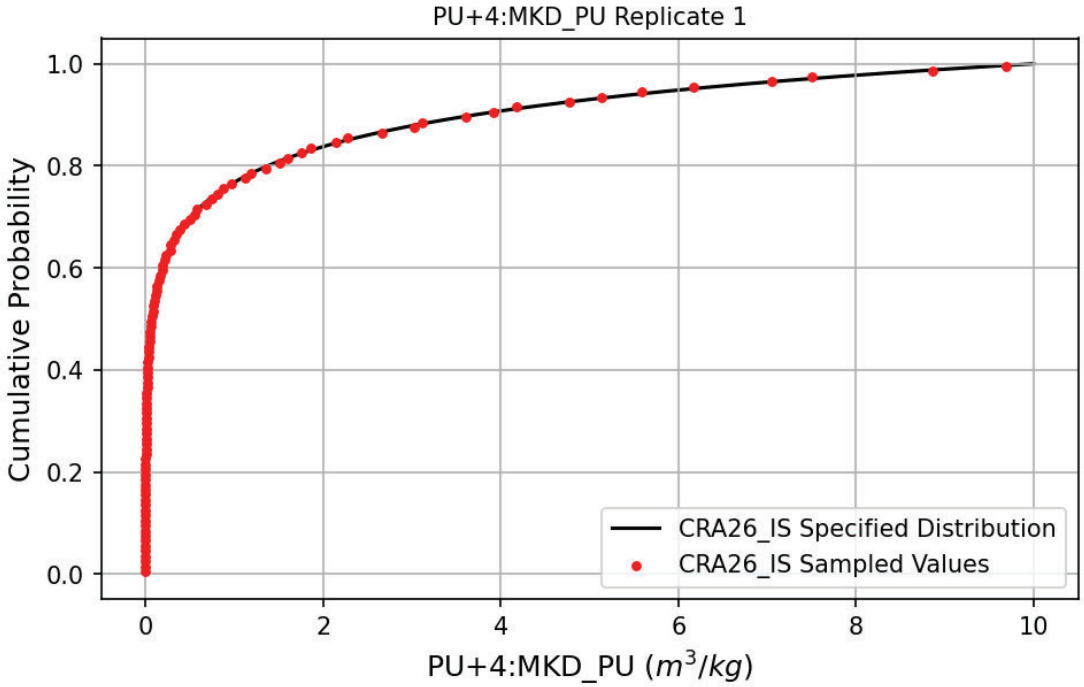

Figure 41. Observed and Expected CDFs for PU+4:MKD_PU (Loguniform Distribution) Replicate 1

Information Only

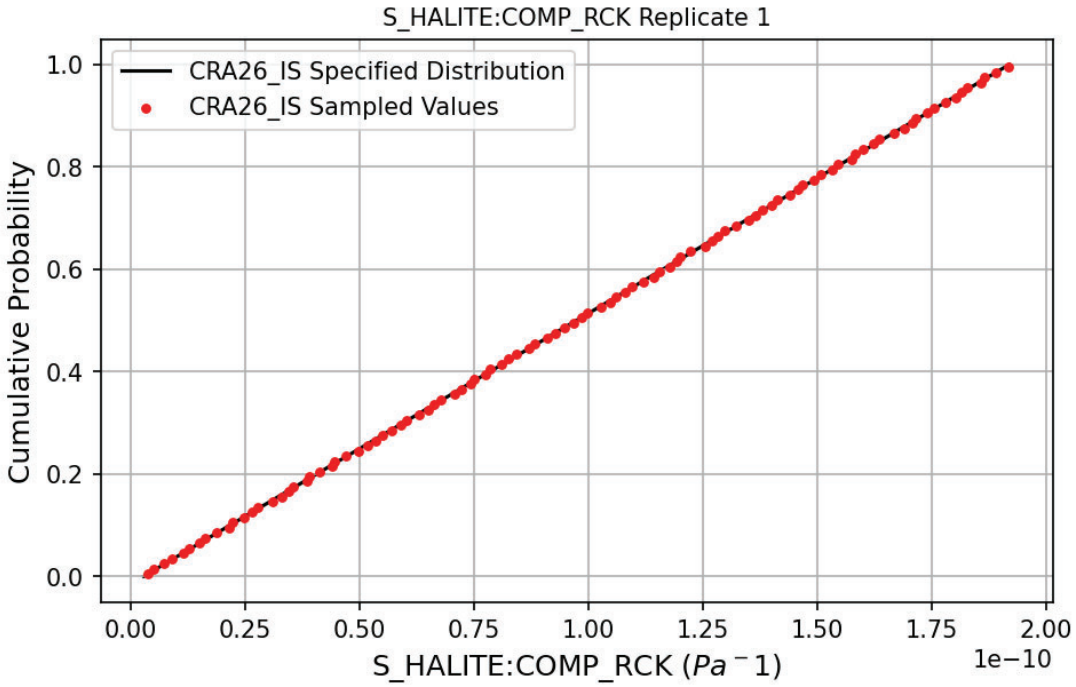

Figure 42. Observed and Expected CDFs for S_HALITE:COMP_RCK (Uniform Distribution) Replicate 1

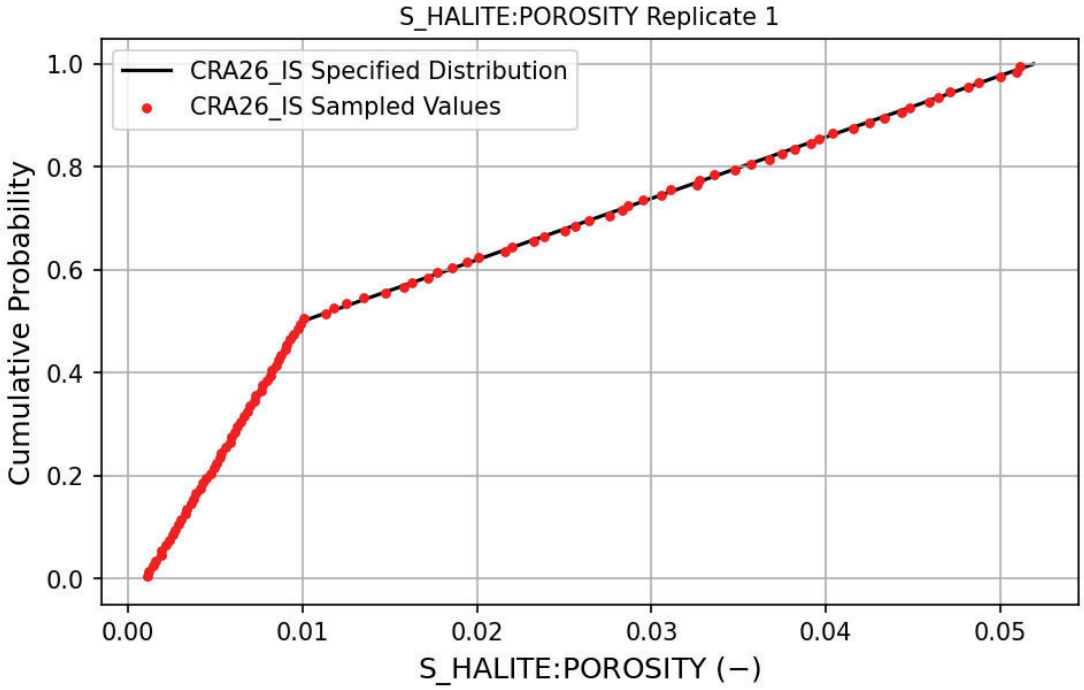

Figure 43. Observed and Expected CDFs for S_HALITE:POROSITY (Cumulative Distribution) Replicate 1

Information Only

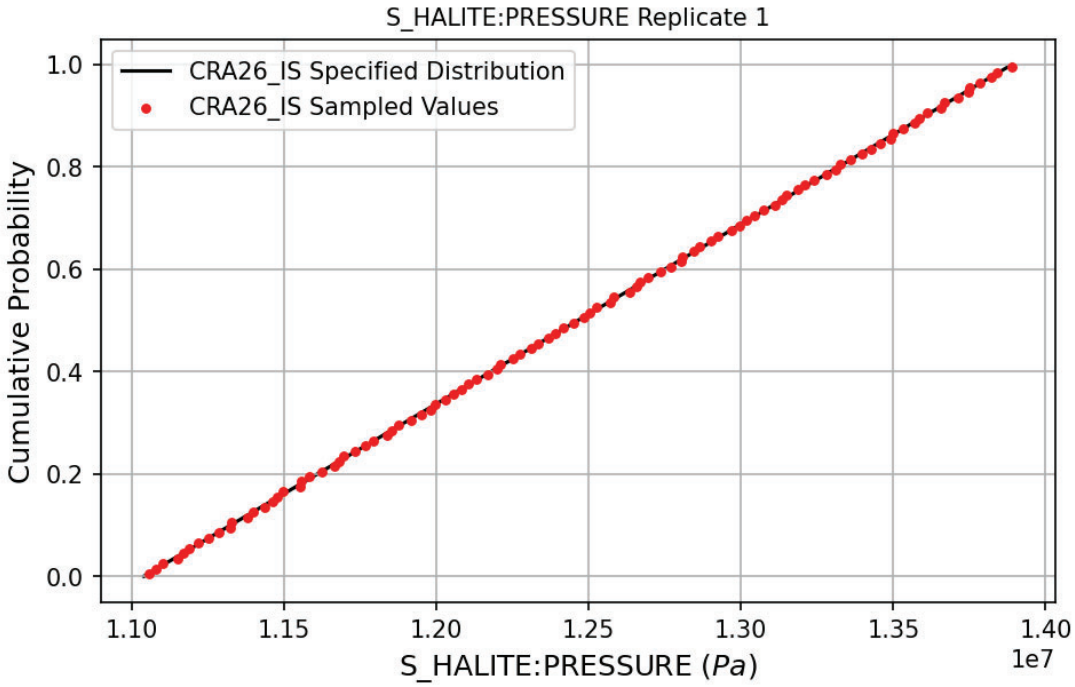

Figure 44. Observed and Expected CDFs for S_HALITE:PRESSURE (Uniform Distribution) Replicate 1

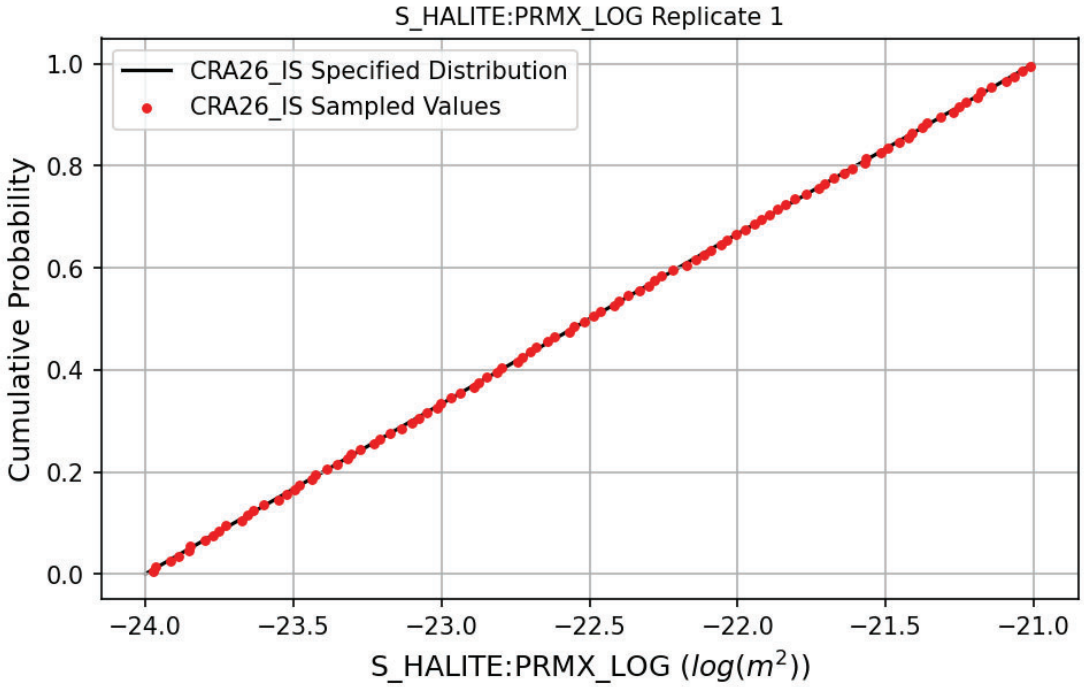

Figure 45. Observed and Expected CDFs for S_HALITE:PRMX_LOG (Uniform Distribution) Replicate 1

Information Only

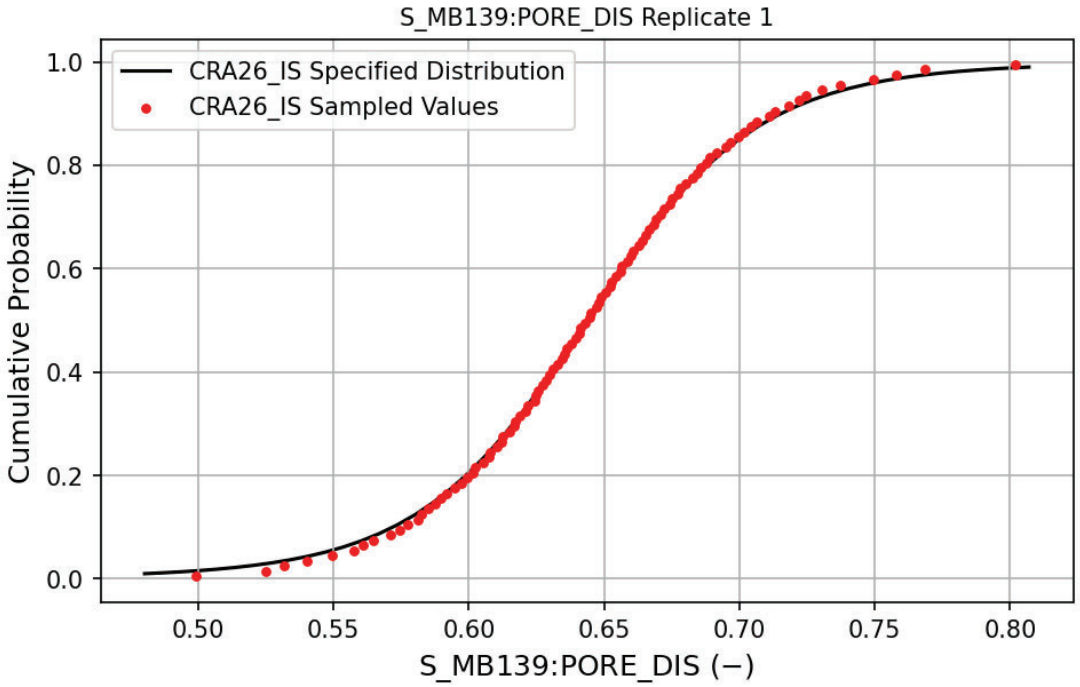

Figure 46. Observed and Expected CDFs for S_MB139:PORE_DIS (Student Distribution) Replicate 1

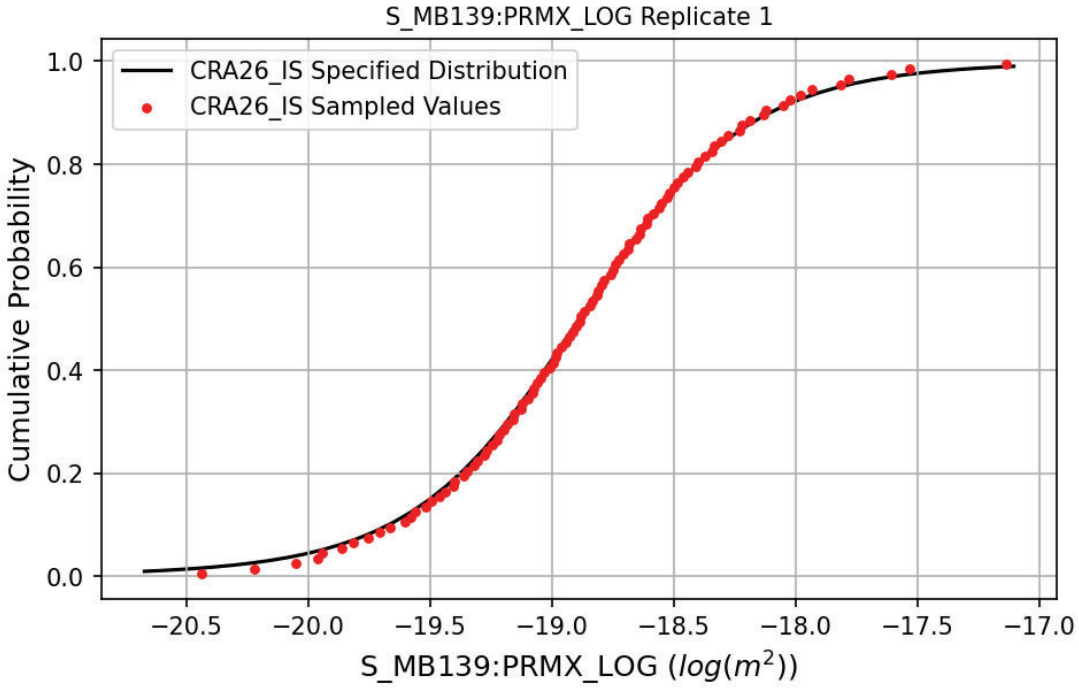

Figure 47. Observed and Expected CDFs for S_MB139:PRMX_LOG (Student Distribution) Replicate 1

Information Only

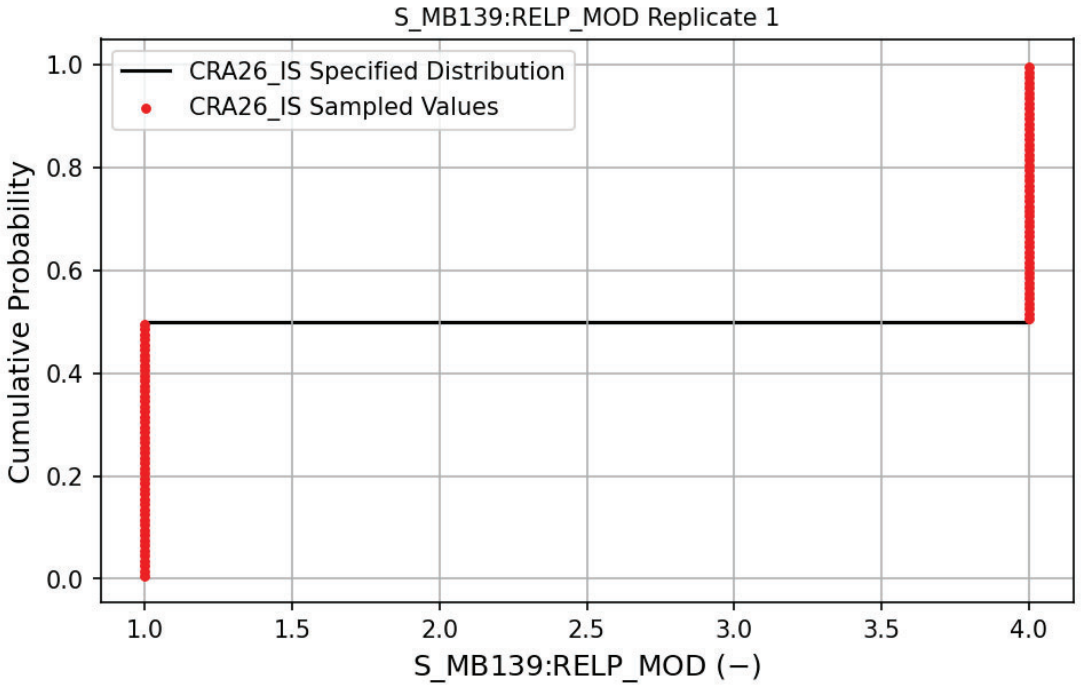

Figure 48. Observed and Expected CDFs for S_MB139:RELP_MOD (Delta Distribution) Replicate 1

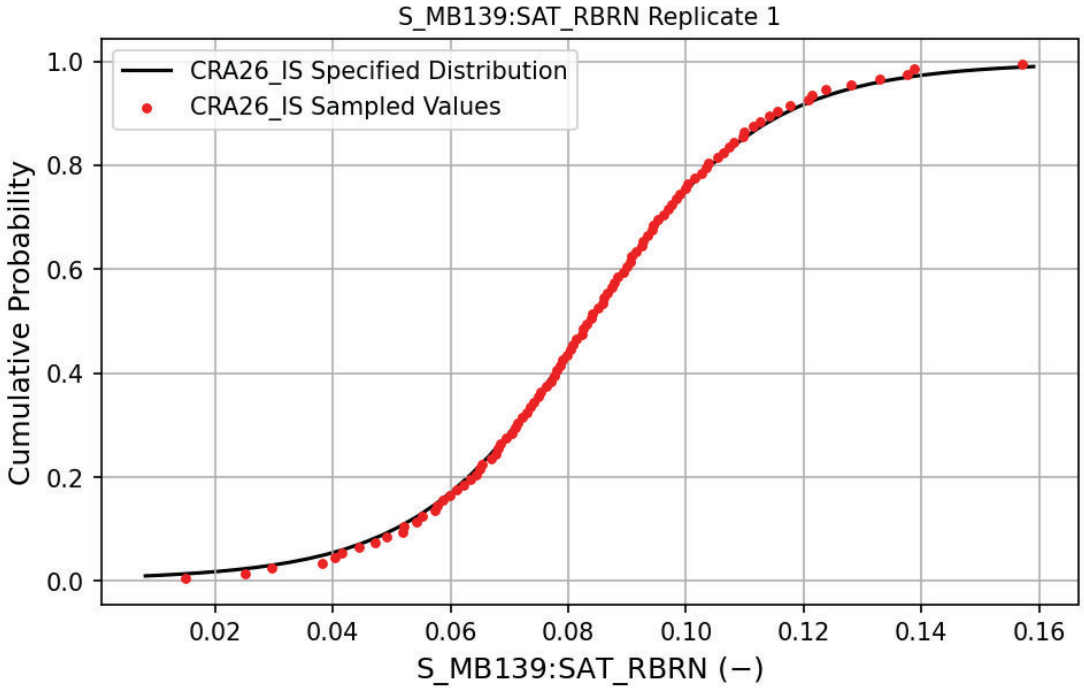

Figure 49. Observed and Expected CDFs for S_MB139:SAT_RBRN (Student Distribution) Replicate 1

Information Only

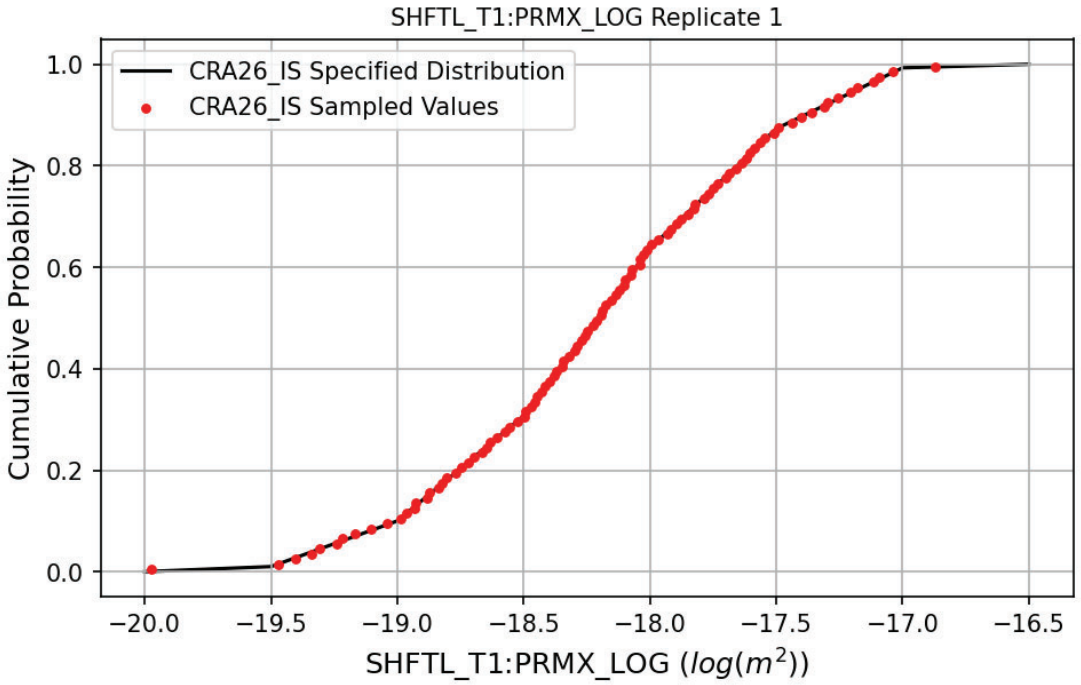

Figure 50. Observed and Expected CDFs for SHFTL_T1:PRMX_LOG (Cumulative Distribution) Replicate 1

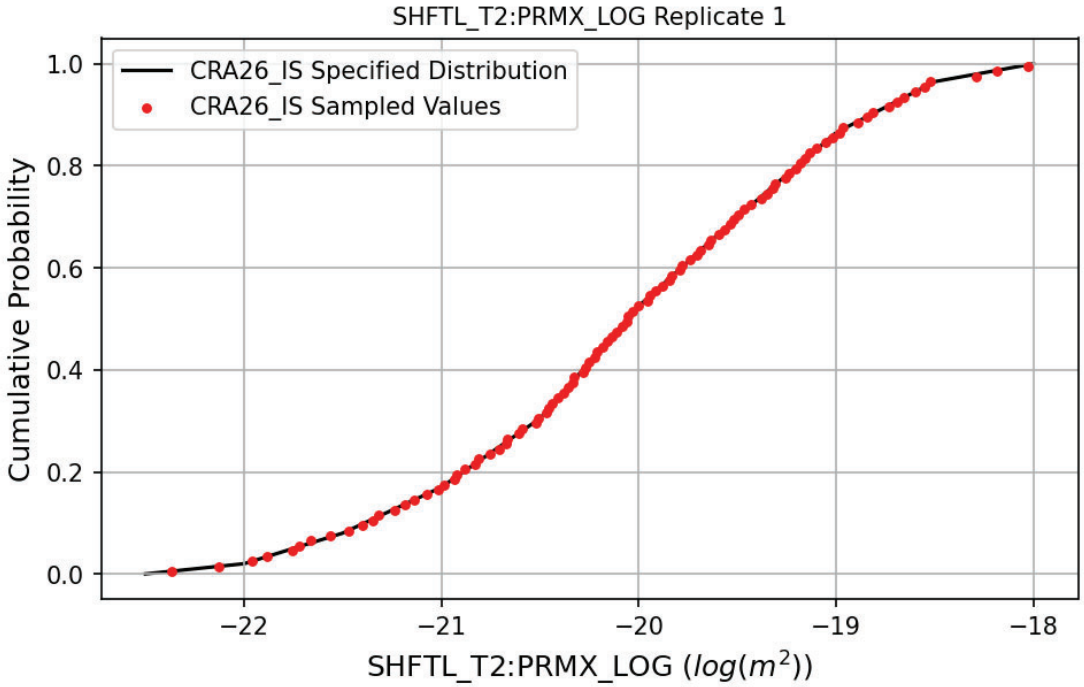

Figure 51. Observed and Expected CDFs for SHFTL_T2:PRMX_LOG (Cumulative Distribution) Replicate 1

Information Only

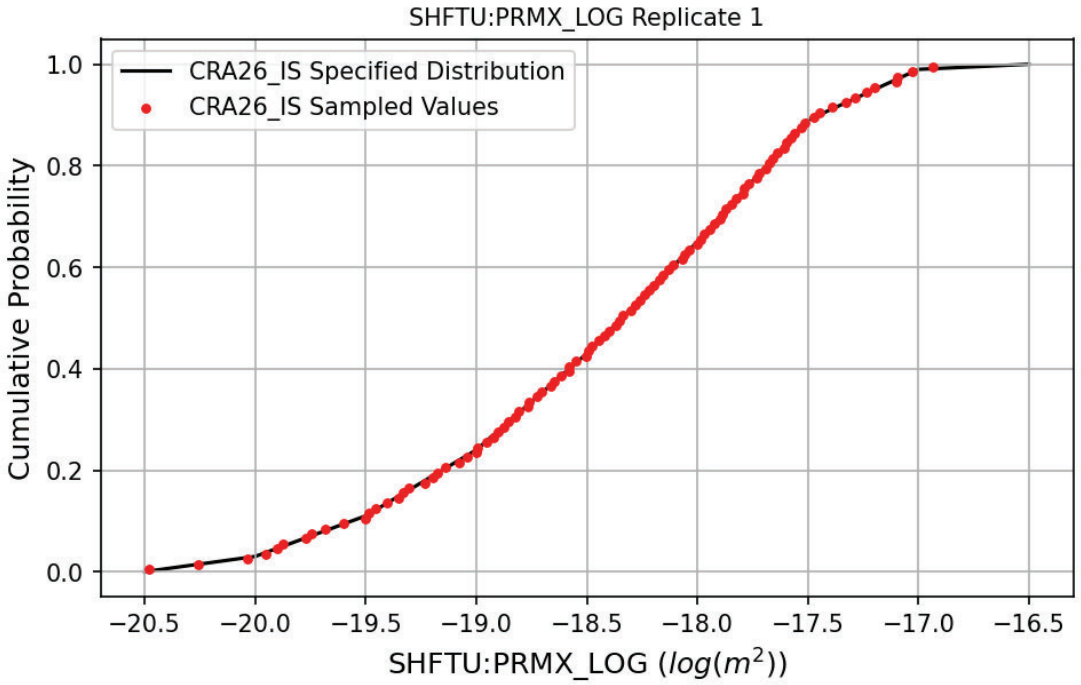

Figure 52. Observed and Expected CDFs for SHFTU:PRMX_LOG (Cumulative Distribution) Replicate 1

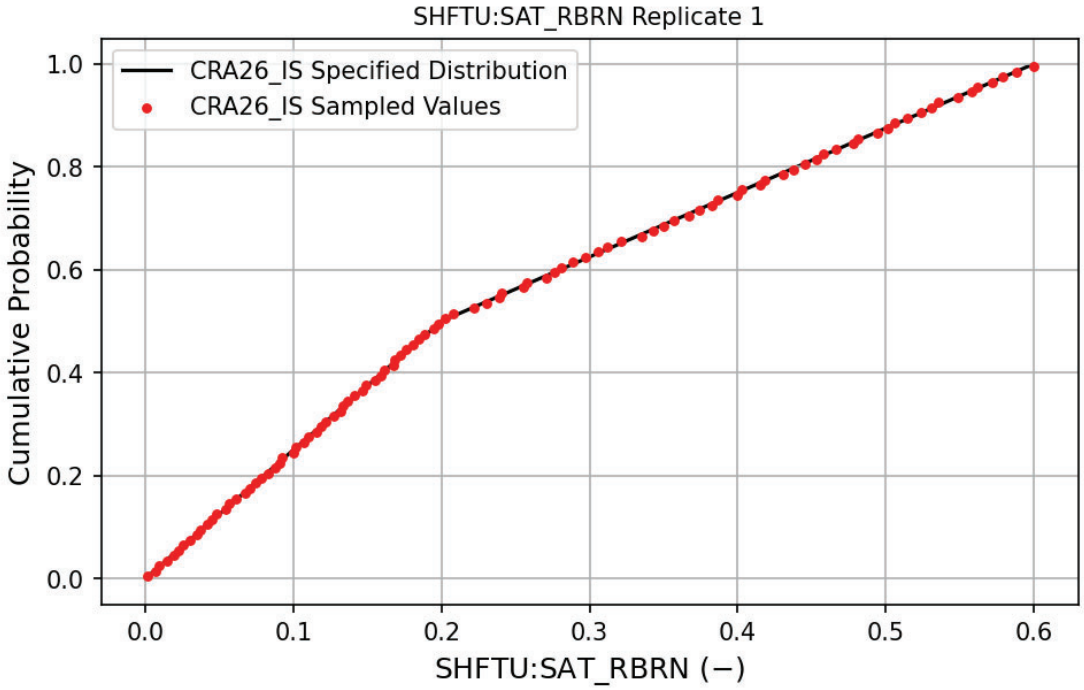

Figure 53. Observed and Expected CDFs for SHFTU:SAT_RBRN (Cumulative Distribution) Replicate 1

Information Only

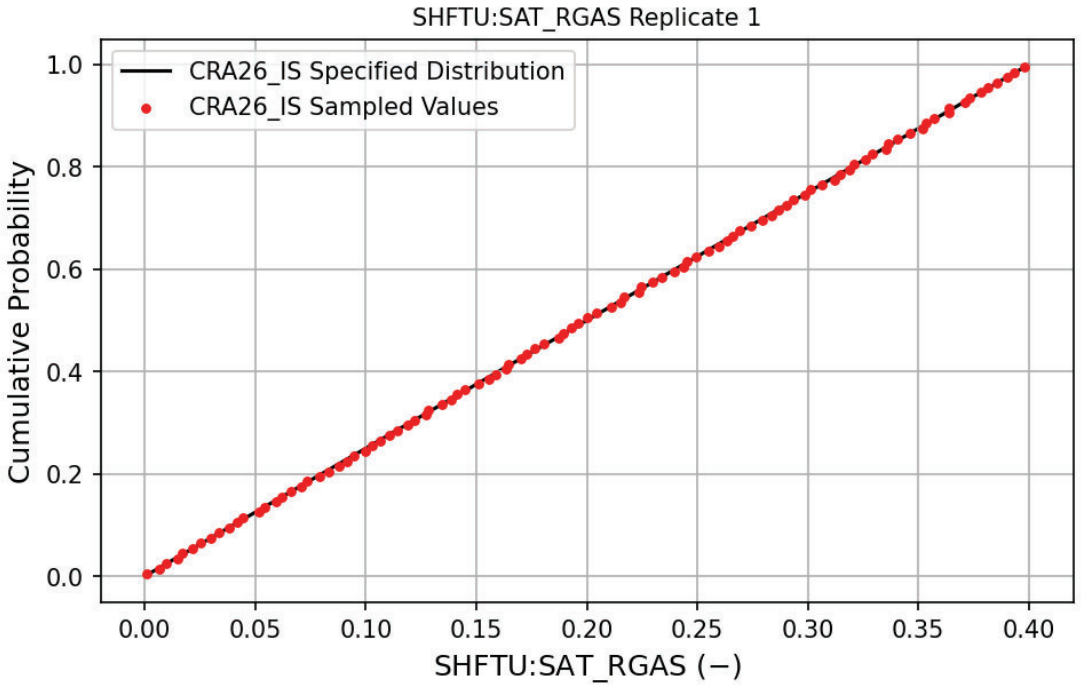

Figure 54. Observed and Expected CDFs for SHFTU:SAT_RGAS (Uniform Distribution) Replicate 1

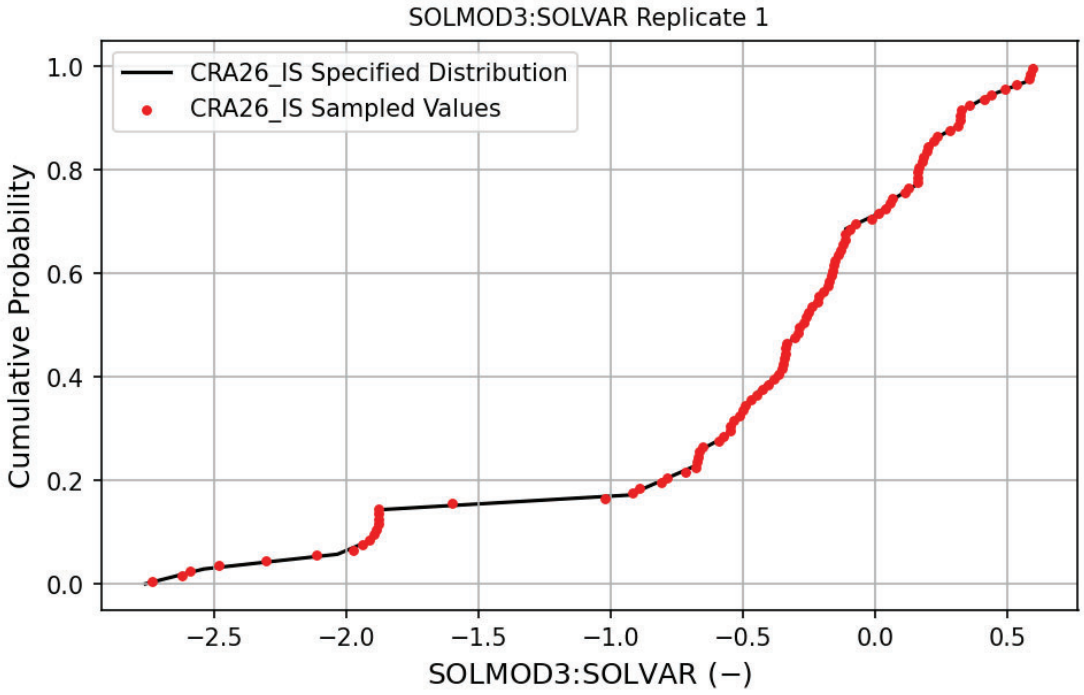

Figure 55. Observed and Expected CDFs for SOLMOD3:SOLVAR (Cumulative Distribution) Replicate 1

Information Only

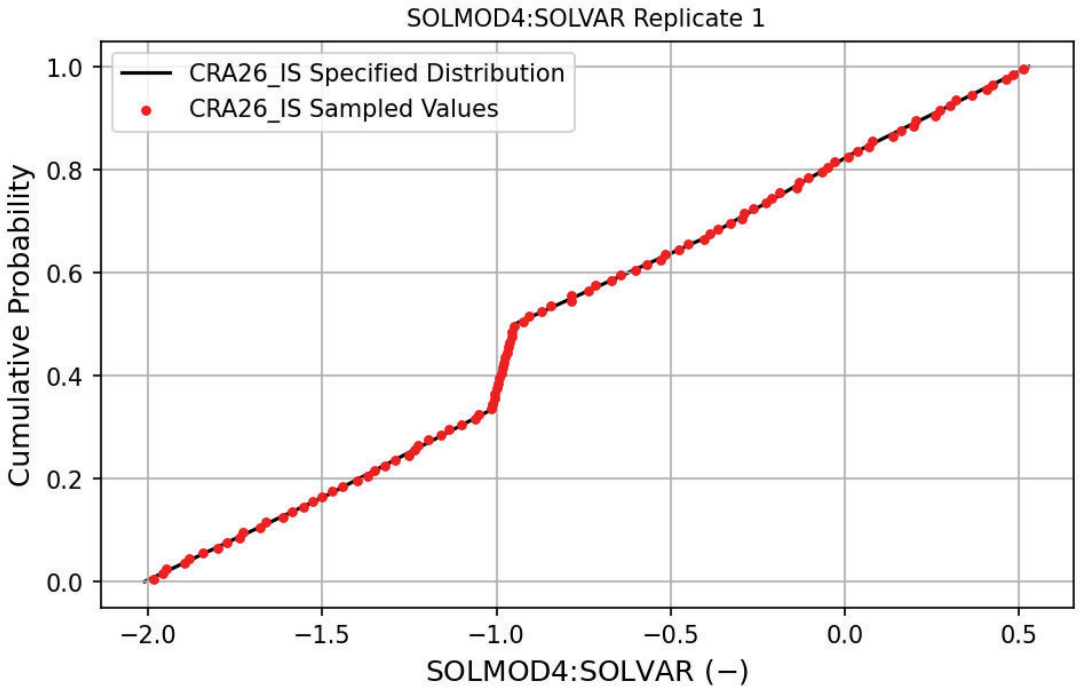

Figure 56. Observed and Expected CDFs for SOLMOD4:SOLVAR (Cumulative Distribution) Replicate 1

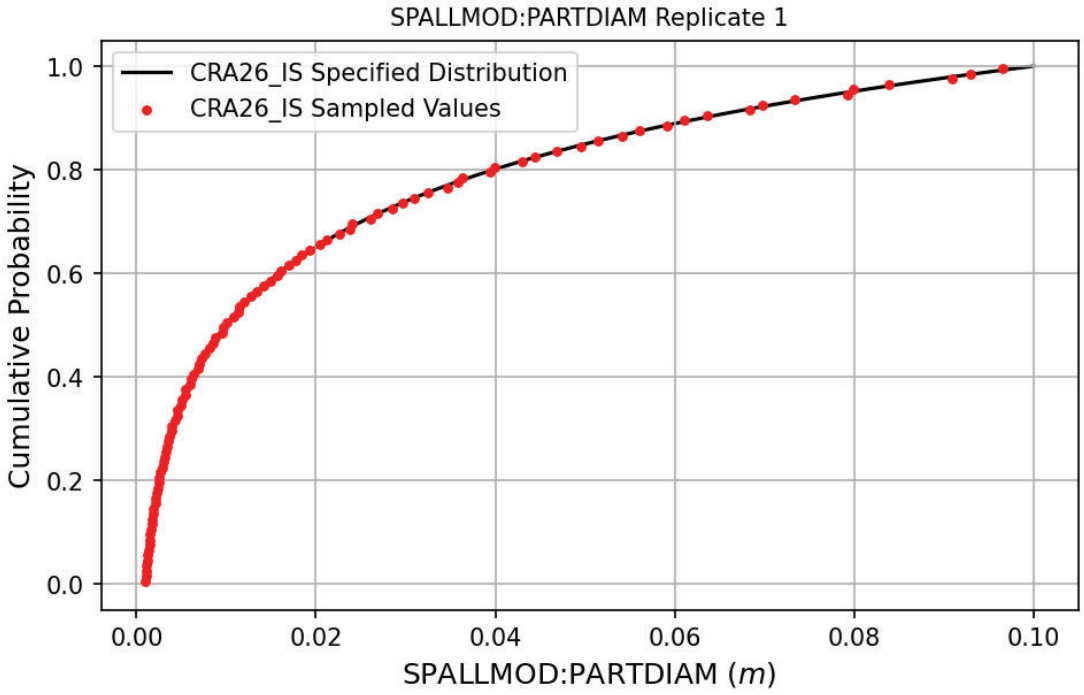

Figure 57. Observed and Expected CDFs for SPALLMOD:PARTDIAM (Loguniform Distribution) Replicate 1

Information Only

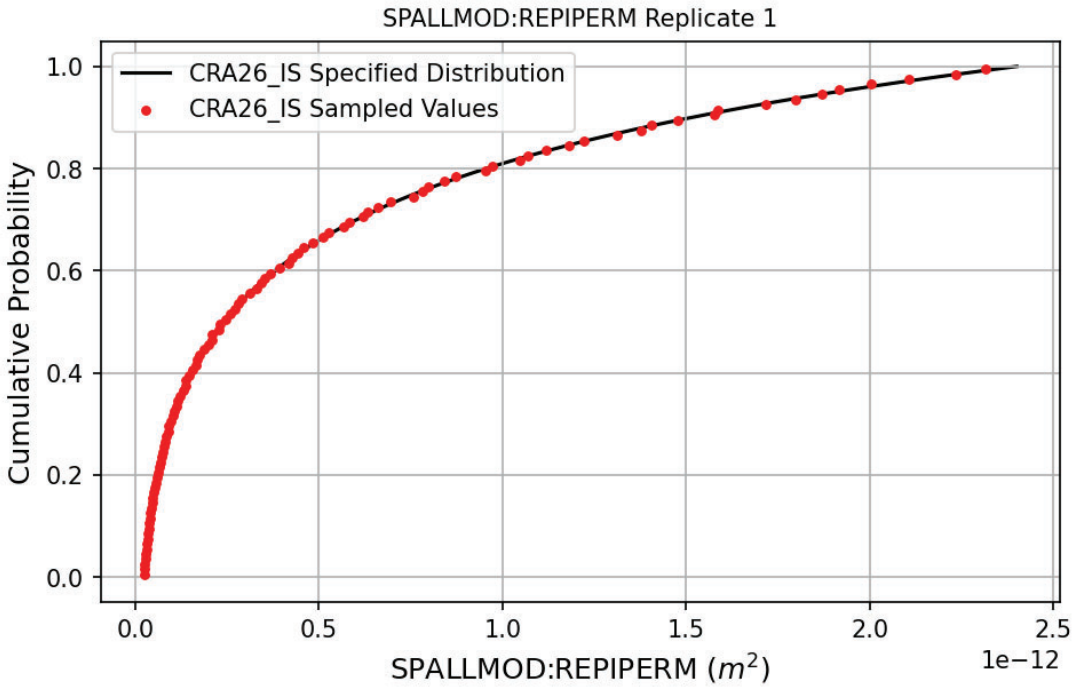

Figure 58. Observed and Expected CDFs for SPALLMOD:REPIPERM (Loguniform Distribution) Replicate 1

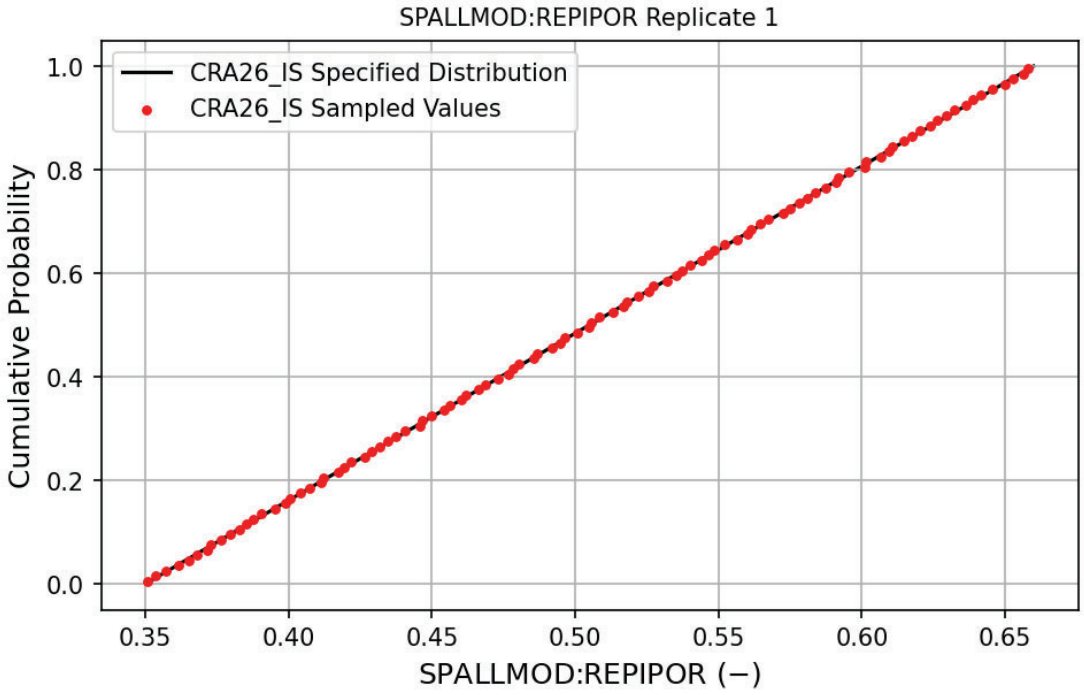

Figure 59. Observed and Expected CDFs for SPALLMOD:REPIPOR (Uniform Distribution) Replicate 1

Information Only

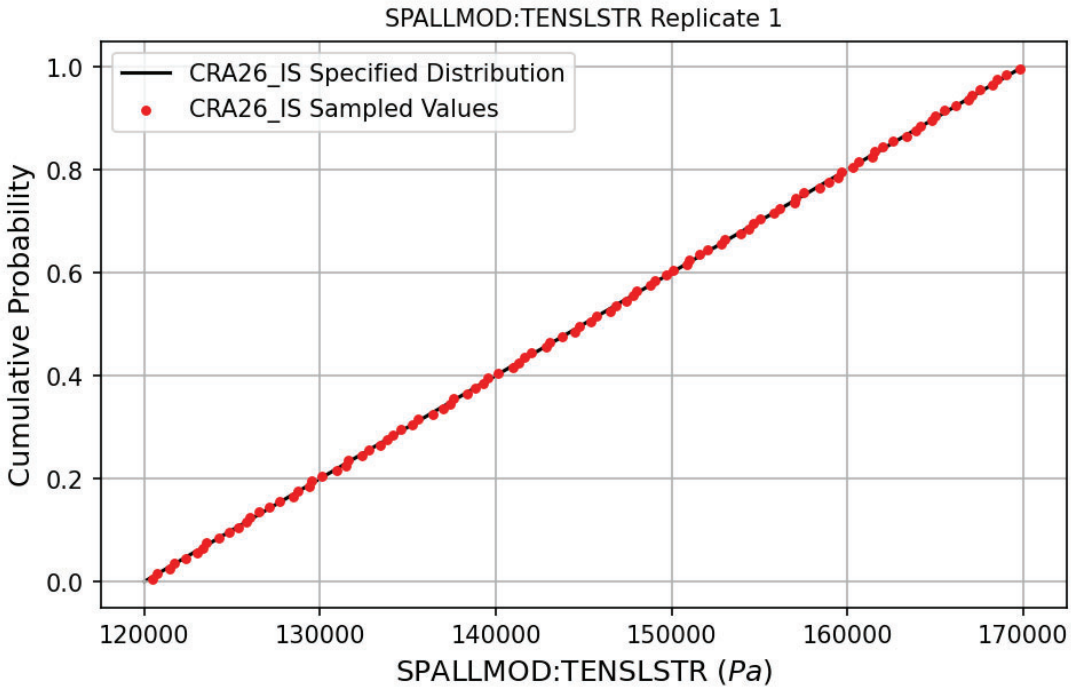

Figure 60. Observed and Expected CDFs for SPALLMOD:TENSLSTR (Uniform Distribution) Replicate 1

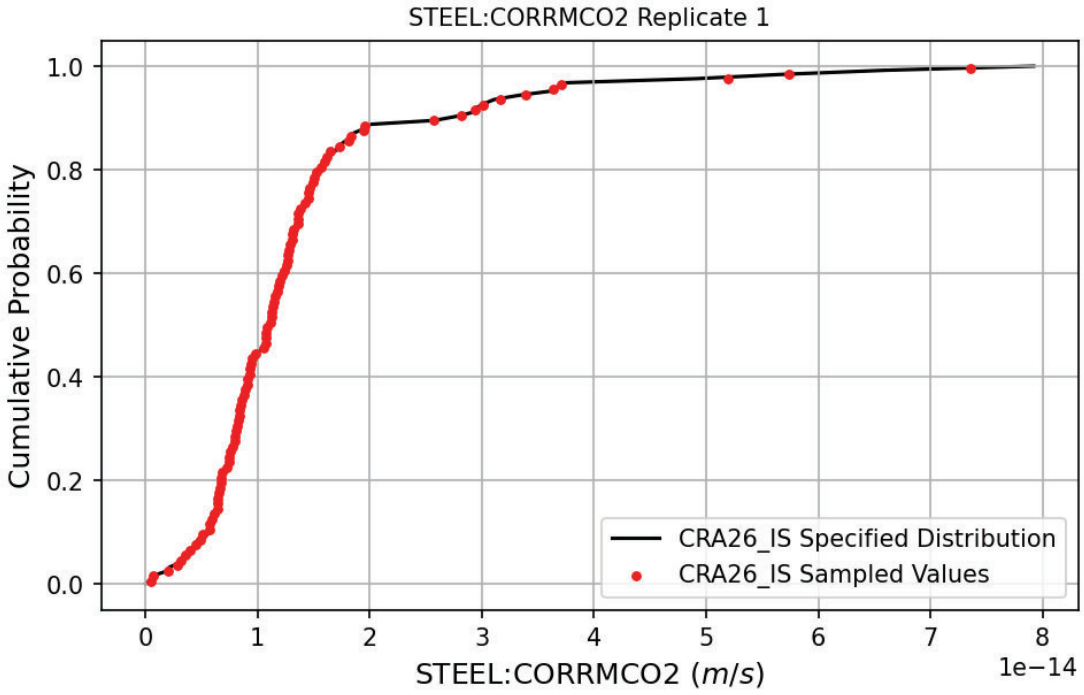

Figure 61. Observed and Expected CDFs for STEEL:CORRMCO2 (Cumulative Distribution) Replicate 1

Information Only

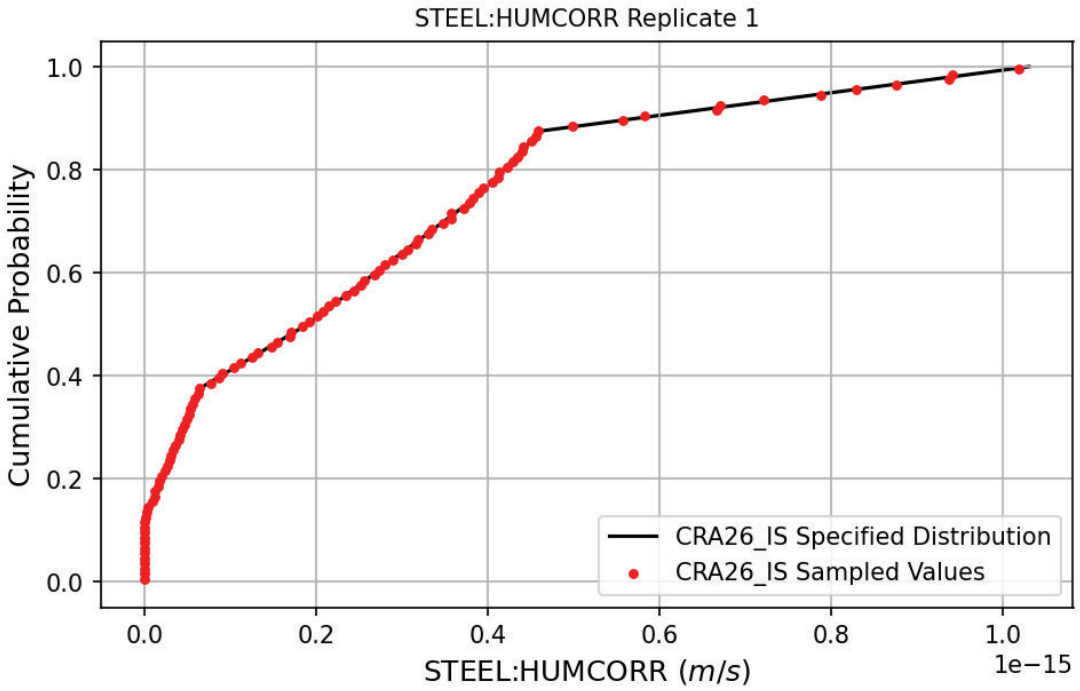

Figure 62. Observed and Expected CDFs for STEEL:HUMCORR (Cumulative Distribution) Replicate 1

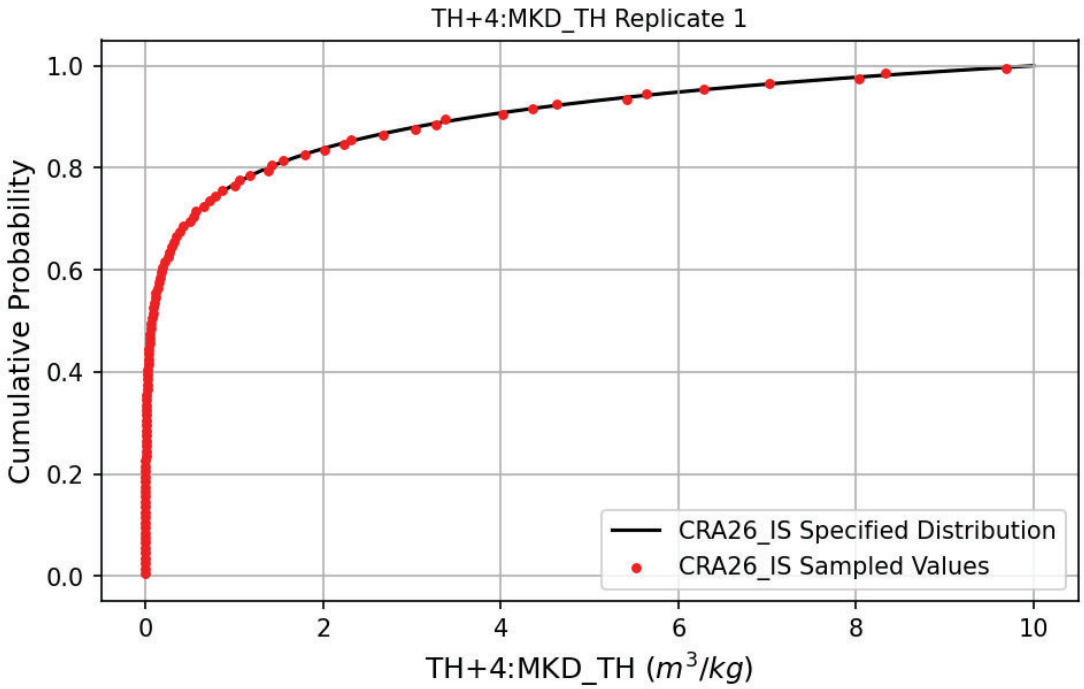

Figure 63. Observed and Expected CDFs for TH+4:MKD_TH (Loguniform Distribution) Replicate 1

Information Only

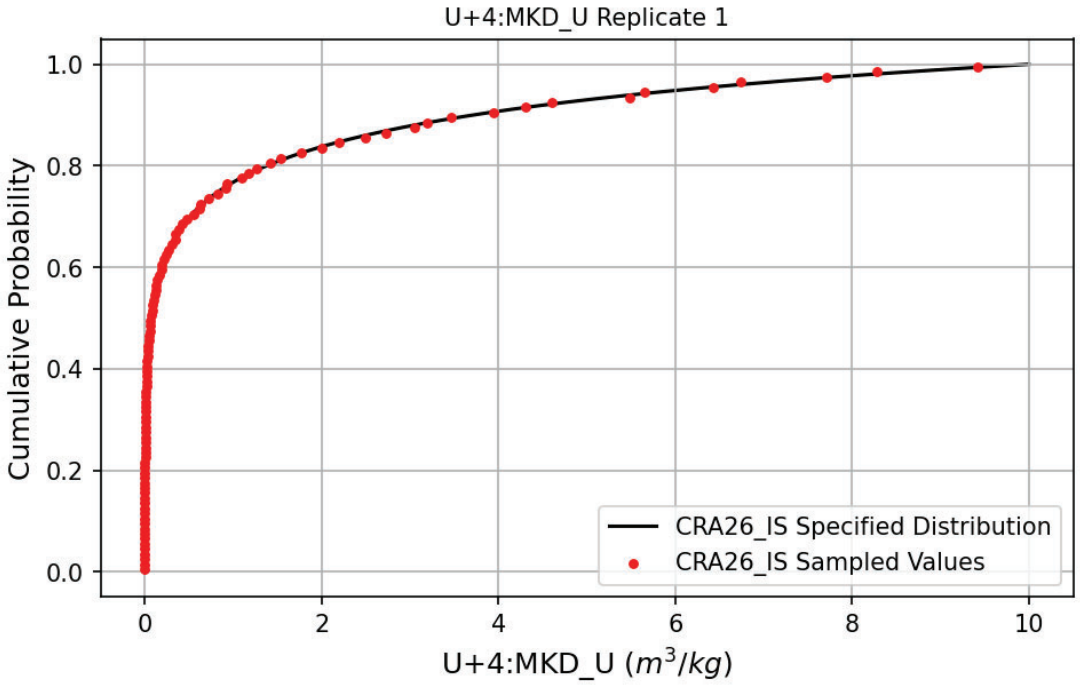

Figure 64. Observed and Expected CDFs for U+4:MKD_U (Loguniform Distribution) Replicate 1

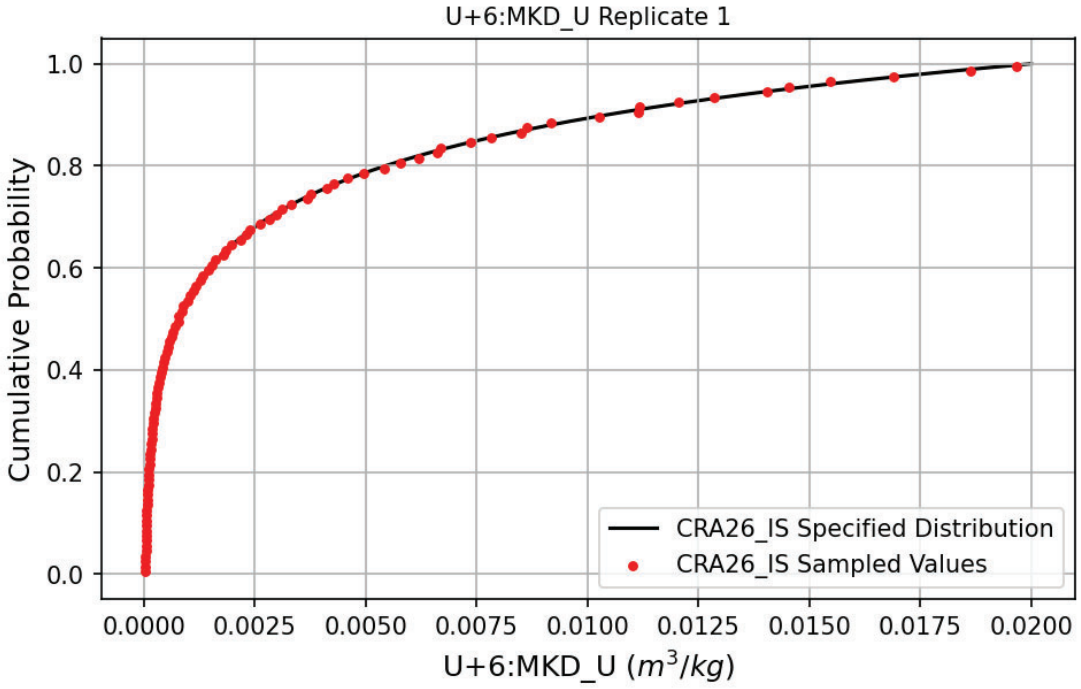

Figure 65. Observed and Expected CDFs for U+6:MKD_U (Loguniform Distribution) Replicate 1

Information Only

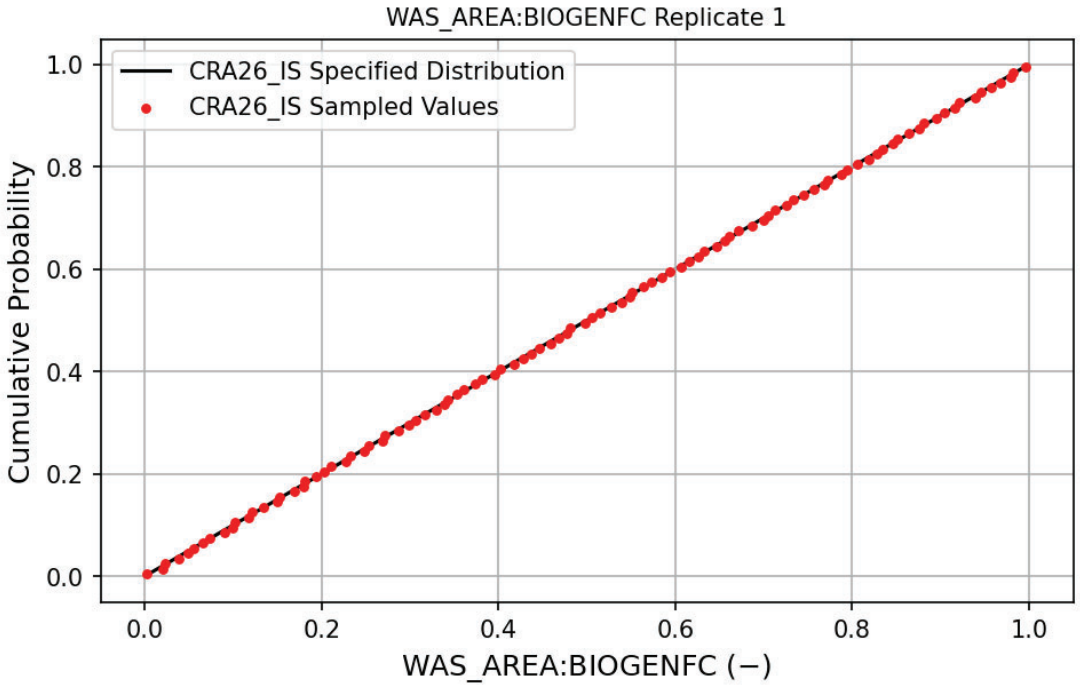

Figure 66. Observed and Expected CDFs for WAS_AREA:BIOGENFC (Uniform Distribution) Replicate 1

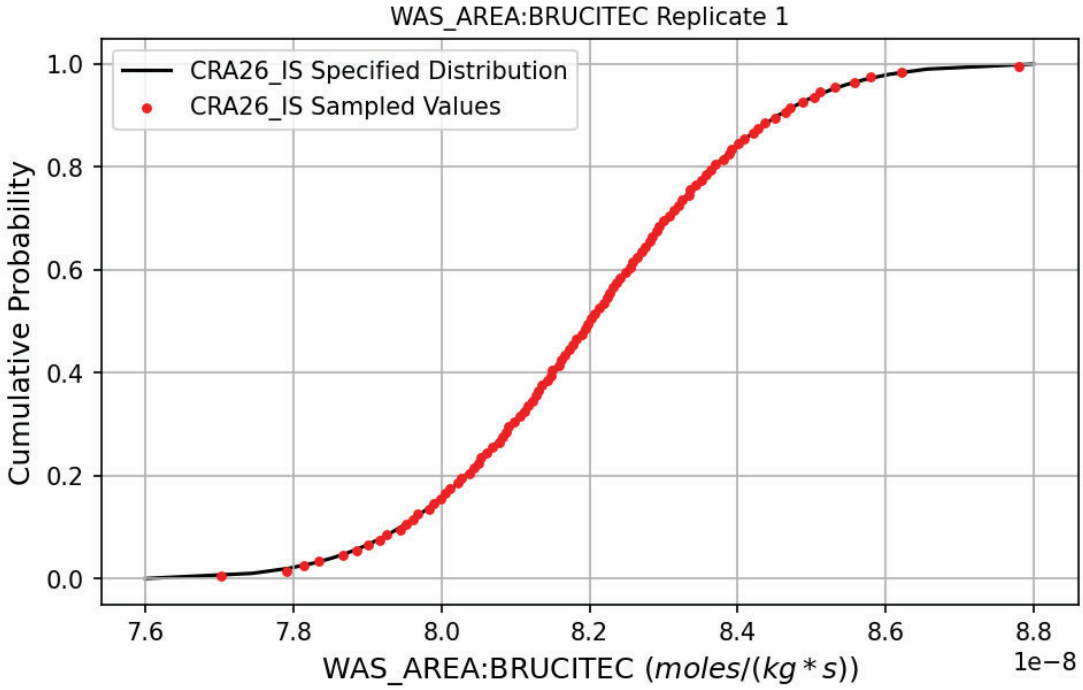

Figure 67. Observed and Expected CDFs for WAS_AREA:BRUCITEC (Cumulative Distribution) Replicate 1

Information Only

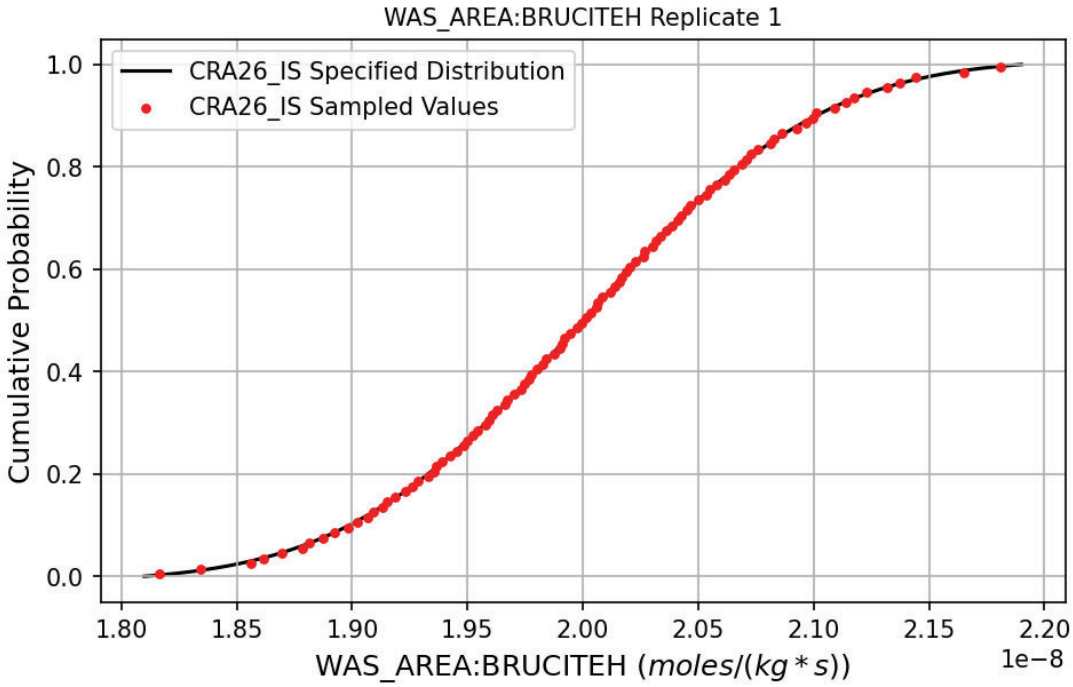

Figure 68. Observed and Expected CDFs for WAS_AREA:BRUCITEH (Normal Distribution) Replicate 1

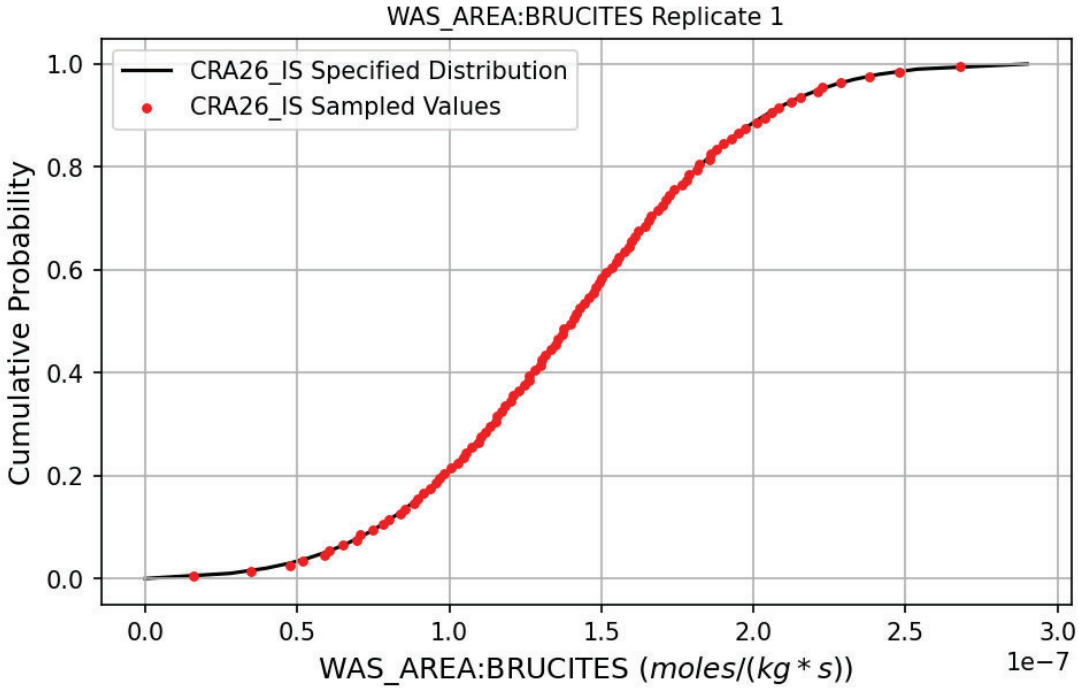

Figure 69. Observed and Expected CDFs for WAS_AREA:BRUCITES (Cumulative Distribution) Replicate 1

Information Only

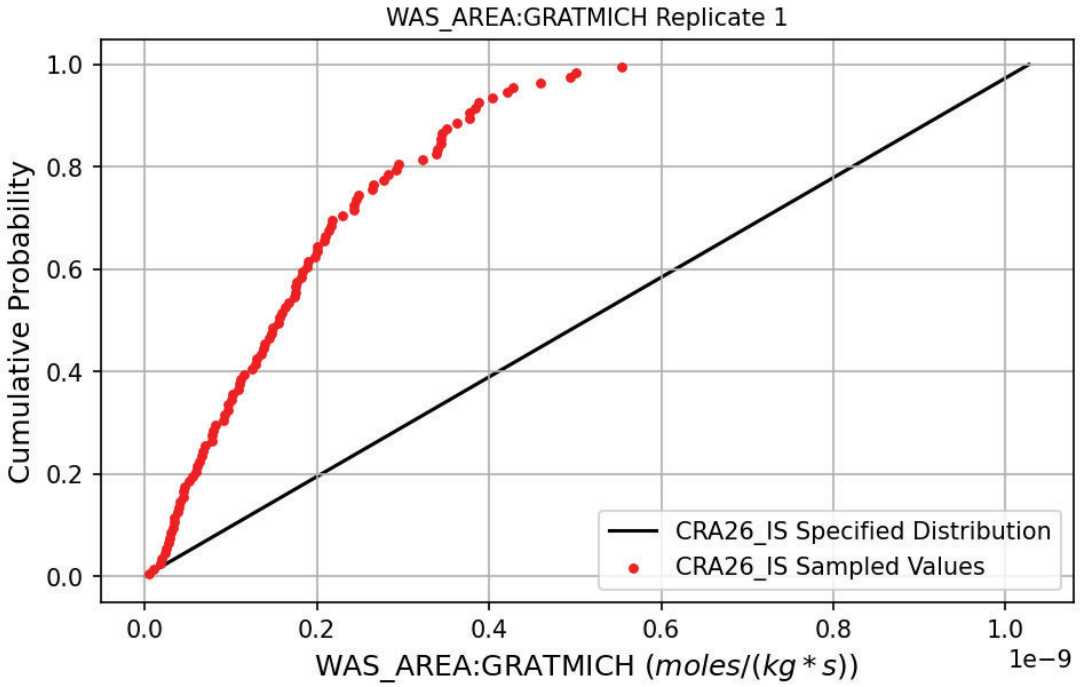

Figure 70. Observed and Expected CDFs for WAS_AREA:GRATMICH (Uniform Distribution) Replicate 1

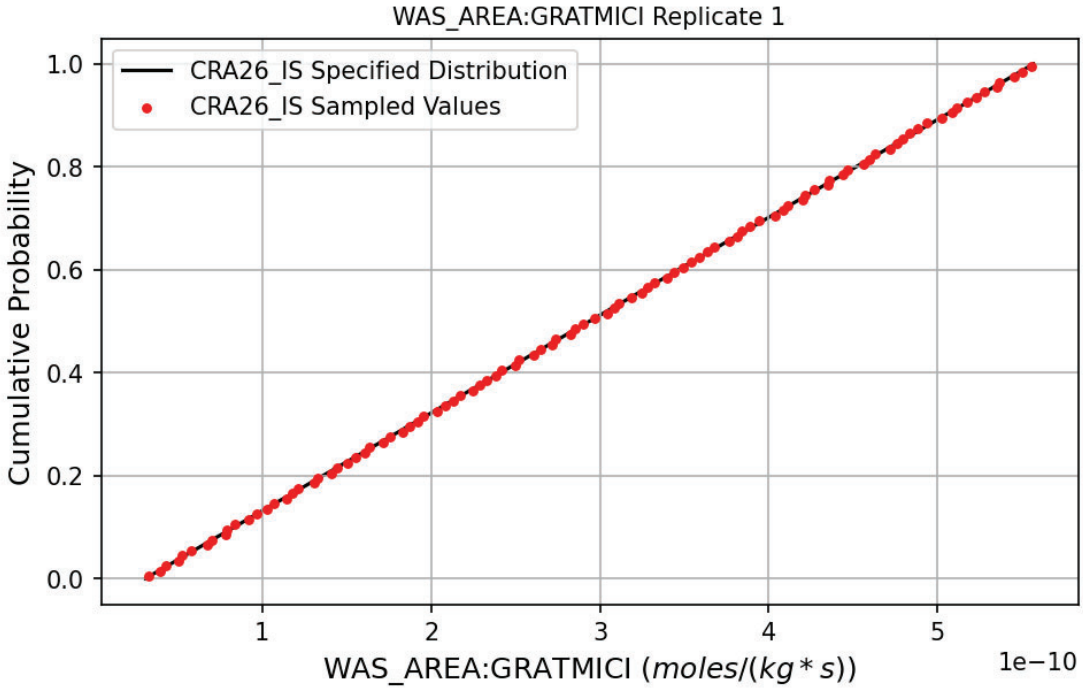

Figure 71. Observed and Expected CDFs for WAS_AREA:GRATMICI (Uniform Distribution) Replicate 1

Information Only

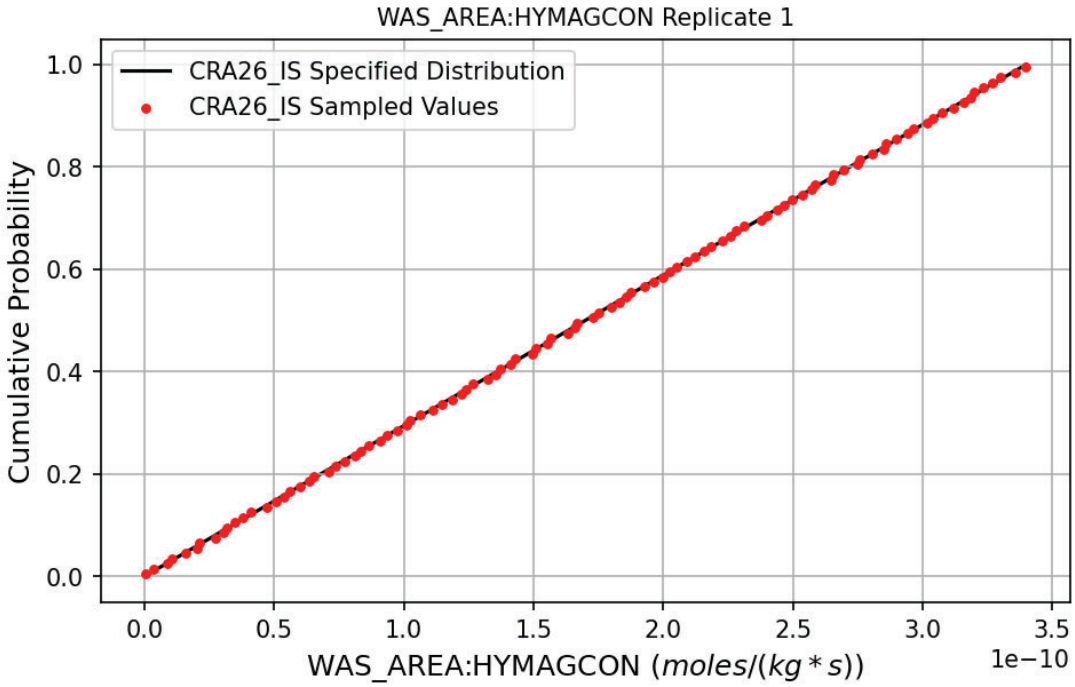

Figure 72. Observed and Expected CDFs for WAS_AREA:HYMAGCON (Uniform Distribution) Replicate 1

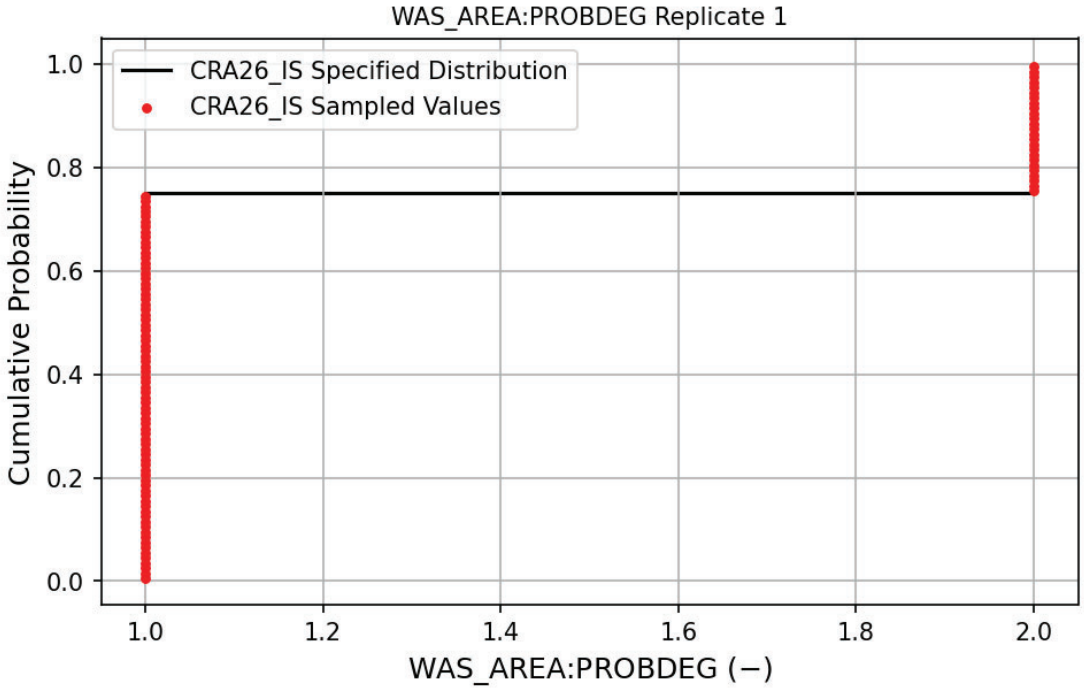

Figure 73. Observed and Expected CDFs for WAS_AREA:PROBDEG (Delta Distribution) Replicate 1

Information Only

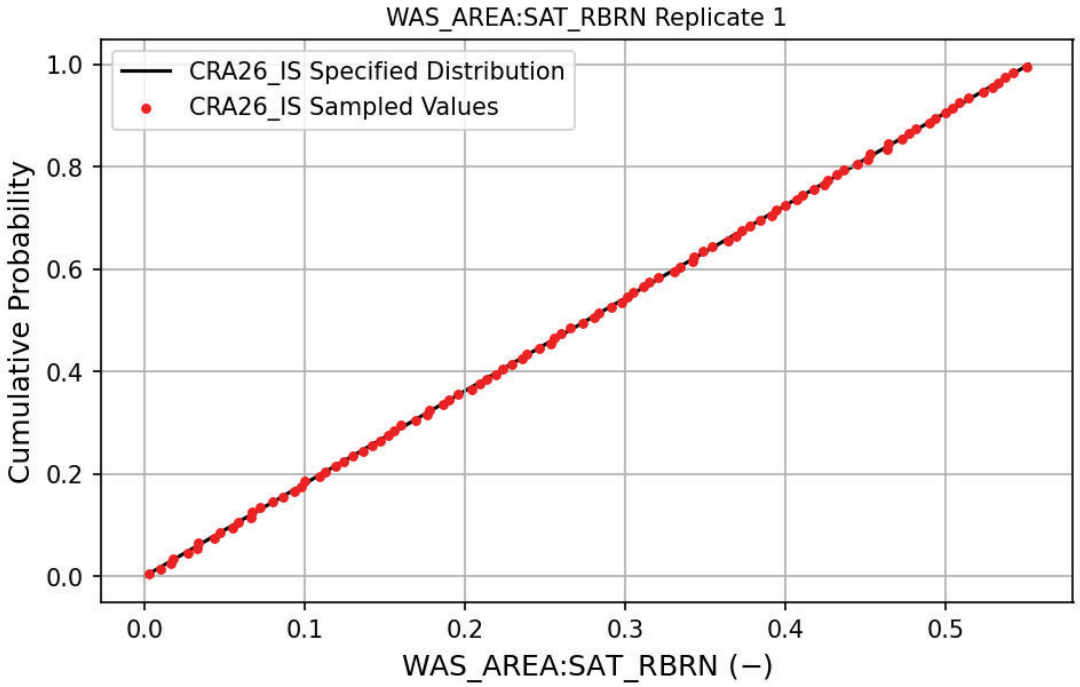

Figure 74. Observed and Expected CDFs for WAS_AREA:SAT_RBRN (Uniform Distribution) Replicate 1

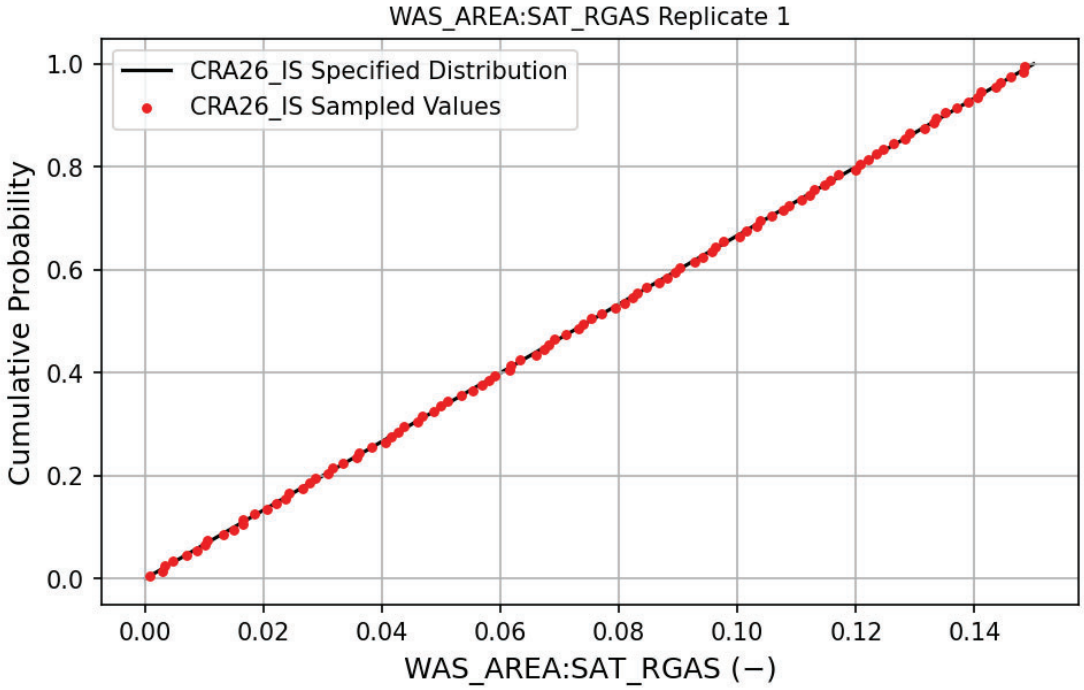

Figure 75. Observed and Expected CDFs for WAS_AREA:SAT_RGAS (Uniform Distribution) Replicate 1

Information Only

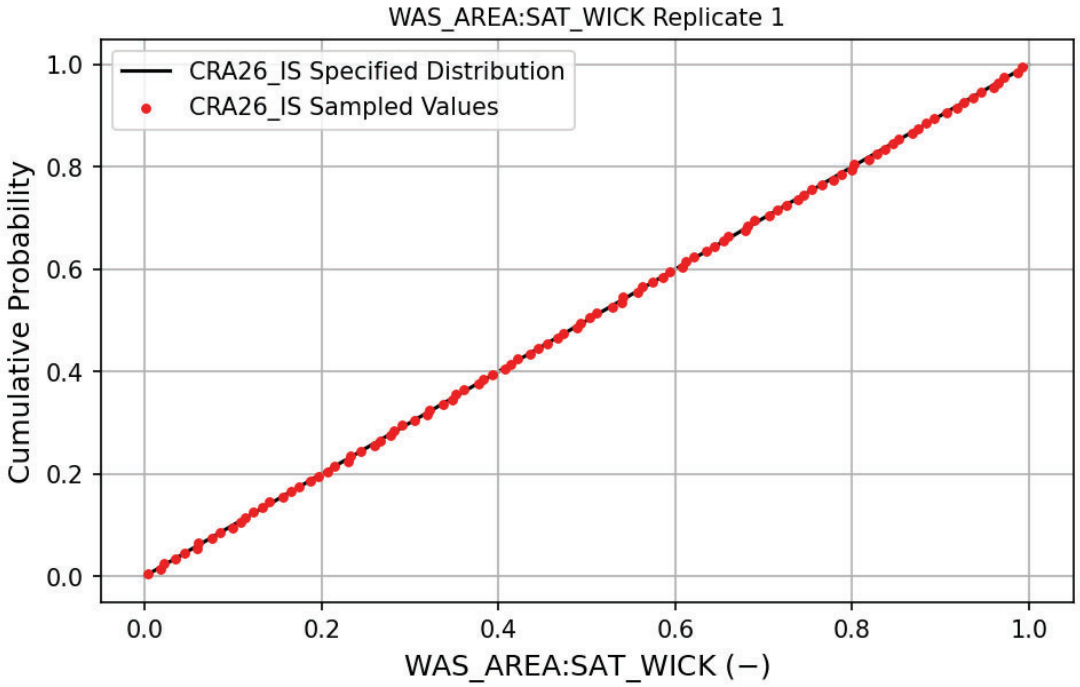

Figure 76. Observed and Expected CDFs for WAS_AREA:SAT_WICK (Uniform Distribution) Replicate 1

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6.0 SUMMARY

LHS was used to generate one hundred vectors of sampled parameter values for each of three replicates for the CRA26_FS and CRA26_IS. The random numbers used in the CRA-2026 PAs were identical to each other and identical parameter values were generated. The random numbers were also identical to the random numbers used in the RPPCR. This allows a direct comparison of the CRA-2026 PAs to previous analyses.

Correlations were assigned to two pairs of variables (S_HALITE:PRMX_LOG and S_HALITE:COMP_RCK, as well as CASTILER:PRMX_LOG and CASTILER:COMP_RCK) and applied during the LHS sampling process. The LHS results were additionally influenced by an enforcement of a conditional relationship between three pairs of parameters: WAS_AREA:GRATMICH and WAS_AREA:GRATMICI, PCS_T3: POROSITY and PCS_T2: POROSITY, and PCS_T2: POROSITY and PCS_T1:POROSITY. Sixty-four parameters were sampled for the CRA26_FS and CRA26_IS calculations, including updated distributions for four parameters. All three replicates of 100 sets of sampled parameters were written to PA_Results for use by other WIPP PA codes.

The resulting sampled data had the expected correlation structure, and the values fell within the expected ranges. The distributions of sampled values matched the expected cumulative distribution functions (CDFs).

Information Only

7.0 REFERENCES

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8.0 APPENDIX A – REPLICATE 2 AND 3 RESULTS

In this appendix, results for replicate 2 and replicate 3 sampling will be shown as results from replicate 1 were shown in the main report.

8.1 Conditional Relationships

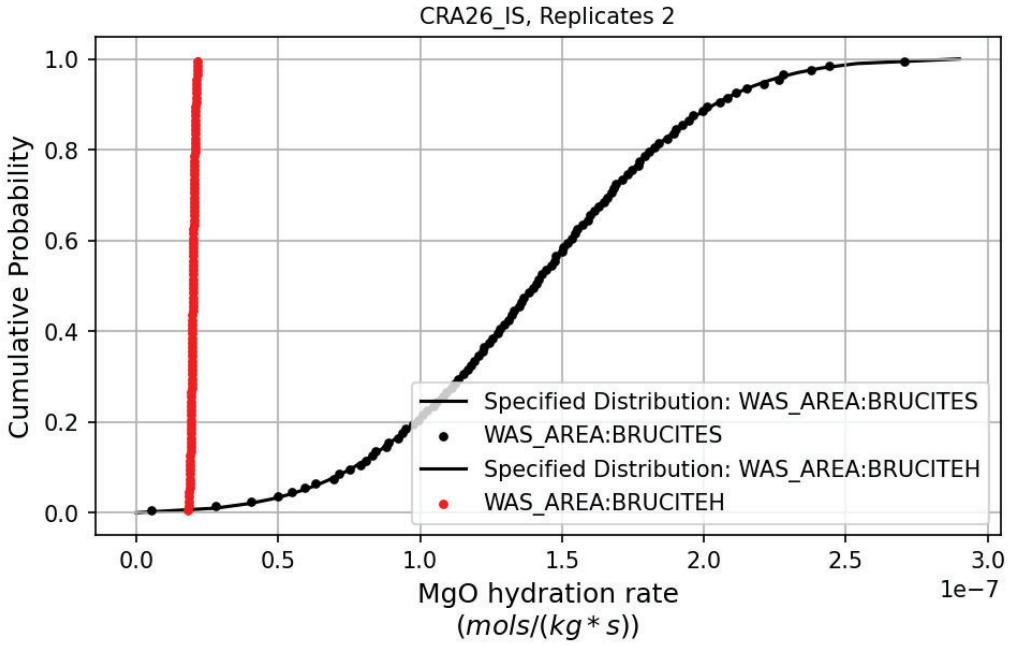

Figure 77. Comparison of WAS_AREA:BRUCITES and WAS_AREA:BRUCITEH Distributions for the CRA26_IS, Replicate 2

Information Only

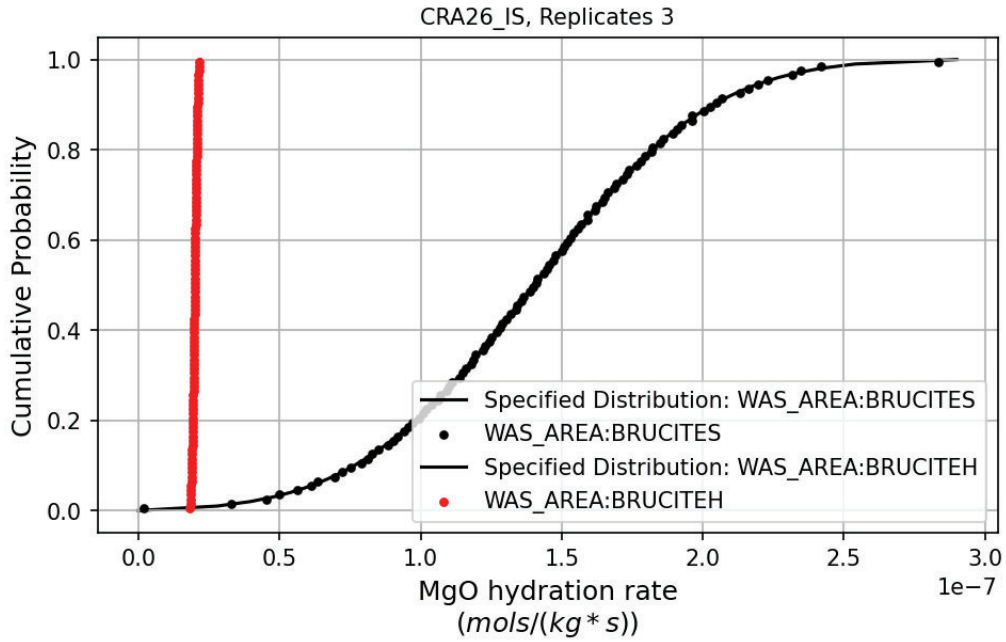

Figure 78. Comparison of WAS_AREA:BRUCITES and WAS_AREA:BRUCITEH Distributions for the CRA26_IS, Replicate 3

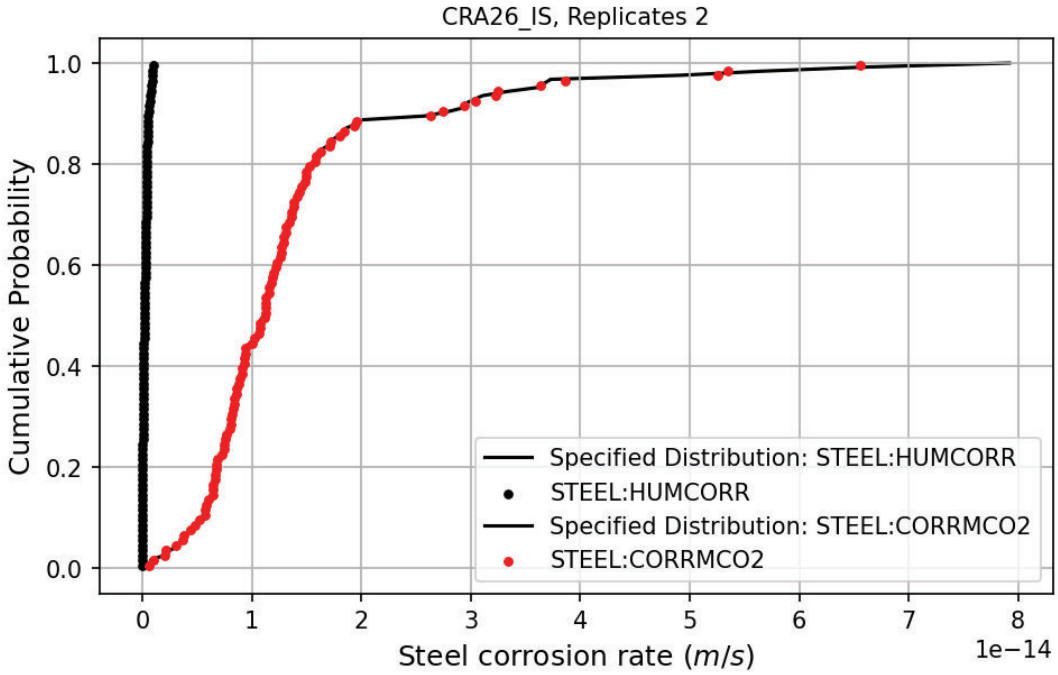

Figure 79. Comparison of STEEL:HUMCORR and STEEL:CORRMCO2 Distributions for the CRA26_IS, Replicate 2

Information Only

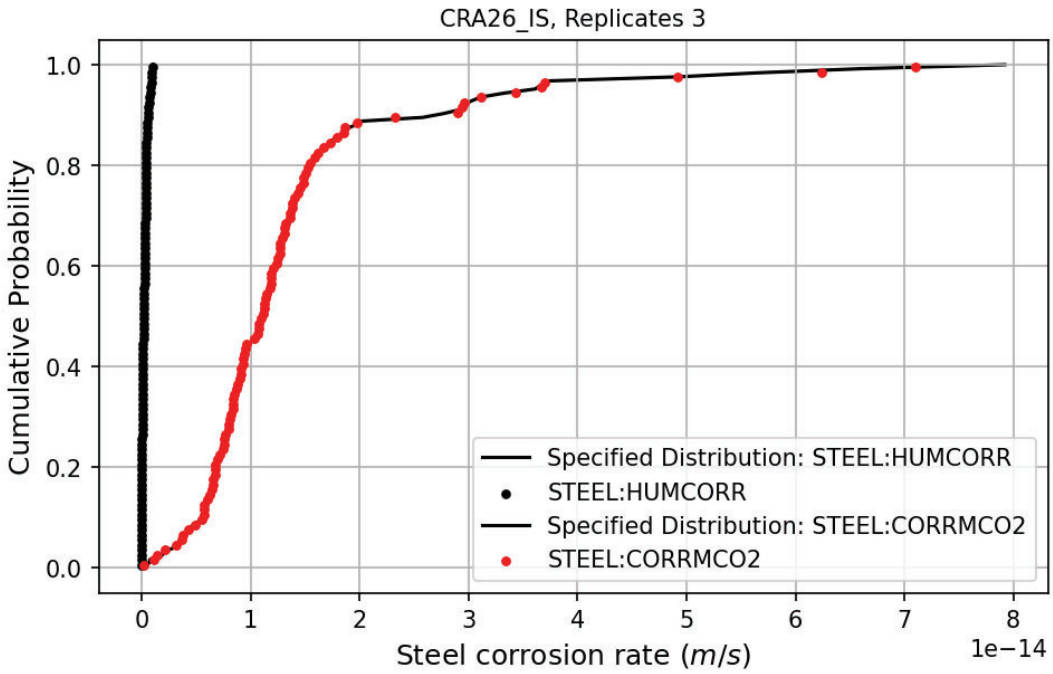

Figure 80. Comparison of STEEL:HUMCORR and STEEL:CORRMCO2 Distributions for the CRA26_IS, Replicate 3

Information Only

8.2 Parameters with Updated Sampled Values Since the RPPCR PA

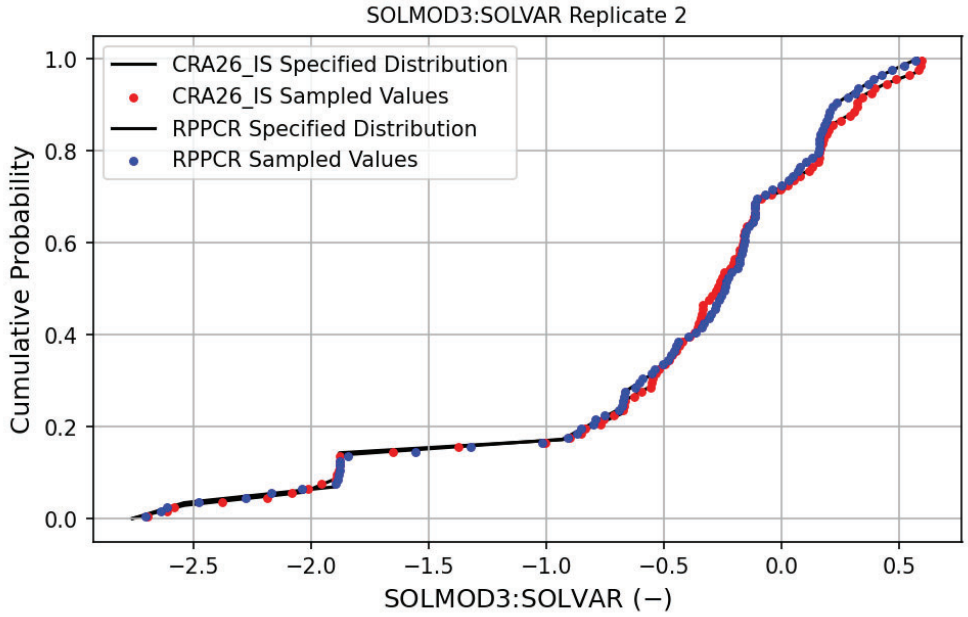

Figure 81. Observed and Expected CDFs for SOLMOD3:SOLVAR, Replicate 2 for the RPPCR and CRA26_IS Analyses

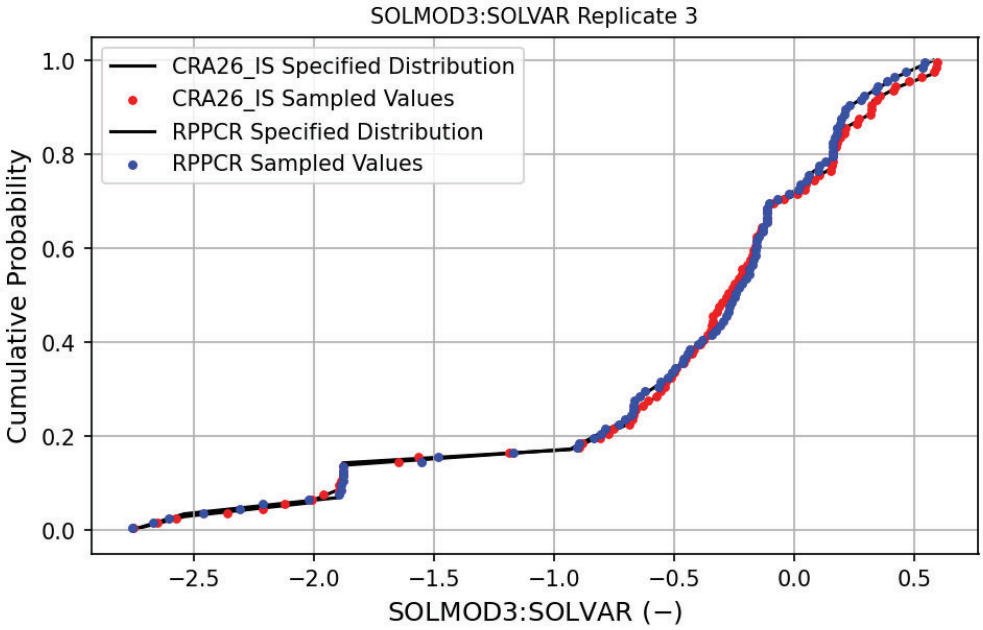

Figure 82. Observed and Expected CDFs for SOLMOD3:SOLVAR, Replicate 3 for the RPPCR and CRA26_IS Analyses

Information Only

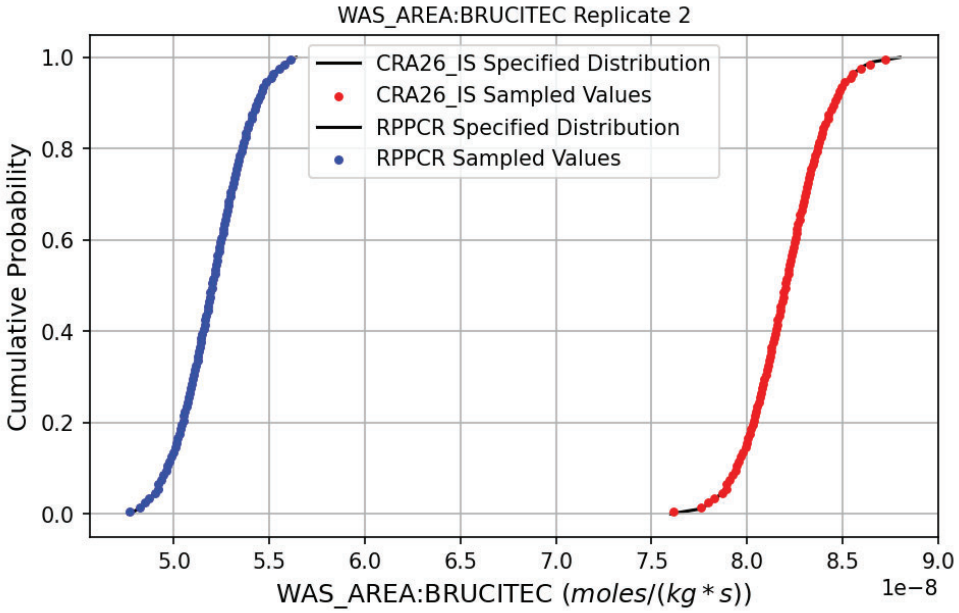

Figure 83. Observed and Expected CDFs for WAS_AREA:BRUCITEC, Replicate 2 for the RPPCR and CRA26_IS Analyses

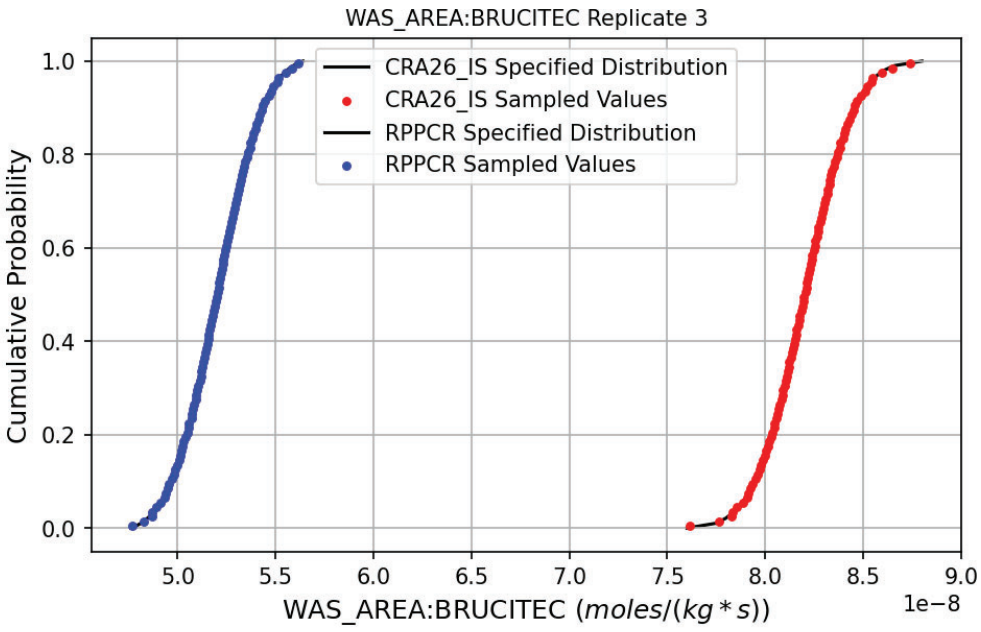

Figure 84. Observed and Expected CDFs for WAS_AREA:BRUCITEC, Replicate 3 for the RPPCR and CRA26_IS Analyses

Information Only

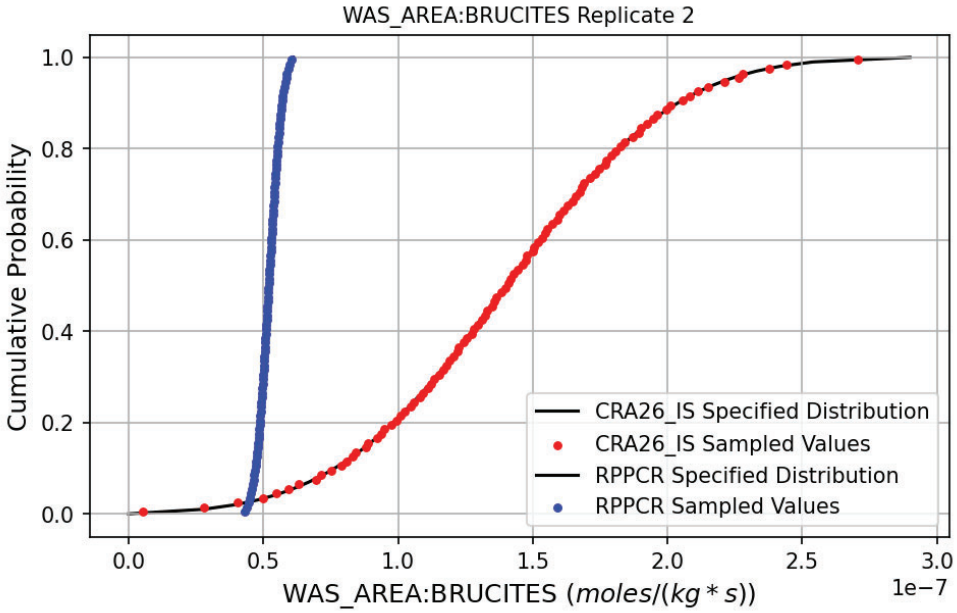

Figure 85. Observed and Expected CDFs for WAS_AREA:BRUCITES, Replicate 2 for the RPPCR and CRA26_IS Analyses

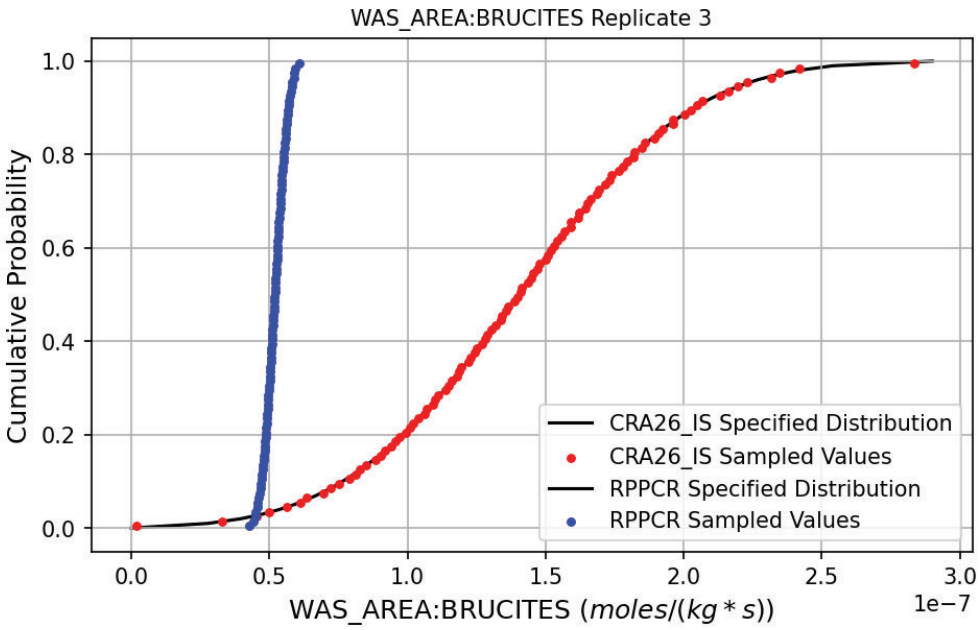

Figure 86. Observed and Expected CDFs for WAS_AREA:BRUCITES, Replicate 3 for the RPPCR and CRA26_IS Analyses

Information Only

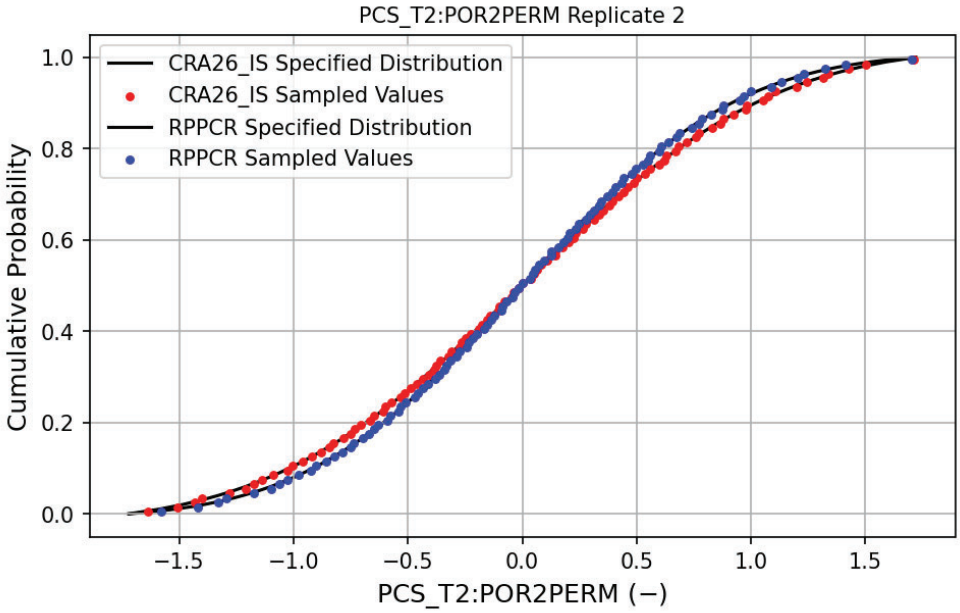

Figure 87. Observed and Expected CDFs for PCS_T2:POR2PERM, Replicate 2 for the RPPCR and CRA26_IS Analyses

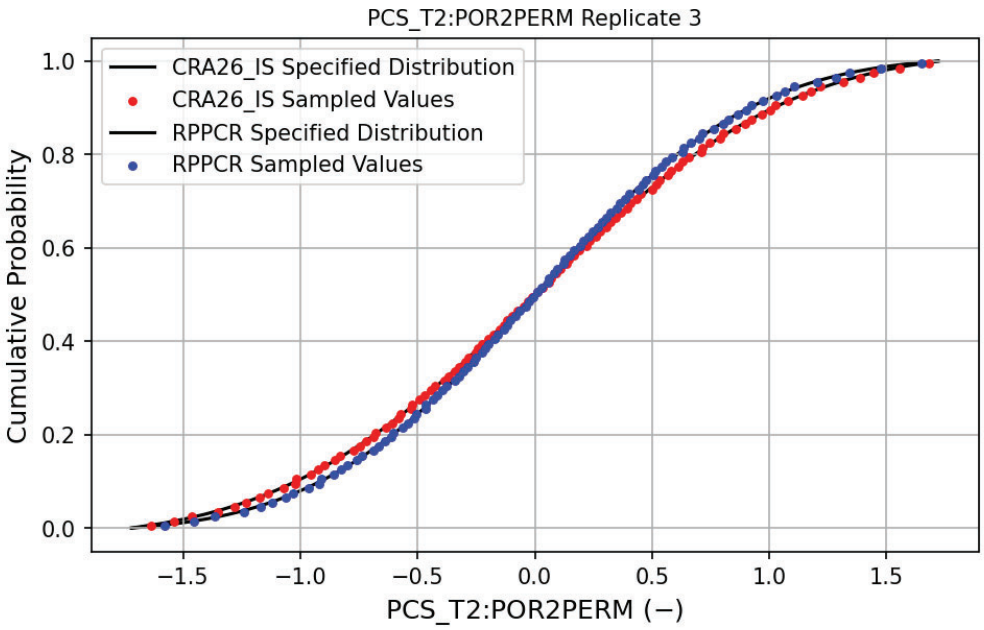

Figure 88. Observed and Expected CDFs for PCS_T2:POR2PERM, Replicate 3 for the RPPCR and CRA26_IS Analyses

Information Only

8.3 Parameters with Conditional Relationships

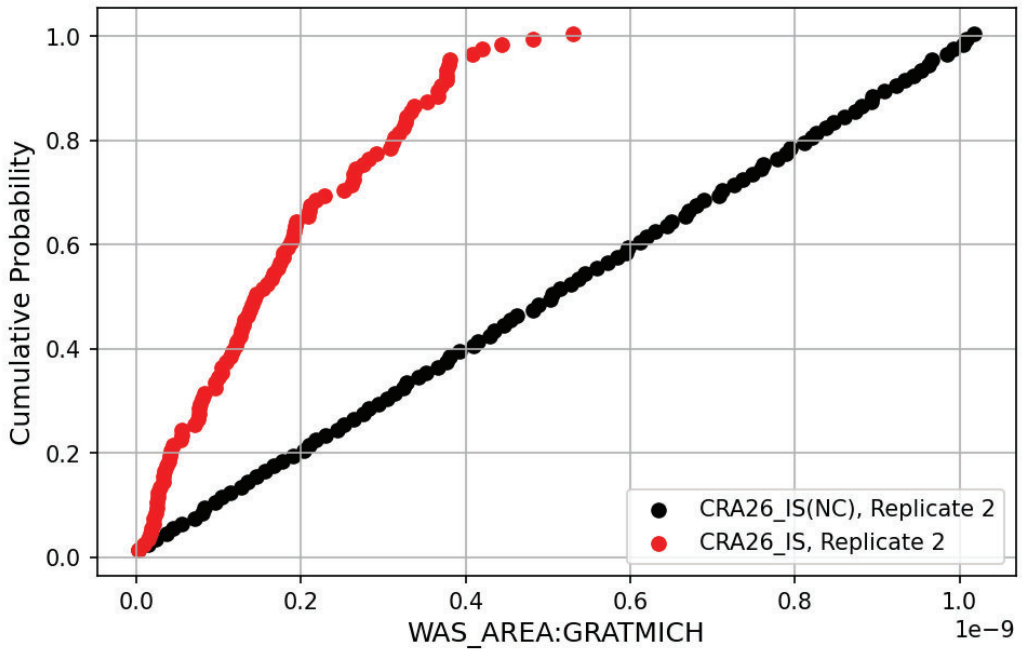

Figure 89. Conditioned and Non-Conditioned Sampled Values for WAS_AREA:GRATMICH, Replicate 2

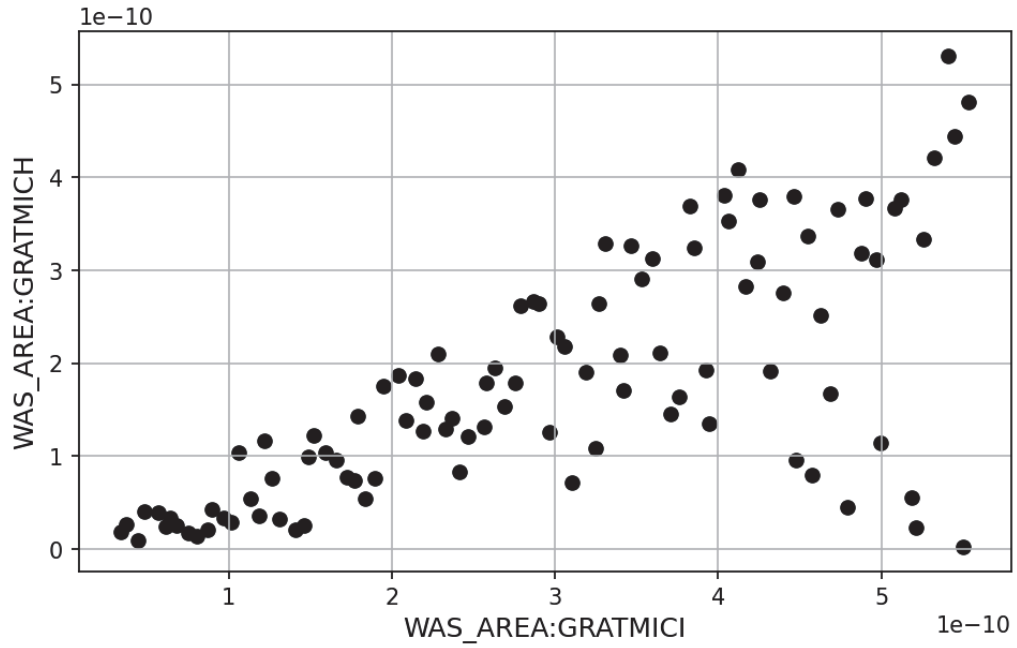

Figure 90. Correlation Between WAS_AREA:GRATMICI and WAS_AREA:GRATMICH, Replicate 2

Information Only

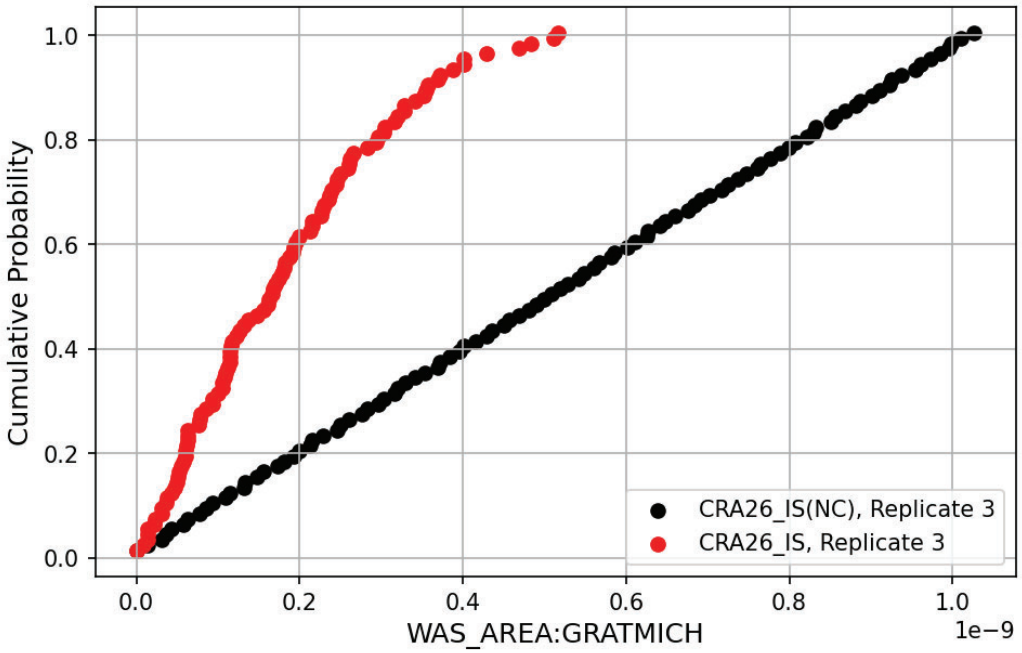

Figure 91. Conditioned and Non-Conditioned Sampled Values for WAS_AREA:GRATMICH, Replicate 3

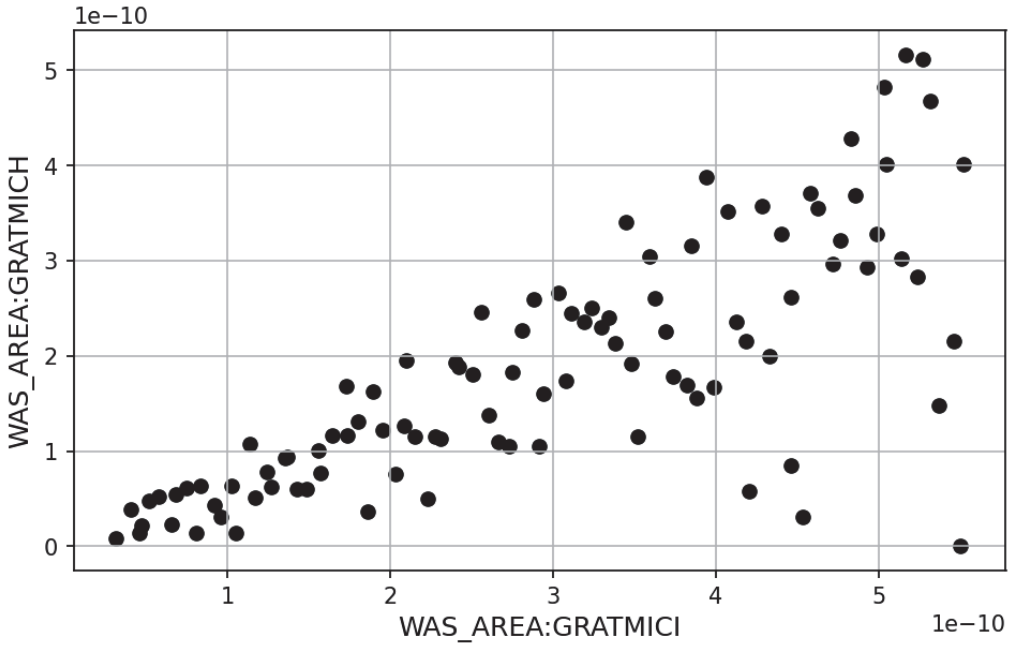

Figure 92. Correlation Between WAS_AREA:GRATMICI and WAS_AREA:GRATMICH, Replicate 3

Information Only

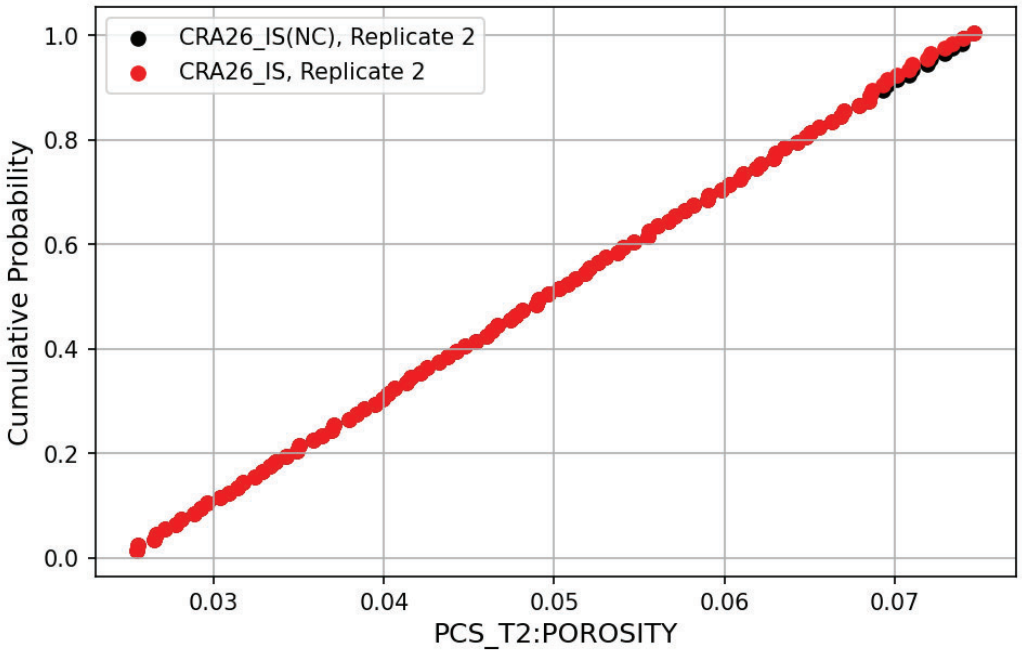

Figure 93. Conditioned and Non-Conditioned Sampled Values for PCS_T2:POROSITY, Replicate 2

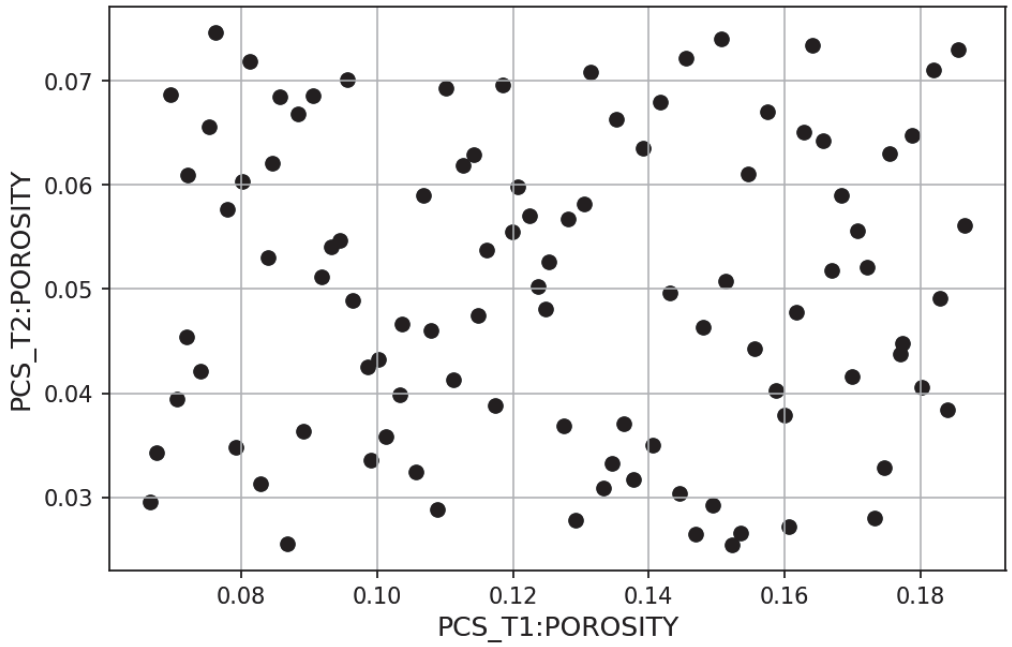

Figure 94. Correlation Between PCS_T1:POROSITY and PCS_T2:POROSITY, Replicate 2

Information Only

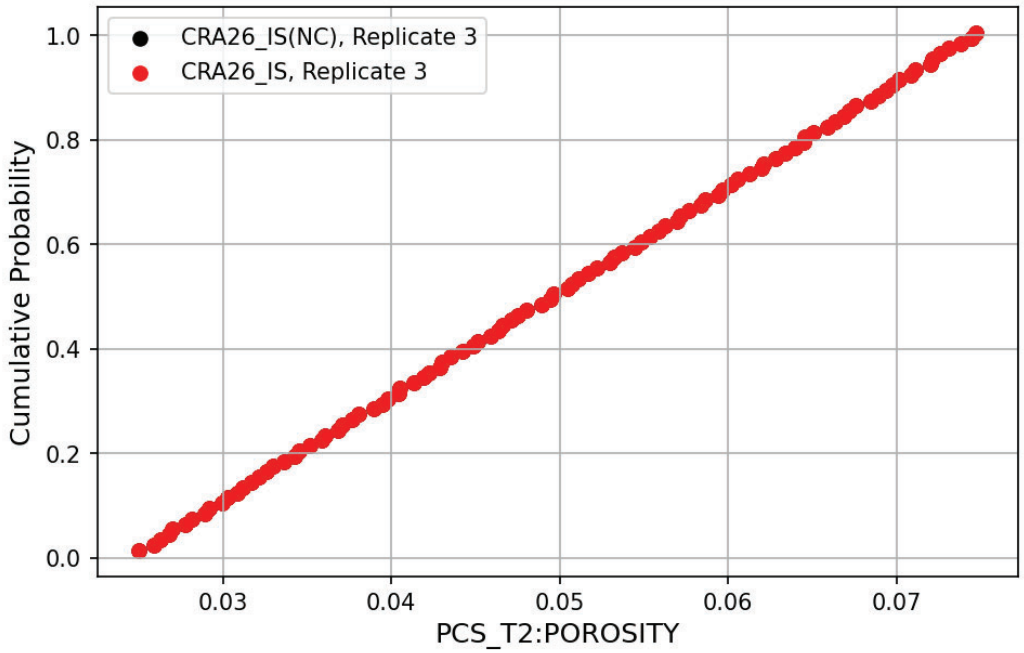

Figure 95. Conditioned and Non-Conditioned Sampled Values for PCS_T2:POROSITY, Replicate 3

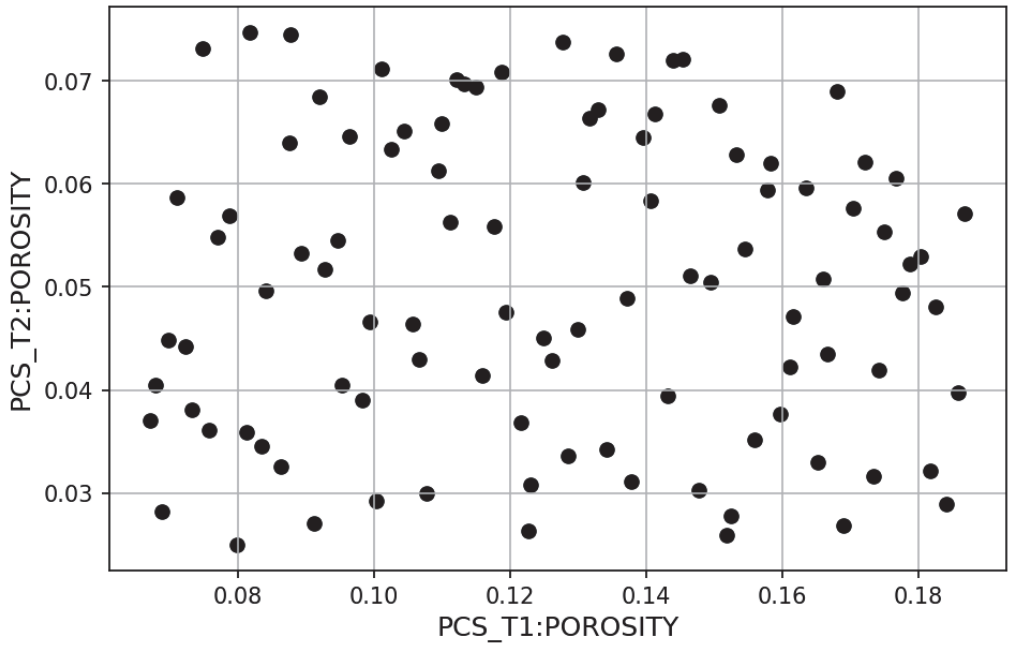

Figure 96. Correlation Between PCS_T1:POROSITY and PCS_T2:POROSITY, Replicate 3

Information Only

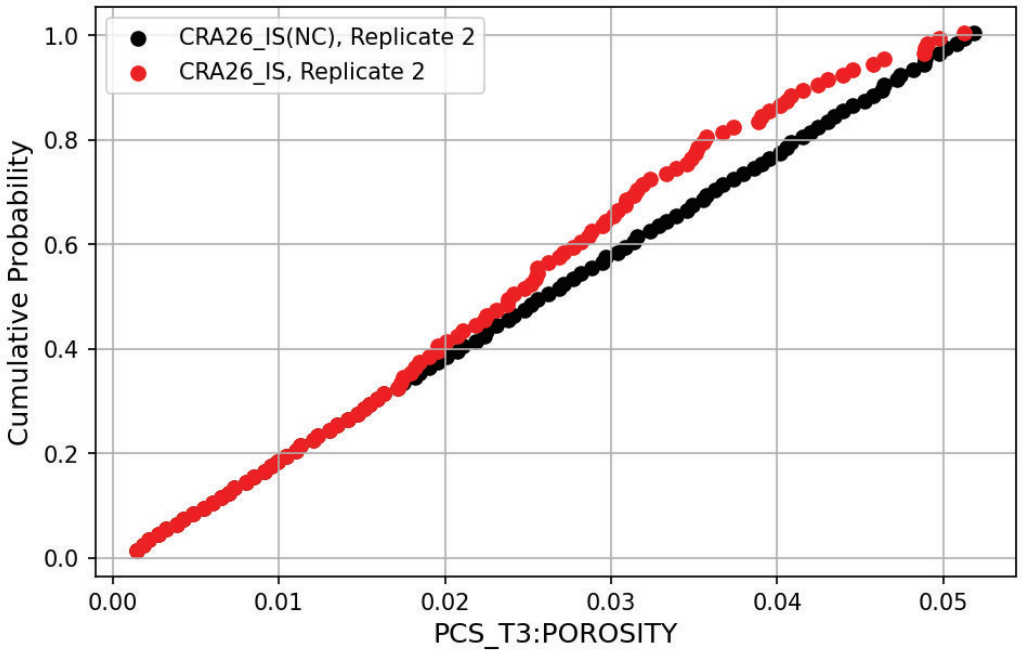

Figure 97. Conditioned and Non-Conditioned Sampled Values for PCS_T3:POROSITY, Replicate 2

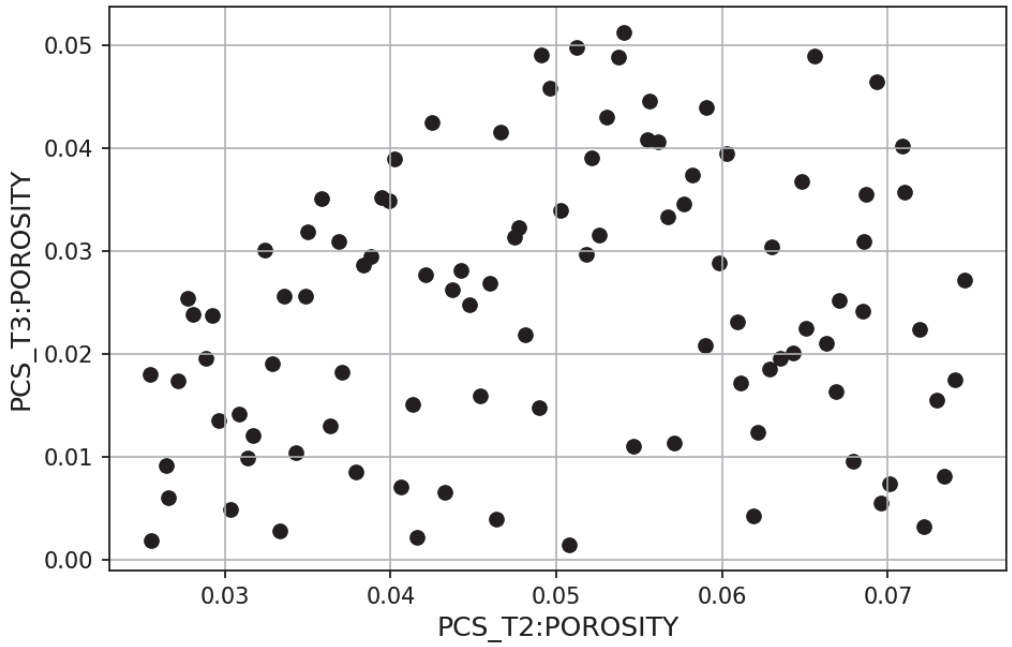

Figure 98. Correlation Between PCS_T2:POROSITY and PCS_T3:POROSITY, Replicate 2

Information Only

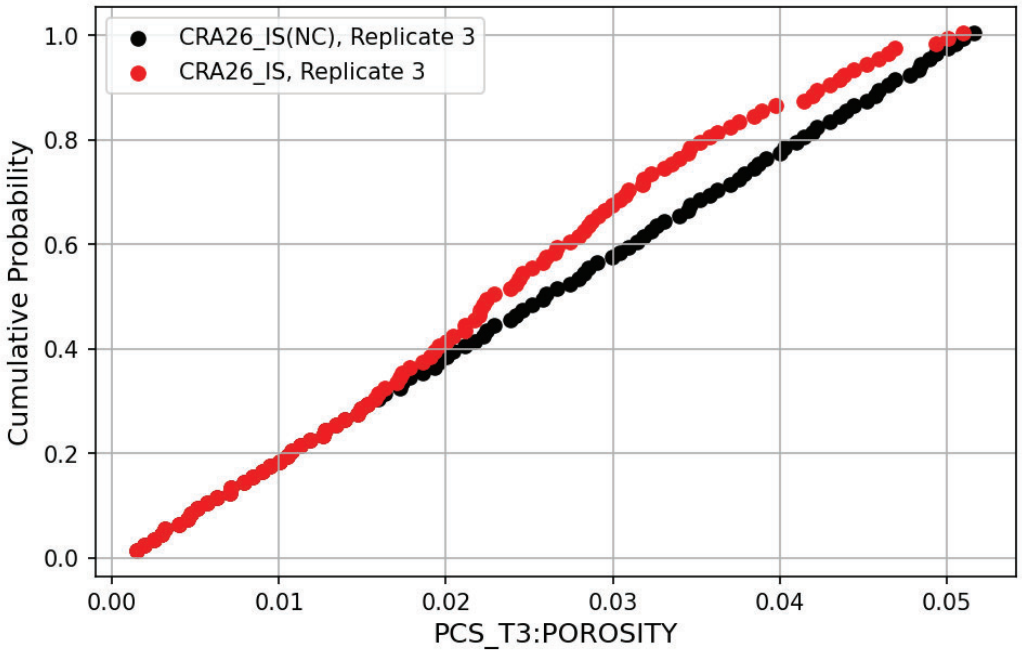

Figure 99. Conditioned and Non-Conditioned Sampled Values for PCS_T3:POROSITY, Replicate 3

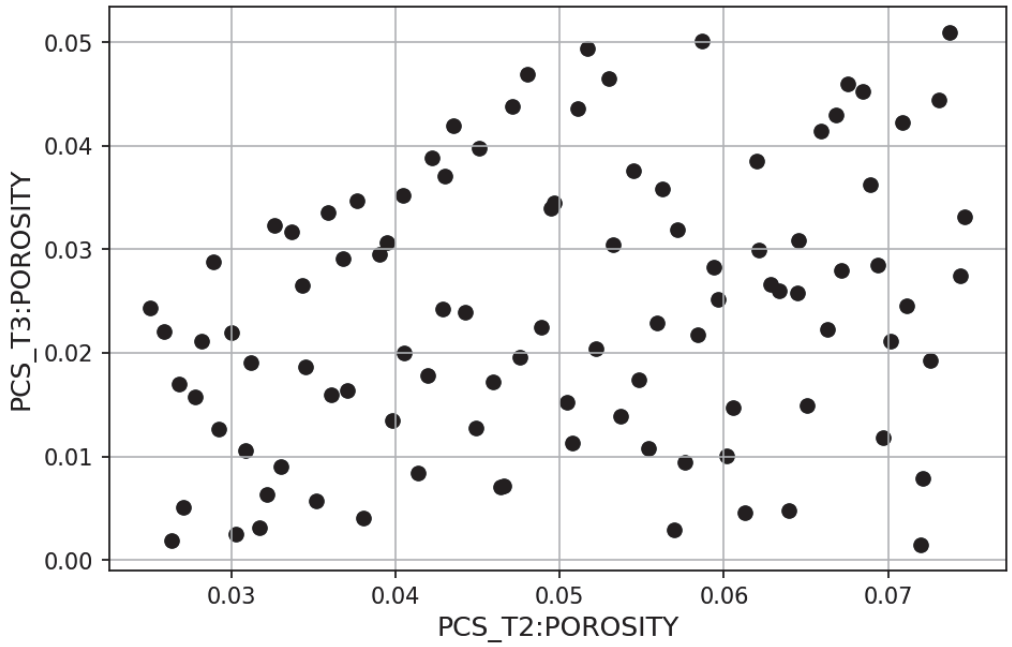

Figure 100. Correlation Between PCS_T2:POROSITY and PCS_T3:POROSITY, Replicate 3

Information Only

8.4 Sampled CDF Comparisons to Input Distributions

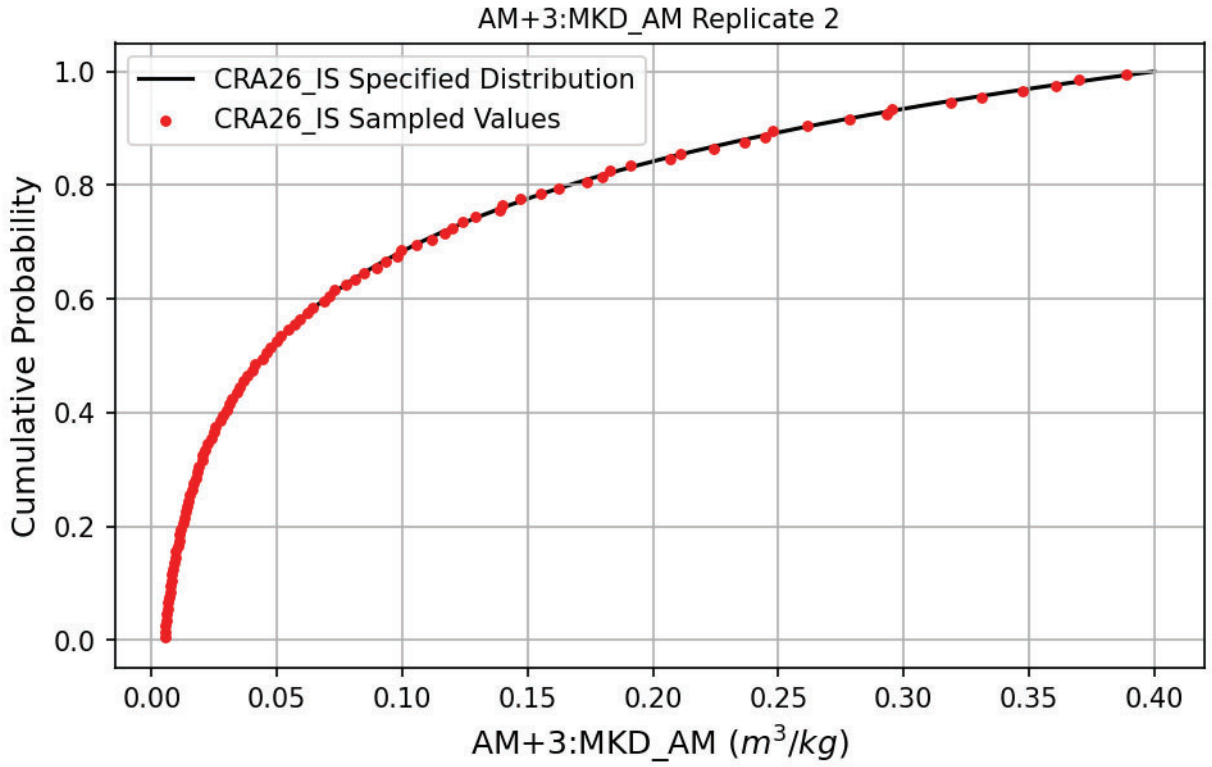

Figure 101. Observed and Expected CDFs for AM+3:MKD_AM (Loguniform Distribution) Replicate 2

Information Only

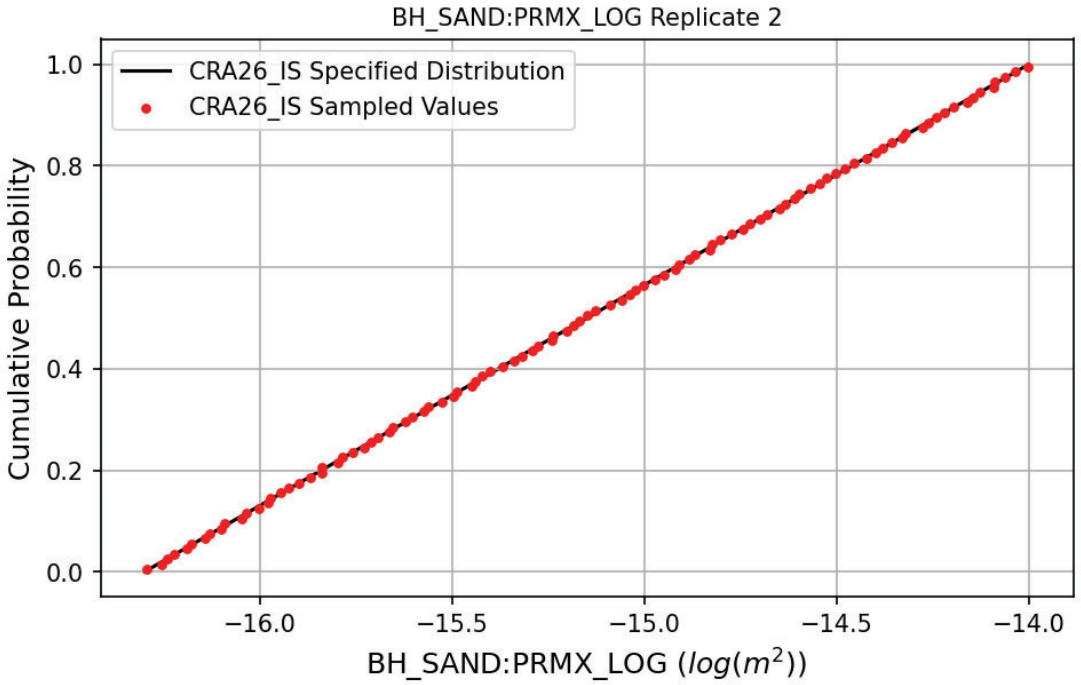

Figure 102. Observed and Expected CDFs for BH_SAND:PRMX_LOG (Uniform Distribution) Replicate 2

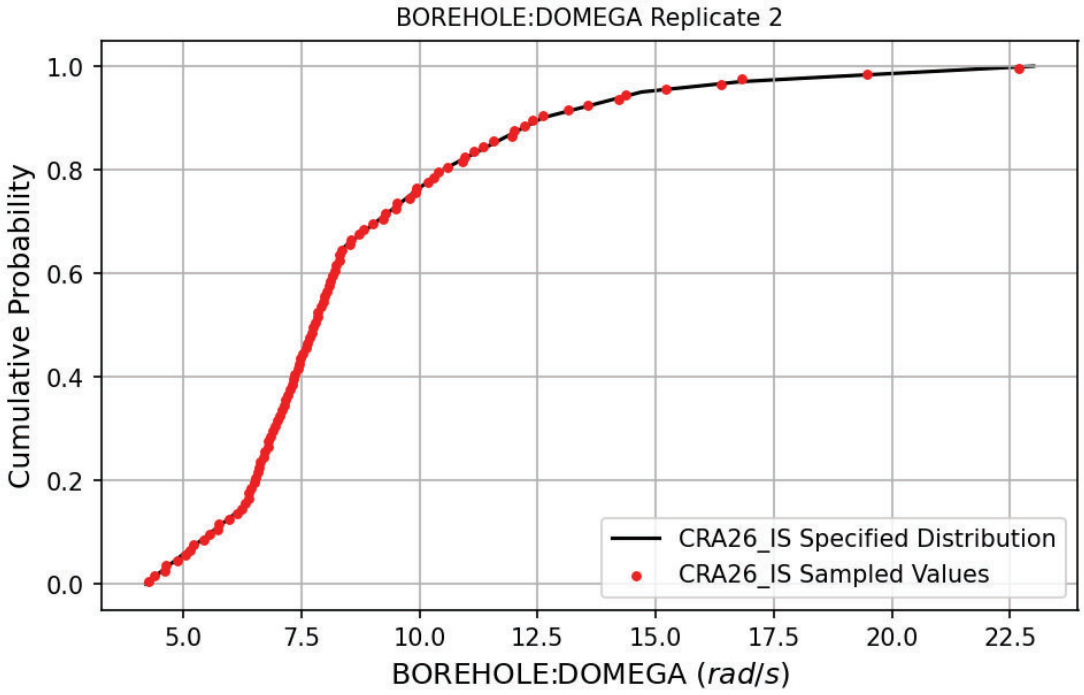

Figure 103. Observed and Expected CDFs for BOREHOLE:DOMEGA (Cumulative Distribution) Replicate 2

Information Only

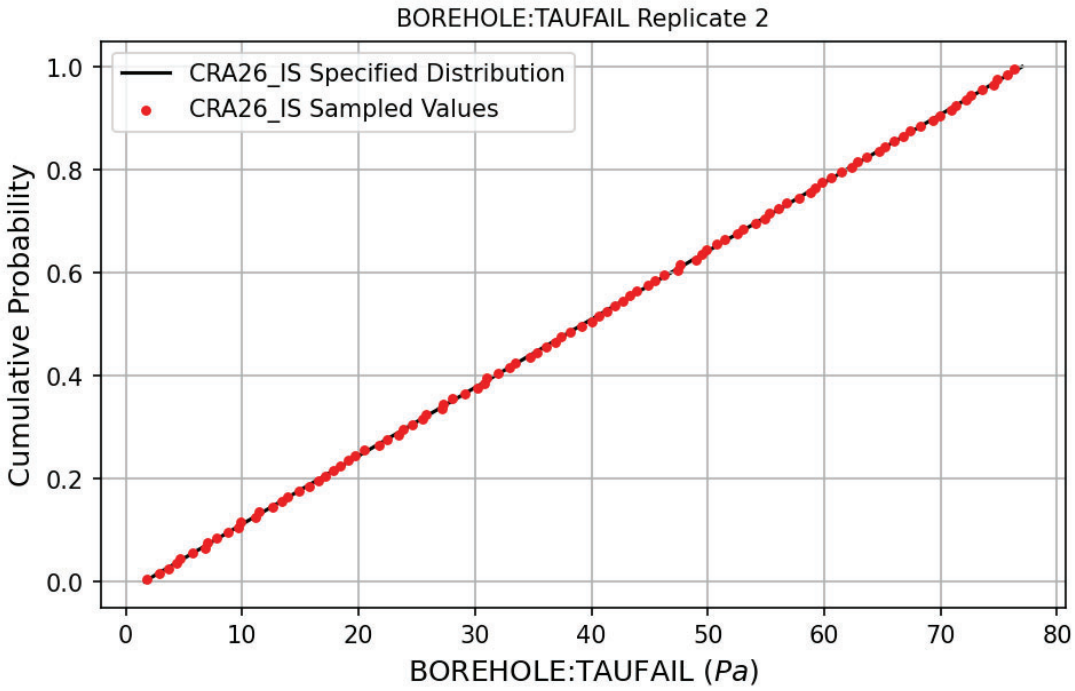

Figure 104. Observed and Expected CDFs for BOREHOLE:TAUFAIL (Uniform Distribution) Replicate 2

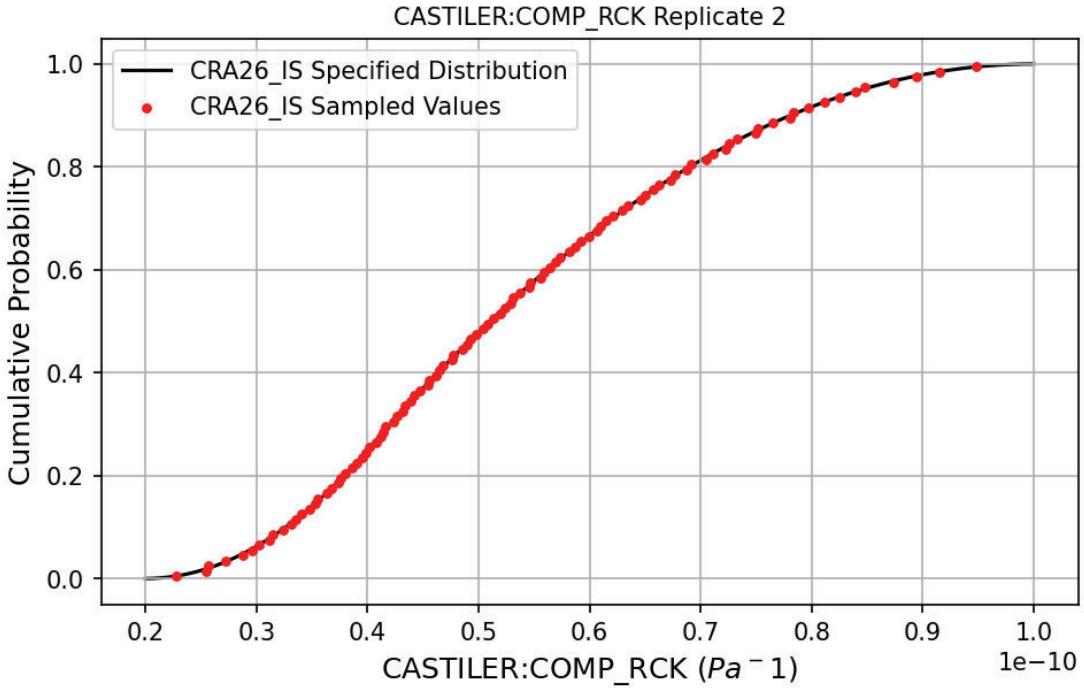

Figure 105. Observed and Expected CDFs for CASTILER:COMP_RCK (Triangular Distribution) Replicate 2

Information Only

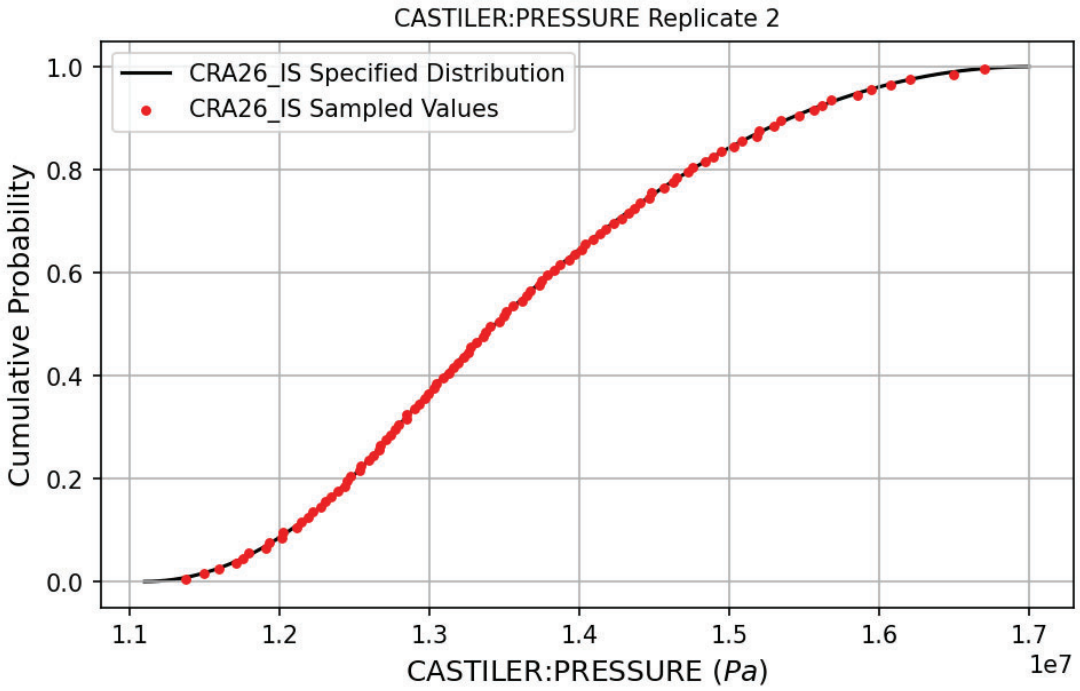

Figure 106. Observed and Expected CDFs for CASTILER:PRESSURE (Triangular Distribution) Replicate 2

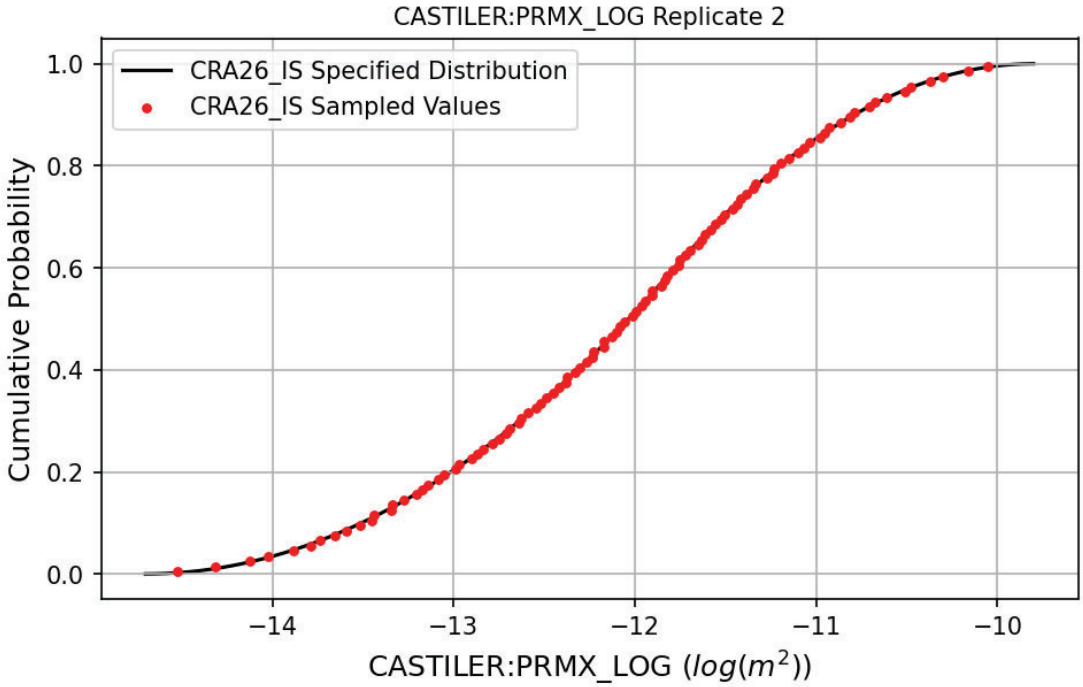

Figure 107. Observed and Expected CDFs for CASTILER:PRMX_LOG (Triangular Distribution) Replicate 2

Information Only

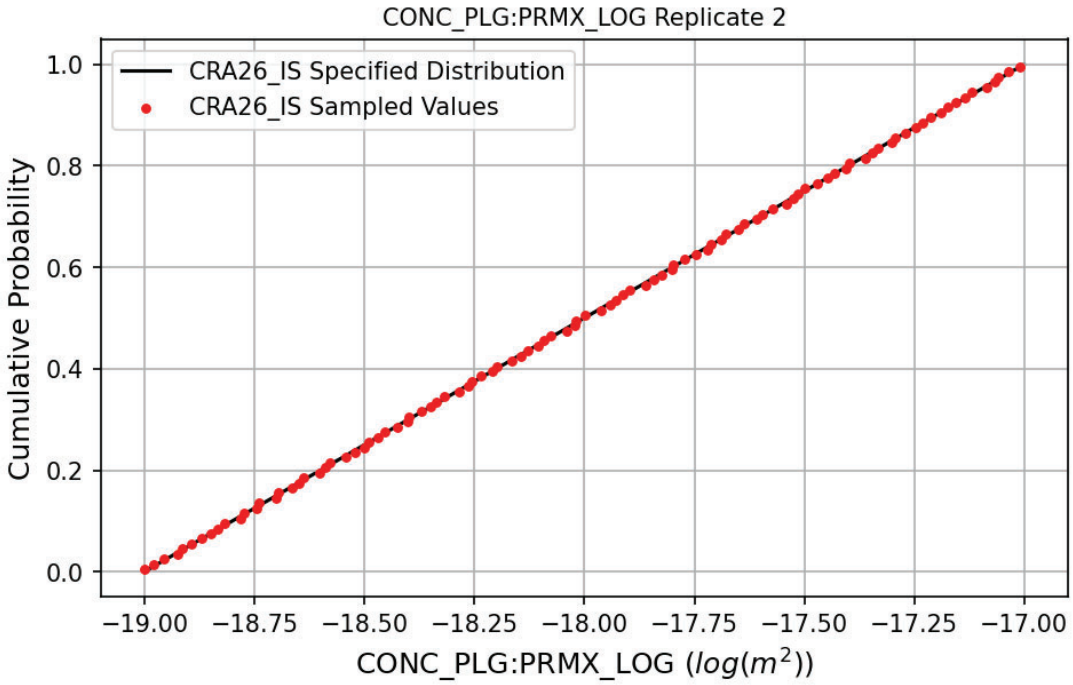

Figure 108. Observed and Expected CDFs for CONC_PLG:PRMX_LOG (Uniform Distribution) Replicate 2

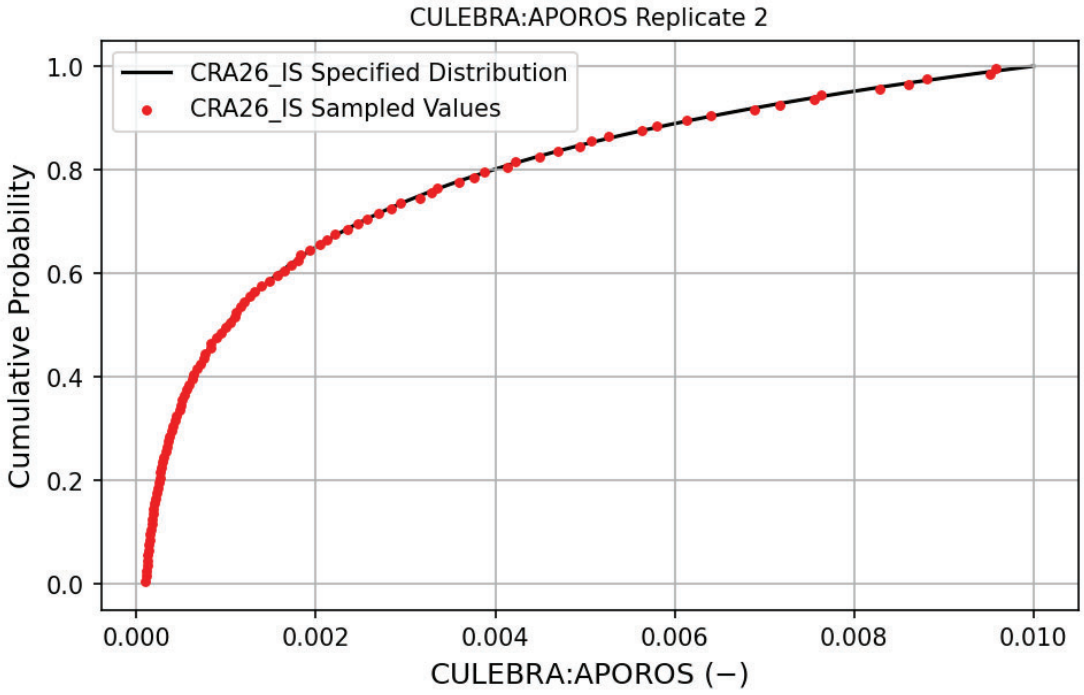

Figure 109. Observed and Expected CDFs for CULEBRA:APOROS (Loguniform Distribution) Replicate 2

Information Only

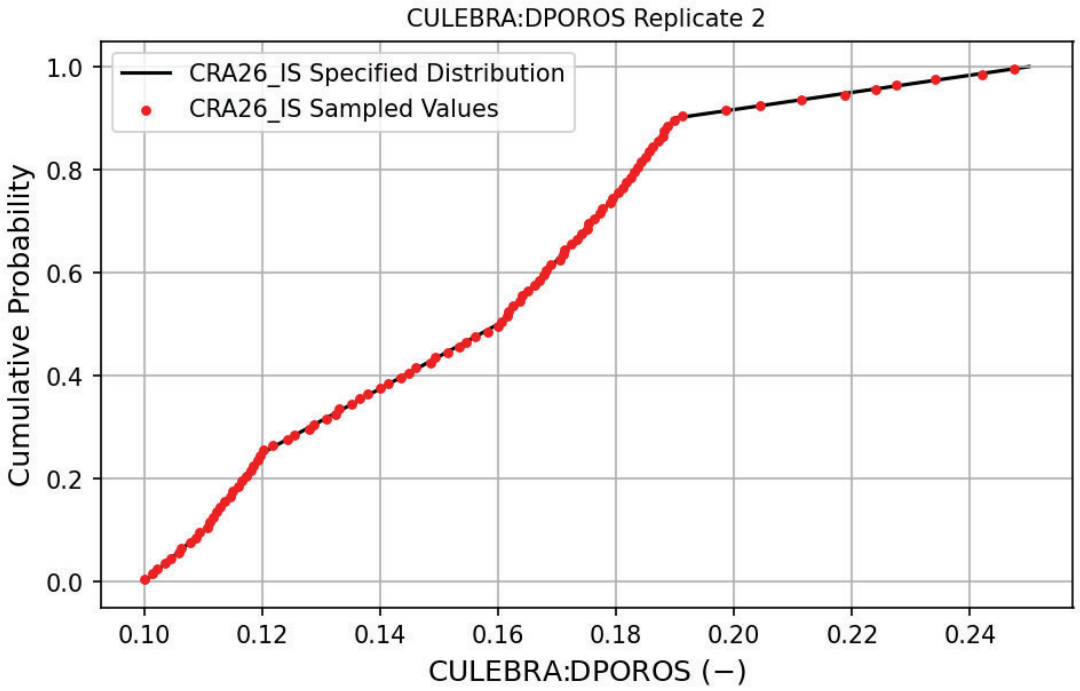

Figure 110. Observed and Expected CDFs for CULEBRA:DPOROS (Cumulative Distribution) Replicate 2

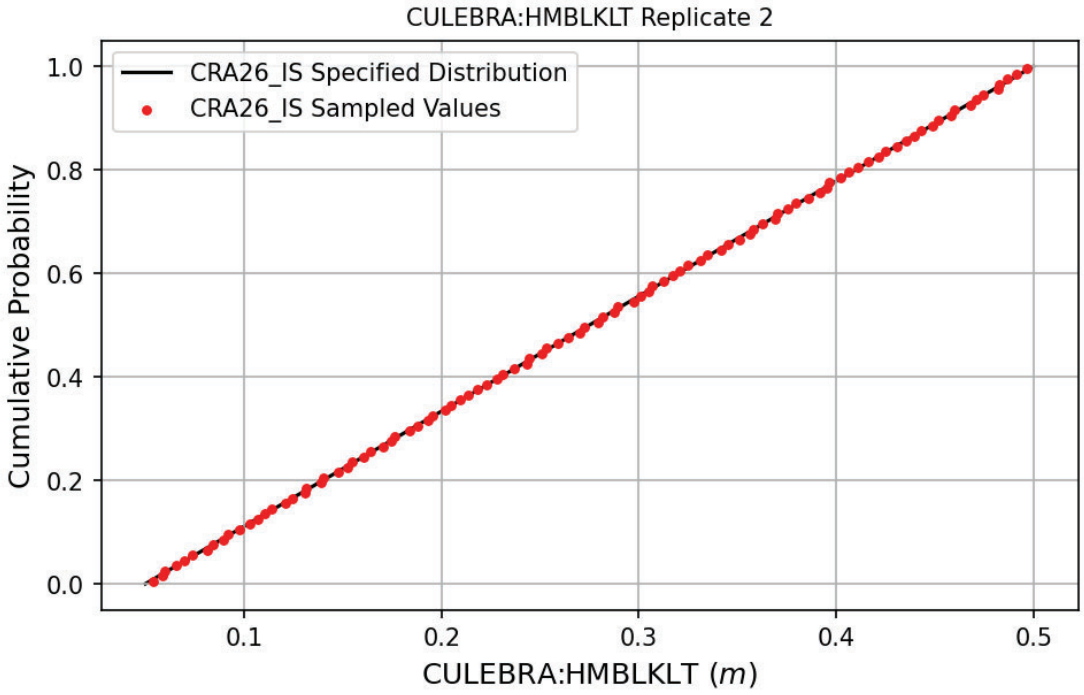

Figure 111. Observed and Expected CDFs for CULEBRA:HMBLKLT (Uniform Distribution) Replicate 2

Information Only

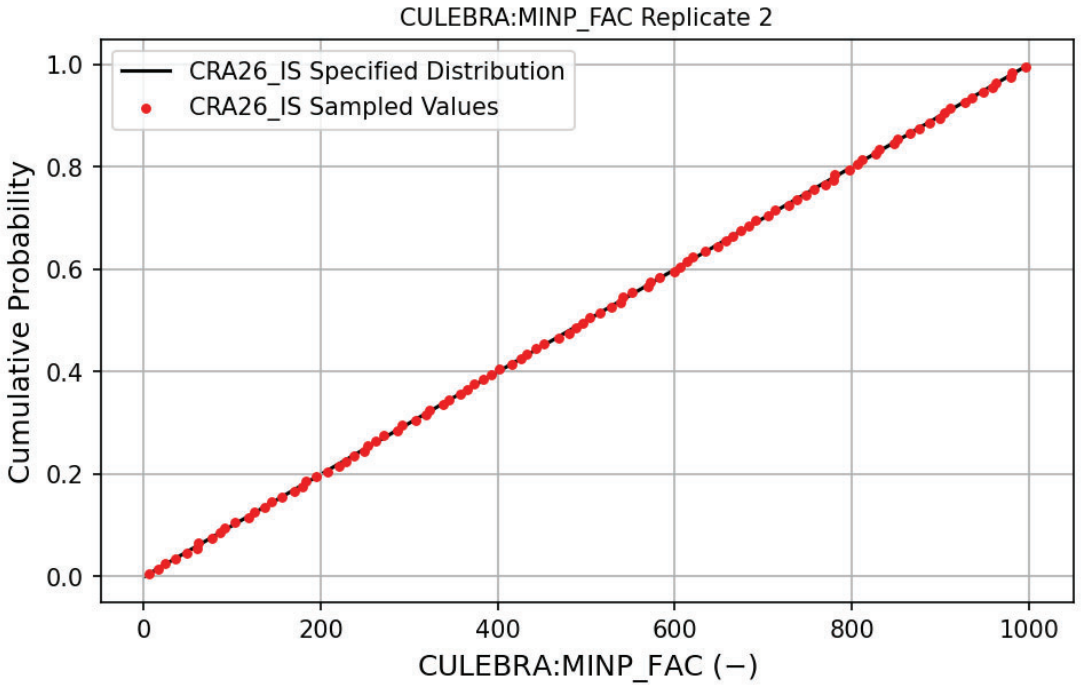

Figure 112. Observed and Expected CDFs for CULEBRA:MINP_FAC (Uniform Distribution) Replicate 2

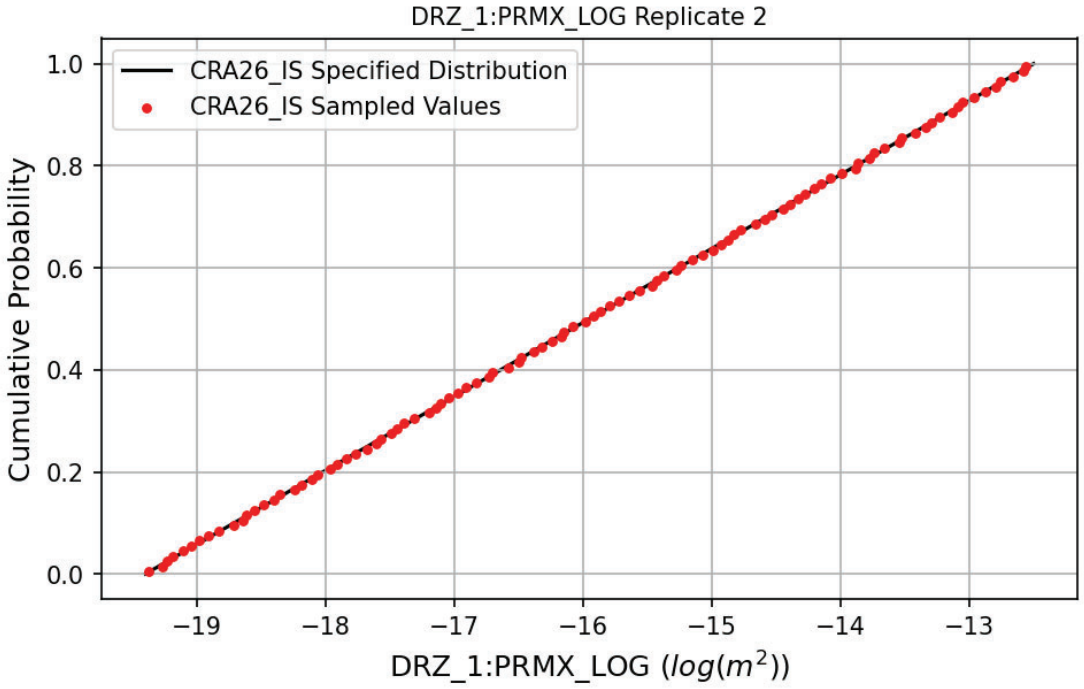

Figure 113. Observed and Expected CDFs for DRZ_1:PRMX_LOG (Uniform Distribution) Replicate 2

Information Only

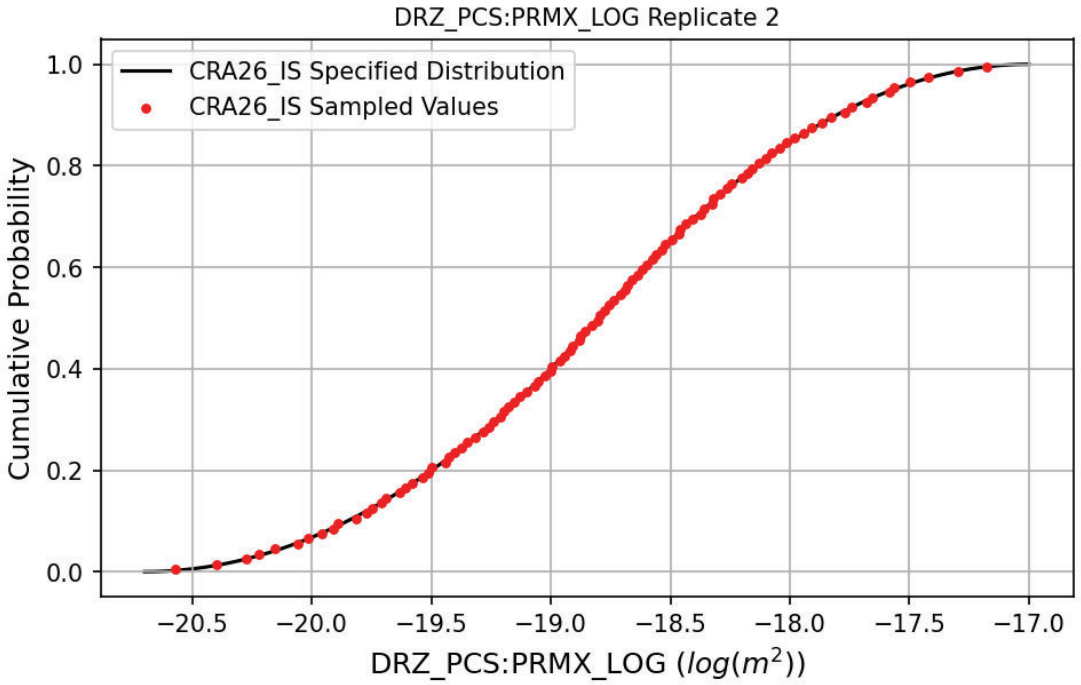

Figure 114. Observed and Expected CDFs for DRZ_PCS:PRMX_LOG (Triangular Distribution) Replicate 2

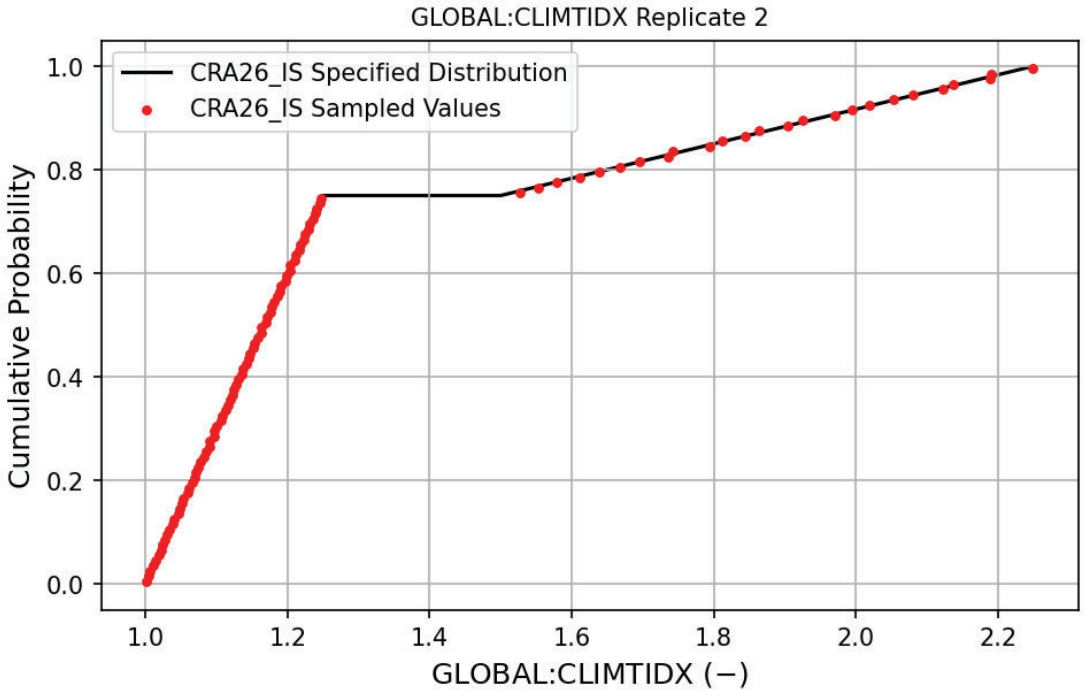

Figure 115. Observed and Expected CDFs for GLOBAL:CLIMTIDX (Cumulative Distribution) Replicate 2

Information Only

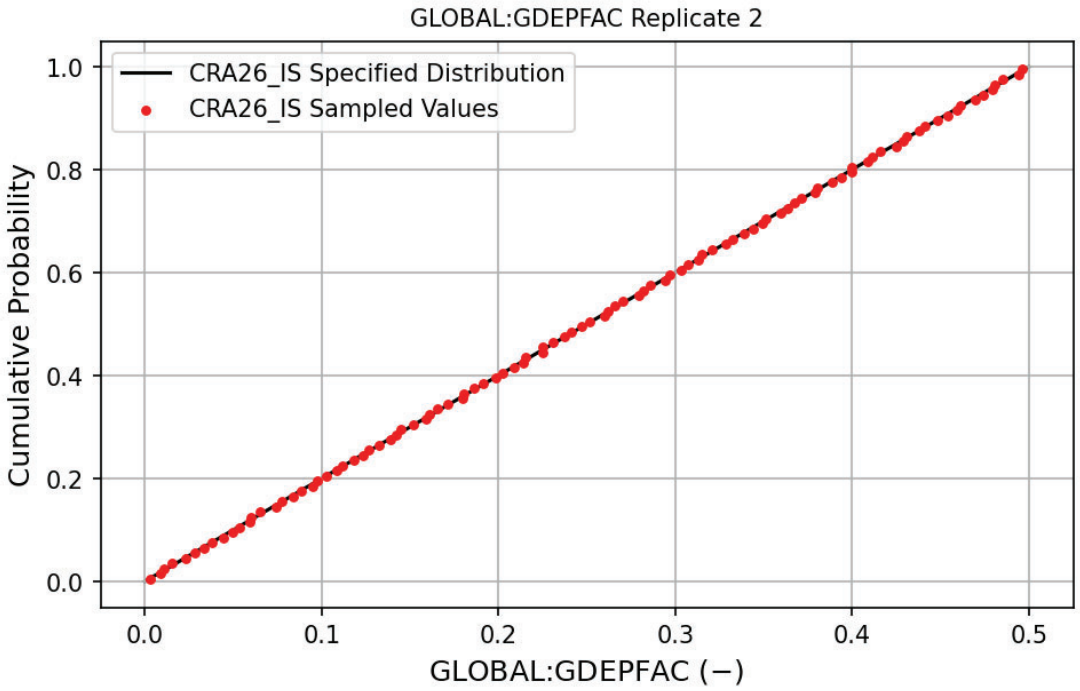

Figure 116. Observed and Expected CDFs for GLOBAL:GDEPFAC (Uniform Distribution) Replicate 2

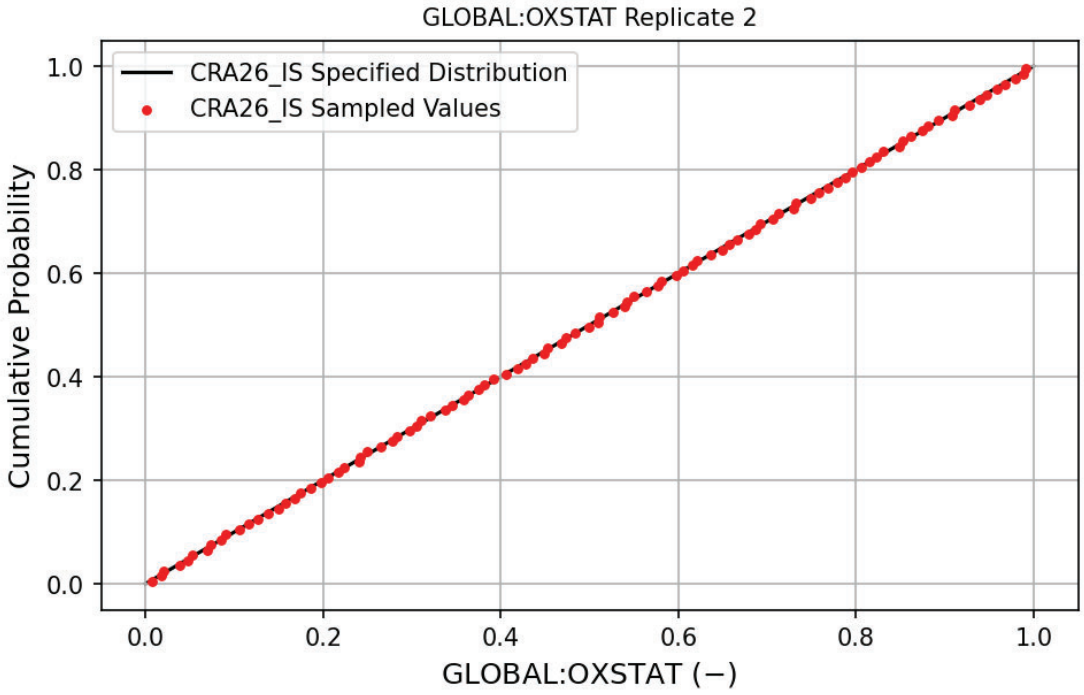

Figure 117. Observed and Expected CDFs for GLOBAL:OXSTAT (Uniform Distribution) Replicate 2

Information Only

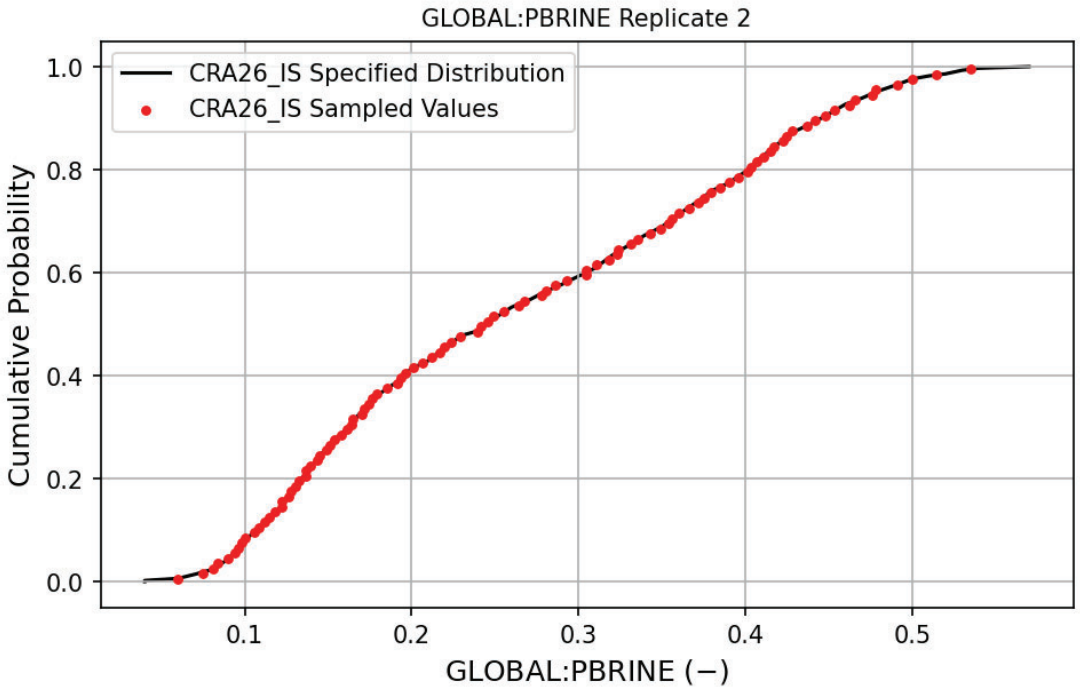

Figure 118. Observed and Expected CDFs for GLOBAL:PBRINE (Cumulative Distribution) Replicate 2

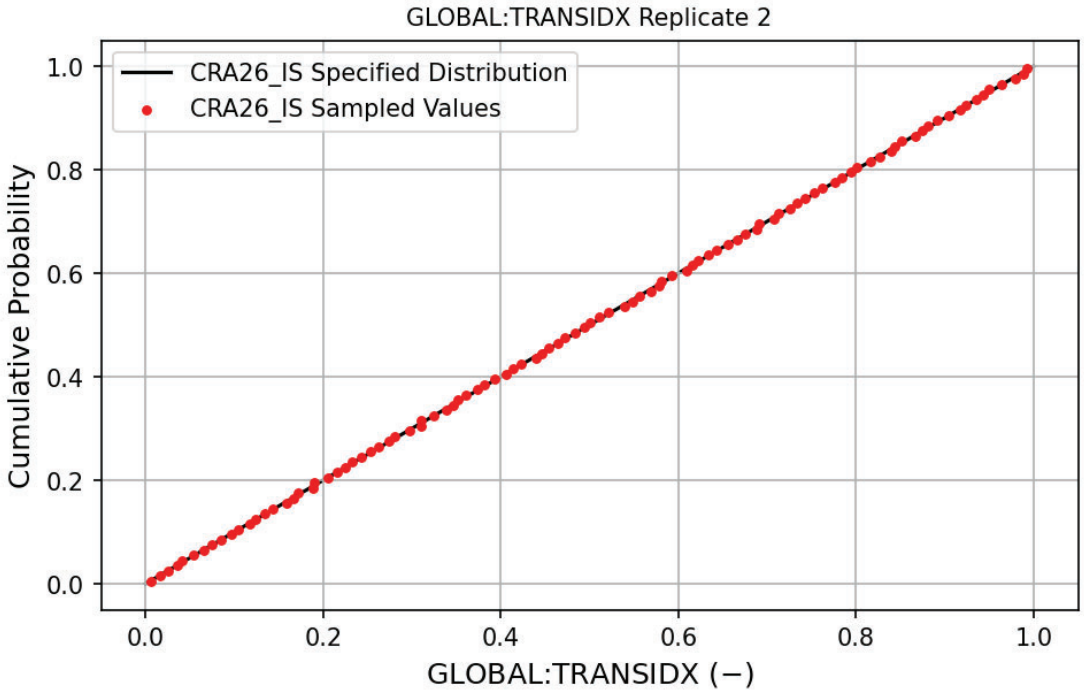

Figure 119. Observed and Expected CDFs for GLOBAL:TRANSIDX (Uniform Distribution) Replicate 2

Information Only

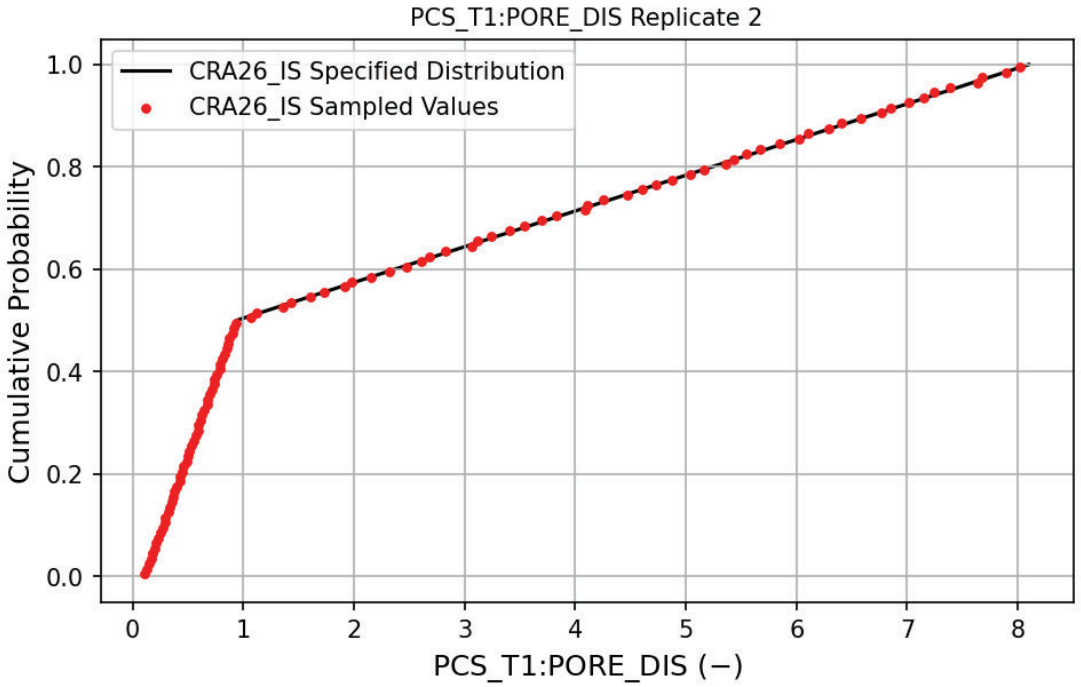

Figure 120. Observed and Expected CDFs for PCS_T1:PORE_DIS (Cumulative Distribution) Replicate 2

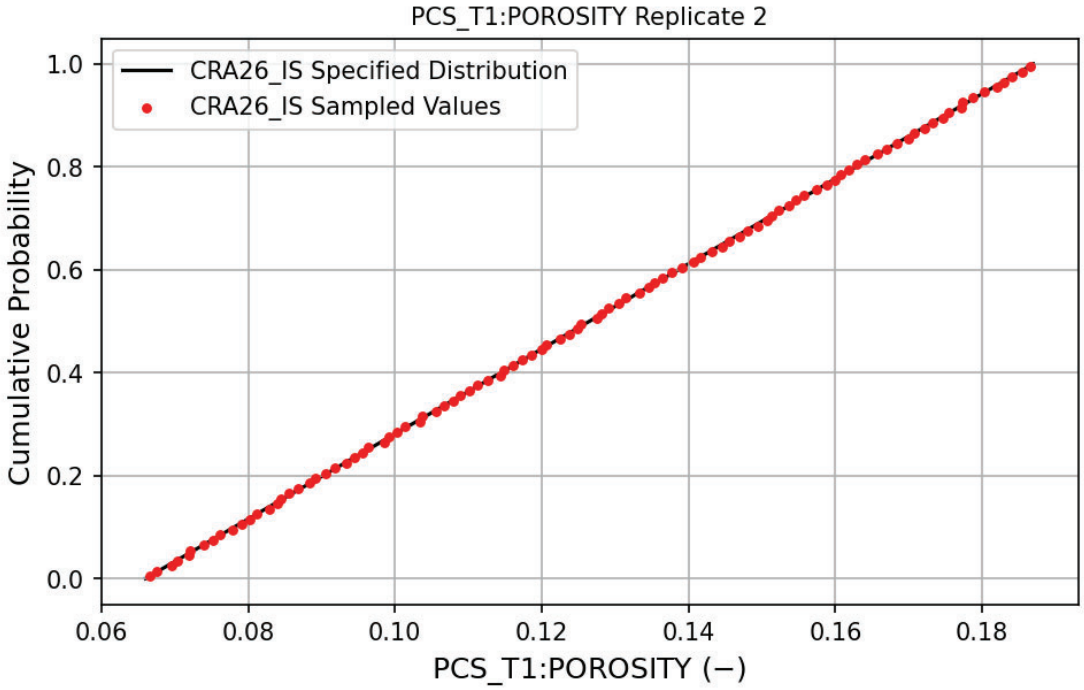

Figure 121. Observed and Expected CDFs for PCS_T1:POROSITY (Uniform Distribution) Replicate 2

Information Only

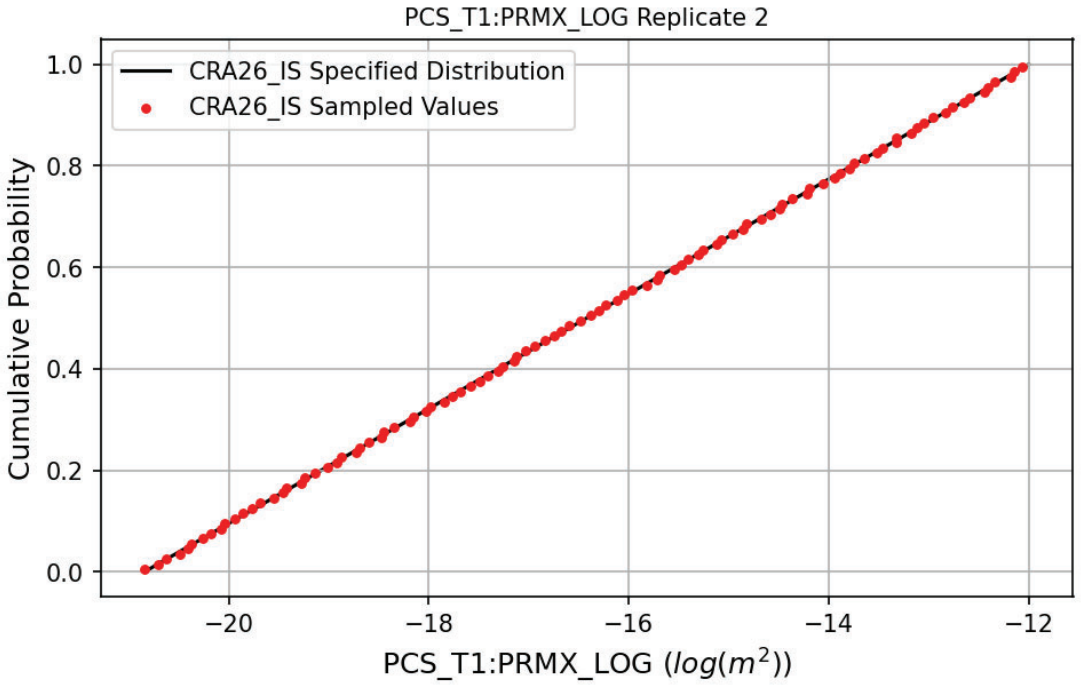

Figure 122. Observed and Expected CDFs for PCS_T1:PRMX_LOG (Uniform Distribution) Replicate 2

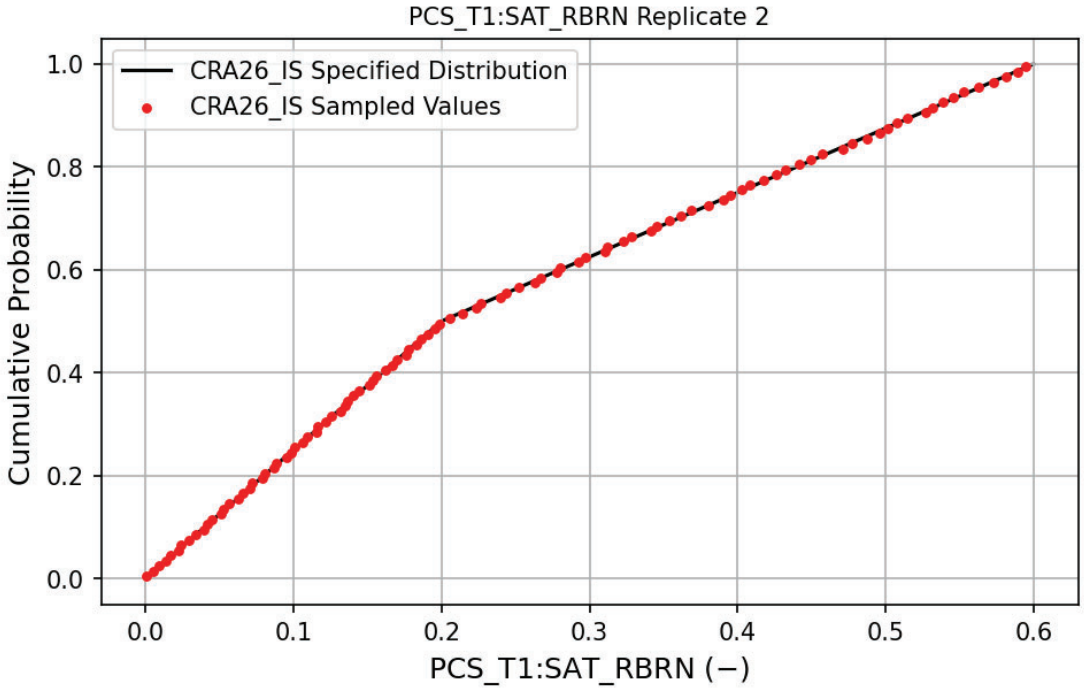

Figure 123. Observed and Expected CDFs for PCS_T1:SAT_RBRN (Cumulative Distribution) Replicate 2

Information Only

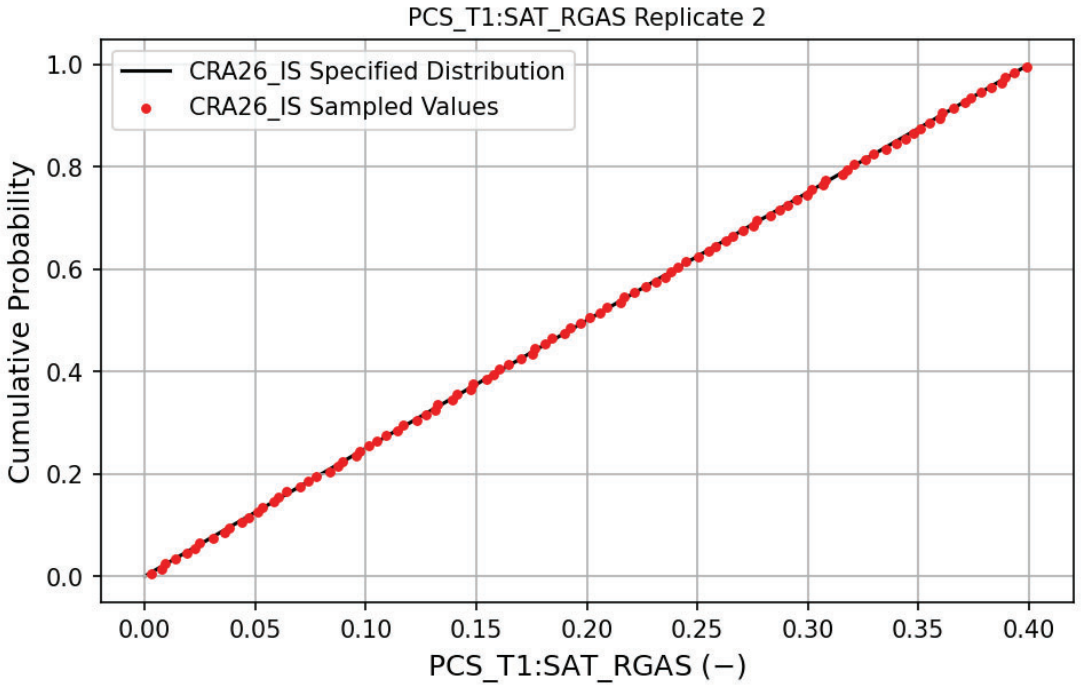

Figure 124. Observed and Expected CDFs for PCS_T1:SAT_RGAS (Uniform Distribution) Replicate 2

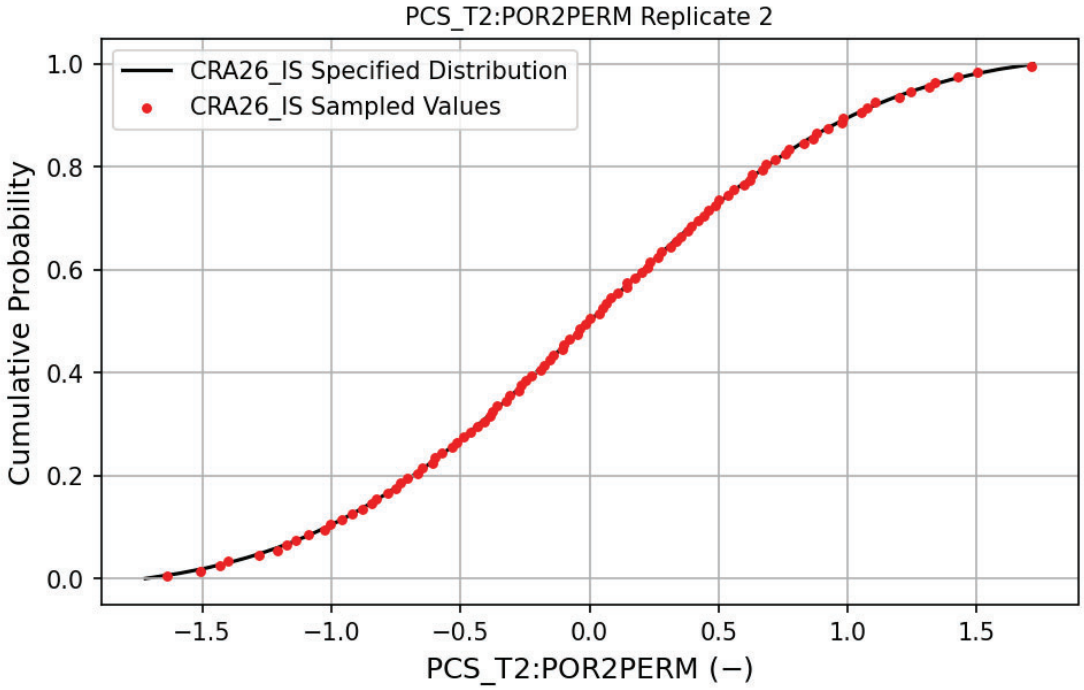

Figure 125. Observed and Expected CDFs for PCS_T2:POR2PERM (Cumulative Distribution) Replicate 2

Information Only

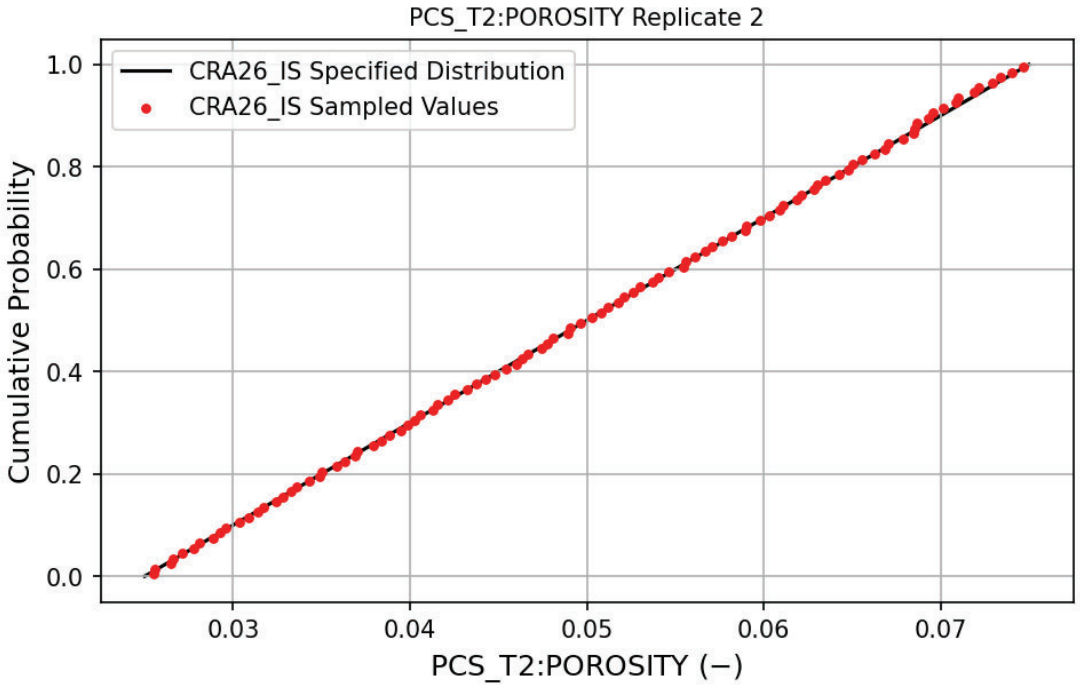

Figure 126. Observed and Expected CDFs for PCS_T2:POROSITY (Uniform Distribution) Replicate 2

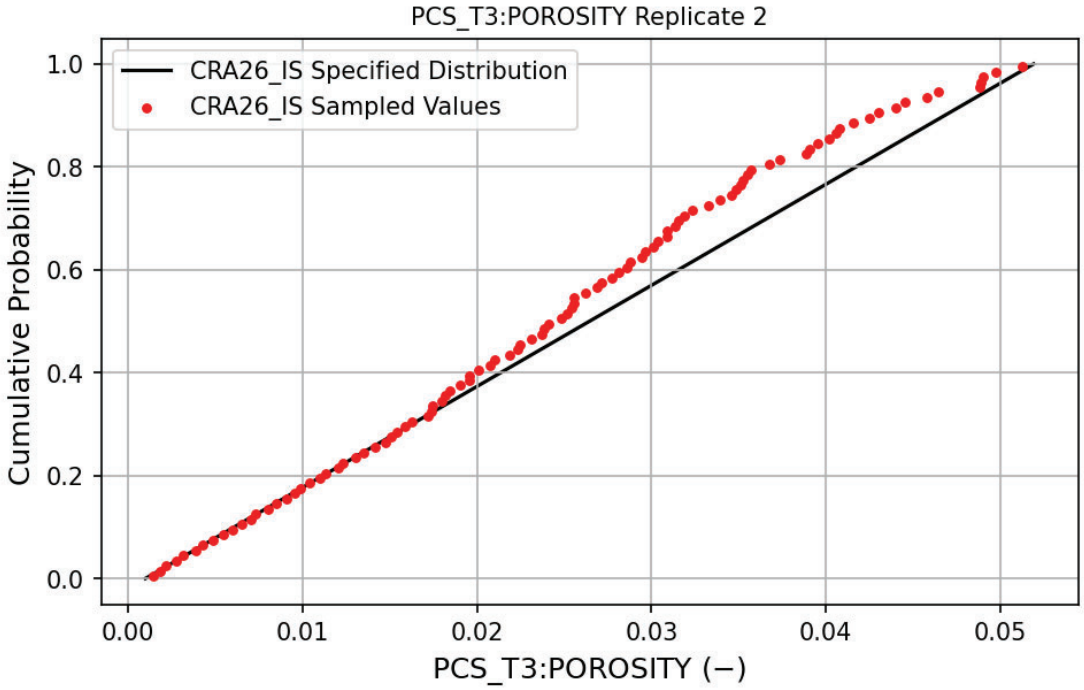

Figure 127. Observed and Expected CDFs for PCS_T3:POROSITY (Uniform Distribution) Replicate 2

Information Only

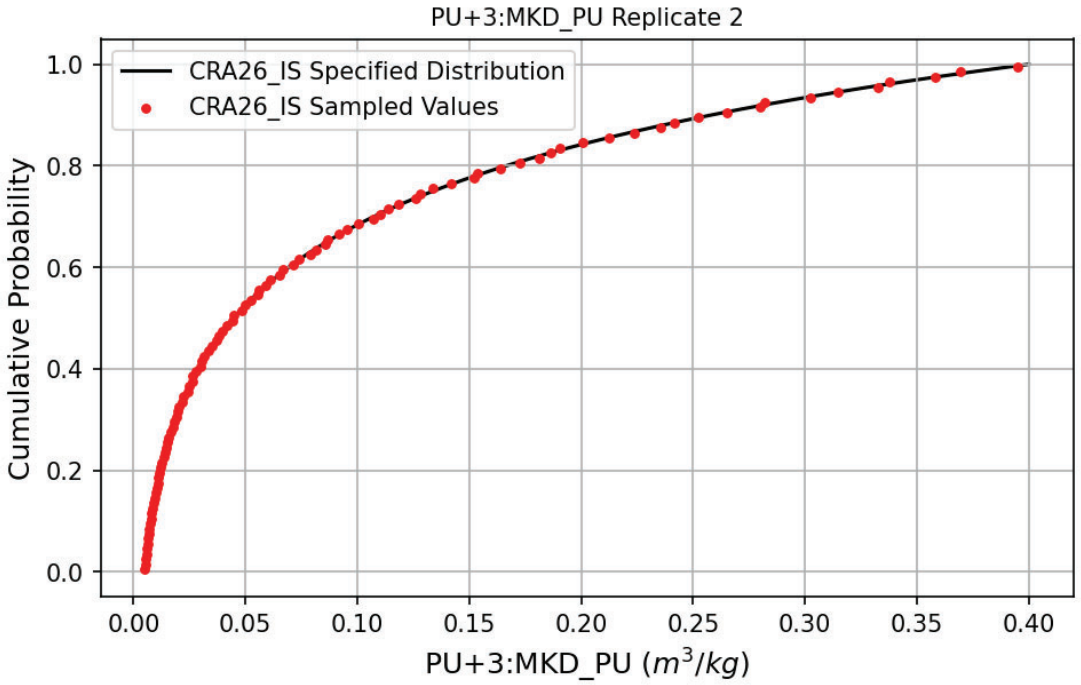

Figure 128. Observed and Expected CDFs for PU+3:MKD_PU (Loguniform Distribution) Replicate 2

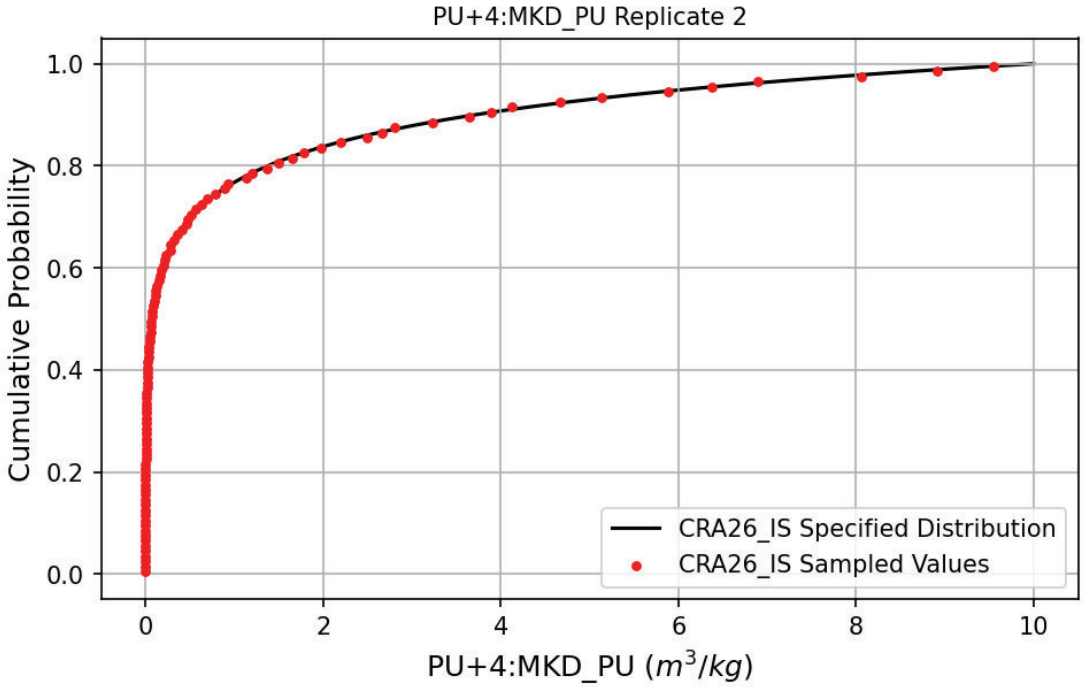

Figure 129. Observed and Expected CDFs for PU+4:MKD_PU (Loguniform Distribution) Replicate 2

Information Only

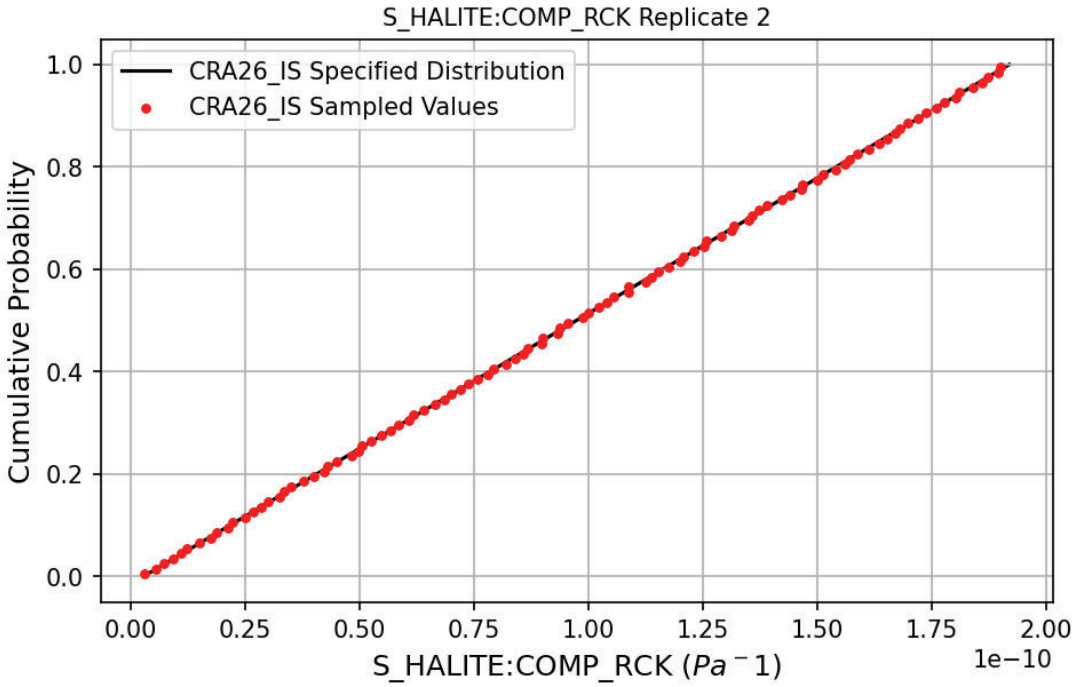

Figure 130. Observed and Expected CDFs for S_HALITE:COMP_RCK (Uniform Distribution) Replicate 2

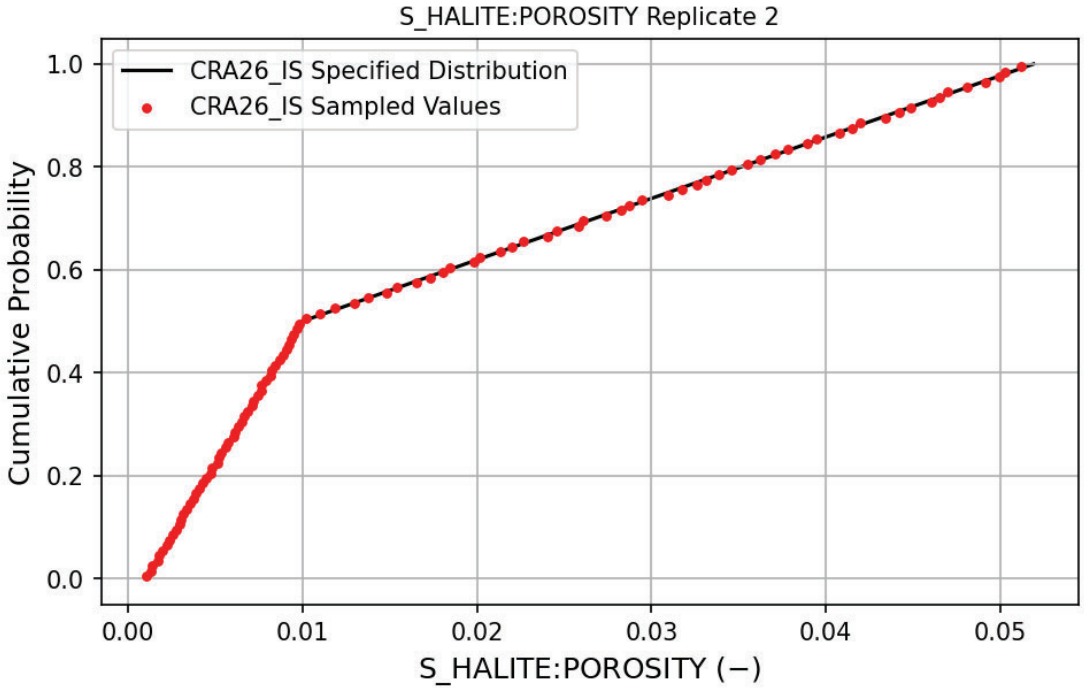

Figure 131. Observed and Expected CDFs for S_HALITE:POROSITY (Cumulative Distribution) Replicate 2

Information Only

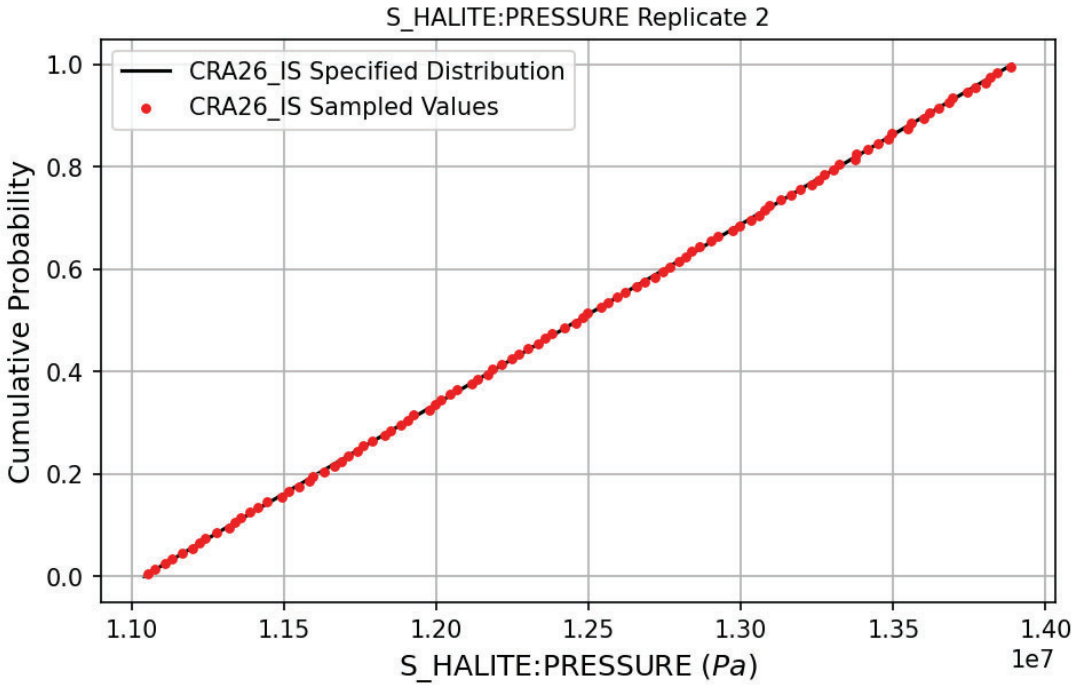

Figure 132. Observed and Expected CDFs for S_HALITE:PRESSURE (Uniform Distribution) Replicate 2

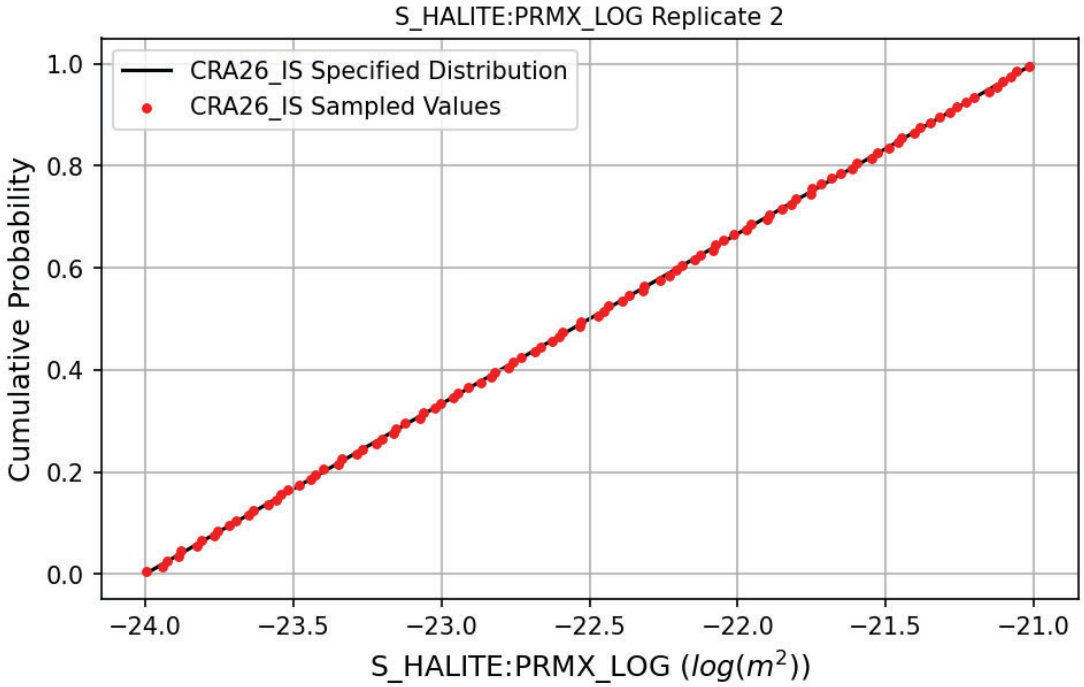

Figure 133. Observed and Expected CDFs for S_HALITE:PRMX_LOG (Uniform Distribution) Replicate 2

Information Only

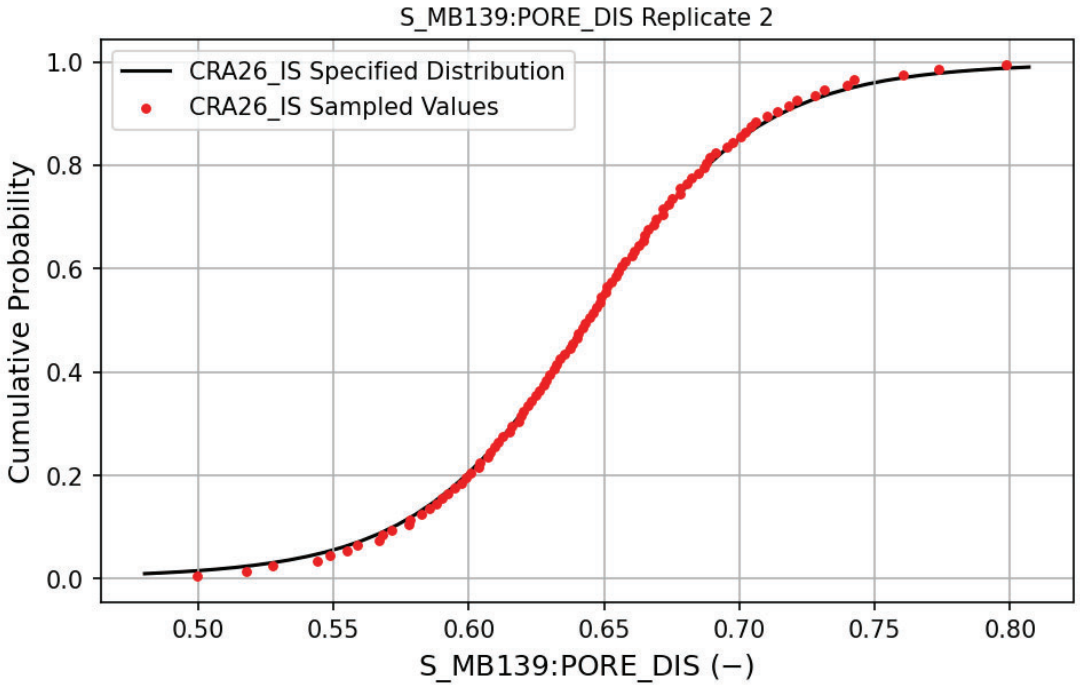

Figure 134. Observed and Expected CDFs for S_MB139:PORE_DIS (Student Distribution) Replicate 2

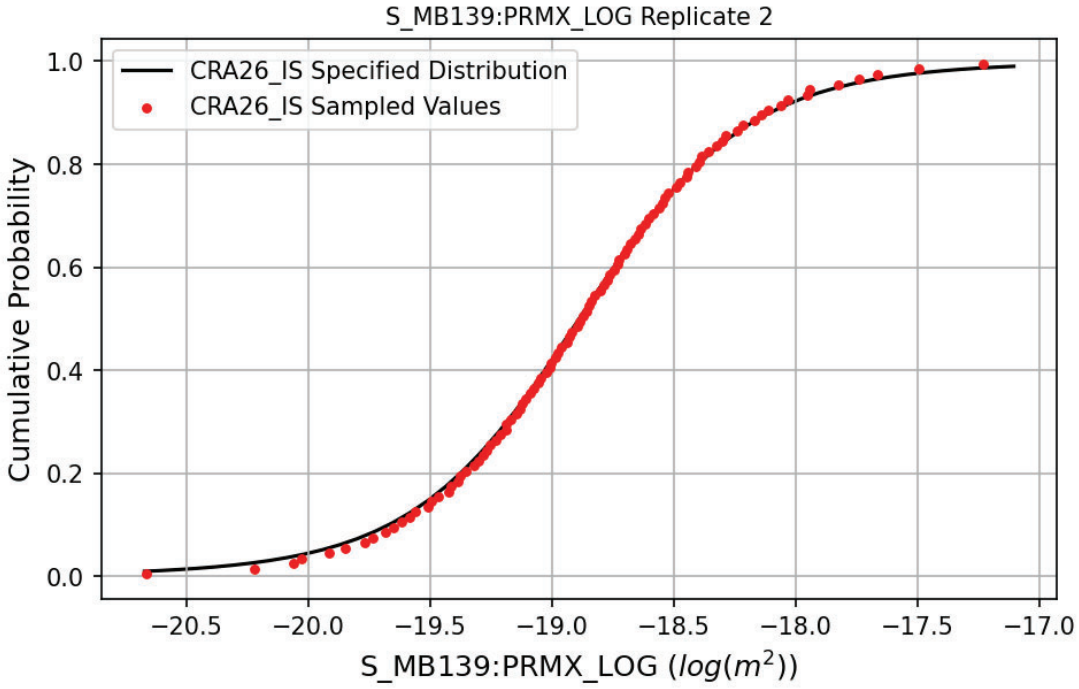

Figure 135. Observed and Expected CDFs for S_MB139:PRMX_LOG (Student Distribution) Replicate 2

Information Only

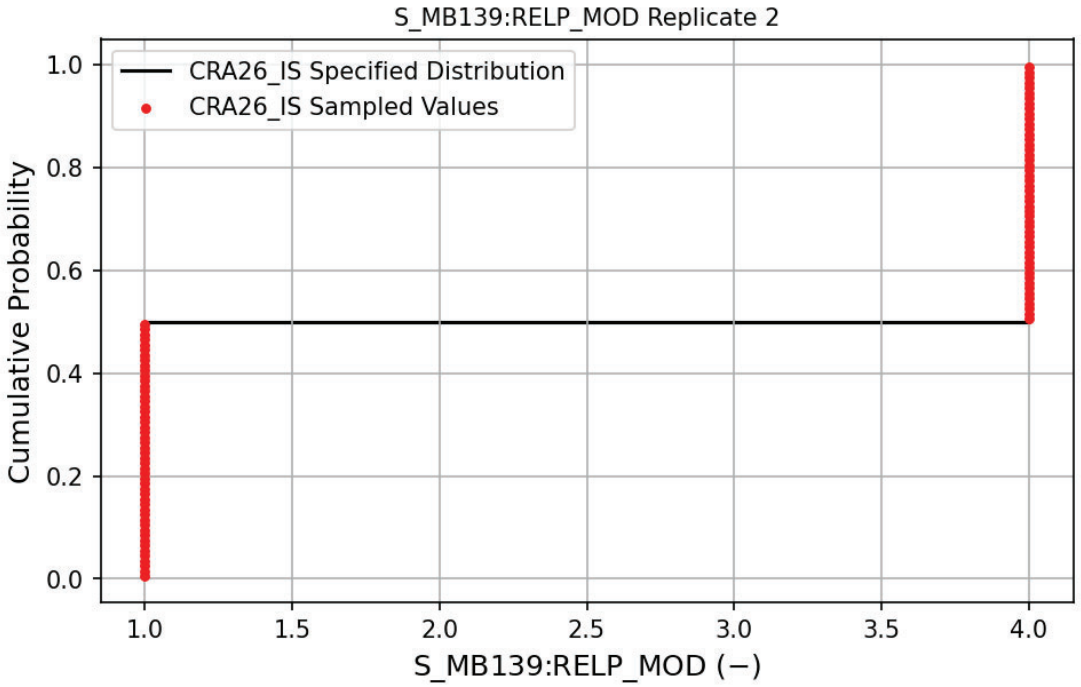

Figure 136. Observed and Expected CDFs for S_MB139:RELP_MOD (Delta Distribution) Replicate 2

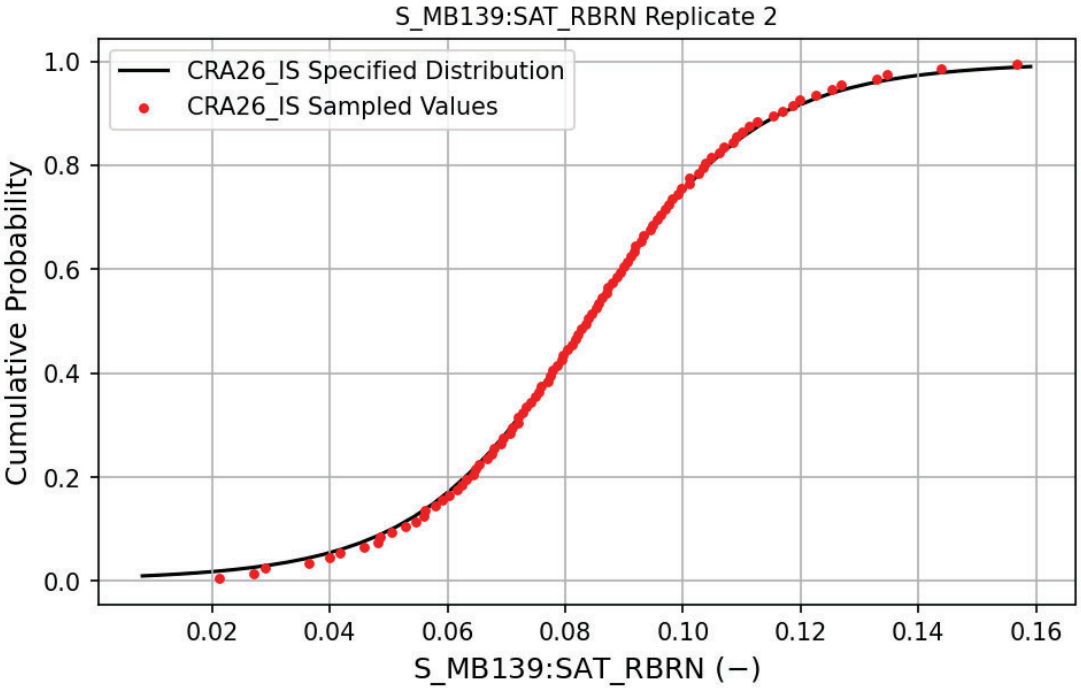

Figure 137. Observed and Expected CDFs for S_MB139:SAT_RBRN (Student Distribution) Replicate 2

Information Only

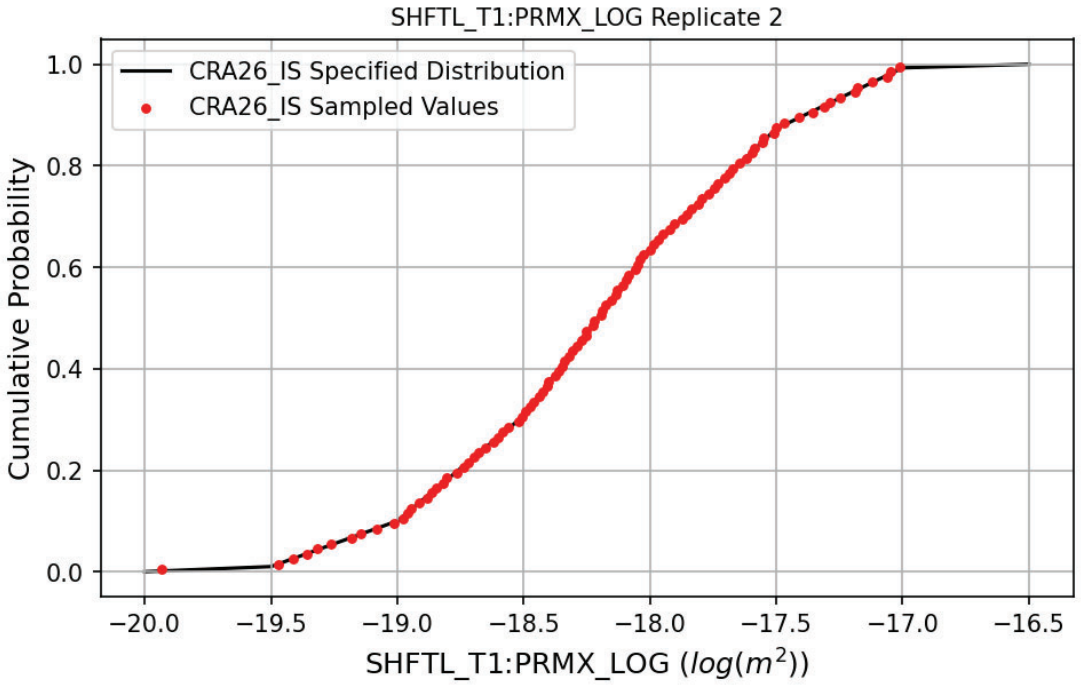

Figure 138. Observed and Expected CDFs for SHFTL_T1:PRMX_LOG (Cumulative Distribution) Replicate 2

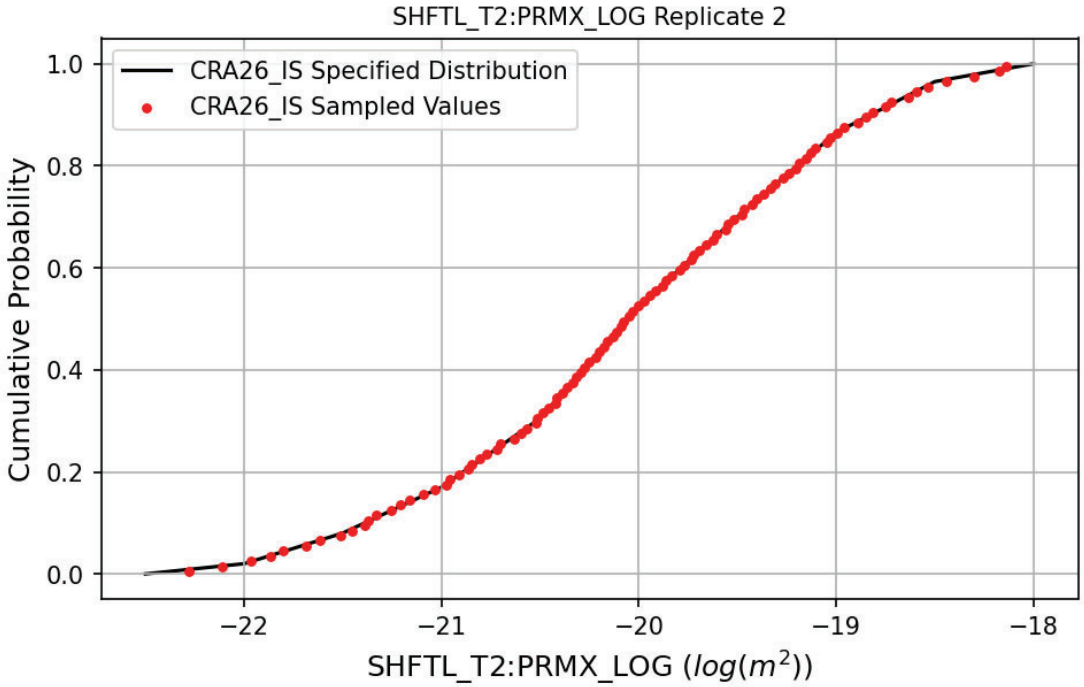

Figure 139. Observed and Expected CDFs for SHFTL_T2:PRMX_LOG (Cumulative Distribution) Replicate 2

Information Only

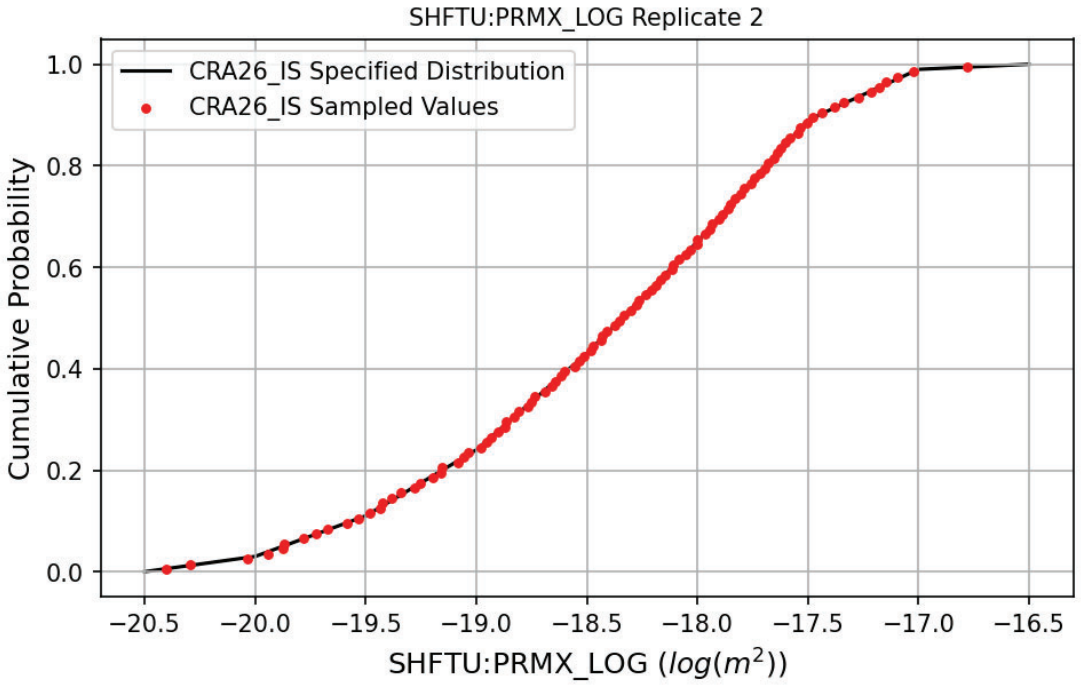

Figure 140. Observed and Expected CDFs for SHFTU:PRMX_LOG (Cumulative Distribution) Replicate 2

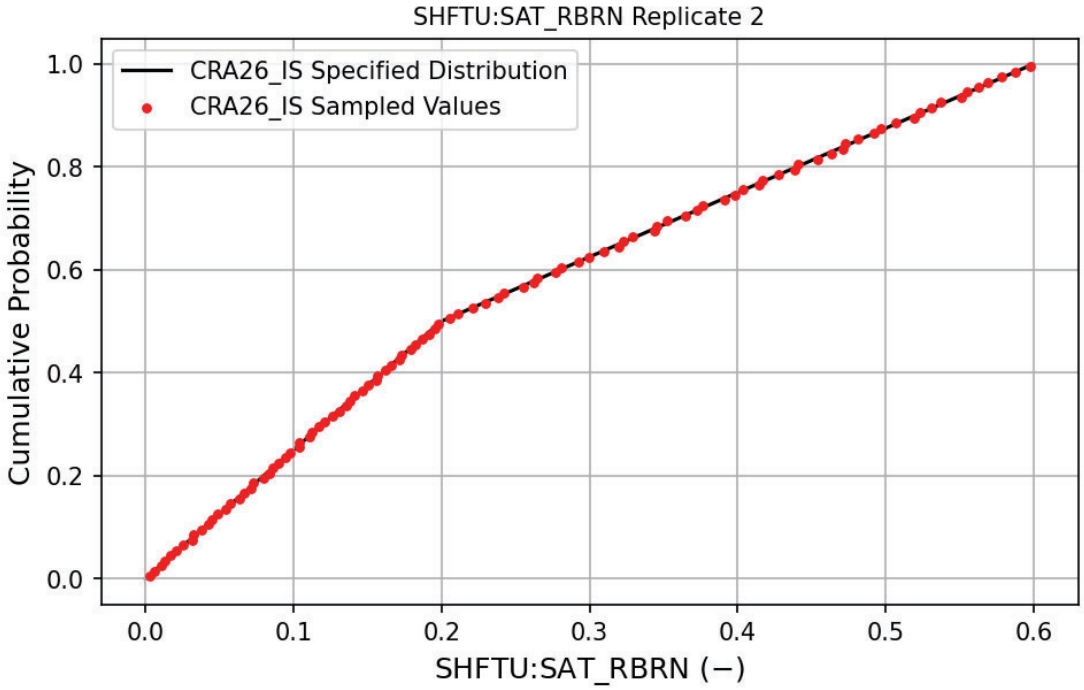

Figure 141. Observed and Expected CDFs for SHFTU:SAT_RBRN (Cumulative Distribution) Replicate 2

Information Only

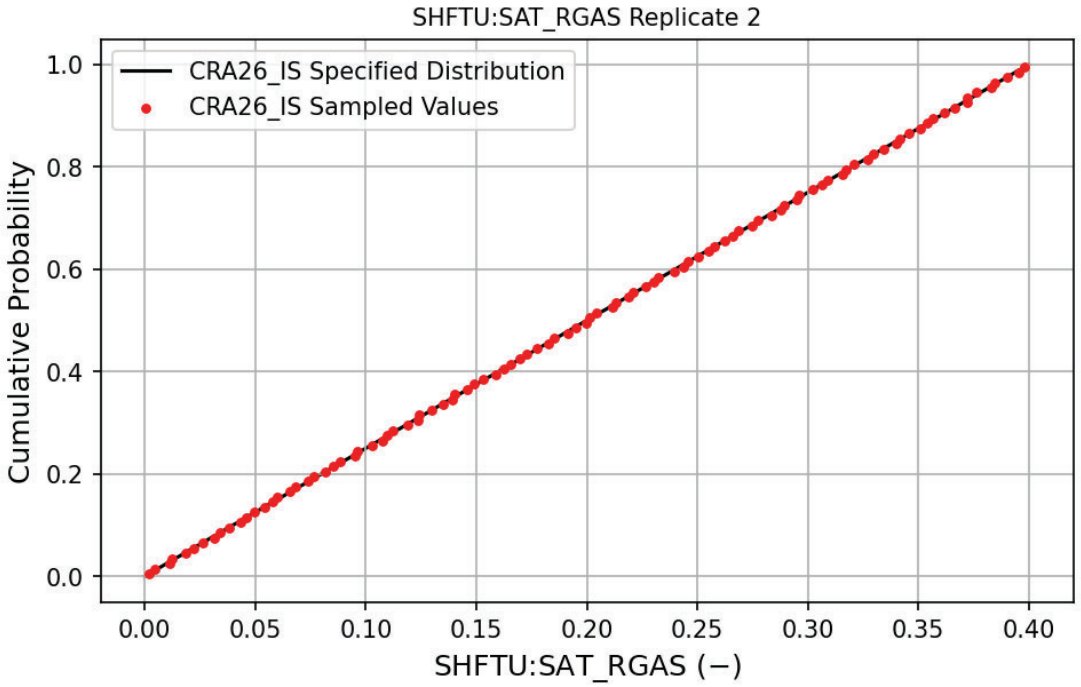

Figure 142. Observed and Expected CDFs for SHFTU:SAT_RGAS (Uniform Distribution) Replicate 2

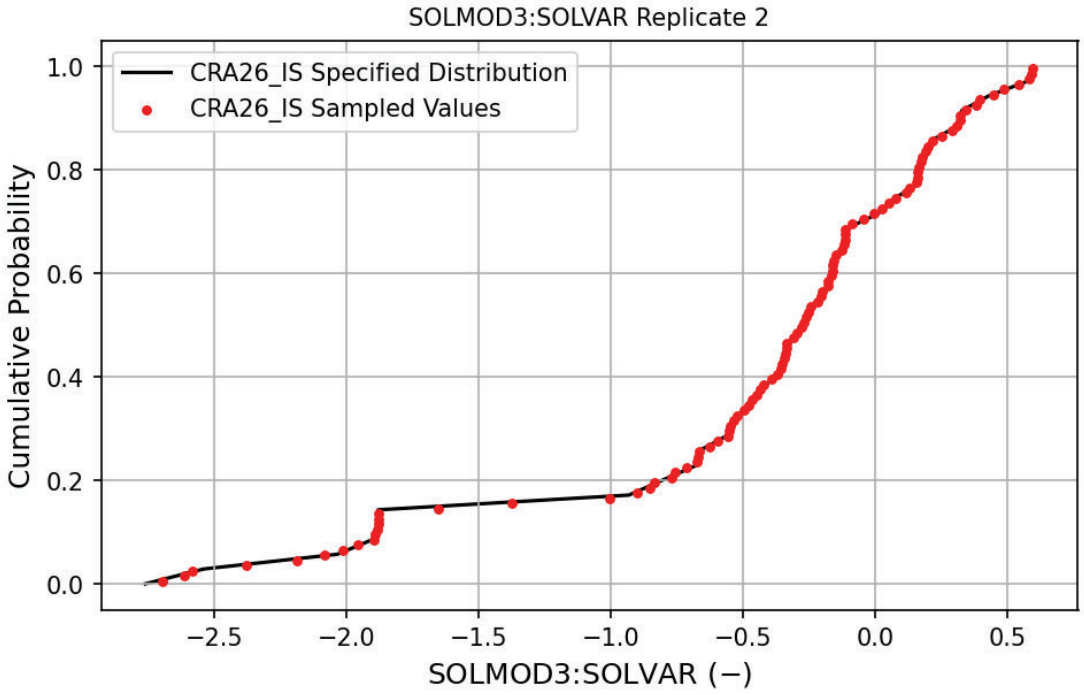

Figure 143. Observed and Expected CDFs for SOLMOD3:SOLVAR (Cumulative Distribution) Replicate 2

Information Only

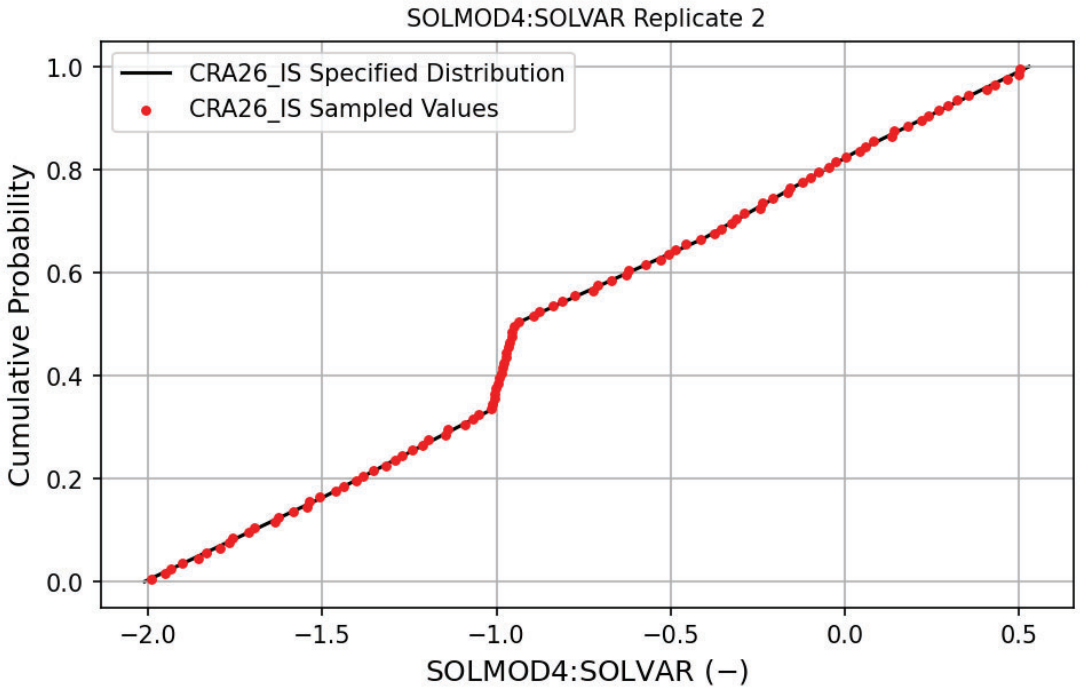

Figure 144. Observed and Expected CDFs for SOLMOD4:SOLVAR (Cumulative Distribution) Replicate 2

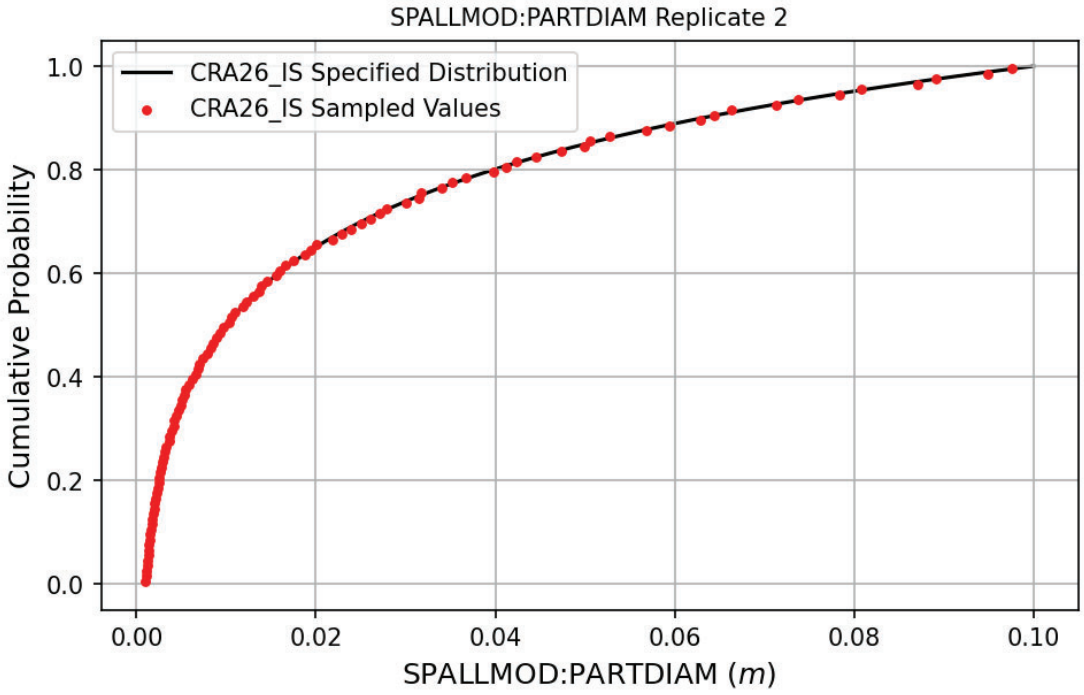

Figure 145. Observed and Expected CDFs for SPALLMOD:PARTDIAM (Loguniform Distribution) Replicate 2

Information Only

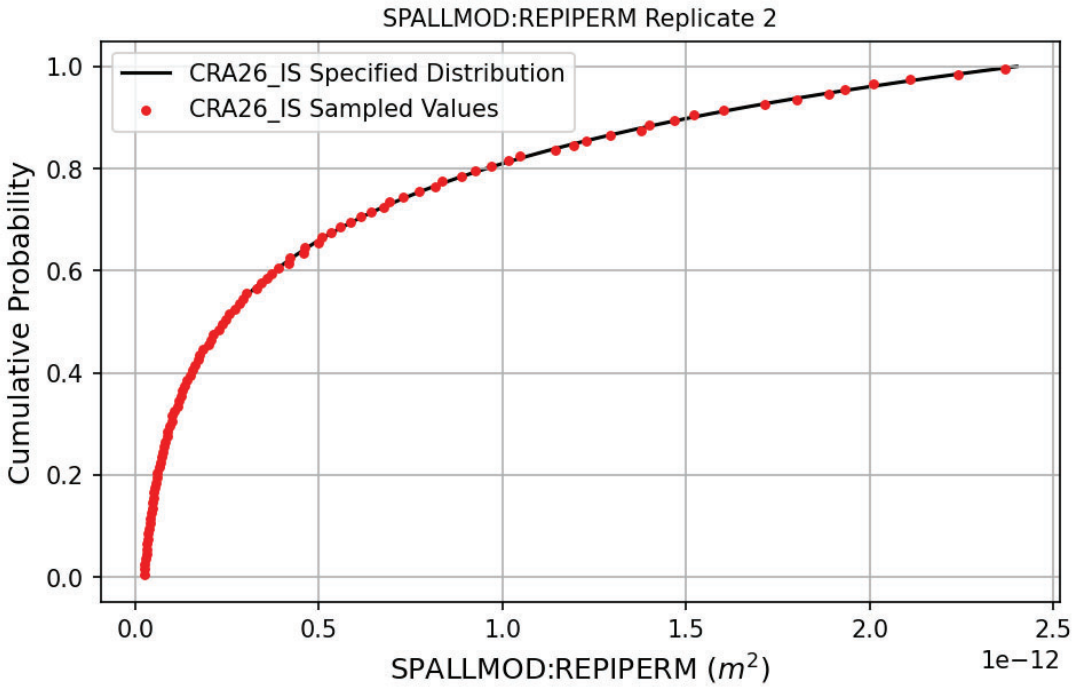

Figure 146. Observed and Expected CDFs for SPALLMOD:REPIPERM (Loguniform Distribution) Replicate 2

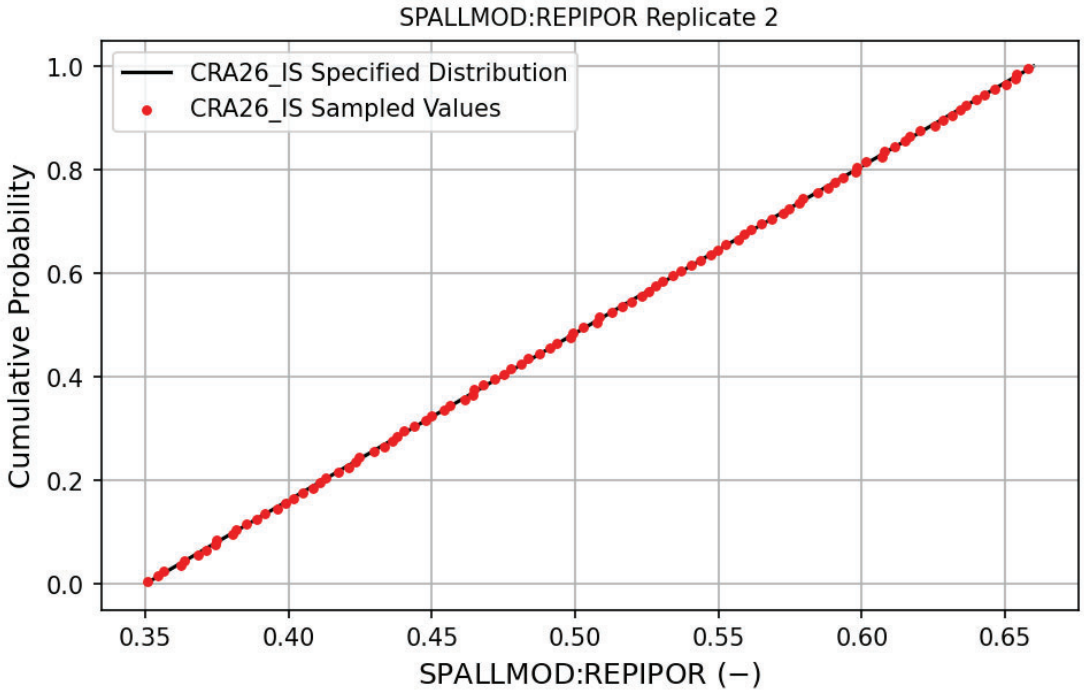

Figure 147. Observed and Expected CDFs for SPALLMOD:REPIPOR (Uniform Distribution) Replicate 2

Information Only

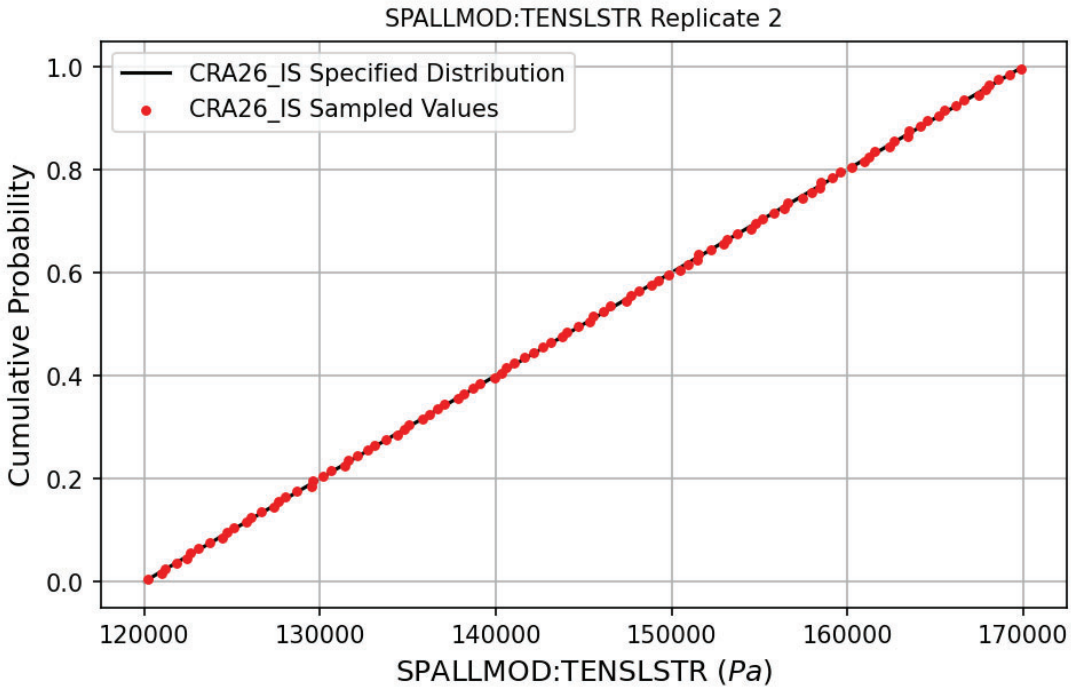

Figure 148. Observed and Expected CDFs for SPALLMOD:TENSLSTR (Uniform Distribution) Replicate 2

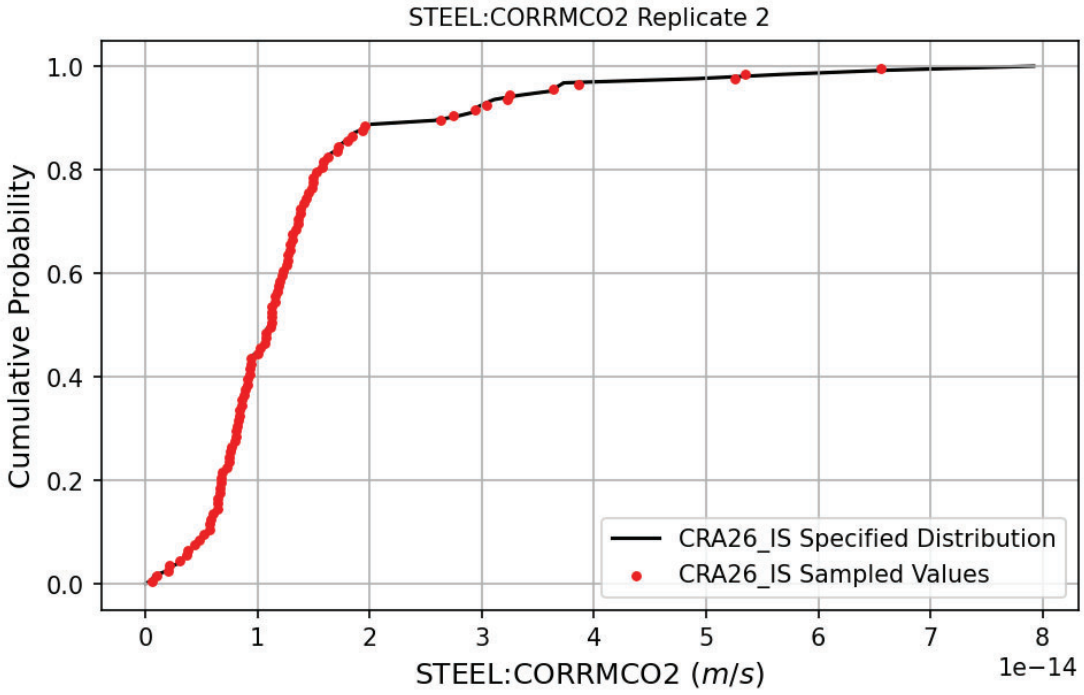

Figure 149. Observed and Expected CDFs for STEEL:CORRMCO2 (Cumulative Distribution) Replicate 2

Information Only

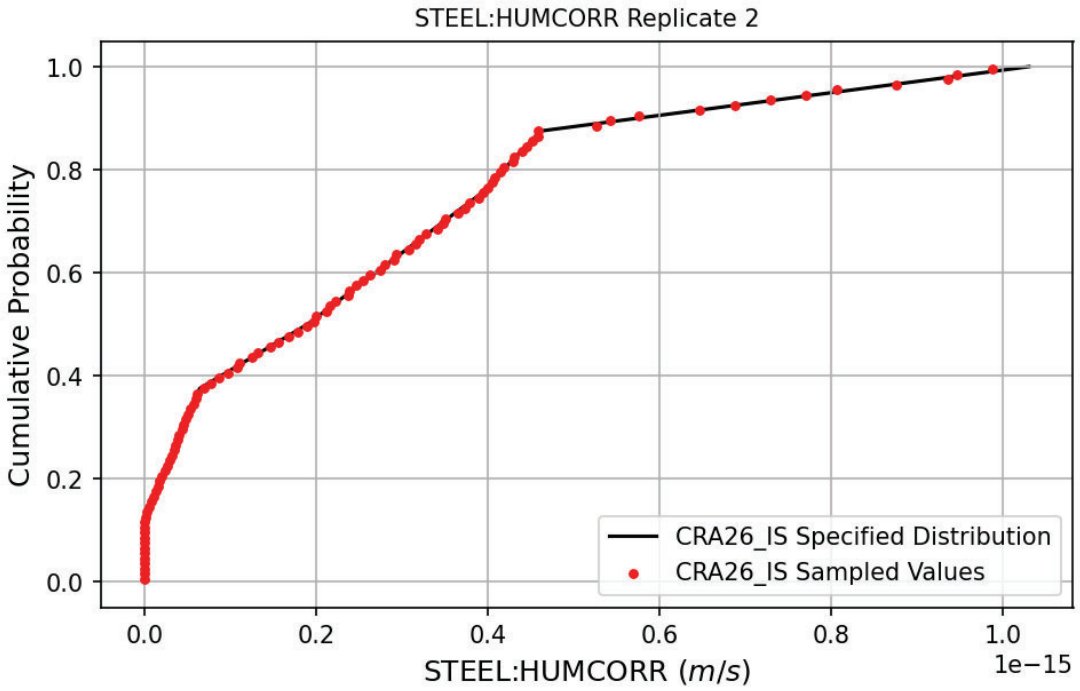

Figure 150. Observed and Expected CDFs for STEEL:HUMCORR (Cumulative Distribution) Replicate 2

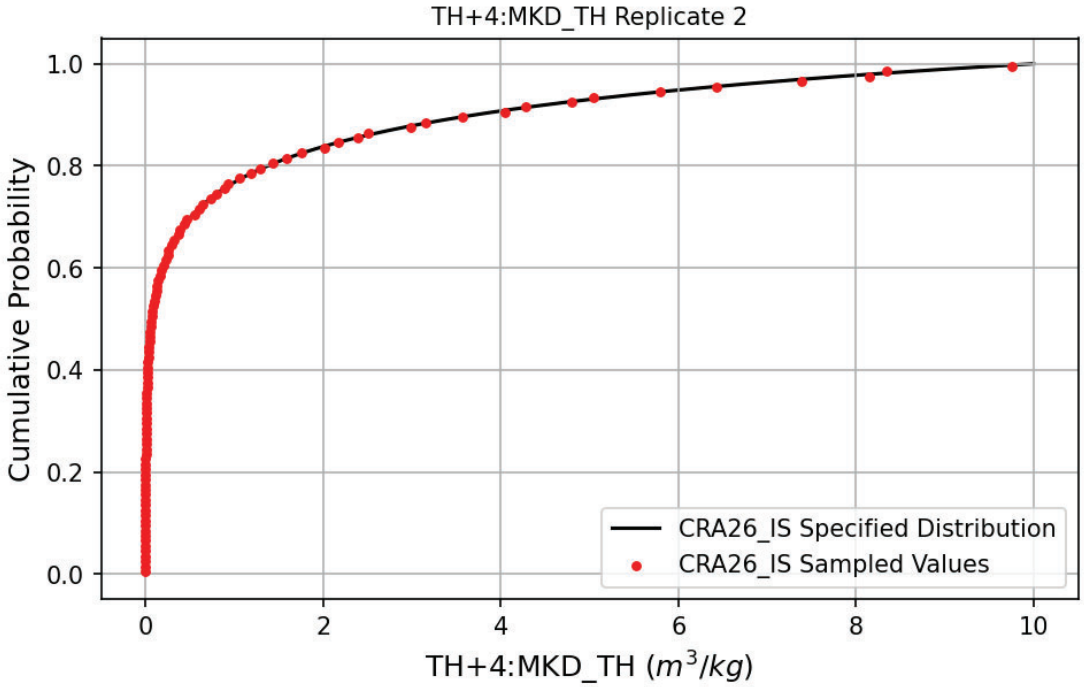

Figure 151. Observed and Expected CDFs for TH+4:MKD_TH (Loguniform Distribution) Replicate 2

Information Only

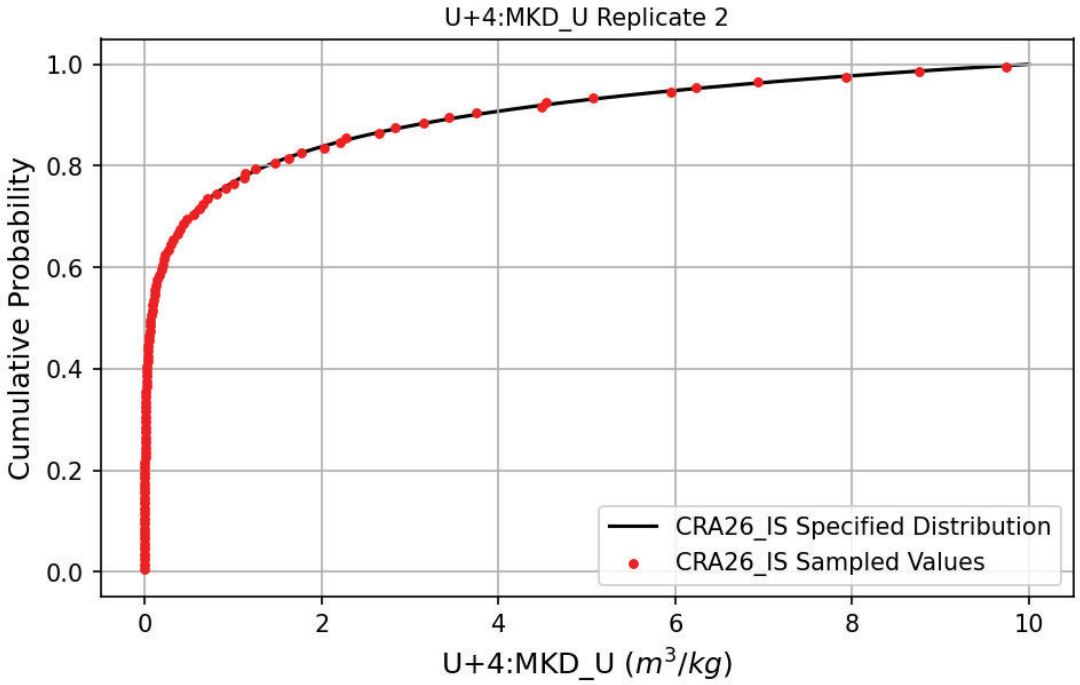

Figure 152. Observed and Expected CDFs for U+4:MKD_U (Loguniform Distribution) Replicate 2

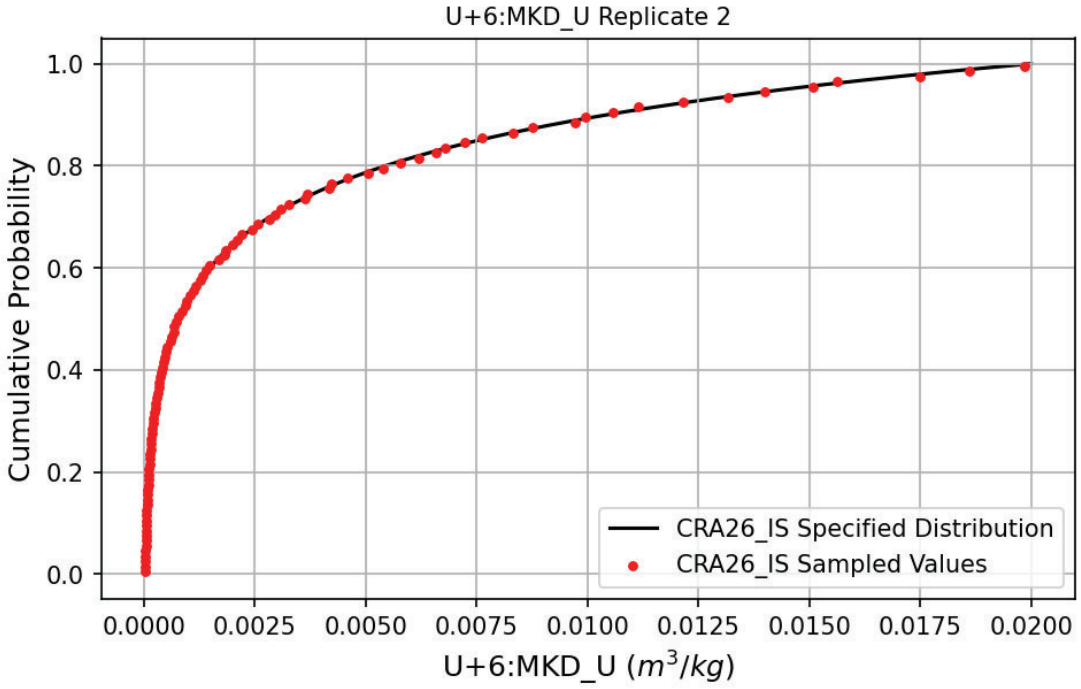

Figure 153. Observed and Expected CDFs for U+6:MKD_U (Loguniform Distribution) Replicate 2

Information Only

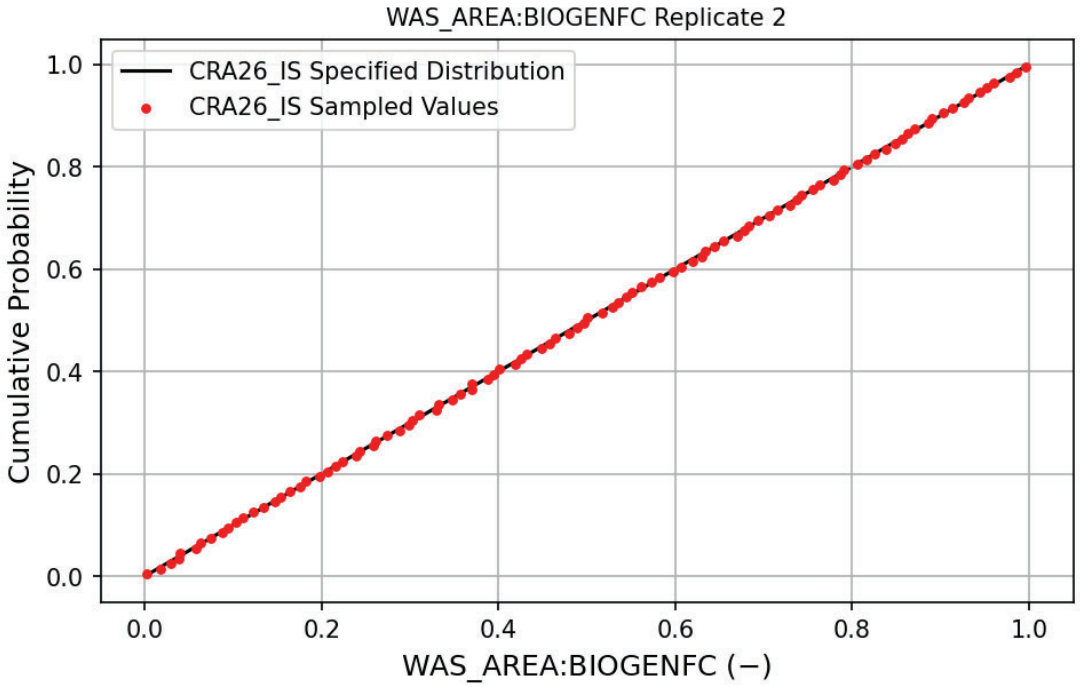

Figure 154. Observed and Expected CDFs for WAS_AREA:BIOGENFC (Uniform Distribution) Replicate 2

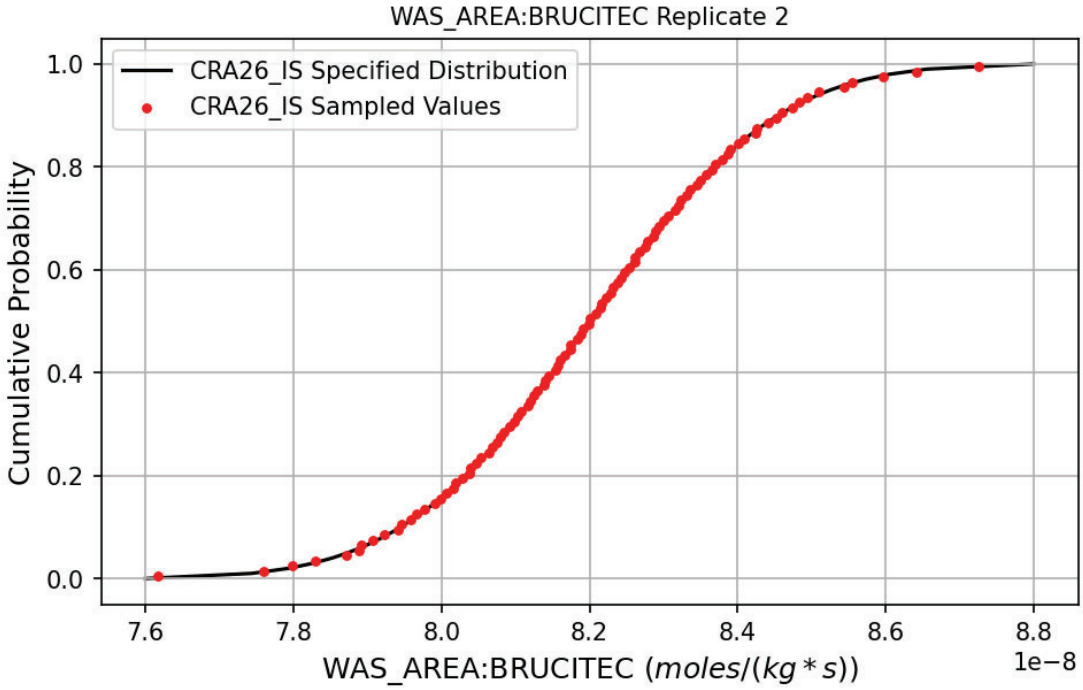

Figure 155. Observed and Expected CDFs for WAS_AREA:BRUCITEC (Cumulative Distribution) Replicate 2

Information Only

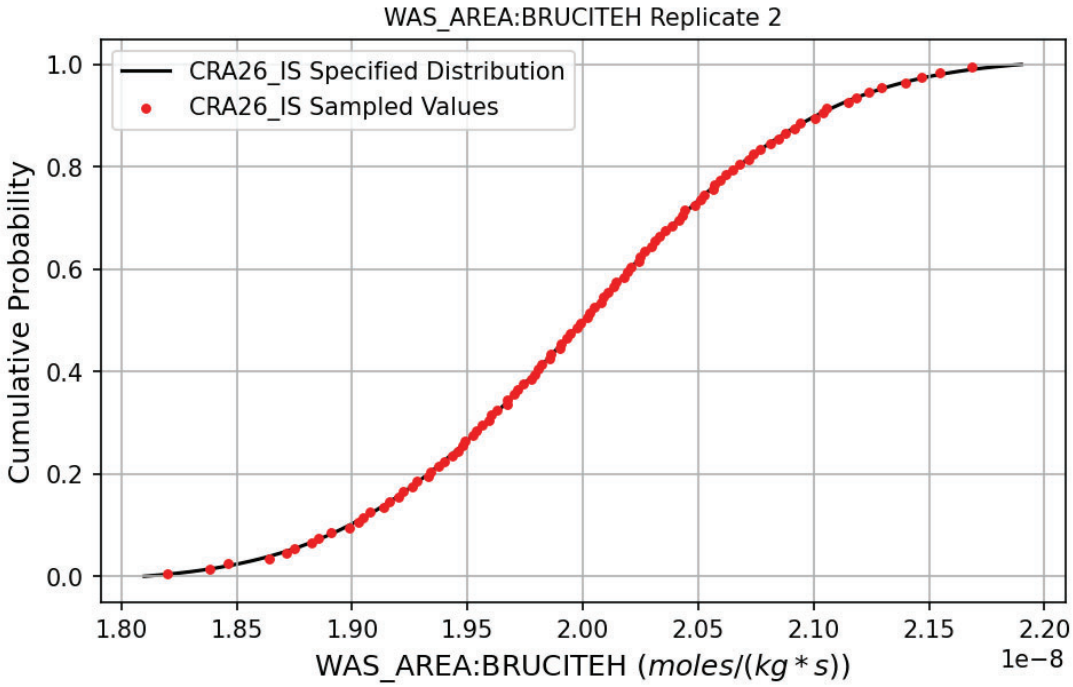

Figure 156. Observed and Expected CDFs for WAS_AREA:BRUCITEH (Normal Distribution) Replicate 2

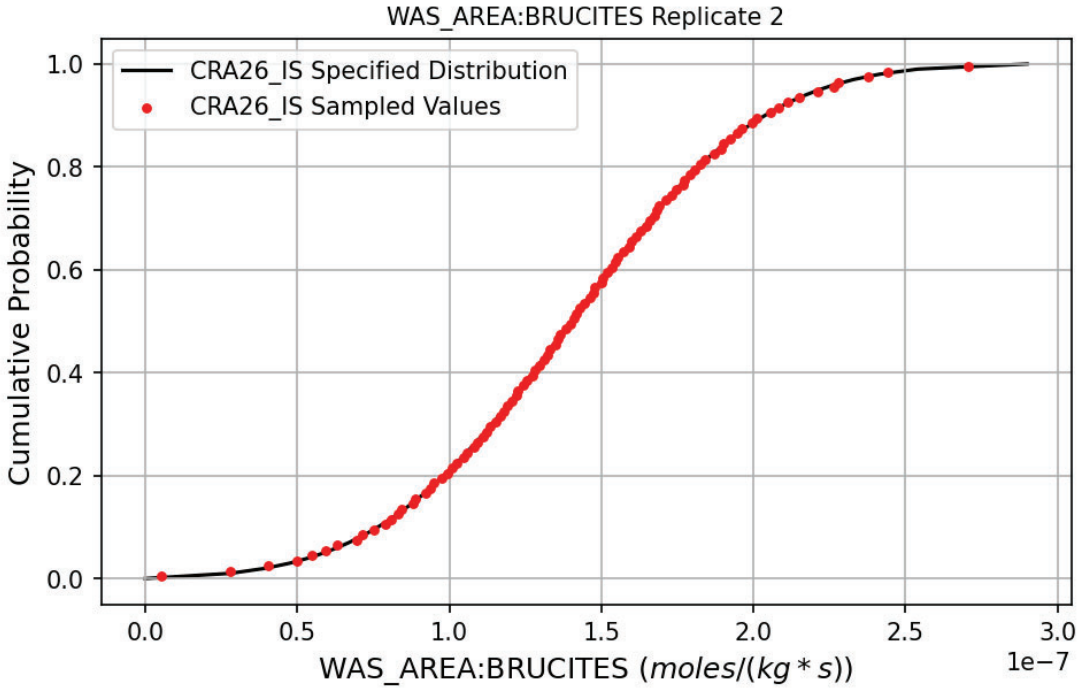

Figure 157. Observed and Expected CDFs for WAS_AREA:BRUCITES (Cumulative Distribution) Replicate 2

Information Only

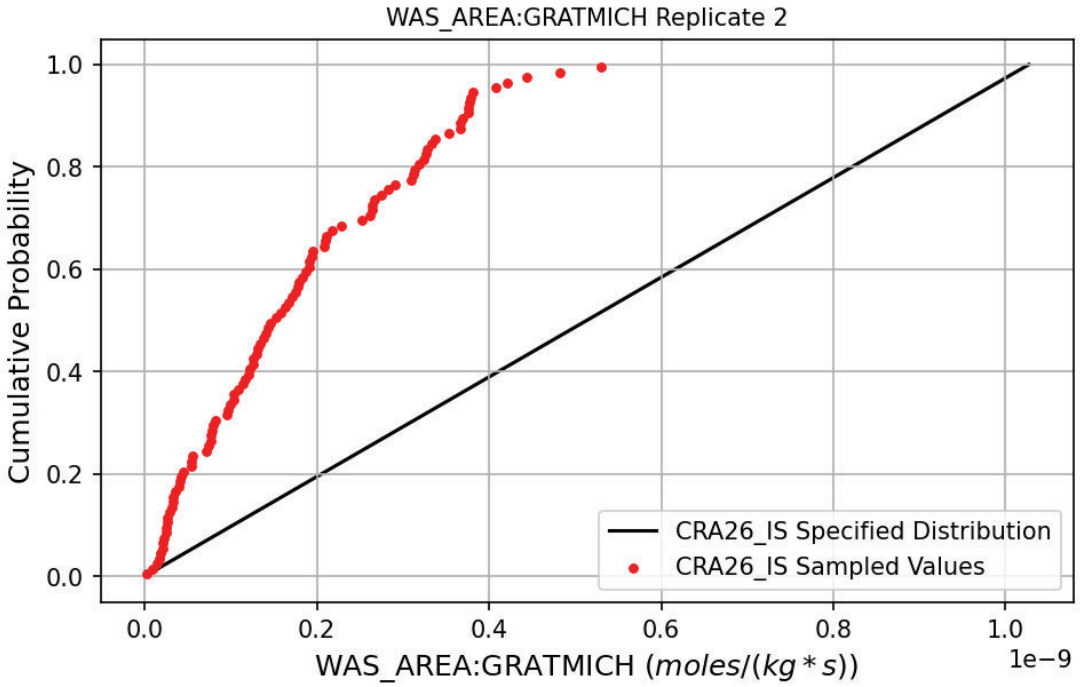

Figure 158. Observed and Expected CDFs for WAS_AREA:GRATMICH (Uniform Distribution) Replicate 2

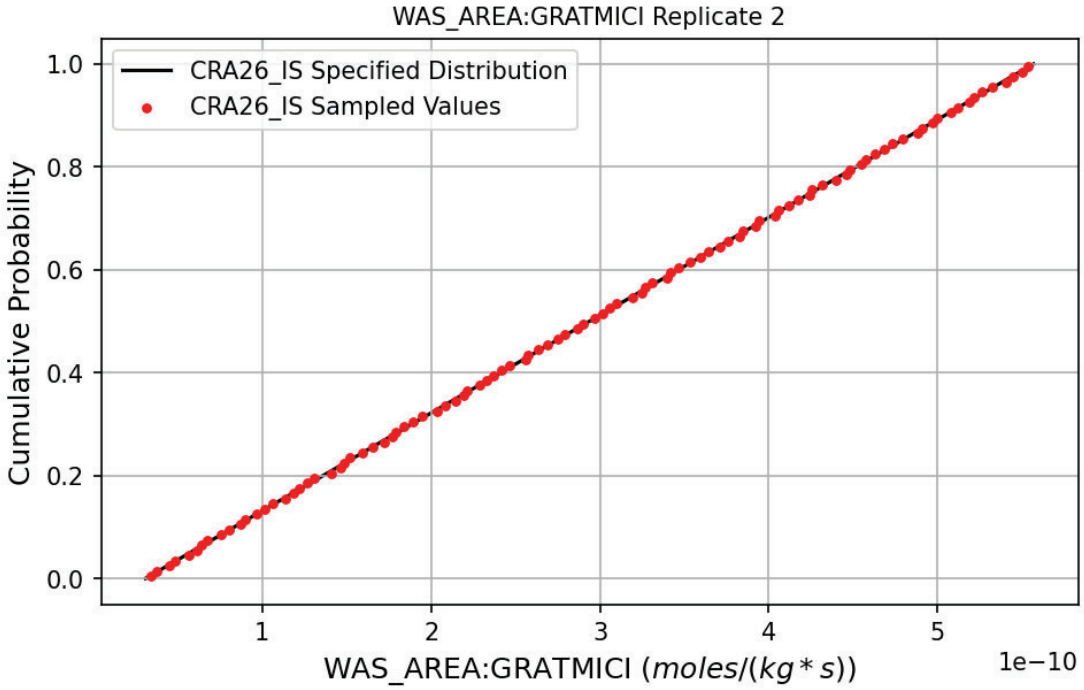

Figure 159. Observed and Expected CDFs for WAS_AREA:GRATMICI (Uniform Distribution) Replicate 2

Information Only

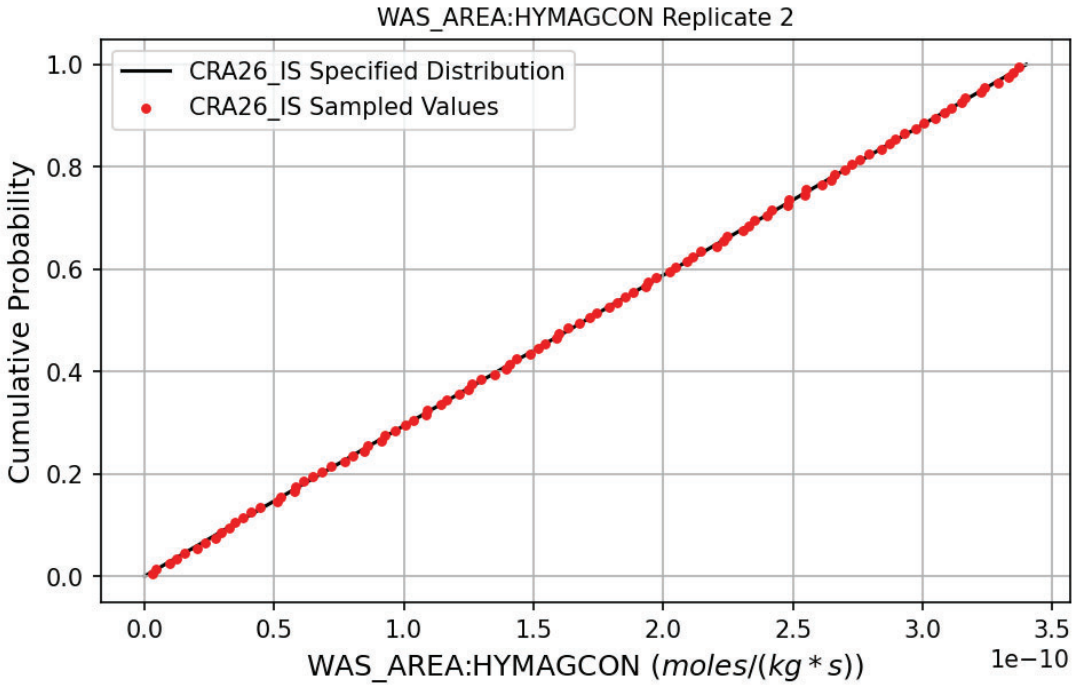

Figure 160. Observed and Expected CDFs for WAS_AREA:HYMAGCON (Uniform Distribution) Replicate 2

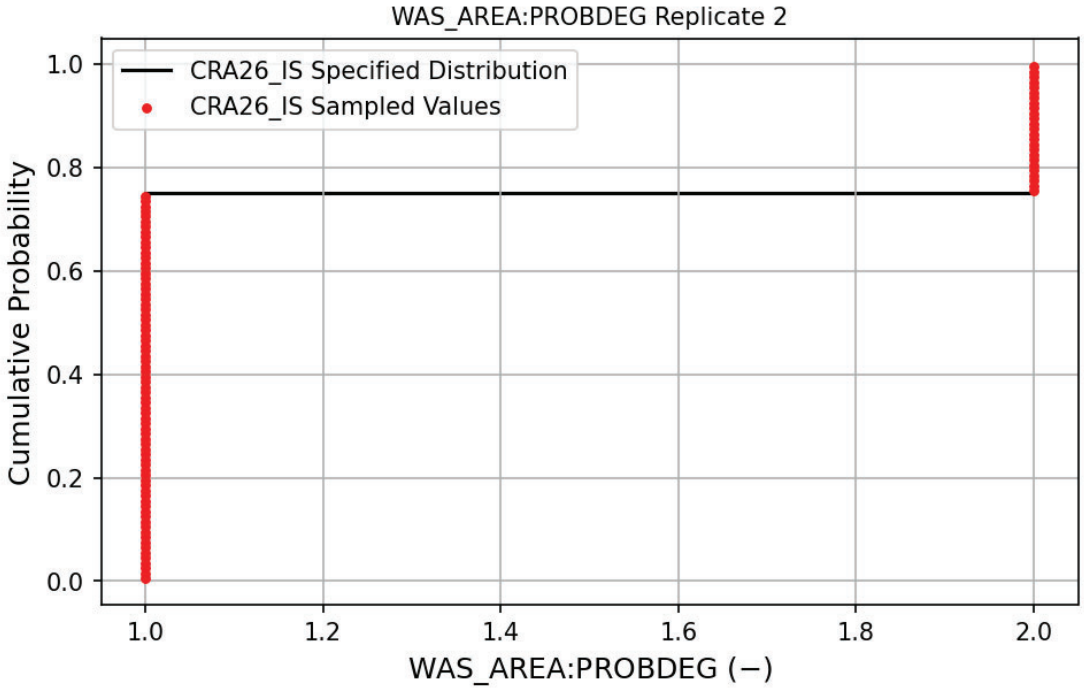

Figure 161. Observed and Expected CDFs for WAS_AREA:PROBDEG (Delta Distribution) Replicate 2

Information Only

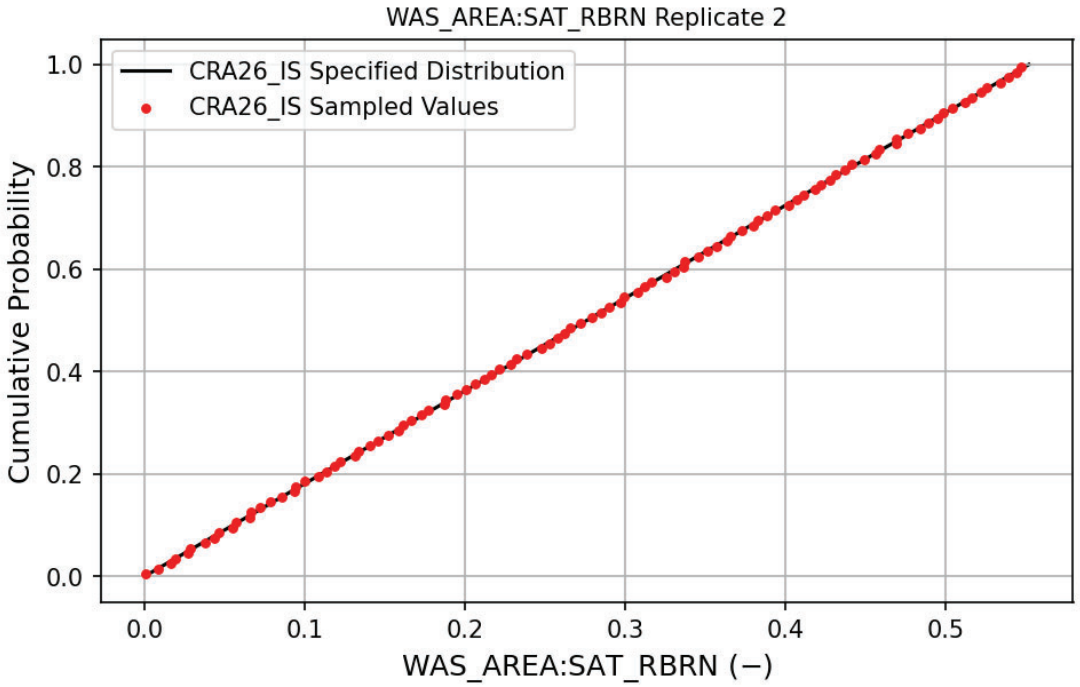

Figure 162. Observed and Expected CDFs for WAS_AREA:SAT_RBRN (Uniform Distribution) Replicate 2

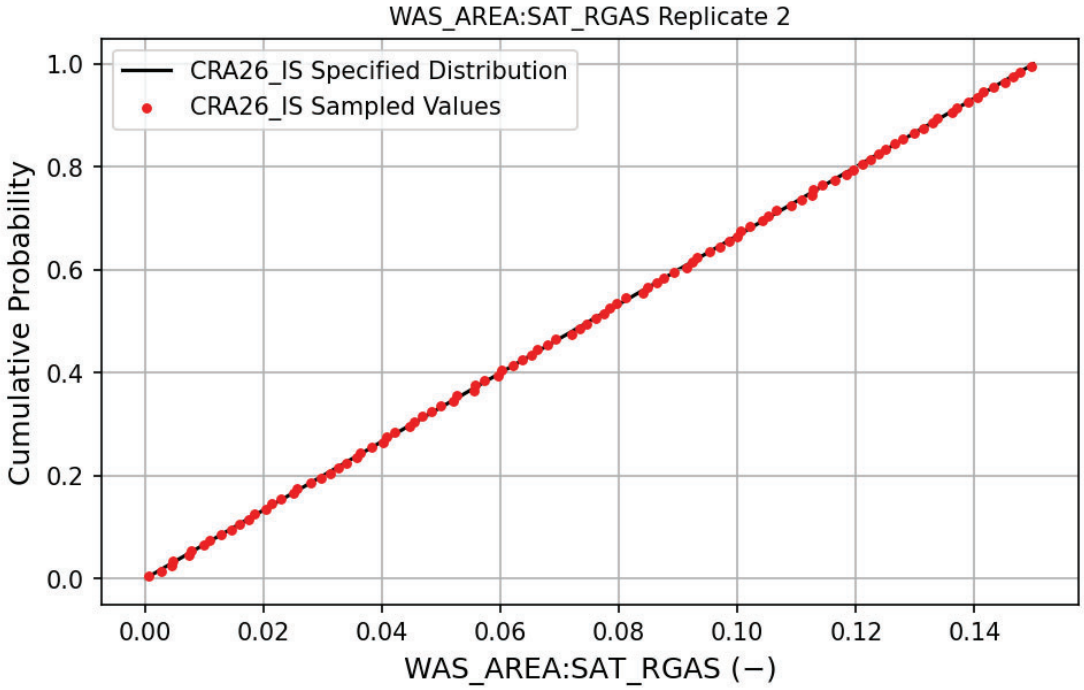

Figure 163. Observed and Expected CDFs for WAS_AREA:SAT_RGAS (Uniform Distribution) Replicate 2

Information Only

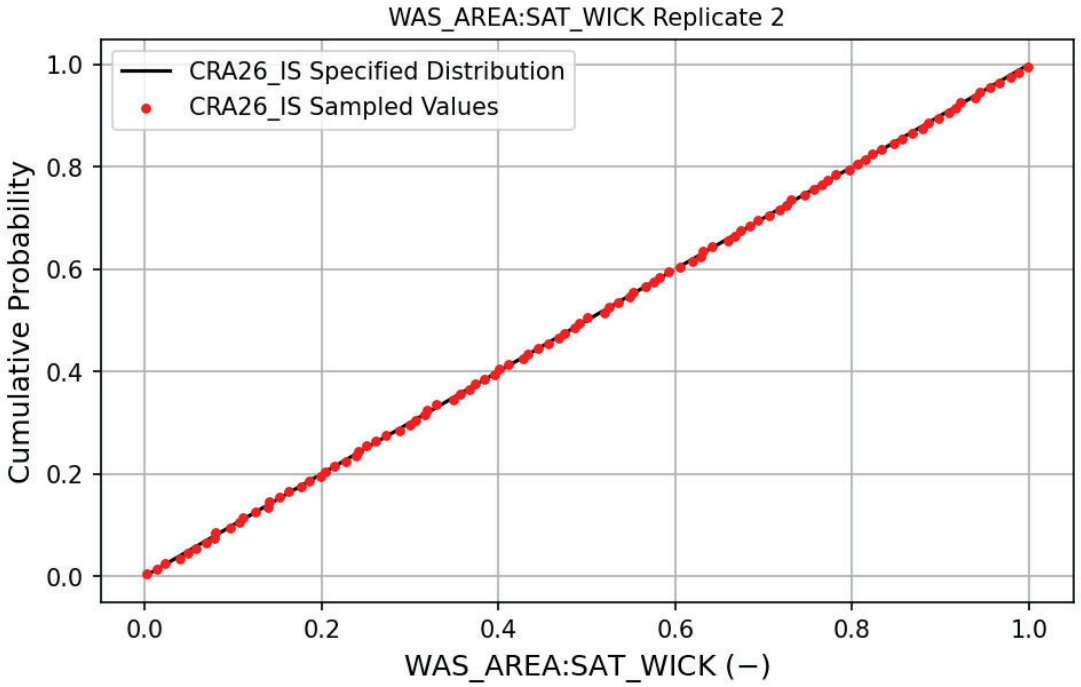

Figure 164. Observed and Expected CDFs for WAS_AREA:SAT_WICK (Uniform Distribution) Replicate 2

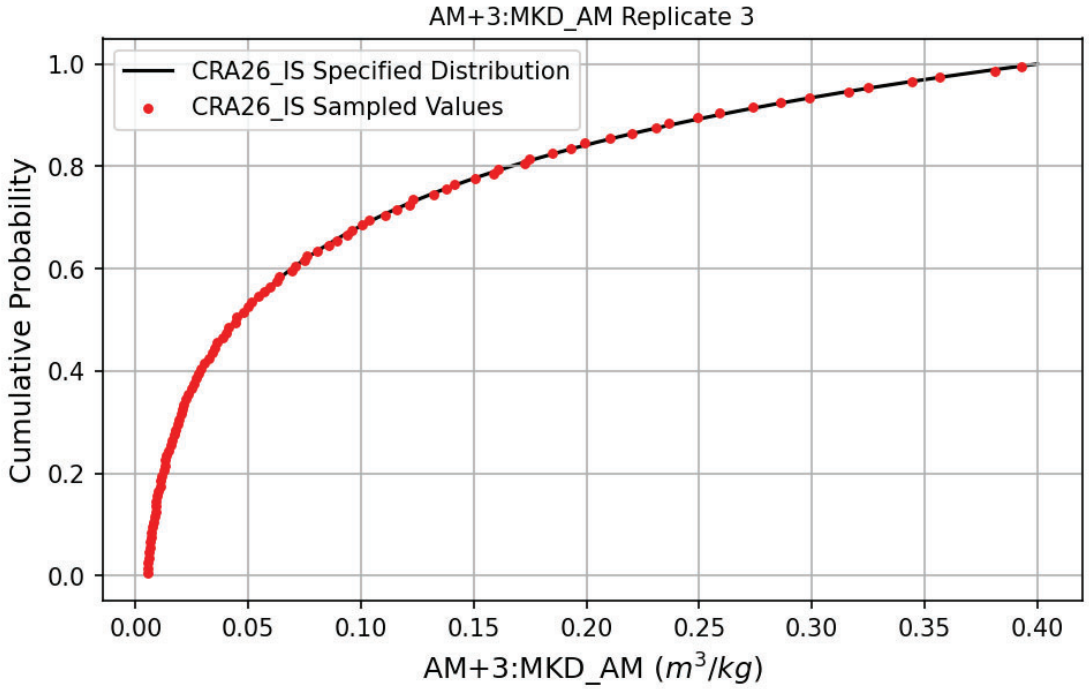

Figure 165. Observed and Expected CDFs for AM+3:MKD_AM (Loguniform Distribution) Replicate 3

Information Only

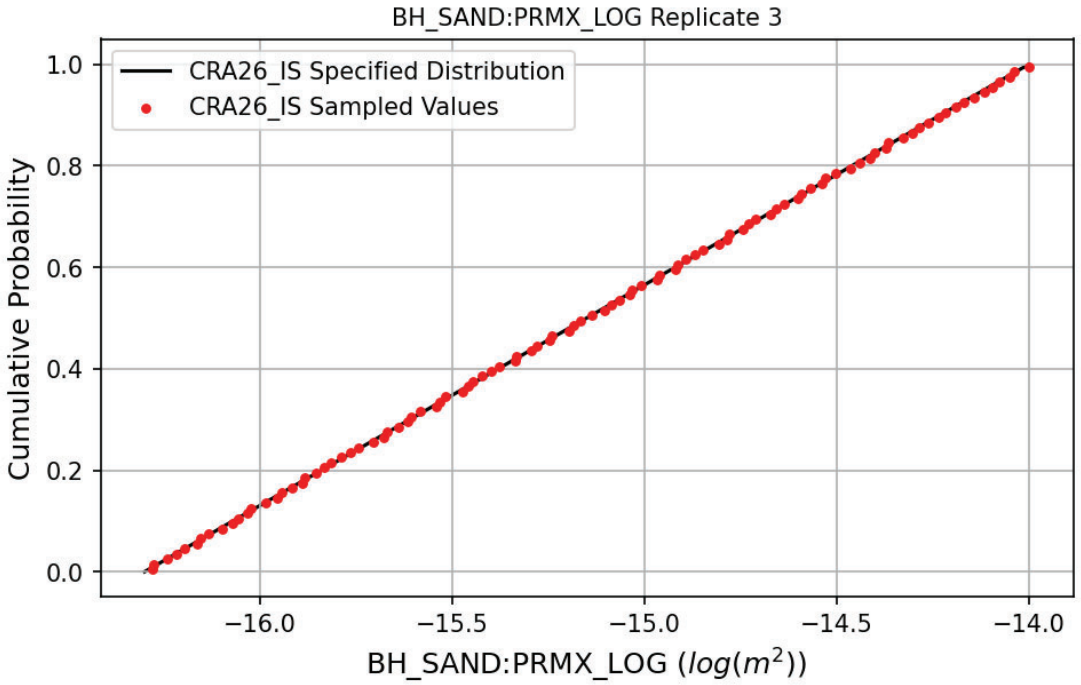

Figure 166. Observed and Expected CDFs for BH_SAND:PRMX_LOG (Uniform Distribution) Replicate 3

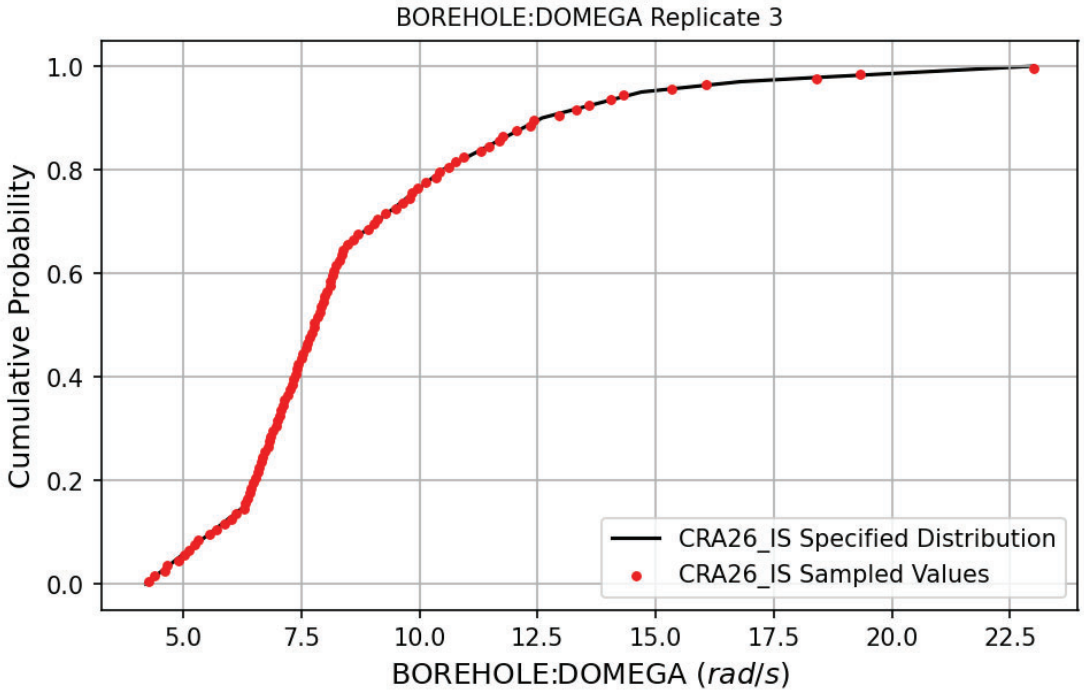

Figure 167. Observed and Expected CDFs for BOREHOLE:DOMEGA (Cumulative Distribution) Replicate 3

Information Only

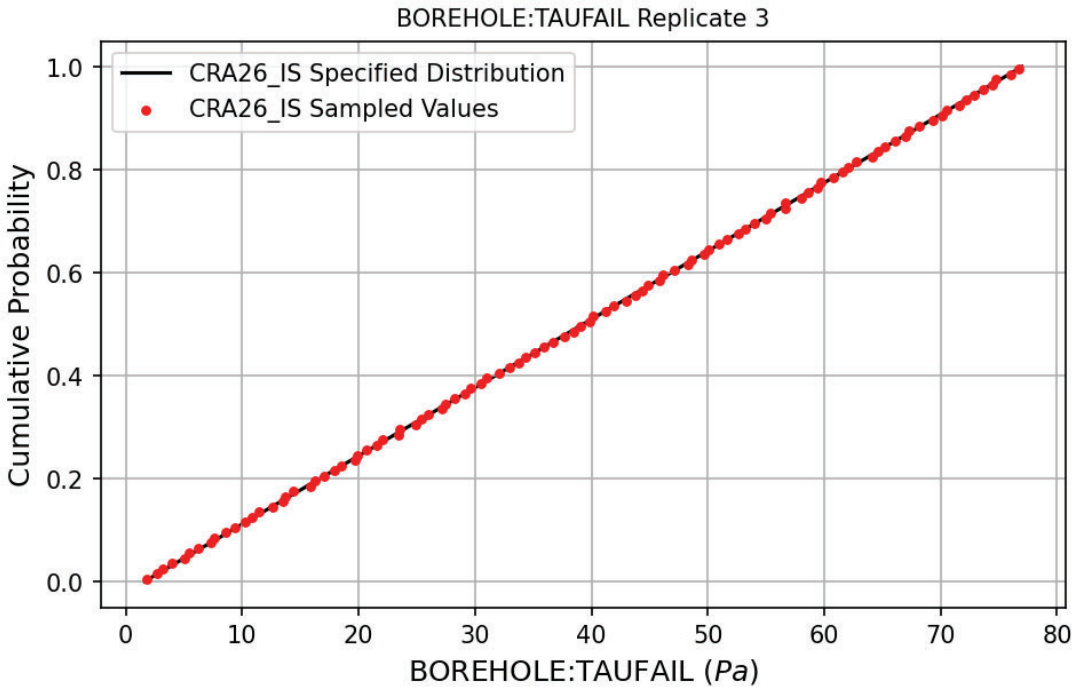

Figure 168. Observed and Expected CDFs for BOREHOLE:TAUFAIL (Uniform Distribution) Replicate 3

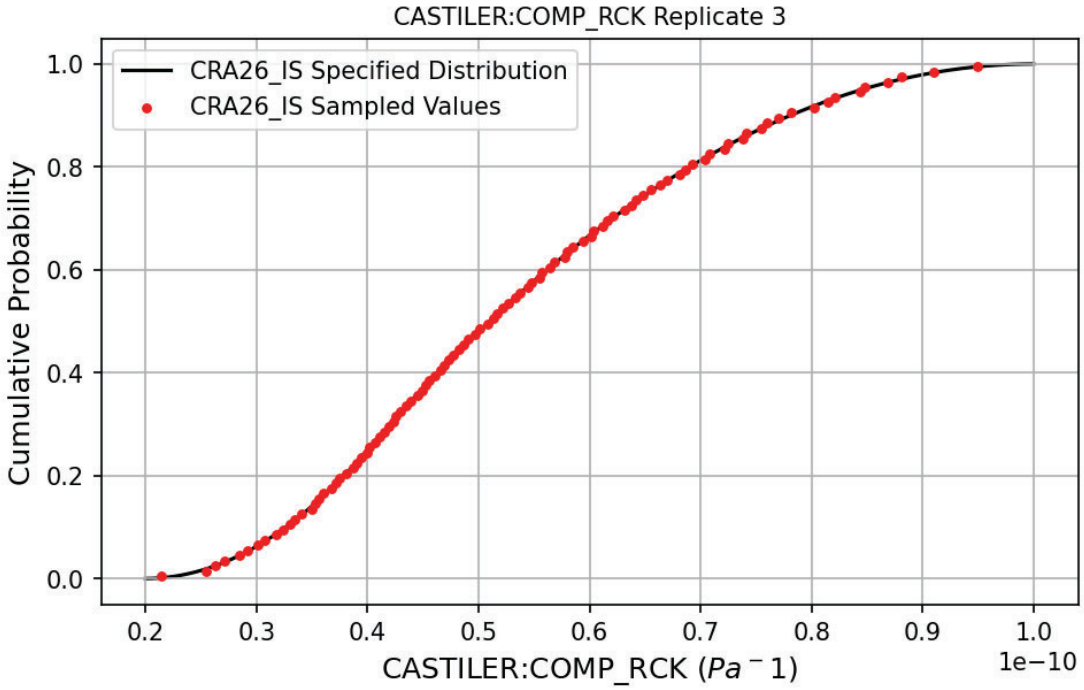

Figure 169. Observed and Expected CDFs for CASTILER:COMP_RCK (Triangular Distribution) Replicate 3

Information Only

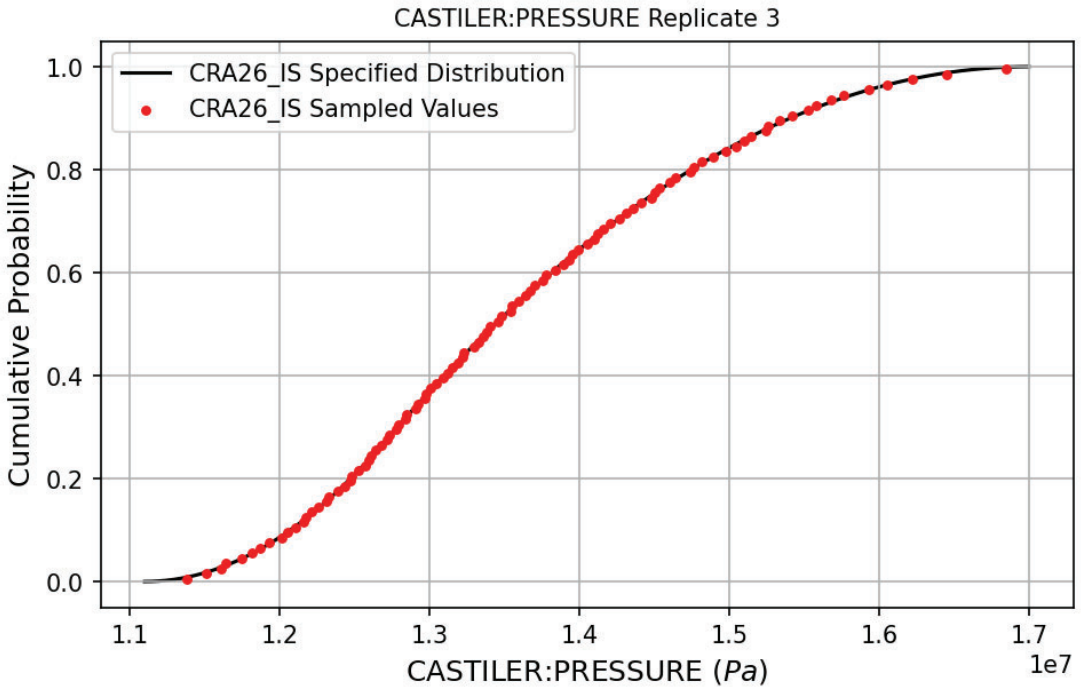

Figure 170. Observed and Expected CDFs for CASTILER:PRESSURE (Triangular Distribution) Replicate 3

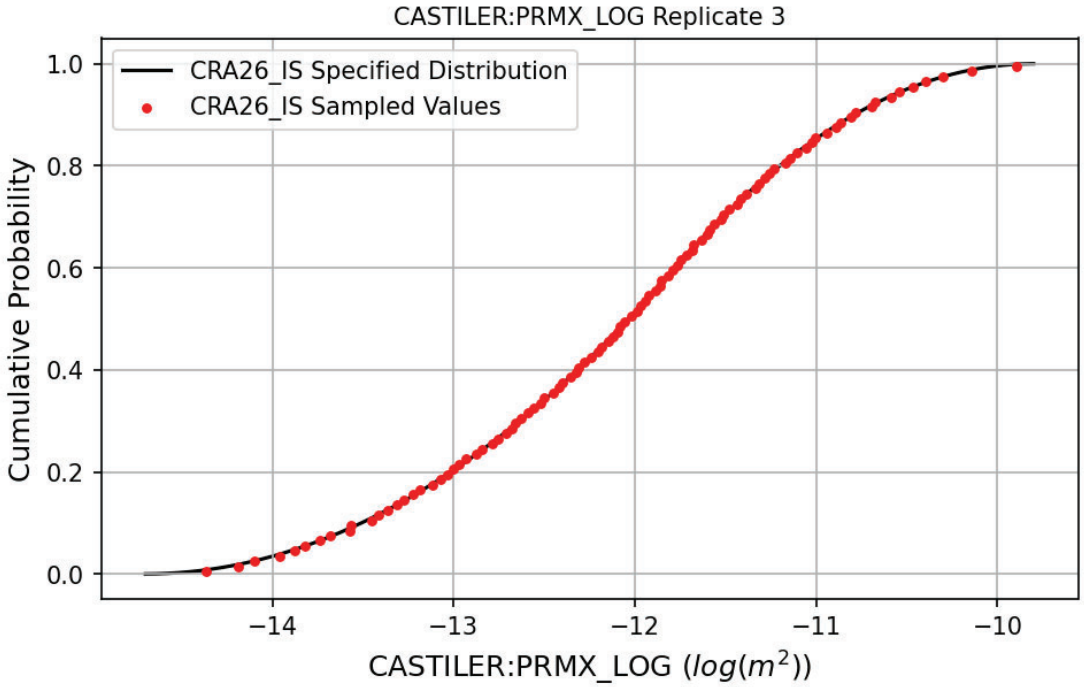

Figure 171. Observed and Expected CDFs for CASTILER:PRMX_LOG (Triangular Distribution) Replicate 3

Information Only

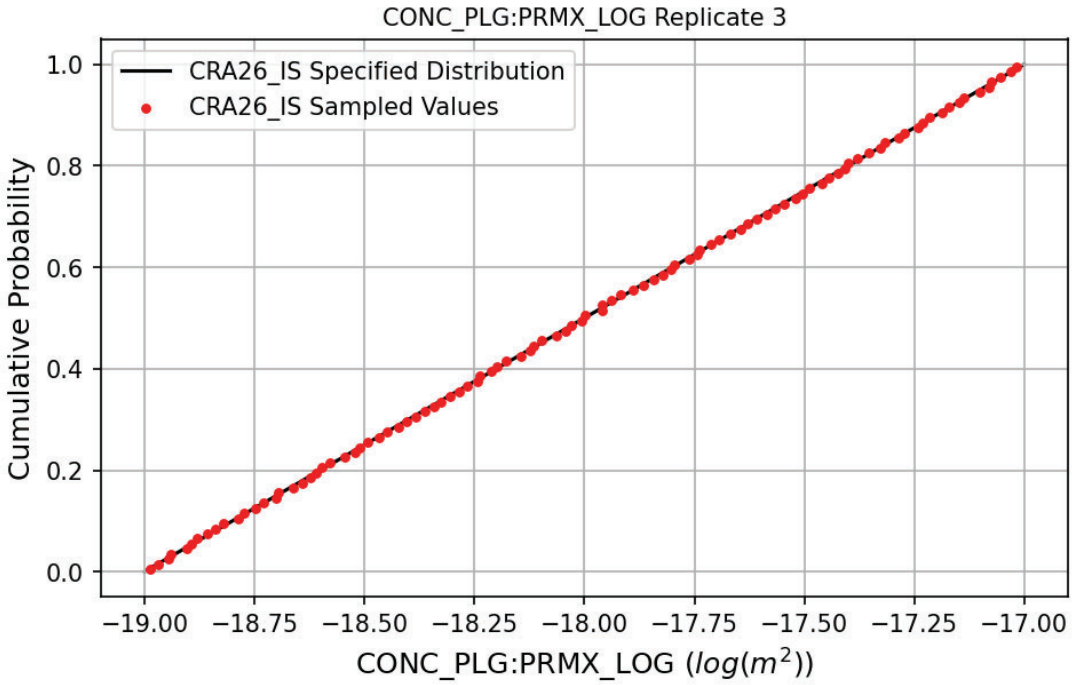

Figure 172. Observed and Expected CDFs for CONC_PLG:PRMX_LOG (Uniform Distribution) Replicate 3

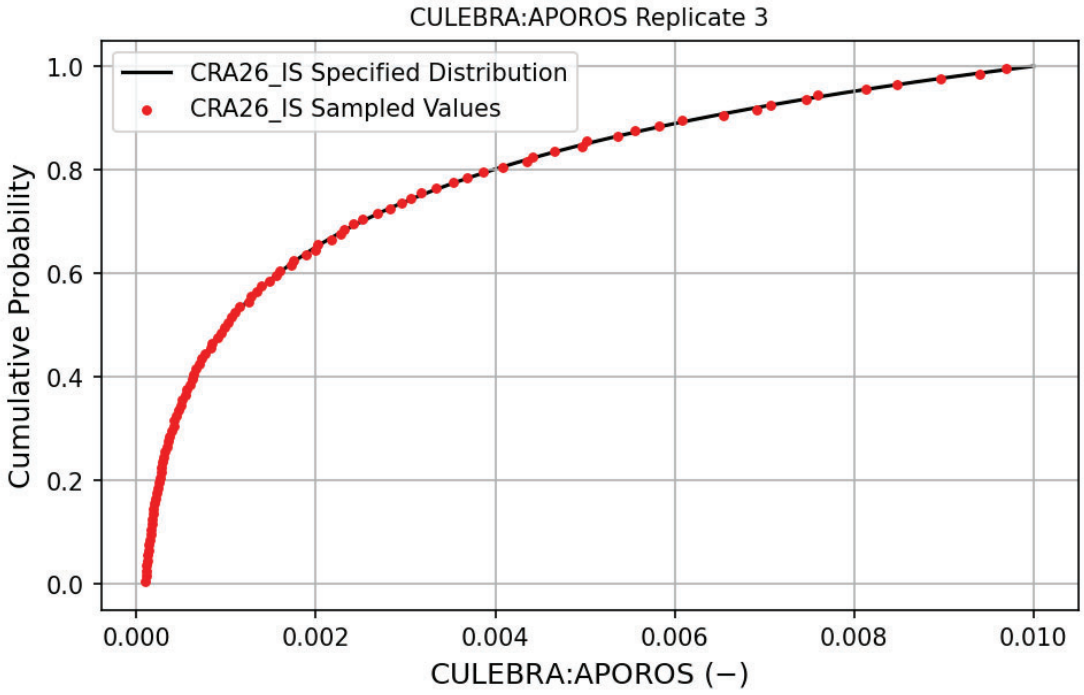

Figure 173. Observed and Expected CDFs for CULEBRA:APOROS (Loguniform Distribution) Replicate 3

Information Only

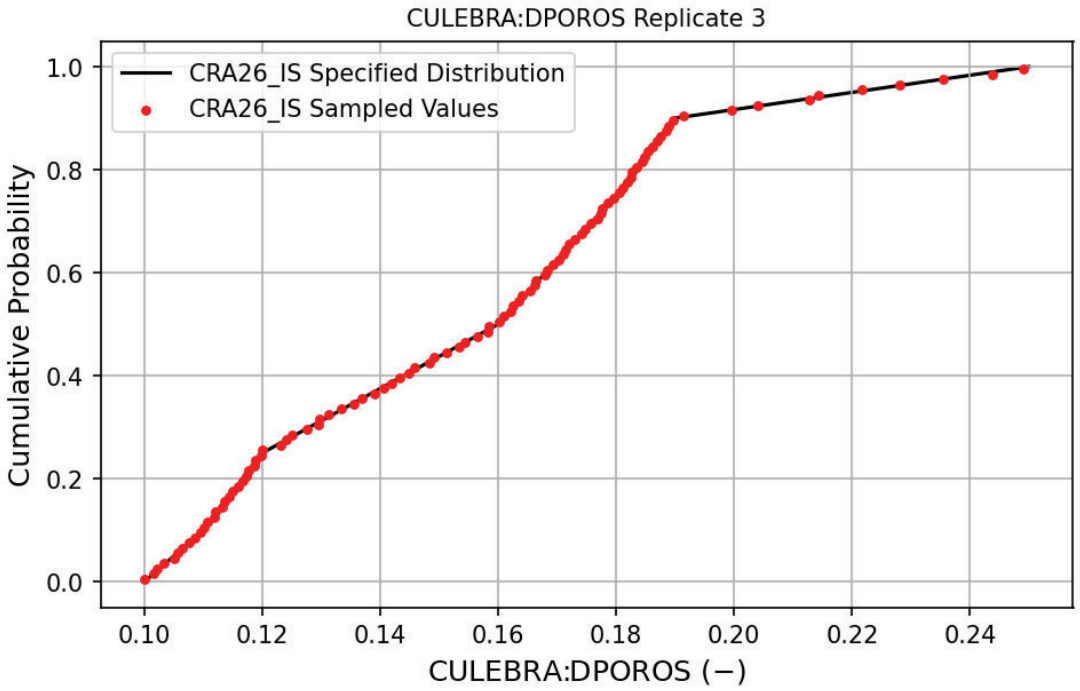

Figure 174. Observed and Expected CDFs for CULEBRA:DPOROS (Cumulative Distribution) Replicate 3

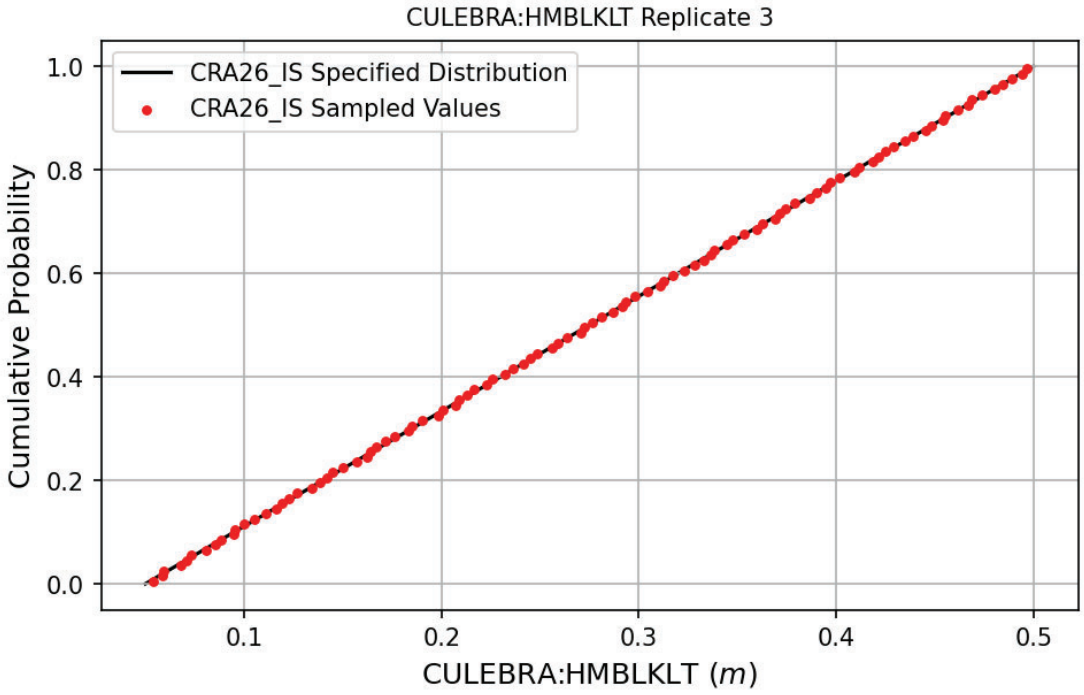

Figure 175. Observed and Expected CDFs for CULEBRA:HMBLKLT (Uniform Distribution) Replicate 3

Information Only

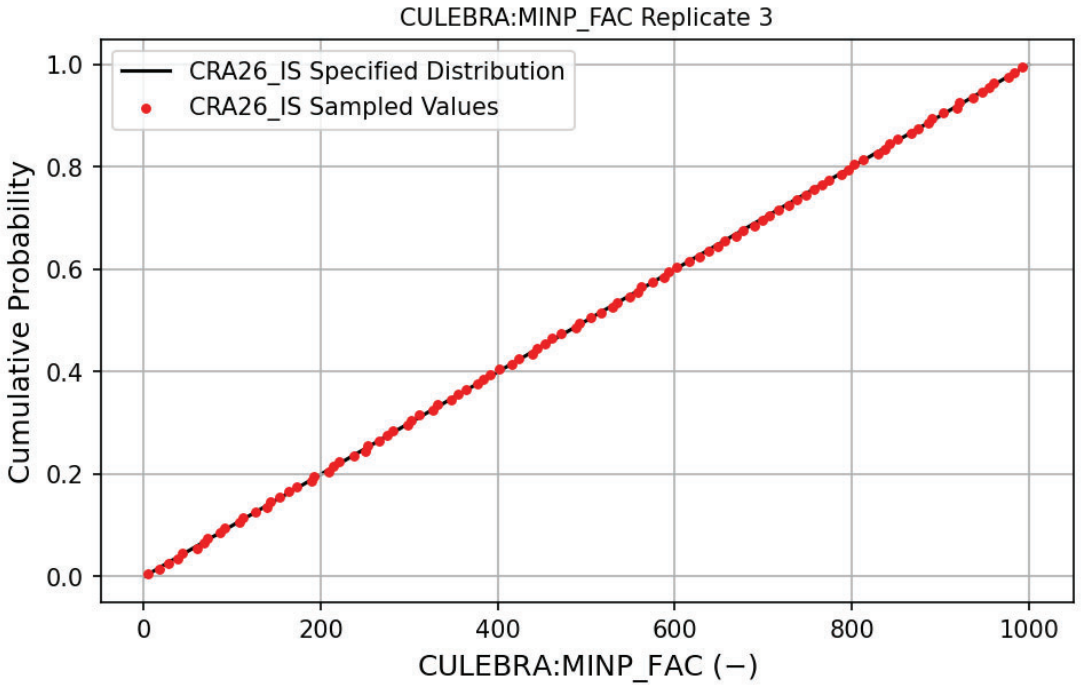

Figure 176. Observed and Expected CDFs for CULEBRA:MINP_FAC (Uniform Distribution) Replicate 3

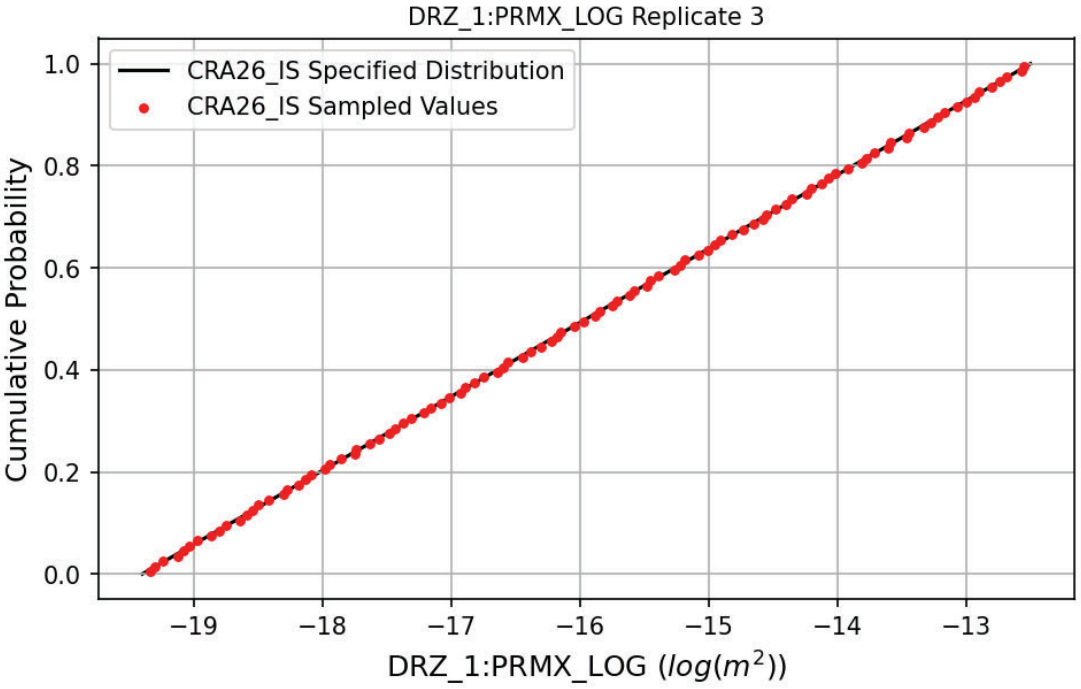

Figure 177. Observed and Expected CDFs for DRZ_1:PRMX_LOG (Uniform Distribution) Replicate 3

Information Only

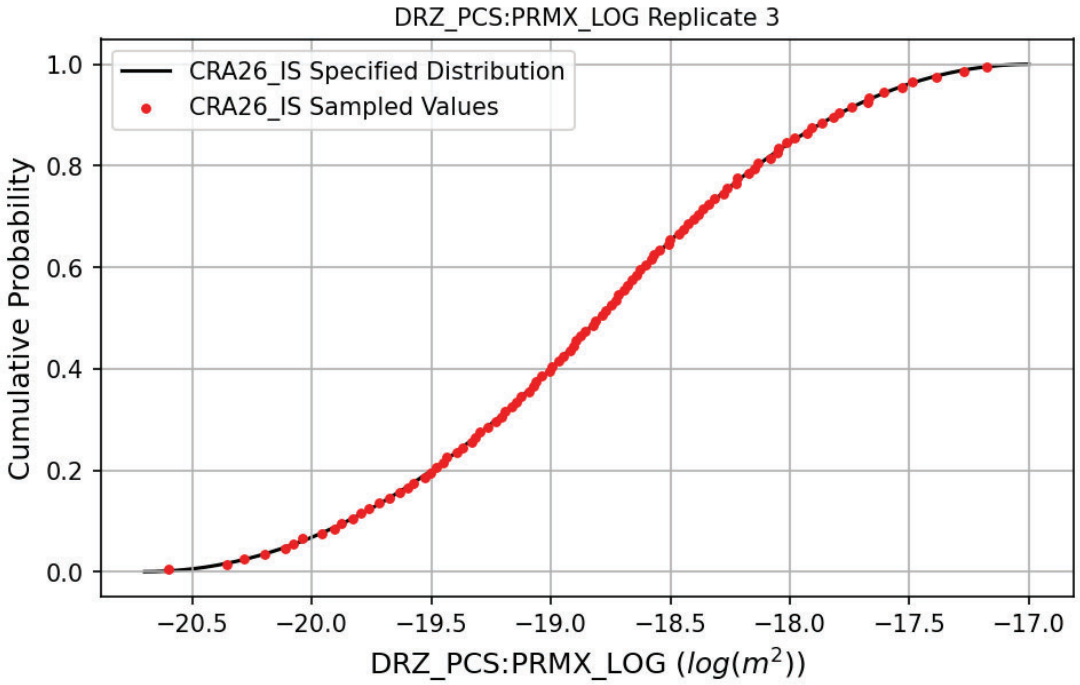

Figure 178. Observed and Expected CDFs for DRZ_PCS:PRMX_LOG (Triangular Distribution) Replicate 3

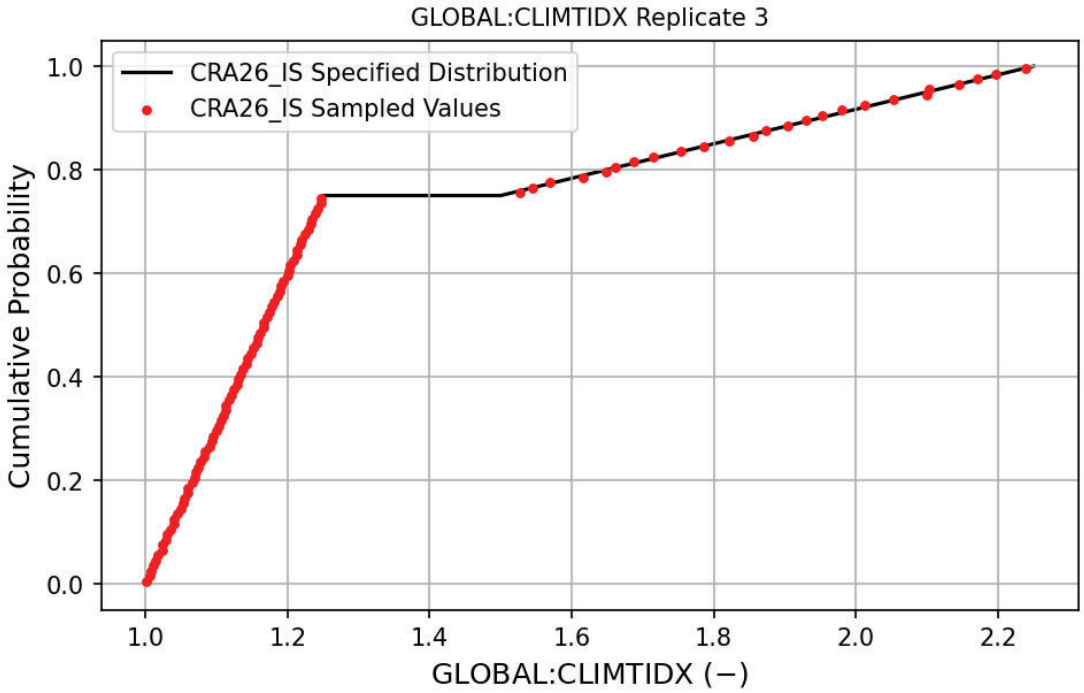

Figure 179. Observed and Expected CDFs for GLOBAL:CLIMTIDX (Cumulative Distribution) Replicate 3

Information Only

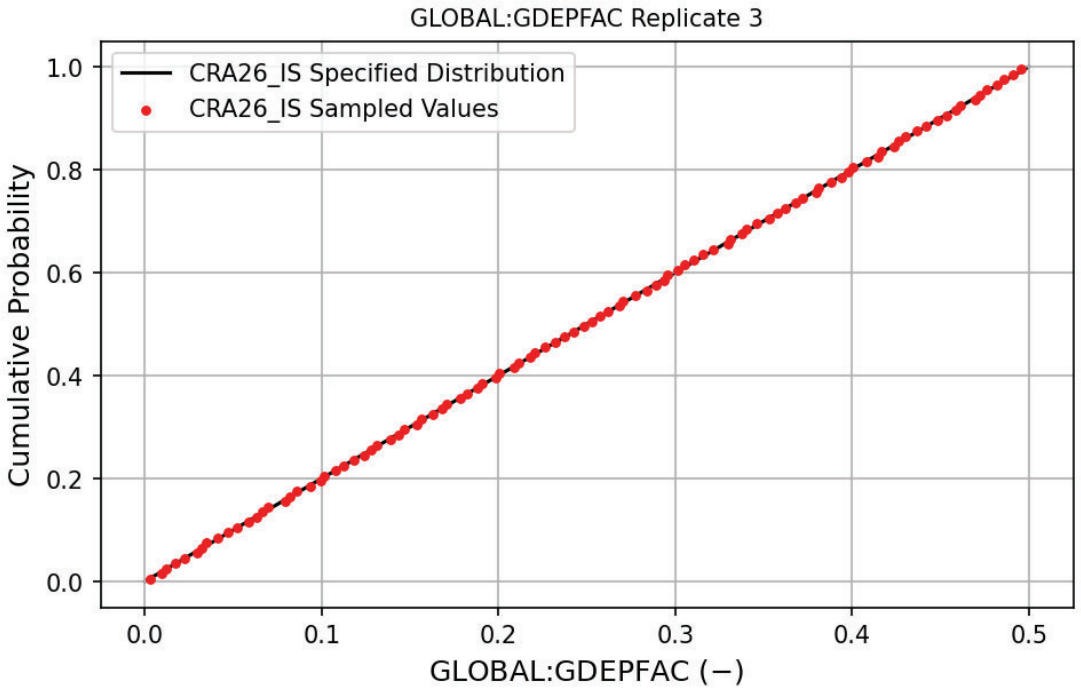

Figure 180. Observed and Expected CDFs for GLOBAL:GDEPFAC (Uniform Distribution) Replicate 3

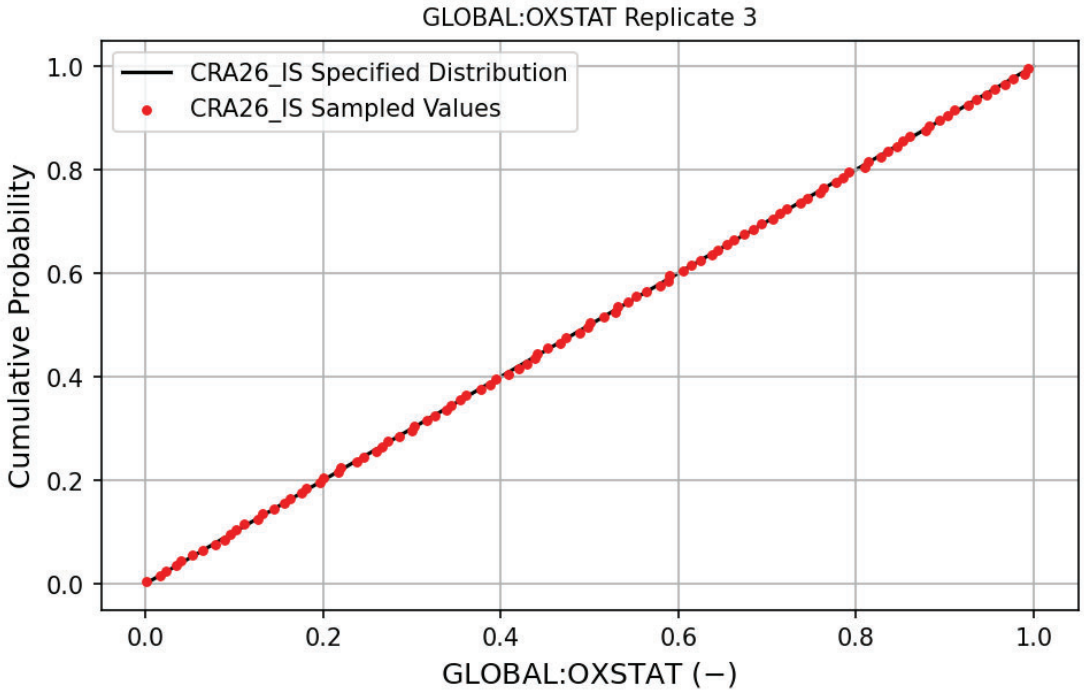

Figure 181. Observed and Expected CDFs for GLOBAL:OXSTAT (Uniform Distribution) Replicate 3

Information Only

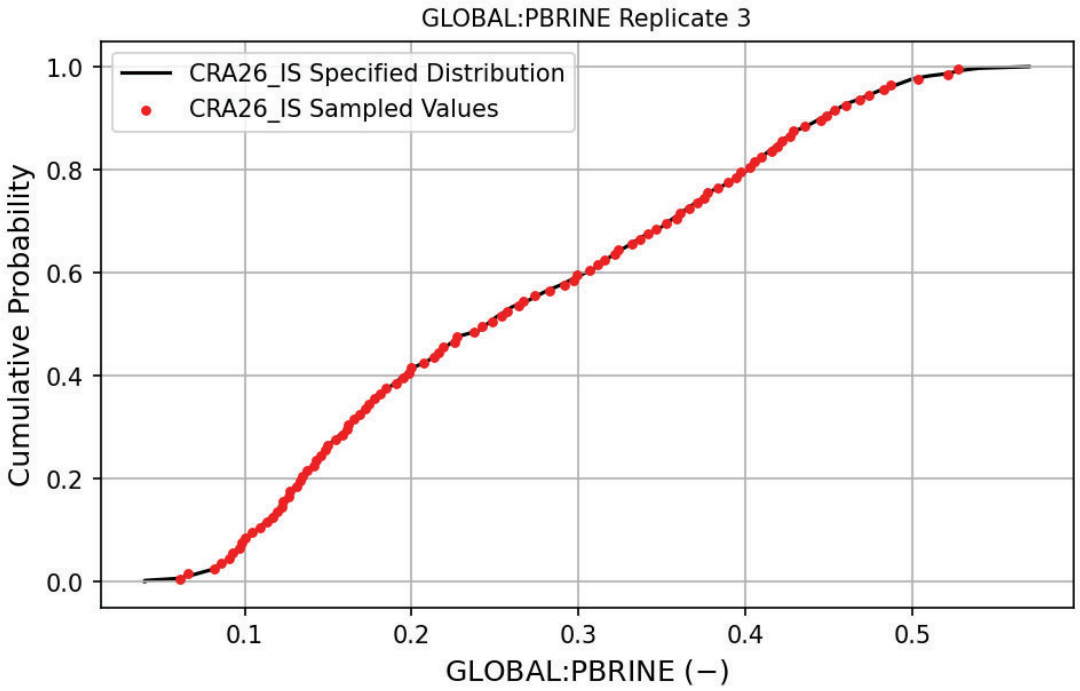

Figure 182. Observed and Expected CDFs for GLOBAL:PBRINE (Cumulative Distribution) Replicate 3

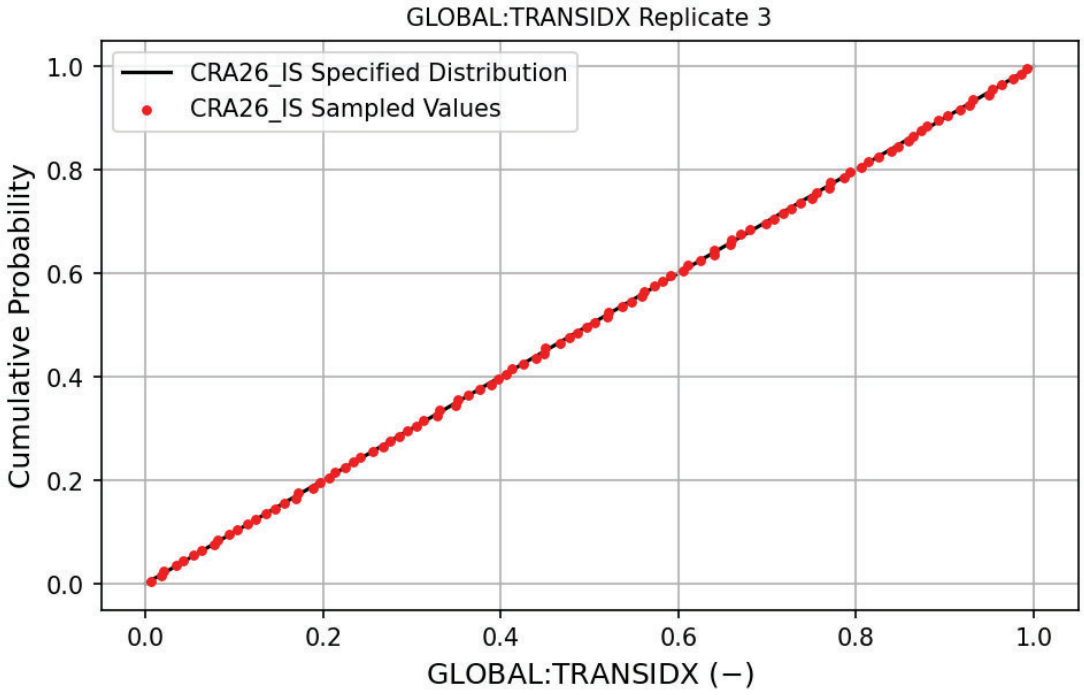

Figure 183. Observed and Expected CDFs for GLOBAL:TRANSIDX (Uniform Distribution) Replicate 3

Information Only

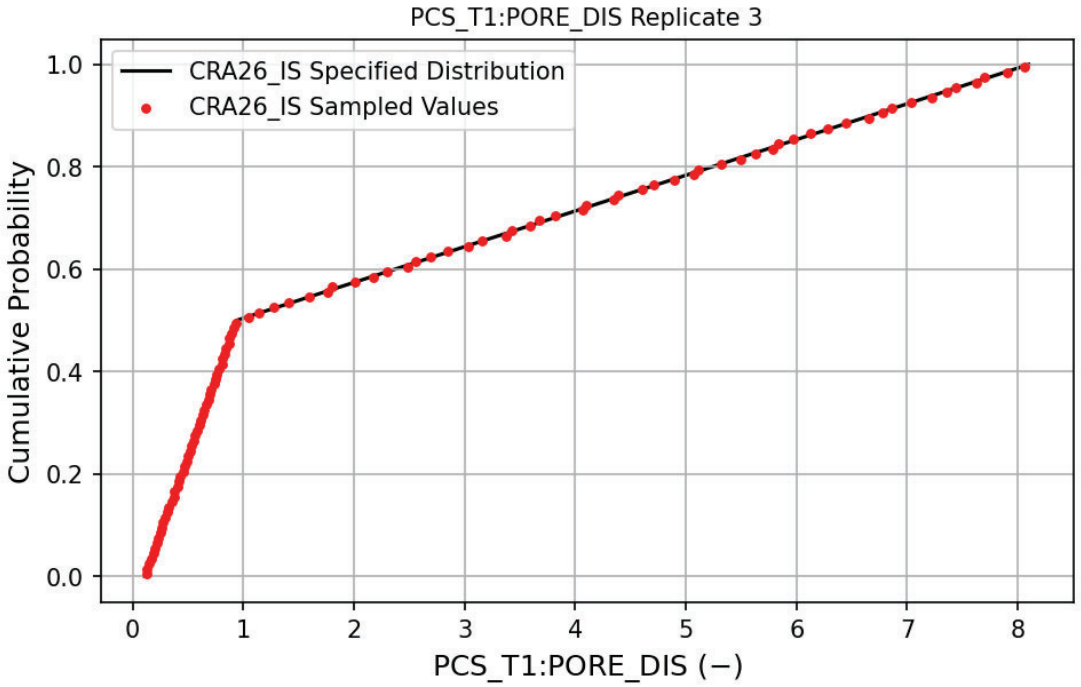

Figure 184. Observed and Expected CDFs for PCS_T1:PORE_DIS (Cumulative Distribution) Replicate 3

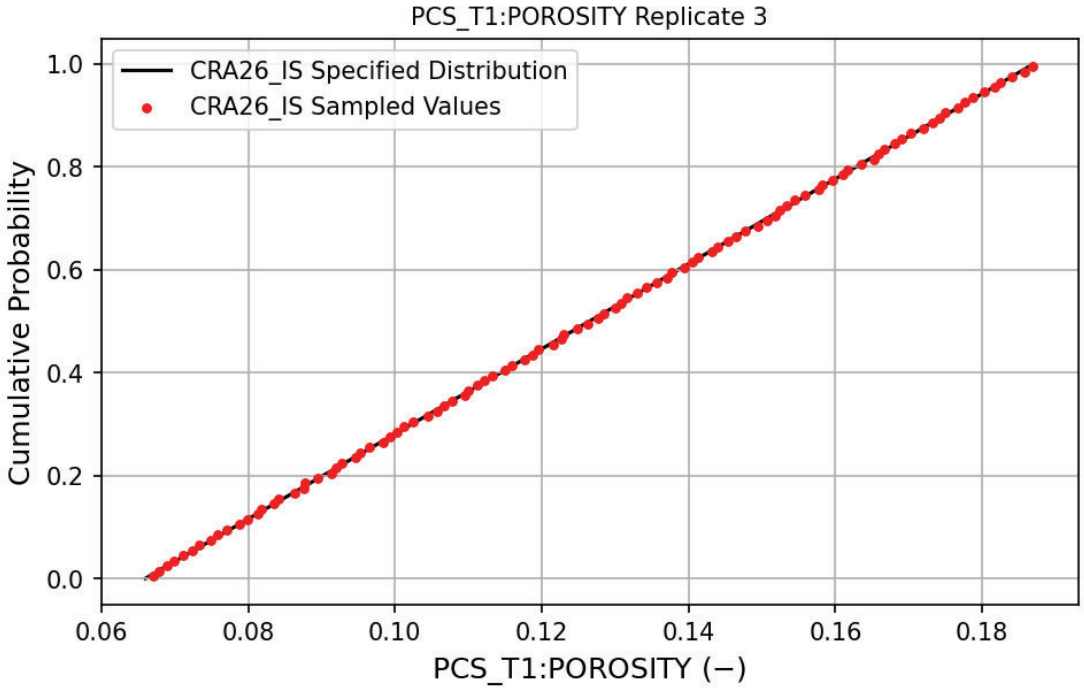

Figure 185. Observed and Expected CDFs for PCS_T1:POROSITY (Uniform Distribution) Replicate 3

Information Only

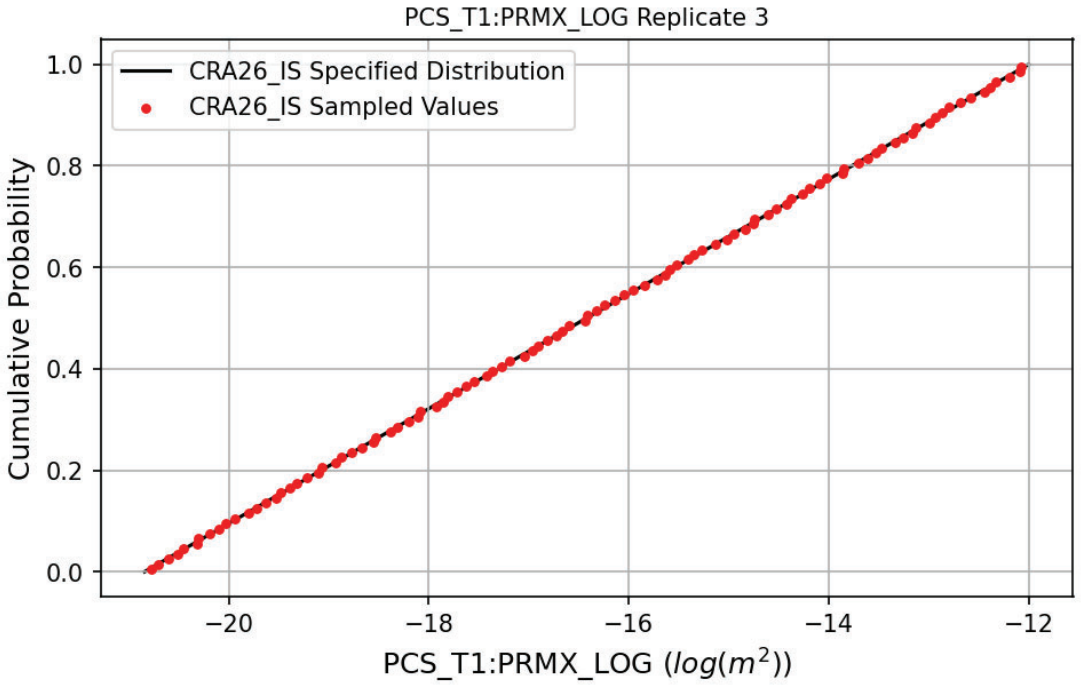

Figure 186. Observed and Expected CDFs for PCS_T1:PRMX_LOG (Uniform Distribution) Replicate 3

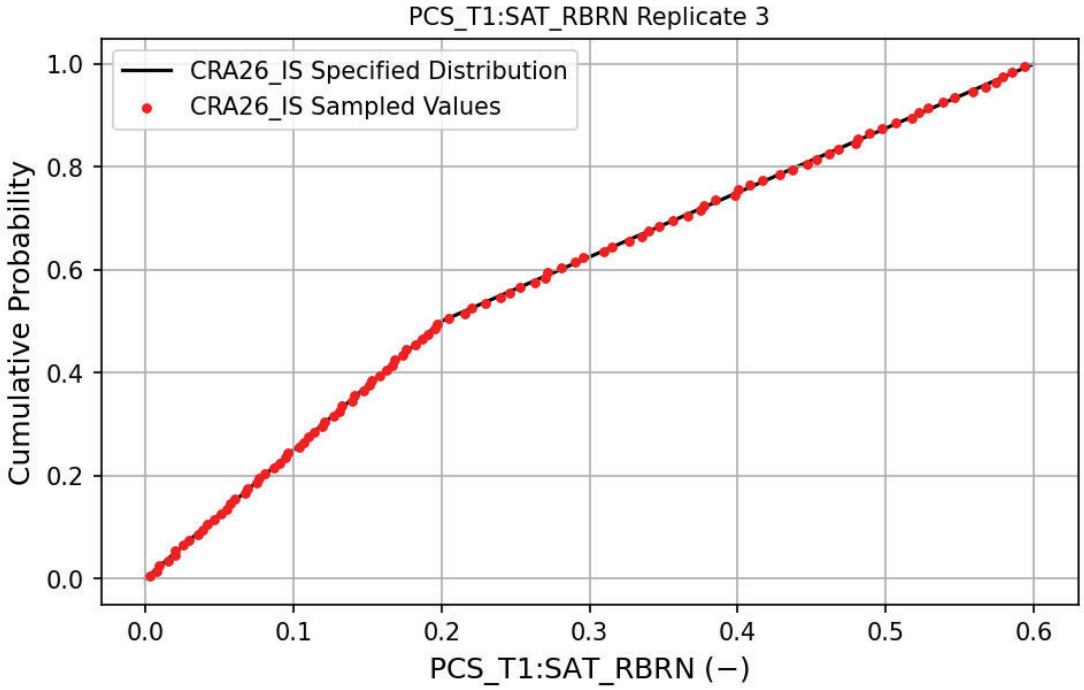

Figure 187. Observed and Expected CDFs for PCS_T1:SAT_RBRN (Cumulative Distribution) Replicate 3

Information Only

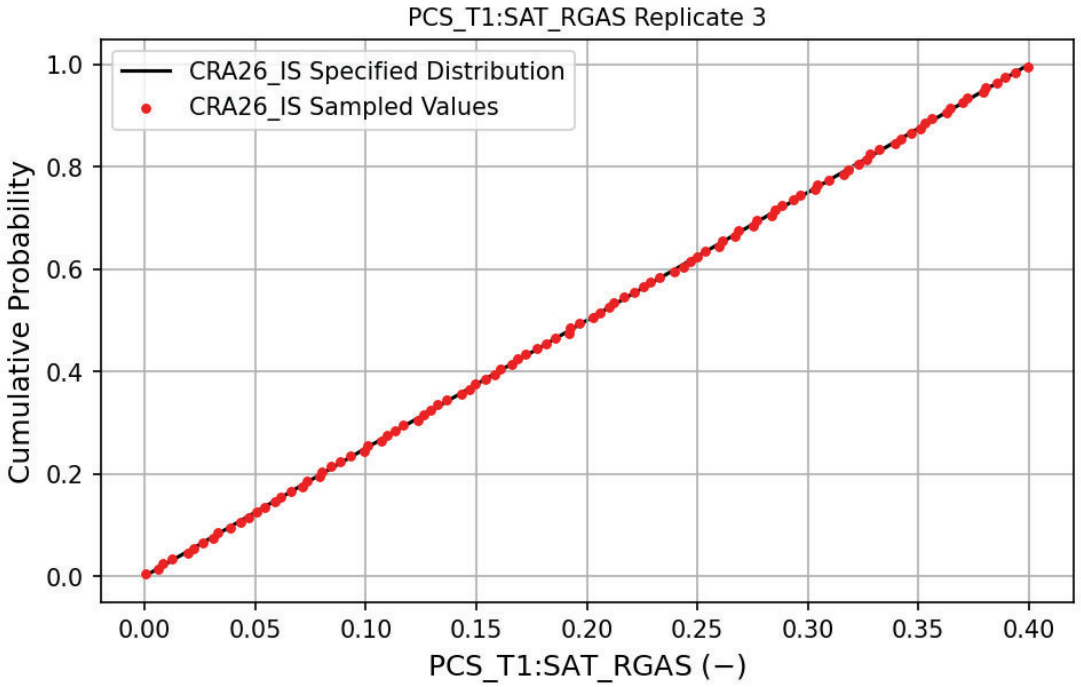

Figure 188. Observed and Expected CDFs for PCS_T1:SAT_RGAS (Uniform Distribution) Replicate 3

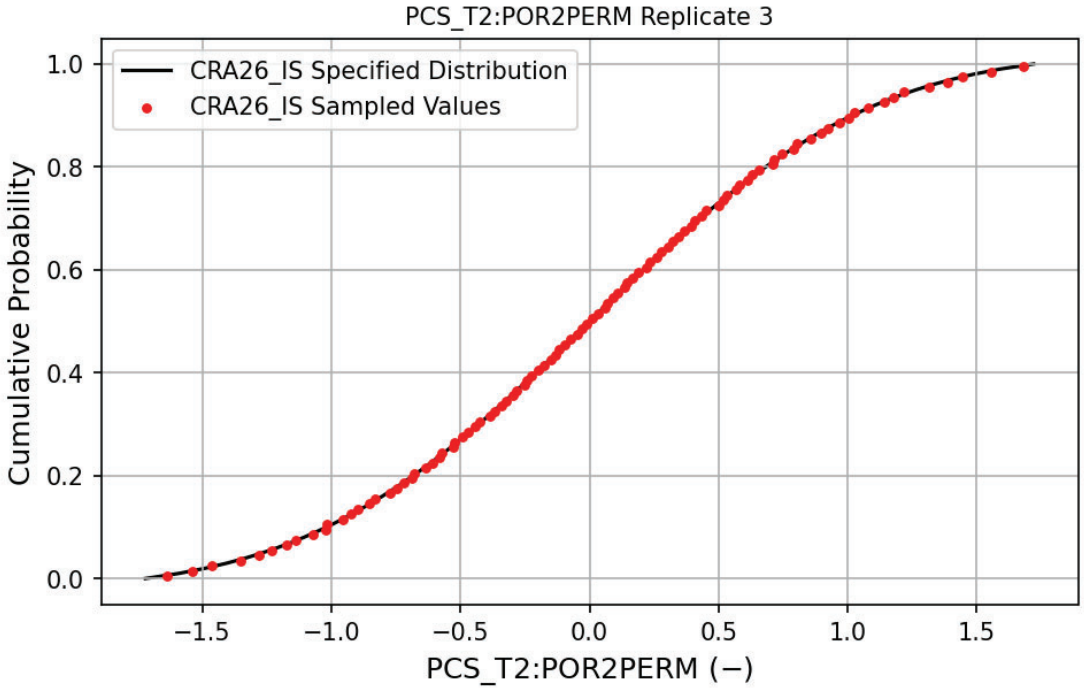

Figure 189. Observed and Expected CDFs for PCS_T2:POR2PERM (Cumulative Distribution) Replicate 3

Information Only

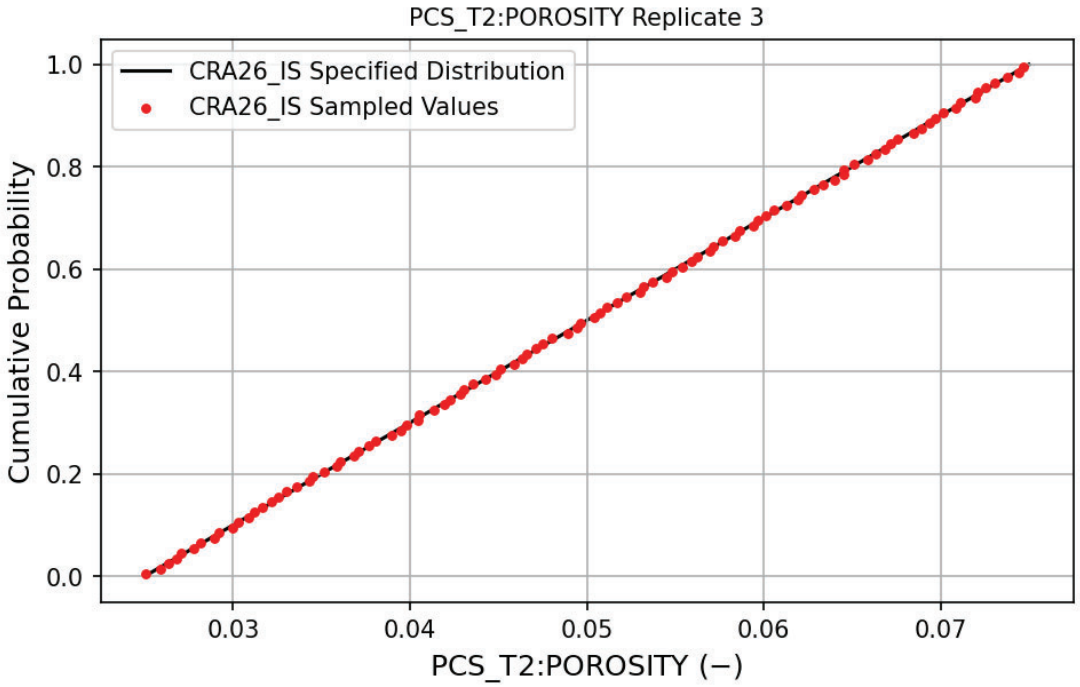

Figure 190. Observed and Expected CDFs for PCS_T2:POROSITY (Uniform Distribution) Replicate 3

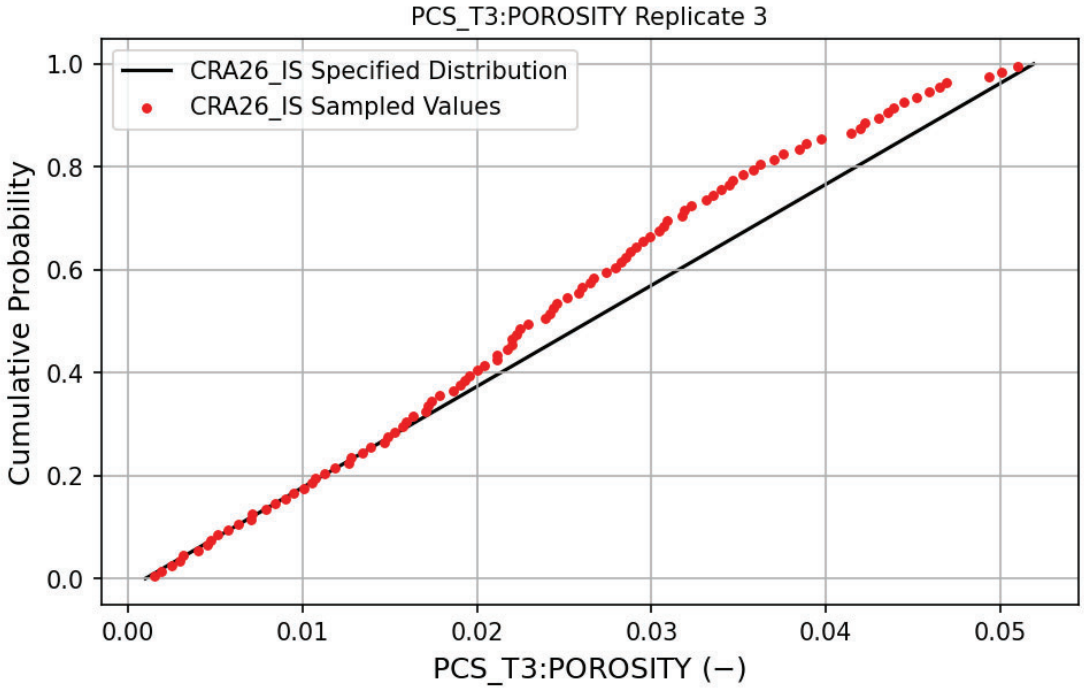

Figure 191. Observed and Expected CDFs for PCS_T3:POROSITY (Uniform Distribution) Replicate 3

Information Only

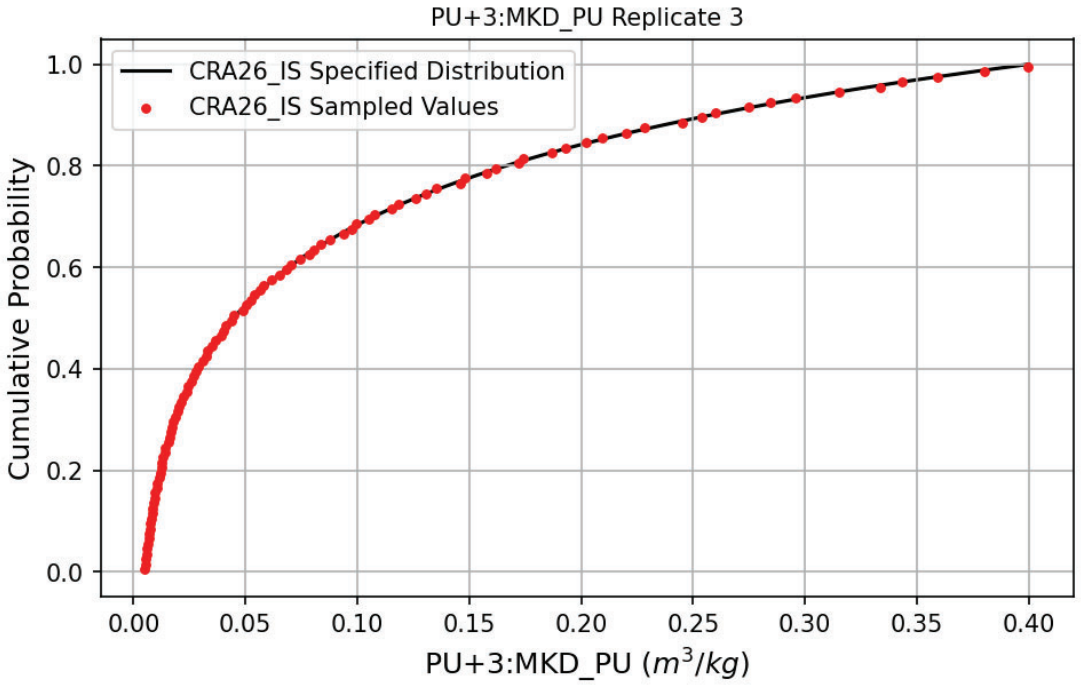

Figure 192. Observed and Expected CDFs for PU+3:MKD_PU (Loguniform Distribution) Replicate 3

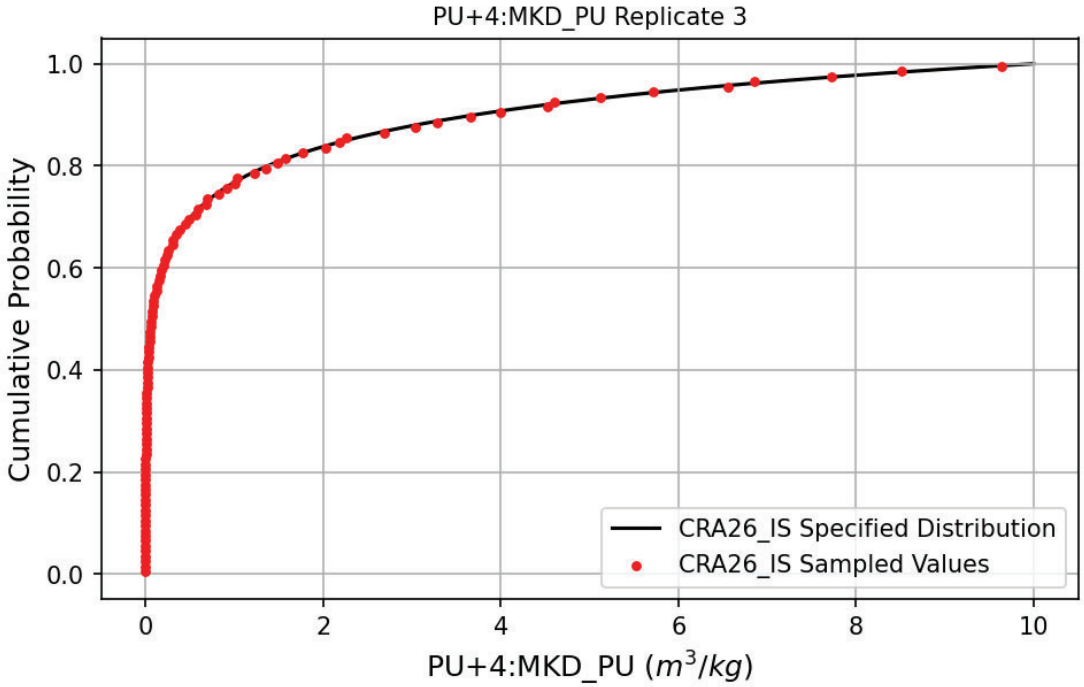

Figure 193. Observed and Expected CDFs for PU+4:MKD_PU (Loguniform Distribution) Replicate 3

Information Only

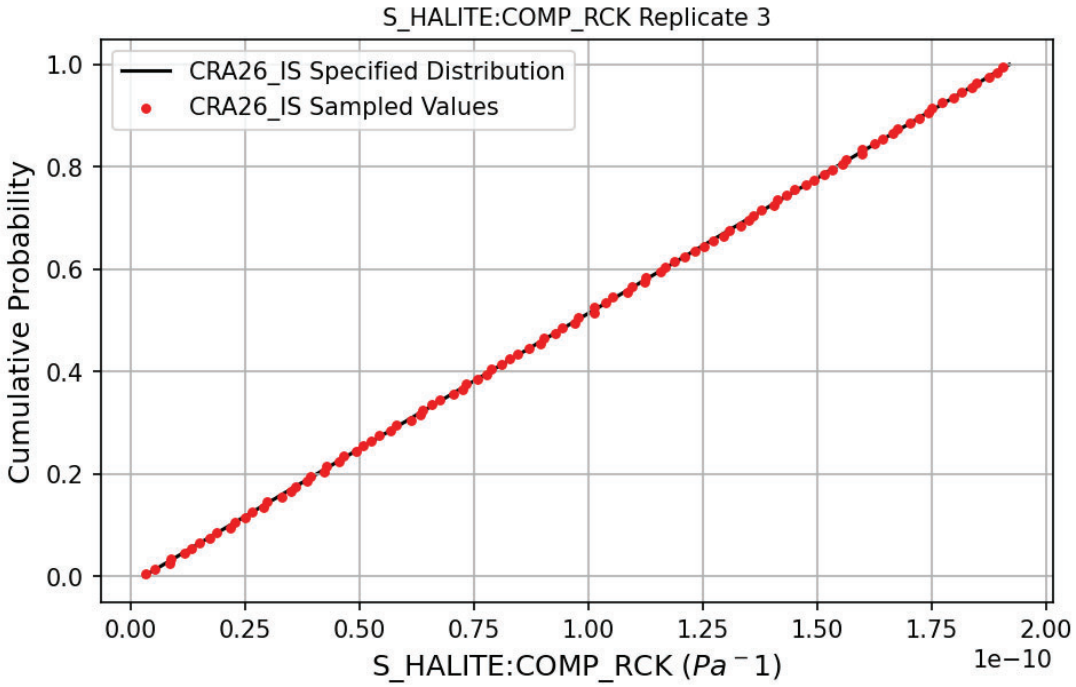

Figure 194. Observed and Expected CDFs for S_HALITE:COMP_RCK (Uniform Distribution) Replicate 3

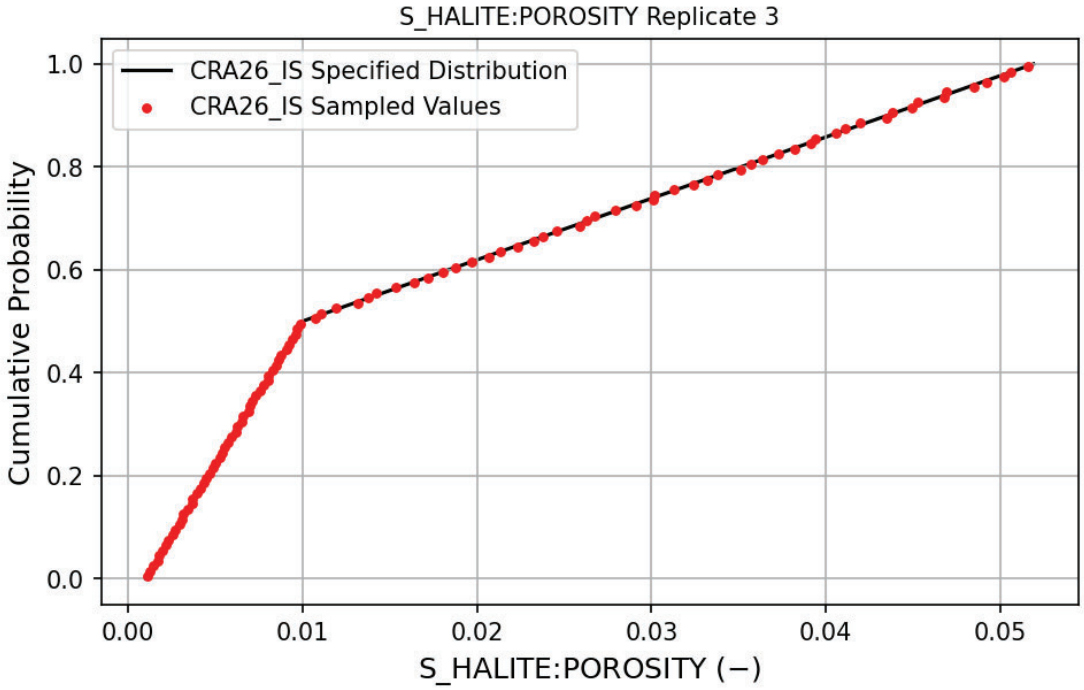

Figure 195. Observed and Expected CDFs for S_HALITE:POROSITY (Cumulative Distribution) Replicate 3

Information Only

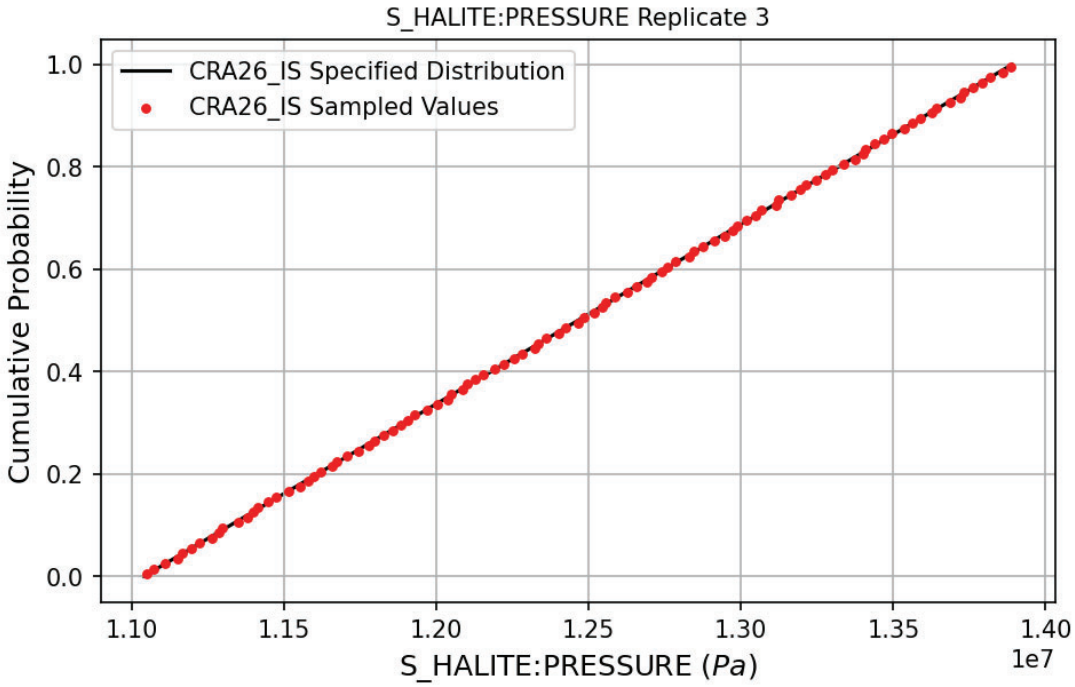

Figure 196. Observed and Expected CDFs for S_HALITE:PRESSURE (Uniform Distribution) Replicate 3

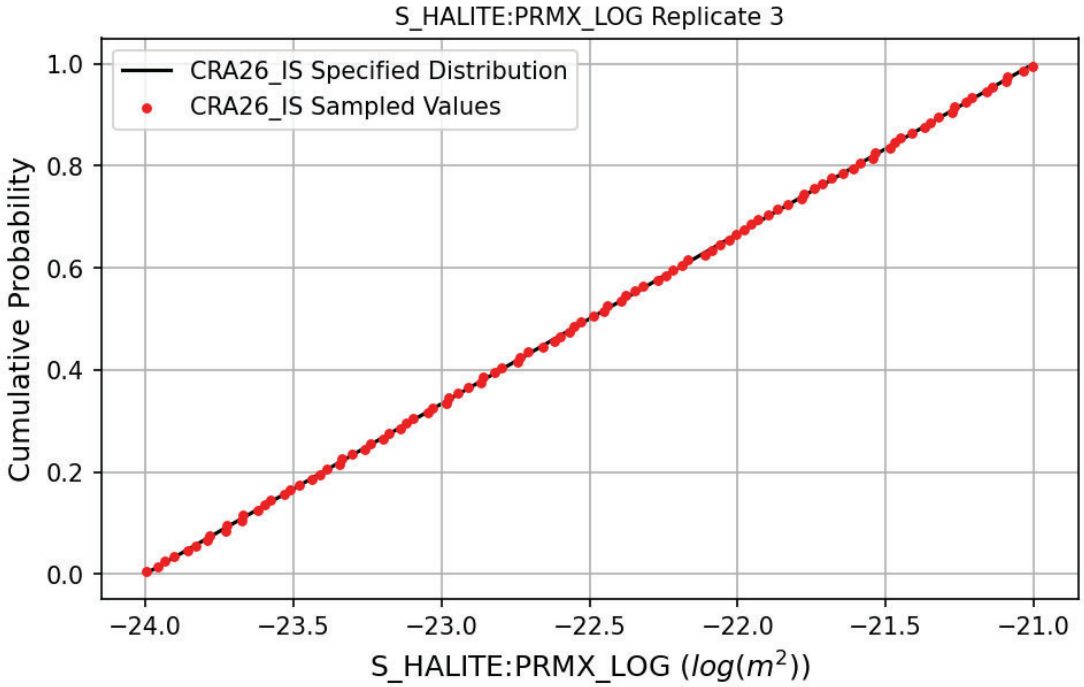

Figure 197. Observed and Expected CDFs for S_HALITE:PRMX_LOG (Uniform Distribution) Replicate 3

Information Only

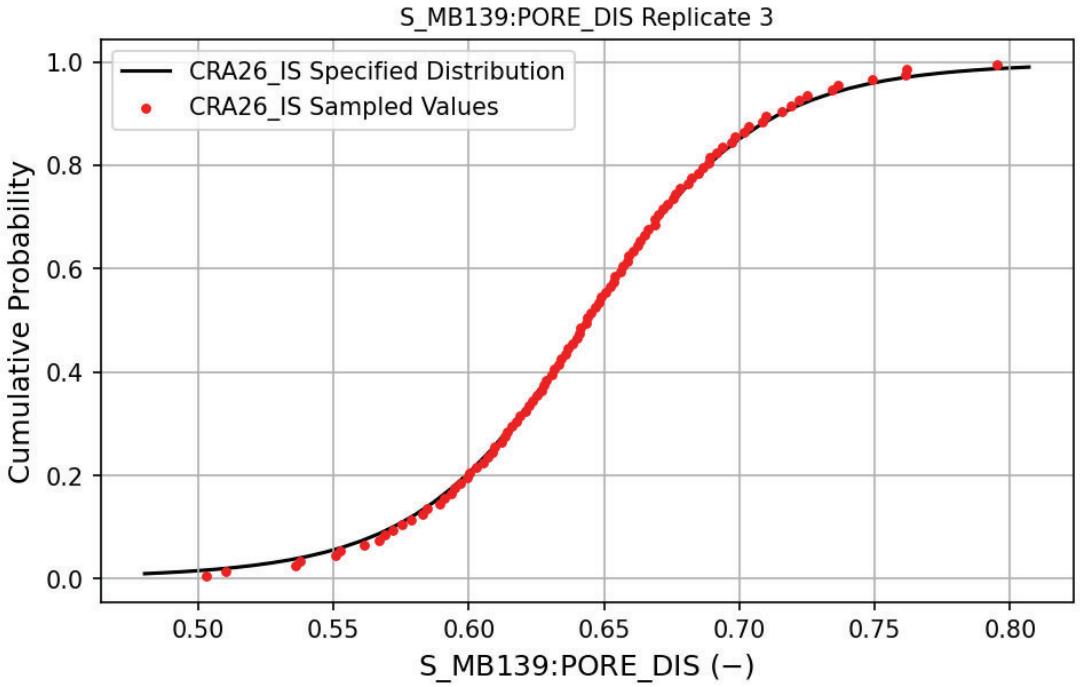

Figure 198. Observed and Expected CDFs for S_MB139:PORE_DIS (Student Distribution) Replicate 3

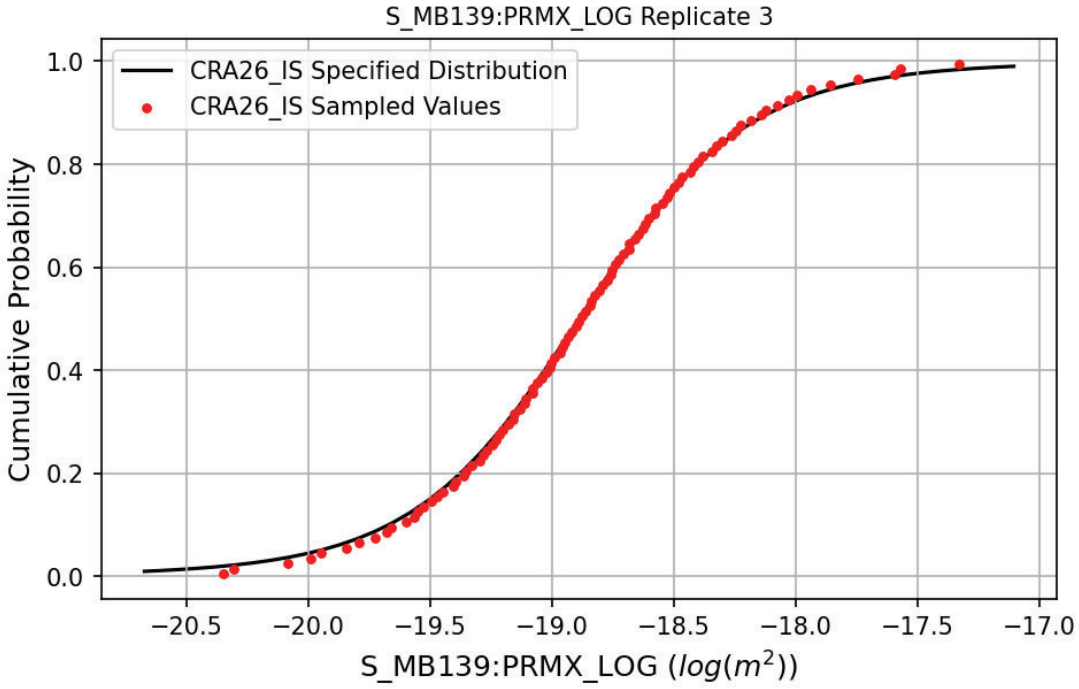

Figure 199. Observed and Expected CDFs for S_MB139:PRMX_LOG (Student Distribution) Replicate 3

Information Only

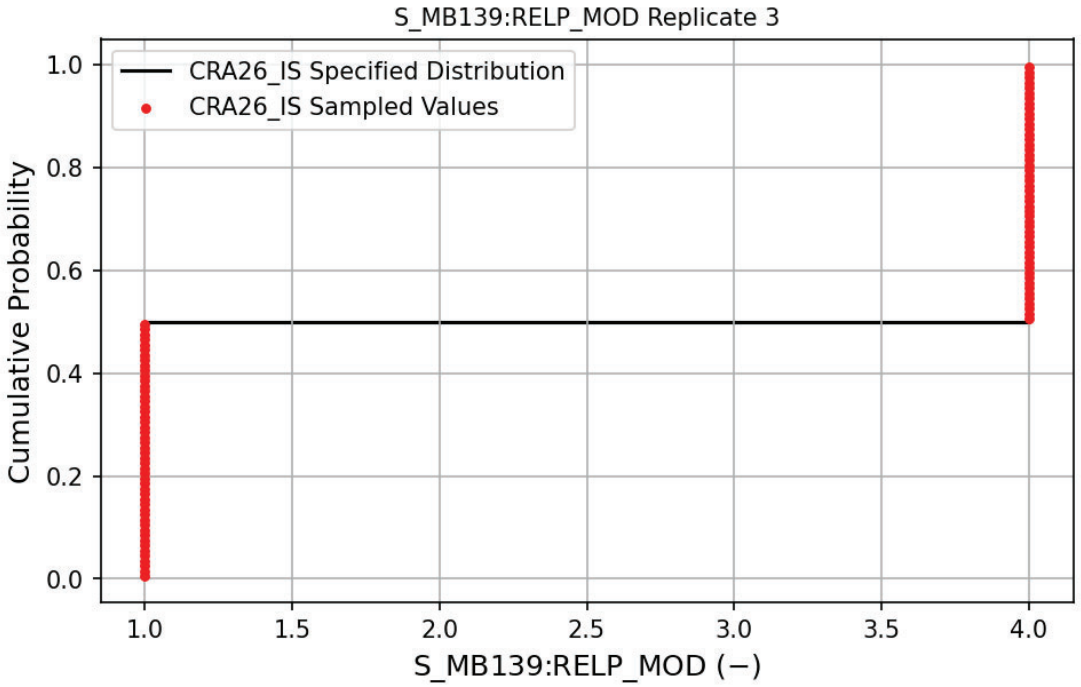

Figure 200. Observed and Expected CDFs for S_MB139:RELP_MOD (Delta Distribution) Replicate 3

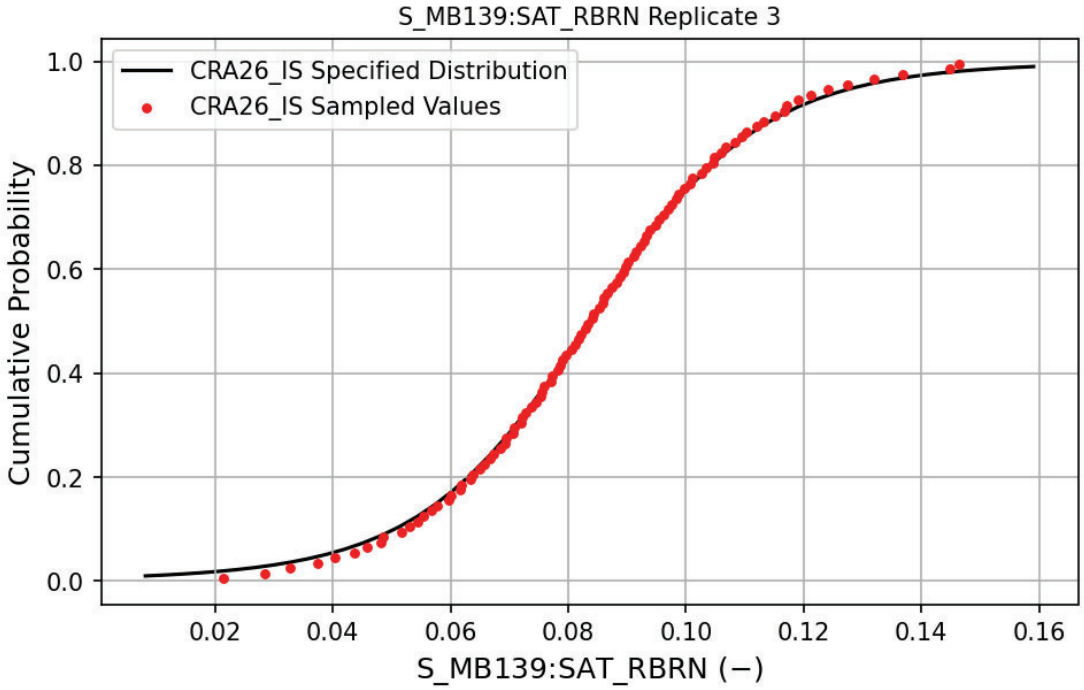

Figure 201. Observed and Expected CDFs for S_MB139:SAT_RBRN (Student Distribution) Replicate 3

Information Only

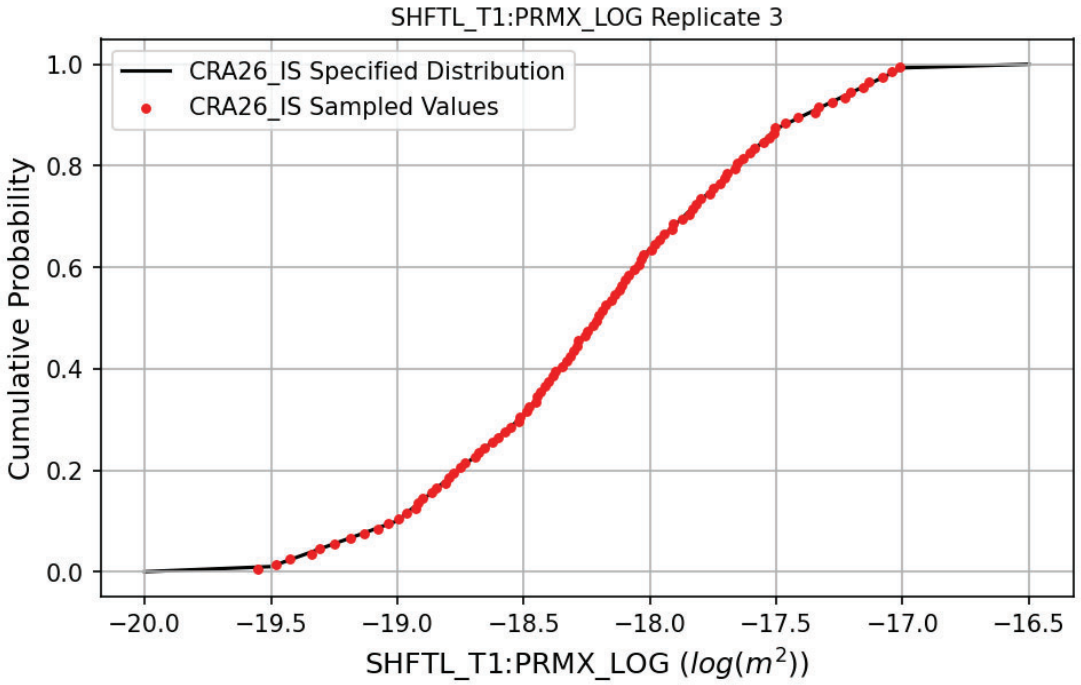

Figure 202. Observed and Expected CDFs for SHFTL_T1:PRMX_LOG (Cumulative Distribution) Replicate 3

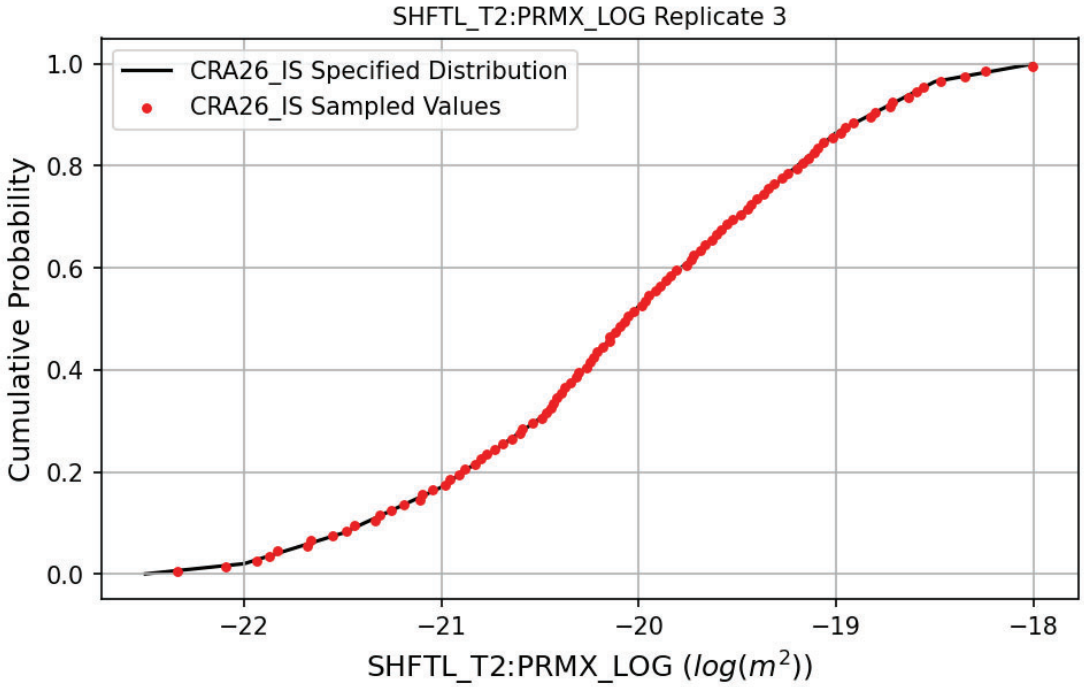

Figure 203. Observed and Expected CDFs for SHFTL_T2:PRMX_LOG (Cumulative Distribution) Replicate 3

Information Only

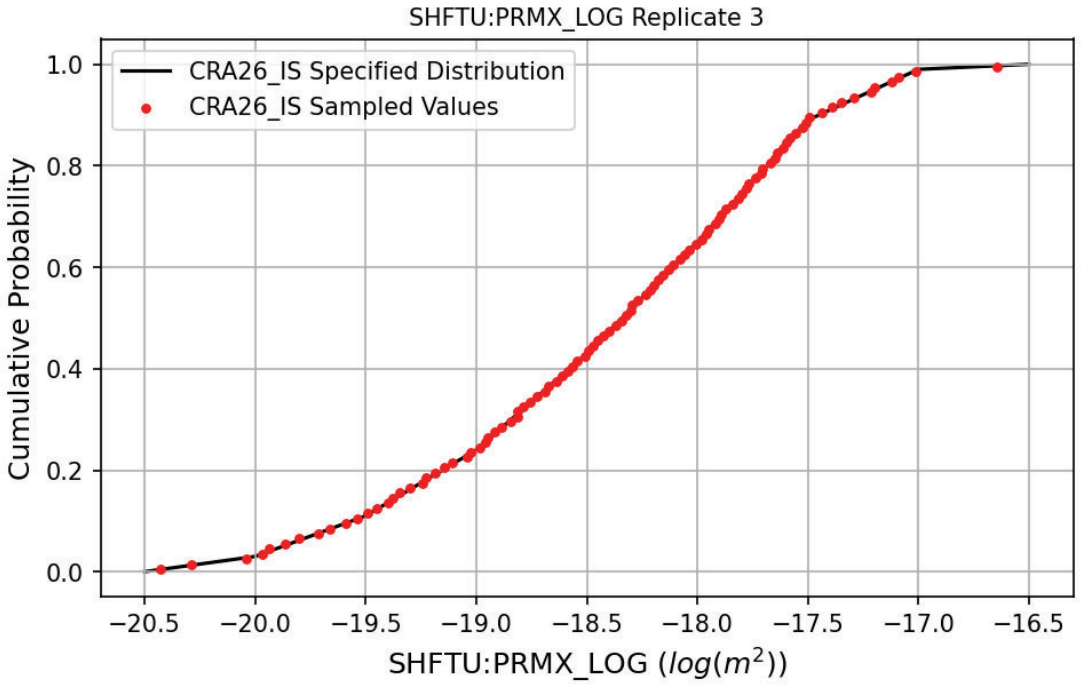

Figure 204. Observed and Expected CDFs for SHFTU:PRMX_LOG (Cumulative Distribution) Replicate 3

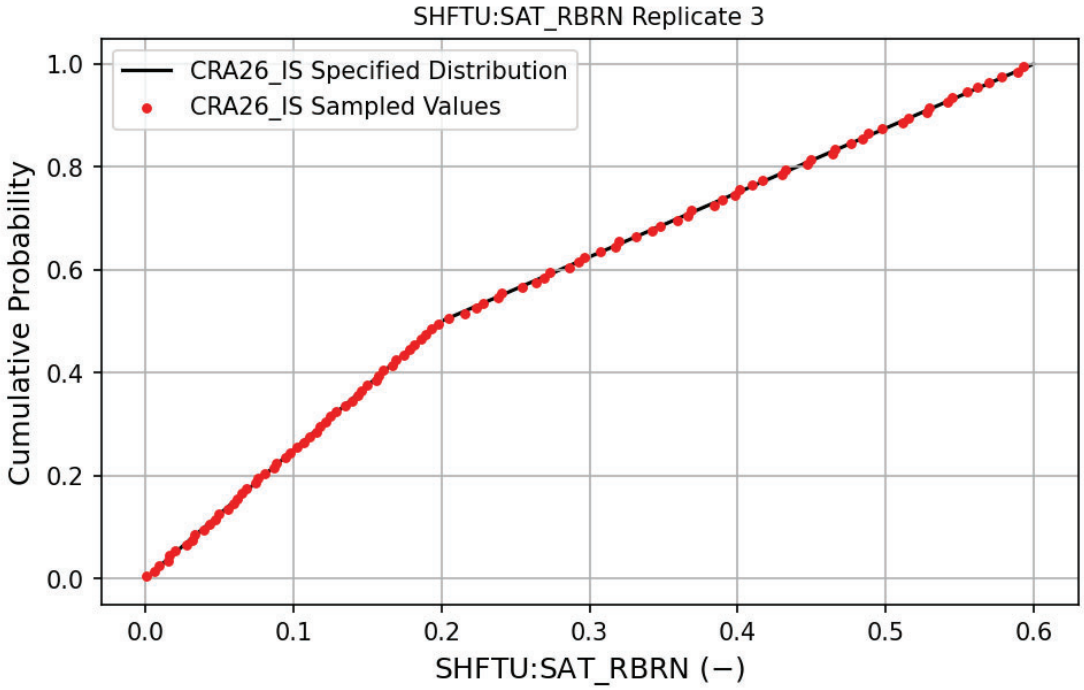

Figure 205. Observed and Expected CDFs for SHFTU:SAT_RBRN (Cumulative Distribution) Replicate 3

Information Only

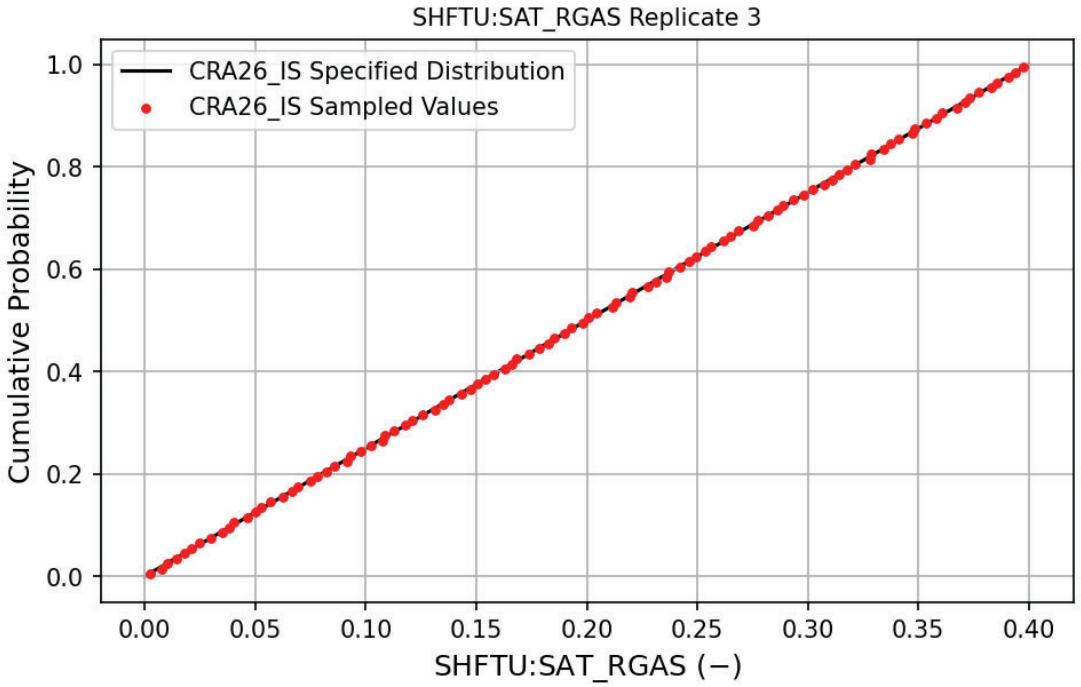

Figure 206. Observed and Expected CDFs for SHFTU:SAT_RGAS (Uniform Distribution) Replicate 3

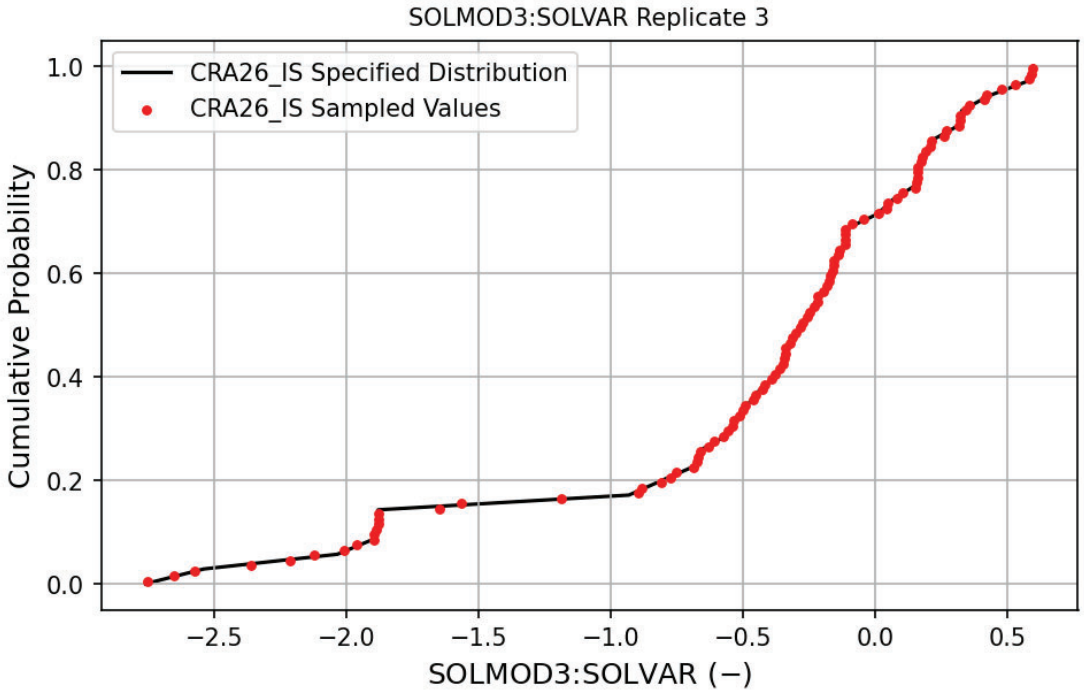

Figure 207. Observed and Expected CDFs for SOLMOD3:SOLVAR (Cumulative Distribution) Replicate 3

Information Only

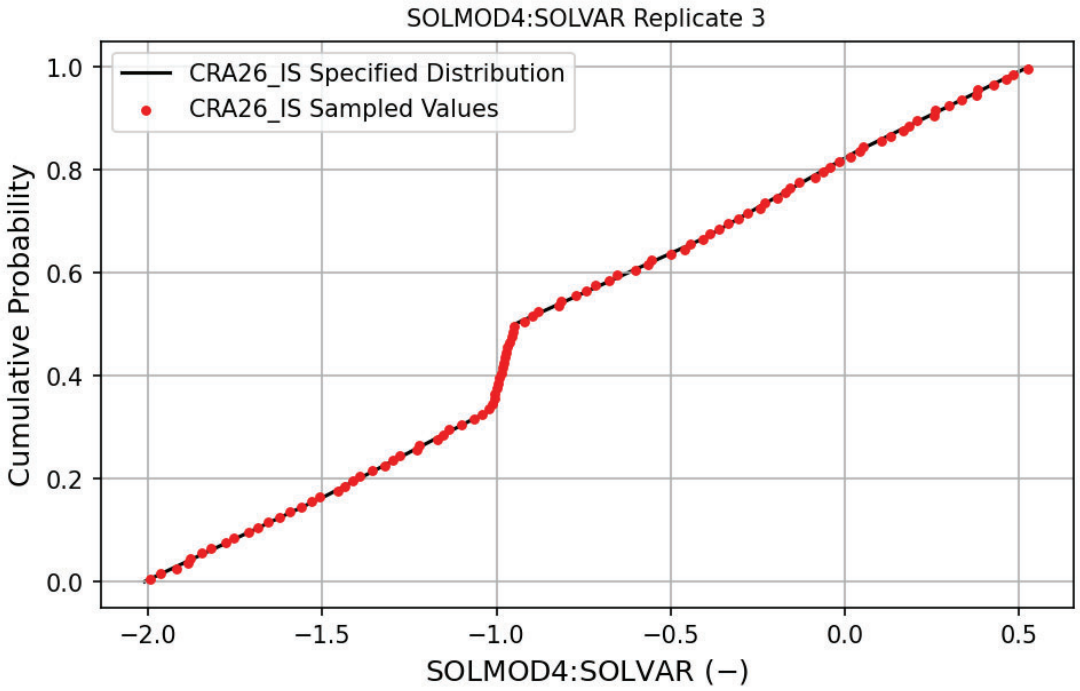

Figure 208. Observed and Expected CDFs for SOLMOD4:SOLVAR (Cumulative Distribution) Replicate 3

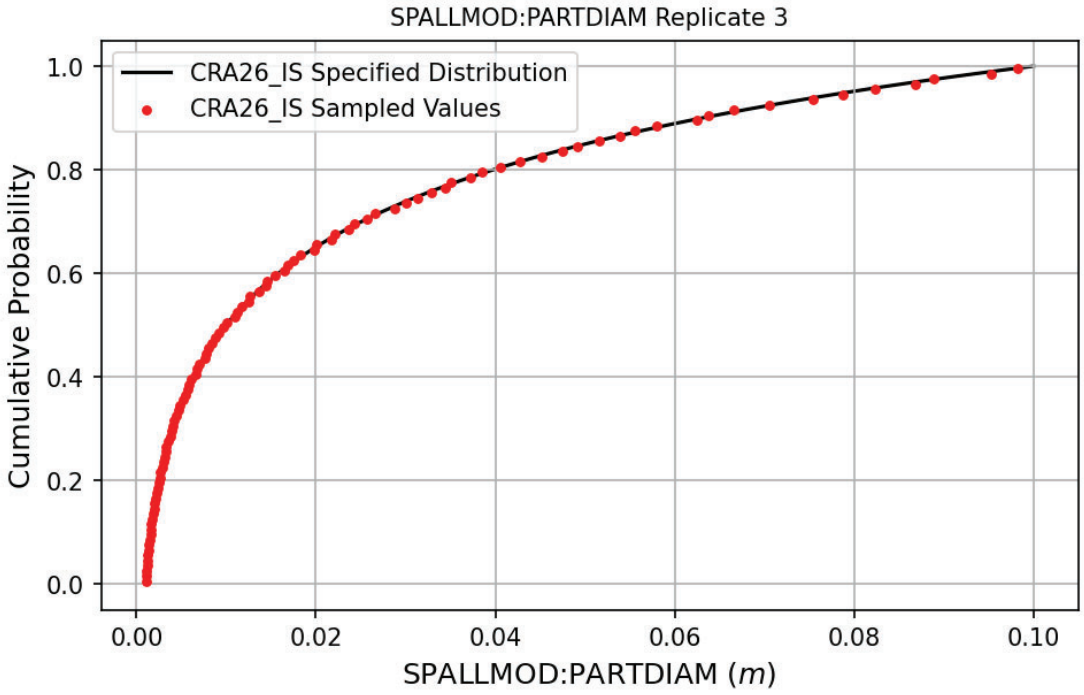

Figure 209. Observed and Expected CDFs for SPALLMOD:PARTDIAM (Loguniform Distribution) Replicate 3

Information Only

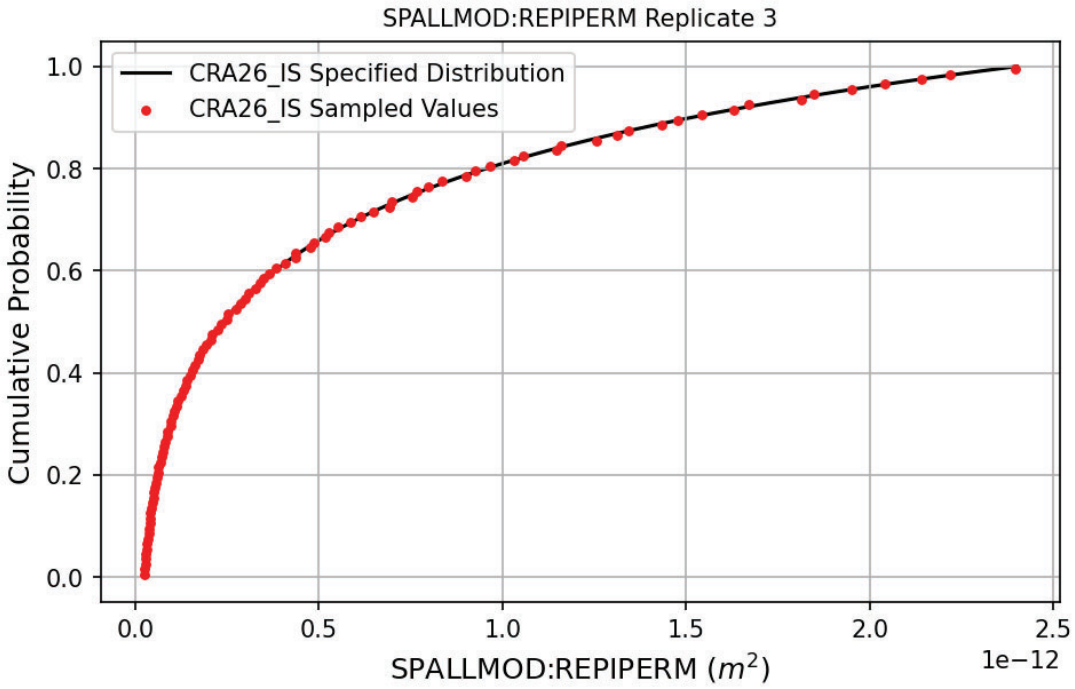

Figure 210. Observed and Expected CDFs for SPALLMOD:REPIPERM (Loguniform Distribution) Replicate 3

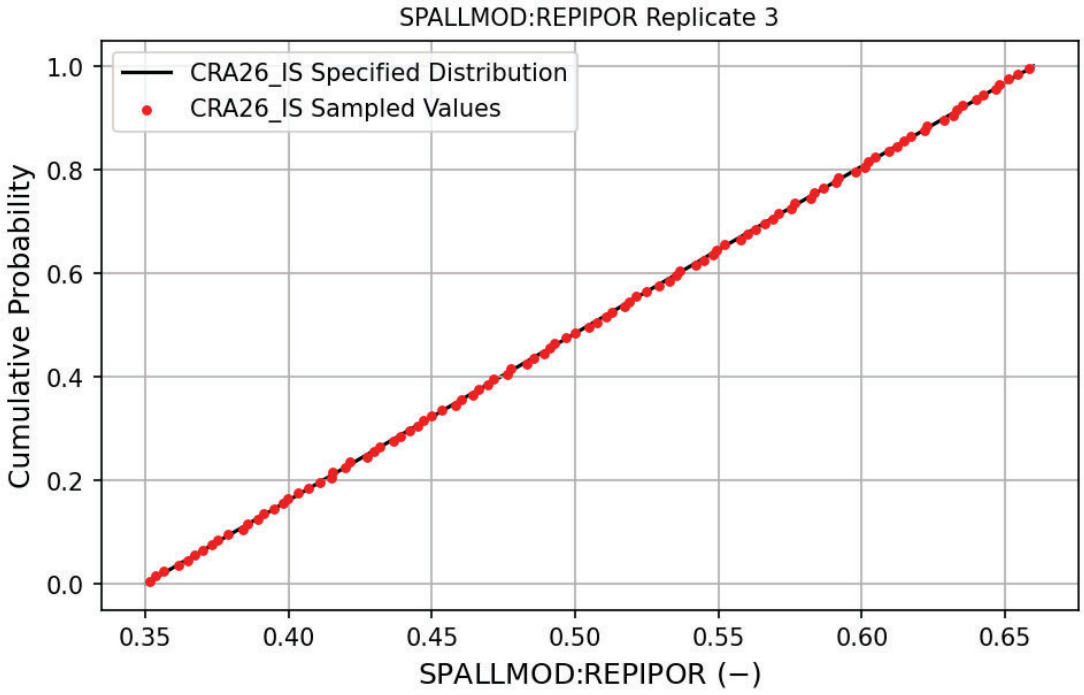

Figure 211. Observed and Expected CDFs for SPALLMOD:REPIPOR (Uniform Distribution) Replicate 3

Information Only

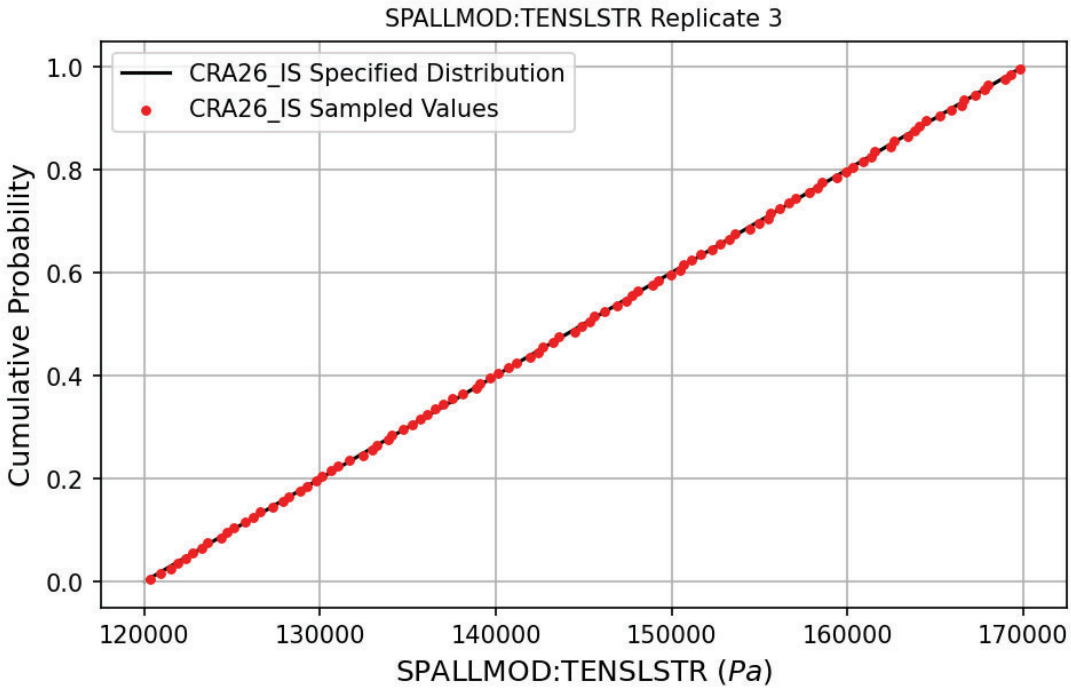

Figure 212. Observed and Expected CDFs for SPALLMOD:TENSLSTR (Uniform Distribution) Replicate 3

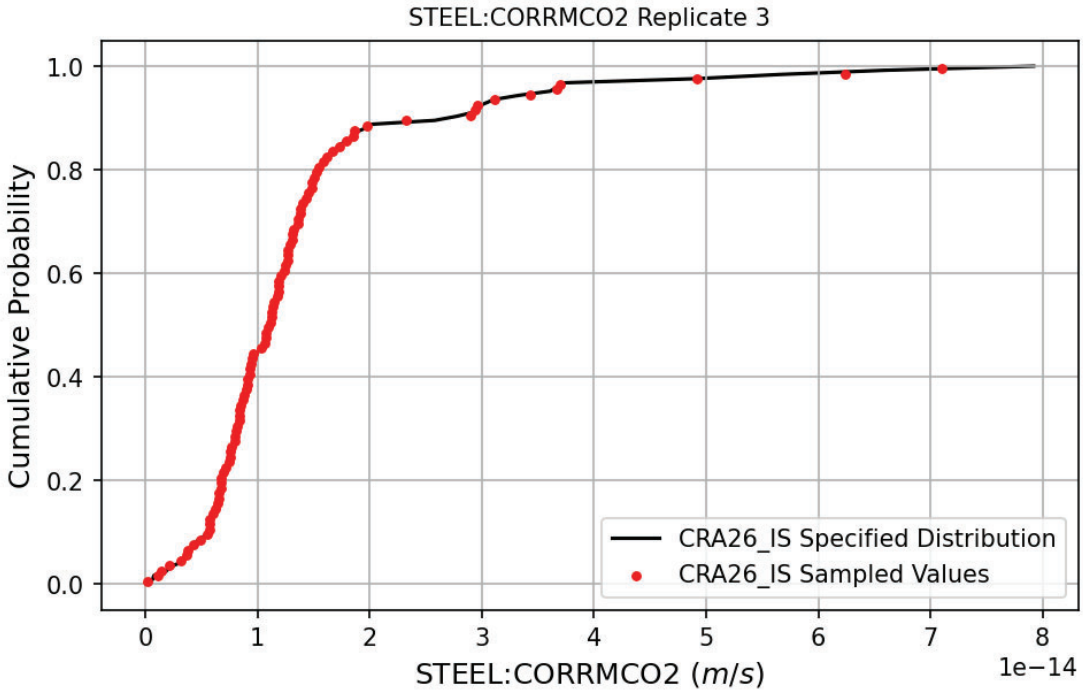

Figure 213. Observed and Expected CDFs for STEEL:CORRMCO2 (Cumulative Distribution) Replicate 3

Information Only

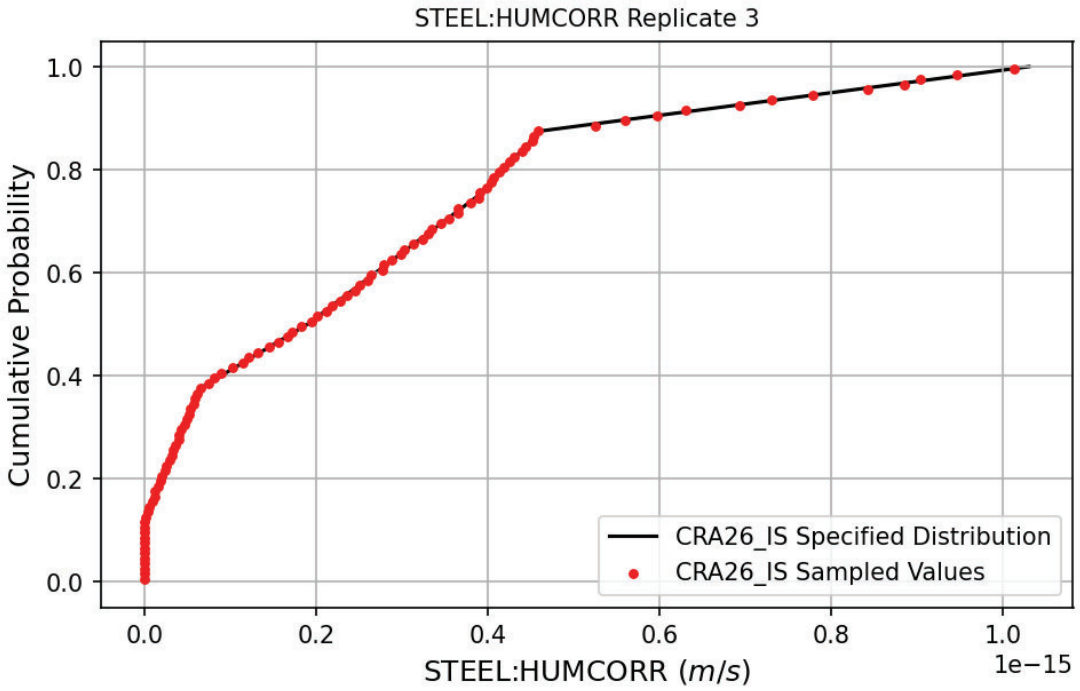

Figure 214. Observed and Expected CDFs for STEEL:HUMCORR (Cumulative Distribution) Replicate 3

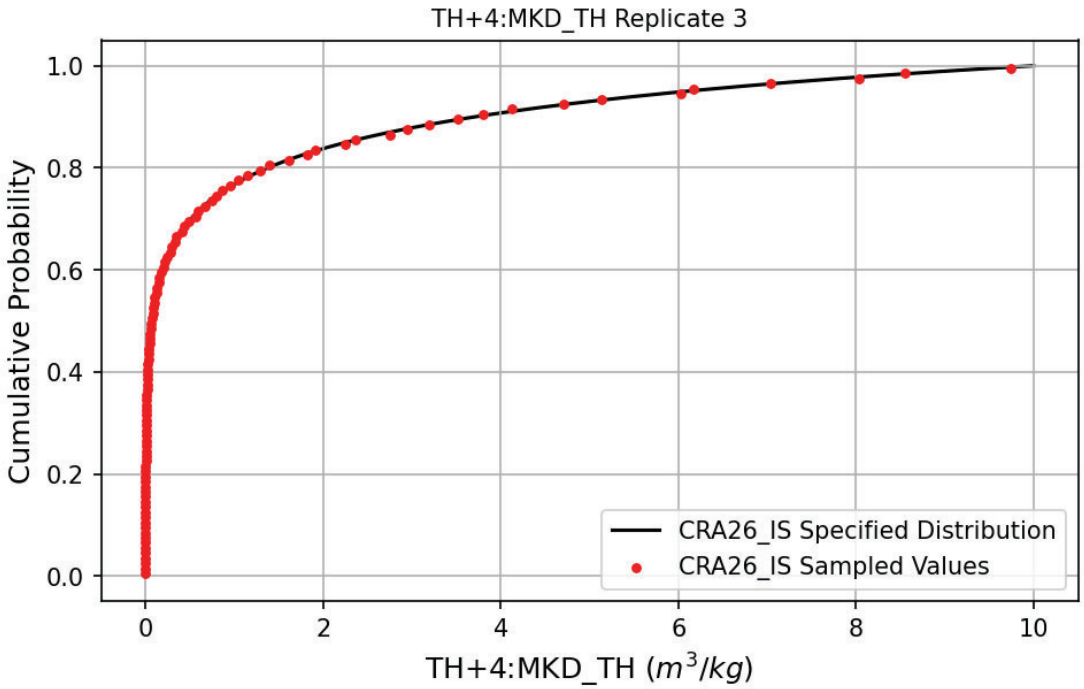

Figure 215. Observed and Expected CDFs for TH+4:MKD_TH (Loguniform Distribution) Replicate 3

Information Only

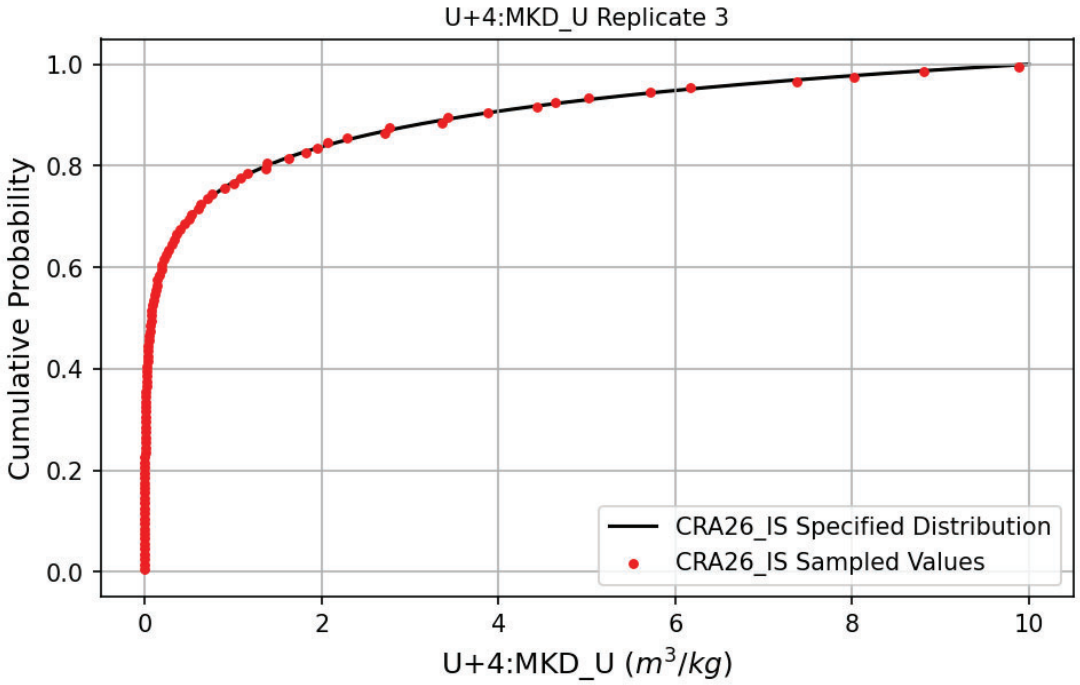

Figure 216. Observed and Expected CDFs for U+4:MKD_U (Loguniform Distribution) Replicate 3

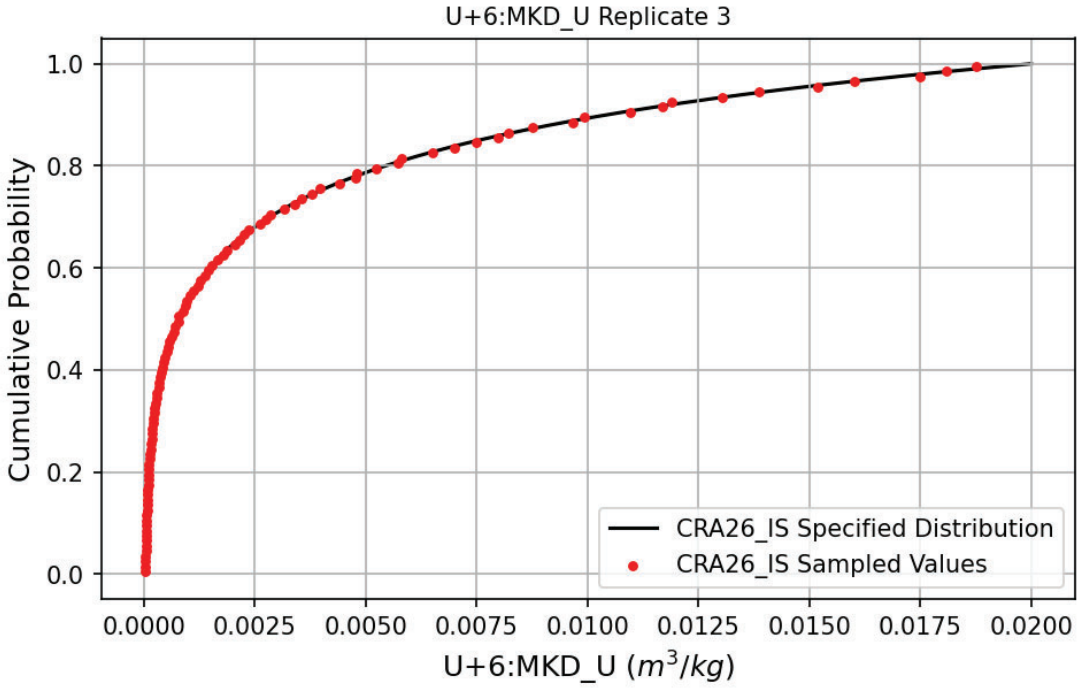

Figure 217. Observed and Expected CDFs for U+6:MKD_U (Loguniform Distribution) Replicate 3

Information Only

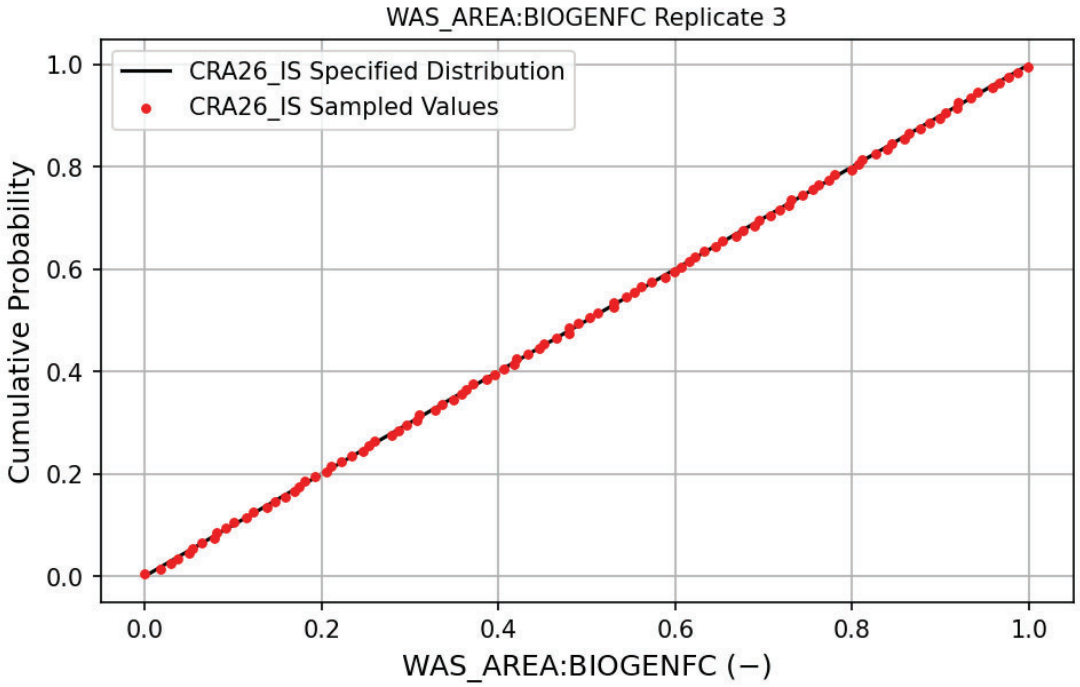

Figure 218. Observed and Expected CDFs for WAS_AREA:BIOGENFC (Uniform Distribution) Replicate 3

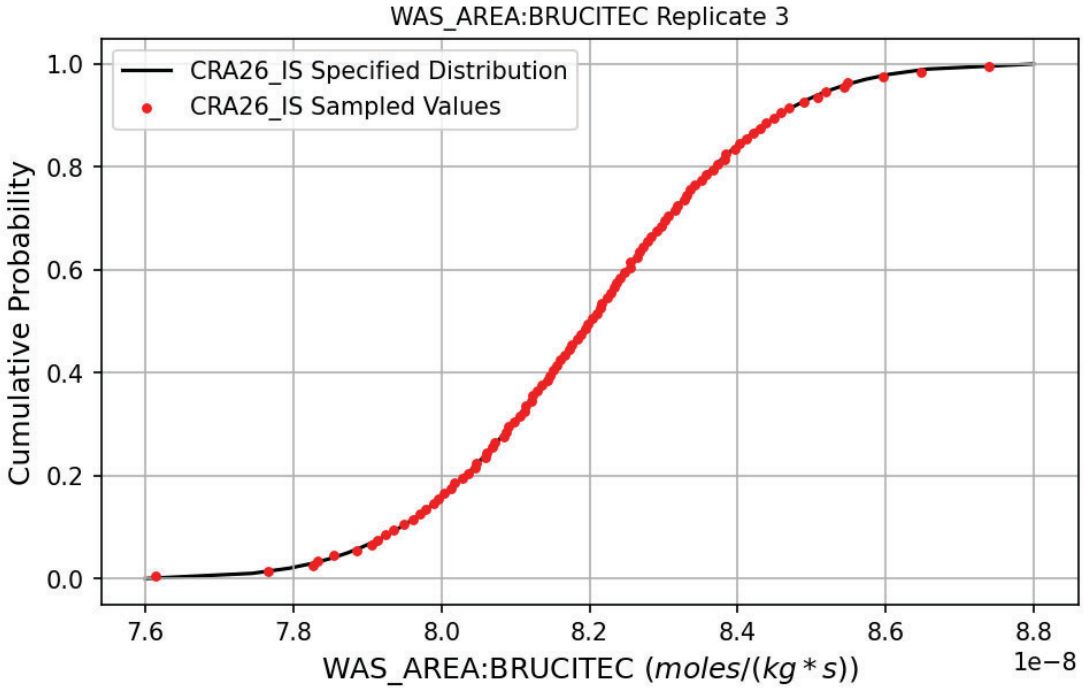

Figure 219. Observed and Expected CDFs for WAS_AREA:BRUCITEC (Cumulative Distribution) Replicate 3

Information Only

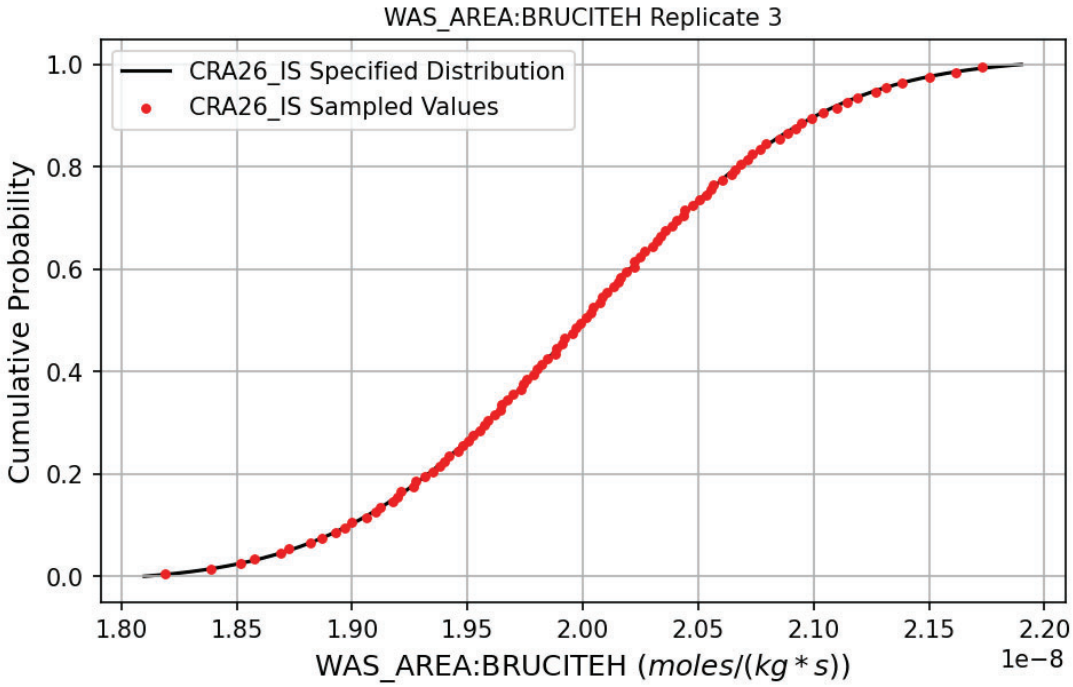

Figure 220. Observed and Expected CDFs for WAS_AREA:BRUCITEH (Normal Distribution) Replicate 3

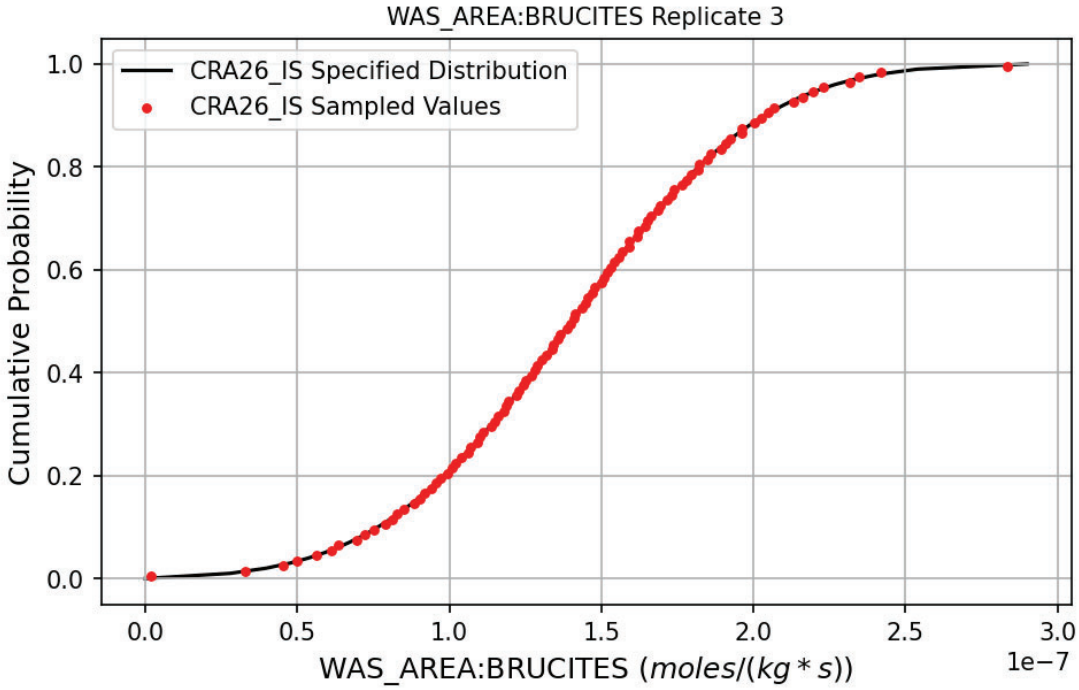

Figure 221. Observed and Expected CDFs for WAS_AREA:BRUCITES (Cumulative Distribution) Replicate 3

Information Only

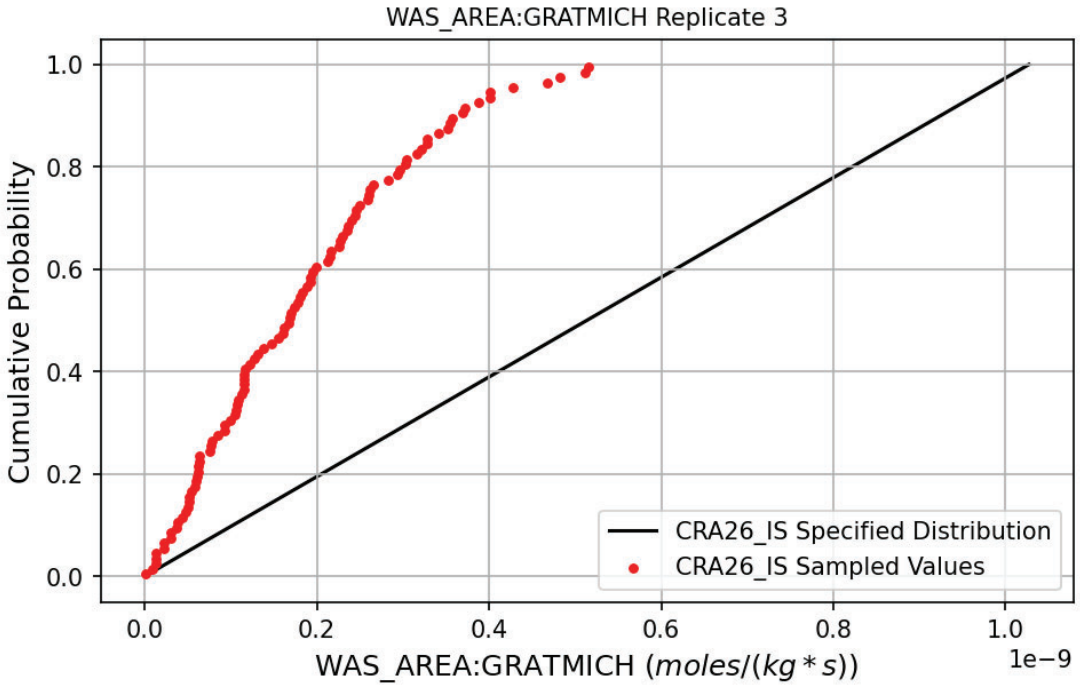

Figure 222. Observed and Expected CDFs for WAS_AREA:GRATMICH (Uniform Distribution) Replicate 3

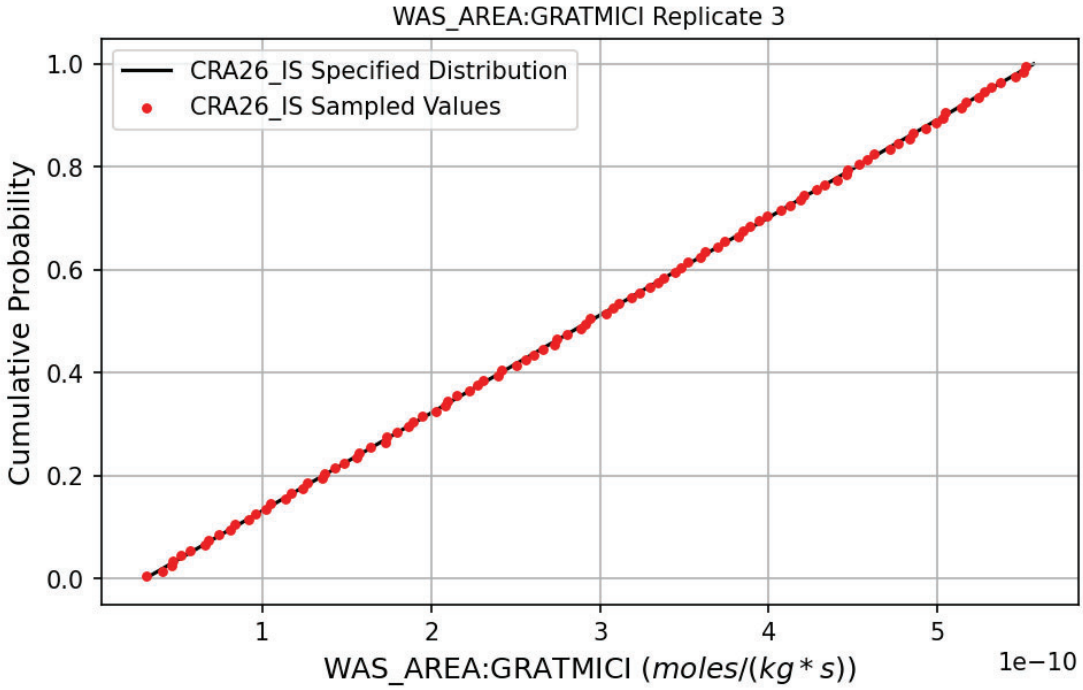

Figure 223. Observed and Expected CDFs for WAS_AREA:GRATMICI (Uniform Distribution) Replicate 3

Information Only

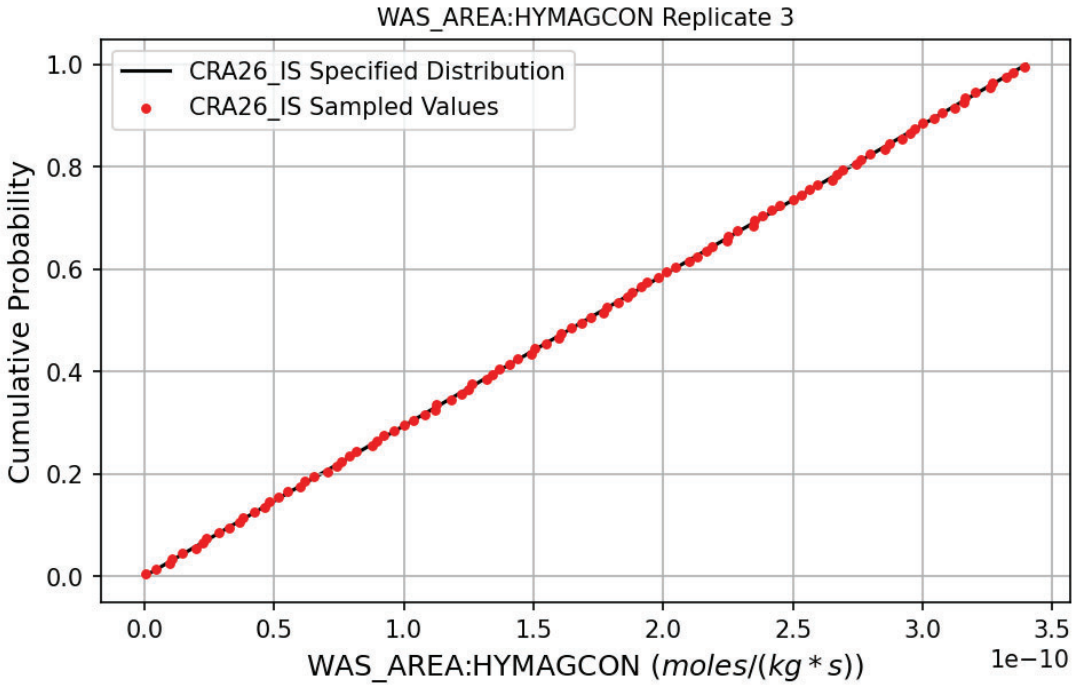

Figure 224. Observed and Expected CDFs for WAS_AREA:HYMAGCON (Uniform Distribution) Replicate 3

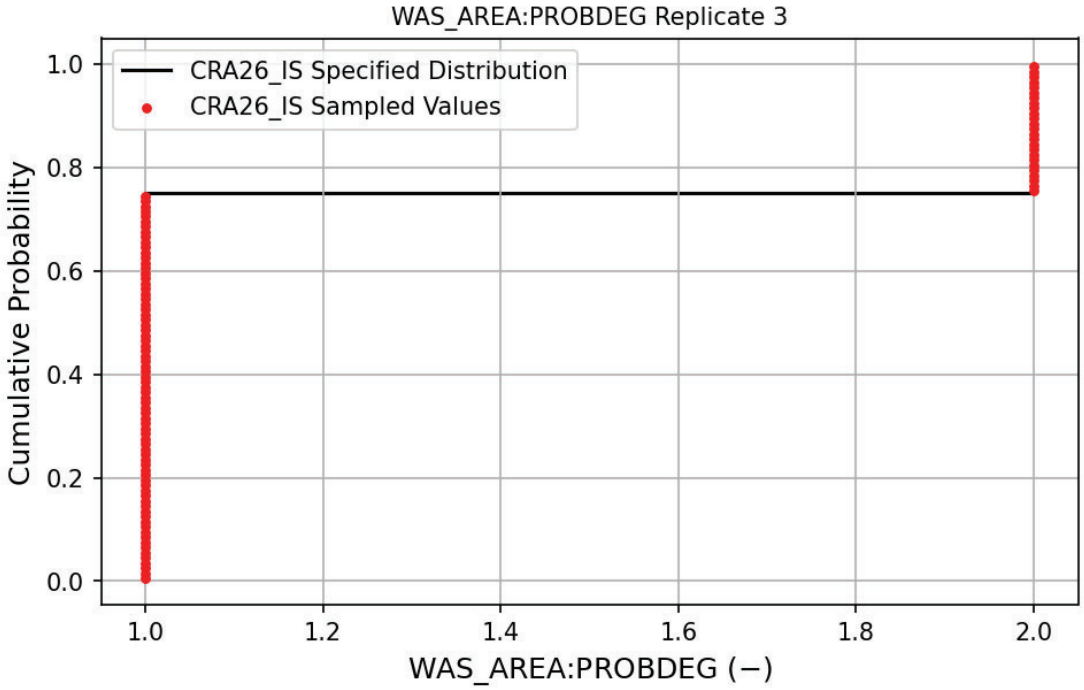

Figure 225. Observed and Expected CDFs for WAS_AREA:PROBDEG (Delta Distribution) Replicate 3

Information Only

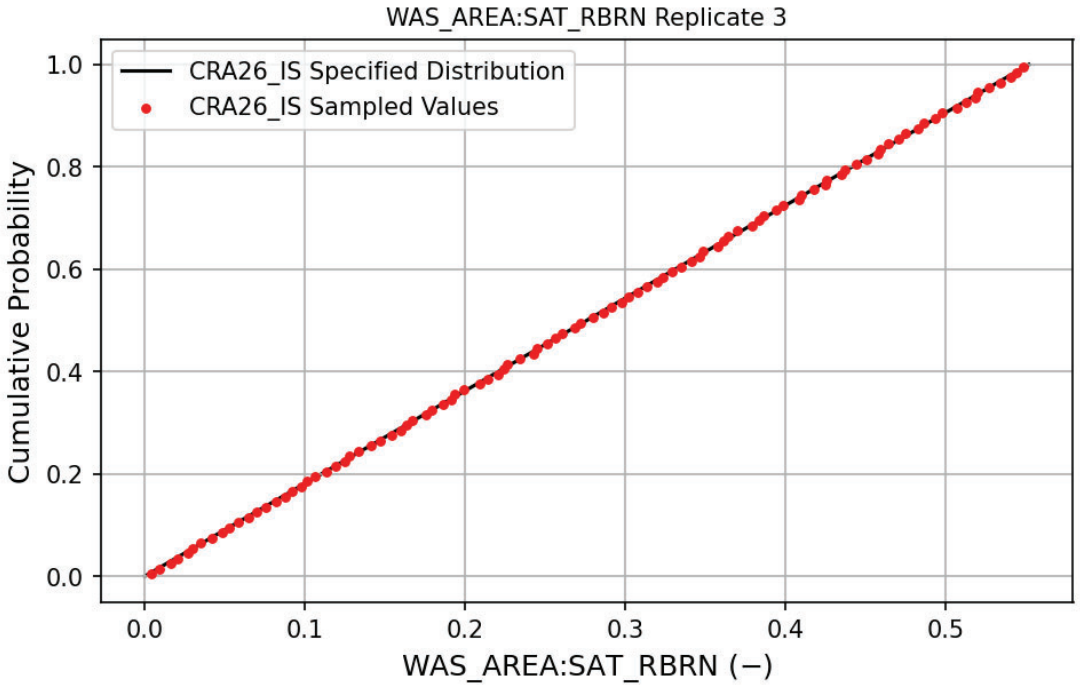

Figure 226. Observed and Expected CDFs for WAS_AREA:SAT_RBRN (Uniform Distribution) Replicate 3

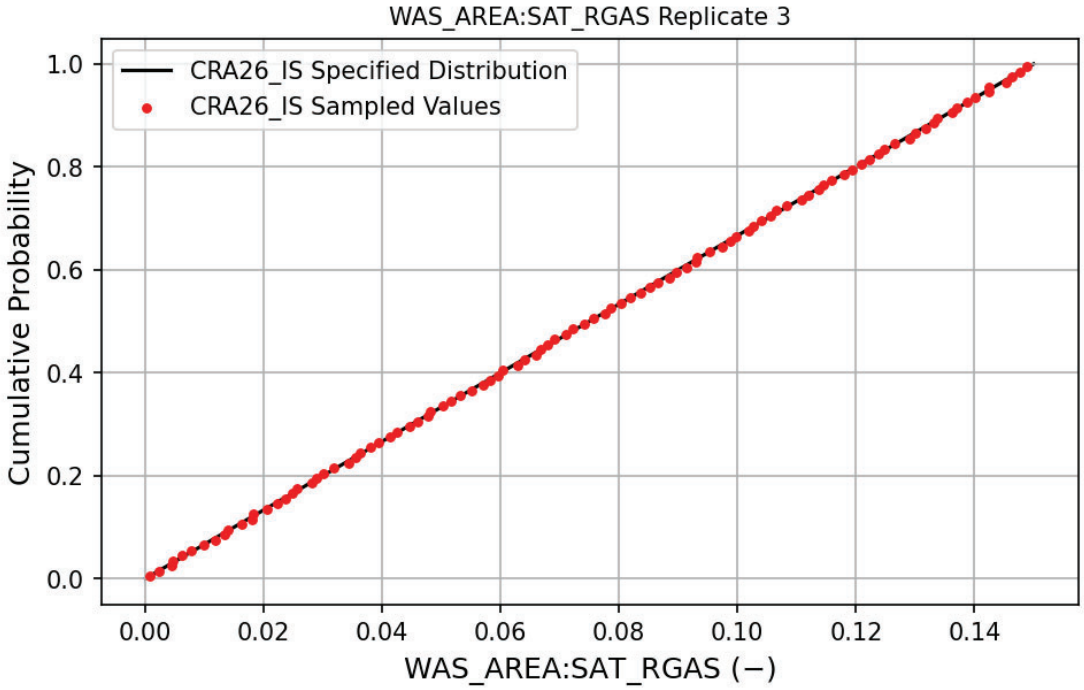

Figure 227. Observed and Expected CDFs for WAS_AREA:SAT_RGAS (Uniform Distribution) Replicate 3

Information Only

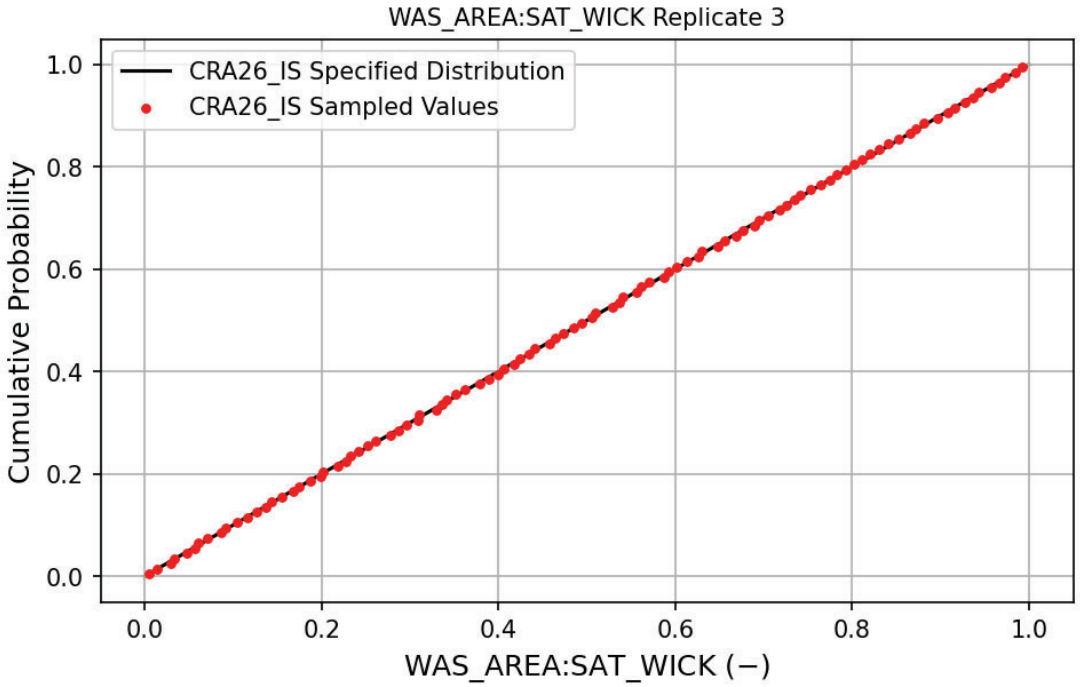

Figure 228. Observed and Expected CDFs for WAS_AREA:SAT_WICK (Uniform Distribution) Replicate 3

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