OFFICE OF CHEMICAL SAFETY AND POLLUTION PREVENTION

WASHINGTON, D.C. 20460

MEMORANDUM

DATE: June 28, 2024

SUBJECT: **Mancozeb and Ethylene Thiourea (ETU)**: Second Revision: Draft Human Health Risk Assessment (DRA) for Registration Review.

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The conclusions conveyed in this assessment were developed in full compliance with *EPA Scientific Integrity Policy for Transparent and Objective Science*, and EPA Scientific Integrity Program's *Approaches for Expressing and Resolving Differing Scientific Opinions.* The full text of *EPA Scientific Integrity Policy for Transparent and Objective Science*, as updated and approved by the Scientific Integrity Committee and EPA Science Advisor can be found here: https://www.epa.gov/system/files/documents/2023-12/scientific_integrity_policy_2012_accessible.pdf. The full text of the EPA Scientific Integrity Program's *Approaches for Expressing and Resolving Differing Scientific Opinions* can be found here: https://www.epa.gov/scientific-integrity/approaches-expressing-and-resolving-differing-scientific-opinions.

This mancozeb draft human health risk assessment (DRA) supersedes the previous DRA (D. Drew *et al*, D465140, 02/10/2023).[1] This revised DRA incorporates minor changes in the occupational risk summary and tables as well as the addition of wine and juice grapes to the occupational post-application assessment.

[1] D. Drew *et al*, D465140, 02/10/2023, Mancozeb and Ethylene Thiourea (ETU): Revised Draft Human Health Risk Assessment (DRA) for Registration Review.

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1.0 Executive Summary

The Health Effects Division (HED) has conducted a revised draft human health risk assessment (DRA) to evaluate the existing uses of the pesticide active ingredient (ai) mancozeb in support of registration review. Mancozeb is a coordination product of zinc ion and maneb (manganese ethylenebisdithiocarbamate) used as a broad-spectrum fungicide in agriculture, professional turf management, and horticulture.

Mancozeb is a fungicide in the class of ethylenebis dithiocarbamates (EBDC), which also includes the fungicides maneb and metiram; all of these compounds have a common metabolite/degradate, ethylenethiourea (ETU). Separate assessments are presented herein for 1) toxicity and exposure to parent compound mancozeb only and 2) toxicity and exposure to ETU derived from mancozeb, including combined exposures from both ETU as an environmental degradate and ETU as an *in vivo* metabolite.

In addition, a separate EBDC aggregate assessment is presented herein that considers combined exposures to ETU from all EBDC uses. There are currently no U.S. registered uses for the EBDCs maneb or metiram. However, there are U.S. tolerances listed in the 40 CFR (180.217) for metiram that are being maintained for import purposes. Therefore, the EBDC aggregate assessment considers combined exposures to ETU from both mancozeb (residential, food, drinking water) and metiram (food).

For residential, occupational, non-occupational, and dietary exposures, including oral, dermal and inhalation routes of exposure, a 7.5% *in vivo* metabolic conversion of absorbed mancozeb to ETU has been used based on rat metabolism data, and has been accounted for in estimating total exposure (via *in vivo* metabolism and direct sources) to ETU.

Use Pattern

Mancozeb is currently registered for foliar use on a wide variety of agricultural use sites including fruit trees, nuts, grains, herbs and spices, fruit and vegetable crops, as well as on ornamentals (professional, commercial, and/or production nurseries and greenhouses) and turfgrass (only golf courses and sod farms). Mancozeb is also registered for use as a seed treatment for a variety of crops. Mancozeb is formulated as a wettable powder (WP), dry flowable (DF), liquid, water soluble packet (WSP), and dust (D). It may be applied by handheld, ground, aerial and chemigation equipment. Seed is treated with commercial and on-farm equipment. All registered labels require handlers to wear baseline attire (i.e., long-sleeve shirt, long pants, shoes, and socks) with varying levels of personal protective equipment (PPE) including chemical resistant gloves, chemical resistant footwear, protective eyewear, and respirator. Mancozeb has numerous registered Section 3 labels along with multiple Special Local Need (SLN) labels which are also considered in this assessment. The restricted entry interval (REI) on all registered labels ranges from 12 to 48 hours.

Exposure Profile

Exposure to mancozeb and/or ETU may occur from ingestion of residues on treated foods and in drinking water. Residential handler exposures are not expected. However, dermal post-application

exposure may occur for adults and children golfing on treated turf. Dermal and/or inhalation exposures may occur for occupational handlers and post-application workers. Non-occupational (dermal for adults, dermal and incidental oral for children) exposures from spray drift may occur.

Hazard Characterization & Dose Response Assessment

The mancozeb and ETU toxicology databases are complete and adequate for hazard characterization. The main targets following exposure to mancozeb and ETU were the thyroid and developing fetus. Mancozeb is metabolized in mammals to ETU as well as degraded to ETU in the environment. Given the metabolism of mancozeb to ETU following oral exposure, much of the toxicity observed in the mancozeb database can be attributed to ETU. As such, the adverse effects observed across both databases are similar.

Mancozeb: In subchronic and chronic oral toxicity studies in which rats and mice were exposed to mancozeb, the main target organ was the thyroid. Progression of toxicity did not occur with increasing duration of exposure. Thyroid toxicity was manifested as alterations in thyroid hormones, increased thyroid weight, and microscopic thyroid lesions (mainly thyroid follicular cell hypertrophy and/or hyperplasia). Decreased thyroxine (T4) and thyroid hyperplasia were also observed following subchronic exposure to rats *via* the inhalation route. No systemic toxicity was observed in a rat subchronic dermal study up to the highest dose tested (1000 mg/kg/day).

Developmental malformations (hydrocephaly, brain atrophy and edema, compressions and hemorrhages of the spinal cord, meningoencephalocele, skeletal system defects, and gross defects [i.e. agnathia, cleft palate, cleft limb]) were observed in the mancozeb rat developmental toxicity study but do not indicate susceptibility to offspring as they occurred at the same dose level that caused maternal mortality. There was no indication of enhanced fetal susceptibility in the mancozeb rabbit developmental study because the late abortions occurred at the same dose that also caused maternal mortality. No adverse reproductive or offspring effects were observed in the two-generation reproduction study up to the highest dose. However, evidence of quantitative susceptibility was noted in the developmental neurotoxicity study with mancozeb, since decreased pup body weight occurred in the absence of maternal toxicity. The concern is low for the quantitative susceptibility as it was observed at dose levels 3-6X higher than the selected mancozeb points of departure (PODs).

No adverse immunotoxic responses were observed in the mancozeb immunotoxicity study.

Acute lethality studies show that mancozeb is not acutely toxic *via* the oral, dermal, or inhalation routes of exposure (Toxicity Category IV). Mancozeb is not a skin irritant (Toxicity Category IV) nor is it a skin sensitizer although it did cause eye irritation (Toxicity Category III).

For mancozeb, the POD to assess acute dietary exposure for females of reproductive age was derived from the developmental rat study. The endpoint was based on increased resorptions and a number of developmental effects (i.e. agnathia, cleft palate/lip, etc). No hazard or appropriate acute endpoint was identified for the general population, including infants and children, from the available oral toxicity database; therefore, no acute dietary risk assessment is required for this population subgroup. For chronic dietary exposures, the POD was derived from the chronic/carcinogenicity study in rats based

on thyroid toxicity. To assess incidental oral and inhalation exposures, the subchronic oral rat and subchronic inhalation studies were selected, respectively, based on thyroid toxicity. A dermal endpoint is not required for mancozeb as no systemic toxicity was observed in the dermal route specific study and all developmental effects observed across the database, when converted to dermal equivalent doses, would result in dermal doses greater than the limit dose. Therefore, the quantification of dermal risk is not required.

The mancozeb risk assessments are based on the most sensitive endpoints in the toxicity database, and the PODs selected for risk assessment are considered protective of any potential adverse effects, including developmental and neurotoxic effects for infants and children. There is no residual uncertainty in the exposure database for mancozeb with respect to dietary and residential exposure. The Food Quality Protection Act (FQPA) safety factor (SF) is reduced to 1X.

For acute dietary (females 13+), the total uncertainty factor (UF) is 100X (10X to account for interspecies extrapolation, 10X to account for intra-species variation, and 1X FQPA SF). For chronic dietary, the total uncertainty factor is 30X [3X to account for interspecies extrapolation (reduced from 10X based on toxicodynamic differences in human vs. rat thyroid), 10X to account for intra-species variation, and 1X FQPA SF].

The residential incidental oral level of concern (LOC) is 30, which includes the following UFs: 3X to account for interspecies extrapolation (reduced based on toxicodynamic differences in human vs. rat thyroid), 10X to account for intra-species variation, and 1X FQPA SF.
The residential/occupational inhalation LOC is 10, which includes the following UFs: 1X to account for interspecies extrapolation (10X reduced to 1X due to the calculation of human equivalent concentrations (HECs) accounting for pharmacokinetic interspecies differences and the toxicodynamics interspecies differences in the human vs. rat thyroid function), 10X to account for intra-species variation, and 1X FQPA SF (residential).

For mancozeb, oral and inhalation exposures can be combined since the same effect (i.e., thyroid toxicity) is the basis for the selected endpoints.

ETU: The thyroid is a target organ for ETU. Following subchronic oral exposure to ETU in guideline rat and dog studies, toxicity to the thyroid manifested as hormone alterations and gross/histopathological changes with corresponding organ weight changes. Adverse effects occurred at similar dose levels as was observed in the subchronic mancozeb studies.

There is evidence of increased susceptibility following *in utero* exposure to ETU in the rat developmental toxicity studies. Developmental defects in the rat developmental toxicity study were similar to those seen with mancozeb, and included hydrocephaly and related lesions, skeletal system defects, and other gross defects. Several developmental toxicity studies with ETU in the open literature demonstrate qualitative fetal sensitivity and quantitative susceptibility. The concern for the sensitivity and susceptibility is low as the PODs based on thyroid toxicity occurred at dose levels 50-250X lower as compared to the fetal effects in the ETU database and open literature.

Since the last assessment, an Extended One-Generation Reproduction Toxicity Study (EOGRTS) with ETU has been submitted. The primary toxic effects were observed in the thyroid and pituitary of the parental and offspring generations. No reproductive effects were observed up to the highest dose tested. A decrease in brain size (weight and macroscopic brain measurements) was observed in postnatal day (PND) 78 animals; however, this effect was observed at a dose level 50X higher than the dose at which thyroid toxicity was observed.

No adverse immunotoxic responses were observed in the ETU immunotoxicity study.

ETU is not acutely toxic *via* the dermal (Toxicity Category III) or inhalation route (Toxicity Category IV). ETU is not a primary skin irritant (Toxicity Category IV).

For ETU, the POD to assess acute dietary exposure for females of reproductive age was derived from the developmental rabbit study based on increased early resorptions. No hazard or appropriate acute endpoint was identified for the general population, including infants and children, from the available oral toxicity database; therefore, no acute dietary risk assessment is required for this population subgroup. For chronic dietary, incidental oral, dermal, and inhalation exposures, the POD was derived from the EOGRTS in rats based on toxicity observed in the pituitary and thyroid.

For ETU, a 10X FQPA SF is retained for chronic dietary, incidental oral, dermal and inhalation assessments as an uncertainty factor (UF) for the use of a LOAEL to extrapolate to a NOAEL (UF_L), since the study selected to establish PODs for these exposures did not identify a NOAEL. For the acute dietary assessment (females 13+), the FQPA SF is reduced to 1X.

For acute dietary (females 13+), the total uncertainty factor (UF) is 100X (10X to account for interspecies extrapolation, 10X to account for intra-species variation, and 1X FQPA SF). For chronic dietary, the total uncertainty factor is 300X [3X to account for interspecies extrapolation (reduced from 10X based on toxicodynamic differences in human vs. rat thyroid), 10X to account for intra-species variation, and 10X FQPA SF].

The residential/occupational dermal, residential/occupational inhalation, and residential incidental oral LOC is 300 which includes the following: 3X to account for interspecies extrapolation (reduced from 10X based on toxicodynamic differences in human vs. rat thyroid), 10X to account for intra-species variation and a 10X FQPA SF (residential)/UF_L (occupational). The dermal absorption factor (DAF) for ETU is 6%.

For ETU, oral, dermal, and inhalation exposures can be combined since the same target organ (i.e., thyroid) was the basis for the selected endpoints.

Cancer

Mancozeb's potential for carcinogenicity (as well as that of the other EBDCs) is assessed by the metabolite, ETU, which is classified as a probable human carcinogen (Group B2), with a cancer potency factor (Q_1^*) of 0.0601 $(mg/kg/day)^{-1}$ for risk assessment based on combined adenomas and/or carcinoma liver tumors in female mice. On this basis, mancozeb cancer risk has been calculated by

estimating exposure to mancozeb-derived ETU (including the metabolic conversion) and using the ETU cancer potency factor to provide a quantitative estimate of risk.

Dietary Exposure and Risk

Tolerances are currently established for residues of mancozeb including its metabolites and degradates [measured as the degradate carbon disulfide (CS_2)] on a number of crop and livestock commodities. In plant commodities, the residues of concern for risk assessment are mancozeb and ETU. For livestock (ruminant) commodities and drinking water, the residue of concern for risk assessment is ETU only.

Acute, chronic, and/or cancer dietary exposure and risk assessments were conducted for mancozeb, ETU from mancozeb, and ETU from combined EBDC uses (mancozeb and metiram). Field trial data were used along with monitoring data for several commodities (EBDC/ETU Market Basket Survey). Empirical processing and cooking factors were utilized. Maximum (for acute) or average (for chronic and cancer) percent crop treated (%CT) estimates were incorporated where available.

The dietary analyses performed for mancozeb were for food only exposure since mancozeb is known to degrade quickly in the environment and is not expected in drinking water sources. ETU may be expected in drinking water from the registered mancozeb uses. ETU is not expected in drinking water as a result of metiram applications since there are no metiram uses registered in the U.S. (tolerances for metiram are maintained for import purposes). The dietary analyses performed for ETU were for both food and drinking water exposures. The ETU dietary analyses incorporated estimated drinking water concentrations (EDWCs) based on modeling (acute and chronic) or monitoring data (cancer).

<u>Mancozeb</u>
For mancozeb, the acute and chronic dietary (food only) risk estimates are below the level of concern for the general U.S. population and all population subgroups (< 100% of the aPAD or cPAD). The acute dietary risk for females 13-49 years old (the only population subgroup for which an acute endpoint is selected) is <1% of the aPAD (at the 99.9th percentile). The chronic dietary risk estimate for the general U.S. population and all population subgroups, including infants and children, is <1% of the cPAD. The population subgroup with the highest chronic risk estimate from mancozeb is children 1-2 years old.

<u>ETU (from Mancozeb)</u>
The acute dietary (food and drinking water) risk estimates for ETU from mancozeb uses are below the level of concern (< 100% of the aPAD). The acute dietary risk for females 13-49 years old (the only population subgroup for which an acute endpoint is selected) is 18% of the aPAD (at the 99.9th percentile).

The chronic dietary (food and drinking water) risk estimates for ETU from mancozeb uses are not of concern for the general U.S. population and all population subgroups (< 100% of the cPAD). The population subgroup with the highest chronic dietary risk estimate for ETU from mancozeb is all infants at 77% of the cPAD.

The cancer dietary (food and drinking water) assessment for ETU from mancozeb uses results in a risk estimate of 1 x 10^{-6}.

ETU (from EBDCs Mancozeb and Metiram)
The acute dietary risk estimates for ETU from both mancozeb (food and drinking water) and metiram (food only) are not of concern. The acute dietary risk for females 13-49 years old is 18% of the aPAD (at the 99.9th percentile).

The chronic dietary risk estimates for ETU from both mancozeb (food and drinking water) and metiram (food only) are not of concern for the general U.S. population and all population subgroups (< 100% of the cPAD). The population subgroup with the highest chronic dietary risk estimate for ETU from mancozeb and metiram is all infants at 77% of the cPAD.

The cancer dietary assessment for ETU from both mancozeb (food and drinking water) and metiram (food only) results in a risk estimate of 2 x 10^{-6}.

Residential Exposure and Risk

Residential Handler Exposure
All registered mancozeb product labels require that handlers wear specific clothing (e.g., long sleeve shirt/long pants) and/or use PPE. Therefore, HED has made the assumption that these products are not for homeowner use and has not conducted a quantitative residential handler assessment.

Residential Post-Application Exposure and Risk
There is the potential for post-application exposure to both mancozeb and mancozeb-derived ETU residues for individuals exposed as a result of being in an environment that has been previously treated with mancozeb. The quantitative exposure/risk assessment for residential post-application exposures is based on the registered golf course turf use (i.e., assumes all other residential uses are removed from labels).

Residential Post-Application Non- Cancer Exposure and Risk
Mancozeb: No dermal endpoint was selected for mancozeb (no dermal hazard); therefore, a quantitative post-application dermal assessment is not required.

ETU: A dermal residential post-application assessment was conducted for ETU. Results from a chemical-specific turf transferable residue (TTR study) were incorporated into the post-application assessment for turf. The risk estimates indicate that the short-term dermal (adult and child golfers) MOEs are not of concern (i.e., MOEs > LOC of 300) with MOEs ranging from 380 to 700.

Residential Post-Application Cancer Exposure and Risk
ETU: The cancer risk estimate for adult dermal post-application exposure to golf course turf is 4x10^{-7}.

Aggregate Exposure and Risk

The acute aggregate risk estimates for mancozeb, ETU from mancozeb, and ETU from EBDCs (mancozeb and metiram) are equivalent to the acute dietary risk estimates and are not of concern.

The chronic aggregate risk estimates for mancozeb, ETU from mancozeb, and ETU from EBDCs (mancozeb and metiram) are equivalent to the chronic dietary risk estimates and are not of concern.

In estimating the short-term aggregate risks for ETU from mancozeb, and ETU from EBDCs (mancozeb and metiram), HED has aggregated non-cancer residential and average dietary exposures.

For ETU short-term aggregate assessments, the appropriate residential scenarios for aggregation are adults, children 6 to < 11 years old, and children 11 to <16 years old post-application dermal exposure from contacting mancozeb-treated turf (golfing). The short-term aggregate assessment for ETU from mancozeb and for ETU from combined EBDCs resulted in the same risk estimates; the short-term aggregate MOEs for adults (310), children 6 to <11 years old (370), and children 11 to < 16 years old (490) are not of concern (LOC of 300).

The cancer aggregate assessment for ETU from mancozeb combines residential post-application exposure for adults contacting mancozeb-treated turf (based on expected lifetime exposure) with the cancer dietary exposure for ETU from mancozeb. The cancer aggregate risk estimate is 2×10^{-6}.

The cancer aggregate assessment for ETU from combined EBDCs (mancozeb and metiram) combines residential post-application exposure for adults contacting mancozeb-treated turf (based on expected lifetime exposure) with the cancer dietary exposure for ETU from mancozeb and metiram. The cancer aggregate risk estimate is 2×10^{-6}.

Non-Occupational Spray Drift

Mancozeb: A quantitative non-occupational spray drift assessment for mancozeb has been completed. Although there is potential for both dermal (adults and children 1 to <2 years old) and incidental oral (children 1 to <2 years old only) exposure, only an incidental oral assessment was completed at this time since a dermal endpoint was not selected for mancozeb. Incidental oral (children 1 to <2 years old) risk estimates were calculated using available chemical-specific TTR data. For children, incidental oral screening-level risk estimates were not of concern at the field edge for all scenarios with MOEs ranging from 530 to 2,200 (LOC = 30).

ETU: A quantitative non-occupational spray drift assessment for ETU has been completed. Dermal (adult) and combined dermal and incidental oral (children 1 to <2 years old) risk estimates were calculated using available chemical-specific TTR data. For adults, dermal screening-level risk estimates were not of concern at the field edge with MOEs ranging from 420 to 1,700 (dermal LOC = 300). For children, combined dermal and incidental oral screening-level risk estimates were of concern at the field edge for most scenarios with MOEs ranging from 140 to 590 (LOC = 300). The distances required for exposures to reach the LOC of 300 range from 10 to 75 ft from the field edge.

Occupational Exposure and Risk

Occupational Handler Exposure and Risk

Occupational handler non-cancer (short- and intermediate-term) assessments were performed for mancozeb and ETU exposures based on the currently registered uses of mancozeb. A handler cancer

assessment was also performed for ETU. Only inhalation exposures were considered for mancozeb because there is no dermal hazard for mancozeb. In the case of ETU, however, inhalation and dermal exposures were considered for both the non-cancer and cancer risk assessments.

Handler Non-Cancer (Mancozeb and ETU)

Mancozeb: Occupational handler non-cancer inhalation risk estimates for *foliar uses* indicate that the short- and intermediate-term inhalation MOEs are not of concern (i.e., MOEs ≥ LOC of 10) with baseline attire (i.e., no respirator). Occupational handler inhalation MOEs range from 28 to 4,300,000.

Occupational handler non-cancer inhalation risk estimates for *seed treatment uses* indicate that the short- and intermediate-term inhalation MOEs are not of concern (i.e., MOEs ≥ LOC of 10) for most scenarios at baseline (i.e., no respirator) for commercial and on-farm seed treatment. Occupational handler inhalation MOEs range from 11 to 94,000 for commercial seed treatment and 7.1 to 120,000 for on-farm seed treatment. One scenario (on-farm treating and planting potato seeds) is of concern at baseline (i.e., no respirator; MOE = 7.1) however, the scenario no longer of concern with the addition of a PF10 respirator (MOE = 71).

ETU: Occupational handler non-cancer combined (dermal and inhalation) risk estimates for *foliar uses* indicate that the short- and intermediate-term combined dermal and inhalation MOEs are of concern (i.e., MOEs < LOC of 300) at baseline (i.e., single layer of clothing) plus label-specified PPE (i.e., gloves and no respirator) for several scenarios with MOEs ranging from 3.7 to 110,000 (LOC = 300). Risk estimates considering maximum PPE (i.e., double/layer plus gloves and PF10 respirator) and/or engineering controls (ECs; closed systems, enclosed cockpits, etc.), where applicable, are still of concern (i.e., MOEs < LOC of 300) for some scenarios with MOEs ranging from 28 to 280. Considering maximum PPE or engineering controls, where applicable, the MOEs range from 28 to 110,000 (LOC = 300).

Occupational handler non-cancer combined (dermal and inhalation) risk estimates for *seed treatment uses* when using an open loading system for *commercial seed treatment*, do not reach acceptable combined (dermal + inhalation) MOEs (i.e., MOEs < 300) for 53 out of 60 scenarios assuming a worker is wearing a single layer of clothing, gloves and no respirator (i.e., the lowest level of clothing and PPE on some seed treatment labels). Risk estimates considering maximum PPE (i.e., double layer of clothing, gloves, and a PF10 respirator) are still of concern (i.e., MOEs < 300) for 49 scenarios (combined dermal + inhalation MOEs range from 3 to 31,000). For *on-farm seed treatment*, 16 out of 23 scenarios do not reach an acceptable combined (dermal + inhalation) MOE (i.e., MOEs <300) at baseline (i.e., single layer and no respirator) plus label-specified PPE (i.e., gloves). Risk estimates considering maximum PPE (i.e., double layer of clothes, gloves, and a PF10 respirator) for 9 scenarios are still of concern with combined (dermal + inhalation) MOEs ranging from 4.9 to 100,000. A summary of the risk estimates can be found in Appendix F.

It should be noted that many labels reviewed for these particular seed treatment uses included requirements for treaters and/or multiple activity workers to wear a respirator; however, this piece of equipment is not listed on all labels (see Appendix E for label-specific PPE).

Handler Cancer (ETU)
The risk estimates for the foliar uses of mancozeb ranged from $7x10^{-4}$ to $4x10^{-8}$ for private growers/handlers (10 days of exposure/year) and $2x10^{-3}$ to $1x10^{-7}$ for commercial handlers (30 days of exposure/year) with baseline attire (i.e., single layer and no respirator) plus label-specified PPE (i.e., gloves).

The risk estimates for the seed treatment uses of mancozeb ranged from $5x10^{-4}$ to $3x10^{-8}$ for private growers (10 days of exposure/year) and $3x10^{-4}$ to $5x10^{-8}$ with baseline attire (i.e., single layer and no respirator) plus label-specified PPE (i.e., gloves) for commercial applicators (30 days of exposure/year).

Occupational Post-Application Dermal Exposure and Risk
Occupational post-application dermal exposure to mancozeb and ETU is expected from the registered uses of mancozeb. A quantitative post-application non-cancer dermal assessment was conducted for ETU but not for mancozeb, as there is no dermal hazard for mancozeb. A post-application cancer dermal assessment was also performed for ETU. Chemical-specific TTR data and chemical-specific dislodgeable foliar residue (DFR) data are available for ETU and are used, where appropriate. Risk estimates (i.e., MOEs) have been summarized by crop category due to the number of crops assessed; these categories include orchard crops, table and raisin grapes, field crops, and greenhouse crops.

Post-Application Dermal Non-Cancer (ETU)
- Risk estimates for representative orchard crops range from 37 to 4,300 on 0-DAT; risk estimates for 11 activities do not reach an acceptable MOE (i.e., MOE > LOC of 300) on 0-DAT (days after treatment).
- Risk estimates for table and raisin grapes range from 16 to 1,300 on 0-DAT; risk estimates for 10 activities do not reach an acceptable MOE (i.e., MOE > LOC of 300) on 0-DAT.
- Risk estimates for representative field crops range from 93 to 12,000 on 0-DAT; risk estimates for 23 activities do not reach an acceptable MOE (i.e., MOE > LOC of 300) on 0-DAT.
- Risk estimates for greenhouse vegetables and greenhouse crops are not of concern (i.e., MOE > LOC of 300) on 0-DAT. Risk estimates range from 490 to 3,600.
- Risk estimates for golf course and sod range from 150 to 1,700 on 0-DAT; risk estimates for 4 scenarios do not reach acceptable MOEs (i.e., MOE > LOC of 300) on 0-DAT.

Post-Application Dermal Cancer (ETU)
Dermal post-application risk estimates for orchard crops range from $7x10^{-6}$ to $5x10^{-8}$. Risk estimates for table and raisin grapes range from $2x10^{-5}$ to $2x10^{-7}$. Risk estimates for all field crops range from $1x10^{-6}$ to $1x10^{-8}$. Risk estimates for greenhouse vegetables and greenhouse crops range from $3x10^{-7}$ to $5x10^{-8}$. Risk estimates for golf course and sod range from $3x10^{-7}$ to $9x10^{-7}$. All risk estimates were calculated using a 30-day average dose.

Occupational Post-Application Inhalation Exposure and Risk
Based on the Agency's current practices, a quantitative non-cancer occupational post-application inhalation exposure assessment was not performed for mancozeb or ETU at this time. If new policies or procedures are put into place, the Agency may revisit the need for a quantitative occupational post-application inhalation exposure assessment for mancozeb.

Environmental Justice Considerations

Potential areas of environmental justice concerns, to the extent possible, were considered in this human health risk assessment (see Section 3.5).

Review of Human Research

See Appendix C for information regarding the use of human research data in this assessment.

2.0 Risk Assessment Conclusions

Non-Cancer (Mancozeb and ETU)

There are no acute or chronic dietary (food and drinking water) risk estimates of concern for mancozeb, ETU from mancozeb, or ETU from combined EBDCs (mancozeb and metiram).

For mancozeb, there are no residential or non-occupational spray drift risk estimates of concern. There are no occupational handler risk estimates of concern with the exception of one handler scenario for potato seed treatment (MOE = 7.1, LOC = 10); this scenario is no longer of concern with the addition of a PF10 respirator (MOE = 71).

For ETU, there are no residential risk estimates of concern. For non-occupational spray drift, there are risk estimates of concern at the field edge for children. There are occupational handler risks of concern for some scenarios, even with the addition of PPE and/or engineering controls. There are occupational post-application risks of concern on the day of application for some scenarios.

There are no short-term aggregate (residential plus dietary) risk estimates of concern for ETU from mancozeb, or ETU from combined EBDCs (mancozeb and metiram).

Cancer (ETU)

The cancer dietary assessment for ETU (from mancozeb uses) resulted in a cancer risk estimate of 1×10^{-6}. The cancer dietary assessment for ETU (from combined EBDC uses) resulted in a cancer risk estimate of 2×10^{-6}. The cancer residential risk estimate for ETU is 4×10^{-7}.

The cancer aggregate assessments for ETU (from mancozeb uses, or from combined EBDC uses) resulted in a cancer aggregate risk estimate of 2×10^{-6}.

The cancer occupational handler assessments for ETU resulted in risk estimates ranging from 3×10^{-8} to 2×10^{-3}. The cancer occupational post-application assessments for ETU resulted in risk estimates ranging from 1×10^{-8} to 2×10^{-5}.

2.1 Data Deficiencies

Analytical standards for mancozeb must be replenished to the EPA National Pesticide Standards Repository (NPSR) (See Section 2.2.1).

The mancozeb residue chemistry database is incomplete. Several studies evaluated in this assessment were concluded to be inadequate. These data gaps were identified in the residue chemistry chapter completed to support the 2005 mancozeb reregistration eligibility decision (RED) (C. Olinger, D305815, 06/14/2005). These residue chemistry data gaps which remain outstanding are:

860.1200 Directions for Use
Product labeling for treating tobacco for the special local need (SLN) registrations are inadequate and do not allow for evaluation of the supporting tobacco field trial data to be made. Clarification must be provided as to the maximum total rate of mancozeb that can be applied to tobacco with the active SLN labels being amended accordingly.

860.1300 Nature Residue - Plants
A tobacco pyrolysis study has not yet been submitted following guidelines to allow the Agency to conduct an exposure assessment to support this registered use. If the maximum residue in any individual composite sample of cured tobacco is >0.1 ppm a pyrolysis study is required. Pyrolysis products resulting from the total toxic residue must be identified and characterized as required for plant metabolism studies.

860.1500 Crop Field Trials
Residue data for tobacco allowing the Agency to conduct an exposure assessment have been submitted but no determination can be made whether they are adequate at this time. Because the SLN labels do not specify the maximum total seasonal rate allowed for treating tobacco with mancozeb, these data may or may not be adequate for risk assessment; a new field trial study is required if the labeled rate is not comparable to the pattern of use depicted in the submitted study (MRID 50646701). Residue data for safflower seed or propagation stock treatment data were provided but concluded to be inadequate because the study was conducted at an insufficient rate. Data are required depicting residues of mancozeb and ETU in/on safflower seed grown from seed treated with a representative product at 0.11 lb ai/100 lb of seed. [Reviewer Note*: there is no tolerance for mancozeb on safflower* in the CFR *but there is a registered use* listed on the most recent Penncozeb 4FL label (EPA Reg. No. 70506-194)].

860.1850 Confined Rotational Crop Study
The confined rotational crop study provided to satisfy the data requirements of the 2005 RED has been concluded to be inadequate because it was conducted at an insufficient rate. A new confined rotational crop study is therefore required, and the registrant is reminded that this study is to be conducted at the maximum labeled rate established for treating crops grown in rotation with mancozeb.

2.2 Tolerance Considerations

2.2.1 Enforcement Analytical Method

The residue of concern for tolerance enforcement is mancozeb measured as carbon disulfide (CS_2). There are adequate methods available for the enforcement of crop tolerances with Pesticide Analytical Manual (PAM) Vol. II listing Methods I, II, III, IV, and A for determining dithiocarbamate residues in/on plant commodities. The Keppel colorimetric method (Method III) is preferred since this procedure determines the EBDC fungicides as a group by degradation to CS_2. The analytical method for the common metabolite ETU is based on the methodology published by Olney and YIP (JAOAC 54:165-169). There are also adequate enforcement methods available to perform the determination of both EBDC and ETU residues in livestock commodities developed by the registrant (P. Savoia, D435427, 04/10/2018). Mancozeb is not recovered through any of the FDA Multi-Residue Method testing protocols.

The EPA National Pesticide Standard Repository (NPSR) has indicated that analytical standards for mancozeb are available from Dow Agro/Corteva and Drexel which expired on 10/23/2019 and 04/24/2020, respectively (electronic communication with T. Cole, 05/26/2020). The registrant is therefore being requested to replenish 1-gram standards of mancozeb as recommended in the guidance letter from Theresa Cole attached as Appendix B of D452107. The address to submit standards is:

USEPA
National Pesticide Standards Repository/Analytical Chemistry Branch/OPP
701 Mapes Road
Fort George G. Meade, MD 20755-5350

The full 9-digit zip code should be used for addressing all correspondence to the repository.

2.2.2 Recommended Tolerances

The current tolerance expression for mancozeb established in 40 CFR §180.176 is adequate.

Tolerances are established for residues of mancozeb (a coordination product of zinc ion and maneb (manganese ethylenebisdithiocarbamate)), including its metabolites and degradates, in or on the commodities in the following table. Compliance with the tolerance levels specified in this paragraph is to be determined by measuring only those mancozeb residues convertible to and expressed in terms of the degradate carbon disulfide.

During registration review, HED implements crop group conversions and commodity definition revisions for existing tolerances resulting from changes to pesticide crop grouping regulations. For mancozeb, there are no crop group conversions applicable to the existing tolerances. HED does, however, recommend correction of the commodity definitions for sugar beet leaves, fennel, peppers, walnuts, and livestock kidney and liver (meat byproducts).

Tolerances for ruminant commodities should now be established separately under 40 CFR §180.176(a)(2) as the tolerance residue definition has changed for these commodities (from parent

mancozeb to ETU). Existing tolerances for poultry and swine (hog) commodities may be removed as there is no expectation of residues of mancozeb (or ETU) in these commodities [40 CFR 180.6(a)(3)].

HED also recommends that the following established tolerances be revised to be consistent with the Organization for Economic Co-operation and Development (OECD) rounding class practice: atemoya at 3 ppm, sugar beet dried pulp at 3 ppm, canistel at 15 ppm, cherimoya at 3 ppm, custard apple at 3 ppm, mango at 15 ppm, oat flour at 1.5 ppm, rye flour at 1.5 ppm, sapodilla at 15 ppm, mamey sapote at 15 ppm, white sapote at 15 ppm, star apple at 15 ppm, sugar apple at 3 ppm, black walnut at 0.7 ppm, English walnut at 0.7 ppm, and wheat flour at 1.5 ppm.

The peanut hay tolerance of 65 ppm can be removed as it is no longer required; product labels have been amended to include a livestock feeding restriction for peanut hay (C. Olinger, D305815, 06/14/2005). The field corn forage, pop corn stover, and sweet corn stover tolerances should be increased to 50 ppm; existing field trial residue data show that residues of mancozeb are greater than the current tolerance levels for these commodities (C. Olinger, D305815, 06/14/2005). In addition, the tolerance for undelinted cotton seed can be removed as it is no longer required. Foliar use on cotton has been removed and only a seed treatment use is currently supported. In addition, a seed treatment uptake study shows no radioactivity detected in mature cotton seed and foliage. Thus, the seed treatment use of mancozeb on cottonseed is concluded to be a non-food use and a tolerance is not needed (C. Olinger, D344719, 04/30/2008).

To support registration review of mancozeb, new processing studies were provided for barley, oats, potato, and wheat. These studies show that residues do not concentrate upon processing and no separate tolerances are needed for the processed commodities of these crops. Therefore, the tolerances for barley bran, barley flour, pearled barley, oat flour, groats/rolled oats, wheat bran, wheat flour, wheat germ, wheat middlings, and wheat shorts can all be removed.

The recommended revisions for the 40 CFR §180.176(a)(1) *General* tolerances based on the registration review of mancozeb and the residue chemistry data provided are summarized below in Table 2.2.2.1.

Table 2.2.2.1. Summary of Tolerance Revisions for Mancozeb (40 CFR §180.176(a)(1) *General*).

Commodity/ **Correct Commodity Definition**	Established Tolerance (ppm)	Recommended Tolerance (ppm)	Comments
Atemoya	3.0	3	Corrected value to be consistent with OECD Rounding Class Practice.
Barley, bran	2	remove	New study shows no concentration of residues upon processing.
Barley, flour	2	remove	
Barley, pearled barley	20	remove	
Beet, sugar, dried pulp	3.0	3	Corrected value to be consistent with OECD Rounding Class Practice.
Beet, sugar, leaves[1]	-	60	Commodity definition revision.

Table 2.2.2.1. Summary of Tolerance Revisions for Mancozeb (40 CFR §180.176(a)(1) *General*).			
Commodity/ **Correct Commodity Definition**	Established Tolerance (ppm)	Recommended Tolerance (ppm)	Comments
Beet, sugar, tops	60	remove	
Canistel	15.0	15	Corrected value to be consistent with OECD Rounding Class Practice.
Cattle, meat byproducts	-	remove[2]	Commodity definition revision. Tolerance residue definition revision recommended; move to (40 CFR §180.176(a)(2) *General*).
Cattle, kidney	0.5	remove	
Cattle, liver	0.5	remove	
Corn, field forage	40	50	Data cited for tolerance reassessment report residues greater than the established limit (C. Olinger, D305815, 06/14/2005).
Corn, pop, stover	40	50	Data cited for tolerance reassessment report residues greater than the established limit (C. Olinger, D305815, 06/14/2005).
Corn, sweet, stover	40	50	Data cited for tolerance reassessment report residues greater than the established limit (C. Olinger, D305815, 06/14/2005)
Cotton, undelinted seed	0.5	remove	Concluded to be a non-food use (D344719, C. Olinger, 04/30/2008).
Cherimoya	3.0	3	Corrected value to be consistent with OECD Rounding Class Practice.
Custard apple	3.0	3	Corrected value to be consistent with OECD Rounding Class Practice.
Fennel, Florence, fresh leaves and stalk	-	2.5	Commodity definition revision.
Fennel	2.5	remove	
Goat, meat byproducts	-	remove[2]	Commodity definition revision. Tolerance residue definition revision recommended; move to (40 CFR §180.176(a)(2) *General*).
Goat, kidney	0.5	remove	
Goat, liver	0.5	remove	
Hog, meat byproducts	-	remove	No expectation of finite residues in livestock, 40 CFR 180.6(a)(3).
Hog, kidney	0.5	remove	
Hog, liver	0.5	remove	
Horse, meat byproducts	-	remove[2]	Commodity definition revision.
Horse, kidney	0.5	remove	
Horse, liver	0.5	remove	

Table 2.2.2.1. Summary of Tolerance Revisions for Mancozeb (40 CFR §180.176(a)(1) *General*).			
Commodity/ **Correct Commodity Definition**	Established Tolerance (ppm)	Recommended Tolerance (ppm)	Comments
			Tolerance residue definition revision recommended; move to (40 CFR §180.176(a)(2) *General*).
Mango	15.0	15	Corrected value to be consistent with OECD Rounding Class Practice.
Oat, flour	1.2	remove	New study shows no concentration of residues upon processing.
Oat, groats/rolled oats	20	remove	
Peanut, hay	65	remove	Labels are amended to include a livestock feeding restriction (D305815, C. Olinger, 06/14/2005).
Pepper, bell	-	12	Commodity definition revision.
Pepper, nonbell	-	12	
Pepper	12	remove	
Poultry, meat byproducts	-	remove	No expectation of finite residues in livestock, 40 CFR 180.6(a)(3).
Poultry, kidney	0.5	remove	
Poultry, liver	0.5	remove	
Rye, flour	1.2	1.5	Corrected value to be consistent with OECD Rounding Class Practice.
Sapodilla	15.0	15	Corrected value to be consistent with OECD Rounding Class Practice.
Sapote, mamey	15.0	15	Corrected value to be consistent with OECD Rounding Class Practice.
Sapote, white	15.0	15	Corrected value to be consistent with OECD Rounding Class Practice.
Sheep, meat byproducts	-	remove[2]	Commodity definition revision.
Sheep, kidney	0.5	remove	Tolerance residue definition revision recommended; move to (40 CFR §180.176(a)(2) *General*).
Sheep, liver	0.5	remove	
Star apple	15.0	15	Corrected value to be consistent with OECD Rounding Class Practice.
Sugar apple	3.0	3	Corrected value to be consistent with OECD Rounding Class Practice.
Walnut, black	-	0.7	

Table 2.2.2.1. Summary of Tolerance Revisions for Mancozeb (40 CFR §180.176(a)(1) *General*).			
Commodity/ **Correct Commodity Definition**	Established Tolerance (ppm)	Recommended Tolerance (ppm)	Comments
Walnut, English	-	0.7	Commodity definition revision. Corrected value to be consistent with OECD Rounding Class Practice.
Walnut	0.70	remove	
Wheat, bran	2	remove	New study shows no concentration of residues upon processing.
Wheat, flour	1.2	remove	
Wheat, germ	20	remove	
Wheat, middlings	20	remove	
Wheat, shorts	2	remove	

[1] The tolerance for sugar beet leaves can be removed as it is no longer a significant livestock feed item or a recognized human food. The registrant should therefore be contacted to discuss their preference for removing or retaining this tolerance.

[2] The tolerances for the meat byproducts (kidney, liver) of cattle, horse, and sheep, should be removed from 40 CFR §180.176(a)(1) and included in 40 CFR §180.176(a)(2) since the residue of concern for tolerance enforcement for these commodities has changed.

Based on the results of a recently submitted dairy cattle feeding study (MRID 50771101), the residue of concern for tolerance enforcement of ruminant commodities has been updated to ETU (previously parent mancozeb only). These data show that a residue definition of ETU is now appropriate as there are no residues of parent mancozeb found in the tissues and milk of cattle. A tolerance of 0.02 ppm is recommended for ETU in milk, as well as tolerances of 0.04 ppm in fat, 0.04 ppm in meat, and 0.02 ppm in meat byproducts for ruminants (and horse). An acceptable analytical enforcement method is available for monitoring ETU residues in livestock commodities. The recommended tolerances for ruminant (and horse) commodities should be under 40 CFR §180.176(a)(2) as shown in Table 2.2.2.2 below.

The tolerance expression for ETU should be added under 40 CFR §180.176(a)(2) and should read as follows:

Tolerances are established for residues of ethylenethiourea (ETU), including its metabolites and degradates, in or on the commodities in the following table. Compliance with the tolerance levels specified in this paragraph is to be determined by measuring only ethylenethiourea, 2-Imidazolidinethione, in or on the commodity.

Table 2.2.2.2. Summary of Tolerances for ETU (40 CFR §180.176(a)(2) *General*).			
Commodity/ **Correct Commodity Definition**	Established Tolerance (ppm)	Recommended Tolerance (ppm)	Comments
Cattle, fat	-	0.04	
Cattle, meat	-	0.04	
Cattle meat byproducts	-	0.02	
Goat, fat	-	0.04	
Goat, meat	-	0.04	

Table 2.2.2.2. Summary of Tolerances for ETU (40 CFR §180.176(a)(2) *General*).			
Commodity/ **Correct Commodity Definition**	Established Tolerance (ppm)	Recommended Tolerance (ppm)	Comments
Goat, meat byproducts	-	0.02	
Horse, fat	-	0.04	
Horse, meat	-	0.04	
Horse, meat byproducts	-	0.02	
Milk	-	0.02	
Sheep, fat	-	0.04	
Sheep, meat	-	0.04	
Sheep, meat byproducts	-	0.02	

2.2.3 International Harmonization

There are Codex and Canada maximum residue levels (MRLs) for residues of mancozeb for some of the same commodities which have U.S. tolerances. While residue definitions are compatible, several U.S. tolerance levels are not harmonized with Codex and Canada MRLs. The tolerances on almond hulls, apple, crabapple, grape, head lettuce, pear, quince, and tomato are lower than those established by Canada and/or Codex. HED has consulted PRD on the opportunities for tolerance harmonization. Because the EBDCs are currently under re-review by both Canada and Codex, PRD recommends deferring any tolerance harmonization until it is more practical as international residue limits for the EBDCs may change (electronic communication, A. Hazlehurst, 09/01/2020). The International Residue Limit (IRL) summary for mancozeb is presented in Appendix D.

2.3 Label Recommendations

2.3.1 Recommendations from Residue Reviews

The mancozeb labels for tobacco use (multiple SLNs) should be amended to specify the maximum use rate. In addition, all mancozeb labels should be amended to specify that only registered crops may be grown in rotation. This label revision is required until an acceptable confined rotational crop study is provided, and realistic plant-back and rotational crop restrictions are subsequently established.

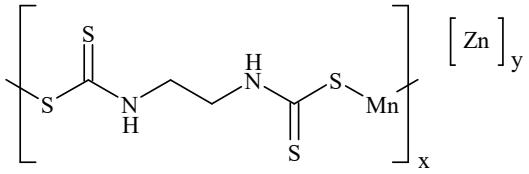
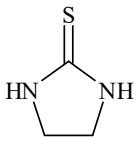
2.3.2 Recommendations from Occupational and Residential Assessment

HED notes that there were risk estimates of concern identified for occupational (handler and post-application) scenarios, as well as spray drift scenarios. HED recommends that the REIs on the labels be reviewed to address post-application risks of concern.

This risk assessment relies on a 2015 study by the Agricultural Handler Exposure Task Force (AHETF) that measured dermal and inhalation exposure for workers who mixed and loaded water-soluble packet pesticide products. Commensurate with the behaviors and practices represented by this data, labels for products formulated in water-soluble packaging should incorporate the Agency's revised instructions for proper mixing and loading of water-soluble packets. This revised language is aimed at ensuring that water-soluble packets are allowed to dissolve in water via mechanical agitation as intended and prevent them from being ruptured by streams of water or other means.

3.0 Introduction

3.1 Chemical Identity

Table 3.1 Mancozeb Nomenclature.	
Chemical structure	
Common name	Mancozeb
Company experimental name	Not applicable
IUPAC name	manganese ethylenebis(dithiocarbamate)(polymeric) complex with zinc salt
CAS name	[[1,2-ethanediylbis[carbamodithioato]](2-)]manganese mixture with [[1,2-ethanediylbis[carbamodithioato]](2-)]zinc
CAS registry number	8018-01-7
Chemical structure of ETU metabolite	 ethylenethiourea

3.2 Physical/Chemical Characteristics

Mancozeb is a coordination product of zinc ion and maneb (manganese ethylene-bisdithiocarbamate), which contains 20% manganese and 2.5% zinc. Technical mancozeb is a yellowish powder with a negligible vapor pressure at 20 °C. Mancozeb is practically insoluble in water and most organic solvents. Mancozeb decomposes in acid and alkaline conditions, with heat, and upon exposure to moisture and air. Mancozeb is short lived in soil and water and would therefore not be expected to remain in surface water long enough to reach a location that would supply water for human consumption. However, mancozeb's degradate ETU is highly water soluble, highly vulnerable to indirect photolysis, and is moderately mobile. ETU has an aerobic soil half-life of 3 days, and an estimated aquatic aerobic metabolism half-life of six days. The measured anaerobic aquatic metabolism half-life is 149 days. ETU has a relatively high vapor pressure, but the high solubility reduces the possibility of losses from surface water due to volatilization. See Appendix B for a table of physicochemical properties of mancozeb and ETU.

3.3 Pesticide Use Pattern

Mancozeb is currently registered for foliar use on a wide variety of agricultural use sites including fruit trees, nuts, grains, herbs and spices, fruit and vegetable crops, as well as on ornamentals (professional, commercial, and/or production nurseries and greenhouses) and turfgrass (golf courses and sod farms). Mancozeb is also registered for use as a seed treatment for a variety of crops. Mancozeb is formulated as a WP, DF, liquid, WSP, and D. It may be applied by handheld, ground, aerial and chemigation equipment. Seed is treated with commercial and on-farm equipment. All registered labels require

handlers to wear baseline attire (i.e., long-sleeve shirt, long pants, shoes, and socks) with varying levels of PPE including chemical resistant gloves, chemical resistant footwear, protective eyewear, and respirator. Mancozeb has numerous registered Section 3 labels along with multiple SLN labels which are also considered in this assessment. The REI on all registered labels ranges from 12 to 48 hours.

A summary of the representative registered commercial end-use products and use sites for mancozeb is provided in Appendix E for the agricultural uses, non-agricultural and residential uses, and seed treatment uses of mancozeb. This summary has been compiled based primarily on the Biological and Economic Analysis Division's (BEAD's) Pesticide Label Use Summary (PLUS) Report (05/12/2020) and a review of several labels identified in that report.

3.4 Anticipated Exposure Pathways

Exposure to mancozeb and/or ETU may occur from ingestion of residues on treated foods and in drinking water. Residential handler exposures are not expected. However, dermal post-application exposure may occur for adults and children golfing on treated turf. Dermal and/or inhalation exposures may occur for occupational handlers and post-application workers. Non-occupational (dermal for adults, dermal and incidental oral for children) exposures from spray drift may occur.

3.5 Consideration of Environmental Justice

Potential areas of environmental justice concerns, to the extent possible, were considered in this human health risk assessment, in accordance with U.S. Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," (http://www.archives.gov/federal-register/executive-orders/pdf/12898.pdf). As a part of every pesticide risk assessment, OPP considers a large variety of consumer subgroups according to well-established procedures. In line with OPP policy, HED estimates risks to population subgroups from pesticide exposures that are based on patterns of that subgroup's food and water consumption, and activities in and around the home that involve pesticide use in a residential setting. Extensive data on food consumption patterns are compiled by the U.S. Department of Agriculture's (USDA's) National Health and Nutrition Examination Survey, What We Eat in America, (NHANES/WWEIA) and are used in pesticide risk assessments for all registered food uses of a pesticide. These data are analyzed and categorized by subgroups based on age and ethnic group. Additionally, OPP is able to assess dietary exposure to smaller, specialized subgroups, and exposure assessments are performed when conditions or circumstances warrant. Whenever appropriate, non-dietary exposures are evaluated, based on home use of pesticide products and associated risks for adult applicators and for toddlers, youths, and adults entering or playing on treated areas post-application are evaluated. Spray drift can also potentially result in post-application exposure and it was considered in this analysis. Further considerations are currently in development, as OPP has committed resources and expertise to the development of specialized software and models that consider exposure to bystanders and farm workers as well as lifestyle and traditional dietary patterns among specific subgroups.

4.0 Hazard Characterization and Dose-Response Assessment

Since the last risk assessment (D. Drew, D457305, 12/14/2020), human *in vitro* dermal absorption

studies were submitted for ETU and integrated into this hazard assessment.

4.1 Toxicology Studies Available for Analysis

Mancozeb is a fungicide in the class of EBDCs, which also includes maneb and metiram; all of these compounds have a common metabolite/degradate, ETU. Mancozeb is metabolized in mammals to ETU as well as degraded to ETU in the environment. This characterization will discuss toxicity from mancozeb and ETU and select separate endpoints and PODs for both chemicals. The mancozeb and ETU databases are complete and adequate for hazard characterization, toxicity endpoint selection, and FQPA SF consideration and contains the following acceptable studies (see Appendix A):

Mancozeb

- Acute toxicity battery
- Subchronic oral toxicity in rats, mice, and dogs
- Subchronic dermal toxicity in rabbits
- Subchronic inhalation toxicity in rats
- Chronic toxicity in rats and dogs
- Developmental toxicity in rats and rabbits
- Reproduction and postnatal toxicity in rats
- Acute neurotoxicity (ACN) and subchronic neuropathology in rats
- Developmental neurotoxicity (DNT) in rats
- Absorption, distribution, metabolism, and excretion (ADME) in rats
- *In vitro* and *in vivo* genotoxicity
- Dermal absorption in rats
- Immunotoxicity in rats

ETU

- Acute toxicity battery
- Subchronic oral toxicity in rats and dogs
- Chronic toxicity in dogs
- Carcinogenicity in mice
- Developmental toxicity in rats and rabbits
- EOGRTS in rats
- Dermal absorption in rats
- Human *in vitro* dermal absorption studies
- Immunotoxicity in rats

As part of registration review for mancozeb, a broad survey of the literature was conducted to identify studies that report toxicity following exposure to mancozeb and ETU *via* exposure routes relevant to human health pesticide risk assessment not accounted for in the agency's toxicology databases. The search strategy employed terms restricted to the name of the chemical plus any common synonyms, and common mammalian models to capture as broad a list of publications as possible for the chemicals of interest. The search strategy returned 209 mancozeb studies and 291 ETU studies from the literature. During the title/abstract and/or full text screening of these studies, a number of studies were identified which could provide qualitative characterization to the toxicity profiles of mancozeb

and ETU. However, all target organs and effects observed in the open literature have already been identified and characterized within the current toxicity databases available for pesticide registration. None of the studies were deemed to contain potentially new quantitative information for the mancozeb/ETU human health risk assessment. One study, Maranghi, *et al.,* 2013[2], provided similar and complementary results as observed in the EOGRTS with ETU and is discussed in more detail in Section 4.3. Appendix A4 contains detailed information regarding the literature review.

4.2 Absorption, Distribution, Metabolism, & Elimination (ADME)

In a rat metabolism study (MRID 00262834 and MRID 00262835), [^{14}C-ethylene] mancozeb was administered as a single oral dose (1.5 mg/kg or 100 mg/kg) and was rapidly absorbed with highest accumulation of radioactivity in the thyroid due to ETU residues; no parent compound was detected in the thyroid. There was no indication of significant overall accumulation of mancozeb and metabolites in the body. The majority of mancozeb was metabolized to ETU and excreted in the urine. Radioactivity was rapidly absorbed into plasma with $t_{1/2}$ absorption times of 0.7- 1.0 hour for the 1.5 mg/kg group and 1.7 hours for the 100 mg/kg group. Peak plasma concentrations were reached within 3 hours for the 1.5 mg/kg group and 6 hours for the 100 mg/kg group. The $t_{1/2}$ for the rapid phase of elimination was approximately 4-6 hours for both dose groups. The $t_{1/2}$ for the slow phase of elimination was 36.5 hours in the 1.5 mg/kg group and 25 hours in the 100 mg/kg group.

The radiolabel was found at higher concentrations in the liver and thyroid in comparison to whole blood concentrations. Peak liver concentrations of radioactivity were reached within 6 hours and were approximately 1.7X higher than whole blood concentrations after 1.5 mg/kg dosing and were approximately 6X higher than whole blood after 100 mg/kg dosing. The thyroid had the highest mean residue concentration of any tissue, although individual thyroid concentrations varied as much as 30X within a group. Peak thyroid concentrations were reached within 6 hours after treatment with 1.5 mg/kg or within 24 hours after treatment with 100 mg/kg mancozeb. Peak thyroid concentrations of radioactivity were 42-45X higher than in whole blood after treatment with 1.5 mg/kg and were 6-16X higher than in whole blood after treatment with 100 mg/kg.

The radioactivity levels in the thyroid decreased between 24 and 48 hours and then increased between 48 and 96 hours. Although radioactivity levels in the thyroid had increased after 48 hours, there was no indication of significant overall accumulation of mancozeb and metabolites in the body. Average radioactivity residue levels in tissues 96 hours post-dosing were <4% of the dose. The area under the plasma concentration-time curve (AUC) for ETU in males was 6.4% of the AUC for plasma radioactivity after dosing with 100 mg/kg radiolabeled mancozeb; the AUC for ETU in females was 3.1% of the AUC for plasma radioactivity. ETU had a plasma $t_{1/2}$ of 3.9 hours in males and 4.7 hours in females.

In oral rat metabolism studies with radiolabeled mancozeb and other EBDCs, approximately 20% of EBDC was converted to ETU on a molar basis, which equated to 7.5% conversion on a weight basis[3]. While this metabolic conversion has been included in the mancozeb and ETU risk assessment for all

[2] Maranghi, *et al.* (2013). Reproductive toxicity and thyroid effects in Sprague Dawley rats exposed to low doses of ethylenethiourea. Food and Chemical Toxicology. 59: 261-271.

[3] A. Kocialski memo: Establishment of an *in vivo* metabolic conversion factor of 7.5% for all ethylene bis (dithio) carbamates (EBDCs) when converting EBDCs to ethylene thiourea (ETU) *in vivo* (TXR 0051840, 09/12/1989).

routes of exposure, there is some uncertainty in assuming the metabolic conversion occurs following dermal and inhalation dosing because absorption after dermal and inhalation dosing initially bypasses the liver.

4.2.1 Dermal Absorption

Mancozeb

There are two non-guideline dermal absorption studies with mancozeb, which together satisfy the guideline requirement for a dermal absorption study. In the first non-guideline study (MRID 00127950) 10 mg of Dithane M-45 (83% mancozeb formulation) was applied to the non-adhesive side of a bandage and attached to a 20 cm^2 clipped area on the back of female SD rats. The bandage was removed after 0 hours (bandage applied and immediately removed) or 6 hours, the area washed, animals sacrificed, and samples collected. An additional group had the bandage applied for 6 hours and was sacrificed at 24 hours. A dermal absorption of 1% after 6 hours exposure was calculated by summing amounts excreted in urine and feces for 24 hours. Absorption was also calculated by determining disappearance from the application site (subtracting amount remaining on bandage and skin from total amount applied). Dermal absorption values of 0.83% for 6 hours exposure and 0.89% for 6 hours followed by recovery for 18 hours were calculated for the disappearance of mancozeb.

In a second non-guideline study (MRID 40955401) 25 µg/cm^2 or 250 µg/cm^2 mancozeb (80.6%) was applied to the shaven backs of 4 male Crl:CD BR rats/group. At 0, 10, or 24 hours post-dosing, the application sites were washed, and samples collected for analysis. The authors attempted to quantify mancozeb by conversion to carbon disulfide (CS_2). However, quantification was confounded by the production of endogenous CS_2. Dermal absorption was calculated by subtracting mancozeb (as CS_2) at 10 and 24 hours from recovery at 0 hours. With this method, dermal absorption of mancozeb at 25 µg/cm^2 was calculated to be 2% at 10 hours and 4% at 24 hours. Dermal absorption of mancozeb at 250 µg/cm^2 was calculated to be <1% at 24 hours.

Using a weight of the evidence approach, the mancozeb dermal absorption factor is 1%. This value is supported by comparison of NOAEL values between the 13-week rat feeding study and the 28-day dermal toxicity study in rats ((9 mg/kg/day/1000 mg/kg/day) * 100) = 0.9% dermal absorption). The dermal absorption factor of 1% is also consistent with dermal absorption factors for other EBDCs including maneb (2% based on rat *in vivo* data) and metiram (1% based on rat *in vivo* data).

ETU

Previously, a DAF of 51% was used to assess dermal risk to ETU based on data from an *in vivo* dermal absorption study in the rat (MRID 40312001). However, since that time, EPA has completed a retrospective analyses of dermal triple pack data, which demonstrated that the *in vitro* studies alone provide similar or more protective estimates of dermal absorption, with only limited exceptions[4]. As a result, the recently submitted human *in vitro* studies alone, which were conducted in accordance with OECD 428 guidelines, can be used to derive a DAF for ETU.

[4] Allen et al. (2021) "Retrospective analysis of dermal absorption triple pack data", *ALTEX - Alternatives to animal experimentation*. https://doi.org/10.14573/altex.2101121.

Human *in vitro* dermal absorption data conducted with a suspension concentrate (SC) formulation (MRID 51840901) and a water dispersible granule (WDG) formulation (MRID 51841501) are available for ETU. Both studies examined absorption following application of a concentrate formulation (SC: 4.75 µg/cm^2; WDG: 3.72 µg/cm^2) and an in-use spray dilution (SC: 0.31 µg/cm^2; WDG: 0.33 µg/cm^2). Human skin was exposed for eight hours, washed, and samples collected at multiple time points up to 24 hours. A DAF of 4% was derived from the spray dilution group in the SC formulation study based on the sum of the receptor fluid (2.50%), receptor chamber wash (0.064%), exposed skin (0.33%), and tape strips 3-20 (0.44%). A similar result was obtained for the WDG in-use spray dilution group. A DAF of 6% was derived based on the sum of the receptor fluid (4.57%), receptor chamber wash (0.082%), exposed skin (0.69%), and tape strips 3-20 (0.296%). Based on the results of the human *in vitro* studies, a DAF of 6% is appropriate for the ETU risk assessment for all scenarios and formulations.

4.3 Toxicological Effects

The main targets following exposure to mancozeb and ETU were the thyroid and developing fetus. Given the metabolism of mancozeb to ETU following oral exposure, much of the toxicity observed in the mancozeb database can be attributed to ETU (see Section 4.2). As such, the adverse effects observed across both databases are similar.

In subchronic and chronic oral toxicity studies in which rats and mice were exposed to mancozeb, the main target organ was the thyroid. Progression of toxicity did not occur with increasing duration of exposure. Adverse effects following both exposure durations included alterations in thyroid hormone levels and follicular cell hypertrophy and/or hyperplasia with corresponding increases in organ weights. Decreased T4 and thyroid hyperplasia were also observed following subchronic exposure to rats *via* the inhalation route. Following subchronic exposure to dogs, decreased body weight, food consumption, dehydration, anemia (also observed following chronic exposure), lymphoid depletion of the thymic cortex, elevated cholesterol, and prostate hypogenesis were observed. The database revealed that the rat and dog are more sensitive to mancozeb exposure as compared to the mouse. No systemic toxicity was observed in a rat subchronic dermal study up to the highest dose tested (1000 mg/kg/day).

Following subchronic oral exposure to ETU in guideline rat and dog studies, toxicity to the thyroid manifested as hormone alterations and gross/histopathological changes with corresponding organ weight changes. Adverse effects occurred at similar dose levels as was observed in the subchronic mancozeb studies.

There is also evidence of toxicity to the nervous system following mancozeb exposure. Degeneration of individual sciatic and tibial nerve fibers was observed in the ACN. A non-guideline subchronic neuropathology study also revealed microscopic evidence of peripheral nerve damage to the sciatic, tibial, and sural nerves, and at higher doses, clinical signs related to defective motor function (reluctance to walk). However, neurotoxicity was not observed in a developmental neurotoxicity study. It should be noted that the doses tested in the developmental neurotoxicity study were lower (highest dose tested 30 mg/kg/day) than where adverse effects were observed in the rat subchronic neuropathology study (50/63 mg/kg/day males/females, respectively). In the developmental neurotoxicity study, maternal effects were not observed up to the highest dose tested, while a decrease in pup body weight (↓11-22%) was observed at this dose level.

In a guideline developmental rat study with mancozeb, maternal effects occurred at a lower dose level than fetal effects and included decreased food consumption and body weight. Fetal effects, which occurred at a dose that was lethal to dams, included hydrocephaly, brain atrophy and edema, compressions and hemorrhages of the spinal cord, deficiency of tissue in the olfactory bulb, decreased ossification of the skull, and meningoencephalocele (meninges of the brain protruding through the skull). These observations are known to be caused by a defect in neural tube closure[5]. Defects throughout the skeletal system included curved clavicle, fused sternebrae, absent caudal or sacral vertebrae, fused and/or thickened ribs, wavy ribs, misshapen or incomplete ossification of hindlimb long bones, kyphosis, incomplete ossification or misshapen pelvis. Gross defects included agnathia (small or absent lower jaw), cleft palate, cleft lip, club limb, stubby tail, forelimb flexure, kinked tail, and cryptorchidism.

In the mancozeb guideline rabbit developmental study, late abortions occurred at the same dose as maternal mortality and related clinical signs. Due to the unknown etiology of the abortions, they are considered both a maternal and fetal effect. In a two-generation reproduction study with mancozeb, there were no adverse reproductive or offspring effects up to the highest dose tested (69/79 mg/kg/day; males/females, respectively); parental toxicity included body weight decrements and thyroid toxicity at the highest dose tested.

In an available guideline rabbit developmental toxicity study with ETU, increased resorptions were observed, which is considered both a maternal and developmental effect due to the unknown etiology. At higher doses, hydrocephaly and a domed shaped head was also observed in fetuses. The primary literature also supports the developmental toxicity observed following mancozeb and ETU exposure. Effects on the developing fetus following ETU exposure include, but are not limited to, exencephaly, hydrocephaly, dilated ventricles, a hypoplastic cerebellum, cerebellar dysplasia, cerebral atrophy, and microphthalmia (see Table A.2.4 for more detailed characterization). In many cases, the developmental effects occurred at a lower dose level than maternal toxicity. In addition, there is evidence that postnatal mortality, hydrocephaly, microphthalmia, cerebellar dysplasia, and cerebral atrophy can occur in the developing fetus following a single exposure of ETU to dams on gestation day 15.

An EOGRTS in the rat is available for ETU with the primary toxic effects observed in the thyroid. Parental and offspring toxicity were observed at the same dose level. Parental toxicity included an increased incidence of diffuse follicular cell hypertrophy of the thyroid and hypertrophy of the pars distalis of the pituitary in males. Offspring presented with similar effects which included decreased T4 with a corresponding increase in TSH (PND 4 pups), hypertrophy of the pars distalis of the pituitary in males (PND 90), and diffuse follicular cell hypertrophy of the thyroid in males (PND 90). A dairy cattle feeding study was submitted to support the residue chemistry database (MRID 50771101) and revealed that ETU is capable of partitioning to milk. This data suggests that offspring were exposed both *in utero* and possibly during lactation through maternal milk. No adverse effects on the reproductive system were observed up to the highest dose tested (10 mg/kg/day). A decrease in brain size (weight and macroscopic brain measurements) was observed in PND 78 animals; however, this effect was observed at a dose level 50X higher than where thyroid toxicity was observed. Adverse thyroid effects were also observed in a published reproduction and thyroid toxicity study in rats

[5] https://www.cdc.gov/ncbddd/birthdefects/facts-about-neural-tube-defects.html. Kousa, Y.A. et al. (2019). The TFAP2A-IRF6-GRHL3 genetic pathway is conserved in neurulation. Human Molecular Genetics. 28(10):1726-1737.

(Maranghi, *et al.,* 2013). Histological changes in the thyroid and alterations in thyroid hormone levels were noted in dams and in the offspring of the exposed dams. Dose levels in the EOGRTS (0, 0.2, 2.0, 10 mg/kg/day) and the published literature study (0, 0.1, 0.3, 1.0 mg/kg/day) were similar and provided complementary results for characterization of thyroid toxicity following ETU exposure.

Immunotoxicity studies are available for both mancozeb and ETU. No adverse immunotoxic responses were observed in either study while systemic effects were observed in the mancozeb (increased liver and thyroid weights) and ETU studies (alterations is thyroid hormone levels).

Mancozeb's potential for carcinogenicity (as well as that of the other EBDCs) is assessed by the metabolite, ETU, which is classified as a probable human carcinogen (Group B2), with a cancer potency factor (Q_1^*) of 0.0601 $(mg/kg/day)^{-1}$ for risk assessment based on combined adenomas and/or carcinoma liver tumors in female mice (A. Kocialski, TXR 0057460, 09/26/1991). On this basis, mancozeb cancer risk has been calculated by estimating exposure to mancozeb-derived ETU (including the metabolic conversion) and using the ETU cancer potency factor to provide a quantitative estimate of risk.

Acute lethality studies show that mancozeb is not acutely toxic *via* the oral, dermal, or inhalation routes of exposure (Toxicity Category IV). Mancozeb is not a skin irritant (Toxicity Category IV) nor is it a skin sensitizer although it did cause eye irritation (Toxicity Category III). ETU is not acutely toxic *via* the dermal (Toxicity Category III) or inhalation route (Toxicity Category IV). ETU is not a primary eye or skin irritant (Toxicity Category IV). Neither an acute oral study nor a dermal sensitization study is available for ETU.

4.4 Safety Factor for Infants and Children (FQPA Safety Factor)[6]

The mancozeb risk assessment team recommends that the 10X FQPA SF be retained for the following exposure scenarios: ETU chronic dietary, ETU incidental oral, ETU dermal, and ETU inhalation. The retention of the 10X FQPA SF is to account for a LOAEL to NOAEL extrapolation as the study selected to establish PODs did not identify a NOAEL. For the remaining mancozeb and ETU exposure scenarios, the 10X FQPA SF can be reduced to 1X. For these exposure scenarios, the toxicology database is complete and exposure analyses are unlikely to underestimate the risk of exposure. Although there is evidence of increased susceptibility in the databases, all effects are well-characterized and selected endpoints are protective for the observed effects.

4.4.1 Completeness of the Toxicology Database

The toxicology database is considered complete for evaluating and characterizing toxicity, assessing children's susceptibility under FQPA, and selecting endpoints for pertinent exposure pathways. There are guideline studies for developmental toxicity in rats and rabbits, reproduction toxicity in rats, acute neurotoxicity, subchronic neuropathology, immunotoxicity, and developmental neurotoxicity in rats for mancozeb. The ETU database contains a guideline developmental rabbit study, an EOGRTS in the

[6] HED's standard toxicological, exposure, and risk assessment approaches are consistent with the requirements of EPA's children's environmental health policy (https://www.epa.gov/children/epas-policy-evaluating-risk-children).

rat, an immunotoxicity study, and data from multiple studies in the open literature (Appendix A.3) that characterize the developmental toxicity of this chemical.

4.4.2 Evidence of Neurotoxicity

Neurotoxicity was observed in the mancozeb toxicity database. Degeneration of individual sciatic and tibial nerve fibers was observed in the ACN. Injury to peripheral nerves (demyelination, myelin phagocytosis, Schwann cell proliferation, thickened myelin sheath, intrasheath ellipsoids, neurofibrillary degeneration, and myelin ovoids, bubbles, and debris) was seen microscopically in the rat subchronic neuropathology study with associated clinical signs (abnormal gait and limited use of rear legs) and loss of muscle mass. No neurotoxicity was observed in the mancozeb developmental neurotoxicity study in rats. It should be noted that the doses tested in the developmental neurotoxicity study were lower (highest dose tested 30 mg/kg/day) than where adverse effects were observed in the rat subchronic neuropathology study (50/63 mg/kg/day males/females, respectively). Developmental effects related to the nervous system were observed in fetal rats and included, but were not limited to, hydrocephaly, brain atrophy, compressions and hemorrhages of the spinal cord, meningoencephalocele, cleft palate, and cleft lip (See Section 4.3). All selected endpoints are protective of the neurotoxicity observed across the mancozeb database. The fetal effects occurred at a dose level 17X-102X higher than all selected PODs.

A decrease in brain size (weight and macroscopic brain measurements) was observed in PND 78 animals in the EOGRTS with ETU. Developmental effects were also observed across the ETU database and included hydrocephaly, doomed shaped heads, exencephaly, dilated ventricles, a hypoplastic cerebellum, cerebellar dysplasia, cerebral atrophy, and microphthalmia (see Section 4.3). However, the concern for neurotoxicity is low as the PODs based on thyroid toxicity which occurred at dose levels 50-250X lower as compared to the observed fetal effects and all selected endpoints and PODs are protective of the neurotoxicity observed across the database.

4.4.3 Evidence of Sensitivity/Susceptibility in the Developing or Young Animals

Developmental malformations in the mancozeb rat developmental toxicity study did not indicate susceptibility to offspring as they occurred at the same dose level that caused maternal mortality. There was no indication of enhanced susceptibility to offspring in the mancozeb rabbit developmental study because the abortions occurred at the same dose that also caused maternal mortality. No adverse reproductive or offspring effects were observed in the two-generation reproduction study up to the highest dose tested (69/79 mg/kg/day in males/females, respectively). However, evidence of quantitative susceptibility was noted in the developmental neurotoxicity study with mancozeb, since decreased pup body weight occurred in the absence of maternal toxicity. The concern is low for the quantitative susceptibility as it was observed at dose levels 3-6X higher than the selected mancozeb PODs.

There is evidence of increased susceptibility following *in utero* exposure to ETU in the rat developmental toxicity studies. Several developmental toxicity studies with ETU in the open literature demonstrate qualitative fetal sensitivity and quantitative susceptibility (see Section 4.3). The concern

for the sensitivity and susceptibility is low as the PODs based on thyroid toxicity occurred at dose levels 50-250X lower as compared to the fetal effects in the ETU database and open literature.

4.4.4 Residual Uncertainty in the Exposure Database

There is no residual uncertainty in the exposure database for mancozeb with respect to dietary and residential exposure. The dietary assessments include assumptions that result in high-end estimates of dietary food exposure. Also included in the assessments are modeled drinking water estimates that are designed to be protective of the highest potential residue levels in drinking water from among a range of exposure scenarios. In addition, the residential exposure assessment was conducted based on the Residential Standard Operating Procedures (SOPs) and chemical-specific data such that residential exposure and risk will not be underestimated.

4.5 Toxicity Endpoint and Point of Departure Selections

Toxicity endpoints and points of departure (PODs) for dietary, residential, and occupational exposure scenarios are summarized below and in Table 4.5.3.1 – Table 4.5.3.5. Certain no observed adverse effect levels (NOAELs)/lowest observed adverse effect levels (LOAELs) within the toxicity profile table contain results that are no longer considered adverse based upon current practices (*e.g.* decreased body weight gain in the absence of decreased absolute body weight); however, only study NOAELs/LOAELs that would quantitively impact endpoint selection were updated. In addition, studies conducted with mancozeb utilized ~83% active ingredient rather than the recommended pure technical material. As such, the doses from studies which were selected for mancozeb endpoints/POD were adjusted to reflect 100% active ingredient and the adjusted doses are presented in Tables 4.5.3.1 – Table 4.5.3.5.

Mancozeb

Acute dietary (general population, including infants and children): No hazard or appropriate acute endpoint attributable to a single exposure was identified for the general population, including infants and children, from the available oral toxicity database; therefore, no acute dietary risk assessment is required. At 2000 mg/kg (NOAEL=1000 mg/kg), adverse neuropathology was observed in the ACN. However, these findings were not considered appropriate for the acute dietary endpoint as a single dose of 2000 mg/kg (2 grams) is a highly unlikely exposure scenario. No other appropriate acute endpoint attributable to a single exposure was identified for this population group from the available database.

Acute dietary (females 13-49 years of age): An acute reference dose (aRfD) of 1.54 mg/kg (NOAEL = 154 mg/kg) was derived from the developmental rat study (MRID 00246663) in which resorptions (not identified as early or late), agnathia, cleft palate, cleft lip, meningoencephalocele, ablepharia, exencephaly, dilated ventricles of the brain, and compression and/or hemorrhaging of the spinal cord were observed at 617 mg/kg/day. This study is appropriate to assess acute dietary exposure as the aforementioned effects may be the result of a single exposure. This endpoint is also relevant to females of reproductive age. The total uncertainty factor is 100X (10X to account for interspecies

extrapolation, 10X to account for intra-species variation, and 1X FQPA SF). The aRfD (1.54 mg/kg) is equal to the aPAD (1.54 mg/kg).

Chronic dietary (all populations): The chronic dietary endpoint was derived from the combined chronic toxicity/carcinogenicity study in rats (MRID 41903601) based on decreased T4, increased TSH, enlarged thyroids, increased thyroid weight, and thyroid hypertrophy/hyperplasia (LOAEL= 37 mg/kg/day; NOAEL= 6 mg/kg/day). This study is appropriate to assess the chronic duration of exposure and the population group of concern. This POD is protective of all chronic toxicity in the mouse carcinogenicity and the chronic dog study in addition to the parental toxicity observed in the two-generation reproduction toxicity study. The total uncertainty factor is 30X (3X to account for interspecies extrapolation, 10X to account for intra-species variation, and 1X FQPA SF). The cRfD (0.2 mg/kg/day) is equal to the cPAD (0.2 mg/kg/day).

The interspecies uncertainty factor is reduced from 10X to 3X because of toxicodynamic differences in adult thyroid function that result in greater sensitivity of the adult rat to hypothyroidism compared to adult humans. The 3X toxicodynamics part of the 10X interspecies factor is removed in those assessments that are based on rat thyroid toxicity endpoints, leaving the 3X portion for toxicokinetic interspecies differences. In order to reduce this factor, an understanding of thyroid sensitivity between adult rats and pups is required. In an available open literature study (Tox Sci 120(2). 2011. Axelstad, *et al.*) dams were exposed to mancozeb on GD 7-PND 16. There were no adverse alterations in T4, thyroid weight, or histopathology (only conducted in PND 16 animals) in PND 16 or PND 24 offspring up to the highest dose tested (150 mg/kg/day). Pups were not directly dosed after birth and exposure was only assumed to occur through maternal milk. It should be noted that a mancozeb dairy cattle feeding study (MRID 50771101) was submitted to support the residue chemistry database. Mancozeb residues were not detected in milk; however, ETU residues were. In addition, no sensitivity or susceptibility was observed in the ETU EOGRTS which greater supports the lack of potential sensitivity to thyroid toxicity following mancozeb exposure.

Incidental oral/Adult oral (short and intermediate term durations): The subchronic oral toxicity study in rats (MRID 00160704) was used for the selection of the mancozeb incidental oral/adult oral endpoint and is based on decreased T4 observed in female rats (LOAEL = 20 mg/kg/day; NOAEL = 10 mg/kg/day). This POD is protective of all adverse effects observed in the subchronic mouse, subchronic dog, subchronic neuropathology, DNT, developmental rat, and developmental rabbit studies. The subchronic dog study has a lower NOAEL (3 mg/kg/day) but this is an artifact of the dose selection for this study and the selected POD is protective of the adverse effects observed at 29 mg/kg/day in the subchronic dog study. The LOC = 30 (3X to account for interspecies extrapolation [reduced based on toxicodynamic differences in human vs. rat thyroid function as discussed above], 10X to account for intra-species variation, and 1X FQPA SF).

Dermal (short and intermediate term durations): No systemic toxicity was observed in a dermal toxicity study in rats up to the limit dose (1000 mg/kg/day). All developmental effects observed in the DNT, developmental rat, and developmental rabbit studies, when converted to dermal equivalents using a DAF=1%, would result in dermal doses greater than the limit dose (1500-12,800 mg/kg/day). Therefore, quantification of dermal risk is not required for mancozeb.

Inhalation (short and intermediate term durations): The subchronic inhalation study (MRID 00159471) with mancozeb was used for the selection of the short and intermediate term inhalation endpoint based on decreased T4 and thyroid hyperplasia in females (LOAEC = 0.391 mg/L; NOAEC = 0.095 mg/L). This POD is appropriate for the route and duration of exposure and is protective of all developmental effects observed in the database.

Human-equivalent concentrations (HECs) and doses (HEDs) were calculated using the NOAEC and the regional deposited-dose ratio (RDDR) based on the route-specific study. The RDDR accounts for the particulate diameter [mass median aerodynamic diameter (MMAD) and geometric standard deviation (GSD)] and estimates the different dose fractions deposited along the respiratory tract. The RDDR also accounts for interspecies differences in ventilation and respiratory tract surface areas. For the mancozeb route-specific study, an RDDR was estimated at 2.829 based on the extrarespiratory effects, a MMAD of 3.8 µm, a GSD of 2.1, and the average female SD rat body-weight values[7] of 204 grams. The resulting HECs and HEDs are presented in Table 4.5.3.3. The LOC = 10 [1X to account for interspecies extrapolation (10X reduced to 1X due to the calculation of HECs accounting for *pharmacokinetic interspecies differences* and the *toxicodynamics interspecies differences* in the human vs. rat thyroid function as discussed above), 10X to account for intra-species variation, and 1X FQPA SF].

ETU

Acute dietary (general population, including infants and children): No hazard or appropriate acute endpoint attributable to a single exposure was identified from the available oral toxicity database; therefore, no acute dietary risk assessment is required for the general population, including infants and children.

Acute dietary (females 13-49 years of age): An acute reference dose (aRfD) of 0.05 mg/kg (NOAEL = 5 mg/kg) was derived from the developmental rabbit study (MRID 47976403) in which increased early resorptions were observed at 15 mg/kg/day. This study is appropriate to assess acute dietary exposure as early resorptions may be the result of a single exposure and the endpoint is relevant to females 13+. This POD is protective of all potential acute effects in the ETU database and open literature including the hydrocephaly, brain malformations, and/or cleft palate formation observed in the developmental rat studies (MRID 00093929, MRID 45937601, MRID 45924404, MRID 48985801, MRID 45924405, Ruddick and Khera, and Saillenfait *et al*.). The total uncertainty factor is 100X (10X to account for interspecies extrapolation, 10X to account for intra-species variation, and 1X FQPA SF). The aRfD (0.05 mg/kg) is equal to the aPAD (0.05 mg/kg).

Chronic dietary (all populations): The chronic dietary endpoint was derived from the EOGRTS in rats (MRID 49140301) based on hypertrophy of the pars distalis of the pituitary in males (PND 90), increased TSH and decreased T4 in PND 4 pups, diffuse follicular cell hypertrophy of the thyroid in males (PND 90), and an increased incidence of diffuse follicular cell hypertrophy of the thyroid and hypertrophy of the pars distalis of the pituitary in parental males (LOAEL= 0.2 mg/kg/day; NOAEL not established). This study is appropriate to assess the chronic duration of exposure and the population group of concern. This POD is the most sensitive endpoint in the database and is protective of all developmental and thyroid effects observed within the ETU database and open literature. The total

[7] Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry; Table 4-5.

uncertainty factor is 300X (3X to account for interspecies extrapolation, 10X to account for intra-species variation, and 10X FQPA SF to account for a LOAEL to NOAEL extrapolation). The interspecies uncertainty factor is reduced from 10X to 3X because of toxicodynamic differences in adult thyroid function that result in greater sensitivity of the adult rat to hypothyroidism compared to adult humans. The 3X toxicodynamics part of the 10X interspecies factor is removed in those assessments that are based on rat thyroid toxicity endpoints, leaving the 3X portion for toxicokinetic interspecies differences. The cRfD (0.0007 mg/kg/day) is equal to the cPAD (0.0007 mg/kg/day).

Incidental oral/Adult oral (short and intermediate term durations): The EOGRTS in rats (MRID 49140301) was used for the selection of the ETU incidental oral/adult oral endpoint and is discussed above in detail (LOAEL = 0.2 mg/kg/day; NOAEL not established). This POD is protective of all developmental and thyroid effects observed within the ETU database and open literature. The LOC = 300 (3X to account for interspecies extrapolation, 10X to account for intra-species variation, and 10X FQPA SF).

Dermal (short and intermediate term durations): The EOGRTS in rats (MRID 49140301) was used for the selection of the ETU short and intermediate term dermal endpoint and is discussed above in detail (LOAEL = 0.2 mg/kg/day; NOAEL not established). This POD is protective of all developmental and thyroid effects observed within the ETU database and open literature. The LOC = 300 (3X to account for interspecies extrapolation, 10X to account for intra-species variation, and 10X FQPA SF). DAF=6%.

Inhalation (short and intermediate term durations): The EOGRTS in rats (MRID 49140301) was used for the selection of the ETU short and intermediate term inhalation endpoint and is discussed above in detail (LOAEL = 0.2 mg/kg/day; NOAEL not established). This POD is protective of all developmental and thyroid effects observed within the ETU database and open literature. The LOC = 300 (3X to account for interspecies extrapolation, 10X to account for intra-species variation, and 10X FQPA SF).

4.5.1 Recommendation for Combing Routes of Exposure for Risk Assessment

When there are potential occupational and residential exposures to a pesticide, the risk assessment must address exposures from the three major routes (oral, dermal, and inhalation) and determine whether the individual exposures from these routes can be combined. If two or more exposures have endpoints based on the same target organ or system, then they can be combined. For mancozeb, incidental oral and inhalation exposures can be combined since similar effects (i.e., thyroid toxicity) were the basis for the selected endpoints. For ETU, incidental oral, dermal, and inhalation can be combined since the same target organ (i.e., thyroid) was the basis for the selected endpoints.

4.5.2 Cancer Classification and Risk Assessment Recommendation

Thyroid follicular cell adenomas and carcinomas were increased in high-dose males and females in the combined rat toxicity/carcinogenicity study with mancozeb. Doses in a mouse study were too low to assess carcinogenicity, and there were no treatment-related changes in tumor rates. Mancozeb's potential for carcinogenicity is assessed based on the metabolite, ETU, which is classified as Group B2, with a cancer potency factor [Q_1*, 0.0601 $(mg/kg/day)^{-1}$] for risk assessment based on combined adenomas and/or carcinoma liver tumors in female mice (A. Kocialski, TXR 0057460, 09/26/1991). On

this basis, mancozeb cancer risk has been calculated by estimating exposure to mancozeb-derived ETU (including the metabolic conversion) and using the ETU cancer potency factor to provide a quantitative estimate of risk.

4.5.3 Summary of Points of Departure and Toxicity Endpoints Used in Human Risk Assessment

Table 4.5.3.1. Summary of Toxicological Doses and Endpoints for Mancozeb for Use in Dietary and Non-Occupational Human Health Risk Assessments.

Exposure/ Scenario	POD	Uncertainty/ FQPA Safety Factors	RfD, PAD, Level of Concern for Risk Assessment	Study and Toxicological Effects
Acute Dietary (General Population, including Infants and Children)	No hazard or appropriate acute endpoint attributable to a single exposure was identified from the available oral toxicity database; therefore, no acute dietary risk assessment is required following acute exposure to the general population, including infants and children.			
Acute Dietary (Females 13-49 years of age)	NOAEL = 154 mg/kg	UF_A = 10X UF_H = 10X FQPA SF = 1X	Acute RfD = 1.54 mg/kg aPAD = 1.54 mg/kg	Developmental Rat (MRID 00246663) LOAEL = 617 mg/kg based on resorptions, agnathia, cleft palate, cleft lip, meningoencephalocele, ablepharia, exencephaly, dilated ventricles of the brain, compression and/or hemorrhaging of the spinal cord
Chronic Dietary (All Populations)	NOAEL = 6 mg/kg/day	UF_A = 3X* UF_H = 10X FQPA SF = 1X	Chronic RfD = 0.2 mg/kg/day cPAD = 0.2 mg/kg/day	Combined Chronic/Carcinogenicity in Rats (MRID 49140301) LOAEL = 37 mg/kg/day based on decreased T4, increased TSH, enlarged thyroids, increased thyroid weight, and thyroid hypertrophy/hyperplasia
Incidental Oral/Adult Oral Short (1-30 days) and Intermediate-Term (1-6 months)	NOAEL = 10 mg/kg/day	UF_A = 3X* UF_H = 10X FQPA SF = 1X	Residential LOC for MOE = 30	Subchronic Oral in Rats (MRID 00160704) LOAEL = 20 mg/kg/day based on decreased T4 in females
Dermal Short (1-30 days) and Intermediate-Term (1-6 months)	No systemic toxicity was observed in a dermal toxicity study in rats up to the limit dose (1000 mg/kg/day). All developmental effects observed in the DNT, developmental rat, and developmental rabbit studies, when converted to dermal equivalents using a DAF=1%, would results in dermal doses greater than the limit dose (1500-12,800 mg/kg/day). Therefore, quantification of dermal risks is not required for mancozeb.			
Inhalation Short (1-30 days) and Intermediate-Term (1-6 months)	NOAEC=0.095 mg/L See Table 4.5.3.3 for HEC/HED calculations	UF_A = 1X** UF_H = 10X FQPA SF = 1X	Residential LOC for MOE = 10	Subchronic Inhalation in Rats (MRID 00159471) LOAEC =0.391 mg/L based on decreased T4 and thyroid hyperplasia in females
Cancer (oral, dermal, inhalation)	Due to the *in vivo* metabolism of mancozeb to ETU, cancer exposure to mancozeb will be assessed using the ETU cancer classification. ETU Classification: ETU is classified as a **Group B2** carcinogen with a linear low-dose extrapolation approach for human risk assessment based on liver tumors in female mice. Q1* = 6.01 $x10^{-2}$ $(mg/kg/day)^{-1}$			

Point of departure (POD) = A data point or an estimated point that is derived from observed dose-response data and used to mark the beginning of extrapolation to determine risk associated with lower environmentally relevant human exposures. NOAEL = no-observed adverse-effect level. LOAEL = lowest-observed adverse-effect level. NOAEC = no-observed adverse-effect concentration. LOAEC = lowest-observed adverse-effect concentration. UF = uncertainty factor. UF_A = extrapolation from animal to human (interspecies). UF_H = potential variation in sensitivity among members of the human population (intraspecies). FQPA SF = FQPA Safety Factor. PAD = population-adjusted dose (a = acute, c = chronic). RfD = reference dose. MOE = margin of exposure. LOC = level of concern. N/A = not applicable.

* The interspecies uncertainty factor is reduced from 10X to 3X because of toxicodynamic differences in adult thyroid function that result in greater sensitivity of the adult rat to hypothyroidism compared to adult humans. The 3X toxicodynamics part of the 10X interspecies factor is removed in those assessments that are based on rat thyroid toxicity endpoints, leaving the 3X portion for toxicokinetic interspecies differences.

** 10X reduced to 1X due to the calculation of HECs accounting for *pharmacokinetic interspecies differences* and the *toxicodynamics interspecies differences* in the human vs. rat thyroid function

Table 4.5.3.2 Summary of Toxicological Doses and Endpoints for Mancozeb for Use in Occupational Human Health Risk Assessments.

Exposure/ Scenario	POD	Uncertainty Factors	Level of Concern for Risk Assessment	Study and Toxicological Effects
Dermal Short (1-30 days) and Intermediate-Term (1-6 months)	No systemic toxicity was observed in a dermal toxicity study in rats up to the limit dose (1000 mg/kg/day). All developmental effects observed in the DNT, developmental rat, and developmental rabbit studies, when converted to dermal equivalents using a DAF=1%, would results in dermal doses greater than the limit dose (1500-12,800 mg/kg/day)			
Inhalation Short (1-30 days) and Intermediate-Term (1-6 months)	NOAEC=0.095 mg/L See Table 4.5.3.3 for HEC/HED calculations	UF_A = 1X** UF_H = 10X	Occupational LOC for MOE = 10	Subchronic Inhalation in Rats (MRID 00159471) LOAEC =0.391 mg/L based on decreased T4 and thyroid hyperplasia in females
Cancer (oral, dermal, inhalation)	Due to the *in vivo* metabolism of mancozeb to ETU, cancer exposure to mancozeb will be assessed using the ETU cancer classification. ETU Classification: ETU is classified as a **Group B2** carcinogen with a linear low-dose extrapolation approach for human risk assessment based on liver tumors in female mice. Q1* = 6.01 $x10^{-2}$ $(mg/kg/day)^{-1}$			

Point of departure (POD) = A data point or an estimated point that is derived from observed dose-response data and used to mark the beginning of extrapolation to determine risk associated with lower environmentally relevant human exposures. NOAEL = no-observed adverse-effect level. LOAEL = lowest-observed adverse-effect level. NOAEC = no-observed adverse-effect concentration. LOAEC = lowest-observed adverse-effect concentration. UF = uncertainty factor. UF_A = extrapolation from animal to human (interspecies). UF_H = potential variation in sensitivity among members of the human population (intraspecies). MOE = margin of exposure. LOC = level of concern. N/A = not applicable.

** 10X reduced to 1X due to the calculation of HECs accounting for *pharmacokinetic interspecies differences* and the *toxicodynamics interspecies differences* in the human vs. rat thyroid function

Table 4.5.3.3 Summary of HEC/HED values for Mancozeb*

Population	Scenario	Toxicity Duration Adjustment[a]		HEC[b]		HED (mg/kg/day)[c]
		Daily	Weekly	mg/L	mg/m^3	
Occupational	Handler	0.75	1	0.202	201.57	19.07
Residential	Handler	NA	NA	0.269	268.76	6.36
	Outdoor post-application	NA	NA	0.269	268.76	7.31
	Indoor post-application	NA	0.714	0.192	191.97	4.54
	Bystander	0.25	0.714	0.048	47.99	NA

* The inhalation values have been calculated based on the 2018 revised spreadsheets. The HED calculation has been revised to be based on the same breathing rate used to derive the HEC – resulting in a single HED as the toxicological point of departure. In terms of risk estimates, the effect of this error correction is not unidirectional – some previously-calculated risks will be higher, while some will be lower.

NA = not applicable (the expected duration of the exposure scenario is less than the duration in the available inhalation toxicity studies; downward adjustments are not permitted).

[a] Toxicity duration adjustment from 6 hours/day, 5 days/week in the route-specific inhalation study.

[b] HEC =human-equivalent concentration; HEC = rat POD x daily duration adjustment x weekly daily duration adjustment x RDDR.

[c] HED = human-equivalent dose; HED = HEC (mg/L) x human specific conversion factor (11.8 L/hr-kg) x respiratory tract to oral absorption ratio (1) x duration of daily exposure for activity (occupational handler = 8 hrs/day, residential handler and indoor post-application = 2 hrs/day, residential outdoor post-application = 2.3 hrs/day).

Table 4.5.3.4 Summary of Toxicological Doses and Endpoints for ETU for Use in Dietary and Non-Occupational Human Health Risk Assessments.

Exposure/ Scenario	POD	Uncertainty/ FQPA Safety Factors	RfD, PAD, Level of Concern for Risk Assessment	Study and Toxicological Effects
Acute Dietary (General Population, including Infants and Children)	No hazard or appropriate acute endpoint attributable to a single exposure was identified from the available oral toxicity database; therefore, no acute dietary risk assessment is required following acute exposure to the general population, including infants and children.			
Acute Dietary (Females 13-49 years of age)	NOAEL = 5 mg/kg	UF_A = 10X UF_H = 10X FQPA SF = 1X	Acute RfD = 0.05 mg/kg aPAD = 0.05 mg/kg	Developmental Rabbit (MRID 47976403) LOAEL = 15 mg/kg based on increased early resorptions
Chronic Dietary (All Populations)	LOAEL = 0.2 mg/kg/day	UF_A = 3X* UF_H = 10X FQPA SF = 10X	Chronic RfD = 0.0007 mg/kg/day cPAD = 0.0007 mg/kg/day	EOGRTS in Rats (MRID 49140301) LOAEL = 0.2 mg/kg/day based on hypertrophy of the pars distalis of the pituitary in males (PND 90), increased TSH in both sexes and decreases in T4 in PND 4 pups, diffuse follicular cell hypertrophy of the thyroid in males (PND 90), and increased incidence of diffuse follicular cell hypertrophy of the thyroid and hypertrophy of the pars distalis of the pituitary in parental males
Incidental Oral/Adult Oral Short (1-30 days) and Intermediate-Term (1-6 months)	LOAEL = 0.2 mg/kg/day	UF_A = 3X* UF_H = 10X FQPA SF = 10X	Residential LOC for MOE = 300	EOGRTS in Rats (MRID 49140301) LOAEL = 0.2 mg/kg/day based on hypertrophy of the pars distalis of the pituitary in males (PND 90), increased TSH in both sexes and decreases in T4 in PND 4 pups, and diffuse follicular cell hypertrophy of the thyroid in males (PND 90), and increased incidence of diffuse follicular cell hypertrophy of the thyroid and hypertrophy of the pars distalis of the pituitary in parental males

Table 4.5.3.4 Summary of Toxicological Doses and Endpoints for ETU for Use in Dietary and Non-Occupational Human Health Risk Assessments.

Exposure/ Scenario	POD	Uncertainty/ FQPA Safety Factors	RfD, PAD, Level of Concern for Risk Assessment	Study and Toxicological Effects
Dermal Short (1-30 days) and Intermediate-Term (1-6 months)	LOAEL = 0.2 mg/kg/day DAF = 6%	UF_A = 3X* UF_H = 10X FQPA SF = 10X	Residential LOC for MOE = 300	EOGRTS in Rats (MRID 49140301) LOAEL = 0.2 mg/kg/day based on hypertrophy of the pars distalis of the pituitary in males (PND 90), increased TSH in both sexes and decreases in T4 in PND 4 pups, and diffuse follicular cell hypertrophy of the thyroid in males (PND 90), and increased incidence of diffuse follicular cell hypertrophy of the thyroid and hypertrophy of the pars distalis of the pituitary in parental males
Inhalation Short (1-30 days) and Intermediate-Term (1-6 months)	LOAEL = 0.2 mg/kg/day	UF_A = 3X* UF_H = 10X FQPA SF = 10X	Residential LOC for MOE = 300	EOGRTS in Rats (MRID 49140301) LOAEL = 0.2 mg/kg/day based on hypertrophy of the pars distalis of the pituitary in males (PND 90), increased TSH in both sexes and decreases in T4 in PND 4 pups, and diffuse follicular cell hypertrophy of the thyroid in males (PND 90), and increased incidence of diffuse follicular cell hypertrophy of the thyroid and hypertrophy of the pars distalis of the pituitary in parental males
Cancer (oral, dermal, inhalation)	Classification: ETU is classified as a **Group B2** carcinogen with a linear low-dose extrapolation approach for human risk assessment based on liver tumors in female mice. $Q1^* = 6.01 \times 10^{-2}$ $(mg/kg/day)^{-1}$			

Point of departure (POD) = A data point or an estimated point that is derived from observed dose-response data and used to mark the beginning of extrapolation to determine risk associated with lower environmentally relevant human exposures. NOAEL = no-observed adverse-effect level. LOAEL = lowest-observed adverse-effect level. UF = uncertainty factor. UF_A = extrapolation from animal to human (interspecies). UF_H = potential variation in sensitivity among members of the human population (intraspecies). FQPA SF = FQPA Safety Factor. PAD = population-adjusted dose (a = acute, c = chronic). RfD = reference dose. MOE = margin of exposure. LOC = level of concern. N/A = not applicable.

* The interspecies uncertainty factor is reduced from 10X to 3X because of toxicodynamic differences in adult thyroid function that result in greater sensitivity of the adult rat to hypothyroidism compared to adult humans. The 3X toxicodynamics part of the 10X interspecies factor is removed in those assessments that are based on rat thyroid toxicity endpoints, leaving the 3X portion for toxicokinetic interspecies differences.

Table 4.5.3.5 Summary of Toxicological Doses and Endpoints for ETU for Use in Occupational Human Health Risk Assessments.				
Exposure/ Scenario	**POD**	**Uncertainty Factors**	**Level of Concern for Risk Assessment**	**Study and Toxicological Effects**
Dermal Short (1-30 days) and Intermediate-Term (1-6 months)	LOAEL = 0.2 mg/kg/day DAF = 6%	UF_A = 3X* UF_H = 10X UF_L = 10X	Occupational LOC for MOE = 300	EOGRTS in Rats (MRID 49140301) LOAEL = 0.2 mg/kg/day based on hypertrophy of the pars distalis of the pituitary in males (PND 90), increased TSH in both sexes and decreases in T4 in PND 4 pups, and diffuse follicular cell hypertrophy of the thyroid in males (PND 90), and increased incidence of diffuse follicular cell hypertrophy of the thyroid and hypertrophy of the pars distalis of the pituitary in parental males
Inhalation Short (1-30 days) and Intermediate-Term (1-6 months)	LOAEL = 0.2 mg/kg/day	UF_A = 3X* UF_H = 10X UF_L = 10X	Occupational LOC for MOE = 300	EOGRTS in Rats (MRID 49140301) LOAEL = 0.2 mg/kg/day based on hypertrophy of the pars distalis of the pituitary in males (PND 90), increased TSH in both sexes and decreases in T4 in PND 4 pups, and diffuse follicular cell hypertrophy of the thyroid in males (PND 90), and increased incidence of diffuse follicular cell hypertrophy of the thyroid and hypertrophy of the pars distalis of the pituitary in parental males
Cancer (oral, dermal, inhalation)	Classification: ETU is classified as a **Group B2** carcinogen with a linear low-dose extrapolation approach for human risk assessment based on liver tumors in female mice. Q1* = 6.01 $x10^{-2}$ $(mg/kg/day)^{-1}$			

Point of departure (POD) = A data point or an estimated point that is derived from observed dose-response data and used to mark the beginning of extrapolation to determine risk associated with lower environmentally relevant human exposures. NOAEL = no-observed adverse-effect level. LOAEL = lowest-observed adverse-effect level. UF = uncertainty factor. UF_A = extrapolation from animal to human (interspecies). UF_H = potential variation in sensitivity among members of the human population (intraspecies). UF_L = use of a LOAEL to extrapolate a NOAEL. MOE = margin of exposure. LOC = level of concern. N/A = not applicable.

* The interspecies uncertainty factor is reduced from 10X to 3X because of toxicodynamic differences in adult thyroid function that result in greater sensitivity of the adult rat to hypothyroidism compared to adult humans. The 3X toxicodynamics part of the 10X interspecies factor is removed in those assessments that are based on rat thyroid toxicity endpoints, leaving the 3X portion for toxicokinetic interspecies differences.

4.6 Endocrine Disruptor Screening Program

As required by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Federal Food, Drug, and Cosmetic Act (FFDCA), EPA reviews numerous studies to assess potential adverse outcomes from exposure to chemicals. Collectively, these studies include acute, subchronic and chronic toxicity, including assessments of carcinogenicity, neurotoxicity, developmental, reproduction, and general or systemic toxicity. These studies include endpoints which may be susceptible to endocrine influence, including effects on endocrine target organ histopathology, organ weights, estrus cyclicity, sexual maturation, fertility, pregnancy rates, reproductive loss, and sex ratios in offspring. For ecological hazard assessments, EPA evaluates acute tests and chronic studies that assess growth, developmental and reproductive effects in different taxonomic groups. As part of its reregistration decision for

mancozeb, EPA reviewed these data and selected the most sensitive endpoints for relevant risk assessment scenarios from the existing hazard database. However, as required by FFDCA section 408(p), mancozeb and ETU are subject to the endocrine screening part of the Endocrine Disruptor Screening Program (EDSP).

EPA has developed the EDSP to determine whether certain substances (including pesticide active and other ingredients) may have an effect in humans or wildlife similar to an effect produced by a "naturally occurring estrogen, or other such endocrine effects as the Administrator may designate." The EDSP employs a two-tiered approach to making the statutorily required determinations. Tier 1 consists of a battery of 11 screening assays to identify the potential of a chemical substance to interact with the estrogen, androgen, or thyroid (E, A, or T) hormonal systems. Chemicals that go through Tier 1 screening and are found to have the potential to interact with E, A, or T hormonal systems will proceed to the next stage of the EDSP where EPA will determine which, if any, of the Tier 2 tests are necessary based on the available data. Tier 2 testing is designed to identify any adverse endocrine-related effects caused by the substance and establish a dose-response relationship between the dose and the E, A, or T effect.

Under FFDCA section 408(p), the Agency must screen all pesticide chemicals. Between October 2009 and February 2010, EPA issued test orders/data call-ins for the first group of 67 chemicals, which contains 58 pesticide active ingredients and 9 inert ingredients. A second list of chemicals identified for EDSP screening was published on June 14, 2013[8] and includes some pesticides scheduled for registration review and chemicals found in water. Neither of these lists should be construed as a list of known or likely endocrine disruptors. For further information on the status of the EDSP, the policies and procedures, the lists of chemicals, future lists, the test guidelines and the Tier 1 screening battery, please visit our website.[9]

5.0 Dietary Exposure and Risk Assessment

5.1 Residues of Concern Summary and Rationale

The residues of concern for risk assessment and the residues to be included in the tolerance expression for mancozeb are summarized in the table below. For plants, the tolerance expression for mancozeb includes parent mancozeb, measured as CS_2. For risk assessment, however, both parent mancozeb and ETU residues must be considered for plant-based commodities. In drinking water, the residue of concern for risk assessment is the degradate ETU.

Previously, for livestock (ruminants), the residue of concern for tolerance enforcement was parent mancozeb and the residue of concern for risk assessment was mancozeb and ETU.
However, based on the results of a recently submitted dairy cattle feeding study (MRID 50771101), the residues of concern for ruminants has been updated. The residue of concern for both tolerance enforcement and risk assessment of ruminant commodities is now ETU as there are no residues of parent mancozeb found in the tissues or milk of cattle.

[8] See https://www.regulations.gov/document?D=EPA-HQ-OPPT-2009-0477-0074 for the final second list of chemicals.
[9] https://www.epa.gov/endocrine-disruption

Table 5.1 Summary of Metabolites and Degradates to be included in the Risk Assessment and Tolerance Expression			
Matrix		Residues included in Risk Assessment	Residues included in Tolerance Expression
Plants	Primary Crop	Mancozeb & ETU	Mancozeb, measured as CS_2
	Rotational Crops	No data are available. Identified as a data gap in the RED.[1]	
Livestock	Ruminant	ETU	ETU
Drinking Water		ETU	Not Applicable

[1] A confined rotational crop study required by the 2005 mancozeb reregistration eligibility decision has not been satisfied as the newly submitted study (MRID 50940201) has been concluded to be inadequate; therefore, this data requirement remains outstanding.

5.2 Food Residue Profile

Field trial data show residues are generally quantifiable in crops and tend to decline with increasing pre-harvest intervals (PHIs). Adequate analytical methods are available to enforce all recommended tolerances for crop and livestock commodities. Although mancozeb is a longstanding chemical supported by numerous studies, its residue chemistry database is incomplete. The following residue studies were provided to satisfy outstanding data requirements: crop field trials for safflower (MRID 50590001) and tobacco (MRID 50646701); processing studies for barley (MRID 50585601), oats (MRID 50624401), potatoes (MRID 50646702) and wheat (MRID 50709801); a ruminant feeding study (MRID 50771101); and a confined rotational crop study (MRID 50940201). The studies for safflower and confined rotational crops are concluded to be inadequate because the rates used for study were too low. The tobacco field trials may be adequate if the rate used in the study is found to be comparable to the maximum seasonal rate of application which requires clarification. The new processing studies are adequate in showing that residues do not concentrate in any processed fractions of barley, oats, potatoes, and wheat. The new ruminant feeding study showed that no quantifiable residues of parent mancozeb are expected in the tissues and milk of cattle. However, residues of ETU are expected in milk and edible tissues of ruminants. Poultry and swine commodities all fall under category 3 of 40 CFR 180.6(a), no expectation of finite residues. Because an acceptable confined rotational crop study remains outstanding, only registered crops may be grown in rotation until realistic plant-back and rotational crop restrictions can be established.

5.3 Water Residue Profile

The Environmental Fate and Effect Division (EFED) has provided a drinking water assessment to support the registration review of mancozeb (M. Ruhman, D459932, 12/10/2020). ETU is highly water soluble and may reach both surface and ground water under some conditions and is the residue of concern for drinking water dietary assessment. ETU surface water EDWCs provided by EFED were based on Pesticide in Water Calculator (PWC version 1.52) modeling (based on mancozeb turf use) or available monitoring data. The acute surface water EDWCs range from 0.1 ppb from monitoring data to 75.9 ppb as a model output. The cancer surface water EDWC is 0.1 ppb based on monitoring data. The non-cancer chronic surface water EDWC is 6.71 ppb based on modeling.

For ETU in ground water, the acute EDWC of 3.63 ppb is based on the PWC model (based on mancozeb

turf use). For both non-cancer chronic and cancer, the ground water EDWC of 0.21 ppb is based on monitoring data.

The highest, most protective EDWCs were selected for use in the dietary assessments and were included as point estimates in the dietary analyses. The EDWC of 75.9 ppb (modeling) was used for acute dietary assessments. The EDWC of 6.71 ppb (modeling) was used in the chronic dietary assessment. The EDWC of 0.21 ppb (monitoring) was used in the cancer dietary assessments.

ETU estimated drinking water concentrations provided by EFED are summarized below.

Table 5.3. EDWCs of ETU From the Pesticide Use of Mancozeb.

Water Source	*Acute (1-d Average) (µg/L)*	*Non-cancer chronic (1-10-year Average)*	*Cancer chronic*
Surface Water	A range from **0.1 (monitoring)**[1] to **75.9 (modeling)**[2]	**6.71 (modeling)**[2]	0.1 (monitoring)
Ground Water[3]	3.63 (modeling)[3]	**0.21 (monitoring)**[1]	

[1] Two-year surface and ground water targeted monitoring.

[2] Surface water acute and non-cancer values from use on turf (FLturf scenario)

[3] Ground water acute value from modeling use on turf (FL-central ridge scenario)

EFED-Recommended values are **bolded**

5.4 Dietary Risk Assessment

5.4.1 Description of Residue Data Used in Dietary Assessment

Acute, chronic, and/or cancer dietary (food and drinking water) exposure and risk assessments were conducted for mancozeb, ETU from mancozeb, and ETU from combined EBDC uses (mancozeb and metiram). The assessments used the Dietary Exposure Evaluation Model software with the Food Commodity Intake Database (DEEM-FCID) Version 4.02. This software uses 2005-2010 food consumption data from the U.S. Department of Agriculture's (USDA's) National Health and Nutrition Examination Survey, What We Eat in America, (NHANES/WWEIA).

For mancozeb and ETU from mancozeb, field trial data were used along with monitoring data for several commodities (EBDC/ETU Market Basket Survey). For ETU from metiram, field trial data for imported bananas and imported grape, wine (the only relevant metiram tolerances) were used. For ETU from combined EBDCs (mancozeb and metiram), the applicable residue inputs (bananas and grape wine) were combined based on a representative proportion of these data [weighted using Biological and Economic Analysis Division (BEAD) estimated %CT data (Section 5.4.2)]. Using the BEAD import consumption share data, the ETU residue input value used for the acute, chronic, and cancer dietary analyses was combined assuming 85% of bananas are treated with mancozeb and 15% are treated with metiram (100%CT total). For grape wine, the ETU residue input for the acute dietary analysis was combined using the BEAD estimates of 20% maximum %CT for mancozeb and 35% maximum import

consumption share for metiram (55%CT total). For the chronic and cancer dietary analyses, the ETU residue input for grape wine was combined using the BEAD estimates of 10% average %CT for mancozeb and 30% average import consumption share for metiram (40%CT total). Default processing factors were not used as empirical processing and cooking factors determined from extensive studies conducted with mancozeb and the other EBDCs were utilized. Maximum (for acute) or average (for chronic and cancer) percent crop treated (%CT) estimates were incorporated where available.

The dietary analyses performed for mancozeb were for food only exposure since mancozeb is known to degrade quickly in the environment and is not expected to reach drinking water sources. The dietary analyses performed for ETU were for both food and drinking water exposures. Total ETU residues for dietary food exposure consist of ETU found in food commodities plus the metabolic ETU formed as a result of consuming parent EBDC. EBDCs may also be converted to ETU during processing, usually when the process involves heating. See Attachment 2 of D467014 (D. Nadrchal, 02/10/2023) for calculations used for conversion of EBDCs to ETU through metabolism and food processing. The Environmental Fate and Effects Division (EFED) provided EDWCs for ETU based on modeling (acute and chronic) or monitoring data (cancer) (Table 5.3).

5.4.2 Percent Crop Treated Used in Dietary Assessment

Mancozeb: BEAD provided initial %CT estimates for mancozeb (Mancozeb Screening Level Usage Analysis (SLUA), 10/05/2020). Additional %CT data for barley, Chinese broccoli, Chinese cabbage, pop corn, cranberries, flax, grape juice, oats, rice, sorghum, and triticale were also provided by BEAD (Mancozeb Screening Level Usage Analysis (SLUA) and Percent Crop Treated for Additional Uses, 10/2020). A percent import consumption value of 25% for tangerines was also provided by BEAD (EBDC Dietary Assessment: Analysis of Import Share of U.S. Consumption for Tangerines/Mandarin Oranges, 10/14/2020). An import share of consumption of bananas and grape wine (bottled) in the U.S. was also determined by BEAD (Mancozeb/Metiram Dietary Assessment: Import Share of U.S. Consumption of Bananas and Wine (grapes), 12/02/2020). BEAD determined that the import share of U.S. bananas projected to be treated with metiram previously noted by the registrant at 15% is still reliable. For grape wine (bottled), BEAD determined that the average import share of consumption is 30% with a maximum import share of wine (grape) consumption of 35%.

Using this information, the following maximum %CT estimates for mancozeb were used to refine the acute dietary risk assessments of mancozeb and ETU for the following crops: almonds: 2.5%; apples: 50%; asparagus: 25%; barley: 2.5%; broccoli: 15%; broccoli, Chinese: 25%; cabbage: 25%; cabbage, Chinese: 25%; cantaloupes: 15%; carrots: 5%; corn: 2.5%; corn, pop: 2.5%, cranberries: 20%; cucumbers: 45%; flax: 2.5%; garlic: 60%; grapes, juice: 40%; grapes, raisin: 10%, grapes, table: 40%; grapes, wine: 20%; honeydew: 2.5%; lettuce, head: 70%; lettuce, leaf: 70%; oats: 2.5%; onions: 75%; peanuts: 2.5%; pears: 70%; peppers, bell: 40%; peppers, non-bell: 40%; potatoes: 60%; pumpkins: 20%; rice: 2.5%; sorghum: 5%; squash, summer: 35%; squash, winter: 35%; sugar beets: 30%; sweet corn: 15%; tomatoes: 40%; triticale: 2.5%; walnuts: 65%; watermelons: 60%; and wheat: 2.5%.

The following average %CT estimates for mancozeb were used to refine the chronic and cancer dietary risk assessments of mancozeb and ETU for the following crops: almonds: 1%; apples: 45%; asparagus: 15%; barley: 2.5%; broccoli: 5%; broccoli, Chinese: 15%; cabbage: 15%; cabbage, Chinese: 15%;

cantaloupes: 10%; carrots: 1%; corn: 1%; corn, pop: 1%; cranberries: 20%; cucumbers: 35%; flax: 2.5%; garlic: 20%; grapes, juice: 15%; grapes, raisin: 5%; grapes, table: 15%; grapes, wine: 10%; honeydew: 1%, lettuce, head: 60%; lettuce, leaf: 60%; oats: 2.5%; onions: 65%; peanuts: 1%; pears: 60%; peppers, bell: 25%; peppers, non-bell: 25%; potatoes: 50%; pumpkins: 15%; rice: 2.5%; sorghum: 5%; squash, summer: 25%; squash, winter: 25%; sugar beets: 10%; sweet corn: 10%; tomatoes: 20%; triticale: 1%; walnuts: 55%; watermelons: 50%; and wheat: 1%.

For all livestock and game commodities, the highest %CT estimate for the feed items in the re-calculation of livestock dietary burden was used for the refinement of meat and milk (sweet corn; 10%CT avg./15%CT max.). 100%CT assumption is used for all other registered crop uses of mancozeb.

Metiram: There are no registered uses of metiram in the U.S. However, U.S. tolerances are established for residues of metiram in bananas and grape, wine. 100%CT assumption is used for these commodities.

5.4.3 Acute and Chronic Dietary Risk Assessment for Mancozeb

Acute and Chronic Dietary (food only) Exposure and Risk Results for Mancozeb

For mancozeb, the acute and chronic dietary (food only: mancozeb is not expected in drinking water) risk estimates are below the level of concern for the general U.S. population and all population subgroups (< 100% of the aPAD or cPAD). The acute dietary risk for females 13-49 years old (the only population subgroup for which an acute endpoint is selected) is <1% of the aPAD (at the 99.9th percentile). The chronic dietary risk estimate for the general U.S. population and all population subgroups, including infants and children, is <1% of the cPAD. The population subgroup with the highest chronic risk estimate from mancozeb is children 1-2 years old at <1% of the cPAD with an exposure of 0.000293 mg/kg/day.

Table 5.4.3. Dietary Exposure and Risk Estimates of Food Only Determined for the Registered Uses of Mancozeb.

Population Subgroup	Acute Assessment (99.9th Percentile)			Chronic Assessment		
	aPAD, mg/kg/day	Exposure Estimate, mg/kg/day	% aPAD	cPAD, mg/kg/day	Exposure Estimate, mg/kg/day	% cPAD
U.S. Population				0.20	0.000098	<1%
All infants				0.20	0.000096	<1%
Children 1-2 yrs*				0.20	**0.000310**	**<1%**
Children 3-5 yrs				0.20	0.000256	<1%
Children 6-12 yrs				0.20	0.000115	<1%
Youth 13-19 yrs				0.20	0.000052	<1%
Adults 20-49 yrs				0.20	0.000082	<1%
Adults 50-99 yrs				0.20	0.000090	<1%
Females 13-49 yrs	1.54	0.012131	<1%	0.20	0.000090	<1%

Bolded is most highly exposed population subgroup.

5.4.4 Acute, Chronic, and Cancer Dietary Risk Assessment for ETU from Mancozeb

Acute and Chronic Dietary (food and drinking water) Exposure and Risk Results for ETU from the Registered Uses of Mancozeb

The acute dietary (food and drinking water) risk estimates for ETU from mancozeb uses are below the level of concern (< 100% of the aPAD). The acute dietary risk for females 13-49 years old (the only population subgroup for which an acute endpoint is selected) is 18% of the aPAD (at the 99.9th percentile).

The chronic dietary (food and drinking water) risk estimates for ETU from mancozeb uses are not of concern for the general U.S. population and all population subgroups (< 100% of the cPAD). The population subgroup with the highest chronic dietary risk estimate for ETU from mancozeb is all infants at 77% of the cPAD with an exposure of 0.000539 mg/kg/day. Drinking water is the major contributer to the chronic dietary exposure. When drinking water is removed, the chronic dietary risk estimate (food only) for infants is 4.7 % of the cPAD.

Table 5.4.4.1. Dietary Exposure and Risk Estimates of Food and Drinking Water Determined for ETU from the Registered Uses of Mancozeb.

Population Subgroup	Acute Assessment (99.9th Percentile Food & Water)			Chronic Assessment (Food & Water)			Chronic Assessment (Food only)	
	aPAD, mg/kg/day	Exposure Estimate, mg/kg/day	% aPAD	cPAD, mg/kg/day	Exposure Estimate, mg/kg/day	% cPAD	Exposure Estimate, mg/kg/day	% cPAD
U.S. Population				0.0007	0.000159	23	0.000023	3.3
All infants*				0.0007	**0.000539**	**77**	0.000033	4.7
Children 1-2 yrs				0.0007	0.000262	38	0.000076	11
Children 3-5 yrs				0.0007	0.000209	30	0.000057	8.2
Children 6-12 yrs				0.0007	0.000140	20	0.000027	3.9
Youth 13-19 yrs				0.0007	0.000111	16	0.000015	2.1
Adults 20-49 yrs				0.0007	0.000155	22	0.000020	2.9
Adults 50-99 yrs				0.0007	0.000150	22	0.000019	2.8
Females 13-49 yrs	0.05	0.008741	18	0.0007	0.000153	22	0.000020	2.9

Bolded is most highly exposed population subgroup

Cancer Dietary (food and drinking water) Exposure and Risk for ETU from the Registered Uses of Mancozeb

The cancer dietary (food and drinking water) assessment for ETU from mancozeb uses results in a risk estimate of 1 x 10^{-6}.

Table 5.4.4.2. Cancer Dietary Exposure and Risk Results for ETU from the Registered Uses of Mancozeb.

Population Subgroup	Exposure (mg/kg/day)	Estimated Cancer Risk
Adults 20-49 years old – Food and Water	0.000024	1 x 10^{-6}
Adults 20-49 years old – Food Only	0.000020	1 x 10^{-6}

Cancer Risk = (Q_1*) (Food Exposure).
Q_1* = 0.0601 $(mg/kg/day)^{-1}$

5.4.5 Acute, Chronic, and Cancer Dietary Risk Assessment for ETU from Combined EBDC Uses (Mancozeb and Metiram)

Acute and Chronic Dietary (food and drinking water) Exposure and Risk Results for ETU from the Combined Uses of Mancozeb and Metiram

The acute dietary risk estimates for ETU from both mancozeb (food and drinking water) and metiram (food only) are not of concern (< 100% of the aPAD). The acute dietary risk for females 13-49 years old (the only population subgroup for which an acute endpoint is selected) is 18% of the aPAD (at the 99.9th percentile).

The chronic dietary risk estimates for ETU from both mancozeb (food and drinking water) and metiram (food only) are not of concern for the general U.S. population and all population subgroups (< 100% of the cPAD). The population subgroup with the highest chronic dietary risk estimate for ETU from mancozeb and metiram uses is all infants at 77% of the cPAD with an exposure of 0.000540 mg/kg/day. Drinking water is the major contributer to the chronic dietary exposure. When drinking water is removed, the chronic dietary risk estimate (food only) for infants is 4.8% of the cPAD.

Table 5.4.5.1. Dietary Exposure and Risk Estimates of Food and Drinking Water Determined for ETU from the Combined Uses of Mancozeb and Metiram.

Population Subgroup	Acute Assessment (99.9th Percentile Food & Water)			Chronic Assessment (Food & Water)			Chronic Assessment (Food only)	
	aPAD, mg/kg/day	Exposure Estimate, mg/kg/day	% aPAD	cPAD, mg/kg/day	Exposure Estimate, mg/kg/day	% cPAD	Exposure Estimate, mg/kg/day	% cPAD
U.S. Population				0.0007	0.000159	23	0.000024	3.4
All infants*				0.0007	**0.000540**	**77**	0.000034	4.8
Children 1-2 yrs				0.0007	0.000264	38	0.000078	11
Children 3-5 yrs				0.0007	0.000210	30	0.000058	8.3
Children 6-12 yrs				0.0007	0.000140	20	0.000028	3.9
Youth 13-19 yrs				0.0007	0.000111	16	0.000015	2.2
Adults 20-49 yrs				0.0007	0.000155	22	0.000020	2.9
Adults 50-99 yrs				0.0007	0.000151	22	0.000020	2.8
Females 13-49 yrs	0.05	0.008763	18	0.0007	0.000153	22	0.000020	2.9

Bolded is most highly exposed population subgroup.

Cancer Dietary (food and drinking water) Exposure and Risk Results for ETU from the Combined Uses of Mancozeb and Metiram

The cancer dietary (food and drinking water) assessment for ETU from mancozeb and metiram uses results in a risk estimate of 2 x 10^{-6}.

Table 5.4.5.2. Cancer Dietary Exposure and Risk Results for ETU from the Combined Uses of Mancozeb and Metiram.

Population Subgroup	Exposure (mg/kg/day)	Estimated Cancer Risk
Adults 20-49 years old – Food and Water	0.000025	2 x 10^{-6}
Adults 20-49 years old – Food Only	0.000020	1 x 10^{-6}

Cancer Risk = (Q_1*) (Food Exposure).
Q_1* = 0.0601 $(mg/kg/day)^{-1}$

6.0 Residential Exposure

There are existing residential uses that have been assessed in this document to reflect updates to HED's 2012 Residential SOPs[10] along with policy changes for body weight assumptions. The revision of residential exposures will impact the human health aggregate risk assessment for mancozeb and ETU.

6.1 Residential Handler Exposure

HED uses the term "handlers" to describe those individuals who are involved in the pesticide application process. HED believes that there are distinct tasks related to applications and that exposures can vary depending on the specifics of each task. Residential handlers are addressed somewhat differently by HED as homeowners are assumed to complete all elements of an application without use of any protective equipment.

All registered mancozeb product labels with residential use sites (e.g., turf, ornamentals, and cut flowers) require that handlers wear specific clothing (e.g., long sleeve shirt/long pants) and/or use PPE. Therefore, HED has made the assumption that these products are not for homeowner use and has not conducted a quantitative residential handler assessment.

6.2 Residential Post-application Exposure/Risk Estimates

There is the potential for post-application exposure to both mancozeb and mancozeb-derived ETU for individuals exposed as a result of being in an environment that has been previously treated with mancozeb. The quantitative exposure/risk assessment for residential post-application exposures is based on the registered golf course turf use. Adults and children who come into contact with treated turf (golfing) may receive dermal exposure to mancozeb and ETU residues. Residential post-application exposure is expected to be short-term in duration.

No dermal POD was selected for mancozeb at this time (no dermal hazard); therefore, a quantitative post-application dermal assessment is not required for mancozeb. A dermal post-application assessment for ETU was conducted.

The lifestages selected for each post-application scenario are based on an analysis provided as an Appendix in the 2012 Residential SOPs[11]. While not the only lifestage potentially exposed for these post-application scenarios, the lifestage that is included in the quantitative assessment is health-protective for the exposures and risk estimates for any other potentially exposed lifestage.

[10] Available: http://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide

[11] Available: http://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide

Residential Post-application Non-Cancer

A series of assumptions and exposure factors served as the basis for completing the non-cancer residential post-application dermal risk assessments. These assumptions and factors are detailed in Section 5.2 of D465683 (D. Carter, 02/10/2023). The maximum turf application rate (17.4 lb ai/A) was used in the assessment. Chemical-specific TTR data was used.

As a Tier 1 approach, HED typically uses the highest predicted Day 0 value from across the geographic sites monitored in the TTR study. For assessing dermal exposures from ETU residues, the highest measured residue for ETU at the CA site (due to fluctuating residues and residues below the level of quantification (LOQ) at other sites; see Appendix E of D465683, D. Carter, 02/10/2023) and mancozeb chemical-specific data (highest predicted day 0 residue across all three sites) were used which resulted in no risk estimates of concern.

See Section 4.0 of D465683 (D. Carter, 02/10/2023) for details of the ETU conversion/degradation factors used in the residential assessments.

Summary of Residential Post-application Non-Cancer Exposure and Risk Estimates

Table 6.2.1 provides a summary of the estimated residential post-application exposures and risk estimates for ETU. Results from a chemical-specific TTR study were incorporated into the post-application assessment for turf. The risk estimates indicate that the short-term dermal (adult and children 6 to <11 and children 11 to <16 years old) MOEs are not of concern (i.e., MOEs > LOC of 300) with MOEs ranging from 380 to 700.

Table 6.2.1. Residential Post-application Non-cancer Exposure and Risk Estimates - ETU.

Lifestage	Post-application Exposure Scenario		Application Rate[1] (lb ai/A)	Foliar ETU Dose (mg/kg/day)[3]	Metabolized ETU Dose (mg/kg/day)[4]	Total ETU Dose (mg/kg/day)[5]	MOEs[6] (LOC = 300)
	Use Site	Route of Exposure					
CA TTR Predicted Day 0 Residue for mancozeb[2]: 0.15 ug/cm^2; Study App Rate for CA: 11.3 lb ai/A CA TTR Measured Day 0 Residue for ETU[2]: 0.0195 ug/cm^2; Study App Rate for CA: 11.3 lb ai/A							
Adult	Golfing	Dermal	17.4	0.0005	0.000046	0.0004	380
Child 6 < 11 years old				0.0003	0.000025	0.0003	700
Child 11to <16 years old				0.0004	0.000038	0.0002	460

1 Application rate based on registered labels; see Appendix E.
2 TTR based on MRID 44958501. Residue data adjusted for differences in application rates.
3 Foliar ETU Dose (mg/kg/day) = Daily ETU Exposure (mg/kg/day) x ETU DAF (6%) ÷ BW (80 kg).
4 Metabolized ETU Dose (mg/kg/day) = Daily Mancozeb Exposure (mg/kg/day) x Mancozeb DAF (1%) x Metabolic Conversion Factor (7.5%) ÷ BW (80 kg). (Metabolized ETU = mancozeb metabolized to ETU internally, within the exposed individual.)
5 Total ETU Dose (mg/kg-day) = Foliar ETU Dose (mg/kg/day) + Metabolized ETU Dose (mg/kg/day).
6 MOE = POD (0.2 mg/kg/day) ÷ Total ETU Dose (mg/kg/day).

Residential Post-application Dermal Cancer Exposure

Post-application cancer risk estimates for adults were calculated using a linear low-dose extrapolation approach in which a lifetime average daily dose (LADD) is first calculated and then compared with a Q_1^* that has been calculated for ETU based on dose response data in the appropriate toxicology study ($Q_1^* = 6.01 \times 10^{-2}$ (mg/kg/day)$^{-1}$).

TTR Residues & Yearly Dermal Dose Estimates

Chemical-specific TTR data were used. To determine the average total (combined ETU and mancozeb-derived ETU) dermal dose over the course of a year, HED calculated an average residue for both ETU (with ETU specific data) and mancozeb-derived ETU (with mancozeb specific data) by utilizing the highest residue for each scenario and inputing daily dissipation each day until the next application date. Then, using these average residues, an ETU dose and a mancozeb-derived ETU dose were calculated which was combined to determine the total ETU dose. The combined dose was used to determine the total cancer risk estimates.

The algorithms and assumptions used to estimate the LADD and cancer risk for residential post-application exposures can be found in D465683 (D. Carter, 02/10/2023).

Summary of Residential Post-application Cancer Exposure and Risk Estimates

Table 6.2.2 reflects the residential post-application dermal cancer risk estimate for ETU. The cancer risk estimates for adults from exposure to golf courses is 4×10^{-7}.

Table 6.2.2. Residential Post-application Cancer Exposure and Risk Estimates for ETU.

Lifestage	Post-application Exposure Scenario[2]		Dermal LADD (mg/kg/day)[2]	Total Dermal LADD (mg/kg/day)[3]	Cancer Risk Estimate[4]
CA TTR Predicted Day 0 Residue for mancozeb: 0.15 ug/cm^2; Study App Rate for CA: 11.3 ug/cm^2 CA TTR Predicted Day 0 Residue for ETU: 0.0195 ug/cm^2 (ETU); Study App Rate for CA: 11.3 ug/cm^2					
Adult	Golfing	ETU	6.9×10^{-6}	6.9×10^{-6}	4×10^{-7}
		Metabolized ETU	2.5×10^{-7}		

1 Metabolized ETU = mancozeb metabolized to ETU internally, within the exposed individual.

2 Dermal LADD (mg/kg/day) = Dermal dose (mg/kg/day) × [Days per year of exposure (days/yr) ÷ 365 days/year] × [Years per lifetime of exposure (yrs) ÷ Lifetime expectancy (78 yrs)].
ETU dermal dose (mg/kg/day) = ETU Exposure (mg/kg/day) x ETU DAF (6%) ÷ body weight (80 kg)
Metabolized ETU dermal dose (mg/kg/day) = Mancozeb Exposure (mg/kg/day) x Mancozeb DAF (0.01) x Metabolic conversion (7.5%) ÷ body weight (80 kg)

3 Total LADD (mg/kg/day) = ETU Dermal LADD (mg/kg/day) + Metabolized ETU Dermal LADD (mg/kg/day).

4 Cancer risk estimates = Total LADD × Q_1^*, where $Q_1^* = 6.01 \times 10^{-2}$ (mg/kg/day)$^{-1}$

6.3 Residential Risk Estimates for Use in Aggregate Assessment

Table 6.3.1 reflects the residential risk estimates for use in the aggregate assessment for ETU.

- The recommended residential exposure for use in the adult, children 6 to <11 years old, and children 11 to < 16 years old aggregate assessments is dermal post-application exposure golfing.

Table 6.3.1. Recommendations for the Residential Exposures for the ETU Aggregate Assessment.

Lifestage	Exposure Scenario	Dose (mg/kg/day)[1]							MOE[2] (Total ETU) (LOC = 300)			
		Dermal		Inhalation		Oral		Total	Dermal	Inhalation	Oral	Total
		ETU	Metabol. ETU	ETU	Metabol. ETU	ETU	Metabol. ETU					
Adult	Post-application exposure golfing	0.0005	0.00005	NA	NA	NA	NA	0.0005	380	NA	NA	380
Child 6 to < 11 years old		0.0003	0.00003	NA	NA	NA	NA	0.0004	700	NA	NA	700

Table 6.3.1. Recommendations for the Residential Exposures for the ETU Aggregate Assessment.												
Lifestage	Exposure Scenario	Dose (mg/kg/day)[1]							MOE[2] (Total ETU) (LOC = 300)			
		Dermal		Inhalation		Oral		Total	Dermal	Inhalation	Oral	Total
		ETU	Metabol. ETU	ETU	Metabol. ETU	ETU	Metabol. ETU					
Child 11 to <16 years old		0.0004	0.00004	NA	NA	NA	NA	0.0003	460	NA	NA	460

[1] Dose = the highest dose for each applicable lifestage of all residential scenarios assessed. Total = dermal + inhalation + incidental oral (where applicable).
[2] MOE = the MOEs associated with the highest residential doses. Total = 1 ÷ (1/Dermal MOE) + (1/Inhalation MOE) + (1/Incidental Oral MOE), where applicable.

Table 6.3.2 reflects the residential cancer risk estimate that is recommended for use in the adult cancer aggregate assessment for ETU.

Table 6.3.2. Recommendations for the Residential Exposures for the ETU Cancer Aggregate Assessment.			
Lifestage	Exposure Scenario	Total Dermal LADD[1] (mg/kg/day)	Cancer Risk[2]
Adults	Golfing (dermal)	6.9×10^{-6}	4×10^{-7}

[1] Total LADD (mg/kg/day) = ETU Dermal LADD (mg/kg/day) + Metabolized ETU Dermal LADD (mg/kg/day).
[2] Cancer risk estimates = Total LADD × Q_1^*, where $Q_1^* = 6.01 \times 10^{-2}$ $(mg/kg/day)^{-1}$

7.0 Aggregate Exposure/Risk Characterization

In accordance with the FQPA, HED must consider and aggregate (add) pesticide exposures and risks from three major sources: food, drinking water, and residential exposures. In an aggregate assessment, exposures from relevant sources are added together and compared to quantitative estimates of hazard (e.g., a NOAEL or PAD), or the risks themselves can be aggregated. When aggregating exposures and risks from various sources, HED considers both the route and duration of exposure.

7.1 Acute Aggregate Risk

Typically, HED does not consider residential exposures when assessing acute aggregate risk unless such exposures can be characterized as a series of single-day exposures, which is not the case for mancozeb and ETU. Therefore, acute aggregate risk estimates for mancozeb, ETU from mancozeb, and ETU from EBDCs (mancozeb and metiram) are equivalent to the acute dietary risk estimates (Section 5.4) and are not of concern.

7.2 Short- Term Aggregate Risk

ETU (from Mancozeb Uses)

In estimating the short-term aggregate risk for ETU from mancozeb uses, HED has aggregated the non-cancer residential exposure for ETU from mancozeb uses (Table 6.3.1) and average dietary (food and water) exposure for ETU from mancozeb uses (Table 5.4.4.1). The scenarios for aggregation are adults, children 6 to <11 years old, and children 11 to < 16 years old dermal post-application exposure to treated turf while golfing. The short-term aggregate MOEs for adults (310), children 6 to <11 years old (370), and children 11 to < 16 years old (490) are not of concern (LOC of 300).

Table 7.2.1. ETU (from Mancozeb Use) Short-Term Aggregate Risk Calculations.							
Population (Application Scenario)	Short- Term Scenario						
	NOAEL mg/kg/day	LOC[1]	Max Allowable Exposure[2] mg/kg/day	Average Food and Water Exposure mg/kg/day[3]	Residential Exposure mg/kg/day[4]	Total Exposure mg/kg/day[5]	Aggregate MOE (food, water, and residential)[6]
Adults (golfing)	0.2	300	0.000667	0.000155	0.0005	0.000655	310
Children 6 to <11 years old (golfing)	0.2	300	0.000667	0.000140	0.0004	0.000540	370
Children 11 to <16 years old (golfing)	0.2	300	0.000667	0.000111	0.0003	0.000411	490

[1] LOC=300 (3X inter-species uncertainty factor. 10X intra- species uncertainty factor, and 10X FQPA SF).

[2] Maximum Allowable Exposure (mg/kg/day) = NOAEL/LOC.

[3] The child dietary exposures used "Children 6-12 yrs" and "Youth 13-19 yrs" (Table 5.4.4.1). For ETU from mancozeb, the child lifestage with the highest dietary exposure (all infants) does not match the child lifestages for residential exposure being aggregated (children 6 to <11 yrs and children 11 to <16 yrs). The lifestages selected for each residential post-application scenario are based on an analysis provided as an Appendix in the 2012 Residential SOPs. This analysis provides a quantitative and qualitative basis for the representative lifestage for most residential post-application scenarios involving children, as well as reasons why a residential assessment is not conducted for infants. For children, therefore, this aggregate assessment only combines the residential exposure estimates for children (6 to <11 yrs and 11 to <16 yrs) with the average dietary exposure estimates for the most similar lifestages (Children 6-12 yrs and Youth 13-19 yrs).

[4] Residential Exposure = Dermal exposure (Table 6.3.1).

[5] Total Exposure = Avg Food & Water Exposure + Residential Exposure).

[6] Aggregate MOE = [NOAEL/(Total Exposure)].

ETU from Combined EBDC Uses (Mancozeb and Metiram)

In estimating the short-term aggregate risk for ETU from combined EBDCs (mancozeb and metiram), HED has aggregated the non-cancer residential exposure for ETU from mancozeb uses (there are no registered uses of metiram in the U.S.) (Table 6.3.1) and average dietary (food and water) exposure for ETU from mancozeb and metiram (Table 5.4.5.1). The scenarios for aggregation are adults, children 6 to <11 years old, and children 11 to < 16 years old dermal post-application exposure to treated turf while golfing. The short-term aggregate MOEs for adults (310), children 6 to <11 years old (370), and children 11 to < 16 years old (490) are not of concern (LOC of 300).

Table 7.2.2. ETU (from Mancozeb and Metiram Uses) Short-Term Aggregate Risk Calculations.							
Population (Application Scenario)	Short- Term Scenario						
	NOAEL mg/kg/day	LOC[1]	Max Allowable Exposure[2] mg/kg/day	Average Food and Water Exposure mg/kg/day[3]	Residential Exposure mg/kg/day[4]	Total Exposure mg/kg/day[5]	Aggregate MOE (food, water, and residential)[6]
Adults (golfing)	0.2	300	0.000667	0.000155	0.0005	0.000655	310
Children 6 to <11 years old (golfing)	0.2	300	0.000667	0.000140	0.0004	0.000540	370
Children 11 to <16 years old (golfing)	0.2	300	0.000667	0.000111	0.0003	0.000411	490

[1] LOC=300 (3X inter-species uncertainty factor. 10X intra- species uncertainty factor, and 10X FQPA SF).

[2] Maximum Allowable Exposure (mg/kg/day) = NOAEL/LOC.

[3] The child dietary exposures used "Children 6-12 yrs" and "Youth 13-19 yrs" (Table 5.4.5.1). For ETU from mancozeb and metiram, the child lifestage with the highest dietary exposure (all infants) does not match the child lifestages for residential exposure being aggregated (children 6 to <11 yrs and children 11 to <16 yrs). The lifestages selected for each residential post-application scenario are based on an analysis provided as an Appendix in the 2012 Residential SOPs. This analysis provides a quantitative and qualitative basis for the representative lifestage for most residential post-application

scenarios involving children, as well as reasons why a residential assessment is not conducted for infants. For children, therefore, this aggregate assessment only combines the residential exposure estimates for children (6 to <11 yrs and 11 to <16 yrs) with the average dietary exposure estimates for the most similar lifestages (Children 6-12 yrs and Youth 13-19 yrs).

[4] Residential Exposure = Dermal exposure (Table 6.3.1).

[5] Total Exposure = Avg Food & Water Exposure + Residential Exposure).

[6] Aggregate MOE = [NOAEL/(Total Exposure)].

7.3 Chronic Aggregate Risk

Chronic aggregate risk assessments address exposures that are likely to occur continuously for greater than six months. In the case of mancozeb, residential exposures are not expected to occur on a chronic basis; therefore, the chronic aggregate risk estimates for mancozeb, ETU from mancozeb, and ETU from EBDCs (mancozeb and metiram) are equivalent to the chronic dietary risk estimates (Section 5.4) and are not of concern.

7.4 Cancer Aggregate Risk

ETU (from Mancozeb)

The cancer aggregate assessment for ETU from mancozeb combines residential post-application exposure for adults contacting mancozeb-treated turf (based on expected lifetime exposure) with the cancer dietary (food and water) exposure for ETU from mancozeb. The cancer aggregate risk estimate is 2×10^{-6}.

Table 7.4.1. ETU (from Mancozeb) Aggregate Cancer Risk Estimates.

Population	Cancer Slope Factor (Q_1*)	Food and Water Exposure (mg/kg/day)[1]	Residential Exposure (LADD - mg/kg/day[2]	Aggregate Cancer Risk (food, water, residential)[3]
Adults	0.0601	2.4×10^{-5}	6.9×10^{-6}	2×10^{-6}

[1] Table 5.4.4.2.

[2] Table 6.3.2.

[3] Aggregate Cancer Risk = (Q_1*) (Food & Water Exposure + Residential LADD).

ETU from Combined EBDC Uses (Mancozeb and Metiram)

The cancer aggregate assessment for ETU from combined EBDCs (mancozeb and metiram) combines residential post-application exposure for adults contacting mancozeb-treated turf (based on expected lifetime exposure) with the cancer dietary (food and water) exposure for ETU from mancozeb and metiram. The cancer aggregate risk estimate is 2×10^{-6}.

Table 7.4.2. ETU (from Mancozeb and Metiram) Aggregate Cancer Risk Estimates.

Population	Cancer Slope Factor (Q_1*)	Food and Water Exposure (mg/kg/day)[1]	Residential Exposure (LADD - mg/kg/day[2]	Aggregate Cancer Risk (food, water, residential)[3]
Adults	0.0601	2.5×10^{-5}	6.9×10^{-6}	2×10^{-6}

[1] Table 5.4.5.2.

[2] Table 6.3.2.

[3] Aggregate Cancer Risk = (Q_1*) (Food & Water Exposure + Residential LADD).

8.0 Non-Occupational Spray Drift Exposure and Risk Estimates

Off-target movement of pesticides can occur via many types of pathways and it is governed by a variety of factors. Sprays that are released and do not deposit in the application area end up off-target and can lead to exposures to those it may directly contact. They can also deposit on surfaces where contact with residues can eventually lead to indirect exposures (*e.g.*, children playing on lawns where residues have deposited next to treated fields). The potential risk estimates from these residues can be calculated using drift modeling onto 50 feet wide lawns coupled with methods employed for residential risk assessments for turf products.

The approach to be used for quantitatively incorporating spray drift into risk assessment is based on a premise of compliant applications which, by definition, should not result in direct exposures to individuals because of existing label language and other regulatory requirements intended to prevent them.[12] Direct exposures would include inhalation of the spray plume or being sprayed directly. Rather, the exposures addressed here are thought to occur indirectly through contact with impacted areas, such as residential lawns, when compliant applications are conducted. Given this premise, exposures for children (1 to 2 years old) and adults who have contact with turf where residues are assumed to have deposited via spray drift thus resulting in an indirect exposure are the focus of this analysis analogous to how exposures to turf products are considered in risk assessment.

In order to evaluate the drift potential and associated risks, an approach based on drift modeling coupled with techniques used to evaluate residential uses of pesticides was utilized. Essentially, a residential turf assessment based on exposure to deposited residues has been completed to address drift from the agricultural applications of mancozeb and ETU**.** In the spray drift scenario, the deposited residue value was determined based on the amount of spray drift that may occur at varying distances from the edge of the treated field using the AgDrift (v2.1.1) model and the *Residential Exposure Assessment Standard Operating Procedures Addenda 1: Consideration of Spray Drift Policy*. Once the deposited residue values were determined, the remainder of the spray drift assessment was based on the algorithms and input values specified in the recently revised (2012) *Standard Operating Procedures for Residential Risk Assessment (SOPs)*.

A screening approach was developed based on the use of the AgDrift model in situations where specific label guidance that defines application parameters is not available.[13] AgDrift is appropriate for use only when applications are made by aircraft, airblast orchard sprayers, and groundboom sprayers. When AgDrift was developed, a series of screening values (i.e., the Tier 1 option) were incorporated into the model and represent each equipment type and use under varied conditions. The screening options specifically recommended in this methodology were selected because they are plausible and represent a reasonable upper bound level of drift for common application methods in agriculture. These screening options are consistent with how spray drift is considered in a number of ecological risk assessments and in the process used to develop drinking water concentrations used for risk assessment. In all cases, each scenario is to be evaluated unless it is not plausible based on the anticipated use pattern (e.g., herbicides are not typically applied to tree canopies) or specific label

[12] This approach is consistent with the requirements of the EPA's Worker Protection Standard.

[13] https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment#AgDrift

prohibitions (e.g., aerial applications are not allowed). Section 8.1 provides the screening level drift related risk estimates.

In many cases, risks are of concern when the screening level estimates for spray drift are used as the basis for the analysis. In order to account for this issue and to provide additional risk management options additional spray drift deposition fractions were also considered. These drift estimates represent plausible options for pesticide labels.

8.1 Combined Risk Estimates from Lawn Deposition Adjacent to Applications

The spray drift risk estimates are based on an estimated deposited residue concentration as a result of the screening level agricultural application scenarios. Mancozeb (which degrades to ETU) is used on numerous crops and can be applied via airblast, groundboom, and aerial equipment. The recommended drift scenario screening level options are listed below:

- **Groundboom applications** are based on the AgDrift option for high boom height and using very fine to fine spray type using the 90th percentile results.
- **Orchard airblast applications** are based on the AgDrift option for Sparse (Young/Dormant) tree canopies.
- **Aerial applications** are based on the use of AgDrift Tier 1 aerial option for a fine to medium spray type and a series of other parameters which are described in more detail below (e.g., wind vector assumed to be 10 mph in a downwind direction for entire application/drift event).[14]

In addition to the screening level spray drift scenarios described above, additional results are provided in Appendix F which represent viable drift reduction technologies (DRTs) that represent potential risk management options. In particular, different spray qualities have been considered as well as the impact of other application conditions (e.g., boom height, use of a helicopter instead of fixed wing aircraft, crop canopy conditions).

Exposures were considered for 50 feet wide lawns where the nearest side of the property was directly adjoining the treated field (at field edge) and at varied distances up to 300 feet downwind of a treated field. Since there are a number of different registered application rates, and risks of concern were identified, results are provided for the highest registered application rates for each occupational handler category (representative crops selected) to give an overall summary of the potential risk estimates from spray drift and are presented in Tables 8.1.1 and 8.1.2.

Combining Exposures/Risk Estimates:
Mancozeb: Dermal and incidental oral exposures are anticipated; however, there is no dermal endpoint selected. Therefore, only incidental oral exposures have been quantitatively assessed and there are no additional routes to combine.

[14] AgDrift allows for consideration of even finer spray patterns characterized as very fine to fine. However, this spray pattern was not selected as the common screening basis since it is used less commonly for most agriculture.

ETU: Dermal and incidental oral risk estimates were combined for children in this assessment since the toxicological effects for these exposure routes were similar.

Non-Occupational Spray Drift Exposure and Risk Estimate Equations

The algorithms used to estimate non-cancer exposure and dose for occupational handlers can be found in Appendix C of D465683 (D. Carter, 02/10/2023).

Summary of Non-Occupational Spray Drift Exposure and Risk Estimates

Risk estimates can be found in Appendix F (Tables F.1 through F.3.). Tables 8.1.1 and 8.1.2 present a summary of the non-occupational spray drift exposure risk estimates for both dermal (adult and children 1 to < 2 years old) and combined dermal and incidental oral (children 1 to < 2 years old only) for mancozeb and ETU. Risk estimates were calculated using chemical-specific TTR.

Mancozeb: For children, incidental oral screening-level risk estimates were not of concern at the field edge for all scenarios with MOEs ranging from 530 to 2,200 (LOC = 30).

ETU: For adults, dermal screening-level risk estimates were not of concern at the field edge with MOEs ranging from 420 to 1,700 (dermal LOC = 300). For children, combined dermal and incidental oral screening-level risk estimates were of concern at the field edge for most scenarios with MOEs ranging from 140 to 590 (LOC = 300). The distances required for exposures to reach the LOC of 300 range from 10 to 75 ft from the field edge.

Table 8.1.1. Screening Level Spray Drift Risk Estimates - Mancozeb.

Representative Crop/Rate Group		Spray Type/ Nozzle Configuration	Application Rate[a] (lb ai/A)	Mancozeb Chemical-Specific Adjusted TTR (ug/cm^2)[b]	Incidental Oral MOE[c] (LOC = 30)
					At Edge
Almond (highest orchard/vineyard rate) and **Cranberry** (highest typical-acreage field crop rate)	Aerial	Fine to Medium	4.8	0.064	530
	Groundboom	High Boom Very fine to Fine			730
	Airblast (almond only)	Sparse			950
Barley (highest high-acreage field crop rate)	Aerial	Fine to Medium	1.6	0.024	1,600
	Groundboom	High Boom Very fine to Fine			2,200
Pear (SLN Labels Rate)	Groundboom	High Boom Very fine to Fine	6.38	0.085	550
	Airblast	Sparse			720

a Application rate (lb ai/A) from registered labels. See Appendix D. For orchard/vineyard scenarios, there are 3 SLN labels (OR170001, WA090019, and WA120007) that allow a rate of 6.38 lb ai/A which exceeds the rate (4.8 lb ai/A) on Section 3 labels; therefore, the higher rate of 6.38 lb ai/A was included in this assessment as well.

b Adjusted TTR (ug/cm^2) = Label application rate (lb ai/A) x TTR from study (0.015 ug/cm^2) ÷ Study application rate (11.3 lb ai/A)

c MOEs at various distances from field edge = incidental POD (0.2 mg/kg/day) ÷ Dose (mg/kg/day), where the incidental oral dose is calculated using the algorithms provided in the Turf Residential SOPs (http://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide), and the TTR used in the calculations is the estimated TTR * drift fraction of spray drift that deposits on lawns at various distances from the field edge (see Appendix B).

Table 8.1.2. Screening Level Spray Drift Risk Estimates - ETU.								
Representative Crop/Rate Group		Spray Type/ Nozzle Configuration	Application Rate[a] (lb ai/A)	ETU Chemical-Specific Adjusted TTR (ug/cm²)[b]	Mancozeb Chemical-Specific Adjusted TTR (ug/cm²)[b]	Adult Dermal MOE[c] at Edge (LOC = 300)	Combined Child Dermal and Incidental Oral	
							MOE[c] at Edge (LOC = 300)	Distance at which MOE ≥ LOC (ft) [MOE]
Almond (highest orchard/vineyard rate) and **Cranberry** (highest typical-acreage field crop rate)	Aerial	Fine to Medium	4.8	0.008	0.064	420	140	75 [430]
	Groundboom	High Boom Very fine to Fine				580	200	10 [450]
	Airblast (almond only)	Sparse				760	260	10 [500]
Barley (highest high-acreage field crop rate)	Aerial	Fine to Medium	1.6	0.003	0.024	1300	430	NA
	Groundboom	High Boom Very fine to Fine				1700	590	NA
Pear (SLN Labels Rate)	Groundboom	High Boom Very fine to Fine	6.38	0.011	0.085	440	150	10 [340]
	Airblast	Sparse				570	190	10 [380]

a Application rate (lb ai/A) from registered labels. See Appendix D. For orchard/vineyard scenarios, there are 3 SLN labels (OR170001, WA090019, and WA120007) that allow a rate of 6.38 lb ai/A which exceeds the rate (4.8 lb ai/A) on Section 3 labels; therefore, the higher rate of 6.38 lb ai/A was included in this assessment as well.

b Adjusted TTR (ug/cm²) = Label application rate (lb ai/A) x TTR from study (0.0195 or 0.015 ug/cm²) ÷ Study application rate (11.3 lb ai/A)

c MOEs at various distances from field edge = incidental POD (0.2 mg/kg/day) ÷ Dose (mg/kg/day), where the incidental oral dose is calculated using the algorithms provided in the Turf Residential SOPs (http://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide), and the TTR used in the calculations is the estimated TTR * drift fraction of spray drift that deposits on lawns at various distances from the field edge (see Appendix B).

9.0 Non-Occupational Bystander Post-Application Inhalation Exposure and Risk Estimates

Volatilization of pesticides may be a source of post-application inhalation exposure to individuals nearby pesticide applications. The agency sought expert advice and input on issues related to volatilization of pesticides from its FIFRA Scientific Advisory Panel (SAP) in December 2009, and received the SAP's final report on March 2, 2010 (http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0687-0037). The agency has evaluated the SAP report and has developed a Volatilization Screening Tool and a subsequent Volatilization Screening Analysis (http://www.regulations.gov/#!docketDetail;D=EPA-HQ-OPP-2014-0219). During Registration Review, the Agency will utilize this analysis to determine if data (i.e., flux studies, route-specific inhalation toxicological studies) or further analysis is required for mancozeb.

In addition to this screen, the Agency did a search to determine if available air monitoring data were available for mancozeb. Mancozeb was included in air monitoring conducted by the Pesticide Action Network North America (PANNA) in Minnesota from June 2006 to August 2008 on potatoes. In 2008, a total of 10 field samples were selected from two sites in Frazee and one site in Perham and were sent to a commercial lab for analysis. Mancozeb was not detected and because these sampling and analytical methods could not be used to detect ETU, it is uncertain whether the mancozeb results (non-detections) were due to degradation to ETU or whether overall mancozeb and ETU levels were not detectable. (http://www.panna.org/sites/default/files/TechReport_MN-Drift_May2012-2.pdf). However, given that all results from the available post-application or ambient air monitoring data for

mancozeb were less than the limit of detection (LOD), a quantitative assessment has not been conducted.

10.0 Cumulative Exposure/Risk Characterization

Unlike other pesticides for which EPA has followed a cumulative risk approach based on a common mechanism of toxicity, EPA has not made a common mechanism of toxicity finding as to mancozeb and any other substances. Mancozeb does produce a toxic metabolite, ETU, which is produced by other EBDC compounds. Risks from combined exposures to ETU from all EBDC compounds are addressed as a separate ETU aggregate risk assessment. For the purposes of this action, EPA has not assumed that mancozeb has a common mechanism of toxicity with other substances. In 2016, EPA's Office of Pesticide Programs released a guidance document entitled, *Pesticide Cumulative Risk Assessment: Framework for Screening Analysis* [https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/pesticide-cumulative-risk-assessment-framework]. This document provides guidance on how to screen groups of pesticides for cumulative evaluation using a two-step approach beginning with the evaluation of available toxicological information and if necessary, followed by a risk-based screening approach. This framework supplements the existing guidance documents for establishing common mechanism groups (CMGs)[15] and conducting cumulative risk assessments (CRA)[16]. During Registration Review, the agency will utilize this framework to determine if the available toxicological data for mancozeb suggests a candidate CMG may be established with other pesticides. If a CMG is established, a screening-level toxicology and exposure analysis may be conducted to provide an initial screen for multiple pesticide exposure.

11.0 Occupational Exposure

11.1 Occupational Handler Exposure/Risk Estimates

HED uses the term handlers to describe those individuals who are involved in the pesticide application process. HED believes that there are distinct job functions or tasks related to applications and exposures can vary depending on the specifics of each task. Job requirements (amount of chemical used in each application), the kinds of equipment used, the target being treated, and the level of protection used by a handler can cause exposure levels to differ in a manner specific to each application event.

Based on the anticipated use patterns and current labeling, types of equipment and techniques that can potentially be used, occupational handler exposure is expected from the registered uses of mancozeb. Because ETU is an environmental degradate and metabolite of mancozeb, both mancozeb and ETU exposures have been assessed. Short- and intermediate-term dermal and inhalation exposures are expected. Since the PODs for short- and intermediate-term exposures are the same, short-term exposure and risk estimates are protective of intermediate-term durations. A cancer assessment is also performed for ETU. For mancozeb, a dermal POD was not selected; therefore, only

[15] *Guidance For Identifying Pesticide Chemicals and Other Substances that have a Common Mechanism of Toxicity* (USEPA, 1999)

[16] *Guidance on Cumulative Risk Assessment of Pesticide Chemicals That Have a Common Mechanism of Toxicity* (USEPA, 2002)

inhalation risk estimates were calculated. For ETU, dermal and inhalation risk estimates were combined in this assessment, since the toxicological effects for these exposure routes are the same.

A series of assumptions and exposure factors served as the basis for completing the occupational handler risk assessments. These assumptions and factors are detailed in Section 8.0 of D465683 (D. Carter, 02/10/2023). Maximum applications rates were used in this assessment, although for the cancer assessment typical rates may be more representative. See Section 4.0 of D465683 (D. Carter, 02/10/2023) for details of the ETU conversion/degradation factors used in the occupational assessments.

Personal Protective Equipment: Estimates of dermal and inhalation exposure were calculated for various levels of PPE. Results are presented for "baseline" (i.e., single layer of clothing consisting of a long sleeved shirt, long pants, shoes plus socks, no respirator) plus label-specified PPE (i.e., gloves) or engineering controls where applicable, as well as baseline with various levels of PPE as necessary (e.g., double layer of clothing, respirator, etc). The mancozeb product labels direct mixers, loaders, applicators and other handlers to wear baseline attire as well as varying level of PPE including: chemical resistant gloves, chemical resistant footwear, protective eyewear, respirator. Refer to Appendix E for label-specific PPE.

Estimates of inhalation exposure and risk for occupational handler exposure assessments consider the reduction in exposure afforded by respirators. Typically, results are presented for "baseline," defined as no respirator, and then, because they are the occupational standard in the pesticide industry, for half-face filtering facepiece or elastomeric respirators, quantified via application of their corresponding assigned protection factor (APF) of 10 (90% exposure reduction). This format, in some cases along with risk estimates for engineering controls, provides a variety of options for risk management decisions. This risk assessment presents potential inhalation risk estimates of concern when using a half-face filtering facepiece or elastomeric respirator (i.e., a PF10 respirator).

Summary of Occupational Handler Non-Cancer Exposure and Risk Estimates

Mancozeb:
Occupational handler non-cancer inhalation risk estimates for foliar uses can be found in Appendix F (Table F.4) as well as the corresponding spreadsheet entitled "Mancozeb_USEPA-OPP-HED_ Occupational Handler Exposure_May2021.xlsx" (see D465683, D. Carter, 02/10/2023). The risk estimates indicate that the short- and intermediate-term inhalation MOEs are not of concern (i.e., MOEs ≥ LOC of 10) with baseline attire (i.e., no respirator). Occupational handler inhalation MOEs range from 28 to 4,300,000 (LOC = 10).

Occupational handler non-cancer inhalation risk estimates for seed treatment uses can be found in Appendix F (Table F.5) as well as the corresponding spreadsheet entitled "Mancozeb_Seed_Treatment_USEPA OPP HED Occupational Handler Exposure Spreadsheet_March2022.xlsx" (see D465683, D. Carter, 02/10/2023). Occupational handler inhalation MOEs range from 11 to 94,000 for commercial seed treatment and 7.1 to 120,000 for on-farm seed treatment. One scenario (on-farm treating and planting potato seeds) is of concern at baseline (i.e., no

respirator; MOE = 7.1) however, the scenario no longer of concern with the addition of a PF10 respirator (MOE = 71).

ETU:
Occupational handler non-cancer dermal and inhalation risk estimates for foliar uses can be found in Appendix F (Table F.6) as well as the corresponding spreadsheet entitled "ETU_USEPA-OPP-HED_ Occupational Handler Exposure_May2021.xlsx" (see D465683, (D. Carter, 02/10/2023). The risk estimates indicate that the short- and intermediate-term combined dermal and inhalation MOEs are of concern (i.e., MOEs < LOC of 300) at baseline (i.e., single layer of clothing) plus label-specified PPE (i.e., gloves and no respirator) for several scenarios with MOEs ranging from 3.7 to 110,000 (LOC = 300). When considering maximum PPE (i.e., double/layer plus gloves and PF10 respirator) and/or engineering controls (i.e., closed systems, enclosed cockpits, etc.), where applicable, there are some scenarios that are still of concern (i.e., MOEs < LOC of 300) with MOEs ranging from 28 to 280. Considering maximum PPE and/or engineering controls, the MOEs range from 28 to 110,000 (LOC = 300).

Occupational handler non-cancer dermal and inhalation risk estimates for seed treatment uses can be found in Appendix F (Table F.7) as well as the corresponding spreadsheet entitled "ETU_USEPA-OPP-HED_Seed Treatment and Planting Exposure_March2022.xlsx" (see D465683, D. Carter, 02/10/2023). For commercial seed treatment, 53 out of 60 scenarios do not reach acceptable combined (dermal + inhalation) MOEs (i.e., MOEs < 300) assuming a worker is wearing a single layer of clothing, gloves and no respirator (the lowest level of clothing and PPE on some seed treatment labels). Risk estimates considering maximum PPE (i.e., double layer of clothing, gloves, and a PF10 respirator) are still of concern (i.e., MOEs < 300) for 49 scenarios (combined dermal + inhalation MOEs range from 3 to 31,000). For on-farm seed treatment, 16 out of 23 scenarios do not reach an acceptable combined (dermal + inhalation) MOE (i.e., MOEs < 300) at baseline (i.e., single layer and no respirator) plus label-specified PPE (i.e., gloves). Risk estimates considering maximum PPE (i.e., double layer of clothes, gloves, and a PF10 respirator) are still of concern for 9 scenarios with combined (dermal + inhalation) MOEs ranging from 4.9 to 100,000. A summary of the risk estimates has been provided in Appendix F.

It should be noted that many labels reviewed for these particular seed treatment uses included requirements for treaters and/or multiple activity workers to wear a respirator; however, this piece of equipment is not listed on all labels (see Appendix E for label-specific PPE).

The Agency matches quantitative occupational exposure assessment with appropriate characterization of exposure potential. While HED presents quantitative risk estimates for human flaggers where appropriate, agricultural aviation has changed dramatically over the past two decades. According the 2012 National Agricultural Aviation Association (NAAA) survey of their membership, the use of GPS for swath guidance in agricultural aviation has grown steadily from the mid 1990's. Over the same time period, the use of human flaggers for aerial pesticide applications has decreased steadily from ~15% in the late 1990's to only 1% in the most recent (2012) NAAA survey. The Agency will continue to monitor all available information sources to best assess and characterize the exposure potential for human flaggers in agricultural aerial applications.

HED has no data to assess exposures to pilots using open cockpits. The only data available is for exposure during aerial applications (covering both airplanes and helicopters) of liquid formulations to pilots in enclosed cockpits (data from AHETF) and of granule formulations in enclosed cockpits (data from the Pesticide Handlers Exposure Database (PHED)). Therefore, risks to pilots are assessed using the engineering control (enclosed cockpits) and baseline attire (long-sleeve shirt, long pants, shoes, and socks); use of the data in this fashion is consistent with the Agency's Worker Protection Standard (WPS) stipulations for engineering controls, which says label-required PPE for applicators can be reduced when using an enclosed cockpit (40 CFR 170.240(d)(6)(iii)) as well as a provision regarding use of gloves for aerial applications (40 CFR 170.240(d)(6)(i)), which says pilots are not required to wear protective gloves for the duration of the application. With this level of protection, there are no risk estimates of concern for applicators.

WSP is an engineering control designed to prevent direct contact between users and the pesticide formulation in the packages, thereby reducing exposures. Users place the packets into water which dissolves the packaging, releasing the formulation into the water without exposure to significant dusts or liquid aerosols. The formulation within the packaging then mixes with the water so it can be applied as a liquid spray.

This risk assessment relies on a 2015 study by the AHETF that measured dermal and inhalation exposure for workers who mixed and loaded WSP pesticide products. This data is considered the most reliable data for conducting exposure and risk assessments for such products. During the initial stages of the AHETF field study, the AHETF identified work practices that the Agency agreed were inconsistent with the use of WSP as an engineering control intended to reduce exposures. For example, AHETF observed that some workers placed the packets in removable baskets hanging from the open tank hatch and used streams of water from hoses or overhead recirculation systems as agitation methods to break open and dissolve the packaging, resulting in visible and substantial amounts of airborne powder and/or liquid aerosol where the mixer/loader was working. Current labels, including those under consideration in this risk assessment, are silent or unclear on the use of baskets in the hatch and methods of agitation.

The AHETF, in consultation with the Agency, California's Department of Pesticide Regulation (CDPR) and the Canadian Pest Management Regulatory Agency (PMRA), drafted a set of best practices for handling and adding WSP to spray tanks. The resulting AHETF "mixing/loading water-soluble packet" dataset excludes monitoring results for activities inconsistent with these practices. Commensurate with use of the new dataset, the Agency has since formatted those best practices into label language to be included on all WSP pesticide products. This revised language ensures that users know WSP are intended to dissolve in water via mechanical agitation and not to rupture them via streams of water or other means. In order to achieve the intended benefits from proper use of WSP, these best practices should be incorporated directly on product labels, conflicting language should be removed from the same labels, and users should receive effective and timely training on the new procedures.

Occupational Handler Cancer Exposure and Risk Equations (ETU)

Cancer risk estimates were calculated using a linear low-dose extrapolation approach in which a LADD is first calculated and then compared with a Q_1* that has been calculated for ETU based on dose

response data in the appropriate toxicology study (Q_1* = 6.01 x 10^{-2} (mg/kg/day)$^{-1}$). Absorbed average daily dose (ADD) levels were used as the basis for calculating the LADD values. Dermal and inhalation ADD values were first added together to obtain combined ADD values. LADD values were then calculated and compared to the Q_1* to obtain cancer risk estimates. The algorithms and assumptions used to estimate the LADD and cancer risk for occupational handlers can be found in D465683 (D. Carter, 02/10/2023).

Summary of Occupational Handler Cancer Exposure and Risk Estimates (ETU)

Occupational handler cancer combined dermal and inhalation risk estimates for foliar uses can be found in Appendix F (Table F.8) as well as the corresponding spreadsheet entitled "ETU_USEPA-OPP-HED_ Occupational Handler Exposure_May2021.xlsx" (see D465683, D. Carter, 02/10/2023).

The cancer risk estimates for the foliar uses of mancozeb ranged from 7x10^{-4} to 4x10^{-8} for private growers/handlers (10 days of exposure/year) and 2x10^{-3} to 1x10^{-7} for commercial handlers (30 days of exposure/year) with baseline attire (i.e., single layer and no respirator) plus label-specified PPE (i.e., gloves).

Occupational handler cancer combined dermal and inhalation risk estimates for seed treatment uses can be found in Appendix F (Table F.9) as well as the corresponding spreadsheet entitled "ETU_USEPA OPP HED_Seed Treatment and Planting Exposure_March2022.xlsx" (see D465683, D. Carter, 02/10/2023).

The risk estimates for the seed treatment uses of mancozeb ranged from 5x10^{-4} to 3x10^{-8} for private growers (10 days of exposure/year) and 3x10^{-4} to 5x10^{-8} with baseline attire (i.e., single layer and no respirator) plus label-specified PPE (i.e., gloves) for commercial applicators (30 days of exposure/year).

11.2 Occupational Post-application Exposure/Risk Estimates

HED uses the term post-application to describe exposures that occur when individuals are present in an environment that has been previously treated with a pesticide (also referred to as re-entry exposure). Such exposures may occur when workers enter previously treated areas to perform job functions, including activities related to crop production, such as scouting for pests or harvesting. Post-application exposure levels vary over time and depend on such things as the type of activity, the nature of the crop or target that was treated, the type of pesticide application, and the chemical's degradation properties. In addition, the timing of pesticide applications, relative to harvest activities, can greatly reduce the potential for post-application exposure.

11.2.1 Occupational Post-application Inhalation Exposure/Risk Estimates

There are multiple potential sources of post-application inhalation exposure to individuals performing post-application activities in previously treated fields. These potential sources include volatilization of pesticides and resuspension of dusts and/or particulates that contain pesticides. The agency sought expert advice and input on issues related to volatilization of pesticides from its FIFRA SAP in December 2009, and received the SAP's final report on March 2, 2010 (http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2009-0687-0037). The agency has evaluated the SAP report and has developed

a Volatilization Screening Tool and a subsequent Volatilization Screening Analysis (https://www.regulations.gov/#!docketDetail;D=EPA-HQ-OPP-2014-0219). During Registration Review, the agency will utilize this analysis to determine if data (i.e., flux studies, route-specific inhalation toxicological studies) or further analysis is required for mancozeb.

In addition, the Agency is continuing to evaluate the available post-application inhalation exposure data generated by the ARTF. Given these two efforts, the Agency will continue to identify the need for and, subsequently, the way to incorporate occupational post-application inhalation exposure into the agency's risk assessments.

Although a quantitative occupational post-application inhalation exposure assessment was not performed for mancozeb, an inhalation exposure assessment was performed for occupational/commercial handlers. Handler exposure resulting from application of pesticides outdoors is likely to result in higher exposure than post-application exposure. Therefore, these handler inhalation exposure estimates would be protective of most occupational post-application inhalation exposure scenarios.

Furthermore, for mancozeb, inhalation exposure during dusty mechanical activities such as shaking and mechanical harvesting is another potential source of post-application inhalation exposure. However, the airblast applicator scenario is believed to represent a reasonable worst-case surrogate estimate of post-application inhalation exposure during these dusty mechanical harvesting activities. The non-cancer inhalation risk estimate for commercial airblast application is not of concern (i.e., MOE > LOC of 10).

The Worker Protection Standard for Agricultural Pesticides contains requirements for protecting workers from inhalation exposures during and after greenhouse applications through the use of ventilation requirements [40 CFR 170.110, (3) (Restrictions associated with pesticide applications)].

A post-application inhalation exposure assessment is not required for seed treatment uses as exposure is expected to be negligible. Seed treatment assessments provide quantitative inhalation exposure assessments for seed treaters and secondary handlers (i.e., planters). These exposure estimates would be protective of any potential low-level post-application inhalation exposure that could result from these types of applications.

11.2.2 Occupational Post-application Dermal Exposure/Risk Estimates

Mancozeb: Occupational post-application dermal exposures are anticipated for the registered uses of mancozeb; however, a quantitative dermal assessment was not conducted as no dermal POD was selected for parent compound mancozeb.

ETU: Occupational post-application dermal exposures are assessed below for ETU. Dermal exposure to ETU is expected to be short- to intermediate-term.

Seed Treatment: Occupational post-application dermal exposures from seed treatment uses are not anticipated. The potential for post-application exposures following the planting of treated seeds is

unlikely because sustained levels of contact with treated seed after it has been placed in the soil or other planting media would not be expected because no routine cultural practice required for the production of agricultural commodities involves such an activity, as defined in the no/low contact criteria in the Worker Protection Standard (WPS).

A series of assumptions and exposure factors served as the basis for completing the occupational post-application dermal risk assessments. These assumptions and factors are detailed in Section 8.0 of D465683 (D. Carter, 02/10/2023). Maximum applications rates were used in this assessment, although for the cancer assessment typical rates may be more representative.

Chemical-specific TTR data and chemical-specific DFR data are available and were used in the occupational post-application dermal assessments, where appropriate. Apple DFR data (MRID 44959602) were used for all orchard crops. Grape DFR data (MRID 44959601) were used for grapes only. Tomato DFR data (MRID 44959603) were used for all other field crops. Greenhouse Tomato DFR data (MRID 44961701) were used for all other greenhouse vegetables and greenhouse crop (ornamentals). Averaging of the TTR and apple DFR data (the only DFR study with multiple study sites/locations) was considered; however, it was determined not to be appropriate. For the other DFR studies (grape, tomato, and greenhouse tomato), the highest predicted day-0 residue was used from the study site/location. A more detailed explanation can be found in D465683 (D. Carter, 02/10/2023).

Occupational Post-application Non-Cancer Dermal Risk Estimates

Occupational post-application dermal risk estimates can be found in Appendix F (Table F.10) as well as the corresponding spreadsheet entitled "ETU_USEPA-OPP-HED_ExpoSAC Policy 3_Occupational Pesticide Re-entry Exposure Calculator_March2021_w-cancer.xlsx" (see D. Carter, D465683, 02/10/2023).

Risk estimates for representative orchard crops range from 37 to 4,300 on 0-DAT; risk estimates for 11 activities do not reach an acceptable MOE (i.e., MOE > LOC of 300) on 0-DAT; these activities are summarized in Table 11.2.2.2.

Table 11.2.2.2. Summary of Occupational Post-Application Non-Cancer Risks of Concern – Orchard Crops

Crop	Activity	WA Chemical-Specific Data		NY Chemical-Specific Data	
		MOE on 0-DAT	DAT at which MOE ≥ LOC [MOE]	MOE on 0-DAT	DAT at which MOE ≥ LOC [MOE]
Almond	Scouting	280	3 [300]	230	4 [320]
Pome Fruits (apple, crabapple, pear, quince)[a]	Scouting	280	3 [300]	230	4 [320]
	Hand Harvesting	110	32 [300]	95	15 [310]
	Hand Pruning	280	3 [300]	230	4 [320]
	Training	280	3 [300]	230	4 [320]
	Thinning Fruit, Hand	45	>35 [130]	37	27 [310]
Christmas Trees	Hand Set Irrigation	130	29 [300]	110	13 [300]
	Hand Harvesting	170	18 [300]	140	10 [320]
Subtropical/Tropical Fruit (mango, papaya, sugar apple, cherimoya, atemoya, custard apple, sweetsop, , canistel, mamey sapote, sapodilla, white sapote, banana, plantain,	Hand Harvesting	280	3 [300]	230	4 [310]
	Thinning Fruit, Hand	110	34 [300]	89	16 [320]

Table 11.2.2.2. Summary of Occupational Post-Application Non-Cancer Risks of Concern – Orchard Crops					
Crop	Activity	WA Chemical-Specific Data		NY Chemical-Specific Data	
		MOE on 0-DAT	DAT at which MOE ≥ LOC [MOE]	MOE on 0-DAT	DAT at which MOE ≥ LOC [MOE]
sweetsop, star apple [caimito])[b]					

a. Surrogate crop assessed = apple
b. Surrogate crop assessed = mango and papaya

Risk estimates for table and raisin grapes range from 16 to 1,300 on 0-DAT; risk estimates for 10 activities do not reach an acceptable MOE (i.e., MOE > LOC of 300) on 0-DAT; these activities are summarized in Table 11.2.2.3.

Table 11.2.2.3. Summary of Occupational Post-Application Non-Cancer Risks of Concern – Grapes			
Crop	Activity	MOE on 0-DAT	DAT at which MOE ≥ LOC [MOE]
Grapes, Table	Girdling	16	>30 [56]
	Hand Set Irrigation	160	15 [300]
	Turning	16	>30 [56]
	Tying/Training	55	>30 [190]
	Hand Harvesting	55	>30 [190]
	Leaf Pulling	55	>30 [190]
Grapes, Raisin	Hand Set Irrigation	160	15 [300]
	Tying/Training	55	>30 [190]
	Hand Harvesting	55	>30 [190]
	Leaf Pulling	55	>30 [190]
Grapes, Wine/Juice	Hand Set Irrigation	160	15 [300]

Risk estimates for representative field crops range from 93 to 12,000 on 0-DAT; risk estimates for 23 activities do not reach an acceptable MOE (i.e., MOE > LOC of 300) on 0-DAT; these activities are summarized in Table 11.2.2.4.

Table 11.2.2.4. Summary of Occupational Post-Application Non-Cancer Risks of Concern – Field Crops			
Crop	Activity (crop height/foliage density)	MOE on 0-DAT	DAT at which MOE ≥ LOC [MOE]
Banana	Hand Harvesting	290	1 [330]
Broccoli	Scouting	150	6 [310]
	Hand Harvesting	150	6 [310]
	Hand Weeding	150	6 [310]
Cabbage	Hand Weeding	150	6 [310]
Corn, sweet, grain	Hand Harvesting	93	10 [320]
Cranberry	Hand Harvesting (raking)	190	4 [310]
	Scouting	190	4 [310]
Cucurbit Vegetables (cantaloupe, cucumber, gourd, pumpkin, squash, melons, and squash)[a]	Hand Set Irrigation	220	3 [320]
Lettuce, leaf	Hand Set Irrigation	280	1 [310]
Onion, bulb, garlic, shallot, bulb[b]	Hand Set Irrigation	220	3 [320]
	Scouting	290	1 [330]
	Hand Weeding (low/full)	98	9 [300]
	Hand Weeding (low/min)	220	3 [320]
Onion, green, leek, shallot, fresh leaves[c]	Hand Harvesting	290	1 [330]
	Hand Set Irrigation	220	3 [320]
	Scouting	290	1 [330]

Table 11.2.2.4. Summary of Occupational Post-Application Non-Cancer Risks of Concern – Field Crops			
Crop	**Activity (crop height/foliage density)**	**MOE on 0-DAT**	**DAT at which MOE ≥ LOC [MOE]**
	Hand Weeding (low/full)	98	9 [300]
	Hand Weeding (low/min)	290	1 [330]
Pepper, bell	Hand Set Irrigation	220	3 [320]
Pepper, chili	Hand Set Irrigation	220	3 [320]
Tobacco	Hand Set Irrigation	260	1 [300]
Tomato	Hand Set Irrigation	220	3 [320]

a. Surrogate crop assessed = cucumber
b. Surrogate crop assessed = onion, bulb
c. Surrogate crop assessed = onion, green

Risk estimates for greenhouse vegetables and greenhouse crops are not of concern (i.e., MOE > LOC of 300) on 0-DAT. Risk estimates range from 490 to 3,600.

Risk estimates for golf course and sod range from 150 to 1,700 on 0-DAT; risk estimates for 4 scenarios do not reach acceptable MOEs (i.e., MOE > LOC of 300) on 0-DAT; these activities are summarized in Table 11.2.2.5.

Table 11.2.2.5. Summary of Occupational Post-Application Non-Cancer Risks of Concern – Golf Course and Sod			
Crop	**Activity**	**MOE on 0-DAT**	**DAT at which MOE ≥ LOC [MOE]**
		CA Chemical-Specific Data	
Golf Course	Maintenance	270	1 [300]
Sod	Maintenance	150	7 [330]
	Harvesting, Slab	150	7 [330]
	Transplanting/Planting	150	7 [330]

While the quantitative occupational exposure assessment includes risk estimates for table grape cane turning and girdling, information provided by USDA, university extension agents, industry specialists, and grower groups[1] indicate that the prevalence and exposure potential of both practices has decreased as grape trellis systems have changed over time. Cane turning (also referred to as cane "moving" or "throwing") is a part of trellis or canopy management by which canes are turned/moved/thrown by hand from one side of the trellis to the other in order to promote grape productivity by altering the canopy's airflow and exposure to sunlight. Girdling, a highly specialized skill, involves scoring a cut into the vine bark approximately ¼" deep around the entire circumference, and 8 to 12 inches above the ground which alters nutrient transport and can result in larger grapes. The Agency uses two studies, one from the late 1980s[2] and the other from the early 1990s[3], to estimate workers' pesticide exposure potential while turning and girdling in grape vineyards. The studies indicate that both cane turning and girdling have the potential for high exposure following pesticide applications via extensive contact with foliar residue (quantitatively represented by a transfer coefficient of 19,300 cm^2/hr).

Based on information provided to the Agency[4], open-gable/Y-trellis systems have increasingly replaced older/T-trellis systems, and these modern Y-trellis systems no longer require turning or throwing canes to manage trellis canopies and crop growth; therefore, these post-application scenarios (i.e., grape turning) are not applicable when modern Y-trellis systems are in in place. However, despite the large majority of table grapes being grown with more modern Y-trellis systems (approximately 85% of table grape growers), the Agency's assessment and risk estimates remain relevant for the smaller fraction of

growers who do not use the modern Y-trellis system who's workers may still perform turning or throwing cane activities for canopy management.

Additionally, not only do the modern Y-trellis systems reduce the need to girdle grape canes to promote larger berry size, in comparison to the older trellis systems represented by the studies that EPA uses for assessing risk during girdling, photographs and videos provided to EPA suggest that modern Y-trellis systems, with their more open, raised canopies and less draping of foliage, also reduce the potential for contact with pesticide residues during girdling. Grape grower groups also noted that a key objective of table grape breeding programs is to develop varieties that do not need to be girdled due to their large natural berry size (Gabler, 2020[5]; Vasquez, 2020[6]). Therefore, while the high exposure potential represented by EPA's current girdling assessment still accurately represent the smaller fraction of growers still using older T-trellis systems, workers conducting girdling activities under the modern/Y-trellis systems are expected to have lower exposure potential in line with that of pruning, tying/training, or hand harvesting activities.

Overall, risk estimates and any corresponding REIs or other risk management actions for turning and girdling grapes should be considered in light of the differing trellis systems. For older T-trellis systems, the cane turning and girdling activity transfer coefficient (TC) of 19,300 cm^2/hr is relevant as currently established in risk assessment. However, for the modern Y-trellis systems, turning activities are no longer considered a relevant activity for exposure assessment. Lastly, for modern Y-trellis system girdling activities, a reduced exposure potential is anticipated. While no new monitoring data are currently available, based on a transfer coefficient in line with that of pruning, tying/training, or hand harvesting activities with a TC of 5,500 cm^2/hr may be more representative of actual exposures. The Agency will continue to monitor all available information sources to best assess and characterize the exposure potential for workers in grape agricultural settings.

Restricted Entry Interval

Mancozeb and ETU are classified as Toxicity Categories IV and III, respectively, via the dermal route and Toxicity Category IV for skin irritation potential. Neither is a skin sensitizer. Mancozeb does not have a dermal POD and therefore, a quantitative dermal post-application assessment was not conducted; however, an assessment was conducted for its metabolite, ETU. Short- and intermediate-term post-application risk estimates were of concern on day 0 (12 hours following application) for most activities for ETU with implications for re-entry extending out to almost 30 days for some activities. HED recommends that the REIs on the labels be reviewed to address those concerns.

Occupational Post-application Cancer Dermal Exposure and Risk Equations

As was done for occupational handlers, post-application cancer risk estimates were calculated using a linear low-dose extrapolation approach in which a LADD is first calculated and then compared with a Q_1* that has been calculated for ETU based on dose response data in the appropriate toxicology study (Q_1* = 6.01×10^{-2} $(mg/kg/day)^{-1}$). The algorithms used to estimate the LADD and cancer risk for occupational workers can be found in Appendix B of D465683 (D. Carter, 02/10/2023).

Occupational Post-application Cancer Dermal Risk Estimates

Occupational post-application cancer dermal risk estimates can be found in the corresponding spreadsheet entitled "ETU_USEPA-OPP-HED_ExpoSAC Policy 3_Occupational Pesticide Re-entry

Exposure Calculator_March2021_w-cancer.xlsx" (see D465683, D. Carter, 02/10/2023). A summary of risk estimates can be found in Appendix F. Risk estimates were calculated using a 30-day average dose.

- Risk estimates for orchard crops range from $7x10^{-6}$ to $5x10^{-8}$.
- Risk estimates for table and raisin grapes range from $2x10^{-5}$ to $2x10^{-7}$.
- Risk estimates for all field crops range from $1x10^{-6}$ to $1x10^{-8}$.
- Risk estimates for greenhouse vegetables and greenhouse crops range from $3x10^{-7}$ to $5x10^{-8}$.
- Risk estimates for golf course and sod range from $3x10^{-7}$ to $9x10^{-7}$.

12.0 Incident and Epidemiological Data Review

HED performed a Tier II review of human incidents and epidemiology for Mancozeb (E. Evans *et al*, D460067, 11/30/2020). This review focused on potential adverse exposure events reported to a range of pesticide incident programs, including OPP's Incident Data System (IDS), National Pesticide Information Center (NPIC), NIOSH's Sentinel Event Notification System for Occupational Risk (SENSOR) program for pesticides, and the California Department of Pesticide Regulation's Pesticide Illness Surveillance Program (PISP). HED found that the acute health effects reported for mancozeb are consistent among the databases queried. Based on this review, HED found adverse health effects involved symptoms that included neurological, respiratory, dermal, ocular, and gastrointestinal effects. HED did not identify any aberrant effects outside of those anticipated. These effects were generally mild/minor to moderate in severity and resolved rapidly. HED found that off-site movement exposure (spray drift) was commonly reported to IDS, SENSOR-Pesticides and California PISP. In addition, HED found that most of the mancozeb incidents reported to SENSOR (83%) and California PISP (93%) were occupational cases. Most of these occupational incidents occurred while conducting routine work, including fieldwork. Overall, the incidents reported were mostly low severity and do not warrant further investigation.

In order to assess the epidemiologic evidence on the potential adverse effects of mancozeb exposure, HED performed a systematic review of the epidemiologic literature on mancozeb, including its components maneb and zineb, and identified 53 articles that investigated a range of health outcomes, including 12 studies on carcinogenic health outcomes and 41 on the non-carcinogenic outcomes Parkinson's Disease, respiratory effects, thyroid disease, and a range of other health outcomes. While there were some individual studies identified that reported a positive association between mancozeb exposure and some adverse health effects, the overall evidence was based on a small body of studies (i.e., typically only one study population per health outcome) that often had substantive limitations with respect to their study design, exposure assessment approach, and sample sizes. As such, HED concluded that overall, there was insufficient epidemiologic evidence to suggest a clear associative or causal relationship exists between mancozeb exposure and the adverse health effects examined in the available epidemiologic literature. The Agency will continue to monitor the epidemiology data and -- if a concern is triggered -- additional analysis will be conducted.

13.0 References

E. Evans *et al*, D460067, 11/30/2020. Mancozeb: Tier II Incident and Epidemiology Report.

M. Ruhman, D459932, 12/10/2020. Mancozeb: Drinking Water Assessment to Support Registration Review.

P. Savoia, D452107, D452167 & D454663, 12/14/2020. Mancozeb. Required Residue Chemistry Data Provided to Support Registration Review. Summary of Analytical Chemistry and Residue Data.

D. Carter, D459484, 12/14/2020. Mancozeb. Occupational and Residential Exposure Assessment in Support of Registration Review.

D. Carter, D465683, 02/10/2023. Mancozeb. Revised Occupational and Residential Exposure Assessment in Support of Registration Review.

D. Carter, 014504_TG00618629_ORE_2024-06-28. Mancozeb. Second Revision: Occupational and Residential Exposure Assessment in Support of Registration Review.

D. Nadrchal, D467014, 02/10/2023. Mancozeb. Acute, Chronic, and Cancer Dietary Exposure and Risk Assessments of Food and Drinking Water for the Ethylene Bisdithiocarbamate (EBDC) Fungicide Mancozeb, as well as Aggregate Dietary Assessment of the Common Metabolite/Degradate Ethylene Thiourea (ETU) Resulting from the Combined Uses of the EBDC Fungicides Mancozeb and Metiram to Support Registration Review. Update to Dietary Exposure Evaluation Model (DEEM)Version 4.02.

Appendix A. Toxicology Profile

A.1 Mancozeb Toxicology Data Requirements

The requirements (40 CFR 158.340) for mancozeb are below. Use of the new guideline numbers does not imply that the new (1998) guideline protocols were used.

Study		Technical	
		Required	Satisfied
870.1100	Acute Oral Toxicity	yes	yes
870.1200	Acute Dermal Toxicity	yes	yes
870.1300	Acute Inhalation Toxicity	yes	yes
870.2400	Acute Eye Irritation	yes	yes
870.2500	Acute Dermal Irritation	yes	yes
870.2600	Skin Sensitization	yes	yes
870.3100	90-Day Oral Toxicity in Rodents	yes	yes
870.3150	90-Day Oral Toxicity in Nonrodents	yes	yes
870.3200	21/28-Day Dermal Toxicity	yes	yes
870.3250	90-Day Dermal Toxicity	CR	----
870.3465	90-Day Inhalation Toxicity	yes	yes
870.3700a	Prenatal Developmental Toxicity (rodent)	yes	yes
870.3700b	Prenatal Developmental Toxicity (nonrodent)	yes	yes
870.3800	Reproduction and Fertility Effects	yes	yes
870.4100a	Chronic Toxicity (rodent)	yes	yes
870.4100b	Chronic Toxicity (nonrodent)	yes	yes
870.4200a	Carcinogenicity (rat)	yes	yes [1]
870.4200b	Carcinogenicity (mouse)	yes	yes [1]
870.4300	Combined Chronic Toxicity/Carcinogenicity	yes	yes [1]
870.5100	Mutagenicity—Bacterial Reverse Mutation Test	yes	yes
870.5300	Mutagenicity—Mammalian Cell Gene Mutation Test	yes	yes
870.5385	Mutagenicity—Structural Chromosomal Aberrations	yes	yes
870.5550	Mutagenicity—Other Genotoxic Effects	yes	yes
870.5900	Mutagenicity—Cytogenetics	yes	yes
870.6200a	Acute Neurotoxicity Screening Battery (rat)	yes	yes
870.6200b	90-Day Neurotoxicity Screening Battery (rat)	yes	yes
870.6300	Developmental Neurotoxicity	yes	yes
870.7485	Metabolism and Pharmacokinetics	yes	yes
870.7600	Dermal Penetration	yes	yes
870.7800	Immunotoxicity	yes	yes

[1] Satisfied by carcinogenicity studies with ETU

A.2 Mancozeb Toxicity Profiles

T Table A.2.1 Acute Toxicity Data for Mancozeb

Guideline No.	Study Type	MRID(s)	Results	Toxicity Category
870.1100	Acute Oral (rat)	00142522	LD_{50} > 5,000 mg/kg (M & F)	IV
870.1200	Acute Dermal (rabbit)	00142522	LD_{50} > 5,000 mg/kg (M & F)	IV
870.1300	Acute Inhalation (rat)	00145996	LC_{50} > 5.14 mg/L (M & F)	IV
870.2400	Primary Eye Irritation (rabbit)	00142522	Corneal involvement clearing in < 7 days	III
870.2500	Primary Skin Irritation (rabbit)	00142522	Slightly irritating	IV
870.2600	Dermal Sensitization (guinea pig)	40469501	Not a dermal sensitizer (Buehler)	N/A

Table A.2.2 Toxicity Profile for Mancozeb		
Guideline No./Study Type	MRID No. (year)/Classification/Doses	Results
870.3100 90-day oral - rat	00160704 (1986) TXR 0013954 Acceptable/Guideline 0, 30, 60, 125, 250, or 1000 ppm males: 0, 2, 4, 7, 15, 57 mg/kg/day females: 0, 2, 4, 9, 18, 75 mg/kg/day	NOAEL= 9 mg/kg/day (F); 15 mg/kg/day (M) LOAEL=18 mg/kg/day based on decreased serum T (F); 57 mg/kg/day based on body weight decrements, changes in thyroid hormones, changes in liver enzymes, microscopic changes in the liver and thyroids, increased absolute and relative thyroid weights, and increased relative liver weights (M)
870.3100 90-day oral - mouse	00259888 (1985) TXR 0013954 Acceptable/Guideline 0, 10, 100, 1000, 10000 ppm males: 0, 2, 18, 167, or 1663 mg/kg/day females: 0, 2, 22, 234, or 2160 mg/kg/day	NOAEL=18/22 mg/kg/day (M/F) LOAEL=167/234 mg/kg/day in (M/F), based on microscopic lesions of thyroid follicular cell hypertrophy or hyperplasia in females and decreased liver mixed function oxidase enzyme activity in males
870.3150 90-day oral - dog	00261537 (1986) TXR 0013954 Acceptable/Guideline 0, 10, 100, 1000, 5000 ppm males: 0, 0.29, 3.0, 29, 102 mg/kg/day females: 0, 0.32, 3.0, 29, 109 mg/kg/day	NOAEL=3.0/3.0 mg/kg/day (M/F) LOAEL =29/29 mg/kg/day (M/F) based on dehydration, decreased body weights and food consumption, anemia, lymphoid depletion of the thymic cortex, elevated cholesterol and prostate hypogenesis
870.3200 28-day dermal toxicity - rats	40588201 (1988) TXR 0013954 Acceptable/Guideline 0, 10, 100, or 1000 mg/kg/day	NOAEL ≥ 1000 mg/kg/day [HDT] in males and females LOAEL = not established
870.3465 90-day inhalation - rat	00159471 (1986) TXR 0013954 Acceptable/Guideline 0, 0.018, 0.079, or 0.326 mg/L	NOAEC=0.079 mg/L LOAEC=0.326 mg/L based upon body weight decrements in males, thyroid hyperplasia in females, and decreased thyroxine (T4) in females.

Table A.2.2 Toxicity Profile for Mancozeb		
Guideline No./Study Type	MRID No. (year)/Classification/Doses	Results
870.4100 Chronic Oral Toxicity - rat	41903601 (1990) TXR 0058090 Acceptable/Guideline 0, 20, 60, 125, 750 ppm males: 0, 1, 2, 5, or 31 mg/kg/day females: 0, 1, 3, 7, or 40 mg/kg/day	NOAEL=5/7 mg/kg/day (M/F) LOAEL =31/40 mg/kg/day (M/F) based on decreased T4, increased TSH, enlarged thyroids, increased thyroid weight, and thyroid hypertrophy/hyperplasia
870.4200 Carcinogenicity - mouse	41981801 (1991) TXR 0013954 Unacceptable/Non-guideline Dosing considered inadequate for assessing the carcinogenic potential due to minimal toxicity in the study (Carcinogenicity Peer Review memo; I. Mauer and E. Rinde, 11/19/1992) 0, 30, 100, or 1000 ppm males: 0, 4, 13, or 131 mg/kg/day females: 0, 5, 18, or 180 mg/kg/day *Much of the mancozeb degraded to ETU by weeks 52-80*	NOAEL =13/18 mg/kg/day (M/F) LOAEL=131/180 mg/kg/day (M/F) based on minor body weight decrements and changes in thyroid hormone levels.
870.4100 Chronic oral toxicity - dog	41810501 (1988) TXR 0013954 Acceptable/Guideline 0, 50, 200, 800, 1600 ppm males: 0, 2, 7, 27, 54 mg/kg/day females: 0, 2, 7, 29, 60 mg/kg/day	NOAEL=2/7 mg/kg/day (M/F) LOAEL =7/29 mg/kg/day (M/F), based on decreased body weight gain (males only) and anemia (females only)
870.6200a Acute neurotoxicity – rat	47126201 (2005) TXR 0058090 Acceptable/Guideline 0, 500, 1000, 2000 mg/kg/day	NOAEL=1000 mg/kg LOAEL=2000 mg/kg based on degeneration of individual nerve fibers with myelin ovoid formation in the proximal sciatic nerve of one male and in the tibial nerve of two males

Table A.2.2 Toxicity Profile for Mancozeb		
Guideline No./Study Type	MRID No. (year)/Classification/Doses	Results
Non-Guideline Subchronic neuropathology – rat	42034101 (1991) TXR 0013954 0, 20, 125, 750 ppm, or 5000 ppm males: 0, 1, 8, 50, or 339 mg/kg/day females: 0, 2, 11, 63, or 412 mg/kg/day	NOAEL=8/11 mg/kg/day (M/F) LOAEL=50/63 mg/kg/day (M/F) based on microscopic evidence of peripheral nerve damage and decreased body weight gain in females 339/412 mg/kg/day (M/F): Female mortality, ↓ body weight in males (↓45%); Clinical signs in both sexes – reluctance to walk, etc
870.6300 Developmental neurotoxicity - rat	47872902 (2008) 47872901 (2008) TXR 0055287 Acceptable/Non-guideline 0, 5, 15, 30 mg/kg/day	<u>Maternal:</u> NOAEL= 30 mg/kg/day (HDT) LOAEL= not established <u>Offspring:</u> NOAEL= 15 mg/kg/day LOAEL= 30 mg/kg/day based on decreased pup weight (11-22%) in range-finding study
Non-guideline Modified DNT – rat	Tox Sci 120(2). 2011. Axelstad, et al 0, 50, 100, 150/100 mg/kg/day GD 7–PND 16	<u>Maternal:</u> Decreased body weight gain and T4 at 50 mg/kg/day; paralysis and sacrifices at 150 mg/kg/day <u>Offspring:</u> No effects on T4, organ weight, histopathology, motor activity, startle response, or spatial learning at any dose <u>Reproduction:</u> No effects
870.3700 Developmental toxicity – rat	00246663 (1980) TXR 0013954 Acceptable/Guideline 0, 2, 8, 32, 128, or 512 mg/kg/day	<u>Maternal</u>: NOAEL=32 mg/kg/day LOAEL=128 mg/kg/day, based on decreased food consumption, body weight, and body weight gains At 512 mg/kg/day: maternal mortality <u>Developmental:</u> NOAEL=128 mg/kg/day LOAEL=512 mg/kg/day, based on hydrocephaly, gross developmental defects, skeletal defects, cryptorchidism, abortions, increased resorptions, and decreased fetal weight
870.3700 Developmental toxicity - rabbit	40433001 (1987) TXR 0013954 Acceptable/Guideline 0, 10, 30, or 80 mg/kg/day	<u>Maternal:</u> NOAEL=30 mg/kg/day LOAEL=80 mg/kg/day, based on abortions, mortality, and clinical signs <u>Developmental</u>: NOAEL=30 mg/kg/day LOAEL=80 mg/kg/day, based on abortions

Table A.2.2 Toxicity Profile for Mancozeb		
Guideline No./Study Type	MRID No. (year)/Classification/Doses	Results
870.3800 Reproduction and post-natal toxicity - rat	41365201 (1988) TXR 0013954 Acceptable/Guideline 0, 30, 120, or 1200 ppm males: 0, 2, 7, 69 mg/kg/day females: 0, 2, 7, or 79 mg/kg/day	Parental: NOAEL=7/7 mg/kg/day (M/F) LOAEL=69/79 mg/kg/day (M/F), based on body weight decrements, increased relative thyroid weights, and increased incidence of thyroid follicular cell hyperplasia Offspring: NOAEL≥ 69/79 mg/kg/day (HDT) LOAEL= not established Reproduction: NOAEL≥ 69/79 mg/kg/day (HDT) LOAEL= not established
870.5100, 870.5300 Gene Mutation	00259044 (three studies) -Mutagenicity: *Salmonella* - *in vitro* mammalian: CHO/HGPRT - mouse host-mediated	 Negative with and without activation Negative with and without activation Negative
870.5900, 870.5385 Cytogenetics/Structural Chromosomal Aberrations	40810202 (TXR 0006987) 00259044 40788901 (TXR 0006987) - CHO cells - *in vivo* bone marrow cytogenetics - Mouse micronucleus assay	 Positive (stronger response without activation) Negative Negative
870.5550 Other Genotoxic Effects	40611701 (TXR 0006784) 40810205 (TXR 0006987) 00259044 00259044 00259044 40810201 (TXR 0006987) - Unscheduled DNA Synthesis-hepatocytes - Unscheduled DNA Synthesis-HeLa cells - SCE in CHO cells - *in vitro* transformation 10T1/2 cell - *in vitro* transformation /promotion10T1/2 cell - DNA damage in *E. coli* pol A	 Negative Positive with/without activation, not concentration dependent Positive without activation, negative with activation Negative Negative Positive (stronger response without activation)

Table A.2.2 Toxicity Profile for Mancozeb		
Guideline No./Study Type	MRID No. (year)/Classification/Doses	Results
870.7485 Metabolism- rat	00262834 (1986) 00262835 (1986) TXR 0013954 Acceptable/Guideline Single oral dose - 1.5 or 100 mg/kg [^{14}C-ethylene] mancozeb 14 daily doses at 0.75 mg/kg (unlabeled) followed by single oral dose at 1.5 mg/kg (^{14}C-mancozeb)	Majority of radioactivity recovered in excreta within 24 hours of dosing. Radioactivity was evenly distributed between urine (49-56%) and feces (36-65%). Biliary excretion was <9% of AD for the 1.5 mg/kg group and was<4% for the 100 mg/kg dose. Radioactivity was rapidly absorbed into plasma with $t_{1/2}$ absorption times of 0.7-1.0 hour for the low-dose group and 1. 7 hours for the high-dose group. Peak plasma concentrations were reached within 3 hours for the 1.5 mg/kg group and 6 hours for the 100 mg/kg group. The $t_{1/2}$ for the rapid phase of elimination was approximately 4-6 hours for both dose groups. The $t_{1/2}$ for the slow phase of elimination was 36.5 hours in the 1.5 mg/kg group and 25 hours in the 100 mg/kg group. The thyroids had the highest mean residue concentration with peak concentrations reached within 6 hours (1.5 mg/kg) or 24 hours (100 mg/kg). The radioactivity concentrations in the thyroids decreased between 24-48 hours and increased between 48-96 hours. Major compounds in feces were mancozeb and ETU and ETU in urine.
870.7485 Metabolism – mice	41656301 (1990) TXR 0013954 Unacceptable/Guideline; not all urinary metabolites were identified. Data was submitted as surrogate data for a maneb worker reentry data requirement. Single oral dose – 2.5 and 150 mg/kg (^{14}C-mancozeb) 14 daily doses at 2.5 mg/kg (unlabeled) followed by single oral dose at 2.5 mg/kg (^{14}C-mancozeb)	Mancozeb was rapidly absorbed, extensively metabolized, and rapidly excreted. Over a 7-day period, 97-103% of the AD was excreted from the animals. Peak tissue (including plasma) concentration of radioactivity occurred l and 2 hours after the administration of the test compound. One of four major metabolites of mancozeb in the urine was identified to be ETU. The amount of ETU represents <5% of the AD. The remaining 3 major metabolites which constitute significant portion (86-98%) of the urinary radioactivity were not identified.
870.7600 Dermal absorption - rat	MRID 00127950 (1980) TXR 0013954 Acceptable/Non-guideline when considered with MRID 40955401 10 mg Dithane M-45 (83% a.i.)	Mancozeb + ETU in urine for 24 hours was 0.0264 mg and feces 0.0571 mg. A dermal absorption of 1.01% after 6 hours exposure was calculated by summing amounts excreted in urine and feces for 24 hours. Absorption was also calculated by determining disappearance from application site (subtracting amount remaining on bandage and skin from total amount applied). Dermal absorption values of 0.83% for 6 hours exposure and 0.89% for 6 hours followed by recovery for 18 hours were calculated for the disappearance of mancozeb.

Table A.2.2 Toxicity Profile for Mancozeb		
Guideline No./Study Type	MRID No. (year)/Classification/Doses	Results
870.7600 Dermal absorption - rat	40955401 (1988) TXR 0013954 Acceptable/Non-guideline when considered with MRID 00127950 25 µg/cm² or 250 µg/cm² (80.6% a.i. aqueous suspension)	Attempted to quantify mancozeb by conversion to CS_2 but animals produced endogenous CS_2. Since biological samples could not be analyzed for mancozeb, the study authors calculated dermal absorption by subtracting mancozeb (as CS_2) at 10 and 24 hours from recovery at 0 hours. With this method, dermal absorption of mancozeb at 25 µg/cm² was calculated to be 2% at 10 hours and 4% at 24 hours. Dermal absorption of mancozeb at 250 µg/cm² was calculated to be <1% at 24 hours.
870.7800 Immunotoxicity - rat	48794801 (2012) TXR 0056583 Acceptable/Guideline 0, 50, 200, 1000 ppm males: 0, 4, 16, 81 mg/kg/day females: not tested	<u>Systemic:</u> NOAEL=16 mg/kg/day LOAEL= 81 mg/kg/day based on significant increases of absolute and relative liver and thyroid weights <u>Immunotoxicity:</u> NOAEL=81 mg/kg/day (HDT) LOAEL= not established

A.3 ETU Toxicity Profiles

Table A.3.1 Acute Toxicity of ETU				
Guideline No.	Study Type	MRID(s)	Results	Toxicity Category
870.1100	Acute Oral (mouse)	40552601	LD_{50} > 2130 mg/kg (F)	III
870.1200	Acute Dermal (rat)	45888101	LD_{50} > 2,000 mg/kg (M & F)	III
870.1300	Acute Inhalation (rat)	45888102	LC_{50} > 10.4 mg/L (M & F)	IV
870.2400	Primary Eye Irritation (rabbit)	45888104	No irritation[1]	III
870.2500	Primary Skin Irritation (rabbit)	45888103	No irritation	IV
870.2600	Dermal Sensitization	N/A	N/A	N/A

[1] The primary eye irritation study was classified Unacceptable because a UV light was not observed with fluorescein staining, however, another study is not required (M. Lewis, D289726, 4/30/2003)

Table A.3.2 Toxicity Profile of ETU		
Guideline No./Study Type	MRID No (year)/Classification/Doses	Results
870.3100 90-day oral - rat	00160704 (1986) TXR :0005318 Acceptable/Non-guideline 250 ppm males: 14 mg/kg/day females: 18 mg/kg/day	NOAEL = <14 mg/kg/day (LDT) LOAEL = 14 mg/kg/day based on reduced body weight, changes in thyroid hormone and TSH levels, increased thyroid and liver weight, microscopic thyroid hyperplasia and liver hypertrophy

Table A.3.2 Toxicity Profile of ETU		
Guideline No./Study Type	MRID No (year)/Classification/Doses	Results
870.3100 90-day oral - mice	00154192 (1985) Unacceptable/Guideline Unacceptable because ETU concentrations varied widely. 0, 1, 10, 100, 1,000 ppm males: 0, 0.16, 2, 18, 168 mg/kg/day females: 0, 0.22, 2, 24, 231 mg/kg/day	NOAEL = 2 mg/kg/day LOAEL = 18 mg/kg/day based on microscopic thyroid hypertrophy/hyperplasia
870.3100 90-day oral - dog	42174201 (1991) TXR 0009681 Acceptable/Guideline 0, 10, 150, 2000 ppm males: 0, 0.39, 6, 66 mg/kg/day females: 0, 0.42, 7, 72 mg/kg/day	NOAEL = 0.39 mg/kg/day LOAEL = 6 mg/kg/day based on elevated cholesterol. (Note: this endpoint was not considered robust enough for use in risk assessment)
870.4100 Chronic oral toxicity/carcinogenicity - rat	42607801 (1992) TXR 0010729 Unacceptable/Guideline 0, 0.5, 2.5, 5.0, or 125 ppm males: 0, 0.04, 0.17, 0.37, 8.91 mg/kg/day females: 0, 0.05, 0.25, 0.49, 13.57 mg/kg/day	Concentration of ETU in feed varied widely and doses could not be determined. Microscopic thyroid hyperplasia occurred in the low-dose group. At higher doses, changes in thyroid hormone and TSH levels, increased thyroid weight, and grossly enlarged livers. Increases in thyroid follicular adenomas and pituitary adenomas in high-dose males.
Non-guideline Chronic oral toxicity/carcinogenicity – mice	45924403 (1992) Fund. Appl. Tox. 18: 405-417 w/ and w/out perinatal exposure	This study was used to determine the Q1* for ETU of 6.01 x 10^{-2} $(mg/kg/day)^{-1}$ based upon female mouse liver adenomas and/or carcinomas. Thyroid follicular cell adenomas and carcinomas, hepatocellular adenomas and carcinomas, and pituitary adenomas were increased.
870.4100 Chronic oral toxicity - dog	42338101 (1992) Acceptable/Guideline 0, 5, 50, or 500 ppm males: 0, 0.18, 2, 20 mg/kg/day females: 0, 0.19, 2, or 20 mg/kg/day	NOAEL = 0.18 mg/kg/day LOAEL = 2 mg/kg/day based on increased thyroid weight and microscopic changes in thyroid (hypertrophy, follicular dilatation) At the high dose, mortality, anemia, and microscopic hepatocellular necrosis

Table A.3.2 Toxicity Profile of ETU		
Guideline No./Study Type	MRID No (year)/Classification/Doses	Results
870.3150 90-day oral - dog	41863401 (1989) Acceptable/Non-guideline 4-week range-finder 0, 196, 980, 4900 ppm males: 0, 7, 34, or 172 mg/kg/day females: 0, 8, 36, or 197 mg/kg/day	NOAEL = 7 mg/kg/day LOAEL = 34 mg/kg/day based on decreased levels of thyroid hormones, gross thyroid lesions
870.3700 Developmental toxicity - rat	00093929 (1980) Acceptable/Non-guideline 50 mg/kg/day (distilled water) GD 6-15. Only one dose group was included in the study.	<u>Maternal:</u> NOAEL = <50 mg/kg/day LOAEL = 50 mg/kg/day based on decreased body weight gain (↓36%) <u>Developmental</u>: NOAEL = <50 mg/kg/day LOAEL = 50 mg/kg/day based on numerous central nervous system defects (hydrocephaly and related malformations); gross developmental defects; skeletal defects and decreased fetal weight (↓13%).
Non-guideline Developmental toxicity - rat	45937601 (1973) Khera, K.S. 1973. Teratology 7:243-252 0, 5, 10, 20, 40, 80 mg/kg/day	<u>Maternal:</u> NOAEL = 40 mg/kg/day LOAEL = 80 mg/kg/day based on mortality (9 of 11 after 7-8 days) <u>Developmental:</u> NOAEL = 5 mg/kg/day LOAEL = 10 mg/kg/day based on exencephaly, dilated ventricles, and hypoplastic cerebellum. At 20 mg/kg/day, hydrocephalus, encephalocele, meningocele, micrognathia, abnormal flexion of ankle, kinky or twisted tail At ≥40 mg/kg/day ligodactyl, domed head, retarded ossification of the skull occurred. At 80 mg/kg/day coloboma of the eyelids, hemimelia, syndactyl, cleft palate, ectopic kidney, rudimentary calvarium, short tail, scoliosis and several types of skeletal anomalies occurred. Decreased fetal weight was noted at 40 mg/kg/day in group I (↓10%) and group III (↓21%) and at 80 mg/kg/day in group II (↓44%). Fetuses at 40 mg/kg/day in group II had weights comparable to controls. Number of live fetuses and corpora lutea were comparable to controls in all groups.

Table A.3.2 Toxicity Profile of ETU		
Guideline No./Study Type	MRID No (year)/Classification/Doses	Results
Non-guideline Developmental toxicity - rat	45924404 (1979) Chernoff, et al., J. Toxicol. Env. Health 5: 821-834 (1) 0, 5, 10, 20, 30, 40, or 80 mg/kg/day from GD 7-21 (2) 0, 20, 25, or 30 mg/kg/day from GD 7 - PND 15	Maternal: NOAEL = 40 mg/kg/day LOAEL = 80 mg/kg/day based on reduced body weight and 25% maternal mortality *Gestational exposure only*: Developmental: NOAEL = 10 mg/kg/day (↓7% fetal BW) LOAEL = 20 mg/kg/day, based on hydrocephalus (12 fetuses/5 litters) Decreased ossification was also observed at 30 mg/kg/day and above. At 40 mg/kg/day, encephalocele, kyphosis, and digit defects (oligodactyl, syndactyl) were also observed. At 80 mg/kg/day, fetal mortality was increased and there were increases in cleft palate, limb defects (micromelia, hemimelia), edema, and micrognathia. *Gestational and postnatal exposure*: Postnatal toxicity at 30 mg/kg/day included hydrocephalus, dome-shaped heads, and pup mortality
Non-guideline Developmental toxicity - rat	MRID 48985801 (1977) Khera and Tryphonas Tox Appl Pharm 42:85-97. 1977 Dams received a single oral dose on gestation day 15: 0, 15, 30, or 45 mg/kg	Maternal: NOAEL/LOAEL not reported. Developmental: NOAEL = 15 mg/kg LOAEL = 30 mg/kg based on postnatal mortality, hydrocephaly, microphthalmia, cerebellar dysplasia, cerebral atrophy, and in survivors, motor defects and dome-shaped head
Non-guideline Developmental toxicity - rat	No MRID Ruddick and Khera. Teratology 12:277-282, 1975 Dams received a single dose on one gestation day between GD 6-21: 0 or 240 mg/kg	Maternal: No maternal toxicity observed. Developmental: Teratogenic effects in fetuses from GD 10-21; greatest frequency of defects between GD 12-15; no defects before GD 10; ETU affected development of brain, kidney, eye, and axial and appendicular systems
Non-guideline Developmental toxicity - rat	No MRID Saillenfait, *et al.,* Fund. Appl. Toxicol. 17: 300-408, 1991 0, 15, 25, or 35 mg/kg/day from GD 6-20	Maternal: NOAEL= not established LOAEL = 15 mg/kg/day based on decreased body weight gain (LDT) Developmental: NOAEL = 15 mg/kg/day LOAEL = 25 mg/kg/day based on dilated ventricles of the brain, hydroureter, short/kinky tail, and dilated ureters

Table A.3.2 Toxicity Profile of ETU		
Guideline No./Study Type	MRID No (year)/Classification/Doses	Results
		At 35 mg/kg/day, hydrocephaly, anencephaly, meningocele, meningorrhea, hyrdronephrosis, dilated renal pelvis, and vertebral abnormalities were observed
Non-guideline Developmental toxicity -rat	45924405 (1978) Teramoto, et al., Congenital Anomalies 18: 11-17, 1978 0, 10, 20, 30, 40, 50 mg/kg/day GD 6-15	Developmental: NOAEL= <10 mg/kg/day (LDT) LOAEL = 10 mg/kg/day based on dilated brain ventricles At higher doses, fetal death, meningocele, micrognathia, hydronephrosis, renal agenesis, uterine hypoplasia, skeletal anomalies, short/kinky tail, and scoliosis were observed
870.3700 Developmental toxicity - rabbit	47976403 (2010) TXR 0056548 Acceptable/Guideline 0, 5, 15, 50 mg/kg/day GD 7-29	Maternal: NOAEL = 5 mg/kg/day LOAEL = 15 mg/kg/day based on increased resorptions Developmental: NOAEL = 5 mg/kg/day LOAEL = 15 mg/kg/day based on increased resorptions At 50 mg/kg/day post-implantation loss, decreased fetal body weight (↓10%), hydrocephaly (1), and domed head (2) were observed
Non-guideline Developmental toxicity - hamster	45924405 (1978) Teramoto, et al., Congenital Anomalies 18: 11-17, 1978 0, 90, 270, 810 mg/kg/day from GD 6-13	Developmental: NOAEL = 90 mg/kg/day LOAEL = 270 mg/kg/day based on skeletal malformations and short/kinky tail. At 810 mg/kg/day fetal deaths, dilated brain ventricles, cleft palate, micrognathis, and anal atresia were observed
Non-guideline Developmental toxicity - mice	45924405 (1978) Teramoto, et al., Congenital Anomalies 18: 11-17, 1978 0, 200, 400, or 800 mg/kg/day GD 7-15	No maternal or developmental toxicity was observed.
870.3800 Reproduction and post-natal toxicity - rat	42391701 (1992) 42391801 (1992) TXR 0009806 Unacceptable/ Non-guideline Unacceptable because of stability problems. Mg/kg/day could not be calculated. 0, 2.5, 25, 125 ppm	Parental: microscopic thyroid hyperplasia/hypertrophy in mid and/or high-dose groups No reproductive effects attributed to treatment.

Table A.3.2 Toxicity Profile of ETU		
Guideline No./Study Type	MRID No (year)/Classification/Doses	Results
OECD 443 Extended one-generation reproduction toxicity - rat	49140301 (2013) TXR 0056983 Acceptable/Guideline 0, 2.8, 28, or 140 ppm 0, 0.2, 2.0, or 10 mg/kg/day	Parental: NOAEL = 2.8 ppm (0.2 mg/kg/day) LOAEL = 28 ppm (2.0 mg/kg/day) based on an increased incidence of diffuse follicular cell hypertrophy of the thyroid and hypertrophy of the pars distalis of the pituitary in males Offspring: NOAEL = not observed LOAEL = 2.8 ppm (0.2 mg/kg/day) based on an increase in the incidence and severity of individual cells of the pars distalis of the pituitary in males, increased TSH in both sexes and decreases in T4 in PND 4 pups, and diffuse follicular cell hypertrophy of the thyroid in males. Reproduction: NOAEL = 140 ppm (10 mg/kg/day) LOAEL = Not established Developmental neurotoxicity: NOAEL = 28 ppm (2 mg/kg/day) LOAEL = 140 ppm (10 mg/kg/day) based on decreased brain size in both sexes
870.7600 Dermal absorption – rat	40312601 (1987) Acceptable/Non-guideline	Dermal absorption = 51%
OECD 428 *In vitro* dermal absorption (human skin)	MRID 51840901 (2022) Concentrate: 4.75 µg/cm^2 Dilution: 0.31 µg/cm^2 Acceptable/Guideline	DAF of 4% derived from the spray dilution group is most appropriate for risk assessment purposes. Derived from the potentially absorbable dose (receptor fluid [2.50%] + receptor chamber wash [0.064%] + exposed skin [0.33%] + tape strips 3-20 [0.44%]) = 3.34% and rounded up to 4%.
OECD 428 *In vitro* dermal absorption (human skin)	MRID 51841501 (2022) Concentrate: 3.72 µg/cm^2 Dilution: 0.33 µg/cm^2 Acceptable/Guideline	DAF of 6% derived from the spray dilution group is the most appropriate for risk assessment purposes. Derived from the potentially absorbable dose (receptor fluid [4.57%] + receptor chamber wash [0.082%] + exposed skin [0.69%] + tape strips 3-20 [0.296%]) = 5.63% and rounded up to 6%.
870.7800 Immunotoxicity - rat	48794502 (2012) TXR 0056580 Acceptable/Guideline 0, 10, 50, 250 ppm males: 0, 1, 4, 19 mg/kg/day females: not tested	Systemic: NOAEL=not established LOAEL= 1 mg/kg/day (LDT) based on decreased thyroid hormone levels Immunotoxicity: NOAEL=19 mg/kg/day (HDT) LOAEL= not established

A.4 Literature Search for Mancozeb and ETU

Date and Time of Search: 07/09/2020; 10:25 am
Search Details:
((*Mancozeb*)) AND (rat OR mouse OR dog OR rabbit OR monkey OR mammal)

PubMed hits: 209
Number of Swift Articles: 133 for Animal
Number of Swift Articles: 136 for Human
Number of Swift Articles: 0 for No Tag

Date and Time of Search: 07/09/2020; 10:40 am
Search Details:
((*Ethylenethiourea*)) AND (rat OR mouse OR dog OR rabbit OR monkey OR mammal)

PubMed hits: 291
Number of Swift Articles: 232 for Animal
Number of Swift Articles: 141 for Human
Number of Swift Articles: 0 for No Tag

All studies identified in the PubMed search were screened when the citation list was ≤100. Screening of larger citations lists (>100 citations) was conducted after prioritization in SWIFT-Review and focused on studies identified with the "Animal" and/or "Human" tag.

Conclusion of Literature Search: Following title/abstract and/or full text screening, a number of studies were identified which could provide qualitative characterization to the toxicity profiles of mancozeb and ETU. However, all target organs and effects observed in the open literature have already been identified and characterized within the current toxicity databases available for pesticide registration. None of the studies were deemed to contain potentially new quantitative information for the mancozeb/ETU human health risk assessment. One study, Maranghi, *et al.,* 2013, provided similar and complementary results as observed in the EOGRTS with ETU and is discussed in more detail in Section 4.3.

*PubMed is a freely available search engine that provides access to life science and biomedical references predominantly using the MEDLINE database.

**SWIFT-Review is a freely available software tool created by Sciome LLC that assists with literature prioritization. SWIFT-Review was used to prioritize studies identified in the PubMed search based on the model of interest in the study (e.g. human, animal, *in vitro*, etc.).
Studies could have resulted in multiple tags which would account for citations identified in PubMed not matching the number of tagged citations."

Appendix B. Physical/Chemical Properties

Table B.1 Physicochemical Properties of Mancozeb [1]				
Parameter	Mancozeb Polymer		Mancozeb Anionic Monomer ($C_4H_6N_2S_4$)	
	Value	Source, Study MRID[2] (Classification)	Value	Source, Study MRID[2] (Classification)
Molecular Weight	540.7 g mole^{-1}	Calculated	210.19 g mole^{-1}	Calculated
Water Solubility	0.67; 6.2, and 16 ppm	MRID 45736503 (A); EU database[2]; Registrant follow-up; Practically insoluble	2.814 x 10^4 ppm @ 25°C	EPI SUITE v4.11 Highly soluble; Semi volatile
Vapor Pressure (V.P)	<2.10 × 10^{-8} torr @ 20°C	MRID 45736503 (A) Non-volatile under field conditions	1.77 × 10^{-6} torr @ 25°C	
Henry's Law Content	<1,88 x 10^{-6} to <7.88 x 10^{-8} atm. m^3 mole^{-1} @20°C	Estimated from V.P., M. Wt. & W. Sol.; Non-volatile from water	2.25 x 10^{-11} atm. m^3 mole^{-1} @25°C	Estimated from V.P., molecular weight and solubility; Non-volatile from water
Octanol-water partition coefficient: K_{OW} (log K_{OW})	--	--	0.62 (4.17)	EPI SUITE v4.11; Not likely to bioconcentrate

[1] Reference: EFED Memo; M. Ruhman, D459932, 12/10/2020

[2] Study Classification: A= Acceptable; S= Supplemental and U= Un-acceptable; EU Pesticide properties database URL: https://sitem.herts.ac.uk/aeru/ppdb/en/Reports/424.htm

Table B.2 Physicochemical Properties of ETU [1]		
Parameter [2]	Value	Study MRID (Classification) [3]
Molecular Weight (M. Wt.); PC code	102.2 g mole^{-1}; PC code: 600016	PubChem[3] Highly soluble, No significant volatility
	$C_3H_6N_2S$ CAS: 96-45-7	
Water Solubility at 30 °C (Sol.)	20 g L^{-1}	
Vapor Pressure (V.P. torr)	2.02×10^{-6} @ 25°C	
Henry's Law constant (atm-m^3 mole^{-1})	1.36×10^{-13} @ 25°C	Estimated (V.P, Sol.& M. wt.); Not likely to volatilize from water/wet soil
Log Dissociation Constant (pKa)	Not determined (Forms no OH or H ions)	MRID 45736503 (A) Not likely to bioconcentrate
Octanol-water partition coefficient: log K_{OW} (K_{OW})	-1.08 (0.08)	

[1] Reference: EFED Memo; M. Ruhman, D459932, 12/10/2020

[2] ETU was the test material used in organic carbon normalized distribution coefficients (adsorption/desorption study and in the Steady State Bioconcentration Factor

[3] - PubChem URL: https://pubchem.ncbi.nlm.nih.gov/compound/2723650

- [N] Studies submitted since the problem formulation was completed are designated as MRID[N]
- Study Classification: A= Acceptable; S= Supplemental and U= Unacceptable
- This adsorption/desorption was originally classified as unacceptable due to the possibility of occurrence of degradation of ETU before conducting the experiment. However, the study was classified as supplemental following registrant submittal of data suggesting that the applied test substance included significant quantities of ETU.

Appendix C. Review of Human Research

This risk assessment relies in part on data from studies in which adult human subjects were intentionally exposed to a pesticide or other chemical. These data, which include studies from PHED 1.1; the AHETF database; the Outdoor Residential Exposure Task Force (ORETF) database; the ARTF database; ExpoSAC Policy 14 (SOPs for Seed Treatment); the Residential SOPs (Lawns/Turf, Gardens/Trees); and other registrant-submitted exposure monitoring studies (44958501, 44959601, 44959602, 44959603, 44961701), are (1) subject to ethics review pursuant to 40 CFR 26, (2) have received that review, and (3) are compliant with applicable ethics requirements. For certain studies, the ethics review may have included review by the Human Studies Review Board. Descriptions of data sources, as well as guidance on their use, can be found at the Agency website[17].

[17] https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/occupational-pesticide-handler-exposure-data and https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/occupational-pesticide-post-application-exposure

Appendix D. International Residue Limits Status Sheet.

(014504; 07/20/2020)

Summary of US and International Tolerances and Maximum Residue Limits.					
Residue Definition:					
US	Canada			Mexico	Codex
40 CFR §180.176(a) *General.* Mancozeb, a coordination product of zinc ion and maneb (manganese ethylenebisdithiocarbamate, expressed in terms of the degradate carbon disulfide.	Ethylenebis-dithiocarbamate fungicides: manganese and zinc ethylenebis(dithiocarbamate) (polymeric).				Dithiocarbamates: For compliance with MRLs in plant and animal commodities: Total dithiocarbamates, determined as CS_2, evolved during acid digestion and expressed as mg CS_2/kg.
Commodity[1]	*Tolerance (ppm)/Maximum Residue Limit (mg/kg)*				
	US Established	HED-Recommended	Canada	Mexico[2]	Codex
Almond	0.1	0.1			0.1
Almond, hulls	4	4			20
Apple	0.6	0.6	7		5
Asparagus	0.1	0.1			0.1
Atemoya	3.0	3			
Banana	2	2			2
Barley, bran	2	2			
Barley, flour	1.2	1.2			
Barley, grain	1	1			1
Barley, hay	30	30			
Barley, pearled barley	20	20			
Barley, straw	25	25			25 barley straw and fodder, dry
Beet, sugar, dried pulp	3.0	3			
Beat, sugar, roots	1.2	1.2			0.5
Beet, sugar, leaves	60	60			
Broccoli	7	7	7		
Cabbage	9	9	7		5
Canistel	15.0	15			
Cattle, meat byproducts	0.5	0.5			0.1
Cherimoya	3.0	3			
Corn, field, forage	40	40			
Corn, field, grain	0.06	0.06			
Corn, field, stover	15	15			
Corn, pop, grain	0.1	0.1			
Corn, pop, stover	40	40			
Corn, sweet, forage	70	70			
Corn, sweet, kernel plus cob with husks removed	0.1	0.1			0.1
Corn, sweet, stover	40	40			2 maize fodder dry
Cotton, undelinted seed	0.5	0.5			
Crabapple	0.6	0.6			5
Cranberry	5	5			5
Custard apple	3.0	3			

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Commodity[1]	*Tolerance (ppm)/Maximum Residue Limit (mg/kg)*				
	US Established	HED-Recommended	Canada	Mexico[2]	Codex
Fennel, Florence, fresh leaves and stalk	2.5	2.5			
Flax, seed	0.15	0.15			
Ginseng	1.2	1.2			0.3 root 1.5 dried

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Commodity[1]	*Tolerance (ppm)/Maximum Residue Limit (mg/kg)*				
	US Established	HED-Recommended	Canada	Mexico[2]	Codex
Goat, meat byproducts	0.5	0.5			0.1
Grape	1.5	1.5	7		5
Hog, meat byproducts	0.5	0.5			0.1
Horse, meat byproducts	0.5	0.5			0.1
Lettuce, head	3.5	3.5	7		0.5
Lettuce, leaf	18	18	7		10 romaine
Mango	15.0	15			2
Oat, flour	1.2	1.5			
Oat, grain	1	1			
Oat, groats/rolled oat	20	20			
Oat, hay	30	30			
Oat, straw	25	25			
Onion, bulb	1.5	1.5	0.5		0.5
Papaya	9	9			5
Peanut	0.1	0.1			0.1
Peanut, hay	65	65			5 peanut fodder
Pear	0.6	0.6	7		5
Pepper, bell	12	12	7		1

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Commodity[1]	*Tolerance (ppm)/Maximum Residue Limit (mg/kg)*				
	US Established	HED-Recommended	Canada	Mexico[2]	Codex
Pepper, nonbell	12	12	7		3 nonbell peppers 20 dried chili pepper
Potato	0.2	0.2			0.2
Poultry, meat byproducts	0.5	0.5			0.1 edible offal
Quince	0.6	0.6			5
Rice, grain	0.06	0.06			
Rye, bran	2	2			
Rye, flour	1.2	1.5			
Rye, grain	1	1			
Rye, straw	25	25			
Sapodilla	15.0	15			
Sapote, mamey	15.0	15			
Sapote, white	15.0	15			
Sheep, meat byproducts	0.5	0.5			0.1
Sorghum, grain, forage	0.15	0.15			
Sorghum, grain, grain	0.25	0.25			
Sorghum, grain, stover	0.15	0.15			
Star apple	15.0	15			
Sugar apple	3.0	3			
Tangerine[3]	10	10			10 mandarins
Tomato	2.5	2.5	4		2
Vegetable, cucurbit, group 9	2.0	2	4 cucumber		2 cucumber 1 summer squash 0.1 winter squash

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40 CFR §180.176(a) *General.* Mancozeb, a coordination product of zinc ion and maneb (manganese ethylenebisdithiocarbamate, expressed in terms of the degradate carbon disulfide.	Ethylenebis-dithiocarbamate fungicides: manganese and zinc ethylenebis(dithiocarbamate) (polymeric).				Dithiocarbamates: For compliance with MRLs in plant and animal commodities: Total dithiocarbamates, determined as CS_2, evolved during acid digestion and expressed as mg CS_2/kg.
Commodity[1]	*Tolerance (ppm)/Maximum Residue Limit (mg/kg)*				

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Residue Definition:					
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40 CFR §180.176(a) *General.* Mancozeb, a coordination product of zinc ion and maneb (manganese ethylenebisdithiocarbamate, expressed in terms of the degradate carbon disulfide.	Ethylenebis-dithiocarbamate fungicides: manganese and zinc ethylenebis(dithiocarbamate) (polymeric).				Dithiocarbamates: For compliance with MRLs in plant and animal commodities: Total dithiocarbamates, determined as CS_2, evolved during acid digestion and expressed as mg CS_2/kg.
Commodity[1]	*Tolerance (ppm)/Maximum Residue Limit (mg/kg)*				
	US Established	HED-Recommended	Canada	Mexico[2]	Codex
	US Established	HED-Recommended	Canada	Mexico[2]	Codex
Walnut, black	0.70	0.7			
Walnut, English	0.70	0.7			
Wheat, bran	2	2			
Wheat, flour	1.2	1.2			
Wheat, germ	20	20			
Wheat, grain	1	1			1
Wheat, hay	303	30			
Wheat, middlings	20	20			
Wheat, shorts	2	2			
Wheat, straw	25	25			25 straw and fodder dry
Completed using Global MRL. 20-July-2020					

[1] Includes all commodities relevant to this chemical.

[2] Mexico adopts US tolerances and/or Codex MRLs for its export purposes.

[3] There are no U.S. registrations for use of mancozeb on tangerine. Includes all commodities relevant to this chemical.

Appendix E. Summary of Use Directions

Table E.1. Summary of Use Directions for Registered Uses of Mancozeb - Foliar

Crop/ Use Site	Formulation[1]	% AI	Registration Number	Application Type and Equipment	Application Rate (lb. ai/A)	Gallons of Water/Acre	Retreatment Interval (RTI; days)	Restricted Entry Interval (REI)	Pre-Harvest Interval (PHI; days)	Personal Protective Equipment (PPE)[2]
Orchard/Vineyard[3]										
Almond	DF	75	70506-234	Aerial, Ground, Handheld, Chemigation	4.8	2	7	24	NS	SL, G
	SC	75	34704-1120	Aerial, Ground, Handheld, Chemigation	4.8	10	7	24	NS	SL, G, Protective Eyewear
Banana	DF	75	70506-234	Aerial, Ground, Handheld, Chemigation	2.25	2	14	24	0	SL, G
	FC	37	70506-194; 62719-396	Aerial, Ground, Handheld, Chemigation	2.4	2	14	24	0	SL, G
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	2.4	2	14	24	0	SL, G
Caprifig	DF	75	70506-234	Dip Treatment	0.03 lb ai/gal	100	NS	24	NS	SL, G
	SC	75	34704-1120	Dip Treatment	0.03 lb ai/gal	100	NS	24	NS	SL, G, Protective Eyewear
	WP	80	70506-183	Dip Treatment	0.03 lb ai/gal	25	NS	24	NS	SL, G
Christmas Trees	DF	75	1001-77; 70506-234	Aerial, Ground, Handheld, Chemigation	3	1	7	24	14	SL, G
	FC	37	70506-194; 62719-396	Aerial, Ground, Handheld, Chemigation	3.2	2	14	24	14	SL, G
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	3.2	10	14	24	14	SL, G

Table E.1. Summary of Use Directions for Registered Uses of Mancozeb - Foliar

Crop/ Use Site	Formulation[1]	% AI	Registration Number	Application Type and Equipment	Application Rate (lb. ai/A)	Gallons of Water/Acre	Retreatment Interval (RTI; days)	Restricted Entry Interval (REI)	Pre-Harvest Interval (PHI; days)	Personal Protective Equipment (PPE)[2]
Grapes, Table/Raisin/Wine/Juice	DF	75	70506-194	Aerial, Ground, Handheld, Chemigation	3	2	3'', 8'', 7-10d	24	66	SL, G
	FC	37	70506-194; 62719-396	Aerial, Ground, Handheld, Chemigation	3.2	2	0.5", 3", 8", 7-10d	24	66	SL, G
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	3.2	10	0.5", 3", 8", 7-10d	24	66	SL, G
Papaya	DF	75	70506-234	Aerial, Ground, Handheld, Chemigation	1.88	50	14	24	0	SL, G
	FC	37	70506-194; 62719-396	Aerial, Ground, Handheld, Chemigation	2	20	14	24	0 to 14	SL, G
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	1.6	2	14	24	0	SL, G
Pome Fruits (Apple, Crabapple, Quince, Pear)	DF	75	70506-234	Aerial, Ground, Handheld, Chemigation	4.5	50	7	24	77 or DNA after bloom	SL, G
	FC	37	70506-194; 62719-396	Aerial, Ground, Handheld, Chemigation	4.8	2	7	24	77 or DNA after bloom	SL, G
	WP	80	70506-183	**Aerial, Ground, Chemigation**	**4.8**	**50**	7	24	77	SL, G, R
	DF	75	OR170001; WA090019; WA120007	**Ground (Pear only)**	**6.38**	**100**	7	24	77	SL, G, Protective Eyewear
Subtropical/Tropical Fruit (Sugar Apple, Cherimoya, Atemoya, Custard Apple, Sweetsop, Mango, Star Apple, Canistel, Mamey sapote, sapodilla, white sapote))	DF	75	70506-234	Aerial, Ground, Handheld, Chemigation	1.88	10	7	24	0	SL, G
	SC	75	34704-1120	Aerial, Ground, Handheld, Chemigation	1.88	10	7 to 14	24	0	SL, G, Protective Eyewear
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	2	10	7 to 14	24	0	SL, G
Walnut	DF	75	70506-234	Aerial, Ground, Handheld	1.8	10	7	24	75	SL, G, R-Aerial
	SC	75	34704-1120	Aerial, Ground, Handheld	1.8	10	7	24	75	SL, G, Protective Eyewear, R-Aerial

Table E.1. Summary of Use Directions for Registered Uses of Mancozeb - Foliar										
Crop/ Use Site	**Formulation[1]**	**% AI**	**Registration Number**	**Application Type and Equipment**	**Application Rate (lb. ai/A)**	**Gallons of Water/Acre**	**Retreatment Interval (RTI; days)**	**Restricted Entry Interval (REI)**	**Pre-Harvest Interval (PHI; days)**	**Personal Protective Equipment (PPE)[2]**
Typical Acreage Field Crop[3]										
Asparagus	DF	75	70506-234	Aerial, Ground, Handheld, Chemigation (fern)	1.5	2	10	24	120	SL, G
				Dip Treatment	**0.0075 lb ai/gal**	**100**	NS		NS	
	FC	37	62719-396; 70506-194	Aerial, Ground, Handheld, Chemigation: fern	1.6	2	10	24	120 to 180	SL, G
				Dip Treatment	**0.008 lb ai/gal**	**100**	NS		NS	
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation (fern)	1.6	2	10	24	120 to 180	SL, G
				Dip Treatment	**0.008 lb ai/gal**	**100**	NS		NS	
Broccoli	DF	75	70506-234	Aerial, Ground, Handheld, Chemigation	1.58	2	7	24	7	SL, G, R-Aerial
	FC	37	70506-194; 62719-396	Aerial, Ground, Handheld, Chemigation	1.6	2	7	24	7	SL, G, R-Aerial
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	1.6	2	7	24	7	SL, G
Cabbage	DF	75	70506-234	Aerial, Ground, Handheld, Chemigation	1.58	2	7	24	7	SL, G, R-Aerial
	SC	75	34704-1120	Aerial, Ground, Handheld, Chemigation	1.5	2	7	24	7	SL, G, Protective Eyewear, R-Aerial
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	1.6	2	7	24	7	SL, G
Carrot (including tops)	DF	75	ID080012; OR170003; OR130003; WA030030	Aerial, Ground, Handheld,, Chemigation	1.5	10	7	24-48	NS	SL, G, Protective Eyewear-WA030030
	FC	37	OR090016; WA090020	Aerial, Ground, Handheld,	1.5	2	7	24	NS	SL, G

Table E.1. Summary of Use Directions for Registered Uses of Mancozeb - Foliar

Crop/ Use Site	Formulation[1]	% AI	Registration Number	Application Type and Equipment	Application Rate (lb. ai/A)	Gallons of Water/Acre	Retreatment Interval (RTI; days)	Restricted Entry Interval (REI)	Pre-Harvest Interval (PHI; days)	Personal Protective Equipment (PPE)[2]
9. Cucurbit Vegetables (Cantaloupe, Cucumber, Gourd, Pumpkin, Squash, Melons, and Squash)	DF	75	1001-77; 70506-234	Aerial, Ground, Handheld, Chemigation	2.25	2	7	24	5	SL, G
	FC	37	62719-396; 70506-194	Aerial, Ground, Handheld, Chemigation	2.4	2	7	24	5	SL, G
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	2.4	10	7	24	5	SL, G
Chard, Swiss	DF	75	OR020030; OR130003; WA020028; WA130003	Aerial, Ground, Handheld,	1.5	2	7	24	NS	SL, G
	FC	37	OR090016; WA090020	Aerial, Ground, Handheld,	1.5	2	7	24	NS	SL, G
Coriander	DF	75	OR020030; OR130003; WA020028; WA130003	Aerial, Ground, Handheld,	1.5	2	7	24	NS	SL, G
	FC	37	OR090016; WA090020	Aerial, Ground, Handheld,	1.5	2	7	24	NS	SL, G
Corn, Sweet	DF	75	70506-234	Aerial, Ground, Handheld, Chemigation	1.13	2	4	24	7 to 40	SL, G
	FC	37	70506-194; 62719-396	Aerial, Ground, Handheld, Chemigation	1.2	2	4	24	7 to 40	SL, G
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	1.2	2	4	24	7 to 40	SL, G
Cranberry	**DF**	**75**	**70506-234**	**Aerial, Ground, Chemigation**	**4.5**	**2**	**7**	**24**	**30**	**SL, G**
	FC	**37**	**70506-194; 62719-396**	**Aerial, Ground, Chemigation**	**4.8**	**2**	**7**	**24**	**30**	**SL, G**
	WP	**80**	**70506-183**	**Aerial, Ground, Chemigation**	**4.8**	**2**	**7**	**24**	**30**	**SL, G**
Dill	DF	75	OR020030; OR130003; WA130003; WA020028	Aerial, Ground, Handheld	1.5	2	7	24	NS	SL, G
	FC	37	OR090016; WA090020	Aerial, Ground, Handheld	1.5	2	7	24	NS	SL, G

Table E.1. Summary of Use Directions for Registered Uses of Mancozeb - Foliar

Crop/ Use Site	Formulation[1]	% AI	Registration Number	Application Type and Equipment	Application Rate (lb. ai/A)	Gallons of Water/Acre	Retreatment Interval (RTI; days)	Restricted Entry Interval (REI)	Pre-Harvest Interval (PHI; days)	Personal Protective Equipment (PPE)[2]
Endive (Escarole)	DF	75	OR020030; OR130003; WA130003; WA020028	Aerial, Ground, Handheld	1.5	2	7	24	NS	SL, G
	FC	37	OR090016; WA090020	Aerial, Ground, Handheld,	1.5	2	7	24	NS	SL, G
Fennel	DF	75	70506-234	Aerial, Ground, Handheld, Chemigation	1.5	2	7	24	14	SL, G
	FC	37	70506-194; 62719-396	Aerial, Ground, Handheld, Chemigation	1.6	2	7	24	14	SL, G
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	1.6	2	7	24	14	SL, G
Garden Beet	DF	75	OR020030; OR130003; WA020028	Aerial, Ground, Handheld	1.5	2	7	24	NS	SL, G
	FC	37	OR090016; WA090020	Aerial, Ground, Handheld	1.5	2	7	24	NS	SL, G
Garlic	DF	75	70506-234	Aerial, Ground, Handheld, Chemigation	2.25	2	7	24	7	SL, G
	FC	37	70506-194; 62719-396	Aerial, Ground, Handheld, Chemigation	2.4	2	7	24	7	SL, G
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	2.4	2	7	24	7	SL, G
Ginseng	DF	75	70506-234	Aerial, Ground, Handheld, Chemigation	1.5	2	7	24	30	SL, G
	SC	75	34704-1120	Aerial, Ground, Handheld, Chemigation	1.5	2	7	24	30	SL, G, Protective Eyewear
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	1.6	2	7	24	30	SL, G
Leafy Brassica Greens	DF	75	WA020028	Aerial, Ground, Handheld	1.5	2	7	24	NS	SL, G
	FC	37	WA090020	Aerial, Ground, Handheld	1.5	2	7	24	NS	SL, G

Table E.1. Summary of Use Directions for Registered Uses of Mancozeb - Foliar										
Crop/ Use Site	Formulation[1]	% AI	Registration Number	Application Type and Equipment	Application Rate (lb. ai/A)	Gallons of Water/Acre	Retreatment Interval (RTI; days)	Restricted Entry Interval (REI)	Pre-Harvest Interval (PHI; days)	Personal Protective Equipment (PPE)[2]
Leek	DF	75	OR020030; OR130003; WA020028; WA130003	Aerial, Ground, Handheld	1.5	2	7	24	NS	SL, G
	FC	37	OR090016; WA090020	Aerial, Ground, Handheld	1.5	2	7	24	NS	SL, G
Lettuce	DF	75	70506-234; 90332-2; OR020030; OR130003; WA020028; WA130003	Aerial, Ground, Handheld, Chemigation	1.88	2	7	24	10 to 14	SL, G, R-Aerial
	FC	37	62719-396; 70506-194; OR090016; WA090020	Aerial, Ground, Handheld, Chemigation	1.6	2	7	24	10 to 14	SL, G, R-Aerial
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	1.6	2	7	24	10 to 14	SL, G
Onion	DF	75	70506-234; OR130003; OR020030; WA020028; WA130003	Aerial, Ground, Handheld, Chemigation	2.25	2	7	24	7	SL, G
	FC	37	62719-396; 70506-194; OR090016; WA090020	Aerial, Ground, Handheld, Chemigation	2.4	2	7	24	7	SL, G
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	2.4	2	7	24	7	SL, G
Parsley	DF	75	OR130003; OR020030; WA020028; WA130003	Aerial, Ground, Handheld	1.5	2	7	24	NS	SL, G
	FC	37	OR090016; WA090020	Aerial, Ground, Handheld	1.5	2	7	24	NS	SL, G
Parsnip	DF	75	OR130003; OR020030; WA020028; WA130003	Aerial, Ground, Handheld	1.5	2	7	24	NS	SL, G
	FC	37	OR090016; WA090020	Aerial, Ground, Handheld	1.5	2	7	24	NS	SL, G

Table E.1. Summary of Use Directions for Registered Uses of Mancozeb - Foliar

Crop/ Use Site	Formulation[1]	% AI	Registration Number	Application Type and Equipment	Application Rate (lb. ai/A)	Gallons of Water/Acre	Retreatment Interval (RTI; days)	Restricted Entry Interval (REI)	Pre-Harvest Interval (PHI; days)	Personal Protective Equipment (PPE)[2]
Pepper	DF	75	70506-234	Aerial, Ground, Handheld, Chemigation	2.4	2	7	24	7	SL, G, R-Aerial
	FC	37	70506-194; 62719-396	Aerial, Ground, Handheld, Chemigation	2.4	2	7	24	7	SL, G, R-Aerial
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	1.6	2	7	24	7	SL, G
Plantain	DF	75	70506-234	Aerial, Ground, Handheld, Chemigation	2.25	2	14	24	0	SL, G
	FC	37	70506-194; 62719-396	Aerial, Ground, Handheld, Chemigation	2.4	2	14	24	0	SL, G
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	2.4	2	14	24	0	SL, G
Shallott	DF	75	70506-234	Aerial, Ground, Handheld, Chemigation	2.25	2	7	24	7	SL, G
	FC	37	70506-194; 62719-396	Aerial, Ground, Handheld, Chemigation	2.4	2	7	24	7	SL, G
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	2.4	2	7	24	7	SL, G
Spinach	DF	75	OR020030; OR130003; WA020028; WA130003	Aerial, Ground, Handheld	1.5	2	7	24	NS	SL, G, R-Aerial
	FC	37	OR090016; WA090020	Aerial, Ground, Handheld	1.5	2	7	24	NS	SL, G, R-Aerial
Tobacco	DF	75	OH020006; PA080001; MD080004; MO080004; NC080002; OH080003; SC080004; TN080007; VA080004; CT120001; CT140002; IN120001; MO120007; OH120001; PA120002; SC120006; VA120004; KY110033; MA150001; TN140003; CT140001;	Aerial, Ground, Handheld, Chemigation	1.96	100	5 to 7	24	21 to 30	SL, G

Table E.1. Summary of Use Directions for Registered Uses of Mancozeb - Foliar										
Crop/ Use Site	**Formulation[1]**	**% AI**	**Registration Number**	**Application Type and Equipment**	**Application Rate (lb. ai/A)**	**Gallons of Water/Acre**	**Retreatment Interval (RTI; days)**	**Restricted Entry Interval (REI)**	**Pre-Harvest Interval (PHI; days)**	**Personal Protective Equipment (PPE)[2]**
			KY080005; NC080003; TN080009; VA080005							
Tomato	DF	75	70506-234	Aerial, Ground, Handheld, Chemigation	2.25	2	7	24	5	SL, G
	SC	75	34704-1120	Aerial, Ground, Handheld, Chemigation	2.25	2	7	24	5	SL, G, Protective Eyewear
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	2.4	2	7	24	5	SL, G
High Acreage Field Crop[3]										
Barley	**DF**	**75**	**70506-234**	**Aerial, Ground, Handheld, Chemigation**	**1.5**	**2**	**7**	**24**	**26**	**SL, G**
	FC	**37**	**70506-194; 62719-396**	**Aerial, Ground, Handheld, Chemigation**	**1.6**	**2**	**7**	**24**	**26 to 46**	**SL, G**
	WP	**80**	**70506-183**	**Aerial, Ground, Handheld, Chemigation**	**1.6**	**2**	**7**	**24**	**26 to 46**	**SL, G**
Corn, Field/Pop	DF	75	70506-234	Aerial, Ground, Handheld, Chemigation	1.13	2	4	24	7 to 40	SL, G
	FC	37	70506-194; 62719-396	Aerial, Ground, Handheld, Chemigation	1.2	2	4	24	7 to 40	SL, G
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	1.2	2	4	24	7 to 40	SL, G
Peanuts	DF	75	70506-234	Aerial, Ground, Handheld	1.5	2	7	24	14	SL, G
	FC	37	70506-194; 62719-396	Aerial, Ground, Handheld, Chemigation	1.6	2	7	24	14	SL, G
	WP	80	70506-183	Aerial, Ground, Handheld, chemigation	1.6	2	7	24	14	SL, G

Table E.1. Summary of Use Directions for Registered Uses of Mancozeb - Foliar

Crop/ Use Site	Formulation[1]	% AI	Registration Number	Application Type and Equipment	Application Rate (lb. ai/A)	Gallons of Water/Acre	Retreatment Interval (RTI; days)	Restricted Entry Interval (REI)	Pre-Harvest Interval (PHI; days)	Personal Protective Equipment (PPE)[2]
Potato	DF	75	70506-234; 90332-2	Aerial, Ground, Handheld, Chemigation	1.5	2	3 to 5	24	3 to 14	SL, G
				Dip Treatment	**0.0188 lb/gal**	**50**	NS	24	NS	
	SC	75	34704-1120	Aerial, Ground, Handheld, Chemigation	1.5	2	3	24	3 to 14	SL, G, Protective Eyewear
				Dip Treatment	**0.0188 lb/gal**	**50**	NS		NS	SL, G, Protective Eyewear, R
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	1.68	2	5	24	3 to 14	SL, G
				Dip Treatment	**0.02 lb/gal**	**50**	NS		NS	
Rye, Wheat, Triticale, Oats	DF	75	70506-234	Aerial, Ground, Handheld, Chemigation	1.5	3	7	24	26	SL, G
	FC	37	70506-194; 62719-396	Aerial, Ground, Handheld, Chemigation	1.6	2	7	24	26-46	SL, G
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	1.6	2	7	24	26-46	SL, G
Sugar Beet	DF	75	70506-234; OR020030; OR130003	Aerial, Ground, Handheld, Chemigation	1.5	2	7	24	14	SL, G
	FC	37	70506-194; 62719-396; OR090016	Aerial, Ground, Handheld, Chemigation	1.6	2	7	24	14	SL, G
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	1.6	2	7	24	14	SL, G
Turf (Sod, Golf Course)[3]										
Sod	DF	75	70506-234; 1001-77	Aerial, Ground, Handheld	17.4	44	10	24	5	SL, G
	SC	75	34704-1120	Aerial, Ground, Handheld, Chemigation	17.4	5	10	24	5	SL, G, R

Table E.1. Summary of Use Directions for Registered Uses of Mancozeb - Foliar										
Crop/ Use Site	**Formulation[1]**	**% AI**	**Registration Number**	**Application Type and Equipment**	**Application Rate (lb. ai/A)**	**Gallons of Water/Acre**	**Retreatment Interval (RTI; days)**	**Restricted Entry Interval (REI)**	**Pre-Harvest Interval (PHI; days)**	**Personal Protective Equipment (PPE)[2]**
Golf Course (Greens and Tees)	DF	75	70506-234; 1001-77	Aerial, Ground, Handheld, Chemigation	17.4	44	10	24	NS	SL, G
	SC	75	34704-1120	Aerial, Ground, Handheld, Chemigation	17.4	5	10	24	NS	SL, G, Protective Eyewear
	WSP	64	58185-31	Ground, Handheld	10.45	218	NS	NS	NS	SL, G, R, Headgear, WSP
Golf Course (Fairways)/Professional/Industrial/Institutional	DF	75	70506-234; 1001-77	Aerial, Ground, Handheld, Chemigation	17.4	44	10	24	NS	SL, G
	SC	75	34704-1120	Aerial, Ground, Handheld, Chemigation	17.4	5	10	24	NS	SL, G, Protective Eyewear
	WSP	64	58185-31	Ground, Handheld	10.45	218	NS	NS	NS	SL, G, R, Headgear, WSP
	WSP	64	58185-31	Ground, Handheld	10.45	218	NS	NS	NS	SL, G, R, Headgear, WSP
Nursery or Greenhouse Vegetables and Ornamentals; Landscaping, plants/flowers/trees/shrubs[3]										
Ornamentals: Indoor/Outdoor	DF	75	1001-77; 70506-234	Aerial, Ground, Handheld, Chemigation	1.5	10; 5 (aerial)	7	24	NS	SL, G
	FC	37	70506-194; 62719-396	Aerial, Ground, Handheld, Chemigation	1.2	100	7	24	NS	SL, G
	WP	80	70506-183	Aerial, Ground, Handheld, Chemigation	1.6	100	7	24	NS	SL, G
	WSP	64	58185-31	Ground, Handheld	1.44	75	7	24	NS	SL, G, R, Headgear, WSP
Cut Flowers	FC	37	62719-396	Aerial, Ground, Handheld, Chemigation	1.2	100	7	24	NS	SL, G
	WSP	**64**	**58185-31**	**Ground, Handheld**	**2.05**	**100**	**7**	**24**	**NS**	**SL, G, R, Headgear, WSP**
Vegetable Transplants (Cucumbers, Fennel, Melons, Squash, Tomatoes)	**DF**	**75**	**1001-77**	**Aerial, Ground, Handheld Chemigation**	**2.25**	**200**	**7 to 10**	**24**	**5 to 14**	**SL, G**

[1] DF = dry flowable. FC = flowable concentrate. WP = wettable powder. WSP = water-soluble packet.
[2] PPE: SL, G = single layer, gloves. R = respirator. Headgear = chemical-resistant headgear. WSP = water-soluble packet.
[3] Occupational handler category.
[4] **Bold text** = highest rates used for assessment.

Table E.2. Summary of Use Directions for Registered Uses of Mancozeb – Seed Treatment.

Use Site	Amount Seed Treated (Commercial)	Amount Seed Treated (On Farm)	lb seed planted/day	Form[1]	%AI	Reg. No	Equipment	lb ai/lb seed	Personal Protective Equipment (PPE)[2]
Cereal Grains (Barley)	360,000 (Wheat surrogate)	19,600	19,600	DF	75	70506-234	Seed Treatment, Commercial	0.0315	SL, G
				FC	37	62719-396	Seed Treatment, Commercial	0.00209	SL, G
				EC	37	70506-345	Seed Treatment, On Farm	0.00209	SL, G, R
				D	10	400-558	Seed Treatment, On Farm	0.00131	SL, G, R
				WP	80	70506-183	Seed Treatment, Commercial (Planter Box Only)	0.0021	SL, G, R
Cereal Grains (Oats)	360000 (Wheat surrogate)	18,000	18,000	DF	75	70506-234	Seed Treatment, Commercial	0.0473	SL, G
				FC	37	62719-396	Seed Treatment, Commercial	0.00313	SL, G
				EC	37	70506-345	Seed Treatment, On Farm	0.00313	SL, G, R
				D	10	400-558	Seed Treatment, On Farm	0.00197	SL, G, R
				WP	80	70506-183	Seed Treatment, Commercial (Planter Box Only)	0.00315	SL, G, R
Cereal Grains (Rye)	360000 (Wheat surrogate)	18,000	18,000	DF	75	70506-234	Seed Treatment, Commercial	0.027	SL, G
				FC	37	62719-396	Seed Treatment, Commercial	0.00178	SL, G
				EC	37	70506-345	Seed Treatment, On Farm	0.00178	SL, G, R
				D	10	400-558	Seed Treatment, On Farm	0.00113	SL, G, R
				WP	80	70506-183	Seed Treatment, Commercial (Planter Box Only)	0.0018	SL, G, R
Cereal Grains (Sorghum)	360000 (Wheat surrogate)	960	960	DF	75	70506-234	Seed Treatment, Commercial	0.0338	SL, G
				FC	37	70506-194; 62719-396	Seed Treatment, Commercial	0.00225	SL, G
				EC	37	70506-345	Seed Treatment, On Farm	0.00225	SL, G, R
				D	10	400-558	Seed Treatment, On Farm	0.00094	SL, G, R
				WP	80	70506-183	Seed Treatment, Commercial	0.00225	SL, G, R
Cereal Grains (Wheat, Triticale)	360000 (Wheat surrogate)	31,400 (wheat); 21,800 (triticale)	31,400	DF	75	70506-234	Seed Treatment, Commercial	0.0248	SL, G
				FC	37	62719-396	Seed Treatment, Commercial	0.00163	SL, G
				EC	37	70506-345	Seed Treatment, On Farm	0.00163	SL, G, R
				D	10	400-558	Seed Treatment, On Farm	0.00103	SL, G, R
				WP	80	70506-183	Seed Treatment, Commercial (Planter Box Only)	0.00165	SL, G, R

Table E.2. Summary of Use Directions for Registered Uses of Mancozeb – Seed Treatment.

Use Site	Amount Seed Treated (Commercial)	Amount Seed Treated (On Farm)	lb seed planted/day	Form[1]	%AI	Reg. No	Equipment	lb ai/lb seed	Personal Protective Equipment (PPE)[2]
Cereal Grains (Corn)	339,500	5,910	5,910	DF	75	70506-234	Seed Treatment, Commercial	0.0405	SL, G
				FC	37	70506-194; 62719-396	Seed Treatment, Commercial	0.00269	SL, G, R (70506-194)
				EC	37	70506-345	Seed Treatment, On Farm	0.00269	SL, G, R
				WP	80	70506-183	Seed Treatment, Commercial	0.0027	SL, G, R
Cotton	125,000	3,780	3,780	DF	75	70506-234	Seed Treatment, Commercial	0.045	SL, G
				FC	37	70506-194; 62719-396	Seed Treatment, Commercial	0.003	SL, G, R (70506-194)
				EC	37	70506-345	Seed Treatment, On Farm	0.003	SL, G, R
				WP	80	70506-183	Seed Treatment, Commercial	0.003	SL, G, R
Flax	125,000 (Canola Surrogate)	3,780	4,000	DF	75	70506-234	Seed Treatment, Commercial	0.0533	SL, G
				FC	37	70506-194; 62719-396	Seed Treatment, Commercial	0.0533	SL, G, R (70506-194)
				EC	37	70506-345	Seed Treatment, On Farm	0.00353	SL, G, R
				WP	80	70506-183	Seed Treatment, Commercial	0.00355	SL, G, R
Peanuts	126,000	18,300	18,300	DF	75	70506-234	Seed Treatment, Commercial	0.12	SL, G
				FC	37	70506-194; 62719-396	Seed Treatment, Commercial	0.008	SL, G, R (70506-194)
				EC	37	70506-345	Seed Treatment, On Farm (Shelled)	0.008	SL, G, R
				WP	80	70506-183	Seed Treatment, Commercial (Shelled)	0.008	SL, G, R
Potato	800,000	425,000	425,000	D	8	2935-539	Seed Treatment, Commercial/On Farm	0.0008	SL, G, R
				FC	37	70506-194; 62719-396	Seed Treatment, Commercial	0.000781	SL, G, R
				EC	37	70506-345	Seed Treatment, On Farm	0.000781	SL, G, R
Rice	302,500	31,300	31,300	DF	75	70506-234	Seed Treatment, Commercial	0.027	SL, G
				FC	37	70506-194; 62719-396	Seed Treatment, Commercial	0.002	SL, G, R (70506-194)
				EC	37	70506-345	Seed Treatment, On Farm	0.002	SL, G, R
				D	10	400-558	Seed Treatment, On Farm	0.00125	SL, G, R
				WP	80	70506-183	Seed Treatment, Commercial	0.032	SL, G, R

Table E.2. Summary of Use Directions for Registered Uses of Mancozeb – Seed Treatment.

Use Site	Amount Seed Treated (Commercial)	Amount Seed Treated (On Farm)	lb seed planted/day	Form[1]	%AI	Reg. No	Equipment	lb ai/lb seed	Personal Protective Equipment (PPE)[2]
Safflower	80,000 (Sunflower surrogate)	2,800	2,800	DF	75	70506-234	Seed Treatment, Commercial	0.015	SL, G
				FC	37	70506-194; 62719-396	Seed Treatment, Commercial	0.001	SL, G
				EC	37	70506-345	Seed Treatment, On Farm	0.001	SL, G, R
				D	10	400-558	Seed Treatment, On Farm	0.00094	SL, G, R
				WP	80	70506-183	Seed Treatment, Commercial	0.001	SL, G, R
Small seeded vegetables (Tomato)	3,000	87	81	DF	75	70506-234	Seed Treatment, Commercial	0.06	SL, G
				FC	37	70506-194; 62719-396	Seed Treatment, Commercial	0.004	SL, G, R (70506-194)
				EC	37	70506-345	Seed Treatment, On Farm	0.004	SL, G, R
				WP	80	70506-183	Seed Treatment, Commercial	0.004	SL, G, R

[1] DF = dry flowable. FC = flowable concentrate. EC = emulsifiable concentrate. WP = wettable powder. D = dust.

[2] PPE: SL, G = single layer, gloves. R = respirator.

Appendix F. Non-Occupational/Occupational Exposure and Risk Summary Tables

Table F.1. Children (1 to < 2 years old) Risk Estimates (MOEs) Related to Indirect Exposure to Spray Drift for the Incidental Oral Route of Exposure - Mancozeb.

Crop/Rate Group	Spray Type/ Nozzle Configuration	Applica. Rate (lb ai/A)	TTR_t (ug/cm²)	At Edge	10 Feet	25 Feet	50 Feet	75 Feet	100 Feet	125 Feet	150 Feet	200 Feet	250 Feet	300 Feet
				Incidental Oral MOE (LOC = 30)										
Almond (orchard/vineyard highest rate) and Cranberry (typical acreage field crop highest rate)														
Aerial	***Fine to Medium***	4.8	0.534	530	650	810	1,100	1,400	1,800	2,200	2,500	3,300	4,000	4,900
	Medium to Coarse			650	880	1,200	1,700	2,400	3,100	3,900	4,700	6,500	8,600	11,000
	Coarse to Very Coarse			750	1,100	1,700	2,600	3,700	4,900	6,200	7,600	11,000	14,000	17,000
	Very Fine to Fine			370	400	450	520	610	690	780	880	1,100	1,300	1,400
	AT401, M, 10 mph, 37% SD			580	750	960	1,300	1,800	2,300	2,800	3,300	4,300	5,300	6,500
	WASP, M, 10 mph, 37% SD			630	800	1,100	1,600	2,200	2,800	3,400	4,000	5,300	6,500	7,600
	AT401, C, 10 mph, 25% SD			690	970	1,400	2,000	2,900	3,800	4,700	5,700	8,000	11,000	12,000
	WASP, C, 10 mph, 25% SD			800	1,100	1,600	2,600	3,600	4,900	5,900	7,600	11,000	14,000	15,000
	AT401, VC, 10 mph, 20% SD			780	1,200	1,900	3,100	4,400	5,900	7,600	9,800	14,000	17,000	23,000
	WASP, VC, 10 mph, 20% SD			990	1,600	2,400	3,800	5,500	7,200	9,800	11,000	17,000	20,000	23,000
Ground-boom	***High Boom Very fine to Fine***			730	1,500	2,400	3,900	5,500	6,800	8,000	9,800	12,000	17,000	20,000
	Low Boom Very fine to Fine			1,600	4,300	6,800	11,000	14,000	17,000	20,000	23,000	27,000	34,000	46,000
	High Boom Fine to Medium/Coarse			2,800	7,200	11,000	15,000	20,000	23,000	27,000	27,000	34,000	46,000	46,000
	Low Boom Fine to Medium/Coarse			4,100	11,000	17,000	23,000	27,000	34,000	46,000	46,000	68,000	68,000	68,000
Airblast	***Sparse***			950	1,600	3,100	6,800	12,000	20,000	30,000	43,000	76,000	120,000	170,000
	Normal			46,000	68,000	110,000	150,000	230,000	270,000	340,000	460,000	460,000	680,000	680,000
	Dense			3,200	4,900	7,800	14,000	20,000	28,000	35,000	43,000	59,000	76,000	91,000
	Vineyard			17,000	33,000	62,000	110,000	170,000	230,000	270,000	340,000	460,000	680,000	680,000

Table F.1. Children (1 to < 2 years old) Risk Estimates (MOEs) Related to Indirect Exposure to Spray Drift for the Incidental Oral Route of Exposure - Mancozeb.

Crop/Rate Group	Spray Type/ Nozzle Configuration	Applica. Rate (lb ai/A)	TTR_t (ug/cm²)	At Edge	10 Feet	25 Feet	50 Feet	75 Feet	100 Feet	125 Feet	150 Feet	200 Feet	250 Feet	300 Feet
				Incidental Oral MOE (LOC = 30)										
Barley (high acreage field crop highest rate)														
Aerial	***Fine to Medium***	1.6	0.178	1,600	2,000	2,400	3,200	4,200	5,400	6,500	7,600	10,000	12,000	15,000
	Medium to Coarse			1,900	2,600	3,600	5,000	7,100	9,300	12,000	14,000	20,000	26,000	32,000
	Coarse to Very Coarse			2,200	3,300	5,000	7,700	11,000	15,000	19,000	23,000	32,000	41,000	51,000
	Very Fine to Fine			1,100	1,200	1,300	1,600	1,800	2,100	2,300	2,600	3,200	3,800	4,300
	AT401, M, 10 mph, 37% SD			1,800	2,200	2,900	3,900	5,300	6,800	8,400	9,800	13,000	16,000	20,000
	WASP, M, 10 mph, 37% SD			1,900	2,400	3,200	4,800	6,500	8,400	10,000	12,000	16,000	20,000	23,000
	AT401, C, 10 mph, 25% SD			2,100	2,900	4,100	6,100	8,700	11,000	14,000	17,000	24,000	32,000	37,000
	WASP, C, 10 mph, 25% SD			2,400	3,400	4,900	7,700	11,000	15,000	18,000	23,000	32,000	41,000	46,000
	AT401, VC, 10 mph, 20% SD			2,300	3,600	5,700	9,300	13,000	18,000	23,000	29,000	41,000	51,000	68,000
	WASP, VC, 10 mph, 20% SD			3,000	4,700	7,200	11,000	16,000	22,000	29,000	34,000	51,000	59,000	68,000
Ground-boom	***High Boom Very fine to Fine***			2,200	4,400	7,300	12,000	16,000	21,000	24,000	29,000	37,000	51,000	59,000
	Low Boom Very fine to Fine			4,800	13,000	21,000	32,000	41,000	51,000	59,000	68,000	82,000	100,000	140,000
	High Boom Fine to Medium/Coarse			8,400	22,000	32,000	46,000	59,000	68,000	82,000	82,000	100,000	140,000	140,000
	Low Boom Fine to Medium/Coarse			12,000	34,000	51,000	68,000	82,000	100,000	140,000	140,000	210,000	210,000	210,000
Airblast	***Sparse***			2,900	4,900	9,300	21,000	37,000	60,000	91,000	130,000	230,000	370,000	510,000
	Normal			140,000	210,000	320,000	460,000	680,000	820,000	1,000,000	1,400,000	1,400,000	2,100,000	2,100,000
	Dense			9,700	15,000	23,000	41,000	61,000	84,000	110,000	130,000	180,000	230,000	270,000
	Vineyard			51,000	100,000	190,000	340,000	510,000	680,000	820,000	1,000,000	1,400,000	2,100,000	2,100,000

Table F.1. Children (1 to < 2 years old) Risk Estimates (MOEs) Related to Indirect Exposure to Spray Drift for the Incidental Oral Route of Exposure - Mancozeb.

Crop/Rate Group	Spray Type/ Nozzle Configuration	Applica. Rate (lb ai/A)	TTR_t (ug/cm²)	At Edge	10 Feet	25 Feet	50 Feet	75 Feet	100 Feet	125 Feet	150 Feet	200 Feet	250 Feet	300 Feet
				Incidental Oral MOE (LOC = 30)										
Pear, SLN Rate														
Ground-boom	***High Boom Very fine to Fine***	6.38	0.709	550	1,100	1,800	2,900	4,100	5,100	6,100	7,400	9,400	13,000	15,000
	Low Boom Very fine to Fine			1,200	3,200	5,100	7,900	10,000	13,000	15,000	17,000	21,000	26,000	34,000
	High Boom Fine to Medium/Coarse			2,100	5,400	7,900	11,000	15,000	17,000	21,000	21,000	26,000	34,000	34,000
	Low Boom Fine to Medium/Coarse			3,100	8,600	13,000	17,000	21,000	26,000	34,000	34,000	51,000	51,000	51,000
Airblast	***Sparse***			720	1,200	2,300	5,100	9,400	15,000	23,000	32,000	57,000	94,000	130,000
	Normal			34,000	51,000	79,000	110,000	170,000	210,000	260,000	340,000	340,000	510,000	510,000
	Dense			2,400	3,700	5,900	10,000	15,000	21,000	26,000	32,000	45,000	57,000	69,000
	Vineyard			13,000	25,000	47,000	86,000	130,000	170,000	210,000	260,000	340,000	510,000	510,000

1. TTR (ug/cm²) = TTR of 0.15 ug/cm² x (Label App rate lb ai/A ÷ 11.3 lb ai/A) where 11.3 lb ai/A is the application rate in the TTR study.
2. MOEs at various distances from field edge = Dermal POD (10 mg/kg/day) ÷ Dose (mg/kg/day), where the dermal dose is calculated using the algorithms provided in the Turf Residential SOPs.

Table F.2. Adult Risk Estimates (MOEs) Related to Indirect Exposure to Spray Drift for the Dermal Route of Exposure - ETU.														
Crop/Rate Group	Spray Type/ Nozzle Configuration	Applica. Rate (lb ai/A)	Adjusted TTR (ug/cm²)	At Edge	10 Feet	25 Feet	50 Feet	75 Feet	100 Feet	125 Feet	150 Feet	200 Feet	250 Feet	300 Feet
				Dermal MOE (LOC = 300)										
Almond (orchard/vineyard highest rate) and Cranberry (typical acreage field crop highest rate)														
Aerial	***Fine to Medium***	4.8	0.00828	420	520	640	840	1,100	1,400	1,700	2,000	2,700	3,200	3,900
	Medium to Coarse			520	700	950	1,300	1,900	2,500	3,100	3,800	5,200	6,800	8,400
	Coarse to Very Coarse			590	880	1,300	2,100	2,900	3,900	4,900	6,000	8,400	11,000	14,000
	Very Fine to Fine			290	320	360	420	480	550	620	700	860	1,000	1,100
	AT401, M, 10 mph, 37% SD			460	590	770	1,000	1,400	1,800	2,200	2,600	3,400	4,200	5,200
	WASP, M, 10 mph, 37% SD			500	640	840	1,300	1,700	2,200	2,700	3,200	4,200	5,200	6,000
	AT401, C, 10 mph, 25% SD			550	770	1,100	1,600	2,300	3,000	3,800	4,500	6,400	8,400	9,900
	WASP, C, 10 mph, 25% SD			640	900	1,300	2,100	2,900	3,900	4,700	6,000	8,400	11,000	12,000
	AT401, VC, 10 mph, 20% SD			620	950	1,500	2,500	3,500	4,700	6,000	7,800	11,000	14,000	18,000
	WASP, VC, 10 mph, 20% SD			790	1,200	1,900	3,000	4,400	5,700	7,800	9,100	14,000	16,000	18,000
Groundboom	***High Boom Very fine to Fine***			580	1,200	1,900	3,100	4,400	5,400	6,400	7,800	9,900	14,000	16,000
	Low Boom Very fine to Fine			1,300	3,400	5,400	8,400	11,000	14,000	16,000	18,000	22,000	27,000	36,000
	High Boom Fine to Medium/Coarse			2,200	5,700	8,400	12,000	16,000	18,000	22,000	22,000	27,000	36,000	36,000
	Low Boom Fine to Medium/Coarse			3,300	9,100	14,000	18,000	22,000	27,000	36,000	36,000	54,000	54,000	54,000
Airblast	***Sparse***			760	1,300	2,500	5,400	9,900	16,000	24,000	34,000	60,000	99,000	140,000
	Normal			36,000	54,000	84,000	120,000	180,000	220,000	270,000	360,000	360,000	540,000	540,000
	Dense			2,600	3,900	6,200	11,000	16,000	22,000	28,000	34,000	47,000	60,000	73,000
	Vineyard			14,000	27,000	49,000	91,000	140,000	180,000	220,000	270,000	360,000	540,000	540,000

Table F.2. Adult Risk Estimates (MOEs) Related to Indirect Exposure to Spray Drift for the Dermal Route of Exposure - ETU.

Crop/Rate Group	Spray Type/ Nozzle Configuration	Applica. Rate (lb ai/A)	Adjusted TTR (ug/cm²)	At Edge	10 Feet	25 Feet	50 Feet	75 Feet	100 Feet	125 Feet	150 Feet	200 Feet	250 Feet	300 Feet
				Dermal MOE (LOC = 300)										
Barley (high acreage field crop highest rate)														
Aerial	***Fine to Medium***	1.6	0.00276	1,300	1,600	1,900	2,500	3,300	4,300	5,200	6,000	8,000	9,600	12,000
	Medium to Coarse			1,500	2,100	2,800	4,000	5,600	7,400	9,300	11,000	16,000	20,000	25,000
	Coarse to Very Coarse			1,800	2,600	4,000	6,200	8,800	12,000	15,000	18,000	25,000	33,000	41,000
	Very Fine to Fine			870	960	1,100	1,200	1,400	1,700	1,900	2,100	2,600	3,000	3,400
	AT401, M, 10 mph, 37% SD			1,400	1,800	2,300	3,100	4,200	5,400	6,700	7,800	10,000	13,000	16,000
	WASP, M, 10 mph, 37% SD			1,500	1,900	2,500	3,800	5,200	6,700	8,200	9,600	13,000	16,000	18,000
	AT401, C, 10 mph, 25% SD			1,600	2,300	3,300	4,900	6,900	9,100	11,000	14,000	19,000	25,000	30,000
	WASP, C, 10 mph, 25% SD			1,900	2,700	3,900	6,200	8,600	12,000	14,000	18,000	25,000	33,000	36,000
	AT401, VC, 10 mph, 20% SD			1,900	2,800	4,500	7,400	11,000	14,000	18,000	23,000	33,000	41,000	54,000
	WASP, VC, 10 mph, 20% SD			2,400	3,700	5,700	9,100	13,000	17,000	23,000	27,000	41,000	47,000	54,000
Groundboom	***High Boom Very fine to Fine***			1,700	3,500	5,800	9,300	13,000	16,000	19,000	23,000	30,000	41,000	47,000
	Low Boom Very fine to Fine			3,800	10,000	16,000	25,000	33,000	41,000	47,000	54,000	65,000	82,000	110,000
	High Boom Fine to Medium/Coarse			6,700	17,000	25,000	36,000	47,000	54,000	65,000	65,000	82,000	110,000	110,000
	Low Boom Fine to Medium/Coarse			9,900	27,000	41,000	54,000	65,000	82,000	110,000	110,000	160,000	160,000	160,000
Airblast	***Sparse***			2,300	3,900	7,400	16,000	30,000	48,000	73,000	100,000	180,000	300,000	410,000
	Normal			110,000	160,000	250,000	360,000	540,000	650,000	820,000	1,100,000	1,100,000	1,600,000	1,600,000
	Dense			7,700	12,000	19,000	33,000	49,000	67,000	84,000	100,000	140,000	180,000	220,000
	Vineyard			41,000	80,000	150,000	270,000	410,000	540,000	650,000	820,000	1,100,000	1,600,000	1,600,000

Table F.2. Adult Risk Estimates (MOEs) Related to Indirect Exposure to Spray Drift for the Dermal Route of Exposure - ETU.

Crop/Rate Group	Spray Type/ Nozzle Configuration	Applica. Rate (lb ai/A)	Adjusted TTR (ug/cm²)	At Edge	10 Feet	25 Feet	50 Feet	75 Feet	100 Feet	125 Feet	150 Feet	200 Feet	250 Feet	300 Feet
				Dermal MOE (LOC = 300)										
Pear, SLN Rate														
Groundboom	***High Boom Very fine to Fine***	6.38	0.011	440	880	1,500	2,300	3,300	4,100	4,800	5,800	7,400	10,000	12,000
	Low Boom Very fine to Fine			960	2,600	4,100	6,300	8,200	10,000	12,000	14,000	16,000	20,000	27,000
	High Boom Fine to Medium/Coarse			1,700	4,300	6,300	9,100	12,000	14,000	16,000	16,000	20,000	27,000	27,000
	Low Boom Fine to Medium/Coarse			2,500	6,800	10,000	14,000	16,000	20,000	27,000	27,000	41,000	41,000	41,000
Airblast	***Sparse***			570	980	1,800	4,100	7,400	12,000	18,000	26,000	45,000	74,000	100,000
	Normal			27,000	41,000	63,000	91,000	140,000	160,000	200,000	270,000	270,000	410,000	410,000
	Dense			1,900	2,900	4,700	8,200	12,000	17,000	21,000	26,000	36,000	45,000	55,000
	Vineyard			10,000	20,000	37,000	68,000	100,000	140,000	160,000	200,000	270,000	410,000	410,000

Red bolded MOEs are risks of concern.

1. TTR (ug/cm²) = TTR of 0.15 ug/cm² x (Label App rate lb ai/A ÷ 11.3 lb ai/A) where 11.3 lb ai/A is the application rate in the TTR study.
2. MOEs at various distances from field edge = Dermal POD (10 mg/kg/day) ÷ Dose (mg/kg/day), where the dermal dose is calculated using the algorithms provided in the Turf Residential SOPs.

Table F.3. Children (1 to < 2 years old) Risk Estimates (MOEs) Related to Indirect Exposure to Spray Drift for the Combined Dermal and Incidental Oral Routes of Exposure - ETU.

Crop/Rate Group	Spray Type/ Nozzle Configuration	Applica. Rate (lb ai/A)	Adjusted TTR_t (ug/cm^2)	At Edge	10 Feet	25 Feet	50 Feet	75 Feet	100 Feet	125 Feet	150 Feet	200 Feet	250 Feet	300 Feet
				Combined (Dermal + Incidental Oral) MOE (LOC = 300)										
Almond (orchard/vineyard highest rate) and Cranberry (typical acreage field crop highest rate)														
Aerial	***Fine to Medium***	4.8	0.00828	140	180	220	290	430	480	580	680	900	1,100	1,300
	Medium to Coarse			170	270	320	450	720	840	1,100	1,300	1,800	2,300	2,800
	Coarse to Very Coarse			200	340	450	690	1,100	1,300	1,700	2,000	2,800	3,700	4,600
	Very Fine to Fine			99	120	120	140	190	190	210	240	290	340	390
	AT401, M, 10 mph, 37% SD			160	230	260	350	540	610	750	880	1,200	1,400	1,800
	WASP, M, 10 mph, 37% SD			170	240	290	430	660	750	920	1,100	1,400	1,800	2,000
	AT401, C, 10 mph, 25% SD			190	300	370	550	890	1,000	1,300	1,500	2,200	2,800	3,300
	WASP, C, 10 mph, 25% SD			220	350	440	690	1,100	1,300	1,600	2,000	2,800	3,700	4,100
	AT401, VC, 10 mph, 20% SD			210	360	510	840	1,400	1,600	2,000	2,600	3,700	4,600	6,100
	WASP, VC, 10 mph, 20% SD			270	480	650	1,000	1,700	1,900	2,600	3,100	4,600	5,300	6,100
Ground-boom	***High Boom Very fine to Fine***			200	450	660	1,100	1,700	1,800	2,200	2,600	3,300	4,600	5,300
	Low Boom Very fine to Fine			430	1,300	1,800	2,800	4,200	4,600	5,300	6,100	7,400	9,200	12,000
	High Boom Fine to Medium/Coarse			750	2,200	2,800	4,100	6,000	6,100	7,400	7,400	9,200	12,000	12,000
	Low Boom Fine to Medium/Coarse			1,100	3,500	4,600	6,100	8,400	9,200	12,000	12,000	18,000	18,000	18,000
Airblast	***Sparse***			260	500	830	1,800	3,800	5,400	8,200	12,000	20,000	33,000	46,000
	Normal			12,000	21,000	28,000	41,000	70,000	74,000	92,000	120,000	120,000	180,000	180,000
	Dense			870	1,500	2,100	3,700	6,300	7,500	9,400	12,000	16,000	20,000	25,000
	Vineyard			4,600	10,000	17,000	31,000	52,000	61,000	74,000	92,000	120,000	180,000	180,000

Table F.3. Children (1 to < 2 years old) Risk Estimates (MOEs) Related to Indirect Exposure to Spray Drift for the Combined Dermal and Incidental Oral Routes of Exposure - ETU.

Crop/Rate Group	Spray Type/ Nozzle Configuration	Applica. Rate (lb ai/A)	Adjusted TTR_t (ug/cm^2)	At Edge	10 Feet	25 Feet	50 Feet	75 Feet	100 Feet	125 Feet	150 Feet	200 Feet	250 Feet	300 Feet
				Combined (Dermal + Incidental Oral) MOE (LOC = 300)										
Barley (high acreage field crop highest rate)														
Aerial	***Fine to Medium***	1.6	0.00276	430	600	650	860	1,300	1,500	1,800	2,000	2,700	3,300	3,900
	Medium to Coarse			520	810	960	1,300	2,200	2,500	3,200	3,800	5,300	6,900	8,500
	Coarse to Very Coarse			600	1,000	1,300	2,100	3,400	3,900	5,000	6,100	8,500	11,000	14,000
	Very Fine to Fine			300	370	360	420	560	560	630	710	870	1,000	1,200
	AT401, M, 10 mph, 37% SD			470	690	780	1,100	1,600	1,800	2,300	2,600	3,500	4,300	5,300
	WASP, M, 10 mph, 37% SD			510	730	860	1,300	2,000	2,300	2,800	3,300	4,300	5,300	6,100
	AT401, C, 10 mph, 25% SD			560	890	1,100	1,600	2,700	3,100	3,800	4,600	6,500	8,500	10,000
	WASP, C, 10 mph, 25% SD			650	1,000	1,300	2,100	3,300	3,900	4,800	6,100	8,500	11,000	12,000
	AT401, VC, 10 mph, 20% SD			630	1,100	1,500	2,500	4,100	4,800	6,100	7,900	11,000	14,000	18,000
	WASP, VC, 10 mph, 20% SD			800	1,400	1,900	3,100	5,000	5,800	7,900	9,200	14,000	16,000	18,000
Ground-boom	***High Boom Very fine to Fine***			590	1,400	2,000	3,200	5,000	5,500	6,500	7,900	10,000	14,000	16,000
	Low Boom Very fine to Fine			1,300	3,900	5,500	8,500	13,000	14,000	16,000	18,000	22,000	28,000	37,000
	High Boom Fine to Medium/Coarse			2,300	6,600	8,500	12,000	18,000	18,000	22,000	22,000	28,000	37,000	37,000
	Low Boom Fine to Medium/Coarse			3,300	10,000	14,000	18,000	25,000	28,000	37,000	37,000	55,000	55,000	55,000
Airblast	***Sparse***			770	1,500	2,500	5,500	11,000	16,000	25,000	35,000	61,000	100,000	140,000
	Normal			37,000	63,000	85,000	120,000	210,000	220,000	280,000	370,000	370,000	550,000	550,000
	Dense			2,600	4,500	6,300	11,000	19,000	23,000	28,000	35,000	48,000	61,000	74,000
	Vineyard			14,000	31,000	50,000	92,000	160,000	180,000	220,000	280,000	370,000	550,000	550,000

Table F.3. Children (1 to < 2 years old) Risk Estimates (MOEs) Related to Indirect Exposure to Spray Drift for the Combined Dermal and Incidental Oral Routes of Exposure - ETU.														
Crop/Rate Group	Spray Type/ Nozzle Configuration	Applica. Rate (lb ai/A)	Adjusted TTR_t (ug/cm^2)	At Edge	10 Feet	25 Feet	50 Feet	75 Feet	100 Feet	125 Feet	150 Feet	200 Feet	250 Feet	300 Feet
				Combined (Dermal + Incidental Oral) MOE (LOC = 300)										
Pear, SLN Rate														
Ground-boom	***High Boom Very fine to Fine***	6.38	0.0110	**150**	340	490	790	1,300	1,400	1,600	2,000	2,500	3,500	4,000
	Low Boom Very fine to Fine			330	980	1,400	2,100	3,200	3,500	4,000	4,600	5,500	6,900	9,200
	High Boom Fine to Medium/Coarse			570	1,700	2,100	3,100	4,500	4,600	5,500	5,500	6,900	9,200	9,200
	Low Boom Fine to Medium/Coarse			840	2,600	3,500	4,600	6,300	6,900	9,200	9,200	14,000	14,000	14,000
Airblast	***Sparse***			**190**	380	630	1,400	2,900	4,100	6,200	8,700	15,000	25,000	35,000
	Normal			9,200	16,000	21,000	31,000	53,000	55,000	69,000	92,000	92,000	140,000	140,000
	Dense			660	1,100	1,600	2,800	4,700	5,700	7,100	8,700	12,000	15,000	18,000
	Vineyard			3,500	7,700	13,000	23,000	39,000	46,000	55,000	69,000	92,000	140,000	140,000

Red bolded MOEs are risks of concern.

1. TTR (ug/cm^2) = TTR of 0.15 ug/cm^2 x (Label App rate lb ai/A ÷ 11.3 lb ai/A) where 11.3 lb ai/A is the application rate in the TTR study.
2. MOEs at various distances from field edge = Dermal POD (10 mg/kg/day) ÷ Dose (mg/kg/day), where the dermal dose is calculated using the algorithms provided in the Turf Residential SOPs.

Table F.4. Occupational Handler Non-Cancer Exposure and Risk Estimates for Mancozeb - Foliar.

Exposure Scenario	Crop or Target[1]	Inhalation Unit Exposure (µg/lb ai)[2] Level of PPE or Engineering control	Maximum Application Rate[3]	App Rate Unit	Area Treated or Amount Handled Daily4	Area Treated/Amount Handled Unit	Inhalation Dose (mg/kg/day)[5]	Inhalation MOE[6] (LOC = 10)
Mixer/Loader								
Dry Flowable, Aerial, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	8.96 [No-R]	2.25	lb ai/acre	60	acres	0.0151	1300
	Orchard/Vineyard	8.96 [No-R]	6.38	lb ai/acre	350	acres	0.25	76
	Sod	8.96 [No-R]	17.4	lb ai/acre	350	acres	0.683	28
	Field crop, typical	8.96 [No-R]	4.5	lb ai/acre	350	acres	0.176	110
	Field crop, high-acreage	8.96 [No-R]	1.5	lb ai/acre	1200	acres	0.201	95
Dry Flowable, Airblast, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	8.96 [No-R]	2.25	lb ai/acre	20	acres	0.00504	3800
	Orchard/Vineyard	8.96 [No-R]	6.38	lb ai/acre	40	acres	0.0286	670
Dry Flowable, Chemigation, Broadcast	Orchard/Vineyard	8.96 [No-R]	6.38	lb ai/acre	350	acres	0.25	76
	Field crop, typical	8.96 [No-R]	4.5	lb ai/acre	350	acres	0.176	110
	Field crop, high-acreage	8.96 [No-R]	1.5	lb ai/acre	350	acres	0.0588	320
	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	8.96 [No-R]	2.25	lb ai/acre	60	acres	0.0151	1300
	Nursery (ornamentals, vegetables, trees, container stock)	8.96 [No-R]	2.25	lb ai/acre	60	acres	0.0151	1300
Dry Flowable, Groundboom, Broadcast	Golf course (fairways, tees, greens)	8.96 [No-R]	17.4	lb ai/acre	40	acres	0.078	240
	Field-grown ornamental crops	8.96 [No-R]	1.5	lb ai/acre	40	acres	0.00673	2800
	Nursery (ornamentals, vegetables, trees, container stock)	8.96 [No-R]	2.25	lb ai/acre	60	acres	0.0151	1300
	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	8.96 [No-R]	2.25	lb ai/acre	60	acres	0.0151	1300
	Sod	8.96 [No-R]	17.4	lb ai/acre	80	acres	0.156	120
	Orchard/Vineyard	8.96 [No-R]	6.38	lb ai/acre	40	acres	0.0286	670

Table F.4. Occupational Handler Non-Cancer Exposure and Risk Estimates for Mancozeb - Foliar.

Exposure Scenario	Crop or Target[1]	Inhalation Unit Exposure (µg/lb ai)[2] Level of PPE or Engineering control	Maximum Application Rate[3]	App Rate Unit	Area Treated or Amount Handled Daily4	Area Treated/Amount Handled Unit	Inhalation	
							Dose (mg/kg/day)[5]	MOE[6] (LOC = 10)
	Field crop, typical	8.96 [No-R]	4.5	lb ai/acre	80	acres	0.0404	470
	Field crop, high-acreage	8.96 [No-R]	1.5	lb ai/acre	200	acres	0.0336	570
Dry Flowable, Dip Treatment,	Orchard/Vineyard	8.96 [No-R]	0.008	lb ai/gallon	1000	gallons solution	0.0286	670
	Field crop, typical	8.96 [No-R]	0.03	lb ai/gallon	1000	gallons solution	0.0404	470
	Field crop, high-acreage	8.96 [No-R]	0.02	lb ai/gallon	1000	gallons solution	0.0336	570
Liquid, Aerial, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	0.219 [No-R]	1.2	lb ai/acre	60	acres	0.000198	96000
	Orchard/Vineyard	0.219 [No-R]	4.8	lb ai/acre	350	acres	0.0046	4200
	Sod	0.219 [No-R]	17.4	lb ai/acre	350	acres	0.0166	1200
	Field crop, typical	0.219 [No-R]	4.8	lb ai/acre	350	acres	0.0046	4200
	Field crop, high-acreage	0.219 [No-R]	1.6	lb ai/acre	1200	acres	0.00525	3600
Liquid, Airblast, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	0.219 [No-R]	1.2	lb ai/acre	20	acres	0.0000658	290000
	Orchard/Vineyard	0.219 [No-R]	4.8	lb ai/acre	40	acres	0.000525	36000
Liquid, Chemigation, Broadcast	Orchard/Vineyard	0.219 [No-R]	4.8	lb ai/acre	350	acres	0.0046	4200
	Sod	0.219 [No-R]	17.4	lb ai/acre	350	acres	0.0166	1200
	Field crop, typical	0.219 [No-R]	4.8	lb ai/acre	350	acres	0.0046	4200
	Field crop, high-acreage	0.219 [No-R]	1.6	lb ai/acre	350	acres	0.00154	12000
	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.219 [No-R]	1.2	lb ai/acre	60	acres	0.000198	96000
	Nursery (ornamentals, vegetables, trees, container stock)	0.219 [No-R]	1.2	lb ai/acre	60	acres	0.000198	96000

Table F.4. Occupational Handler Non-Cancer Exposure and Risk Estimates for Mancozeb - Foliar.

Exposure Scenario	Crop or Target[1]	Inhalation Unit Exposure (µg/lb ai)[2] Level of PPE or Engineering control	Maximum Application Rate[3]	App Rate Unit	Area Treated or Amount Handled Daily4	Area Treated/Amount Handled Unit	Inhalation	
							Dose (mg/kg/day)[5]	MOE[6] (LOC = 10)
Liquid, Groundboom, Broadcast	Golf course (fairways, tees, greens)	0.219 [No-R]	17.4	lb ai/acre	40	acres	0.0019	10000
	Field-grown ornamental crops	0.219 [No-R]	1.2	lb ai/acre	40	acres	0.000131	150000
	Nursery (ornamentals, vegetables, trees, container stock)	0.219 [No-R]	1.2	lb ai/acre	60	acres	0.000198	96000
	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.219 [No-R]	1.2	lb ai/acre	60	acres	0.000198	96000
	Sod	0.219 [No-R]	17.4	lb ai/acre	80	acres	0.00381	5000
	Orchard/Vineyard	0.219 [No-R]	4.8	lb ai/acre	40	acres	0.000525	36000
	Field crop, typical	0.219 [No-R]	4.8	lb ai/acre	80	acres	0.00105	18000
	Field crop, high-acreage	0.219 [No-R]	1.6	lb ai/acre	200	acres	0.000876	22000
Liquid, Dip Treatment	Orchard/Vineyard	0.219 [No-R]	0.03	lb ai/gallon	1000	gallons solution	0.000525	36000
	Field crop, typical	0.219 [No-R]	0.008	lb ai/gallon	1000	gallons solution	0.00105	18000
	Field crop, high-acreage	0.219 [No-R]	0.02	lb ai/gallon	1000	gallons solution	0.000876	22000
Wettable Powder, Aerial, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	2.75 [No-R]	1.6	lb ai/acre	60	acres	0.0033	5800
	Orchard/Vineyard	2.75 [No-R]	4.8	lb ai/acre	350	acres	0.0578	330
	Field crop, typical	2.75 [No-R]	4.8	lb ai/acre	350	acres	0.0578	330
	Field crop, high-acreage	2.75 [No-R]	1.6	lb ai/acre	1200	acres	0.066	290
Wettable Powder, Airblast, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	2.75 [No-R]	1.6	lb ai/acre	20	acres	0.0011	17000
	Orchard/Vineyard	2.75 [No-R]	4.8	lb ai/acre	40	acres	0.0066	2900

Table F.4. Occupational Handler Non-Cancer Exposure and Risk Estimates for Mancozeb - Foliar.

Exposure Scenario	Crop or Target[1]	Inhalation Unit Exposure (µg/lb ai)[2] Level of PPE or Engineering control	Maximum Application Rate[3]	App Rate Unit	Area Treated or Amount Handled Daily4	Area Treated/Amount Handled Unit	Inhalation	
							Dose (mg/kg/day)[5]	MOE[6] (LOC = 10)
Wettable Powder, Chemigation, Broadcast	Orchard/Vineyard	2.75 [No-R]	4.8	lb ai/acre	350	acres	0.0578	330
	Field crop, typical	2.75 [No-R]	4.8	lb ai/acre	350	acres	0.0578	330
	Field crop, high-acreage	2.75 [No-R]	1.6	lb ai/acre	350	acres	0.0193	990
	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	2.75 [No-R]	1.6	lb ai/acre	60	acres	0.0033	5800
	Nursery (ornamentals, vegetables, trees, container stock)	2.75 [No-R]	1.6	lb ai/acre	60	acres	0.0033	5800
Wettable Powder, Groundboom, Broadcast	Field-grown ornamental crops	2.75 [No-R]	1.6	lb ai/acre	40	acres	0.0022	8700
	Nursery (ornamentals, vegetables, trees, container stock)	2.75 [No-R]	1.6	lb ai/acre	60	acres	0.0033	5800
	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	2.75 [No-R]	1.6	lb ai/acre	60	acres	0.0033	5800
	Orchard/Vineyard	2.75 [No-R]	4.8	lb ai/acre	40	acres	0.0066	2900
	Field crop, typical	2.75 [No-R]	4.8	lb ai/acre	80	acres	0.0133	1400
	Field crop, high-acreage	2.75 [No-R]	1.6	lb ai/acre	200	acres	0.011	1700
Wettable Powder, Dip Treatment	Orchard/Vineyard	2.75 [No-R]	0.008	lb ai/gallon	1000	gallons solution	0.0066	2900
	Field crop, typical	2.75 [No-R]	0.03	lb ai/acre	1000	gallons solution	0.0133	1400
	Field crop, high-acreage	2.75 [No-R]	0.02	lb ai/acre	1000	gallons solution	0.011	1700
Water-soluble Packet, Airblast, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	2.6 [EC]	1.44	lb ai/acre	20	acres	0.000936	20000
Water-soluble Packet, Groundboom, Broadcast	Golf course (fairways, tees, greens)	2.6 [EC]	10.45	lb ai/acre	40	acres	0.0136	1400
	Field-grown ornamental crops	2.6 [EC]	1.44	lb ai/acre	40	acres	0.00188	10000
	Nursery (ornamentals, vegetables, trees, container stock)	2.6 [EC]	2.05	lb ai/acre	60	acres	0.004	4800

Table F.4. Occupational Handler Non-Cancer Exposure and Risk Estimates for Mancozeb - Foliar.

Exposure Scenario	Crop or Target[1]	Inhalation Unit Exposure (µg/lb ai)[2] Level of PPE or Engineering control	Maximum Application Rate[3]	App Rate Unit	Area Treated or Amount Handled Daily4	Area Treated/Amount Handled Unit	Inhalation Dose (mg/kg/day)[5]	Inhalation MOE[6] (LOC = 10)
	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	2.6 [EC]	2.05	lb ai/acre	60	acres	0.004	4800
Applicator								
Spray (all starting formulations), Aerial, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	0.0049 [EC]	1.2	lb ai/acre	60	acres	0.00000441	4300000
	Orchard/Vineyard	0.0049 [EC]	6.38	lb ai/acre	350	acres	0.000136	140000
	Sod	0.0049 [EC]	17.4	lb ai/acre	350	acres	0.000373	51000
	Field crop, typical	0.0049 [EC]	4.8	lb ai/acre	350	acres	0.000103	190000
	Field crop, high-acreage	0.0049 [EC]	1.6	lb ai/acre	1200	acres	0.000118	160000
Spray (all starting formulations), Airblast, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	4.71 [No-R]	2.25	lb ai/acre	20	acres	0.00265	7200
	Orchard/Vineyard	4.71 [No-R]	6.38	lb ai/acre	40	acres	0.015	1300
Spray (all starting formulations), Groundboom, Broadcast	Golf course (fairways, tees, greens)	0.34 [No-R]	17.4	lb ai/acre	40	acres	0.00296	6500
	Field-grown ornamental crops	0.34 [No-R]	1.6	lb ai/acre	40	acres	0.000273	70000
	Nursery (ornamentals, vegetables, trees, container stock)	0.34 [No-R]	2.25	lb ai/acre	60	acres	0.000574	33000
	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.34 [No-R]	2.25	lb ai/acre	60	acres	0.000574	33000
	Sod	0.34 [No-R]	17.4	lb ai/acre	80	acres	0.00591	3200
	Orchard/Vineyard	0.34 [No-R]	6.38	lb ai/acre	40	acres	0.00109	18000
	Field crop, typical	0.34 [No-R]	4.8	lb ai/acre	80	acres	0.00164	12000
	Field crop, high-acreage	0.34 [No-R]	1.6	lb ai/acre	200	acres	0.00136	14000

Table F.4. Occupational Handler Non-Cancer Exposure and Risk Estimates for Mancozeb - Foliar.

Exposure Scenario	Crop or Target[1]	Inhalation Unit Exposure (µg/lb ai)[2] Level of PPE or Engineering control	Maximum Application Rate[3]	App Rate Unit	Area Treated or Amount Handled Daily4	Area Treated/Amount Handled Unit	Inhalation Dose (mg/kg/day)[5]	Inhalation MOE[6] (LOC = 10)
Flagger								
Spray (all starting formulations), Aerial, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	0.202 [No-R]	2.25	lb ai/acre	60	acres	0.000341	56000
	Orchard/Vineyard	0.202 [No-R]	6.38	lb ai/acre	350	acres	0.00564	3400
	Sod	0.202 [No-R]	17.4	lb ai/acre	350	acres	0.0154	1200
	Field crop, typical	0.202 [No-R]	4.8	lb ai/acre	350	acres	0.00424	4500
	Field crop, high-acreage	0.202 [No-R]	1.6	lb ai/acre	350	acres	0.00141	14000
Mixer/Loader/Applicator								
Dry Flowable, Backpack, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	140 [No-R]	0.011	lb ai/gallon solution	7	gallons solution	0.000135	140000
Dry Flowable, Backpack, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	69.1 [No-R]	0.011	lb ai/gallon solution	15	gallons solution	0.000143	130000
Dry Flowable, Manually-pressurized Handwand, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	23.6 [No-R]	0.011	lb ai/gallon solution	7	gallons solution	0.0000228	840000
Dry Flowable, Manually-pressurized Handwand, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	23.6 [No-R]	0.011	lb ai/gallon solution	15	gallons solution	0.0000486	390000
Dry Flowable, Mechanically-pressurized Handgun, Broadcast (foliar)	Orchard/Vineyard	8.68 [No-R]	0.0638	lb ai/gallon solution	1000	gallons solution	0.00693	2800
Dry Flowable, Mechanically-pressurized Handgun, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	448 [No-R]	0.011	lb ai/gallon solution	175	gallons solution	0.0108	1800
Dry Flowable, Mechanically-pressurized Handgun, Broadcast	Golf course (fairways, tees, greens)	42 [No-R]	0.4	lb ai/acre	5	acres	0.00105	18000
Dry Flowable, Mechanically-pressurized Handgun, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	448 [No-R]	0.011	lb ai/gallon solution	300	gallons solution	0.0185	1000
Dry Flowable, Mechanically-pressurized Handgun, Broadcast (foliar)	Field crop, typical	8.68 [No-R]	0.48	lb ai/gallon solution	1000	gallons solution	0.0521	370
Liquid, Backpack, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	140 [No-R]	0.012	lb ai/gallon solution	7	gallons solution	0.000148	130000
Liquid, Backpack, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	69.1 [No-R]	0.012	lb ai/gallon solution	15	gallons solution	0.000155	120000
Liquid, Manually-pressurized Handwand, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	23.6 [No-R]	0.012	lb ai/gallon solution	7	gallons solution	0.0000248	770000

Table F.4. Occupational Handler Non-Cancer Exposure and Risk Estimates for Mancozeb - Foliar.

Exposure Scenario	Crop or Target[1]	Inhalation Unit Exposure (µg/lb ai)[2] Level of PPE or Engineering control	Maximum Application Rate[3]	App Rate Unit	Area Treated or Amount Handled Daily4	Area Treated/Amount Handled Unit	Inhalation	
							Dose (mg/kg/day)[5]	MOE[6] (LOC = 10)
Liquid, Manually-pressurized Handwand, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	23.6 [No-R]	0.012	lb ai/gallon solution	15	gallons solution	0.0000531	360000
Liquid, Mechanically-pressurized Handgun, Broadcast (foliar)	Orchard/Vineyard	8.68 [No-R]	0.48	lb ai/gallon solution	1000	gallons solution	0.0521	370
Liquid, Mechanically-pressurized Handgun, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	448 [No-R]	0.012	lb ai/gallon solution	175	gallons solution	0.0118	1600
Liquid, Mechanically-pressurized Handgun, Broadcast	Golf course (fairways, tees, greens)	1.9 [No-R]	17.4	lb ai/acre	5	acres	0.00206	9300
Liquid, Mechanically-pressurized Handgun, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	448 [No-R]	0.012	lb ai/gallon solution	300	gallons solution	0.0201	950
Liquid, Mechanically-pressurized Handgun, Broadcast (foliar)	Field crop, typical	8.68 [No-R]	0.48	lb ai/gallon solution	1000	gallons solution	0.0521	370
Wettable Powder, Backpack, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	140 [No-R]	0.016	lb ai/gallon solution	7	gallons solution	0.000196	97000
Wettable Powder, Backpack, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	69.1 [No-R]	0.016	lb ai/gallon solution	15	gallons solution	0.000208	92000
Wettable Powder, Manually-pressurized Handwand, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	23.6 [No-R]	0.016	lb ai/gallon solution	7	gallons solution	0.000033	580000
Wettable Powder, Manually-pressurized Handwand, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	23.6 [No-R]	0.016	lb ai/gallon solution	15	gallons solution	0.0000708	270000
Wettable Powder, Mechanically-pressurized Handgun, Broadcast (foliar)	Orchard/Vineyard	8.68 [No-R]	0.096	lb ai/gallon solution	1000	gallons solution	0.0104	1800
Wettable Powder, Mechanically-pressurized Handgun, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	448 [No-R]	0.016	lb ai/gallon solution	175	gallons solution	0.0156	1200
Wettable Powder, Mechanically-pressurized Handgun, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	448 [No-R]	0.016	lb ai/gallon solution	300	gallons solution	0.0269	710
Wettable Powder, Mechanically-pressurized Handgun, Broadcast (foliar)	Field crop, typical	8.68 [No-R]	0.48	lb ai/gallon solution	1000	gallons solution	0.0521	370
Water-soluble Packet, Backpack, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	140 [No-R]	0.021	lb ai/gallon solution	7	gallons solution	0.000258	74000
Water-soluble Packet, Backpack, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	69.1 [No-R]	0.021	lb ai/gallon solution	15	gallons solution	0.000273	70000
Water-soluble Packet, Manually-pressurized Handwand, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	23.6 [No-R]	0.021	lb ai/gallon solution	7	gallons solution	0.0000434	440000
Water-soluble Packet, Manually-pressurized Handwand, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	23.6 [No-R]	0.021	lb ai/gallon solution	15	gallons solution	0.0000929	210000

Table F.4. Occupational Handler Non-Cancer Exposure and Risk Estimates for Mancozeb - Foliar.

Exposure Scenario	Crop or Target[1]	Inhalation Unit Exposure (µg/lb ai)[2] Level of PPE or Engineering control	Maximum Application Rate[3]	App Rate Unit	Area Treated or Amount Handled Daily4	Area Treated/Amount Handled Unit	Inhalation	
							Dose (mg/kg/day)[5]	MOE[6] (LOC = 10)
Water-soluble Packet, Mechanically-pressurized Handgun, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	448 [No-R]	0.021	lb ai/gallon solution	175	gallons solution	0.0206	930
Water-soluble Packet, Mechanically-pressurized Handgun, Broadcast	Golf course (fairways, tees, greens)	18 [No-R]	0.048	lb ai/acre	5	acres	0.000054	350000
Water-soluble Packet, Mechanically-pressurized Handgun, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	448 [No-R]	0.021	lb ai/gallon solution	300	gallons solution	0.0353	540

1. Orchard crops include the following crops currently listed on mancozeb labels: almond, banana, Christmas trees, grapes, papaya, pome fruits (apple, crabapple, quince, pear), subtropical/tropical fruit (sugar apple, cherimoya, atemoya, custard apple, sweetsop, mango, star apple, canistel, mamey sapote, sapodilla, white sapote), walnut.
   Typical-acreage field crops include the following crops currently listed on mancozeb labels: asparagus, broccoli, cabbage, carrots, cucurbits, swiss chard, coriander, sweet corn, cranberry, dill, endive, fennel, garden beet, garlic, ginseng, leafy brassica greens, leek, lettuce, onion, parsley, parsnip, pepper, plantain, shallot, spinach, tobacco, tomato.
   High-acreage field crops include the following crops currently listed on mancozeb labels: barley, field/popcorn, peanuts, potato, rye, wheat, triticale, oats, sugar beet.
2. Based on the "Occupational Pesticide Handler Unit Exposure Surrogate Reference Table" (https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/occupational-pesticide-handler-exposure-data); Level of PPE: No-R, EC = no-respirator, engineering controls.
3. Based on registered labels (see Appendix E).
1. Exposure Science Advisory Council Policy #9.1.
2. Inhalation Dose = Inhalation Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) x Application Rate (lb ai/acre or gal) × Area Treated or Amount Handled (A or gal/day) ÷ BW (80 kg).
3. Inhalation MOE = Inhalation POD (19.1 mg/kg/day) ÷ Inhalation Dose (mg/kg/day).

Table F.5. Occupational Handler Non-Cancer Exposure and Risk Estimates for Mancozeb – Seed Treatment.						
Crop/Target Category	Specialized Treatment or Formulation	Activity	Application Rate (lb ai/lb seed)[1]	Exposure Variable[2]	Inhalation Dose[3] (mg/kg-day) [No-R, unless otherwise noted]	Inhalation MOE[4] [No-R, unless otherwise noted] (LOC = 10)
Commercial Seed Treatment						
Barley	NA	Treating	0.0315	360,000 (AST)	0.51	110
		Packaging			0.105	37
		Cleaning		2.5 hours (AD)	0.509	180
		Loading/Planting		184,240,000 (NSP)	0.206	38
Corn, field	NA	Treating	0.0405	339,500 (AST)	0.619	93
		Packaging			0.134	31
		Cleaning		2.5 hours (AD)	0.198	140
		Loading/Planting		8,050,000 (NSP)	0.0844	96
Cotton	NA	Treating	0.045	125,000 (AST)	0.254	230
		Packaging			0.149	75
		Cleaning		2.5 hours (AD)	0.14	130
		Loading/Planting		17,000,000 (NSP)	0.1	140
Flax	NA	Treating	0.0533	125,000 (AST)	0.3	190
		Packaging			0.176	64
		Cleaning		2.5 hours (AD)	0.176	110
		Loading/Planting		243,936,000 (NSP)	0.255	110
Oat	NA	Treating	0.0473	360,000 (AST)	0.766	75
		Packaging			0.156	25
		Cleaning		2.5 hours (AD)	0.703	120
		Loading/Planting		234,000,000 (NSP)	0.226	27
Peanut	NA	Treating	0.12	126,000 (AST)	0.68	85
		Packaging			0.398	28
		Cleaning		2.5 hours (AD)	1.81	48
		Loading/Planting		8,400,000 (NSP)	0.0096	11
Potato	NA	Treating	0.0008	800,000 (AST)	0.0288	2000
		Packaging			0.00265	660
		Cleaning		2.5 hours (AD)	0.28	7200
		Loading/Planting		2,125,728 (NSP)	0.145	68
Rice	NA	Treating	0.032	302,500 (AST)	0.435	130
		Packaging			0.106	44
		Cleaning		2.5 hours (AD)	0.825	180
		Loading/Planting		487,672,000 (NSP)	0.146	23
Rye	NA	Treating	0.027	360,000 (AST)	0.438	130
		Packaging			0.0895	44
		Cleaning		2.5 hours (AD)	0.401	210
		Loading/Planting		324,000,000 (NSP)	0.081	48
Safflower	NA	Treating	0.015	360,000 (AST)	0.243	240
		Packaging			0.0498	79
		Cleaning		2.5 hours (AD)	0.0346	380
		Loading/Planting		38,102,400 (NSP)	0.183	550
Sorghum, grain	NA	Treating	0.0338	360,000 (AST)	0.548	100
		Packaging			0.112	35

Table F.5. Occupational Handler Non-Cancer Exposure and Risk Estimates for Mancozeb – Seed Treatment.						
Crop/Target Category	Specialized Treatment or Formulation	Activity	Application Rate (lb ai/lb seed)[1]	Exposure Variable[2]	Inhalation Dose[3] (mg/kg-day) [No-R, unless otherwise noted]	Inhalation MOE[4] [No-R, unless otherwise noted] (LOC = 10)
		Cleaning		2.5 hours (AD)	0.0268	170
		Loading/Planting		8.000.000 (NSP)	0.0027	710
Tomato	Film-coated	Treating	0.06	3,000 (AST)	0.0081	7100
	Film-coated	Packaging			0.199	2400
	Film-coated	Cleaning		2.5 hours (AD)	0.00431	96
	Film-coated	Loading/Planting		10.454.400 (NSP)	0.000203	4400
	Encrusted/Pelleted	Treating		225 (AST)	0.000608	94000
	Encrusted/Pelleted	Packaging			0.199	31000
	Encrusted/Pelleted	Cleaning		2.5 hours (AD)	0.00431	96
	Encrusted/Pelleted	Loading/Planting		10.454.400 (NSP)	0.134	4400
Triticale	NA	Treating	0.0248	360,000 (AST)	0.401	140
		Packaging			0.0823	48
		Cleaning		2.5 hours (AD)	0.446	230
		Loading/Planting		327,000,000 (NSP)	0.134	43
Wheat	NA	Treating	0.0248	360,000 (AST)	0.401	140
		Packaging			0.0823	48
		Cleaning		2.5 hours (AD)	0.643	230
		Loading/Planting		300,000,000 (NSP)	0.51	30
On-Farm Seed Treatment						
Barley	Liquid	Treating & Planting	0.00209	184,240,000 (NSP)	0.019	1000
	Dust/Powder [Solids]		0.00131		0.204	94
Corn, field	Liquid		0.00209	8,050,000 (NSP)	0.00574	3300
Cotton	Liquid		0.003	17,000,000 (NSP)	0.00525	3600
Flax	Liquid		0.003	243,936,000 (NSP)	0.00556	3400
Oat	Liquid		0.00313	234,000,000 (NSP)	0.0261	730
	Dust/Powder [Solids]		0.00197		0.28	68
Peanut	Liquid		0.008	8,400,000 (NSP)	0.0678	280
Potato	Liquid		0.000781	2,125,728 (NSP)	0.154	120
	Dust/Powder [Solids]		0.0008		2.69	7.1
					0.269 [PF10-R]	71 [PF10-R]
Rice	Liquid		0.002	487,672,000 (NSP)	0.029	660
	Dust/Powder [Solids]		0.00125		0.309	62
Rye	Liquid		0.00178	324,000,000 (NSP)	0.0149	1300
	Dust/Powder [Solids]		0.00113		0.161	120
Safflower	Liquid		0.001	38,102,400 (NSP)	0.0013	15000
	Dust/Powder [Solids]		0.00094		0.0209	910
Sorghum, grain	Liquid		0.00225	8,000,000 (NSP)		
	Dust/Powder [Solids]		0.00094		0.001	19000
Tomato	Liquid		0.004	10,454,400 (NSP)	0.00714	2700
Triticale	Liquid		0.00163	327,000,000 (NSP)	0.000161	120000
	Dust/Powder [Solids]		0.00103		0.0165	1200
Wheat	Liquid		0.00163	300,000,000 (NSP)	0.178	110
	Dust/Powder [Solids]		0.00103		0.0238	800

Red bolded MOEs are risks of concern.

* PPE: No-R = No Respirator. PF10-R = Protection Factor 10 Respirator.

[1] Seed Treatment Application rates based on the registered mancozeb labels. See Appendix E.

[2] HED default for lb seed treated/planted per day from HED Exposure Science Advisory Council Policy 15.2 (January 2022). Exposure Variables: Cleaning, Activity Duration (AD, hrs); Packaging and Treating, Amount Seed Treated (AST, lb seed); Loading/Planting, Number of Seeds Planted (NSP, number of seeds).

[3] *Commercial Seed Treaters and Packagers:* Inhalation Dose = Inhalation Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) × Application Rate (lb ai/lb seed) × Amount of Seed Treated (lb seed/day) ÷ BW (80 kg).
Commercial Seed Treatment Cleaners: Inhalation Dose = Inhalation Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) × Application Rate (lb ai/lb seed) × Activity Duration (2.5 hr) ÷ BW (80 kg).
Commercial Seed Treatment Loading/ Planting: Inhalation Dose (mg/kg/day) = Inhalation Unit Exposure (mg/day) × Conversion Factor (0.001 mg/µg) × Application Rate (lb ai/seed) × Number of Seeds Planted (NSP) ÷ BW (80 kg).
On-Farm Treaters/Planters: Inhalation Dose = Inhalation Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) × Application Rate (lb ai/lb seed) × Number of Seeds Planted (NSP) ÷ BW (80 kg).

[4] Inhalation MOE = Inhalation POD (19.1 mg/kg/day) ÷ Total Inhalation Dose (mg/kg/day).

Table F.6. Occupational Handler Non-Cancer Exposure and Risk Estimates for ETU - Foliar.

Exposure Scenario	Crop or Target[1]	Dermal Unit Exposure (µg/lb ai)[1]	Level of PPE or Engineering control	Inhalation Unit Exposure (µg/lb ai)[1]	Level of PPE or Engineering control[1]	Maximum Application Rate (lb ai/A)[2]	Area Treated or Amount Handled Daily (acres)[3]	LOC = 300				
								Dermal		Inhalation		Total
								Total Dose (mg/kg/day)[4]	MOE[5]	Total Dose[6] (mg/kg/day)	MOE[7]	MOE[8]
Mixer/Loader												
Dry Flowable, Aerial, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	51.6	SL/G	0.896	PF10 R	2.25	60	0.0000706	2800	0.000115	1700	1100
	Orchard/Vineyard	12.5	EC/G	0.26	EC/PF10 R	4.8	350	0.000213	940	0.000415	480	320
	Sod	12.5	EC/G	0.26	EC/PF10 R	17.4	350	0.000771	260	0.0015	130	87
	Field crop, typical	12.5	EC/G	0.26	EC/PF10 R	4.5	350	0.000199	1000	0.00039	510	340
	Field crop, high-acreage	12.5	EC/G	0.26	EC/PF10 R	1.5	1200	0.000228	880	0.000445	450	300
Dry Flowable, Airblast, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	51.6	SL/G	8.96	No-R	2.25	20	0.0000235	8500	0.000383	520	490
	Orchard/Vineyard	51.6	SL/G	0.896	PF10 R	4.8	40	0.0001	2000	0.000163	1200	750
Dry Flowable, Chemigation, Broadcast	Orchard/Vineyard	12.5	EC/G	0.26	EC/PF10 R	4.8	350	0.000213	940	0.000415	480	320
	Field crop, typical	12.5	EC/G	0.26	EC/PF10 R	4.5	350	0.000199	1000	0.00039	510	340
	Field crop, high-acreage	41.2	DL/G	0.896	PF10 R	1.5	350	0.000219	910	0.000447	450	300
	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	51.6	SL/G	0.896	PF10 R	2.25	60	0.0000706	2800	0.000115	1700	1100
	Nursery (ornamentals, vegetables, trees, container stock)	51.6	SL/G	0.896	PF10 R	2.25	60	0.0000706	2800	0.000115	1700	1100
Dry Flowable, Groundboom, Broadcast	Golf course (fairways, tees, greens)	12.5	EC/G	0.26	EC/PF10 R	17.4	40	0.0000881	2300	0.000172	1200	790
	Field-grown ornamental crops	51.6	SL/G	8.96	No-R	1.5	40	0.0000314	6400	0.000511	390	370
	Nursery (ornamentals, vegetables, trees, container stock)	51.6	SL/G	0.896	PF10 R	2.25	60	0.0000706	2800	0.000115	1700	1100
	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	51.6	SL/G	0.896	PF10 R	2.25	60	0.0000706	2800	0.000115	1700	1100
	Sod	12.5	EC/G	0.26	EC/PF10 R	17.4	80	0.000176	1100	0.000344	580	380
	Orchard/Vineyard	51.6	SL/G	0.896	PF10 R	4.8	40	0.0001	2000	0.000163	1200	750
	Field crop, typical	51.6	SL/G	0.896	PF10 R	4.8	80	0.0002	1000	0.000327	610	380
	Field crop, high-acreage	51.6	SL/G	0.896	PF10 R	1.5	200	0.000157	1300	0.000256	780	490

Table F.6. Occupational Handler Non-Cancer Exposure and Risk Estimates for ETU - Foliar.

Exposure Scenario	Crop or Target[1]	Dermal Unit Exposure (µg/lb ai)[1]	Level of PPE or Engineering control	Inhalation Unit Exposure (µg/lb ai)[1]	Level of PPE or Engineering control[1]	Maximum Application Rate (lb ai/A)[2]	Area Treated or Amount Handled Daily (acres)[3]	LOC = 300				
								Dermal		Inhalation		Total
								Total Dose (mg/kg/day)[4]	MOE[5]	Total Dose[6] (mg/kg/day)	MOE[7]	MOE[8]
Dry Flowable, Dip Treatment, Broadcast (foliar)	Field crop, high-acreage	51.6	SL/G	8.68	No-R	0.008	1000 gallons solution	0.00000418	48000	0.0000659	3000	2800
	Field crop, typical	51.6	SL/G	8.68	No-R	0.02	1000 gallons solution	0.0000104	19000	0.000165	1200	1100
	Orchard/Vineyard	51.6	SL/G	8.68	No-R	0.03	1000 gallons solution	0.0000157	13000	0.000247	810	760
Liquid, Aerial, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	37.6	SL/G	0.219	No-R	1.2	60	0.0000274	7300	0.000015	13000	4700
	Orchard/Vineyard	29.1	DL/G	0.0219	PF10 R	4.8	350	0.000495	400	0.000035	5700	370
	Sod	4.02	EC/G	0.011	EC/No-R	17.4	350	0.000248	810	0.0000637	3100	640
	Field crop, typical	29.1	DL/G	0.0219	PF10 R	4.8	350	0. 000495	400	0.000035	5700	370
	Field crop, high-acreage	29.1	DL/G	0.0219	PF10 R	1.6	1200	0.000566	350	0.0000399	5000	330
Liquid, Airblast, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	37.6	SL/G	0.219	No-R	1.2	20	0.00000913	22000	0.000005	40000	14000
	Orchard/Vineyard	37.6	SL/G	0.219	No-R	4.8	40	0.0000731	2700	0.0000399	5000	1800
Liquid, Chemigation, Broadcast	Orchard/Vineyard	29.1	DL/G	0.0219	PF10 R	4.8	350	0. 000495	400	0.000035	5700	370
	Sod	4.02	EC/G	0.011	EC/No-R	17.4	350	0.000248	810	0.0000637	3100	640
	Field crop, typical	29.1	DL/G	0.0219	PF10 R	4.8	350	0. 000495	400	0.000035	5700	370
	Field crop, high-acreage	37.6	SL/G	0.219	No-R	1.6	350	0.000214	930	0.000117	1700	600
	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	37.6	SL/G	0.219	No-R	1.2	60	0.0000274	7300	0.000015	13000	4700
	Nursery (ornamentals, vegetables, trees, container stock)	37.6	SL/G	0.219	No-R	1.2	60	0.0000274	7300	0.000015	13000	4700
Liquid, Groundboom, Broadcast	Golf course (fairways, tees, greens)	37.6	SL/G	0.219	No-R	17.4	40	0.000265	750	0.000144	1400	490
	Field-grown ornamental crops	37.6	SL/G	0.219	No-R	1.2	40	0.0000182	11000	0.00000998	20000	7100
	Nursery (ornamentals, vegetables, trees, container stock)	37.6	SL/G	0.219	No-R	1.2	60	0.0000274	7300	0.000015	13000	4700
	Greenhouse (ornamentals, roses,	37.6	SL/G	0.219	No-R	1.2	60	0.0000274	7300	0.000015	13000	4700

Table F.6. Occupational Handler Non-Cancer Exposure and Risk Estimates for ETU - Foliar.

Exposure Scenario	Crop or Target[1]	Dermal Unit Exposure (µg/lb ai)[1]	Level of PPE or Engineering control	Inhalation Unit Exposure (µg/lb ai)[1]	Level of PPE or Engineering control[1]	Maximum Application Rate (lb ai/A)[2]	Area Treated or Amount Handled Daily (acres)[3]	LOC = 300				
								Dermal		Inhalation		Total
								Total Dose (mg/kg/day)[4]	MOE[5]	Total Dose[6] (mg/kg/day)	MOE[7]	MOE[8]
	cut flowers, container stock, vegetables)											
	Sod	37.6	SL/G	0.0219	PF10 R	17.4	80	0.00053	380	0.000029	6900	360
	Orchard/Vineyard	37.6	SL/G	0.219	No-R	4.8	40	0.0000731	2700	0.0000399	5000	1800
	Field crop, typical	37.6	SL/G	0.219	No-R	4.8	80	0.000146	1400	0.0000799	2500	900
	Field crop, high-acreage	37.6	SL/G	0.219	No-R	1.6	200	0.000122	1600	0.0000666	3000	1000
Liquid, Dip Treatment, Broadcast (foliar)	Field crop, high-acreage	51.6	SL/G	8.68	No-R	0.008	1000 gallons solution	0.00000418	48000	0.0000659	3000	2800
	Field crop, typical	51.6	SL/G	8.68	No-R	0.02	1000 gallons solution	0.0000104	19000	0.000165	1200	1100
	Orchard/Vineyard	51.6	SL/G	8.68	No-R	0.03	1000 gallons solution	0.0000157	13000	0.000247	810	760
Wettable Powder, Aerial, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	57.5	SL/G	2.75	No-R	1.6	60	0.0000559	3600	0.000251	800	650
	Orchard/Vineyard	12.5	EC/G	0.26	EC/PF10 R	4.8	350	0.000213	940	0.000415	480	320
	Field crop, typical	12.5	EC/G	0.26	EC/PF10 R	4.8	350	0.000213	940	0.000415	480	320
	Field crop, high-acreage	12.5	EC/G	0.26	EC/PF10 R	1.6	1200	0.000243	820	0.000474	420	280
Wettable Powder, Airblast, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	57.5	SL/G	2.75	No-R	1.6	20	0.0000186	11000	0.0000836	2400	2000
	Orchard/Vineyard	57.5	SL/G	2.75	No-R	4.8	40	0.000111	1800	0.000502	400	330
Wettable Powder, Chemigation, Broadcast	Orchard/Vineyard	12.5	EC/G	0.26	EC/PF10 R	4.8	350	0.000213	940	0.000415	480	320
	Field crop, typical	12.5	EC/G	0.26	EC/PF10 R	4.8	350	0.000213	940	0.000415	480	320
	Field crop, high-acreage	57.5	SL/G	0.275	PF10 R	1.6	350	0.000326	610	0.000146	1400	420
	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	57.5	SL/G	2.75	No-R	1.6	60	0.0000559	3600	0.000251	800	650
	Nursery (ornamentals, vegetables, trees, container stock)	57.5	SL/G	2.75	No-R	1.6	60	0.0000559	3600	0.000251	800	650
Wettable Powder, Groundboom, Broadcast	Field-grown ornamental crops	57.5	SL/G	2.75	No-R	1.6	40	0.0000373	5400	0.000167	1200	980
	Nursery (ornamentals, vegetables, trees, container stock)	57.5	SL/G	2.75	No-R	1.6	60	0.0000559	3600	0.000251	800	650

Table F.6. Occupational Handler Non-Cancer Exposure and Risk Estimates for ETU - Foliar.

Exposure Scenario	Crop or Target[1]	Dermal Unit Exposure (µg/lb ai)[1]	Level of PPE or Engineering control	Inhalation Unit Exposure (µg/lb ai)[1]	Level of PPE or Engineering control[1]	Maximum Application Rate (lb ai/A)[2]	Area Treated or Amount Handled Daily (acres)[3]	LOC = 300				
								Dermal		Inhalation		Total
								Total Dose (mg/kg/day)[4]	MOE[5]	Total Dose[6] (mg/kg/day)	MOE[7]	MOE[8]
	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	57.5	SL/G	2.75	No-R	1.6	60	0.0000559	3600	0.000251	800	650
	Orchard/Vineyard	57.5	SL/G	2.75	No-R	4.8	40	0.000111	1800	0.000502	400	330
	Field crop, typical	57.5	SL/G	0.275	PF10 R	4.8	80	0.000224	890	0.000101	2000	620
	Field crop, high-acreage	57.5	SL/G	0.275	PF10 R	1.6	200	0.000186	1100	0.0000836	2400	750
Wettable Powder, Dip Treatment, Broadcast (foliar)	Field crop, high-acreage	51.6	SL/G	8.68	No-R	0.008	1000 gallons solution	0.00000418	48000	0.0000659	3000	2800
	Field crop, typical	51.6	SL/G	8.68	No-R	0.02	1000 gallons solution	0.0000104	19000	0.000165	1200	1100
	Orchard/Vineyard	51.6	SL/G	8.68	No-R	0.03	1000 gallons solution	0.0000157	13000	0.000247	810	760
Water-soluble Packet, Airblast, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	12.5	EC/G	2.6	EC/No-R	1.44	20	0.00000365	55000	0.0000712	2800	2700
Water-soluble Packet, Groundboom, Broadcast	Golf course (fairways, tees, greens)	12.5	EC/G	0.26	EC/PF10 R	10.45	40	0.000053	3800	0.000104	1900	1300
	Field-grown ornamental crops	12.5	EC/G	2.6	EC/No-R	1.44	40	0.00000729	27000	0.000143	1400	1300
	Nursery (ornamentals, vegetables, trees, container stock)	12.5	EC/G	2.6	EC/No-R	2.05	60	0.0000156	13000	0.000304	660	630
Water-soluble Packet, Groundboom, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	12.5	EC/G	2.6	EC/No-R	2.05	60	0.0000156	13000	0.000304	660	630
Applicator												
Spray (all starting formulations), Aerial, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	2.08	EC/G	0.0049	EC/No-R	1.2	60	0.00000152	130000	0.000000335	600000	110000
	Orchard/Vineyard	2.08	EC/G	0.0049	EC/No-R	4.8	350	0.0000353	5700	0.00000782	26000	4700
	Sod	2.08	EC/G	0.0049	EC/No-R	17.4	350	0.000129	1600	0.0000283	7100	1300
	Field crop, typical	2.08	EC/G	0.0049	EC/No-R	4.8	350	0.0000353	5700	0.00000782	26000	4700
	Field crop, high-acreage	2.08	EC/G	0.0049	EC/No-R	1.6	1200	0.0000404	5000	0.00000894	22000	4100

Table F.6. Occupational Handler Non-Cancer Exposure and Risk Estimates for ETU - Foliar.

Exposure Scenario	Crop or Target[1]	Dermal Unit Exposure (µg/lb ai)[1]	Level of PPE or Engineering control	Inhalation Unit Exposure (µg/lb ai)[1]	Level of PPE or Engineering control[1]	Maximum Application Rate (lb ai/A)[2]	Area Treated or Amount Handled Daily (acres)[3]	LOC = 300				
								Dermal		Inhalation		Total
								Total Dose (mg/kg/day)[4]	MOE[5]	Total Dose[6] (mg/kg/day)	MOE[7]	MOE[8]
Spray (all starting formulations), Airblast, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	14.6	EC/G	0.068	EC/No-R	2.25	20	0.00000665	30000	0.00000291	69000	21000
	Orchard/Vineyard	14.6	EC/G	0.068	EC/No-R	4.8	40	0.0000284	7000	0.0000124	16000	4900
Spray (all starting formulations), Groundboom, Broadcast	Golf course (fairways, tees, greens)	16.1	SL/G	0.34	No-R	17.4	40	0.000113	1800	0.000225	890	600
	Field-grown ornamental crops	16.1	SL/G	0.34	No-R	1.6	40	0.0000104	19000	0.0000207	9700	6400
	Nursery (ornamentals, vegetables, trees, container stock)	16.1	SL/G	0.34	No-R	2.25	60	0.000022	9100	0.0000436	4600	3100
	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	16.1	SL/G	0.34	No-R	2.25	60	0.000022	9100	0.0000436	4600	3100
	Sod	16.1	SL/G	0.34	No-R	17.4	80	0.000227	880	0.000449	450	300
	Orchard/Vineyard	16.1	SL/G	0.34	No-R	4.8	40	0.0000313	6400	0.000062	3200	2100
	Field crop, typical	16.1	SL/G	0.34	No-R	4.8	80	0.0000626	3200	0.000124	1600	1100
	Field crop, high-acreage	16.1	SL/G	0.34	No-R	1.6	200	0.0000521	3800	0.000104	1900	1300
Flagger												
Spray (all starting formulations), Aerial, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	12	SL/G	0.202	No-R	2.25	60	0.000035	5700	0.0000553	3600	2200
	Orchard/Vineyard	12	SL/G	0.202	No-R	4.8	350	0.000205	980	0.000322	620	380
	Sod	10.6	DL/G	0.0202	PF10 R	17.4	350	0.000654	310	0.000117	1700	**260**
	Field crop, typical	12	SL/G	0.202	No-R	4.8	350	0.000205	980	0.000322	620	380
	Field crop, high-acreage	12	SL/G	0.202	No-R	1.6	350	0.000068	2900	0.000107	1900	1100
Mixer/Loader/Applicator												
Dry Flowable, Backpack, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	11200	SL/G	140	No-R	0.011 lb ai/gallon solution	7 gallons solution	0.00000873	23000	0.0000103	19000	10000
Dry Flowable, Backpack, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	30500	SL/G	69.1	No-R	0.011 lb ai/gallon solution	15 gallons solution	0.0000509	3900	0.0000108	19000	3200
Dry Flowable, Manually-pressurized Handwand, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	430	SL/G	23.6	No-R	0.048 lb ai/gallon solution	7 gallons solution	0.00000146	140000	0.00000753	27000	23000

Table F.6. Occupational Handler Non-Cancer Exposure and Risk Estimates for ETU - Foliar.

Exposure Scenario	Crop or Target[1]	Dermal Unit Exposure (µg/lb ai)[1]	Level of PPE or Engineering control	Inhalation Unit Exposure (µg/lb ai)[1]	Level of PPE or Engineering control[1]	Maximum Application Rate (lb ai/A)[2]	Area Treated or Amount Handled Daily (acres)[3]	LOC = 300				
								Dermal		Inhalation		Total
								Total Dose (mg/kg/day)[4]	MOE[5]	Total Dose[6] (mg/kg/day)	MOE[7]	MOE[8]
Dry Flowable, Manually-pressurized Handwand, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	430	SL/G	23.6	No-R	0.011 lb ai/gallon solution	15 gallons solution	0.000000719	280000	0.0000037	54000	45000
Dry Flowable, Mechanically-pressurized Handgun, Broadcast (foliar)	Orchard/Vineyard	1360	DL/G	0.868	PF10 R	0.048 lb ai/gallon solution	1000 gallons solution	0.000661	300	0.0000396	5100	280
Dry Flowable, Mechanically-pressurized Handgun, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	3610	SL/G	44.8	PF10 R	0.011 lb ai/gallon solution	175 gallons solution	0.0000704	2800	0.0000819	2400	1300
Dry Flowable, Mechanically-pressurized Handgun, Broadcast	Golf course (fairways, tees, greens)	1400	SL/G	42	No-R	0.4	5	0.0000284	7000	0.0000798	2500	1800
Dry Flowable, Mechanically-pressurized Handgun, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	3610	SL/G	44.8	PF10 R	0.011 lb ai/gallon solution	300 gallons solution	0.00012	1700	0.000141	1400	770
Dry Flowable, Mechanically-pressurized Handgun, Broadcast (foliar)	Field crop, typical	1360	DL/G	0.868	PF10 R	0.48 lb ai/gallon solution	1000 gallons solution	0.00661	30	0.000396	510	28
Liquid, Backpack, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	11200	SL/G	140	No-R	0.012 lb ai/gallon solution	7 gallons solution	0.00000953	21000	0.0000112	18000	9700
Liquid, Backpack, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	30500	SL/G	69.1	No-R	0.012 lb ai/gallon solution	15 gallons solution	0.0000556	3600	0.0000118	17000	3000
Liquid, Manually-pressurized Handwand, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	430	SL/G	23.6	No-R	0.012 lb ai/gallon solution	7 gallons solution	0.000000366	550000	0.00000188	110000	92000
Liquid, Manually-pressurized Handwand, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	430	SL/G	23.6	No-R	0.012 lb ai/gallon solution	15 gallons solution	0.000000784	260000	0.00000404	50000	42000

Table F.6. Occupational Handler Non-Cancer Exposure and Risk Estimates for ETU - Foliar.

Exposure Scenario	Crop or Target[1]	Dermal Unit Exposure (µg/lb ai)[1]	Level of PPE or Engineering control	Inhalation Unit Exposure (µg/lb ai)[1]	Level of PPE or Engineering control[1]	Maximum Application Rate (lb ai/A)[2]	Area Treated or Amount Handled Daily (acres)[3]	LOC = 300				
								Dermal		Inhalation		Total
								Total Dose (mg/kg/day)[4]	MOE[5]	Total Dose[6] (mg/kg/day)	MOE[7]	MOE[8]
Liquid, Mechanically-pressurized Handgun, Broadcast (foliar)	Orchard/Vineyard	1360	DL/G	0.868	PF10 R	0.48 lb ai/gallon solution	1000 gallons solution	0.00661	30	0.000396	510	28
Liquid, Mechanically-pressurized Handgun, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	3610	SL/G	44.8	PF10 R	0.012 lb ai/gallon solution	175 gallons solution	0.0000767	2600	0.0000894	2200	1200
Liquid, Mechanically-pressurized Handgun, Broadcast	Golf course (fairways, tees, greens)	450	DL/G	1.9	No-R	17.4	5	0.000397	500	0.000157	1300	360
Liquid, Mechanically-pressurized Handgun, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	3610	SL/G	44.8	PF10 R	0.012 lb ai/gallon solution	300 gallons solution	0.000132	1500	0.000153	1300	700
Liquid, Mechanically-pressurized Handgun, Broadcast (foliar)	Field crop, typical	1360	DL/G	0.868	PF10 R	0.48 lb ai/gallon solution	1000 gallons solution	0.00661	30	0.000396	510	28
Wettable Powder, Backpack, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	11200	SL/G	140	No-R	0.016 lb ai/gallon solution	7 gallons solution	0.0000127	16000	0.0000149	13000	7200
Wettable Powder, Backpack, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	30500	SL/G	69.1	No-R	0.016 lb ai/gallon solution	15 gallons solution	0.0000741	2700	0.0000158	13000	2200
Wettable Powder, Manually-pressurized Handwand, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	430	SL/G	23.6	No-R	0.016 lb ai/gallon solution	15 gallons solution	0.000000488	410000	0.00000251	80000	67000
Wettable Powder, Manually-pressurized Handwand, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	430	SL/G	23.6	No-R	0.016 lb ai/gallon solution	40 gallons solution	0.00000104	190000	0.00000538	37000	31000
Wettable Powder, Mechanically-pressurized Handgun, Broadcast (foliar)	Orchard/Vineyard	1360	DL/G	0.868	PF10 R	0.096 lb ai/gallon solution	175 gallons solution	0.00661	30	0.000396	510	28
Wettable Powder, Mechanically-pressurized Handgun, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	3610	SL/G	44.8	PF10 R	0.016 lb ai/gallon solution	300 gallons solution	0.000102	2000	0.000119	1700	920

Table F.6. Occupational Handler Non-Cancer Exposure and Risk Estimates for ETU - Foliar.

Exposure Scenario	Crop or Target[1]	Dermal Unit Exposure (µg/lb ai)[1]	Level of PPE or Engineering control	Inhalation Unit Exposure (µg/lb ai)[1]	Level of PPE or Engineering control[1]	Maximum Application Rate (lb ai/A)[2]	Area Treated or Amount Handled Daily (acres)[3]	LOC = 300				
								Dermal		Inhalation		Total
								Total Dose (mg/kg/day)[4]	MOE[5]	Total Dose[6] (mg/kg/day)	MOE[7]	MOE[8]
Wettable Powder, Mechanically-pressurized Handgun, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	3610	SL/G	44.8	PF10 R	0.016 lb ai/gallon solution	1000 gallons solution	0.000175	1100	0.000204	980	520
Wettable Powder, Mechanically-pressurized Handgun, Broadcast (foliar)	Field crop, typical	1360	DL/G	0.868	PF10 R	0.48 lb ai/gallon solution	7 gallons solution	0.00661	**30**	0.000396	510	**28**
Water-soluble Packet, Backpack, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	11200	SL/G	140	No-R	0.021 lb ai/gallon solution	15 gallons solution	0.0000167	12000	0.0000196	10000	5500
Water-soluble Packet, Backpack, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	30500	SL/G	69.1	No-R	0.021 lb ai/gallon solution	40 gallons solution	0.0000973	2100	0.0000207	9700	1700
Water-soluble Packet, Manually-pressurized Handwand, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	430	SL/G	23.6	No-R	0.021 lb ai/gallon solution	40 gallons solution	0.00000064	310000	0.0000033	61000	51000
Water-soluble Packet, Manually-pressurized Handwand, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	430	SL/G	23.6	No-R	0.021 lb ai/gallon solution	40 gallons solution	0.00000137	150000	0.00000706	28000	24000
Water-soluble Packet, Mechanically-pressurized Handgun, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	3610	SL/G	44.8	PF10 R	0.021 lb ai/gallon solution	300 gallons solution	0.000135	1500	0.000157	1300	700
Water-soluble Packet, Mechanically-pressurized Handgun, Broadcast	Golf course (fairways, tees, greens)	855	SL/G	18	No-R	0.048 lb ai/gallon solution	1000 gallons solution	0.00000208	96000	0.0000041	49000	32000
Water-soluble Packet, Mechanically-pressurized Handgun, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	3610	SL/G	44.8	PF10 R	0.021	5	0.00023	870	0.000268	750	400

Red bolded MOEs are risks of concern.

1. Orchard crops include the following crops currently listed on mancozeb labels: almond, banana, Christmas trees, grapes, papaya, pome fruits (apple, crabapple, quince, pear), subtropical/tropical fruit (sugar apple, cherimoya, atemoya, custard apple, sweetsop, mango, star apple, canistel, mamey sapote, sapodilla, white sapote), walnut.
   Typical-acreage field crops include the following crops currently listed on mancozeb labels: asparagus, broccoli, cabbage, carrots, cucurbits, swiss chard, coriander, sweet corn, cranberry, dill, endive, fennel, garden beet, garlic, ginseng, leafy brassica greens, leek, lettuce, onion, parsley, parsnip, pepper, plantain, shallot, spinach, tobacco, tomato.
   High-acreage field crops include the following crops currently listed on mancozeb labels: barley, field/popcorn, peanuts, potato, rye, wheat, triticale, oats, sugar beet.

2. Based on the "Occupational Pesticide Handler Unit Exposure Surrogate Reference Table" (https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/occupational-pesticide-handler-exposure-data); Level of PPE: SL/G, DL/G, No-R, PF10, EC = single layer/gloves, double layer/gloves, no-respirator, PF10 respirator, engineering controls.
3. Based on registered labels (see Appendix E).
4. Exposure Science Advisory Council Policy #9.1.
5. Total Dermal Dose = ETU Dermal Dose (mg/kg/day) + Metabolized ETU Dermal Dose (mg/kg/day)
   ETU Dermal Dose = Dermal Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) x [Tank Mix Conversion (0.001 for mixer/loader) or (0.002 for applicator or M/L/A)]* × Application Rate (lb ai/acre or gal) × Area Treated or Amount Handled (A or gal/day) × DAF (6%) ÷ BW (80 kg).
   Metabolized ETU Dermal Dose = Dermal Unit Exposure (µg/lb ai) x Conversion Factor (0.001 mg/µg) x Metabolic Conversion Factor (7.5%)* × Application Rate (lb ai/acre or gal) × Area Treated or Amount Handled (A or gal/day) × DAF (1%) ÷ BW (kg).
6. Dermal MOE = Dermal POD (0.2 mg/kg/day) ÷ Total Dermal Dose (mg/kg/day).
7. Total Inhalation Dose = ETU Inhalation dose (mg/kg/day) + Metabolized ETU Inhalation Dose (mg/kg/day)
   ETU Inhalation Dose = Inhalation Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) x [Tank Mix Conversion (0.001 for mixer/loader) or (0.002 for applicator or M/L/A)]* × Application Rate (lb ai/acre or gal) × Area Treated or Amount Handled (A or gal/day) ÷ BW (80 kg).
   Metabolized ETU Dose = Inhalation Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) × Metabolic Conversion Factor (7.5%)* x Application Rate (lb ai/acre or gal) × Area Treated or Amount Handled (A or gal/day) ÷ BW (80 kg).
8. Inhalation MOE = Inhalation POD (0.21 mg/kg/day) ÷ Total Inhalation Dose (mg/kg/day).
9. Total MOE = POD (0.21 mg/kg/day) ÷ Total Dermal Dose + Total Inhalation Dose **OR** Total MOE = 1 ÷ (1/Dermal MOE + 1/Inhalation MOE).

* See section 4.0 for further details.

Table F.7. Occupational Handler Non-Cancer Exposure and Risk Estimates for ETU – Seed Treatment.

Crop/Target Category	Specialized Treatment or Formulation	Worker Activity	Application Rate (lb ai/lb seed)[1]	Exposure Variable[2]	Combined MOE[3,4,5,6,7,8,9] (LOC = 300)			
					SL/G + No-R	DL/G + No-R	SL/G + PF10	DL/G + PF10
Commercial Seed Treatment								
Barley	NA	Treating	0.0315	360,000 (AST)	11	12	28	33
		Packaging			4.9	5	34	37
		Cleaning		2.5 hours (AD)	7.6	8.1	11	11
		Loading/Planting		184,240,000 (NSP)	4.6	4.8	23	28
Corn, field	NA	Treating	0.0405	339,500 (AST)	8.9	9.4	23	27
		Packaging			4.1	4.1	29	31
		Cleaning		2.5 hours (AD)	5.9	6.3	8.1	8.8
		Loading/Planting		8,050,000 (NSP)	12	12	57	72
Cotton	NA	Treating	0.045	125,000 (AST)	21	23	56	65
		Packaging			9.5	9.6	68	73
		Cleaning		2.5 hours (AD)	5.3	5.7	7.2	7.9
		Loading/Planting		17,000,000 (NSP)	17	17	84	100
Flax	NA	Treating	0.0533	125,000 (AST)	18	19	47	55
		Packaging			8.4	8.5	59	64
		Cleaning		2.5 hours (AD)	4.5	4.8	6.1	6.7
		Loading/Planting		243,936,000 (NSP)	13	14	67	82
Oat	NA	Treating	0.0473	360,000 (AST)	7	7.3	19	21
		Packaging			3.2	3.3	23	25
		Cleaning		2.5 hours (AD)	5.1	5.4	6.9	7.5
		Loading/Planting		234,000,000 (NSP)	3.3	3.4	16	20
Peanut	NA	Treating	0.12	126,000 (AST)	8.2	8.7	21	25
		Packaging			3.7	3.8	26	28
		Cleaning		2.5 hours (AD)	2	2.1	2.7	3
		Loading/Planting		8,400,000 (NSP)	1.2	1.3	6.2	7.7
Potato	NA	Treating	0.0008	800,000 (AST)	190	200	490	570
		Packaging			87	88	600	660
		Cleaning		2.5 hours (AD)	300	320	400	450
		Loading/Planting		2,125,728 (NSP)	8.3	8.7	41	51
Rice	NA	Treating	0.032	302,500 (AST)	12	13	33	38
		Packaging			5.7	5.8	40	44
		Cleaning		2.5 hours (AD)	7.6	8.1	11	11
		Loading/Planting		487,672,000 (NSP)	2.8	2.9	14	17
Rye	NA	Treating	0.027	360,000 (AST)	12	13	33	38
		Packaging			5.7	5.8	40	44
		Cleaning		2.5 hours (AD)	9	9.4	12	13
		Loading/Planting		324,000,000 (NSP)	5.8	6.1	29	36
Safflower	NA	Treating	0.015	360,000 (AST)	22	23	59	68
		Packaging			10	11	73	79
		Cleaning		2.5 hours (AD)	16	17	22	24
		Loading/Planting		38,102,400 (NSP)	67	70	330	410

Table F.7. Occupational Handler Non-Cancer Exposure and Risk Estimates for ETU – Seed Treatment.

Crop/Target Category	Specialized Treatment or Formulation	Worker Activity	Application Rate (lb ai/lb seed)[1]	Exposure Variable[2]	Combined MOE[3,4,5,6,7,8,9] (LOC = 300)			
					SL/G + No-R	DL/G + No-R	SL/G + PF10	DL/G + PF10
Sorghum, grain	NA	Treating	0.0338	360,000 (AST)	9.7	10	26	31
		Packaging			4.6	4.6	32	34
		Cleaning		2.5 hours (AD)	7	7.4	9.6	10
		Loading/Planting		8.000.000 (NSP)	88	91	430	520
Tomato	Film-coated	Treating	0.06	3,000 (AST)	670	710	1700	2100
	Film-coated	Packaging			300	310	2100	2300
	Film-coated	Cleaning		2.5 hours (AD)	4	4.2	5.5	5.9
	Film-coated	Loading/Planting		10.454.400 (NSP)	540	560	2700	3300
	Encrusted/Pelleted	Treating		225 (AST)	9000	9500	24000	28000
	Encrusted/Pelleted	Packaging			4100	4100	29000	31000
	Encrusted/Pelleted	Cleaning		2.5 hours (AD)	4	4.2	5.5	5.9
	Encrusted/Pelleted	Loading/Planting		10.454.400 (NSP)	540	560	2700	3300
Triticale	NA	Treating	0.0248	360,000 (AST)	14	14	35	41
		Packaging			6.3	6.4	44	48
		Cleaning		2.5 hours (AD)	9.7	10	13	14
		Loading/Planting		327,000,000 (NSP)	5.2	5.4	26	32
Wheat	NA	Treating	0.0248	360,000 (AST)	14	14	35	41
		Packaging			6.3	6.4	44	48
		Cleaning		2.5 hours (AD)	9.7	10	13	14
		Loading/Planting		300,000,000 (NSP)	3.6	3.8	18	22
On-Farm Seed Treatment								
Barley	Liquid	Treating/Planting	0.00209	184,240,000 (NSP)	130	130	820	880
	Dust/Powder [Solids]		0.00131		11	12	55	65
Corn, field	Liquid		0.00209	8,050,000 (NSP)	420	430	2700	2900
Cotton	Liquid		0.003	17,000,000 (NSP)	470	470	3000	3200
Flax	Liquid		0.003	243,936,000 (NSP)	440	440	2800	3000
Oat	Liquid		0.00313	234,000,000 (NSP)	93	95	580	640
	Dust/Powder [Solids]		0.00197		8.2	8.5	39	47
Peanut	Liquid		0.008	8,400,000 (NSP)	36	36	230	240
Potato	Liquid		0.000781	2,125,728 (NSP)	16	16	100	110
	Dust/Powder [Solids]		0.0008		0.85	0.88	4.1	4.9
Rice	Liquid		0.002	487,672,000 (NSP)	84	85	530	580
	Dust/Powder [Solids]		0.00125		7.4	7.6	36	42
Rye	Liquid		0.00178	324,000,000 (NSP)	160	160	1000	1100
	Dust/Powder [Solids]		0.00113		14	15	69	80
Safflower	Liquid		0.001	38,102,400 (NSP)	1900	1900	12000	13000
	Dust/Powder [Solids]		0.00094		110	110	520	620
Sorghum, grain	Liquid		0.00225	8,000,000 (NSP)	2400	2500	15000	17000
	Dust/Powder [Solids]		0.00094		320	330	1500	1800
Tomato	Liquid		0.004	10,454,400 (NSP)	15000	15000	94000	100000
Triticale	Liquid		0.00163	327,000,000 (NSP)	150	150	940	1000
	Dust/Powder [Solids]		0.00103		13	14	63	75
Wheat	Liquid		0.00163	300,000,000 (NSP)	100	100	650	700
	Dust/Powder [Solids]		0.00103		8.8	9.1	43	50

Red bolded MOEs are risks of concern.

[1] Seed Treatment Application rates based on the registered mancozeb labels. See Appendix E.

[2] HED default for lb seed treated/planted per day from HED Exposure Science Advisory Council Policy 15.2 (January 2022). Exposure Variables: Cleaning, Activity Duration (AD, hrs); Packaging and Treating, Amount Seed Treated (AST, lb seed); Loading/Planting, Number of Seeds Planted (NSP, number of seeds).

[3] Unit Exposures from HED Exposure Science Advisory Council Policy 14: Standard Operating Procedures for Seed Treatment.

[4] PPE: SL/G = Single Layer/Gloves, DL/G = Double Layer/Gloves, No-R = No Respirator, and PF10 R = PF10 Respirator

[5] Total Dermal Dose = ETU Dermal Dose (mg/kg/day) + Metabolized ETU Dermal Dose (mg/kg/day)

ETU Dermal Dose

Commercial Seed Treaters and Packagers: Dermal Dose = Dermal Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) × [Tank Mix Conversion (0.001 for commercial activities) or (0.002 for on farm activities)]* × Application Rate (lb ai/lb seed) × Amount of Seed Treated (lb seed/day) × DAF (6 %) ÷ BW (80 kg).

Commercial Seed Treatment Cleaners: Dermal Dose = Dermal Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) × [Tank Mix Conversion (0.001 for commercial activities) or (0.002 for on farm activities)]* Application Rate (lb ai/lb seed) × Activity Duration (2.5 hr) × DAF (6 %) ÷ BW (80 kg).

Commercial Seed Treatment Loading/Planting: Dermal Dose (mg/kg/day) = Dermal Unit Exposure (mg/day) × Conversion Factor (0.001 mg/µg) × [Tank Mix Conversion (0.001 for commercial activities) or (0.002 for on farm activities)]* × Application Rate (lb ai/seed) × Number of Seeds Planted (NSP) x Dermal Absorption Factor (6%) ÷ BW (80 kg).

On-Farm Treaters/Planters: Dermal Dose = Dermal Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) × [Tank Mix Conversion (0.001 for commercial activities) or (0.002 for on farm activities)]* × Application Rate (lb ai/lb seed) × Number of Seeds Planted (NSP) × DAF (6 %) ÷ BW (80 kg).

Metabolized ETU Dermal Dose

Commerical Seed Treaters and Packagers: Dermal Dose = Dermal Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) × Metabolic Conversion Factor (7.5%)* × Application Rate (lb ai/lb seed) × Amount of Seed Treated (lb seed/day) × DAF (6 %) ÷ BW (80 kg).

Commercial Seed Treatment Cleaners: Dermal Dose = Dermal Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) × Metabolic Conversion Factor (7.5%)* × Application Rate (lb ai/lb seed) × Activity Duration (2.5 hr) × DAF (6 %) ÷ BW (80 kg).

Commercial Seed Treatment Loading/ Planting: Dermal Dose (mg/kg/day) = Dermal Unit Exposure (mg/day) × Conversion Factor (0.001 mg/µg) × [Tank Mix Conversion (0.001 for commercial activities) or (0.002 for on farm activities)]* × Application Rate (lb ai/seed) × Number of Seeds Planted (NSP) x Dermal Absorption Factor (6%) ÷ BW (80 kg).

On-Farm Treaters/Planters: Dermal Dose = Dermal Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) × Metabolic Conversion Factor (7.5%)* × Application Rate (lb ai/lb seed) × Number of Seeds Planted (NSP) × DAF (6 %) ÷ BW (80 kg).

[6] Dermal MOE = Dermal POD (0.2 mg/kg/day) ÷ Total Dermal Dose (mg/kg/day).

[7] Total Inhalation Dose = ETU Inhalation dose (mg/kg/day) + Metabolized ETU Inhalation Dose (mg/kg/day)

ETU Inhalation Dose

Commercial Seed Treaters and Packagers: Inhalation Dose = Inhalation Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) × [Tank Mix Conversion (0.001 for commercial activities) or (0.002 for on farm activities)]* × Application Rate (lb ai/lb seed) × Amount of Seed Treated (lb seed/day) ÷ BW (80 kg).

Commercial Seed Treatment Cleaners: Inhalation Dose = Inhalation Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) × [Tank Mix Conversion (0.001 for commercial activities) or (0.002 for on farm activities)]* × Application Rate (lb ai/lb seed) × Activity Duration (2.5 hr) ÷ BW (80 kg).

Commerical Seed Treatment Loading/ Planting: Inhalation Dose (mg/kg/day) = Inhalation Unit Exposure (mg/day) × Conversion Factor (0.001 mg/µg) × [Tank Mix Conversion (0.001 for commercial activities) or (0.002 for on farm activities)]* × Application Rate (lb ai/seed) × Number of Seeds Planted (NSP) ÷ BW (80 kg).

On-Farm Treaters/Planters: Inhalation Dose = Inhalation Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) × [Tank Mix Conversion (0.001 for commercial activities) or (0.002 for on farm activities)]* × Application Rate (lb ai/lb seed) × Number of Seeds Planted (NSP) ÷ BW (80 kg).

Metabolized ETU Dose

Commercial Seed Treaters and Packagers: Inhalation Dose = Inhalation Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) × Metabolic Conversion Factor (7.5%)* × Application Rate (lb ai/lb seed) × Amount of Seed Treated (lb seed/day) ÷ BW (80 kg).

Commercial Seed Treatment Cleaners: Inhalation Dose = Inhalation Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) × × Metabolic Conversion Factor (7.5%)* × Application Rate (lb ai/lb seed) × Activity Duration (2.5 hr) ÷ BW (80 kg).

Commercial Seed Treatment Loading/ Planting: Inhalation Dose (mg/kg/day) = Inhalation Unit Exposure (mg/day) × Conversion Factor (0.001 mg/µg) × Metabolic Conversion Factor (7.5%)* × Application Rate (lb ai/seed) × Number of Seeds Planted (NSP) ÷ BW (80 kg).

On-Farm Treaters/Planters: Inhalation Dose = Inhalation Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) × Metabolic Conversion Factor (7.5%)* × Application Rate (lb ai/lb seed) × Number of Seeds Planted (NSP) ÷ BW (80 kg).

[8] Inhalation MOE = Inhalation POD (0.21 mg/kg/day) ÷ Total Inhalation Dose (mg/kg/day).

[9] Total MOE = POD (0.21 mg/kg/day) ÷ Total Dermal Dose + Total Inhalation Dose

* See section 4.0 of D465683, (D. Carter, 02/10/2023) for further details.

Table F.8. Occupational Handler Cancer Exposure and Risk Estimates for ETU -Foliar.

Exposure Scenario	Crop or Target	Private Handler						Commercial Handler					
		LADD (mg/kg/day)				Total LADD[3]	Cancer Risk Estimate[4]	LADD (mg/kg/day)				Total LADD[3]	Cancer Risk Estimate[4]
		Dermal[1]	PPE	Inhalation[2]	PPE			Dermal[1]	PPE	Inhalation[2]	PPE		
Mixer/Loader													
Dry Flowable, Aerial, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	0.0000643	SL/G	0.000186	No-R	0.00025	2E-05	0.000193	SL/G	0.000557	No-R	0.000749	5E-05
Dry Flowable, Aerial, Broadcast	Orchard/Vineyard	0.000799	SL/G	0.00232	No-R	0.00312	2E-04	0.0024	SL/G	0.00697	No-R	0.00937	6E-04
Dry Flowable, Aerial, Broadcast	Sod	0.0029	SL/G	0.0084	No-R	0.0113	7E-04	0.0087	SL/G	0.0252	No-R	0.0339	2E-03
Dry Flowable, Aerial, Broadcast	Field crop, typical	0.00075	SL/G	0.00216	No-R	0.00291	2E-04	0.00225	SL/G	0.00649	No-R	0.00874	5E-04
Dry Flowable, Aerial, Broadcast	Field crop, high-acreage	0.000857	SL/G	0.00247	No-R	0.00333	2E-04	0.00257	SL/G	0.00741	No-R	0.00999	6E-04
Dry Flowable, Airblast, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	0.0000214	SL/G	0.000062	No-R	0.0000834	5E-06	0.0000642	SL/G	0.000186	No-R	0.00025	2E-05
Dry Flowable, Airblast, Broadcast	Orchard/Vineyard	0.0000913	SL/G	0.000264	No-R	0.000355	2E-05	0.000274	SL/G	0.000793	No-R	0.00107	6E-05
Dry Flowable, Chemigation, Broadcast	Orchard/Vineyard	0.000799	SL/G	0.00232	No-R	0.00312	2E-04	0.0024	SL/G	0.00697	No-R	0.00937	6E-04
Dry Flowable, Chemigation, Broadcast	Field crop, typical	0.00075	SL/G	0.00216	No-R	0.00291	2E-04	0.00225	SL/G	0.00649	No-R	0.00874	5E-04
Dry Flowable, Chemigation, Broadcast	Field crop, high-acreage	0.00025	SL/G	0.000723	No-R	0.000972	6E-05	0.000749	SL/G	0.00217	No-R	0.00292	2E-04
Dry Flowable, Chemigation, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.0000643	SL/G	0.000186	No-R	0.00025	2E-05	0.000193	SL/G	0.000557	No-R	0.000749	5E-05
Dry Flowable, Chemigation, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	0.0000643	SL/G	0.000186	No-R	0.00025	2E-05	0.000193	SL/G	0.000557	No-R	0.000749	5E-05
Dry Flowable, Groundboom, Broadcast	Golf course (fairways, tees, greens)	0.000331	SL/G	0.000959	No-R	0.00129	8E-05	0.000992	SL/G	0.00288	No-R	0.00387	2E-04
Dry Flowable, Groundboom, Broadcast	Field-grown ornamental crops	0.0000286	SL/G	0.0000827	No-R	0.000111	7E-06	0.0000859	SL/G	0.000248	No-R	0.000334	2E-05
Dry Flowable, Groundboom, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	0.0000643	SL/G	0.000186	No-R	0.00025	2E-05	0.000193	SL/G	0.000557	No-R	0.000749	5E-05

Table F.8. Occupational Handler Cancer Exposure and Risk Estimates for ETU -Foliar.

Exposure Scenario	Crop or Target	Private Handler						Commercial Handler					
		LADD (mg/kg/day)				Total LADD[3]	Cancer Risk Estimate[4]	LADD (mg/kg/day)				Total LADD[3]	Cancer Risk Estimate[4]
		Dermal[1]	PPE	Inhalation[2]	PPE			Dermal[1]	PPE	Inhalation[2]	PPE		
Dry Flowable, Groundboom, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.0000643	SL/G	0.000186	No-R	0.00025	2E-05	0.000193	SL/G	0.000557	No-R	0.000749	5E-05
Dry Flowable, Groundboom, Broadcast	Sod	0.000663	SL/G	0.00192	No-R	0.00258	2E-04	0.00199	SL/G	0.00575	No-R	0.00774	5E-04
Dry Flowable, Groundboom, Broadcast	Orchard/Vineyard	0.0000913	SL/G	0.000264	No-R	0.000355	2E-05	0.000274	SL/G	0.000793	No-R	0.00107	6E-05
Dry Flowable, Groundboom, Broadcast	Field crop, typical	0.000183	SL/G	0.000529	No-R	0.000712	4E-05	0.00055	SL/G	0.00159	No-R	0.00214	1E-04
Dry Flowable, Groundboom, Broadcast	Field crop, high-acreage	0.000143	SL/G	0.000413	No-R	0.000556	3E-05	0.000428	SL/G	0.00124	No-R	0.00167	1E-04
Liquid, Aerial, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	0.000025	SL/G	0.00000243	No-R	0.0000274	2E-06	0.0000749	SL/G	0.0000073	No-R	0.0000822	5E-06
Liquid, Aerial, Broadcast	Orchard/Vineyard	0.000583	SL/G	0.0000566	No-R	0.000639	4E-05	0.00175	SL/G	0.00017	No-R	0.00192	1E-04
Liquid, Aerial, Broadcast	Sod	0.00211	SL/G	0.000204	No-R	0.00232	1E-04	0.00634	SL/G	0.000612	No-R	0.00697	4E-04
Liquid, Aerial, Broadcast	Field crop, typical	0.000583	SL/G	0.0000566	No-R	0.000639	4E-05	0.00175	SL/G	0.00017	No-R	0.00192	1E-04
Liquid, Aerial, Broadcast	Field crop, high-acreage	0.000666	SL/G	0.0000645	No-R	0.000731	4E-05	0.002	SL/G	0.000194	No-R	0.00219	1E-04
Liquid, Airblast, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	0.00000832	SL/G	0.000000809	No-R	0.00000913	6E-07	0.000025	SL/G	0.00000243	No-R	0.0000274	2E-06
Liquid, Airblast, Broadcast	Orchard/Vineyard	0.0000666	SL/G	0.00000645	No-R	0.0000731	4E-06	0.0002	SL/G	0.0000194	No-R	0.000219	1E-05
Liquid, Chemigation, Broadcast	Orchard/Vineyard	0.000583	SL/G	0.0000566	No-R	0.000639	4E-05	0.00175	SL/G	0.00017	No-R	0.00192	1E-04
Liquid, Chemigation, Broadcast	Sod	0.00211	SL/G	0.000204	No-R	0.00232	1E-04	0.00634	SL/G	0.000612	No-R	0.00697	4E-04
Liquid, Chemigation, Broadcast	Field crop, typical	0.000583	SL/G	0.0000566	No-R	0.000639	4E-05	0.00175	SL/G	0.00017	No-R	0.00192	1E-04
Liquid, Chemigation, Broadcast	Field crop, high-acreage	0.000194	SL/G	0.0000189	No-R	0.000213	1E-05	0.000583	SL/G	0.0000568	No-R	0.000638	4E-05
Liquid, Chemigation, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.000025	SL/G	0.00000243	No-R	0.0000274	2E-06	0.0000749	SL/G	0.0000073	No-R	0.0000822	5E-06

Table F.8. Occupational Handler Cancer Exposure and Risk Estimates for ETU -Foliar.

Exposure Scenario	Crop or Target	Private Handler						Commercial Handler					
		LADD (mg/kg/day)				Total LADD[3]	Cancer Risk Estimate[4]	LADD (mg/kg/day)				Total LADD[3]	Cancer Risk Estimate[4]
		Dermal[1]	PPE	Inhalation[2]	PPE			Dermal[1]	PPE	Inhalation[2]	PPE		
Liquid, Chemigation, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	0.000025	SL/G	0.00000243	No-R	0.0000274	2E-06	0.0000749	SL/G	0.0000073	No-R	0.0000822	5E-06
Liquid, Groundboom, Broadcast	Golf course (fairways, tees, greens)	0.000242	SL/G	0.0000234	No-R	0.000266	2E-05	0.000727	SL/G	0.0000701	No-R	0.000797	5E-05
Liquid, Groundboom, Broadcast	Field-grown ornamental crops	0.0000166	SL/G	0.00000161	No-R	0.0000182	1E-06	0.0000498	SL/G	0.00000483	No-R	0.0000546	3E-06
Liquid, Groundboom, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	0.000025	SL/G	0.00000243	No-R	0.0000274	2E-06	0.0000749	SL/G	0.0000073	No-R	0.0000822	5E-06
Liquid, Groundboom, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.000025	SL/G	0.00000243	No-R	0.0000274	2E-06	0.0000749	SL/G	0.0000073	No-R	0.0000822	5E-06
Liquid, Groundboom, Broadcast	Sod	0.000482	SL/G	0.0000468	No-R	0.000529	3E-05	0.00145	SL/G	0.000141	No-R	0.00159	1E-04
Liquid, Groundboom, Broadcast	Orchard/Vineyard	0.0000666	SL/G	0.00000645	No-R	0.0000731	4E-06	0.0002	SL/G	0.0000194	No-R	0.000219	1E-05
Liquid, Groundboom, Broadcast	Field crop, typical	0.000133	SL/G	0.0000129	No-R	0.000146	9E-06	0.000398	SL/G	0.0000387	No-R	0.000439	3E-05
Liquid, Groundboom, Broadcast	Field crop, high-acreage	0.000111	SL/G	0.0000108	No-R	0.000121	7E-06	0.000332	SL/G	0.0000323	No-R	0.000364	2E-05
Wettable Powder, Aerial, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	0.0000509	SL/G	0.0000406	No-R	0.0000915	6E-06	0.000153	SL/G	0.000122	No-R	0.000274	2E-05
Wettable Powder, Aerial, Broadcast	Orchard/Vineyard	0.000891	SL/G	0.000711	No-R	0.0016	1E-04	0.00267	SL/G	0.00213	No-R	0.00479	3E-04
Wettable Powder, Aerial, Broadcast	Field crop, typical	0.000891	SL/G	0.000711	No-R	0.0016	1E-04	0.00267	SL/G	0.00213	No-R	0.00479	3E-04
Wettable Powder, Aerial, Broadcast	Field crop, high-acreage	0.00101	SL/G	0.000811	No-R	0.00183	1E-04	0.00304	SL/G	0.00243	No-R	0.0055	3E-04
Wettable Powder, Airblast, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	0.000017	SL/G	0.0000135	No-R	0.0000305	2E-06	0.0000509	SL/G	0.0000406	No-R	0.0000915	6E-06
Wettable Powder, Airblast, Broadcast	Orchard/Vineyard	0.000101	SL/G	0.0000811	No-R	0.000183	1E-05	0.000304	SL/G	0.000243	No-R	0.00055	3E-05
Wettable Powder, Chemigation, Broadcast	Orchard/Vineyard	0.000891	SL/G	0.000711	No-R	0.0016	1E-04	0.00267	SL/G	0.00213	No-R	0.00479	3E-04
Wettable Powder, Chemigation, Broadcast	Field crop, typical	0.000891	SL/G	0.000711	No-R	0.0016	1E-04	0.00267	SL/G	0.00213	No-R	0.00479	3E-04
Wettable Powder, Chemigation, Broadcast	Field crop, high-acreage	0.000298	SL/G	0.000237	No-R	0.000535	3E-05	0.000893	SL/G	0.000712	No-R	0.0016	1E-04

Table F.8. Occupational Handler Cancer Exposure and Risk Estimates for ETU -Foliar.

Exposure Scenario	Crop or Target	Private Handler						Commercial Handler					
		LADD (mg/kg/day)				Total LADD[3]	Cancer Risk Estimate[4]	LADD (mg/kg/day)				Total LADD[3]	Cancer Risk Estimate[4]
		Dermal[1]	PPE	Inhalation[2]	PPE			Dermal[1]	PPE	Inhalation[2]	PPE		
Wettable Powder, Chemigation, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.0000509	SL/G	0.0000406	No-R	0.0000915	6E-06	0.000153	SL/G	0.000122	No-R	0.000274	2E-05
Wettable Powder, Chemigation, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	0.0000509	SL/G	0.0000406	No-R	0.0000915	6E-06	0.000153	SL/G	0.000122	No-R	0.000274	2E-05
Wettable Powder, Groundboom, Broadcast	Field-grown ornamental crops	0.0000339	SL/G	0.000027	No-R	0.000061	4E-06	0.000102	SL/G	0.0000811	No-R	0.000183	1E-05
Wettable Powder, Groundboom, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	0.0000509	SL/G	0.0000406	No-R	0.0000915	6E-06	0.000153	SL/G	0.000122	No-R	0.000274	2E-05
Wettable Powder, Groundboom, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.0000509	SL/G	0.0000406	No-R	0.0000915	6E-06	0.000153	SL/G	0.000122	No-R	0.000274	2E-05
Wettable Powder, Groundboom, Broadcast	Orchard/Vineyard	0.000101	SL/G	0.0000811	No-R	0.000183	1E-05	0.000304	SL/G	0.000243	No-R	0.00055	3E-05
Wettable Powder, Groundboom, Broadcast	Field crop, typical	0.000204	SL/G	0.000164	No-R	0.000368	2E-05	0.000612	SL/G	0.000491	No-R	0.0011	7E-05
Wettable Powder, Groundboom, Broadcast	Field crop, high-acreage	0.00017	SL/G	0.000135	No-R	0.000305	2E-05	0.000509	SL/G	0.000406	No-R	0.000915	6E-05
Water-soluble Packet, Airblast, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	0.00000332	EC/G	0.0000115	EC/No-R	0.0000149	9E-07	0.00000996	EC/G	0.00000345	EC/PF10 R	0.0000134	8E-07
Water-soluble Packet, Groundboom, Broadcast	Golf course (fairways, tees, greens)	0.0000482	EC/G	0.000167	EC/No-R	0.000215	1E-05	0.000145	EC/G	0.0000502	EC/PF10 R	0.000195	1E-05
Water-soluble Packet, Groundboom, Broadcast	Field-grown ornamental crops	0.00000664	EC/G	0.0000231	EC/No-R	0.0000298	2E-06	0.0000199	EC/G	0.00000693	EC/PF10 R	0.0000268	2E-06
Water-soluble Packet, Groundboom, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	0.0000143	EC/G	0.0000492	EC/No-R	0.0000634	4E-06	0.0000428	EC/G	0.0000148	EC/PF10 R	0.0000575	3E-06
Water-soluble Packet, Groundboom, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.0000143	EC/G	0.0000492	EC/No-R	0.0000634	4E-06	0.0000428	EC/G	0.0000148	EC/PF10 R	0.0000575	3E-06

Table F.8. Occupational Handler Cancer Exposure and Risk Estimates for ETU -Foliar.

Exposure Scenario	Crop or Target	Private Handler						Commercial Handler					
		LADD (mg/kg/day)				Total LADD[3]	Cancer Risk Estimate[4]	LADD (mg/kg/day)				Total LADD[3]	Cancer Risk Estimate[4]
		Dermal[1]	PPE	Inhalation[2]	PPE			Dermal[1]	PPE	Inhalation[2]	PPE		
Applicator													
Spray (all starting formulations), Aerial, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	0.00000139	EC/G	5.42E-08	EC/No-R	0.00000144	9E-08	0.00000417	EC/G	0.000000163	EC/No-R	0.00000432	3E-07
Spray (all starting formulations), Aerial, Broadcast	Orchard/Vineyard	0.0000322	EC/G	0.00000127	EC/No-R	0.0000334	2E-06	0.0000966	EC/G	0.0000038	EC/No-R	0.0001	6E-06
Spray (all starting formulations), Aerial, Broadcast	Sod	0.000117	EC/G	0.00000459	EC/No-R	0.000122	7E-06	0.000351	EC/G	0.0000138	EC/No-R	0.000365	2E-05
Spray (all starting formulations), Aerial, Broadcast	Field crop, typical	0.0000322	EC/G	0.00000127	EC/No-R	0.0000334	2E-06	0.0000966	EC/G	0.0000038	EC/No-R	0.0001	6E-06
Spray (all starting formulations), Aerial, Broadcast	Field crop, high-acreage	0.0000368	EC/G	0.00000145	EC/No-R	0.0000382	2E-06	0.00011	EC/G	0.00000435	EC/No-R	0.000115	7E-06
Spray (all starting formulations), Airblast, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	0.00066	SL/G	0.0000326	No-R	0.000693	4E-05	0.00198	SL/G	0.0000977	No-R	0.00208	1E-04
Spray (all starting formulations), Airblast, Broadcast	Orchard/Vineyard	0.00282	SL/G	0.000139	No-R	0.00295	2E-04	0.00845	SL/G	0.000417	No-R	0.00885	5E-04
Spray (all starting formulations), Groundboom, Broadcast	Golf course (fairways, tees, greens)	0.000103	SL/G	0.0000364	No-R	0.00014	8E-06	0.00031	SL/G	0.000109	No-R	0.00042	3E-05
Spray (all starting formulations), Groundboom, Broadcast	Field-grown ornamental crops	0.0000095	SL/G	0.00000336	No-R	0.0000129	8E-07	0.0000285	SL/G	0.0000101	No-R	0.0000387	2E-06
Spray (all starting formulations), Groundboom, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	0.00002	SL/G	0.00000706	No-R	0.000027	2E-06	0.0000601	SL/G	0.0000212	No-R	0.0000811	5E-06

Table F.8. Occupational Handler Cancer Exposure and Risk Estimates for ETU -Foliar.

Exposure Scenario	Crop or Target	Private Handler						Commercial Handler					
		LADD (mg/kg/day)				Total LADD[3]	Cancer Risk Estimate[4]	LADD (mg/kg/day)				Total LADD[3]	Cancer Risk Estimate[4]
		Dermal[1]	PPE	Inhalation[2]	PPE			Dermal[1]	PPE	Inhalation[2]	PPE		
Spray (all starting formulations), Groundboom, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.00002	SL/G	0.00000706	No-R	0.000027	2E-06	0.0000601	SL/G	0.0000212	No-R	0.0000811	5E-06
Spray (all starting formulations), Groundboom, Broadcast	Sod	0.000207	SL/G	0.0000727	No-R	0.000279	2E-05	0.00062	SL/G	0.000218	No-R	0.000837	5E-05
Spray (all starting formulations), Groundboom, Broadcast	Orchard/Vineyard	0.0000285	SL/G	0.00001	No-R	0.0000386	2E-06	0.0000856	SL/G	0.0000301	No-R	0.000116	7E-06
Spray (all starting formulations), Groundboom, Broadcast	Field crop, typical	0.000057	SL/G	0.0000202	No-R	0.0000772	5E-06	0.000171	SL/G	0.0000605	No-R	0.000232	1E-05
Spray (all starting formulations), Groundboom, Broadcast	Field crop, high-acreage	0.0000475	SL/G	0.0000167	No-R	0.0000642	4E-06	0.000142	SL/G	0.0000502	No-R	0.000193	1E-05
Flagger													
Spray (all starting formulations), Aerial, Broadcast	Nursery (ornamentals, vegetables, trees, container stock)	0.000032	SL/G	0.00000895	No-R	0.0000409	2E-06	0.0000959	SL/G	0.0000268	No-R	0.000123	7E-06
Spray (all starting formulations), Aerial, Broadcast	Orchard/Vineyard	0.000187	SL/G	0.0000521	No-R	0.000238	1E-05	0.000561	SL/G	0.000156	No-R	0.000715	4E-05
Spray (all starting formulations), Aerial, Broadcast	Sod	0.000674	SL/G	0.000189	No-R	0.000863	5E-05	0.00202	SL/G	0.000568	No-R	0.00259	2E-04
Spray (all starting formulations), Aerial, Broadcast	Field crop, typical	0.000187	SL/G	0.0000521	No-R	0.000238	1E-05	0.000561	SL/G	0.000156	No-R	0.000715	4E-05

Table F.8. Occupational Handler Cancer Exposure and Risk Estimates for ETU -Foliar.

Exposure Scenario	Crop or Target	Private Handler						Commercial Handler					
		LADD (mg/kg/day)				Total LADD[3]	Cancer Risk Estimate[4]	LADD (mg/kg/day)				Total LADD[3]	Cancer Risk Estimate[4]
		Dermal[1]	PPE	Inhalation[2]	PPE			Dermal[1]	PPE	Inhalation[2]	PPE		
Spray (all starting formulations), Aerial, Broadcast	Field crop, high-acreage	0.000062	SL/G	0.0000173	No-R	0.0000793	5E-06	0.000186	SL/G	0.000052	No-R	0.000238	1E-05
Mixer/Loader/Applicator													
Dry Flowable, Backpack, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.00000795	SL/G	0.00000166	No-R	0.00000961	6E-07	0.0000239	SL/G	0.00000498	No-R	0.0000288	2E-06
Dry Flowable, Backpack, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	0.0000463	SL/G	0.00000176	No-R	0.0000481	3E-06	0.000139	SL/G	0.00000527	No-R	0.000144	9E-06
Dry Flowable, Manually-pressurized Handwand, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.00000133	SL/G	0.00000122	No-R	0.00000254	2E-07	0.00000398	SL/G	0.00000365	No-R	0.00000763	5E-07
Dry Flowable, Manually-pressurized Handwand, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	0.000000655	SL/G	0.000000597	No-R	0.00000125	8E-08	0.00000197	SL/G	0.00000179	No-R	0.00000376	2E-07
Dry Flowable, Mechanically-pressurized Handgun, Broadcast (foliar)	Orchard/Vineyard	0.000907	SL/G	0.000064	No-R	0.000971	6E-05	0.00272	SL/G	0.000192	No-R	0.00291	2E-04
Dry Flowable, Mechanically-pressurized Handgun, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.000064	SL/G	0.000133	No-R	0.000197	1E-05	0.000192	SL/G	0.000398	No-R	0.00059	4E-05
Dry Flowable, Mechanically-pressurized Handgun, Broadcast	Golf course (fairways, tees, greens)	0.0000258	SL/G	0.0000129	No-R	0.0000387	2E-06	0.0000774	SL/G	0.0000387	No-R	0.000116	7E-06
Dry Flowable, Mechanically-pressurized Handgun, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	0.00011	SL/G	0.000227	No-R	0.000337	2E-05	0.000329	SL/G	0.000682	No-R	0.00101	6E-05
Dry Flowable, Mechanically-pressurized Handgun, Broadcast (foliar)	Field crop, typical	0.00907	SL/G	0.00064	No-R	0.00971	6E-04	0.0272	SL/G	0.00192	No-R	0.0291	2E-03

Table F.8. Occupational Handler Cancer Exposure and Risk Estimates for ETU -Foliar.

Exposure Scenario	Crop or Target	Private Handler						Commercial Handler					
		LADD (mg/kg/day)				Total LADD[3]	Cancer Risk Estimate[4]	LADD (mg/kg/day)				Total LADD[3]	Cancer Risk Estimate[4]
		Dermal[1]	PPE	Inhalation[2]	PPE			Dermal[1]	PPE	Inhalation[2]	PPE		
Liquid, Backpack, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.00000868	SL/G	0.00000182	No-R	0.0000105	6E-07	0.000026	SL/G	0.00000546	No-R	0.0000315	2E-06
Liquid, Backpack, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	0.0000506	SL/G	0.00000191	No-R	0.0000526	3E-06	0.000152	SL/G	0.00000572	No-R	0.000158	1E-05
Liquid, Manually-pressurized Handwand, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.000000333	SL/G	0.000000305	No-R	0.000000638	4E-08	0.000000999	SL/G	0.000000915	No-R	0.00000191	1E-07
Liquid, Manually-pressurized Handwand, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	0.000000714	SL/G	0.000000653	No-R	0.00000136	8E-08	0.00000214	SL/G	0.00000196	No-R	0.00000409	2E-07
Liquid, Mechanically-pressurized Handgun, Broadcast (foliar)	Orchard/Vineyard	0.00907	SL/G	0.00064	No-R	0.00971	6E-04	0.0272	SL/G	0.00192	No-R	0.0291	2E-03
Liquid, Mechanically-pressurized Handgun, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.00007	SL/G	0.000145	No-R	0.000215	1E-05	0.00021	SL/G	0.000435	No-R	0.000645	4E-05
Liquid, Mechanically-pressurized Handgun, Broadcast	Golf course (fairways, tees, greens)	0.000707	SL/G	0.0000253	No-R	0.000733	4E-05	0.00212	SL/G	0.000076	No-R	0.0022	1E-04
Liquid, Mechanically-pressurized Handgun, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	0.00012	SL/G	0.000247	No-R	0.000368	2E-05	0.00036	SL/G	0.000741	No-R	0.0011	7E-05
Liquid, Mechanically-pressurized Handgun, Broadcast (foliar)	Field crop, typical	0.00907	SL/G	0.00064	No-R	0.00971	6E-04	0.0272	SL/G	0.00192	No-R	0.0291	2E-03
Wettable Powder, Backpack, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.0000115	SL/G	0.00000241	No-R	0.0000139	8E-07	0.0000346	SL/G	0.00000723	No-R	0.0000417	3E-06
Wettable Powder, Backpack, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	0.0000675	SL/G	0.00000256	No-R	0.0000701	4E-06	0.000202	SL/G	0.00000767	No-R	0.00021	1E-05

Table F.8. Occupational Handler Cancer Exposure and Risk Estimates for ETU -Foliar.

Exposure Scenario	Crop or Target	Private Handler						Commercial Handler					
		LADD (mg/kg/day)				Total LADD[3]	Cancer Risk Estimate[4]	LADD (mg/kg/day)				Total LADD[3]	Cancer Risk Estimate[4]
		Dermal[1]	PPE	Inhalation[2]	PPE			Dermal[1]	PPE	Inhalation[2]	PPE		
Wettable Powder, Manually-pressurized Handwand, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.000000445	SL/G	0.000000406	No-R	0.000000851	5E-08	0.00000134	SL/G	0.00000122	No-R	0.00000255	2E-07
Wettable Powder, Manually-pressurized Handwand, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	0.00000095	SL/G	0.00000087	No-R	0.00000182	1E-07	0.00000285	SL/G	0.00000261	No-R	0.00000546	**3E-07**
Wettable Powder, Mechanically-pressurized Handgun, Broadcast (foliar)	Orchard/Vineyard	0.00907	SL/G	0.00064	No-R	0.00971	6E-04	0.0272	SL/G	0.00192	No-R	0.0291	2E-03
Wettable Powder, Mechanically-pressurized Handgun, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.0000932	SL/G	0.000192	No-R	0.000285	2E-05	0.00028	SL/G	0.000575	No-R	0.000856	5E-05
Wettable Powder, Mechanically-pressurized Handgun, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	0.00016	SL/G	0.000331	No-R	0.000491	3E-05	0.000479	SL/G	0.000992	No-R	0.00147	9E-05
Wettable Powder, Mechanically-pressurized Handgun, Broadcast (foliar)	Field crop, typical	0.00907	SL/G	0.00064	No-R	0.00971	6E-04	0.0272	SL/G	0.00192	No-R	0.0291	2E-03
Water-soluble Packet, Backpack, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.0000152	SL/G	0.00000317	No-R	0.0000184	1E-06	0.0000457	SL/G	0.00000952	No-R	0.0000553	3E-06
Water-soluble Packet, Backpack, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	0.0000886	SL/G	0.00000336	No-R	0.000092	6E-06	0.000266	SL/G	0.0000101	No-R	0.000276	2E-05
Water-soluble Packet, Manually-pressurized Handwand, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.000000583	SL/G	0.000000534	No-R	0.00000112	7E-08	0.00000175	SL/G	0.0000016	No-R	0.00000335	2E-07

Table F.8. Occupational Handler Cancer Exposure and Risk Estimates for ETU -Foliar.

Exposure Scenario	Crop or Target	Private Handler						Commercial Handler					
		LADD (mg/kg/day)				Total LADD[3]	Cancer Risk Estimate[4]	LADD (mg/kg/day)				Total LADD[3]	Cancer Risk Estimate[4]
		Dermal[1]	PPE	Inhalation[2]	PPE			Dermal[1]	PPE	Inhalation[2]	PPE		
Water-soluble Packet, Manually-pressurized Handwand, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	0.00000124	SL/G	0.00000114	No-R	0.00000238	1E-07	0.00000372	SL/G	0.00000343	No-R	0.00000715	4E-07
Water-soluble Packet, Mechanically-pressurized Handgun, Broadcast	Greenhouse (ornamentals, roses, cut flowers, container stock, vegetables)	0.000123	SL/G	0.000253	No-R	0.000376	2E-05	0.000368	SL/G	0.00076	No-R	0.00113	7E-05
Water-soluble Packet, Mechanically-pressurized Handgun, Broadcast	Golf course (fairways, tees, greens)	0.00000189	SL/G	0.000000664	No-R	0.00000256	2E-07	0.00000568	SL/G	0.00000199	No-R	0.00000767	5E-07
Water-soluble Packet, Mechanically-pressurized Handgun, Broadcast (foliar)	Nursery (ornamentals, vegetables, trees, container stock)	0.000209	SL/G	0.000434	No-R	0.000643	4E-05	0.000627	SL/G	0.0013	No-R	0.00193	1E-04

1. Orchard crops include the following crops currently listed on mancozeb labels: almond, banana, Christmas trees, grapes, papaya, pome fruits (apple, crabapple, quince, pear), subtropical/tropical fruit (sugar apple, cherimoya, atemoya, custard apple, sweetsop, mango, star apple, canistel, mamey sapote, sapodilla, white sapote), walnut.
   Typical-acreage field crops include the following crops currently listed on mancozeb labels: asparagus, broccoli, cabbage, carrots, cucurbits, swiss chard, coriander, sweet corn, cranberry, dill, endive, fennel, garden beet, garlic, ginseng, leafy brassica greens, leek, lettuce, onion, parsley, parsnip, pepper, plantain, shallot, spinach, tobacco, tomato.
   High-acreage field crops include the following crops currently listed on mancozeb labels: barley, field/popcorn, peanuts, potato, rye, wheat, triticale, oats, sugar beet.
2. Dermal LADD (mg/kg/day) = Total Dermal dose (mg/kg/day) × [Days per year of exposure (days/yr) ÷ 365 days/year] × [Years per lifetime of exposure (35 yrs) ÷ Lifetime expectancy (78 yrs)].
   Total Dermal Dose = ETU Dermal Dose (mg/kg/day) + Metabolized ETU Dermal Dose (mg/kg/day)
   ETU Dermal Dose = Dermal Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) x [Tank Mix Conversion (0.001 for mixer/loader) or (0.002 for applicator or M/L/A)]* × Application Rate (lb ai/acre or gal) × Area Treated or Amount Handled (A or gal/day) × DAF (6%) ÷ BW (80 kg).
   Metabolized ETU Dermal Dose = Dermal Unit Exposure (µg/lb ai) x Conversion Factor (0.001 mg/µg) x Metabolic Conversion Factor (7.5%)* × Application Rate (lb ai/acre or gal) × Area Treated or Amount Handled (A or gal/day) × DAF (1%) ÷ BW (80 kg).
3. Inhalation LADD (mg/kg/day) = Total Inhalation Dose (mg/kg/day) × [Days per year of exposure (days/yr) / 365 days/year] × [Years per lifetime of exposure (35 yrs) ÷ Lifetime expectancy (78 yrs)].
   Total Inhalation Dose = ETU Inhalation dose (mg/kg/day) + Metabolized ETU Inhalation Dose (mg/kg/day)
   ETU Inhalation Dose = Inhalation Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) x [Tank Mix Conversion (0.001 for mixer/loader) or (0.002 for applicator or M/L/A)]* × Application Rate (lb ai/acre or gal) × Area Treated or Amount Handled (A or gal/day) ÷ BW (80 kg).
   Metabolized ETU Dose = Inhalation Unit Exposure (µg/lb ai) × Conversion Factor (0.001 mg/µg) × Metabolic Conversion Factor (7.5%)* x Application Rate (lb ai/acre or gal) × Area Treated or Amount Handled (A or gal/day) ÷ BW (80 kg)
4. Total LADD (mg/kg/day) = Dermal LADD (mg/kg/day) + Inhalation LADD (mg/kg/day).
5. Cancer risk estimate = LADD (mg/kg/day) × Q_1^*, where Q_1^* = 0.0601 $(mg/kg/day)^{-1}$.

* See section 4.0 of D465683 (D. Carter, 02/10/2023) for further details.

Table F.9. Occupational Handler Cancer Exposure and Risk Estimates for ETU – Seed Treatment.

Crop/Target Category	Specialized Treatment or Formulation	Worker Activity	Application Rate (lb ai/lb seed)[1]	Combined MOE[3,4,5] (LOC = 300)			
				SL/G + No-R	DL/G + No-R	SL/G + PF10	DL/G + PF10
Commercial Seed Treatment							
Barley	NA	Treating	0.0315	1E-04	9E-05	2E-05	1E-05
		Packaging		5E-05	5E-05	1E-05	1E-05
		Cleaning		1E-04	1E-04	4E-05	4E-05
		Loading/Planting		8E-05	7E-05	2E-05	2E-05
Corn, field	NA	Treating	0.0405	4E-05	4E-05	2E-05	2E-05
		Packaging		2E-05	2E-05	2E-05	1E-05
		Cleaning		5E-05	4E-05	6E-05	5E-05
		Loading/Planting		8E-05	8E-05	8E-06	6E-06
Cotton	NA	Treating	0.045	3E-05	3E-05	8E-06	7E-06
		Packaging		2E-05	2E-05	6E-06	6E-06
		Cleaning		5E-05	5E-05	6E-05	6E-05
		Loading/Planting		1E-04	9E-05	5E-06	4E-06
Flax	NA	Treating	0.0533	3E-05	3E-05	9E-06	8E-06
		Packaging		6E-05	6E-05	8E-06	7E-06
		Cleaning		1E-04	1E-04	7E-05	7E-05
		Loading/Planting		9E-05	8E-05	7E-06	6E-06
Oat	NA	Treating	0.0473	1E-04	1E-04	2E-05	2E-05
		Packaging		6E-05	5E-05	2E-05	2E-05
		Cleaning		1E-04	1E-04	6E-05	6E-05
		Loading/Planting		2E-04	2E-04	3E-05	2E-05
Peanut	NA	Treating	0.12	3E-04	3E-04	2E-05	2E-05
		Packaging		2E-06	2E-06	2E-05	2E-05
		Cleaning		5E-06	5E-06	2E-04	2E-04
		Loading/Planting		1E-06	1E-06	7E-05	6E-05
Potato	NA	Treating	0.0008	5E-05	5E-05	9E-07	8E-07
		Packaging		4E-05	3E-05	7E-07	7E-07
		Cleaning		8E-05	8E-05	1E-06	1E-06
		Loading/Planting		6E-05	6E-05	1E-05	9E-06
Rice	NA	Treating	0.032	2E-04	2E-04	1E-05	1E-05
		Packaging		4E-05	3E-05	1E-05	1E-05
		Cleaning		8E-05	8E-05	4E-05	4E-05
		Loading/Planting		5E-05	5E-05	3E-05	3E-05
Rye	NA	Treating	0.027	8E-05	7E-05	1E-05	1E-05
		Packaging		2E-05	2E-05	1E-05	1E-05
		Cleaning		4E-05	4E-05	4E-05	3E-05
		Loading/Planting		3E-05	3E-05	2E-05	1E-05
Safflower	NA	Treating	0.015	7E-06	6E-06	8E-06	6E-06
		Packaging		4E-05	4E-05	6E-06	6E-06
		Cleaning		1E-04	1E-04	2E-05	2E-05
		Loading/Planting		6E-05	6E-05	1E-06	1E-06

Table F.9. Occupational Handler Cancer Exposure and Risk Estimates for ETU – Seed Treatment.

Crop/Target Category	Specialized Treatment or Formulation	Worker Activity	Application Rate (lb ai/lb seed)[1]	Combined MOE[3,4,5] (LOC = 300)			
				SL/G + No-R	DL/G + No-R	SL/G + PF10	DL/G + PF10
Sorghum, grain	NA	Treating	0.0338	5E-06	5E-06	2E-05	1E-05
		Packaging		7E-07	6E-07	1E-05	1E-05
		Cleaning		1E-06	1E-06	5E-05	4E-05
		Loading/Planting		1E-04	1E-04	1E-06	8E-07
Tomato	Film-coated	Treating	0.06	8E-07	8E-07	3E-07	2E-07
	Film-coated	Packaging		5E-08	5E-08	2E-07	2E-07
	Film-coated	Cleaning		1E-07	1E-07	8E-05	8E-05
	Film-coated	Loading/Planting		1E-04	1E-04	2E-07	1E-07
	Encrusted/Pelleted	Treating		8E-07	8E-07	2E-08	2E-08
	Encrusted/Pelleted	Packaging		3E-05	3E-05	2E-08	1E-08
	Encrusted/Pelleted	Cleaning		7E-05	7E-05	8E-05	8E-05
	Encrusted/Pelleted	Loading/Planting		5E-05	4E-05	2E-07	1E-07
Triticale	NA	Treating	0.0248	8E-05	8E-05	1E-05	1E-05
		Packaging		3E-05	3E-05	1E-05	9E-06
		Cleaning		7E-05	7E-05	3E-05	3E-05
		Loading/Planting		5E-05	4E-05	2E-05	1E-05
Wheat	NA	Treating	0.0248	1E-04	1E-04	1E-05	1E-05
		Packaging		1E-04	9E-05	1E-05	9E-06
		Cleaning		5E-05	5E-05	3E-05	3E-05
		Loading/Planting		1E-04	1E-04	2E-05	2E-05
On-Farm Seed Treatment							
Barley	Liquid	Treating/Planting	0.00209	3E-06	3E-06	5E-07	5E-07
	Dust/Powder [Solids]		0.00131	4E-05	4E-05	8E-06	7E-06
Corn, field	Liquid		0.00209	1E-06	1E-06	2E-07	2E-07
Cotton	Liquid		0.003	1E-06	9E-07	2E-07	1E-07
Flax	Liquid		0.003	1E-06	1E-06	2E-07	1E-07
Oat	Liquid		0.00313	5E-06	5E-06	8E-07	7E-07
	Dust/Powder [Solids]		0.00197	5E-05	5E-05	1E-05	1E-05
Peanut	Liquid		0.008	1E-05	1E-05	2E-06	2E-06
Potato	Liquid		0.000781	3E-05	3E-05	4E-06	4E-06
	Dust/Powder [Solids]		0.0008	5E-04	5E-04	1E-04	9E-05
Rice	Liquid		0.002	5E-06	5E-06	8E-07	8E-07
	Dust/Powder [Solids]		0.00125	6E-05	6E-05	1E-05	1E-05
Rye	Liquid		0.00178	3E-06	3E-06	4E-07	4E-07
	Dust/Powder [Solids]		0.00113	3E-05	3E-05	6E-06	5E-06
Safflower	Liquid		0.001	2E-07	2E-07	4E-08	3E-08
	Dust/Powder [Solids]		0.00094	4E-06	4E-06	8E-07	7E-07
Sorghum, grain	Liquid		0.00225	2E-07	2E-07	3E-08	3E-08
	Dust/Powder [Solids]		0.00094	1E-06	1E-06	3E-07	2E-07
Tomato	Liquid		0.004	3E-08	3E-08	5E-09	4E-09
Triticale	Liquid		0.00163	3E-06	3E-06	5E-07	4E-07
	Dust/Powder [Solids]		0.00103	3E-05	3E-05	7E-06	6E-06

Table F.9. Occupational Handler Cancer Exposure and Risk Estimates for ETU – Seed Treatment.

Crop/Target Category	Specialized Treatment or Formulation	Worker Activity	Application Rate (lb ai/lb seed)[1]	Combined MOE[3,4,5] (LOC = 300)			
				SL/G + No-R	DL/G + No-R	SL/G + PF10	DL/G + PF10
Wheat	Liquid		0.00163	4E-06	4E-06	7E-07	6E-07
	Dust/Powder [Solids]		0.00103	5E-05	5E-05	1E-05	9E-06

[1] Seed Treatment Application rates based on the registered mancozeb labels. See Appendix E.

[2] HED default for lb seed treated/planted per day from HED Exposure Science Advisory Council Policy 15.2 (December 2017)

[3] Unit Exposures from HED Exposure Science Advisory Council Policy 14: Standard Operating Procedures for Seed Treatment.

[4] PPE: SL/G = Single Layer/Gloves, DL/G = Double Layer/Gloves, No-R = No Respirator, and PF10 R = PF10 Respirator

[5] Cancer risk estimate = Combined Average LADD (mg/kg/day) × Q_1^*, where Q_1^* = 0.0601 $(mg/kg/day)^{-1}$.

Table F.10. Occupational Post-Application Non-Cancer and Cancer Risk Summary for ETU.[1]

Crop	Crop Height	Foliage Density	Application Rate (lb ai/A)	Activity	Transfer Coefficient (cm^2/hr or gm/hr)	Non-Cancer		Cancer
						Dermal MOE[2,3] (LOC = 300)	DAT at which MOE ≥ LOC [MOE]	Cancer Risk Estimate
						0-DAT		30-day Average Dose
WA Apple DFR Data (MRID 44959602)								
Almond	High	Full	4.8	Poling	100	1600		2E-07
				Orchard maintenance				
	High	Full		Harvesting, Mechanical (shaking)	190	850		3E-07
	Low	Min		Transplanting	230	700		4E-07
	High	Full		Scouting	580	280	3 [300]	1E-06
Apple	HIGH	FULL	4.8	Weeding, Hand	100	1600		2E-07
	LOW	FULL						
	HIGH	FULL		Propping				
	HIGH	FULL		Orchard maintenance				
	LOW	MIN		Transplanting	230	700		4E-07
	HIGH	FULL		Scouting	580	280	3 [300]	1E-06
	HIGH	FULL		Pruning, Hand				
	LOW	MIN						
	HIGH	FULL		Training				
	HIGH	FULL		Harvesting, Hand	1400	110	32 [300]	3E-06
	HIGH	FULL		Thinning Fruit, Hand	3600	45	>35 [130]	7E-06
Christmas Tree	HIGH	FULL	3.2	Weeding, Hand	100	2400		1E-07
	LOW	MIN						
	HIGH	FULL		Grading/Tagging				
	LOW	MIN						
	LOW	MIN		Transplanting	230	1000		3E-07
	HIGH	FULL		Scouting	580	420		7E-07
	LOW	MIN						
	HIGH	FULL		Shaping				
	HIGH	FULL		Harvesting, Hand	1400	170	18 [300]	2E-06
	HIGH	FULL		Irrigation (hand set)	1900	130	29 [300]	2E-06
	LOW	FULL						
Mango	HIGH	FULL	2.0	Pruning, Hand	580	660		4E-07
	HIGH	FULL		Scouting				
	HIGH	FULL		Harvesting, Hand	1400	280	3 [300]	1E-06
	HIGH	FULL		Thinning Fruit, Hand	3600	110	34 [300]	3E-06
Papaya	HIGH	FULL	2.0	Orchard maintenance	100	3900		8E-08
	HIGH	FULL		Weeding, Hand				
	LOW	MIN		Transplanting	230	1700		2E-07
	HIGH	FULL		Scouting	580	660		4E-07
	HIGH	FULL		Pruning, Hand				
	HIGH	MIN						
	HIGH	FULL		Harvesting, Hand	1400	280	3 [300]	1E-06

Table F.10. Occupational Post-Application Non-Cancer and Cancer Risk Summary for ETU.[1]

Crop	Crop Height	Foliage Density	Application Rate (lb ai/A)	Activity	Transfer Coefficient (cm^2/hr or gm/hr)	Non-Cancer		Cancer
						Dermal MOE[2,3] (LOC = 300)	DAT at which MOE ≥ LOC [MOE]	Cancer Risk Estimate
						0-DAT		30-day Average Dose
Walnut, English	HIGH	FULL	1.8	Orchard maintenance	100	4300		7E-08
	HIGH	FULL		Poling				
	HIGH	FULL		Weeding, Hand				
	HIGH	FULL		Harvesting, Mechanical (shaking)	190	2300		1E-07
	LOW	MIN		Transplanting	230	1900		2E-07
	HIGH	FULL		Scouting	580	740		4E-07
NY Apple DFR Data (MRID 44959602)								
Almond	High	Full	4.8	Orchard maintenance	100	1300		1E-07
	High	Full		Poling				
	High	Full		Harvesting, Mechanical (shaking)	190	700		2E-07
	Low	Min		Transplanting	230	580		3E-07
	High	Full		Scouting	580	230	4 [320]	7E-07
Apple	HIGH	FULL	4.8	Weeding, Hand	100	1300		1E-07
	LOW	FULL						
	HIGH	FULL		Propping				
	HIGH	FULL		Orchard maintenance				
	LOW	MIN		Transplanting	230	580		3E-07
	HIGH	FULL		Scouting	580	230	4 [320]	7E-07
	HIGH	FULL		Pruning, Hand				
	LOW	MIN						
	HIGH	FULL		Training				
	HIGH	FULL		Harvesting, Hand	1400	95	15 [310]	2E-06
	HIGH	FULL		Thinning Fruit, Hand	3600	37	27 [310]	5E-06
Christmas Tree	HIGH	FULL	3.2	Weeding, Hand	100	2000		9E-08
	LOW	MIN						
	HIGH	FULL		Grading/Tagging				
	LOW	MIN						
	LOW	MIN		Transplanting	230	870		2E-07
	HIGH	FULL		Scouting	580	350		5E-07
	LOW	MIN						
	HIGH	FULL		Shaping				
	HIGH	FULL		Harvesting, Hand	1400	140	10 [320]	1E-06
	HIGH	FULL		Irrigation (hand set)	1900	110	13 [300]	2E-06
	LOW	FULL						
Mango	HIGH	FULL	2.0	Pruning, Hand	580	550		3E-07
	HIGH	FULL		Scouting				
	HIGH	FULL		Harvesting, Hand	1400	230	4 [310]	7E-07
	HIGH	FULL		Thinning Fruit, Hand	3600	89	16 [320]	2E-06

Table F.10. Occupational Post-Application Non-Cancer and Cancer Risk Summary for ETU.[1]

Crop	Crop Height	Foliage Density	Application Rate (lb ai/A)	Activity	Transfer Coefficient (cm^2/hr or gm/hr)	Non-Cancer		Cancer
						Dermal MOE[2,3] (LOC = 300)	DAT at which MOE ≥ LOC [MOE]	Cancer Risk Estimate
						0-DAT		30-day Average Dose
Papaya	HIGH	FULL	2.0	Orchard maintenance	100	3200		5E-08
	HIGH	FULL		Weeding, Hand				
	LOW	MIN		Transplanting	230	1400		1E-07
	HIGH	FULL		Scouting	580	550		3E-07
	HIGH	FULL		Pruning, Hand				
	HIGH	MIN						
	HIGH	FULL		Harvesting, Hand	1400	230	4 [310]	7E-07
Walnut, English	HIGH	FULL	1.8	Orchard maintenance	100	3600		5E-08
	HIGH	FULL		Poling				
	HIGH	FULL		Weeding, Hand				
	HIGH	FULL		Harvesting, Mechanical (shaking)	190	1900		9E-08
	LOW	MIN		Transplanting	230	1500		1E-07
	HIGH	FULL		Scouting	580	610		3E-07
Grape DFR Data (MRID 44959601)								
Grape, Table	LOW	MIN	3.2	Transplanting	230	1300		2E-07
	HIGH	FULL		Scouting	640	470		5E-07
	HIGH	FULL		Pruning, Hand				
	HIGH	FULL		Weeding, Hand				
	HIGH	FULL		Irrigation (hand set)	1900	160	15 [300]	2E-06
	HIGH	FULL		Tying/Training	5500	55	>30 [190]	5E-06
	LOW	MIN						
	HIGH	FULL		Harvesting, Hand				
	HIGH	FULL		Leaf Pulling				
	HIGH	FULL		Girdling	19300	16	>30 [56]	2E-05
	HIGH	FULL		Turning				
Grape, Raisin	LOW	MIN	3.2	Transplanting	230	1300		2E-07
	HIGH	FULL		Scouting	640	470		5E-07
	HIGH	FULL		Pruning, Hand				
	HIGH	FULL		Weeding, Hand				
	HIGH	FULL		Irrigation (hand set)	1900	160	>30 [190]	2E-06
	HIGH	FULL		Tying/Training	5500	55	>30 [190]	5E-06
	LOW	MIN						
	HIGH	FULL		Harvesting, Hand				
	HIGH	FULL		Leaf Pulling				

Table F.10. Occupational Post-Application Non-Cancer and Cancer Risk Summary for ETU.[1]

Crop	Crop Height	Foliage Density	Application Rate (lb ai/A)	Activity	Transfer Coefficient (cm^2/hr or gm/hr)	Non-Cancer		Cancer
						Dermal MOE[2,3] (LOC = 300)	DAT at which MOE ≥ LOC [MOE]	Cancer Risk Estimate
						0-DAT		30-day Average Dose
Grape, Wine/Juice	HIGH	FULL	3.2	Scouting	640	470		5E-07
	HIGH	FULL		Pruning, Hand	640	470		5E-07
	HIGH	FULL		Irrigation (hand set)	1900	160	15 [300]	2E-06
	HIGH	FULL		Weeding, Hand	640	470		5E-07
	HIGH	MIN		Scouting	640	470		5E-07
	LOW	MIN						
	LOW	MIN		Propagating	640	470		5E-07
	LOW	MIN		Transplanting	230	1300		2E-07
	HIGH	FULL		Bird Control	640	470		5E-07
	LOW	MIN		Trellis Repair	640	470		5E-07
Field Tomato DFR Data (MRID 44959603)								
Asparagus	HIGH	FULL	1.6	Weeding, Hand	70	8800		1E-08
	LOW	MIN						
	LOW	FULL						
	HIGH	FULL		Scouting	210	2900		4E-08
	LOW	MIN						
	LOW	FULL						
	LOW	MIN		Transplanting	230	2700		5E-08
	LOW	MIN		Harvesting, Hand	1100	560		2E-07
	HIGH	FULL		Irrigation (hand set)	1900	320		4E-07
	LOW	MIN						
	LOW	FULL						
Banana	HIGH	FULL	2.4	Weeding, Hand	100	4100		3E-08
	LOW	FULL						
	HIGH	FULL		Harvesting, Hand	1400	290	1 [330]	4E-07
Barley	LOW	FULL	1.6	Scouting	1100	560		2E-07
	LOW	MIN						
Beet, sugar	LOW	FULL	1.6	Weeding, Hand	70	8800		1E-08
	LOW	MIN						
	LOW	MIN		Thinning Plants, Hand				
	LOW	FULL		Scouting	210	2900		4E-08
	LOW	MIN						
Beet, garden	LOW	MIN	1.5	Thinning Plants, Hand	70	9400		1E-08
	LOW	MIN		Weeding, Hand				
	LOW	FULL						
	LOW	FULL		Scouting	210	3100		4E-08
	LOW	MIN						
	LOW	FULL		Harvesting, Hand	1100	600		2E-07
	LOW	FULL		Irrigation (hand set)	1900	350		4E-07

Table F.10. Occupational Post-Application Non-Cancer and Cancer Risk Summary for ETU.[1]

Crop	Crop Height	Foliage Density	Application Rate (lb ai/A)	Activity	Transfer Coefficient (cm^2/hr or gm/hr)	Non-Cancer		Cancer
						Dermal MOE[2,3] (LOC = 300)	DAT at which MOE ≥ LOC [MOE]	Cancer Risk Estimate
						0-DAT		30-day Average Dose
Broccoli	LOW	MIN	1.6	Transplanting	230	2700		5E-08
	LOW	MIN		Scouting	330	1900		7E-08
	LOW	MIN		Thinning Plants, Hand				
	LOW	MIN		Weeding, Hand	1400	440		3E-07
	LOW	FULL		Irrigation (hand set)	1900	320		4E-07
	LOW	MIN						
	LOW	FULL		Scouting	4200	150	6 [310]	8E-07
	LOW	FULL		Harvesting, Hand				
	LOW	FULL		Weeding, Hand				
Cabbage	LOW	MIN	1.6	Transplanting	230	2700		5E-08
	LOW	MIN		Scouting	330	1900		7E-08
	LOW	MIN		Thinning Plants, Hand				
	LOW	FULL		Scouting	1400	440		3E-07
	LOW	FULL		Harvesting, Hand				
	LOW	FULL		Harvesting, Mechanically-assisted				
	LOW	MIN		Weeding, Hand				
	LOW	FULL		Irrigation (hand set)	1900	320		4E-07
	LOW	MIN						
	LOW	FULL		Weeding, Hand	4200	150	6 [310]	8E-07
Carrot	LOW	FULL	1.5	Weeding, Hand	70	9400		1E-08
	LOW	MIN						
	LOW	FULL		Scouting	210	3100		4E-08
	LOW	MIN						
	LOW	FULL		Harvesting, Hand	1100	600		2E-07
	LOW	FULL		Irrigation (hand set)	1900	350		4E-07
	LOW	MIN						
Corn, field	LOW	MIN	1.2	Weeding, Hand	70	12000		1E-08
	LOW	FULL						
	LOW	MIN		Scouting	210	3900		3E-08
	LOW	FULL						
	HIGH	FULL		Scouting	1100	750		2E-07
	HIGH	FULL		Irrigation (hand set)	1900	430		3E-07
	LOW	MIN						
	LOW	FULL						
Corn, pop	LOW	MIN	1.2	Weeding, Hand	70	12000		1E-08
	LOW	FULL						
	LOW	MIN		Scouting	210	3900		3E-08
	LOW	FULL						
	HIGH	FULL		Scouting	1100	750		2E-07
	HIGH	FULL		Irrigation (hand set)	1900	430		3E-07

Table F.10. Occupational Post-Application Non-Cancer and Cancer Risk Summary for ETU.[1]

Crop	Crop Height	Foliage Density	Application Rate (lb ai/A)	Activity	Transfer Coefficient (cm^2/hr or gm/hr)	Non-Cancer		Cancer
						Dermal MOE[2,3] (LOC = 300)	DAT at which MOE ≥ LOC [MOE]	Cancer Risk Estimate
						0-DAT		30-day Average Dose
	LOW	MIN						
	LOW	FULL						
Corn, sweet, grain	LOW	MIN	1.2	Weeding, Hand	70	12000		1E-08
	LOW	FULL						
	LOW	FULL		Scouting	210	3900		3E-08
	LOW	MIN						
	HIGH	FULL			1100	750		2E-07
	HIGH	FULL		Irrigation (hand set)	1900	430		3E-07
	LOW	MIN						
	HIGH	FULL		Harvesting, Hand	8800	93	10 [320]	1E-06
Cranberry	LOW	FULL	4.8	Pruning, Hand (shears)	70	2900		4E-08
	LOW	FULL		Weeding, Hand				
	LOW	MIN		Transplanting	230	890		1E-07
	LOW	FULL		Harvesting, Hand (raking)	1100	190	4 [310]	7E-07
	LOW	FULL		Scouting				
Cucumber	LOW	FULL	2.4	Scouting	90	4600		3E-08
	LOW	MIN						
	LOW	FULL		Weeding, Hand				
	LOW	MIN						
	LOW	FULL		Pruning, Hand				
	LOW	FULL		Thinning Fruit, Hand				
	LOW	MIN						
	LOW	MIN		Transplanting	230	1800		7E-08
	LOW	FULL		Harvesting, Hand	550	750		2E-07
	LOW	FULL		Harvesting, Mechanically-assisted				
	LOW	FULL		Training				
	LOW	FULL		Irrigation (hand set)	1900	220	3 [320]	6E-07
	LOW	MIN						
Greens, leafy	LOW	MIN	1.5	Thinning Plants, Hand	70	9400		1E-08
	LOW	FULL		Weeding, Hand				
	LOW	MIN						
	LOW	FULL		Scouting	210	3100		4E-08
	LOW	MIN						
	LOW	MIN		Transplanting	230	2900		4E-08
	LOW	FULL		Harvesting, Hand	1100	600		2E-07
	LOW	FULL		Irrigation (hand set)	1900	350		4E-07
	LOW	MIN						

Table F.10. Occupational Post-Application Non-Cancer and Cancer Risk Summary for ETU.[1]

Crop	Crop Height	Foliage Density	Application Rate (lb ai/A)	Activity	Transfer Coefficient (cm^2/hr or gm/hr)	Non-Cancer		Cancer
						Dermal MOE[2,3] (LOC = 300)	DAT at which MOE ≥ LOC [MOE]	Cancer Risk Estimate
						0-DAT		30-day Average Dose
Lettuce, leaf	LOW	MIN	1.88	Thinning Plants, Hand	70	7500		2E-08
	LOW	MIN		Weeding, Hand				
	LOW	FULL						
	LOW	FULL		Scouting	210	2500		5E-08
	LOW	MIN						
	LOW	MIN		Transplanting	230	2300		5E-08
	LOW	FULL		Harvesting, Hand	1100	480		3E-07
	LOW	FULL		Irrigation (hand set)	1900	280	1 [310]	4E-07
	LOW	MIN						
Nursery Crop (Ornamentals, Non-bearing Plants)	HIGH	FULL	1.6	Harvesting, Hand	230	2700		5E-08
	LOW	FULL						
	HIGH	MIN						
	HIGH	FULL		Pruning, Hand				
	LOW	FULL						
	HIGH	MIN						
	HIGH	FULL		Scouting				
	LOW	FULL						
	HIGH	FULL		Container Moving				
	HIGH	FULL		Weeding, Hand				
	LOW	FULL						
	HIGH	FULL		Transplanting				
	LOW	FULL						
	HIGH	MIN						
	LOW	MIN						
	LOW	MIN		Grafting				
	LOW	MIN		Propagating				
	LOW	FULL		Pinching				
	HIGH	FULL						
	LOW	FULL		Tying/Training				
	HIGH	FULL		Irrigation (hand set)	1900	320		4E-07
	LOW	FULL						
Onion, bulb	LOW	MIN	2.4	Scouting	330	1200		1E-07
	LOW	MIN		Thinning Plants, Hand				
	LOW	FULL		Scouting	1400	290	1 [330]	4E-07
	LOW	MIN		Weeding, Hand				
	LOW	FULL		Irrigation (hand set)	1900	220	3 [320]	6E-07
	LOW	MIN						
	LOW	FULL		Weeding, Hand	4200	98	9 [300]	1E-06
Onion, green	LOW	MIN	2.4	Scouting	330	1200		1E-07
	LOW	MIN		Thinning Plants, Hand				

Table F.10. Occupational Post-Application Non-Cancer and Cancer Risk Summary for ETU.[1]

Crop	Crop Height	Foliage Density	Application Rate (lb ai/A)	Activity	Transfer Coefficient (cm^2/hr or gm/hr)	Non-Cancer		Cancer
						Dermal MOE[2,3] (LOC = 300)	DAT at which MOE ≥ LOC [MOE]	Cancer Risk Estimate
						0-DAT		30-day Average Dose
	LOW	FULL		Scouting	1400	290	1 [330]	4E-07
	LOW	MIN		Weeding, Hand				
	LOW	FULL		Harvesting, Hand				
	LOW	FULL		Irrigation (hand set)	1900	220	3 [320]	6E-07
	LOW	MIN						
	LOW	FULL		Weeding, Hand	4200	98	9 [300]	1E-06
Parsley	LOW	FULL	1.5	Weeding, Hand	70	9400		1E-08
	LOW	MIN						
	LOW	MIN		Thinning Plants, Hand				
	LOW	FULL		Scouting	210	3100		4E-08
	LOW	MIN						
	LOW	MIN		Transplanting	230	2900		4E-08
	LOW	FULL		Harvesting, Hand	1100	600		2E-07
	LOW	FULL		Irrigation (hand set)	1900	350		4E-07
	LOW	MIN						
Peanut	LOW	FULL	1.6	Weeding, Hand	70	8800		1E-08
	LOW	MIN						
	LOW	FULL		Scouting	210	2900		4E-08
	LOW	FULL		Irrigation (hand set)	1900	320		4E-07
Pepper, bell	LOW	MIN	2.4	Weeding, Hand	70	5900		2E-08
	LOW	FULL						
	LOW	FULL		Scouting	210	2000		6E-08
	LOW	MIN						
	HIGH	FULL						
	LOW	MIN		Transplanting	230	1800		7E-08
	HIGH	FULL		Harvesting, Hand	1100	370		3E-07
	LOW	FULL						
	LOW	FULL		Tying/Training				
	LOW	FULL		Irrigation (hand set)	1900	220	3 [320]	6E-07
	LOW	MIN						
Pepper, chili	LOW	MIN	2.4	Weeding, Hand	70	5900		2E-08
	LOW	FULL						
	LOW	FULL		Pruning, Hand				
	LOW	FULL		Scouting	210	2000		6E-08
	LOW	MIN						
	HIGH	FULL						
	LOW	MIN		Transplanting	230	1800		7E-08
	HIGH	FULL		Harvesting, Hand	1100	370		3E-07
	LOW	FULL						

Table F.10. Occupational Post-Application Non-Cancer and Cancer Risk Summary for ETU.[1]

Crop	Crop Height	Foliage Density	Application Rate (lb ai/A)	Activity	Transfer Coefficient (cm^2/hr or gm/hr)	Non-Cancer		Cancer
						Dermal MOE[2,3] (LOC = 300)	DAT at which MOE ≥ LOC [MOE]	Cancer Risk Estimate
						0-DAT		30-day Average Dose
	LOW	FULL		Irrigation (hand set)	1900	220	3 [320]	6E-07
	LOW	MIN						
Potato	LOW	FULL	1.68	Weeding, Hand	70	8400		1E-08
	LOW	MIN		Scouting	210	2800		4E-08
	LOW	FULL						
	LOW	FULL		Irrigation (hand set)	1900	310		4E-07
	LOW	MIN						
Potato, Sweet	LOW	FULL	1.6	Weeding, Hand	70	8800		1E-08
	LOW	MIN						
	LOW	FULL		Scouting	210	2900		4E-08
	LOW	MIN						
	LOW	MIN		Transplanting	230	2700		5E-08
	LOW	MIN		Irrigation (hand set)	1900	320		4E-07
	LOW	FULL						
Spinach	LOW	FULL	1.5	Weeding, Hand	70	9400		1E-08
	LOW	MIN						
	LOW	MIN		Thinning Plants, Hand				
	LOW	MIN		Scouting	210	3100		4E-08
	LOW	FULL						
	LOW	MIN		Transplanting	230	2900		4E-08
	LOW	FULL		Harvesting, Hand	1100	600		2E-07
	LOW	FULL		Irrigation (hand set)	1900	350		4E-07
	LOW	MIN						
Swiss Chard	LOW	MIN	1.5	Weeding, Hand	70	9400		1E-08
	LOW	FULL						
	LOW	MIN		Thinning Plants, Hand				
	LOW	MIN		Scouting	210	3100		4E-08
	LOW	FULL						
	LOW	MIN		Transplanting	230	2900		4E-08
	LOW	FULL		Harvesting, Hand	1100	600		2E-07
	LOW	MIN		Irrigation (hand set)	1900	350		4E-07
	LOW	FULL						
Tobacco	HIGH	FULL	1.96	Weeding, Hand	90	5600		2E-08
	LOW	MIN						
	LOW	FULL						
	HIGH	FULL		Scouting				
	LOW	FULL						
	LOW	MIN						
	LOW	MIN		Transplanting	230	2200		6E-08
	HIGH	FULL		Harvesting, Mechanically-assisted	800	630		2E-07

Table F.10. Occupational Post-Application Non-Cancer and Cancer Risk Summary for ETU.[1]

Crop	Crop Height	Foliage Density	Application Rate (lb ai/A)	Activity	Transfer Coefficient (cm^2/hr or gm/hr)	Non-Cancer		Cancer
						Dermal MOE[2,3] (LOC = 300)	DAT at which MOE ≥ LOC [MOE]	Cancer Risk Estimate
						0-DAT		30-day Average Dose
	HIGH	FULL		Harvesting, Hand				
	HIGH	FULL		Canopy Management				
	HIGH	FULL		Irrigation (hand set)	1900	260	1 [300]	5E-07
Tomato	HIGH	FULL	2.4	Pruning, Hand	70	5900		2E-08
	LOW	FULL						
	LOW	MIN						
	LOW	FULL		Weeding, Hand				
	HIGH	FULL						
	LOW	MIN						
	LOW	FULL		Scouting	210	2000		6E-08
	LOW	MIN						
	HIGH	FULL						
	LOW	MIN		Transplanting	230	1800		7E-08
	HIGH	FULL		Harvesting, Hand	1100	370		3E-07
	LOW	FULL						
	HIGH	FULL		Tying/Training				
	LOW	FULL						
	LOW	MIN						
	HIGH	FULL		Irrigation (hand set)	1900	220	3 [320]	6E-07
Wheat, spring	LOW	MIN	1.6	Weeding, Hand	70	8800		1E-08
	LOW	FULL						
	LOW	FULL		Scouting	1100	560		2E-07
	LOW	MIN						
Wheat, winter	LOW	MIN	1.6	Weeding, Hand	70	8800		1E-08
	LOW	FULL						
	LOW	FULL		Scouting	1100	560		2E-07
	LOW	MIN						
Greenhouse Tomato DFR Data (MRID 44959603)								
Greenhouse vegetable	LOW	MIN	2.25	Transplanting	230	2600		6E-08
	HIGH	FULL		Irrigation (hand watering)				
	HIGH	FULL		Harvesting, Hand	1200	490		3E-07
	LOW	FULL						
	LOW	MIN		Pinching				
	HIGH	FULL						
	HIGH	FULL		Pollination				
	LOW	FULL		Pruning, Hand				
	LOW	MIN						
	HIGH	FULL						

Table F.10. Occupational Post-Application Non-Cancer and Cancer Risk Summary for ETU.[1]

Crop	Crop Height	Foliage Density	Application Rate (lb ai/A)	Activity	Transfer Coefficient (cm^2/hr or gm/hr)	Non-Cancer		Cancer
						Dermal MOE[2,3] (LOC = 300)	DAT at which MOE ≥ LOC [MOE]	Cancer Risk Estimate
						0-DAT		30-day Average Dose
	HIGH	FULL		Scouting				
	LOW	MIN						
	HIGH	FULL		Turning				
	HIGH	FULL		Tying/Training				
	HIGH	FULL		Weeding, Hand				
	LOW	MIN						
	LOW	MIN		Propagating				
Greenhouse Crop (Ornamentals, Non-bearing Plants)	HIGH	FULL	1.6	Harvesting, Hand	230	3600		5E-08
	LOW	FULL						
	HIGH	MIN						
	HIGH	FULL		Pruning, Hand				
	LOW	FULL						
	HIGH	MIN						
	HIGH	FULL		Scouting				
	LOW	FULL						
	HIGH	FULL		Container Moving				
	HIGH	FULL		Weeding, Hand				
	LOW	FULL						
	HIGH	FULL		Transplanting				
	LOW	FULL						
	HIGH	MIN						
	LOW	MIN						
	LOW	MIN		Grafting				
	LOW	MIN		Propagating				
	LOW	FULL		Pinching				
	HIGH	FULL						
	LOW	FULL		Tying/Training				
CA Mancozeb/CA Highest ETU Residue TTR Data								
Golf Course	LOW	FULL	17.4	Maintenance, greens only	2500	390		3E-07
	LOW	FULL		Maintenance	3700	270	1 [300]	5E-07
Sod	LOW	FULL	17.4	Maintenance	6700	150	7 [330]	9E-07
	LOW	FULL		Harvesting, Slab				
	LOW	FULL		Transplanting/Planting				

1. DAT = day after treatment. MOE = margin of exposure. LOC = level of concern.
2. Total Dermal Dose = ETU Dermal Dose (mg/kg/day) + Metabolized ETU Dermal Dose (mg/kg/day)
   ETU Dermal Dose = [DFR/TTR (µg/cm^2) × Transfer Coefficient × 0.001 mg/µg × 8 hrs/day × dermal absorption (6 %)] ¸ BW (80 kg).
   Metabolized ETU Dermal Dose =[DFR/TTR (µg/cm^2) × Transfer Coefficient × 0.001 mg/µg × 8 hrs/day × Metabolic Conversion Factor (7.5%)* × dermal absorption (6 %)] ¸ BW (80 kg).
3. MOE = POD (0.2 mg/kg/day) / Daily Dermal Dose (mg/kg/day).

* See Section 4.0 of D465683 (D. Carter, 02/10/2023) for details.