

Wildfire Catastrophe Model Checklist

The purpose of this checklist of technical guidelines, associated disclosures, and test cases is to provide information for evaluating whether modeled aggregate loss projections for wildfire losses by catastrophe models used within rate filings are reliable and based upon established concepts, data, equations, and principles, as well as best available scientific information and data, insurance claim expertise, and other assumptions appropriate for wildfire risk.

Instructions:

- **Pre-Application Required Information Determination (PRID) Procedure:** In a PRID procedure this checklist, including the appendix of preliminary test cases, serves as a scoping document for the types of information that will be provided. A modeler may provide the information during the PRID procedure through: 1) their standard client documentation, 2) presentations and verbal questioning, 3) written responses, and/or 4) any other form/mechanism requested by the Model Advisor. In this case, the “Disclosures for End-Users’ Use of Wildfire Catastrophe Models” section, which requires insurer-specific information, serves only as a reference for what information the modeler may need to be able to produce for a client insurer in a final report for use in a complete rate application (in addition to any Required Model Information).

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Glossary

General Modeling Terms

***The General Modeling Terms below are defined within the context of general modeling terms applicable to all topic areas addressed by these Guidelines. These terms and definitions are not intended and may not necessarily be a comprehensive distillation/representation of all relevant scientific literature.*

- **habitational structures / buildings:** refers to main structures that serve as the primary dwelling structure used by its occupants to live and contain their personal belongings, and secondary structures such as gazebos, outbuildings, and sheds are additional structures located on the same parcel but separate from the primary structure. Such secondary structures are included in the loss curves for the main, primary structures.
- **commercial residential property(ies) / commercial residential building(s):** refers to structures or buildings that are used in part or in whole for habitational purposes and insurable under a commercial insurance policy. Insured losses may include those for contents to the extent included in the coverages, but may be covered under a separate insurance policy.
- **personal residential property(ies) / personal residential building(s):** refers to structures or buildings that are used solely for habitational purposes and insurable under a personal dwelling insurance policy. Insured losses may include those for contents to the extent included in the coverages.
- **downscaled/downscaling:** refers to the methods for obtaining high-resolution inputs (*i.e.* weather inputs) from coarser-resolution global or regional models by developing a relationship between the historic observed global or regional patterns and data and the locally observed responses for the same historical period.
- **end-user/entity:** refers to the specific insurer/insurance company that is submitting a rate filing containing modeled loss projections derived from their use of a catastrophe model through the use of their own data (claims, trend, portfolio) as an input into the model.
- **model:** refers to a simplified or generalized representation of reality, which in the context of catastrophe models refers to a comprehensive set of formal structures, algorithms, equations, data, and components that capture processes associated with the effects of a peril (in this case wildfires) and its impact of personal residential and commercial residential properties leading to insured losses.
 - The relationship between a “**model**” and “**sub-model**” shall be understood with the specific context and architecture of the overall catastrophe model and a specific module within it. A model may be a standalone component or it may be composed of two or more sub-models with varying hierarchical relations to each other.

Hazard Terms

***The terms below are defined within the context of incorporating certain parameters related to fire characteristics within the hazard module of a catastrophe model (including as part of any wildfire hazard models within the hazard module) and are not intended and may not necessarily be a comprehensive distillation/representation of all relevant scientific literature. In general, wildfire-related terms are intended to be consistent with their definitions and usage per the [NWCG Glossary of Wildland Fire](#). Usage of “fire” below is understood to be in relation to wildfire.*

- **area burned / burned area:** represents the final fire size (*e.g.* number of acres) within the final fire perimeter of a specific, individual incident or simulated wildfire event, including unburned and unburnable fuel islands.
- **Base Wildfire Set:** refers to the selection and creation of a reference wildfire database to represent historical fire regimes in California whose individual events were originally contained in one or more

historical wildfire databases (*e.g.* **historical wildfire dataset**), which can be subsequently modified with additional data or by statistically adjusting certain parameters, including to incorporate potential impacts from climate change, and which is used to calibrate and validate modeled wildfires and to create large number of simulated events (*e.g.* **wildfire stochastic events set(s)**).

- **fire (fireline) intensity**: The rate of heat release per unit time per unit length of fire front. Numerically, it is the product of the heat yield, the quantity of fuel consumed in the fire front, and the rate of spread.
- **fire occurrence frequency**: The quantification of the probability that a fire will ignite within a particular area.
- **fire regime**: Description of the patterns of fire occurrences, frequency, size, severity, and sometimes vegetation and fire effects as well, in a given area or eco-system/eco-region. A fire regime is a generalization based on fire histories at individual sites. Fire regimes can often be described as cycles because some parts of the histories usually get repeated, and the repetitions can be counted and measured, such as fire return interval.
- **fire severity**: Degree to which a site has been altered or disrupted by fire; loosely, a product of fire intensity and residence time.
- **historical wildfire dataset**: refers to a reference dataset of historical wildfires compiled from unmodified, historical data contained in one or more historical wildfire databases created by academic or governmental authorities.
- **Reference California Historical Wildfire Dataset**: refers to the unmodified dataset for fire perimeters and burned area for historical California wildfires from 1970 to 2020, extracted from CAL FIRE's FRAP FOD 9 database (published Aug. 3, 2021), and intended to be used for purposes of complying with and reporting disclosures where expressly referenced. It may comprise a subset of a larger **historical wildfire dataset** used by the modeling organization to create a **Base Wildfire Set**.
- **wildfire hazard model/sub-model**: a set of physics and/or empirical equations that form a mathematical representation of the behavior of fire in uniform wildland fuels, most notably simulating fire spread. (*See sub-model* definition in *General Modeling Terms*).
 - **fuel model**: a simulated fuel complex for which all fuel descriptors required for the solution of a mathematical rate of spread model have been specified.
- **wildfire stochastic events set**: refers to the creation of a catalog of simulated events (*e.g.* database of scenario events for a specific peril, in this case wildfires) using historical data (*e.g.* **Base Wildfire Set**) and realistic parameters to represent a wide range of plausible scenarios for a specific peril, including to incorporate potential impacts from climate change. Each event is typically characterized by a location, path, or specific strength, intensity or size (as appropriate for the peril), and annual probability of occurrence (also known as event rate). [Catastrophe Models \(Property\) \(naic.org\)](https://naic.org).

Statistical Terms

*** The terms below are defined within the context of incorporating various statistical methods and statistical models throughout the various components and routines in catastrophe models, such as fitting probability distributions to historical data (or historical data adjusted to climate change) to generate stochastic wildfire events. Usage of "fire" below is understood to be in relation to wildfire.*

- **sensitivity analysis (SA)**: represents the quantification of the magnitude of the output by identifying and quantifying the input variables that impact the magnitude of the output when the variables are varied simultaneously or individually through individual test cases. The objective is to systematically manipulate the parameters and inputs to compare and measure the impact such changes have on the model's output from one test case to another, often in relation to a specific reference point such as, in the case of catastrophe models, a structure exposure dataset.
- **uncertainty analysis (UA)**: represents the quantification of the uncertainty in the outputs that

accumulate from each of the uncertainties related to every underlying parameter, data source, sub-model, and process in a catastrophe model. Although there is a relation between the sensitivity and uncertainty in a model and the same test cases may be used to analyze both, SA and UA are not the same as the variables that contribute the most to uncertainty may be different than the variables to which the model is more sensitive.

Vulnerability Terms

***The terms below are defined within the context of incorporating certain parameters related to characteristics of structures/buildings and surrounding areas within the engineering/vulnerability module of a catastrophe model (including as part of any vulnerability models or sub-models within the engineering/vulnerability module) and are not intended and may not necessarily be a comprehensive distillation/representation of all relevant scientific literature.*

- **damage functions / vulnerability functions:** refers to mathematical equations/algorithms that describe the relationship between the relevant characteristics of the hazard (such as defined “intensity measures” (IMs) or intervals of **fire intensity**) and the degree of damage (e.g. structural /physical damage) for specific assets/structures based on relevant construction and surrounding area characteristics. Some models’ damage functions do not measure the differences in intensity. It directly relates the hazard intensity to the resulting damage, not to the probability of damage.
- **vulnerability:** represents the localized conditions and characteristics of buildings/structures and immediate surrounding areas being modeled that impact the probability that such buildings/structures and their inner contents will be destroyed or damaged to varying degrees by various events (e.g. wildfires), often quantified through damage / vulnerability functions. Vulnerability typically comprised of three components: (i) the extent of damage to the building/structure, (ii) the extent of damage to their inner contents based on occupancy or other justifiable, relevant factors, and (iii) the extent of time such building/structure will remain unusable until repaired or rebuilt.

Actuarial Terms

***The terms below are defined within the context of incorporating certain parameters related to the treatment of insurance-related data, including from end-user input data, within the financial module of a catastrophe model.*

- **catastrophe/ic:** a relatively infrequent event or phenomenon that produces unusually large aggregate losses.
- **catastrophe loss:** damage to an insured asset attributed to a catastrophic event that results in a financial loss.
- **demand surge:** a sudden and usually temporary increase in the costs of materials, services, and labor due to the increased demand for them following a catastrophe.
- **exceedance probability (EP) curve:** An exceedance probability (EP) curve calculates the loss for each event in the portfolio, produced either by the sum of all losses each simulated year (aggregate loss) or the largest event in each simulated year (occurrence loss) and ranks each event by the probability of the event exceeding the aggregate or occurrence-based loss amount. ([NAIC COE Catastrophe Models](#); see [Exceedance Probability in Catastrophe Modeling - CAS 2021](#) for mathematical derivation)
- **average annual losses (AAL) / wildfire loss costs:** derived from the exceedance probability curve and equals the sum of the periodic losses from every simulated period (typically a year), each period varying the frequency and intensity of events (perils), all divided by the total number of periods in the catalog, which represents a long-term average of possible losses; a positive AAL is not correlated with an expectation that an insurer will sustain a loss in any given period (typically a year). (See [Exceedance Probability in Catastrophe Modeling - CAS 2021](#) for an example of mathematical derivation).

- **Probable Maximum Loss / Return Period Loss:** It is an amount that is expected to be exceeded with a given probability by an event or in a year. For example, a 100-year occurrence PML of \$6 million (\$6M) means that there is a 1-in-100 (1 percent) chance of a loss of at least \$6M in a given year. ([Probable Maximum Loss – CAS 2021](#)).

Computational Information Terms

*** The terms below are defined within the context of understanding computing system design and architecture.*

- **module:** with the context of scientific computing and software design, a module is a self-contained, independent unit of code that performs logically discrete functions by encapsulating related functionality, data structures, and implementation details and that interacts through defined interfaces with other modules performing other functionalities, for the purpose of organizing the overall software code and to make the programming modular and reusable. Within the context of catastrophe models, it can also be defined as a major organizational unit, component, or structure of an entire system, which may be subdivided into additional sub-units or sub-components such as models and sub-models. Many current catastrophe models have three or four modules, depending on the architecture, whose name may vary, but whose underlying functionality remains the same: Hazard, Vulnerability, and Exposure/Financial. ([Insurance Topics | Catastrophe Models \(Property\) | NAIC](#))

End-Users' Use of Model Terms

***The terms below are defined within the context of selecting, modifying, or adjusting certain input data and model settings, and are not intended and may not necessarily be a comprehensive distillation/representation of all relevant scientific and industry standards.*

- **Primary Amount of Insurance (AOI):** is defined as the coverage A amount for homeowner policy types, coverage C amount for renter or condominium owner policy types, and aggregate property structure limits (across all structures listed on the policy's declarations page or listed on a schedule attached to the policy) for commercial policy type.
- **Total Amount of Insurance Years (AIY):** The total combined limits (dwelling, additional structures, personal contents, and loss of use/business interruption) pertaining to the property coverages underlying each policy.

General Guidelines For Wildfire Catastrophe Models

Purpose: The purpose of the guidelines contained in this section is to promote consistent performance of wildfire catastrophe models for **habitational buildings** and **habitational structures**. Specific guidelines include those that provide a high-level view of the scope of the **wildfire catastrophe model** (G-1), and ensure that: the model was developed and is maintained by professionals with the requisite experience (G-2), the geographic insured exposure locations are accurate and appropriate (G-3), the components of the model are independent and logical (G-4), and the documentation of the model is maintained and quality controlled (G-5).

Guideline G-1. Scope of the Wildfire Catastrophe Model and Its Implementation

The wildfire catastrophe model shall project loss costs and average, aggregate, and probable maximum loss levels for damage to insured residential and habitational property from wildfire events.

A documented process shall be maintained to assure continual agreement and accurate correspondence of databases, data files, and computer source code to presentation materials, scientific and technical literature, and modeling organization documents.

All software, data, and flowcharts (1) located within the wildfire catastrophe model, (2) used to validate the wildfire catastrophe model, (3) used to project modeled wildfire loss costs and wildfire average, aggregate, and probable maximum loss levels, and (4) used to create forms required by any Guideline, shall be considered within the scope of the Computational Guidelines.

A subset of the forms shall be produced through an automated procedure or procedures as indicated in the form instructions.

Vintage of data, code, and scientific and technical literature used shall be justifiable.

Guideline G-2. Qualifications of Modeling Organization Personnel and Consultants Engaged in Development of the Wildfire Catastrophe Model

Wildfire catastrophe model construction, testing, and evaluation shall be performed by modeling organization personnel or consultants who possess the necessary skills, formal education, and experience to develop the relevant components for wildfire loss projection methodologies.

The wildfire catastrophe model and its submission documentation shall be reviewed by modeling organization personnel or consultants in the following professional disciplines with requisite experience: engineering (currently licensed Professional Engineer), statistics (advanced degree or equivalent experience), actuarial science (Associate or Fellow of the Casualty Actuarial Society), wildfire-specific expertise (documented with appropriate advanced science or engineering degree), meteorology (advanced science or engineering degree), and computational science (advanced degree or equivalent experience and certifications). These individuals shall certify Expert Certification Forms G-1 through G-7, as applicable.

Guideline G-3. Location / Geospatial Information for Data Inputs

Location and geospatial information used in all aspects of the catastrophe model shall be of appropriate granularity and up to date, including but not limited to, the following constraints:

- *ZIP Codes, when used in the wildfire catastrophe model, shall not differ from the United States*

Postal Service publication date by more than 24 months at the date of submission of the wildfire catastrophe model. ZIP Code information shall originate from the United States Postal Service.

- *Centroids, when used in the wildfire catastrophe model, shall be based on population data and/or other wildfire-relevant criteria.*
- *Geospatial information purchased by the modeling organization shall be verified by the modeling organization for accuracy and appropriateness.*
- *If any wildfire catastrophe model components are dependent on geospatial databases, a logical process shall be maintained for ensuring these components are consistent with the recent database updates.*
- *Geocoding methodology shall be clearly justified.*

Guideline G-4. Independence of Wildfire Catastrophe Model Components

The hazard, vulnerability, and actuarial components of the wildfire catastrophe model shall each be theoretically sound without compensation for potential bias from other components.

Where missing data exist, an explanation shall be given for how models interpolate, average, exclude, or estimate missing data.

Guideline G-5. Editorial Compliance

The submission and any revisions provided throughout the review process shall be reviewed and edited by a person or persons with experience in reviewing technical documents who shall certify on the relevant Form and on Form G-1, General Modeling Guideline Expert Certification, that the submission has been personally reviewed and is editorially correct.

General Disclosures For Wildfire Catastrophe Models

Disclosure G-1 Scope of the Wildfire Catastrophe Model and Its Implementation

1. Specify the wildfire catastrophe model version identification and, if relevant, the third-party vendor that produced the model. If the wildfire catastrophe model is implemented on more than one platform, specify each platform identifying the primary platform and the distinguishing aspects of each platform. Specify whether there is a more recent version of this model available from the vendor and, if so, why this more recent version is not being used.
2. Provide a comprehensive summary of the wildfire catastrophe model, including without limitation the wildfire behavior model (also known as wildfire hazard model) and any other aggregate or actuarial model that uses the results from the wildfire hazard model. This summary should include a technical description of the wildfire catastrophe model and all of its modules, submodules, and each major component (including their spatiotemporal resolution) used to project loss costs and probable maximum loss levels for damage to insured residential and habitational property from wildfire events causing damage in California. Describe the theoretical basis of the wildfire catastrophe model and include a thorough description of the methodology and input data used for the model and its modules, particularly on components of the wildfire hazard model such as, (without limitation as applicable), fire and wind interactions, ignition

locations, climate/meteorological and terrain inputs and parameters, and the wildfire fuel mode (e.g. fuel type and fuel moisture); the vulnerability components; and the insured loss components used in the wildfire catastrophe model. The description should be complete and must not reference unpublished work. Additionally, with each version of the model, description of comprehensive validation and verification studies conducted according to the American Institute of Aeronautics and Astronautics (AIAA G-077-1998 Guide for the Verification and Validation of Computational Fluid Dynamics Simulations) and/or other comparable modeling industry standards on model components must be included.

3. Provide a flowchart that illustrates interactions among the major wildfire catastrophe model components.
4. Provide a diagram defining the network organization in which the wildfire catastrophe model is designed and operates.
5. Provide detailed information on the wildfire catastrophe model implementation on more than one platform, if applicable. In particular, submit Forms S-5, Average Annual Zero Deductible Statewide Wildfire Loss Costs – Historical versus Modeled; V-2, Wildfire Mitigation Measures and Buildings' Secondary Characteristics, Range of Changes in Damage; A-1, Owners' Zero Deductible Personal and Commercial Residential Property Wildfire Loss Costs by Impacted Centroid; A-4, Wildfire Loss Output Ranges; and A-8, Wildfire Probable Maximum Loss for California, from each platform including additional calculations showing no differences. **These forms are contained in the other sections of the disclosures document noted by the letter (e.g. Statistical Guidelines for Wildfire Catastrophe Models (S), Wildfire Vulnerability Guidelines (V), etc.).**
6. Provide a comprehensive list of complete references pertinent to the wildfire catastrophe model by guideline grouping using professional citation standards.
7. **The following disclosure is only applicable if the wildfire catastrophe model has been used for determination of the projected aggregate losses in a prior rate filing, and previously provided responses to these guidelines and disclosures:** If model components, input data or parameters, or version have been changed, provide the following information related to such changes.
 - A. Wildfire catastrophe model changes:
 - i. A summary description of changes that affect the residential properties' wildfire loss costs or wildfire probable maximum loss levels for personal lines, commercial lines, or both;
 - ii. A list of all other changes; and
 - iii. The rationale for each change.

Disclosure G-2 Qualifications of Modeling Organization Personnel and Consultants Engaged in Development of the Wildfire Catastrophe Model

1. Modeling Organization Background
 - A. Describe the ownership structure of the modeling organization engaged in the development

of the wildfire catastrophe model. Describe affiliations with other companies and entities and the nature of the relationship, if any. Indicate if the modeling organization has changed its name and explain the circumstances.

- B. If the wildfire catastrophe model is developed by an entity other than the modeling organization, describe its organizational structure and indicate how proprietary rights and control over the wildfire catastrophe model and its components are exercised. If more than one entity is involved in the development of the model, describe all involved.
- C. If the wildfire catastrophe model is developed by an entity other than the modeling organization, describe the funding source for the development of the model.
- D. Describe any services other than wildfire modeling provided by the modeling organization.
- E. Indicate if the modeling organization has ever been involved directly in litigation or challenged by a governmental authority where the credibility of one of its wildfire catastrophe model versions for projection of wildfire loss costs or wildfire probable maximum loss levels was disputed. Describe the nature of each case and its conclusion.

2. Professional Credentials

- A. Provide in a tabular format (a) the highest degree obtained (discipline and university), (b) employment or consultant status and tenure in years, and (c) relevant experience, publications, and responsibilities of individuals currently involved in the acceptability process or in any of the following aspects of the wildfire catastrophe model:
 - i. Hazard
 - ii. Statistics
 - iii. Vulnerability
 - iv. Actuarial Science
 - v. Computer/Information Science
- B. Identify any new employees or consultants (since the previous submission) engaged in the development of the wildfire catastrophe model or the model-related information for this rate filing.
- C. Provide visual business workflow documentation connecting all personnel related to wildfire catastrophe model design, testing, execution, maintenance, and decision-making.

3. Independent Peer Review

- A. Provide reviewer names, qualifications, affiliation, and dates of external independent peer reviews that have been performed on the following components as currently functioning in the wildfire catastrophe model:
 - i. Hazard
 - ii. Statistics
 - iii. Vulnerability

- iv. Actuarial Science
 - v. Computer/Information Science
- B. Provide documentation of independent peer reviews directly relevant to the modeling organization responses to the current guidelines, disclosures, and forms for wildfire catastrophe models. Identify any unresolved or outstanding issues as a result of these reviews.
- C. Describe the nature of any on-going or functional relationship the modeling organization has with any of the persons performing the independent peer reviews.

Disclosure G-3 Insured Exposure Location

1. Provide a description of the geographic information system (GIS) software and tools used for geocoding.
2. List the current geospatial databases used by the wildfire catastrophe model and the model components to which they relate. Provide the effective (official United States Postal Service) dates corresponding to the ZIP Code databases, if applicable.
3. Describe in detail how invalid geospatial locations (including ZIP Codes if applicable) are handled.
4. Describe the data, methods, and process used in the wildfire catastrophe model to convert among street addresses, geocode locations (latitude-longitude), and eco-regions or relevant wildfire spatial areas designated by the modeling organization, as well as conversion to ZIP Codes if applicable.
5. List and provide a brief description of each wildfire catastrophe model eco-regions and relevant wildfire spatial-based database, including any ZIP Code-based database, if applicable, and centroids.
6. Describe the process for updating wildfire catastrophe model eco-region and relevant wildfire spatial-based databases, including ZIP Code-based databases if applicable.

Disclosure G-4 Independence of Wildfire Catastrophe Model Components

1. Describe the process used to ensure that the primary components of the wildfire catastrophe model (hazard, vulnerability, and actuarial components) operate independently and do not compensate, calibrate, or adjust for any bias or deficiencies arising from any other component.

Disclosure G-5 Editorial Compliance

1. Describe the process used for document control of the submission. Describe the process used to ensure that the paper and electronic versions of specific files are identical in content.
2. Describe the process used by the signatories on Expert Certification Forms G-1 through G-7 to ensure that the information contained under each set of Guidelines and Disclosures is accurate

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and complete.

Hazard Guidelines For Wildfire Catastrophe Models

Purpose: The purpose of the guidelines under this section is to enable verification that the wildfire events used in the **wildfire hazard model** are realistic by reflecting the range of variation of fire characteristics with respect to their **fire occurrence frequency**, **fire intensity**, **fire severity**, seasonality, and **area burned** representing diverse historical **fire regimes** across California (Wildfire Hazard Guideline-1, abbreviated below as H-1). It will also ensure these events are generated using established concepts, data, equations, and principles as well as best available scientific information and data for determining the fire input parameters, model algorithms, and model assumptions (H-2), such that the probability of fire occurrence, fire intensity, and fire severity of the wildfires in an events catalog or similar data set reasonably reflects the historical record with respect to those fire regimes and geographic locations (H-3). It will ensure that the drivers of fire occurrence frequency and behavior are represented in a way that is scientifically sound and appropriate for the modeling approach taken (H-4). It will demonstrate appropriate consideration for weather considerations and climate change (H-5 and H-6). Finally, each of the individual components of the wildfire hazard model including associated **sub-models** shall be validated (H-7).

Guideline H-1. Base Wildfire Set

*The **Base Wildfire Set** should be developed based on past wildfire events using existing historical wildfire dataset(s) such as the National Interagency Fire Occurrence Sixth Edition (or later, incorporating 1992-2020 for ignitions), CAL FIRE's FRAP FOD 9 (incorporating 1950 – present for fire perimeters and area), and the interagency MTBS (incorporating relevant periods from 1984 to present for past fire occurrence, burned area boundary, and burn severity). Different data sets may be used and combined, but justification must be provided, for instance, including fire severity data for the largest fires (MTBS) with a wider range of fire perimeters (CAL FIRE FRAP FOD 9).*

A wildfire hazard model may be constructed in any scientifically sound and defensible fashion, including through appropriate, scientifically-sound climate change-related weather input adjustments and through justified adjustments to the Base Wildfire Set. However, annual frequencies used in wildfire hazard model/sub-model validation shall be based upon the Base Wildfire Set chosen, allowing for modifications if justified. The model's characteristics, assumptions, and sensitivity to spatiotemporal resolutions should be transparent and disclosed for each version.

Guideline H-2. Wildfire Hazard Model Inputs, Parameters, and Characteristics

Wildfire inputs, parameters, and characteristics in this section are specifically those that relate to physical conditions to simulate the range of possible ignitions and fire spread. Methods for depicting all modeled wildfire parameters and characteristics both spatially and, if applicable, temporally, shall be based on information documented in current scientific and technical literature. This pertains to fuel type, loading, and fuel moisture content (live and dead, if used), ambient temperature, soil and air moisture content, windspeeds and directions, topographical features, conversion factors, climate-related adjustments, and any other parameters and characteristics. Model-specific variables, including ember distribution adjustments, crown fire transition and fire acceleration, must be denoted and justified for each version of the model. If fires in urban areas (structures, etc.) are represented in the model, provide details on applied inputs and characteristics used in urban conflagration models to represent their combustion, fire spread, and abatement, including the impact of mitigation measures such as defensible space, home hardening, and surrounding fuel treatments, if appropriate.

Representation and treatment of ignition sources, natural and human, including utility sources, shall be consistent with current state-of-the-science and shall be implemented with appropriate geographic-information-system data, accounting for empirically determined probabilistic spatial distributions. Specific detail of the ignitions used, including their spatial extent and variations due to, at a minimum, population, roads, and power infrastructure should be detailed. Modifications to ignition risk because of mitigation and resiliency efforts, such as due to utility and other infrastructure mitigation efforts, should be detailed if incorporated. The ideal treatment of ignition sources would be probabilistic and account for the spatial patterns of both lightning and human caused ignitions. Wildfire hazard models shall use clearly described methods for fire spread simulation and/or determining output parameters and characteristics including fire intensity, flame length, ember deposition, and/or any other relevant fire behavior outputs from the model. Incorporation of the effects of fuel treatments, prescribed burning, and other wildfire-related landscape and fuels management, whether in the model or underlying fuels layers, should be justified and clearly described.

Guideline H-3. Wildfire Probability Distributions

Modeled probability distributions of wildfire occurrence and burned area shall be shown to be consistent with the chosen historical wildfire dataset(s) in California. Frequency distributions of fire occurrence, burned area, and inter-annual variability should be compared between model outputs and the historical database for eco-regions and/or other relevant, justified spatial areas that are fire prone, and take into account changing fire regimes across the State. Fire severity or other relevant exposure metrics should be compared if model outputs and input historical databases with this data are applicable. Output comparisons should also be provided for selected low, average, and highly active fire seasons. Seasonality impacts should also be addressed in some comparisons.

The criteria to categorize low, average, and highly active fire seasons and appropriate eco-regions/spatial areas shall be determined by the modeling organization using appropriate methodology and relevant scientific literature.

Modeled wildfire frequency distributions shall reflect the Base Wildfire Set used for different return period for wildfires and shall be consistent with those observed for each wildfire-prone segment of California. Deviations from the Base Wildfire Set should be discussed and quantitatively compared with physical justifications and, if appropriate, additional data to justify provided results.

It is not recommended for wildfire sub-models to be calibrated or to consider observed wildfire frequency distributions beyond the California border reaching into neighboring states unless a neighboring state's landscape and other wildfire risk characteristics are modeled specifically for the purpose of examining wildfires that may spread across state lines including through urban conflagration.

Any functions required to adjust the Base Wildfire Set or its outputs in order to develop frequency distributions as a function of location should be detailed and justified. This includes functions to adjust ember distribution and spread into developed areas.

Guideline H-4. Wildfire Fuel Model

*A spatial fuel map incorporating a current version of LANDFIRE or an alternate appropriate dataset shall be used for the full range of chosen conditions in support of a **fuel model** simulating fire occurrence frequency, intensity, severity, and area burned. Use of alternate datasets, modifications to LANDFIRE, or other chosen datasets for fuel treatments, past fire occurrence, or other appropriate changes shall be*

justified with details provided on resolution, methodology, and update frequency.

Data used to represent vegetation and vegetation management for fuel loading shall be regularly updated with methods and data sources clearly indicated. If urban fuel data is used similar information shall be provided. Details should be provided on resolution, methodology, and update frequency.

The translation of land use and land cover or other source information into fuel loading and wildfire spread shall be consistent with current state-of-the-science and shall be implemented with appropriate geographic-information-system data.

Representation of topography, including slope, and translation to wildfire rate of spread across the landscape shall be consistent with current state-of-the-science and shall be implemented with appropriate geographic-information-system data.

Landscape area fuel treatments and forest management actions shall be represented in the model for the full range of simulated fire-weather conditions, including extreme events and worst-case scenarios.

Guideline H-5. Weather inputs

*Input weather conditions (such as wind speed, wind direction, wind gust, temperature, and humidity) used to initialize wildfire hazard models shall be clearly defined and cited. The spatial and temporal resolution of the weather inputs shall be specified. Any processing applied to input data to generate value-added weather inputs (e.g., **downscaled** or bias corrected) such as weather modeling (e.g., dynamical modeling) and **downscaling** (e.g. WindNinja, use of artificial intelligence methods), shall be described in detail. In cases where value-added approaches are used, details of the original forcing data used shall be specified.*

While there is no standard or benchmark for weather inputs, sufficient justification shall be provided on how the weather inputs are used to both reflect localized weather specific to fire hazards in the state and to account for sufficient variability in capturing fire weather conditions, including extreme events commensurate with observed or modern climatology.

Describe whether and how fuel moisture content is calculated from the weather inputs. Provide specific equations or methods and how these data are used in the fire model (e.g., does the model account for dynamic fuel moisture driven by changing weather conditions?).

Weather inputs shall be validated against reference ‘observation’ datasets. These data may include in-situ data from Remote Automated Weather Stations (RAWS), output from NOAA’s Real-Time Mesoscale Analysis (RTMA), among others. Validation shall consider issues related to station siting and quality control for in-situ observations, where appropriate, and span a representative portion of the state. Validation efforts should at minimum include statistics related to mean, variability, and extremes for individual meteorological variables.

Guideline H-6 Present Day Climate Change Adjustments

Describe efforts for modernizing weather datasets to account for ongoing changes in climate. Justification for the methods used in codifying climate change adjustments should be consistent with Established concepts, data, equations, and principles as well as best available scientific information and data. Weather data should target contemporary conditions for the rate period. As such, relying exclusively on historical data or very short records (e.g., last five years) may not be well suited to assess

current hazard. Efforts to account for present day climate change adjustments can include statistical incorporation of recent trends or incorporation of output from climate model simulations. Uses of climate model output in present day climate change adjustments shall consider uncertainty in selection of climate model(s), climate forcing scenario(s), and use of ensembles. Details of the datasets and approaches used to augment the weather inputs and how such adjustments alter the distribution (e.g., means and variance of individual weather variables). This includes specifying which variables were or were not adjusted, and the justification for doing so.

Climate change adjustments shall be quantified through the depiction of changes in attributes of individual variables. Likewise, models that calculate and use weather inputs to calculate fuel moisture should articulate how fuel moisture changes due to present day climate change adjustments.

Guideline H-7. Wildfire Hazard Model Validation

*All individual components of the wildfire hazard model (including the sub-models or components for fire spread, crown fire transition, ember transport and other components referenced in H-1 to H-6) shall be fully justified and, where appropriate, validated in accordance with each such section against existing comparison points such as analytical models, the **Reference California Historical Wildfire Dataset**, past prescribed fires, individual wildfire event data, and/or other scientifically-accepted methods.*

The sensitivity of the overall wildfire hazard model to model inputs, especially those that have limited existing justification (such as ember parameters and fire acceleration) should be provided. Existing scientific literature used to develop the model, adjustments made to the model to fit to specific datasets, and any “tuning” or adjustments of the model to fit specific outputs or metrics should be explicitly detailed.

Hazard Disclosures For Wildfire Catastrophe Models

Disclosure H-1 Base Wildfire Set

1. Specify the historical wildfire dataset(s) release date and the time-period used to develop and implement fire occurrence frequency and behavior characteristics, such as fire intensity, fire severity, and fire perimeters, into the wildfire hazard model.
2. If the modeling organization has made any modifications to the historical wildfire dataset(s) or to the Base Wildfire Set related to fire occurrence frequency and behavior characteristics, provide justification for such modifications.
3. Include a flowchart illustrating how changes in the historical wildfire dataset(s) and Base Wildfire Set(s) database are used in the calculation of wildfire distribution, including with respect to both fire occurrence frequency and area burned.
4. If the wildfire hazard model and/or any associated sub-models incorporate systematic modification of the historical data leading to differences from the historical wildfire dataset(s), describe how this is incorporated and provide comparisons to the Base Wildfire Set and modeled wildfire events (stochastic event set), including fire occurrence frequency and area burned.
5. If the modeling organization has accounted for climate change in either developing stochastic events

set(s) based on the historical record or modifying other components in the wildfire hazard model development, (i) specify additional data, databases, and modifications used and (ii) justify their use and explain their impact in modeling California fire occurrence frequency and behavior characteristics in view of the peer-reviewed scientific literature and in relation to the model's assumptions and sensitivity to spatiotemporal resolutions.

6. If the modeling organization has accounted for changes in fuels or other input variables to account for changes **not** related to climate change in the wildfire hazard model development, such as the impact of fuel treatments, (i) specify additional data, databases, and modifications used and (ii) justify their use and explain their impact in modeling California fire occurrence frequency and behavior characteristics in view of the peer-reviewed scientific literature and in relation to the model's assumptions and sensitivity to spatiotemporal resolutions.

Disclosure H-2 Wildfire Hazard Model Inputs, Parameters, and Characteristics

1. Identify the wildfire inputs and parameters related to physical conditions referenced in the corresponding guideline that are used in the wildfire hazard model to simulate the range of possible ignitions and fire spread, and provide justification, including with respect to: the dataset basis for fitted distribution; the methods used, including to represent spatial parameters and temporal parameters if applicable; any smoothing techniques employed; and citations to relevant peer-reviewed scientific literature as applicable.
2. Describe the method, reason, and supporting material for selecting wildfire parameters, including with respect to urban conflagration (such as building materials) to represent combustion, fire spread, and abatement in urban areas.
3. Identify whether wildfire parameters are modeled as random variables, functions, or fixed values for the stochastic events set. Provide rationale for the choice of parameter representations.
4. Describe if and how any wildfire parameters are treated differently in the Base Wildfire Set and stochastic events set(s) and provide rationale.
5. Describe the spatiotemporal treatment of fire intensity, flame length, crown fires, ember deposition and any other relevant fire behavior parameters (which alternatively can be disclosed in conjunction with the treatment of fuel loads and weather in H-4 and H-5 below).
6. Describe the representation and treatment of ignition sources (natural and human), including utility sources, consistent with current state-of-the-science and empirically determined probabilistic spatial distributions. Describe, if incorporated, modifications to ignition risk because of mitigation and resiliency efforts, such as due to utility and other infrastructure mitigation efforts. Describe any adjustments to ignition risk depending on weather (e.g., as it affects power infrastructure ignition risk).
7. Incorporation of the effects of fuel treatments, prescribed burning, and other wildfire-related landscape and fuels management, whether in the model or underlying fuels layers, should be justified and clearly described

8. Describe the historical wildfire dataset(s) used as the basis for the Base Wildfire Set, including resolution. Discuss the appropriateness of the wildfire stochastic events set with reference to the historical wildfire dataset(s).
9. If the Base Wildfire Set is partitioned or modified, describe how the wildfire parameters are affected.
10. Describe any evolution over time of the functional representation of wildfire parameters during an individual wildfire life cycle, such as fire-weather interactions and fuel moisture modifications.

Disclosure H-3 Wildfire Probability Distributions

1. Provide a complete list of the assumptions used in creating the wildfire stochastic events sets or other datasets based on the Base Wildfire Set.
2. Provide the criteria used by the modeling organization to categorize low, average, and highly active fire seasons.
3. Provide a map and the criteria used by the modeling organization to delineate appropriate wildfire eco-regions/wildfire-specific spatial areas for the State of California.
4. Provide a brief rationale for the probability distributions used for all wildfire input parameters and characteristics, including to develop frequency distributions as a function of location and temporal variability and, if specifically modeled, inclusive of wildfires that spread across state lines including through urban conflagration. Demonstrate the quality of fit.
5. If changes are subsequently made to the model or any input parameters, describe and justify any changes made and how the new wildfire stochastic events set relate to the Base Wildfire Set from the previously reviewed wildfire hazard model. Describe the methodology used to make such changes.
6. Provide one or more graphics that compares the distribution of modeled wildfire occurrence frequency and burned area with the Base Wildfire Set, including with respect to seasonality.

Disclosure H-4 Wildfire Fuel Model

1. Describe the source and specific spatial fuel map(s) used for the full range of simulated fire-weather conditions. If they change dynamically, describe the methods for this change and show examples. If spatial fuel maps were modified, detail and justify every modification and provide a copy of the modified spatial fuel map(s).
2. Describe dataset(s), methodology, resolution and update frequency used to account for variation of fuel loading in the wildfire hazard model where applicable, including with respect to fuel treatments and any other forest management actions, as well as past fire occurrence frequency. Document and justify any difference in the methodology for treating historical and stochastic events sets.

3. If wildland-urban interface (WUI) fuels, urban fuels, or both are accounted for in the model, describe how they are parameterized and included.
4. Identify all non-meteorological variables (including topography, slope, and fuels) that affect fire intensity estimation or wildfire rate of spread.
5. Provide the collection and publication dates of the land use and land cover data used in the wildfire hazard model and justify their timeliness for California.
6. Describe the methodology used to convert land use and land cover information into a spatial distribution of fuel loading in California if used to generate the fuel layers.
7. Describe any variations in the treatment of weather and ignition in relation to fuel and fuel moisture in the wildfire hazard model for stochastic versus historical events and justify this variation.

Disclosure H-5 Weather Inputs

1. Describe and cite the source(s) of all the weather data used. Include all the variables that are used, their spatial and temporal attributes, and, as applicable, methodology related to create means, variability, and extremes for individual meteorological variables.
2. Provide a rationale for how the selected weather inputs reflect localized weather specific to fire hazards for the timespan being simulated.
3. Provide a rationale for how the selected weather inputs account for sufficient variability in extreme fire weather conditions commensurate with modern climatology.
4. Describe any methodology used to process the weather data (e.g., bias correction, downscaling efforts). Provide justification and citations to existing literature where relevant.
5. Detail how air moisture and fuel moisture content is calculated from weather inputs. Provide specific equations or methods of how this is accomplished.
6. Demonstrate the consistency of the weather inputs with observed data, including for extreme fire weather conditions. Comparisons of the weather inputs should at least be shown for wind speed and relative humidity. Describe and justify the appropriateness of the weather inputs taken from weather databases used in the weather validation to represent annual and seasonal variations as well as to appropriately capture extreme fire events that drive losses.

Disclosure H-6 Present Day Climate Change Adjustments

1. Describe the approach used to account for ongoing changes in climate in adjusting weather inputs to present day conditions. Specify any ancillary datasets (e.g., climate models) used to account for

such changes and any statistical processing used.

2. Specify which variables were adjusted in cases where only a subset was changed and provide justification.

Disclosure H-7 Wildfire Hazard Model Validation

1. Please provide a schematic or diagram that represents the overall architecture of the wildfire hazard model, including all components (inputs, parameters including other sub-models/model components, and outputs).
2. For each sub-model or model component, specify the sub-model or model component; how it is modified and validated, including, but not limited to, by comparing trends or with past fires; and cite papers and sources. Provide a justification for any specific sub-model or model component that is not validated.

Statistical Guidelines For Wildfire Catastrophe Models

Purpose: The purpose of the guidelines under this section are to ensure that the statistical models underpinning the wildfire catastrophe model are implemented using established concepts, data, equations, and principles as well as best available scientific information and data, insurance claim expertise, and other assumptions appropriate for the risk or peril being modeled such that: the various **models** and **sub-models** contained within the wildfire catastrophe model, including the **wildfire hazard model**, are reasonably and methodically designed (Statistical Guideline for Wildfire Catastrophe Models 1, abbreviated below as S-1); the outputs from models and sub-models within the wildfire catastrophe model are appropriately sensitive to input parameters and result in reasonable overall loss outputs (S-2); the statistical models properly analyze and quantify uncertainty throughout the catastrophe model (S-3); the probabilistic catastrophe model is interpretable and has been run enough times such that the standard error of the wildfire output range is appropriately bounded and can be considered negligible (S-4); the catastrophe model can reasonably reproduce known wildfire losses for past events (S-5); and any differences between historical and modeled **annual average statewide wildfire losses** are statistically plausible and explainable (S-6). Many aspects of wildfire catastrophe model development and implementation involve fitting a probability distribution to historical data, for example, in generating stochastic events that comprise the **wildfire stochastic events set** in the wildfire hazard module. These fitted statistical models need to be rigorously checked to ensure that the distributions reflect the current and projected state of the climate and wildfire related inputs and that the sensitivity of the outputs to perturbations are reasonable and interpretable.

Guideline S-1. Modeled Results and Goodness-of-Fit

The use of historical data in developing the wildfire catastrophe model and other models and sub-models shall be supported by rigorous and reproducible methods published in current scientific literature and relevant technical documents.

Modeled and historical results shall reflect statistical agreement using current scientific and statistical methods for the academic disciplines appropriate for the components and characteristics of the various models and sub-models, including the wildfire hazard model.

Guideline S-2. Sensitivity Analysis for Wildfire Catastrophe Model Output

The modeling organization shall have assessed the sensitivity of temporal and spatial outputs throughout the various models and sub-models with respect to the simultaneous variation of input variables using current scientific and statistical methods in the appropriate disciplines and shall have taken appropriate action so that interactions and correlations among the input variables result in reasonable and justifiable overall model loss outputs and loss projections.

Guideline S-3. Uncertainty Analysis for Wildfire Catastrophe Model Output

The modeling organization shall have performed an uncertainty analysis on the temporal and spatial outputs of the wildfire catastrophe model using current scientific and statistical methods in the appropriate disciplines and shall have taken appropriate action to identify those variables that contribute to the uncertainty so as to reduce uncertainty in the outputs and result in reasonable and justifiable overall model loss outputs and loss projections. The analysis shall identify and quantify the extent that input variables impact the uncertainty in wildfire catastrophe model output as the input variables are simultaneously varied.

Guideline S-4. Aggregation & Convolution Levels

At all spatial convolution and temporal aggregation levels, the contribution to the error in wildfire loss cost estimates attributable to the sampling process shall be plausible and explainable, and shall have taken appropriate action to significantly minimize divergence due to sampling differences so that the contribution to the error to wildfire loss estimates is negligible.

Guideline S-5. Replication of Known Wildfire Losses

*The wildfire catastrophe model shall estimate incurred wildfire losses in an unbiased manner on a sufficient body of past wildfire events, which represents the diversity of observed event types and losses, from more than one company or source (at least three), including open-source community-driven datasets spanning a full range of housing densities that include the Wildland Urban Interface (WUI) zones (e.g. DINS dataset), and with narrative explanations of how the dataset is sufficiently robust and comprehensive, including the most current data available to the modeling organization. This guideline applies separately to **personal residential property** losses and, to the extent data are available, to **commercial residential property** losses. Personal residential property wildfire loss experience may be used to replicate commercial losses for the habitational structure-only and contents-only portion of the wildfire losses. The replications shall be produced on an objective body of wildfire loss data by eco-region and/or other relevant, justified spatial areas.*

Guideline S-6. Comparison of Projected Wildfire Loss Costs

The difference due to uncertainty between historical and modeled annual average statewide wildfire loss costs shall be statistically plausible, explainable, and justifiable using scientific literature and statistical methods that are consistent with the body of data and established statistical expectations and norms.

Statistical Disclosures For Wildfire Catastrophe Models

Disclosure S-1 Modeled Results and Goodness-of-Fit

1. Identify the framework that governs the spatiotemporal statistical modeling approach used for the wildfire loss estimates and the overall model outputs including the inference and diagnostic methods, and reasoning for computation of posteriors.
2. Identify details of the statistical methods used for data analysis, including: characterizing any correlations or statistical dependence between the relevant model inputs at each stage or sub-model (e.g. by providing linear or nonlinear correlation coefficients, or joint probability distributions of the relevant parameters that goes into, for example, the wildfire hazard model, the vulnerability model(s), the actuarial and financial model(s)); and documenting the effects or influence of the inputs on those model's output(s) and on the overall inferred outcomes (e.g. if applicable, conducting feature importance or similar analysis).
3. Describe the name, type, and purpose of the tests performed to validate the generated loss outputs/ results of the wildfire catastrophe model. Additionally, elaborate on the details of the test statistics such as degrees-of-freedom, confidence statement, level of significance, and power of the test.
4. Provide the dates and location of wildfire loss of the insurance and wildfire claims data used for

validation and verification of the wildfire actuarial and financial model.

5. Provide an assessment of uncertainty in wildfire **probable maximum loss** levels and **wildfire loss costs** for wildfire output ranges at the appropriate spatiotemporal scales using confidence intervals or other scientific characterizations of uncertainty.
 - Characterize the selected error metrics (e.g., if applicable, RMSE, L-Infinity, MAE) between the modeled wildfire losses and the observed or known wildfire losses for different scales of aggregations through space and time.
6. Justify any differences between the historical and modeled loss outputs/results by demonstrating statistical agreement using current scientific and statistical methods relevant to the academic disciplines associated with the various wildfire catastrophe model components or modules.
7. Provide graphical comparisons of modeled and historical data and goodness-of-fit tests for the wildfire hazard model, the vulnerability model(s), the actuarial/financial model(s), and the overall wildfire catastrophe model. (Examples to include are fire occurrence frequencies, area burned, and physical damages.) The following items may be included:
 - For final model outputs: Difference between individual incurred historical losses and modeled losses at different spatial and temporal aggregation levels.
 - For fire models, if variables and outputs exist in the modeling pipeline, the following may be used, for example:
 - Difference between observed and modeled area burned at different spatial and temporal scales.
 - Difference between observed and modeled number of habitational structures damaged (found in the burnt area) at different spatial scales.
 - Difference between reported and modeled fire arrival times at different spatial scales.

Disclosure S-2 Sensitivity Analysis for Wildfire Catastrophe Model Output

1. Identify the most sensitive aspect of the wildfire hazard model, the vulnerability model(s), the actuarial/financial model(s), and the overall wildfire catastrophe model and the basis for making this determination.
2. Identify the full range of available parameters and input variables for the wildfire catastrophe model and justify within the context of such a range being realistic and plausible based on scientific and academic research, including deviation from historical antecedents due to climate change as supported by scientific principles and methodology.

3. Identify the aspect or parameter of the wildfire catastrophe model with the greatest contribution to the outputs under full range of model runs and the basis for making this determination, as well as other input variables that impact the magnitude of the output when varied simultaneously. Describe the degree to which these sensitivities affect output results and provide illustrative examples.
4. Describe how other aspects of the wildfire catastrophe model may have a significant impact on the sensitivities in output results and the basis for making this determination.

Disclosure S-3 Uncertainty Analysis for Wildfire Catastrophe Model Output

1. Identify the major contributors to the uncertainty in wildfire catastrophe model outputs, the basis for making this determination, and the quantification for each of those major contributors. Provide a full discussion of the type and direction (forward propagation, inverse propagation) of the uncertainties and the degree to which they affect output results and illustrate with relevant examples.
2. Describe how other aspects of the wildfire catastrophe model or their combined effects may have a significant impact on the uncertainties in modeled loss outputs and loss results and the basis for making this determination. In case of a multicomponent catastrophe model, provide characterization of uncertainty for each component or module (*e.g.* hazard module, vulnerability module, and the actuarial/financial module), and describe the input and output uncertainties once all components are connected.
3. Describe and justify any action or inaction as a result of the uncertainty analyses performed.

Disclosure S-4 Aggregation & Convolution Levels

1. Describe and justify the sampling, aggregation plan, and the adopted spatiotemporal resolution used to obtain the average annual wildfire loss costs and wildfire loss output ranges. For example, for a Monte Carlo simulation, indicate steps taken to determine sample size. For an importance sampling design or other sampling scheme, describe the underpinnings of the design and how it achieves the required performance.
2. Document and describe the influence of the sampling and aggregation methods used in the sensitivity analysis section.
3. Describe and justify any action or inaction as a result of the sampling analyses performed.

Disclosure S-5 Replication of Known Wildfire Losses

1. Describe the nature and results of the analyses performed to validate the wildfire loss projections generated separately for personal and commercial residential property wildfire losses. Include analyses for the 2018, 2020, and 2021 wildfire seasons and sample population that represents the diversity of the observed event types and losses, including representative of the various eco-

regions or other relevant wildfire-specific spatial areas, to the extent data are available.

Disclosure S-6 Comparison of Projected Wildfire Loss Costs

1. Describe the name, purpose, results and details of the statistics of the tests performed to validate the expected wildfire loss projections generated. If a set of simulated wildfires or simulation trials was used to determine these wildfire loss projections, specify the convergence tests that were used and the results. Specify the number of wildfires or trials that were used.
2. Identify and justify differences, if any, in how the wildfire catastrophe model produces wildfire loss costs for specific historical events versus wildfire loss costs for events in the wildfire stochastic events set.

Vulnerability Guidelines For Wildfire Catastrophe Models

Purpose: The purpose of the guidelines under this section are to ensure that the data and **models** used to estimate **vulnerability** for **personal** and **commercial residential buildings** are developed and documented appropriately and support the downstream impact on modeled losses (**average annual losses** and **probable maximum loss** levels) including from the treatment of uncertainties. This includes ensuring that appropriate methodology and relevant factors (including, but not limited to, building design, features, and materials; wildfire-related building codes; building elements; and characteristics and separation from other surrounding habitational structures and secondary and appurtenant structures) are incorporated into building wildfire **vulnerability functions** (Wildfire Vulnerability Guideline-1, abbreviated below as V-1). It also includes ensuring that wildfire vulnerability functions and estimated damages are appropriately affected by habitational building contents characteristics in relation to characteristics of the wildfire and relevant habitational building structure(s) (V-2), and that the time element of wildfire vulnerability functions is appropriately developed, informed by historical damage assessment, claims, and economic data, and documented (V-3), in addition consideration of the potential impacts of smoke if it is explicitly modeled. These vulnerability guidelines are developed to ensure that the relative influence of wildfire mitigation measures; defensible space and any other potential hazards surrounding the habitational structure that are associated with wildfire structure damage; other secondary characteristics of the **habitational structure/building**, on the probability of habitational structure damage are appropriately accounted for within the vulnerability model, to the extent not already accounted for in the hazard module or other components of the catastrophe model; and at a minimum, the fire mitigation actions associated with the **Safer from Wildfire Framework** must be incorporated in a manner that reasonably reflects analyses using empirical data (V-4).

Guideline V-1. Derivation of Habitational Building Wildfire Vulnerability Functions

Development of the habitational building wildfire vulnerability functions shall be based on evidence found in the scientific literature quantifying the relative importance of different factors associated with structure damage, and at least two or more of the following: (1) insurance claims data, (2) laboratory or field testing, (3) fire dynamics and/or structural modeling and analysis based on experimental and/or empirical research, and (4) post- event site investigations. Any development of the habitational building wildfire vulnerability functions based on structural analysis using experimental and/or empirical research, post-event site investigations, and laboratory or field testing shall be supported by empirical data such as CAL FIRE's Damage Inspection Program (DINS) dataset.

The derivation of the habitational building wildfire vulnerability functions and the treatment of associated uncertainties shall be developed following methods accepted in the scientific literature with appropriate references and justification for the approach taken. Results from the vulnerability functions should be consistent with evidence found in the scientific literature quantifying the relative importance of different factors associated with structure damage.

Habitational building stock classification shall be representative of California construction for personal and commercial residential buildings. To the extent not already accounted for in the hazard module or other components of the catastrophe model, treatment of structure density and separation shall be described and justified.

The derivation and application of wildfire vulnerability functions should account for the relevant

habitational building design, features, and materials; wildfire-related building codes; structural/building elements; and the primary characteristics of and separation from other surrounding habitational buildings and secondary and appurtenant structures, including but not limited to those listed in V-4 below such as: roof type, siding material, vent screens, eaves, windows panes and construction materials, neighboring sheds/outbuilding, flammable decks, and fences. However, to the extent a feature or element is incorporated and considered as part of the primary characteristics of the building/structure when developing the wildfire vulnerability function(s), it should not be cumulatively considered in developing the portion(s) of those vulnerability function(s) that account for wildfire mitigation measures pursuant to V-4 below. If information on building elements is unavailable, year of construction may also be considered as a proxy for building materials and structural elements to the extent supported by empirical data.

Wildfire vulnerability functions shall be separately derived for commercial residential building structures (including the impact from appurtenant structures), personal residential building structures (including the impact from appurtenant structures), and manufactured homes (including mobile homes), as well as differentiating among different building occupancies.

Building wildfire vulnerability functions shall include damage as attributable to ember exposure, radiant heat exposure, direct flame contact and relevant residence time element. The weighting of each should reflect the relative likelihood of each causing structure ignition, based on empirical and historical data in similar ecoregions of California. For example, in most cases, embers are the most common source of structure ignition, followed by radiant heat and direct flame contact.

Guideline V-2. Derivation of Building Contents Wildfire Vulnerability Functions: loss and smoke

Development of the wildfire vulnerability functions for the contents insured within buildings shall be based on data and factors from at least two or more of the following: (1) insurance claims data, (2) laboratory or field testing, (3) fire dynamics and/or structural modeling and analysis based on experimental and/or empirical research, and (4) post- event site investigations.

The relationship between the building and building content wildfire vulnerability functions shall be consistent with, and supported by, the relationship between the occupancy and structure types and the observed historical data. Consideration of the potential impacts of smoke damage may also be included within the building contents vulnerability functions or as separate vulnerability functions if it is explicitly modeled.

Guideline V-3. Derivation of Time Element Wildfire Vulnerability Functions

Development of the time element wildfire vulnerability functions shall be based on the scientific literature, fire dynamics and/or structural modeling and analysis based on experimental and/or empirical research, and supported by at least one of the following: (1) insurance claims data, (2) post-event site investigations and, (3) if justified, relevant economic data and factors such as demand surge. Any development of the time element wildfire vulnerability functions based on post- event site investigations, and fire dynamics and/or structural modeling and analysis based on experimental and/or empirical research, shall be further supported by historical data.

Calculations for the Time Element Wildfire Vulnerability Functions should be based on appropriate and relevant spatiotemporal data with relevant resolutions according to peer-reviewed scientific literature, valid claims data, or other appropriate data sources.

The relationship between the building wildfire vulnerability functions and time element wildfire vulnerability functions shall be consistent with, and supported by, the relationship observed in historical data and relevant insurance claims data as applicable to personal and commercial property residential buildings, including as related to additional living expenses (housing, food, and transportation) and other relevant business interruption losses.

Time element wildfire vulnerability function derivations shall consider the estimated time required to repair or replace the habitational structure/building.

Time element wildfire vulnerability functions shall include time element wildfire losses associated with damage to the infrastructure caused by a wildfire.

Guideline V-4. Wildfire Mitigation Measures and Buildings' Secondary Characteristics

To the extent not already accounted for in the hazard module or other components of the catastrophe model, modeling of wildfire mitigation measures used to improve a building's wildfire resistance, the corresponding effects on wildfire vulnerability, and associated uncertainties shall be theoretically sound and consistent with evidence found in the scientific literature -- including structural modeling, experimental research and/or empirical research- -quantifying the relative importance of different factors associated with structure damage as well as fire dynamics. These measures shall include wildfire-specific construction techniques and mitigation measures that affect the performance of the building and the damage to contents.

The modeling of specific mitigation measures should be multivariate and account for unique combinations of factors characteristic of different properties in different ecoregions, including without limitation, relevant property-level and surrounding vegetation both within and beyond defensible space zones that have been documented as significantly associated with structure damage and destruction; and wildfire-relevant primary and secondary characteristics of buildings and surrounding structures, including but not limited to those listed in below. For example, some structures do not have eaves and some properties have minimal land for creating defensible space. Examples of wildfire mitigation measures to account for shall include at least those referenced by the Safer form Wildfires framework and in CCR 2644.9 (d)(1)(A) and (d)(1)(B), but are not limited to those if justified. However, to the extent a feature or element is incorporated and considered as part of the primary characteristics of the building/structure when developing the wildfire vulnerability function(s) pursuant to V-1 above, it should not be cumulatively considered in developing the portion(s) of those vulnerability function(s) that account for wildfire mitigation measures.

The relative ranking and modeled effect of different parcel-level and neighborhood-level mitigation measures should reflect the best available science and should account for nonlinear relationships and interactions with other environmental factors that influence vulnerability, such as slope, topographic position, neighborhood characteristics (like building density, land use, and proximity and continuity), and to the extent incorporated into the vulnerability analysis, moisture content of immediate and surrounding vegetation.

The modeling organization shall justify all wildfire mitigation measures and other secondary characteristics of buildings considered by the wildfire catastrophe model. Application of wildfire mitigation measures that affect the performance of the building and the damage to contents shall be justified as to the impact on reducing damage whether done individually or in combination. Treatment of

individual and combined secondary characteristics of buildings that affect the performance of the building and the damage to contents shall be justified.

Vulnerability Disclosures For Wildfire Catastrophe Models

Disclosure V-1 Derivation of Habitational Building Wildfire Vulnerability Functions

- 1. The following disclosure is not applicable to the first time the modeling organization submits their catastrophe model for review:** Describe any modifications to any of the building vulnerability components of the model since the last version previously submitted.
- 2. The following disclosure is only applicable if the wildfire catastrophe model has been used for determination of the projected aggregate losses in a prior rate filing, and previously provided responses to these guidelines and disclosures:** Describe any new insurance company wildfire claims datasets, including catastrophe claims, or other relevant data sources reviewed since the last model version previously submitted. For each new wildfire claims dataset and new data source, indicate if they have been incorporated into the newly submitted model version.
3. Provide a flowchart documenting the process by which the wildfire vulnerability functions for habitational buildings for personal and commercial residential properties are derived and implemented.
4. Describe the nature, source, and extent of any wildfire claims data used to develop the personal and commercial residential building wildfire vulnerability functions, including, as applicable, summarizing laboratory or field testing and post-event site investigations; provide a brief description of the resulting use of these data in the validation of the wildfire vulnerability functions. Describe in detail the breakdown of data into number of policies, number of insurers, dates of wildfire loss, amount of wildfire loss, number of exposures, and amount of dollar exposure, including treatment of incomplete and missing values; separated into personal residential building structures, commercial residential building structures, and manufactured homes. If the end-user's wildfire claims data can be used in the development of the vulnerability functions or if the end-user can make adjustments to property value or insurance-to-value (ITV) assumptions to the base claims data, identify and justify the range of possible adjustment to the base claims data, including insurance-to-value (ITV) assumptions, assumptions made due to incomplete wildfire claims data, and adjustments for depreciation. Justification for all actual adjustments made for modeling losses for a specific rate filing will need to be submitted with such filing, including a comparison of how those actual adjustments fall within the range of possible adjustments.
5. Describe the assumptions, data other than end-user's wildfire claims data (including Cal Fire damage inspection or insurance industry claims data), methods (e.g. statistical modeling using historical data, and fire dynamics and/or structural modeling and analysis based on experimental and/or empirical research), and processes, and justifications for such, used for the development of the building wildfire vulnerability functions and cite the scientific literature supporting the chosen methodology and assumptions. Discussions of assumptions shall include, without limitation, those related to creation of baseline average property values or other property value

indices.

6. Describe the sources, quantification, and treatment of uncertainties associated with the building wildfire vulnerability functions.
7. Describe the categories of the different building wildfire vulnerability functions for personal and commercial residential buildings. Specifically, for every unique building wildfire vulnerability function, include descriptions and consideration in the development of: the building types, building construction elements (including, as applicable, statewide and county wildfire-related building codes and enforcement) and primary building characteristics; structure separation and density, ecoregions or other justified, relevant delineation of distinctive fire regimes within the state of California; year of construction; and occupancy types. Describe and justify assumptions made based on year of construction alone or together with other factors. Provide the total number of building wildfire vulnerability functions available for use in the catastrophe model for personal and commercial residential classifications.
8. Describe the process by which local and statewide fire-fighting practices, or other active fire-suppression strategies are considered in the development of vulnerability functions, if applicable. If any of these factors are also considered in the hazard modeling, describe the process by which their effects are apportioned between hazard and vulnerability analysis.
9. Describe the relationship between wildfire vulnerability functions for habitational buildings/structures and secondary and appurtenant structures, and their consistency with insurance company wildfire claims data, including description and justification for any assumptions regarding the characteristics and treatment of secondary and appurtenant structures.
10. Describe the assumptions, data (including both industry and end-user's insurance wildfire claims data), methods, and processes used to develop building wildfire vulnerability functions when:
 - A. residential construction types are unknown.
 - B. one or more primary building characteristics are unknown, but one or more wildfire-relevant or secondary characteristics of buildings are known.
 - C. one or more wildfire-relevant or secondary characteristics of buildings are unknown.
 - D. building input characteristics are conflicting.
11. Identify the direct flame contact, radiant heat exposure, ember exposure or deposition rate, and relevant residence time (e.g., the duration of direct flame contact, radiant heat exposure, and ember exposure) at which the wildfire model begins to estimate damage; if different wildfire behavior-related factor(s) are used to estimate when damage begins (for example, flame height, fire intensity), or if functions are instead based on statistical analysis of historical loss data, describe and provide justification.
12. Describe the threshold of damage (e.g. percentage of damage) at or above which the wildfire catastrophe model assumes a total building loss.

Disclosure V-2 Derivation of Building Contents Wildfire Vulnerability Functions:

loss and smoke

1. **The following disclosure is only applicable if the wildfire catastrophe model has been used for determination of the projected aggregate losses in a prior rate filing, and previously provided responses to these guidelines and disclosures:** Describe any modifications to the content vulnerability component of the model since the last version previously submitted.
2. Provide a flowchart documenting the process by which the contents wildfire vulnerability functions are derived and implemented.
3. Describe the assumptions, data, methods, and processes used to develop and validate the contents wildfire vulnerability functions. Describe and justify assumptions made based on occupancy alone or together with other factors citing scientific literature supporting the chosen methodology and assumptions.
4. Provide the total number of contents wildfire vulnerability functions. Describe whether different and multiple contents wildfire vulnerability functions are used for personal residential building structures, commercial residential building structures, and manufactured homes and the basis for such, including without limitation as applicable, unit location for condo owners, multiplexes, and apartment renters and differentiation between various habitational building and unit classes. Describe as well whether building occupancies are accounted within each such content vulnerability functions.
5. If smoke damage is explicitly modeled, describe the assumptions, data, methods, and processes used to develop and validate the contents smoke-related vulnerability functions and their relationship to the structure and contents wildfire vulnerability functions; if smoke damage is not explicitly modeled, describe the treatment of smoke damage within all of the wildfire vulnerability functions for contents, including with respect to different habitational building and unit classes.
6. Describe the sources, quantification, and treatment of uncertainties associated with the contents' wildfire vulnerability functions.

Disclosure V-3 Derivation of Time Element Wildfire Vulnerability Functions

1. **The following disclosure is only applicable if the wildfire catastrophe model has been used for determination of the projected aggregate losses in a prior rate filing, and previously provided responses to these guidelines and disclosures:** Describe any modifications to the time element vulnerability component of the wildfire catastrophe model since the last version previously submitted.
2. Provide a flowchart documenting the process by which the time element wildfire vulnerability functions are derived and implemented.
3. Describe and justify the assumptions, data, methods, and processes used to develop and validate the time element wildfire vulnerability functions, including time to repair or replace damaged habitational structures and treatment of relevant spatiotemporal data and selection of resolution,

citing scientific literature supporting the chosen methodology and assumptions.

4. Describe how time element wildfire vulnerability functions take into consideration the damage to local and regional infrastructure.
5. Describe the relationship between the different building classes and time element wildfire vulnerability functions.
7. Describe the sources, quantification, and treatment of uncertainties associated with the time element wildfire vulnerability functions.

Disclosure V-4 Wildfire Mitigation Measures and Buildings' Secondary Characteristics

1. **The following disclosure is only applicable if the wildfire catastrophe model has been used for determination of the projected aggregate losses in a prior rate filing, and previously provided responses to these guidelines and disclosures:** Describe any modifications to the treatment of wildfire mitigation measures and secondary characteristics of buildings as described in Vulnerability Guidelines V-4 in the wildfire catastrophe model since the last version previously submitted.
2. Describe the procedures used to calculate the impact of wildfire mitigation measures and secondary characteristics of buildings, including statistical or simulation software, its identification, and current version, and code or scripts if applicable. Describe whether or not such procedures have been modified since the last version previously submitted.
3. Describe how different landscaping features (e.g., defensible space) related to wildfire mitigation measures on the property are considered in the development of the wildfire vulnerability functions and how their treatment compares to other factors in the model. Explain which characteristics of landscaping functions are considered. If any of these factors are also considered in the hazard modeling, describe the process by which their effects are apportioned between hazard and vulnerability analysis.
4. Provide a description of the wildfire mitigation measures and secondary characteristics of buildings used by the vulnerability model.
5. Describe how wildfire mitigation measures and secondary characteristics of buildings are implemented in the vulnerability model. Identify any assumptions.
6. Describe how the effects of multiple wildfire mitigation measures (different building elements, materials, defensible space, and immediate and surrounding vegetation up to 100 feet) and secondary characteristics of buildings are combined in the model and the process used to ensure that multiple wildfire mitigation measures and secondary characteristics of buildings are correctly combined.
7. Describe how building and contents damage are affected by performance of wildfire mitigation measures and secondary characteristics of buildings. Identify any assumptions.

8. Describe how Wildfire mitigation measures and secondary characteristics of buildings affect the uncertainty of the vulnerability. Identify any assumptions

Actuarial Guidelines For Wildfire Catastrophe Models

Purpose: The purpose of the guidelines under this section are to ensure: that the treatment of historical loss data used to calibrate the wildfire catastrophe model and of input data originating from the **end-user** (e.g. insurers) is used throughout the model appropriately and any adjustments or assumptions are explained (A-1); that the losses represent only losses incurred as a result of wildfire (A-2); that the treatment of insurance coverage is based upon generally accepted actuarial methods (A-3); that **wildfire loss costs** and wildfire **probable maximum losses** are appropriately calculated and incorporate appropriate adjustments (A-4); that the model treatment of policy conditions is based upon generally accepted actuarial methods (A-5); and that modeled wildfire loss costs vary logically according to risk and data (A-6).

Guideline A-1. Loss Data and End-User Input Data

*The modeling organization's use of historical insurance claims data and other post-disaster loss data, including treatment of missing values, to define **catastrophe losses** and to calibrate modeled wildfire losses shall be based upon generally accepted actuarial, underwriting, and statistical procedures.*

All modifications, adjustments, assumptions, end-user inputs and end-user input file identification, and defaults necessary for the end-user to use the wildfire catastrophe model shall be documented and shall be included with the wildfire catastrophe model output report. Treatment of missing values or other edits, inclusions, or deletions for end-user inputs required to run the wildfire catastrophe model shall be documented and described with the output report. All such modifications, adjustments, and assumptions shall additionally be based upon generally accepted actuarial, underwriting, and statistical procedures, and justified in a memorandum.

Guideline A-2. Wildfire Events Resulting in Modeled Wildfire Losses

Modeled wildfire loss costs and wildfire probable maximum loss levels shall reflect all insured damages from wildfires.

The modeling organization shall have a documented definition of wildfire and wildfire-related losses, and specify what other types of loss, if any, are considered and included in the modeled wildfire catastrophe losses and modeled wildfire loss costs, including but not limited to losses from smoke, landslide, debris flow, water damage from the fire suppression, and tree damage.

Guideline A-3. Wildfire Coverages

*The methods used in the calculation of **habitational building** wildfire loss costs, including the effect of law and ordinance coverage, shall be based upon generally accepted actuarial methods.*

The methods used in the calculation of commercial building wildfire loss costs shall be based upon generally accepted actuarial methods

The methods used in the calculation of appurtenant structure wildfire loss costs shall be based upon generally accepted actuarial methods.

The methods used in the calculation of contents wildfire loss costs shall be based upon generally accepted actuarial methods.

The methods used in the calculation of time element wildfire loss costs shall be based upon generally accepted actuarial methods.

Guideline A-4. Modeled Wildfire Loss Cost and Wildfire Probable Maximum Loss Level Considerations

Wildfire loss cost projections and wildfire probable maximum loss levels shall not include expenses, risk load, investment income, premium reserves, taxes, assessments, profit margin, or any other type of loading.

Wildfire loss cost projections and wildfire probable maximum loss levels shall be capable of being calculated from exposures at the model's finest level of resolution (such as geocode or latitude-longitude level of resolution). The spatial resolution shall be defined and documented by the modeling organization.

***Demand surge** and/or post loss amplification shall be included in the wildfire model's calculation of wildfire loss costs and wildfire probable maximum loss levels using relevant data, generally accepted actuarial and economic methods, and reasonable assumptions.*

Guideline A-5. Wildfire Policy Conditions

Generally accepted actuarial methods shall be used in the development of mathematical distributions to reflect the effects of deductibles and policy limits.

The relationship among the modeled deductible wildfire loss costs shall be reasonable.

Guideline A-6. Wildfire Loss Outputs and Logical Relationships to Risk

For each of the logical relationships listed below, the methods and assumptions used in the estimation of wildfire loss costs and wildfire probable maximum loss levels in relation to those variations shall be based upon generally accepted actuarial methods and generally accepted practices covered by one or more of the Guidelines in other sections of this guidance.

- A. Unless justified by (1) scientific literature, (2) laboratory or field testing, (3) fire dynamics and/or structural modeling and analysis based on experimental and/or empirical research, and/or (4) post-event site investigations and historical data, wildfire loss costs shall exhibit a logical relation to risk, varying in an appropriate and proportionate manner in relation to changes in the risk factors, such that wildfire loss costs shall not exhibit a significant change when the underlying risk does not change significantly and likewise only exhibiting a significant change when there is justification for a significant change in the assessment of the underlying risk.*
- B. Wildfire loss costs produced by the wildfire model, or changes in wildfire loss costs due to increase in localized risk, shall be positive and non-zero for all valid and impacted localized areas (appropriate geospatial area), and shall not be negative for all other non-impacted California areas. Impacted zones or localized areas should be defined or delineated.*
- C. Wildfire loss costs cannot increase as the quality of construction type, materials, and workmanship increases, all other factors held constant.*
- D. Wildfire loss costs cannot increase as the presence of fixtures or construction techniques designed*

for hazard mitigation increases, all other factors held constant.

- E. *Wildfire loss costs cannot increase as both the presence of individual structure and property-level mitigation and/or the presence of community hazard mitigation measures increases (if considered by the model), all other factors held constant.*
- F. *Wildfire loss costs cannot increase as the fire-resistant design provisions and materials increase, all other factors held constant.*
- G. *Wildfire loss costs cannot increase as the amount of structure separation increases within the defensible space and the extent of mitigation actions within the defensible space increases, all other factors held constant.*
- H. *Wildfire loss costs cannot increase as wildfire-related building code enforcement increases (e.g., Chapter 7-A of the California Building Code and any further modifications and NFPA-1144), all other factors held constant.*
- I. *Wildfire loss costs shall decrease as deductibles increase, all other factors held constant.*
- J. *The relationship of wildfire loss costs for individual coverages (e.g., habitational building, appurtenant structure, contents, and time element) shall be consistent with the coverages provided.*
- K. *Wildfire output ranges shall be logical for the type of risk being modeled and apparent deviations shall be justified.*
- L. *For wildfire loss cost and wildfire probable maximum loss level estimates derived from and validated with historical insured wildfire losses, the assumptions in the derivations concerning (1) construction characteristics, (2) policy provisions, (3) coinsurance, and (4) contractual provisions, shall be appropriate based on the type of risk being modeled.*

Actuarial Disclosures For Wildfire Catastrophe Models

Disclosure A-1. Loss Data and End-User Input Data

1. Describe the data, methods and assumptions used to calibrate modeled wildfire losses based on historical insurance claims or other post-disaster loss data, including how wildfire catastrophe losses were defined, ascertained, and apportioned from such claims or post-disaster loss data.
2. Detail and justify how insurance-to-value (ITV) assumptions to end-user's input data and exposures that are being modeled regarding property values, depreciation, and actual cash value impact the resulting modeled wildfire damage and loss. Provide example calculations showing the impact of varying ITV assumptions (e.g., 100% vs. 80%). This disclosure and justification are in addition to and distinct from the disclosure in Vulnerability Disclosures, V-1(4).
3. Detail what policy form types (residential such as homeowners, dwelling property, manufactured

homes, tenants, and condo unit owners; habitational commercial such as building and personal property, condominium association, and business income) are supported by the model.

4. Detail what deductible options (e.g., percentage, dollar) are supported and how deductibles and coverage limits are used by the catastrophe model. Provide example calculations for each type of deductible showing the interaction between damage, deductible, limits, and insured loss.
5. Provide a copy of the end-user input form(s) used by the wildfire catastrophe model with the options available for selection by the end-user for the California wildfire catastrophe model under review. Describe the process followed by the end-user to generate the output(s) produced from the input form. Include the wildfire catastrophe model name, version identification, and platform identification on the input form. All items included in the input form should be clearly labeled and defined.
6. Disclose the specific inputs required to use the wildfire catastrophe model. Provide an example of the wildfire catastrophe model output report including the wildfire catastrophe model name, version identification, and platform identification. All items included in the output report should be clearly labeled, highlighted, and defined.
7. Provide a list of all options available (including, but not limited to, demand surge and vulnerability functions) to the end-user.
8. Describe actions performed to ensure the validity of the end-user or other input data used for wildfire catastrophe model inputs or for validation/verification.
9. Disclose if and how changing the order of the wildfire catastrophe model input exposure data produces different modeled output or results.
10. Disclose if removing or adding policies from the wildfire catastrophe model input file affects the modeled output or results for the remaining policies.

Disclosure A-2. Wildfire Events Resulting in Modeled Wildfire Losses

1. Disclose the definition or parameters/distinctions used to categorize wildfire losses as catastrophic or to segregate wildfire losses from other fire-related losses, including with respect to partial losses.
2. Describe how damage from wildfire model generated fires is excluded or included in the calculation of wildfire loss costs and wildfire probable maximum loss levels for California, including the treatment of wildfires originating outside California that spread across state lines including through urban conflagration.
3. Identify any and all components of wildfire-related damage (including without limitation fire, smoke, landslide, debris flow, water damage from fire suppression, and tree damage) and describe how each such component is treated in the calculation of wildfire loss costs and wildfire probable maximum loss levels for California.

Disclosure A-3. Wildfire Coverages

1. Describe the methods used in the wildfire catastrophe model to calculate wildfire loss costs for habitational building coverage associated with personal and commercial residential properties.
2. Describe the methods used in the wildfire catastrophe model to calculate wildfire loss costs for appurtenant structure coverage associated with personal and commercial residential properties.
3. Describe the methods used in the wildfire catastrophe model to calculate wildfire loss costs for contents coverage associated with personal and commercial residential properties.
4. Describe the methods used in the wildfire catastrophe model to calculate wildfire loss costs for time element coverage associated with personal and commercial residential properties.
5. Describe the methods used in the wildfire catastrophe model to account for law and ordinance coverage associated with personal residential properties and, as applicable, commercial residential properties.

Disclosure A-4. Modeled Wildfire Loss Cost and Wildfire Probable Maximum Loss Level Considerations

1. Describe the method(s) used to estimate wildfire loss costs and wildfire probable maximum loss levels and the treatment of associated uncertainties. Identify any source documents used and any relevant research results.
2. Identify all possible resolutions available for the reported wildfire loss output ranges. Identify the finest level of resolution (i.e., the most granular level) for which wildfire loss costs and wildfire probable maximum loss levels can be provided.
3. Describe how the wildfire catastrophe model incorporates demand surge and/or post-loss amplification in the calculation of wildfire loss costs and wildfire probable maximum loss levels and provide ratios of wildfire loss costs and wildfire probable maximum loss with and without demand surge and with/without each other post loss amplification mechanisms. Provide the range of demand surge used.
4. Provide citations to published papers, if any, or modeling-organization studies that were used to develop how the wildfire catastrophe model estimates demand surge and/or post-loss amplification.
5. Describe how and to what degree wildfire loss costs and wildfire probable maximum loss levels have been validated (e.g., comparisons to past insurance experience, independent reviews, and studies).

Disclosure A-5. Wildfire Policy Conditions

1. Describe the methods used in the wildfire catastrophe model to treat deductibles (both flat and percentage), policy limits, and insurance-to-value criteria when projecting wildfire loss costs and wildfire probable maximum loss levels. Discuss data or documentation used to validate the method used by the wildfire catastrophe model.

2. Describe if and how the wildfire catastrophe model treats policy exclusions and loss settlement provisions.
3. Describe if and how the wildfire catastrophe model treats hours clauses.

Disclosure A-6. Wildfire Loss Outputs and Logical Relationships to Risk

1. **The following disclosure is only applicable if the wildfire catastrophe model has been used for determination of the projected aggregate losses in a prior rate filing, and previously provided responses to these guidelines and disclosures:** Describe and detail modifications to the financial module/component of the wildfire catastrophe model since the last version previously submitted.
2. Detail how impacted zones, eco-regions, or wildfire-specific spatial areas impacted by wildfires are delineated geographically.
3. Describe the calculation of uncertainty intervals.
4. Describe how the wildfire catastrophe model produces wildfire probable maximum loss levels.
5. Provide citations to published scientific and technical literature, if any, or modeling-organization studies, that were used to estimate wildfire probable maximum loss levels.
6. Describe how the wildfire probable maximum loss levels produced by the wildfire catastrophe model include the effects of personal and commercial residential property insurance coverage.
7. Provide an explanation for all Wildfire loss costs that are not consistent with the requirements of this guideline.
8. **The following disclosure is only applicable if the wildfire catastrophe model has been used for determination of the projected aggregate losses in a prior rate filing, and previously provided responses to these guidelines and disclosures:** Provide an explanation of the differences in wildfire loss output ranges between a previously submitted wildfire catastrophe model and the wildfire catastrophe model under current review.
9. Identify the assumptions used to account for the effects of coinsurance on commercial residential property wildfire loss costs.

Computational Information Guidelines For Wildfire Catastrophe Models

Purpose: The purpose of the guidelines under this section are to ensure that: the wildfire catastrophe model is appropriately and comprehensively documented along with the sources for input data and third-party databases and models (CI-1), that the executable model components and services had thorough specification of requirements (CI-2), was designed according to those requirements (CI-3), and is implemented based upon those requirements (CI-4). The guidelines of this section are also to ensure that the model was appropriately verified through verification tests (CI-5), that the interfaces for the model are state of the art and useable with no ambiguity for the user (CI-6), and that there is a formal procedure for identifying, organizing, and maintaining model versions (C-7). Finally, this section also includes guidelines to ensure that the wildfire catastrophe model is secured against unauthorized access, that any data associated with the model or its inputs are secure and cannot be accessed without authorization, is protected against viruses, and is backed up and redundant (C-8).

Guideline CI-1. Wildfire Catastrophe Model Documentation

Wildfire catastrophe model functionality and technical descriptions shall be documented formally in an archival format separate from the use of correspondence including emails, presentation materials, and unformatted text files. The documentation should include the constraints of the use of the model (i.e., how not to use it) and the proper scope of its use situationally, temporally and spatially.

A primary document repository shall be maintained, containing or referencing a complete set of documentation specifying the wildfire catastrophe model architecture, detailed model description, scientific basis with references, and functionality within its implementation. Documentation shall be indicative of current model development and software engineering practices.

All computer software (i.e., user interface, scientific, engineering, actuarial, data preparation, and validation) relevant to the wildfire catastrophe model shall be consistently documented and dated with versions.

The following shall be maintained: (1) a table describing all changes in the wildfire catastrophe model from the previously reviewed wildfire catastrophe model to the initial submission this year, and (2) a table of all substantive changes since this year's initial submission.

Documentation shall be created separately from the source code.

A list of all externally procured or licensed, currently used, wildfire modelling-specific software and data assets shall be maintained. The list shall include (1) asset name, (2) asset version number, (3) asset acquisition date, (4) asset acquisition source, (5) asset acquisition mode (e.g., lease, purchase, open source), and (6) length of time asset has been in use by the modeling organization.

Guideline CI-2. Wildfire Catastrophe Model Requirements

A complete set of requirements for each executable model component and services, as well as for each database or data file accessed by a component, shall be maintained. Requirements shall be updated whenever changes are made to the wildfire catastrophe model.

Guideline CI-3. Wildfire Catastrophe Model Organization and Component Design

The following shall be maintained and documented: (1) detailed control, benchmark and data flowcharts and interface specifications for each software component, (2) schema definitions and vocabulary (e.g.,

data dictionaries) for each database and data file, (3) flowcharts and scientific workflows illustrating model-related flow of information and its processing by modeling organization personnel or consultants, (4) network connectivity and organization, microservices and computing environment, and (5) system model representations associated with (1)-(4) above. Documentation shall be focused on transparency and communication of all components that contribute to the wildfire catastrophe model output.

All flowcharts (e.g., software, data, and system models) in the submission or in other relevant documentation shall be based on (1) a referenced industry guideline (e.g., UML, BPMN, SysML), or (2) a comparable internally-developed guideline which is separately documented.

Guideline CI-4. Wildfire Catastrophe Model Implementation

A complete procedure of coding guidelines consistent with accepted software engineering practices shall be maintained.

Network connectivity and organization, microservices and computing environment documentation shall be maintained.

A complete procedure used in creating, deriving, ingesting or procuring and verifying databases or data files accessed by components shall be maintained.

Provenance of all components shall be traceable, through explicit component identification in the wildfire catastrophe model representations (e.g., flowcharts) including and specific implementation approaches for including physical environment.

A table of all software components actively contributing to wildfire loss costs and wildfire probable maximum loss levels shall be maintained with the following table columns: (1) component name, (2) pseudocode and number of lines of code, minus blank and comment lines, and (3) number of explanatory comment lines.

Each component shall be consistently commented at a quality level for a software engineer unfamiliar with the code to be able to comprehend the component logic at a reasonable level of abstraction.

The following is not applicable to the first time the modeling organization submits their catastrophe model for review: *The following documentation shall be maintained for all components or data modified by items identified in Disclosures re General Modeling Guidelines, G-1 (Scope of the Wildfire Catastrophe Model and Its Implementation), Disclosure #7:*

- A. A list of all equations and formulas used in documentation of the wildfire catastrophe model with definitions of all terms and variables, and*
- B. A cross-referenced list of implementation source code terms and variable names to ensure crosschecking the satisfaction of the requirements specified within General Modeling Guideline G.1.*

Wildfire catastrophe model code and data shall be accompanied by documented maintenance, testing, and update plans with their schedules. The vintage of the code and data shall be justified using transparent documentation of the provider and version.

Guideline CI-5. Wildfire Catastrophe Model Verification

General: For each component, procedures shall be maintained for verification, such as code inspections,

reviews, calculation crosschecks and benchmarks, and walkthroughs, sufficient to demonstrate code correctness to the extent private source code audits can be made possible when required. Verification procedures shall include tests performed by modeling organization personnel other than the original component developers.

Component Testing:

- A. Testing software shall be used to assist in documenting and analyzing all components.*
- B. Unit tests shall be performed and documented for each updated component.*
- C. Regression tests shall be performed and documented on incremental builds.*
- D. Integration tests shall be performed and documented to ensure the correctness of all wildfire catastrophe model components. Testing shall be performed to ensure that all components have been executed at least once to verify their functionality.*

Data Testing:

- A. Testing software shall be used to assist in documenting and analyzing all databases and data files accessed by components.*
- B. Integrity, consistency, and correctness checks shall be performed and documented on all versions of all databases and data files accessed by the components.*

Guideline CI-6. Human-Computer Interaction

Interfaces shall be implemented as consistent with accepted principles and practices of Human-Computer Interaction (HCI), Interaction Design, and User Experience (UX) engineering in compliance with California accessibility requirements.

Interface options used in the wildfire catastrophe model shall be easily distinguishable, explicit, and distinctly emphasized.

Guideline CI-7. Wildfire Catastrophe Model Maintenance and Revision

A clearly written development cycle and refresh policy shall be implemented for review, maintenance, and revision of the wildfire catastrophe model and network organization, including verification and validation of revised components, databases, and data files.

A revision to any portion of the previously submitted wildfire catastrophe model that results in any change in any California residential wildfire loss cost or wildfire probable maximum loss levels across any geospatial segments/areas shall result in a new wildfire catastrophe model version identification. New version identifications are not intended to be limited solely for this reason.

Issue tracking (e.g., with version control) software shall be used to identify and describe all errors, as well as modifications to code, data, and documentation.

A list of all wildfire catastrophe model versions since the initial submission for this year shall be maintained. Each wildfire catastrophe model description shall have a unique version identification and a list of additions, deletions, and changes that define that version maintained by a formal version control platform.

Guideline CI-8. Wildfire Catastrophe Model Security

Cybersecurity procedures shall be implemented and fully documented for (1) secure access to individual computers where the software components or data can be created or modified, (2) secure operation of the wildfire catastrophe model by clients, if relevant, to ensure that the correct software operation cannot be compromised, (3) anti-virus software installation for all machines where all components and data are being accessed, and (4) secure access to documentation, software, and data in the event of a catastrophe.

Computational Information Disclosures For Wildfire Catastrophe Models

Disclosure CI -1 Wildfire Catastrophe Model Documentation

1. Disclose all documentation specified by this Guideline in PDF format.
2. Provide a list and brief description of the software engineering methodologies, including wildfire-specific, (e.g. Kanban, Scrum, Agile, etc.) utilized for the software lifecycle.

Disclosure CI-2 Wildfire Catastrophe Model Requirements

1. Provide a description of the wildfire catastrophe model and platform(s) documentation for interface; human factors; functionality; system documentation; network organization; data, human, and material resources; system models; security; and quality assurance.

Disclosure CI-3 Wildfire Catastrophe Model Organization and Component Design

1. Provide a schematic illustrating key model components and subcomponents, and their hierarchical relationship.

Disclosure CI-4 Wildfire Catastrophe Model Implementation

1. Specify the hardware, operating system, and essential software required to use the wildfire catastrophe model on a given platform.

Disclosure CI-5 Wildfire Catastrophe Model Verification

1. State whether any two executions of the wildfire catastrophe model with no changes in input data, parameters, code, and seeds of random number generators produce the same wildfire loss costs and wildfire probable maximum loss levels, or comparable loss levels within the bounds of explainable standard error of prediction or standard explainable error.
2. Provide an overview of the component testing procedures.
3. Provide a description of verification approaches used for externally acquired data, software, and models.

Disclosure CI-6 Human-Computer Interaction

1. Identify procedures used to design, implement, and evaluate interface options.

Disclosure CI-7 Wildfire Catastrophe Model Maintenance and Revision

1. Identify procedures used to review and maintain code, data, and documentation.
2. Describe the rules underlying the wildfire catastrophe model and code revision identification systems.

Disclosure CI-8 Wildfire Catastrophe Model Security

1. Describe methods used to ensure the security and integrity of the code, data, and documentation. These methods include the security aspects of each platform and its associated hardware, software, and firmware.

Guidelines For End-Users' Use Of Wildfire Catastrophe Models

Purpose: The purpose of these guidelines is to ensure that the specific use of a catastrophe model by the **end-user** (i.e. insurers submitting rate applications) within the rate filing is appropriate and fit for the intended purpose. This includes ensuring that the exposure data (U-1) and policy information (U-2) used as input to the model in the rate filing is quality controlled and meets the best practices set by the model provider. It also includes guidelines to ensure that the model settings used to develop the loss projections and any other information are appropriate and fit to use for the rate filing with respect to the model design (U-3) and that the model itself is appropriate for the wildfire hazard, including geographic and meteorological, economic, and social context for which the rate filing is submitted (U4).

Guideline U-1. End-Users'/Insurers' Wildfire Exposure Data

Wildfire exposure data from the end-user (i.e. insurer) used as input to the model for contribution to a rate filing shall be quality controlled and provided in a form that meets the best practices required by the model and in accordance with actuarial standards of practice.

Any alterations to, including extrapolation, adjustment factors, or filtering of, the exposure data before input into the model must be explained, and justified.

Information on the distribution of various characteristics of the exposure data must be provided to the California Department of Insurance as it was input into the model and in accordance with the relevant wildfire exposures characteristics specified in the Vulnerability Guidelines.

Guideline U-2. Wildfire Insurance Policy Information

Wildfire insurance policy information data used as input to the model for contribution to a rate filing shall be quality controlled and provided in a form that meets the best practices required by the model and in accordance with actuarial standards of practice.

Any alterations or adjustments to the wildfire insurance policy data before input into the model must be explained and justified.

Information on the distribution of various characteristics of the wildfire insurance policy information used as input to the model must be provided to the California Department of Insurance as it was input into the model.

Guideline U-3. Settings of Wildfire Catastrophe Model

The model settings and parameters used to produce any wildfire catastrophe model output used in a rate filing must be in accordance with the most accurate and justifiable use of the model for the specific rate filing.

Guideline U-4. Wildfire Catastrophe Model Used

The wildfire catastrophe model chosen for use in the rate filing must have been developed in such a way that it is appropriate for California's geographical, meteorological/hazard, economic, environmental conditions, building codes, and social context.

Actuarial services used to design, develop, select, modify, or use (including any combination thereof) catastrophe models or incorporate modeled losses for purposes of a rate filing must be performed in

accordance with the applicable standards set forth by the Actuarial Standards Board, Actuarial Standards of Practice with respect to catastrophe models and with respect to data quality.

Disclosures For End-Users' Use Of Catastrophe Wildfire Models

Special Instructions: End-users of the model must disclose specific information for Disclosures U-1 through U-4 in a Complete Rate Application. Model vendors need not disclose specific information for these disclosures within a PRID Procedure but must demonstrate capability to provide this information to end-users in a final report.

Disclosure U -1 End-Users'/Insurers' Wildfire Exposure Data

1. Describe the process used to validate wildfire exposure data from the end-user (i.e. insurance company / insurer) used as an input, including the use of specific checks, reference information, or any other process in conformance with the applicable standards set forth by the Actuarial Standards Board, Actuarial Standards of Practice.
2. Describe the wildfire exposure data used as an input, including without limitation:
 - A. all the sources, the type(s) of exposures, and the dates of evaluation; and
 - B. the extent the data is specific/exclusive to the insurance company (i.e. end-user) or to the Group making the rate filing.
3. Detail the percentage distribution within the actual exposure data used to derive the modeled losses based on the primary AOI related to:
 - A. geographic level of detail for the insured structures:
 - Latitude/Longitude (in addition and separately include the percentage of policies verified)
 - street address (in addition and separately include the percentage of policies verified)
 - ZIP Code (in addition and separately include percentage of policies verified)
 - County
 - Other (Specify)
 - Unknown
 - Total = 100% including rounding
 - B. Fire Policy Form - residential (4 dwelling units or less):
 - Homeowners HO-3 or equivalent (ISO HO-1,2,5,8)
 - Dwelling Owner-Occupied Policies
 - Dwelling Tenant-Occupied, including Landlord Protection Policies
 - Lender/Forced-Placed and Real Estate Owned (REO), Occupied and unoccupied
 - Condominium HO-6 or equivalent (owner and tenant combined)
 - Mobile Homes (owner and tenant combined)
 - Renters contents-only
 - Unknown
 - Total = 100% including rounding

C. Fire Policy Form - commercial:

- Habitational (5 or more dwelling units)
- Retail
- Mixed habitational/retail (5 or more dwelling units)
- Office
- Construction
- Industrial
- Farm/Agricultural
- Other (Specify)
- Unknown
- Total = 100% including rounding

D. wildfire-related construction:

- year structure built categorized within bands:
 - Pre- 1905: Prior to first national unified building code
 - 1905-22: Pre-enactment of State Housing Act
 - 1923-52: State Housing Act, pre-enactment of State Building Standards Law
 - 1953-78: State Bldg. Stds. Law, pre-enactment of CBC Title 24
 - 1979-96: CBC Title 24
 - 1997-2007: CBC Title 24 revised based on 1997 Uniform Building Code fire
 - safety standards
 - 2008-now: Post CBC Chp. 7A
- Compliant with wildfire-related building codes (CBC Chp. 7A)
- presence of wildfire safety actions by category as described by CCR §2644.9 Mitigation in Rating Plans and Wildfire Risk Models (see Vulnerability Form V-2)
- Unknown attributes regarding compliance with CBC Chp. 7A
- Unknown attributes for all of the wildfire safety actions in (iii) above.

Total = 100% including rounding

Disclosure U -2 Wildfire Insurance Policy Information

1. Detail the percentage distribution within the actual exposure data based on the primary AOI related to (including the percentage of policies missing data for each field):
 - A. coverage amount,
 - B. coverage types (A, B, C, D or all)
 - C. coverage limits for each coverage type (actual cash value, replacement cost, extended replacement cost with percentage limit, guaranteed replacement costs), and
 - D. deductibles
2. Describe any limitations of the input data (such as missing exposure or location information) and justify how these limitations were overcome.
3. Describe the level of damage at which the end-user considers a loss to be a total loss.

Disclosure U -3 Setting of Wildfire Catastrophe Model

1. For each catastrophe model used in a rate filing, describe what are the model developer's standard settings and for each separate run using that model, describe and justify every deviation from each of those standard settings, including but not limited to:

- A. Base Wildfire Set or to wildfire stochastic events set(s)
 - Frequency
 - Burned Area
 - Extreme fire weather conditions
 - Extreme wildfire events, frequency and burned area
 - Seasonality of wildfires
 - **Climate Change adjustment (if not considered already)**
- B. Modeled Financial Losses
 - Demand surge
 - Smoke Damage
 - List other perils beyond wildfire coverage that the model settings and thus projected loss output assumes is covered. If there are none, explicitly state that.
 - Scaling or multiplicative modification of loss estimates other than 1.00
 - Alternative vulnerability curves
- C. Wildfire Mitigation / Safety Actions / Resiliency
 - Wildfire Mitigation Levels – parcel level
 - Wildfire Mitigation Levels – community level
 - Wildfire Mitigation Levels – utilities
 - Wildfire Mitigation Levels – prescribed burn treatments/fuel load treatments
 - Correlation of damage across exposures for different Wildfire Mitigation Levels

Disclosure U -4 Wildfire Catastrophe Model Used

1. If more than one wildfire catastrophe model was relied upon to derive the model output (*i.e.* modeled loss projections) in a rate filing, justify the methodology used to generate combined/composite outputs, including weighting assigned to each model or to each model's contribution towards a specific loss metric such as to develop separate rate level indications by category for personal and commercial residential properties such as homeowners, condominiums, mobile homes, and content-only policies.
2. For each wildfire catastrophe model used, describe the process used to validate model output (*i.e.* modeled loss projections), including the use of specific checks, reference information, or any other process in conformance with the applicable standards set forth by the Actuarial Standards Board, Actuarial Standards of Practice.
3. For each wildfire catastrophe model used, describe and justify any adjustments made to the model output prior to its use in the rate filing, including for all indications (including those that apply to class plan variables, discounts, and surcharges)
4. Describe and justify if the following were applied to **input** data:
 - A. Trend Adjustments (Specify type and associated date) - annualized percentage applied
 - B. Any other adjustment
5. Describe and justify if the following were applied to **output** data:
 - A. Loss adjustment expense (LAE) adjustments – annualized percentage applied
 - B. Trend Adjustments (Specify type and associated date) – annualized percentage applied

C. Any other adjustment

6. Provide the amount of insurance, in dollars, in total and separately for coverage types (A-dwelling, B-additional structures, C-contents, and D-loss of use or business interruption) used in the model for the appropriate policy form.
7. Provide a reconciliation between amount of insurance in total used in the model **and total Amount of Insurance Year (AIY)** used in the Standard Exhibits underlying the complete rate application. The reconciliation should be consistent with the policy forms in the rate filing.
8. Provide a reconciliation between number of exposures by form and coverage type used in the model and in the Standard Exhibits underlying the complete rate application.

Appendix I: Preliminary Test Cases For Wildfire Catastrophe Models

This appendix includes several types of test cases:

1. Test cases or validation showing comparisons of model results to historical losses for four historical wildfires of varying pyro-dynamic characteristics (Preferably the 2021 Caldor Fire, the 2020 CZU Fire, the 2018 Carr Fire, and the 2018 Woolsey Fire) – Form S-4.
2. Test cases or validation demonstrating the justification and sensitivity of the wildfire model output to all relevant parameters that can be varied – Form S-3; Form S-6.
3. Test cases or validation demonstrating the sensitivity of the wildfire model output to vulnerability features, including all wildfire mitigation elements at all scales (home, landscape, etc.) – Form V-1; Form V-2; Form V-3; Form V-4; Form V-5.
4. Test cases or validation demonstrating comparisons of statewide modeled losses to historical losses statewide – Form S-5; Form A-2; Form A-3; Form A-8.
5. Test cases or validation demonstrating comparison of modeled fire frequency and severity to historical fire frequency/severity – Form H-1; Form H-2; Form S-1.

Form H-1: Annual Occurrence Frequency & Burned Area

Purpose: This form provides information to illustrate the differences among statewide and regional frequencies of fire occurrence and areas burned of California wildfires for historical and modeled wildfires.

- A. One or more automated programs or scripts should be used to generate and arrange the data in Form H-1, Annual Occurrence Frequency & Burned Area. Any processing, factor weighting, and averaging should be described in an addendum to the plots and/or tables requested.

- B. Provide modeled probability distributions of wildfire occurrence and area burned versus a California Historical Wildfire Dataset using Table H-1A below and by producing a contour map at the highest available resolution (zip code-level or more granular) and a county-level table. Output comparisons should be presented aggregated statewide and at the highest available resolution (Zip-code or more granular). These analyses should be shown side-by-side with analysis of the chosen historical wildfire dataset(s) using the same script or program method. Output comparisons should also be provided for a selected low, average, and highly active fire season. Justify the selection of low, average, and high fire seasons. Seasonality impacts should also be addressed in some comparisons (when shown to be relevant). All frequencies and ratios should be rounded to three decimal places.

STATEWIDE (aggregate)						
	Reference CA Historical Wildfire Dataset		Base Wildfire Set		Modeled Wildfire Events (stochastic events set)	
Fire Season Severity	Area Burned (average & cumulative)	Fire Occurrence Frequency	Area Burned	Fire Occurrence Frequency	Area Burned	Fire Occurrence Frequency
<i>Low</i>						
<i>Ave.</i>						
<i>High</i>						

For Every identified ECO-REGION / Defined Spatial Area						
	Reference CA Historical Wildfire Dataset		Base Wildfire Set		Modeled Wildfire Events (stochastic events set)	
Fire Season Severity	Area Burned (average & cumulative)	Fire Occurrence Frequency	Area Burned	Fire Occurrence Frequency	Area Burned	Fire Occurrence Frequency
<i>Low</i>						
<i>Ave.</i>						
<i>High</i>						

County-level						
	Reference CA Historical Wildfire Dataset		Base Wildfire Set		Modeled Wildfire Events (stochastic events set)	
County	Area Burned (average & cumulative)	Fire Occurrence Frequency	Area Burned	Fire Occurrence Frequency	Area Burned	Fire Occurrence Frequency

- C. Describe wildfire hazard model variations from the historical frequencies.

- D. Provide vertical bar graphs depicting distributions of wildfires frequencies by category (by burned area and by fire severity) and by wildfire-relevant region/eco-region of California (providing in H-3 criteria used by the modeling organization to delineate such) and, if specifically modeled, inclusive of wildfires that spread across state lines including through urban conflagration. Data should include fire occurrence frequency and area burned. Output comparisons should also be provided for a selected low, average, and highly active fire season and provide in H-3 criteria used by the modeling organization to categorize as such. Fire severity or other relevant exposure metrics should be compared if model outputs and input historical databases with this data are applicable.

- E. If the historical data used in the creation of the Base Wildfire Set are partitioned or modified, provide an explanation of the modifications. As part of this explanation, provide addition copies of Form H-1, Annual Occurrence Frequency & Burned Area to demonstrate the historical annual occurrence frequency for the applicable partition (and its complement) or modification and the modeled annual occurrence frequency.

- F. Describe how the historical and modeled wildfire hazard model fire perimeters are established and to the extent validated, in relation to diverse historical wildfires.

- G. **The following disclosure is only applicable if the wildfire catastrophe model has been used for determination of the projected aggregate losses in a prior rate filing, and previously provided responses to these guidelines and disclosures:** If the Base Wildfire Set is subsequently modified, list all wildfires added, removed, or modified from the currently accepted wildfire catastrophe model version of the Base Wildfire Set, alongside justification for the modifications.

Notes on Form H-1, Annual Occurrence Frequency & Burned Area:

- 1. Each historical and modeled wildfire, regardless of reported or modeled damage, is listed in each wildfire-relevant region/eco-region and county of California where it spreads and causes damage, but counted only once in the Statewide (aggregate) in Table H-1A. Wildfires recorded for neighboring states which spread into California need not have reported damage in California

2. Form H-1, Annual Occurrence Frequency & Burned Area; Form A-2, Reference California Historical Wildfire Dataset Statewide Wildfire Losses; and Form S-1, Probability and Frequency by Area Burned of California Wildfires per Year, are based on the period consistent with Wildfire Hazard Guideline H-1, Base Wildfire Set. It is intended that the wildfires set underlying Forms H-1, Annual Occurrence Frequency & Burned Area; A-2, Reference California Historical Wildfire Dataset Statewide Wildfire Losses; and S-1, Probability and Frequency by Area Burned of California Wildfires per Year, will be the same.

3. In Wildfire Hazard Guideline H-1, Base Wildfire Set, the modeling organization may exclude wildfires only if justified on how such exclusion does not impact the modeling of wildfire hazard, or include additional complete wildfire seasons, or may modify data for historical wildfires based on evidence in current scientific and technical literature. This may result in the modeling organization's Base Wildfire Set differing from the wildfires set listed in Form A-2, Reference California Historical Wildfire Dataset Statewide Wildfire Losses. In this case, the modeling organization should modify the wildfires set listed in Form A-2, Reference California Historical Wildfire Dataset Statewide Wildfire Losses, to make it consistent with the modeling organization's Base Wildfire Set. The modeling organization's Base Wildfire Set should be used to populate the historical counts and frequency of Form H-1, Annual Occurrence Frequency & Burned Area.

Form H-2: Maps of Extreme Wildfire Perimeters

Purpose: This form provides information to illustrate the ability of the wildfire hazard model to simulate regional variations in extreme historical wildfires.

- A. Provide color-coded contour plots on a map with appropriate localized boundaries of the maximum burnt acreage for the modeled version of the Base Wildfire Set at the highest available resolution (zip-code or more granular). Plot the position and value of the maximum burnt acreage on the contour map.

Use the following isotach values and interval color-coding:

(1)	<299 acres	Light Blue
(2)	300-999	Medium Blue
(3)	1,000-4,999	Blue
(4)	5,000-29,999-	Light Grey
(5)	30,000-59,999	Medium Grey
(6)	60,000-99,999	Dark Grey
(7)	100,000-299,999	Light Red
(8)	300,000-499,999	Medium Red
(9)	500,000-999,999	Dark Red
(10)	>1,000,000 acres	Magenta

Contouring in addition to these isotach values may be included.

- B. For each eco-region/ spatial area and for each county, provide histograms of the maximum burnt acreage for the wildfire stochastic events set using each of the isotach values in part A for the X-axis. Compare the distribution of the actual burn area in the Reference California Historical Wildfire Dataset for all years in the dataset and the maximum burnt acreage from the wildfire stochastic events set.
- C. Include Form H-2, Maps of Extreme Wildfire Perimeters, in a submission appendix.

Form S-1: Probability and Frequency By Area Burned of California Wildfires Per Year

Purpose: This form provides information to illustrate the differences among the Reference California Historical Wildfire Dataset, the Base Wildfire Set, and modeled wildfire frequencies and probability by burned area of all wildfires per year in California.

- A. One or more automated programs or scripts should be used to generate and arrange the data in Form S-1, Probability and Frequency By Area Burned of California Wildfires per Year.
- B. Complete the table below for the modeled probabilities for all California wildfires per year. If the modeling organization has modified the Base Wildfire Set, as identified in their response to Wildfire Hazard Guideline H-1, Base Wildfire Set, then the probabilities and frequencies of the modified set should also be provided in the appropriate columns. Probabilities should be rounded to three decimal places. The frequency values for the Base Wildfire Set shall be multiplied by a factor that is the number of years in the in the Reference California Historical Wildfire Dataset divided by the number of years in the Base Wildfire Set.
- C. Include Form S-1, Probability and Frequency By Area Burned of California Wildfires per Year, in a submission appendix.

Probability and Frequency by Area Burned of California Wildfires Per Year						
Max area burned (acres)	Reference CA Historical Wildfire Dataset Probability	Base Wildfire Set Probability	Modeled Probability	Reference CA Historical Wildfire Dataset Frequency	Base Wildfire Set Frequency	Modeled Frequency
<299						
300-999						
1,000-4,999						
5,000-29,999						
30,000-59,999						
60,000-99,999						
100,000-299,999						
300,000-499,999						
500,000-999,999						
>1,000,000						

Probability and Frequency of Loss Causing California Wildfires Per Year						
Number of Wildfires That Result in Losses Per Year	Reference CA Historical Wildfire Dataset Probability	Base Wildfire Set Probability	Modeled Probability	Reference CA Historical Wildfire Dataset Frequency	Base Wildfire Set Frequency	Modeled Frequency
0						
1						
2						
3						
4						
5						
6						
7						
8						
9						
10 or more						

Form S-2: Examples of Wildfire Loss Exceedance Estimates (Specific information to be provided at a future date)

Form S-3: Distributions of Stochastic Wildfire Parameters

Purpose: This form identifies the probability distributions used in the stochastic wildfire model used to generate wildfire stochastic events and provides their justification.

- A. Provide the probability distribution functional form used for each stochastic wildfire parameter in the wildfire module.

- B. Provide a summary of the justification for each functional form selected for each general classification and the goodness-of-fit tests used.
 - Year Range Used for Fitting refers to the year range of data upon which the distribution parameters are estimated.

 - Year Range Used for Validation refers to the year range of data upon which the goodness-of-fit statistics are based.

 - If the parameter (variable) is an input to the wildfire hazard model or derived from its outputs, identify the variable and elaborate on the method of population for estimating the distribution. For example, the fire intensity or flame length may change by perturbing the acceleration or the spot ignition probability in the wildfire hazard model; provide distributions and information for both.

- C. Include Form S-3, Distributions of Stochastic Wildfire Parameters, in a submission appendix.

Stochastic Wildfire Parameter (Function or Variable)	Functional Form of Distribution	Data Sources	Year Range Used		Justification for Functional Form and Parameter Estimates
			For Fitting	For Validation	

Form S-4: Validation Comparisons

Purpose: This form provides information to illustrate the differences between actual and modeled wildfire loss for a variety of specified conditions.

- A. Provide a sufficient body of comparisons (at least four validation cases) of actual personal residential property exposures and wildfire loss to modeled exposures and wildfire loss such that the validation set represents the diversity of observed wildfire event types and losses in California to the extent data are available.
- Provide these comparisons by line of insurance, construction type, policy coverage, eco-regions or other relevant wildfire-specific spatial areas, or other level of similar detail in addition to total wildfire losses. Include wildfire loss as a percentage of total exposure.
 - Total exposure represents the total amount of insured values (all coverages combined) in the area affected by the wildfire. This would include exposures for policies that did not have a wildfire loss. If this is not available, use exposures for only those policies that had a wildfire loss. Specify which one was used.
 - To the extent data are available, comparisons should include wildfire losses from:
 - Southern California: 2018 Woolsey Fire
 - Sierra Nevada Mountains: 2020 Caldor Fire
 - Northern California: 2018 Carr Fire
 - Coastal California: 2020 CZU Complex Fire
 - For each of the selected fires, provide the historical information relied upon and disclose any additional assumptions or modifications made to recreate these wildfires, including but not limited to (as applicable): ignition point, eco-region categorization, localized fuel load conditions, weather inputs, and characteristics of exposures at the property and community level.
- B. Provide a validation comparison of actual habitational commercial property exposures and wildfire loss to modeled exposures and wildfire loss. Use and provide a definition of the wildfire catastrophe model relevant commercial property classifications.
- C. Provide scatter plots of modeled versus historical wildfire losses for each of the required validation comparisons. Plot the historical wildfire losses on the x-axis and the modeled wildfire losses on the y-axis. If different spatiotemporal aggregation levels are used, provide this plot for each level.
- D. Include Form S-4, Validation Comparisons, in a submission appendix.

Example Formats for Personal Residential Buildings:

Wildfire = _____

Exposure = Specify total exposure or wildfire loss only _____

WUI Classification	Structure Density Classification	Insurers' Aggregate Actual Wildfire Loss / Exposure	Modeled Wildfire Loss / Exposure	Difference
Non-WUI	0-4 DU/AC (Gross)			
	5-10 DU/AC (Gross)			
	10-15 DU/AC (Gross)			
	18-58 DU/AC (Net)			
	>59 DU/AC (Net)			
WUI	0-4 DU/AC (Gross)			
	5-10 DU/AC (Gross)			
	10-15 DU/AC (Gross)			
	18-58 DU/AC (Net)			
	>59 DU/AC (Net)			
Total				

Wildfire = _____

Exposure = Specify total exposure or wildfire loss only _____

Coverage	Insurers' Aggregate Actual Wildfire Loss / Exposure	Modeled Wildfire Loss / Exposure	Difference
A			
B			
C			
D			
Total			

Example Format for Commercial Residential Buildings:

Wildfire =

Exposure = Specify total exposure or wildfire loss only _____

WUI Classification	Structure Density Classification	Insurers' Aggregate Actual Wildfire Loss / Exposure	Modeled Wildfire Loss / Exposure	Difference
Non-WUI	0-10 DU/AC (Gross)			
	10-15 DU/AC (Gross)			
	18-36 DU/AC (Net)			
	37-58 DU/AC (Net)			
	>59 DU/AC (Net)			
WUI	0-10 DU/AC (Gross)			
	10-15 DU/AC (Gross)			
	18-36 DU/AC (Net)			
	37-58 DU/AC (Net)			
	>59 DU/AC (Net)			
Total				

Form S-5: Average Annual Zero Deductible Statewide Wildfire Loss Costs – Historical versus Modeled

Purpose: This form provides an illustration of the differences in actual and modeled average annual zero deductible statewide personal and commercial residential property wildfire loss costs.

- A. Provide contour map of the average annual zero deductible personal and commercial residential property wildfire loss costs at the highest available resolution (zip-code or more granular) and a table at county-level resolution produced using the list of wildfires in the Reference California Historical Wildfire Dataset and the Base Wildfire Set as defined in Wildfire Hazard Guideline H-1, Base Wildfire Set.

- B. Provide a comparison with the statewide personal and commercial residential property wildfire loss costs produced by the wildfire catastrophe model on an average industry basis.

Upon any future update of any of the Wildfire Catastrophe Model Checklist, complete the last two rows to provide a comparison of the results using the prior and the updated Guidelines and Disclosures.

Average Annual Zero Deductible Statewide Personal and Commercial Residential Property Wildfire Loss Costs			
Time Period	Reference CA Historical Wildfires Dataset	Base Wildfire Set	Modeled Stochastic Events Set
Current Wildfire Catastrophe Model Submission (Jan 2025 Wildfire Catastrophe Model Checklist)	N/A		
Previously Reviewed Wildfire Catastrophe Model Version* (Jan 2025 Wildfire Catastrophe Model Checklist)	N/A		
Percent Change Current Submission/ Previously Reviewed*	N/A		
Submitted Wildfire Catastrophe Model* (Wildfire Catastrophe Model Checklist)	N/A (as of 2025)	N/A (as of 2025)	N/A (as of 2025)
Percent Change Using Prior / Updated Wildfire Catastrophe Model Checklist*	N/A (as of 2025)	N/A (as of 2025)	N/A (as of 2025)

**NA if no current or previously reviewed wildfire catastrophe mode*

Average Annual Zero Deductible Statewide Personal Commercial Residential Property Wildfire Loss Costs (County-level)			
County	Reference CA Historical Wildfires Dataset	Base Wildfire Set	Modeled Stochastic Events Set
	N/A		
	N/A		
	N/A		
	N/A		
	N/A		

- C. Provide the 95% confidence interval on the differences between the means of the historical and modeled personal and commercial residential property wildfire loss costs.

- D. If the data are partitioned or modified, provide the average annual zero deductible statewide personal and commercial residential property wildfire loss costs for the applicable partition (and its complement) or modification, as well as the modeled average annual zero deductible statewide personal and commercial residential property wildfire loss costs in additional copies of Form S-5, Average Annual Zero Deductible Statewide Wildfire Loss Costs – Historical versus Modeled.

- E. Include Form S-5, Average Annual Zero Deductible Statewide Wildfire Loss Costs – Historical versus Modeled, in a submission appendix.

Form S-6: Hypothetical Events for Sensitivity and Uncertainty Analysis (Preliminary Version)

Purpose: This form requires the wildfire catastrophe model to be run under a variety of specified parameter settings in order to perform detailed sensitivity and uncertainty analyses, primarily focused on fire behavior.

- A. Provide sensitivity analysis (SA) and uncertainty analysis (UA) for variables related to fire behavior using a hypothetical wildfire event. In the sensitivity analysis worksheet, all variables are randomly and simultaneously varied while for the uncertainty analysis, one variable is varied while all other variables are held constant.
- B. Variables used in the sensitivity analysis and uncertainty analysis should include, but are not limited to, distance of wildfire ignition point (for UA: 1 mile, 15 miles, 50 miles and indicate cardinal or intercardinal direction of fire spread), fuel load (for UA: 1 hr, 10 hrs, 100 hrs), average/sustained 10m wind speed (for UA: 5 mph, 15 mph, 45 mph), relative humidity (for UA: 0-20%, 21-60%, 61%+), any conversion factors. For relative humidity, fuels should acclimate to the prescribed humidity for 3 days before the scenario.
- C. One or more automated programs or scripts shall be used to generate and arrange the data in Form S-6.

Form V-1: One Hypothetical Event

Purpose: This form illustrates the general behavior and reasonableness of building wildfire vulnerability functions by comparing the catastrophe model loss outputs over a hypothetical exposure data in a wildland-urban interface eco-region for a cluster of buildings in one community with varying building characteristics and defensible space features, which such simulation repeated using the same exposures but varying the wind speed in the hypothetical wildfire event with set initial fire parameters.

- A. The hypothetical wildfire should be represented by a point of ignition located $\frac{1}{2}$ a mile east of the edge of the cluster of buildings representing a community. The scenario should be run at different sustained winds speeds at height of 10 meters using the same fuel load at point of ignition and due west in the direction of the community. Model fire spread over a 25 x 25 miles grid centered on the point of ignition until fire abatement and the sample personal and commercial residential exposure data provided, and report the modeled building and contents damage ratios and time element loss ratios summarized by community and building characteristics described below.

The personal and commercial residential exposure data should consist of 100 habitational structures divided between personal and commercial residential properties within one community, each habitational structure with certain defined but varied separation and building characteristics from all other habitational structures and secondary/appurtenant structures. The exposure data should define: (1) the relative separation between the 100 habitational buildings and secondary/appurtenant structures with approximately equal number of structures in each of four structure separation bins (0-12 in, 13-120 in, 121-360 in, 361+ in), as well select characteristics for defensible space Zones 1 (0-5 ft), 2 (5-30ft), and 3 (>30ft); and (2) for each habitational structure, replacement cost value for Coverages A, B, and C and the coverage limits for Coverage D. Every habitational structure and appurtenant/secondary structure should have the characteristics listed in one reference structure specifications noted in the table below, and may further be assigned by the modeling organization additional characteristics upon justifying criteria used for such assumptions (*e.g.* year built and current structure stock in the chose eco-region). The modeling organization shall disclose any additional adjustments or assumptions for these structures that are absolutely necessary to run the simulation.

The 100 structures should be distributed according to the following:

- 30% Reference Older Unmitigated Residential Structure
- 30% Reference Newer Mitigated Residential Structure
- 10% Reference Unmitigated Commercial Habitational Structure
- 10% Reference Mitigated Commercial Habitational Structure
- 10% Reference Unmitigated Manufactured Home Structure
- 10% Reference Unmitigated Manufactured Home Structure

Do not include appurtenant structure, contents, or time element coverages in the habitational building damage ratios. Do not include habitational building, appurtenant structure, or time element coverages in the contents damage ratios. Do not include habitational building, appurtenant structure, or contents coverages in the time element loss ratios.

For completing Part A damage ratios, the Estimated Damage for each individual sustained wind

speed range is the sum of wildfire loss to all structures in the grid subjected to that individual sustained wind speed range, ignoring wind gusts and excluding demand surge. Subject Exposure is all wildfire exposures in the grid subjected to that individual wind speed range.

For completing Part B damage ratios, the Estimated Damage is the sum of wildfire loss to all structures of a specific structure separation distance in all of the winds peed ranges, ignoring wind gusts and excluding demand surge. Subject Exposure is all wildfire exposures in the grid of that specific structure separation.

For completing Part C damage ratios, the Estimated Damage is the sum of wildfire loss to all structures of a specific vegetation-related defensible space type in all of the winds peed ranges, ignoring wind gusts and excluding demand surge. Subject Exposure is all wildfire exposures in the grid of that specific vegetation-related defensible space type.

Reference Older Unmitigated Residential Structure	Reference Newer Mitigated Residential Structure
4 or less units One story Class D roof Wood siding Wood framed exterior walls Single paned glass windows Wooden deck adjacent (75 sq. feet) Opened eaves Vents not covered with 1/8in mesh Mulch in Zone 1 (defensible space) Medium Fuel load in Zone 2 (defensible space) Constructed in 1995	4 or less units One story Asphalt shingles (Class A) roof Fire resistant vinyl siding Wood framed exterior walls Double paned glass windows Vents covered with 1/8 in mesh No deck or surrounding flammable material in Zone 1 Low fuel in Zone 2 (defensible space) Constructed in 2010 (compliant with CBC Chp. 7A)
Reference Unmitigated Commercial Habitational Structure	Reference Mitigated Commercial Habitational Structure
5 units or more units No fire-resistant shutters Single paned glass windows Constructed in 1980	5 units or more units Fire resistant exterior walls Double paned glass windows Class A fire resistant roof No deck or surrounding flammable material in Zone 1 Low fuel in Zone 2 (defensible space) 2010 Construction (compliant with CBC Chp. 7A)
Reference Unmitigated Manufactured Home Structure	Reference Mitigated Manufactured Home Structure
Single unit Manufactured in 1980	Single unit Manufactured in 1980 No deck or surrounding flammable material in Zone 1

B. Describe the criteria used to classify and differentiate between the different fuel load ranges in the defensible space (low, medium, high).

- C. For each wind speed range, indicate average total simulated time from fire ignition to abatement.
- D. Confirm that the structures used in completing the form are identical to those in the above table for the reference structures. For each additional assumption necessary to complete this form (for example, regarding structural characteristics, duration, or surface roughness), provide the reasons why the assumptions were necessary as well as a detailed description of how they were included.
- E. Provide separate plots of the Estimated Damage/Subject Exposure (y-axis) versus wind speed (x-axis) in Part A and versus structure separation (x-axis) in Part B, for the Building, Contents, and Time Element data.
- F. Include Form V-1, One Hypothetical Event, in a submission appendix.

Part A – Damage Ratios

Windspeed (mph, sustained)	Estimated Building Loss Damage/ Subject Building Exposure	Estimated Contents Loss Damage/ Subject Contents Exposure	Estimated Time Element Loss/ Subject Time Element Exposure
0 – 5	_____	_____	_____
6 – 15	_____	_____	_____
16 – 30	_____	_____	_____
31 – 45	_____	_____	_____
46 – 60	_____	_____	_____

Part B

Structure-Structure Separation	Estimated Building Loss Damage/ Subject Building Exposure	Estimated Contents Loss Damage/ Subject Contents Exposure	Estimated Time Element Loss/ Subject Time Element Exposure
0 – 12 inches	_____	_____	_____
13 – 120 inches	_____	_____	_____
121 – 360 inches	_____	_____	_____
361+ inches	_____	_____	_____

Part C

Defensible Space Fuel Load	Estimated Building Damage/ Subject Building Exposure	Estimated Contents Damage/ Subject Contents Exposure	Estimated Time Element Loss/ Subject Time Element Exposure
Low	_____	_____	_____
Medium	_____	_____	_____
High	_____	_____	_____

Form V-2: Wildfire Mitigation Measures and Building's Secondary Characteristics, Range of Changes in Damage

Purpose: This form illustrates the measure of impact of wildfire mitigation measures and secondary characteristics on building vulnerability functions when implemented individually or in combination at certain sustained wind speeds.

- A. Explain how the wildfire vulnerability functions for the reference structures are developed. Demonstrate that the wildfire vulnerability function for each of the three reference unmitigated habitational structures in Form V-1 is related to one of the wildfire model's standard building structure vulnerability functions for unmitigated constructions.

- B. Place the reference structures at the same location as in Form V-1.

- C. Provide the change in the zero deductible personal residential reference building structure damage ratio (not wildfire loss cost) for each individual wildfire mitigation measure and secondary characteristic listed in Form V-2, Wildfire Mitigation Measures and Secondary Characteristics, Range of Changes in Damage, as well as for the combination of the wildfire mitigation measures and secondary characteristics provided for the Mitigated Residential Structure and the Mitigated Commercial Habitational Structure in Form V-1.

- D. List assumptions necessary to complete this form (for example, regarding age, condition, duration, or surface roughness), and provide the rationale for the assumptions as well as a detailed description of how they are implemented.

- E. Provide an explanation for cells filled with "0" or blank cells.

- F. Provide this form in PDF and Excel format without truncation. The file name should include the abbreviated name of the modeling organization, the wildfire guidelines year, and the form name. Also include Form V-2, Wildfire Mitigation Measures and Buildings' Secondary Characteristics, Range of Changes in Damage, in a submission appendix.

INDIVIDUAL WILDFIRE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS		PERCENTAGE CHANGES IN DAMAGE ((REFERENCE DAMAGE RATIO - MITIGATED DAMAGE RATIO) / REFERENCE DAMAGE RATIO) * 100											
		RESIDENTIAL BUILDING					COMMERCIAL BUILDING						
		WINDSPEED (MPH)*					WINDSPEED (MPH)*						
		5	15	30	45	60	5	15	30	45	60		
	REFERENCE HABITATIONAL BUILDING	—	—	—	—	—	—	—	—	—	—	—	—
COMMUNITY LEVEL	Fire Risk Reduction Community / Firewise USA Site												
	Other Wildfire Resilient Community Designation (Specify)												
DEFENSIBLE SPACE	Vegetation & Debris free decks												
	No combustibile material within 5 ft of habitational structure												
	Non-combustible material used for improvements w/in 5 ft of habitational structure (e.g. fences, gates, decks)												
	No combustibile structures within 30 ft (or in all of the area under control) of habitational structure												
	Compliant with PRC §4291 and similar												
	Fuel within Zones 1, 2 and 3												
STRUCTURE HARDENING	Class-A Fire Rated Roof												
	Enclosed Eaves												
	Fire Resistant Vents												
	Multi-pane Windows												
	Exterior surfaces with at least 6 inches of noncombustible vertical clearance measured from ground-up												
	Fire-resistant shutters (doors/windows)												
	Non-combustible Exterior Walls												
	Non-combustible gutters & downspouts												
Other Secondary Characteristics (specify)													
WILDFIRE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS IN COMBINATION		PERCENTAGE CHANGES IN DAMAGE ((REFERENCE DAMAGE RATIO - MITIGATED DAMAGE RATIO) / REFERENCE DAMAGE RATIO) * 100											
		RESIDENTIAL BUILDING					COMMERCIAL BUILDING						
		WINDSPEED (MPH)*					WINDSPEED (MPH)*						
		5	15	30	45	60	5	15	30	45	60		
	MITIGATED HABITATIONAL BUILDING												

*Windspeeds are sustained at 10-meters above ground.

Form V-3: Wildfire Mitigation Measures and Buildings' Secondary Characteristics, Mean Damage Ratios and Wildfire Loss Costs

Purpose: This form illustrates the assessment of the impact of wildfire mitigation measures and secondary characteristics on building vulnerability functions when implemented individually or in combination at certain windspeeds. The form also illustrates the underlying wildfire vulnerability functions and the wildfire loss costs for the reference unmitigated and mitigated constructions.

- A. Place the reference structures at the same location as in Form V-1.
- B. Provide the mean damage ratio (without including any insurance considerations) to the reference unmitigated residential and commercial habitational buildings for each individual wildfire mitigation measure and secondary characteristic listed in Form V-3, as well as the percent damage for the combination of the wildfire mitigation measures and secondary characteristics provided for the Mitigated Residential Structure and the Mitigated Commercial Habitational Structure below.
- C. Provide the zero deductible residential wildfire loss cost rounded to three decimal places, for the reference unmitigated building and for each individual wildfire mitigation measure and secondary characteristic listed in Form V-3, as well as the wildfire loss cost for the combination of the wildfire mitigation measures and secondary characteristics provided for the Mitigated Structures below.
- D. List assumptions necessary to complete Form V-3, for example, regarding age, condition, duration, or surface roughness. Provide the rationale and a detailed description of how the assumptions are implemented.
- E. Provide a graphical representation of the wildfire vulnerability curves for the reference unmitigated residential and commercial habitational buildings and the mitigated buildings.
- F. Provide this form in PDF and Excel format without truncation and in a submission appendix. The file name shall include the abbreviated name of name of the modeling organization, the wildfire guidelines year, and the form name.

INDIVIDUAL WILDFIRE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS		MEAN DAMAGE RATIO										Wildfire Loss Costs	
		RESIDENTIAL BUILDING					COMMERCIAL BUILDING					Res.	Comm.
		WINDSPEED (MPH)*					WINDSPEED (MPH)*					Across All Windspeeds	
		5	15	30	45	60	5	15	30	45	60		
	REFERENCE HABITATIONAL BUILDING	—	—	—	—	—	—	—	—	—	—	—	—
COMMUNITY LEVEL	Fire Risk Reduction Community / Firewise USA Site												
	Other Wildfire Resilient Community Designation (Specify)												
DEFENSIBLE SPACE	Vegetation & Debris free decks												
	No combustible material within 5 ft of habitational structure												
	Non-combustible material used for improvements w/in 5 ft of habitational structure (e.g. fences, gates, decks)												
	No combustible structures within 30 ft (or in all of the area under control) of habitational structure												
	Compliant with PRC §4291 and similar												
	Fuel within Zones 1, 2 and 3												
STRUCTURE HARDENING	Class-A Fire Rated Roof												
	Enclosed Eaves												
	Fire Resistant Vents												
	Multi-pane Windows												
	Exterior surfaces with at least 6 inches of noncombustible vertical clearance measured from ground-up												
	Fire-resistant shutters (doors/windows)												
	Non-combustible Exterior Walls												
	Non-combustible gutters & downspouts												
	Other Secondary Characteristics (specify)												
WILDFIRE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS IN COMBINATION		MEAN DAMAGE RATIO										Wildfire Loss Costs	
		RESIDENTIAL BUILDING					COMMERCIAL BUILDING					Res.	Comm.
		WINDSPEED (MPH)*					WINDSPEED (MPH)*					Across All Windspeeds	
		5	15	30	45	60	5	15	30	45	60		
	MITIGATED HABITATIONAL BUILDING												

*Windspeeds are sustained at 10-meters above ground.

Form V-4: Differences in Wildfire Mitigation Measures and Buildings’ Secondary Characteristics

Purpose: This form illustrates the impact of changes in the wildfire model of the wildfire mitigation measures and secondary characteristics from the last version previously submitted. **This form is only applicable if the wildfire catastrophe model has been used for determination of the projected aggregate losses in a prior rate filing, and previously provided responses to these preliminary test case forms.**

- A. Provide the differences between the values reported in Form V-2, Wildfire Mitigation Measures and Buildings’ Secondary Characteristics, Range of Changes in Damage, relative to the equivalent data compiled from the last version previously submitted.
- B. Provide a list and describe any assumptions made to complete this Form V-4, including, for example, regarding age, condition, duration, or surface roughness.
- C. Provide a summary description of the differences.
- D. Provide this form in PDF and Excel format without truncation. The file name should include the abbreviated name of the modeling organization, the wildfire guidelines year, and the form name. Also include Form V-4, Differences in Wildfire Mitigation Measures and Buildings’ Secondary Characteristics, in a submission appendix.

INDIVIDUAL WILDFIRE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS		DIFFERENCES FROM FORM V-2 RELATIVE TO PRIOR MODEL VERSION (Not applicable for first time submissions)										
		RESIDENTIAL BUILDING					COMMERCIAL BUILDING					
		WINDSPEED (MPH)*					WINDSPEED (MPH)*					
		5	15	30	45	60	5	15	30	45	60	
	REFERENCE Habitational BUILDING	—	—	—	—	—	—	—	—	—	—	—
COMMUNITY LEVEL	Fire Risk Reduction Community / Firewise USA Site											
	Other Wildfire Resilient Community Designation (Specify)											
DEFENSIBLE SPACE	Vegetation & Debris free decks											
	No combustible material within 5 ft of habitational structure											
	Non-combustible material used for improvements w/in 5 ft of habitational structure (e.g. fences, gates, decks)											
	No combustible structures within 30 ft (or in all of the area under control) of habitational structure											
	Compliant with PRC §4291 and similar											
	Fuel within Zones 1, 2 and 3											
STRUCTURE HARDENING	Class-A Fire Rated Roof											
	Enclosed Eaves											
	Fire Resistant Vents											
	Multi-pane Windows											
	Exterior surfaces with at least 6 inches of noncombustible vertical clearance measured from ground-up											
	Fire-resistant shutters (doors/windows)											
	Non-combustible Exterior Walls											
	Non-combustible gutters & downspouts											
	Other Secondary Characteristics (specify)											
WILDFIRE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS IN COMBINATION		DIFFERENCES FROM FORM V-2 RELATIVE TO PRIOR MODEL VERSION										
		RESIDENTIAL BUILDING					COMMERCIAL BUILDING					
		WINDSPEED (MPH)*					WINDSPEED (MPH)*					
		5	15	30	45	60	5	15	30	45	60	
	MITIGATED Habitational BUILDING											

*Windspeeds are sustained at 10-meters above ground.

Form V-5: Differences in Wildfire Mitigation Measures and Buildings’ Secondary Characteristics, Mean Damage Ratios and Wildfire Loss Costs

Purpose: This form illustrates the impact of changes in the wildfire model of wildfire mitigation measures and secondary characteristics and the underlying wildfire loss costs for the reference unmitigated and mitigated constructions from the last version previously submitted. **This form is only applicable if the wildfire catastrophe model has been used for determination of the projected aggregate losses in a prior rate filing, and previously provided responses to these guidelines and disclosures.**

- A. Provide the differences between the values reported in Form V-3, Wildfire Mitigation Measures and Buildings’ Secondary Characteristics, Mean Damage Ratios and Wildfire Loss Costs, relative to the equivalent data compiled from the last version previously submitted.
- B. Provide a list and describe any assumptions made to complete this form V-5, including, for example, regarding age, condition, duration, or surface roughness.
- C. Provide a summary description of the differences.
- D. Provide this form in PDF and Excel format. The file name should include the abbreviated name of the modeling organization, the wildfire guidelines year, and the form name. Also include Form V-5, Differences in Wildfire Mitigation Measures and Buildings’ Secondary Characteristics, Mean Damage Ratios and Wildfire Loss Costs, in a submission appendix.

DIFFERENCES FROM FORM V-3 RELATIVE TO PRIOR MODEL VERSION (Not applicable for first time submissions)													
INDIVIDUAL WILDFIRE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS		MEAN DAMAGE RATIO										Wildfire Loss Costs	
		RESIDENTIAL BUILDING					COMMERCIAL BUILDING					Res.	Comm.
		WINDSPEED (MPH)*					WINDSPEED (MPH)*					Across All Windspeeds	
		5	15	30	45	60	5	15	30	45	60		
	REFERENCE HABITATIONAL BUILDING	—	—	—	—	—	—	—	—	—	—	—	—
COMMUNITY LEVEL	Fire Risk Reduction Community / Firewise USA Site												
	Other Wildfire Resilient Community Designation (Specify)												
DEFENSIBLE SPACE	Vegetation & Debris free decks												
	No combustible material within 5 ft of habitational structure												
	Non-combustible material used for improvements w/in 5 ft of habitational structure (e.g. fences, gates, decks)												
	No combustible structures within 30 ft (or in all of the area under control) of habitational structure												
	Compliant with PRC §4291 and similar												
	Fuel within Zones 1, 2 and 3												
STRUCTURE HARDENING	Class-A Fire Rated Roof												
	Enclosed Eaves												
	Fire Resistant Vents												
	Multi-pane Windows												
	Exterior surfaces with at least 6 inches of noncombustible vertical clearance measured from ground-up												
	Fire-resistant shutters (doors/windows)												
	Non-combustible Exterior Walls												
	Non-combustible gutters & downspouts												
Other Secondary Characteristics (specify)													
DIFFERENCES FROM FORM V-3 RELATIVE TO PRIOR MODEL VERSION													
WILDFIRE MITIGATION MEASURES AND SECONDARY CHARACTERISTICS IN COMBINATION		MEAN DAMAGE RATIO										Wildfire Loss Costs	
		RESIDENTIAL BUILDING					COMMERCIAL BUILDING					Res.	Comm.
		WINDSPEED (MPH)*					WINDSPEED (MPH)*					Across All Windspeeds	
		5	15	30	45	60	5	15	30	45	60		
	MITIGATED HABITATIONAL BUILDING												

*Windspeeds are sustained at 10-meters above ground

**Form A-1: Owners' Zero Deductible Personal and Commercial Residential
Property Wildfire Loss Costs by Impacted Centroid (Specific information to
be provided at a future date)**

Form A-2: Reference California Historical Wildfire Dataset Statewide Wildfire Losses

Purpose: This form illustrates the modeling organization’s ability to reasonably replicate historical California wildfire losses in the Reference California Historical Wildfire Dataset.

- A. Provide the total insured wildfire loss assuming zero deductible policies for individual historical wildfires. The list of wildfires in this form should include all California wildfires in the Reference California Historical Wildfire Dataset.

The modeling organization should populate the table below. Each historical wildfire should be identified by the name used in the Reference California Historical Wildfire Dataset (CAL FIRE FRAP FOD 9 database). For wildfires resulting in zero loss, the table entry should be left blank.

Wildfire Name	Abatement Date	Year	Wildfire Name	Eco-Region / Defined Spatial Area	Personal Residential Insured Wildfire Losses (\$)	Commercial Residential Insured Wildfire Losses (\$)
					(Total)	(Total)

- B. If additional assumptions are necessary to complete this form, provide the rationale for the assumptions as well as a detailed description of how they are included and implemented.
- C. Provide this form in Excel format. The file name should include the abbreviated name of the modeling organization, the wildfire guidelines year, and the form name. Also include Form A-2, Reference California Historical Wildfire Dataset Statewide Wildfire Losses, in a submission appendix.

Form A-3: Replicating Select Wildfire Historical Losses

Purpose: This form illustrates the modeling organization’s ability to reasonably replicate select historical wildfire losses for personal and commercial residential properties.

- A. One or more automated programs or scripts should be used to generate and arrange the data in Form A-3, Wildfire Losses.
- B. Provide the percentage of personal and commercial residential property zero deductible wildfire total loss, rounded to four decimal places, and the modeled loss from each of the wildfires in the Select Historical Wildfire Exposure Dataset for each affected impacted zone, with explanation and justification for resolution used.

The wildfire loss cost calculations must be produced by the wildfire catastrophe model being evaluated and should be the same wildfire parameters as used in completing Form A-2, Reference California Historical Wildfire Dataset Statewide Wildfire Losses.

Impacted Zone / Eco-Region / ZIP Code	Woolsey (2018)		Caldor (2021)		Carr (2018)		CZU Complex (2020)	
	Personal & Commercial Residential Modeled Total Loss (\$)	Percent of Total Loss (%)	Personal & Commercial Residential Modeled Total Loss (\$)	Percent of Total Loss (%)	Personal & Commercial Residential Modeled Total Loss (\$)	Percent of Total Loss (%)	Personal & Commercial Residential Modeled Total Loss (\$)	Percent of Total Loss (%)

- C. Provide maps color-coded by impacted zone/eco-region depicting the percentage of total personal and commercial residential property wildfire loss from each select historical wildfire, using the following interval coding.

Red	> 5%
Light Red	> 2% to 5%
Pink	> 1% to 2%
Light Pink	> 0.5% to 1%
Light Blue	> 0.2% to 0.5%
Medium Blue	> 0.1% to 0.2%
Blue	> 0% to 0.1%
White	0%

- D. Plot the relevant fire perimeter on each map. Include the wildfire perimeters used in calculating the historical wildfire losses and justification for the choices used when reviewed.
- E. Provide this form in both Excel and PDF format. The file name should include the abbreviated name of the modeling organization, the wildfire guidelines year, and the form name.

Form A-4: Wildfire Losses Output Range (Specific information to be provided at a future date)

Form A-5: Percentage Change in Wildfire Loss Output Ranges (Specific information to be provided at a future date)

Form A-6: Logical Relationships to Wildfire Risk (Specific information to be provided at a future date)

Form A-7: Percentage Change in Logical Relationships to Wildfire Risk (Specific information to be provided at a future date)

Form A-8: Wildfire Probable Maximum Loss for California

Purpose: This form provides an illustration of the distribution of wildfire losses. The form also illustrates that appropriate calculations were used to produce both expected annual wildfire losses and wildfire probable maximum loss levels.

- A. One or more automated programs or scripts should be used to generate and arrange the data in Form A-8, Wildfire Probable Maximum Loss for California.

- B. Provide a detailed explanation of how the expected annual wildfire losses and return periods are calculated and any assumptions made in the process.

- C. Complete Part A showing the personal and commercial residential property wildfire probable maximum loss for California. For the Expected Annual Wildfire Losses column, provide personal and commercial residential property, zero deductible statewide wildfire loss costs based on personal and commercial residential property zero deductible exposure data.
 - In the column, Return Period (Years), provide the return period associated with the average wildfire loss within the ranges indicated on a cumulative basis. For example, if the average wildfire loss is \$4,705 million for the range \$4,501-\$5,000 million, provide the return period associated with a wildfire loss that is \$4,705 million or greater.
 - For each wildfire loss range in millions (\$1,001-\$1,500, \$1,501-\$2,000, \$2,001-\$2,500) the average wildfire loss within that range should be identified and then the return period associated with that wildfire loss calculated. The return period is then the reciprocal of the probability of the wildfire loss equaling or exceeding this average wildfire loss size.
 - The probability of equaling or exceeding the average of each range should be smaller as the ranges increase (and the average wildfire losses within the ranges increase). Therefore, the return period associated with each range and average wildfire loss within that range should be larger as the ranges increase. Return periods should be based on cumulative probabilities.
 - A return period for an average wildfire loss of \$4,705 million within the \$4,501-\$5,000 million range should be lower than the return period for an average wildfire loss of \$5,455 million associated with a \$5,001-\$6,000 million range.

- D. **The following item is only applicable if the wildfire catastrophe model has been used for determination of the projected aggregate losses in a prior rate filing, and previously provided responses to these preliminary test cases:** Provide a graphical comparison of the current submitted wildfire catastrophe model commercial and Residential Return Periods Wildfire loss curve to the previously reviewed wildfire catastrophe model Residential Return Periods Wildfire loss curve. Residential Return Period (Years) should be shown on the y-axis on a log-10 scale with Wildfire Losses in Billions shown on the x-axis. The legend should indicate the corresponding wildfire catastrophe model with a solid line representing the current year and a dotted line representing the previously reviewed wildfire model.

- E. Provide the expected wildfire loss and 10% (lower bound) and 90% (upper bound) wildfire loss levels for each of the Personal and Commercial Residential Return Periods given in Part B, Annual Aggregate, and Part C, Annual Occurrence. Describe how the uncertainty in wildfire vulnerability functions has been propagated to the uncertainty in portfolio loss and how it relates to the 10% and 90% wildfire loss levels.
- F. If additional assumptions are necessary to complete this form, provide the rationale for the assumptions as well as a detailed description of how they are included and implemented.
- G. Provide this form in both PDF and Excel format. The file name should include the abbreviated name of the modeling organization, the wildfire guidelines year, and the form name. Also include Form A-8, Wildfire Probable Maximum Loss for California, in a submission appendix.

Part A – Personal and Commercial Residential Wildfire Probable Maximum Loss for California

WILDFIRE LOSS RANGE (MILLIONS)			TOTAL WILDFIRE LOSS	AVERAGE WILDFIRE LOSS (MILLIONS)	Total Burned Area	EXPECTED ANNUAL WILDFIRE LOSSES*	RETURN PERIOD (YEARS)
\$ >0	to	\$ 500					
\$ 501	to	\$ 1,000					
\$ 1,001	to	\$ 1,500					
\$ 1,501	to	\$ 2,000					
\$ 2,001	to	\$ 2,500					
\$ 2,501	to	\$ 3,000					
\$ 3,001	to	\$ 3,500					
\$ 3,501	to	\$ 4,000					
\$ 4,001	to	\$ 4,500					
\$ 4,501	to	\$ 5,000					
\$ 5,001	to	\$ 6,000					
\$ 6,001	to	\$ 7,000					
\$ 7,001	to	\$ 8,000					
\$ 8,001	to	\$ 9,000					
\$ 9,001	to	\$ 10,000					
\$ 10,001	to	\$ 11,000					
\$ 11,001	to	\$ 12,000					
\$ 12,001	to	\$ 13,000					
\$ 13,001	to	\$ 14,000					
\$ 14,001	to	\$ 15,000					
\$ 15,001	to	\$ 16,000					
\$ 16,001	to	\$ 17,000					
\$ 17,001	to	\$ 18,000					
\$ 18,001	to	\$ 19,000					
\$ 19,001	to	\$ 20,000					
\$ 20,001	to	\$ 21,000					
\$ 21,001	to	\$ 22,000					
\$ 22,001	to	\$ 23,000					
\$ 23,001	to	\$ 24,000					
\$ 24,001	to	\$ 25,000					
\$ 25,001	to	\$ 26,000					
\$ 26,001	to	\$ 27,000					
\$ 27,001	to	\$ 28,000					
\$ 28,001	to	\$ 29,000					
\$ 29,001	to	\$ 30,000					
\$ 30,001	to	\$ 35,000					
\$ 35,001	to	\$ 40,000					
\$ 40,001	to	\$ 45,000					
\$ 45,001	to	\$ 50,000					
\$ 50,001	to	\$ 55,000					
\$ 55,001	to	\$ 60,000					
\$ 60,001	to	\$ 65,000					
\$ 65,001	to	\$ 70,000					
\$ 70,001	to	\$ 75,000					
\$ 75,001	to	\$ 80,000					
\$ 80,001	to	\$ 90,000					
\$ 90,001	to	\$ 100,000					
\$ 100,001	to	\$ Maximum					
Total							

*Personal and commercial residential zero deductible statewide Wildfire loss using the personal and commercial residential zero deductible exposure data.

Part B – Personal and Commercial Residential Wildfire Probable Maximum Loss for California – Annual Aggregate

Return Period (Years)	Expected Wildfire Loss Level	10% Loss Level	90% Loss Level
Top Event			
1,000			
500			
250			
100			
50			
20			
10			
5			

Part C – Personal and Commercial Residential Wildfire Probable Maximum Loss for California – Annual Occurrence

Return Period (Years)	Expected Wildfire Loss Level	10% Loss Level	90% Loss Level
Top Event			
1,000			
500			
250			
100			
50			
20			
10			
5			