

Cause for Structure Fires

Determining cause is an important area of fire data analysis. For structure fires, the NFIRS employs a hierarchical schema that uses many different data elements to assign a cause to each incident. The schema examines the causal information for an incident and attempts to assign a cause through a series of queries. The first query checks to see if the incident's exposure number (EXP_NO) is greater than zero. If so, the incident is assigned to the Exposure cause category. If not, the second query checks to see if the cause of ignition is Intentional (FireIncident.txt, CAUSE_IGN = 1). If not, the queries proceed accordingly until a cause is determined or, if a cause cannot be determined, is Unknown.

The series of queries is used to assign one of 35 possible Priority Cause Codes to each structure fire. Following this, the Priority Cause Codes are aggregated in two steps to create a Main Fire Cause Code (16 values) and a General Cause Code (7 values). The Main Fire Cause Code is frequently used by the USFA in analyses involving structure fire cause. These cause codes are provided with the Public Data Release (PDR) in Causes.txt. The field PCC contains the Priority Cause Code for the incident, CAUSE_CODE contains the Main Fire Cause Code, and GCC contains the General Cause Code. The cause codes can be related to the incident using the ID fields (i.e., STATE, FDID, INC_DATE, INC_NO, and EXP_NO) or the primary incident key (INCIDENT_KEY).

Three-Level Structure Fire Cause Hierarchy

The series of queries used to determine cause applies 38 distinct criteria in the order shown in the following table to determine the Primary Cause Code. Each Primary Cause Code is also mapped to a Main Fire Cause Code and a General Cause Code.

Test No.	Priority Cause Codes		Main Fire Cause Codes		General Cause Codes	
	Code	Description	Code	Description	Code	Description
1	03	Exposure	12	Exposure	06	Exposure
2	04	Intentional	01	Intentional	01	Firesetting
3	38	Cause Under Investigation	16	Cause Under Investigation	07	Unknown
4	05	Children Playing	02	Playing with Heat Source	01	Firesetting
5	36	Other Playing	02	Playing with Heat Source	01	Firesetting
6	06	Natural	11	Natural	02	Natural
7	07	Fireworks	09	Other Heat	05	Flame, Heat
8	08	Explosives	09	Other Heat	05	Flame, Heat
9	09	Smoking	03	Smoking	05	Flame, Heat
10	11	Heating	04	Heating	03	Equipment
11	11	Heating	04	Heating	03	Equipment
12	12	Cooking	05	Cooking	03	Equipment
13	13	Air Conditioning	07	Appliances	03	Equipment
14	14	Electrical Distribution	06	Electrical Malfunction	04	Electrical
15	15	Appliances	07	Appliances	03	Equipment
16	16	Special Equipment	10	Other Equipment	03	Equipment
17	16	Special Equipment	10	Other Equipment	03	Equipment
18	17	Processing Equipment	10	Other Equipment	03	Equipment
19	18	Torches	08	Open Flame	05	Flame, Heat
20	19	Service Equipment	10	Other Equipment	03	Equipment
21	20	Vehicle, Engine	10	Other Equipment	03	Equipment
22	25	Unclassified Fuel Powered Equipment	10	Other Equipment	03	Equipment
23	39	Unclassified Equipment with Other or Unknown Fuel Source	13	Unknown	07	Unknown
24	26	Unclassified Electrical Malfunction	06	Electrical Malfunction	04	Electrical
25	27	Matches, Candles	08	Open Flame	05	Flame, Heat
26	28	Open Fire	08	Open Flame	05	Flame, Heat
27	29	Other Open Flame, Spark	09	Other Heat	05	Flame, Heat
28	30	Friction, Hot Material	09	Other Heat	05	Flame, Heat
29	31	Ember, Rekindle	08	Open Flame	05	Flame, Heat
30	32	Other Hot Object	09	Other Heat	05	Flame, Heat
31	06	Natural 2	11	Natural	02	Natural
32	21	Heat Source or Product Misuse	15	Other Unintentional, Careless	07	Unknown
33	22	Equipment Operation Deficiency	14	Equipment Misoperation, Failure	03	Equipment
34	23	Equipment Failure, Malfunction	14	Equipment Misoperation, Failure	03	Equipment
35	37	Trash, Rubbish	13	Unknown	07	Unknown
36	24	Other Unintentional	15	Other Unintentional, Careless	07	Unknown
37	33	Exposure 2	12	Exposure	06	Exposure
38	34	Unknown	13	Unknown	07	Unknown

Note: Fires are assigned to a cause category in the hierarchical order shown. For example, if the fire is judged to be intentionally set and a match was used to ignite it, it is classified as intentional and not open flame because intentional is higher on the list.

Primary Cause Code Criteria

These 38 queries, applied in order, assign a Primary Cause Code to each Structure Fire. Note that all queries also include this pseudo-code: BasicIncident.INC_TYPE = 111-123 & BasicIncident.AID != 3 & BasicIncident.AID != 4.

Order	PCC Code	PCC Description	PCC Pseudo-Code
1	03	Exposure	BasicIncident.EXP_NO != 0
2	04	Intentional	BasicIncident.EXP_NO = 0 & FireIncident.CAUSE_IGN = 1
3	38	Cause Under Investigation	BasicIncident.EXP_NO = 0 & FireIncident.CAUSE_IGN = 5 & Arson.CASE_STAT = 1-5
4	05	Children Playing	BasicIncident.EXP_NO = 0 & (((FireIncident.FACT_IGN_1 = 19 FireIncident.FACT_IGN_2 = 19) FireIncident.CAUSE_IGN = 2) & FireIncident.AGE = 1-9 & FireIncident.HUM_FAC_7 = 7)
5	36	Other Playing	BasicIncident.EXP_NO = 0 & (FireIncident.FACT_IGN_1 = 19 FireIncident.FACT_IGN_2 = 19)
6	06	Natural	BasicIncident.EXP_NO = 0 & (FireIncident.HEAT_SOURC = 70-74 FireIncident.CAUSE_IGN = 4 FireIncident.FACT_IGN_1 = 65 FireIncident.FACT_IGN_2 = 65)
7	07	Fireworks	BasicIncident.EXP_NO = 0 & FireIncident.HEAT_SOURC = 54
8	08	Explosives	BasicIncident.EXP_NO = 0 & (FireIncident.HEAT_SOURC = 50-53 FireIncident.HEAT_SOURC = 55-59)
9	09	Smoking	BasicIncident.EXP_NO = 0 & FireIncident.HEAT_SOURC = 61-63
10	11	Heating	BasicIncident.EXP_NO = 0 & BasicIncident.INC_TYPE != 113 & FireIncident.FIRST_IGN != 76 & FireIncident.EQUIP_INV = 123-124
11	11	Heating	BasicIncident.EXP_NO = 0 & ((BasicIncident.INC_TYPE = 114 BasicIncident.INC_TYPE = 116) (BasicIncident.INC_TYPE != 113 & FireIncident.EQUIP_INV = 100, 120-122, 125-152))
12	12	Cooking	BasicIncident.EXP_NO = 0 & (BasicIncident.INC_TYPE = 113 FireIncident.EQUIP_INV = 630-649, 654 (FireIncident.FIRST_IGN = 76 & FireIncident.EQUIP_INV = 123-124))
13	13	Air Conditioning	BasicIncident.EXP_NO = 0 & FireIncident.EQUIP_INV = 111-117, 445, 652, 655, 656
14	14	Electrical Distribution	BasicIncident.EXP_NO = 0 & (FireIncident.FACT_IGN_1 = 37 FireIncident.FACT_IGN_2 = 37 FireIncident.EQUIP_INV = 200-223, 226-227, 230-299)
15	15	Appliances	BasicIncident.EXP_NO = 0 & (FireIncident.EQUIP_INV = 310-316, 318-319, 345, 600, 611-612, 621-623, 651, 653, 730-759, 800, 810-869, 871, 874-876, 881-883, 891-897 (FireIncident.EQUIP_INV = 872 & FireIncident.EQ_POWER != 20-39))
16	16	Special Equipment	BasicIncident.EXP_NO = 0 & ((BasicIncident.INC_TYPE = 115, 117 & FireIncident.FACT_IGN_1 = <blank> & FireIncident.FACT_IGN_2 = <blank>) (FireIncident.FACT_IGN_1 != 10-27, 50-58 & FireIncident.FACT_IGN_2 != 10-27, 50-58))

17	16	Special Equipment	BasicIncident.EXP_NO = 0 & FireIncident.EQUIP_INV = 224, 340-344, 346-349, 361, 372-374, 376-377, 400, 410-429, 431-432, 440-444, 446-451, 500-599, 700-729 & FireIncident.FACT_IGN_1 != 10-27, 50-58 & FireIncident.FACT_IGN_2 != 10-27, 50-58
18	17	Processing Equipment	BasicIncident.EXP_NO = 0 & FireIncident.EQUIP_INV = 300, 317, 320-329, 351, 353, 355-358, 371 & FireIncident.FACT_IGN_1 != 10-27, 50-58 & FireIncident.FACT_IGN_2 != 10-27, 50-58
19	18	Torches	BasicIncident.EXP_NO = 0 & (FireIncident.FACT_IGN_1 = 13 FireIncident.FACT_IGN_2 = 13 FireIncident.EQUIP_INV = 331-334)
20	19	Service Equipment	BasicIncident.EXP_NO = 0 & FireIncident.EQUIP_INV = 225, 228-229, 352, 354, 362-365, 433-434 & FireIncident.FACT_IGN_1 != 10-27, 50-58 & FireIncident.FACT_IGN_2 != 10-27, 50-58
21	20	Vehicle, Engine	BasicIncident.EXP_NO = 0 & (FireIncident.MOB_INVOL = 2-3 FireIncident.HEAT_SOURC = 68 FireIncident.EQUIP_INV = 375)
22	25	Unclassified Fuel Powered Equipment	BasicIncident.EXP_NO = 0 & FireIncident.HEAT_SOURC = 10-12 & FireIncident.EQ_POWER = 10-49 & FireIncident.FACT_IGN_1 != 10-27, 50-58 & FireIncident.FACT_IGN_2 != 10-27, 50-58
23	39	Unclassified Equipment with Other or Unknown Fuel Source	BasicIncident.EXP_NO = 0 & FireIncident.HEAT_SOURC = 10-12 & FireIncident.EQ_POWER != 10-49 & FireIncident.FACT_IGN_1 != 10-27, 50-58 & FireIncident.FACT_IGN_2 != 10-27, 50-58
24	26	Unclassified Electrical Malfunction	BasicIncident.EXP_NO = 0 & (FireIncident.HEAT_SOURC = 13 FireIncident.FACT_IGN_1 = 30-36 FireIncident.FACT_IGN_2 = 30-36 FireIncident.EQUIP_INV = 200)
25	27	Matches, Candles	BasicIncident.EXP_NO = 0 & (FireIncident.HEAT_SOURC = 64-66 (FireIncident.EQUIP_INV = 872 & FireIncident.EQ_POWER = 20-39) FireIncident.EQUIP_INV = 873)
26	28	Open Fire	BasicIncident.EXP_NO = 0 & FireIncident.HEAT_SOURC = 67
27	29	Other Open Flame, Spark	BasicIncident.EXP_NO = 0 & FireIncident.HEAT_SOURC = 60, 69
28	30	Friction, Hot Materials	BasicIncident.EXP_NO = 0 & FireIncident.HEAT_SOURC = 41-42
29	31	Ember, Rekindle	BasicIncident.EXP_NO = 0 & (FireIncident.HEAT_SOURC = 43 FireIncident.FACT_IGN_1 = 72 FireIncident.FACT_IGN_2 = 72)
30	32	Other Hot Object	BasicIncident.EXP_NO = 0 & FireIncident.HEAT_SOURC = 40
31	06	Natural 2	BasicIncident.EXP_NO = 0 & (FireIncident.FACT_IGN_1 = 60-66 FireIncident.FACT_IGN_2 = 60-66)
32	21	Heat Source or Product Misuse	BasicIncident.EXP_NO = 0 & (FireIncident.FACT_IGN_1 = 10-19 FireIncident.FACT_IGN_2 = 10-19)
33	22	Equipment Operation Deficiency	BasicIncident.EXP_NO = 0 & (FireIncident.FACT_IGN_1 = 50-58 FireIncident.FACT_IGN_2 = 50-58)

34	23	Equipment Failure, Malfunction	BasicIncident.EXP_NO = 0 & (FireIncident.FACT_IGN_1 = 20-27 FireIncident.FACT_IGN_2 = 20-27 FireIncident.CAUSE_IGN = 3)
35	37	Trash, Rubbish	BasicIncident.EXP_NO = 0 & (BasicIncident.INC_TYPE = 118 FireIncident.FIRST_IGN = 96)
36	24	Other Unintentional	BasicIncident.EXP_NO = 0 & (FireIncident.FACT_IGN_1 = 20-27 FireIncident.FACT_IGN_2 = 20-27 FireIncident.CAUSE_IGN = 2)
37	33	Exposure 2	BasicIncident.EXP_NO = 0 & (FireIncident.FACT_IGN_1 = 70-71, 73-75 FireIncident.FACT_IGN_2 = 70-71, 73-75 FireIncident.HEAT_SOURC = 80-89)
38	34	Unknown	BasicIncident.EXP_NO = 0

Main Structure Fire Cause Hierarchy in Hierarchical Order

For USFA's analytic purposes, all structure fires in the NFIRS fall into one of the 16 Main Fire Cause categories, denoted by a code. The cause categories include determinations of intent (intentional, investigation, playing, unintentional), accidental fires (smoking, heating, etc.), natural fires, exposure fires, and malfunction fires. Note that the cause categories listed in the following table are in hierarchical order.

Cause Category	Code	Definition
Exposure	12	Caused by heat spreading from another hostile fire.
Intentional	01	Cause of ignition is intentional, or fire is deliberately set.
Cause Under Investigation	16	Cause is under investigation, and a valid NFIRS Arson Module is present.
Playing with Heat Source	02	Includes all fires caused by individuals playing with any materials contained in the categories below as well as fires where the factors contributing to ignition include playing with heat source. Children playing with fire are included in this category.
Natural	11	Caused by the sun's heat, spontaneous ignition, chemicals, lightning, static discharge, high winds, storms, high water including floods, earthquakes, volcanic action, and animals.
Other Heat	09	Includes fireworks, explosives, flame/torch used for lighting, heat or spark from friction, molten material, hot material, heat from hot or smoldering objects.
Smoking	03	Cigarettes, cigars, pipes, and heat from undetermined smoking materials.
Heating	04	Includes confined chimney or flue fire, fire confined to fuel burner/boiler malfunction, central heating, fixed and portable local heating units, fireplaces and chimneys, furnaces, boilers, water heaters as source of heat.
Cooking	05	Includes confined cooking fires, stoves, ovens, fixed and portable warming units, deep fat fryers, open grills as source of heat.
Appliances	07	Includes televisions, radios, video equipment, phonographs, dryers, washing machines, dishwashers, garbage disposals, vacuum cleaners, hand tools, electric blankets, irons, hairdryers, electric razors, can openers, dehumidifiers, heat pumps, water cooling devices, air conditioners, freezers and refrigeration equipment as source of heat.
Electrical Malfunction	06	Includes electrical distribution, wiring, transformers, meter boxes, power switching gear, outlets, cords, plugs, surge protectors, electric fences, lighting fixtures, electrical arcing as source of heat.
Other Equipment	10	Includes special equipment (radar, x-ray, computer, telephone, transmitters, vending machine, office machine, pumps, printing press, gardening tools, or agricultural equipment), processing equipment (furnace, kiln, other industrial machines), service, maintenance equipment (incinerator, elevator), separate motor or generator, vehicle in a structure, unspecified equipment.
Open Flame, Spark (heat from)	08	Includes torches, candles, matches, lighters, open fire, ember, ash, rekindled fire, backfire from internal combustion engine as source of heat.
Other Unintentional, Careless	15	Includes misuse of material or product, abandoned or discarded materials or products, heat source too close to combustibles, other unintentional (mechanical failure/malfunction, backfire).
Equipment Misoperation, Failure	14	Includes equipment operation deficiency, equipment malfunction.
Unknown	13	Cause of fire undetermined or not reported.

Cause for Vehicle, Outside, and Other Fires

While these cause categories have usefulness for the other property types — vehicle, outside and other fires — there are limitations. For these property types, the causes of fires are based on the distributions of the NFIRS cause of ignition (CAUSE_IGN) data element located on the fire incident file. This data element captures a very broad sense of the cause of the fire.

Cause of Fire Versus Cause of Fire Death/Fire Injury

There is a subtle, but important, difference in the phrases “cause of fire,” “cause of a fire that results in deaths/injuries” (i.e., cause of fatal fires or of fires that result in injuries), and “cause of fire deaths.” The latter phrase is an incorrect application of the fire cause methodology to the one-to-many relationship of fire to deaths and injuries.

The first phrase, “cause of fire,” is a straightforward application of the NFIRS cause hierarchy to count the number (or determine the percent) of fires that fall into a particular category. The second phrase, “cause of a fire that results in deaths/injuries” is also a straightforward application of the hierarchy to count types of fires—this time to count only those fires where deaths or injuries result. An analysis of casualty-producing fires is an informative analytic task that is very important to understanding the risks of specific behaviors or circumstances and to better identify life safety issues.

The phrase, “cause of fire deaths,” is not as precise as, “cause of fires that resulted in deaths/injuries.” The hierarchical schema used to determine structure fire cause does not examine factors that may have contributed to reported casualties, so it is incorrect to say that Exposure, Intentional, or any of the other Cause Categories is the cause of any fire casualty.

In principle, it is the cause of the fire that results in deaths and injuries (as well as dollar loss) that should be analyzed — not numbers of deaths and injuries (or dollar losses) associated with fire causes. Therefore, analyses of fire cause address fires that result in deaths (fatal fires), fires that result in injuries, and fires that result in dollar loss.

Children Playing

The NFIRS 5.0 causes, as defined by the USFA, no longer address the specific cause of “children playing.” The USFA has opted for the overall cause of “playing with fire.” To determine, to the extent possible, if a child playing with a heat source (such as matches or stove top) caused the fire, the analyst will need to include the human factor contributing to ignition where age was a factor (HUM_FAC_7) is equal to 7 in the query criteria, factors contributing to ignition and other requirements. In addition, an age range or cutoff for the associated age variable will need to be included. *It is important to note that the priority causes cannot be taken out of context from the matrix; doing so will include incidents that would have been included in other priority codes based on earlier steps in the matrix. It is recommended that the entire cause matrix be implemented.*

Smoking-Related (Smoking) Versus Smoking Materials

The term “smoking-related fires” applies to those fires that are caused by cigarettes, cigars, pipes, and heat from undetermined smoking materials. The USFA differentiates between smoking as a cause of fires and fires ignited by smoking materials. Smoking (or smoking-related fires) is considered a behavioral cause. Fires ignited by smoking materials are considered as a group of fires where smoking materials were the heat source. The two sets are similar but not identical. A deliberately-set fire with smoking materials as the heat of ignition would be considered an “intentional” fire; a fire unintentionally set by someone smoking (cigarettes, cigars, or other smoking materials) would be considered a “smoking-related fire.”

As well, “smoking-related” or “smoking materials” is not synonymous with cigarettes. Cigarettes, however, are by far the leading smoking material heat source reported to the NFIRS under the ‘open flame and smoking materials’ heat source category. In fact, in 2020, cigarettes accounted for 78.7% of smoking material heat sources (i.e., HEAT_SOURC = 61, 62, 63), cigars and pipes accounted for 1.5%, and undetermined smoking materials accounted for 19.8%.