"False Alarms and Unwanted Activations"
From:

U.S. EXPERIENCE WITH SMOKE ALARMS AND OTHER FIRE DETECTION/ALARM EQUIPMENT

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False Alarms and Unwanted Activations

False alarms and nuisance activations (in all occupancy types, not just homes) are problems to both the fire service and to building occupants. False alarms tie up fire department resources. Nuisance activations interrupt other activities and may lead people to ignore the early warning of a smoke alarm. They are the leading reason for deliberately disabling smoke alarms. In 2003, U.S. fire departments responded to 2,189,500 false alarms, excluding good intent calls and smoke scares. Ten percent of all fire department responses were to false calls; only 7% were to fires. (Medical aid calls accounted for 61% of the responses.) [55]

Figure 4 shows that 36% of the false calls were due to system malfunctions. Thirty-five percent (35%) of the false calls were unintentional calls, including incidents in which smoke alarms operated as designed, but the operation was unwelcome and unneeded, such as activations while broiling.

Other countries are having similar problems. In New Zealand, false alarms accounted for almost 40% of the fire call responses during 1998. About half of all false alarms came from fire alarm systems. Fifty-one percent of New Zealand's false alarms were caused by 8% of the alarm systems.[56] In the United Kingdom, false alarms accounted for about 47% of the fire call responses in 2001, with 27% of all fire calls being false calls "due to apparatus."[57]

Since 1997, U.S. fire departments have responded to more false alarms than real fires. (See Figure 5.) Because of the toll on fire department resources, some communities have imposed or are considering imposing fees on property owners or fire alarm businesses after multiple nuisance or false alarms. The National Burglar and Fire Alarm Association and the False Alarm Reduction Association have jointly developed a model fire alarm ordinance that includes a fee ratio for properties having more than three false or nuisance alarms over the course of a year.[58]

Section 11.7.8.2 of the *2002* edition of NFPA 72, *National Fire Alarm Code,*®, allows remote monitoring stations to "verify alarm signals prior to reporting them to the fire service provided that the verification process does not delay the reporting by more than 90 seconds." This provision applies to household alarms only.

Peter Finley of the Vineland, New Jersey Fire Department won a 2002 outstanding research award for his analysis of the verification and response dilemma with residential fire alarm systems. In his survey of fire departments protecting populations of 47,000 to 67,000 (About one-third responded.), he found that three-quarters of the departments did

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[55] Michael J. Karter, Jr., *Fire Loss in the United States during 2003,* Quincy, MA: NFPA, 2004, pp. 25-26, available from http://www.nfpa.org/assets/files/PDF/OS.fireloss.pdf.
[56] New Zealand Fire Service –"False Alarms Costs," from http://www.fire.org.nz/facts_stats/false_alarm/false.htm.
[57] Lorraine Watson, Georgina Ford, Darren Sugg, and Jon Gamble, *Fire Statistics — United Kingdom 2001,* London, U.K., Office of the Deputy Prime Minister, Fire Statistics and Research, April 29, 2003, pp. 11, 57, available at http://www.odpm.gov.uk/stellent/groups/odpm_fire/documents/page/odpm_fire_608483.hcsp.
[58] National Burglar & Fire Alarm Association and False Alarm Reduction Association, "Model Fire Alarm Ordinance – A Joint Document of NBFAA/FARA, 8/27/01, from http://www.faraonline.org/ModelFireOrdinance.pdf.

not permit this verification of residential alarms. In his study, 89% did not consider smoke from cooking or burnt food to be a false alarm, and smoke from candles or a fireplace was not considered a false alarm by 70%. Forty-five percent issued fines, penalties or citations to repeat false alarm offenders. Responding departments indicated that, on average, actual fires caused 2.8% of the residential fire alarm activations, 26.5% were caused by smoke from cooking or burnt food, 3.7% were triggered by steam from a shower, 4.1% were triggered by smoke from fireplaces, candles, etc., 23.8% were other accidental activations, and 31.2%, on average, were system malfunctions.

Finley also surveyed Vineland households with residential fire alarm activations in the previous year. Eighty-four percent said they tried to stop the fire department from responding.[59]

There are no easy answers for handling the increased load of false alarms generated by fire alarm systems. NFPA and the fire service have promoted these systems because of the early warning they provide. Fire can move very quickly and the early warning and fire department notification save lives. Should fire departments elect to require verification, the risk of liability, not to mention the risk to life and property, could be high. However, firefighters face the risk of needless response, and these false alarms tax scare resources.

When smoke alarm batteries were missing, it was usually because of annoying alarm activations from cooking.

As noted earlier, batteries were removed or disconnected far more frequently than was AC power. In the CPSC study, when batteries were removed or disconnected from alarms, the leading reason was unwanted activations. Removal for this reason was eight times as frequent as removal to use the batteries in another product.[60] The leading problems cited for smoke alarms with dead batteries or missing or disconnected power sources were: 1) alarming to cooking fumes and 2) alarming continuously when powered. (Some of the latter may have been the device chirping to indicate a low battery.) These two were cited with roughly equal frequency. Sounding too often for unspecified reasons was the next most frequently cited unwanted alarm problem. Alarming to steam or humidity was cited about one-fourth to one-third as often as either of the two leading problems.[61]

1/3 of alarms cited for nuisance activations were located incorrectly.

Nuisance alarm problems often can be addressed by moving the device to a different location or by switching from ionization-type to photoelectric-type devices. One-third of the devices studied for nuisance alarms in the National Smoke Detector Project were reportedly in locations that made nuisance alarms more likely, often *less than five feet* from a potential source of smoke, steam, or moisture sufficient to produce nuisance alarms.[62]

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[59] Peter J. Finley, Jr., "Residential Fire Alarm Systems: The Verification and Response Dilemma," Executive Analysis of Fire Service Operations in Emergency Management, an applied research project submitted to the National Fire Academy as part of the Executive Fire Officer Program, from http://www.usfa.fema.gov/pdf/efop/tr 02pf.pdf, pp. 27-40.

[60] Charles L. Smith, *Smoke Detector Operability Survey – Report on Findings*, Bethesda, MD: U.S. Consumer Product Safety Commission, November 1993, p. 12.

[61] Charles L. Smith, *Smoke Detector Operability Survey – Report on Findings*, Bethesda, MD: U.S. Consumer Product Safety Commission, November 1993, p. 22.

[62] Charles L. Smith, *Smoke Detector Operability Survey – Report on Findings*, Bethesda, MD: U.S. Consumer Product Safety Commission, November 1993, p. 23.

NIST study draws similar conclusions.
As part of their research into the performance of smoke alarms in today's homes, the National Institute of Standards and Technology (NIST) conducted tests on a variety of scenarios associated with nuisance alarms. In these tests, they found that ionization smoke alarms had a tendency to activate in response to aerosols produced during some normal cooking. They recommended that such smoke alarms be placed as far as possible from cooking equipment but still in the protected area.[63]

Ionization devices had a disproportionate share of nuisance alarms.
Cooking smoke tends to contain more of the smaller particles (less than one micron) that activate an ionization-type device rather than the larger particles that activate a photoelectric-type device. In the National Smoke Detector Project, 97% of the devices tested for involvement in nuisance alarms were ionization-type devices, although they comprised only 87% of all devices in the study.[64]

Reducing the sensitivity of smoke alarms can reduce the likelihood of nuisance alarms. The National Smoke Detector Project referenced one dormitory study that found that devices involved in nuisance alarms were more sensitive, on average, than those that were not.[65] However, the project report cautioned that reduced sensitivity could adversely affect a smoke alarm's ability to provide timely warning of a real fire.

The few studies of field experience with unwanted alarms have shown consistently that smoke detection and alarm systems produce far more nuisance activations than real alarms. A study of Veterans Administration hospitals found 15.8 unwanted activations for every real alarm, or one unwanted activation for every six devices per year.[66]

An earlier study of home smoke detection as units in an Automatic Remote Residential Alarm System (ARRAS) in The Woodlands, TX, found 27.0 unwanted activations for every real alarm, or unwanted activations in six of every seven homes each year.[67] While both studies identified a number of steps that could be taken to sharply reduce the rate of unwanted activations, the current rate is so high that neither study expects unwanted activations can be made less frequent than real smoke activations. Thus, nuisance activations may continue to induce owners to deactivate their smoke alarms.

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[63] Richard W. Bukowski, Richard D. Peacock, Jason D. Averill, Thomas G. Cleary, Neslon P. Bryner, William D. Walton, Paul A. Reneke, and Erica D. Kuligowski, NIST Technical Note 1455, *Performance of Home Smoke Alarms: Analysis of the Response of Several Available Technologies in Residential Fire Settings*, Washington, DC: U.S. Department of Commerce, National Institute of Standards and Technology, July 2004, p. 250, available at http://smokealarm.nist.gov/HSAT.pdf.
[64] Charles L. Smith, *Smoke Detector Operability Survey – Report on Findings*, Bethesda, MD: U.S. Consumer Product Safety Commission, November 1993, Appendix B, pp. 20-21.
[65] Charles L. Smith, *Smoke Detector Operability Survey – Report on Findings*, Bethesda, MD: U.S. Consumer Product Safety Commission, November 1993, Appendix B, pp. 20-21.
[66] Peter M. Dubivsky and Richard W. Bukowski, *False Alarm Study of Smoke Detectors in Department of Veterans Affairs Medical Centers (VAMCS)*, NISTIR 89-4077, Gaithersburg, MD: National Institute of Standards and Technology, May 1989, p. 45.
[67] Remote Detection and Alarm for Residences - The Woodlands System, Washington: U.S. Fire Administration, May 1980.

In a 2004 survey conducted for the NFPA, 40% of the respondents with smoke alarms reported that one had sounded at least once in the past twelve months.[68] Sixty-nine percent reported activations due to cooking activities, 13% were due to battery problems, including the low-battery chirping, 5% were due to steam (frequently from a shower), and 4% of the activations were due to smoke alarm tests.

All respondents who reported that an alarm had sounded were asked for their first thought after they heard it:

- 24% said that food had burned;
- 11% thought about how to turn off the smoke alarm;
- 11% were unconcerned because they know what caused it to sound;
- 8% investigated;
- *Only 8% thought there was a fire and they should get out;*
- 7% recognized the low battery signal;
- 7% were annoyed at what they assumed to be a nuisance alarm;
- 3% noted that the smoke alarm works;
- 3% thought they should have sued the exhaust fan; and
- 2% didn't recognize it as a smoke alarm and wondered what it was.

As noted in Finley's study, some of the nuisance activations, particularly from cooking, fall into a gray area. A sounding smoke alarm may remind a cook who has left the kitchen area of food on the stove requiring immediate attention. While not yet a fire, the potential exists if corrective action is not taken. If such action is taken, the situation can often be quickly resolved without fire department involvement. Only 13% of the cooking fires experienced by people interviewed in the British Crime Survey were reported to the fire department. This was the lowest share of any of the fire causes studied.[69]

These responses show that most people do not automatically assume a sounding smoke alarm is an emergency situation. In some cases, they know what caused the alarm and know that they are safe. However, lives have been lost when real alarms were mistakenly considered false. Unwanted activations can generate a dangerous sense of complacency.

The best solution would seem to involve working with fire alarm companies and homeowners to ensure that appropriate equipment is used in the correct locations, and perhaps switching to photoelectric detection equipment in areas exposed to cooking smoke or bathroom steam. Sometimes, the threat of penalties may facilitate a search for a solution. However, the threat may also deter and delay the reporting of real fires.

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[68] 2004 Fire Prevention Week Survey conducted for National Fire Protection Association by Harris Interactive Market Research, pp. 11-14.

[69] Rebecca Aust, *Home Office Statistical Bulletin, Fires in the Home: Findings from the 2000 British Crime Survey,* London, U.K., Crime and Criminal Justice Unit, Research, Development and Statistics Directorate of the Home Office, August 2, 2001, Issue 13/01, pp. 11-12, available from http://www.homeoffice.gov.uk/rds/pdfs/hosb1301.pdf.

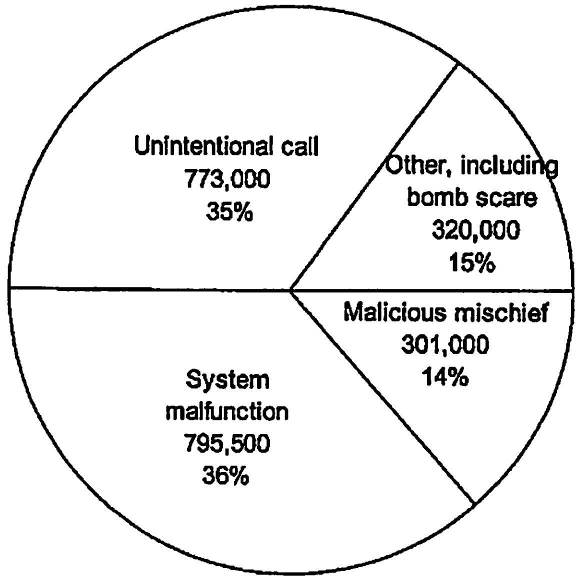
Naperville, IL study found that after a "shakedown" period, newer technology reduced rate of unwanted activations.

A 1996-1998 study of unwanted commercial fire alarm activations in Naperville, Illinois compared the frequency of unwanted activations with the age and number of systems. In this study of fire department responses to unwanted alarms, 30-32% of unwanted alarms came during the "shakedown" period, i.e., from installations less than 12 months old. After this period, the newer systems produced fewer false (responses to non-smoke stimuli) alarms than the older ones.[70] The Model Fire Ordinance of NBFAA and FARA proposes a 45-day grace period after a new installation is completed before the imposition of any false alarm fees.[71]

[70] Fred Conforti, "False Alarms: The Battle Isn't Over," *NFPA Journal*, July/August 1999, Volume 93, Number 4, pp. 86-89.

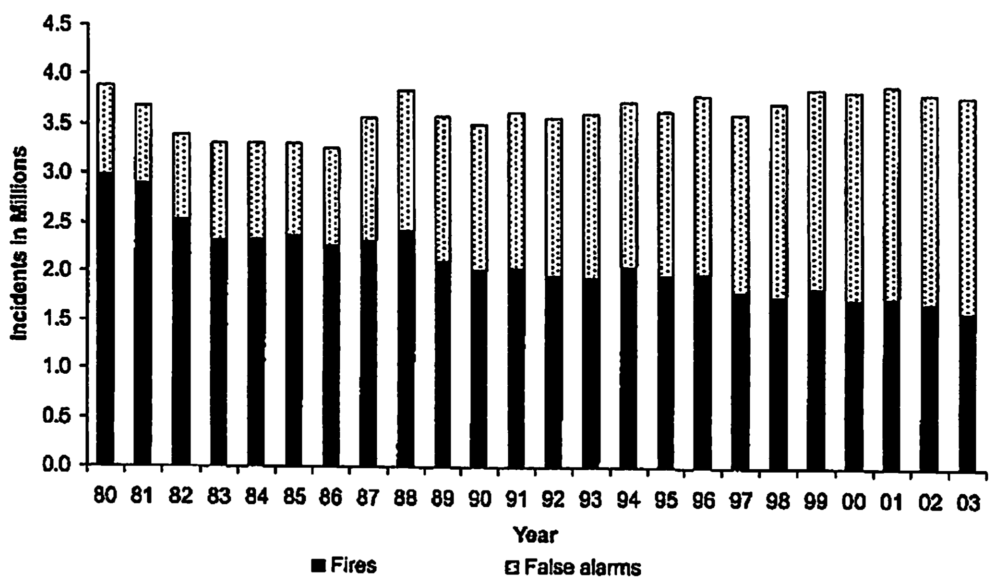
[71] National Burglar & Fire Alarm Association and False Alarm Reduction Association, "Model Fire Alarm Ordinance – A Joint Document of NBFAA/FARA," 8/27/01, p. 8, from http://www.faraonline.org/ModelFireOrdinance.pdf.

Figure 4. U.S. False Alarms during 2003



Source: Michael J. Karter, Jr., *Fire Loss in the United States during 2003*, Quincy, MA: NFPA, 2004, pp. 25-26, available from http://www.nfpa.org/assets/files/PDF/OS.fireloss.pdf.

Figure 5. Reported Fires and False Alarms: 1980-2003



Source: Michael J. Karter, Jr., *Fire in the United States*, Annual reports, Quincy, MA: NFPA.

Appendix E: How National Estimates Statistics Are Calculated

Estimates are made using the National Fire Incident Reporting System (NFIRS) of the Federal Emergency Management Agency's (FEMA's) United States Fire Administration (USFA), supplemented by the annual stratified random-sample survey of fire experience conducted by the National Fire Protection Association (NFPA), which is used for calibration.

Databases Used

NFIRS provides annual computerized data bases of fire incidents, with data classified according to a standard format based on the NFPA 901 Standard. Roughly three-fourths of all states have NFIRS coordinators, who receive fire incident data from participating fire departments and combine the data into a state database. These data are then transmitted to FEMA/USFA. Participation by the states, and by local fire departments within participating states, is voluntary. NFIRS captures roughly one-third to one-half of all U.S. fires each year. More than one-third of all U.S. fire departments are listed as participants in NFIRS, although not all of these departments provide data every year.

The strength of NFIRS is that it provides the most detailed incident information of any national data base not limited to large fires. NFIRS is the only data base capable of addressing national patterns for fires of all sizes by specific property use and specific fire cause. (The NFPA survey separates fewer than 20 of the hundreds of property use categories defined by NFPA 901 and solicits no cause-related information except for intentional fires.) NFIRS also captures information on the presence and performance of smoke alarms and sprinklers.

The NFPA survey is based on a stratified random sample of roughly 3,000 U.S. fire departments (or just over one of every ten fire departments in the country). The survey includes the following information: (1) the total number of fire incidents, civilian deaths, and civilian injuries, and the total estimated property damage (in dollars), for each of the major property use classes defined by the NFPA 901 Standard; (2) the number of on-duty firefighter injuries, by type of duty and nature of illness; and (3) information on the type of community protected (e.g., county versus township versus city) and the size of the population protected, which is used in the statistical formula for projecting national totals from sample results.

The NFPA survey begins with the NFPA Fire Service Inventory, a computerized file of about 30,000 U.S. fire departments, which is the most complete and thoroughly validated such listing in existence. The survey is stratified by size of population protected to reduce the uncertainty of the final estimate. Small rural communities protect fewer people per department and are less likely to respond to the survey, so a large number must be surveyed to obtain an adequate sample of those departments. (NFPA also makes follow-up calls to a sample of the smaller fire departments that do not respond, to confirm that those that did respond are truly representative of fire departments their size.) On the other hand, large city departments are so few in number and protect such a large proportion of the total U.S. population that it makes sense to survey all of them. Most respond, resulting in excellent precision for their part of the final estimate.

Projecting NFIRS to National Estimates
To project NFIRS results to national estimates, one needs at least an estimate of the NFIRS fires as a fraction of the total so that the fraction can be inverted and used as a multiplier or scaling ratio to generate national estimates from NFIRS data. But NFIRS is a sample from a universe whose size cannot be inferred from NFIRS alone. Also, participation rates in NFIRS are not necessarily uniform across regions and sizes of community, both of which are factors correlated with frequency and severity of fires. This means NFIRS may be susceptible to systematic biases. No one at present can quantify the size of these deviations from the ideal, representative sample, so no one can say with confidence that they are or are not serious problems. But there is enough reason for concern so that a second data base - the NFPA survey - is needed to project NFIRS to national estimates and to project different parts of NFIRS separately. This multiple calibration approach makes use of the annual NFPA survey where its statistical design advantages are strongest.

There are separate projection formulas for four major property classes (residential structures, non-residential structures, vehicles, and other) and for each measure of fire severity (fire incidents, civilian deaths, and civilian injuries, and direct property damage).

For example, the scaling ratio for 1998 civilian deaths in residential structures is equal to the total number of 1998 civilian deaths in residential structure fires reported to fire departments, according to the NFPA survey (3,250), divided by the total number of 1998 civilian deaths in residential structure fires reported to NFIRS (1,224). Therefore, the scaling ratio is 3,250/1,224 = 2.66.

The scaling ratios for civilian deaths and injuries and direct property damage are often significantly different from those for fire incidents. Except for fire service injuries, average severity per fire is generally higher for NFIRS than for the NFPA survey. Use of different scaling ratios for each measure of severity is equivalent to assuming that these differences are due either to NFIRS under-reporting of small fires, resulting in a higher-than-actual loss-per-fire ratio, or possible biases in the NFIRS sample representation by region or size of community, resulting in severity-per-fire ratios characteristic only of the oversampled regions or community sizes.

Note that this approach also means that the NFPA survey results for detailed property-use classes (e.g., fires in storage structures) may not match the national estimates of the same value.

Calculating National Estimates of Particular Types of Fires
Most analyses of interest involve the calculation of the estimated number of fires not only within a particular occupancy but also of a particular type. The types that are mostly frequently of interest are those defined by some ignition-cause characteristic. The six cause-related characteristics most commonly used to describe fires are: form of the heat that caused the ignition, equipment involved in ignition, form or type of material first ignited, the ignition factor that brought heat source and ignited material together, and area of origin. Other characteristics of interest are victim characteristics, such as ages of persons killed or injured in fire.

For any characteristic of interest in NFIRS, some reported fires have that characteristic unknown or not reported. If the unknowns are not taken into account, then the propensity to report or not report a characteristic may influence the results far more than the actual patterns on that characteristic. For example, suppose the number of fires remained the same for several consecutive years, but the percentage of fires with cause unreported steadily declined over those years. If the unknown-cause fires were ignored, it would appear as if fires due to every specific cause increased over time while total fires remained unchanged. This, of course, does not make sense.

Consequently, most national estimates analyses allocate unknowns. This is done by using scaling ratios defined by NFPA survey estimates of totals divided by only those NFIRS fires for which the dimension in question was known and reported. This approach is equivalent to assuming that the fires with unreported characteristics, if known, would show the same proportions as the fires with known characteristics. For example, it assumes that the fires with unknown ignition factor contain the same relative shares of child-playing fires, incendiary-cause fires, short circuit fires, and so forth, as are found in the fires where ignition factor was reported.

Rounding Errors

The possibility of rounding errors exists in all our calculations. One of the notes on each table indicates the extent of rounding for that table, e.g., deaths rounded to the nearest one, fires rounded to the nearest hundred, property damage rounded to the nearest hundred thousand dollars. In rounding to the nearest one, functional values of 0.5 or more are rounded up and functional values less than 0.5 are rounded down. For example, 2.5 would round to 3, and 3.4 would round to 3. In rounding to the nearest one, a stated estimate of 1 could be any number from 0.5 to 1.49, a roughly threefold range.

The impact of rounding is greatest when the stated number is small relative to the degree of rounding. As noted, rounding to the nearest one means that stated values of 1 may vary by a factor of three. Similarly, the cumulative impact of rounding error - the potential gap between the estimated total and the sum of the estimated values as rounded - is greatest when there are a large number of values and the total is small relative to the extent of rounding.

Suppose a table presented 5-year averages of estimated deaths by item first ignited, all rounded to the nearest one. Suppose there were a total of 30 deaths in the 5 years, so the total average would be 30/5 = 6.

In case 1, suppose 10 of the possible items first ignited each accounted for 3 deaths in 5 years. Then there would be 10 entries of 3/5 = 0.6, rounded to 1, and the sum would be 10, compared to the true total of 6.

In case 2, suppose 15 of the possible items first ignited each accounted for 2 deaths in 5 years. Then there would be 15 entries of 215 = 0.4, rounded to 0, and the sum would be 0, compared to the true total of 6.

Here is another example: Suppose there were an estimate of 7 deaths total in 1992 through 1996. The 5-year average would be 1.4, which would round to 1, the number we would show as the total. Each death would represent a 5-year average of 0.2.

If those 7 deaths split as 4 deaths in one category (e.g., smoking) and 3 deaths in a second category (e.g., heating), then we would show 4 x 0.2 = 0.8 deaths per year for smoking and 3 x 0.2 = 0.6 deaths per year for heating. Both would round to 1, there would be two entries of 1, and the sum would be 2, higher than the actual rounded total.

If those 7 deaths split as 1 death in each of 7 categories (quite possible since there are 12 major cause categories), then we would show 0.2 in each category, always rounding to 0, and the sum would be 0, lower than the actual rounded total. The more categories there are, the farther apart the sum and total can -- and often do -- get.

Note that percentages are calculated from unrounded values, and so it is quite possible to have a percentage entry of up to 100%, even if the rounded number entry is zero.