

Applying Safety Standards for Flammable Refrigerants

Refrigerant safety standards and resulting building codes have been very restrictive in the use of flammable refrigerants for HVAC&R products. But as societal demands to control climate change are forcing HVAC designers to consider new lower global warming potential (GWP) refrigerants that are flammable, stakeholders have been working to develop the understanding and practice on how to apply these refrigerants. After more than 10 years, product safety standards and ASHRAE application safety standards are in their final stages of being updated to allow the use of flammable refrigerants.

ASHRAE Journal conducted a roundtable discussion with several industry experts who have been working to update standards related to handling flammable refrigerants (see next page for contributors).

Moderator Steve Kujak: We've been using nonflammable refrigerants for 70, 80 years. What are the major new practices incorporating and handling flammables in the standards?

Rusty Tharp: Many of the same practices we use for the AIs will also apply to flammable A2L, A2 and A3 refrigerants. For example, with A1, these refrigerants are under pressure, so you've got to be careful when you're handling them. You've got to keep cylinders upright during transportation, you have to secure the cylinders properly in storage and secure them properly in transportation. A lot of those same rules we use for current refrigerants still apply with A2Ls. Then, while

some of the codes and standards are being modified, we do expect that, for A2L refrigerants, much of the storage and transportation requirements are going to be similar.

Craig Grider: The biggest change in practices for refrigerants I've been a part of is the development and then utilization of new safety standards for appliances and equipment using flammable refrigerants. I want to start off by pointing out that the development of UL 60335-2-40 [*Standard for Household And Similar Electrical Appliances—Safety—Part 2-40: Particular Requirements for Electrical Heat Pumps, Air-Conditioners and Dehumidifiers*] was a monumental task for the HVAC industry because the breadth and scope covers a wide range of HVAC products. UL 60335-2-40 has combined under one standard now, products from prior standards such as UL 1995 [*Heating and Cooling Equipment*], UL 484 [*Standard for Room Air Conditioners*] and UL 474 [*Standard for Dehumidifiers*].

So now, we have had to look at products that span from small room air conditioners all the way up to large chillers that operate at thousands of volts. With that, it becomes difficult to look at how we need to apply requirements for the safe use of flammable refrigerants across the entire board of HVAC and refrigeration products.

The main focus currently for most of the industry is A2L refrigerants. We have accepted A2s and A3s into the safety standards, but for now at least, the charge limitations are much lower than those of A2Ls. The industry is going to need to work doing research and updating these standards on a continuous basis as we try to keep up with the new designs and innovative technology that will come with the change to flammable refrigerants. So again for me, this is a huge scope we're looking at, and that's why it's taken over a decade with a lot of research testing and discussions by the industry to get to this point.

Kujak: I know there's discussion around charge limit changes and detectors for use of flammables. Let's talk a bit about that.

Brian Rodgers: We started on international standards first, which stemmed from IEC SC61D, the international subcommittee responsible for IEC 60335-2-40 for air-conditioning equipment and the UL SDP (Standard Development Process). We decided to join forces, and work on the IEC 60335-2-40 standard first. We brought this back and drafted the UL-60335-2-40 with North American deviations. Once research and consensus was achieved, we proposed the same A2L requirements to UL 60335-2-89. We decided to put UL 60335-2-89 [*Household and Similar Electrical Appliances - Safety - Part 2-89: Particular Requirements for Commercial Refrigerating Appliances with an Incorporated or Remote Refrigerant Unit or Compressor*] for commercial refrigeration on hold and do all the work in the air-conditioning industry first and then bring that into the UL 60335-2-89 group to harmonize safety practices. As of the date of this roundtable recording, the second edition of UL 60335-2-89 was to be published in the U.S. on Oct. 27. We tried to harmonize the charge limits, and the mitigation schemes, and detector requirements as much as possible between the UL 60335-2-89 and the UL-60335-2-40.

If you look at the third edition of UL-60335-2-40 that's currently published, and the UL 60335-2-89 standard, a lot of the requirements and concepts for charge limits

and mitigation strategies are very similar. We are working on the fourth edition of UL-60335-2-40. It's gone out for preliminary review; we're currently reviewing well over 700 comments that were received, and the standards are diverging as the two working groups have different opinions on what is safe for the two types of equipment. The commercial refrigeration requirements are going to be quite a bit different. You think of a multi-split system—they really have the same thing in commercial refrigeration where you've got a rack system back in the back in the machinery room, and you're supplying several cases, whether they're freezer cases or refrigeration cases. Each standard has the same kind of concepts. Keep it below the lower flammability limit (LFL).

We have this M1 charge limit—M1 is the charge limit when only room area is used to determine the charge limit: $M1 \leq 6 \times LFL$. Above that we have to look at mitigation, and that involves mitigation methods like turning on safety shutoff valves, or turning on fans, shutting down compressors, or maybe leaving them on if it reduces the leak rate. So there's a lot of harmonization between commercial refrigeration and the air-conditioning world. But one thing we're looking at is—we've done so much research—we've involved the fire service and the building code guys into developing these requirements. There have been struggles. We've done a lot of training out there, and the fire service and the code guys are starting to see that we really can have safe equipment using flammables. As long as the installation is done properly to the manufacturer's instructions, you can have a safe application as well.

Grider: Following on what Brian was saying, one of the major installation changes happening in the codes and standards for charge limitations is that we are looking at the releasable charge. So that it's not just about the total

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Status of Standards Discussed in This Roundtable

- UL 60335-2-40, *Standard for Household And Similar Electrical Appliances—Safety—Part 2-40: Particular Requirements for Electrical Heat Pumps, Air-Conditioners and Dehumidifiers*

Rodgers: The fourth edition of UL-60335-2-40 is currently out for preliminary review. It received well over 700 review comments. The committee's goal is to publish the standard in the early third quarter of 2022 and to make a proposal to the building codes that the fourth edition go into 2024 building codes.

- UL 60335-2-89, *Household and Similar Electrical Appliances - Safety - Part 2-89: Particular Requirements for Commercial Refrigerating Appliances with an Incorporated or Remote Refrigerant Unit or Compressor*

Rodgers: This standard was scheduled to be published October 27, 2021.

- ASHRAE Standard 15-2019, *Safety Standard for Refrigeration Systems*

Tharp: Several addenda to this standard have been published already. The standard does allow for A2L refrigerants today, but as noted elsewhere during the roundtable, the current requirements are more restrictive than UL 60335-2-40, 3rd edition and UL 60335-2-89, 2nd edition. A couple of states do reference the current Standard 15-2019. As mentioned, there are several addenda that have been published, and several more that are on the way. For Standard 15 itself, most of those addenda are expected to be published within roughly a year or so aligning with the publication of UL-60335-2-40's 4th edition.

- ASHRAE Standard 15.2P, *Safety Standard for Refrigeration Systems in Residential Applications*

VerShaw: This proposed standard has undergone three public reviews and an advisory public review. It is about to undergo a fourth more focused review, which we plan to be the last review before publishing late this year or early 2022.

Once Standard 15.2P is published, then the residential coverage will be removed from Standard 15; then Standard 15 will cover commercial and Standard 15.2P will cover residential fixed systems. ■

charge of the system, but what is releasable in the event of a leak.

Rodgers: Let me interject, the AHRTI 9015 report was accepted recently and is now published on the AHRI website under Research. That project looked at the mitigation strategies in UL 60335-2-89 and in UL-60335-2-40, and it verified our mitigation strategies.

Jennifer Butsch: Overall, both UL 60335-2-89 and UL 60335-2-40 have been updated to incorporate the safe use of A2Ls and, relative to the commercial refrigeration side, A3s. In particular most of these standards updates focus on mitigation and safety measures designed to prevent conditions needed to have a flammable event.

In both cases there is recognition that to have a flammable event you need to be somewhere between the lower flammability limit and the upper flammability limit. So, if we can prevent that from occurring, then there would never be a situation in which a flammable event could occur. In both cases these safety standards are replacing existing standards to which equipment is certified today. So, although this conversation focuses around A2Ls, and flammable refrigerants in general, both standards updates took into account mechanical and electrical requirements that needed to be pulled over from other standards as well.

Kujak: Jim VerShaw, do you want to jump into the discussion?

Jim VerShaw: Some of the things you're going to notice as you start installing equipment with A2Ls is that the refrigerant bottles service techs are going to be using will have left-handed threads on them. Then some systems will require refrigerant detection systems. Those are probably the bigger differences they're going to see on the servicing side from what they're dealing with currently. Most installations in the past had to be checked to meet RCL (refrigerant concentration limit). But usually it wasn't calculated (for residential applications) because it was so hard to hit that level that it wasn't important to do so.

With A2L refrigerants, the installer's going to have to understand how much refrigerant can be released into the space, and how big the room size is, to see if there is a leak it will hit the maximum refrigerant concentration levels or not. That's going to be determined after the system is fully charged up. Not until that point will they know the total releasable charge, and then they can calculate how close the installed system is to the maximum

allowable. That will determine whether or not a detection system is needed for the system. These are the key things that are going to be different in terms of what the installer's going to have to look at.

From a manufacturer's viewpoint, a lot of things are going to stay pretty much the same, except in the control box where the contractors will be limited to how much power they can transfer, so if a leak of refrigerant occurs, it can't ignite the refrigerant and cause a fire. Overall, the A2Ls, while they are more flammable than A1s, are not explosive, and I feel that we've created standards and installation instructions that will make these new systems very safe and very reliable

Kujak: I've heard twice so far in the conversation that we're pushing some requirements over to the installation side, and we're going to have to look at the application where we didn't before with the non-flame propagation refrigerants. Is that a concern for people here?

Rodgers: Regarding the charge limit and the room area size, we're helping the installers out by requiring a label on some of this, especially as we talk about how UL 60335-2-40 covers room air conditioners, spot coolers, those type of things. We're putting on there—based on the charge, to install the product, in the minimum sized room area—you've got to have at least this many square feet to install this piece of equipment. So that's going to help out, especially the consumer that buys these goods. He's going to say, "Okay, I want an air conditioner for my bedroom." He'll be able to say, "Well, my bedroom's this size, I need to do this to be safe."

To help the consumer we have added Annex DD in UL 60335-2-40, which adds minimum requirements for the installation and servicing of the equipment. One such requirement is to mark the minimum room area that the equipment can be installed in.

Grider: What Brian is saying is interesting because in this situation we had a safety standard UL 60335-2-40, which in some cases was leading the codes in the development. A lot of the installation requirements are still prevalent in this safety standard, but those are being transferred over to installation standards such as ASHRAE Standard 15 [*Safety Standard for Refrigeration Systems*] and ASHRAE Standard 15.2P [*Safety Standard for Refrigeration Systems in Residential Applications*] where they belong.

Steve, your question was, "Is there concern about putting some of these requirements on the installer?" In

ASHRAE Standard 15, and in ASHRAE Standard 15.2P, there has been a lot of discussion and consideration of that very question. Concerns from the industry included questions like, "Well, do we really want installers having to do complex calculations in the field to determine maximum charge limits based on the design of the occupied spaces?" We needed to provide tools that will allow them to quickly make these determinations.

So instead, from the certification standpoint, like Brian said, we're looking at the installation requirements as provided by manufacturers.

We're doing some of those calculations to verify room areas and how the manufacturer's going to go about putting the information out there in an easy way for the installer to interpret and apply. But in the end, it's going to come down to following the codes, like Standard 15 and Standard 15.2P, to see, "Is the product certified?" Okay, it is. Now, how is it being applied per that installation manual, which would dictate everything, like Brian said.

VerShaw: In Standard 15.2P we're using tables instead of equations to aid the installer to determine the installation limitations when using A2Ls. And 15.2 has safety factors built in. Brian mentioned the testing done in AHRTI 9015, and that allowed us to relax some of the safety factors such that you can get a little more charge in a given room size. I think all of that is helping us be less concerned about proper installation. Of course, with any air-conditioning installation you're always concerned that they got the duct sizes right, and they've got the wiring done right, and they've got the piping done right. That doesn't change. Here they must take that extra step to understand the room sizes and the amount of releasable charge.

Kujak: So, I know we've been talking about UL-60335-2-40. Are these same practices and charge limits all the same with UL 60335-2-89?

Grider: No, and that's intentional because the way commercial refrigeration appliances are installed is different than HVAC, and there are different code requirements for egress and things like that, which have to be considered as to where they're installed. Lobbies and foyers—those type of areas are going to have different charge limitation requirements than, say, the freezer that's hidden in the back of the commercial kitchen.

Rodgers: You think of the major difference—especially these factory-sealed systems—they typically use an A3

refrigerant, not the A2Ls. So the second edition of UL 60335-2-89 for example is going to allow for open cases, up to 500 grams (1.1 lb) of an A3. For closed-door cases, because you think if you have an evaporator leak that refrigerant could accumulate in the closed door case, or that drawer case and not come out all at once, we're allowing only 300 grams (0.67 lb).

Commercial refrigeration, when we're using the A3s, we have this test. It is Annex CC in UL 60335-2-89 where we are looking at the concentration at 50% LFL around the enclosure, because a commercial kitchen has many ignition sources. An A3 is highly flammable, and can be really explosive. So, if you fail the Annex CC test and get above 50% of the LFL around the enclosure, we're saying you cannot put an ignition source within 20 ft (6 m) of that. That's a marking that is going to go on the equipment, and that's carried over into ASHRAE Standard 15. So in the commercial kitchen, it's going to limit the size of that commercial refrigerator. You're not going to be able to have one of these cases that has 300 grams (0.67 lb) of an A3 located in that space.

Kujak: I think a lot of readers can relate to commercial refrigeration, because every time I go to the grocery store, almost everything has a door on it now to meet the U.S. Department of Energy efficiency minimums.

Rodgers: Right.

Kujak: So it seems we're going to more and more to enclosed spaces for everything in the refrigeration area.

Butsch: That was one of our concerns when we developed the standard: retrofitting doors onto equipment is common practice today. But with a flammable refrigerant that won't be allowed, unless you bring the whole case into compliance with the lower charge limits and mitigations outlined in UL 60335-2-89 and ASHRAE Standard 15.

Kujak: Who regulates that? Let's say a grocery store hires somebody and says, "I'm going to put doors on all my open cases." What jurisdiction has authority over these installations to show compliance?

Grider: If you do that, and you had a listed refrigerator display case, and you put a door on it, if that is not part of the listing to have that door on it, it is now no longer listed, because you modified the construction. So you would technically not have a listed product anymore.

Tharp: Proposed addendum I to ASHRAE Standard 15-2019 says it has to be approved for a door to be put on. As to who actually enforces it, it's the same as all codes.

Right? There's a local authority having jurisdiction (AHJ) who does the enforcement aspects. As people note concerns, there will be people who do things and don't follow the code and don't pull permits, that does happen. But as a general rule, if people are following the rules, an AHJ will come to validate the change.

Kujak: Is that a rigorous process?

Tharp: I'm going to say Brian Rogers and Craig Grider probably have a lot more interaction with AHJs than I do. But, based upon my knowledge, it's a challenge sometimes for contractors to go get in line for an inspection by the AHJ. And I've seen places where AHJs are very picky.

Grider: These days, just given the way things are going, it could be longer queue times for inspections and approvals. I will say by the time a request for a site evaluation gets to UL or any safety consultant, it's usually a quick turnaround for us to complete the work. When we come out, we're just assessing the installation with minimal testing; we're looking at the construction and comparing it to the safety standard, and once we complete all our checks we are giving the AHJ the information they need to feel comfortable with it. So, I think probably just like what Rusty was saying, just the queue time getting the AHJ involved because—like so many of us currently—they are backed up too. What do you think, Brian?

Rodgers: Yeah, it's what we'd call field evaluation. That's called out in proposed Addendum I to Standard 15. So one of the options is, the AHJ can say, "I want an NRTL [nationally recognized testing laboratory] to come out and do a field evaluation." Craig says, "One of the NRTLs can come out there, evaluate that product, make sure now that it's got a door it doesn't exceed that 300 gram [0.67 lb] charge." We may want to do some follow-up testing. Did the manufacturer actually do some testing prior where the door is an option already? That type of thing. We'd come out there and do that evaluation. It's done today when they modify equipment in the field.

Kujak: Do the standards prevent people from converting units from Class A1 refrigerants to Class A2L, A2 or A3 refrigerants? Is that called out specifically?

Tharp: Yes, both Standard 15 and Standard 15.2P specifically say you can't change refrigerant classes.

Rodgers: Actually, the EPA came out and made it a law that you cannot retrofit household refrigerators from R-134a to an A3. Really, they're using isobutane in many household refrigerators. There was a big rash of that,

especially in the south where installers were grabbing their jug of propane from their gas grill and charging these household refrigerators, and they were getting an evaporator leak. In those old systems, they had a defrost heater in that evaporator. If that evaporator leaked and that defrost heater kicked on, boom, their refrigerator blows up. I got a lot of pictures of these over the years. The AHJ would say what, “What happened?” I go, “They probably charged it with propane.”

Kujak: So, I hear we’re going to put left-handed threads on bottles. How are we going to prevent a workaround on the unit if they still have right-handed threads on the cylinder?

VerShaw: Well, that’s actually a discussion we’ve been having. Just because you have threads one way or another doesn’t mean somebody can’t rig something up to work with whatever threads they encounter. I don’t think that’s a big deal. I think the other issue on retrofit is the EPA’s SNAP rule for A2Ls, in air conditioning anyway. EPA says it’s only approved for use in new equipment.

Grider: So, as a hypothetical here, what happens if the installer changes out the outdoor unit to one that’s approved for A2L, and then goes inside and does the necessary changes, maybe just swaps out the coil. Does that meet the definition of what’s required in Standard 15 and Standard 15.2P currently?

VerShaw: Well, Standard 15.2P and I think Standard 15 both say that the indoor and the outdoor units need to be certified for the refrigerants being used. So you won’t find R-32, or R-454B, or R-452B on any indoor unit right now. So, the indoor coil needs to be changed to one that is certified for flammables, and of course ASHRAE Standard 15 and ASHRAE Standard 15.2P require a UL listing. That’s how the rules are set up.

Greg Relue: What Craig and Jim said is correct. If a new A2L condensing unit and a new uncased coil are tested to the same refrigerant as the condensing unit by the manufacturers and labeled for the given refrigerant, it can be installed per Standard 15 or Standard 15.2P.

Rodgers: I think there’s still a huge concern about the interconnecting line set because typically they’re behind walls and you can’t see them. In one of those things, if we have a joint outside that space, it needs to be put in a vented chase. We don’t know these line sets. We’ve been arguing for years: do we make them replace the line set, even though we know they probably won’t? But we don’t

know if there’s a joint in there, and it could be a leaky joint.

VerShaw: That’s why Standard 15.2P in their piping section requires substantially more in terms of pressure testing and vacuum testing than has been done in the past—to ensure if that you’re going to use existing piping, or if you’re putting in new piping, that you have all the joints done appropriately, and they are going to hold up.

Tharp: Jim VerShaw on the Standard 15.2P group did a good job of putting those testing requirements together. That’ll help validate that there’s not a leak in a wall somewhere.

Butsch: In EPA SNAP Rule 23 they did allow for reuse of existing tubing. But every other component (compressor, evaporator, condenser) needs to be new. I agree that Standard 15.2P did a great job. Now we have to make sure that the training gets out there to the people in the field. The documents have been well vetted and put together and thought through. But communicating and training folks in the field is really where the rubber meets the road, so to speak.

Kujak: The previous roundtable we did on refrigerant regulation, when we talked to Andrea Voigt, Director General of the European Partnership for Energy and the Environment in Brussels, Belgium, she said the biggest gap they have is training. Obviously, we’re probably not well trained right now in the U.S.

Tharp: The Refrigeration Service Engineers Society, has had a training program for several years for flammable refrigerants. The industry is working very hard to make sure there are training programs available. Anybody can go today to North American Technician Excellence’s (NATE) website, to Air Conditioning Contractors of America (ACCA), to other such organizations for training programs for A2Ls. And, we obviously know that most OEMs will have their own programs in addition to what these other entities provide.

Grider: Then, from a standpoint of meeting the standard requirements, you’ve got UL and others that are training the manufacturers, because the manufacturers need to understand what the certification body and the test agencies are going to require. We’re the ones that are interpreting UL-60335-2-40 and UL 60335-2-89. So, we train the manufacturers who then in turn, like Rusty said as the OEMs, can train their engineers, so that the design practices are met. Then, they can train the industry as needed.

Rodgers: I still think there's a gap. These guys have to have their EPA certificate. But it's usually just that installer's owner that goes out there, then everybody under him that works for him, that actually goes out there and does the work. They rely on his certificate to go buy refrigerant, to go buy equipment. I think there's going to be that gap. Are the owners of these installers and their workforce out there, that actually do the day-to-day, if we still have a gap of those guys being trained?

Kujak: What I have heard is we need training to handle and service flammable refrigerants, but I am also hearing we need training on how to install and apply a product using flammable refrigerants. Earlier, it sounded like it is all the same but only slightly different when using flammables, but upon closer inspection, the differences are quite large. Right?

VerShaw: Well, I think the biggest difference is the room volume and the releasable charge. The instructions are going to have to be very clear with good explanation of what must be done. Every time a company rolls out a new product that's different, the manufacturer provides information to the people who are going to install that new product to make sure it gets installed properly, like when variable speed systems came out, with very complicated electronics and control schemes. We went through that, and it went pretty smoothly, and I think this will as well.

But yeah, right now I don't think EPA's going to require additional certification for technicians. We'll see if that changes. Some states may, but I think, as Rusty mentioned, there's flammable refrigerant information available today, and the OEMs will have information on how to install their products going forward.

Grider: The mitigation practices are what are going to be key for the industry service techs and most of the installers to understand. A lot of work has been done within the last two years harmonizing between UL 60335-2-40 and Standard 15 and Standard 15.2P on what these mitigation practices are going to be. In a lot of cases, it should be pretty clear as to what the form of mitigation is, whether that's a refrigerant detection system, or some other means such as safety shutoff valves to control the releasable charge. Or, you've got what would be considered to be continuous operation of a circulation fan. But understanding what those mitigations are—why they're there—will help anybody that's installing.

That gets back to what I think Brian was talking about, maybe with the gap of just doing some training there. If you don't understand what the mitigation is, and why it's being used, it's difficult to understand how it should be applied.

Kujak: Something I was thinking about just now, we talk about room area. My house, it's a very open space. How do you handle all these connected rooms that might have a hallway?

VerShaw: For residential, that's detailed in Standard 15.2P. If you have a space with no door, it's considered connected. If you have a door, there are requirements about the size of the gap under the door. It's all well laid out. Standard 15.2P covers applications with different elevations—and when there is an open area on the second floor that goes to the lower floor. It tells you how to calculate the maximum charge levels. That's all in there.

Kujak: Do these rules apply to refrigeration products, and are they the same in UL 60335-2-89 as well?

Grider: Yes.

Kujak: So they have that similar methodology?

Grider: Right.

Rodgers: We tried to copy over as much into the second edition of UL 60335-2-89 from UL-60335-2-40. Like I said, we wanted to get the work done in UL-60335-2-40 and not have two different groups trying to do the same thing.

Grider: Yes, the mitigation requirements implemented in both standards are similar and both have requirements for the manufacturer to provide installation manuals that detail how to apply those mitigations. These manuals must provide tables and clear guidance on how to install the product within a defined space while considering things such as releasable charge, connected spaces and ventilation.

Kujak: So it's all the same, but now it's more different.

Butsch: Yes. You also have to consider spaces like walk-in coolers and freezers that have minimum volume limitations, and that is outlined in the UL 60335-2-89 standard. This minimum volume/intended use will be marked on the unit and/or included in the installation instructions.

Kujak: My last question to everybody is the one thing you want readers to know and remember about flammable refrigerants?

Tharp: These refrigerants can be safely used. Such safe use is based upon appropriate preparation, the

training and education we talked about and the appropriate care following the installation, service, operation manuals and labels, as well as the standard industry best practices.

Butsch: With the implementation of the AIM Act, directing the EPA to phase down HFCs by 85% over the next 15 years, A2Ls are critical in achieving that. Although A2Ls are suitable replacements for existing refrigerants, they're not drop-ins. So training is key to the success of this transition.

VerShaw: I think moving to a GWP that's a quarter to a third less than the GWP of R-410A is good for the environment and good for the country. That does move us to slightly flammable refrigerants, but with the work that we've done on codes and standards, these new systems are going to be safe, and they will be relatively easy to install and maintain, and we shouldn't be worrying about them.

Grider: I'm just going to continue to echo what everybody else has said, and add that with the amount of research and discussions that have taken place over the

last decade, I am not concerned about the safe implementation of flammable refrigerants. Also, consider that we are just adopting and improving practices that were already in place in Europe and Asia for appliances using flammable refrigerants. In every committee I've been a participant, we've listened to any concerns from code officials and regulatory bodies, and then the Industry has done its best to address all their questions with research-backed data. So because of this, I think these are going to be safe appliances.

Relue: I would agree with Craig's comments. The science in our testing and research have shown if the equipment is designed, manufactured to the standards and installed per the manufacturer's instructions and the codes, the products will be safe to use in both residential and commercial environments.

Rodgers: We've been working on this for well over 10 years, and I believe that the equipment is safe as long as it's installed properly to the manufacturer's instructions and the codes. ■

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