

# The Pros Of LNG: An In-Depth Discussion With Dr. Phani K. Raj

By Tyler Reeb  
Editor

Diligent observers of the debate over Sound Energy Solution's (SES) proposal to build a liquefied natural gas (LNG) terminal at the Port of Long Beach know there is no shortage of purported experts passionately arguing for or against the controversial project. Further, most familiar with the review processes for high-profile environmental impact reports (EIRs) and environmental impact statements (EISs) will tell you that it is a common practice for opposing factions to "stack up" experts to bolster their respective cases.

SES, a Mitsubishi subsidiary, seeks to build an LNG importation terminal in conjunction with ConocoPhillips on Pier T in the Port of Long Beach. LNG is natural gas that has been cooled to minus 259 degrees Fahrenheit into a liquid form hundreds of times more condensed than its gaseous form, which makes it a profitable and importable energy source. If built, SES' proposed facility would receive LNG imports delivered by tanker ships. The terminal itself would include two massive storage tanks (each tank would be 176 feet tall and 255 feet wide), re-gasification facilities, pipelines and delivery and unloading equipment. The 25-acre terminal site would be located less than two miles from sections of Downtown Long Beach. Opponents of the project – including the California Public Utilities Commission (CPUC), community members and scientists who have studied the hazards of liquefied gases – argue the proposed terminal would put residents and workers in those nearby urban areas at risk if there were a fire or explosion caused by an accident, natural disaster or terrorist attack at the site.

However, late last year, the Federal Energy Regulatory Commission (FERC) and the Long Beach Harbor Commission issued a joint draft EIR/EIS that, by and large, declared the proposed LNG terminal safe. In the weeks that followed the release of that document, the CPUC, other state agencies and the City of Long Beach raised a substantial number of questions and concerns they had with the document. Supporters and opponents of the project are now awaiting the release of the final EIR/EIS, which will seek to address all the questions raised in response to the draft EIR/EIS.

Meanwhile, the Business Journal has actively examined the perspectives of both project opponents and supporters. Recently, the Business Journal interviewed Dr. Jerry Havens, probably the most visible and respected opponent of LNG terminals built in close proximity to heavily urbanized areas. (That interview is available for download at [www.lbbj.com/pdfs.php](http://www.lbbj.com/pdfs.php).)

With the intent of presenting both dissenting and approving stances on the proposed LNG facility, this reporter caught up with Dr. Phani Raj, president of Technology & Management Systems, Inc., an individual that SES representatives have characterized as an LNG expert who supports the construction of an onshore LNG terminal in the Port of Long Beach.

## Q&A With Dr. Phani Raj

**LBBJ:** To start off, I think it would be useful for our readers to understand your thoughts on LNG generally as a transitional fuel in the years ahead.

**Raj:** LNG is nothing but a cooled version of the natural gas that we are used to in our kitchens . . . and process industries as well. It is not a new fuel. It is a new form of the same fuel that the society has been using for the last 100 years. It is a hydrocarbon, which means it has a carbon and a hydrogen atom just like any other fuel that we are familiar with – for example gasoline, diesel and our home heating oil. The only reason LNG is used in commerce is because one gets an advantage of about 640-to-1 in the . . . volume of the gas. It's very hard to deal with large quantities of [natural] gas, especially when one needs to transfer it from where it is mined thousands of miles away to where it is used, like, for example, the U.S. So LNG is a liquid; it is [stored] at a very low temperature, like minus 260 degrees Fahrenheit. It is called a cryogenic liquid and it is not any more dangerous, in my opinion, compared to any other fuel that we are used to and has been used very safely in this country and everywhere else in the world for a number of years – decades, in fact, more than that. So that's my view of LNG.

**LBBJ:** Do you think the proposed LNG terminal that SES seeks to build in the Port of Long Beach poses any homeland security or public safety threats to Long Beach residents and workers?

**Raj:** You know, that's a very difficult question to answer. I have not really looked in[to] any, for anybody [involved] in the security issues, but what I am aware of compared to all the other things [is that SES' proposed project] is as secure a place as you're ever going to get. First of all, the security regime that's going to be in place has to . . . meet the regulatory requirements of the U.S. Coast Guard under what is called the Waterways Suitability Assessment Requirement. You know, this is not any more of an interesting target to anybody than any other target that we have to protect equally well. . . . Obviously, it's a large energy storage facility and there are a lot of other energy storage facilities and there are a lot of other chemical storage facilities, which pose equal or more danger to the society and, in my opinion, this is a very well guarded facility – or at least it's supposed to be well guarded – compared to, for

example, what you might think in the normal port environment, where you have thousands and thousands of containers that come in. One doesn't have the means at the moment . . . or even the time, to review everything. So, I think if you look at the Port of Long Beach compared to all of the other things that are going on, this probably is a much more safe facility because it is going to be guarded 24/7 with a very strict security regiment.

**LBBJ:** But what risks do you think the project poses?

**Raj:** From a security risk [standpoint] or from just an ordinary risk from the perspective of safety?

**LBBJ:** Well, as I said before, homeland security or public safety risks – what are they?

**Raj:** First of all, let's understand something. LNG is a flammable material. That means it burns if it is ignited. And society would not be using it were it not for the fact that it burned. If it didn't burn, we wouldn't use it in our boilers, our kitchen stoves or home heating. So, the fact that it is stored and if it gets ignited first, there is a fire risk, obviously. But is this a unique one? No, it is not. . . . Any other flammable liquid – gasoline, propane, fuel lines of every kind – also pose the same kind of risk. So, I don't think this is any more of a risk compared to any other fuels of the same sized storage. But from a homeland security perspective, again, I've got to qualify my statement, I'm not an expert in security issues. But, as a common citizen, I can think of many other, let's say, targets that probably are more vulnerable and less protected than an LNG facility is ever going to be. LNG is going to be very, very carefully protected simply because it has been discussed in the public domain for so long and with so many people talking about it. So from a risk perspective, I don't see this as any more risky than any other facility. So, again, I've got to really qualify my statement by saying that I'm thinking, maybe [I'm] a better informed ordinary citizen than an expert on security affairs.

**LBBJ:** Do you think the many homeland security- and public safety-related concerns raised in response to the draft EIR/EIS for the proposed project were warranted?

**Raj:** I don't think so. If you look at the facility design and, obviously, it's not built and you can only go by the design that's being discussed and submitted to the Federal Energy Regulatory Commission, or FERC, and their review of the design of the facility and all the other security and safety regimes . . . and protocols that go with the facility. First of all, this is going to be designed with what is called a full containment tank. That means there are going to be two very massive walls for each tank – one containing the liquid and the other would contain the liquid were the inner tank to fail for any reason whatsoever . . . The second thing is that Pier T, where this [proposed terminal] is going to be located is an ideal place [because] it's surrounded by industrial sites – it is an industrial site. There are no residential properties anywhere within a mile of the facility and the port is going to be well guarded. And the port itself . . . is well designed to handle large ships from the traffic perspective as well as from the perspective of safety. The security regime we just talked about is going to be in place – certainly the Coast Guard will vet it through their regulatory requirements and only if they give [a] permit will this project ever go in terms of the security and safety. By the way, the Coast Guard security requirement does not stop at the waterline. It also goes into the facility itself. So both the physical facility as well as the traffic patterns and the ship management is a part of the Coast Guard requirement. You know, I always say the price for freedom is eternal vigilance and I think . . . SES has taken that very carefully into consideration. So, it's going to be well guarded and, in my opinion, the safety and security risks are minimal compared to any other facility that we in this country have been used to for at least 50 years if not more.

**LBBJ:** So, with that said, why do you think that agencies like the CPUC and other state agencies would take such a strong stance against this facility?

**Raj:** I think that question is better directed at them than to me, but . . . my guess is that, first of all, for whatever reason LNG has gotten kind of a public hype and compared to a lot of other facilities and industrial sites that we have in this country, it doesn't pose any more danger. Now, let me go back to historical [examples] here: People have talked about the large problems here [but] if you look at the worst accident that we've had in this country – in the United States now – I think it is the Texas City Disaster of 1947, where two ships filled with ammonium nitrate fertilizer blew up in Texas City. That probably ranks as the largest industrial accident that we've had and nothing like that has happened ever since then. Even in that case, this is a blast damage and . . . obviously there was a lot of destruction and so on and so forth but if you look at the fatality risks and those things, there were only about 600 people [who were killed]. Compare that to what happened in Bhopa in India in 1984: there was a toxic material that got released [that] killed about 15,000 people and the injuries were something like 100,000-plus. So, we have a lot of toxic material storage in this country . . . including such places as municipalities storing chlorine – nobody seems to be concerned about those things, or at least if they are concerned about it, they are not voicing it in as loud a voice as we hear for LNG. So my feeling is that [LNG] has gotten to be a kind of whipping boy for all the people who subscribe to BANANAs, which is . . . Build Absolutely Nothing Anywhere Near

## Phani K. Raj Backgrounder



Phani K. Raj holds S.M. and Ph.D. degrees in Mechanical Engineering from Harvard University as well as an MBA degree from Northeastern University. He has more than 30 years professional experience in conducting safety research and assessing risks in the storage, transportation, handling and utilization of hazardous materials, including Liquefied Natural Gas (LNG). His work has included the development of mathematical models to describe the accidental release behavior of chemicals and flammable materials. He has participated in the design, development and implementation of LNG spill experiments in China Lake, California, sponsored by the U.S. Coast Guard. He has analyzed the data from this series of tests and developed mathematical models to predict the hazards from large-scale spills of LNG. He is currently under contract to the U.S. Department of Transportation to develop new models to describe the hazardous effects of LNG fires. He has also performed risk assessment studies on the transportation of LNG in trucks, barges and ships. He has testified before public utility commissions and the Federal Power Commission on the hazards and risks from LNG transportation and the types of mitigation measures that will reduce these risks. He has been consultant to several LNG companies including, Distrigas of Massachusetts Corp, Boston Gas, Commonwealth Gas & Electric, Colonial Gas, etc.

Raj, who has served as president of Technology & Management Systems, Inc. since 1981, has provided consulting and research and development services to a number of Federal Government agencies on issues of safety (chemicals, nuclear materials, fuels and energy fluids). He is also currently working with several large industrial clients, including Exxon Mobile, ConocoPhillips and Weaver's Cove Energy based in Fall River, Massachusetts.

Since 1996, Raj has been a member of the National Fire Protection Association's ("58") Committee on Liquefied Petroleum Gases (LPG). He is also serving as a member of the NFPA 59 A, Liquefied Natural Gas Committee.

Dr. Raj has managed more than 140 projects involving safety, risks, economics and management issues related to transportation, fixed facility storage and handling of chemicals and fuels. He has performed risk assessment studies and has presented the findings in public hearings in understandable terms, has been an expert technical witness before courts and public bodies on behalf of industrial clients. He has also worked with a number of law firms on cases involving releases of hazardous materials and their impact on the populations. He has edited a volume on proceedings of a conference held at MIT on LNG fire issues.

Anyone or NIMBY [Not In My Back Yard]. I think the questions are really societal concerns, but the concerns are misplaced. Because if [you] take . . . the risk approach and say, "How risky is an LNG plant compared to any other plant that we have been used to?" It doesn't pose any more risk and, in fact, it is so well regulated compared to a lot of other industries that I think the risk is far lower in my opinion. This is an informed person talking here.

**LBBJ:** I have to go back to something you said earlier in our discussion. You were very careful to characterize yourself as an informed citizen and somebody who was not an official homeland security expert. So, on the one hand you're telling me that LNG terminals are safe but, on the other hand, it seems that your position does not contemplate a discussion of an informed, official, worst-case policy position on a potential terrorist attack on the proposed Long Beach facility. I am trying to make sense of how you are arriving at your opinion and what, exactly, you mean.

**Raj:** I am looking at even . . . the worst situation that could be pulled off. I mean, if you're talking [about] some very large – effort by a terrorist, that's not going to happen. If that is the case, then we have a problem in this country. If somebody can come with big ships and ram into an LNG facility, that's not going to happen, but, if it's a small band of people, then the kind of damage that can be created by simply somebody carrying something on the back of his backpack, or sneaking it in, is not going to affect an LNG tanker, the kind that is being proposed for the SES facility. It's a double concrete wall, three feet thick and none of those things are going to be penetrable. So . . . that's what I mean by informed assessment. Now, I don't know all the details about how many people will be coming and how many people might come or what are all the things that homeland security may have information on and intelligence on, but I think that just thinking about the kinds of things that could be effective in trying to breach this security . . . and breach the physical facilities – that ain't going to happen and that's not easy . . . When you talk about worst case, the worst case in an LNG facility is that the tank disappears. I, as a scientist, cannot think of a phenomenon, natural or otherwise, that can really create that – taking the whole tank off . . . People talk about the one disaster that happened with LNG in 1944, I believe in Cleveland, when there were no regulations as to the . . . materials for the construction of the tanks and . . . that's all way past now, because we have very stringent requirements of construction, both from the perspective of the material compatibility as well as taking into consideration very large natural phenomena such as earthquakes. So those are the only things that could perhaps, if ever, compromise a very large storage [facility]. Now, talking about somebody coming and ramming something into a three-foot thick concrete wall twice over is not something that is easy to do. If you want to get those kinds of things – and I'm just thinking in terms as a mechanical engineer and the kinds of energies that you need to breach those things – then you have a very large effort by somebody and, if that goes unnoticed, we have a problem in this country.

**LBBJ:** So it seems that of the truly worst-case scenarios, you are almost making them externalities and putting that off on the U.S. Department of Homeland Security and saying they should be able to take care of this. . .

**Raj:** No, no, I am not saying that they should – well, that is one of their missions – but that’s not what I am saying. What I am saying is the kinds of equipment and the resources you would need to breach the kinds of tanks that you are talking about is phenomenal . . . The tanks that SES is proposing can withstand up to 9 Richter earthquakes . . . we have never had this in this country, ever. The largest that I have ever heard of is 8.5 in Alaska . . . Those are the kinds of phenomena that we are talking about to breach the tank. I can’t think about somebody coming in with . . . something in his backpack and then strapping himself to a tank. First of all, that’s a completely unrealistic phenomenon to think of and, secondly, it’s not going to do any damage to the tank with the kinds of things that we are talking about.

**LBBJ:** What about a U.S.S. Cole-type attack on a tanker, or something like that?

**Raj:** That is where the security regime in the port is very important and that’s what the Coast Guard is going to do about it. That’s what their job is – to really evaluate the security protocol that the applicant provides. Now what do you take into consideration in their security assessment, I am not privy to [that]. . . . This is in protected water in the . . . Port of Long Beach and for somebody to very [quickly] . . . and unnoticed and unevaluated before is something of a pie-in-the-sky approach in people talking about attacks. That’s my view, again, I’ve got to qualify it by saying that I don’t have all the intelligence information that the responsible parties and the government have.

**LBBJ:** So it seems that you have a clear position, you’re a supporter of the technology and when you look at situations like the City of Philadelphia’s recent resolution to oppose the proposed LNG facility within its municipal boundaries, or the decision in Mobile, Alabama, to reject a proposed facility or the litigation in Fall River, Massachusetts, it seems that you’re saying that you can support such projects because some of these worst-case scenarios, you feel, are pie-in-the-sky, whereas those who oppose the projects maybe see them as a more viable threat that concerns them.

**Raj:** You’ve got to really then look at the worldwide approach to this. Obviously the United States is a target, as we’ve already seen in 9/11. But there are other things that are going on in the world as we speak, where LNG plants are being built in Europe [and] . . . in Japan. There have been more kinds of terrorist actions in Japan including in subways and the kinds of things we have heard about. Then you mean to say that the people in the world are all stupid? I think the question that we have to ask is what is the risk compared to everything else that human beings are already exposed [to], continuously being exposed [to] . . . You mentioned the City of Philadelphia, you mentioned about the lawsuit by the attorneys general of the states of Rhode Island and Massachusetts – and Massachusetts is where I live, by the way – have filed against FERC. By the way, it’s not against the company, it’s against FERC, it’s about their decisionmaking. But that’s a policy issue, and I can’t speak about those kinds of things. . . . Why somebody objected – I mean, you know, people are objecting in this state for the proposition for wind farms. Now, talk about wind farms being objectionable. We want clean energy. Where is that energy going to come from? . . . When you flip a switch, you want the light in your room or the heat in your house, but nobody wants to pay for the protection that that provides them by having a plant built somewhere. Soon enough, what’s going to happen is that the economic potential of this country is going to suffer because of these kinds of objections – that’s my personal opinion.

**LBBJ:** I think there’s no doubt that, given the future projected energy demands that we face as a nation, we need to diversify and find an array of transitional fuels until we can develop some long-term solutions.

**Raj:** But the thing is, there is opposition to even something like quote-unquote clean energy sources – wind, tides, you know, anything in between. Even those things are being opposed. So, if you ask me, “Why are they being opposed.” I can’t answer for why they are being opposed. People have their own self-interests and, as I said, the NIMBYs and the BANANAs are very well entrenched.

**LBBJ:** One thing I want to do before we get into the remaining questions is ask you about your current projects. I can see in looking at your Curriculum Vitae and related materials that you are working with ConocoPhillips, Exxon Mobile and Weaver’s Cove Energy, Fall River, Massachusetts. That looks like . . .

**Raj:** Let me qualify those things. I do have contracts with each one of these companies. I’m not working full time as a great designer of all these things. I’m asked once in a while – this is all on retainer – I’m asked some questions and I answer them to the best of my . . . professional abilities . . . When you say Weaver’s Cove, yeah, they . . . asked some questions about how far does the radiation from this tank go, or something like that. It’s not that I’ve designed anything, I’ve not designed an entire project or anything. But I will be supporting and responding to questions that they ask.

**LBBJ:** Are you familiar with the proposal by Woodside Energy Ltd. to build an offshore LNG importation facility 22 miles off the coast of Malibu with an underwater pipeline that will connect to the Los Angeles International Airport area?

**Raj:** I’m not very familiar with that project. I have read

that . . . I think you had actually asked a question of Dr. [Jerry] Havens and that’s about all my knowledge about that.

**LBBJ:** If this concept is indeed feasible and implementable, and the technology existed to build these offshore importation facilities that could provide virtually the same macroeconomic benefits to Southern California as the onshore facility proposed in Long Beach, would you be supportive of putting facilities such as these off the coast of California and other states to provide a solution to our need for more natural gas without facing all the community opposition?

**Raj:** You’re asking me a question about offshore versus onshore for LNG facilities. I am of the opinion that there are advantages and disadvantages in both. It’s a matter of economics, convenience and other business-related [factors] that make these [kinds of decisions] . . . From a safety perspective, it is a case, at least for me, of six of one or half a dozen of the other. Offshore facilities are not a panacea. We just have to go to Katrina to see what happened to offshore facilities in the gulf. They were all shut down, they had to be evacuated and quite a few of them are still not back on the stream yet. So, again, with an offshore always as the best solution – I’m not going to subscribe to that thesis. It depends on the conditions – economics, public issues, safety issues and everything else. Now let me qualify one of those things. I think the safety issues of onshore facilities have been overblown – no pun intended here – because there is so much information that is there in the public domain that people have not considered. Let me give you an example. A large LNG fire behaves very much like a large gasoline fire. I have a paper coming soon in a technical journal, peer-reviewed on these issues, I have presented this information in American Association of Chemical Engineers meetings. So what happens is when you have a large fire of LNG, which is a concern to a lot of people, it gets starved of oxygen and becomes pretty much like a black smoky fire that we all see in rubber tires burning and gasoline fires, so the calculations that everybody has used, including the regulatory requirements, have assumed this to be an extraordinary bright fire and that is one of the major concerns, one of the reasons why people are very concerned, because one calculates very large distances from hazards, which unfortunately is incorrect, in my opinion. They are overly conservative by orders of magnitude, I mean by factors of three and four in distances. So, the reason that everyone thinks offshore is the best thing is because we are protecting the public from potential disasters. Well, if offshore is such a panacea then we may just have to move the entire industrial base of this country to offshore. That’s not going to happen. We have refineries in this country everywhere that are onshore, we have chemical facilities, our chemical manufacturing facilities – we’re not going to be moving every one of those things offshore. And so why [is it] only LNG that has to go offshore? is my question. So when you ask me, “Would I support it?” it’s a case-by-case basis you’re gonna look at it . . . Policy may be misguided, in my opinion, if you just simply impose it only on LNG.

**LBBJ:** It seems that this business of determining end-point calculation criteria for worst-case scenario assessments related to the proposed LNG terminal at the Port of Long Beach revolves around whether or not the calculations use the 1.5-kilowatt-per-square-meter calculation or the five-kilowatt-per-square-meter calculation. What is your view on that?

**Raj:** First of all, the 1.5 kilowatt per meter squared has absolutely no scientific basis other than the fact that it is just about slightly more than what you and I would experience when we go on a midday [walk] in the sun. I know Dr. Havens introduced this. He’s a good friend of mine, and he is entitled to his views and convictions. But I can tell you that five kilowatts per meter squared has been in existence for a long enough time and has protected very well. The second . . . I want to go to this modeling business . . . if you look at all these models that people use, they assume that there is absolutely nothing in between the fire and the person that is going to be exposed to it . . . That is . . . definitely not the case in the Port of Long Beach and certainly not the case in most industrial locations. First of all, [with a] fire – unlike toxic materials – the fire effect is a line-of-sight effect. If there is even a tree in front of you, you’re protected . . . and so there are a lot of buildings, a lot of stacked up containers in the case of the Port of Long Beach, there are tall buildings everywhere, even the houses [are] protected. So, the fact that somebody draws a circle and says that’s five kilowatts per meter squared or 1.5 kilowatts [per meter squared] is not the correct thing, because that circle does not really represent the five kilowatts per meter squared simply because there’s so much shadow effect . . .

I want to discuss this issue on three levels. First of all, the science [of] burns – there’s really not much literature on actual exposure of people to thermal radiation from fires and their effects being systematically and scientifically investigated. The only one that I have reviewed – and I have reviewed all of this literature very carefully – is that there was a set of volunteers that exposed themselves with their arms to some little spotlights from a very high-intensity lamp back in the 1950s. So the five kilowatt per meter squared [level was tested] and they felt pain and then some blisters and so forth. That comes from a very small area of exposure. And certainly this whole thing has now gone to the exposure and people are now incorrectly, and rather badly, are calling this a fatality criteria – it’s not. Five kilowatts per meter squared is nothing more than

what you have probably seen if you sit very close to a fireplace for a while in your house. . . . The issue of the science behind this burning itself is on shaky ground.

Second thing is, remember . . . people are clothed almost all of the time when they are outside – so you are exposing, at best, maybe about six or seven percent of the body, you know maybe the face or the front part of the neck. That, too, again as I told you, if a person moves about 20-30 feet he’s probably in a shadow in any of the industrial and residential areas from these fires. So [he or she] is not going to be exposed directly.

Last but not least, the NFPA [National Fire Protection Association] criteria on which this is based on the assumption that there are 50 or more people in a completely open ground – like in a playground or a basketball [court] – who are going to be exposed to this and they won’t be able to protect themselves. That’s not the way it is. If you look at specifically [the] Long Beach area, I have not seen anything like a playground within about a mile of the facility . . . Five kilowatts per meter squared . . . is a fairly good regulatory requirement that has protected people and continues to . . . Last but not least . . . if the criteria was not that good then people very far away from forest fires would be burned and perhaps even face fatality. We haven’t heard of anybody, not a single individual, being burned . . . by a big forest fire. Forest fire sizes are the kinds of sizes that are . . . being postulated for LNG release scenarios. So even the evidence doesn’t support it. And if you want to go to 1.5 kilowatts per meter squared then . . . this is for an occurrence that might not happen at all, if at all, once in a million years or more. So, are we now asking ourselves to be no more inconvenienced than going into a bright sun?

**LBBJ:** Now you’re comparing exposure levels to sitting next to a fireplace or walking under a bright sun. I’ve read accounts that if a person receives five kilowatts per square meter of thermal radiation to their unprotected skin, they’ll get second-degree burns in about 20-30 seconds. I have also read that the U.S. Department of Housing and Urban Development, as well as other agencies, along with several other European countries, embrace the 1.5-kilowatt-per-square-meter criteria. So, bearing what I’ve just said in mind, what are the most compelling reasons why policymakers looking to do whatever they can do to ensure public safety should go with the five as opposed to the 1.5 criteria?

**Raj:** Let me address the HUD question first . . . Their requirement is for HUD-funded, multi-dwelling units to be constructed where . . . within the borders of the facility that’s being constructed would be storage of fuels . . . Obviously these fuels are meant for heating the houses, I guess. And in those situations, when you have multi-dwelling homes and so on, you’ll also have a playground very close inside, probably, and therefore, they had this very low requirement. However, there is one thing that you have to remember: that the same regulation that you are referring to . . . it also provides for mitigation. If, for some reason, the line of sight is obstructed by geography or a [constructed] wall . . . then the regulations do not apply. . . .

Let me address the European standards. The European standards, by the way, are all risk-based. While 1.5 kilowatts per meter squared may be required in some instances, five kilowatts per meter squared is what is required for most of the other requirements. What they do is they go back and calculate how many elderly people are there in the community, how many handicapped people or challenged people are there [and how many] children are there [and] count all of them, and for them you say 1.5 kilowatts per meter squared and then go five kilowatts per meter squared for the rest of the population and find the overall risk. And if the risk is below 10 to minus four then it is accepted completely, irrespective of how many people would be exposed within the 1.5 kilowatts per meter squared or five kilowatts per meter squared. We don’t have that risk-based system in this country. Our regulations are very prescriptive. It simply says you draw a line from five kilowatts per meter squared if somebody is exposed – actually not “somebody” it has to be more than 50, that’s the NFPA requirement – so I think comparing one piece of the pie and not the entire pie is incorrect.

**LBBJ:** Which do you prefer, the European risk-based model or the prescriptive U.S. regulatory model?

**Raj:** Everything is risky. There is no such thing as a risk-free society. When I walk out of my home, I can fall off my stairs and get injured or hit by a truck. So, the risk-based approach is the proper approach because it balances a lot of different, diverse elements. By the way . . . if you look at the . . . safety requirements in England, it is based not just on the basis of just a flux level but the total dosage to a person. Because, if you are very close to a fire and looking at it, you may get a larger dose than if you’re just running away from it. So it’s a dosage criteria, which probably makes more sense than a single flux criteria that we in the U.S. are used to . . . If you ask me as a scientist and having worked in this area for 35 years now in LNG and other chemicals [requiring] hazard assessment[s] . . . a risk-analysis-based regulation makes more sense. ■