From: Dirk Dunning, retired professional engineer

Testimony on SB 360, House Bill 2332, & House Bill 2692, and HB 2995 (Clean Energy Bill)

I write today in opposition to SB 360, HB 2332, HB 2692, and in support of HB 2995 as written.

SB 360, HB 2332 and HB 2692 are individually and collectively are an affront to the citizens of Oregon, and to a sane discussion of policy surrounding nuclear power. They propose to carve out a special exemption for a limited set of persons. These proposals should be soundly rejected.

I have a unique perspective on the proposed actions. I am a retired Registered Professional Engineer, and formerly licensed Nuclear Power Engineer. For the last 25 years of my career I worked at the Oregon Department of Energy as senior staff doing technical analysis and policy review of nuclear matters and in the cleanup of the nuclear mess at the Hanford Nuclear Reservation in eastern Washington State, as well as for Nuclear Safety and Energy Emergency Response for the State of Oregon. I was on call 24/7 throughout my entire career in that role, principally concerned with the Columbia Generating Station and every conceivable nuclear accident at Hanford or the Columbia Generating Station.

Nuclear was a field with promise 70 years ago. That time and that promise is now gone. Now with 70 years of experience we know with certainty that nuclear power has severe and fatal flaws in all of its forms. Whereas once long ago nuclear power was touted as being “too cheap to meter”, we know today that nuclear cannot economically compete with power from solar, wind, hydroelectric production or natural gas from either renewable or non-renewable sources.

Whereas in the beginning it was believed that the problems with nuclear waste was minor and would one day be solved, we know today that we are no closer to having a permanent geologic repository for the waste than we were then. Worse, we know today that operating nuclear power plants build in long lived radioactive wastes including highly mobile wastes and extremely difficult actinides wastes. The problems in dealing with these wastes has proven to be unsolvable. We should not create more such wastes until we have first dealt with the wastes already created. The prospects for doing that are miniscule.

The public spoke firmly and clearly on this issue. SB 360, HB 2332 and HB 2692 propose to ignore and over-ride the requirements imposed by the citizens of Oregon. That is unconscionable and plainly unacceptable. The legislature should not now consider over-riding the publics policy requirement in this mater. This should only ever be changed by a vote of the people, following a very public, very open investigation of the full range of issues and be followed by a thorough vetting and debate of those issues showing how the problems have been solved (past tense).

All of the involved issues were heavily debated, discussed and analyzed in the 1970s in Oregon. As part of that the Citizens of the State passed an Initiative limiting nuclear power until such time as certain conditions were met - including the creation and operation of a licensed high-level nuclear waste repository.

In the nearly half century since, we are no closer to having a high-level waste repository now than we were then. The proponents of these bills propose to wipe away the citizens considered vote on that. DO NOT DO IT.

At the very least, should this ever be earnestly considered, it must be referred to the citizens of the State for a public State wide vote following a broad and deep discussion of the issues with

the citizens of the State. And that should only follow the convening of a State wide public policy committee to examine, discuss and report on all aspects of the issue.

This was done once before. In the 1970s, then Governor Tom McCall created an office in the Governor's Office to examine the whole range of energy issues following the oil embargo of 1973. Nuclear power was a part of that.

That review resulted in a major report:
"TRANSITION, A BOOK ON FUTURE ENERGY: NUCLEAR OR SOLAR?".

The report was issued by the Governor's Office on January 1, 1975. Two Governors, Tom McCall and Robert Straub signed off on the recommendations made in the report, Including the never since changed policy of the State of Oregon to oppose the use of nuclear power.

They concluded on page 142:

> "***If alternatives to nuclear fission were not available, we would likely pursue the development of this immensely hazardous source of energy. But since we have viable alternative energy sources and conservation programs, it cannot possibly be in the best interests of present and unborn populations to strike the "Faustian Bargain".***"

They were correct in their analysis. History has born them out. This Office was folded into the newly created Oregon Department of Energy. The report the office issued though dated is remarkably prescient. It formed the foundational basis for the Oregon Department of Energy.

Their conclusions and discussion is as, or more, applicable now as it was then. The per unit cost and reliability of wind, solar and hydroelectric power are now so good and so low that nuclear at any scale is unable to financially compete or play any meaningful role - particularly not as base load power. Reactors that can surge to meet demand impose additional requirements and costs that make them ill suited an uneconomical for that role as well.

The proposed small reactors have no future place in the energy supply of the United States beyond certain military applications. Even there it was the Stated view of Admiral Hymen Rickover, the father of the US Nuclear Navy, in his retirement speech to the Congress that naval reactors should be retired from use soon as a viable alternative to them exists.

The US Nuclear Navy has an astoundingly good nuclear safety record, due largely to the uncompromising Safety Culture created by Admiral Rickover. In his retirement address to the Congress, and also in part due to their not having to hew to doing everything in the least expensive way. Instead, they do it the right way - and only the right way. Admiral Rickover said in part:

> *"COMMENTS ON NUCLEAR POWER*
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> *I think that ultimately we will need nuclear power because we are exhausting our nonrenewable resources; that is, coal and oil. I think they will go far more rapidly than we think they will and the cost is already going up. I believe that nuclear power for commercial purposes shows itself to be more economic, but that's a fake line of reasoning because we do not take into account the potential damage the release of radiation may do to future generations.*
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> *I'll be philosophical. Until about two billion years ago, it was impossible to have any life on earth; that is, there was so much radiation on earth you couldn't have any life - fish or anything.*

Gradually, about two billion years ago, the amount of radiation on this planet and probably in the entire system reduced and made it possible for some form of life to begin, and it started in the seas, I understand from what I've read, and that amount of radiation has been gradually decreasing because all radiation has a half-life, which means ultimately there will be no radiation.

Now, when we go back to using nuclear power, we are creating something which nature tried to destroy to make life possible. Now that is the philosophical aspect, whether it's nuclear power or using radiation for medical purposes or whatever. Of course, those are not bad because they don't last long, but every time you produce radiation, you produce something that has life, in some cases for billions of years, and I think there the human race is going to wreck itself, and it's far more important that we get control of this horrible force and try to eliminate it.

I do not believe that nuclear power is worth it if it creates radiation. Then you might ask me why do I have nuclear-powered ships? That's a necessary evil. I would sink them all.

I'm not proud of the part I've played in it. I did it because it was necessary for the safety of this country. That's why I'm such a great exponent of stopping this whole nonsense of war and attempt to limit war have always failed. The lesson of history is: When a war starts, every nation will ultimately use whatever weapon has been available. That is the lesson learned time and again. Therefore, we must expect, if another war - a serious war - breaks out, we will use nuclear energy in some form. That's due to the imperfection of human beings."

http://www.worldfuturefund.org/Articles/rickover.html

Yes - that is correct. The father of the Nuclear Navy opposed the continued use of nuclear power in any form. Though the Admiral was correct in his time in suggesting that commercial nuclear power might play a role, the costs, dangers and problems with nuclear have abundantly demonstrated that nuclear power no longer has any role to play at all.

Nuclear reactors are not low carbon "clean" power as has often been asserted. They never have been. They do not produce "clean energy" by any measure. The entire supply chain from ore mining, through milling, separation, enrichment, and fuel fabrication uses vast amounts of carbon based fuels. The concrete and steels used in the construction of the facility likewise entail huge carbon costs. And once the plant ceases operation, the dismantlement, burial, and deep burial of the nuclear wastes produced carry enormous carbon costs. All of these are a part of the nuclear fuel cycle. Yet the nuclear industry studiously tries to pretend they do not exist, and falsely claims that nuclear is low carbon. It is nothing of the sort.

The Clean Energy Bill HB 2995 should (as it does now) specifically and categorically exclude nuclear power from consideration, along with coal and other carbon intensive sources of power.

Neither is nuclear power cheap. Nuclear is among the most expensive ways to generate energy. It carries huge upfront energy costs. And it entails enormous long term risks and costs. Once a plant is begun, the financial viability of the companies and government units are very much at stake, as many jurisdictions have learned to their great despair.

Oregon is blessed with immense resources of Hydroelectric, Solar and Wind energy. We have no need of nuclear. Each of these is vastly less expensive than nuclear. And their costs are declining, while nuclear continues to rise. The costs arguments do not support nuclear power at any scale.

The industry argues that they are needed for base load power. This is the power that cannot be turned off, and that returns the least price of any power. Nuclear cannot compete here. Wind

and solar production combined approximately match the power profile of human power consumption, with increased use in the day time and decreased use at night. Hydroelectric power plays the role of the battery for storage and surge capacity in the Pacific Northwest. Nuclear does not. Nuclear wants to take the bottom off the power supply business and require that every other source provide variable power, increasing their market costs. This is wrong.

With the impending cataclysmic Cascadia Subduction zone earthquake, and other lesser disasters, Oregon needs too aggressively move to distributed power production and utilization. We must not refocus our power supplies into central power stations. We should have solar power on as many roofs in Oregon as we can manage so that when disasters inevitably do strike, that most communities are able to continue with little power disruption. Centralized power, even in the guise of 'smaller' nuclear plants cannot support that. During disasters, nuclear power plants are often forced offline for safety reasons, exacerbating the power outages.

The problems are much worse even than this. The nuclear power industry creates enormous uninsurable dangers. As a result, the Federal Government has limited liability in the event of nuclear disasters. That unfairly and inequitably shifts the burden to the very people harmed in a nuclear disaster.

The industry suffers from excessive hubris. This has resulted in a seriously flawed safety culture that has resulted in the catastrophic destruction of the Chernobyl and Fukushima reactors, resulting in large numbers of deaths, and unimaginable risks for times longer than civilization has existed. There have been dozens of other close calls with large disasters.

At Fukushima the engineers failed to understand that salt rapidly corrosively destroys steel and fuels at reactor temperatures, and that salt isn't even soluble in water under those conditions. Nevertheless they injected salt water to "cool" the reactor. Instead, the salt rained out around the fuel, heating it further and rapidly failed the primary vessel and fuel.

At Chernobyl, the Chief engineer in charge over-rode safety requirements and performed a full scram of the reactor. In doing so he failed to remember or understand that the design of the reactor was compromised to increase power production in ways that made a full reactor scram extremely dangerous. As a result, the reactor arguably suffered a previously unimaginable in core low yield nuclear detonation.

Each of these and dozens of similar mistakes were small decisions in a time of crisis that made the conditions vastly worse.

In the US, the Nuclear Regulatory Commission engineers discovered that the control drive mechanisms at nearly all operating nuclear plants were severely compromised with long vertical and circular cracks leaking live steam that risked the ejection of control rods and loss of control of the reactors in ways not analyzed in the safety analyses. The NRC then instituted a little noted complex wide replacement of these control drive sleeves. This problem existed for a long time before the NRC discovered it.

Other welding issues resulted in a near complete through wall failure at the Davis Besse nuclear reactor due to a similar crack leak leading to severe corrosion of the reactor head. Davis Besse was spared a catastrophic failure by pure luck.

At Idaho, the US Department of Energy found that the Expended Core Facility had an uncontrollable leak. As a result they conducted a little noted emergency removal of spent nuclear fuel from the basin and replacement of the basin. Though no public analysis of this event has been made; based on data from the Waste Encapsulation Storage Facility (WESF) at

Hanford, it is very likely that the failure was the result of intense gamma ray exposure destroying the structural integrity of the concrete basin walls.

My points here is several fold. There is an immense amount of classified knowledge that is not shared with the civilian industry. In all nuclear operations there is an over emphasis on those aspects that are known and understood and a serious lack of appreciation of those that are not. These sorts of failings are unfortunately common in the nuclear industry. Precisely how much impact this has on these proposed designs will never be known. What is known is that every major nuclear accident has as its root cause these same sorts of limitations. They lie in wait - hidden or undiscovered.

This was true at Three Mile Island, Chernobyl, Fukushima, Davis Besse, Windscale, Tanks A-105 & SY-101, the K-Basins and the Waste Encapsulation Storage Facility (WESF) at Hanford, and at many many others.

Nuclear has a proven track record of being an unsafe form of power production when cost has any measure of importance in the design and operation of the facility, or when safety culture is the least bit under appreciated. It is only in the highly socialized command structure of a military operation that it has been done safely. Even then, the relative safety is extremely dependent on the safety culture created around it. The Russians did far more poorly in that regard, and lost several nuclear submarines to severe nuclear accidents as a direct result.

I fear that the proponents of these measures may have similar blind spots with these small reactor proposals.

That these are small reactors does not assure their safety. That safety is determined by the precise design and a comprehensive and complete examination of every possible safety issue. Unfortunately, the nuclear industries track record strongly suggests that these are seldom thought through sufficiently to prevent even the worst disasters.

At Hanford I personally found, highlighted and drove the issues involved in the cleanup of the K Basins, which then contained 2,350 metric tons (as uranium) of 20 year old rotting nuclear fuel about 500 feet from the Columbia River. When I pressed those issues in 1993, the DOE Manager in charge commented referring to my concerns that "*…. if that happened, it would make Chernobyl look like child's play*." His comment responding to my concern led the US Department of Energy to conduct a nation wide Spent Nuclear Fuel Working Group Report. It confirmed each and all of my concerns. It went on to detail and identify hundreds of other severe problems across the complex. That one problem at K-Basins took a decade to resolve and cost over 2 billion dollars to dry out the rotting fuel and to move it into safe dry storage. Even seemingly small problems caused by nuclear facilities are inevitably enormously costly to remedy. Even then "clean up" is a misnomer. Enormous amounts of risk and residual material nearly always remain to poison the land, air and water for time periods longer that this country has existed.

At Hanford, the US Government has left an immense amount of radioactive cesium and strontium in the Waste Encapsulation Storage Facility long beyond the design life of the building. Throughout that time, DOE failed to realize the damage that the immense gamma radiation exposure caused to the basins concrete walls. The concrete is so severely damaged as to risk yet another beyond Chernobyl potential accident. I jointly drove the resolution of that problem with a DOE engineer. Due in large part to my efforts, that problem is scheduled to be resolved in the next several years with the transfer of the capsules to dry storage.

There are many other similar instances. These problems though seemingly far removed from the proposed reactors - have direct application. Oregon is home to the Cascadia subduction zone. We WILL experience a massive subduction zone earthquake at some point, likely in the next 30-100 years. We are overdue.

The proposed reactors will inevitably rely on concrete for their construction. In addition to causing the emission of huge amounts of carbon to the atmosphere, the concrete poses an additional risk. Concrete fails under severe radiation exposure. And as has become painfully evident there is a tendency to forget this fact. Worse, dry concrete is affected far more severely and more rapidly than wetted concrete. Just how bad that problem is is as yet not confirmed. DOE and the industry studiously try not to gather that data.

What I learned in my quarter century working on nuclear problems is just how myopic the nuclear profession can be. They see the short term benefits easily enough. But they often fail to see, assess or deal with the long term risks. And they have made excruciatingly little progress on dealing with nuclear waste.

Instead, the industry has repeatedly tried to define away the problem and to abandon highly radioactive waste in poor waste forms in the near surface, or to simply not clean up the wastes at all.

At the same time they have downplayed the documented risks to people and attempted to waive those away by comparing them to the now immense average annual exposure people have to radiation through medical procedures. All radiation exposure causes accumulative harm. In certain circumstances, such as medical procedures, the risks these exposures entail is justified by the potential benefit. The exposure to people without such benefits is not warranted - and certainly not without their knowing and considered permission and their direct benefit.

Periodically all nuclear plants must go offline for maintenance and refueling. Generally these are planned outages. Quite often they are not. When they go offline the shutdown takes out a sizable portion of production. When this happens without warning, it creates severe problems. In that sense nuclear is unreliable. The plants often cannot be immediately restarted. Extensive outages are required before they can safely restart.

Even then, the economic pressures are such that plants often run with damaged equipment. The Columbia Generating Station is an example of this. Today it is operating with a broken bracket on a main pump inside the reactor. Rather than shutdown and fix this, the operators have received permission from the NRC to inject hydrogen gas to reduce the rate of damage to the remaining bracket and to operate under those conditions. This greatly increases the risks of a catastrophic failure, and greatly increasing the severity of the resulting accident.

The spent fuel pools at every reactor store an immense amount of highly radioactive fuel in a tight pack storage condition which maximizes radiation exposure to the concrete in the basins - ignoring the lessons from WESF and the Expended Core Facility in Idaho about the grave dangers that poses. Even today the nuclear industry tries very hard to ignore this major problem. All of the spent fuel pools at every nuclear facility need to be urgently emptied into dry storage. New temporary pools are needed that greatly decrease the dose exposure to the concrete in the pools. Extensive detailed studies of how ‘dry’ concrete reacts to gamma ray exposure are urgently needed. The very limited data that does exist suggests that the risk is about a thousand times higher for damage to dry concrete than to wet concrete. Yet there are very few data points to assess that risk. This gravely increases the risk of a basin failure and the consequent release of radioactive materials.

The legislature should reject these proposals as being unwarranted risks to the citizens of Oregon, and a violation of the trust of the citizens of Oregon and faith in the policy choice the citizens made via Initiative. Nuclear has no place in the energy makeup of our future.