UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE COMMISSION

PILGRIM WATCH COMMENT REGARDING ADDITIONAL REQUIREMENTS FOR CONTAINMENT VENTING STYSTEMS FOR BWRs WITH MARK I AND MARK II CONTAINMENTS IN SUPPORT OF FILTERS (OPTION 3) AND RUPTURE DISCS

Mary Lampert
Pilgrim Watch, Director
148 Washington Street
Duxbury, MA 02332
Tel. 781-934-0389
Email: mary.lampert@comcast.net
November 19, 2012

CONTENTS

PILGRIM WATCH COMMENT REGARDING ADDITIONAL REQUIREMENTS FOR CONTAINMENT VENTING SYSTEMS FOR BWRs WITH MARK I AND MARK II CONTAINMENTS IN SUPPORT OF FILTERS AND RUPTURE DISCS

Pilgrim Watch (herein "PW") supports NRC Staff's recommendation to implement Option 3 that found that, "the combination of quantitative and qualitative factors best supports the installation of filtered venting systems at BWRs with Mark I and II containments."[1]

PW respectfully disagrees with the ACRS' recommendation to implement Option 4, a "do nothing now" Performance Based Approach "to identify performance objectives for Mark I and II containments and equipment additions and procedural enhancements, including filtered vents, to be evaluated and implemented to meet these objectives."[2] There is no justification to delay and risk acting only *after* an accident occurs; nor is there need to reinvent the wheel. The NRC Staff saw filtered containment venting systems with rupture discs during their April 2012 trip to Sweden and Switzerland. Indeed they are currently in use in many other countries today and will be installed at others soon; for example in Slovenia and Japan that learned its lesson the hard way. Our citizens deserve the same protection.

In addition, PW supports requiring rupture discs so that neither water nor electrical supply is needed and operator intervention is not necessary to actuate the system.

I. INTRODUCTION-DTV HISTORY & LESSONS FROM FUKUSHIMA

Twenty-three U.S. reactors are the same design as the failed Fukushima reactors – all are GE, Mark I, BWRs. Almost forty years ago, the NRC identified a serious design flaw in these

[1] Consideration of Additional Requirements For Containment Venting Systems For BWRs With Mark I And Mark II Containments, ACRS Full Committee Meeting, NRC Staff, November 1, 2012, Slide 10; Mark I BWR Reactors: Browns Ferry 1, 2 & 3 (AL); Brunswick 1 & 2 (NC); Cooper 1 (NE) Dresden 2 & 3 (Il); Duane Arnold 1 (IA); Fermi 2 (MI); Fitzpatrick 1 (NY); Hatch 1 & 2 (GA); Hope Creek 1 (NJ); Monticello 1 (MN); Nine Mile Point 1 (NY); Oyster Creek 1 (NJ); Peach Bottom 2 & 3 (PA) ; Pilgrim 1 (MA); Quad Cities 1 & 2 (IL); Vermont Yankee 1 (VT). Mark II BWR Reactors: Columbia (WA); LaSalle, 1&2 (IL); Limerick 1 &2 (PA); Nine Mile (NY); Susquehanna, 1&2(PA)

[2] ACRS Review if Staff's Draft SECY Paper on Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containment Designs, Letter to The Honorable Allison M. Macfarlane, November 8, 2012

reactors - in certain accident scenarios the containment would fail in the event of pressure build up. NRC Staff and ACRS recognize this risk today.

A supposed "fix" was recommended, and put into place in the late 1980's– a direct torus vent (DTV) to relieve pressure in order to save the containment by releasing unfiltered material directly into the atmosphere. Pilgrim's DTV was the first and it provided a model for other reactors. Attachment A describes Pilgrim's DTV and provides an example with what is wrong with the status quo. Pilgrim, like the other Mark I's, simply assumed that the DTV would work; that theoretical assumption was the underpinning of its assumed probabilities in accident sequences. "The use of the direct torus vent as a means of containment heat removal has been shown to have a major impact upon the results of Class II accident sequences.[3]" but this "major impact" was "shown," and assumed to be effective, only by theoretical analysis. The only real tests of the DTV – Unit 1, Unit 2, and Unit 3 at Fukushima, March 2011 – all failed. Three out of three failures is not a good score.

The actual failure of the DTV at Fukushima is new and significant information that now must be considered. Fukushima proved that:

(1) Properly trained operators decided not to open the DTV when they should have because they feared the effects offsite of significant unfiltered releases;
(2) When the operators finally decided to open the DTV, they were unable to do so in a timely manner;
(3) The failure of the DTV to vent in time leads to containment failure/explosions that result in significant ongoing offsite consequences.

Prior to Fukushima, concerns regarding the operational safety of the DTV focused simply on accidental releases - measures to assure no single operator error in valve operation could activate the DTV and mistakenly release unfiltered radiation into the environment. Now, after the DTV's first and only real test, it is clear that what is most important is not a theoretical mistaken release; rather the new and significant issue is the likelihood that the DTV simply won't work as

[3] Pilgrim Nuclear Power Station Individual Plant Examination for Internal Events Per GL-88-20, Volume 1, Prepared for Boston Edison Co., September 1992, pg, 5.0-13

currently designed when release is required to save the containment. Both a filter system, and rupture disc must be part of NRC's requirement.

II. FILTERS-OPTION 3

A. Introduction

Install filtered vent systems. PW supports the Staff's recommendation to install a filtered vent system for both quantitative and qualitative reasons. Some countries -- including France, Sweden, and Germany -- have installed filtered vent system at their reactors; and Japan and Slovenia based on lessons learned from Fukushima are installing filtered vents on their reactors. (Bloomberg, Nuclear Power Daily, Nov 20, 2012) The United States has lagged behind and not adopted filtered vents. The NRC has a second chance.

Fukushima, PW's and the Massachusetts Attorney General's filings in Pilgrim Nuclear Power Station's license renewal proceedings (beginning June 1 and June 2, 2011 respectively), and PW's Request for Hearing Regarding the Insufficiency of the Order Modifying Licenses With Regard To Reliable Spent Fuel Pool Instrumentation (EA-12-051), April 2, 2012 all clearly showed the importance of requiring filtered DTV's in order to:

1. Protect public health and property in the event that it is necessary to vent; no one can doubt that an unfiltered release is more dangerous than one that has been filtered.
2. Assure operators follow orders to open the vent. As shown in Japan, there is a significant risk that even properly trained operators are likely to decide not to open the DTV when they should because they fear the effects offsite of significant unfiltered releases.

The ACRS' and the industry's main arguments against filtering are disingenuous.

1. The water in the suppression chamber (wetwell) is not an effective filter system.
2. Filters are not dangerous because they will cause some backpressure.

3. There is no need for further study to evaluate other potential innovative options to reduce radioactive material releases in lieu of adopting what is now known to be safe and effective.
4. Filters are needed for the reliable hardened containment vents because there is no assurance that the sequence of bad things that must happen in order to need a filter for containment vents will not occur at a U.S. reactor.

B. Arguments Supporting Option 3 - Requiring Filters

PW respectfully requests the NRC Commissioners to follow their own Staff's recommendation and require U.S. Mark I and Mark II reactors install filtered DTV's in order to:

- Protect public health in the event that it is necessary to release.
- Assure operators follow orders to open the vent. As in Japan, properly trained operators here are likely to decide not to open the DTV when they should because they fear the effects offsite of significant unfiltered releases.

David Lochbaum explained the case for filtered venting succinctly in *To Filter or Not to Filter That Is the Question with Only One Sane Answer*.[4] He said that:

> "Under normal operating conditions, when BWRs operate above 5% power, gaseous releases are processed through *high energy particulate air* (HEPA) filters and charcoal filters that significantly reduce the radioactivity content discharged to the environment (Figure 1)."

[4] *To Filter Or Not To Filter That Is The Question With Only One Sane Answer,* David Lochbaum, Union Of Concerned Scientist, 2012 http://allthingsnuclear.org/to-filter-or-not-to-filter-that-is-the-question-with-only-one-sane-answer/

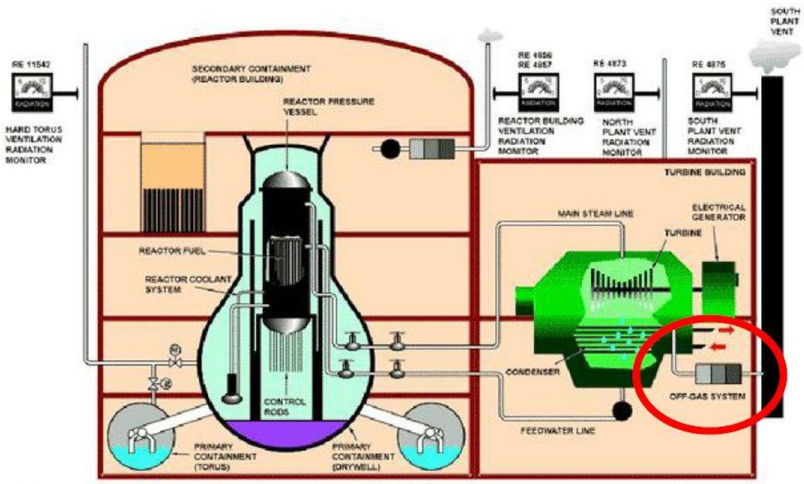


Figure 1

"During design-basis accidents, gaseous releases from BWRs are processed through another system with HEPA and charcoal filters that significantly reduce radioactivity levels being discharged. The design objective of this filter system is to remove over 99% of the radioactive particles (Figure 2)."

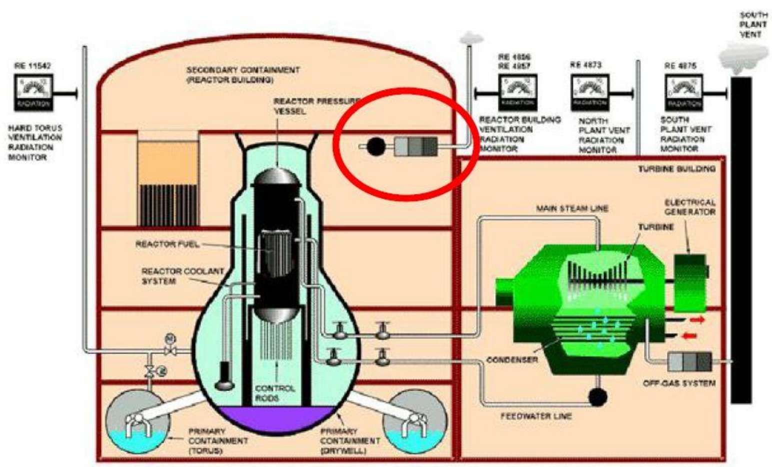


Figure 2

"But during severe, or beyond-design-basis accidents, gases released via the BWR reliable hardened containment vents do not pass through HEPA filters or charcoal filters before being discharged (Figure 3)."

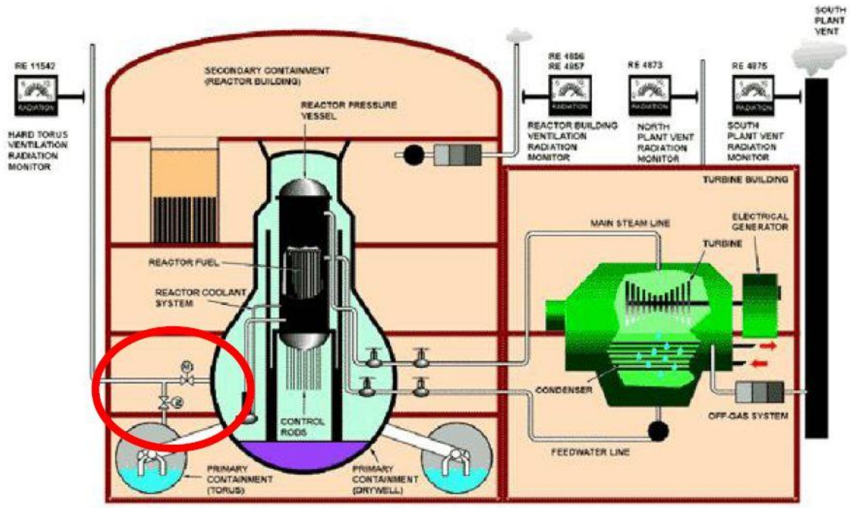


Figure 3

“So, when the radioactivity level to be released is as high as it ever gets, the absolute least amount of protection against it is provided (Figure 4). That’s indefensible – and all too simple to remedy.”

Relative Scale	Normal Operation	Design Basis Accidents	Severe Accidents
Amount of Radioactivity	Smallest	Medium	Largest
Amount of Filtering	Highest	Highest	Lowest
Threat to the Public and Workers	Smallest	Medium	Largest

“In 1989, the NRC ordered BWR owners to install hardened containment vents.

In 2012, the NRC ordered BWR owners to install reliable hardened containment vents.

This leaves the NRC one order shy of getting it right.

The public is not protected by hardened containment vents.

The public is not protected by reliable hardened containment vents.

The public is only protected by filtered reliable hardened containment vents.

It may take the NRC three orders to get it right.

> The NRC will not be serving the American public well if it takes 23 years or more to write and issue this third order. The NRC must get it right now.
>
> If justice delayed is justice denied; filters delayed is protection denied."

C. The arguments against filtering are disingenuous. They include:

- Industry's and ACRS' argument that the water in the suppression chamber (wetwell) is an effective filter system
- Industry's argument that filters are dangerous because of creating backpressure
- ACRS' argument to delay the decision, Option 4, claiming that there is need for further study to evaluate other potential innovative options to reduce radioactive material releases; although ACRS recognizes that "enhanced filtering strategy addresses the limitations of Mark I and Mark II containments under severe accident conditions and increases defense in depth." (ACRS Letter to Commissioners, November 8, 2012 pg., 4)
- Commissioner Svinicki's earlier position that filters are not needed for the reliable hardened containment vents because the sequence of bad things that must happen in order to need a filter for containment vents is so long that it will never occur at a U.S. reactor.

<u>What's wrong with These Arguments?</u>

1. Suppression Chamber (Wetwell) Insufficient Filter System- No Excuse

The US industry and TEPCO defended their decisions not to add filters to the DTVs by claiming that the water pool in the suppression chamber (wetwell) is as effective as some other kind of filter system that it could have installed when adding the DTVs. The ACRS makes a similar statement in its letter to the Commissioners (Letter, 3). It says that "scrubbing of releases from the wetwell… by the suppression pool, and drywell sprays if they are available…allows substantial radioactive material retention in the containment;" but, ACRS failed to substantiate their opinion or bother to define or qualify what "substantial" may mean.

Industry's and ACRS' claims are incorrect. Scrubbing may result in some "radioactive material retention in the containment," but the amount of radioactive material in a filtered release is certain to be orders of magnitude less than that of a release that has only been scrubbed.

The FILTRA system installed at the Swedish Barsebäck nuclear power station, for example, was **in addition to** any filtration provided by the wetwell pool, not in place of it.[5] Barsebäck had boiling water reactors like those in Fukushima and those in the US. Filters were also added to BWRs in Germany and Switzerland.

Furthermore, it's not clear how effective the filter effect of the wetwell on its own really is. A U.S. report from 1988 entitled "Filtered venting considerations in the United States[6]" writes:

> Within the United States, the only commercial reactors approved to vent during severe accidents are boiling water reactors having water suppression pools. The pool serves to scrub and retain radionuclides. The degree of effectiveness has generated some debate within the technical community. The decontamination factor (DF) associated with suppression pool scrubbing can range anywhere from one (no scrubbing) to well over 1000 (99.9 % effective). This wide band is a function of the accident scenario and composition of the fission products, the pathway to the pool (through spargers, downcomers, etc.), and the conditions in the pool itself. Conservative DF values of five for scrubbing in MARK I suppression pools, and 10 for MARK II and MARK III suppression pools have recently been proposed for licensing review purposes. These factors, of course, exclude considerations of noble gases, which would not be retained in the pool. (Emphasis added)

The decontamination factor of 5 for the Mark I containment (as used in units 1 through 5 of Fukushima Daiichi and the 23 in the U.S.) means that 80% of the radioactive substances (excluding noble gases) is retained, while 20% is released. The FILTRA system installed at 10

[5] The filtered venting system under construction at Barseback,1 Aug 1985 **...** A filter venting containment system, bearing the acronym FILTRA will be installed at the Swedish nuclear power plant Barseback. http://www.osti.gov/energycitations/product.biblio.jsp?osti_id=6309422
[6] Filtered Venting Considerations in the United States, R. Jack Oallman, L.G. (Jerry) Human, John (Jack) Kudrick:: http://www.osti.gov/energycitations/purl.cover.jsp?purl=/6945722-maXGrD/6945722.pdf

Swedish nuclear power plants and one in Switzerland is designed to ensure that in a severe accident 99.9% of core inventory is retained in the containment or the filters.

The difference between a release of up to 20% after scrubbing, and only 0.1% after filtering is huge. Industry and the ACRS seem to ignore that up to 200 times more radioactivity will be released in the system defended by TEPCO and U.S. BWR Mark I operators versus the enhanced system that is already in use in Europe and that is commercially available worldwide.

Japan has shown that the U.S. industry's and the NRC's assumptions of the scrubbing effectiveness of the wetwell are wrong. Dr. Frank von Hippel explained this in a briefing to the NRC over thirty years ago.

> For accidents in which the damage is sufficient to open large pathways from the core to the containment, there will not be sufficient water available to trap the radioactive materials of concern, nor will the pathway be so torturous that a significant amount wills tick to surfaces before reaching the containment atmosphere. Similarly if the containment fails early enough, there will be insufficient time for aerosols to settle in the reactor building floor.[7]

Further, Dr. von Hipple concluded in *Second chances: Containment of a reactor meltdown,* Bulletin of Atomic Scientists, March 14, 2012[8] that:

> The unspoken argument against requiring that US nuclear power plants be retrofitted with filtered vents was that the industry thought that they were already safe enough and that the expense would be wasteful. And, as today, the commission did not want to force the industry to do more than it was willing to do.
>
> In 2002, the NRC, despite alarming evidence that a pressure vessel had almost corroded through, refused to force an owner to shutdown the reactor for inspection before its regular refueling shutdown. After a review, the NRC's own inspector general concluded: "NRC appears to have informally established an unreasonably high burden of requiring absolute proof of a safety problem, versus lack of a reasonable assurance of maintaining public health and safety."
>
> We failed after Three Mile Island in 1979 to reform the Nuclear Regulatory Commission or force improved containment designs. The tragedy in Japan may have given us another opportunity

[7] Bulletin of Atomic Scientists: Containment of a Reactor Meltdown, Frank von Hippel, March 15, 2011, note 16
[8] http://thebulletin.org/print/web-edition/features/second-chances-containment-of-reactor-meltdown

2. Backpressure- No Excuse

Industry has argued that filters would be dangerous due to backpressure. Not so. Their argument is about saving money, not safety. Backpressure is an issue, but not an obstacle. The issue of backpressure is repeatedly faced at nuclear reactors, and it has been successfully managed. For example:

- In the flow path for water drawn from the condenser and returned to the reactor vessel (BWRs) and steam generators (PWRs), there are filter/demineralizer units that create a backpressure issue.
- In the flow path from the condenser to the offgas stack for BWRs, there are HEPA and charcoal filters that create a backpressure issue.
- In the flow path from the secondary containment of BWRS to the elevated release point, there are HEPA and charcoal filters that create a backpressure issue.

Any filter is likely to create backpressure because it introduces a resistance to the flow moving through the piping and ducting. To push the flow through the filters requires a differential pressure that would not be present if the filters were not there; but that is easily resolved .

In the case of the condensate paths to the reactor vessel/steam generators, the filters require the condensate pumps installed between the condensers and filters to have greater horsepower to make sure the flow goes through the filters. It costs more money up front to buy the larger motored pumps and then more money to operate them, but those costs are outweighed by the benefits of cleaner/purer water entering the reactor vessels/steam generators.

In the HEPA/charcoal filter case, the designers did the same thing. They simply connected the ducting/piping to a larger vessel.

<u>In the case of the torus vent</u>, if one placed a filter in the existing 8-inch diameter hardened vent pipe, it would result in the pressure inside the containment having to rise to a higher value so as to be able to push the same amount of flow through the hardened vent. This is the backpressure effect. But any engineer worth his or her salt could easily design a system to work despite this effect. This is proved by the examples cited. Look at the cases of the condensate filter/demineralizer and the HEPA/charcoal filters already installed at nuclear power plants. They

also faced backpressure challenges. In the condensate case, designers did not squeeze the filter/demineralizers into the existing piping. Instead, they connected existing piping to big metal tanks called demineralizer vessels. They are many feet in diameter and there are typically around 8 of them for a plant the size of Pilgrim. By having water in two pipes flow into larger vessels, the water pressure drops along the way. The backpressure effect is offset by increasing the size of the flow pathway.

In the torus vent case, there is no doubt that a competent designer could install a sand/water/whatever filter system between the connection to the torus and the elevated release point that would enable the desired flow rate to be processed successfully. We understand that it is a ridiculously simple exercise -- the controlling factors are the design containment pressure (which is fixed), the ambient air pressure (which is defined over a fairly narrow range), the specified flow rate through the torus vent line, and the pressure drop across the selected filter media. With these values known, one can easily determine how large the container for the filter media needs to be in order to handle the specified flow rate within the prescribed differential pressure.

It is true that installing filters in the torus vent lines will cause higher pressure inside containment than if no filters were present; but, this is hardly a "show-stopper." Operators are now instructed to open the torus vents when containment pressure reaches (x) pounds per square inch (psi). At (x) psi, the opened torus vents keeps the containment pressure below the value that could cause it to catastrophically fail. With properly designed filters installed in the torus vent lines, the procedures may need to be revised to guide the operators to open the vent valves at (y) psi, a slightly lower pressure, to accommodate the backpressure from the filters. With a properly designed filter, the pressure reduction - if any - will be negligibly small.

Therefore, the only reasons not to install a filter in the torus vent line is incompetence (capable engineers are unavailable) or cheapness (funds for the capable engineer or their designs is unavailable). At least some of the U.S. nuclear industry has the skill set to design such a filter system; if they do not, they can find it in Europe. The US simply needs the will to make it happen.

3. Option 4 - Further Study – No Excuse

The ACRS recommends kicking the can down the road. Its letter to the Commission acknowledges that "enhanced filtering strategy addresses the limitations of Mark I and Mark II containments under severe accident conditions and increases defense in depth," but says that there is a need for further study to evaluate other potential innovative options to reduce radioactive material releases." (ACRS November 8, 2012 Letter, pg., 4) Option 4 may provide research grants to academic institutions and save industry money but it plays a dangerous and unnecessary game of Russian roulette with our families.

What's wrong?

a. The ACRS assumes that no accident requiring venting will happen in the U.S. until after we have evaluated "other potential innovative options to reduce radioactive material releases." The Japanese apparently assumed the same, but Fukushima happened nonetheless.

b. There is no need for delay when there are multiple filtered designs available, tested and in use today. Spring 2012, the NRC Staff visited Sweden and Switzerland "to obtain and exchange information with countries having experience with facilities that have installed filtered containment venting systems (HFCVS).[9] Sweden required that the FCVS for its Bareseback reactor be operational by 1985; set performance standards (described in NRC Staff's International Report); required that 99.9% of radioisotopes, excluding noble gasses, should be retained; and Sweden's other reactors followed. Yet, nearly 30 years after Sweden added filters, ACRS recommends that we study it. Certainly there may or may not be something better down the road but we have a tested and available solution today to protect our families.

Staff's International Trip Report's General Findings, at 3, are clear that currently available FCVS's are available and can readily be installed in existing reactors:

[9] International Trip Report is available on Adams ML 12178A670, pg., 2 and multiple reports in Adams -November 6, 2012, daily folder under package ML123100517

General Findings Applicable to Sweden and Switzerland

- Mitigation capability for severe accidents is a legal and regulatory requirement.
- Sweden and Switzerland took steps to strengthen containment as a matter of preserving defense in depth in the event of a severe accident
- Both countries implemented a holistic approach to preserving the containment function by requiring FCVS as well as redundant and diverse methods of providing water to protect the containment liner under the reactor vessel.
- Representatives from the owners/operators uniformly expressed an overall satisfaction with the FCVS. The owners/operators did not identify any technical difficulties relating to the installation and maintenance of their respective FCVS systems.
- The construction and installation of the FVCSs did not significantly impact normal operations or extend scheduled refueling outage times.
- Construction was generally completed within 2 to 3 years.

The Forsmark 3, Sweden is pictured below.

FILTRA-MVSS (circled) at Forsmark 3, Sweden

One example: Westinghouse FILTRA-MVSS (multi-venturi scrubber system) is described as a passive, self-regulating system for filtered pressure relief of BWR/PWR reactor containments.[10] The system is passively actuated by means of a rupture disc. A typical design basis for the system is a total loss of AC power for 24 hours leading to loss of core cooling ability. This includes a total loss of electrical power from both the external grid and all plat-specific power back-up systems, as well as loss of steam turbine-driven core cooling pumps. It says that

This existing system is designed to meet Swedish regulations requiring 99.9 % of the core inventory of radioactivity (excluding noble gasses) be retained in the containment or filtered in case of venting. It has high decontamination factors for gas -carried particles, aerosols and

[10] http://www.westinghousenuclear.com/Products_&_Services/docs/flysheets/NS-ES-0207.pdf

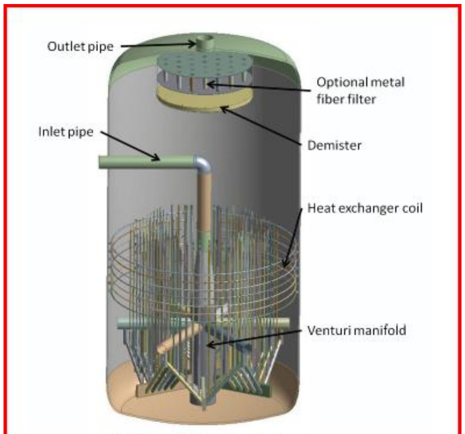
elemental iodines. It is fully passive for at least 24 hours after initial venting and requires no startup time.

For a BWR, the FILTRA-MVSS could easily be connected to the hardened vent. The filter consists of several filtration steps, all of which are contained in the tank: the multi-venturi scrubber, a water pool, a moisture separator, and finally an optional metal fiber filter.

Westinghouse describes the benefits of its existing and commercially available filter system:

- Passive design for at least 24-hours-no operator action required to activate system
- Very high removal efficiencies:
  - Aerosols > 99.00 % decontamination factor (D) > 10,000 with optional fiber filter for smallest particles
  - Elemental Iodine> 99.99% (DF> 10,000)
  - Organic Iodine: > 80% (DF>5)
  - Same DF for all flow rates
- Designed all seismic loads
- Designed wide range postulated accidents
- Ability to avoid and cope with oxyhydrogen combustion
- May be used in feed-and-bleed mode for long-term core cooling

Experience: Westinghouse's FILTRA-MVSS has been installed in 10 Swedish NPPs and one Swiss NPP.



FILTRA-MVSS system design

c. Cost-Benefit Analysis Tools Required To Evaluate ACRS' Envisioned Potential Options to Reduce Releases are Outdated: The consequence tools to evaluate the effectiveness of ACRS' "potential options" are outdated and do not incorporate lessons learned from Fukushima.[11] The fundamental deficiencies in the NRC approved economic consequence analysis require that the regulatory framework itself must be changed. Unless they are changed, it is unlikely that any of the potential innovative options to reduce radioactive material releases that may result from following ACRS' Option 4 recommendation will ever be implemented.

The ACRS Additional Comments by ACRS Members Joy Rempe and Steve Schultz identified this problem and "recommended that actions be implemented now to improve the analysis and tools providing results for the basis on which such decisions are made." (ACRS, pg., 5)

Dr. Edwin Lyman, Senior Scientist at the Union of Concerned Scientists summarized it well:[12]

> One might think, therefore, that the NRC should modify its cost-benefit analysis guidelines to incorporate lessons learned from Fukushima *before* using such an analysis to assess the costs and benefits of the other recommended upgrades to safety requirements. Indeed, the Near Term Task Force considered development of a new post-Fukushima regulatory framework to be its top recommendation.
>
> However, the Commission ordered the staff to put such an effort on the back burner, effectively leaving it to be resolved only *after* all the other recommendations had been addressed. This has created a pattern of circular reasoning that could endanger the implementation of all the other proposed actions, and could leave the NRC chasing its tail for years to come.

---

[11] See: Pilgrim Watch Comment Regarding Secy-12-110, Consideration Of Economic Consequences Within The NRC's Regulatory Framework, September 6, 2012

[12] Going in Circles, Dr. Edwin Lyman, Union Concerned Scientists, December 22, 2011. http://allthingsnuclear.org/nrcs-post-fukushima-response-going-in-circles/#

4. "It Won't Happen Here" – No Excuse

The final argument against filtering fantasizes that filters are not needed for the reliable hardened containment vents because the sequence of bad things that must happen in order to need a filter for containment vents will never occur at a U.S. reactor. This head-in-the sand approach is, at best, nothing more than wishful thinking. It ignores the NRC's policy of defense-in-depth, real-world experience and common sense.

David Lochbaum, Union of Concerned Scientists, in a recent article, *To Filter Or Not To Filter That Is The Question With Only One Sane Answer*[13] observed that at the NRC's Regulatory Information Conference in March 2012, Commissioner Kristine Svinicki said that she felt filters were not needed for the reliable hardened containment vents. Basically, Commissioner Svinicki apparently believed back in March that what would have to happen to need filters is so unlikely that it for all practical purposes won't happen at a U.S. reactor.

David Lochbaum's article explains what's wrong with that assumption:

> Commissioner Svinicki and all her colleagues unanimously voted to require owners to install reliable hardened containment vents. The long sequence of bad things that must happen before venting is exactly the same length whether the vents are filtered or not – neither one step longer nor one step shorter. Since the Commissioners believe – as demonstrated by their 5-0 vote – that the risk of accident justifies requiring reactors to have reliable hardened containment vents, then that very same risk justifies requiring filters on those vents, to deal with the radiation from the accident that the vents were needed for in the first place. Conversely, if that risk is not high enough to require filtered venting, then it is also not high enough to require unfiltered venting.

Or to carry this line of thought to its absurd logical conclusion, if the risk is not high enough to require filtered venting, the risk is not high enough to require emergency planning either.

[13] *To Filter Or Not To Filter That Is The Question With Only One Sane Answer,* David Lochbaum, Union Of Concerned Scientist, 2012 http://allthingsnuclear.org/to-filter-or-not-to-filter-that-is-the-question-with-only-one-sane-answer/

Second NRC policy recognizes that it is a mistake to rely on PRAs because of a long list of uncertainties necessitating defense-in-depth and not assuming accidents will start and play out in the analyzed way. (See discussion below in section IV)

III. REQUIRE RUPTURE DISCS SO THAT NEITHER WATER NOR ELECTRICAL SUPPLY IS NEEDED AND OPERATOR INTERVENTION IS NOT NECESSARY TO ACTUATE THE SYSTEM

A. Rationale

1. Rupture Discs: After Fukushima, the New York Times reported that, five years before the DTVs at the Fukushima Daiichi nuclear plant were disabled by the accident the DTVs were supposed to handle, engineers at a reactor in Minnesota warned American regulators about the very problem. [14] One of the engineers, Anthony Sarrack, notified staff members at the NRC that the design of venting systems was seriously flawed at his reactor and others in the United States similar to the ones in Japan. He later left the industry in frustration because managers and regulators did not agree. As Mr. Sarrack said, and Fukushima proved,

> [T]he vents, which are supposed to relieve pressure at crippled plants and keep containment structures intact, should not be dependent on electric power and workers' ability to operate critical valves because power might be cut in an emergency and workers might be incapacitated.

Mr. Sarrack recommended rupture disks**,** relatively thin sheets of steel that break and allows venting without any operator command or moving parts when the pressure reaches a specified level. But the NRC gave into those in the industry that argued that if a disk is used that there would be not be a way to close the vent once pressure is relieved in order to hold in radioactive materials – put the "genie back in the bottle." Rather than requiring that such a "way" be provided, the NRC again saved the industry money, and effectively forgot that the major problem that needed to be faced was containment failure.

[14] U.S. Was Warned on Vents before Failure at Japan's Plant, NYT, Matthew Wald, May 18, 2011

Industry's argument is nonsense. Rupture discs are already provided, for example, in the Westinghouse FILTRA-MVSS described above and used in 10 Swedish reactors and one Swiss reactor.

A 1988 document, Filtered Venting Considerations in the United States, [15] concluded that, "Obvious advantages of a rupture disc system include (a) suppression of venting during design basis accidents and (b) minimizing unnecessary or inadvertent venting."

The article also said that "[t]he main restriction by a rupture disc is the inability to vent the containment at low pressures. Postulated reasons for venting at low containment pressure include (a) to reduce driving force from the containment when anticipating vessel failure with an early drywell liner melt-through, b) to remove the containment hydrogen prior to vessel failure and early drywell liner melt- through, and (c) to reduce the containment pressure prior to a high pressure vessel failure to prevent an early containment overpressure failure." But if this is in fact an issue, there is an easy fix - a bypass that would likely cost two more valves and extra pipe.

A rational requirement would require both filtering and redesign of the DTV venting system to include rupture discs. At the NRC May 2, 2012 Public Meeting Order EA-12-050 Mary Lampert (PW) asked the technical staff a very straightforward question, whether they saw any downside to rupture discs, qualified as paired with filters. Robert Dennig, Branch Chief Technical Staff Containment and Vent Branch NRR again responded, "No."

The opening through containment created by a rupture disc in a filtered vent system is comparable to the containment bypass pathway created when steam generator tubes in pressurized water reactors fail. While the size of the opening may be larger for BWR filtered vent systems (unless multiple steam generator tubes fail), any radioactivity passing through that opening on the BWR would pass through a filter before reaching the atmosphere. The flow passing through failed steam generator tubes on a PWR reach the atmosphere with no filtering. The NRC accepts releases through failed steam generator tubes; there is not a reason that it should not also accept *filtered* releases through BWR filtered vent systems.

---

[15] Filtered Venting Considerations in the United States, Oallman, Hulman, and Kudrick, OSTI

IV. DEFENSE IN DEPTH

The Staff, like the Swedes in the 1980's,[16] properly found that its proposed recommendation to add external filters enhanced defense-in-depth (containment vulnerabilities and severe accident uncertainties).[17] Defense in depth is at the core of NRC's safety philosophy and basic to NRC fulfilling its AEA requirements to protect public health and safety and also to protect property. The ultimate purpose of defense-in-depth is to compensate for uncertainty. There is, and can be, no *certainty* that no US accident will occur.

A. Uncertainty

Because of uncertainty, PW understands that NRC policy is not to simply rely on PRA's alone to judge what is necessary to protect public health, safety and property. Uncertainty requires defense in depth, e.g., filters and rupture discs.

Kamiar Jamali's (DOE Project Manager for Code Manual for MACCS2) *Use of Risk Measures in Design and Licensing Future Reactors,*[18] explains that "PRA" uncertainties are so large and so unknowable that it is a huge mistake to use a single number coming from them for any decision regarding adequate protection. "Examples of these uncertainties include probabilistic quantification of single and common-cause hardware or software failures, occurrence of certain physical phenomena, human errors of omission and commission, magnitudes of source terms, radionuclide release and transport, atmospheric dispersion, biological effects of radiation, dose calculations, and many others." (Jamali, Pg., 935) NRC Commissioners[19] "have not endorsed a 'risk-based' approach to regulation because of the

---

[16] In the early 1980's Swedish authorities "determined …that cost-benefit considerations would not be the deciding factor in whether or not to ultimately require FCVS at Forsmark, Ringhais and Oskarshamn." (International Trip Report, 4) The FCVSs were "based on the need to preclude the "cliff-edge" effects resulting from uncertainties associated with conventional deterministic and risk analyses." (Ibid, 5)

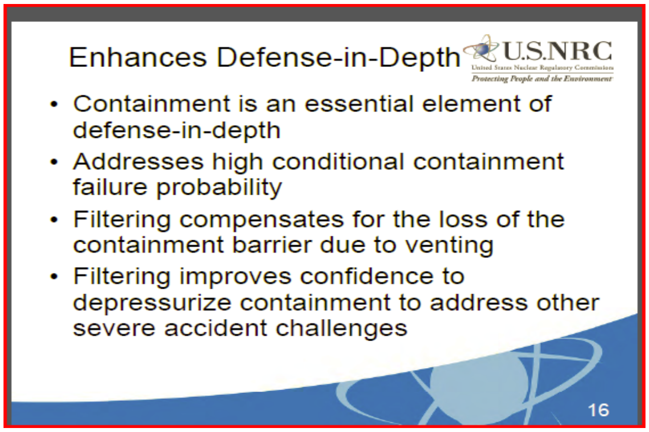
[17] Consideration Of Additional Requirements For Containment Venting Systems For BWRs With Mark I And Mark II Containments, ACRS Full Committee Meeting, NRC Staff, November 1, 2012, Slides 11,16,17

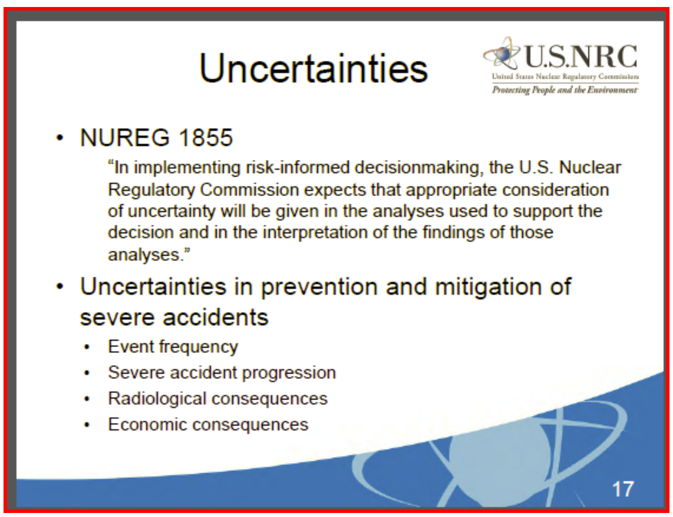
[18] Kamiar Jamali, *Use of Risk Measures in Design and Licensing Future Reactors,* Reliability Engineering and System Safety 95 (2010) 935-943

[19] SECY-98-144 White Paper on Risk Informed and Performance –Based Regulation, January 22, 1998. Staff requirements memorandum approved March 1, 1999; NRC Regulatory Guide 1.174, An approach for using probabilistic risk assessment in risk-informed decisions on plant changes to the licensing basis, Rev. 1, November 2002 (Section 1.4 states "…the NRC has chosen a more restrictive policy that would permit only small increases in risk, and then only when it is reasonably assured, among other things, that sufficient defense in depth and sufficient margins are maintained. This policy is adopted because of uncertainties and to

uncertainties in quantitative results in PRAs. These uncertainties are large for currently operating plants, particularly in the so-called Level 2 and Level 3 PRAs."[20]

The Staff discussed specific concerns about containment venting, and the need for the defense-in-depth provided by filtering, in its November 1 presentation to the ACRS, slides 16 and 17.





PW's foregoing discussion also highlights uncertainties or the "unexpected." For example, it is uncertain, as in Japan, whether properly trained operators in the U.S. will open an

account for the fact that safety issues continue to emerge regarding design, construction, and operational matters notwithstanding the maturity of the nuclear power industry."

[20] Kamiar Jamali, *Use of Risk Measures in Design and Licensing Future Reactors*, Reliability Engineering and System Safety 95 (2010) ,936

unfiltered DTV when they should because they fear the effects offsite of significant unfiltered releases. After all they are humans first and have family, friends and community that would be impacted. Furthermore, it is uncertain when the operators finally decide to open the vent that they will be able to do so due, for example to equipment malfunctioning or high radiation fields. It also is uncertain how effective the filter effect of the wetwell will be on its own. For example if the damage is sufficient to open large pathways from the core to the containment, there will not be sufficient water available to trap the radioactive materials of concern, nor will the pathway be so torturous that a significant amount will stick to surfaces before reaching the containment atmosphere. Similarly if the containment fails early enough, there will be insufficient time for aerosols to settle in the reactor building floor. It is uncertain whether the meteorology at the particular time necessary to vent would be such that the largest concentration of people would be impacted. It is uncertain that the accident progression would allow for timely notification of the population to evacuate prior to the release of the unfiltered vent.

Regulatory Guide 1.174, which deals with risk-informed decision making on changes to the licensing basis of plants, provides a good summary. It says that, "Defense-in-Depth…has been and continues to be an effective way to account for uncertainties in equipment and human performance." Recurrent themes in applications of defense-in-depth are don't rely on one element of design no matter how confident, and guard against the unexpected, i.e., don't assume accidents will start and play out in the analyzed way. Fukushima sadly showed this to be true; do we in the U.S. have to learn the hard way, also?

B. Current Consequence Analysis Tools Insufficient

As discussed above, it would be a mistake and contrary to NRC policy to simply rely on PRA's alone to judge whether filters and rupture discs are necessary to protect public health, safety and property. The ACRS additional comments (at 5) pointed out that the MACCS2 is outdated post-Fukushima, and the ACRS therefore advised NRC to modify now its cost-benefit analysis guidelines to incorporate lessons learned from Fukushima *before* using such an analysis to assess the costs and benefits of the post-Fukushima recommended upgrades to safety requirements.[21]

V. CONCLUSION

It is not news that Pilgrim's, or any other BWR Mark I's or Mark II's, containment will not hold up if too much pressure builds up inside. Neither is it new that U.S. Mark I's like their sister Fukushima reactors installed an *unfiltered* vent to let radioactive gases out in an accident. What is new are three significant pieces of information.

The first is that we now know that, even with improved scrubbing, an unfiltered vent will release 200 times as much radioactivity as will a filtered one.

Second, we now know that one unintended consequence is that poisoning unnecessarily offsite neighborhoods can make operators hesitant to use the vent until perhaps too late, upping the probability of containment failure/explosions.

Third, unless made completely passive by properly installing relief valves, DTV's are likely to fail. Before Fukushima the DTV had not been tested. At Fukushima, DTV systems failed three times in their first real-world tests.

The final cost of the Fukushima disaster remains to be calculated, but TEPCO now estimates it needs at least $137 billion dollars and the number keeps climbing.[22] By comparison, filtered vents and rupture discs are cheap. Their cost is fully justified; and the risk for the public will be reduced significantly. Citizens should not be faced with the equivalent having life boats that crewman won't launch before the ship goes down or that don't float.

---

[21] *Pilgrim Watch Comment Regarding Secy-12-110, Consideration of Economic Consequences within the NRC's Regulatory Framework (*September 6, 2012) reviewed the limitations of NRC's and industry's current methodology for estimating consequences of a severe accident; and it is attached for your convenience.

[22] ***Bloomberg*** - Fukushima $137 Billion Cost Has Tepco Seeking More Aid - Tsuyoshi Inajima and Yasumasa Song, November 8, 2012.

Respectfully submitted,

(Electronically signed)
Mary Lampert
Pilgrim Watch, Director
148 Washington Street
Duxbury, MA 02332
Tel. 781-934-0389
Email: mary.lampert@comcast.net
November 19, 2012

ATTACHMENT A

PILGRIM'S DTV- HOW IT WORKS- AN EXAMPLE OF WHAT'S WRONG WITH THE STATUS QUO

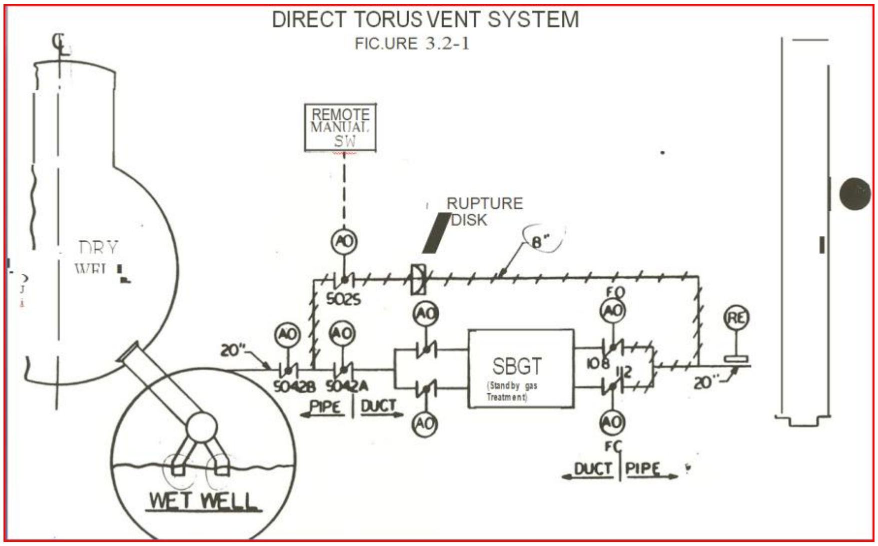
Pilgrim's DTV is described in Boston Edison's *Initial Assessment of Pilgrim Safety Enhancement, Section 3.2, Installation of DTVS Attachment to BECO letter 88-126, Section 3.2 Revision 1 "Installation of a Direct Torus Vent System (DTVS)* pages 14,-19B, Rev. 1 (7/25/88)

The Initial Assessment says:

> Pilgrim's DTVs provides a direct vent path from the torus air space to the main stack, in parallel with and bypassing the Standby Gas Treatment System (SGTS). The DTVS provides a new 8" line branching off the existing torus purge exhaust line between the containment isolation valves (outside containment) with a reconnection to the existing torus purge exhaust line downstream of the SGTS. The new torus vent line is also provided with its own containment isolation valve and rupture disc, set to relieve at 30 psig.

The following diagram, that shows the branch line with its own containment isolation valve 5025 and Rupture Disc, is included in the attachment to BECO's letter. It will be noted that the Rupture Disc is downstream of valves AO-5042B and AO-5025, and that both of these values are normally closed and are designed to be opened either remotely from the control room or manually.[23]

[23] Some initial reports indicated that the Fukushima DTV did not include "updates" that were present in US Mark I Reactors such as that at PNPS. Those reports were apparently not correct. Pilgrim Watch's understanding is that the Fukushima DTVs had been upgraded, and are essentially the same as that at PNPS



The accompanying discussion in the BECO letter attachment says, among other things:

- The vent line provides a direct vent path from the torus to the main stack bypassing the SBGTS. The bypass is an 8" line (hatched line in diagram) –the upstream end is connected to the pipe between the primary containment isolation valves AO-5042 A & B. The downstream end of the bypass is connected to the 20" main stack line downstream of the SBGTS valves AON-108 and AON-112.
- An 8" butterfly valve (AO-5025), which can be remotely operated from the control room, is added downstream of 8" valve AO-5052B. This valve acts as the primary containment outboard isolation valve for the DTV line. Test connections are provided upstream and downstream of AO-5025.

- AO-5042B was replaced in 1988 with a DC solenoid valve (powered from essential 125 volt DC) so that it would operate without dependence on AC power. AO-5025 is also provided with a DC solenoid powered from a redundant 125 volt DC source. Both valves are normally closed and are closed in a "fail-safe" position. One inch nitrogen lines are added to provide nitrogen to valves AO-5042B and AO-5025.
- Valve AO-5025 is controlled by a remote manual key-locked control switch. During normal operation, power to AO-5025 DC solenoid will also be disabled by removal of fuses in the wiring to the solenoid valve to assure it cannot be inadvertently opened.

The 7/25/88 document said that an additional fuse will be installed to power valve status indication for AO-5025 in the main control room.

- A rupture disc is included in the piping to provide a second leakage barrier. It is designed to open below containment design pressure, but will remain intact up to pressures equal to or greater than those which cause automatic containment isolation during accident conditions.

See also, Chairman Kenneth M. Carr, Responses to Concerns raised by W.R. Griffin, June 21, 1990, Enclosure 2 Possibility Of A Vacuum Breaker Remaining Open (Q.2 Response, pp.,2-3, 5)

- Each penetration consists of a vacuum breaker and an air operated butterfly valve in series. During normal operation, valves are closed; the vacuum breaker is maintained closed by the weight of the disc, and the butterfly valve is maintained closed by positive actuator air pressure.
- Therefore, during the entire positive pressure profile of the event, the penetration has two closed barriers in series. It is only during the end of the pressurization phase that the penetration is aligned into its vacuum breaker role. Because of this double barrier protection and the fact the both valves are not expected to change position during the pressurization phase of the event, the staff has concluded that failure of the penetration as a leak tight barrier is not credible and need not be considered in design basis.
- The fact the Pilgrim DTVS rupture disc is designed to rupture at 30 psi is not related to the NRC's recommendation that specified the venting pressure at the containment design pressure. The set pressure for the rupture disc does not control the venting pressure because there are two closed isolation valves in the flow path.
- These two valves are normally closed and will open manually by the operator if venting is needed. The maximum containment pressure at which the operators are expected to open the vent valve is 56 psig (not 60 psi), which is the NRC recommendation on venting pressure.

- The rupture disc is designed to serve as an additional leakage barrier at pressures below 30 psi. It is designed to open below the containment design pressure, but will be intact up to a pressure equal or greater that those pressures that cause an automatic containment isolation during an accident conditions. Therefore, its presence in the line can effectively eliminate the negative consequences of inadvertent actuation of the vent valves at pressures below 30 psi. The set pressure of 30 psi for the rupture disc satisfies these design objectives.
- The isolation valves, AO-5025 and AO-5042B, are designed with ac independent power supplies. These two valves are powered from essential dc power and are backed up with diverse nitrogen actuation capability. Therefore in case of an SBO event, the valves would be available for venting. The venting concept is mainly designed to slow overpressure transients of the containment. During some ATWS (anticipated transient without scram) events, the pressure in the containment will rapidly increase. Venting pressure could be reached in a matter of minutes rather than hours. Therefore venting may not prevent containment failure because of the high containment pressurization rate but would provide additional time to scram the reactor and delay the core melt.

In other words and greatly simplified, the DTV will vent excess pressure from the containment *only* if normally closed valves AO-5025 and AO-5042b can be opened.

At Fukushima, TEPCO was unable to open the normally closed valves in all three DTV's, and there is no redundancy.[24]

Pilgrim's control room has 2 key locked switches in series that have to be opened manually when the need to use the DTV occurs. If, as happened at Fukushima, the normally-closed isolation valves cannot be opened from the control room, the next step is to try to open the isolation valves manually – but this also proved impossible at Fukushima since radiation levels were too high.

---

[24] Redundancy, of course, could have been provided at both Fukushima and Pilgrim, e.g., by a parallel vent line with a 50-55 psig rupture disc followed by a normally open valve that would be closed when pressures had dropped to an accept able level, but that would have cost the industry more money.

Failed Valves: Pilgrim's DTV isolation valves appear to be essentially the same as those that failed at Fukushima. Supposedly "automatic" systems do fail (as they did at Fukushima) and manual systems may also (both mechanically and because radiation is too high to permit manual operation). Why is there no redundancy?

DC Batteries: *Pilgrim Nuclear Power Station Individual Plant Examination For Internal Events Per Gl-88-20, Volume 1*, Prepared by Boston Edison Co., September 1992 (Exh.4) says that:

- [T] he direct torus vent requires both DC batteries for operation (C.2-10)
- 125VDC Bus (Battery) "A" This bus is required for operation of the direct torus vent. (C.2-14)
- 125VDC Bus (Battery) "B" This bus is also required for operation of the direct torus vent. (Ibid)
- The containment torus venting system would be unavailable if one DC division is unavailable. (C-4-8)