BEFORE THE STATE OF WASHINGTON
ENERGY FACILITY SITE EVALUATION COUNCIL

In the Matter of Application No. 96-1

Olympic Pipe Line Company

Cross Cascade Pipeline Project

PRE-FILED TESTIMONY OF DR. JOHN P. WAGNER

ISSUE:

FIRE AND EXPLOSION RISKS

SPONSOR:

City of North Bend, Washington
City of Snoqualmie, Washington
Cascade Columbia Alliance

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Please state your name and describe the area of your testimony.

I am John Wagner and I am an expert in the field of flammability. I have reviewed the proposed Olympic Pipe Line Company proposal to assess the risk of fires and explosions associated with the pipeline.

Would you please summarize your qualifications?

I have a Ph.D. in chemical engineering and diversified experience working for both corporations and academic institutions. My training, experience, and research cover several fields including combustion and flammability, surface chemistry and physics (emulsions and foam), electric chemical engineering, and environmental engineering. My Ph.D. and Masters of Science in chemical engineering were received from Johns Hopkins University in 1966 and 1964 respectively. I am currently the Associate Director and Research Engineer for the Engineering Biosciences Research Center at Texas A&M University in College Station, Texas. My prior employment includes time as a staff engineer and senior staff engineer for EXXON Research and Engineering Company.

I am a registered professional engineer in Texas and I am a member of the American Institute of Chemical Engineers; American Society of Safety Engineers; and the American Chemical Society.

Research and consulting that I have done in the field of flammability includes fire detection and spontaneous combustion detection problems, internal flammability problems, and electrostatic induced ignition.

My resume is attached as Exhibit JPW-1.

What did you review to prepare for your analysis?

Generally, I reviewed various documents and papers in my personal library which deal with flammability and explosion issues, especially those dealing with petroleum products. In addition to those listed in the References section of my report, I reviewed Chapter 2 "Consequence Analysis" pp. 59-183, in *Chemical Process Quantitative Risk Analysis* by the Center for Chemical Process Safety of the AIChE - ISBN 0-8169-0402-2. Specific to this project, I reviewed pertinent portions of the Revised Application and Draft EIS.

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What was your focus in analyzing the flammability and explosion issues?

I focused on three areas. One, I analyzed flammability and explosion issues that would occur generally along the pipeline route.

Two, the project includes a substantial tank farm at Kittitas. There are unique (for this project) fire and explosion issues associated with that tank farm which I evaluated.

Three, I assessed flammability and explosion issues unique to the tunnel at Snoqualmie Pass.

Let's start with the general flammability issues. Could you describe generally the flammability concerns associated with a leak from the pipeline?

Yes. The first thing to recognize is that it takes an extremely small amount of product release to create a flammable situation. Gasoline and the other products to be transported in the pipeline vaporize when exposed to the open air. Hydrocarbon vapors can be flammable and explosive, depending on the concentration and atmospheric conditions. One part of my analysis was to determine how large of an area would be covered by flammable vapors assuming a leak of a given size.

For instance, in one part of my report, I assume a leak of only 100 gallons (less than three barrels). I calculate how large of an area would be flammable if this 100 gallons spill vaporized. My calculations demonstrate that a 100 gallon spill could give rise to a circular flammable zone with a diameter of nearly 450 feet (the radius would be 225 feet). That is to say that if a 100 gallon spill were to vaporize at a given point, a flammable vapor cloud would be created which would extend roughly 225 feet in all directions.

What is the significance of a flammable vapor cloud?

When a vapor cloud is flammable, it means that if an ignition source is introduced to that flammable vapor, it will combust and/or explode.

What sorts of things could occur that would constitute an ignition source for a vapor cloud?

Well obviously, if anyone lit a match, that would do it. But there are many other less obvious sources. The tiniest spark will do. Turning on and off a flashlight or even dropping a flashlight and breaking its bulb can result in a spark which would ignite a flammable vapor cloud. Electrostatic sparking would be another example.

What is electrostatic sparking?

Electrostatic sparking is what we frequently refer to as static electricity. A spark can be generated by something as innocuous as removing a nylon jacket.

Can you give us other examples of ignition sources?

Yes. Another one which has been in the news quite a bit of late is the spark that can be generated by degraded wiring. It is believed that this might have been the source of ignition which caused the explosion of the fuel vapors in the tanks on TWA Flight 800. There are places along the pipeline route where there are high powered electrical lines and even fiber optic cables which can be the source of ignition of a vapor cloud.

Did you calculate to what extent there would be damage if a vapor cloud were ignited?

Yes. I assumed that a 1,000 gallon spill (less than 25 barrels) had vaporized. If this vapor cloud were ignited, it would destroy completely all buildings within 368 feet with a presumed loss of life for anyone within that area. Partial collapse of buildings would extend out for 1,195 feet. There would be broken windows and other similar damage for a distance of slightly more than one mile.

I performed similar calculations assuming a vapor cloud generated by a 10,000 gallon spills (less than 250 barrels). In that instance, there would be virtually complete destruction of all buildings within 793 feet (with assumed loss of life); partial destruction of buildings to 2,573 feet (about one-half of a mile); and glass breakage and other similar damage to a distance of slightly more than two miles.

Did you have an opportunity to assess the significance of this in the context of specific buildings along the proposed right-of-way?

Yes, because one of the clients is the City of North Bend, I focused my efforts there simply by way of example. Using the smaller hypothesized spill, i.e., only 1,000 gallons, ignition of the vapor cloud would destroy the Two Rivers High School (approximately 280 feet from the pipeline); and the North Bend Elementary School (approximately 330 feet from the pipeline). Other buildings are even closer and would be destroyed including the North Bend Community Services building (approximately 60 feet) and the Puget Sound Energy Electrical Substation (right on the pipeline route) as well as numerous houses, some of which are as close as 40 feet to the pipeline.

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What were your findings with regard to flammability and explosion issues at the Snoqualmie Pass tunnel?

First, I determined the size of the flammability zone for a vapor cloud generated by vaporization of a 100 gallon spill. Because the vapor cloud would be confined both vertically and sideways, it would extend a considerable distance along the length of the tunnel. In fact, I have calculated that a 100 gallon vapor cloud in the tunnel would extend along the bottom one foot of air space for 2.32 miles -- virtually the length of the tunnel. (The vapor would tend to lay on the floor because it is heavier than air.)

What is the significance of this finding?

This finding means that even a very small leak in the tunnel when vaporized would make virtually the entire tunnel length a flammable zone. Any source of ignition in the tunnel could ignite the vapor cloud. Again, something as innocuous as dropping a flashlight or removing a nylon jacket could create the spark that would ignite the vapor cloud.

What impacts would result if a vapor cloud in the tunnel were ignited?

Obviously, it would depend on the amount of product that had vaporized. But as I mentioned earlier, because of the tremendous energy contained in refined petroleum products, it would not take very much to create massive impacts.

It is difficult to model the situation because of unusual geometry with the tunnel (i.e., semi-confined). But suffice it to say that a vapor cloud from a 1,000 gallon spill if ignited would probably kill anyone in the tunnel, cause the collapse of portions or all of the tunnel, and possibly sever the fiber optic cables buried in the tunnel. Depending on how close the center of the vapor cloud was to the end of the tunnel and how much product had vaporized, there could also be significant damage and death outside the portals of the tunnel, too. It is probable that this would ignite trees in the area and lead to a forest fire if conditions were conducive (i.e., if it were the dry time of the year).

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What were the findings of your analysis of the situation at the Kittitas tank farm?

Let me begin by providing a brief description of the facilities proposed for the Kittitas tank farm. The tank farm is a facility where Olympic would take product off the pipeline and hold it in storage tanks for delivery to truckers.

Olympic proposes that at build-out the Kittitas tank farm would have ten above-ground storage tanks: nine would be 48 feet high and 100 to 150 feet in diameter. The tenth one would be a transmix/relief tank 30 feet high and 50 feet in diameter. The total storage capacity would be over 36,000,000 gallons of product.

The terminal also includes truck loading racks, parking for tanker trucks, and other facilities and buildings.

What are the flammability issues that arise out of this facility?

First, you have the same flammability issues here that you have at any other point along the pipeline. For instance, as described above, if a 1,000 gallon leak were to vaporize and be ignited, it would typically cause the complete destruction of buildings within 368 feet, partial destruction of buildings within 1,195 feet, and glass breakage and other similar damage to buildings within a mile. But the significance of this damage is greater here because of the type of buildings within close range, i.e., ten fuel storage tanks holding over 36,000,000 gallons of product. The risk, then, is that a relatively small leak gives rise to a vapor cloud which is ignited and causes a chain reaction leading to fire involvement of one or more of the larger fuel tanks. This could lead to tank rupture and an overflowing of the diked region leading to a much larger pool fire. It is difficult to assess how large this pool fire could be because of the unknown terrain. However, the distance for ignition of wood from a 470 foot diameter pool is around 650 feet which could easily increase by 50 percent if there were a larger pool size. If that occurred, you would expect heavy property damage and loss of life in a zone that extended outwards beyond 650 feet.

Are there other flammability and explosion issues unique to the Kittitas tank farm?

Yes. Another area of concern stems from the proposed containment dikes Olympic proposes to build around the storage tanks. In the event of a leak from one of the tanks, these dikes would contain the released product instead of allowing it to flow over the landscape at will. However, if the dikes work as expected, then a different problem has been created: we now have a pool of highly flammable fluid which can readily be ignited. The petroleum industry is very familiar with so-called "pool fires" which develop in these situations. I have calculated that if a pool fire resulting from rupture of the contents of a single 150 foot diameter tank were to result, radiant heating such as second degree burns

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would extend outward a distance of 1,233 feet (nearly a quarter of a mile). Among other things, this would mean that people in the community could not get closer than a quarter mile to the main fire or to secondary fires that would be ignited in the immediate area. Thus, they could not assist extinguishing brush fires which would lead to an even larger fire impact zone.

What conclusions did you reach regarding the adequacy of Olympic's plans for fire protection at the Kittitas terminal?

The application provides extremely limited information on the proposed fire protection for the Kittitas tank farm. A lack of detail makes it very difficult for me (or anyone else) to assess the adequacy of the fire protection plans. Nonetheless, there are a few items which jump out as being indications that the fire protection plans are very inadequate.

The water supply from the City of Kittitas is clearly inadequate for fighting a large tank fire. Olympic apparently recognizes this by making reference to its plan to rely on firefighters coming in from California or Texas. But relying on out-of-state firefighters is fraught with other problems.

First, Olympic claims that firefighters from California or Texas would be able to reach the Kittitas tank farm within three hours. This seems incredibly and unjustifiably optimistic. How would Olympic communicate with, mobilize, and transport adequate resources and personnel from Texas or California to Kittitas in three hours?

Second, bringing personnel in from out-of-state does not do much good if there is not an adequate water and pressure delivery capabilities in Kittitas.

Third, there is no indication that Olympic plans to have personnel trained in large tank fire suppression on-site. This would mean that the community would be essentially defenseless until aid from out-of-state arrived.

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What is the significance of these shortcomings in Olympic's proposed fire suppression system?

The deficiencies in fire suppression noted almost insure full tank farm involvement before highly skilled personnel from other parts of the country could arrive. A possible scenario can involve rupture of additional tanks due to thermal stresses and thus, an overflowing of the diked region with burning fuel. In this scenario, the fire would most probably have to burn itself out; even highly skilled personnel from other parts of the country would not be able to effectively suppress a conflagration of this magnitude.

Did you prepare a report?

Yes. Attached as Exhibit JPW-2 is my report entitled "Flammability Analysis of Hydrocarbon Vapors at Kittitas Terminal, Local Communities and Chicago, Milwaukee-St. Paul Railroad Tunnel." I have summarized the report's findings in this testimony. Additional information is included in the report which I incorporate into this testimony by this reference.

Do you have any videos which illustrate the type of fires that you have been describing in your testimony.

Yes. I am incorporating with my testimony a composite videotape of seven petroleum product fires that have occurred in recent years. Three of them were the result of a pipeline explosion and fire (Cal-Nev in 1989; Williams in 1986; and San Jacinto River in 1994); four of them resulted from fires at a tank farm (Tampa in 1990; Great Bend, Kansas in 1989; Kansas City, Kansas in 1959; and Delaware County, Pennsylvania in 1998). The videotape and accompanying text are identified with exhibit numbers as follows:

Williams Pipeline Explosion and Fire - text	JPW-3
Cal-Nev Pipeline Explosion and Fire - text	JPW-4
Citgo Tank Farm Fire (Tampa) - text	JPW-5
Great Bend, Kansas and Kansas City, Kansas Tank Farm Fires - text	JPW-6
Tosco Refinery Fire and Explosion (Delaware County, Pennsylvania) - text	JPW-7
San Jacinto River - text	JPW-8
Composite video	JPW-9

The composite video includes excerpts from other videos about those seven fires and a video describing a spill into the Rappanhannock River in Virginia; voice-overs using material from JPW-3 through JPW-8; and a map of North Bend, Washington.

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