BEFORE THE STATE OF WASHINGTON
ENERGY FACILITY SITE EVALUATION COUNCIL

In the Matter of: *Application No. 2013-01* *TESORO SAVAGE, LLC* *VANCOUVER ENERGY DISTRIBUTION TERMINAL*	CASE NO. 15-001 WRITTEN EXPERT TESTIMONY OF MICHAEL S. HILDEBRAND

TESTIMONY ON THE CAPABILITY OF THE CITY OF SPOKANE, WASHINGTON TO RESPOND TO A HIGH HAZARD FLAMMABLE TRAIN DERAILMENT INVOLVING BAKKEN CRUDE OIL.

SUBMITTED BY MICHAEL S. HILDEBRAND, CSP, CHMM, CFPS
ON BEHALF OF THE CITY OF SPOKANE, WASHINGTON

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Mr. Hildebrand has forty-four years experience in hazardous materials planning and emergency response. In 1989 he co-founded Hildebrand and Noll Associates, Inc. (HNA) with Gregory Noll. During their twenty-seven year business partnership, they have served as consultants to industry and government on over 700 consulting projects throughout the world.

In addition to his work with HNA, Mr. Hildebrand serves as the President of Yvorra Leadership Development Foundation (YLD), which he co-founded in 1988. YLD is a non-profit, tax-exempt organization which provides financial support to emergency responders through scholarships. www.yld.org.

During his career Mr. Hildebrand served as the Chief Technical Officer for Hazardous Materials Training, and Information Services, Columbia, Maryland, as the Director of Safety and Fire Protection for the American Petroleum Institute, as a Researcher with the International Association of Fire Chiefs, and as a Hazardous Materials Technician with the National Transportation Safety Board in Washington, D.C.

Mr. Hildebrand served four years as an active duty firefighter and medic with the U.S. Air Force (1972-1976). He was an active volunteer firefighter for twenty years. From 1980 to 1990 he served as a member of the Prince George's County, (Maryland) Hazardous Materials Response Team where he held the position of Shift Officer for five years.

Mr. Hildebrand is the co-author of nine textbooks including Hazardous Materials: Managing the Incident - 4th edition, now in its 27th year of publication.

Mr. Hildebrand currently serves as a member of the National Fire Protection Association (NFPA) Technical Committee on Hazardous Materials / WMD Response Personnel (NFPA 472). He is a former member of the NFPA Flammable and Combustible Liquids Committee (NFPA-30), and was a member of the NFPA Standards Council.

Mr. Hildebrand is a Certified Safety Professional with the Board of Certified Safety Professionals, a Certified Fire Protection Specialist with the Fire Protection Specialist Certification Board, and a Certified Hazardous Materials Manager by the Institute of Hazardous Materials Management.

He has a B.S., in Fire Safety Analysis and Investigation, from the University of Maryland at College Park, and holds an A.A. in Fire Science from Montgomery College, Rockville, Maryland.

INTRODUCTION

Tesoro Savage Petroleum Terminal LLC proposes to construct and operate a new crude oil terminal in the Port of Vancouver, Washington. The terminal will receive an average of 360,000 barrels of crude oil per day by way of the BNSF railroad. The crude oil will be unloaded from trains, stored on-site, and loaded onto marine vessels at a marine terminal located at the Port of Vancouver in Clark County, Washington. The crude oil will be moved to the terminal by High Hazard Flammable Trains (HHFT) trains that will transit the city limits of Spokane, Washington. [1] HHFT unit trains have been transiting rail lines through Spokane for several years, and while the hazards and risks presented by these trains has not changed, building the new terminal in Vancouver will increase the risk of a derailment in Spokane due to higher traffic density.

In June 2014 the City of Spokane retained Hildebrand and Noll Associates, Inc. to render an opinion on the operational readiness of emergency services to respond to and mitigate a HHFT incident within the city limits. Several gaps in emergency preparedness and response capability were identified. Eight recommendations were made to the City of Spokane emergency services. See Appendix – A which summarizes the findings. A copy of the full June 2014 report has been filed with EFSEC as Ex2501-000039-SPO.

In September 2015 the City of Spokane once again retained Hildebrand and Noll Associates, Inc. [2] to prepare written testimony on the emergency response capability of the city to respond to a High Hazard Flammable Train derailment and spill or fire involving Bakken crude oil. In October 2015 another site inspection was conducted to determine what progress had been made in improving Spokane's emergency response capabilities.

This testimony will: 1) Provide an overview of HHFT tank car derailment performance; 2) Summarize lessons learned from actual emergency responses to HHFT incidents; and 3) Describe Spokane's current emergency response capabilities to deal with an HHFT derailment.

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[1] The U.S. Department of Transportation – Pipeline and Hazardous Materials Safety Administration (DOT / PHMSA) defines High Hazard Flammable Trains (HHFT) as trains that have a continuous block of twenty (20) or more tank cars loaded with a flammable liquid (*i.e.*, unit train), or thirty-five (35) or more cars loaded with a flammable liquid dispersed through a train (*i.e.*, manifest train with other cargo-type cars interspersed).

[2] Hildebrand and Noll Associates, Inc. was founded in 1989 and specializes in hazardous materials emergency planning and response. Mr. Hildebrand has 44 years experience in emergency planning and response and is the coauthor of Hazardous Materials: Managing the Incident 4th edition, Jones and Bartlett Learning (2014).

HHFT TANK CAR DERAILMENT PERFORMANCE

At the present time, crude oil and ethanol are transported in DOT-111 or CPC-1232 tank cars. On April 30, 2015, the US DOT/PHMSA issued revised, risk-based regulations pertaining to HHFT operations and tank car standards. During the period of 2017 through 2025, DOT-111 and CPC-1232 tank cars used for the shipment of flammable liquids will be either removed from service, retrofitted to meet a new enhanced CPC-1232 standard, or replaced by the new DOT-117 tank car. New tank cars constructed after October 1, 2015 must meet the DOT-117 design or performance criteria.

The following facts can be noted with respect to the behavior of the railroad tank cars in a HHFT derailment scenario:

- Legacy DOT-111 and non-jacketed CPC-1232 (*i.e.*, Interim DOT-111) tank cars have not performed well in high-energy derailment scenarios. Jacketed CPC-1232 tank cars have performed slightly better than non-jacketed tank cars.

- Observations from actual derailment performance show that the number of tank cars that breach or fail is dependent on the type of tank car involved (*e.g.*, DOT-111, CPC-1232 jacketed vs. non-jacketed tank car) and the configuration of the derailment (*i.e.*, in-line vs. accordion style). Tank cars that pile up generally sustain greater numbers of car-to-car impacts that result in breaches, or will be susceptible to cascading thermal failures from exposure to pool fires. Tank cars that roll over in-line are less susceptible to a container breach, but may leak from damaged valves and fittings.

- During a dynamic derailment, tank cars are stressed mechanically and may breach due to punctures from couplers or other objects such as broken rails or as a result of damaged fittings. Tank cars damaged by mechanical stress often burn.[3] Other causes of tank car failure may include: (a) thermal stress from an external fire impinging on the tank car shell; (b) the heat-induced weakening and thinning of the tank car shell metal; and (c) internal tank car pressure. The hazards posed by the release of flammable liquids include flash fires, pool fires, and dynamic energy release from container failure (*i.e.*, fireballs with associated shock wave and possible separation of the tank shell.

A review of research literature by the Sandia National Laboratory for U.S. DOT/PHMSA showed that a 100 ton release of a flammable liquid (approximately equivalent to a 30,000 gallon tank car) with a density similar to kerosene or gas oil would produce a fireball diameter of approximately 200 meters (656 feet) and

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[3] Sandia National Laboratories, "Literature Survey of Crude Oil Properties Relevant to Handling and Fire Safety in Transport" (Albuquerque, NM: Sandia National Laboratories March 2015.) Section 7.2.1, Page-78. A copy of the Sandia Report has been filed with EFSEC as Ex2502-000096-SPO.

a duration of about 10 – 20 seconds. Note: "Gas Oil" is fuel distilled from petroleum.[4]

Observations that can be made with respect to the behavior of the railroad tank cars in a HHFT scenario include:

- Derailments resulting in a liquid pool fire scenario can lead to the failure of valve gaskets, which leads to additional tank car leaks and associated issues during derailment clean-up and recovery operations.

- Heat induced tears have been observed on tank cars containing both crude oil and ethanol.[5] While the majority of heat induced tears have occurred during the initial 4-6 hours of an incident, tank car failures can occur at any time. Heat induced tearing has occurred within 20 minutes of the derailment and as long as 8+ hours following the initial derailment.

Experience has demonstrated that HHFT incidents are large, complex and lengthy response scenarios that will generate numerous response issues beyond those normally seen by most local-level response agencies. In addition to the hazardous materials issues associated with the response problem, there will be a number of other secondary response issues that will require attention by the Incident Commander. These will include evacuation, foam and water supply logistics, situational awareness, information management, public affairs, and infrastructure restoration. Managing an HHFT derailment and fire in an urban environment would require an Incident Management Team working in a Unified Command; *e.g.*, National Incident Management System Type-III Team.

LESSONS LEARNED FROM ACTUAL RESPONSES TO HHFT DERAILMENTS

Based on our experience as hazardous materials emergency planning and response specialists, and from studying the experience from actual HHFT train derailments and fires, there are a number of observations that can be made that would directly relate to what the City of Spokane's emergency services would face in dealing with an HHFT derailment with fire.

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[4] Sandia National Laboratories, "Literature Survey of Crude Oil Properties Relevant to Handling and Fire Safety in Transport" (Albuquerque, NM: Sandia National Laboratories March 2015.) Section 7.2.1, Page-78.

[5] A Heat Induced Tear, also referred to as a thermal tear, is a longitudinal failure that occurs in the portion of the tank car shell surrounding the vapor space of the tank following exposure to pool fire conditions. Thermal tears involving DOT-111 and CPC-1232 tank cars in HHFT derailments resulting in fire have been measured from 2 feet to 16 feet in length.

Typical Fire Department Response vs. the Actual HHFT Experience

Most fire service emergencies are "high intensity, short duration events" that are terminated in a matter of hours. In contrast, HHFT train derailment spills and fires are long duration, major environmental incidents that will extend over several days. With few exceptions HHFT incidents cannot be safely managed by a single agency or organization. These are "All Hands" incidents that require a coordinated fire department and Emergency Management Agency response that is supported by mutual aid organizations, State and Federal technical support, Oil Spill Response Organizations (OSRO's), emergency response specialists from the railroad, and organized in a Unified Command format to bring the incident to closure.

An HHFT train derailment scenario will likely be the largest flammable liquid incident encountered by most emergency response agencies in their history. Challenges will include the location and access to the incident, the overall size and scope of the problem, the rapid growth of the fire, spill control, and the level of resources available in the first two hours of the incident. The large quantities of foam concentrate required for fire control present most fire departments with significant challenges that include: (a) Having the right type of foam concentrate and in sufficient quantities; (b) A foam logistics plan to move foam caches to the scene of the incident; (c) Ability to access the burning tank cars; and (d) Adequate and sustainable water supply and the proper foam eduction and application devices. Initiating large flow foam operations at HHFT scenarios will be a significant operational challenge for most public fire departments.

Fire Control Experience

Experience from reviewing actual HHFT incidents shows that potential fire attack using foam as an extinguishing agent can fall into two different operational environments:[6] (1) offensive operations to rapidly control or extinguish the fire in the early phases of the incident timeline; and (2) final extinguishment of the fire in the later phases of the incident timeline after the size and intensity of the fire have greatly diminished (*i.e.*, equilibrium has occurred).[7] The following observations have been made from actual HHFT incidents involving tank car fires:

- Extinguishing HHFT fires in the initial phase requires a water supply capable of supporting high volume master streams for exposure protection. In addition, large quantities of foam concentrate are needed to arrive at the

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[6] Hildebrand and Noll Associates, Inc. reviewed 24 HHFT train derailments that occurred between 2006 to 2015. The total number of tank cars derailed in these incidents involving ethanol or crude oil was 443 cars of which 314 breached releasing 6,529,311 gallons of product. In 20 of the 24 incidents a fire was involved due to tank car failures.

[7] HHFT fire equilibrium is the point where the fire is confined to a specific area with little probability of growth, there is low probability of additional heat induced tears or container breaches, and there are no current Pressure Relief Device activations indicating continued heating of tank cars.

scene and be placed into action in the early phase of the fire. Most fire departments do not have foam concentrate stockpiles that can be rapidly deployed in time to change the outcome of the fire timeline. (First 1 to 2 hours).

- Once "equilibrium" of the fire has been achieved and the tank car metal has cooled, individual tank cars with breaches and internal fires can be extinguished using Class B foam. The use of Class B firefighting foams in combination with dry chemical extinguishing agents (*e.g.*, Purple K or potassium bicarbonate) will be critical tools in the controlling and extinguishing pressure fed fire scenarios.

HHFT Fire Timeline Based on Real World Experience

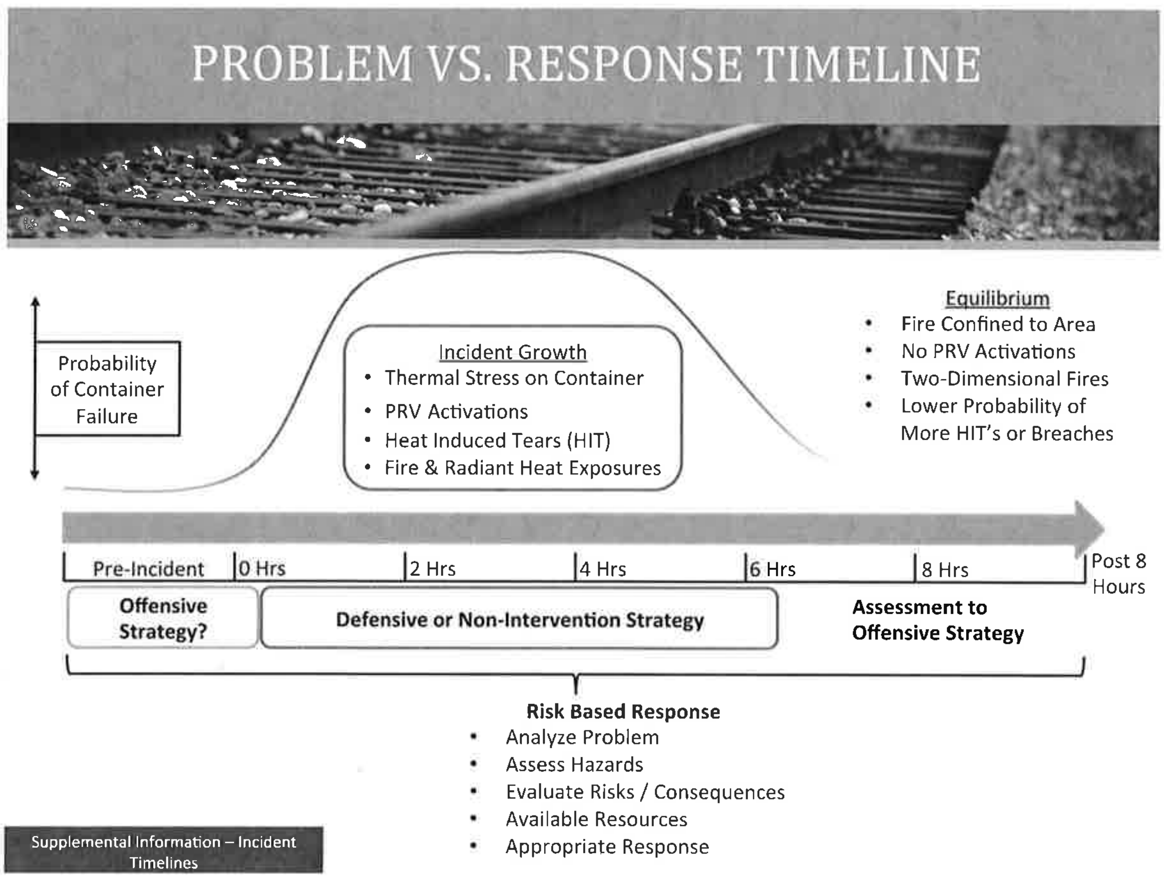
The behavior of HHFT derailments resulting in tank car beaches goes through three distinct phases as illustrated in the graphic shown on page-7. These include:

Phase-1: The initial derailment and fire. (1 hour into the incident). If derailed tank cars are initially breached through mechanical or valve failure and an ignition occurs, the breached cars burn and the fire will impinge adjacent exposures. These exposures may include unbreached tank cars which can result in additional tank car failures and an increase in the size of the fire. In this phase of the incident there may be a window of opportunity for the fire department to intervene and use an offensive strategy to attempt to attack and extinguish the fire. An adequate supply of water and foam concentrate must be available to execute an offensive strategy. Based on actual HHFT derailment experience, to date, <u>no</u> HHFT fires have been controlled or extinguished by a fire department using offensive strategy in the early Phase-1 of the incident.

Phase-2: Incident Growth. (2 to 8 hours into the incident). In this phase of the incident, the fire grows larger and becomes very hot and intense. Incident growth will generally follow a process of: (a) thermal stress from the initial fire upon the tank cars; (b) activation of tank car pressure relief devices; (c) continued thermal stress on adjoining tank cars from a combination of both pool fires and pressure-fed fires from activated Pressure Relief Devices; (d) increasing probability of container failures through heat induced tears; and (e) subsequent fire and radiant heat exposures on surrounding exposures when explosive release events occur. In this middle phase of the incident, the fires are extremely hot and three-dimensional making them difficult and unsafe to approach. Running or unconfined spill fires and releases may occur. Spills may flow into storm drains and other underground structures creating secondary spills and fires. In addition, the use of large water streams for cooling may also spread the fire to unintentional areas. The window of opportunity for extinguishment closes and the fire department has to switch to either a defensive or non-intervention strategy. The curve on the graphic shown on page-7 represents the probability of additional container failures, which leads to a cascading and growth response scenario.

Phase-3: Equilibrium. (8 to 12+ hours.) Fires will continue to burn off the available flammable liquid fuel until such time that it achieves a level of "equilibrium" and is no longer growing in size or scope. An analysis of historical incidents shows that equilibrium at a major incident may not occur for approximately 8-12 hours. There is a lower probability of additional heat induced tears or tank car breaches once equilibrium is achieved.

"Equilibrium" benchmarks would include the fire being confined to a specific area and no longer increasing in size or scope, no Pressure Relief Device activations, the fire dynamic being two-dimensional.



CURRENT SPOKANE EMERGENCY RESPONSE CAPABILITIES

Based on the October 2015 review, Hildebrand and Noll Associates, Inc. found that the City of Spokane Fire Department and the Spokane Department of Emergency Management made good progress in improving their emergency preparedness and response capability to deal with an HHFT derailment. As noted in the introduction, the June 2014 study generated eight recommendations for improvement. Interviews and inspections conducted during the second site visit in October 2015 indicated that nearly all of the eight recommendations made in 2014 were implemented or would be addressed by early 2016. In essence, the city and county have made their best effort to utilize regional resources to prepare for an HHFT derailment scenario. Some examples of improvements that have been made since June 2014 include obtaining advanced training on HHFT trains at national level schools, conducting exercises, improving plans, strengthening mutual aid agreements among public safety agencies, and preparing detailed transportation mapping that identifies elevation and drainage to support spill control decision-making.

The city and county of Spokane have very good emergency response capability to deal with the typical flammable liquids emergency; but an HHFT derailment with fire will present significant challenges depending where the derailment occurs and the number of cars that are breached.

One of the greatest challenges the fire department would face if an HHFT derailment occurred is the quantity of crude oil that might be spilled and burn. For example, in 24 HHFT tank train incidents a total of 314 cars breached. This is an average of 13 tank cars breached per incident. As a practical example, 13 crude oil tank cars burning is the approximate equivalent of 48 gasoline cargo tank trucks. Just 3 tank cars breached would be the equivalent of 11 gasoline tank trucks burning. One tank car would be the equivalent of 3.7 gasoline tank trucks.

In addition to the quantity of crude oil spilled, there are several areas within the city center where a derailment involving a fire would be extremely challenging for the fire department. Areas that are especially vulnerable are:

1. The overpasses between Cedar and Adams Street where surface drainage flows downhill from 2nd to 1st. There are also numerous structural exposures with high occupancy in this area. Any derailment in this area might place rail cars on top of buildings on the 1st street side. Rooftops are lower than the track's elevation.

2. The elevated overpass between Lincoln and Post. A derailment at this location might drop rail cars directly into the Ruby-2 Hotel. The historic Davenport hotel would also be exposed to fire. Drainage flows from the elevated railway downhill toward the Davenport Hotel toward 1st.

3. The elevated rail bridge in the 200 block of Sprague Street, cross street Division.

Spill control in the downtown area would present an immediate problem if tank cars ruptured and burned. Terrain characteristics can significantly impact the size of the fire area, especially when the slope flows away from the derailment site and the surface is paved.

If burning crude oil entered storm drainage in some areas along Spokane's downtown rail corridor, the fire would likely spread burning crude oil to other locations downstream and cause secondary fire or tertiary fires through throughout the drainage system. Storm drainage flows to the Spokane River. If several tank cars were breached, keeping the burning flammable liquid out of the storm system would be key to confining the fire.

The Spokane Fire Department, with the support of mutual aid organizations may be able to control an HHFT derailment in parts of the city where: (a) There is low population density and evacuation is not an immediate priority; (b) The derailment site is accessible to fire apparatus; (c) There is an adequate water supply readily available to support master streams and they can be placed in service rapidly; and most critical; (e) Adequate quantities of foam concentrate within the region, including Fairchild Air Force Base, could be marshaled and placed in service within the first hour of the incident.

If the HHFT derailment occurred in the city center in vulnerable areas as described above, the Spokane Fire Department and its mutual aid partners would face extreme challenges to: (a) Simultaneously evacuate the threatened area; (b) Implement spill control tactics to prevent burning crude oil from entering the storm water system and spreading the fire and pollutants to the river; (c) Protecting exposures like buildings and infrastructure from the fire; and (d) Establishing a water supply and placing master streams and firefighting foam in services within an hour. As pointed out earlier in the testimony, to date, no fire department has been able to successfully mount a fire attack on an HHFT train derailment in the initial phase of the incident. A controlled burn during Phase-2 has been the adopted strategy until the fire reaches equilibrium and can then be extinguished after the fire subsides.

DECLARATION

I, Michael S. Hildebrand, declare under penalty of perjury under the laws of the State of Washington that I make this declaration of personal knowledge, could and would competently testify to its content and that the foregoing is true and correct.

DATED this 7th day of May, 2016 at Port Republic, Maryland.

Michael S. Hildebrand

Michael S. Hildebrand, CSP, CHMM, CFPS
Hildebrand and Noll Associates, Inc.