Application Of Fire Fighting Equipment For Tanker Fires

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If an outside resource is called to assist in the extinguishment of a fire on a marine vessel, it can be conclude that the incident is larger than the ships system can handle. Tankers in particular pose difficulty when the cargo is involved due to the closed design of the product system. In the event a fire occurs in the product tanks the closed system becomes breached, meaning that the vapor space above the liquid level is the explosive range. At the time of ignition a vapor air explosion will occur, the magnitude of the vapor air explosion is dependant upon the volume of liquid in the tank. The larger the vapor space the larger the resulting vapor air explosion.

The energy released from the vapor air explosion exits via the week points of the closed system, to include ullage hole covers, inspection covers, deck weld seams, etc. Unfortunately the vapor air explosion can also damage the firewater piping rendering the ships fire-fighting capabilities useless. As the fire progresses and the deck plate begins to warp due to the intense heat the separating cargo tank bulkheads can separate at the point between the under deck and the bulkhead itself. When this occurs the vapors in the Adjoining tanks come in contact with the open flames and another vapor air explosion can occur. This process can continue until all of the cargo holds are involved in fire, all the while reducing the vessels structural integrity. As an outside resource this is how a response team normally finds the vessel, multiple if not all cargo tanks involved, compromised vessel stability, damaged fire water system, with no crew onboard.
The selection of fire-fighting equipment is important, as many obstacles must be overcome if the effort is to be successful.

Equipment Selection

Monitor Nozzles – Although the appearance is of one large fire in reality the incident is composed of many smaller fires separated by bulkheads burning simultaneously. If the application density is based upon the entire desk space and not the individual cargo tanks the possibility for success greatly escalates. Several important nozzle features should be considered. The nozzle through distance, or reach, is an important factor because the streams have to be delivered to the fuel surface. The greater the distance of the nozzle stream the further the response vessel can stand off of the burning vessel resulting in an overall safer fire fighting effort. The nozzle should also produce a tight stream pattern, the longer the stream stays together the less fallout resulting in higher application densities to the fuel surface. Another feature to consider is the ability to change the pattern of the stream from straight stream to full fog. This is important for two reasons, at the initial stage of the attack the monitor streams should be on straight stream to allow for the greatest distance of the nozzle stream, in the position is where the term knock-down (90% of extinguishment) takes place, as extinguishment begins and the majority of the burning liquid is extinguished the fire fighting vessel begins to move closer to the distressed tanker, the fire fighting efforts become more precise as the remaining fires are usually separated and spread out along the deck.. Full fog capability on the nozzle provides the fire fighter with the protection in the event the fire should reflash while being in close proximity. Variable gallonage nozzles are an added bonus when compared to the standard fixed gallonage. As the fire fighting team approaches the vessel the nozzle volumes can be reduced eliminating the full force impact that a results in a high volume monitor at close range, this concept also reduces the surface impact velocity of the streams and prevents the spreading of fuel. As the fire reduces in size and the fire fighting efforts become more precise the nozzle volumes need to be reduced. The nozzle selected should also have the capability of remote foam proportioning outside the fire fighting vessels system. This ability provides the fire fighting team the redundancy of foam proportioning in the event the foam system fails or when the foam concentrate reserves are depleted in the system.

Hydro-Chem Nozzles – Another feature that enhances the safety and extinguishing efforts is a dual agent system called Hydro-Chem. Described as a self-contained chemical additive system capable of mixing, aspirating, and delivering a high quality finished foam while simultaneously discharging dry chemical into the center of the master stream for maximum range. This technology could be supplied with the fire fighting vessels water/foam monitors or as a stand-alone system. As the static fires are extinguished normally there are many fires burning at the opening of the cargo tanks where the above deck plating remains intact. One must first understand the concept of flammable liquid fire fighting to appreciate the significance of this technology. The flammable liquids contained in the tanks are extinguished by the application of a foam blanket. The foam blanket travels across the fuel surface and eliminates the vapor yield preventing the vapors from forming flammable mixtures with air above the liquid surface. As the foam blanket is applied in a fuel tank that has the above deck space intact the vapors produced by the fuel surface are Suppressed but the vapors above the blanket are still present but the vapor to oxygen ratio is to rich to burn. As the small fires burning at the hatches continue the vapor inside the tank are consumed by the small fires (can be classified as vent fires) the consumed vapors are replaced by the external atmospheric air. As this process continues the vapor space above the foam blanket continues to lean out until the vapor space reaches the explosive range resulting in another vapor air explosion. These types of vent fires are best extinguished via the use of dry chemical. Hydro-Chem provides the fire fighting teams with a method of deploying dry chemical at greater distances with increased application densities.

Foam wands – Foam wands are small portable foam making devices that can be placed to provide a direct foam application in areas where larger monitors or where safety issues utilizing hand lines are not possible. Only a very small opening is required to blanket a fuel surface, the foam produced from these devices is a homogeneous array of very small stable bubbles with a long drain time providing superior post suppression.

Thermal imaging and infrared thermometers - Both types of technology is important to reveal fires that may not be visible to the eye (i.e. under deck). It must be noted that after extinguishment the incident changes from a fire scenario to a exposed fuel and vapor scenario. The steel structure retains the heat from the fire for a long duration in conjunction with oxygen starved fires in the tanks that produce a heavy build up of carbon deposits on the under deck surfaces. These are both sources for reignition of the product involved. The thermal imaging device will provide a broad scan of the spaces involved while the infrared thermometers (pyrometers) will indicate actual temperatures exposing the areas in question.

Foam Concentrate – Defined as a stable aggregation of small bubbles of lower density than oil or water that demonstrate a tenacious quality for covering horizontal surfaces.

Foam concentrate selection is a very critical aspect of the fire fighting equation. There are basically two types of foam concentrates available to the fire industry today Proteins (P) and Aqueous Film Forming Foams (AFFF). Foam concentrates have four basic extinguishing mechanisms.

1. Cools the fuel and adjacent metal surfaces
2. Smothers the fire and prevents air from mixing with the vapors
3. Suppresses the flammable vapors and prevents their release
4. Separates the flames from the fuel surface.

The protein based foams normally require an air to water/foam solution ratio of 8:1 or higher. While the AFFF type concentrates can be applied at much lower expansion rates typically 3:1. The nozzle from which the water foam solution is discharged produces this expansion. The higher the expansion of a water/foam stream the more air it contains and the larger the foam bubble. Large bubbles create more drag, which minimizes the distances that the water/foam streams can be thrown effectively. Protein based foams must be discharged through a mechanical air adding nozzle; this type of nozzle does not have the full fog/straight stream capability as discussed earlier. AFFF's produce a foam blanket that can be used via the aspirating nozzles or the more conventional non-aspirating nozzles thus providing the fire-fighting vessel with more choices in nozzle selections. The lower the expansion the more fluid the produced foam blanket is, a fluid foam blanket has the added benefit of securing the fire at quicker times when compared to the less fluid protein foam blanket. AFFF's by definition produce a microscopic film of water that actually floats on the top of the fuel surface. This aqueous film prevents the vapors from being released from the fuel surface while providing the equivalent type blanket that the protein foam blanket provides.

The information provided in this document is based on the successful control/extinguishment of over 100 major flammable/combustible fires during the past twenty years by Williams Fire & Hazard Control, to include 32 marine vessel incidents.