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ESTUDIO DEL DISTRITO PETROLERO DE PUENTE ARANDA

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IMPACTO SOBRE LA SEGURIDAD DEL AREA VECINA Y DEL IMPACTO AMBIENTAL SOBRE LA COMUNIDAD

Estudio elaborado para la
OFICINA PARA LA PREVENCION DE EMERGENCIAS

Elaborado por la
ORGANIZACION IBEROAMERICANA DE PROTECCION CONTRA INCENDIOS

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TABLA DE CONTENIDO

	Página
Introducción	1
Alcance	1
Conclusiones	3
Estudios anteriores	5
Evaluación actual	6
Situación Abril 1996	6
Mejoras pasivas y activas 1974 - 1996	7
Seguridad del Terminal Petrolero	8
Impacto Ambiental	9
- Introducción	9
ESSO COLOMBIANA LIMITED	10
EMPRESA COLOMBIANA DE PETROLEOS	10
MOBIL DE COLOMBIA	11
SHELL COLOMBIA	11
TEXAS PETROLEUM COMPANY	11
Conclusión	12
Contaminación Atmosférica	12

ANEXOS

Anexo No. 1:	Parámetros disposición almacenamiento	14
Anexo No. 2:	Bases para el análisis de riesgo del Almacenamiento.	24
Anexo No. 3:	Partes informe de la NFPA-1980	25
Anexo No. 4:	Estudios anteriores.	
	Decreto 283: Ministerio de Minas y Energía para plantas de almacenamiento de Combustibles.	
	Norma API - 2021: Combate de incendios alrededor de tanques de almacenamiento de petróleo.	

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JULIO - NOVIEMBRE DE 1995

INTRODUCCION

El presente estudio es realizado para la OFICINA DE PREVENCION DE EMERGENCIAS (OPES), a través de la ORGANIZACION IBEROAMERICANA DE PROTECCIÓN CONTRA INCENDIOS - OPCI.

El trabajo fue elaborado por el Ingeniero JAIME MONCADA P. con la colaboración de expertos en Seguridad Contra Incendios y Ambiental como el Sr. JAIME ESTEBAN RODRIGUEZ y el Sr. RAMON VILLEGAS.

ALCANCES.

El estudio busca dar criterios y respuesta a puntos tales como:

* Estudio comparativo para establecer el riesgo potencial del Terminal Petrolero de Puente Aranda.

* Impacto Físico, Social, Económico y Ambiental actual y proyectado.

* Medidas de seguridad existentes, su alcance y hasta que punto cumplen con la normatividad.

* Optimización de las medidas en el presente y su proyección.

Para su realización deben tenerse en cuenta las normas aplicables como las NFPA que son las más aceptadas en América, los criterios de API (American Petroleum Institute) y el Decreto 283 del Ministerio de Minas y Energía.

La referencia principal para este análisis es la Norma NFPA 30, pues además de ser el documento más utilizado en toda américa es referencia del Decreto 283 del Ministerio de Minas y Energía, de Enero 30 de 1990, que entre otras cosas dice en el Capítulo II Artículo 5:

" La ubicación, diseño, construcción y pruebas de las instalaciones de abastecimiento de los combustibles líquidos, derivados del petróleo deberán ceñirse a los requisitos que se establecen en el presente Decreto y las Normas Icontec. Para lo no estipulado en las Normas mencionadas, se aplicará la Norma NFPA 30."

Se utilizaron además otros criterios como la Norma API 650, API 2021 y otras normas NFPA relacionadas como:

NFPA 11	Espumas de Baja Expansión.
NFPA 15	Aspersores de agua.
NFPA 16	Sistemas de Regaderas de Espuma.
NFPA 20	Bombas de Incendio
NFPA 22	Tanques de Almacenamiento de Agua.
NFPA 24	Redes Privadas de Incendios.

CONCLUSIONES

1. Las Plantas de abastecimiento de combustibles de Puente Aranda, no constituyen un riesgo serio para la comunidad que la rodea. No es un riesgo que sea superior al que se encuentra en todas las zonas industriales de Bogotá. Es un riesgo propio y típico de la vida moderna.

2. Las plantas de abastecimiento de combustibles, en todo el mundo desarrollado se encuentran próximas a los sitios de consumo (Estaciones de Servicio).

3. Las condiciones de seguridad de Puente Aranda han mejorado sustancialmente en los últimos 20 años después del incendio en la planta de la Esso. Han mejorado las condiciones pasivas, los sistemas de protección contra incendios, la interconexión de las redes de agua y de los sistemas de bombeo, el nivel de conocimiento de los riesgos, las brigadas de emergencia, la conciencia sobre el manejo y disposición de residuos.

4. El nivel de almacenamiento de combustibles disminuyó de los 800.000 bls en 1974 y hoy en día se encuentra en el nivel de los 400.000 barriles aproximadamente.

   El riesgo mayor, más serio y delicado para el sector que representa el almacenamiento de gas propano en esferas y balas, desapareció. Queda solo un tanque o bala de propano que debe ser trasladado y los propietarios solo esperan la colaboración de las autoridades en definir o aprobar el sitio donde será instalado para efectuar el traslado.

5. Las plantas distribuidoras y envasadoras de gas en cilindros pequeños constituyen un riesgo manejable y se recomienda que eliminen el parqueo nocturno de los carrostanques "transportadores de gas", en el sector, los cuales constituyen un riesgo muy serio para la comunidad. Esto es urgente y demanda una acción inmediata.

6. Las áreas periféricas actuales que quedaron desocupadas por el traslado del gas o que están sin ocupar, deben constituir un cinturón adicional de seguridad. Las Empresas distribuidoras de combustible deben adquirirlas y pueden usarlas en muchas actividades como: mezcla y almacenamiento de lubricantes, almacenes generales, servicios a las estaciones de servicio, reparación, talleres o simplemente como áreas verdes.

   La ciudad de Santafé de Bogotá, debe prohibir el uso de esas zonas en proyectos no industriales, evitar una masificación de vivienda en la zona delimitada y la invasión por barrios sub-normales frecuentes en la ciudad.

   La planta de Puente Aranda debe continuar funcionando donde actualmente está ubicada.

7. Es aconsejable que se construyan por lo menos dos (2) estaciones de distribución, similares a Puente Aranda: una (1) en el Norte, alrededor de Chía y otra en el Sur (área de Usme), para disminuir las distancias que se deben recorrer desde Puente Aranda a las Estaciones de Servicio al Norte y al Sur.

8. Anualmente la OPES debe solicitarle a las compañías distribuidoras de combustibles un concepto de la Organización Iberoamericana de Protección Contra Incendios - OPCI, sobre el estado de las plantas y se pronuncie sobre temas como:

   a. Se conservan igual, han mejorado o han desmejorado en sus condiciones de protección contra incendios y manejo ambiental.

   b. El estado de funcionamiento, operabilidad de las protecciones pasivas existentes y de los sistemas de Protección Contra Incendios.

   c. Se mantiene o ha mejorado la calidad del factor humano, Planes de Emergencia, Plan de ayuda mutua, nivel de entrenamiento, relaciones con el Cuerpo de Bomberos y autoridades locales de ayuda en Emergencias.

IMPACTO AMBIENTAL

a) Las plantas han tomado medidas para controlar las posibles causas de contaminación que se describen en el informe.

b) Es evidente que existe un riesgo potencial de contaminación del agua por los efluentes, residuos, derrames de hidrocarburos líquidos, y es responsabilidad de las plantas establecer el programa y los sistemas de control adecuados. El riesgo de contaminación atmosférica por gases de combustión es otro riesgo potencial presente y en caso de un incendio se producirá inevitablemente.

Los dos riesgos ambientales son independientes de la ubicación de la planta y su efecto. Las consecuencias son las mismas, así sea que las Plantas estén en Arauca, Cusiana, Barrancabermeja, Medellín, Facatativa o Puente Aranda.

La forma de control es la misma donde quiera que se encuentren. Los métodos de control son conocidos. Las plantas los conocen, están concientes de ello y están adoptando las medidas de control para ser realizadas en el año de 1996.

ESTUDIOS ANTERIORES

En 1980 la NFPA efectuó un análisis del área para definir el grado de riesgo del área de Puente Aranda. Un extracto de los hallazgos y resultados de ese trabajo se incluyen en el apéndice 1 el cual debe tenerse en cuenta para el análisis del problema.

La opinión de la NFPA en 1980 era que no existía mayor riesgo para el Distrito de Puente Aranda y que aún el aumento del volumen de almacenamiento no prestaría mayor riesgo si se seguían las recomendaciones de NFPA 30

Para mejorar aún más la seguridad interna de las Plantas dio una serie de recomendaciones sobre la protección de las instalaciones.

En 1984, cuando aun no se habían establecido los sistemas de protección en Puente Aranda y las condiciones eran las mismas encontradas por la NFPA, se presentó un incendio en la Planta ESSO por un derrame en un tanque de techo cónico con membrana flotante.

Ante la falta en 1984 de sistemas de combate, la falla en los sistemas de refrigeración, la capacidad insuficiente de agua, la carencia de equipos de sistemas de espuma y la falta de capacitación del Cuerpo de Bomberos de Bogotá la decisión en ese incidente fue aceptar una quema controlada, la cual se prolongó por 74 horas y se quemaron cerca de 100.000 Bls. Desde entonces, no se ha vuelto a presentar otro incendio en las Plantas de almacenamiento de Puente Aranda.

Por la falta de agua, deficiencias de refrigeración, falta de subdiques entre los tanques y por la existencia de una válvula de bronce que se fundió, se calentaron e incendiaron dos tanques vecinos a las 20 horas de haberse iniciado el fuego.

Como era de esperarse y según lo dice la Norma 11 de NFPA respecto de tanques construidos según la Norma API 650, el incendio de líquidos estables en un tanque bien fabricado, se traduce en un fuego prolongado donde los combustibles arden a una rata de 15 a 25 cm. (por cada hora), con generación de humos y productos de combustión y nada más.

Líquidos estables se consideran aquellos productos como la gasolina corriente y la extra, la gasolina de aviación, keroseno y aceites diesel. Estos productos no producen ebullición desbordante, ni rebosamiento por ebullición o por frotación. Se queman, se consumen hasta agotarse y los tanques se doblan hacia dentro pero no se abren. Para que haya incendio dentro el tanque la explosión debe ser suficientemente fuerte para abrir o botar la tapa. Si no la bota o no se abre el incendio será exterior y no interior.

EVALUACION ACTUAL

En Septiembre y Octubre de 1995 se realizó otra inspección de las instalaciones de Puente Aranda.

El resultado de esa inspección se resume así:

1. El almacenamiento de productos líquidos bajo de 800000 Bls en 1980 a cerca de 400000 Bls en 1995.

2. El almacenamiento de gases licuados del petróleo prácticamente ya no existe pues fue trasladado a Mansilla y Sabrinsky Point.

Queda solo el llenado y almacenamiento en cilindros de 20, 40 y 100 libras en cilindros de acero. La Empresa Progas, tiene funcionando un tanque horizontal pero esta dispuesto a su traslado inmediato una vez que le autoricen el nuevo sitio.

SITUACION EN ABRIL DE 1996 DEL AREA DE PUENTE ARANDA

La inspección de todas las Plantas de Abastecimiento de Puente Aranda mostró los siguientes resultados:

- Con relación a 1980 el volumen de almacenamiento disminuyó - El tanque incendiado de 80000 Bls de la ESSO no fue reemplazado.

- El almacenamiento de Gas L.P.G. fue trasladado a Mancilla y a Sabrinski Point. queda el llenado de cilindros pequeños y el almacenamiento de esos cilindros.

- El área sur de la línea férrea continúa con la misma dedicación que tenía en 1980, como zona industrial.

- El área norte después de la vía férrea tiene dedicación residencial pero la distancia a los almacenamientos más próximos es mayor a 60 metros. (Tanques de Bases Lubricantes de la Shell).

- Con lo anterior sería suficiente para afirmar nuevamente que la zona de Puente Aranda no representa un riesgo para el área vecina, pues no ha desmejorado su situación y por el contrario ha mejorado sustancialmente disminuyendo el riesgo.

  Si en 1980 el área no constituía un riesgo para la comunidad menos lo es en el presente.

MEJORAS PASIVAS Y ACTIVAS EN PUENTE ARANDA - 1974 - 1996

Para mejorar el estado de seguridad de las Plantas y de acuerdo con las recomendaciones de la NFPA, se realizaron obras como:

1. Construcción y/o. mejora de Redes de Agua Contra Incendios y la Interconexión de todas las redes contra incendios de todas las plantas, lo cual suma la capacidad de bombeo y el almacenamiento de agua a volumen y flujos superiores a las necesidades individuales de cada planta.

2. Instalación de sistemas fijos para combate de incendio con espuma. Todas las plantas cuentan con protección para tanques y diques de acuerdo con NFPA 11.

3. Instalación de sistemas fijos de espuma en los llenaderos de carro tanques, según NFPA 16.

4. Aumento de la capacidad de bombeo instalando nuevas bombas en Texas, Mobil y la Esso. Las bombas siguen la Norma NFPA 20.

5. Instalación de alarmas de alto - nivel en los tanques para el control de derrames.

6. Construcción de subdiques en los patios de almacenamiento para separar los tanques.

7. Planes de emergencia para todas las plantas.

8. Conformación de Brigadas de Emergencia en todas las plantas.

9. Dotación de equipos, vestidos y accesorios para las Brigadas.

10. Programa y ejecución de entrenamiento periódico para las Brigadas y simulacros.

11. El nivel de conocimiento del personal que maneja las plantas ha mejorado y la decisión expresada en todas las visitas es clara sobre el proceso de continuar la capacitación y mejorar el nivel de conocimiento.

12. Formación de una asociación de ayuda mutua de la zona de Puente Aranda ASOPAR, que coordina y orienta la actividad de Prevención de la zona.

En el anexo 1 se incluye la información recogida durante la visita a la zona de Puente Aranda y que sirve de base para este trabajo.

Esa información confirma el criterio sobre la condición de seguridad para la comunidad que rodea el Terminal Petrolero de Puente Aranda.

SEGURIDAD DEL TERMINAL PETROLERO

Nuestra opinión puede resumirse de siguiente forma:

1. Los terminales petroleros para abastecer las estaciones de servicio deben estar lo más cerca posible a los sitios de consumo.

2. La distancia de recorrido de los carrotanques a las estaciones de servicio debe reducirse.

3. El Terminal de Puente Aranda reemplaza aproximadamente 1000 viajes diarios de carros tanque los cuales tendrían que recorrer 65 kilómetros hasta Mancilla creando un riesgo alto para la comunidad que circunda la vía de circulación de esos carros, aumentando posibles errores de los conductores y los accidentes por el deterioro del equipo transportador que no siempre está en las condiciones mínimas de seguridad deseable.

4. En la actualidad con sólo un terminal en la ciudad hay vehículos que viajan 40 Km. desde Puente Aranda para atender estaciones del norte y el sur de la ciudad.

   Es conveniente que desde ahora se acelere la construcción de un terminal en el Norte y se seleccione un área en el Sur para otra estación en esa zona.

5. Dada la situación actual y la coyuntura del traslado de las Plantas de Gas a las empresas del Terminal de Puente Aranda, con la colaboración del Gobierno, deben establecer un corredor de seguridad utilizando las áreas no construidas existentes atrás de la Texas, al lado de la Mobil y controlando el uso de los sitios donde funcionaba el almacenamiento de Gases Licuados de Petróleo.

IMPACTO AMBIENTAL SOBRE LA COMUNIDAD

INTRODUCCION.

Uno de los riesgos importantes para la comunidad que generan las instalaciones petroleras como las plantas de almacenamiento de Puente Aranda, está dado por la posibilidad de contaminación del agua y del aire.

1. Derrames, escapes, manejo de desechos sólidos y principalmente líquidos.

2. Productos de combustión generados en un incendio.

Se estima que un litro de hidrocarburo al mezclarse con 20.000 litros de agua la contamina a 50 ppm, nivel que se considera alto.

Al analizar este punto debe considerarse que en países tropicales solo una pequeña parte de los derrames llega realmente a las corrientes de agua, pues la mayoría se evapora por acción solar o degradada por acción bacteriológica.

Debe ponerse especial atención a esta situación y el control de residuos debe realizarse independientemente de donde esto se genere, es decir, de donde este situada la Planta.

Independientemente de que se trasladen o no las plantas de almacenamiento, la contaminación tiene la misma importancia, y así lo establecen las autoridades ambientales al poner límites máximos de contaminación a los efluentes; (aproximadamente 30° C de temperatura y 3 ppm), antes de poder hacer su vertimiento a las fuentes de agua, ya sea que la planta ubicada en Arauca, Coveñas, Cusiana, Medellín o Bogotá.

El control es necesario sea que las plantas se trasladen o no y las exigencias para los vertimientos son las mismas.

El propósito de la protección ambiental es lograr el control necesario para que las posibilidades de contaminación sean mínimas.

En general las plantas del sector de Puente Aranda analizadas en este estudio han tomado medidas de control que aunque están bien orientadas, requieren mejoras.

Todas las compañías visitadas cuentan con planes para evitar la contaminación y han desarrollado programas en este sentido. En general todas tienen para 1996 y como meta la optimización del control de sus efluentes líquidos.

De las inspecciones de planta se deducen las siguientes recomendaciones :

ESSO COLOMBIANA LIMITED

INSPECCION AMBIENTAL.

* La Zona de químicos y desechos de mantenimiento no se encuentra pavimentada.

* La Bodega de tambores se encuentra pavimentada en gran parte.

* Los diques de los tanques 43 y 296, presentan problemas de grietas.

* Se hace necesario evaluar la separación de las aguas lluvias de las aceitosas, pues pueden presentar problemas de rebosamientos de las cajas separadoras y sobrepasar el volumen de agua que maneja la caja API.

* Debe evaluarse la frecuencia de muestreo en la descarga de la caja Separadora al canal. (Vertimientos).

* La ESSO estudia el nuevo diseño de sus cajas separadoras y espera realizar esta obra en el año 1996.

EMPRESA COLOMBIANA DE PETROLEOS - ECOPETROL

INSPECCION AMBIENTAL.

Debe implementarse la pavimentación del múltiple de operaciones. La piedra actúa como una esponja que impide la propagación de la espuma para control de incendios, y además estando sobre tierra los hidrocarburos se absorben en ella.

No existe un medio (diques, etc.) de contención de vertimientos, por lo cual estos van directamente a cajas o canales y al separador que no tendría capacidad para controlarlos.

Se hace necesario considerar la separación de las aguas lluvias aceitosas, pues pueden causar problemas de rebosamiento en las cajas separadoras y un mayor volumen del agua que debe manejar el API.

Debe evaluarse la frecuencia del muestreo en la descarga de la caja separadora al canal (vertimiento).

Durante el período de realización de este trabajo Ecopetrol Puente Aranda licitó la evaluación y corrección de los posibles problemas existentes.

MOBIL COLOMBIA

INSPECCION AMBIENTAL.

Es necesario evaluar la separación de las aguas lluvias de las aguas aceitosas, pues se pueden presentar rebosamientos de la caja separadora y un mayor volumen de agua que debe manejar la caja API.

Debe evaluarse la frecuencia del muestreo que se viene realizando cada año, en la descarga de la caja separadora al canal (vertimientos).

La Mobil para 1996, tiene presupuesto aprobado para el mejoramiento de la base del área de los diques, de los tanques que se encuentren sin inpermeabilizar y el mejoramiento del sistema de medición de las borras.

SHELL COLOMBIA

INSPECCION AMBIENTAL.

Es necesario evaluar la separación de las aguas lluvias de las aguas aceitosas, pues se pueden presentar rebosamientos de la caja separadora y un mayor volumen de agua que debe manejar la caja API.

Debe evaluarse la frecuencia del muestreo que se viene realizando cada año, en la descarga de la caja separadora al canal (vertimientos).

Mejorar la base de los diques de los tanques.

La Shell se encuentra instalando una planta de tratamiento de aguas residuales y espera tenerla en funcionamiento antes de finalizar el año.

TEXAS PETROLEUM CO.

INSPECCION AMBIENTAL.

Es necesario evaluar la separación de las aguas lluvias de las aguas aceitosas, pues se pueden presentar rebosamientos de la caja separadora y un mayor volumen de agua que debe manejar la caja API.

Debe evaluarse la frecuencia del muestreo del vertimiento que se viene realizando por parte de la Empresa de Acueducto y Alcantarillado de Bogotá, en la descarga de la caja separadora al canal.

TEXACO, para 1996 tiene proyectos para manejar las aguas lluvias independientemente de las aguas aceitosas y el mejoramiento del Lanfarme de su trampa de grasas.

CONCLUSION

No importa donde funcionen las plantas de almacenamiento de combustibles para que el control ambiental deba ser el adecuado.

La contaminación por líquidos no es un factor determinante para decidir si la planta está en el lugar adecuado.

La situación actual o la proyectada en caso de que se trasladen las plantas, tiene las mismas implicaciones desde el punto de vista de contaminación por líquidos o por gases.

EMISIONES DE GASES Y PRODUCTOS DE COMBUSTION.

El problema principal de la emisión de gases de combustión consiste fundamentalmente del efecto de calentamiento de la atmósfera de la tierra por el efecto invernadero a causa de la emisión de gas carbónico CO2, producto principal en la composición de gases de combustión. En un incendio se libera también un poco de NO2, CO y material sólido en el humo por residuos carbonaceos. Además se liberan trazas de hidrocarburos no quemados usualmente livianos.

Una gasolina, un kerosene o un aceite combustible (ACPM), llamados productos blancos por no tener residuos pesados (alquitranes, breas) queman combinandose con el oxígeno del aire y se convierten típicamente en :

$$C7H16+1502 \text{ -------> } 7CO2+8H2O$$

En la realidad en incendios de derrames y en tanques la combustión no es completa y se liberan trazos de CO, aldehidos y productos no quemados, (hidrocarburos como: propanos, metanos). No existe una restricción a la cantidad de oxígeno disponible y la mayoría de CO formado en el interior de la llama arde en la periferia para formar CO2.

$$2CO+O2\text{------}>2CO2$$

Aunque la combustión no es perfecta, no es estequiométrica y por ocurrir al aire libre no puede decirse que exista una restricción a la cantidad de oxígeno como la que existe en los automotores donde la entrada del aire está regulada por el carburador de los carros detenidos en los semáforos o "trancones", aspiran poco aire y la combustión es muy mala e incompleta produciendo gran cantidad de contaminantes atmosféricos nocivos.

En incendios en tanques de almacenamiento con hidrocarburos no ha sido reportada la presencia de cantidades peligrosas de CO cerca de los incendios, ni de óxidos de nitrógeno que pudieran causar efectos nocivos. El Problema principal viene del efecto invernadero.

El efecto invernadero no es puntual, sino global. El CO2 liberado en cualquier parte de Colombia finalmente afecta a todo el país, al globo y viceversa.

En la práctica los gases de combustión de un incendio de tres (3) días en una Planta de abastecimiento (Puente Aranda 1974 - Diciembre duró tres (3) días quemando cerca de 100.000 Gls. de gasolina, y ACPM). 1984

En ese incendio se quemaron:

100.000.x 0.159 m3/ barril x 0.75 de densidad = 11.200 Toneladas.

Se produjeron aproximadamente tres toneladas de CO2 por cada tonelada de combustible, o sea 33.600 toneladas de CO2 liberados a la atmósfera terrestre en esos tres días. Esto mismo pasaría en la selva Amazónica o en el desierto del Sahara.

Sí Puente Aranda no existiera donde está y se traslada el abastecimiento, por ejemplo a Facatativa - Mansilla o a Zipaquirá tendríamos que transportar los productos 65 Klm. y se requerirían diariamente un estimado de 1000 viajes de carros tanque y cada uno requeriría recorrer :

130 Kilómetros (ida y vuelta)

10 Kilómetros (al estacionamiento)

---

140 Kilómetros

Un consumo diario de 20 galones de gasolina o de aceite Diesel y los 1000 carros quemarían 20.000 galones. Son 478 barriles diarios y en 210 días (7 meses), se consumirían los 100.000 barriles del incendio en Puente Aranda.

Por comparación desde 1974, o sea 22 años, no se ha presentado incendio en Puente Aranda y si se habrían consumido solo para traer a Bogotá el combustible necesario:

100.000 x 22 x 12/7 = 3.771.425 barriles

El efecto invernadero por la combustión de esos millones de barriles es acumulativo y por ser quemados en automotores son más contaminantes que un incendio al aire libre (oxígeno restringido).

Tener instalaciones bien diseñadas (NFPA 30 y API 650) reduce el riesgo de incendio, aumenta las posibilidades de control del derrame y/o del incendio y si se puede apagar, reducirá el tiempo de combustión y por lo tanto la generación de humo y gases.

Esto refuerza nuestra opinión sobre la necesidad de establecer otros sitios de abastecimiento para Bogotá. Uno al Norte y otro al Sur. (Ej. Usme - Chía), para disminuir el recorrido de los carros tanques hasta las estaciones de servicio.

ANEXO No. 1

INFORMACION ELABORADA SOBRE LAS PLANTAS.

Para determinar el grado de seguridad de las Plantas, se realizaron inspecciones y se levanto en campo la información necesaria para analizar el riesgo con base en la Norma NFPA 30.

En la visita a las Plantas se hizo un inventario de los tanques de almacenamiento y se consignó en una tabla :

El número del tanque
Tipo
Vertical con techo fijo (cónico)
Vertical con techo fijo (cónico) y pantalla flotante horizontal (cilíndrico)
Contenido
Altura en M
Volumen en bls.
Diámetro A en metros
La distancia B a la Línea de lindero más próxima que pueda ser o esté construida incluyendo el lado opuesto de una vía pública.
Según NFPA 30 mayor a la mitad del diámetro cuando hay protección a exposiciones y hay sistema de espuma según NFPA 11, o un diámetro cuando solo hay Protección a exposiciones.
La distancia C, se refiere a la distancia, a la línea de lindero o a una construcción importante
La Norma pide un tercio (1/3) de diámetro

Se incluye la información sobre la existencia o no de alarmas de alto nivel.

En el cuadro siguiente se establecen las distancias entre tanques con los tanques vecinos. Se da el No. del tanque, el diámetro, el número de los tanques vecinos., el diámetro, la distancia entre ellos y la distancia de norma que para este caso es de 1/6 de la suma de los diámetros de tanques adyacentes. En la columna de observaciones se destacan unos pocos casos de tanques que están en el límite máximo y debe ponerse refrigeración con anillos aspersores fijos.

Se incluye un informe sobre las condiciones y sistemas de protección existentes.

ESSO COLOMBIANA LIMITED

Está dentro de los parámetros de La Norma NFPA 30 y la API 650.

En algunos tanques pequeños como el 565, 645, 619 se encuentran más cerca de otros de lo que fuera deseable según Norma NFPA 30

EMPRESA COLOMBIANA DE PETROLEOS - ECOPETROL

Solo tiene un tanque de 500 bls. y el más próximo sería un tanque de la Mobil a una distancia muy superior a la pedida por la norma.

SHELL COLOMBIA

Los tanques 5, 6 y 13 están fuera de Norma en cuanto a sus distancias entre tanques. Debe moverse o eliminarse el tanque 5 para usarlo con solventes o cambiar su uso, como para almacenar bases lubricantes.

MOBIL DE COLOMBIA

La única observación se refiere al tanque 125 de 30.000 bls., cuya distancia al lindero de Ecopetrol está un poco por debajo de la exigida por la Norma NFPA 30.

Esta limitación en la práctica se elimina cuando siendo empresas del mismo tipo, las partes aceptan la presencia de los tanques en su vecindad, y al eliminar la línea de lindero las distancias a propiedades o a los tanques en la propiedad vecina quedan dentro de las distancias exigidas.

TEXAS PETROLEUM CO.

Solo unos tanques que almacenan bases lubricantes están a distancias por debajo de la Norma 30.

Los productos como las bases lubricantes tienen puntos de llama por encima de 93o.C. y son difíciles de incendiar a menos que estén durante muchas horas expuestos a incendio de otros tanques vecinos. Su refrigeración es más sencilla y su extinción es posible con espuma y aún con agua utilizando una técnica especial.

En las tablas anexas, la columna A se refiere al diámetro del tanque.

La Columna B es la distancia a la línea de lindero incluyendo el lado opuesto de una vía pública.

La columna C se refiere a la distancia a la línea de lindero o a una construcción importante.

ESSO COLOMBIANA LIMITED

DIQUES : Altura muro sobre patios " 50 cm.

DRENAJES: Profundidad: 40 cms.
Ancho : 28 cms.

Tubería Drenaje: 6 Pulgadas
Válvula sifón de: 1/2 pulgadas

DISTANCIA TANQUES.

Vía pública más próxima: 105 metros.
Construcción: 165 metros.
Construcciones dentro de la Planta : 98 metros.
Tanques Mobil: 85 metros

TIPO DE PROTECCION

Los tanques de combustibles cuentan con dos tipos de alarma:

* Una alarma fija graduada para dar alarma a 10 minutos del rebose
* Un sistema de alarmas (RTG) para niveles bajo, alto (a 15 min. del rebose) y alto - alto (a 5 min. del rebose).

EQUIPO.

La planta esta equipada con:

17 hidrantes para refrigeración.
1 Tanque de espuma fluroproteinica con capacidad para 1595 gls. para los tanques. Esta se aplica al 3% mediante un proporcionador de presión balanceada, tipo RF- 4 de 60 A 600 GPM.

Sistema de Bombas.

2 Motobombas para agua concentrado de espuma:

*	Eléctrica	BALDON Modelo : PTA 11162 125HP,200 - 250 PSI,850 GPM
*	Diesel	DETROIT DIESEL ALLISON 200 - 250 PSI 850 GPM

2 Motobombas para espuma:

* Eléctrica

* Diesel TWIN DISC.
Modelo : C106SP3

2 Sistemas de aireadores:

* Uno PHB para aplicar las espumas por la parte inferior del tanque.
sistema PHB: TK 356,664,341,619,382,296, y 389

* Uno MCS (Cámaras) para aplicarla por la parte superior:
sistema MCS: TK 430, 719, 447, 541 - pantalla.

LLENADERO

Largo : 42 metros
Ancho : 12 metros

Distancia tanque más próximo : 58 m.
Distancia a construcción más próximo : 30 m.
Número de islas : 4 (8 posiciones)
Número C/T. para atender : 8
Drenaje alrededor : 3 canales de 42 m. de largo.

TIPO DE PROTECCION:

Rociadores tipo regadera a: parte superior K=3.0
Rociadores tipo Direccionable : parte inferior K=3.0
Detectores Térmicos : 135 grados Farenheith.
Estaciones Manuales : Dos a cada extremo plataforma
Espuma: Tanque vejiga de 450 gls. para 20 minutos
Proporcionador espuma con válvula tipo bola para espuma
Válvulas DELUGE para agua llenadero

RED DE AGUA.

2 Tanques de agua de 10.240 bls. y 2.000 bls.
2 Motobombas para agua de enfriamiento :
* Eléctrica : LINCOLN AC MOTOR
1500 GPM,120 PSI, 150 HP

* Diesel DETROIT DIESEL ALLINSON
Modelo : PTA 15P273
1500 GPM, 120 PSI

1 Red principal de dos anillos, con diámetro de tubería de 8 pulg.
14 Número de hidrantes
9 Número de monitores de espuma
3 Número de estaciones de espuma

INTERCONEXION CON LA ESSO, ECOPETROL, MOBIL.

Tubería : 6"
Bombas de apoyo: MOBIL 750 GPM 150 PSI
ECOPETROL 1000 GPM 125 PSI

OTROS SERVICIOS.

Bodegas : Tambores LUBES
Empacados LUBES
Repuestos
Ventas
Casetas de Seguridad

Un Taller destinado al mantenimiento de la Planta.

Un laboratorio para hacer las pruebas básicas :API, PUNTO DE CHISPA, CURVA DESTILACION.

Una planta de emergencia de 450 KVA.

BRIGADAS CONTRA INCENDIO

La planta cuenta con un inventario de seguridad:

6	Trajes y cascos de bombero
3	Equipo de aire auto-contenido
1	Traje de asbesto
3	Máscara contra gases
13	Tambores de espuma de 55 gls.
4	Baldes de 20 lts.
28	Baldes de 5 gls.
3	Proporcionadores de espuma para carros
1	Proporcionadores de espuma para tambor
15	Extinguidores de 150 Lbs.
60	Extinguidores de 30 Lbs.
3	Mantas
1	Camillas
2	Carro rueda metálica
11	Monitores fijos

BRIGADA CONTRA INCENDIO.

Actualmente existe una Brigada, un planes de Atención de emergencia para los dos Turnos: Diurno y Nocturno.

ESS0 COLOMBIANA
DISTRIBUCION DE TAQUES DE ALMACENAMIETO

TK.No.	TIPO	CONTENIDO	ALTURA Mts	VOLUMEN-Bls	(A) Mts	(B) Mts	NORMA	(C) Mts	NORMA	ALARMAS	OBSERVACIONES
266	Vertical	Diesel	8.6	9.600	15.2	20	15.2	Mayo 20	5.06	Alto Nivel	
296	Vertical	Jet A	8.4	9.500	15.2	40	15.2	22	5.06	Alto Nivel	
317	Vertical	Diesel	8.79	9.900	15.2	16	15.2	Mayo 20	5.06	Alto Nivel	
341	Vertical	Varsol	5.3	1.000	6.1	80	6.1	Mayo 20	2	Alto Nivel	
356	Vertical	Mogas	8.5	24.100	23.8	80	23.8	72	2.03	Alto Nivel	
382	Vertical	Kero	11.5	4.400	9.1	68	9.1	Mayo 20	7.93	Alto Nivel	
389	vertical	Jet A	11.5	4.800	9.1	68	9.1	Mayo 20	3.03	Alto Nivel	
430	V.P.Flot	Mogas	11.4	26.900	22.9	26	22.9	Mayo 20	7.63	Alto Nivel	
447	Vertical	Extra	11.26	4.200	9.1	68	9.1	Mayo 20	3.03	Alto Nivel	
510	Vertical	Bencina	5.7	1.700	8	48	8	Mayo 20	2.66	Alto Nivel	
535	V.P.Flot	Paradine	5.3	900	6.1	72	6.1	60	24	Alto Nivel	
541	Vertical	Av.Gas	11.4	4.300	9.2	10	9.2	Mayo 20	3.07	Alto Nivel	
565	Vertical	I.P.A.	4.6	200	3.2	18	3.2	Mayo 20	1.07	Alto Nivel	
619	Vertical	Jet A	5.4	1.000	6.1	54	6.1	Mayo 20	2.03	Alto Nivel	
645	Vertical	Mek	5.2	1.000	6.1	44	6.1	Mayo 20	2.03	Alto Nivel	
664	Horizontal	Tolueno	5.2	1.000	6	72	6	Mayo 20	2	Alto Nivel	
702	Horizontal	Tinher	2.5	200	2.58	64	2.58	Mayo 20	0.86	Alto Nivel	
703	Horizontal	Isopar	2.5	200	2.58	60	2.58	Mayo 20	0.86	Alto Nivel	
719	Horizontal	Jet A	9.15	9.200	15.1	42	15.1	Mayo 20	5.03	Alto Nivel	

0000214

TK.No.	TIPO	CONTENIDO	ALTURA Mts	VOLUMEN-Bls	(A) Mts	(B) Mts	NORMA	(C) Mts	NORMA	ALARMAS	OBSERVACIONES
563	Horizontal	A.T.F		100	2	64	2	Mayo 20	0.66	Alto Nivel	
564	Horizontal	Fenso		200	2	64	2	Mayo 20	0.66	Alto Nivel	
683	Horizontal	Gear		200	2	64	2	Mayo 20	0.66	Alto Nivel	
697	Horizontal	Colorado		200	2	64	2	Mayo 20	0.66	Alto Nivel	
701	Horizontal	Friol		200	2	64	2	Mayo 20	0.66	Alto Nivel	
708	Horizontal	Gear		100	2	54	2	60	0.66	Alto Nivel	
1259	Horizontal	Gear		200	2	36	2	50	0.66	Alto Nivel	
1260	Horizontal	Colorado		200	2	36	2	54	0.66	Alto Nivel	

220022

ESSO COLOMBIANA LIMITED
SEPARACION ENTRE TANQUES

TANQUE No.	DIAMETRO	AL TANQUE No.	DIAMETRO	DISTANCIA Mts	NORMA	OBSERVACIONES
ESSO - 266	15.2	541	9.2	9.2	4.07	
	15.2	430	22.9	16	6.35	
	15.2	719	15.14	8	5.06	
	15.2	619	6.1	22	3.55	
ESSO - 317	15.2	510	8	4	3.87	
	15.2	703	2,58	5.4	2.96	
	15.2	645	6.1	4.4	3.55	
	15.2	565	3.2	3.2	3.07	
ESSO - 341	6.1	356	23.8	4.90	4.98	En el límite máximo ponerle refrigeración.
	6.1	563	2.4	14	1.42	
	6.1	564	2.4	13.2	1.42	
	6.1	683	2.4	12	1.42	
	6.1	697	2.4	12.8	1.42	
	6.1	701	2.4	14.8	1.42	
	6.1	708	2.4	16.8	1.42	
ESSO - 356	23.8	664	6	4.8	4.97	En el límite máximo ponerle refrigeración.
	23.8	341	6.1	5.2	4.98	
	23.8	535	6	8.4	4.97	
	23.8	564	2.4	18	4.37	
	23.8	683	2.4	15.6	4.37	
	23.8	697	2.4	13.2	4.37	
	23.8	701	2.4	10.8	4.37	
	23.8	708	2.4	9.6	4.37	

230003

ESSO - 382	9.1	447	9.1	3.6	3.03	
	9.1	389	9.1	3.2	3.03	
	9.1	296	15.2	6	4.05	
ESSO - 389	9.1	382	9.1	3.6	3.03	
	9.1	296	15.7	6	4.13	
ESSO - 430	22.9	619	6.1	7.2	4.83	
	22.9	719	15.14	11.6	6.34	
	22.9	266	15.2	15.6	6.35	
	22.9	541	9.2	14	5.35	

V20000

ESSO COLOMBIANA LIMITED
SEPARACION ENTRE TAQUES

TANQUE No.	DIAMETRO	AL TANQUE No.	DIAMETRO	DISTANCIA-Mts	NORMA	OBSERVACIONES
ESSO - 447	9.1	382	9.1	3.6	3.03	
	9.1	296	15.2	14	4.05	
	9.1	619	6.1	11.2	2.53	
	9.1	719	15.14	8	4.04	
	9.1	430	22.9	22.4	5.33	
ESSO - 510	8	702	2.58	8.4	1.76	
	8	703	2.58	8	1.76	
	8	317	15.2	4	3.87	
	8	719	15.14	22.8	3.86	
ESSO - 535	6	708	2.4	19.2	1.40	
	6	356	23.8	8.4	4.97	
ESSO - 541	9.2	266	15.2	9.2	4.07	
	9.2	430	22.9	12.4	5.35	
ESSO - 565	3.2	317	15.2	2.8	3.07	En el límite máximo ponerle refrigeración.
	3.2	645	6.1	7.2	1.55	
ESSO - 619	6.1	430	22.9	5.2	4.83	
	6.1	719	15.4	4	3.58	
	6.1	447	9.1	8	2.53	
	6.1	382	9.1	20.8	2.53	
	6.1	296	15.2	20.8	3.55	
ESSO - 645	6.1	565	3,2	7,2	1,55	
	6.1	317	15,2	4,4	3,55	
	6.1	703	2,58	20	1,45	

0100025

ESSO COLOMBIANA LIMITED
SEPARACION ENTRE TAQUES

TANQUE No.	DIAMETRO	AL TANQUE No.	DIAMETRO	DISTANCIA-Mts	NORMA	OBSERVACIONES
ESSO - 664	6	341	6,1	3,2	2,02	
	6	356	23,8	4,8	4,97	En el límite máximo, ponerle Refrigeración.
	6	719	15,14	23,6	3,52	
ESSO - 702	2,58	703	2,58	0,8	0,86	
	2,58	510	8	8,2	1,76	
	2,58	341	6,1	14	1,45	
	2,58	664	6	15,2	1,43	
ESSO - 703	2,58	702	2,58	0,8	0,86	
	2,58	317	15,2	5,2	2,96	
	2,58	510	8	8	1,76	
	2,58	645	6,1	20	1,45	

920000

ESSO COLOMBIANA-SEPARACION ENTRE TANQUES

TANQUE No.	DIAMETRO	AL TANQUE No.	DIAMETRO	DISTANCIA-Mts	NORMA	OBSERVACIONES
ESSO - 719	15.14	447	9.1	20	4.04	
	15.14	619	6.1	4	3.54	
	15.14	430	22.9	11.2	6.34	
	15.14	266	15.2	8	5.06	
	15.14	510	8	21.2	3.86	
ESSO - 563	2	564	2	1.2	0.67	
ESSO - 564	2	563	2	1.2	0.67	
	2	683	2	2	0.67	
	2	341	6.1	11.2	1.35	
ESSO - 683	2	564	2	2	0.67	
	2	697	2	1.2	0.67	
	2	341	6.1	12	1.35	
ESSO - 697	2	341	6.1	12	1.35	
	2	683	2	1.2	0.67	
	2	341	6.1	12.8	1.35	
	2	356	23.8	13.2	4.30	
	2	701	2	2.4	0.67	
ESSO - 701	2	697	2	2.4	0.67	
	2	708	2	1.6	0.67	
	2	356	23.8	10.8	4.30	
	2	341	6.1	12.8	1.35	
ESSO - 708	2	701	2	1.6	0.67	
	2	356	23.8	9.2	4.30	
	2	535	6	19.2	1.33	

MOBIL DE COLOMBIA
DISTRIBUCION DE TANQUES DE ALMACENAMIENTO

TANQUE No	TIPO	CONTENIDO	ALTURA-Mts	VOLUMEN-Bls	(A)	(B)	NORMA	(C)mts	NORMA	ALARMA	OBSERVACIONES
101	Cónico	Diesel	11.9	11500	13.71	Mayo 20	13.71	Mayo 20	4.57	Alto nivel	
102	Cónico	Diesel	11.9	10600	10.67	Mayo 20	10.67	Mayo 20	3.55	Alto nivel	
103	Cónico	Kero	8.3	5100	10.67	Mayo 20	10.67	Mayo 20	3.55	Alto nivel	
104	P.Flot.	Premiun	8.3	4750	13.71	Mayo 20	13.71	Mayo 20	4.57	Alto nivel	
109	P.Flot.	Premiun	11	6700	13.71	Mayo 20	13.71	Mayo 20	4.57	Alto nivel	Pant.Proc.Ins.
119	P.Flot.	Mogas	10.36	20000	17.98	Mayo 20	17.98	Mayo 20	5.99	Alto nivel	
125	P.Flot.	Mogas	10	30000	23.17	Mayo 10	23.17	Mayo 10	7.72	Alto nivel	A lindero de Ecopetrol
146	Cónico	Pegasol	5.8	964	5.79	Mayo 20	5.19	Mayo 20	1.93	Alto nivel	Disolvente No.4
187	Cónico	Bencina	8.3	4700	13.71	Mayo 20	13.71	Mayo 20	4.57	Alto nivel	

NOTA: El caso del tanque 125 de Techo Cónico con pantalla flotante está fuera de Norma con relación al lindero de Ecopetrol. La distancia cuando exíste protección con espuma es de 1/2 diámetro, o sea 11.60 mts y solo tiene 10 mts.

La Norma NFPA 30 permite que las dos (2) Compañías de común acuerdo decidan aceptar el lindero común, como no existente y en ese caso desaparece esta limitante.

820000

MOBIL DE COLOMBIA - SEPARACION ENTRE TANQUES

TANQUE	DIAMETRO	AL TANQUE No.	DIAMETRO	DISTANCIA	NORMA	OBSERVACIONES
MOBIL - 101	13.71	102	10.67	8.4	4.06	
	13.71	104	13.71	16	4.57	
	13.71	119	17.98	25.4	5.28	
	13.71	187	13.71	21.6	4.57	
MOBIL - 102	10.67	146	5.79	12	2.74	
	10.67	101	13.71	8.4	4.06	
	10.67	103	10.67	7.2	3.56	
MOBIL - 103	10.67	102	10.67	7.2	3.56	
	10.67	146	5.79	5.2	2.74	
MOBIL - 104	13.71	125	23.17	28.4	6.15	
	13.71	119	17.98	12.4	5.28	
	13.71	101	13.71	16	4.57	
MOBIL - 109	13.71	187	13.71	9.6	4.57	
	13.71	119	17.98	10.4	5.28	
MOBIL - 119	17.98	125	23.17	14	6.86	
	17.98	104	13.71	12.4	5.28	
	17.98	187	13.71	10	5.28	
	17.98	109	13.71	10.4	5.28	
MOBIL - 125	23.17	104	13.71	28.4	6.15	
	23.17	119	17.98	14	6.86	
	23.17	Ecopetrol 01	4.5	15	4.61	
MOBIL - 146	5.79	103	10.67	5.2	2.74	
	5.79	102	10.67	12	2.74	
MOBIL - 187	13.71	101	13.71	21.6	4.57	
	13.71	119	17.98	10	5.28	
	13.71	109	13.71	9.6	4.57	

60000

MOBIL DE COLOMBIA
SEPARACION ENTRE TANQUES

TANQUE	DIAMETRO	AL TANQUE No.	DIAMETRO	DISTANCIA	NORMA	OBSERVACIONES
MOBIL - 101	13.71	102	10.67	8.4	4.06	
	13.71	104	13.71	16	4.57	
	13.71	119	17.98	25.4	5.28	
	13.71	187	13.71	21.6	4.57	
MOBIL - 102	10.67	146	5.79	12	2.74	
	10.67	101	13.71	8.4	4.06	
	10.67	103	10.67	7.2	3.56	
MOBIL - 103	10.67	102	10.67	7.2	3.56	
	10.67	146	5.79	5.2	2.74	
MOBIL - 104	13.71	125	23.17	28.4	6.15	
	13.71	119	17.98	12.4	5.28	
	13.71	101	13.71	16	4.57	
MOBIL - 109	13.71	187	13.71	9.6	4.57	
	13.71	119	17.98	10.4	5.28	
MOBIL - 119	17.98	125	23.17	14	6.86	
	17.98	104	13.71	12.4	5.28	
	17.98	187	13.71	10	5.28	
	17.98	109	13.71	10.4	5.28	
MOBIL - 125	23.17	104	13.71	28.4	6.15	
	23.17	119	17.98	14	6.86	
	23.17	Ecopetrol 01	4.5	15	4.61	
MOBIL - 146	5.79	103	10.67	5.2	2.74	
	5.79	102	10.67	12	2.74	
MOBIL - 187	13.71	101	13.71	21.6	4.57	
	13.71	119	17.98	10	5.28	
	13.71	109	13.71	9.6	4.57	

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EMPRESA COLOMBIANA DE PETROLEOS -Distrito Oleoductos
TERMINAL PUENTE ARANDA

ALMACENAMIENTO.

No existen tanques para almacenamiento de productos.

TANQUE

Relevo
Capacidad 500 barriles
Techo cónico fijo
Contenido hidrocarburos limpios. Normalmente vacio
Altura 5.3 Mts.
Diámetro 4.5 Mts.

DIQUE

Altura 9 Mts.
Capacidad 770 barriles

DISTANCIA TANQUES RELEVO

A la sala de operaciones: 33 Mts.
Tanque 125 Mobil a la sala de operaciones: 43 Mts.

TIPO DE PROTECCION.

Alarma de alto nivel
Refrigeración con agua
Proporcionador de espuma manual
Espuma disponible 180 Galones

OTROS SERVICIOS.

Almacén de repuestos y material
Talleres
Planta de emergencia
Oficinas
Laboratorio

RED DE AGUA

Almacenamiento de agua 7500 barriles
Motor Detroit Diesel
RPM 2100
Modelo: 10447012
24O HP.
Bomba centrífuga
Modelo 6.5 M.
Flujo 1000 Gpm. a 120 Psi

INTERCONEXION:

* Esso Colombiana: 6 pulgadas.
* Mobil de Colombia: 6 pulg. por succión y descarga
* Texas Petroleum : 6 pulagadas.

EQUIPO ADICIONAL

34 Extintores de PQS. 20 Lbs.
7 Extintores de PQS.150 Lbs.
5 Extintores CO2 20 Lbs.
6 Extintores de Hallon

BRIGADA CONTRA INCENDIOS

Básica tres personas
Tiempo laborable 12 personas

EQUIPO.

8 Cascos bomberos
4 Chaquetones
4 Pantalones
12 Guantes
20 Mangueras 1 1/2
2 Equipo Autocontenido
1 Camillas

EQUIPO AMBIENTAL.

Separador API
Plan Local de emergencias
Plan ayuda Mutua. ASOPAR.
Alarma sonora de operación manual

SHELL COLOMBIA S.A.

DIQUES.

Altura exterior 2.20 mts.
Altura interior 1.50 mts.

TIPO DE PROTECCION.

** **Red de agua.**

1 Tanque de 160.000 galones de agua alimentados de un pozo profundo y del acueducto.
1 Bomba contra incendios Patterson Size 6x5 DMD, con capacidad de 1250 GPM a 200 PSI.
Motor Diesel Cummins modelo NT.855F4 320 HP a 1760 RPM
1 Sistema eléctrico con batería de 24 a 36 Voltios Tipo 80, encendido automático por baja presión.
2 Hidrante tipo Milan
10 Hidrante Monitores
5 Gabinetes
7 Duchas de enfriamiento para tanques en tuberías de 6 pulgadas de Diámetro, y Tanques 5,6 y 8 en tubería de 4 pulgadas de Diámetro.

** **Red de Espuma.**

1 Sistema de inyección por la base a tanque No. 7
1 Trayler
2 Inductores de 450
2 Boquilla de Espuma
2 Tramos de manguera Duraline
1 Trayler con tanque de 900 litros de concentrado
3 Inductores
2 Generadores de contrapresión
7 Tramos de manguera
12 Tambores de 200 litros de Espuma Angus
15 Bidones de 20 litros para solventes marca Angus.

EQUIPO ADICIONAL.

Trayler porta equipos
Mangueras de 2 1/2 y 1 1/2 pulgadas
Extintores portátiles
Boquillas de Patrón graduable
LLaves pentagonal de acoples
* Extintores portátiles
10 Extintores de 150 libras de Polvo químico Seco.
87 Extintores de diferentes tamaños.

BRIGADA CONTRA INCENDIO.

21	Brigadistas en turno diario con entrenamiento cada 4 meses
1	Cuarto de Emergencias
2	Equipo S.C.B.A.
2	Chaquetones tipo Bombero
1	Pantalón tipo Bombero
3	Pares de guantes
3	Pares de botas
3	Cascos tipo bombero
	Otros equipos de protección personal

EQUIPO AMBIENTAL.

Separador API
Interceptores de Aceite en caso de derrames fuera de diques

LLENADERO.

1	LLenadero de un solo servicio ubicado en Granel lubricantes
1	Llenadero de un solo servicio en solventes el cual no se usa

OTROS SERVICIOS.

Patios de Almacenamiento
Bodegas de Almacenamiento
Bodegas de Repuestos y Materiales
Talleres de Mantenimiento
Oficinas
Laboratorios

Cuando la línea de lindero se encuentra dividiendo empresas del mismo tipo de ocupación (caso MOBIL, ECOPETROL, ESSO) las empresas pueden establecer un acuerdo mutuo y eliminar la línea de lindero. En ese caso se aplicaría sólo la distancia a los edificios importantes o la distancia entre tanques.

En la tabla 2-1 se establecen dos distancias:

- Cuando hay protección a exposiciones.
- Cuando hay además sistema fijo de espuma o de inertización

Para nuestro análisis se tomaron las distancias como sí sólo existiera protección a exposiciones. En este caso las distancias son 100% superiores al caso cuando existen sistemas aprobados de espuma.

En el caso más crítico todos los tanques cumplen con estas distancias, con excepción del tanque vertical No. 7 que contiene cocinol en diámetros de 19.53 m, que se encuentra a 15 metros del lindero con el vecino.
Como este tanque tiene protección por un sistema de espuma, esa distancia es solo de 9.76m. y el tanque cumples con la Norma.

DISTRIBUCION DE TANQUES DE ALMACENAMIENTO
ECOPETROL Y SHELL DE COLOMBIA

TK No.	TIPO	CONTENIDO	ALTURA (mts)	VOLUMEN-Bls	(A)	(B)	NORMA	(C) Mts	NORMA	ALARMAS	OBSERVACIONES
E.01	Vertical	H. Limpios	5.3	500	4.5	25	4.5	33			
SHELL											
1	Vertical	Base Lubric.	14.24	10.000	12	55	4.51	Mayo 20	4.60		
2	Vertical	Base Lubric.	14.26	10.000	12	55	4.51	Mayo 20	4.60		
3	Vertical	Base Lubric.	13.65	10.000	12.19	55	4.51	Mayo 20	4.60		
4	Vertical	Base lubric.	9.1	6.190	12.19	23	4.51	Mayo 20	4.60		
5	Vertical	Solvente	4.55	119	5	28	5	Mayo 20	1.67	Alto Nivel	
6	Vertical	Solvente	4.55	119	5	20	5	Mayo 20	1.67	Alto Nivel	
7	Vertical	Cocinol	12.7	23.810	19.53	15	19.53	Mayo 20	6.51		
8	Vert.Domo	Solvente	4.6	119	8.82	12	8.82	Mayo 20	2.94		
9	Vertical	Base Lubric.	5.6	1.572	7.62	4	4.51	Mayo 20	3.00		
10	Vertical	Base Lubric.	9.2	3.810	9.15	3.5	4.57	Mayo 20	4.60		
11	Vertical	Aceite Dielec.	4.81	476	4.58	2	3.05	Mayo 20	1.50		
12	Vertical	Aditivo	6.43	429	3	8	3.05	Mayo 20	1.50		
13	Vertical	Solvente	3.35	119	4	34	4.50	Mayo 20	1.33	Alto Nivel	
14	Horizontal	Tinher	3.35	119	2	50	3.02	Mayo 20	1.52		
15	Horizontal	Solvente	3.35	119	3	45	3.02	Mayo 20	1.52		
16	Horizontal	Solvente	3.35	119	3	45	3.02	Mayo 20	1.52		
17	Horizontal	Solvente	3.35	119	3	42	3.02	Mayo 20	1.52		
18	Horizontal	Solvente	3.35	119	3	42	3.02	Mayo 20	1.52		
19	Horizontal	Solvente	3.35	119	3	38	3.02	Mayo 20	1.52		
20	Horizontal	Solvente	3.35	119	3	38	3.02	Mayo 20	1.52		
21	Vertical	Aditivo Lubric.	5.5	1.572	7.62	34	4.51	Mayo 20	3.00		
22	Vertical	Aditivo Lubric.	7.47	858	4.82	34	3.05	Mayo 20	3.00		

NOTA: Las distancias para los tanques 5,6,7,8 y 13 se dan como u diámetro, es decir la distancia cuando solo hay protección a exposiciones. Como también hay sistema de Espuma según la Norma NFPA-11. La distancia requerida es de 1/2 diámetro. o sea la mitad de la mostrada en la columna C de Norma, y están dentro de las distancias exigídas.

SEPARACION ENTRE TANQUES
ECOPETROL Y SHELL DE COLOMBIA

TANQUE No 1	DIAMETRO	AL TANQUE No	DIAMETRO.	DISTANCIA (Mts)	NORMA	OBSERVACIONES
ECOPETROL - 01	4.5	Mobil 125	23.17	15	4.61	
SHELL 01	12	2	12	15.5	4.00	
	12	7	19.53	20	5.26	
	12	22	4.82	22.5	2.80	
SHELL 02	12	1	12	15.5	4.00	
	12	7	19.53	20	5.26	
	12	3	12.19	15	4.03	
	12	21	7.62	30	3.27	
SHELL - 03	12.19	2	12	15	4.03	
	12.19	4	12.19	15	4.06	
	12.19	13	4	19	2.70	
	12.19	14	2	12	2.37	
	12.19	15	3	9	2.53	
	12.19	17	3	9	2.53	
	12.19	19	3	10	2.53	
	12.19	21	3	11	2.53	
SHELL - 04	12.19	7	19.53	27	5.29	
	12.19	6	5	10	2.87	
	12.19	5	5	9	2.87	
	12.19	13	4	12	2.70	
	12.19	14	2	22	2.37	
	12.19	3	12.19	15	4.06	
	12.19	2	12	28	4.03	

000036

SEPARACION ENTRE TANQUES
ECOPETROL Y SHELL DE COLOMBIA

TANQUE No 1	DIAMETRO	AL TANQUE No	DIAMETRO.	DISTANCIA (Mts)	NORMA	OBSERVACIONES
SHELL - 05	19.78	6	17.78	2	6.26	Fuera de Norma
	19.78	13	4	1.5	3.96	Fuera de Norma
	19.78	14	12.19	9	5.33	
SHELL - 06	17.78	5	19.78	2	6.26	Fuera de Norma
	17.78	4	12.19	10	5.00	

000037

SEPARACION ENTRE TANQUES
ECOPETROL Y SHELL DE COLOMBIA

TANQUE No 1	DIAMETRO	AL TANQUE No	DIAMETRO.	DISTANCIA (Mts)	NORMA	OBSERVACIONES
SHELL - 07	19.53	1	12	20	5.26	
	19.53	2	12	20	5.26	
	19.53	3	12.19	37	5.29	
	19.53	4	12.19	27	5.29	
SHELL - 08	8.82				1.47	No aparece en el Plano
SHELL - 09	7.62	21	7.62	8	2.54	
	7.62	10	9.15	6	2.80	
SHELL - 10	9.15	9	7.62	6	2.80	
	9.15	22	8.82	3	2.33	
	9.15	12	3	10	2.03	
	9.15	11	4.58	8	2.29	
SHELL - 11	4.58	12	3	2	1.26	
	4.58	22	4.82	8	1.57	
	4.58	10	9.15	9	2.29	
SHELL - 12	3	22	4.82	5	1.30	
	3	10	9.15	10	2.03	
	3	11	4.58	2	1.26	
SHELL - 13	4	5	5	1.5	1.50	Fuera de Norma
	4	4	12.19	12	2.70	

00038

SEPARACION ENTRE TANQUES
ECOPETROL Y SHELL DE COLOMBIA

TANQUE No 1	DIAMETRO	AL TANQUE No	DIAMETRO.	DISTANCIA (Mts)	NORMA	OBSERVACIONES
SHELL - 14	2	15 y 16	3	2	0.83	
	2	3	12.19	12	2.37	
	2	13	4	15.5	1.00	
	2	4	12.19	22	2.37	
SHELL 17 y 18	3	15 y 16	3	2	1.00	
	3	19 y 20	3	2	1.00	
	3	3	12.19	9	2.53	
SHELL 19 y 20	3	21 y 22	3	2	1.00	
	3	17 y 16	3	2	1.00	
	3	3	12.19	10	2.53	
SHELL 20 y 21	3	19 y 20	3	2	1.00	
	3	3	12.19	11	2.53	

000009

SISTEMA DE PROTECCION.

** **Red de Agua.**

1 Piscina de 4500 barriles de agua.
1 Tanque de 1993 barriles
1 Tanques de 1237 barriles (un total de 7730 barriles de agua disponible para incendio).

INTERCONEXION CON MOBIL Y LA ESSO.

Bomba número I: Marca: Wortington
Modelo: 5ln-22 Impeller (para refrigeración)
Presión de cierre: 550 pies y nominalmente 1400 gpm a 215 psi y 2100 gpm a 400 pies de cabeza.
Motor: Diesel Caterpilar de 420 HP. 1886 RPM.

Bomba número II: Marca: Wortington 1000 GPM a 120 psi, para red de espuma.
Motor: Diesel 196 HP, 1834 RPM.

** **Red de Espuma.**

2 Equipos proporcionadores a presión, con taque de 350 galones de concentrado cada uno.

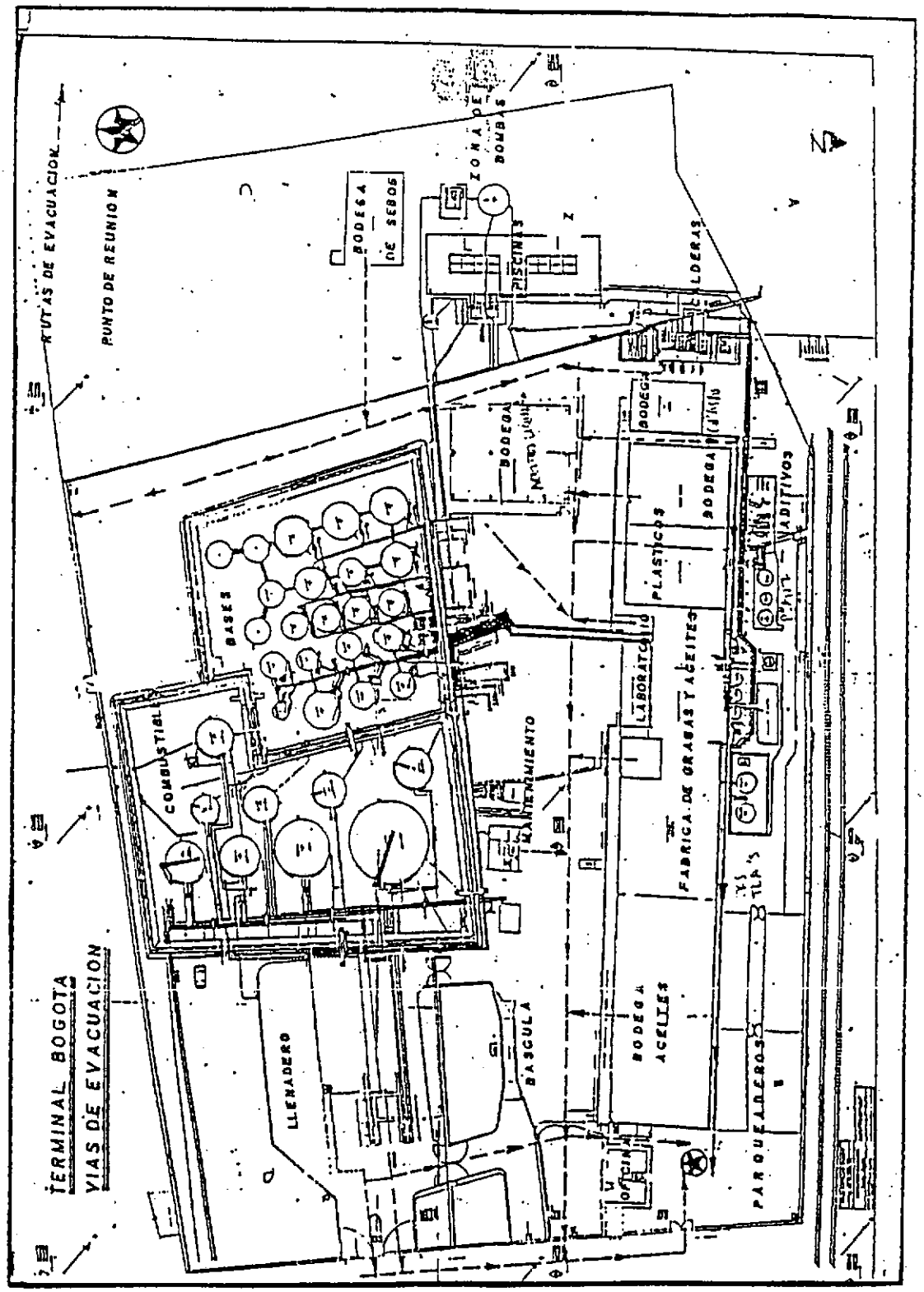
Proporcionadores PPH con presión de operación en rango de 60-750 gpm, rata óptima de 500 gpm, caída de presión entre 1 a 20 psi, caída óptima 10 psi y presión de trabajo 150 psi, conectados en paralelo y pueden trabajar individual o simultáneamente.

OTRAS PROTECCIONES.

1 Brigada de emergencia con 30 personas de base.
4 Equipos de línea de fuego.
1 Equipo de SCBA.

EQUIPO AMBIENTAL.

1 Separador API
Drenajes de 4 pulgadas.


TERMINAL BOGOTA
VIAS DE EVACUACION
PUNTO DE REUNION
RUTAS DE EVACUACION
BODEGA DE SEBOS
ZONA DE BOMBAS
PISCINAS
CALDERAS
BODEGA
BODEGA
BODEGA
PLASTICOS
ADITIVOS
BASES
COMBUSTIBLE
LABORATORIO
MANTENIMIENTO
FABRICA DE GRASAS Y ACEITES
LLENADERO
BASCULA
BODEGA ACEITES
PARQUEADEROS
OFICINA

TEXACO
DISTRIBUCION DE TANQUES DE ALMACENAMIENTO

TK.No.	TIPO	CONTENIDO	ALTURA	VOLUMEN-Bls	(A)	(B)	NORMA	(C) mts	NORMA	ALARMAS	OBSERVACIONES
27664	Techo Flot.	Gasol. Blanca	11.19	7500	12	11.5	6	11.5	2	Alto Nivel	
27666	Cónico	J.P.1	12.18	7500	12	Mayo 20	12	Mayo 20	4	Alto Nivel	
27665	Cónico	Diesel	12.18	27000	15.7	Mayo 20	15.7	Mayo 20	2.7	Alto Nivel	
27663	Techo Flot.	Gasolina	11.42	3000	22.5	Mayo 20	11.3	Mayo 20	3.8	Alto Nivel	
31118	Cónico	Kero	10.62	5000	9.3	Mayo 20	9.3	Mayo 20	1.6	Alto Nivel	
31187	Cónico	Gasol.Super	10.98	5000	10.7	Mayo 20	10.7	Mayo 20	1.8	Alto Nivel	
31117	Cónico	Gasol. Av.	10.08	7000	10.7	Mayo 20	10.7	Mayo 20	1.8	Alto Nivel	
31214	Cónico	Gasolina	12.75	7000	10.8	Mayo 20	10.8	Mayo 20	1.8	Alto Nivel	
32037	Cónico	J.P.1	10.98	6000	11	19	11	Mayo 19	1.9	Alto Nivel	
30202	Vertical	Hav.SAE 40	5.8	1500	7.5	16.2	4.5	Mayo 20	3		
30204	Vertical	Ursa Super	5.8	1500	7.5	12.7	4.5	Mayo 20	3		
30206	Vertical	HAV.SAE.50	5.8	3000	10.68	Mayo 20	4.5	Mayo 20	4.5		
30203	Vertical	BP 22 HF	5.8	500	4.7	Mayo 20	0.91	Mayo 20	1.5		
30205	Vertical	MVIP.1300r	5.8	1500	7.6	Mayo 20	4.5	17	3		
30207	Vertical	Hav.20X450	5.8	1500	7.6	Mayo 20	4.5	Mayo 20	3		
30208	Vertical	Ursa Super	5.8	1000	6	Mayo 20	3	Mayo 20	3		
32190	Vertical	BP 320 HF	9.22	2500	7.5	Mayo 20	4.5	Mayo 20	4.5		
30214	Vertical	BP 68 HF	5.87	1540	7.5	Mayo 20	4.5	Mayo 20	3		
32197	Vertical	BP 68 HF	9.61	2570	7.6	Mayo 20	4.5	Mayo 20	4.5		
32196	Vertical	BN 100 H	9.49	2600	7.6	Mayo 20	4.5	Mayo 20	4.5		
32141	Vertical	TLA 679	7.37	2865	9.1	Mayo 20	4.5	Mayo 20	4.5		

0000042

TEXAS PETROLEUM CO.
DISTRIBUCION DE TANQUES DE ALMACENAMIENTO

TK.No.	TIPO	CONTENIDO	ALTURA	VOLUM(BLS)	(A)	(B)	NORMA	(C) mts	NORMA	ALARMAS	OBSERVACIONES
32195	Vertical	BP-320-HF	5.87	1500	7.5	Mayo 20	4.5	Mayo 20	3		
32140	Vertical	HVI 55	9.2	1500	7.5	Mayo 20	4.5	Mayo 20	3		
3000-4	Vertical	TLA 688-C	9.2	3000	9.1	Mayo 20	4.5	Mayo 20	4.5		
1500-2	Vertical	BN-100 H	9.2	1500	7.5	Mayo 20	4.5	Mayo 20	3		
5000-1	Vertical	BN-460 H	9.2	5000	10.67	Mayo 20	4.5	Mayo 20	4.5		
5000-2	Vertical	HVI-650	9.2	5000	10.67	Mayo 20	4.5	Mayo 20	4.5		
5000-3	Vertical	HVI-95	9.2	5100	10.68	Mayo 20	4.5	Mayo 20	4.5		
1555-1	Vertical	HVI-95	5.5	1500	7.5	Mayo 20	4.5	Mayo 20	3		
Nuevo			7.31	2000	7.7	Mayo 20	4.5	Mayo 19	4.5		
Nuevo			7.31	2000	7.7	Mayo 20	4.5	Mayo 20	4.5		

000043

TEXACO COLOMBIANA
SEPARACION ENTRE TANQUES

TANQUE No.	DIAMETRO	AL TANQUE No.	DIAMETRO	DISTANCIA-Mts	NORMA	OBSERVACIONES
EXACO - 01 7664	12	2	12	4	4.00	
	12	5	9.3	5.5	3.55	
EXACO - 02 7666	12	1	12	4	4.00	
	12	5	9.3	4.5	3.55	
	12	3	15.7	4.7	4.62	
	12	6	10.7	7.5	3.78	
EXACO - 03 7665	15.7	2	12	4.7	4.62	
	15.7	6	10.7	5	4.40	
	15.7	7	10.7	7.7	4.40	
	15.7	4	22.5	6	6.37	
EXACO - 04 7663	22.5	3	15.7	6	6.37	
	22.5	7	10.7	5.5	5.53	
	22.5	8	10.8	6	5.55	
EXACO - 05 118	9.3	1	12	5.5	3.55	
	9.3	2	12	4.5	3.55	
	9.3	6	10.7	6	3.33	
EXACO - 06 187	10.7	5	9.3	6	3.33	
	10.7	2	12	7.5	3.78	
	10.7	3	15.7	5	4.40	
	10.7	7	10.7	10.5	3.57	
EXACO - 07 117	10.7	6	10.7	10.5	3.57	
	10.7	3	15.7	7.7	4.40	
	10.7	4	22.5	5.5	5.53	
EXACO - 08 214	10.8	4	22.5	6	5.55	

0004

TEXACO COLOMBIANA
SEPARACION ENTRE TANQUES

TANQUE No.	DIAMETRO	AL TANQUE No.	DIAMETRO	DISTANCIA-Mts	NORMA	OBSERVACIONES
EXACO - 09 2027	11	5	9.3	13	3.38	
EXACO - 30202	7.5	204	7.5	3.6	2.50	
	7.5	205	7.5	7.8	2.50	
	7.5	207	7.5	10.8	2.50	
EXACO - 30203	4.7	30206	10.6	4	2.55	
	4.7	30208	6	11.5	1.78	
	4.7	32190	7.5	7.2	2.03	
EXAS - 32140	7.5	30214	7.5	3.8	2.50	
	7.5	32141	9.1	3	2.77	
	7.5	32195	7.5	2.3	2.50	
	7.5	32197	7.6	4.7	2.52	
	7.5	3000-4	9.1	2.5	2.77	No aparece en el Plano
	7.5	5000-2	10.67	3.3	3.03	
	7.5	5000-3	10.68	6.2	3.03	
EXACO - 32141	9.1	30214	7.5	2.6	2.77	
	9.1	32140	7.5	3.1	2.77	
	9.1	32195	7.5	6	2.77	
	9.1	5000-1	10.67	3.3	3.30	
	9.1	5000-2	10.67	5.5	3.30	
EXACO - 32190	7.5	30203	4.7	7.2	2.03	
	7.5	30206	10.68	10	3.03	
	7.5	30208	6	3	2.25	
	7.5	32196	7.6	5.1	2.52	

TEXAS PETROLEUM CO.
SEPARACION ENTRE TANQUES

TANQUE No.	DIAMETRO	AL TANQUE No.	DIAMETRO	DISTANCIA-Mts	NORMA	OBSERVACIONES
EXACO - 30208	6	30206	7.6	6.8	2.27	
	6	30207	7.6	6.2	2.27	
	6	32190	7.5	3	2.25	
	6	32196	7.6	3.3	2.27	
	6	32197	7.6	6.2	2.27	
EXACO - 30214	7.5	30205	7.6	2.3	2.52	
	7.5	32140	7.5	6.2	2.50	
	7.5	32141	9.1	4.2	2.77	
	7.5	32195	7.5	2	2.50	Fuera de Norma

TEXACO COLOMBIANA
SEPARACION ENTRE TANQUES

TANQUE No.	DIAMETRO	AL TANQUE No.	DIAMETRO	DISTANCIA-Mts	NORMA	OBSERVACIONES
	7.5	30205	7.6	3.6	2.52	
	7.5	30207	7.6	3.2	2.52	
	7.5	30214	7.5	2	2.50	Fuera de Norma
TEXACO - 32195	7.5	32140	7.5	3.6	2.50	
	7.5	32197	7.6	1.8	2.52	Fuera de Norma
	7.5	3000-4	9.1	7.3	2.77	
	7.6	30208	6	3.3	2.27	
	7.6	32190	7.5	5.1	2.52	
TEXACO - 32196	7.6	32196	7.6	1.8	2.53	Fuera de Norma
	7.6	1500-2	7.5	3.8	2.52	
	7.6	3000-4	9.1	4.6	2.78	
	7.5	30207	7.6	2.8	2.52	
	7.5	30208	6	6.3	2.25	
TEXACO - 32197	7.5	32140	7.5	7.8	2.50	
	7.5	32195	7.5	1.8	2.50	Fuera de Norma
	7.5	32196	7.6	1.8	2.52	Fuera de Norma
	7.5	3000-4	9.1	2.6	2.77	
TEXACO -1500-1	7.5	1500-2	7.5	6	2.50	
	7.5	5000-3	10.68	2.2	3.03	
	7.5	32196	7.6	3.8	2.52	
	7.5	1500-1	10.67	6	3.03	
TEXACO -1500-2	7.5	3000-4	9.1	3.2	2.77	
	7.5	5000-3	10.68	8.6	3.03	

TEXAS PETROLEUM CO.
SEPARACION ENTRE TANQUES

TANQUE No.	DIAMETRO	AL TANQUE No.	DIAMETRO	DISTANCIA-Mts	NORMA	OBSERVACIONES
	7.5	30202	7.5	3.8	2.50	
	7.5	30206	10.6	10.7	3.02	
EXACO - 30204	7.5	30206	10.6	3.6	3.02	
	7.5	30207	7.5	6.8	2.50	
	7.5	30208	6	12	2.25	
	7.5	31117	10.7	12.7	3.03	
	7.5	30202	7.5	5.8	2.50	
EXACO -30205	7.5	30207	7.6	3.8	2.52	
	7.5	30214	7.5	2.5	2.50	
	7.5	32196	7.5	3.6	2.50	
	10.6	30203	4.7	4	2.55	
	10.6	30204	7.5	3.3	3.02	
EXACO - 30206	10.6	30207	7.6	11	3.03	
	10.6	30208	6	6.8	2.77	
	10.6	22190		10	1.77	
	7.5	30202	7.5	10.7	2.50	
	7.5	30204	7.5	6.8	2.50	
	7.5	30205	7.6	3.8	2.52	
EXACO - 30207	7.5	30206	7.6	11.2	2.52	
	7.5	30208	6	6.8	2.25	
	7.5	32195	7.5	3	2.50	
	7.5	32197	7.6	2	2.52	Fuera de Norma

TEXAS PETROLEUM CO.
SEPARACION ENTRE TANQUES

TANQUE No.	DIAMETRO	AL TANQUE No.	DIAMETRO	DISTANCIA-Mts	NORMA	OBSERVACIONES
TEXACO - 3000-4	9.1	32140	7.5	3.5	2.77	
	9.1	32196	7.6	2.8	2.78	
	9.1	22197		4.7	1.52	
	9.1	1500-2	7.5	2	2.77	
	9.1	5000-3	10.68	2.5	3.30	
TEXACO -5000-1	10.67	32140	7.5	7.6	3.03	
	10.67	32141	9.1	3.3	3.30	
	10.67	5000-2	10.67	2.4	3.56	
TEXACO - 5000-2	10.67	32140	7.5	3.3	3.03	Fuera de Norma
	10.67	32141	9.1	5.5	3.30	
	10.67	3000-4	9.1	6	3.30	
	10.67	5000-1	10.67	2.4	3.56	
	10.67	5000-3	10.68	2.4	3.56	
TEXACO - 5000-3	10.67	32140	7.5	6	3.03	
	10.67	1500-1	7.5	1.3	3.03	
	10.67	1500-2		5	1.78	
	10.67	3000-4	9.1	2.4	3.30	
	10.67	5000-2	10.67	2.4	3.56	

ANEXO No. 2

000050

BASES PARA ANALISIS DEL RIESGO DE ALMACENAMIENTO

La seguridad de los tanques de almacenamiento se basan en nuestro hemisferio en normas de construcción como la API 650. La ubicación de distancia, separación entre tanques se encuentran contempladas en la Norma NFPA 30.

Para claridad de la Norma NFPA 30 definimos algunas distancias que son relevantes en el análisis de los riesgos.

Se usan las siguientes Tablas de la norma NFPA 30:

** La Tabla 2.1.: Para líquidos estables en tanques con presión de funcionamiento igual o menor de 2.5 lb/pulg2 (17.2 Kpa) para líquidos estables (gasolina, Kero, aceites)

** La tabla 2.5.: Para líquidos clase III-B (tienen punto de inflación mayor a 93°C) bases lubricantes.

** La tabla 2.6.: Tabla de referencia para ser usada con la Tabla 2.1.

** La tabla 2.7.: Distancias mínimas entre los tanques (casco a casco). Hay dos distancias específicas que se miden:

* Distancia mínima desde el límite de la propiedad sobre la cual esté, o pueda ser construída, incluyendo el lado opuesto de una vía pública.

* Es la distancia a los linderos de la propiedad en estudio y que puedan ser construídos en ellos. Si el lindero fuera una calle, un rio, una vía férrea, la distancia se tomaría hasta el otro lado si sobre esa línea se pudiera construir.

* La distancia mínima desde el lado más cercano de cualquier lindero común o vía pública o desde el edificio importante más cercano en la misma propiedad.

* La definición de edificio importante se toma por estar ocupado por personas, por su costos o su valor estratégico para el proceso.

ANEXO No. 3

000051

INFORME NFPA EN 1980 Y EN ABRIL 9 AL 18 DE 1980

Un equipo de expertos de la NFPA (National Fire Protection Association) de la NFPA efectuaron una investigación sobre la zona con el fin de evaluar las instalaciones para la distribución y el almacenamiento de combustibles en Puente Aranda y determinar el nivel existente de seguridad, dar las recomendaciones para su mejoramiento e identificar los requerimientos para aumentar el tamaño de almacenamiento y de las instalaciones si fuere necesario.

La inspección descartó la existencia de deficiencias o de riesgos mayores que pusieran una amenaza sobre el Distrito de Puente Aranda. La mayoría del equipo en las instalaciones cumple con los requerimientos de las normas NFPA. Las deficiencias encontradas fueron plasmadas en un informe con las recomendaciones pertinentes.

El contrato no solicitaba un estudio detallado del almacenamiento de gases licuados del petróleo y su distribución, pero anotaba que la decisión de mover esas instalaciones del Distrito de Puente Aranda, reduciría significativamente el riesgo de fuego y explosión.

En el año 1980, la NFPA decía que la expansión del almacenamiento de líquidos inflamables y combustibles en el Distrito de Puente Aranda no aumenta el riesgo a las áreas vecinas siempre que en la instalación se sigan las normas aplicables para esta ocupación.

Las áreas que requieren atención para la protección son la mejor en el suministro de agua de la red pública y del Cuerpo de Bomberos de la Ciudad.

Cada una de las instalaciones cuenta con un tanque de agua o un estanque, una bomba de incendio y una red hidráulica. Esos sistemas debe interconectarse para mejorar el nivel o capacidad general de respuesta; mejorar el servicio público de agua (volumen y presión) mejorar la capacidad de los sistemas privados y al interconectarlos serán además una fuente de alimentación para el Cuerpo de Bomberos.

Otra observación dada por la NFPA es sobre el sistema de espuma el cual es un paso positivo en el control de incendios.

La protección de los llenaderos de carros tanque como el que estaba instalándose en la ESSO es un buen ejemplo y debe ser seguido por TEXAS y MOBIL.

Los Edificios de almacenamiento o producción de lubricantes deben protegerse con regaderas automáticas, que aunque no sean requeridas por los códigos, ni ese riesgo constituya una amenaza para el área de Puente Aranda son necesarios para proteger las estructuras y sus contenidos, es decir la seguridad interior de los bienes.

ECOPETROL sirve como una terminal del oleoducto y recibe varios productos líquidos incluyendo LPG el cual es entregado a las compañías distribuidoras vecinas.

En las plantas de la MOBIL, TEXAS y ESSO operan plantas de distribución. La TEXAS tiene varios tanques de LPG. ECOPETROL, COLGAS y otras dos compañias operan almaceamiento y distribución de LPG.

La protección existente en 1980 consiste en protección con agua para refrigeración, sistema de alarma manual, extintores portatiles y otros elementos para uso de la Brigada de Incendios.

En la inspeccion realizada por la NFPA se anotó en términos específicos para las plantas visitadas sobre el cumplimiento de las instalaciones a los requisitos de la norma NFPA 30. Código de Líquidos Combustibles e Inflamables que regula el diseño, la ubicación y la disposición de las plantas petroquímicas.

Lo anterior se realizó cotejando lo existente con lo mandado porla norma NFPA 30 en sus tablas 2.1, 2.6 y 2.7 que se incluyen en este informe y cuya aplicación se explica con la figura siguiente que define las distancias de importancia junto con normas sobre la capacidad y disposición de los diques, la construcción de los tanques según las normas API especialmente la API 650. Las tablas 2.1, 2.6 y 2.7 de NFPA son la base para las adoptadas por el Decreto 283 del Ministerio de Minas que aparecen en las tablas con los números 2 y el literal a. del Capítulo II Artículos 18 y 19.

En 1980 la NFPA encontró en las diferentes plantas:

PLANTA DE LA ESSO COLOMBIANA LIMITED

Se revisaron todos los almacenamientos y se concluyó que con muy pocas excepciones se cumplen con los requisitos exigídos en la norma NFPA 30.

En los casos donde no se cumple totalmente con la norma dieron las recomendaciones contempladas en el mismo código por medio de sistemas fijos de protección.

Recomendaron un sistema fijo de protección con espuma para los tanques ESSO No, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22 y 23 anotando que, aunque no son exigídos por el código aumentaría aun más el nivel de seguridad de la Planta.

PLANTA DE LA TEXAS PETROLEUM CO.

La recomendación dada es un sistema fijo de espuma para los tanques TK 27665, 27663 y 31117 cumpliendo los parámetros dados en la norma NFPA-30. Como no son exigidos por la norma recomedaron con el mismo criterio que para la planta ESSO, proteger los tanques con sistemas fijos.

Aunque no es necesario según el Código, los expertos de la NFPA recomendaron instalar un sistema fijo de protección con espuma para los tanques TK 125, 103, 109 y 119. Sobre los diques encontró que su capacidad era suficiente para contener el volúmen del tanque mayor como lo pide la NFPA 30.

Construir en todas las plantas subdivisiones dentro de los diques para individualizar los tanques mayores de 10000 Bls en un solo dique, y a grupos de tanques cuya suma no pase de 15000 Bls. Los subdiques por lo menos con capacidad de 10% del tanque contenido y no menor a 48 cm de alto.

Se recomendo además que aunque solo unos pocos tanques requerían sistemas fijos de espuma, se les colocara a todos los tanques verticales teniendo en cuenta la capacidad limitada de respuesta del Cuerpo de Bomberos de Bogotá.

Se encontró en 1980 que solo se contaba con unos pocos tambores de espuma de 5 galones y unos pocos formadores para aplicar manualmente la espuma. No existía ningún sistema fijo.

Instalar sistemas de espuma para los llenaderos de carros tanques y canales de drenaje.

En el estudio se anotó que para los edificio de oficinas, bodegas, laboratorios, centros de comunicación y control no tenían sistemas de protección y aunque son áreas que no constituyen un riesgo para vecindad de Puente Aranda, recomendaron fueran protegidos con sistemas de regaderas automáticas en almacenes, talleres, laboratorios y oficinas para defender el patrimonio y la continuidad de operación de las plantas.

Sobre la disponibilidad de agua se encontró que el almacenamiento individual de cada planta era inadecuada para un incendio grande y recomendó que todas las plantas interconectarán sus sistemas y en esa forma se conseguirían los flujos necesarios para un fuego grande.

Se realizaron pruebas a la Red Pública y se encontro que las presiones y los flujos eran pobres a causa de que la red se encontraba en un extremo de la red de agua de Bogotá, lo cual es un extremo muerto y no conectado a una tubería grande.

Recomendaron prioritariemente que la red fuera reforzada conectándola a una red más poderosa. Al otro lado de la línea ferrea existe una red fuerte que permite mejorar la zona.

Instalar alarmas de alto y alto-alto nivel en los tanques, en las plantas y un centro de recibo de alarmas de los sistemas manuales o automáticos de todas las plantas.

Se enfatizó la falta de recursos y de habilidad del Cuerpo de Bomberos de Bogotá para atender riesgos en plantas petroquímicas. No cuentan con equipos para atender este tipo de incendios y a eso se unía la falta de conocimiento sobre esos riesgos y la falta de comunicación entre los vehiculos, la central y los Bomberos con otras fuente de ayuda.

Se destacó la falta de entrenamiento, coordinación con las plantas sobre los procedimientos escritos para la operación del Cuerpo de Bomberos y de los planes de emergencia.

Recomendaron además que las Brigadas Industriales incipientes deberían agruparse para trabajar coordinadamente y establecer una ayuda mutua.

En general la conclusión dada por la NFPA en 1980 se resume de la forma siguiente:

"La expansión de las facilidades para almacenamiento de líquidos inflamables y combustibles en el Distrito de Puente Aranda no aumentará el riesgo a las áreas vecinas siempre que se cumpla con las normas.

No sólo se descartaba la existencia de riesgos mayores sino que se aceptaba el aumento del almacenamiento en Puente Aranda".

ANEXO No. 4

000055

FLAMMABLE AND COMBUSTIBLE LIQUID HANDLING AND STORAGE

Martin Henry

El Sr. Henry por muchos años fué resposable por la norma NFPA-30: Líquidos Inflamables y Combustibles y el editor del Handbook de Líquidos Inflamables y Combustibles de la NFPA. Actualmente es asesor de protección contra incendios despúes de su retiro de la NFPA en el año 1.993.

TANK STORAGE

000056

For economic reasons, bulk quantities of flammable and combustible liquids are generally stored in tanks which may be installed underground, aboveground, or even inside buildings under special conditions.

When using properly designed, installed, and maintained storage tanks, the greatest hazards are probably those associated with the transferring of the liquid to or from storage, rather than the storage itself. The hazard of storage does not necessarily depend upon the quantity of liquids being stored but rather is more dependent upon other factors, such as the characteristics of the liquid, the design of the tank, foundations and supports, size and location of vents, related piping and connections, as well as operating procedures.

TANK CONSTRUCTION

The preferred materials for use in the construction of aboveground tanks are steel and concrete because of their relatively high resistance to heat conditions that would be expected during exposure fires. Tanks built of materials with low melting points, such as aluminum, plastics, etc., will readily fail under exposure fire conditions and thereby intensify the situation.

Details for steel tank construction are outlined in the following standards:

1. Welded Steel Tranks for Oil Storage, Std. No. 650, 1978 American Petroleum Institute, 2101 L Street NW, Washington, DC 20037

2. Bolted Tanks for Storage for Production Liquids, Spec. No. 12B, 1977, American Petroleum Institute, 2101 L Street NW, Washington, DC 20037

3. Field Welded Tanks for Storage of Production Liquids, Spec. No 12D, 1977, American Petroleum Inst. 2101 L Street, NW, Washington, DC 20037

4. Shop Welded Tanks for Storage of Production Liquids, Spec. No. 12F, 1977, American Petroleum Inst. 2101 L St. NW, Washington, DC 20037

5. Standard for Aboveground Tanks for Flammable and Combustible Liquids, UL 142, Underwriters Laboratories, Inc. 207 E. Ohio Street, Chicago, IL 60611

Installation: The rupture of an aboveground tank or a leak in the tank shell or piping connected to the tank, at a point below the liquid level, could result in all the liquid above the leak being released into the surrounding environment. Therefore, if possible, aboveground tanks should be installed on ground that slopes away from important buildings, plant utilities, other flammable or combustible storage tanks, and other hazardous operations or processes. Where this cannot be achieved, the tanks can be isolated by means of dikes, drainage systems, etc. NFPA 30, Flammable and Combustible Liquids Code, contains detailed informtion on tank spacing, dikes, drainage systems and other pertinent information associated with the installation of aboveground tanks.

Aboveground tank fires: The history of tank fires tells us that the probability of a fire starting within a properly designed, constructed, and maintained aboveground storage tank is remote. Fires rarely occur in tanks containing the higher flash point combustible liquids. The majority of tank fires involve the lighter, more volatile Class I materials and are usually the result of releases from leaks, ruptures, or overflows. Ignition of the vapors, which may take place at some distance from the tank, results in the fire flashing back and exposing the tank. When exposed to a spill fire, the shell of a large vertical steel tank, above the liquid level, will generally soften and collapse into the tank without splitting the tank shell.

000059

Internal explosions: Internal explosions occur when the vapor space of a storage tank is in the flammable range and an ignition source is present. The two most frequent ignition sources are static electricity and lightning. Liquids that are stored at temperatures near or above their flash points are most likely to have a vapor space that is in the flammable range and, therefore, are the most susceptible to ignition and explosions.

Liquids with low flash points will be most susceptible when the surrounding air temperature is reduced for extended periods, such as during the winter months in colder climates. On the other hand, the higher flashpoint liquids will be susceptible when heated to temperatures near or above their flash points.

Due to their design, floating roof tanks provide the greatest degree of firesafety for aboveground installations. Although fires do occur in floating roof tanks, they're not common and are generally restricted to the seal space between the roof and the shell of the tank. Such fires are generally extinguished with portable extinguishers, hand foam lines, or installed foam protection. Explosions have occurred, however, when the floating roof tanks were virtually empty of liquids or the roof had sunk or had been allowed to rest on the low level supports, permitting a flammable vapor space to be present.

Table III

000060

(Table 2-6 of NFPA #30)

Reference Table for Use in Tables 2-1 to 2-4 of NFPA #30

Capacity Tank Gallons	"B" Dimension Minimum Distance in Feet from Property Line which is or can be Built Upon, Including the Opposite Side of a Public Way	"C" Dimension Minimum Distance in Feet from Nearest Side of any Public Way or from Nearest Important Bldg. on the Same Property
275 or less	5	5
276 to 750	10	5
751 to 12,000	15	5
12,001 to 30,000	20	5
30,001 to 50,000	30	10
50,001 to 100,000	50	15
100,001 to 500,000	80	25
500,001 to 1,000,000	100	35
1,000,001 to 2,000,000	135	45
2,000,001 to 3,000,000	165	55
3,000,001 or more	175	60

Table IV

000061

(Table 2-7 of NFPA #30)

Minimum Tank Spacing (Shell-to-Shell)

	Floating Roof Tanks	Fixed Roof Tanks	
		Class I or II Liquids	Class IIIA Liquids
All tanks not over 150 feet diameter	1/6 sum of adjacent tank diameters but not less than 3 ft.	1/6 sum of adjacent tank diameters but not less than 3 ft.	1/6 sum of adjacent tank diameters but not less than 3 feet
Tanks larger than 150 feet diameter			
If remote impounding is in accordance with 2-2.3.2 of NFPA #30	1/6 sum of adjacent tank diameters	1/4 sum of adjacent tank diameters	1/6 sum of adjacent tank diameters
If impounding is around tanks in accordance with 2-2.3.3 of NFPA #30	1/4 sum of adjacent tank diameters	1/3 sum of adjacent tank diameters	1/4 sum of adjacent tank diameters

Appendix C

Fuel Characteristics

The following tables provide some important characteristics of fuel oils:

Table B.1

Heat Wave Settling and Burn-Off Rates

Inches Per Hour

Kind of Oil	Heat Wave Settling Rate	Burn-Off Rate
Light Crudes: (25° API and above)		
Dry (under 0.3% water)	15 to 35	4 to 18
Wet (over 0.3% water)	17 to 50	4 to 18
Heavy Crude and Fuel:		
Dry (under 0.3% water)	3 to 20	3 to 5
Wet (over 0.3% water)	12 to 50	3 to 5
Kerosene:	None	5 to 8
Gasoline:	None	9

Table C.1

Fuel Characteristics

	Flash Point, °F		Explosive Limits % by Vol.		Auto-Ignition Temp. °F	Vapor Density (Air=1.0)	Specific Gravity (Water=1.0)	Boil. Poin
	Open Cup	Closed Cup	Lower	Upper				
Fuel Oil No. 2		126-230	.7	6.0	494	Above 1	0.80-0.90	340-
Fuel Oil No. 5		130-310	1.0	5.0		Above 1	0.92-1.07	
Fuel Oil No. 6		150-430	1.0	5.0	765	Above 1	0.92-1.07	
Gasoline		-50	1.3	7.6	700	3.0-4.0	0.71-0.76	91-4

000063

5. RISK OF STORING FLAMMABLE & COMBUSTIBLE LIQUIDS

There are three primary ignition sources for oil storage tanks. They are lightning, welding or cutting, and common ignition sources igniting spills. Ignition by lightning cannot be eliminated even with grounding. Welding and cutting operations, even though controlled, cannot be eliminated. Once a spill occurs, the vapors may contact any number of ignition sources in the storage area. In other words, the total elimination of ignition sources is not possible.

The potential loss as a result of a fire involving a storage tank can be expressed in terms of dollars per minute based on the average burning rate of gasoline at 9 inches per hour and kerosene at 6.5 inches per hour. Table I.A and I.B provide information on the values of tanks containing oil and the dollar values lost during a tank fire.

Table I.A

Value of Tank Contents Considering a Full Tank

Tank Dia. (Feet)	Capacity of Tank 40 Ft. High (Barrels)	Value of Contents @ $40/Barrel	Capacity of Tank 48 Ft. High (Barrels)	Value of Contents @ $40/Barrel
35	6,500	$ 260,000.		
60	20,000	800,000.	24,000	$ 960,000.
90	45,000	1,800,000.	54,000	2,160,000.
120	80,000	3,200,000.	96,000	3,840,000.
140	109,000	4,360,000.	130,000	5,200,000.
160	143,000	5,720,000.	170,000	6,800,000.
180	180,000	7,200,000.	217,000	8,680,000.
200	223,000	8,920,000.	268,000	10,720,000.
220	269,000	10,760,000.	324,000	12,960,000.
240	320,000	12,800,000.	385,000	15,400,000.
260	376,000	15,040,000.	452,000	18,080,000.
280	437,000	17,480,000.	525,000	21,000,000.
300	500,000	20,000,000.	601,000	24,040,000.

Table I.B

Dollar Loss Per Minute
from a Fire Involving a Storage Tank

Tank Diameter (Ft.)	Barrels of Kerosene Burned Per Minute	Dollar Loss @ $40/Barrel
25	0.6	$ 24.
36	1.2	48.
60	3.5	140.
90	7.8	312.
120	13.9	556.
144	19.9	796.
160	24.7	988.
179	30.9	1,236.
200	38.5	1,540.
220	46.6	1,864.
240	55.5	2,220.
260	65.1	2,604.
279	75.0	3,000.
300	86.7	3,468.

When assessing the potential loss, the exposure to adjacent tanks must also be considered. If ineffective fire fighting efforts are employed, the potential for adjacent tanks being ignited can be serious. Of course, this depends on separation distance between tanks, dikes between tanks, wind direction and velocity, and the commodity stored in the adjacent tanks.

A fire involving a storage tank will burn for several days unless effective steps are taken to empty the tank or extinguish the fire. A 40 foot high tank full of kerosene would burn approximately 3 days. A 48 foot high tank would burn approximately 3.7 days if full when ignited.

The rapid pumping out of the contents of an involved tank to another tank is generally impractical due to the lack of available space in adjacent tanks and the normal arrangement of piping and pumps. Even if the oil could be pumped out in a reasonable period of time, the tank shell would be destroyed due to the heat of the fire.

The extinguishment of fires in tanks larger than 120 feet in diameter with water alone is highly improbable. The use of foam is the only reliable method available to extinguish large tank fires.

Table II

Stable Liquids (Operating Pressure 2.5 psig or Less) 000066

See Figure A.

Type of Tank	Protection	"B" Dimension Minimum Distance in Ft. from Property Line Which is or can be Built Upon, Including the Opposite Side of a Public Way & Shall be not less than 5 Ft.	"C" Dimension Minimum Distance in Ft. from Nearest Side of Any Public Way or from Nearest Important Bldg. on the Same Property & Shall be not less than 5 Feet
FLOATING ROOF -	Protection for Exposures*	1/2 times dia. of tank	1/6 times dia. of tank
	None	Diameter of tank but need not exceed 175 feet	1/6 times diameter of tank
VERTICAL with WEAK ROOF to SHELL SEAM	Approved foam or inerting sys. on tanks not exceeding 150 ft. in diameter**	1/2 times dia. of tank	1/6 times dia. of tank
	Protection for Exposures*	Diameter of tank	1/3 times dia. of tank
	None	2 times dia. of tank but need not exceed 350 feet	1/3 times dia. of tank
HORIZONTAL and VERTICAL with EMERGENCY RELIEF VENTING TO LIMIT PRESSURES TO 2.5 psig	Approved inerting sys. on the tank or approved foam sys. on vertical tanks	1/2 times Table III	1/2 times Table III
	Protection for Exposures*	Table III	Table III
	None	2 times Table III	Table III

*See definition for "Protection for Exposures." (Pg. 4)
**For tanks over 150 ft. in diameter use "Protection for Exposures" or "None" as applicable.

tection thus provided is at least equal to that required. Further, the authority having jurisdiction must conclude that equivalent safety or fire protection has been provided.

1-1.5.2 In certain installations the provisions of this code shall be permitted to be altered at the discretion of the authority having jurisdiction after consideration of special features such as topographical conditions, barricades, walls, adequacy of building exits, nature of occupancies, proximity to buildings or adjoining property, and character of construction of such buildings, capacity and construction of proposed tanks, and character of liquids to be stored, the nature of the process, the degree of private fire protection to be provided, and the adequacy of the facilities of the fire department to cope with flammable or combustible liquid fires.

When evaluating specific situations, other physical characteristics and chemical properties of liquids, such as boiling point, vapor pressure, vapor density, specific gravity, water solubility, and toxicity, might have to be considered, along with the topography, building construction features, and exposure conditions. Conditions that allow spillage or percolation into water supplies, or vapor travel that might prevent the escape of persons from the area in the event of an accident must be considered by the engineer who designs the facility to comply with NFPA 30 and by the authority that enforces NFPA 30. Greater protection, or even prohibition of an installation, might be necessary in densely populated neighborhoods or in areas where the public fire suppression capabilities are not sufficient to provide reasonable protection for the public.

1-1.5.3 Other regulations, such as for environmental protection, may impose requirements that are not anticipated by this code. Where acceptable to the authority having jurisdiction, alternate arrangements affording protection at least equivalent to that required by this code shall be permitted to be used.

This paragraph was added to allow flexibility in applying NFPA 30 to situations where other bodies of regulations also apply and might conflict NFPA 30's requirements. Situations such as this are becoming more common as stronger environmental regulations are established at the federal, state, and local level. In most cases, these other regulations exceed what is required by NFPA 30. In some jurisdictions, for example, the required volumetric capacity of a dike is 110 percent of the capacity of the largest tank, as opposed to NFPA 30's requirement of 100 percent.

1-1.6 Existing plants, equipment, buildings, structures, and installations for the storage, handling, or use of flammable or combustible liquids that are not in strict compliance with the terms of this code shall be permitted to be continued in use at the discretion of the authority having jurisdiction provided they do not constitute a recognized hazard to life or adjoining property. The existence of a situation that might result in an explosion or sudden escalation of a fire, such as inadequate ventilation of confined spaces, lack of adequate emergency venting of a tank, failure to fireproof the supports of elevated tanks, or lack of drainage or dikes to control spills, might constitute such a hazard.

Codes are designed to protect life and property. If exposure is limited to property alone, noncomplying conditions in existence prior to adoption of a particular edition of a code might be allowed to continue via a "grandfather clause."[1] This approach is reasonable since code provisions are often developed or evolve as a result of fire loss experience. Requiring current compliance with laws that did not exist at the time of construction would be unreasonable, unless subsequent experience clearly shows a high degree of risk to life or to exposed property. The recognized hazards enumerated in 1-1.6 serve as a guide to the authority having jurisdiction and are not all-inclusive. Where such recognized hazards exist, a "grandfather clause" exclusion might not be applicable and the recognized hazard might constitute grounds for applying codes retroactively.

1-1.7 This code shall not apply to:

1-1.7.1 Transportation of flammable and combustible liquids. These requirements are contained in the U.S. Department of Transportation regulations or in NFPA 385, *Standard for Tank Vehicles for Flammable and Combustible Liquids*.

"Transportation" is intended to include movement of flammable and combustible liquids by air, rail, truck, ship, and pipeline. The U.S. Department of Transportation (DOT) regulations are normally applied only to interstate shipments, with intrastate shipment being regulated by state or local laws. These regulations are contained in Title 49 of the *Code of Federal Regulations*, Parts 172 through 179. NFPA 385, *Standard for Tank Vehicles for Flammable and Combustible Liquids*, is often used as the basis for local and

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1-1.7.3 Liquefied gas

state legislation that regulates intrastate truck shipments, although the DOT regulations are sometimes adopted by reference for the same purpose.

The following Formal Interpretation on the 1984 edition of NFPA 30 addressed the question of applicability to long-term storage of liquids in tank vehicles. It is still applicable.

Formal Interpretation 84-4
Reference: 1-1, Scope and Application

Background: Tank trailers and semi-trailers are loaded with flammable or combustible liquid and moved to a storage yard. There, the tankers may be kept for days, weeks, or months before being shipped to another location or being moved to another part of the same plant site. Some of the tankers are not roadworthy.

Question: Do such tank vehicles, used for the temporary storage of flammable and combustible liquids, need to meet the requirements of NFPA 30, *Flammable and Combustible Liquids Code*, for drainage, impoundment, separation distances, etc.?

Answer: Yes.

Issue Edition: 1984
Reference: 1-1
Date: April 1987

In some situations, applicability of NFPA 30 depends on one's definition of "temporary." A tank vehicle that is routinely used to store a liquid for periods of time exceeding several days is being used as a portable storage tank and should be treated according to the requirements of this Code. However, a tank vehicle holding a liquid awaiting shipment to a consignee can be considered to be in transport and not subject to NFPA 30, even though there might be a delay of several days between loading and actual shipment.

1-1.7.2 Storage, handling, and use of fuel oil tanks and containers connected with oil burning equipment. These requirements are covered separately in NFPA 31, *Standard for the Installation of Oil-Burning Equipment.*

1-1.7.3 Liquefied gases. (*See definition.*)

1-1.7.4 Cryogenic liquids. (*See definition.*)

Paragraphs 1-1.7.3 and 1-1.7.4 serve to point out that neither liquefied gases nor cryogenic fluids are within the scope of NFPA 30. However, definitions of both have been added to assist the user in recognizing these materials.

1-1.7.5 Storage of flammable and combustible liquids on farms and isolated construction projects. These requirements are covered separately in NFPA 395, *Standard for the Storage of Flammable and Combustible Liquids at Farms and Isolated Sites.*

NFPA 395, with accompanying commentary, is included in this Handbook. The scope of NFPA 395 has been broadened to include any isolated site, subject to the review and approval of the authority having jurisdiction.

1-1.7.6 Liquids without flash points that can be flammable under some conditions, such as certain halogenated hydrocarbons and mixtures containing halogenated hydrocarbons. (*See NFPA 321, Standard on Basic Classification of Flammable and Combustible Liquids.*)

Examples of liquids without flash points that might be flammable under certain conditions (such as being heated in a closed vessel) are methyl bromide, dichloromethane, trichloroethane, and trichloroethylene. NFPA 49, *Hazardous Chemicals Data* and NFPA 491M, *Manual of Hazardous Chemical Reactions*, can be useful in identifying such materials.

1-1.7.7 Storage and handling of aerosol products. These requirements are covered separately in NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products.*

Until the 1990 edition of NFPA 30, flammable aerosols were considered to be equal in hazard to Class IA liquids and were addressed. In 1987, the NFPA authorized a standards development project to specifically address aerosol products. The new Committee on Aerosol Products began development of NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*, in February of 1988. The new document was adopted at NFPA's 1990 Annual Meeting.

1-1.7.8 Mists, sprays, or foams.

Two such operations are spray finishing and spray lay-up of glass fiber reinforced plastic resins, details of which are given in NFPA 33, *Standard for Spray Application Using Flammable and Combustible Materials.* (*See also the discussion following 1-1.4.*)

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Portable Tank. Any closed vessel having a liquid capacity over 60 U.S. gallons (227 L) and not intended for fixed installation.

Note that portable tanks that do not exceed 660 gal are covered by Chapter 4, while portable tanks exceeding 660 gal (2498 L) are covered by Chapter 2. (*See also the information following "Storage Tank."*)

Pressure Vessel. Any fired or unfired vessel within the scope of the applicable section of the ASME *Boiler and Pressure Vessel Code.*

Process or Processing. An integrated sequence of operations. The sequence can be inclusive of both physical and chemical operations, unless the term is modified to restrict it to one or the other. The sequence can involve, but is not limited to, preparation, separation, purification, or change in state, energy content, or composition.

Protection for Exposures. Fire protection for structures on property adjacent to liquid storage. Fire protection for such structures shall be acceptable when located either within the jurisdiction of any public fire department or adjacent to plants having private fire brigades capable of providing cooling water streams on structures on property adjacent to liquid storage.

Adequate exposure protection depends on a fire protection system or fire protection agency that can provide a barrier to the transmission of heat or a method for absorbing the heat generated by a fire. A public fire department will normally have sufficient hose stream capability to provide a thermal barrier in the form of a water curtain, and NFPA 30 recognizes this capability. The larger plant fire brigades will normally have this capability also, but an extensive private water supply and hose system or a fire apparatus pumping engine will be required in addition to personnel.

It is important to note that the "protection for exposure" concept, as applied in NFPA 30, refers to the adjacent property, not to the property on which the liquid is stored. Thus, for example, a bulk plant can position its storage tanks closer to a neighboring facility if the latter has protection for exposures, such as a fire brigade. The bulk plant might or might not have a fire brigade of its own.

Refinery. A plant in which flammable or combustible liquids are produced on a commercial scale from crude petroleum, natural gasoline, or other hydrocarbon sources.

Safety Can. An approved container, of not more than 5 gal (18.9 L) capacity, having a spring-closing lid and spout cover and so designed that it will safely relieve internal pressure when subjected to fire exposure.

The safety can is not designed or intended for use in areas where the periodic release of flammable vapors may create a hazardous atmosphere (such as in the trunk of an automobile). The main purpose of the safety can is preventing explosion of the overheated container, while still providing the utility of a closed container. To accomplish this, a spring-operated cap is provided on the pouring spout, eliminating the need for a flame arrester in the spout. Even if the vapors coming past the spring-loaded cover are in the flammable range, their velocity would be at least an order of magnitude greater than the intrinsic velocity of a flame through the vapors, so a flashback into the safety can would be unlikely should the vapors be ignited by an external source. (*See Figure 1-4.*) In spite of this, it is customary to find safety cans fitted with flame arresters in order to meet specific listing requirements.

Secondary Containment Tank. A tank having an inner and an outer wall with an interstitial space (annulus) between the walls and having means for monitoring the interstitial space for a leak. Underground secondary containment tanks are of either Type I or Type II construction.

With the recognition in Exception No. 2 to subsection 2-3.4.1 of Chapter 2, Tank Storage, of secondary containment-type aboveground tanks, it was necessary to specify that the "Type I" and "Type II" designations refer only to underground tanks.

Type I. A primary tank wrapped by an exterior shell that is in direct contact with it. The exterior shell might or might not wrap the full 360 degree circumference of the primary tank.

Type II. A primary tank wrapped by an exterior shell that is physically separated from it by stand-offs and wraps the full 360 degree circumference of the primary tank.

Stable Liquid. Any liquid not defined as unstable.

Storage Tank. Any vessel having a liquid capacity that exceeds 60 gal (227 L), is intended for fixed installation and is not used for processing.

This definition emphasizes that any tank, including a portable tank as defined in this Code, is considered a storage tank and thus subject to the



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Tank Storage

2-1 Scope.

This chapter shall apply to aboveground, underground, and inside storage of liquids in fixed tanks and in portable tanks whose capacity exceeds 660 gal (2498 L).

It is sometimes assumed that Chapter 2 applies only if a tank exceeds 660 gallons (2498 L) capacity. This is not correct. Chapter 2 applies to *any* fixed tank, regardless of capacity. The "660 gallons (2498 L)" refers only to portable tanks. Chapter 4, Container and Portable Tank Storage, covers portable tanks up to and including 660 gallons (2498 L) capacity, but refers the user to Chapter 2 for those portable tanks *exceeding* 660 gallons (2498 L). Also, Chapter 4 applies only to the storage of portable tanks. If a portable tank is connected to a fixed piping system, it takes on the characteristics of a fixed tank and appropriate requirements of Chapter 2 apply.

2-2 Design and Construction of Tanks.

2-2.1 Materials. Tanks shall be designed and built in accordance with recognized good engineering standards for the material of construction being used and shall be of steel or approved noncombustible material, with the following limitations and exceptions:

"Recognized good engineering standards" for the design and erection of tanks for the storage of flammable liquids have evolved from over one hundred years of experience. No single standard is universally applicable because of the wide variety of liquids and their properties, and latitude in the choice of materials permitted where circumstances warrant. The standards listed in 2-2.3, 2-2.4, and 2-2.5 cover designs that embody a suitable factor of safety to ensure that tanks will safely contain their contents under normal operating conditions. Emergency conditions, such as exposure to fire, require special details of construction or special protection. Such requirements are dealt with later.

The phrase "or approved noncombustible material" was added to the 1984 edition of NFPA 30 to allow other construction materials where desirable or where need dictates. Use of the word "approved" empowers the authority having jurisdiction to exercise discretion regarding what is acceptable.

(a) The material of tank construction shall be compatible with the liquid to be stored. In case of doubt about the properties of the liquid to be stored, the supplier, producer of the liquid, or other competent authority shall be consulted.

(b) Tanks constructed of combustible materials shall be subject to the approval of the authority having jurisdiction and limited to:

1. Installation underground, or
2. Use where required by the properties of the liquid stored, or
3. Storage of Class IIIB liquids aboveground in areas not exposed to a spill or leak of Class I or Class II liquid, or
4. Storage of Class IIIB liquids inside a building protected by an approved automatic fire extinguishing system.

(c) Unlined concrete tanks shall be permitted to be used for storing liquids having a gravity of 40 degrees API or heavier. Concrete tanks with special linings shall be permitted to be used for other services provided the design is in accordance with sound engineering practice.

The expression "40 degrees API" is a measure of the specific gravity of the liquid. Through long custom, the specific gravity of petroleum products has been designated in terms of degrees API, as measured with a hygrometer calibrated according to the following formula:

$$\text{Degrees API} = \frac{141.5}{\text{sp.gr.}} - 131.5$$

000071

The API gravities for petroleum products range from about 10° (for heavy lubricating oils) up to 80° or more (for casinghead gasoline). A low number indicates a more dense, more viscous, less volatile fluid. Normal motor grade gasoline has an API gravity in the range of 55° to 65°. "40° API" corresponds roughly to kerosene or light stove distillate oil. Such materials have flash points of about 130°F (54.4°C). Thus, a minor leak of a 40° API liquid from an unlined tank would not create an ignition hazard, and such tanks are permitted.

(d) Tanks shall be permitted to have combustible or noncombustible linings. The choice of a suitable protective lining shall depend upon the properties of the liquid stored.

Tanks are occasionally lined with plastic material, such as spray-on epoxy resins, to provide corrosion protection or to provide protection against minor leaks. It does not matter whether the lining material is combustible or noncombustible because the quantity is small and will not contribute to fire loss. Such a lining, even though electrically insulating, will not increase the risk of ignition from static electricity. (*See NFPA 77, Recommended Practice on Static Electricity.*)

This paragraph is the basis for allowing the spray-on application of an epoxy resin liner to the inside wall of a tank to repair minor leaks. The decision to allow such a repair has historically been left to the authority having jurisdiction. However, environmental regulations for underground storage systems might prohibit such repairs on underground tanks or specify more stringent controls. At the least, it is expected that such a repair will be allowed only once in the lifetime of a tank.

As noted in the second sentence of this paragraph, care must be exercised selecting a lining material. The lining should be compatible with and resistant to degradation from any liquid that is likely to be stored in the tank.

(e) Special engineering consideration might be required if the specific gravity of the liquid to be stored exceeds that of water or if the tank is designed to contain liquids at a liquid temperature below 0°F (<-17.8°C).

These considerations are addressed in API 650, *Welded Steel Tanks for Oil Storage*, [*see 2-1.3.1(b)*]. The word "might" (line 1 above) is an indication that special engineering consideration is not always required.

2-2.2 Fabrication.

2-2.2.1 Tanks shall be permitted to be of any shape or type consistent with sound engineering design.

Sound engineering design can provide a structurally acceptable tank of any shape. However, as a practical matter, economy in fabrication, the material used, and the operating pressure limit the shape of a tank to one of the following:

1. Vertical cylindrical tanks with flat or nearly flat bottoms and flat, coned, or domed fixed roofs, or open tops with floating roofs.
2. Horizontal cylindrical tanks with flat or domed ends.
3. Spherical or toroidal tanks.

In all cases, the foundation and supporting structure must be considered as an integral part of the design. (*See Section 2-6.*)

2-2.2.2 Metal tanks shall be welded, riveted and caulked, or bolted, or constructed by use of a combination of these methods.

Tanks must be constructed to be liquidtight up to the maximum fill level.

2-2.3 Atmospheric Tanks.

The term "atmospheric tank" is defined in Section 1-2 as a tank operating at pressures from atmospheric up to and including 0.5 psig (3.5 kPa). API 650, *Welded Steel Tanks for Oil Storage*, uses the expression "internal pressures approximating atmospheric." For most large atmospheric tanks, the maximum permissible operating pressure will be somewhat less than 0.5 psig because it is considered undesirable that the roof plate welds be continuously stressed by pressure. A maximum operating pressure of about 1 in. (2.5 cm) of water or 0.6 oz/sq in. (0.25 kPa) is considered acceptable for large tanks.

2-2.3.1 Atmospheric tanks, including those incorporating secondary containment, shall be built in accordance with recognized standards of design *or* approved equivalents. Atmospheric tanks shall be built, installed, and used within the scopes of their approvals or within the scopes of any of the following:

(a) Underwriters Laboratories Inc., *Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids*, UL 142; *Standard for Steel Underground Tanks for Flammable and Combustible Liquids*, UL 58; or *Standard for Steel Inside Tanks for Oil Burner Fuel*, UL 80.

(b) American Petroleum Institute Standard No. 650, *Welded Steel Tanks for Oil Storage*, Eighth Edition.

(c) American Petroleum Institute Specifications 12B, *Bolted Tanks for Storage of Production Liquids*, Twelfth Edition; 12D, *Field Welded Tanks for Storage of Production Liquids*, Eighth Edition; or 12F, *Shop Welded Tanks for Storage of Production Liquids*, Seventh Edition.

(d) American Society for Testing and Materials, *Standard Specification for Glass-Fiber Reinforced Polyester Underground Petroleum Storage Tanks*, ASTM D 4021.

(e) Underwriters Laboratories Inc., *Standard for Glass-Fiber Reinforced Plastic Underground Storage Tanks for Petroleum Products*, UL 1316.

The wording of this paragraph is broad enough to allow flexibility in tank design and installation methods. The authority having jurisdiction may allow departures from recognized standards (e.g., for double-walled tanks) in cases where special needs or unusual situations warrant, so long as equivalent performance is ensured. This enhanced flexibility has proven to be beneficial as environmental protection receives more attention, for aboveground tanks as well as underground tanks. Witness the many factory-built "new technology" tanks being produced today, such as concrete-encased tanks and double-walled tanks.

The allowance for bolted tanks storing crude oil in producing areas in 2-1.3.1(c), recognizes the fact that the tanks are usually small. An oil well normally has a relatively short useful life, consequently, the need for tanks might be temporary. A bolted tank is easily dismantled and moved to a new location. Although such tanks are vulnerable to fire damage from a ground fire because of damage to the gaskets, the advantages outweigh the shortcomings. At main gathering stations and pipeline terminals, more substantial tanks would be required.

2-2.3.2 Low-pressure tanks and pressure vessels shall be permitted to be used as atmospheric tanks.

This simply means that a tank designed for pressure will be acceptable for a less demanding service. However, the more stringent spacing requirements for pressure tanks specified in 2-3.1 are not to be waived unless the emergency venting system has the required capacity at atmospheric pressure.

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2-2.3.3 Atmospheric tanks shall not be used for the storage of a liquid at a temperature at or above its boiling point.

A liquid having a boiling point below the prevailing atmospheric temperature would be expected to boil continuously if stored in an atmospheric tank, involving considerable product loss and a greatly increased risk of ignition. (The boiling rate would depend on the rate at which the tank received heat from the surrounding atmosphere and from solar radiation.) In interpreting this paragraph, the liquid's atmospheric boiling point should be taken as that at the location of the tank, not at sea level. The boiling point of a liquid at an altitude of 10,000 ft (3,050 m) may be as much as 20°F (11°C) lower than it would be at sea level. As a practical matter, this usually dictates that liquids at temperatures close to their boiling points be stored in pressure tanks, simply to avoid product loss.

2-2.4 Low-Pressure Tanks.

2-2.4.1 The normal operating pressure of the tank shall not exceed the design pressure of the tank.

2-2.4.2 Low-pressure tanks shall be built in accordance with recognized standards of design. Low-pressure tanks shall be permitted to be built in accordance with:

(a) American Petroleum Institute Standard No. 620, *Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, Fifth Edition.

(b) The principles of the *Code for Unfired Pressure Vessels*, Section VIII, Division I of the ASME *Boiler and Pressure Vessel Code*.

2-2.4.3 Tanks built according to Underwriters Laboratories Inc. requirements in 2-2.3.1 shall be permitted to be used for operating pressures not exceeding 1 psig (6.9 kPa) and shall be limited to 2.5 psig (17.2 kPa) under emergency venting conditions.

Tanks constructed to UL 142 specifications are shop-built and leak-tested prior to shipment as completely assembled units. Although horizontal tanks are pressure-tested to 5 to 7 psig (34.4 to 48.2 kPa), they are limited to service at a 1 psig (6.9 kPa) maximum internal operating pressure and to 2.5 psig (17.2 kPa) under emergency venting conditions. These restrictions recognize that failure of a horizontal tank is invariably accompanied by release of the tank contents. Vertical tanks are only required to be tested to a pres-

000073

sure that exceeds 1.5 psig (10.3 kPa); however, they are also subject to liquid release upon failure, so the same service restrictions apply. There is an exception: vertical tanks built to UL 142 specifications and labeled "Built to Weak Shell-to-Roof Joint Design" are not expected to fail in such a manner as to release the contents. It is assumed that the weak seams will fail upon overpressure and only vapors will be released.

The term "emergency venting conditions" is not defined in Section 1-2. It is meant to describe a situation where a tank is fully exposed to flame, resulting in heating and boiling of the tank contents. Normal venting is based solely on liquid addition or withdrawal and atmospheric temperature and pressure changes. (*See also 2-3.5 and 2-3.6.*)

Since consequences of fire exposure can have a substantial effect on the permissible spacing and location of tanks as set forth in Section 2-3.2, it is necessary to deal with this subject before commenting on specific requirements.

Flames contacting aboveground tanks can heat the contained liquid, causing it to boil, and can also damage tank supports and the unwet portion of the tank shell. Boiling effects can be mitigated by design (*2-3.6.3*) or by additional relief valves (*2-3.6.4 through 2-3.6.9*). Supports for elevated tanks can be insulated to delay failure or constructed of fire-resistive materials, as covered in Section 2-6.

Flame contact on the unwet portion of the shell of a steel tank can heat that portion of the shell to the point that it loses much of its structural strength. For a vertical tank, this heating can result in distortion at the top of the shell, but tank collapse and spill of contents is not likely. Heating the top of the shell of a horizontal tank, however, is likely to result in structural failure, with release of contents.

For a pressure tank, the result of heating the unwet portion of the shell can be serious. Such tanks usually store liquids having boiling points below atmospheric temperature and, therefore, their relief valves are set to maintain the resulting higher pressure. When heated sufficiently, the shell will lose strength and the resulting tear is likely to spread below the liquid level. This tear can extend completely around a horizontal tank so as to sever the head, release the contents, and cause the pieces to rocket. The possibility of this type of failure is recognized in Table 2-2. This phenomenon is known as a "BLEVE" (Boiling Liquid-Expanding Vapor Explosion), defined as a catastrophic failure of a container into two or more major pieces at a moment in time when the contained liquid is at a temperature well above its boiling point at normal atmospheric pressure. The classic cases of BLEVEs have involved tank cars of liquefied petroleum gases, but the phenomenon is applicable to liquids as well.

2-2.4.4 Pressure vessels shall be permitted to be used as low-pressure tanks.

2-2.5 Pressure Vessels.

2-2.5.1 The normal operating pressure of the vessel shall not exceed the design pressure of the vessel.

2-2.5.2 Storage tanks designed to withstand pressures above 15 psig (103.4 kPa) shall meet the requirements of Section 1-4.

The 15 psig (103.4 kPa) criterion corresponds to the definition of a pressure vessel by the ASME *Boiler and Pressure Vessel Code*. [*See 2-1.4.2(b).*]

2-2.6 Provisions for Internal Corrosion. Where tanks are not designed in accordance with the American Petroleum Institute, American Society of Mechanical Engineers, or the Underwriters Laboratories Inc. standards, or if corrosion is anticipated beyond that provided for in the design formulas used, additional metal thickness or suitable protective coatings or linings shall be provided to compensate for the corrosion loss expected during the design life of the tank.

2-3 Installation of Outside Aboveground Tanks.

The requirements of this section are intended to ensure that tanks are located so they will not jeopardize structures on the property of others. In the early days when tanks had wood-supported combustible roofs, it was not uncommon for fire to spread from one tank to another. Thus, regulations provided that tanks be widely spaced from each other and from all other facilities. With the advent of the steel roof, this risk greatly decreased. Experience indicated that, given no ground-spill fire, one tank could burn without damaging neighboring tanks or adjoining property. However, distances between adjacent tanks and between tanks and property lines or adjacent structures remain principal planning criteria. Instead of basing spacing on an arbitrarily selected distance, it is now considered more practical and realistic to base it on a fraction of tank diameter. Tables 2-1 through 2-4 employ this concept, while Tables 2-5 and 2-6 determine spacing by tank capacity.

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2-3.1 This section shall include installations in which tanks are above, at, or belowgrade and are without backfill.

This statement emphasizes the fact that a tank that is belowgrade, but not backfilled, such as might be the case for a tank installed in a pit or in a diked area that is lower than the surrounding terrain, is subject to the requirements of this Section.

2-3.2 Location with Respect to Property Lines, Public Ways, and Important Buildings on the Same Property.

Paragraphs 2-3.2.1 through 2-3.2.8 and Tables 2-1 through 2-6 govern the siting of tanks in relation to surrounding buildings, public roads and highways, and property lines.

Tables 2-1 through 2-4, used in conjunction with Table 2-6, apply to Classes I, II, and IIIA liquids and base their spacing requirements on the characteristics of the liquid, the manner in which it is stored, the type of tank used, protection provided for the tank, and protection provided for exposures. Class IIIB liquids are covered in 2-3.2.6 and Table 2-5.

"Protection for exposures" is defined in Section 1-2. The tables recognize that it can be difficult, sometimes impossible, to extinguish a tank fire. Therefore, efforts are directed at protecting adjacent buildings and adjoining properties. Fire protection for exposures *should not* be confused with fire suppression systems and equipment used to fight a tank fire. The tables also recognize that there is little possibility of extinguishing a fire in a tank that exceeds 150 ft (45 m) in diameter. Even with fixed fire suppression equipment installed, set-up time is often required, during which exposed tanks or structures will need to be protected from radiant heat to prevent fire spread.

The tables use several terms having somewhat special meanings, the understanding of which will help the user apply the provisions of this chapter. These terms are:

— property line that is or can be built upon,
— liquids with boil-over characteristics,
— emergency venting devices,
— weak roof-to-shell seam,
— operating at pressures not in excess of 2.5 psig, and
— unstable liquids.

Property Line that is or can be Built Upon. A basic premise of the spacing requirements of this Section is that the tank should not threaten

adjacent property on the other side of the property line. The separation distances apply regardless of whether there is actually a structure present on the adjacent property or whether the land is vacant. Future construction on the adjacent property must be anticipated. However, not all adjacent property *can* be built upon, as shown in Figure 2.1. In such a case, a tank could be built closer to a property line than otherwise would be allowed, as long as suitable precautions are taken to protect the public in areas beyond the property line.

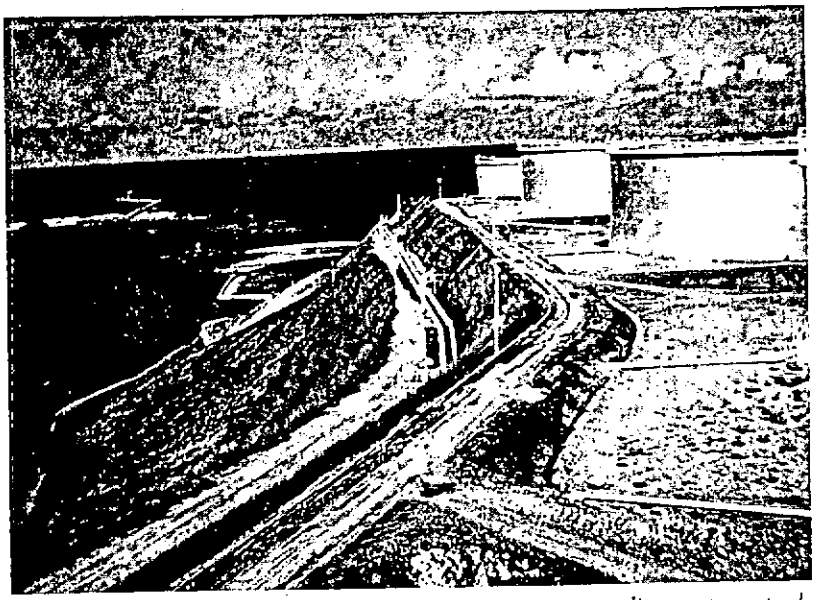

Figure 2.1 An example of a situation where property adjacent to a tank cannot be built upon.

Liquids with Boil-over Characteristics. Tanks that store liquids having boil-over characteristics are subject to the stricter spacing requirements of Table 2-3. Although the term "boil-over" is defined in Section 1-2, a more detailed explanation is in order here.

Any liquid will boil if sufficiently heated. In open-pool burning, the liquid surface receives radiant energy from the flames and this energy supports the boiling. For most liquids, a steady state condition develops and burning proceeds until the liquid is consumed. (In fact, once steady state is reached, the burning rate is predictable.) In a tank, boiling can result in a rise in the liquid level due to the entrained bubbles. Thus, a full tank can overflow. This, however, is referred to as a "froth-over"; it is *not* a boil-over. To have boil-

000075

over characteristics, a liquid must have a wide range of boiling points, including a substantial proportion of volatile components and a highly viscous residue. It must also have at least a small amount of water-in-oil emulsion. This combination is present in most crude oils, but seldom in other petroleum products. It is sometimes mistakenly presumed that asphalts are boil-over liquids. Burning asphalt will froth over during fire fighting operations, but is not susceptible to the more violent boil-over.

When an open-top tank of crude oil is involved in a fire, the following sequence of events occurs.

As the fire burns, the surface layer is depleted of its volatile components, becomes hotter and denser than the original mixture, and sinks below the surface to be replaced by fresh, unburned oil. A gradually deepening layer of very hot oil [200°F (93°C) or more] migrates downward through the tank contents. When this layer reaches a previously-settled layer of emulsion near the bottom of the tank, the water droplets in the emulsion are superheated to a temperature well above the boiling point at the prevailing pressure (atmospheric pressure plus the static head of the liquid above the layer). Boiling proceeds with explosive violence, resulting in the expulsion of as much as half of the tank contents, a sudden spread of burning oil over a wide area, and an overhead fireball. This is a boil-over and is the reason for the restrictions given in 2-2.1.4 and Table 2-3. Figure 2.2 illustrates what leads to a boil-over. (*See also Appendix B of API 2021, Guide for Fighting Fires In and Around Petroleum Storage Tanks.*)

Emergency Venting Devices. Emergency relief venting is covered in 2-3.6, but is not defined in NFPA 30. The word "emergency" means something unusual or beyond the conditions of normal operation, such as the exposure of a tank to surrounding fire. All of the tanks subject to the requirements of NFPA 30 contain a liquid that can burn. Fires seldom originate in tanks, and when they do, the fire normally burns itself out without serious consequences. The emergency arises when liquid is spilled from a tank or from interconnecting piping and is ignited, producing what is commonly known as a "ground fire" or "spill fire." Tank contents exposed to such a fire are subject to boiling and evolution of vapor far in excess of what might be produced by normal operation. (*See 2-3.5.*) Emergency relief venting as described in 2-3.6 is required to accommodate this excess vapor development. A weak roof-to-shell seam is one acceptable mechanism for providing emergency relief venting and is discussed in the commentary following 2-2.4.3 and, more fully, in the commentary following 2-3.6.3. The objective of this type of construction is to ensure that a vertical tank will fail in such a way that no liquid will escape.

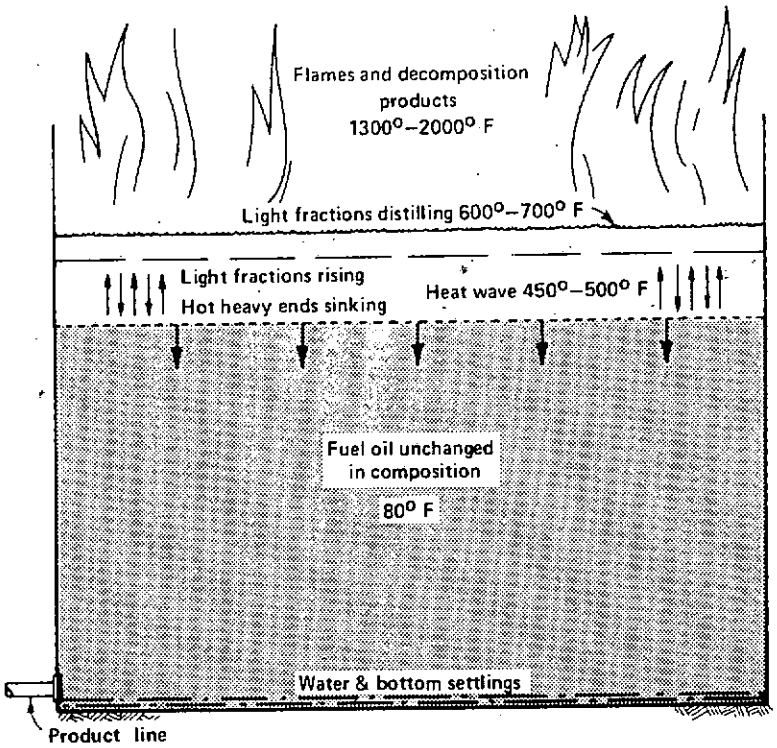

Figure 2.2 Boil-over process in a fuel oil tank fire.

Operating Pressures. The wording of 2-3.2.1 provides that Table 2-1 will apply to tanks with operating pressures up to 2.5 psig (17.2 kPa), provided they are equipped with emergency venting of sufficient capacity to prevent pressures rising above this point. Tanks with operating pressures in excess of 2.5 psig (17.2 kPa) are covered by Table 2-2. The reason for the substantially increased spacing requirements of Table 2-2 is that a tank at higher pressure is more likely to fail violently. A further restriction in the placement of these tanks is given in 2-3.2.8.

Unstable Liquids. Unstable liquids are defined in Section 1-2 and examples are given in the commentary that follows the definition. Their unpredictable characteristics require special spacing. (*See 2-3.2.5 and Table 2-4.*)

Application of these tables can be more readily understood by studying Table 2-1, which applies to stable liquids, i.e., liquids that do not undergo thermal decomposition. First, consider the headings of the four vertical columns, noting that as one progresses downward in the table, the required spacing becomes progressively greater.

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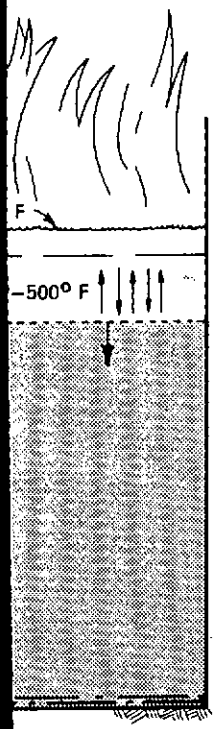

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BOOK

Type of Tank

Floating Roof. The first category consists of tanks having floating roofs, either open-top (exposed to the external environment) or covered (as with an existing fixed roof). Experience has shown that open-top tanks with floating roofs are not likely to have the total liquid surface involved in fire because the only place where an ignitible mixture exists is in the narrow seal space between the floating roof and the tank shell, between the liquid surface and the underside of the seal. Such tanks are unlikely to be ignited by flaming brands because such brands rarely fall close to the seal space. A floating roof tank is unlikely to be ignited by a direct lightning strike unless the roof is almost at the top of the tank. As first designed, floating roof tanks were occasionally ignited by an electrical charge on the roof surface that was released coincident with a lightning strike. This charge could escape from the roof to the shell, producing a spark in the seal space and igniting a small fire around the rim of the roof. Corrective measures involved placing metallic conductors (shunts) between the rim of the floating roof and the metallic parts of the seal that bear against the tank shell. Such measures have been largely effective. In any event, a fire in the seal space of a floating roof tank can often be extinguished by hand extinguishers or small hose lines. Of importance is the fact that if a floating roof sinks, it will probably interfere with the thermal circulation of the oil and obstruct development of a boil-over.

For all of the preceding reasons, a vertical steel tank with a floating roof is given preferred treatment from the standpoint of exposing surrounding property to fire. This applies even if the floating roof is covered with a fixed roof having adequate ventilation.

Note that a floating roof having a metal pan that does not meet the requirements of 2-3.2.1(a) or that incorporates combustible flotation components, which are subject to destruction from a seal fire, is considered no better than a fixed roof tank and is treated as such.

Vertical with Weak Roof-to-Shell Seam. The second category consists of vertical tanks with fixed roofs having weak roof-to-shell seams. These are tanks that have a weak joint where the roof panels are attached to the tank shell, either inherently or by design, as shown in Figure 2.3. This weak joint allows the roof to tear free from the tank shell before any other joint fails. In a fire emergency, this is caused by internal pressure due either to boiling of the liquid inside the tank or to an internal explosion.

Horizontal and Vertical with Emergency Relief Venting. The third category consists of vertical tanks and horizontal tanks with emergency

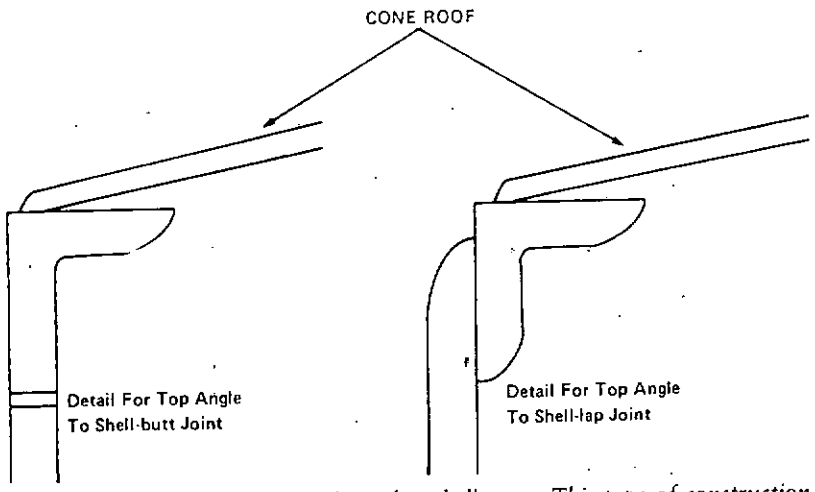

Figure 2.3 Details of the weak roof-to-shell seam. This type of construction is acceptable for relieving excessive internal pressure caused by exposure fires.

relief devices (other than a weak roof-to-shell attachment) that are capable of limiting internal pressure to 2.5 psig (17.2 kPa) under fire exposure conditions. In spite of adequate pressure relief, these tanks are not immune to failure if unwet portions of the shell are weakened by flame contact. Therefore, greater spacing requirements are assigned. Note that tanks that can be subjected to pressures greater than 2.5 psig (17.2 kPa) under fire exposure conditions, because they normally operate at greater than atmospheric pressure, are covered by Table 2-2.

Tanks without any form of roof are not recognized in NFPA 30.

Protection. In all three tank categories, distinction is made between presence or absence of exposure protection. Protection for exposures is defined in Section 1-2 and explained in more detail at the beginning of this commentary. The intent is that, if fire should occur in the tank, there will be some fire fighting capability available to prevent the ignition of adjacent property. It is assumed that the fire in the tank can safely burn out and that no attempt will be made to extinguish it.

For vertical tanks with weak roof-to-shell seams, additional credit is given for tanks equipped with an inerting system or a foam extinguishing system. However, for tanks exceeding 150 ft (45 m) in diameter, provision of a foam system is not given any credit because of the problem of pumping foam onto the fuel surface at a rate fast enough to be effective.

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Horizontal and vertical tanks with emergency relief venting are treated similarly, but the 150 ft (45 m) diameter limitation for foam systems no longer applies.

Minimum Separation Distances. For each type of tank and each category of exposure protection, there are two sets of separation distances: the first set establishes separation between the tank shell and the property line or the far side of a public way; the second set establishes separation between the tank shell and the near side of a public way and between the tank shell and the nearest important building on the same property. Separation is prescribed as a function of the tank's diameter or its capacity, depending on the type of tank and circumstances. The liquid class is not a factor, but liquids capable of boil-over and unstable liquids are treated differently than typical stable liquids. The separation criteria assumes that the effects of a fire may spread beyond the limits of the owner's property.

The first set of distances ensures that the tank does not pose a threat to a structure on a neighboring property, whether the structure already exists or might be erected at some future time. To ensure that this separation is not just applied to abutting properties, the phrase "including the opposite side of a public way" has been added. The second set of distances ensures that the tanks are far enough removed from a public thoroughfare. It also applies the same separation criteria to any important building on the same property. How does one define "important"? Any building that is normally occupied by people would certainly be considered "important" in this context, for reasons of life safety. But, a high-value, normally unoccupied building might also be considered important. Other examples include an important process structure or a critical control building, even though seldom occupied.

In *no* case can a tank be placed less than 5 ft (1.5 m) from a property line.

The separation distances specified in these tables have been carefully developed through fire experience over the seventy or more years since this Code was first written. The minimum distances to adjoining property and also between tanks (Table 2-7), have occasionally been decreased over the years as the mechanism of fire spread has become better understood through experiment and experience.

Having reviewed Table 2-1, the user should understand the reasons for the additional Tables 2-2, 2-3, 2-4, and 2-5.

The increased spacing in Table 2-2 for all types of tanks and all conditions is required because a tank operating at a pressure greater than 2.5 psig (17.2 kPa) can create a more sudden and more violent incident upon release

of vapor than one operating at a lower pressure. Such an incident might include failure by sudden tearing of the roof or shell, as a result of heating and softening of the metal from direct flame contact.

Table 2-3 addresses the phenomenon of "boil-over," which was discussed in the commentary following paragraph 2-3.2. *Boiling* results when heat is transmitted to the contents of a tank by the flame exposure to the outside of the shell. The tank is usually intact and might not itself be involved in fire, other than vapor burning at the vent. If the tank has a weak roof-to-shell connection or is adequately vented, no liquid spill is likely. The fire can burn out without serious incident.

By contrast, a *boil-over* results from fire in an open-top tank, not from surrounding fire on the ground. A tank having a fixed roof will not burn over the total surface area of the liquid unless the roof has been removed, as by explosion. However, a fixed roof tank with an internal floating roof may experience partial burning of the contents as evidenced by burning at the vents. If the roof has been removed and the tank contains an oil having boil-over characteristics, one or more boil-overs will likely occur. The increased spacing required by Table 2-3 reflects the need for safeguarding adjoining structures against this situation.

Table 2-4 applies to tanks containing unstable liquids (as defined in Section 1-2) that behave unpredictably during fire exposure. For this reason, greater spacings are required.

Spacing requirements for tanks storing Class IIIB liquids, as specified in Table 2-5, are minimal because such tanks are rarely involved in fire.

For examples of determining separation distances, see Figures 2.4, 2.5, and 2.6.

2-3.2.1 Every aboveground tank for the storage of Class I, Class II, or Class IIIA liquids (except as provided in 2-3.2.2), and those liquids with boil-over characteristics and unstable liquids, operating at pressures not in excess of 2.5 psig (17.2 kPa) and designed with a weak roof-to-shell seam (*see 2-3.6.3*), or equipped with emergency venting devices that will not permit pressures to exceed 2.5 psig (17.2 kPa), shall be located in accordance with Table 2-1. Where tank spacing is contingent on a weak roof-to-shell seam design, the user shall present evidence certifying such construction to the authority having jurisdiction, upon request.

(a) For the purpose of Section 2-3, a floating roof tank is defined as one that incorporates either:

1. A pontoon or double-deck metal floating roof in an open-top tank in accordance with API Standard 650, or

Table 2-1 Stable Liquids [Operating Pressure 2.5 psig (17.2 kPa) or Less]

Type of Tank	Protection	Minimum Distance in Ft from Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way	Minimum Distance in Ft from Nearest Side of Any Public Way or from Nearest Important Building on the Same Property
Shall Be Not Less than 5 Ft			

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Table 2-1 Stable Liquids [Operating Pressure 2.5 psig (17.2 kPa) or Less]

Type of Tank	Protection	Minimum Distance in Ft from Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way and Shall Be Not Less than 5 Ft	Minimum Distance in Ft from Nearest Side of Any Public Way or from Nearest Important Building on the Same Property and Shall Be Not Less than 5 Ft
Floating Roof [See 2-3.1.1(a)]	Protection for exposures*	½ times diameter of tank	⅙ times diameter of tank
	None	Diameter of tank but need not exceed 175 ft	⅙ times diameter of tank
Vertical with Weak Roof-to-Shell Seam (See 2-3.5.3)	Approved foam or inerting system** on tanks not exceeding 150 ft in diameter***	½ times diameter of tank	⅙ times diameter of tank
	Protection for exposures*	Diameter of tank	⅓ times diameter of tank
	None	2 times diameter of tank but need not exceed 350 ft	⅓ times diameter of tank
Horizontal and Vertical with Emergency Relief Venting to Limit Pressures to 2.5 psig	Approved inerting system** on the tank or approved foam system on vertical tanks	½ times Table 2-6	½ times Table 2-6
	Protection for exposures*	Table 2-6	Table 2-6
	None	2 times Table 2-6	Table 2-6

SI Units: 1 ft = 0.3 m.
*See definition of "Protection for Exposures."
**See NFPA 69, *Standard on Explosion Prevention Systems.*
***For tanks over 150 ft in diameter, use "Protection for Exposures" or "None," as applicable.

2. A fixed metal roof with ventilation at the top and roof eaves in accordance with API Standard 650 and containing a metal floating roof or cover meeting any one of the following requirements:

(i) A pontoon or double-deck metal floating roof meeting the requirements of API Standard 650.

(ii) A metal floating cover supported by liquidtight metal floating devices that provide sufficient buoyancy to prevent the liquid surface from being exposed when half of the flotation is lost.

Experience has shown that tanks having floating roofs, as described in 2-3.2.1(a), are not likely to be involved in serious fires. Most fires in such tanks have burned only at the seal and are usually easily extinguished. If the tank is of the open-top type, hand-held extinguishing equipment might prove adequate. In cases where a floating roof has sunk, resulting in an open-top tank fire, boil-over has apparently only occurred once, at the Trieste, Italy, Pipeline Terminal in the early 1970s. In this incident, two 500-ft (153-m) diameter crude oil tanks were set afire by explosive charges set by a terrorist group. The floating roofs sunk and boil-over occurred about 12 hours later. In most such cases, it is thought that the sunken roof will present a barrier to the downward progress of the hot oil layer, thus preventing a boil-over. It is for these reasons that floating roof tanks are given preferred treatment in Table 2-3. For a further discussion of floating roofs, see Table 2-1.

Subparagraph (ii) now recognizes flotation devices other than pontoons or floats — honeycomb panels, for example — but, the requirement is somewhat stricter in that the cover cannot tip in any manner that results in exposure of the liquid surface. Previously, NFPA 30 only required that the pan or cover not sink completely. It is now recognized that a cover that tips and exposes any liquid presents as great a degree of fire risk as one that sinks and exposes the entire surface of the liquid.

(b) An internal metal floating pan, roof, or cover that does not meet the requirements of item 2 in (a) above, or one that uses plastic foam (except for seals) for flotation, even if encapsulated in metal or fiberglass, shall be considered a fixed roof tank.

Such construction is considered to be equivalent to a fixed roof tank because metal pan roofs are prone to sinking and because foamed plastic and similar floation devices will not withstand the conditions imposed by a fire.

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2-3.2.2 Vertical tanks having a weak roof-to-shell seam (*see 2-3.6.3*) and storing Class IIIA liquids may be located at one-half the distances specified in Table 2-1, provided the tanks are not within a diked area or drainage path for a tank storing a Class I or Class II liquid.

The relaxation of the spacing requirements of Table 2-1 recognizes that Class IIIA liquids cannot produce a flammable mixture in the vapor space at ordinary temperatures, coupled with the fact that a well-maintained tank with a weak roof-to-shell seam, in the absence of mechanical damage or an extremely violent earthquake, will not fail in such a way as to spill its contents.

2-3.2.3 Every aboveground tank for the storage of Class I, Class II, or Class IIIA liquids, except those liquids with boil-over characteristics and unstable liquids, operating at pressures exceeding 2.5 psig (17.2 kPa) or equipped with emergency venting that will permit pressures to exceed 2.5 psig (17.2 kPa), shall be located in accordance with Table 2-2.

2-3.2.4 Every aboveground tank for storage of liquids with boil-over characteristics shall be located in accordance with Table 2-3. Liquids with boil-over characteristics shall not be stored in fixed roof tanks larger than 150 ft (45.7 m) in diameter, unless an approved inerting system is provided on the tank.

Liquids having boil-over characteristics are permitted in fixed roof tanks larger than 150 ft (45 m) in diameter only if provided with an approved inerting system. The inerting system will not prevent a boil-over, but will greatly reduce the likelihood of ignition by preventing an ignitible mixture from being formed in the vapor space of the tank during all phases of its operation. NFPA 69, *Standard on Explosion Prevention Systems*, defines inerting as "the technique by which a combustible mixture is rendered nonignitible by addition of an inert gas."

The process of inerting an enclosed or nearly enclosed vessel requires that the oxygen concentration in the vapor space be kept low enough (usually below 10 percent) that combustion cannot be initiated. This requires the addition of inert gas at specific flow rates that depend on the maximum oxygen concentration allowed for the tank contents and the size of the tank. (*Maximum oxygen concentrations can be found in NFPA 69, Standard on Explosion Prevention Systems.*) A suitable inert gas does not have to be truly chemically inert, only incapable of supporting combustion, nonreactive with

Table 2-2 Stable Liquids [Operating Pressure Greater than 2.5 psig (17.2 kPa)]

Type of Tank	Protection	Minimum Distance in Ft from Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way	Minimum Distance in Ft from Nearest Side of Any Public Way or from Nearest Important Building on the Same Property
Any Type	Protection for exposures*	1½ times Table 2-6 but shall not be less than 25 ft	1½ times Table 2-6 but shall not be less than 25 ft
	None	3 times Table 2-6 but shall not be less than 50 ft	1½ times Table 2-6 but shall not be less than 25 ft

SI Units: 1 ft = 0.3 m.
*See definition of "Protection for Exposures."

Table 2-3 Boil-Over Liquids

Type of Tank	Protection	Minimum Distance in Ft from Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way, and Shall Be Not Less than 5 Ft	Minimum Distance in Ft from Nearest Side of Any Public Way or from Nearest Important Building on the Same Property and Shall Be Not Less than 5 Ft
Floating Roof [See 2-3.1.1(a)]	Protection for exposures*	½ times diameter of tank	⅙ times diameter of tank
	None	Diameter of tank	⅙ times diameter of tank
Fixed Roof (See 2-3.1.4).	Approved foam or inerting system**	Diameter of tank	⅓ times diameter of tank
	Protection for exposures*	2 times diameter of tank	⅔ times diameter of tank
	None	4 times diameter of tank but need not exceed 350 ft	⅔ times diameter of tank

SI Units: 1 ft = 0.3 m.
*See definition of "Protection for Exposures."
**See NFPA 69, *Standard on Explosion Prevention Systems.*

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Fixed Roof (See 2-3.1.4)	None	Diameter of tank	$\frac{1}{6}$ times diameter of tank
	Approved foam or inerting system**	Diameter of tank	$\frac{1}{3}$ times diameter of tank
	Protection for exposures*	2 times diameter of tank	$\frac{2}{3}$ times diameter of tank
	None	4 times diameter of tank but need not exceed 350 ft	$\frac{2}{3}$ times diameter of tank

SI Units: 1 ft = 0.3 m.
*See definition of "Protection for Exposures."
**See NFPA 69, *Standard on Explosion Prevention Systems*.

the tank contents, and compatible with tank construction materials. Nitrogen, carbon dioxide, and flue or stack gas containing less than 10% oxygen are commonly used. Helium and argon are quite effective, but usually too expensive, except for special applications. Steam is seldom used because it requires that the protected system be continuously heated above 160°F (71°C), and this is usually not practical. An inerting system requires a continuously dependable source of inert gas and a complex control system. Such systems must meet all applicable requirements of NFPA 69, *Standard on Explosion Prevention Systems*, and should be designed, installed, tested, and maintained only by qualified personnel.

It should be noted that, in producing fields and in some refinery operations, fuel gas is sometimes used to inert tanks that contain liquids that do not have boil-over characteristics.

2-3.2.5 Every aboveground tank for the storage of unstable liquids shall be located in accordance with Table 2-4.

An "unstable liquid," as defined in Section 1-2, is one that can undergo violent thermal decomposition or reaction. Because these tanks are unable to contain the violent reaction caused by heating under fire conditions, greater spacing is mandated for these tanks than for tanks storing stable liquids. Tanks storing unstable liquids have the most stringent spacing requirements.

2-3.2.6 Every aboveground tank for the storage of Class IIIB liquids, excluding unstable liquids, shall be located in accordance with Table 2-5, except where located within a diked area or drainage path for a tank(s) storing a Class I or Class II liquid. Where a Class IIIB liquid storage tank is within the diked area or drainage path for a Class I or Class II liquid, 2-3.2.1 or 2-3.2.2 shall apply.

Class IIIB liquids are considered to be almost immune from accidental fire because of their high flash points and extremely low vapor pressures. Thus, required distances from tanks to property lines are minimal. However, if a tank containing a Class IIIB liquid is situated in the drainage path of a Class I or Class II liquid (e.g., in the same diked area), then this tank can be exposed by a spill fire.

2-3.2.7 Where two tank properties of diverse ownership have a common boundary, the authority having jurisdiction shall be permitted, with the written consent of the owners of the two properties, to substitute the distances provided in 2-3.3.1 through 2-3.3.6 for the minimum distances set forth in 2-3.2.

Table 2-4 Unstable Liquids

Type of Tank	Protection	Minimum Distance in Ft from Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way	Minimum Distance in Ft from Nearest Side of Any Public Way or from Nearest Important Building on the Same Property
Horizontal and Vertical Tanks with Emergency Relief Venting to Permit Pressure Not in Excess of 2.5 psig	Tank protected with any one of the following: approved water spray, approved inerting,* approved insulation and refrigeration, approved barricade	Table 2-6 but not less than 25 ft	Not less than 25 ft
	Protection for exposures**	$2\frac{1}{2}$ times Table 2-6 but not less than 50 ft	Not less than 50 ft
	None	5 times Table 2-6 but not less than 100 ft	Not less than 100 ft
Horizontal and Vertical Tanks with Emergency Relief Venting to Permit Pressure over 2.5 psig	Tank protected with any one of the following: approved water spray, approved inerting,* approved insulation and refrigeration, approved barricade	2 times Table 2-6 but not less than 50 ft	Not less than 50 ft
	Protection for exposures**	4 times Table 2-6 but not less than 100 ft	Not less than 100 ft
	None	8 times Table 2-6 but not less than 150 ft	Not less than 150 ft

SI Units: 1 ft = 0.3 m.
*See NFPA 69, *Standard on Explosion Prevention Systems.*
**See definition of "Protection for Exposures."

Table 2-5 Class III

Capacity Gallons
12,000 or less
12,001 to 30,000
30,001 to 50,000
50,001 to 100,000
100,001 or more

SI Units: 1 ft = 0.3 m; 1

Table 2-6 Referenc

Capacity Tank Gallons
275 or less
276 to 750
751 to 12,000
12,001 to 30,000
30,001 to 50,000
50,001 to 100,000
100,001 to 500,000
500,001 to 1,000,000
1,000,001 to 2,000,000
2,000,001 to 3,000,000
3,000,001 or more

SI Units: 1 ft = 0.3 m; 1

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Table 2-5 Class IIIB Liquids

Capacity Gallons	Minimum Distance in Ft from Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way	Minimum Distance in Ft from Nearest Side of Any Public Way or from Nearest Important Building on the Same Property
12,000 or less	5	5
12,001 to 30,000	10	5
30,001 to 50,000	10	10
50,001 to 100,000	15	10
100,001 or more	15	15

SI Units: 1 ft = 0.3 m; 1 gal = 3.8 L.

Table 2-6 Reference Table for Use in Tables 2-1 to 2-4

Capacity Tank Gallons	Minimum Distance in Ft from Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way	Minimum Distance in Ft from Nearest Side of Any Public Way or from Nearest Important Building on the Same Property
275 or less	5	5
276 to 750	10	5
751 to 12,000	15	5
12,001 to 30,000	20	5
30,001 to 50,000	30	10
50,001 to 100,000	50	15
100,001 to 500,000	80	25
500,001 to 1,000,000	100	35
1,000,001 to 2,000,000	135	45
2,000,001 to 3,000,000	165	55
3,000,001 or more	175	60

SI Units: 1 ft = 0.3 m; 1 gal = 3.8 L.

This simply says that, where owners agree, each may accept the risk from any of the tanks on the others' property to the same extent that one accepts the risks from his own.

2-3.2.8 Where end failure of horizontal pressure tanks and vessels can expose property, the tank shall be placed with the longitudinal axis parallel to the nearest important exposure.

	Protection for exposures**	4 times Table 2-6 but not less than 100 ft	Not less than 100 ft
	None	8 times Table 2-6 but not less than 150 ft	Not less than 150 ft

SI Units: 1 ft = 0.3 m.
*See NFPA 69, *Standard on Explosion Prevention Systems.*
**See definition of "Protection for Exposures."

This requirement is based on the fact that a horizontal pressure tank exposed to fire is likely to travel (rocket) axially upon failure. Application of this rule involves the difficult decision as to which structure constitutes the nearest important risk. An office building on the same property or any occupied buildings on adjoining property would be considered "important exposures." A tank containing flammable liquids might also be so considered. A normally unoccupied storage shed would likely not.

2-3.3 Spacing (Shell-to-Shell) between Any Two Adjacent Aboveground Tanks.

2-3.3.1 Tanks storing Class I, II, or IIIA stable liquids shall be separated in accordance with Table 2-7, except as provided in 2-3.3.2.

The minimum spacing between tanks storing stable liquids is given in Table 2-7. The 3 ft (0.9 m) minimum is based on the need for access for maintenance and painting and for application of hose streams to cool a fire-exposed tank. Spacing for larger tanks is an arbitrary fraction of tank diameter, sufficient to permit an orderly and safe arrangement for pipelines and to prevent spread of fire from one tank to another. Spacing alone is not a safeguard against fire spread from spilled liquid, control of which is covered in 2-3.4. Exceptions to these minimum spacing requirements follow. (*For examples of determining minimum spacing between tanks, see Figures 2.4, 2.5, and 2.6.*)

Application of Table 2-7 to horizontal tanks was initiated in the 1984 edition of NFPA 30 to address questions raised about required distances between adjacent horizontal tanks. For spacing purposes, it was determined that horizontal tanks should be treated the same as fixed roof tanks.

2-3.3.2 Crude petroleum tanks having individual capacities not exceeding 126,000 gal (3000 barrels), where located at production facilities in isolated locations, need not be separated by more than 3 ft (0.9 m).

This exception is made because, in a location that does not expose neighboring property, it would be illogical to require large spaces between several tanks where one single tank storing the same quantity of oil would be permissible. Thus, tanks may be placed closer together, resulting in economic piping installation and supervision, without increasing the risk to others.

2-3.3.3 Tanks used only for storing Class IIIB liquids shall be permitted to be spaced no less than 3 ft (0.9 m) apart unless within a diked area or drainage path for a tank storing a Class I or II liquid, in which case the provisions of Table 2-7 shall apply.

Table 2-7 Minim

All tanks not over 150 ft in diameter
Tanks larger than 150 feet in diameter
If remote impounding is in accordance with 2-3.4.2
If impounding is around tanks by diking in accordance with 2-3.4.3

SI Units: 1 ft = 0.3 m.

2-3.3.4 For unstable
one-half the sum of

2-3.3.5 Where tanks
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2-3.3.6 The minimum
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Table 2-7 Minimum Tank Spacing (Shell-to-Shell)

		Fixed or Horizontal Tanks	
	Floating Roof Tanks	Class I or II Liquids	Class IIIA Liquids
All tanks not over 150 ft in diameter	1/6 sum of adjacent tank diameters but not less than 3 ft	1/3 sum of adjacent tank diameters but not less than 3 ft	1/6 sum of adjacent tank diameters but not less than 3 ft
Tanks larger than 150 feet in diameter			
If remote impounding is in accordance with 2-3.4.2	1/6 sum of adjacent tank diameters	1/4 sum of adjacent tank diameters	1/8 sum of adjacent tank diameters
If impounding is around tanks by diking in accordance with 2-3.4.3	1/4 sum of adjacent tank diameters	1/3 sum of adjacent tank diameters	1/4 sum of adjacent tank diameters

SI Units: 1 ft = 0.3 m.

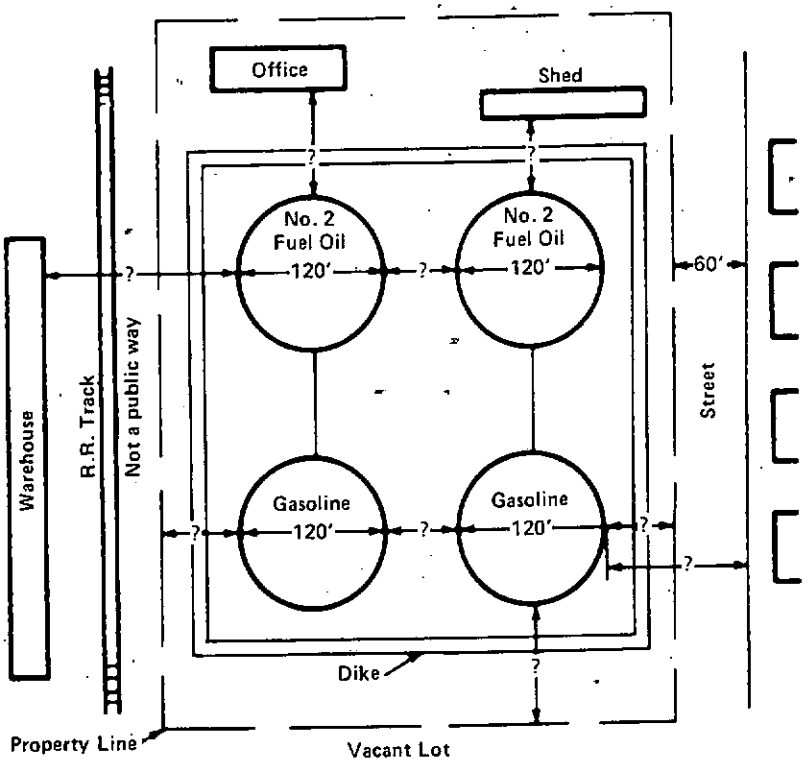
2-3.3.4 For unstable liquids, the distance between such tanks shall not be less than one-half the sum of their diameters.

2-3.3.5 Where tanks are in a diked area containing Class I or Class II liquids, or in the drainage path of Class I or Class II liquids, and are compacted in three or more rows or in an irregular pattern, greater spacing or other means shall be permitted to be required by the authority having jurisdiction to make tanks in the interior of the pattern accessible for fire fighting purposes.

2-3.3.6 The minimum horizontal separation between an LP-Gas container and a Class I, Class II, or Class IIIA liquid storage tank shall be 20 ft (6 m), except in the case of a Class I, Class II, or Class IIIA liquid tank operating at pressures exceeding 2.5 psig (17.2 kPa) or equipped with emergency venting that will permit pressures to exceed 2.5 psig (17.2 kPa), in which case the provisions of 2-3.3.1 and 2-3.3.2 shall apply. Suitable measures shall be taken to prevent the accumulation of Class I, Class II, or Class IIIA liquids under adjacent LP-Gas containers such as by dikes, diversion curbs, or grading. Where flammable or combustible liquid storage tanks are within a diked area, the LP-Gas containers shall be outside the diked area and at least 10 ft (3 m) away from the centerline of the wall of the diked area. The foregoing provisions shall not apply where LP-Gas containers of 125 gal (475 L) or less capacity are installed adjacent to fuel oil supply tanks of 660 gal (2498 L) or less capacity. No horizontal separation is required between aboveground LP-Gas containers and underground flammable and combustible liquid tanks installed in accordance with Section 2-4.

Determining Required Distances — Examples

Example I



SI Units: 1 ft = 0.3 m.

Figure 2.4 Example No. 1: Determining required distances.

Assume that you have the responsibility for approving plans to place four additional tanks in a bulk plant. Two tanks will store No. 2 fuel oil and two will store gasoline. Your job is to ensure that the spacing requirements of NFPA 30, *Flammable and Combustible Liquids Code*, are followed. Assume that there is protection for exposures. All four tanks will be vertical tanks built to API 650 specifications, 120 ft (36 m) in diameter, and will have weak roof-to-shell seams. You must determine the required distance from:

1. The gasoline tanks to the vacant lot.
2. The tanks to the near side of the street.

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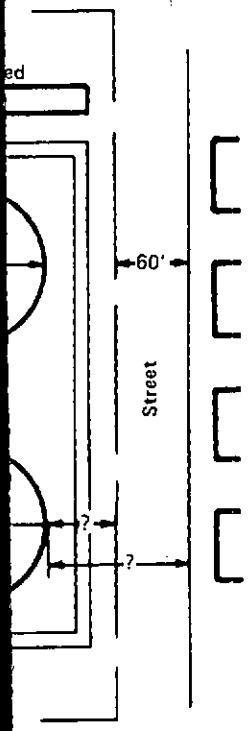
3. The tanks to the opposite side of the street. How does this affect the distance from the tank to the near side of the street in the preceding item? What options do you have to remedy the situation?
4. The fuel oil tank to the shed.
5. The fuel oil tank to the office building.
6. The tanks to the warehouse on the opposite side of the railroad tracks.
7. The tanks to the property line abutting the railroad right-of-way.
8. One tank to another; i.e., shell-to-shell spacing.

Solutions:

1. Table 2-1 indicates that, for a vertical tank with protection for exposures and with weak roof-to-shell seams, the distance to a property line that is or can be built upon should be the diameter of the tank. The distance, then, should be 120 ft (36 m).
2. Table 2-1 indicates a distance of $\frac{1}{3}$ the diameter of the tank from the near side of the street. In this case, that would mean 40 ft (12 m).
3. The distance to the opposite side of the street should be the diameter of the tank, or 120 ft (36 m). However, since the street is 60 ft (18 m) wide and the distance to the near side (in item 2) is just 40 ft (12 m), the plans must be altered in some way. There are a few options. If land availability is favorable, the tanks could be moved; the tanks could be decreased in diameter, to 90 ft (27 m), for example; an approved foam system could be installed that would then lessen the distance requirement to $\frac{1}{2}$ of the diameter, or 60 ft (18 m); finally, one might change the design of the tank to incorporate a floating roof, which would decrease the distance requirement to $\frac{1}{2}$ of the tank diameter.
4. Given no additional pertinent information, one can assume that the shed constitutes an unimportant building on the company's premises. Therefore, there is no specified distance requirement. Naturally, the shed cannot be located within the diked area, so some minimum distance is actually provided, depending on the site layout.
5. The office building must be considered an important structure on the same property, since it is an occupied building. Table 2-1 advises $\frac{1}{3}$ of the tank diameter as a reasonable safe distance, therefore 40 ft (12 m) is the answer.
6. The warehouse constitutes a property line. Table 2-1 requires the separating distance to be the tank diameter, in this case 120 ft (36 m).
7. A railroad is not considered a public way. Therefore, Table 2-1 does not recommend any specific distance. In other words, there is no requirement for separation in the case of railroads.

Examples



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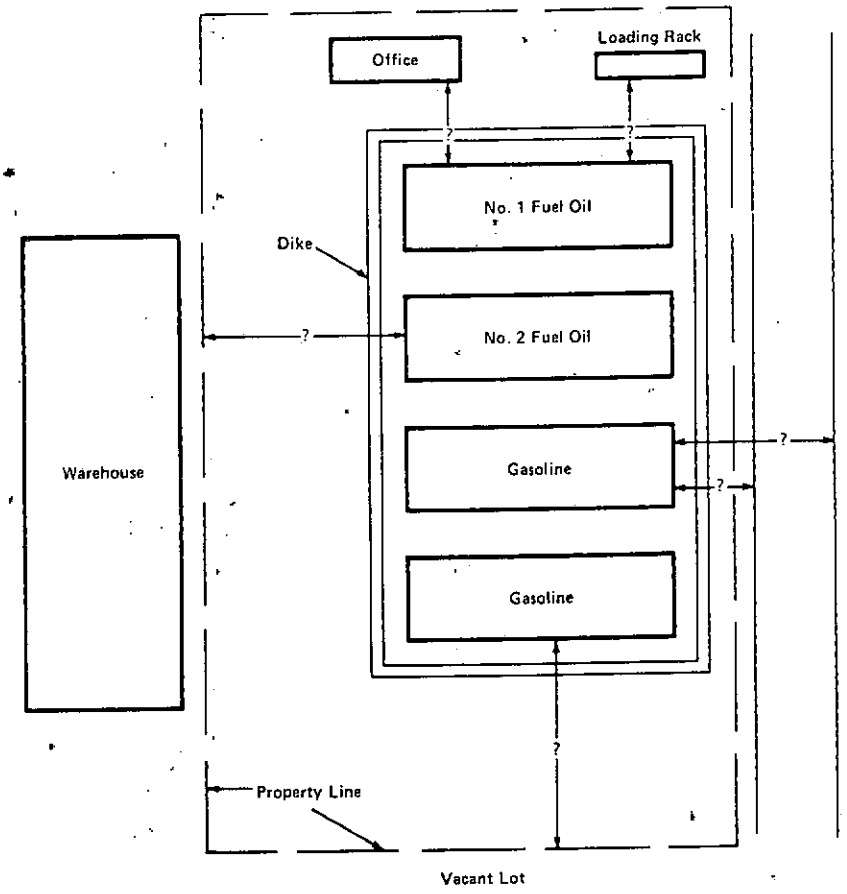
8. Table 2-7 must be consulted to determine shell-to-shell spacing requirements. Since these tanks are less than 150 ft (45 m) in diameter, have fixed roofs, and are storing Class I and Class II liquids, the requirement calls for 1/6 of the sum of adjacent tank diameters. One-sixth of 240 (120 + 120) indicates a 40-ft (12-m) separation between adjacent tanks. Note that the adjacent tank distances are determined on a "one-to-one" basis. The word "adjacent" as used in NFPA 30 does not mean all four tanks in the diagram, but rather a single tank adjacent to its nearest neighbor.

Example 2



ALL TANKS – 20,000 GALLONS CAPACITY
PROTECTION FOR EXPOSURES

SI Units: 1 gal = 3.8 L.

Figure 2.5 Example No. 2: Determining required distances.

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Assume you are a County Fire Inspector responsible for inspecting the small bulk plant illustrated in this figure. All four tanks are horizontal, equipped with emergency relief venting to limit pressures to 2.5 psig (17.2 kPa). There is protection for exposures. Each of the tanks has a capacity of 20,000 gal (75 700 L). In order to verify compliance with NFPA 30, *Flammable and Combustible Liquids Code*, you must determine the minimum distances required from:

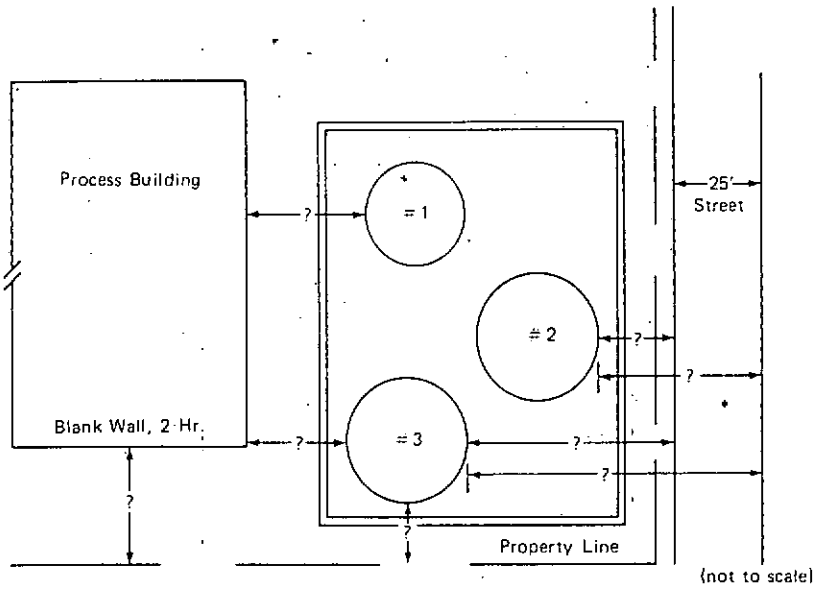
1. The gasoline tank to the property line adjoining the vacant lot.
2. The gasoline tanks to the near side and opposite side of the street.
3. The tank storing No. 1 fuel oil to the loading rack.
4. The tank storing No. 1 fuel oil to the office building.
5. The tank storing No. 2 fuel oil to the property line on which the warehouse is built.

Solutions:

1. Table 2-1 refers the user to Table 2-6 for this situation. Table 2-6 indicates that the distance to the property line must be 20 ft (6 m).
2. Table 2-6 indicates 5 ft (1.5 m) from the nearest side of any public way and 20 ft (6 m) from the opposite side of the public way.
3. The loading rack is certainly an important structure on the same property and the distance indicated by Table 2-6 prescribes a minimum of 5 ft (1.5 m). However, another paragraph in NFPA 30, 5-4.4.1.1, gives specific distances for loading racks, namely 15 ft (4.6 m) for Class II and III liquids and 25 ft (7.6 m) for Class I liquids. Since the loading rack handles Class I and Class II liquids, it should be a distance of 25 ft (7.6 m) from aboveground tanks, warehouses, other plant buildings, or nearest line of adjoining property that can be built upon.
4. Table 2-6 indicates that a 5-ft (1.5-m) distance is required between the tank and the office building.
5. Table 2-6 requires tanks of the indicated capacity to be spaced 20 ft (6 m) from the nearest property line.

NOTE 1: If the preceding set of problems involved tanks on which the emergency venting permitted pressure to exceed 2.5 psig (17.2 kPa), Table 2-2 would have been used. Table 2-2 refers the reader to Table 2-6 and indicates that the distances should be 1½ times those in Table 2-6, but not less than 25 ft (7.6 m).
NOTE 2: If the examples involved an unstable liquid with venting that limited pressures to 2.5 psig (17.2 kPa), Table 2-4 would have required distances 2½ times those in Table 2-6, but not less than 50 ft (15 m).

Example 3



SI Units: 1 gal = 3.87 L; 1 ft = 0.3 m.

Figure 2.6 Example No. 3: Determining required distances where an unstable liquid is involved

As County Fire Inspector, you must evaluate site plans for the process plant shown in Figure 2-6. You must verify compliance with NFPA 30, *Flammable and Combustible Liquids Code.* Tanks #1 and #2 are vertical fixed roof tanks with weak roof-to-shell seams and are 25 ft (7.6 m) in diameter and 30 ft (9 m) high. They contain, respectively, 100,000 gallons (380 000 L) each of toluene and xylene, both stable Class I liquids. Tank #3 is a vertical fixed roof tank with emergency relief venting to permit internal pressure to rise no higher than 2.5 psig (17.2 kPa). This tank is 20 ft (6 m) in diameter and 30 ft (9 m) high and contains 70,000 gallons (266 000 L) of styrene. Styrene is considered an unstable liquid, so the tank is insulated and is protected with a water spray system. The process building houses process vessels. The wall of this building that faces the adjacent property is a blank, two-hour firewall. You must determine the distances required from:

1. The process building to the property line.
2. Tank #3 to the property line and to the process building.
3. The tanks to the near side of the street.

000085

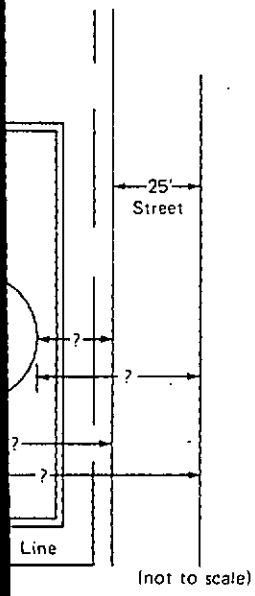
4. The tanks to the far side of the street.
5. Tank #1 to the process building.
6. One tank to another; i.e., shell-to-shell spacing.

Solutions:

1. Chapter 2 does not provide required separation distances for process vessels. This information must be taken from Chapter 5, "Operations." Minimum separation distances are given in Table 5-3.1.1, but paragraph 5-3.1.2 states that, if the process vessels are housed in a building whose exposing wall is a blank, 2-hr firewall, then the separation distance need only exceed 25 ft (7.6 m). Any greater distance called for by Table 5-3.1.1 is waived.

   Thus, the separation distance from process building to property line is "greater than 25 ft (7.6 m)."
2. The separation distances for unstable liquids are found in Table 2-4, which bases itself, in part, on Table 2-6. For separation distance from the property line, the tables require a 50-ft (15-m) separation. For the required distance from the process building, Table 2-4 sets a 25 ft (7.5 m) minimum.
3. and 4. To determine the required distances between the tanks and the near and far sides of the street, only tanks #2 and #3 need be considered. (Tank #1 is set back farther than tank #2 and contains the same class of liquid.) Referring again to Table 2-4, the required distances between Tank #3 and the near and far sides of the street are 25 ft (7.5 m) and 50 ft (15 m), respectively. Note that if the tank itself is not protected, the required distances increase dramatically — by a factor of 2½, if only exposure protection is provided, and by a factor of 5 if no protection at all.

   For Tank #2, Table 2-1 provides the required separation distances. Assuming protection for exposures, this tank must be located one-third the tank diameter from the near side of the street, or 8 ft 4 in. (2.5 m), and one tank diameter from the far side of the street, i.e., 25 ft (7.5 m). Since the street itself is 25 ft (7.5 m) wide and the set-back from the near side is 8 ft 4 in. (2.5 m), an extra margin of safety exists for any property on the opposite side of the street.
5. The distance between Tank #1 and the process building is given in the last column of Table 2-1. This distance is one-third the diameter of the tank, or 8 ft 4 in. (2.5 m).



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6. Shell-to-shell spacing is found in Table 2-7. The minimum spacing between Tanks #1 and #2 is one-sixth the sum of the tank diameters: $\frac{1}{6}$ (25 + 25) = 8 ft 4 in. (2.5 m). The minimum spacing between Tanks #2 and #3, according to Table 2-7, is slightly less: $\frac{1}{6}$ (25 + 20) = 7 ft 6 in. (2.25 m). However, paragraph 2-3.2.4 sets a minimum spacing of one half the sum of the tank diameters where unstable liquids are involved: $\frac{1}{2}$ (45) = 22.5 ft (6.75 m).

2-3.4 Control of Spillage from Aboveground Tanks.

2-3.4.1 Facilities shall be provided so that any accidental discharge of any Class I, II, or IIIA liquids will be prevented from endangering important facilities, and adjoining property, or reaching waterways, as provided for in 2-3.4.2 or 2-3.4.3.

The requirements of this paragraph are based on the rationale that release of product from a tank, however caused, must not be permitted to endanger important facilities and adjoining property or to reach any waterways. The principal fear is that such a spill might be ignited and cause extensive spread of fire. Another major concern is environmental pollution that may be more difficult to control.

It is important to understand that these spill control requirements are primarily directed at releases due to overfilling the tank or due to a major leak of a pipeline connected to the tank. Releases due to a leaking shell are also covered, but these are minor and tend to be much smaller. The spill control provisions of NFPA 30 do not, however, anticipate a catastrophic failure of the entire tank shell, such as happened in Floreffe, PA, in January, 1988.

Exception No. 1: Tanks storing Class IIIB liquids do not require special drainage or diking provisions for fire protection purposes.

Tanks storing Class IIIB liquids do not require spill control for fire protection purposes alone because of the small chance that ignition could occur, although environmental contamination will likely result whether or not a fire occurs.

Exception No. 2: Aboveground secondary containment-type tanks need not meet the requirements of 2-3.4 if all of the following conditions are met:

(a) The capacity of the tank shall not exceed 12,000 gal (45,420 L).

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(b) All piping connections to the tank shall be made above the normal maximum liquid level.

(c) Means shall be provided to prevent the release of liquid from the tank by siphon flow.

(d) Means shall be provided for determining the level of liquid in the tank. This means shall be accessible to the delivery operator.

(e) Means shall be provided to prevent overfilling by sounding an alarm when the liquid level in the tank reaches 90 percent of capacity and by automatically stopping delivery of liquid to the tank when the liquid level in the tank reaches 95 percent of capacity. In no case shall these provisions restrict or interfere with the proper functioning of the normal vent or the emergency vent.

(f) Spacing between adjacent tanks shall be not less than 3 ft (0.9 m).

(g) The tank shall be capable of resisting the damage from the impact of a motor vehicle or suitable collision barriers shall be provided.

(h) Where the interstitial space is enclosed, it shall be provided with emergency venting in accordance with 2-3.6.

This new exception to the spill control provisions of NFPA 30 has been added to address the growing use of factory-built aboveground tanks that incorporate some form of secondary containment. The secondary containment is primarily an environmental protection measure and usually takes the form of a double shell with an annular (interstitial) space or an integral spill pan. In developing this exception, the Technical Committee on Flammable and Combustible Liquids considered many issues and determined that a double shell alone would not provide the level of spill control originally intended.

First, the Technical Committee recognized that secondary containment and spill control are not synonymous. "Secondary containment" is a term applied to double-shell *underground* tanks; such tanks have been in use for many years and are now the choice for underground installations, as a result of the stricter environmental regulations. The outer shell contains any release of product should the inner primary tank develop a leak. The concept has now been applied to aboveground tanks. But, almost all product releases from aboveground tanks result from overfilling or a break in a pipe connected to the tank. Rarely does an aboveground tank release product because of a leak in its shell.

Second, the Technical Committee was not convinced that the bare steel outer shell would not fail prematurely from an exposure fire. Their concern arose from the fact that the contained liquid is not in contact with the outer shell and, therefore, cannot absorb the thermal energy impinging on it.

Third, for smaller tanks, the outer shell offered virtually no impact protection. Piercing the outer shell would likely result in piercing the primary tank as well. Even if the primary tank was not damaged, secondary containment will have been compromised.

The Technical Committee determined that an aboveground secondary containment-type tank could be installed without meeting the spill control provisions of NFPA 30 only if the protective features enumerated above were provided.

The maximum capacity of 12,000 gallons was chosen to correlate with the maximum capacity allowed by NFPA 30A, *Automotive and Marine Service Station Code*, for aboveground tanks at service stations.

Piping connections below the liquid level are not allowed and an antisiphon device is required to prevent release of liquid should there be a break in the pipeline.

Items (d) and (e) are intended to prevent spills due to overfilling the tank. In addition, the overfill prevention features must not interfere with the operation of the normal or emergency vent. This prohibits the use of any float-type device that blocks the normal vent. These tanks will likely have to be pump-filled. Any interference with the proper functioning of the normal vent could overpressure the primary tank.

Item (g) recognizes the inherent collision protection of concrete-encased tanks.

Item (h) is required because many of these tank designs incorporate features whereby small overfills are directed into the interstitial space.

2-3.4.2 Remote Impounding. Where protection of adjoining property or waterways is by means of drainage to a remote impounding area, so that impounded liquid will not be held against tanks, such systems shall comply with the following:

The concept of remote impounding is that any spilled liquid will be led, by grading, swales, ditches, or other channels, to an impounding area large enough to contain all of the liquid in the largest tank that can drain into it. The impounding area must be so located that, if the spill ignites, the fire will not seriously damage other tanks or adjoining property. A reasonable slope away from the tank is required so that liquid will not come to rest closer than 50 ft (15 m) from the tank or 50 ft (15 m) from any property line that can be built upon.

In early tank installations (where tanks were often placed on hills to achieve gravity flow), this objective was easily attained. Installations on relatively flat terrain present a much more difficult problem. It is, nonetheless, possible to

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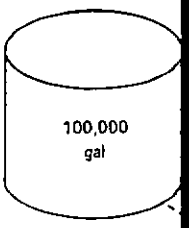

Figure 2.7 The
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(a) A slope of not
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achieve significant drainage control with a minimum of grading. This is much preferred to the short-cut practice of placing each tank in the center of a flat diked area, where even a minor spill will make it likely that piping and control valves will be inaccessible and subject to fire damage. Figure 2.7 illustrates the concept.

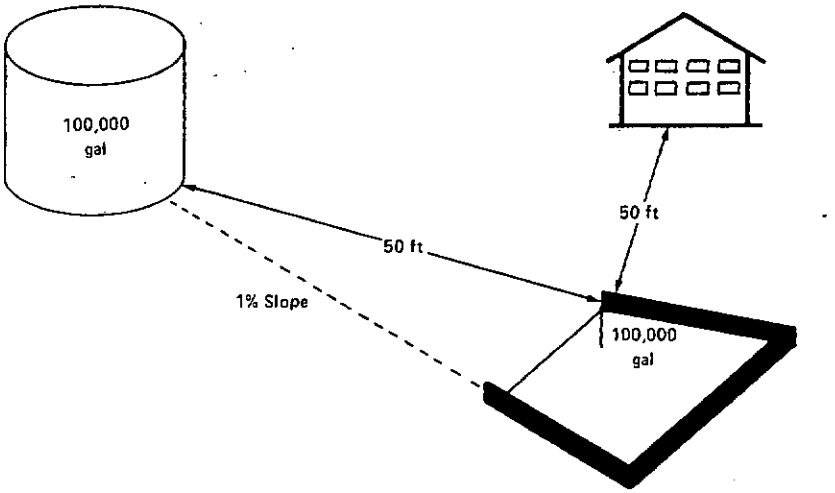

Figure 2.7 The remote impounding area must be large enough to contain all of the liquid from the largest tank that can drain into it. A one percent slope away from the tank generally ensures adequate drainage control.

(a) A slope of not less than 1 percent away from the tank shall be provided for at least 50 ft (15 m) toward the impounding area.

(b) The impounding area shall have a capacity not less than that of the largest tank that can drain into it. Where it is not possible because there is not enough open area around the tanks or it is impractical to provide 100 percent capacity remote impounding, it shall be permitted to provide "partial" remote impounding for some percentage of the required capacity remote from any tank or adjoining property. The required volume exceeding the capacity of the partial remote impoundment shall be provided for by diking meeting the requirements of 2-3.4.3.

The first sentence of this paragraph is part of the original set of requirements. The rest of the paragraph is new. Historically, NFPA 30 has allowed two methods of spill control: remote impounding and diking. It did not, however, explicitly allow both methods to be used in combination, so that the benefits of both methods could be used where space or practicality did

not allow complete compliance with this subsection. Most liquid releases are small, involving only a small percentage of the total capacity of the spill control system. Combined spill control systems allow the facility to take advantage of remote impounding to reduce the risk of small releases, while still providing 100 percent containment for the largest tank should a major incident occur.

(c) The route of the drainage system shall be so located that, if the liquids in the drainage systems are ignited, the fire will not seriously expose tanks or adjoining property.

(d) The confines of the impounding area shall be located so that, when filled to capacity, the liquid level will not be closer than 50 ft (15 m) from any property line that is or can be built upon, or from any tank. Where "partial" remote impounding is used, the liquid level in the partial impound shall meet the requirement of this section. The excess volume shall meet the requirements of impounding by diking as provided or in 2-3.4.3. Tank spacing shall be determined as for tanks impounded in accordance with 2-3.4.3.

Additional requirements have been added to this paragraph to incorporate the concept of combined spill control systems. Containment must be provided for spills that might be larger than the remote impounding area can accomodate.

2-3.4.3 Impounding around Tanks by Diking. Where protection of adjoining property or waterways is by means of impounding by diking around the tanks, such system shall comply with the following:

Diking is less desirable than remote impounding because it allows a ground fire to expose tanks within the diked area, as illustrated in Figure 2.8. However, it is often difficult to provide remote impounding, either because there is not enough open area around the tanks or because environmental regulations prohibit the use of an open impounding basin. Thus, diking becomes an important alternative. The change made to subsection 2-3.4.2 that allows a combined spill control system consisting of both remote impounding and diking provides obvious benefits — a facility that cannot meet the requirements for remote impounding completely might be able to provide partial impounding, with diking providing protection from a major incident.

(a) A slope of not less than 1 percent away from the tank shall be provided for at least 50 ft (15 m) or to the dike base, whichever is less.



Figure 2.8 There
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Application of this

Example 1

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Figure 2.8 There have been many fires that have involved all of the tanks in a single diked area.

(b) The volumetric capacity of the diked area shall not be less than the greatest amount of liquid that can be released from the largest tank within the diked area, assuming a full tank. To allow for volume occupied by tanks, the capacity of the diked area enclosing more than one tank shall be calculated after deducting the volume of the tanks, other than the largest tank, below the height of the dike.

NFPA 30 does not provide a specific definition of "full tank." However, the intent is for the "the greatest amount of liquid that can be released" to be some reasonable quantity. Normally, this is considered to be that quantity represented by the maximum fill height or the overfill point. Also, it should be noted that a few jurisdictions require the dike to be able to hold 110 percent of the largest tank's capacity to provide some "freeboard" for foam application and some additional containment to hold runoff from fire fighting operations.

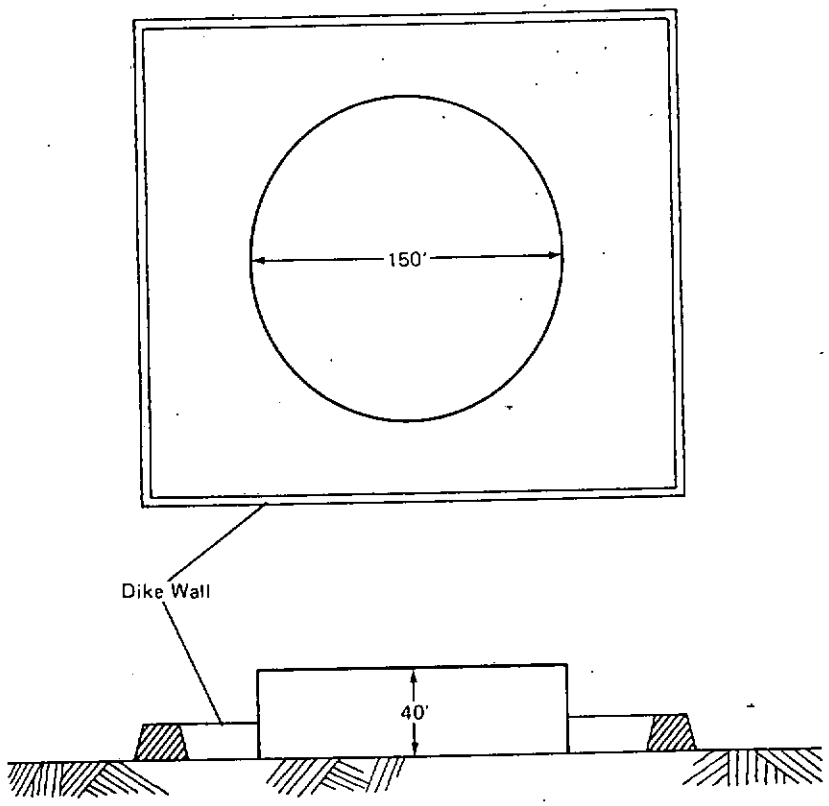
Application of this provision is best illustrated by solving example problems.

Example 1

What is the required volumetric capacity of a dike that will enclose a single 150-ft (45-m) diameter tank with a maximum fill height of 40 ft (12 m)?

Solution:

Paragraph (b) states that the dike enclosure must be capable of holding the greatest amount of liquid that can be released, assuming a full tank. Refer to Figure 2.9.



SI Units: 1 ft = 0.3 m.

Figure 2.9. Example 1.

If the tank shown were to completely release its contents, the liquid in the tank would drain into the dike until the liquid level both inside and outside of the tank are at the same height. Thus, for practical purposes, the volume of the dike, i.e., its area x the height of its wall, must be equal to the maximum capacity of the tank. The capacity of the tank is given by the formula for the volume of a cylinder:

$$V = \frac{\pi d^2 b}{4}$$

where
V = volume
π = 3.14
d = diameter
b = height of the

Solving this equat
imum fill of 706,5

Therefore, the di
dike wall will depe
The calculation p
are in the diked ar

Example 2

There are four ta
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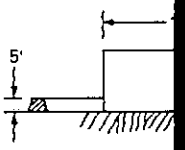
(1.5 m) high dike
Is the capacity o



SI Units: 1 ft =

Solution:

Begin by determ
to the area times t

where
V = volume
π = 3.14
d = diameter
b = height of the tank

Solving this equation for this tank yields a total volumetric capacity at maximum fill of 706,500 ft^3 (19 782 m^3), as follows:

$$V = \frac{\pi(150)^2(40)}{4} = 706{,}500$$

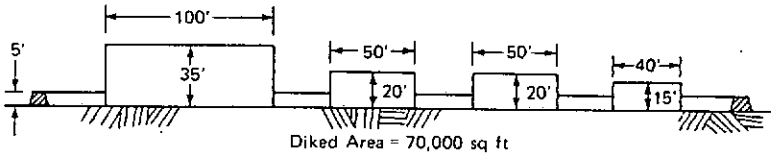
Therefore, the dike enclosure must contain that amount. The height of the dike wall will depend on the square footage available in the diked area.

The calculation procedure is a bit more complex when more than one tank are in the diked area.

Example 2

There are four tanks in a diked area. The largest is 100 ft (30 m) in diameter and has a maximum fill height of 35 ft (10.5m). Two other tanks are each 50 ft (15 m) in diameter with 20 ft (6 m) maximum fill heights, while the fourth tank is 40 ft (12 m) in diameter and has a 15 ft (4.5 m) maximum fill height. The diked area is 70,000 sq ft (6503 m^2) and has a 5 ft (1.5 m) high dike wall. Refer to Figure 2.10.

Is the capacity of the dike sufficient for the largest tank?



SI Units: 1 ft = 0.30 m.

Figure 2.10. Example 2.

Solution:

Begin by determining the total volume of the diked area, which is equal to the area times the height of the dike wall:

$$70{,}000 \times 5 = 350{,}000 \text{ ft}^3 \ (912 \text{ m}^3)$$

Since the three smaller tanks occupy some of the volume of the dike, this volume is unavailable for containing a spill and must be deducted from the capacity of the dike enclosure to obtain the net free capacity of the dike. Keep in mind that they occupy available dike capacity *only up to the height of the dike wall*, i.e., 5 ft (1.5 m). The value h in the formula above, therefore, will be 5 ft (1.5 m).

For the two 50-foot diameter tanks, the volume is:

$$V = \frac{\pi(50)^2(5)}{4} = 9812.5 \text{ ft}^3$$

For the 40-foot diameter tank, the volume is:

$$V = \frac{\pi(40)^2(5)}{4} = 6280 \text{ ft}^3$$

The total for the three smaller tanks is:

$$2(9812.5) + 6280 = 25{,}905 \text{ ft}^3 \ (734 \text{ m}^3)$$

This is the volume that must be subtracted from the gross volume of the dike to obtain the net free volume:

$$350{,}000 - 25{,}905 = 324{,}095 \text{ ft}^3 \ (9178 \text{ m}^3)$$

The volume of the largest tank is:

$$V = \frac{\pi(100)^2(35)}{4} = 274{,}750 \text{ ft} \ (7781 \text{ m}^3)$$

This volume is much less than the net free volume of the diked area, so the dike's capacity is more than sufficient.

Note in both examples that the portion of the total volume of the largest tank that is below the height of the dike wall is considered part of the net free volume of the diked area and is not subtracted out.

(c) To permit access, the outside base of the dike at ground level shall be no closer than 10 ft (3 m) to any property line that is or can be built upon.

This is intended to permit access for fire fighting and to provide additional protection for buildings on adjoining property in the event of a fire in the dike area. (*See Figure 2.11.*)



Figure 2.1

(d) Walls of the dike
designed to be liquidti
3 ft (0.9 m) or more in
(0.6 m) wide. The slop
repose of the material
taining Class I liquids l
ment to prevent seepa
waterways in case of s

It is frequently aske
because several jurisd
a maximum permeabi
uid can be penetrate
requirement, liquidtigh
the dike wall, at least
the dike will normally
results in a spill, it is p
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permeation of liquid f
at least for purposes
regulations might req
ous lining.

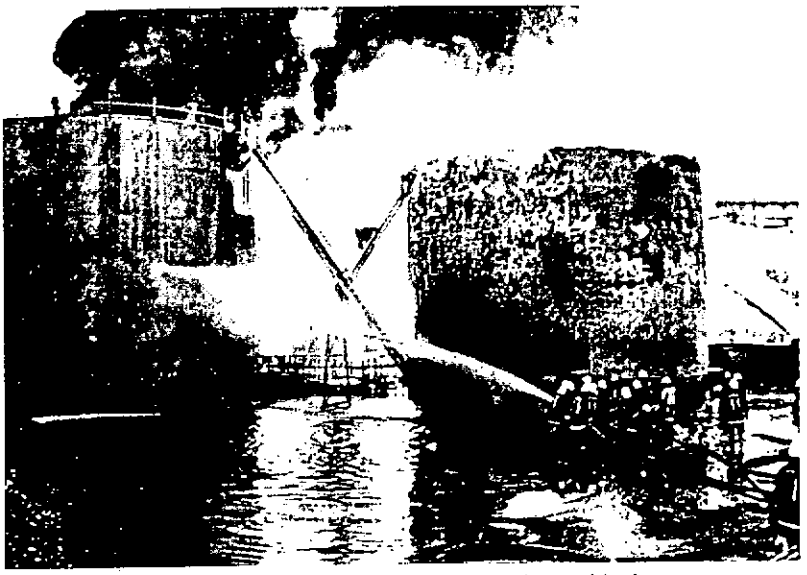


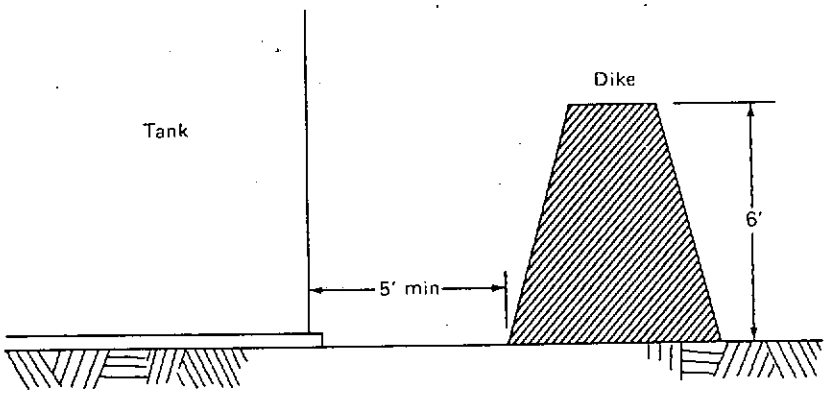
Figure 2.11 Fire fighters operating within a diked area.

(d) Walls of the diked area shall be of earth, steel, concrete, or solid masonry designed to be liquidtight and to withstand a full hydrostatic head. Earthen walls 3 ft (0.9 m) or more in height shall have a flat section at the top not less than 2 ft (0.6 m) wide. The slope of an earthen wall shall be consistent with the angle of repose of the material of which the wall is constructed. Diked areas for tanks containing Class I liquids located in extremely porous soils may require special treatment to prevent seepage of hazardous quantities of liquids to low-lying areas or waterways in case of spills.

It is frequently asked what is meant by "liquidtight." The question arises because several jurisdictions require that the floor and walls of a dike meet a maximum permeability standard. (Permeability measures how easily a liquid can be penetrate or "soak" into a barrier material.) For purposes of this requirement, liquidtight means that the liquid will not breach or soak through the dike wall, at least for some reasonable length of time. Of course, since the dike will normally hold liquid only due to some emergency condition that results in a spill, it is presumed that the spilled liquid will be removed as soon as the emergency has been stabilized. Well compacted clays will resist the permeation of liquid for a reasonable period and are allowed for dike walls, at least for purposes of fire protection. However, environmental protection regulations might require more substantial treatment, such as an impervious lining.

(e) Except as provided in (f) below, the walls of the diked area shall be restricted to an average interior height of 6 ft (1.8 m) above interior grade.

The reason for limiting the general dike height to 6 ft (1.8 m) is to provide an escape route for fire fighters engaged in combating small fires within the dike. Exceptions to this requirement are allowed, but other precautions are then mandated. (*See Figure 2-12.*)



SI Units: 1 ft = 0.3 m.

Figure 2.12 Dike height is generally restricted to 6 ft (1.8 m). Where the dike exceeds this height, the minimum distance between tanks and the toe of the interior of the dike wall must be 5 ft (1.5 m).

(f) Dikes shall be permitted to be higher than an average of 6 ft (1.8 m) above interior grade where provisions are made for normal access and necessary emergency access to tanks, valves, and other equipment, and safe egress from the diked enclosure.

Dike heights might need to exceed 6 ft (1.8 m) where the area available for the dike is limited or where a particular jurisdiction requires all tanks to be individually diked.

1. Where the average height of the dike containing Class I liquids is over 12 ft (3.6 m) high, measured from interior grade, or where the distance between any tank and the top inside edge of the dike wall is less than the height of the dike wall, provisions shall be made for normal operation of valves and for access to tank roof(s) without entering below the top of the dike. These provisions shall be permitted to be met through the use of remote-operated valves, elevated walkways, or similar arrangements.

000091

2. Piping passing through dike walls shall be designed to prevent excessive stresses as a result of settlement or fire exposure.

3. The minimum distance between tanks and toe of the interior dike walls shall be 5 ft (1.5 m).

These provisions reflect a concern for Class I vapors reaching unsafe concentrations when confined in the small space between the dike wall and the tank. Remotely operated valves or elevated walkways eliminate the need for personnel to enter the bottom of the diked area to operate a valve.

It should be emphasized that the provisions of 1, 2, and 3 are required only when the height of the dike wall exceeds 6 ft, as permitted in (f).

(g) Each diked area containing two or more tanks shall be subdivided, preferably by drainage channels or at least by intermediate dikes, in order to prevent spills from endangering adjacent tanks within the diked area as follows:

This requirement is designed to control those relatively small spills that, in the past, have resulted in major fire and destruction of all tanks within a dike enclosure. (*See Figure 2.13.*)

1. Where storing normally stable liquids in vertical cone roof tanks constructed with weak roof-to-shell seam or floating roof tanks, or when storing crude petroleum in producing areas in any type of tank, one subdivision for each tank in excess of 10,000 bbl (1,590,000 L) and one subdivision for each group of tanks [no tank exceeding 10,000 bbl (1,590,000 L) capacity] having an aggregate capacity not exceeding 15,000 bbl (2,385,000 L).

2. Where storing normally stable liquids in tanks not covered in subsection (1), one subdivision for each tank in excess of 2,380 bbl (378,500 L) and one subdivision for each group of tanks [no tank exceeding 2,380 bbl (378,500 L) capacity] having an aggregate capacity not exceeding 3,570 bbl (567,750 L).

3. Where storing unstable liquids in any type of tank, one subdivision for each tank except that tanks installed in accordance with the drainage requirements of NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, shall require no additional subdivision. Since unstable liquids will react more rapidly when heated than when at ambient temperatures, subdivision by drainage channels is the preferred method.

4. Whenever two or more tanks storing Class I liquids, any one of which is over 150 ft (45 m) in diameter, are located in a common diked area, intermediate dikes shall be provided between adjacent tanks to hold at least 10 percent of the capacity of the tank so enclosed, not including the volume displaced by the tank.

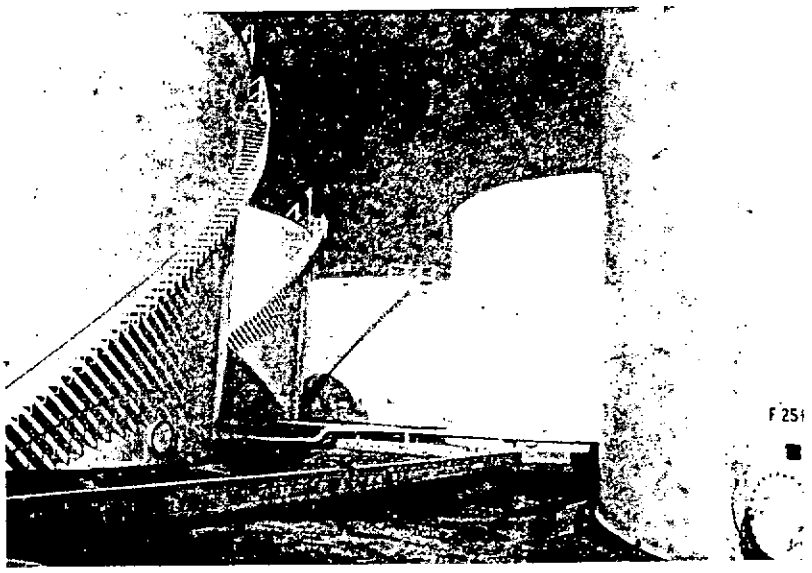


Figure 2.13 These intermediate dikes are required to hold at least 10 percent of the capacity of the tank, not including the volume displaced by the tank, if any tank within the diked area exceeds 150 ft (45 m) in diameter.

5. The drainage channels or intermediate dikes shall be located between tanks so as to take full advantage of the available space with due regard for the individual tank capacities. Intermediate dikes, where used, shall be not less than 18 in. (45 cm) in height.

"With due regard for the individual tank capacities" indicates that an intermediate curb should be further removed from the larger of two adjoining different-sized tanks.

(h) Where provision is made for draining water from diked areas, such drains shall be controlled in a manner so as to prevent flammable or combustible liquids from entering natural water courses, public sewers, or public drains, if their presence would constitute a hazard. Control of drainage shall be accessible under fire conditions from outside the dike.

This is because uncontrolled escape from a dike area would defeat the purpose of the dike itself.

(i) Storage of combustible materials, empty or full drums, or barrels, shall not be permitted within the diked area.

2

2-3.5 Normal Venting f

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Stricter requirements
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Guide for Fighting Fires In and Around Petroleum Storage Tanks

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TEXAS PETROLEUM COMPANY
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- Basic Principles of Fire Prevention, American Petroleum Institues's Seminar on Fundamental Applications of Loss Prevention

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- Process Safety Management, Harold C. Jacobs, E.I. Du Pont de Nemours & Company

FOREWORD

The purpose of this publication is to present procedures which may be practiced to control and extinguish fires in and around petroleum storage tanks and to disseminate information as an aid in understanding the problems and precautions that should be taken.

Matters pertaining to types and maintenance of fire protection equipment as well as the prevention of storage tank fires are covered in other publications.

Suggested revisions are invited and should be submitted to the coordinator, Fire and Safety, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

CONTENTS

PAGE

SECTION 1—GENERAL

1.1 Introduction 1
1.2 Scope and Objectives 1
1.3 Referenced Publications 1

SECTION 2—FIRE FIGHTING AGENTS

2.1 Water 2
2.2 Foams 3
2.3 Dry Chemicals 4
2.4 Combined Agents 5
2.5 Halogenated Hydrocarbons 5

SECTION 3—GUIDANCE FOR FIGHTING FIRES IN AND AROUND TANKS

3.1 Size-Up of Fire 6
3.2 Tactics Applicable to All Tanks 7
3.3 Protecting Adjacent Tanks 7
3.4 Tank Vent Fires—Low-Pressure Tanks 7
3.5 Fighting Ground Fires Around Tanks 8
3.6 Management Decisions 8
3.7 Tank Fire Fighting Records 9

SECTION 4—GUIDANCE FOR CONTROLLING AND EXTINGUISHING TANK FIRES

4.1 Vertical, Atmospheric Fixed-Roof Tanks 9
4.2 Vertical, Low-Pressure Fixed-Roof Tanks Without Weak Seams 11
4.3 Vertical, Atmospheric Fixed-Roof Tanks, With Weak Roof-to-Shell Attachments, Containing Crude Oil 11
4.4 Floating-Roof Tanks Containing Low-Flash-Point Stocks or Crude Oil 15
4.5 Lifter-Roof Storage Tanks 17
4.6 Horizontal, Aboveground, Low-Pressure Storage Tanks 18
4.7 Pressure Storage Tanks 18
4.8 Refrigerated Storage Tanks 21
4.9 Motor Fuel Lead Blending—Weight Tanks—Storage Tanks 24

APPENDIX A—GUIDE OUTLINE FOR COLLECTING DATA DURING AND AFTER A TANK FIRE 25

APPENDIX B—CRUDE OIL TANK BOILOVER, SLOPOVER, OR FROTHOVER 27

APPENDIX C—PREFIRE PLANNING FOR TANK FIRES 29

LIST OF ILLUSTRATIONS

Figures

1 — Typical Roof-to-Shell Attachments 9
2 — Internal Explosion of a Fixed-Roof Tank Without Roof-to-Shell Attachments 12
3 — Boilover of a Cone-Roof Tank 13

000098

4 — Annular-Pontoon Floating-Roof Tank 15
5 — Double-Deck Floating-Roof Tank 15
6 — Flexure Sealing Ring for Floating Roofs 16
7 — Floating Roof Resilient Foam Tube Seal 16
8 — Floating-Roof Seal That Uses Leaf Springs to Maintain the Seal 17
9 — Lifter-Roof Tank 18
10 — Tank Shell Overheated Above Liquid Level 19
11 — Rupture of a Horizontal Butane Vessel 20
12 — Concentrate Cooling Water on Flame-Exposed Metal 22

Tables
1 — Properties of Flammable Materials 23

000099

Guide for Fighting Fires In and Around Petroleum Storage Tanks

SECTION 1—GENERAL

1.1 Introduction

Surveys conducted by API covering the past 30 years show very few petroleum storage tank fires compared with the thousands of tanks used in all phases of petroleum operations. Specific statistics on the number of tanks in service and the number of fires per tank-years of service are not available because of the inability to secure complete, detailed information from tank users both inside and outside the petroleum industry.

In view of the tank fires on record, relatively few people have had direct experience with tank fire fighting. Hence, a guide such as this one is needed.

Prefire planning with proper training at regular intervals is essential to fight fires effectively in or around storage tanks. The type of fire protection that is developed will vary depending on the nature of the plant, its size, and its complexity. In a medium-size plant, the position of fire chief may be a part-time function of one of the plant personnel. Other plant personnel, who can leave their normal work during an emergency, may be trained to serve in assigned firecrew duty. Assistance may be furnished by still others in the plant, depending upon manpower availability. Small plants would follow this plan insofar as is practicable. The largest plants may have a full-time fire chief and one or more full-time firemen who supervise assigned fire crews or brigades. These full-time firemen normally perform fire equipment inspection, maintenance, and training along with fire fighting. Also, they may make fire prevention inspections, conduct gas tests, and issue hot work permits.

Because tanks frequently are connected to complex operating equipment, certain fire fighting decisions involve operations. Therefore, the supervision of storage tank fire fighting is, of necessity, a management-supervisory responsibility.

Experience has proved that a written fire protection plan which explains procedures to be followed and assigns responsibilities should be present at every plant. Practice drills that follow this plan should be conducted.

Plant personnel should investigate the possibility and desirability of joining a mutual-aid group with nearby plants and public fire and police services as a supplement to their fire protection. In these cases, coordination of fire fighting training should be considered a part of such programs.

1.2 Scope and Objectives

The scope and principle value of this material is to train employees to attack and fight petroleum tank fires successfully.

Fire prevention technology and types of fire protection equipment and maintenance data are outside the scope of this publication but are covered in other publications.

The objectives of this manual are to present the petroleum industry's experience (which has proved successful) concerning the following:

1. Fire fighting agents applicable to fires in and around petroleum storage tanks.
2. Precautions and guidance for carrying out the tactics and strategy of fighting fires in and around petroleum storage tanks.
3. Prefire planning for fighting tank fires.

It should be understood that the material contained in this document is basic and must remain flexible enough to relate to situations as they occur. This publication is not a complete treatise on petroleum storage tank fires, nor is it intended to exclude or limit the use of other tactics, methods, or agents of comparable or proven merit.

1.3 Referenced Publications

ANSI[1]

B138.1	*Design and Construction of LP-Gas Installations at Marine and Pipeline Terminals, Natural Gas Processing Plants, Refineries, and Tank Farms* (API Standard 2510)

API

Std 620	*Recommended Rules for Design and Construction of Large, Welded, Low-Pressure Storage Tanks*
Std 650	*Welded Steel Tanks for Oil Storage*
Std 2510	*Design and Construction of LP-Gas Installations at Marine and Pipeline*

[1] American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

	Terminals, Natural Gas Processing Plants, Refineries, and Tank Farms (ANSI B138.1)
Publ 2023	*Guide for Safe Storage and Handling of Heated Petroleum-Derived Asphalt Products and Crude Oil Residua*

NFPA[2]

No. 11	*Foam Extinguishing Systems*
No. 11A	*High Expansion Foam Systems*
No. 11B	*Synthetic Foam and Combined Agent Systems*
No. 30	*Flammable and Combustible Liquids Code*
No. 58	*Liquefied Petroleum Gases, Storage and Handling*
No. 59	*Liquefied Petroleum Gases at Utility Gas Plants*
No. 59A	*Liquefied Natural Gas at Utility Gas Plants*
No. 78	*Lightning Protection*
Film or Slides:	*Fighting Tank Fires with Water*
	Handling LP-Gas Emergencies

Other Organizations

Fire Control—Flammable Liquids and Gases[3]
Thermal Characteristics of Motor Fuel Antiknock Compounds Containing Tetraethyl Lead, Methylethyl Lead, Tetramethyl Lead[4]
Fire Fighting—Unit 1 Fuels and Combustion[5]
Fire Fighting—Unit 2 Water[5]
Fire Fighting—Unit 3 Extinguishers and Foam[5]
Fire Fighting—Unit 4 Tactics and Strategy[5]

[2] National Fire Protection Association, 470 Atlantic Avenue, Boston, Mass. 02210.

[3] California State Department of Education, Fiscal Office, Order Section, 721 Capitol Mall, Sacramento, Calif. 95814.

[4] Published jointly by Ethyl Corporation and E.I. duPont de Nemours and Company.

[5] Resources Development Corporation, 2040 North Loop West, Suite 204, Houston, Tex. 77018.

SECTION 2—FIRE FIGHTING AGENTS

Fire fighting agents which are useful in fighting both ground fires that could involve storage tanks and fires in storage tanks containing petroleum stocks are described in this section.

2.1 Water

Water is used universally as a fire fighting agent. It serves as a cooling, quenching, smothering, emulsifying, diluting, and displacing agent. Water has the greatest heat-absorbing quality of any common material and usually is the most plentiful. It is used for cooling equipment, structures, and tank shells that are exposed to a fire, thus preventing or reducing both heat damage to equipment and overpressure that results from overheating vessel contents. When used as a coarse spray stream, water can sweep pools of burning fluid out from under elevated tanks. Extinguishment will result if the fuel surface can be cooled to below the temperature at which it will give off vapor sufficient to support combustion. An older, inefficient, and unsafe method of attempting to extinguish a fire with water was to direct a straight stream from a safe distance on the fire. A more efficient and safer way of applying water for extinguishment is in the form of a spray. When properly applied in spray form, it is suitable for extinguishing fires in liquid hydrocarbon fuels having a flash point above 38 C (100 F).

Water spray applied lightly to burning heavy viscous liquids with flash points above 93 C (200 F) can produce a layer of froth on the liquid surface which acts like foam and smothers the fire. Fighting a hot asphalt tank fire is an example.

Flammable liquids that are soluble in water may, in some instances, be extinguished by dilution. The percentage of dilution necessary to effect extinguishment varies with the products. For example, a solution of 75 percent water and 25 percent ethyl alcohol will barely support combustion.

Frequently, water is used as a displacement medium in leaking hydrocarbon lines, or it may be used to float the liquid hydrocarbons above a leak in a tank to interrupt product leakage. Water pressure must be greater than product pressure. Water, however, cannot be used to displace refrigerated liquefied petroleum gas or liquefied natural gas from a leaking pipeline because the product temperature is colder than 0 C (32 F).

Water spray is particularly useful for dispersing escaping gases and vapors. It also may be used to protect operating personnel and fire fighters from radiant heat or flame contact.

Water is the principal ingredient in producing fire fighting foam—the agent most commonly used in extinguishing large, flammable liquid fires.

Water can be used effectively to control, but not extinguish, fires in low flash-point fuels.

2.2 Foams

Foams for fire protection purposes are an aggregate of gas-filled bubbles that will float on the surface of a flammable liquid. These foams commonly are made from an aerated water solution and a small percentage of foam liquid concentrate. They are used principally to form a cohesive floating blanket on the liquid surface that extinguishes the fire by smothering and cooling the fuel and prevents reignition by averting formation of combustible mixtures of vapor and air. Foams are suited particularly for extinguishing two-dimensional (flat) flammable liquid fires that involve spills or storage tanks where the foam forms a vapor-sealing blanket that secures the area after extinguishment.

In fires involving jetting or falling fuel (such as a ruptured tank or line), foam is effective only on the fire that arises from fuel spills or on pools that form flat surfaces. Such fires can be extinguished by dry chemical, by shutting off the source of fuel that is feeding the fire, or possibly by water spray.

To achieve extinguishment of tank fires or liquid fires in depth, continuous foam application at the required rate is critical. Unless the required rate of foam is applied and maintained on the liquid surface until a sealing, cohesive foam blanket is established, the fire will not be extinguished.

When foam is applied by hand lines or monitors over the rim of a tank, wind and thermal updrafts frequently carry much of it away. As specified in NFPA No. 11 or 11B, foam must be applied at a higher rate to replace this loss.

Prevention of fire may be achieved by applying a foam blanket to fuel spills. Also, most foams will provide some insulation against exposure to adjacent fires because they can adhere to surfaces.

Foam is not suitable for extinguishment of fires from flammable gases nor from liquids containing large amounts of liquefied petroleum gas.

2.2.1 PROTEIN AIR FOAM

Air or mechanical foam is made by mechanical action or agitation which is done by the turbulent mixing of atmospheric air into the foam solution (water and foam liquid concentrate). This turbulence may be produced by air induced into the solution by venturi action—such as a foam maker—or by rapid, repeated, mechanical agitation.

Three types of protein air foams are discussed in this section: protein foam, fluoroprotein foam, and special-purpose foams. The first two types are available using 3 percent or 6 percent foam-liquid concentrates. Because the storage capacity required is lower, a 3 percent concentrate normally is preferred over that of 6 percent. However, the manufacturer of the foam-making equipment should be consulted as to the correct percent concentrate to be used in any particular system. The third type is available as a 6 percent foam-liquid concentrate or as a two-component system for fighting fires in water soluble or foam-destroying liquids. Proportioners should be designed properly and set for the percent of foam-liquid concentrate to be used to form the desired solution.

2.2.1.1 Protein Foam-Liquid Concentrates

These concentrates were introduced in about 1935 and have been used widely for petroleum spill fires and tank fires. They consist primarily of products from organic proteins plus stablizing additives and inhibitors to protect against freezing, to prevent corrosion of equipment and containers, to resist bacterial decomposition, to control viscosity, and to assure readiness for use under emergency conditions. Foam-liquid concentrates of different types or different manufacturers should not be mixed unless it is established that they are completely interchangeable. For requirements and limitations, see NFPA No. 11.

2.2.1.2 Fluoroprotein Foam-Liquid Concentrates

These concentrates are very similar to protein foam-liquid concentrates but have a synthetic, fluorinated surfactant additive. They form an air-excluding foam blanket and also may deposit a film to prevent evaporation on the surface of a liquid fuel. They were introduced around 1965 to improve the capabilities of fire extinguishment by foam. These foams are usually compatible with current dry-chemical extinguishing agents when used simultaneously on a fire, but this should be verified by the manufacturers or by tests. When compared with protein foam, fluoroprotein foam has a much better resistance to fuel entrainment when submerged in the liquid fuel and therefore can withstand rougher application. This characteristic makes fluoroprotein foam suitable for subsurface injection into tanks or from monitors or hoses over the rim into a tank. For requirements and limitations, see NFPA No. 11.

2.2.1.3 Special-Purpose Foam-Liquid Concentrates

For fighting fires in liquids that are water soluble or that chemically destroy foams made from the earlier-referenced materials, special foaming concentrates have been developed that are foamed mechanically and that form an insoluble barrier at the fuel and foam blanket interface. Commonly called alcohol-type or

polar-solvent-type foams, they vary considerably in chemical composition, acceptable methods of proportioning, useful concentration limits, and other operational parameters. Systems that use these agents require special design consideration. The foam concentrates should not be intermixed among themselves or with other types of concentrates unless they have been established previously as being completely compatible. For requirements and limitations, see NFPA No. 11.

2.2.2 AQUEOUS FILM-FORMING FOAM

This is a relatively new foam which acts both as a barrier to exclude air and to develop an aqueous film on the fuel surface capable of surpressing the evolution of fuel vapors. The foam blanket produced should be of such thickness as to be visible before fire fighters rely on the aqueous film being a vapor suppressant. The film may be present but, because of invisibility, it cannot be relied upon. Aqueous film-forming foam concentrates normally are used in conventional foam-making devices suitable for producing protein foams, but protein foam-producing equipment should not be converted for use with aqueous film-forming foam concentrates without consulting with the manufacturer of the equipment or without a thorough flushing of the complete system, including the foam tank.

The foam produced with aqueous film-forming foam concentrate is dry-chemical compatible and is suitable for combined use with dry chemicals. Protein and fluoroprotein foam concentrates and aqueous film-forming foam concentrates are incompatible and should not be mixed, although foams separately generated with these concentrates are compatible and can be applied to a fire in sequence or simultaneously. Aqueous film-forming foam agent is available as a 3 percent or 6 percent liquid concentrate.

Aqueous film-forming foam concentrates have been developed that are effective in combating fires involving water-miscible and polar liquids as well as ordinary hydrocarbons. These agents have components that chemically react with polar solvents to form a plastic-like film. They can be used in conventional foam-making devices. It should be noted that higher concentrations and higher application rates are required compared with those for ordinary hydrocarbons.

Aqueous film-forming foam is used on spill fires for rapid knockdown, securement, or extinguishment. It may be applied to tanks top-side by fixed, semifixed, or portable methods, provided that adequate cooling water is applied to the tank shell. Along with sufficient cooling of the tank shell and within defined expansion limitations, aqueous film-forming foam is suitable for subsurface injection into tanks containing ordinary hydrocarbons; it is not suitable for subsurface injection into tanks containing water-miscible liquids or polar solvents. For requirements and limitations, see NFPA No. 11B.

2.2.3 HIGH-EXPANSION FOAM

High-expansion foam is made from a synthetic foam concentrate diluted with water at 3 percent or less, as recommended by the manufacturer. The foam is generated in special equipment by passage of air or other gas through a screen or net that is wetted by the foam solution. The foam also may be made in an air-aspirating device. Foam expansion ratios of 100:1 to 1000:1 can be obtained. The foam (of light-weight air bubbles) is suited particularly for confined "Class A or Class B" fires in buildings, warehouses, pits, and so forth, displacing the vapor, heat, and smoke. Because of the low-pressure head developed by the generating equipment, the foam can be applied by pouring rather than by a directional stream from a nozzle. This foam may have restricted application to small spill fires outdoors, as its use is limited because of wind effect. For requirements and limitations, see NFPA No. 11A.

2.2.4 CHEMICAL FOAMS

Chemical foams date back to World War I and were used widely up until the advent of air foams. These foams are at a disadvantage when compared with other foams for handling ease, installation, and equipment maintenance. For these reasons, the demand for chemical foams has decreased during the years, and replacement material may not be readily available.

2.3 Dry Chemicals

Dry chemicals are recognized for their unusual efficiency in extinguishing fires involving flammable liquids. Fast extinguishing action is achieved provided the agent reaches all fire areas without interrupting the application. The finely divided powder acts with a chain-breaking reaction by inhibiting the oxidation process within the flame itself.

Dry chemicals are used frequently to extinguish floating-roof-tank seal fires either alone or in combination with foam when a large area of the seal is burning. These agents are effective on small spill fires and on fires involving jetting or falling fuel. If there is risk of reignition from embers or hot surfaces, these ignition sources should be quenched or cooled with water and secured with foam, or the source of fuel should be shut off before attempting extinguishment.

There are several types of dry chemicals available that are treated with components to produce free-flow and water repellency.

2.3.1 SODIUM BICARBONATE (REGULAR)

Sodium bicarbonate, an ordinary or regular dry chemical, is the least expensive. This agent is not compatible with protein foams because the metallic stearate additives are antifoaming agents that cause breakdown of protein foams. This dry chemical should not be used simultaneously with, prior to, or after using protein foams.

2.3.2 SODIUM BICARBONATE (FOAM-COMPATIBLE)

Sodium bicarbonate, a foam-compatible dry chemical, is treated with silicon polymer to make it foam compatible and suitable to use simultaneously with foam. Any of the foam-compatible dry chemicals should be used where follow-up with foam is expected.

2.3.3 POTASSIUM BICARBONATE

Potassium bicarbonate, usually a foam-compatible dry chemical, has greater extinguishing capability on Class B fires than does sodium bicarbonate (see 2.3.1 and 2.3.2). This characteristic permits operating personnel to fight fires more effectively. It may be compatible with protein foams, depending upon the manufacturer's process and its listing.

2.3.4 POTASSIUM CHLORIDE

Potassium chloride, a foam-compatible dry chemical, has about the same fire extinguishing capability as does potassium bicarbonate (see 2.3.3). It is compatible with all types of foam but usually corrosive to metals such as steel and aluminum.

2.3.5 MONOAMMONIUM PHOSPHATE

Monoammonium phosphate or a mixture of monoammonium and diammonium phosphate, a multipurpose dry chemical, is the only dry chemical that is effective on Class A combustible, non-deep-seated fires as well as Class B flammable liquid and gas fires. It is more effective on Class B fires than is a sodium bicarbonate-based dry chemical but less effective than is a potassium bicarbonate-based dry chemical. It may be compatible with protein foams, depending on the manufacturer's process and its listing.

2.3.6 POTASSIUM CARBAMATE

Potassium carbamate, a foam-compatible dry chemical, is formulated from a reaction produced from potassium bicarbonate and urea. This dry chemical is completely foam compatible and is similar to potassium bicarbonate in its effectiveness on flammable liquid or gas fires.

2.3.7 POTASSIUM SULFATE

Potassium sulfate, a foam-compatible dry chemical, is available in Europe and is not generally used in the United States. It is more effective on flammable liquid and gas fires than is sodium bicarbonate, but it is not considered as effective as is potassium bicarbonate. This dry chemical has superior moisture-resistant qualities.

2.4 Combined Agents

2.4.1 AQUEOUS FILM-FORMING FOAM COMBINED WITH DRY CHEMICAL

Hose reels that are equipped with twinned-hoses and twinned-nozzles and turrets that are equipped with twinned-nozzles, for simultaneous or alternate application of aqueous film-forming foam and dry chemical by one fire fighter, have been developed to provide greater fire fighting capability. Usually aqueous film-forming foam and potassium bicarbonate are the two agents used although multipurpose dry chemical and water with a wetting agent are available. The aqueous film-forming foam concentrate usually is premixed in solution with water and stored in a container that can be pressurized with nitrogen for instantaneous use, similar to a dry chemical extinguisher. Combined-agent storage containers vary in size from 189 to 757 cubic decimeters (50 to 200 gallons) of premixed aqueous film-forming foam solution and from 227 to 1361 kilograms (500 to 3000 pounds) of dry chemical. This design permits fire fighting effectiveness against three-dimensional pressure or leak fires as well as spill fires. The aqueous film-forming foam secures against reflash, as the fire fighter uses dry chemical for fast knockdown and extinguishment. Refer to NFPA 11B, Chapter 4 for system design criteria.

2.5 Halogenated Hydrocarbons

Halogenated hydrocarbons are fully halogenated methane derivatives, colorless, odorless, electrically nonconductive, and commonly referred to as halons. They attack flame by chemical inhibition similar to dry chemicals. Rapid extinguishment of Class B fires is ob-

tained because they interact in a chain-breaking manner to inhibit the oxidation process within the flame. Rapid extinguishment of Class A combustible, non-deep-seated fires also will be obtained. This family of extinguishing agents is particularly effective in dealing with flammable liquid or gas fires and also is effective for extinguishment of Class C fires where a clean agent is desired. There are three halons presently available: Halon 1301 (bromotrifluoromethane); Halon 1211 (bromochlorodifluoromethane); and Halon 2402 (dibromotetrafluoroethane), which has limited application.

2.5.1 BROMOTRIFLUOROMETHANE (HALON 1301)

This agent boils at −58 C (−72 F) and will vaporize close to the discharge nozzle. Its primary application is in total flooding systems where it is super-pressurized with nitrogen to either 2482 kilopascals (360 pounds per square inch gage) or 4137 kilopascals (600 pounds per square inch gage). Storage temperatures for the agent may range from 55 C (130 F) to −29 C (−20 F). Total flooding systems can be designed either to extinguish a fire or inert the atmosphere in the protected, enclosed area. A second use is in specialized, local application systems. The low concentrations required for extinguishment permit use in occupied areas. It is the only halogenated agent currently recognized by the National Fire Protection Association as suitable for use in occupied spaces.

2.5.2 BROMOCHLORODIFLUOROMETHANE (HALON 1211)

This agent boils at −3.3 C (26 F) and will afford reasonably rapid coverage. It has the advantage of being the least expensive of the halogenated agents that can be applied to storage tank fires. Some companies are installing automatic systems that use Halon 1211 for extinguishment of floating-roof-tank rim fires. Halon 1211 generally is used in hand portable fire extinguishers where a clean agent is desired. It is unsuitable for use in total flooding of occupied spaces because of its toxicity.

2.5.3 DIBROMOTETRAFLUOROETHANE (HALON 2402)

This agent boils at 47.2 C (117 F). At normal ambient temperatures, it will discharge and distribute as a liquid. Because of its higher boiling point, it can be recharged without the use of special transfer equipment. Other than in specialized explosion suppression systems, the general use of Halon 2402 has not been established in the United States. It is unsuitable for use in total flooding of occupied areas because of its toxicity.

SECTION 3—GUIDANCE FOR FIGHTING FIRES IN AND AROUND TANKS

Fire protection is a combination of fire prevention, re control, and fire extinguishment. Fire prevention is ught to acquaint people with the causes of fires so ey can be prevented more readily; fire control is ught to minimize the spread of fire and to decrease e damage from fire (some fires are fought best by rmitting the fuel to burn under control until the urce of fuel can be shut off); fire extinguishment is ught so that fires can be fought quickly, skillfully, and fectively.[6]

1 Size-Up of Fire

As in any fire fighting situation (after turning in the arm), the first tactical action to be taken is the "size-." This should be done quickly—by the responsible supervisor—to determine the best tactics and strategy needed to fight the fire and should include the following:

1. Need for rescue of injured (if any).
2. Status of tank and dike valves.
3. Type of tank(s) involved.
4. Characteristics of the tank's contents.
5. Possibility of pumping out atmospheric storage tank contents if extinguishment is difficult or cannot be accomplished.
6. Location of fire—in the tank(s), on the ground, or both.
7. Condition of the tank(s) shell and roof if it can be determined promptly.
8. The immediate need of cooling water for flame-exposed metal.
9. The immediate need for coordinating operating personnel and others who will fight the fire and provide aid.

[6] "Fire Control-Flammable Liquids and Gases," California Fire aining Program, California State Department of Education, Fiscal fice, Order Section, 721 Capitol Mall, Sacramento, Calif. 95814.

3.2 Tactics Applicable to All Tanks

Tank areas and equipment particularly vulnerable to rapid damage from flame contact are as follows:

1. Uninsulated supports.
2. The exposed shell area above the liquid level in the tank.
3. Vents, pressure vacuum valves, pressure controllers, gaging equipment, mixers, and other appurtenances.
4. Foam chambers, foam lines, and other piping that do not have liquid flowing through them.

Cooling-water streams should be applied to the tops of tanks (excluding floating-roof tanks) so that the run-off down the sides of the tank will reduce the heat input of the tank. Water must be kept on tank appurtenances, uninsulated supports, and any portion of the tank shell above the liquid level where there is flame contact.

For pressure tanks, vent discharges should be designed to avoid flame impingement on the tank shell. If the flames from vents are discharging onto the top or shell of the tank, water must be directed on that area to keep it cool. If this cannot be accomplished, all personnel should withdraw from the area.

In fighting any fire exposing pressure tanks, it must be remembered that the time of greatest danger from an internal explosion or rupture from overpressure may be at the time firemen approach the tank to initiate fire fighting or up until the time when sufficient cooling water is applied to the tank to cool the steel. Initial fire fighting should be conducted at maximum hose stream reach and preferably under the protection of wide-angle spray nozzles. These precautions are particularly important when flame is in contact with any horizontal tank or pressure tank (see 4.7.2).

The fire fighting and application of cooling water should be done from the windward side, if possible. Horizontal tanks should be approached from the shell sides only because of their tendency to rupture at the ends or heads. After cooling-water streams are established on the flame-exposed tank shells, efforts can be made to extinguish or control the fire.

When there are simultaneous atmospheric tank fires, foam should be applied only to the number of tanks that can be attacked with the recommended foam rates for at least the recommended period of time for extinguishment, as specified in NFPA No. 11 or 11B. This will decrease the possibility of failing to extinguish any of the tank fires because of an insufficient application rate or exhaustion of foam supplies. These factors should be determined during prefire planning.

3.3 Protecting Adjacent Tanks

Depending upon tank spacing and wind, cooling of adjacent tanks usually is needless unless there is direct flame contact or sufficient radiant heat to scorch the paint.

If there is a question about the temperature and heat absorption of tank shells not directly exposed to flame, check frequently with water spray from long-range water streams and see if steam is produced. If the metal steams, cooling water should be applied until steaming stops. When tanks require cooling, water streams should be fanned on the sides and roofs for best results; this does not apply to the roofs of floating-roof tanks.

Although radiant heat does not seriously damage tank shells, two factors must be kept in mind which may dictate the need for cooling adjacent tanks. These ar s follows:

1. Heat on shells of tanks containing stocks, with an oil temperature above atmospheric temperature, may bring the vapor space of the tank within the flammable range.
2. Heat on shells of tanks containing low flash-point stocks may cause the tank pressure to rise and expel flammable vapors which may ignite or cause failure of a tank. API Type 650 tanks are fitted with a weak roof-to-shell seam that serves as an emergency vent. Likewise, floating-roof tanks may leak vapors in the seal area.

A common error in tank fire fighting is using too much cooling water on exposures. This not only robs volume and pressure from the water supply but can overtax sewers and drainage ditches and make fire fighting difficult. Also, empty or near empty tanks may float from their foundations. These factors should be considered in prefire planning so that water is not indiscriminately used.

3.4 Tank Vent Fires—Low-Pressure Tanks

3.4.1 A fire at a tank vent that is burning with a yellow-orange flame and emitting black smoke indicates that the vapor/air mixture in the tank is above its flammable or explosive limits. This type of fire may be extinguished readily with dry chemical.

3.4.2 A fire at a tank vent that is burning with a snapping blue-red, nearly smokeless flame indicates that the vapor/air mixture in the tank is flammable or explosive. As long as the tank is outbreathing through the pressure vacuum valve, the flame cannot pass from the low-pressure side through the pressure vacuum valve i the high-pressure side of the tank. However, extin-

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guishment with dry chemical should be accomplished quickly to avoid flashback into the tank if heat damages the pressure vacuum valve. This type of fire may be handled in one of two ways:

1. A pressure reduction in the tank will snuff out the fire when the pressure vacuum valve closes. When the tank is exposed to fire, this may be accomplished by applying cooling water to the tank roof and shell. If pumping into the tank causes overpressure, a pressure reduction can be obtained by pumping or switching product out of the tank.
2. Maintain a positive pressure in the tank by introducing fuel gas. When a vapor-rich condition is indicated by change of flame character (see 3.4.1), extinguishment may be accomplished with dry chemical.

3.5 Fighting Ground Fires Around Tanks

As soon as possible, apply cooling water to all flame-exposed metal. Then attempt to extinguish the ground fire by isolating the source of fuel by—

1. Closing pertinent valves with water spray streams when needed for personnel protection.
2. Displacing sufficient hydrocarbon with water to produce a water leak rather than a hydrocarbon leak. If this method is used, the water pressure must be greater than the hydrocarbon pressure in the line or tank. Care must be exercised to avoid overfilling the tank.

When a tank containing a high-flash-point oil is exposed to ground fires, beware of the possibility of a flammable mixture being created in the tank that can be ignited from the hot metal tank shell.

While it is often possible to extinguish some fires involving a leak of fuel gas or liquefied petroleum gas, it should not be done except by shutting off the fuel. A leak, with little chance of being dissipated rapidly by the wind, may become dangerous if extinguished without fuel shutoff. For detailed information on controlling these fires, refer to 4.7 and 4.8.

Ground fires involving petroleum liquids may be extinguished with dry chemical, water spray, or foam. In some cases it may be possible to flush the fuel to a safe location where extinguishment or control may be easier and to reduce flame contact with metal. In northern climates, snowblowers have been used successfully to blow snow over ground fires, piping, and tanks for fire control.

Products with flash points well above 38 C (100 F) or, specifically, above the temperature of the water used, may be extinguished with water spray. Radiant heat from the flame heats the surface of such products, causing vaporization. Evaporation of the water spray droplets first extracts heat from the flame, reducing the flame size. Further application of water spray cools the hot oil surface below its flash point. When vaporization of the product ceases, the fire goes out.

For liquid petroleum products with flash points below 38 C (100 F), water spray reduces flame size for fire control. However, water spray may extinguish a gasoline fire in narrow, deep-walled tanks when steam formed from a water spray remains over the burning gasoline and smothers the fire. Furthermore, small spill gasoline fires sometimes can be extinguished by sweeping the flame off the surface of the burning gasoline with a narrow water spray pattern from spray nozzles.

Foam should be used for extinguishing ground fires around a tank or in fuel-collecting basins. It is necessary to calculate the square-foot area of the fuel liquid surface and apply foam solution at the rate recommended in NFPA No. 11 or 11B, depending upon type of foam used. Such calculations should be made during preplanning, as several foam monitors or hose streams and large foam stocks may be necessary to maintain adequate foam application rates for extinguishment.

As a rule, ground fires around tanks must be controlled or extinguished before attempting to extinguish the fire in tanks.

3.6 Management Decisions

In some cases it is better to let an oil or gas fire burn under control than to try to extinguish it. This is particularly true for all types of gas fires until the source of the fuel can be shut off. Management personnel may wish to establish long-range decisions on the strategy for handling fires in some locations. This preplanning will be helpful to the local supervisor who will be in charge at the start of a fire. Some factors to be considered are described in 3.6.1 through 3.6.3.

3.6.1 It may be impractical to fight a tank fire in an isolated area with insufficient water or manpower. Accepting a burnout while protecting adjacent exposures could be the best solution. However, if a burnout is accepted, provisions for transfer of tank contents should be reviewed. This will reduce the burn time and the product loss.

3.6.2 In some cases the cost of extinguishment could exceed the salvage value of the tank and its contents, even though the fire could be extinguished. Some companies may not attempt extinguishment if a cone-roof tank is less than one-third full and if the probability of extinguishment is poor, unless air pollution is a problem.

3.6.3 Sometimes conditions favor letting a fire burn under control, providing that there is little chance the fire will spread and that adjoining facilities and property are protected. This reduces the risk of injury to fire fighters and conserves extinguishing agents, equipment, and manpower for continued control of the fire. Such information can be useful to assure neighbors, news media personnel, the public fire service, and others that layout and fire control has been established with confidence.

3.7 Tank Fire Fighting Records

In the turmoil of excitement at a major tank fire, recording facts at the scene sometimes is neglected. This is unfortunate for the following two reasons:

1. Dependable data are needed for a critique after the fire. Such a review is necessary to appraise the efficiency of the emergency organization and the tank fire fighting strategy and tactics.
2. When foam is used, data are needed at the start of the fire for calculating the required foam application rates and total foam liquid concentrates needed.

Special data are needed if a cone-roof crude oil tank is involved. See Appendix A for a suggested guide sheet. Copies of this guide sheet (or a similar one) should be used when conducting prefire planning and simulated tank fire drills. Guide sheets should be readily available for emergency use.

SECTION 4—GUIDANCE FOR CONTROLLING AND EXTINGUISHING TANK FIRES

The following fire fighting guides, 4.1 through 4.9, relate to the various types of storage tanks most frequently used in the petroleum industry. Adoption of these guides should include applicable data given in Section 3, or those general guides should be kept in mind in each tank fire fighting situation.

These guides are not intended to exclude good fire fighting judgment or other methods of proven merit. Many variables are present in every emergency, and sound, on-the-spot judgment must be exercised in choosing the course of action.

4.1 Vertical, Atmospheric Fixed-Roof Tanks

This section applies to cone-roof tanks with weak roof-to-shell attachments, as provided in API Standard 650 (Figure 1). Such tanks containing crude oil are covered separately in 4.3.

When equipped with fixed foam chambers, displacement of the roof because of an explosion can damage overhead fixed foam chambers and piping to the point that they would be ineffective or inoperable. Also, foam chambers and piping can be damaged if the tank shell folds from overheating before fire fighting is effective. For these reasons, portable backup equipment is desirable. This can consist of high-back-pressure foam makers for subsurface injection or portable foam towers. However, the higher the flash point of the fuel, the more difficult it is to ignite and the easier it is to extinguish the fire. This is one reason that tanks containing liquids with flash points at or above 38 C (100 F) are not, as a rule, required to be protected by fixed foam systems.

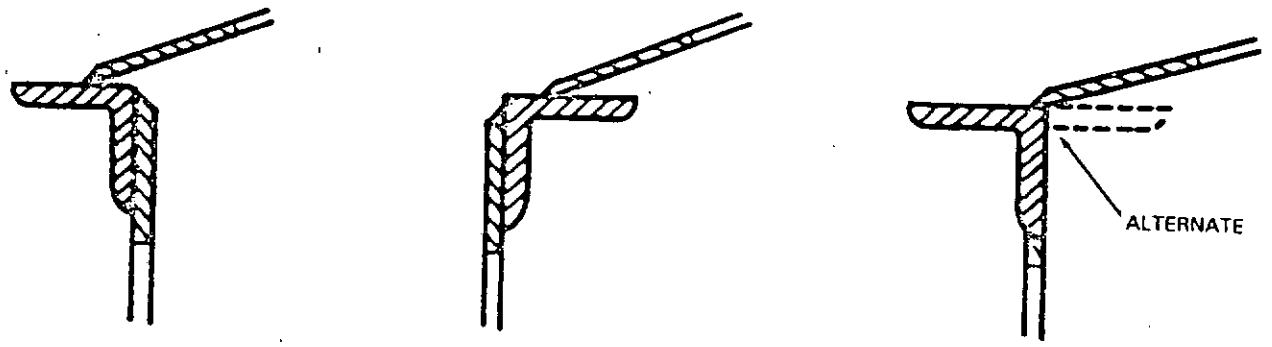

Figure 1 — Typical Roof-to-Shell Attachments

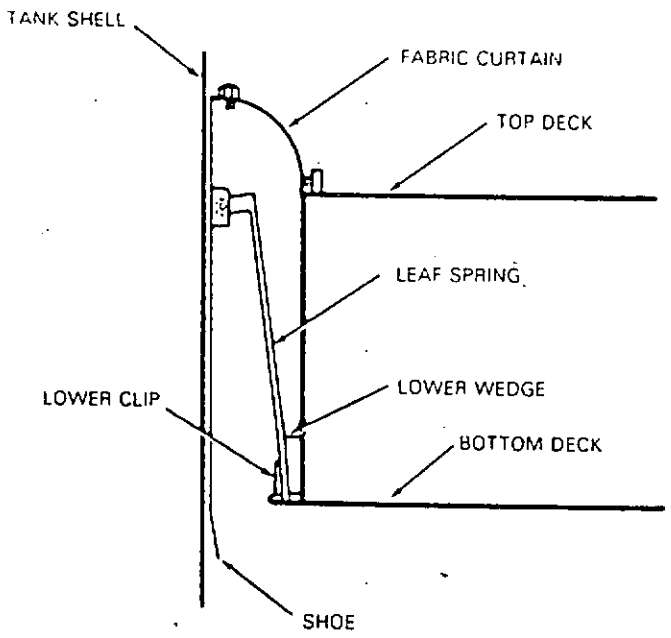

Figure 8 — Floating-Roof Seal That Uses Leaf Springs to Maintain the Seal

These tanks are generally free from an ignitable mixture except during periods of initial fill and thereafter up to 18–25 hours, depending on the volatility of the product stored. During periods of initial fill, the vapor space below the internal roof will vent into the area between the two roofs until the internal roof becomes buoyant. Then it takes time for the space between the two roofs to vent itself free of flammable vapors through the screened vents that are provided. Depending on whether or not contamination of product is a problem, one method of avoiding this situation is to use water to fill the tank until the roof becomes buoyant. Then pump in the product that is to be stored, and after the tank is filled to a level and the water is allowed to settle, it can be drained out. Another method is to inert the vapor space below the floating roof (prior to initial fill) with carbon dioxide, nitrogen, or a similar inerting agent. If neither method is feasible, it may be desirable to avoid initial filling during threatening thunderstorm activity.

It is virtually impossible to fight a covered floating-roof tank rim fire with portable fire extinguishing equipment. The vents are too small to facilitate discharge of foam hose streams from ground into the annular space between the inner floating roof and the shell. However, the possibility of a rim fire is extremely remote because of the Faraday-cage–type construction, which shields the rim from external electrostatic influence. If fixed foam protection is provided, foam should be applied as soon as the rim fire is observed.

In the remote possibility that a fire should occur and the floating deck sinks, start pumping product out of the tank down to the level of the sunken roof. Check the tank water draw and remove any water that has collected. See guides applicable for extinguishment and control listed in 4.1. If the tank leaks at its base, see Section 3, particularly 3.5.

When plastic blankets or aluminum sheet-metal-covered plastic floats are installed in cone-roof tanks, the tanks should not be considered covered floaters but should be considered the same as cone-roof tanks insofar as fire fighting is concerned. The guides under 4.1 then will apply.

4.5 Lifter-Roof Storage Tanks

Lifter-roof storage tanks are those designed and constructed to permit variable vapor space above the liquid surface (see Figure 9 and API Standards 620 and 650). These tanks are intended for storing volatile liquids in which the hydrocarbon vapors can be conserved through roof movement.

When these tanks are in service, flammable mixtures in the vapor space do not exist unless considerable product is being pumped out rapidly, which may cause tanks to inbreathe through vents, creating a flammable mixture. Fires involving these tanks generally are external through leaks, spills, or spread of fire from adjacent facilities.

The following are suggested precautions and procedures in the event of fire in or around these tanks.

4.5.1 SEAL CHAMBER, MANIFOLDS, OR ROOF APPURTENANCES FIRES

Apply cooling water immediately to all flame-exposed metal.

Flames should be extinguished by closing valves to shut off the fuel. Once the leak has been stopped, the fire will be self-extinguished by fuel starvation, or dry chemical may be applied to hasten extinguishment provided that vapor volume would not create a fire hazard. Foam also may be applied to pools of spilled liquid fuel.

If leaks can be stopped by closing valves, use water spray to protect personnel who are approaching valves in the fire area.

If leaks are in piping or at the bottom of the tank, consider using water as a displacing agent.

If the tank is equipped with a seal chamber, regulate the water flow to the chamber to maintain a vapor seal.

Check adjacent tanks and equipment to see if cooling water is needed and apply where necessary (see 3.3).

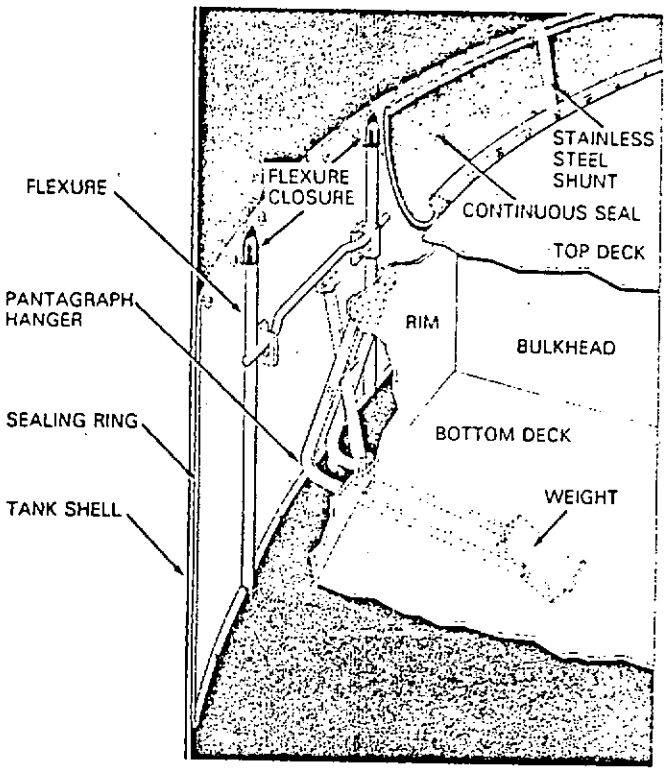

Figure 6 — Flexure Sealing Ring for Floating Roofs

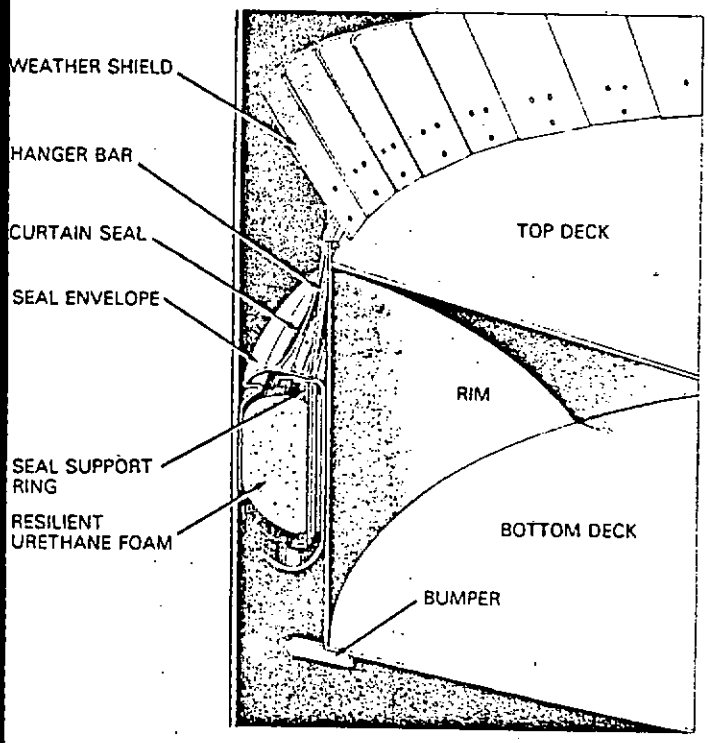

Figure 7 — Floating Roof Resilient Foam Tube Seal

Foam hose streams may be directed into the seal area from the wind girder or the roof. Application may be accomplished by two men from the wind girder working in opposite directions around the tanks. This method is preferred when a large portion of the seal area is burning. The foam not only extinguishes the fire but also acts as a seal to provide securement. If the seal area is burning beneath the stairway top platform, thus preventing access, foam can be applied to the area by portable foam towers, foam monitors, or hose streams from grade. If large tanks are equipped with fixed foam systems, apply foam immediately by this method. For detailed designs of fixed foam systems, see NFPA No. 11, Appendix.

If a seal fire has been burning for a period of time, it may be necessary to apply cooling water to the outside of the tank shell before applying dry chemical. The need for cooling water usually is indicated by blistering or discoloring of the paint on the shell. Water spray should be applied to all flame-exposed metal of the seal space. Avoid directing large, straight streams of foam or water into the flammable product at the damaged roof seal. This can splash product onto the roof, thus increasing the seriousness of the fire and making fire fighting difficult. Also beware of the roof's sinking if too much water or foam is applied. Cooling the shell is helpful to facilitate sealing of foam against the shell or to prevent reignition after dry chemical is used.

When foam is applied from grade with monitors and hoses, it is usually difficult to get sufficient foam into the annular space to cover the seal unless the tank is equipped with a foam dam on the floating roof. Even in this case, foam will fall on the roof outside of the foam dam, which can cause the roof to sink if large amounts of foam are applied. If foam covers the floating roof, water drain valves should be opened. Other methods used for applying foam are fire trucks that are equipped with articulated booms and nozzles and cranes which can be used to hoist foam nozzles fed by hoses.

If the floating roof sinks, there will be complete involvement of the liquid surface. In this case, start pumping product out of the tank down to the level of the sunken roof where extinguishment may be easier. See guides applicable for extinguishment and control listed under 4.1. If the tank leaks near its base, see Section 3, particularly 3.5.

4.4.2 COVERED FLOATING-ROOF TANKS

Covered floating-roof tanks are defined as those with a floating deck and ventilation as described in API Standard 650, Appendix H. Additional information is contained in NFPA No. 11.

Keep cooling water drained from the area.
Stop all transfer of products to the tank.

Consider operating pumps or compressors to lower the roof to its bottom position. Then regulate pumpout to maintain the lowest positive internal pressure, but avoid pulling air into the tank. If feasible and necessary, relieve internal pressure to the plant flare, or if possible, install temporary piping extending from the vent to a safe location where the vapors can be burned.

As the vapor pressure of the tank's contents is reduced, inert gas may be introduced to maintain a positive pressure. This is useful in preventing flame propagation into the tank, will aid in diluting vapors below the lower flammable limits, and may provide extinguishment at the seal or leak.

In the event of fire in the tank, see 4.1 and 4.2.

4.6 Horizontal, Aboveground, Low-Pressure Storage Tanks

These tanks generally are used for storing gasoline, naphtha, or fuel oil at small bulk plants or laboratories.

The fire fighting problems with horizontal tank fires may include uninsulated steel supports or inadequate venting. Through proper prefire planning, these deficiencies should be recognized quickly.

CAUTION—Attack horizontal tank fires from the sides and not in line with the heads or ends of the tanks. If this type of tank ruptures, it usually rockets endwise and may be a great hazard to fire fighters.

Promptly apply cooling water to all flame-exposed metal, including uninsulated steel tank supports, and to the metal heads and shells of the tanks.

Use water spray for personnel protection while closing valves to shut off sources of fuel that are feeding the fire.

If valves cannot be closed to stop leaks from piping or if the leak is near the bottom of the tank, consider using water as a displacing agent.

Flush ground fires from under the tanks and let the fire burn where it will do the least harm. If necessary, extinguish ground fires with foam or dry chemical. Water spray may be used on high-flash-point oils.

Refer to 3.3, 3.4, and 3.5. Also, see NFPA film or slides entitled "Fighting Tank Fires With Water."

4.7 Pressure Storage Tanks

Safety is built into aboveground pressure storage tanks by practicing good engineering design and construction, such as recommended in API Standard 2510, Part 1 (ANSI Standard B138.1), and NFPA No. 58 for storage of liquefied petroleum gas.

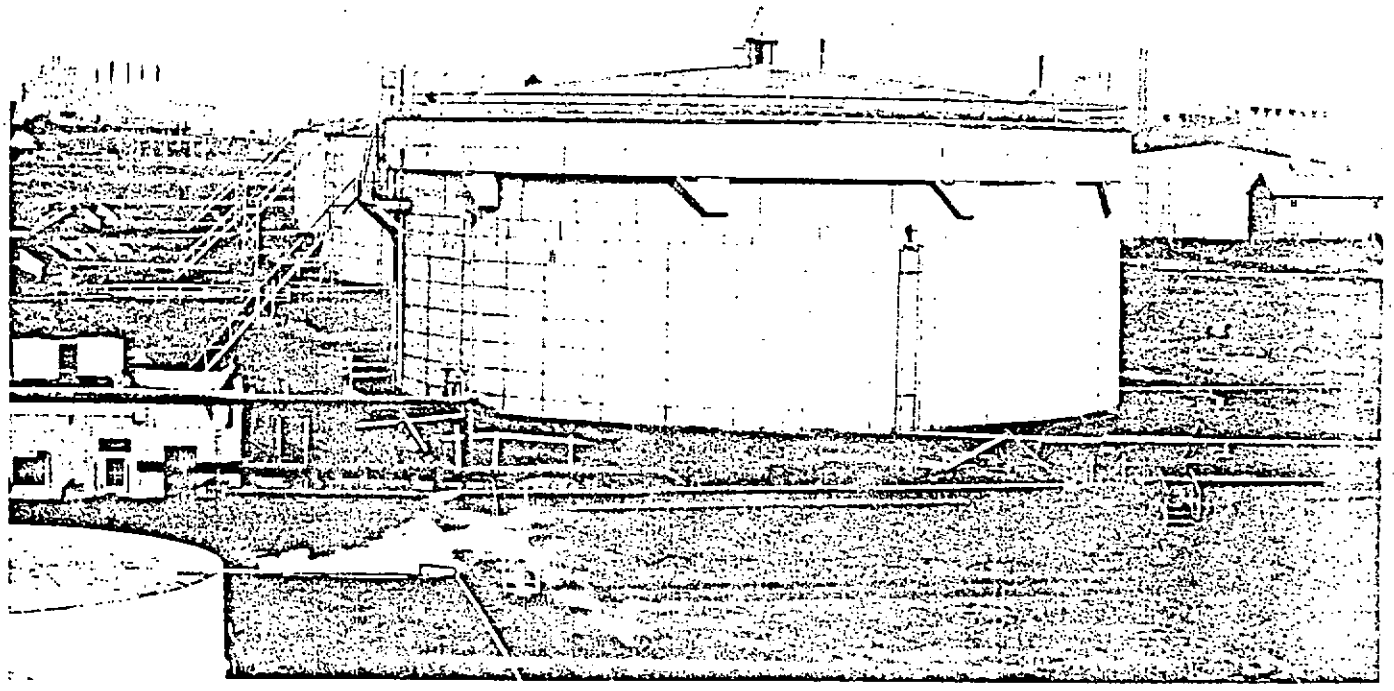

Figure 9 — Lifter-Roof Tank

Uninsulated pressure storage tanks require some special fire fighting tactics that are not needed with atmospheric tanks. Furthermore, different situations require different tactics.

4.7.1 SMALL FIRE UNDER A TANK

Assume there is a small liquefied petroleum gas leak from a pipeline near ground level under a liquefied petroleum gas tank. The liquefied petroleum gas is burning with a 6-foot flame that contacts the bottom of the tank. Two methods of control are possible.

CAUTION—Do not extinguish the flame with dry chemical because the accumulated vapor may reignite and seriously injure fire fighters and damage equipment.

Try extinguishing the fire by blocking off and isolating the leaking section of the pipeline by closing valves to shut off the source of fuel. If the valves are exposed to flame or radiant heat and are unapproachable and if practical, use water spray streams for personnel protection while they are closing the valves.

While depressuring the pipeline, use fixed water spray, if available, for cooling the tank that is exposed to flames. If fixed spray is not available or does not give proper coverage, supplement with water spray streams from hand lines with fixed or portable monitors. If the tank shell is dirty or if the flames have deposited soot on the shell so that the fixed spray does not adequately cover such areas, special attention is necessary, using supplementary water cooling by hoses. Prefire training and testing may indicate some local areas where cooling from fixed spray is uncertain (see 4.7.2 and Appendix C).

If control is not gained promptly, set up water streams to cool exposures while the system is being depressured. This may include depressuring the vapor space of the tank.

4.7.2 LARGE FIRE UNDER A TANK

Assume there is a large liquefied petroleum gas leak from a pipeline or other source which produces a flame that contacts the shell of an uninsulated pressure tank above the liquid level in the tank, such as illustrated in Figure 10.

CAUTION—Fires that cause direct flame contact on the outside surface of an uninsulated pressure storage tank above the liquid level can be very dangerous. Usually after approximately 10 to 30 minutes of direct flame exposure, the vessel ruptures violently. The time lapse depends upon the heat intensity and metal thickness of a local area of the tank shell. Some vessels have ruptured after exposure of approximately 10 minutes.

When the flame overheats the metal tank shell above the liquid level to approximately 425–480 C (800–900 F), the shell starts to bulge outward because the yield strength falls below the tensile stress caused by internal vapor pressure of the product in the tank. This thins the tank shell at the bulged area and the bulging quickly accelerates until rupture occurs.

When a tank ruptures, the superheated liquid in the tank is sprayed out under pressure and quickly vaporizes to produce a large volume of vapor. The vapor ignites instantly and burns on the outside envelope where the flammable vapor-air mixture is present. This outside fire heats and expands the inner too-rich-to-burn core which takes an approximate spherical shape —hence, the term "fireball." The fireball enlarges and rises until all of the vapor is consumed. A typical aerial fireball, such as in Figure 11, shows that 68,000 cubic decameters (18,000 gallons) of liquefied petroleum gas can produce a fireball approximately 300 meters (1000 feet) in diameter, about 90 meters (300 feet) above ground level. Fire fighters who are not protected by structures or by adequate overhead spray from hand lines may be burned seriously by the radiant heat at some distance from the tank.

Ruptures of vessels with combination aerial and ground-level flash fires or explosions are especially dangerous because of the direct, severe flame contact at long distances from the tank. Firemen's conventional, full turnout, protective clothing may not prevent total burn injuries.

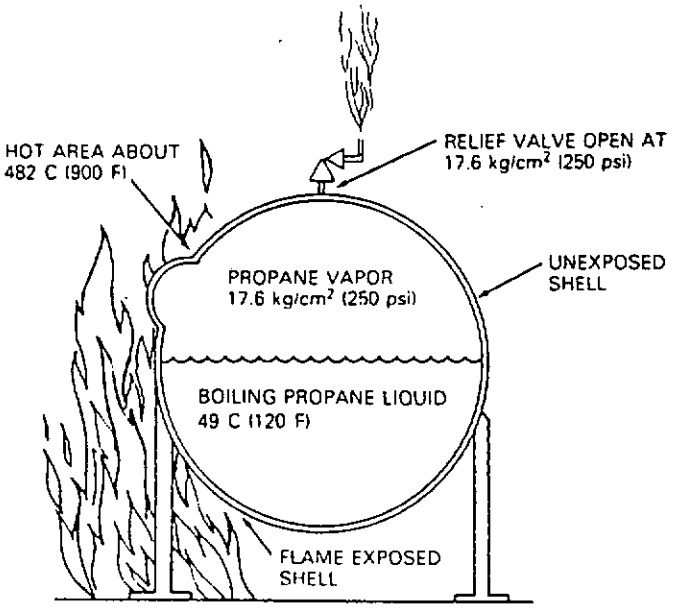

Figure 10 — Tank Shell Overheated Above Liquid Level. This overheating causes a metal bulge because of internal vapor pressure.

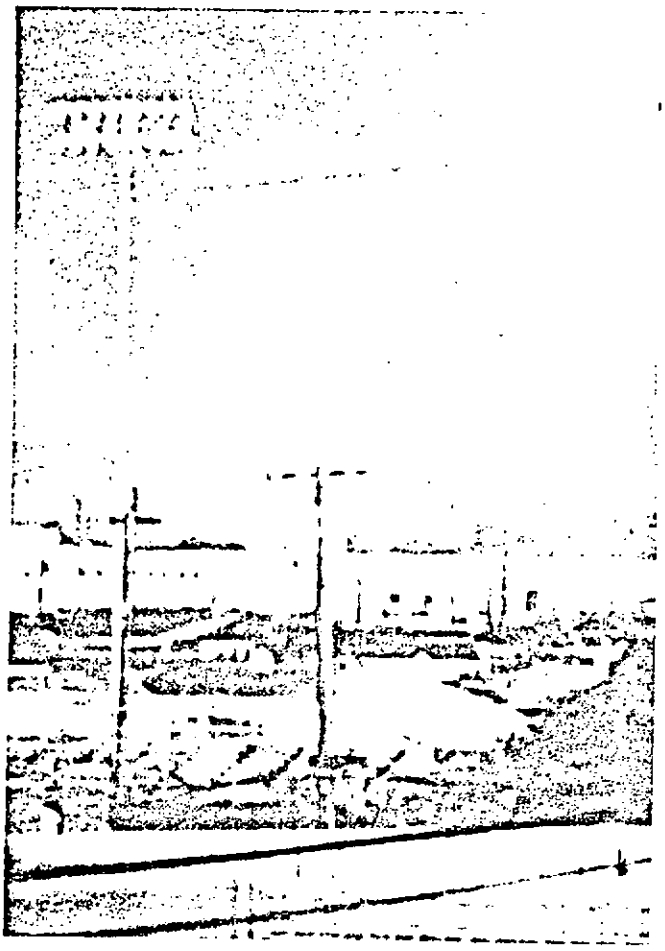

Figure 11 — Rupture of a Horizontal Butane Vessel. Eleven minutes after the fire started, the 3/4-full, 95,000-decameter cubed (25,000-gallon), horizontal butane vessel ruptured with its full length on top, producing this spherical, aerial fireball.

History has shown that an increasing pitch in the sound of a relief valve may indicate the impending rupture of the tank.

Although the tank can have adequate relief-valve capacity based upon fire conditions to meet requirements of API Standard 2510, Part 1, and NFPA No. 58, it still may rupture because the metal shell loses its strength in the area where it is overheated.

The fact that the vessel can rupture in so short a time is of importance to fire fighters, as they can be fatally injured by the radiant heat from the fireball or ground-level flash. This problem requires good emergency supervision.

Size up the fire problem quickly and put cooling water on the hot part of the tank shell immediately or vacate the area if cooling water cannot be applied promptly (within 10 minutes). Select the correct tactics.

When the tank is protected with an automatic, fixed water spray system, check the following.

1. Is the spray system functioning as intended?
2. Is the fire intensity at one area so severe that supplemental cooling from monitors or hand lines is needed quickly?
3. Are there any dry spots on the tank surface above the liquid level that need supplemental cooling?
4. If so, are portable monitors quickly available?
5. Where is the liquid level in the tank? Sometimes after the fire has burned for a while, the liquid level may be indicated by a horizontal line on the exterior surface of the tank. However, at night, or if smoke is involved, the visibility may be limited and the line may be indistinct and unreliable or missing entirely.

When the tank is protected with a manual-start, fixed spray system, check the following.

1. How severe is and how long has the fire been burning?
2. Are the manual-start valves in a safe location or is overhead spray protection needed from hand-line spray nozzles?

Also, check previous questions when using an automatic, fixed water spray system.

When the tank is protected with fixed monitors for cooling, check the following.

1. How severe is and how long has the fire been burning?
2. Should monitor operators be protected with an "umbrella" of spray from hand lines while starting and adjusting the monitor streams?
3. Do the monitors remain fixed on their target or do they tend to drift off target?
4. Is the wind changeable or opposing so that it is difficult to maintain the stream on target?

When the tank has neither a fixed spray system nor fixed monitors, consider the following.

1. Size up the situation promptly and determine if there is a safe strategy to follow. The supervisor is confronted with a number of serious problems and questions that must be solved without delay.
2. How long has the fire been burning? Where is the liquid level in the tank? How severe is the flame contact on the tank shell above the liquid level at the most severely exposed area? Have the relief valves started burning strongly? A large, general ground fire may not be as serious as an intense, smaller fire against the shell at a spot above the liquid level. A large fire may obscure a jet fire that is within the general fire.
3. Is it safe to bring up shorter-range hand lines for cooling the tank shell where it needs cooling while waiting for the monitor streams to start and then retreat to a safe cover? Sometimes fire crews can arrive sufficient-

ly early to set up cooling streams safely if the exposure fire is small. However, remember that with an early, severe exposure fire, the radius of a massive blast can greatly exceed the longest range of a monitor stream and overwhelm any spray streams for personnel protection.

4. Is there any operating equipment that can serve as a shelter for hand-line and monitor operators, assuming that overhead spray streams can be used to protect men from the radiant heat of a fireball should the tank rupture before adequate cooling is established?

5. Have prefire training and tests shown the best places, perpendicular to the axis of horizontal tanks, for location of portable monitors with allowance for wind conditions, best protection of monitor operators, and adequate reach of monitor streams? It should be realized that horizontal tanks do not always rocket endwise.

6. Have prefire tests shown the best type of monitor nozzle to use and the tip size for the flowing water pressure at the nozzle?

4.7.3 UNINSULATED PIPELINE FAILURES CAUSING TANK RUPTURES

Uninsulated pipelines containing liquefied petroleum gas also are subject to failure from flame contact. In turn, the jet fire from the pipeline failure can cause adjoining uninsulated pressure tanks to rupture soon afterward.

Quickly size up the fire and establish the proper short-time control tactics similar to those for an uninsulated tank. Consider, also, the following factors:

1. Possible lack of a fixed spray system for the piping.
2. Difficulty of reaching the pipeline with water streams because of interfering equipment.
3. Difficulty of identifying the critical line with restricted visibility because of congestion, smoke, and so forth.
4. Inability to depressure the line promptly because of connection to a large pressurized vessel.
5. Probability of difficulty with operating controls because of damage that occurred earlier in the fire to automatic or remote-manual control facilities and to instrumentation.
6. Complications of fighting the existing fire along with prevention of failure of a "dry" or blocked-in pipeline being exposed to the fire.

4.7.4 WISELY USING WATER TO PROTECT EXPOSURES

Assume a severe ground fire is exposing one storage tank to direct flame contact while adjoining tanks are exposed only to radiant heat, such as illustrated in Figure 12.

Close the valves on product lines of adjacent tanks. Use adequate cooling water on storage-tank areas that are exposed to direct flame contact and avoid wasting water on areas that are exposed to only radiant heat. Often, conservation of water is very important.

Prefire training helps to size up the situation at the start of fire control operations, thus avoiding problems. However, one typical problem is using excess water which can reduce pressure and volume of water needed to adequately cool exposed tank shell areas where cooling is needed the most. There is a natural tendency sometimes to use all of the cooling water that is available recklessly, regardless of whether or not it is needed.

Radiant heat exposure of bare tanks can increase the tank pressure; open relief valves; and produce large, vertical, noisy jet flames from relief-valve stacks. As long as these flames do not contact exposed metal, there is no risk of metal failure.

4.7.5 MAKING THE DECISION

The most serious tank fire fighting problem is a vessel without cooling-water protection which is exposed to direct flame contact and which may rupture at any time.

Is it safe to make an attack? Conventional fire fighting objectives often are "advance and extinguish." Seldom is a no-advance or retreat considered. The average supervisor in charge may decide to attempt an attack, possibly after a time-consuming size-up, because he was unsure of what action to take.

What is the answer? It is possible to size up the problem promptly and competently if the supervisor in charge has participated actively in sufficient prefire plan studies and has simulated realistic problem drills for the tanks that are involved. Experience has shown too often that "playing it by ear" can be tragic.

4.8 Refrigerated Storage Tanks

These tanks are used for the storage of liquefied petroleum gas or liquefied natural gas at low pressure in the liquid state. Self-refrigeration is accomplished through continuous slow vaporization and condensation of the vapors. Because of the vapor pressure and self-refrigeration effect, flammable air-vapor mixtures do not exist in the tanks. Therefore, when the tanks are in service, fires usually start from leaks or spills.

Although a small liquefied petroleum gas or liquefied natural gas burning leak can be extinguished with dry chemical, as a general rule it should be extinguished only by fuel elimination. Once a fire starts and is extinguished, reignition of a continuing vapor cloud is

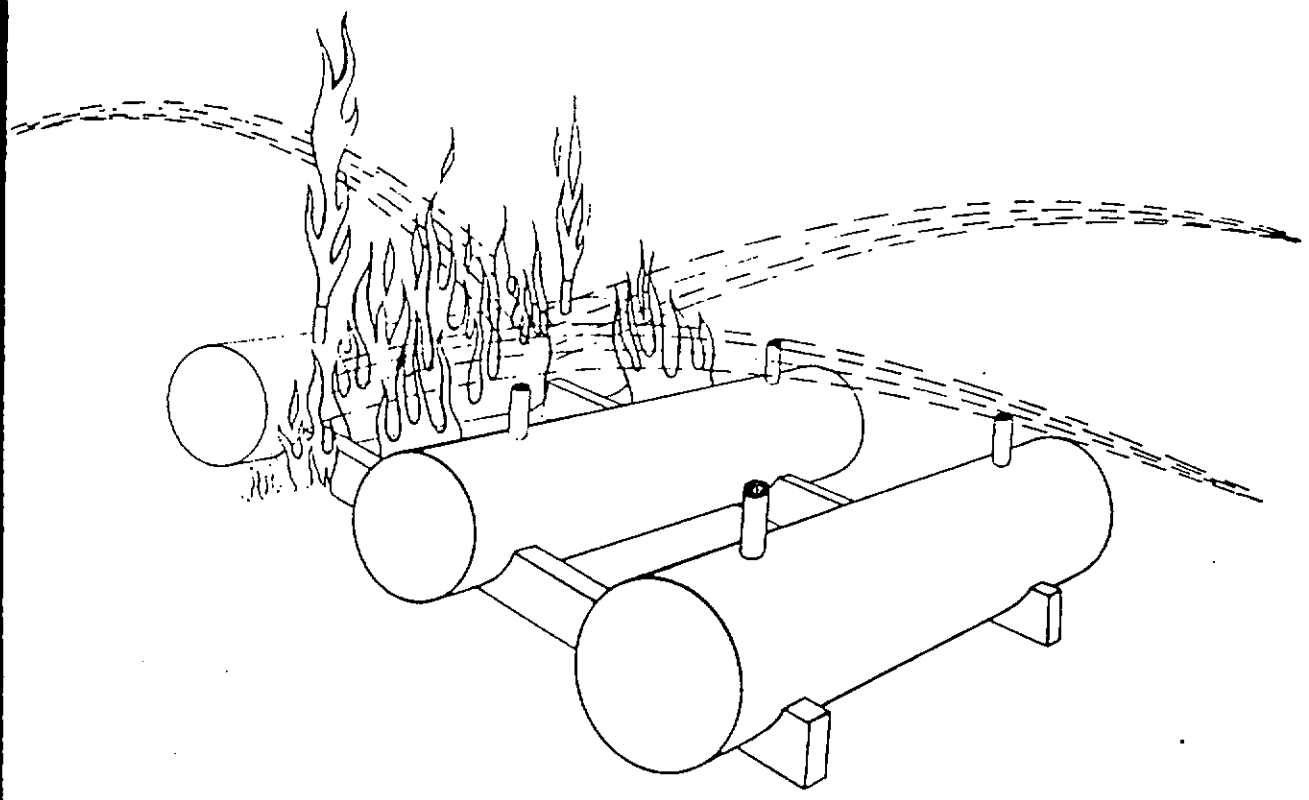

Figure 12 — Concentrate Cooling Water on Flame-Exposed Metal

ible. Reignition sources include hot char from t paint or Class A refuse (paper, burlap sacks, and rth) from hot, thin metal surfaces (metal covering lation, and so forth) or hidden incipient flames in kets or recesses that were not penetrated adequately dry chemical.

dvance under the protection of water spray streams lose valves that stop the flow of fuel. If the flow ot be stopped, protect exposures with water while ire burns itself out. Do not extinguish the fire when uel cannot be shut off because of the risk of reigni- with possible injuries to fire fighters. Let the fire under control.

REFRIGERATED LIQUEFIED PETROLEUM GAS STORAGE TANKS

fety is built into these tanks by practicing good neering design and construction, such as recom- ded in API Standard 620, API Standard 2510 SI B138.1), and NFPA No. 59.

the fire is near the tank, consider using water ms to flush the burning liquid into an open area e it can burn safely. Prefire training should deter- whether this practice is advisable, depending upon nature of the fuel.

y extinguishing the fire by blocking off and isolat- he leaking section with closed valves. If the valves are exposed to flame or radiant heat, use water spray for personnel protection while they are closing the valves. Avoid pools of refrigerated liquefied petroleum gas when doing this.

If a leak is in a pipeline, it is not possible to displace the refrigerated liquefied petroleum gas with water because the product temperature is colder than 0 C (32 F).

When applying water streams on insulated, single-wall tanks, fan the water streams or use water spray to avoid dislodging the insulation and its covering.

If there is flame contact with the outer shell of a double-wall tank, water cooling is important because this shell is not cooled with the liquid inside the tank.

4.8.2 REFRIGERATED LIQUEFIED NATURAL GAS STORAGE TANKS

Recommendations for materials, design, and construction of liquefied natural gas tanks is covered in API Standard 620. Also, NFPA No. 59A outlines basic methods of equipment fabrication, installation, and fire protection as well as operating practices for protection of persons and property.

Liquefied natural gas is primarily liquid methane with a small amount of ethane and traces of heavier hydrocarbons. It is stored at about −162 C (−260 F) and near atmospheric pressure in large insulated tanks.

Table 1—Properties of Flammable Materials

Properties	Flammable Materials					
	Methane	Ethane	Propane	Normal Butane	Isobutane	Hydrogen
Boiling point [C (F)] at atmospheric pressure	−162 (−260)	−89 (−128)	−42 (−44)	−.6 (+31)	−11.7 (+11)	−253 (−423)
Vapor density at boiling point temperature (air = 1)	1.35*	1.66	1.91	2.17	2.25	0.77
Vapor density at atmospheric temperature (air = 1)	0.55	1.04	1.52	2.01	2.01	0.069
Flammable range (percent in air)	5–14	3–12	2–10	2–9	2–9	4–75
Liquid-to-gas ratio	1:632	1:430	1:310	1:240	1:240	1:848

* Vapor density is 1.0 at about −113 C (−172 F)

Also, there are some lined concrete tanks in liquefied natural gas service.

The double-wall steel tank consists of an inner tank made of aluminum alloy or 9 percent nickel-steel in order to store the super cold or "cryogenic" liquid safely. The annular space between the inner alloy tank and the conventional, outer steel tank is filled with insulation. Sometimes the outer wall is of heavy concrete.

A cryogenic liquid usually is defined as one with a boiling point of −73 C (−100 F) or colder.

Methane gas at atmospheric temperature and pressure is approximately one half as heavy as air. However, the cold gas evolved from a boiling liquefied natural gas spill, is heavier than air. One volume of liquefied natural gas produces approximately 632 volumes of gas at atmospheric temperature and pressure. Table 1 lists some of the properties of methane that relate to fire protection and, for comparison, properties of similar flammable materials.

When a liquefied natural gas spill occurs on the ground or on dry macadam, it quickly freezes the ground or macadam. In turn, the liquefied natural gas is heated by the ground. Initially, a large cloud of very cold gas is generated from the vigorous boiling. The visible cloud is condensed moisture in the air that is mixed with the invisible hydrocarbon gas. The cold cloud remains at ground level until warmed by the air or dispersed by wind. Then the warmer methane rises out of the visible water vapor cloud while this cloud evaporates and dissipates.

Shortly after the spill, the ground in contact with the liquid approaches the boiling temperature of the liquefied natural gas [−162 C (−260 F)] and insulates the liquefied natural gas pool from the warmer subsoil. Then the vigorous boiling subsides to a slow, steady boiling rate, and the rate of vaporization and extent of vapor cloud decrease markedly. The water vapor cloud is a useful indicator of the general vapor area. However, in some circumstances, the gas can ignite outside the fringe of the cloud. Field tests indicate that high-expansion foam between 300 and 500:1 may be used to control liquefied natural gas spill fires and to minimize formation of vapor clouds from liquefied natural gas spills.

The initial large cloud from the spill may drift a considerable distance downwind or downgrade and be ignitable at some point. As the boiling of the spill subsides, the extent of the flammable vapor cloud diminishes. The extent of the flammable vapor cloud depends upon the size of the spill, the nature of the surface the liquefied natural gas contacts, and the amount of turbulence caused by wind and other atmospheric conditions.

When liquefied natural gas is spilled on water, it spreads out rapidly and vaporizes quickly. This cold vapor may spread considerable distances before it disperses. The extent of vapor travel depends upon the spill size and the atmospheric conditions.

An interesting phenomenon usually occurs when liquefied natural gas is spilled on water. Popping and cracking noises occur and, under some circumstances, there are more violent reactions that become quite loud and startling. The physical action that causes these reactions is complex, but the conditions involved have been defined and are not considered dangerous or damaging to structures.

Emergency control tactics to dissipate small gas clouds and to prevent their ignition are similar in principle with those for a liquefied petroleum gas spill. For small spills, the liquefied natural gas cloud may be deflected away from potential sources of ignition and dissipated by using water-spray streams from hand lines. Some tests indicate that small liquefied natural gas clouds can be controlled by this method possibly more easily than can a liquefied petroleum gas cloud.

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It has been found that with small spills on land after the initial violent boiling has subsided to a low, steady rate, the zone of flammable gas–air mixture is limited to approximately one spill diameter under no-wind conditions.

Water streams applied to the surface of a liquefied natural gas spill will cause violent boiling. If the spill is burning, it will intensify the fire. Water may be used to cool exposures.

An unburning liquefied natural gas spill at −162 C (−259 F) will cause severe local shrinkage and possible fracture of mild steel that it chills. It may be advisable to flush away the liquefied natural gas with water streams if this does not produce too large a vapor cloud.

Extinguishment of a liquefied natural gas fire is not recommended except by fuel elimination for reasons that were explained here and in 4.7.1.

4.9 Motor Fuel Lead Blending—Weight Tanks—Storage Tanks

With fires around tanks that contain antiknock compounds, cooling water is essential to prevent the metal surfaces in the vapor space of the tanks from reaching temperatures high enough to initiate surface decomposition of the lead and to keep the temperature of lead liquids in the tanks below the critical bulk temperature.

Many variables are present in every emergency, and sound judgment must be exercised in deciding the course of action to be taken. The following are recommended precautions and procedures in the event of fire in the area.

1. Stop transfer and blending operations.
2. Apply cooling water to the tanks immediately. Use a manual, fixed water spray system or check operation of the automatic system if the tank has such protection.
3. If a fire endangers the blending installation, regular plant fire procedures and regulations should be initiated and followed. Also, the nearest representative from the supplier of the motor fuel antiknock should be notified immediately.
4. Hydrocarbon fires in the area may be controlled with dry chemical or foam. The foam application rate should be sufficient to overcome the foam destroyed by the cooling water.
5. Use dry chemical to extinguish vent fires or fires involving flowing hydrocarbons.
6. In case of a prolonged fire in the area, the cooling-water system should be supplemented by portable, monitored fire nozzles playing additional water streams on the tank.

In general, the safety of personnel fighting fires in a blending plant area depends on keeping the antiknock compound below its critical bulk temperature. If the antiknock compound tank has ruptured, skin contact with tank contents or inhalation of any fumes must be avoided.

Water has been found effective for extinguishing burning motor fuel antiknock compounds. Unlike its behavior with oil or gasoline fires, water collects on the surface of the high density antiknock material, effectively separating the fuel vapor from air and thereby preventing reignition. To ensure maximum effectiveness of the water layer, every effort should be made to add the water in a way that minimizes turbulence. Inhalation of combusion products should be avoided.

When a fire occurs in an antiknock storage tank area, the time available before there is danger to fire fighters or to other personnel depends on the amount of compound in the storage tank and on the prompt application of cooling water in adequate quantities.

The following are time factors (based on experience) that may be used to estimate the time available for extinguishing fires before the heat input causes the compounds to reach their critical bulk temperatures[7]:

1. *Condition*—4500 kilograms (10,000 pounds) of antiknock compound in tank (regardless of tank total capacity), with gasoline fire in pit, vent closed, and cooling water system inoperative. Time available—15 minutes to set up portable, monitored fire nozzles to cool the tank or, if that fails, to evacuate personnel from the area.
2. *Condition*—11,000 kilograms (100,000 pounds) of antiknock compound in tank (regardless of tank total capacity), gasoline fire in pit, vent closed, and cooling water system inoperative. Time available—25 minutes to set up portable, monitored fire nozzles to cool the tank or, if that fails, to evacuate personnel from the area.
3. *Condition*—45,000 kilograms (100,000 pounds) of antiknock compound in tank (regardless of tank total capacity), gasoline fire in pit, vent closed, and cooling water system inoperative. Time available—60 minutes to set up portable, monitored fire nozzles to cool the tank or, if that fails, to evacuate personnel from the area.

CAUTION—Allowance should be made for any lapse of time before the fire was reported.

[7] For additional information, reference "Thermal Characteristics of Motor Fuel Antiknock Compounds Containing Tetraethyl Lead, Methylethyl Lead, Tetramethyl Lead" published jointly by Ethyl Corporation and E. I. du Pont de Nemours and Company.

APPENDIX A

GUIDE OUTLINE FOR COLLECTING DATA DURING AND AFTER A TANK FIRE

DESIRED INFORMATION	GET NOW	GET LATER
At Start of Fire		
Time fire first observed	X	
Tank valve settings	X	
Conditions of roof and related factors	X	
Wind direction and estimated rate (and during fire)	X	X
Diameter of tank (to calculate foam and water rates)	X Calc.	
Oil level in tank (to calculate pumpout if conducted)	X Calc.	
Water and basic sediment and water gage (if subsurface application)	X	
Source of ignition and related factors		X
Who witnessed start of fire and from where		X
Was tank quiet or active		X
Character of weather (and during fire)	X	X
Time of first alarm		X
Fire Fighting Response		
What did operators do prior to arrival of help		X
When did supervision arrive	X	
When did fire crews arrive	X	
What equipment did they bring	X	
Where was equipment spotted for use (draw sketch if necessary)	X	
Salvaging Oil if Any		
When was pumpout started	X Calc.	
What was the pumpout rate	X Calc.	
When did pumpout stop and why	X Calc.	
What was the oil level in tank after pumpout	X Calc.	
Fire Fighting Progress (use field sketches if necessary)		
When and where was cooling water started	X	
Number of hose streams—monitors	X	
Size of nozzles and estimated liters per minute (gallons per minute)	X	X Calc.
Foam Application		
Time of foam equipment arrival	X	
What and how much equipment	X	
From what sources	X	
Where was the equipment set up for use (draw sketch)	X	
When was foam first used	X	

DESIRED INFORMATION	GET NOW	GET LATER
Foam Application (Cont'd.)		
Preburn time	X	
Type of foam used	X	
Water, kilograms per centimeters squared (pounds per square inch) to each proportioner and foam maker	X Calc.	
Water, kilograms per centimeters squared (pounds per square inch) from proportioner and foam maker	X Calc.	
Water and foam rates, total liters per minute and liters per minute per meters squared (total gallons per minute and gallons per minute per feet squared)		X Calc.
Changes in burning characteristics	X	
Total foam on hand by types	X Calc.	
Total water on hand	X	
How long will foam stock last	X Calc.	
Time fire considered under control	X	
When was foam application stopped	X	
When was the fire completely out	X	
Average foam rate used		X Calc.
Average cooling-water rate used		X Calc.
Total foam concentrate used		X
For Cone-Roof Crude Oil Tanks Only		
Initial oil level in tank, meters (feet)	X	
Water and basic sediment and water level in tank, meters (feet)	X	
When and where were heat indicator paint stripes used	X	
Progress of heat wave front in relation to horizontal seams	X Calc.	
Heat wave front settling rate	X Calc.	
Time for first "boilover"	X Calc.	
Time and extent of "boilovers"	X	
Time and extent of "slopovers"	X	
Post-Fire Record		
Chronology of fire fighting used		X
Final oil level		X
Oil consumed		X
Estimated total water used		X
Estimated total extinguishing agent used (by types)		X
Lessons learned		X

APPENDIX B

CRUDE OIL TANK BOILOVER[8], SLOPOVER, OR FROTHOVER

Boilover describes a phenomenon which may occur spontaneously during a fire in an open-top tank containing some types of crude oil when, after a long period of quiescent burning, there is a sudden overflow or ejection of some of the residual oil in the tank.

It is caused by boiling water to form a steam-oil froth, creating a sudden expansion. It is the result of the following three conditions, of which the absence of any one will prevent the occurrence.

1. The tank must contain free water or water–oil emulsion at the tank bottom. This situation will normally prevail in tanks storing crude oil.
2. The oil must contain components having a wide range of boiling points such that when the lighter components have been distilled off and burned at the surface, the residue [at a temperature of 149 C (300 F) or over] is more dense than the oil immediately underneath. This residue sinks below the surface and forms a layer of gradually increasing depth which advances downward at a rate substantially faster than the rate of regression of the burning surface. This is the so-called "heat wave." The heat wave is the result of localized settling of a part of the hot surface oil until it reaches the colder oil below; it is not heat conduction from the burning surface downward.
3. Sufficient content of heavy ends in the oil to produce a residue that can form a tough, persistent froth of oil and steam.

A boilover occurs only in a tank with no roof.

Slopover can result when a water stream is applied to the hot surface of a burning oil, provided the oil is viscous and its temperature exceeds the boiling point of water. Since only the surface oil is involved, a slopover is a relatively mild occurrence.

Frothover means the overflowing of a tank not on fire when water or volatile hydrocarbons boil under the surface of a viscous hot oil. A typical example would be when hot asphalt is loaded into a tank car that contains some water. The asphalt is cooled initially by contact with the cold metal, and at first nothing may happen. Later, the water can become superheated. When it finally starts to boil, the asphalt may overflow the tank car.

A similar situation can arise when a tank that is used for storing slops or residuum at temperatures below 93 C (200 F) and that contains a water bottom or wet emulsion receives a substantial addition of hot residuum at a temperature well above 100 C (212 F). After sufficient time has elapsed for the effect of the hot oil to reach the water in a tank, a prolonged boiling action can occur, which can remove a tank roof and spread froth over a wide area.

[8] *ASCE Proceedings*, May 1925; API Annual Meeting, December 9-11, 1924; Mechanical Engineering 47, No. 7, July 1925 by H. H. Hall.

APPENDIX C

PREFIRE PLANNING FOR TANK FIRES

The need for prefire planning is discussed briefly in various parts of this guide. An example of one phase of prefire planning which is especially important to the safety of fire fighters and to loss prevention occurs with liquefied petroleum gas tank fire fighting. Here, time is of utmost importance because an unprotected vessel can rupture quickly unless full protection is established promptly. Fast and accurate sizeup is imperative. Fire history has shown many times that efficient prefire planning is essential to the success of handling liquefied petroleum gas and other critical emergencies.

Fire history also shows that prefire planning is important to successful tank fire fighting involving other fuels; fighting crude oil tank fires is an example.

When organizing a program for any specific storage tank area, some preliminary work is necessary.

1. Who needs the training the most? The supervisors on shift assignments who are in charge of the early fire fighting duties.
2. Who should be their instructor? One who knows the tactics and strategy of tank fire fighting and who is experienced in working prefire plans.

C.1 Preliminary Steps

Before meeting with his team on the prefire planning, the instructor should do the following:

1. Visit the selected tank area. Note its layout and possible logistics problems such as roads, trenches, hydrant locations, drainage, and other local conditions pertinent to tank fire fighting.
2. For starting the program, select two practical types of tank fires. Examples are as follows:
   a. A simple case of a floating-roof seal fire on a large tank under assumed adverse weather conditions.
   b. A more complex case of a cone-roof tank fire with the roof partly blown off and a surrounding dike fire.
3. Secure hydrant flow test data for the area involved which shows hydrant static pressure, residual pressure, and liters per minute (gallons per minute) rates at different key hydrants. Is the water volume and pressure adequate? Is it reliable?
4. Secure copies of the facility's emergency or major disaster plans, as applicable to the tanks.

C.2 First Field Meeting

Discuss with the team the purpose of this prefire plan and what part each individual plays when developing the plan. Explain that the objective is to learn how to size up correctly and handle a potential fire in or around any tank in the given area.

Using conference-type discussions, initially select the easiest and simplest tank fire problem that may be encountered (such as a seal fire on a given floating-roof tank) and do the following:

1. Clearly define the given situation, such as type of fire, weather conditions, time of day, and so forth.
2. Appoint a ranking supervisor to act as the foreman in charge of the simulated fire.
3. Discuss fundamentals of sizeup.
4. Refer to this guide for general and specific points.

Develop conclusions concerning the best method to handle the problem. This should include a discussion of logistics, manpower, water and foam requirements, and best equipment placement for given weather conditions. Tie in operations with fire control and extinguishment. Complete each study thoroughly before proceeding to the next fire problem. Outline the conclusions for refresher training.

Select another and different example of a tank fire problem and handle in a similar manner.

Complete with other types of possible tank fire problems.

1. If foam is used, the instructor should refer to NFPA No. 11 or 11B for basic requirements and make arrangements for inspection and training with the equipment.
2. If dry chemical is used, as for a floating-roof seal fire, consider using water pump tanks or hose lines to prevent reignition caused by hot metal or hot embers in the seal material.
3. If water spray is involved (such as a fixed system at a liquefied petroleum gas tank), have the design data liters per minute per meter squared and tank liters per minute per tank (gallons per minute per feet squared and total gallons per minute per tank) available for discussing principles.
4. The instructor must research these data before the meeting in expectation of the needed discussion and be prepared to discuss fully the principles involved.

After this phase of the prefire planning work has been completed, each supervisor trainee should have gained the needed knowledge to size-up an average emergency situation and know what is the best action to take.

The instructor must know the operations and limitations of the fire fighting equipment that he and the supervisors decide should be used in the various emergency fire problems that are discussed.

A simple discussion of these factors is not enough. The supervisors themselves should assemble and operate the equipment on selected simulated tank fire problems as a second stage of the prefire plan program.

C.3 Simulated Tank Fire Drills

Start by selecting a case of a simple tank fire that is most likely to occur and one in which a most practical drill can be conducted under field conditions without a fire.

Plan the drill when there is less probability of interference or risk of having to terminate it prematurely.

A good drill to study promptness of response and effective tactics is a simulated severe fire in a liquefied petroleum gas storage area with the fixed spray systems assumed to be out of order and thereby requiring use of portable monitors.

Where should hose lines be set up for portable monitors? Avoid working endwise on horizontal tanks.

What is the reach of long-range solid streams under actual conditions with allowance for wind? A proper choice of nozzle tips, sizes, and types is important. As a rule, straight streams from efficient, smooth bore nozzles will deliver more water on a target than will solid streams from combination spray-solid stream nozzles that cause more water "rain-off" in transit. In some cases, combination nozzles are provided to give a wider pattern for shorter-range use. However, this may require locating the monitors too close to the fire area to be accessible if the radiant heat is too severe or if it is unsafe to approach late in the fire. Also, smooth bore nozzles are not as subject to fouling with dislodged line scale and other deposits.

What is the tendency of fixed and portable monitor streams to drift off target? Is it necessary to set the streams on target and then retreat the crew to a safe location where they may be unable to return to the monitors to readjust on target?

Are the fixed monitors properly located to accomplish the needed cooling?

Does the surface drainage quickly dispose of the high rate of water use? Prefire tests at expected maximum water demand are needed to determine if the sewers are likely to become overloaded. Drifting sand, vegetable growth, and poor housekeeping should be checked and sewers test-flowed periodically; open-area drainage in ditches to a nearby burning pit is desirable in order to burn the fuel at a safe place and to avoid plugging of underground sewers. After a fire has started, it is not possible to correct a drainage problem.

Plan on conducting the drill as realistically as possible without short-cutting procedures.

Discuss the case at the drill site as to what will be done. Do not plan any surprises for the first drill.

Lay out and use water hoses and portable monitors for the drill. Discuss their limitations and demonstrate, where practical. For other fuels and tanks, demonstrate the use—insofar as practical—of foam, dry chemical, and other equipment and agents.

Hold a critique afterward and lay out plans for a subsequent drill at a scheduled date.

Before running the monitor tests on liquefied petroleum gas tanks, the fixed spray system should be tested on the dry tank surface. How efficient is the water distribution over the tank shell? Is the shell surface dirty so that water channels and does not cover properly? Are there dry areas under "leg pits"?

How much time is required to get effective supplemental water streams into operation? Remember that liquefied petroleum gas tanks can rupture violently after 10 to 30 minutes of flame contact.

It is particularly important that this prefire study and training in the field be done by the supervisors who may be in charge of fire control at the time of an emergency. Even with good prefire training, some problems can develop. These supervisors must be able to diagnose promptly and to size up problems at the start of any kind of tank fire during a time of stress and poor visibility.

The instructor should organize and supervise this prefire training, but it is essential that line supervisors actively participate.

000122

4.1.1 TANKS WITH A WEAK ROOF-TO-SHELL SEAM THAT CONTAIN PETROLEUM PRODUCTS WITH FLASH POINTS BELOW 93 C (200 F), EXCLUDING CRUDE OIL

4.1.1.1 Tanks With Roof Blown

Apply cooling water immediately to all flame-exposed metal. Start transfer of product while fire fighting efforts are being coordinated for the extinguishment effort. However, the transfer must be stopped prior to subsurface injection.

Extinguish small ground fires with dry chemical and large fires with foam at foam application rates specified in NFPA No. 11 or 11B (also 3.5).

Apply foam to tank through fixed systems or by portable methods at rates specified in NFPA No. 11 or 11B. Fluroprotein foam may be subsurface-injected into tanks through product lines or special inlets. Aqueous film-forming foam may be injected in the same manner as specified in NFPA No. 11B. Factors to consider in prefire planning and training are—

1. *Subsurface injection*

a. Number and spacing of injection points.

b. Appropriate valved connections for high-back-pressure foam makers.

c. The size of foam injection lines needed at the point of inlet to avoid exceeding maximum allowable velocity rates of the foam solution entering the tank. When velocity rates are exceeded, surface turbulence and fuel entrainment occurs. This breaks up the foam blanket, and the entrained fuel will burn and destroy the foam.

d. To force the foam into the tank and against the liquid head requires high-back-pressure foam makers which may require higher pressure for operation than do other types of foam systems.

e. Assurance that bottom water level in the tank is below the foam injection point to avoid excessive foam dilution.

f. On tanks greater than 61 meters (200 feet) in diameter, the subsurface injection method may be needed because foam may not form a sealing cohesive blanket after traveling approximately 30 meters (100 feet) over a burning liquid surface.

g. The design and operating details should be checked with the foam manufacturer.

h. When minimum foam application rates cannot be met through subsurface injection, supplemental foam can be applied by using surface application with portable methods.

2. *Surface application*

Foams may be applied successfully by monitors, hoses, or other portable methods that can deliver large volumes of foam over the rim onto the liquid surface. Foams preferably should be applied more gently to avoid submerging the foam into the hydrocarbon, which causes fuel entrainment and foam destruction. This characteristic usually makes it difficult to lay an effective foam blanket on the liquid surface of large tanks by hoses or monitors from grade. Foam towers should not be erected until foam is ready to be applied, as flame damage to dry towers and their connected hoses may occur.

When a roof is partially intact, a fire under the roof is sometimes difficult to extinguish when foam is applied overhead by portable methods from grade. Surface application of aqueous film-forming or fluoroprotein foams applied overhead may be effective because of their ability to form a vapor-suppressing film. Fluoroprotein or aqueous film-forming foams may be effective if applied by the subsurface method.

4.1.1.2 Leaking Tank Shell, Bottom, or Piping

If the fuel is gasoline or equivalent, keep all sources of ignition away and apply foam to the liquid spill to reduce vaporization.

If possible, displace the product leak with water by pumping water into the tank so that water rather than product leaks from the tank.

Pump the product out of the tank.

Recover the fuel that is leaking to reduce the danger of fire and pollution.

4.1.2 TANKS WITH A WEAK ROOF-TO-SHELL SEAM THAT CONTAIN PETROLEUM PRODUCTS WITH FLASH POINTS ABOVE 93 C (200 F)

See API Publication 2023, *Guide for Safe Storage and Handling of Heated Petroleum-Derived Asphalt Products and Crude Oil Residua*.

The suggested practices stated under 4.1.1 should be applied except when the following conditions exist:

1. When the preburn period has been long enough to heat the liquid product surface to some depth above 93 C (200 F).
2. When the tank product is stored at temperatures above 93 C (200 F).

When either of these conditions exist, long straight streams of water should be fanned over the burning liquid surface. Generally, this will produce frothing, and the water rate should be adjusted accordingly to control the frothing. If the tank is nearly full, pumpout may be desirable to gain room to contain the froth. As the fire and frothing subside, water application by fanning or spraying may be increased. As mentioned earlier, extinguishment can be accomplished if the liq-

000123

uid surface is cooled below the temperature (flash point) at which it will give off sufficient vapors to support combustion. Cooling water should be applied to the tank shell above the liquid level.

After cooling the liquid surface with water, foam may be applied. If the temperature of the liquid surface is above the boiling point of water, the water in the foam will convert to steam, resulting in frothing and foam destruction. However, in this event foam will serve the same purpose as does water. For the foam to form an effective securing foam blanket, the temperature of the liquid surface must be lower than the boiling point of water.

There have been instances of mild-to-violent frothing with some hot, very viscous fuel oils, lube oils, or asphalts when water streams were directed into the hot liquid oil or when too much water had been applied. Therefore, careful application of water in limited quantities at the beginning is necessary, followed by adjustments that depend on the results. Some fire fighters advocate water application rates in the range 0.08–0.2 liter per minute per square meter (0.02–0.05 gallon per minute per square foot) of liquid surface at the start.

Another successful means of extinguishment has been by intermittent application of foam. It may be impossible to cool the liquid surface with long straight streams of water, and intermittent foam applications will cool the surface and minimize slopover.

4.2 Vertical, Low-Pressure Fixed-Roof Tanks Without Weak Seams

These are tanks designed and constructed in accordance with API Standard 620 and are operated with metal temperatures not exceeding 93 C (200 F) and with pressures not exceeding 1 kilogram per square centimeter (15 pounds per square inch gage). Suggested fire fighting practices applicable to lifter-roof, horizontal, and refrigerated tanks are covered separately in 4.5, 4.6, and 4.8, respectively.

Fires involving these tanks are generally attributable to leaks or spread of fires from other sources. If an internal explosion should occur (which is rare), the tank ruptures at its weakest point. This can be at the bottom-to-shell seam and can cause the tank to rocket out of the area, resulting in a severe flash fire followed by a large ground fire (Figure 2). Prefire planning should include consideration of this factor so as to alert fire fighters and prevent injury.

Fire fighting principles and practices pertaining to such tanks are similar to those in other sections of this manual, depending on the type of fire.

4.3 Vertical, Atmospheric Fixed-Roof Tanks, With Weak Roof-To-Shell Attachments, Containing Crude Oil

Different tactics are used when fighting tank fires involving the types of crude oils that can produce a boilover (Appendix B). The supervisor in charge must understand the behavior and be alert to the types of hazards that are not encountered with other fuels (Appendix C).

Certain factors are necessary for boilover action, as follows.

1. The fire must occur in a tank with no roof. A cone-roof tank with its roof blown off is an example. Today crude oil is stored in either floating-roof tanks or in gas-tight, cone-roof tanks that are common in the oil fields and have excellent fire records.

Crude oil tank fires were frequent years ago when wooden roofs were used. They were easily ignited by lightning. Most of what is known today about boilover phenomenon was learned prior to 1930.

2. The components of crude oil must have a wide range of boiling points. A typical crude oil is an example. As the oil burns, the light volatile fractions distill off and burn. The unvaporized, hot [149 C (300 F) and higher] residue, being more dense than the cold crude oil underneath, sinks below the surface. As the fire progresses, the lighter fractions continue to distill out at the interface between the hot residue layer and the cold crude underneath. The burning vapor supplies the heat that continues the distillation. As the residue layer increases in depth, the interface moves downward at a rate about two to three times as fast as the burn-off rate at the oil surface.

The hot residue is called the "heat wave layer" and the interface is called the "heat wave front." The heat wave settling rate for an average crude is approximately 1 meter (3 feet) per hour.

3. The tank must contain water or wet emulsion. This is normal for crude oil tanks. When the hot interface reaches the water or emulsion in the bottom of the tank, it flashes the water into steam. At 204 C (400 F) the expansion from water to a frothy steam mixture is about 2000 times.

4. The crude oil must contain a sufficiently high content of residue to produce a steam-oil froth of tough consistency.

Not all crude oils have these properties. Very light crudes can contain too little residue to make a tank froth. Heavy crudes, asphalts, and heavy fuels contain too little light fractions to produce a sharp heat wave layer. Refined oils contain too little residue. Typical

000124

medium-weight crudes are more likely to boil over; some slop oils also have this characteristic.

A true boilover occurs only when the heat wave front or interface contacts the water or emulsion, usually in the bottom of the tank. Sometimes the tank will almost empty itself in one or more violent eruptions, such as shown in Figure 3. The burning froth wave from a strong boilover can overflow diked areas and be a hazard to unwary fire fighters and to surrounding property. At the start of a strong boilover, a quickly ascending column of rich vapor burns at a high elevation, where air mixes to support combustion. A mushroom overhead flame, accompanied by suddenly increased radiant heat, may be spectacular parts of the phenomenon.

Some medium-heavy crudes may contain suspended lenses of wet emulsion in the tank. The same type of action occurs when the hot interface contacts a suspended emulsion and can cause similar frothing action, depending upon the amount of emulsion present and the character of the hot residue (see 4.3.2).

Depending upon the character of the oil, the action can range from very mild boiling over at the tank rim to

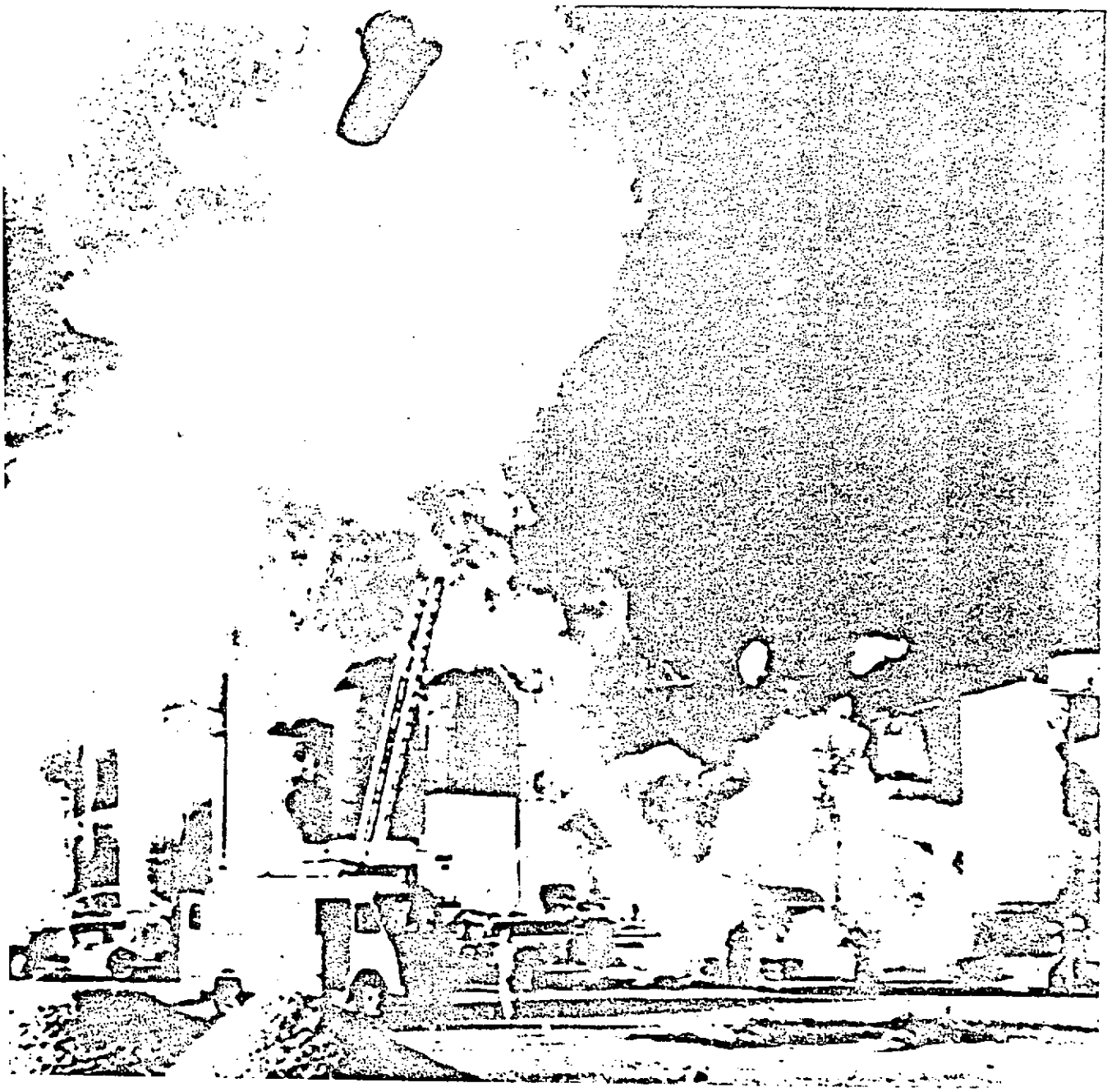

Figure 2 — Internal Explosion of a Fixed-Roof Tank Without Roof-to-Shell Attachments. Tank is vertical and low pressure and has a capacity of 114,000 liters (30,000 gallons).

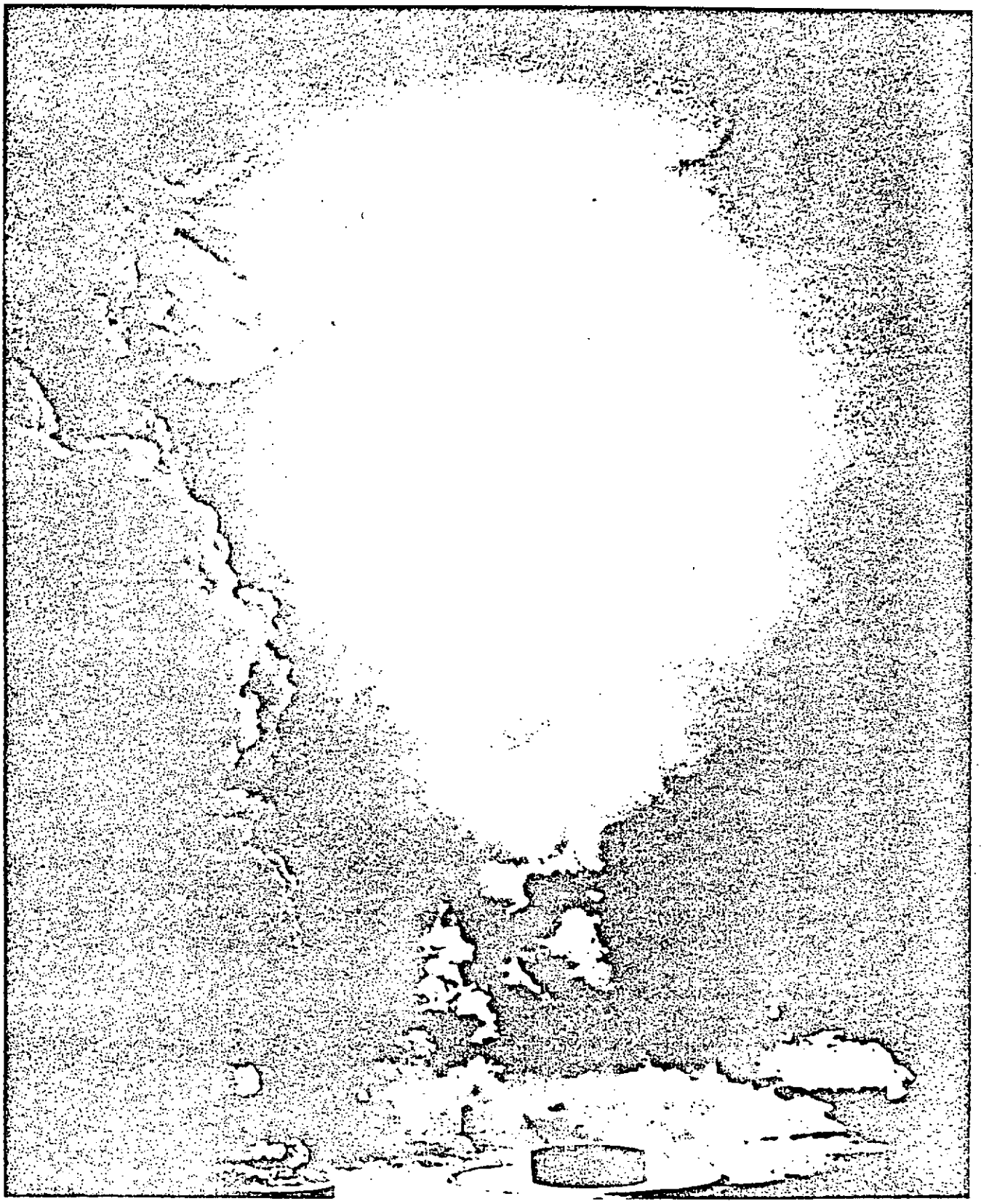

Figure 3 — Boilover of a Cone-Roof Tank. A 9,000,000-liter (55,000-barrel) capacity tank that contained 9 meters (30 feet) of 24 API gravity crude oil boiled-over 10 hours after ingition. The tank that boiled over, hidden by fire and smoke, is 270 meters (900 feet) behind tanks in the foreground. Flame height is in excess of 300 meters (1000 feet).

slow, continuous, steady spillover up to a sudden, olent boilover.

The mechanics of a slopover during a crude oil tank re are different. Any time after the heat wave layer as started to form, if water or foam is applied to the rface of the burning oil, froth is produced that can verflow the rim of the tank unless the outage is suffi- ient to retain it. Such action is called a "slopover." For ummarized information on boilover, slopover, and othover, see Appendix B.

4.3.1 TANKS WITH ROOF BLOWN—EXTINGUISHING TACTICS WITH FOAM

Some crude oil tank fires have been extinguished with oam. Many have not because of their isolation in oil elds, a lack of knowledge of the special tactics required, and other factors. These tactics are discussed ere.

Quick application of foam after the fire starts and efore much heat wave layer has formed is required. Otherwise, the foam will produce burning froth that will destroy the foam or slop it over the rim of the tank.

After a preburn period of 30 minutes or longer, before foam application is attempted, long-range straight streams of water should be fanned over the burning surface deliberately to froth the burning surface for the following two purposes:

1. To produce controlled frothing which, if sufficiently mild, may indicate that after some additional cooling with the water spray, it will be safe to try foam application.
2. To produce more or longer-controlled frothing to cool the heat wave layer. It may be advisable to produce controlled slopover at the tank rim to reduce the depth of the hot layer before attempting foam. If frothing continues, see 4.3.2.

Normally, crude oil tanks contain a wet bottom, and the additional water will have little effect on the end result. Furthermore, much of the water applied by the fanning action will be converted to steam by the hot residue.

Maintain cooling water on the tank shell above the oil level to keep it erect (particularly in areas under foam chambers or where foam towers may be erected later) and to cool the metal so a foam blanket will seal against the shell.

Strategy decisions may include the following:

1. Pumping out oil from the tank to salvage the crude oil and to make room for more frothing. This may cause an early boilover because of low oil level.
2. Checking the tank water draw and removing any water that has collected.

4.3.2 TANKS WITH ROOF BLOWN OR SUNK—TACTICS WHEN FOAM IS UNAVAILABLE OR ARRIVES TOO LATE

When foam is unavailable or if it arrives too late for use, then the strategy is to minimize the damage from the eventual boilover.

Depending on tank innards and estimated time of boilover, it may be possible to start product transfer to minimize product loss and to provide more room for potential boilover.

Move all unnecessary manpower and equipment out of the area and particularly out of the downgrade path of the possible large wave of burning froth.

If possible, direct the burning froth wave to an area where the least damage will occur.

With a true large boilover, the action is so rapid that the sudden froth wave may overflow the dike completely around the tank. With a slower discharge of froth over the rim, much of the froth may be directed as desired.

Erect sheet metal fences or barriers or bulldoze secondary dikes to direct the advancing wave after it has lost momentum.

Frequently observe the progress of the heat wave front as it moves lower into the tank in order to estimate the time of the boilover. Heat wave travel may be checked in the following two ways: (1) apply water to the tank shell and note the location of the interface by water evaporation above the heat wave front; and, if available, (2) apply vertical stripes of special heat indicator paint from the bottom of the tank to above the level of the heat wave layer. The paint changes color at the interface location. Record the rate of movement in inches per hour and check the rate periodically.

If there are lenses of suspended emulsion in the tank or if the interface is not level in the tank, severe frothing can occur unexpectedly which could be hazardous to fire fighters close to the tank. Hence, observation of the fire behavior is important. One or more fire watchers should be assigned to observe constantly the character of the fire. A pending boilover generally is indicated by an increase in height and brightness of the flame, which is sometimes accompanied by a change in the noise of the fire, such as a pronounced "frying" sound. Also, large blobs of burning froth may be projected upward a few feet and may be visible with binoculars from a distance.

Although heat indicator paint or water cooling on the shell may indicate that the heat wave front has reached the bottom of the tank with no change in the character of the quiet, steady burning, this is not an assurance that severe frothing or a boilover is delayed; it may start any time without warning. Prior to the estimated boil-

over time, all personnel should be pulled out of the area, including those handling hose streams on adjacent tanks.

4.3.3 TANKS WITH ROOFS PARTLY INTACT

The development of a heat wave front in a crude oil tank with the roof partly intact or partly sunk is unlikely attributable to the reduced burning rate caused by the partially intact roof. Consideration should be given to the transfer of the product while fire fighting efforts are being coordinated for extinguishment; however, the transfer must be stopped prior to subsurface injection.

For a partially lifted roof, a fixed foam system may be used if installed on the tank. If a fixed system is not available or is damaged from the roof rupture, foam that is subsurface injected may be effective. If these methods fail to extinguish a fire under a partially lifted roof, punch holes in the tank shell or roof above the liquid surface to inject foam spray between the roof and the liquid surface. For subsurface foam injection, refer to 4.1.1.1 for information on precautions.

4.4 Floating-Roof Tanks Containing Low-Flash-Point Stocks or Crude Oils

Open-top and covered floating-roof tanks are designed in accordance with API Standard 650 for storage of low flash volatile stocks and crude oils. The open-top design, which has a good fire record, is of the pontoon or double-deck floating-roof type and is equipped with a pantagraph-type or tube seal. Fires in open-top floating-roof tanks almost invariably occur at the rim from charges induced in the roof attributable to electrical disturbances in the atmosphere or from vapor leaking past the rim seal. If the roof is bonded properly, as specified in NFPA No. 78, or is equipped with a metal weather shield to permit bonding, fires caused by drainoff of induced charges probably will not occur. Another cause of a rim fire would be a direct lightning strike on the rim when the roof is in the high position. On rare occasions, the roof may sink because of improper attempts at rim fire extinguishment which will permit the entire liquid surface to become involved. However, with a properly maintained pontoon or double-deck floating roof and suitable fire fighting procedures, lose of the roof because of sinking should not occur.

Most open-top floating-roof tank fires have been extinguished soon after the fire started. If a rim fire is detected early and prior to its extension around the annular ring, the fire can be extinguished easily by using dry-chemical extinguishers or foam hose lines.

Crude oil generally is stored in floating-roof tanks. If a rim fire occurs, a boilover will not result. If the roof sinks, there is a rare possibility of a boilover.

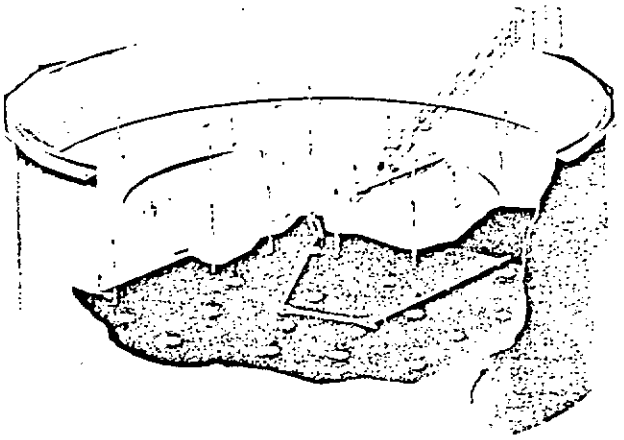

Figure 4 — Annular-Pontoon Floating-Roof Tank

Typical examples of open-top floating roofs and seals are shown in Figures 4, 5, 6, 7, and 8.

4.4.1 OPEN-TOP FLOATING-ROOF TANKS

Seal fires can be extinguished by using 38 millimeter (1 ½-inch) portable, foam hose streams or portable dry-chemical extinguishers. Extinguishment by water spray usually cannot be accomplished, but water spray and dry chemical can be used if foam is not available. The cooling effect of water spray may be needed to cool the steel and to prevent reignition of vapors from embers on the seal fabric. A portable, water pump tank or small hand hose usually is adequate to quench the embers before using dry chemical if the rim fire is detected during early stages. If only dry chemical is to be used, secure a sufficient number of fire extinguishers and fire fighters so that the dry chemical can be applied progressively until the seal fire is extinguished.

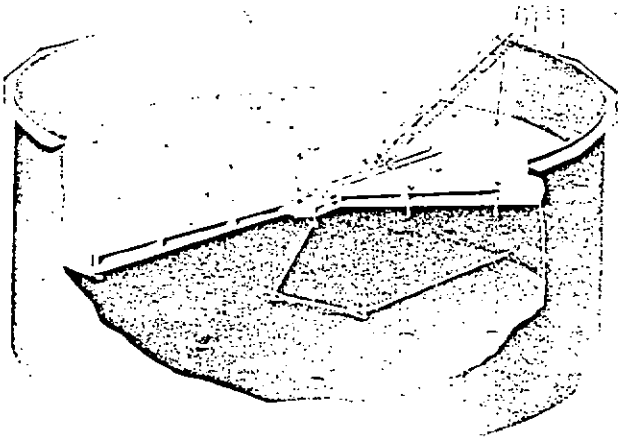

Figure 5 — Double-Deck Floating-Roof Tank Figure

Normas legales para el almacenamiento, manejo, transporte, distribución de combustibles líquidos derivados del petróleo y el transporte por carrotanques de petróleo crudo.



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Oficina para la Prevención de Emergencias

Alcaldía Mayor de Santafé de Bogotá, D.C.

OPES

MINISTERIO DE MINAS Y ENERGIA

DECRETO 283 DE ENERO 30 DE 1990
DECRETO 353 DE FEBRERO 06 DE 1991
DECRETO 1677 DE OCTUBRE 14 DE 1992
DECRETO 300 DE FEBRERO 15 DE 1993
DECRETO 2113 DE OCTUBRE 22 DE 1993

Por el cual se reglamenta el almacenamiento, manejo, transporte, distribución de combustibles líquidos derivados del petróleo y el transporte por carrotanques de petróleo.

EL PRESIDENTE DE LA REPUBLICA DE COLOMBIA

En ejercicio de sus facultades legales y en especial de las que le confiere el numeral 3o. del Artículo 120 de la Constitución Política, el Código de Petróleos (Decreto 1056 de 1953). La Ley 1a. de 1984, la Ley 39 de 1987 y la Ley 26 de 1989.

D E C R E T A:

CAPITULO I

GENERALIDADES

ARTICULO 1. El almacenamiento, manejo, transporte y distribución de los combustibles líquidos derivados del petróleo, es un servicio público que se prestará conforme a lo establecido en la Ley, en el presente Decreto y en las resoluciones del Ministerio de Minas y Energía.

Las plantas de abastecimiento, estaciones de servicio, plantas de llenado y depósitos de GLP y demás establecimientos dedicados a la distribución de productos derivados del petróleo, prestarán el servicio en forma regular, adecuada y eficiente, de acuerdo con las características propias de este servicio público.

ARTICULO 2. En los términos del Artículos 2o. de la Ley 26 de 1989, corresponde exclusivamente al Ministerio de Minas y Energía declarar la saturación o inconveniencia de construcción de plantas de distribución de combustibles líquidos derivados del petróleo y estaciones de servicio, en áreas urbanas o en determinada zonas geográficas del país.

ARTICULO 3. Para efectos del presente decreto se considera:

a. DEFINICIONES:

Gran Distribuidor Mayorista: Se entiende por Gran Distribuidor Mayorista a Empresa Colombiana de Petróleos (ECOPETROL).

Distribuidor Mayorista: Toda persona naturas o jurídica, que a través de una planta de abastecimiento construída con el cumplimiento de los requisitos legales, almacene y distribuya al por mayor combustibles líquidos derivados del petróleo, con excepción del gas licuado del mismo (GPL).

Distribuidos Minorista: Toda persona natural o jurídica que expenda directamente al consumidor, combustibles líquidos derivados del petróleo, con excepción del gas licuado con el mismo GLP, por intermedio de estaciones de servicio propias o arrendadas.

Cambiadero de Aceite: Establecimiento de comercio dedicado principalmente a la lubricación de automotores. Además, puede prestar servicios menores de mantenimiento automotriz .

Diagnosticentro o Serviteca: Establecimiento dedicado al mantenimiento preventivo de vehículos. Generalmente ofrece servicio de diagnóstico sobre funcionamiento del motor, sistemas de dirección y eléctrico; cambio, reparación y venta de llantas y demás servicios afines.

Gran Consumidor: Toda persona natural o jurídica que, con adecuado almacenamiento para petróleo crudo y combustibles líquidos derivados del petróleo y con el lleno de los requisitos legales correspondiente, se provea directamente de las refinerías o plantas de abastecimiento para su propio uso industrial.

Transportador de Combustible: Toda persona natural o jurídica que transporte hidrocarburos y combustibles líquidos derivados del petróleo en vehículos automotores.

Planta de Abastecimiento: Instalación que entrega combustibles líquidos derivados del petróleo a distribuidores minoristas o a grandes consumidores.

Estación de Servicio: Modificado por el Art. 1o. Decreto 353/91. Establecimiento destinado al almacenamiento y distribución de combustibles líquidos derivados del petróleo, excepto gas licuado del petróleo (GLP), para vehículos automotores, a través de equipos fijos (surtidores) que llenan directamente los tanques de combustible. Además, puede incluir facilidades para prestar uno o varios de los siguientes servicios: Lubricación, lavado general y/o de motor, cambio y reparación de llantas, alineación y balanceo, servicio de diagnóstico, trabajos menores de mantenimiento automotor, venta de llantas, neumáticos, lubricantes, baterías y accesorios y demás servicios afines.

Las estaciones de servicio también podrán disponer de instalaciones y equipos para la distribución de gas natural comprimido (GNC) para vehículos automotores, caso en el cual se sujetarán a la reglamentación específica del Ministerio de Minas y Energía.

Surtidor: El dispositivo con registro de volumen y precio del combustible, mediante el cual se entrega el producto directamente en los tanque de combustible de los automotores.

Isla de Surtidor: Es la base o soporte de material resistente y no inflamable, generalmente concreto, sobre la cual van instalados los surtidores o bombas de expendio, construida con una altura mínima de veinte (20) centímetros sobre el nivel del piso y un ancho no menor de un metro con veinte centímetros (1,20 cm.)

Protección a Areas Expuestas: Son las medidas de seguridad contra incendio para las instalaciones y bienes situados en áreas adyacentes a plantas de abasto. Se acepta que existe la protección contra incendio para estas instalaciones o áreas cuando están:

1. Ubicadas dentro de la jurisdicción de un cuerpo de bomberos oficial o voluntario, debidamente equipado.

2. Contiguas a plantas que tengan brigadas privadas contra incendio, capaces de proporcionar chorros de agua para enfriar las instalaciones o áreas expuestas.

3. Cuando la instación expuesta tiene capacidad suficiente de equipos y agua a presión para garantizar esta protección.

Sistema de Protección Contra Incendio: Sistemas contra incendio diseñados y calculados de acuerdo con normas reconocidas internacionalmente, como la NFPA o las Normas ICONTEC pertinentes, con referencia a sistemas de espuma , con rociadores de agua, barreras, redes hidráulicas, etc.

Tanque Atmosférico: Es un tanque de almacenamiento de combustible diseñado para operar a presiones que van, desde la atmosférica hasta 0.035 Kg/cm^2 manométricas (760 a 786 mm de mercurio), medidas en el tope del tanque.

Barril: Un volumen de cuarenta y dos (42) galones americanos o ciento cincuenta y ocho punto nueve (158.9) litros.

Saturación: Se considera que en un área determinada existe saturación de plantas de abastecimiento o de estaciones de servicio, cuando las existentes en tal área, en un momento dado, satisfacen ampliamente las necesidades de abastecimiento, distribución y consumo de combustibles líquidos derivados del petróleo en la respectiva zona.

Punto de Inflamación: La temperatura mínima a la cual un líquido despide vapor en concentración suficiente, para formar una mezcla inflamable con aire, cerca de la superficie del líquido dentro del recipiente que lo contiene.

Ebullición Desbordante: Fenómeno presentado en el incendio de ciertos aceites en un tanque abierto, cuando después de arder por cierto tiempo, hay un repentino aumento en la intensidad del fuego, asociado con la expulsión de aceite incendiado fuera del tanque. Este fenómeno se presenta en la mayoría de los petróleos crudos, combustibles líquidos de amplio intervalo de ebullición como el combustible (Fuel Oil No. 6) y cuando en el fondo del tanque se acumula agua que se vaporiza repentinamente.

Petróleo Crudo: Mezclas de hidrocarburos que tienen un punto de inflamación por debajo de 150°F (65.6°C) y que no han sido procesados en una refinería.

Líquido Inflamable: Un líquido que tiene un punto de inflamación inferior a 100°F (37.8°C0 y una presión de vapor absoluta máxima a 100°F (37.8°C), de 2,82 Kg/cm^2 (2068 mm Hg). Estos líquidos son definidos por la NFPA como clase IA, IB, IC de acuerdo con sus puntos de inflamación y ebullición.

Líquido Combustible: Un líquido que tiene un punto de inflamación igual o superior de 100°F (37.8°C). Estos líquidos son definidos por la NFPA como clase II, IIIA y IIIB de acuerdo con su punto de inflamación.

b. SIGLAS:

ICONTEC:	Instituto Colombiano de Normas Técnicas - Organismo Nacional de Normalización.
NFPA:	The National Fire Protection Asociation. Asociación Nacional de Protección Contra Incendios de los Estados Unidos de Norteamérica, cuyas normas son ampliamente aceptadas en la mayoría de los países.
OPCI	Organización Iberoamericana de Protección Contra Incendios. Es la entidad que interpetra y difunde la Norma NFPA en Iberoamérica y sirve como asesora y consultora para el mundo de habla hispana, con asistencia de la NFPA.
API	American Petroleum Institute. Instituto Americano del Petróleo de Estados Unidos de Norteamérica, encargado de estandarizar y normalizar bajo estrictas especificaciones de control de calidad, diferentes materiales y equipos para la industria petrolera. Igualmente establece normas para el diseño, construcción y pruebas en instalaciones petroleras, incluyendo diseño de equipos y pruebas de laboratorio para derivados del petróleo.
ASME	American Society of Mechanical Engineers. Sociedad Americana de Ingenieros Mecánicos de Estados Unidos de Norteamérica, encargada de velar por la normalización de todo lo relacionado con la Ingeniería Mecánica.
ANSI	American National Standars Institute. Instituto Americano Nacional de Normas de los Estados Unidos de Norteamérica, encargado de coordinar y acreditar las normas técnicas que elaboran diferentes entidades especializadas, tales como la API, NFPA, ASME, etc., sobre diseño, fabricación, inspección y pruebas de equipos industriales utilizados en el montaje de plantas.
GPL	Gas Licuado del Petróleo, también conocido comúnmente como gas propano.
INTRA	Instituto Nacional de Tránsito y Transporte.

c. NORMAS CITADAS:

NFPA 77.	Electricidad Estática.
NFPA 11.	Sistemas de Espuma de Expansión Baja y de Agentes Combinados.
NFPA 70.	Código Eléctrico Nacional.
NFPA 30.	Código de Líquidos Combustibles e Inflamables.
NFPA 30A	Código para Estaciones de Servicio.
NFPA 22.	Tanques de Agua para Protección Contra Incendio en Propiedades Privadas.
NFPA 24.	Instalación de Tuberías de Servicio para Sistema Contra Incendio en Propiedades Privadas.
ANSI-B.31.3	Tuberías para Plantas Químicas y Refinerías de Petróleo.
API 650	Tanques de Almacenamiento Atmosférico.

ARTICULO 4. Modificado por el Art. 2o. Decreto 353/91. Las estaciones de servicio se clasificarán así:

CLASE A: Es el establecimiento de comercio que cumple con a definición estipulada en el artículo anterior y además de vender combustibles, tiene instalaciones adecuadas para prestar dos o más de los siguientes servicios: Lubricación, lavado general y de motor, cambio y reparación de llantas, alineación y balanceo y reparaciones menores. Además puede disponer de instalaciones para la venta de lubricantes, baterías, llantas, neumáticos, accesorios.

CLASE B: Es el establecimiento de comercio que cumple con la definición estipulada en el artículo anterior, dedicado principalmente a la venta de combustibles y además, puede tener instalaciones adecuadas para la venta de lubricantes, baterías, llantas, neumáticos y accesorios.

DE SERVICIO PRIVADO: Es aquella perteneciente a una empresa o institución destinada exclusivamente al suministro de combustibles para sus automotores. Se exceptúan de esta clasificación las estaciones d servicio de empresas de transporte colectivo, las que también están obligadas a prestar servicio al público, excepto cuando estén totalmente cercadas.

CAPITULO II

PLANTAS DE ABASTECIMIENTO

A. ESPECIFICACIONES TECNICAS, UBICACION, DISEÑO Y PLANOS.

ARTICULO 5. La ubicación, diseño, construcción, mejoras, ampliación, aforo y pruebas de las instalaciones de las plantas de abastecimiento de combustibles líquidos derivados del petróleo, deberán ceñirse a los requisitos que se establecen en el presente decreto y en las Normas ICONTEC. Para lo no estipulado en las normas mencionadas, se aplicara la Norma NFPA 30.

ARTICULO 6. El interesado que planee la construcción de una planta de abastecimiento de combustibles líquidos derivados del petróleo, deberá solicitar por escrito al Ministerio de Minas y Energía, la visita de un funcionario de la Dirección General de Hidrocarburos al lote donde se proyecta construir la planta, anexando una descripción general y justificación detallada de la misma; además, deberá incluir un plano general de localización, donde se señalen la ubicación de otras plantas de abastecimiento si existieren y sitios de alta densidad poblacional indicados en el artículo siguiente; capacidad de almacenamiento; combustibles que expenderá; zona de influencia que abastecerá; inversión aproximada y forma de abastecerse de los combustibles.

Parágrafo: El interesado que planee la ampliación o mejoras de una planta de abastecimiento de combustibles líquidos derivados del petróleo, deberá solicitar por escrito al Ministerio de Minas y Energía la visita de un funcionario de la Dirección General de Hidrocarburos con la finalidad de constatar todos los aspectos técnicos y decidir sobre la viabilidad de la misma.

ARTICULO 7: El funcionario que realice la visita de que trata el artículo anterior, deberá estudiar cuidadosamente la documentación presentada por el interesado y verificar que los planos presentados corresponden a la realidad; además, deberá tener en cuenta criterios de racionalización de la distribución de combustibles en el país de acuerdo a las plantas de abastecimiento ya existentes en el área de influencia, con miras a que el Ministerio de Minas y Energía pueda determinar la saturación o inconveniencia; su localización respecto a poliductos, refinerías, otras plantas de abastecimiento existentes en el área de influencia, así como también, distancias de los linderos de la planta proyectada a los linderos más próximos de sitios de alta densidad poblacional, tales como templos, escuelas, colegios, hospitales, clínica, supermercados; centros comerciales, teatros, polideportivos, bibliotecas públicas, clubes sociales, edificios multifamiliares y establecimientos similares, las que deberán ser mínimo de cien (100) metros.

ARTICULO 8. Realizada la visita y con base en el informe presentado por el funcionario de acuerdo con lo estipulado en el artículo anterior, el Ministerio de Minas y Energía autorizará o negará la construcción de la planta de abastecimiento, por medio de resolución motivada.

La resolución de autorización para la construcción de una planta de abastecimiento, tendrá una vigencia de seis (6) meses. Si transcurrido este término o se han presentado los planos indicados en el siguiente artículo, la autorización de construcción precluirá.

ARTICULO 9. Autorizada la construcción de una planta de abastecimiento de combustibles líquidos derivados del petróleo, el interesado deberá presentar a la Dirección General de Hidrocarburos del Ministerio de Minas y Energía para su estudio: Una memoria técnica con descripción detallada del proyecto; autorización de las entidades competentes para la preservación del medio ambiente en las zonas que lo requieran; autorización del Ministerio de Obras Públicas y Transporte en caso de que la planta de abastecimiento se ubique en vías de nacionales; copia auténtica del título de propiedad del lote, debidamente registrado, o prueba del correspondiente acto o negocio jurídico que le permita construir la planta de abastecimiento, y, los siguientes planos a escala adecuada y firmados por un ingeniero o arquitecto debidamente matriculado:

a. Plano de ubicación del lote, con indicación de: 1) cruces de calles; 2) líneas de alcantarillado; 3) punto de desagüe general de la planta; 4) localización de los establecimientos indicados en el artículo séptimo; 5) cables de alta tensión aéreos o enterrados en el área del lote; 6) ríos o quebradas; 7) conexiones a poliductos o refinerías de donde se abastecerá la planta.
Cuando no sea procedente el señalamiento de parte de la información solicitada en este literal, así deberá indicarse.

b. Plano general de la planta, con ubicación de las edificaciones de la misma, tanques, llenaderos, tuberías, casa de bombas, bodegas, talleres y red de instalación de agua para los sistemas contra incendio.

c. Plano de planta y cortes de los llenaderos.

d. Plano de los tanques de almacenamiento con el señalamiento de las siguientes características: espesores y tipo de acero de las láminas, diámetro, volumen, diámetro de los orificios, especificaciones de las válvulas y accesorios, y normas de construcción respectivas y producto, que se almacenará en cada tanque.

e. Plano de la red de tuberías para combustibles dentro de la planta, con indicación de tipo diámetro, espesor y presión máxima de trabajo.

f. Plano del sistema contra incendio.

g. Plano de los sistemas separadores de agua-producto y conexiones a alcantarillado o drenajes.

h. Plano del sistema eléctrico.

Parágrafo Primero: No se podrá iniciar ninguna construcción sin la aprobación previa de los planos por parte del Ministerio de Minas y Energía.

Parágrafo Segundo: No se podrán iniciar operaciones de las instalaciones de una planta de abastecimiento, sin la Licencia de Funcionamiento otorgado por el Ministerio de Minas y Energía.

Parágrafo Tercero: Todo cambio de producto a almacenar en lo tanques, deberá ser previamente autorizado por la Dirección General de Hidrocarburos del Ministerio de Minas y Energía.

ARTICULO 10. Los planos indicados en el artículo anterior se presentarán al Ministerio de Minas y Energía en dos (2) copias, una (1) de las cuales será devuelta al solicitante por la Dirección General de Hidrocarburos dentro de los sesenta (60) días hábiles siguientes, con la correspondiente constancia de aprobación o con las observaciones a que hubiese lugar.

Toda modificación de los planos deberá ser aprobada por el Ministerio de Minas y Energía antes de la iniciación de las respectivas obras.

ARTICULO 11.. El Ministerio de Minas y Energía podrá exigir por escrito información adicional en relación con el proyecto. Sus funcionarios previamente autorizados y debidamente identificados, podrán inspeccionar las obras en cualquier momento y comunicar al interesado por escrito las observaciones que estime conveniente.

ARTICULO 12. El alineamiento de las vías internas respecto a las oficinas, tanques, llenaderos, etc.; deberá ser tal que permita fácil acceso y cómoda circulación de los carrotanques y vehículos. Además, deberá disponerse de sitios adecuados para estacionar los vehículos, de modo que no obstaculicen la circulación. Las vías de doble circulación dentro de las plantas, tendrán un ancho mínimo de seis (6) metros.

ARTICULO 13. Los muros o paredes de las oficinas, talleres y bodegas deberán ser construidos con materiales incombustibles.

ARTICULO 14. Toda planta de abastecimiento de combustibles líquidos derivados del petróleo dispondrá de suficientes y adecuados servicios sanitarios, de acuerdo con el número de personas que allí laboren. Además, dispondrán de estos servicios para el público que llegue a retirar los productos.

ARTICULO 15. Las cañerías de desagüe serán de diámetro apropiado y desembocarán en los sitios autorizados por las empresas de acueducto y alcantarillado de la localidad o por la autoridad competente, teniendo en cuenta las normas sobre contaminación.

B. TANQUES DE ALMACENAMIENTO.

ARTICULO 16. Los tanques de almacenamiento podrán ser de techo fijo o flotante y serán diseñados, construidos y probados de acuerdo con la última edición de las normas API, en especial la 650 y sus apéndices.

ARTICULO 17. Para almacenar productos de alto punto de chispa o inflamación, es decir, superiores a 37.8 °C (100 °F), se pueden utilizar tanques atmosféricos de techo fijo con suelda débil.

Los productos con bajo punto de chispa, inferiores a 37.8 °C (100 °F), se podrán almacenar en tanques de techo o pantalla flotante, con el fin de aumentar la seguridad y disminuir la evaporación. Si se usan tanques de techo fijo con suelda débil, deberán acogerse a condiciones más exigentes de protección tal como se indica en el siguiente artículo.

TABLA No. 1

Capacidad del Tanque en Galones	Distancia Minima desde la pared del tanque al lindero de la propiedad vecina que esta o puede ser sometida a construcción, incluyendo el lado opuesto de una via pública.	Distancia Minima desde la pared del tanque al lado más próximo de cualquier via pública o del edificio importante más cercano de la misma propiedad.
	METROS	METROS
275 o menos	1.50	1.50
276 a 750	3.00	1.50
751 a 12,000	4.60	1.50
12,001 a 30,000	6.00	1.50
30,001 a 50,000	9.00	3.00
50,001 a 100,000	15.00	4.60
100,001 a 500,000	24.40	7.60
500,001 a 1,000,000	30.50	10.60
1,000,001 a 2,000,000	41.00	13.70
2,000,001 a 3,000,000	50.00	16.80
3,000,001 o más	53.40	18.30

PARAGRAFO: Tal como se indica en el articulo 7, la distancia minima desde los lideros de la planta proyectada a sitios de alta densidad ocupacional debe ser minimo de cien (100) metros.

ARTICULO 19. Las distancias minimas entre un tanque que almacene combustibles liquidos pesados con punto de inflamación superior a 93°C (clase IIIB NFPA y las edificaciones, vias de circulación, propiedades adyacentes y equipos son las siguientes:

Capacidad del Tanque en Galones	Distancia Minima desde la pared del tanque al lindero de la propiedad vecina que esta o puede ser sometida a construcción, incluyendo el lado opuesto de una via pública.	Distancia Minima desde la pared del tanque al lado más próximo de cualquier via pública o del edificio importante más cercano de la misma propiedad.
	METROS	METROS
12,000 o menos	1.50	1.50
12,001 a 30,000	3.00	1.50
30,001 a 50,000	3.00	3.00
50,001 a 100,000	4.60	3.00
100,001 o más	4.60	4.60

DISTANCIAS MINIMAS INTERNAS EN PLANTAS DE ABASTECIMIENTO Y A PROPIEDADES ADYACENTES PARA EL ALMACENAMIENTO DE COMBUSTIBLES LIQUIDOS DERIVADOS DEL PETROLEO

A) LIQUIDOS ESTABLES* (PRESION DE OPERACION MENOR DE 0.175 Kg/cm2)

Tipo de Tanque	Protección	Distancia minima desde la pared del tanque al lindero de la propiedad vecina que esta o puede ser sometida a construcción, incluyendo el lado opuesto de una via pública.	Distancia minima desde la pared del tanque al lado más próximo de cualquier via pública o del edificio importante más cercano de la misma propiedad.	Distancia minima desde la pared del tanque a equipo contra incendio, casas de bombas y demás equipos principales de la planta.	Distancia minima entre tanques adyacentes medida de pared a pared.
Techo Flotante	Areas expuestas Protegidas	1/2 diámetro del tanque (minimo 10 metros)	1/6 diámetro del tanque (minimo 5 metros)	1 diámetro del tanque (minimo 15 metros)	1/4 suma de los diámetros de los tanques adyacentes (minimo 2 metros)
	Sin proteccion	1 diámetro del tanque (minimo 20 metros)	1/6 diámetro del tanque (minimo 10 metros)		
Vertical con techo fijo, suelda debil	Areas expuestas Protegidas	1 diámetro del tanque (minimo 20 metros)	1/3 diámetro del tanque (minimo 5 metros)	1 diámetro del tanque (minimo 15 metros)	1/4 suma de los diámetros de los tanques adyacentes (minimo 2 metros)
	Sin protección	2 diámetros del tanque (minimo 40 metros)	1/3 diámetro del tanque (minimo 10 metros)		
	Tanque con protección de espuma o con gas inerte	1/2 diámetros del tanque (minimo 10 metros)	1/6 diámetro del tanque (minimo 5 metros)		
Horizontal y vertical con valvula de alivio	Areas expuestas Protegidas	1/2 veces la tabla No. 1	Una vez la tabla No. 1	1 diámetro del tanque (minimo 15 metros)	1/4 suma de los diámetros de los tanques adyacentes (minimo 2 metros)
	Sin protección	2 veces la tabla No. 1	Una vez la tabla No. 1		
	Sistemas de gas inerte o sistema de espuma en los tanques verticales	1/2 veces la tabla No. 1	1/2 veces la tabla No. 1		

000138

DISTANCIAS MINIMAS INTERNAS EN PLANTAS DE ABASTECIMIENTO Y A PROPIEDADES ADYACENTES PARA EL ALMACENAMIENTO DE COMBUSTIBLES LIQUIDOS DERIVADOS DEL PETROLEO

B) LIQUIDOS ESTABLES‡ (PRESION DE OPERACION MAYOR DE 0.175 Kg/cm2)

Tipo de Tanque	Protección	Distancia minima desde la pared del tanque al lindero de la propiedad vecina que esta o puede ser sometida a construcción, incluyendo el lado opuesto de una via pública.	Distancia minima desde la pared del tanque al lado más próximo de cualquier via pública o del edificio importante más cercano de la misma propiedad.	Distancia minima desde la pared del tanque a equipo contra incendio, casas de bombas y demás equipos principales de la planta.	Distancia minima entre tanques adyacentes medida de pared a pared.
Cualquier Tipo	Areas expuestas Protegidas	1 1/2 veces la tabla No.1 (minimo 10 metros)	1 1/2 veces la tabla No.1 (minimo 10 metros)		1/4 suma de los diámetros de los tanques adyacentes (minimo 2 metros)
	Sin protección	3 veces la tabla No. 1 (minimo 20 metros)	1 1/2 veces la tabla No.1 (minimo 10 metros)	1 diámetro del tanque (minimo 15 metros)	

‡ Cualquier liquido no definido como inestable

DISTANCIAS MINIMAS INTERNAS EN PLANTAS DE ABASTECIMIENTO Y A PROPIEDADES ADYACENTES PARA EL ALMACENAMIENTO DE COMBUSTIBLES LIQUIDOS DERIVADOS DEL PETROLEO

C) LIQUIDOS INESTABLES‡‡

Tipo de Tanque	Protección	Distancia mínima desde la pared del tanque al lindero de la propiedad vecina que esta o puede ser sometida a construcción, incluyendo el lado opuesto de una vía pública.	Distancia mínima desde la pared del tanque al lado más próximo de cualquier vía pública o del edificio importante más cercano de la misma propiedad.	Distancia mínima desde la pared del tanque a equipo contra incendio, casas de bombas y demás equipos principales de la planta.	Distancia mínima entre tanques adyacentes medida de pared a pared.
Horizontal y vertical con válvula de alivio que ventea a presión no mayor de 0.175 Kg/cm	Tanque protegido con cualquiera de los quientes sistemas: Rociador de agua, Gas inerte, Aislamiento y Refrigeración, Barrera	Tabla No.1 (mínimo 15 metros)	Mínimo 15 metros	1 diámetro del tanque (mínimo 15 metros)	1/4 suma de los diámetros de los tanques adyacentes (mínimo 2 metros)
	Áreas expuestas protegidas	2 1/2 veces la tabla No. 1 (mínimo 30 metros)	Mínimo 30 metros		
	Sin protección	5 veces la tabla No. 1 (mínimo 60 metros)	Mínimo 60 metros		
Horizontal y vertical con válvula de alivio que ventea a más de 0.175 Kg/cm	Tanque protegido con cualquiera de los quientes sistemas: Rociador de agua, Gas inerte, Aislamiento y Refrigeración, Barrera	2 veces la tabla No.1 (mínimo 30 metros)	Mínimo 30 metros	1 diámetro del tanque (mínimo 15 metros)	1/2 suma de los diámetros de los tanques adyacentes (mínimo 5 metros)
	Áreas expuestas protegidas	4 veces la tabla No. 1 (mínimo 60 metros)	Mínimo 60 metros		
	Sin protección	8 veces la tabla No. 1 (mínimo 90 metros)	Mínimo 90 metros		

‡‡Los que se polimerizan, descomponen, sufren reacción de condensación o se vuelven autoreactivos bajo condiciones de choque, presión o temperatura.

000410

DISTANCIAS MINIMAS INTERNAS EN PLANTAS DE ABASTECIMIENTO Y A PROPIEDADES ADYACENTES PARA EL ALMACENAMIENTO DE COMBUSTIBLES LIQUIDOS DERIVADOS DEL PETROLEO

D) LIQUIDOS QUE PRODUCEN EBULLICION DESBORDANTE

Tipo de Tanque	Protección	Distancia mínima desde la pared del tanque al lindero de la propiedad vecina que esta o puede ser sometida a construcción, incluyendo el lado opuesto de una vía pública.	Distancia mínima desde la pared del tanque al lado más próximo de cualquier vía pública o del edificio importante más cercano de la misma propiedad.	Distancia mínima desde la pared del tanque a equipo contra incendio, casas de bombas y demás equipos principales de la planta.	Distancia mínima entre tanques adyacentes medida de pared a pared.
Techo Flotante	Areas expuestas protegidas	1/2 diámetro del tanque (mínimo 10 metros)	1/6 diámetro del tanque (mínimo 5 metros)	1 diámetro del tanque (mínimo 15 metros)	1/2 suma de los diámetros de los tanques adyacentes (mínimo 5 metros)
	Sin protección	1 diámetro del tanque (mínimo 20 metros)	1/6 diámetro del tanque (mínimo 5 metros)		
Techo Fijo	Areas expuestas protegidas	2 diámetros del tanque (mínimo 30 metros)	2/3 diámetro del tanque (mínimo 10 metros)	1.5 diámetro del tanque (mínimo 20 metros)	1/2 suma de los diámetros de los tanques adyacentes (mínimo 5 metros)
	Sin protección	4 diámetros del tanque (mínimo 60 metros)	2/3 diámetro del tanque (mínimo 20 metros)		
	Tanque con Protección de Espuma o Gas Inerte	1 diámetro del tanque (mínimo 20 metros)	2/3 diámetro del tanque (mínimo 10 metros)		

000141

Parágrafo: Cada planta de abastecimiento deberá tener un laboratorio para el análisis de los productos, dotado, como mínimo, con equipos para la determinación de punto de chispa, ensayo de destilación y densidad.

ARTICULO 18. La distribución de tanques y demás instalaciones de una planta de abastecimiento de combustibles líquidos derivados del petróleo y su separación con respecto a propiedades adyacentes, deberá cumplir con las distancias mínimas indicadas en la tabla siguiente:

C. MUROS DE RETENCION.

ARTICULO 20. Todo tanque o grupo de tanques que contengan productos de petróleo, deberán estar rodeados por un muro de retención impermeabilizado. Este deberá construirse en concreto, tierra apisonada e impermeabilizada u otro material adecuado. La altura mínima de dichos muros será de sesenta (60) cm.. y la máxima será de dos (2) metros. Estos muros podrán protegerse con grama o pastos de poco crecimiento.

ARTICULO 21. Si un recinto rodeado por un muro de retención contiene un solo tanque, su capacidad neta será por los menos igual a la capacidad del tanque y se calculará, como si tal tanque no existiera. Esto último, teniendo en cuenta que en caso de máximo derrame del tanque, quedará en éste un nivel líquido igual a la altura del muro de retención.

Si el recinto de retención contiene dos o más tanques, su capacidad neta será por los menos igual a la del tanque de mayor capacidad dentro del recinto, más el diez por ciento (10%) de la capacidad de los otros tanques.

ARTICULO 22. El recinto deberá estar provisto de cunetas y sumideros interiores que permitan el fácil drenaje, cuyo flujo deberá controlarse con una válvula o brazo basculante ubicado en el exterior del recinto, que permita la rápida evacuación de las aguas lluvias o combustible que se derramen en una emergencia.

ARTICULO 23. Los tanques descansarán sobre bases firmes, sea de hormigón o de material resistente, seleccionado y compactado. En este último caso, entre el fondo del tanque y la base, se colocará una capa de arena impregnada de emulsión asfáltica.

Cuando haya varios tanques en un recinto común, deberán estar separados por un muro interior de cuarenta y cinco centímetros (45 cm..) de alto como mínimo, para cada tanque con capacidad de diez mil barriles (10.000 bls.) o más y por cada grupo de tanques que no excedan de una capacidad agregada de quince mil barriles (15.000 bls.).

ARTICULO 24. Se prohibe en el interior de los recintos el empleo permanente de mangueras flexibles. Su utilización se limitará a operaciones esporádicas de corta duración. Las motobombas de trasiego deberán estar situadas en el exterior de los recintos.

c. Señales preventivas en colores reflectivos;

d. Protección con un sistema de diluvio con espuma, diseñado de acuerdo con la norma NFPA 11. (16)

E. INSTALACIONES ELECTRICAS.

ARTICULO 34. Todo lo relacionado con las instalaciones eléctricas deberá cumplir con última versión de la Norma NFPA 70.

ARTICULO 35. Todo lo relacionado con la electricidad estática y conexiones a tierra deberá cumplir con ultima versión de la Norma NFPA 77.

F. EQUIPO CONTRA INCENDIO.

ARTICULO 36. En cada planta de abastecimiento, deberá instalarse como mínimo el equipo contra incendio a continuación descrito:

a. Extintores portátiles de mano en la siguiente forma:

Para Bodegas: Dos extintores de polvo químico de nueve (9) kilogramos cada uno, por cada cuatrocientos (400) metros cuadrados de área del piso;

Casa de Bombas: Un extintor de polvo químico de nueve (9) kilogramos por cada doscientos veinticinco (225) metros cuadrados de área del piso;

Llenaderos: Un extintor de polvo químico de nueve (9) kilogramos por cada dos brazos de llenado.

Oficinas: Un extintor multipropósito con una capacidad no inferior a cuatro y medio (4.5) kilogramos. Para el equipo electrónico, un extintor de Halon o de Gas Carbónico no inferior a cinco (5) kilogramos de capacidad;

b. Extintores sobre ruedas.

Un extintor portátil de carretel de polvo químico seco de sesenta y ocho (68) kilogramos por cada dos tanques de almacenamiento mayores de quinientos (500) barriles cada uno.

ARTICULO 37. Además de lo indicado anteriormente, toda planta de abastecimiento deberá tener un sistema de hidrantes y monitores para enfriamento y un mínimo de almacenamiento de agua contra incendio de cuatro horas, de acuerdo con las Normas **NFPA 22 y 24.** También deberá tener un sistema de aplicación y almacenamiento de espuma, en los términos de la Norma **NFPA 11.**

ARTICULO 25. Todas las tuberías y accesorios, dentro y fuera de los recintos o muros de retención, serán de acero-carbón. Las que se instalen dentro deberán diseñarse para resistir altas temperaturas.

D. TUBERIAS Y LLENADEROS.

ARTICULO 26: El diseño y construcción de las tuberías en una planta de abastecimiento deberá hacerse de acuerdo a la última edición de la Norma ANSI-B.31-3.

Para evitar contaminación durante el bombeo, cada producto deberá tener su propia linea de entrega o recibo.

ARTICULO 27. Todas la tuberías enterradas deberán estar protegidas en los cruces de carreteras y caminos, por tubería concéntrica u otro dispositivo equivalente. Los extremos de esta tubería deben sellarse para evitar corrosión del tramo enterrado.

Cuando las condiciones del suelo lo exijan, las líneas subterráneas deberán estar protegidas catódicamente.

ARTICULO 28. La distancia mínima desde las oficinas de la planta, hasta los llenaderos de carrotanques o ferrotanques será de 20 metros.

ARTICULO 29. Los llenaderos para ferrotanques deberán tener su propia área de parqueo, de acuerdo con los reglamentos de la Sociedad Colombiana de Transporte Ferroviario, (S.T.F.).

ARTICULO 30. Los llenaderos para carrotanques deberán ser ubicados de tal modo que permitan el fácil acceso y la rápida evacuación en caso de emergencia.

ARTICULO 31. El techo de un llenadero deberá ser de tal forma, que facilite la aireación y tener una altura suficiente para el manejo de los brazos de llenado en su posición más alta.

ARTICULO 32. La altura de la plataforma de un llenadero deberá permitir al operario alcanzar fácilmente las tapas de los carrotanques o ferrotanques. Cuando la operación de llenado lo requiera, la plataforma deberá estar provista de puentes móviles para el acceso de los vehículos de cargue, en tal forma que no estorben dicha operación.

ARTICULO 33. Toda plataforma deberá estar provista, al menos de:

a. Dos escaleras con una inclinación máxima de cuarenta y cinco grados (45°);

b. Conexiones a tierra para eliminar la corriente estática, una por cada brazo de llenado;

ARTICULO 38. Cada planta de abastecimiento deberá tener un equipo de respiración con un tanque de aire portátil, una camilla de emergencia y un botiquín de primeros auxilios que contenga los elementos necesarios y el procedimiento de utilización.

ARTICULO 39. Toda planta de abastecimiento de combustibles líquidos deberá contar con un sistema de comunicación confiable con los bomberos de la localidad y con las instalaciones vecinas relacionadas con la distribución y almacenamiento de combustibles.

ARTICULO 40. Toda planta de abastecimiento de combustibles líquidos deberá tener en forma escrita un plan de emergencia para casos de fugas o incendio. Así mismo, deberá tener una brigada u organización similar capaz de operar los sistemas y equipos de protección existentes y de poner en funcionamiento el plan de emergencia.

G. PRUEBAS, AFOROS, REVISIONES Y CALIBRACIONES.

ARTICULO 41. Terminada la etapa de construcción, el interesado solicitará la visita de un funcionario del Ministerio de Minas y Energía, con el fin de efectuar una revisión detallada de las instalaciones y edificaciones de acuerdo con los requisitos del presente decreto y presenciar el aforo, las calibraciones de las unidades de medida utilizadas en la entrega de combustibles y las pruebas de los tanques, así como la de tuberías y demás equipos.

Parágrafo Primero: Las pruebas de los tanques de techo fijo y flotante se harán de acuerdo con la última edición de la Norma **API-650** y sus apéndices.

Parágrafo Segundo: Las pruebas de las tuberías, válvulas, bridas y uniones, se harán de acuerdo con la última edición de la Norma **ANSI-B.31-3.**

ARTICULO 42. Terminada la visita de que trata el artículo anterior, se levantará el acta correspondiente, en la que se harán constar los resultados de las pruebas, aforos, calibraciones y revisiones. Además, deberá constar cualquier obra o trabajo adicional que deba realizarse con el fin de cumplir los requisitos con miras a la obtención de licencia de funcionamiento.

El acta deberá firmarse por el funcionario del Ministerio y por el representante del propietario de la planta, y además, por los responsables de las pruebas, calibraciones y aforos.

ARTICULO 43. El funcionario que efectúe la visita, deberá rendir informe escrito y pormenorizado sobre el resultado de la misma. El Ministerio de Minas y Energía comunicará por escrito al propietario de la planta los resultados de la visita y ordenará, si fuere el caso, ejecutar los trabajos u obras necesarias para que la planta reúna todos los requisitos con el fin de otorgarle la licencia de funcionamiento.

La aprobación de la licencia de funcionamiento de las plantas de abastecimiento de combustible derivados del petróleo se hará por resolución motivada.

ARTICULO 44. Es responsabilidad de las plantas de abastecimiento mayoristas de combustibles líquidos derivados del petróleo, mantener en todo tiempo debidamente calibradas las unidades de medida de sus equipos de entrega de combustibles. Para este fin, el recipiente utilizado en la calibración deberá estar debidamente certificado por el Centro de Control y Calidad y Metrología de la Superintendencia de Industria y Comercio u otra entidad debidamente acreditada ante el Ministerio de Minas y Energía. Este verificará periódicamente por medio de sus funcionarios o de quien delegue, que dicha calibración se ajuste a los parámetros del presente decreto.

ARTICULO 45. Cuando la autoridad competente verifique la calibración y el funcionamiento de las unidades de medida y los equipos de entrega de combustibles en las plantas de abastecimiento, se procederá así:

a. Se levantará un acta en la que se dejará constancia de todas las circunstancias observadas en la diligencia, la cual será suscrita por el respectivo funcionario y el distribuidor o el representan del propietario y servirá de base para la apertura de la investigación por eventuales infracciones, si fuere procente.

b. Se entenderá que una unidad de medida se encuentra descalibrada si al momento de verificar la calibración, el nivel de entrega está por encima o por debajo de la línea cero (0) de la escala de medida del calibrador, caso en el cual se procederá a realizar los ajustes correctivos de las fallas encontradas para que la unidad pueda seguir funcionando correctamente;

c. Sin en el curso de la diligencia no fuere posible hacer los ajustes necesarios, se procederá por parte del funcionario a condenar la unidad y ésta no podrá entrar a funcionar hasta tanto se hayan hecho las reparaciones correspondientes, se realice una nueva calibración y se envíe el acta correspondiente al Ministerio de Minas y Energía,

Parágrafo: Si durante la calibración de cualquier unidad de medida de entrega se encuentra una diferencia mayor de uno (1) por mil (1000), por debajo de la línea de referencia del calibrador, se impondrá la sanción correspondiente.