Designation: F1990 – 07 (Reapproved 2013)

Standard Guide for In-Situ Burning of Spilled Oil: Ignition Devices[1]

This standard is issued under the fixed designation F1990; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide relates to the use of in-situ burning of spilled oil. The focus of the guide is in-situ burning of oil on water, but the ignition techniques and devices described in the guide are generally applicable to in-situ burning of oil spilled on land as well.

1.2 The purpose of this guide is to provide information that will enable oil-spill responders to select the appropriate techniques and devices to successfully ignite oil spilled on water.

1.3 This guide is one of four related to in-situ burning of oil spills. Guide F1788 addresses environmental and operational considerations. Guide F2152 addresses fire-resistant booms, and Guide F2230 addresses burning in ice conditions.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.* In particular, the storage, transport, and use of ignition devices may be subject to regulations that will vary according to the jurisdiction. While guidance of a general nature is provided herein, users of this guide should determine regulations that apply to their situation.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D92 Test Method for Flash and Fire Points by Cleveland Open Cup Tester
D975 Specification for Diesel Fuel Oils
F1788 Guide for In-Situ Burning of Oil Spills on Water: Environmental and Operational Considerations
F2152 Guide for In-Situ Burning of Spilled Oil: Fire-Resistant Boom
F2230 Guide for In-situ Burning of Oil Spills on Water: Ice Conditions

3. Terminology

3.1 *Definitions:*

3.1.1 *fire point*—the lowest temperature at which a specimen will sustain burning for 5 s. **(Test Method D92)**

3.1.2 *flash point*—the lowest temperature corrected to a barometric pressure of 101.3 kPa (760 mm Hg), at which application of a test flame causes the vapor of a specimen to ignite under specified conditions of test. **(Test Method D92)**

4. Significance and Use

4.1 This guide describes the requirements for igniting oil for the purpose of in-situ burning. It is intended to aid decision-makers and spill-responders in contingency planning, spill response, and training, and to aid manufacturers in developing effective ignition devices.

4.2 This guide describes criteria for the design and selection of ignition devices for in-situ burning applications.

4.3 This guide is not intended as a detailed operational manual for the ignition and burning of spilled oil.

5. Overview of the Requirements for Igniting Spilled Oil on Water

5.1 The focus of this section is on the in-situ combustion of marine oil spills.

5.2 Successful ignition of oil on water requires two components: heating the oil such that sufficient vapors are produced to support continuous combustion, and then, providing an ignition source to start burning. The temperature at which the oil produces vapors at a sufficient rate to ignite is called the flash point. At a temperature above the flash point, known as the fire point, the oil will produce vapors at a rate sufficient to support continuous combustion.

5.3 For light refined products, such as gasoline and some unweathered crude oils, the fire point may be in the range of ambient temperatures, in which case, little if any, preheating would be required to enable ignition. For other oil products, and particularly those that have weathered or emulsified, or both, the fire point will be much greater than ambient temperatures, and substantial preheating will be required.

[1] This guide is under the jurisdiction of ASTM Committee F20 on Hazardous Substances and Oil Spill Responseand is the direct responsibility of Subcommittee F20.15 on In-Situ Burning.

Current edition approved April 1, 2013. Published July 2013. Originally approved in 1999. Last previous edition approved in 2007 as F1990 – 07. DOI: 10.1520/F1990-07R13.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

5.4 The energy required to raise the temperature of the surface of an oil slick to its fire point depends on the slick thickness. While the oil is being heated by an igniter, heat is being conducted and convected to the underlying water. If the slick is sufficiently thick to insulate against these heat losses and allow the surface layer of oil to heat to its fire point, the oil will start to burn in the vicinity of the igniter. The minimum ignitable thickness for most oils is about 2 to 3 mm (see Guide F1788).

5.5 Aside from oil type, other factors that can affect the ignitability of oil on water include the wind speed and the emulsification of the oil. Secondary factors include ambient temperature and waves. The effect of these factors can be summarized as follows:

5.5.1 The maximum wind speed for successful ignition for large burns has been estimated to be approximately 10 m/s (20 knots) (**1, 2**)[3].

5.5.2 For more rapid flame spreading, slicks should be ignited at the upwind edge.

5.5.3 Weathered oils require a longer ignition time.

5.5.4 The effect of water content is similar to that of weathering, more ignition time being required to ignite a slick of emulsion. Once an emulsified slick is ignited, heat from the fire may break the emulsion and overcome this problem. Emulsion-breaking chemicals can be used to aid in initial ignition attempts.

5.5.5 Emulsions are difficult, if not impossible, to ignite without the use of emulsion-breaking chemicals.

6. Overview of Available Ignition Devices

6.1 *Simple Ignition Techniques:*

6.1.1 Propane or butane torches, or weed burners, and rags or sorbent pads soaked in fuel have been used to ignite oil on water. Propane torches tend to blow thin oil slicks away from the flames and are most applicable to thick contained slicks. Diesel is more effective than gasoline as a fuel to soak sorbents or rags because it burns more slowly, and hence, supplies more preheating to the oil.

6.1.2 Another effective surface-based igniter is gelled fuel. Gelling agents can be used with gasoline, diesel, or crude oil to produce a gelled mixture that is ignited and placed in an oil slick.

6.2 *Hand-Held Igniters*—A variety of igniters have been developed for use as devices to be handthrown, either from ground level or from helicopters. These igniters have used a variety of fuels, including solid propellants, gelled kerosene cubes, reactive chemical compounds, and combinations of these. Burn temperatures for these devices range from 700 to 2500°C, and burn times range from 30 s to 10 min. Most hand-held igniters have delay fuses that provide sufficient time to throw the igniter and allow it and the slick to stabilize prior to ignition.

6.3 *Helicopter-Slung Ignition Systems*—These systems have been adapted from devices used for burning forest slash and for setting backfires during forest-fire control operations. These devices emit a stream of gelled fuel, generally gasoline or a mixture of gasoline, diesel, or crude oil, or a combination thereof. As the gelled fuel leaves the device, it is lighted by an electrically-ignited propane jet. The burning gelled fuel falls as a stream that breaks into individual globules before hitting the slick. The burning globules produce an 800°C flame for up to 6 min. Tank capacities for the gelled fuel mixture range from 110 to 1100 L (30 to 300 gal).

7. Ignition Device Test

7.1 The following is intended as a simple test to evaluate the ability of an ignition device to ignite a thick slick of weathered oil. The ignition test does not consider operability factors, such as safe operation of the device, accuracy of deployment, and reliability of ignition components.

7.2 The test parameters are intended to reflect minimum conditions for acceptable performance. More stringent conditions, such as higher wind speed or the use of weathered or emulsified oils, may be considered for some ignition devices.

7.3 *Test Apparatus*—The ignition test is carried out in an approximately square test container. The test container must have a surface area that is the greater of ten times the area covered by the ignition device, or 1 m^2. A typical test container would be a steel pan of the required dimensions. To minimize wind-shielding by the walls of the container, the fluid level must be within 25 mm of the top of the test container.

7.4 *Test Slick*—The ignition test is carried out on a layer of oil with a maximum thickness of 10 mm and with a minimum underlying water depth of 200 mm. The oil for the ignition test is Diesel Fuel Grade No. 2, which has a minimum flash point of 60°C (see Specification D975).

7.5 *Test Conditions*—At the start of the ignition test, the oil and water temperature must be no higher than 10°C. Throughout the test, the wind speed must be 5 m/s (10 knots) or greater.

7.6 *Initial Ignition Tests*—The test is initiated by activating the ignition device and deploying it into the test slick. It is recommended that initial tests be conducted by simply placing the ignition device on the test slick. The ignition test would be considered successful when flame is observed independent of the igniter, with flame covering the majority of the area of the test container.

7.7 *Tests for Air-Deployed Ignition Devices*—For igniters intended for deployment from helicopters, additional tests should be carried out to simulate air-deployment. These tests need not include ignition of oil but should include deployment of the device from a height of 10 m (minimum, measured from the device to the ground) to confirm that the device functions as intended during deployment. Tests should include deployment and operation of the device from a helicopter to ensure that the device can function in the presence of the helicopter's downwash.

7.8 *Test Record*—The test record must include the time for successful ignition, the actual container dimensions, the initial oil layer thickness, the underlying water depth, the air and

[3] The boldface numbers in parentheses refer to the list of references at the end of this standard.

water temperature at the start of the test, the wind speed, and any general observations of igniter performance.

7.9 *Optional Additional Tests*—In addition to the performance tests listed, consideration should be given to additional testing to address the following items depending on the intended application of the device:

7.9.1 The estimated accuracy of deployment of the ignition device on a target oil slick,

7.9.2 The resistance to damage of the device during deployment,

7.9.3 The performance in shallow pools (less than 100 mm deep) on solid ice,

7.9.4 The dependence on orientation of the igniter for proper performance,

7.9.5 Splash effects during impact with oil and water,

7.9.6 Effect on performance of temporary submergence of the igniter upon impact, and

7.9.7 Sensitivity to wind, rain, and sea state during ignition.

8. Operability

8.1 *Operating Instructions*—Operating instructions shall be supplied with the device and should include a description of the following items where applicable: safe operating procedures; required preparations of the igniter, or application system, or both, from storage to field use; type and amount of debris after use; training requirements; disposal requirements for spent igniters; and, retrieval and handling requirements for igniters that have misfired.

8.2 *Licensing for Transport and Use*—The ignition device must be approved for transport via cargo aircraft. Approvals, or pilot certifications, or both, may be required for devices intended for operation and deployment by helicopter. Users should note that pyrotechnic materials are not commonly transported by air and that such shipments often are rejected at the point of loading at the prerogative of the carrier despite any licensing or approvals.

8.3 *Stability During Flight*—For helicopter-slung devices, provision shall be made for stabilizing the device when carried by a swivel-hook helicopter. Any such stabilizing apparatus shall not impair the ability to jettison the device in the event of an emergency (see 9.3).

8.4 *Temperature Range*—The ignition device should function over an ambient temperature range of –10 to 30°C.

8.5 *Wind Conditions*—The ignition device should function, including deployment and operation from a helicopter, in wind conditions up to 10 m/s (20 knots).

9. Safety

9.1 *Unintended Activation*—The device should include protection against accidental activation.

9.2 *Delay Upon Activation*—For hand-held ignition devices, upon activation of the igniter, there should be a minimum delay of 20 s between the time the device is activated and it begins firing. It should be noted that excessive delay times may be troublesome in allowing the igniter to drift away from the target slick.

9.3 *Jettisoning of Equipment*—For helicopter-slung devices, provision shall be made for jettisoning of the device, including rapid disconnect of any power or control couplings.

9.4 *Operation*—Some ignition devices require an open flame or spark for activation, that may not be desirable or safe in certain applications, for example, for hand-held devices to be deployed from helicopters.

10. Storage

10.1 *Shipping and Storage Regulations*—The manufacturer of the device should specify shipping, handling, and storage instructions, and should note any limits on extreme temperatures, or humidity during storage, or both.

10.2 *Resistance to Degradation*—The device should function after exposure to temperature and humidity extremes and vibration that may be experienced during storage and shipping.

10.3 *Shelf-Life*—The device should have a minimum shelf-life of five years.

10.4 *Maintenance*—Operating instructions should specify any routine maintenance requirements, and should note components of the igniter that are subject to degradation, their expected shelf-life, and the procedure for refurbishment or replacement of parts following the normal shelf-life.

11. Keywords

11.1 ignition; in-situ burning; oil-spill burning; oil-spill disposal