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Temporary back-shell cover for an aircraft fuel tank

Abstract

Disclosed is a temporary protective cover for a back shell of a fuel probe wire harness located at a floor within an aircraft for use during inspection and/or maintenance of the aircraft fuel tank. The temporary protective cover includes a protecting portion and a securing portion. The protecting portion includes a body forming a hollow interior space configured to receive the back shell therein, a bottom side with an opening configured for passage of the back shell into and out of the hollow interior space, and a side with an upwardly extending slot therein for passage of the wire harness through the side into the hollow interior space. The bottom side is configured to engage the floor within the fuel tank when the back shell is located within the hollow interior space. The slot has an open lower end for passage of the wire harness vertically into the slot.

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Background/Summary

(1) Pursuant to 37 C.F.R. § 1.78 (a) (4), this application claims the benefit of and priority to prior filed co-pending Provisional Application Ser. No. 63/585,644, filed Sep. 27, 2023, which is expressly incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

(1) The present invention relates generally to systems, devices, and methods for inspecting and maintaining aircraft fuel tanks and, more particularly, to systems, devices, and methods for preventing damage to aircraft components within the aircraft fuel tanks when inspection and/or

maintenance personnel are required to drop into the aircraft fuel tanks.

BACKGROUND OF THE INVENTION

(2) A large percentage of properly inspecting and maintaining aircraft fuel tanks and their associated systems must be performed within an interior of the fuel tanks. Performing necessary inspection and maintenance tasks requires personnel to physically enter the tank, where many environmental hazards exist. These environmental hazards include fire, explosion, toxic and irritating chemicals, oxygen deficiency, and the confined nature of the fuel tank itself. In order to prevent related injuries to the personnel and damage to the aircraft, organizations must develop specific procedures for identifying, controlling, and/or eliminating hazards associated with fuel-tank entry.

(3) Physical characteristics of the fuel tank itself can create hazards and can also exacerbate fire, explosion, and toxicity hazards. Entry into most aircraft fuel tanks is through an access hole often less than two feet (0.6 meters) long and one foot (0.3 meters) wide. Though interior dimensions of aircraft fuel tanks vary considerably, all such fuel tanks have a limited volume. Thus, a relatively small amount of a chemical inside one of these enclosed spaces can create significant levels of flammable and/or toxic vapor.

(4) Personnel performing work within aircraft fuel-tanks also may damage the aircraft if they are not properly trained and equipped to avoid such damage. Such as, for example but not limited to, mating surfaces of the access opening and covers should be protected during entry so that the surfaces are not scratched or otherwise damaged. Also, components located within aircraft fuel tanks such as, for example but not limited to, fuel pumps, fuel-quantity systems, and associated wiring harnesses and conduits, are also vulnerable to damage if they are struck or dislodged. Components that particularly vulnerable are those components located below the access opening where personnel must drop into the aircraft fuel tank. Furthermore, containment properties of the fuel tanks can be compromised if sealant is damaged or dislodged or if fuel-tank bladders are penetrated.

(5) As a result, there is an ongoing desire to continuously improve training and equipment in order to further reduce injury to inspection and maintenance personnel and/or damage to the aircraft. Accordingly, there is a need for improved equipment for protecting components located within aircraft fuel tanks against damage when inspection and maintenance personnel are required to be inside the aircraft fuel tanks.

SUMMARY OF THE INVENTION

(6) The present invention overcomes the foregoing problems and other shortcomings, drawbacks, and challenges of performing inspections and maintenance within aircraft fuel tanks. While the invention will be described in connection with certain embodiments, it will be understood that the invention is not limited to these embodiments. To the contrary, this invention includes all alternatives, modifications, and equivalents as may be included within the spirit and scope of the present invention.

(7) According to one embodiment of the present invention, a temporary protective cover for a wire harness back shell located at a floor within a fuel tank of an aircraft for use during inspection and/or maintenance of the fuel tank. The temporary protective cover comprises a protecting portion and a securing portion. The protecting portion has body forming a hollow interior space configured to receive the back shell therein, a bottom side with an opening configured for passage of the back shell therethrough into and out of the hollow interior space, and a side with an upwardly extending slot therein for passage of the wire harness through the side into the hollow interior space. The bottom side is configured to engage the floor within the fuel tank when the back shell is located within the hollow interior space. The upwardly extending slot has an open lower end for passage of the wire harness vertically into the slot. The securing portion extends from the protecting portion and is configured to secure the protecting portion over the back shell.

(8) According to another embodiment of the present invention, an aircraft comprises a fuel tank

having a top wall with an access opening therein, a bottom wall having bulkhead fitting through which a wire harness passes through, and a back shell for the wire harness at the bulkhead fitting within the fuel tank and a temporary protective cover including a protecting portion and a securing portion extending from the protecting portion. The protecting portion has a body forming a hollow interior space configured to receive the back shell therein, a bottom side with an opening configured for passage of the back shell therethrough into and out of the hollow interior space, and a side with an upwardly extending slot therein for passage of the wire harness through the side into the hollow interior space. The bottom side is configured to engage the floor within the fuel tank when the back shell is located within the hollow interior space. The vertically extending slot includes an open lower end for passage of the wire harness vertically into the slot. The securing portion extends from the protecting portion and is configured to secure the protecting portion over the back shell.

(9) According to yet another embodiment of the present invention, is a method for temporarily protecting a back shell for a fuel probe wire harness located at a floor within a fuel tank of an aircraft during inspection and/or maintenance of the fuel tank. The method comprises the steps of removing a fuel probe from the fuel probe wire harness, installing a temporary protective cover over the back shell, performing inspection and/or maintenance within the fuel tank after the step of installing the temporary protective cover, removing the temporary protective cover from the back shell after the step of performing inspection and/or maintenance, and reinstalling the fuel probe to the fuel probe wire harness. The temporary protective cover comprises a protecting portion and a securing portion extending from the protecting portion and configured to secure the protecting portion over the back shell. The protecting portion has a body forming hollow interior space configured to receive the back shell therein, a bottom side with an opening configured for passage of the back shell therethrough into and out of the hollow interior space, and a side with an upwardly extending slot therein for passage of the wire harness through the side into the hollow interior space. The bottom side is configured to engage the floor within the fuel tank when the back shell is located within the hollow interior space. The slot has an open lower end for passage of the wire harness vertically into the slot.

(10) Additional objects, advantages, and novel features of the invention will be set forth in part in the description which follows, and in part will become apparent to those skilled in the art upon examination of the following or may be learned by practice of the invention. The objects and advantages of the invention may be realized and attained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the present invention and, together with a general description of the invention given above, and the detailed description of the embodiments given below, serve to explain the principles of the present invention.

(2) FIG. **1**A is a perspective view of an exemplary aircraft.

(3) FIG. **1**B is a top plan view of the aircraft of FIG. **1**.

(4) FIG. **1**C is left side elevational view of the aircraft of FIGS. **1** and **2**.

(5) FIG. **2**A is a perspective diagrammatic view of internal fuel tanks of the exemplary aircraft of FIGS. **1**A to **1**C including an F**1** fuel tank located behind a cockpit of the exemplary aircraft.

(6) FIG. **2**B is a top plan diagrammatic view of the internal fuel tanks of the exemplary aircraft of FIGS. **1**A to **1**C including the F**1** fuel tank located behind the cockpit of the exemplary aircraft.

(7) FIG. **2**C is a left-side elevational diagrammatic view of the internal fuel tanks of the exemplary

aircraft of FIGS. **1**A to **1**C including the F**1** fuel tank located behind the cockpit of the exemplary aircraft.
(8) FIG. **3**A is a downward view into the F**1** fuel tank of the exemplary aircraft of through a top access opening of the F**1** fuel tank.
(9) FIG. **3**B is an enlarged portion of FIG. **3**A showing a wiring harness extending over a bottom wall of the F**1** fuel tank below the top access opening of the F**1** fuel tank.
(10) FIG. **4**A is a top view of a temporary protective cover installed over the wiring harness of FIGS. **3***a* and **3**B according to the present invention.
(11) FIG. **4**B is a side view of the temporary protective cover installed over the wiring harness of FIGS. **3***a* and **3**B according to the present invention.
(12) FIG. **5**A a top/front perspective view of the temporary protective cover of FIGS. **4**A and **4**B.
(13) FIG. **5**B a top/rear perspective view of the temporary protective cover of FIG. **5**A.
(14) FIG. **5**C is top/left-side perspective view of the temporary protective cover of FIGS. **5**A and **5**B.
(15) FIG. **5**D is a bottom/rear perspective view of the temporary protective cover of FIGS. **5**A to **5**C.
(16) FIG. **5**E is a top plan view of the temporary protective cover of FIGS. **5**A to **5**D.
(17) FIG. **5**F is a right-side elevational view of the temporary protective cover of FIGS. **5**A to **5**E.
(18) FIG. **5**G is a front elevational view of the temporary protective cover of FIGS. **5**A to **5**F.
(19) FIG. **5**H is a bottom plan view of the temporary protective cover of FIGS. **5**A to **5**G.
(20) FIG. **5**I is a left-side elevational view of the temporary protective cover of FIGS. **5**A to **5**H.
(21) FIG. **5**J is a rear elevational view of the temporary protective cover of FIGS. **5**A to **5**I.
(22) It should be understood that the appended drawings are not necessarily to scale, presenting a somewhat simplified representation of various features illustrative of the basic principles of the invention. The specific design features of the sequence of operations as disclosed herein, including, for example, specific dimensions, orientations, locations, and shapes of various illustrated components, will be determined in part by the particular intended application and use environment. Certain features of the illustrated embodiments have been enlarged or distorted relative to others to facilitate visualization and clear understanding. In particular, thin features may be thickened, for example, for clarity or illustration.

DETAILED DESCRIPTION OF THE INVENTION

(23) The following examples illustrate particular properties and advantages of some of the embodiments of the present invention. Furthermore, these are examples of reduction to practice of the present invention and confirmation that the principles described in the present invention are therefore valid but should not be construed as in any way limiting the scope of the invention.
(24) FIGS. **1**A to **1**C illustrate an aircraft **100** in an exemplary embodiment of the present invention. The term “aircraft” is used herein to describe a machine or device, such as an airplane, helicopter, glider, dirigible, and the like capable of atmospheric flight. The illustrated aircraft **100** is a F-35 which is a single-seat, single engine, all weather stealth multiple role combat aircraft produced by Lockheed Martin. The aircraft **100** includes a fuselage **102** having a cockpit **104** for a pilot located behind a nose cone **106** of the fuselage **102**. Located within the nose cone **106** is an active electronically scanned array (AESA) radar system as well as other sensors. The illustrated aircraft **100** also includes a right and left wings **108**, **110** that laterally extend outward from opposed sides of the fuselage **102**. Right and left horizontal tail members **112**, **114** extend rearward and laterally outward from a rear end of the fuselage **102**. The wing-tail configuration includes right and left upward extending and laterally spaced-apart vertical stabilizers **116**, **118** that are canted for stealth performance. The single engine is located within the fuselage **102** and is provided with forward facing right and left air inlets **120**, **122** located just behind the cockpit **104** and a thrust nozzle **124** located at a tail of the fuselage **102**. It is noted that the illustrated aircraft **100** is exemplary of a suitable aircraft for application of the present invention only and the aircraft **100**

can alternatively have any other suitable form, purpose, and/or configuration.
(25) As best shown in FIGS. **2**A to **2**C, the illustrated aircraft **100** also includes a plurality of internal fuel tanks **126** located throughout out the aircraft **100**. The illustrated fuel tanks **126** are located within the fuselage **102**, the right and left wings **108**, **110**, and the right and left vertical stabilizers **116**, **118**. Located within the fuselage **102**, from front to rear, are a first fuselage tank F**1**, a second fuselage tank F**2**, right and left third fuselage tanks F**3**R, F**3**L, right and left fourth fuselage tanks F**4**R, F**4**L, and right and left fifth fuselage tanks F**5**R, F**5**L. Located within the wings **108**, **110** are right-wing and left-wing tanks WR, WL. Located within the stabilizers **116**, **118** are right-stabilizer and left-stabilizer tanks SR, SL. The first fuselage tank F**1** is the main engine feed tank and is located behind the cockpit **104**. The first fuselage tank F**1** has a hollow interior space or cavity with a depth of about 6 feet between a top wall or ceiling **128** and a bottom wall or floor **130**. An access opening or hatch **132** is located in the top wall **128** in order to provide access to the interior of the first fuselage tank F**1** to inspection and maintenance personnel. The illustrated access opening **132** is sized about 18 inches by 18 inches. In order to enter the first fuselage tank F**1**, a technician must lower themselves feet first through the access opening **132** and drop to the floor **130**. It is noted that the fuel tanks **126** of the aircraft **100** can alternatively have any other suitable size, quantity, and/or configuration.
(26) FIGS. **3**A and **3**B show the inside of the first fuselage tank F**1** when looking downward toward the floor **130** of the first fuselage tank F**1** through the access opening **132**. Located at the floor **130** below the access opening **132** are two separate and spaced apart harness assemblies **134** for connecting two fuel level probes **136**, which measure the amount of fuel located within the first fuselage tank F**1**, to aircraft control systems (not shown). Each of the illustrated harness assemblies **134** includes a wire harness **137** at least partially bound and/or protected by a braided sleeve **138**. It is noted that any other suitable binding and/or protection means can alternatively be utilized. The term “wire harness”, also known as a wiring harness, cable harness, cable assembly, wire assembly, wiring assembly, or wiring loom, is used in this specification and in the claims to mean one or more electrical cables or wires which transmit signals or electrical power and are typically bound together.
(27) The illustrated harness assemblies **134** also include a bulkhead or bulkhead fitting **139** that passes through the floor **130** of the first fuselage tank F**1** which enables the wire harness **137** to pass through the floor **130** of the first fuselage tank F**1** in a sealed manner. Therefore, when replacing the wire harness **139**, extra aircraft down time is needed because access to the opposite end of the wire harness **139** located below the first fuselage tank F**1** is low observable (LO) intrusive.
(28) The illustrated harness assemblies **134** further include a back shell **140** located at the bulkhead fitting **139** within the first fuselage tank K**1**. The term “back shell” is used in this specification and claims to mean a component that attaches to the back of a connector or other structure that is often designed to guide the wires and/or cables and can be mated with strain relief components, environmental seals, shielding etc. if desired. The back shell **140** can be made from metal or any other suitable material and can be attached or molded over the bulkhead fitting **139**. The illustrated back shell **140** forms a 90-degree angle in the wire harness **137** so that the wire harness **137** perpendicularly extends through the floor **130**- and then turns 90 degrees so that it extends generally parallel along the inner side of the floor **130** within the first fuselage tank K**1**. The illustrated back shell also includes a clamp secured by mechanical fasteners to secure the wire harness **137** in position. However, the back shell **140** can alternatively have any other suitable configuration. Each wire harness **134** extends within the first fuselage tank F**1** from the back shell **140** to a connection with one of the fuel level probes **136**.
(29) Also provided within the first fuselage tank F**1** are one or more mounting or supporting brackets **142** that are each rigidly connected to the floor **130** of the first fuselage tank F**1**. The illustrated mounting bracket **142** is generally L-shaped and formed of sheet metal. The illustrated

mounting bracket **142** is formed of aluminum but any other suitable material can be utilized. The illustrated mounting bracket **142** includes a first leg or web **144** and a second leg or web **146** with a 90-degree bend therebetween. The first leg **144** of the mounting bracket **142** is rigidly and removably secured to a flange **148** vertically extending from the floor **130** of the first fuselage tank F**1** The illustrated first leg **144** is secured to the flange **148** by a plurality of threaded fasteners **150** but it is noted that the mounting bracket **142** can alternatively be secured in any other suitable manner. The second vertically extending leg **146** extends perpendicularly from the flange **148** generally toward the back shell **140** in a cantilevered manner. Fasteners **152** are mounted to the second leg **146** of the mounting bracket **142** for fastening and/or supporting items thereto. It is noted that the mounting bracket **142** can alternatively have any other suitable size and/or configuration.

(30) FIGS. **4**A and **4**B show the harness assembly **134** with a temporary protective cover **154** installed over the bulkhead fitting **139**, the back shell **140**, and a portion of the wire harness **139** adjacent the back shell **140**. The illustrated temporary protective cover **154** includes a protecting portion **154**A and a securing portion **154**B. The protecting portion **154**A is configured to temporarily protect at least the back shell **140** portion of the harness assembly **134** against technicians inadvertently dropping onto it and/or striking or kicking into it while remaining out of the way of inspection and/or maintenance being performed. The illustrated protective portion **154**A includes a body sized and shaped to receive and cover the back shell **149** and an open bottom forming a bottom edge to engage the floor **130** about the back shell **140**. The illustrated securing portion **154**B is configured to secure the protecting portion **154**A in place over the back shell **140**. The illustrated securing portion **154**B temporarily engage the mounting bracket **142** to secure the protecting portion **154**A in position over the back shell **140**. It is noted that the protecting portion **154**A and/or the securing portion **154**B can be configured in any other suitable manner.

(31) The illustrated temporary protective cover **154** is also provided with a “Remove Before Flight” Banner **156**. The illustrated banner **156** is secured to the temporary protective cover **154** by a wire ring extending through a grommet of the banner **156**. It is noted that the banner can alternatively be attached to the temporary protective cover **154** in any other manner. It is also notated that the banner can alternatively have any other suitable configuration or the banner **156** can be eliminated if desired.

(32) FIGS. **5**A to **5**J illustrate a temporary protective cover **154** having the protecting portion **154**A and the securing portion **154**B according to an embodiment of the present invention. The illustrated protecting portion includes a body **158** which forms a hollow interior cavity or space **160** and a bottom side or face **162** that forms an opening **163** into the interior cavity **160**. The illustrated hollow body **158** is shaped as a square cuboid, also referred to as a right squire prism, because it has right and left sides or faces **164**, **166** which are square shaped and front, back, top, and bottom sides or faces **168**, **170**, **172**, **162** which each are rectangular shaped or rectangular frame shaped in the case of the bottom side or face **162**. The illustrated right, left, front, back, and top sides or faces **164**, **166**, **168**, **170**, **172** are formed by planar walls of substantially constant thickness that are connected at right angles. Thus, the edges and corners of the body **158** are all sharp. It is noted that alternatively one or more of the walls can have a non-constant thickness and/or one or more of the edges and corners can be radiused or rounded if desired. The illustrated bottom side or face **162** is formed by bottom edges of the right, left, front, and back walls and is substantially planar to engage the floor **130** of the first fuselage tank F**1** when temporarily installed over the harness assembly **134**. Inner sides of the bottom edges of the right, left, front, and back walls form the opening **163** into the interior cavity **190**. It is noted that alternatively the bottom side could be partially formed by a bottom wall, one or more flanges, or the like if desired. The illustrated right and left sides or faces **164**, **166** are provided with openings **174** sized and shaped for passage of the wire harness **137** through the hollow body **158**. The illustrated openings **174** are each centrally located in the forward/rearward direction and are vertically extending slots extending through the bottom edges

of the right and left sides or faces **164**, **166** so that the hollow body **158** can be lowered over the wire harness **137** such that the wire harness **137** enters the openings **163** through their open lower ends. The upper end of the openings **163** is provided with a radius to provide a hemispherical shape. It is noted that the openings **163** can alternatively have any other suitable size, quantity, shape and/or configuration. The hollow body **158** is sized, shaped, and configured to cover and enclose at least a portion of the harness assembly **134**. In the illustrated embodiment, at least the back shell **140** of the harness assembly **134** is covered and enclosed by the hollow body **158**. It is noted that the protecting portion **154**A can alternatively have any other suitable size, shape and/or configuration.

(33) The illustrated securing portion **154**B includes an arm **176** extending rightward from the right face or side **164** of the hollow body **158** and a flange **178** extending rightward from the right face or side **164** of the hollow body **158** and rearward from the arm **176**. The illustrated arm **176** is a vertically oriented and rectangularly shaped planar sheet that has a substantially uniform thickness between a front side or face **180** and a rear side or face **182**. The illustrated top edge of the arm **180** is a smooth extension of the top side or face **172** of the hollow body **158**. The illustrated arm **176** is spaced rearwardly from the front side or face **168** of the hollow body **158** and is located just forward of the front side of the wire harness opening **174**. It is noted that the arm **176** can alternatively have any other suitable size, shape, location, and/or configuration. The illustrated flange **178** is a horizontally oriented and triangular shaped planar sheet that has a substantially uniform thickness between a top side or face **184** and a bottom side or face **186**. The illustrated top side or face **184** of the flange **178** is a smooth extension of both the top side or face of the hollow body **158** and the top edge of the arm **176**. The illustrated flange extends the full length of the arm **176** from the hollow body **158** to the rightward. The illustrated flange **178** has a width that extends from the arm **176** to the back side or face **170** of the hollow body **158** at its leftward end and the width linearly reduces in the rightward direction until the flange **178** has no width at the rightward end of both the arm **176** and the flange. It is noted that the flange **178** can alternatively have any other suitable size, shape, location, and/or configuration.

(34) The illustrated arm **176** is configured cooperate with the mounting bracket **142** within the first fuselage tank F**1** to secure the hollow body **158** in its desired position. Specifically, the illustrated arm **176** is configured to be positioned parallel to and adjunct the second leg **146** of the mounting bracket **142** so that fastener openings **188** in the arm **176** are aligned with the fasteners **152** in the second leg **146** of the mounting bracket **142** so that they can receive the fasteners **152** to secure the arm **176** to the mounting bracket **142**. The illustrated arm **176** has three fastener openings **188** in a triangular pattern to match the mounting bracket **142**. It is noted that the arm **176** can alternatively have any other suitable quantity and/or configuration of fastener openings **188**. The illustrated flange **178** is provided with an opening or through hole **190** for cooperating with the wire ring of the banner **156** to secure the banner **156** to the flange **178**. The illustrated opening **190** is located near the rightward end of the flange **178** but the opening **190** can alternatively be located at any other location on the flange, the arm **176**, or the temporary protective cover **154**. Banner opening. It is noted that the supporting portion **154**B can alternatively have any other suitable size, shape and/or configuration.

(35) Preferably, the temporary protective cover **154** is a unitary component that comprises a plastic material. The term “unitary component” is used herein and in the claims to mean a component having the character of a unit that is not dividable such as, for example but not limited to, a molded component. More preferably, the temporary protective cover **154** comprises a plastic material which fails prior to a component of the aircraft when over loaded. For example, but not limited to, the temporary protective cover **154** fails prior to the aluminum mounting bracket **154** to which the temporary protective cover **154** is secured when over loaded. Even more preferably, the temporary protective cover comprises ASA (acrylonitrile styrene acrylate). When testing a temporary protective cover **154** comprising ASA, it failed prior to failure of the aluminum mounting bracket

142 when the temporary protective cover was accidentally kicked with excessive force, but it prevented damage to any aircraft components and did not interfere with the work of the inspection and/or maintenance personnel. It is noted that the temporary protective cover **154** can alternatively comprise any other suitable material.

(36) Preferably, the temporary protective cover **154** is formed by any of a variety of 3D printing or additive manufacturing processes. It is noted, however, that the temporary protective cover **154** can alternatively be manufactured by any other suitable manufacturing process.

(37) When the fuel tank F**1** is to be inspected and/or maintenance is to be performed, personnel enter the fuel tank F**1** through the access opening **132** feet first and drop to the floor **130** while trying to avoid dropping onto any of one or probe probe harness back shells **140** located therein. For the primary fuel tank F**1** of the illustrated F-**35** aircraft **100**, two probe harness back shells **140** are mounted directly underneath the access opening **132** for the fuel tank F**1** (best shown in FIGS. **3**A and **3**B). Initially, each fuel level probe **136** is removed. Then each temporary protective cover **154** is temporarily installed by placing the protecting portion **154**A of the temporary protective cover **154** over the back shell **140** such that the bottom side or face **162** of the protecting portion **154**A engages the floor **130** of the fuel tank F**1**. The wire harness **137** extending from the back shell **140** passes through one of the wire openings **174** in the protecting portion **154**A. The securing portion **154** of each temporary protective cover **154** is then secured to hold the protecting portion **154**A in its desired location. In the illustrated embodiment, the securing portion **154**B is secured to the associated mounting bracket **142** with fasteners **152**. The fasteners **152** can be threaded fasteners, quick release fasteners, or any other suitable type of fasteners. Inspection and/or maintenance procedures are then be performed by appropriate personnel. Once the inspection and maintenance procedures are complete, the securing portion **154** of each temporary protective cover **154** is disconnected from the associated mounting bracket **142**. With the securing portion **154** of the temporary protective cover **154** disconnected from the mounting bracket **142**, The protecting portion **154**A of each temporary protective cover **154** is lifted up off of the floor **130** so that the protecting portion **154**A is no longer covers the back shell **140**. With Each temporary protective cover **154** removed, each fuel level probe **136** is reinstalled. Each temporary protective cover **154** is then removed from the fuel tank F**1** along with the inspection and/or maintenance personnel.

(38) The terms “comprises,” “comprising,” “includes,” “including,” “has,” “having,” or any other variations thereof used herein, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. An element preceded by “comprises . . . a” does not, without more constraints, preclude the existence of additional identical elements in the process, method, article, or apparatus that comprises the element.

(39) Reference to “one embodiment,” “certain embodiments,” “an embodiment,” “implementation(s),” “aspect(s),” or similar terms used herein means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, the appearances of such phrases or in various places throughout this specification are not necessarily all referring to the same embodiment. Furthermore, the particular features, structures, or characteristics may be combined in any suitable manner in one or more embodiments without limitation.

(40) The term “or” as used herein is to be interpreted as an inclusive or meaning any one or any combination. Therefore, “A, B or C” means “any of the following: A; B; C; A and B; A and C; B and C; A, B and C.” An exception to this definition will occur only when a combination of elements, functions, steps or acts are in some way inherently mutually exclusive. Also, grammatical conjunctions are intended to express any and all disjunctive and conjunctive combinations of conjoined clauses, sentences, words, and the like, unless otherwise stated or clear from the context. Thus, the term “or” should generally be understood to mean “and/or” and so forth.

(41) All patents, patent applications (and any patents which issue thereon, as well as any corresponding published foreign patent applications), publications, and other documents mentioned throughout this description are hereby incorporated by reference herein. It is expressly not admitted, however, that any of the documents incorporated by reference herein teach or disclose the present invention.
(42) The words “about,” “approximately,” or the like, when accompanying a numerical value, are to be construed as indicating a deviation as would be appreciated by one of ordinary skill in the art to operate satisfactorily for an intended purpose.
(43) It should be understood that every maximum numerical limitation used herein includes every lower numerical limitation, as if such lower numerical limitations were expressly written herein. Every minimum numerical limitation used herein includes every higher numerical limitation, as if such higher numerical limitations were expressly written herein. Every numerical range herein includes every narrower numerical range that falls within such broader numerical range, as if such narrower numerical ranges were all expressly written herein.
(44) For simplicity and clarity of illustration, reference numerals may be repeated among the figures to indicate corresponding or analogous elements. Numerous details are set forth to provide an understanding of the embodiments described herein. The embodiments may be practiced without these details. In other instances, well-known methods, procedures, and components have not been described in detail to avoid obscuring the embodiments described. The description is not to be considered as limited to the scope of the embodiments described herein.
(45) References herein to items in the singular should be understood to include items in the plural, and vice versa, unless explicitly stated otherwise or clear from the text.
(46) While the present invention has been illustrated by a description of one or more embodiments thereof and while these embodiments have been described in considerable detail, they are not intended to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. The invention in its broader aspects is therefore not limited to the specific details, representative apparatus and method, and illustrative examples shown and described. Accordingly, departures may be made from such details without departing from the scope of the general inventive concept.

Claims

1. An aircraft comprising: a fuel tank includes a top wall with an access opening therein, a bottom wall having bulkhead fitting through which a wire harness passes through, and a back shell for the wire harness at the bulkhead fitting within the fuel tank; a temporary protective cover including a protecting portion and a securing portion extending from the protecting portion; wherein the protecting portion has a body forming a hollow interior space configured to receive the back shell therein, a bottom side with an opening configured for passage of the back shell therethrough into and out of the hollow interior space, and a side with an upwardly extending slot therein for passage of the wire harness through the side into the hollow interior space; wherein the bottom side is configured to engage the floor within the fuel tank when the back shell is located within the hollow interior space, wherein the upwardly extending slot has an open lower end for passage of the wire harness vertically into the slot; and wherein the securing portion extends from the protecting portion and is configured to secure the protecting portion over the back shell.
2. The protective cover of claim 1, wherein the protecting portion has a planar top side.
3. The protective cover of claim 1, wherein the protecting portion is shaped as a square cuboid.
4. The protective cover of claim 3, wherein the side with the upwardly extending slot for passage of the wire harness through is located on a right side of the protecting portion and another upwardly extending slot for passage of the wire harness through is located on a left side of the protecting portion.

5. The protective cover of claim 4, wherein the securing portion is a vertically oriented planar flange extending from the right side of the protecting portion adjacent the upwardly extending slot and having at least one fastener opening therein.
6. The protective cover of claim 1, wherein the securing portion is a vertically oriented planar flange extending from the side of the protecting portion adjacent the upwardly extending slot and having at least one fastener opening therein.
7. The protective cover of claim 1, wherein the protective portion and the securing portion are a unitary component formed of plastic.
8. The protective cover of claim 7, wherein the plastic of the protective portion and the securing portion each comprise acrylonitrile styrene acrylate.
9. The protective cover of claim 1, wherein the aircraft is an F-35.