

# Fuel Cell Procedure

<b>Document No.:</b> 3350-00002	<b>Title/Description:</b> Fuel Cell Fill Procedure		
<b>Author:</b> Kurt Stiffel	<b>Approved by:</b>	<b>Revision:</b> 1-00	<b>Effective Date:</b>

## 1.0 Reference Documents

All released OOI documents in Alfresco  
 3161-20000 Fuel Cell Integration and Verification Plan  
 3350-00003 Fuel Cell Drain Procedure  
 3350-00004 Spill Response Procedure

Fuel cell reference documents are located on VAULT at:  
 Vault\Project\_Files\Documentation\Power\Power Notebook\Fuel Cell\

## 2.0 Definitions & Acronyms

See Section 3.0 of document 3161-20000

## 3.0 Training Requirements

All personnel that will handle the methanol (including contractors) at WHOI facilities are required to complete WHOI's hazard communication and chemical safety online training and follow WHOI's hazardous communication and chemical safety procedure. Contact the WHOI EH&S office for links to required training courses and documentation. Information can also be found at <http://ehs.who.edu/ehs/>.

## 4.0 Required PPE and Safety Notes

All personnel within a 25 foot radius of the buoy are required to don splash protection goggles and chemical resistant gloves. These can include polyvinyl plastic, neoprene or rubber.

Contact information for **WHOI EH&S** is 508-289-3347.

Ensure operations are performed in compliance with applicable WHOI/SIO/OSU safety protocols, OOI Safety Plan (1006-10002) and CGSN EH&S Plan (3101-00009). Read and follow all safety warnings in the MSDS. Once the Safety Review in Section 8.1 is complete, have each operator sign-off in the signature block.

## 5.0 Required Tools & Equipment

Buoy Fueling Assembly consisting of:

- 10' Fill Tube with valve and Quick Disconnect, 3/4" OD (1)
- 15' Fill Tube with valve and Quick Disconnect, 3/4" OD (1)
- 25' Vent Tube and Quick Disconnect, 3/4" OD (1)
- 25' Pressure Gauge and Pressure Sensor Tube, 1/4" OD (1)
- 55 Gallon Drum Pump on stand with Quick Disconnects (1)
- 55 Gallon Drum Wrench (1)
- 30' Drum-Buoy Bonding Cable (1)
- 10' Drum-Ground Grounding Cable (1)
- 55 Gallon Drum Premixed Methanol Fuel (6)
- 55 Gallon Drum Grounding Rod (1)

- 9/16" Wrench (1)
- 1/2" Wrench (1)
- 1-1/8" Wrench (1)
- 1-1/16" Wrench (1)
- Pipe Wrench (1)
- Isopropyl Alcohol (A/R)
- Large Plastic Bags (A/R)

Chemical Resistant Gloves (A/R)  
 Splash Protection Goggles (A/R)  
 PIG Spill Kit (1)  
 Kim Wipes (A/R)  
 Teflon Tape (A/R)  
 Fire Extinguisher, ABC (1)  
 Traffic Cones or Caution Tape (A/R)  
 Zip Ties, Large (A/R)  
 Extension Cord (A/R)

**6.0 Fueling Precautions**

Unused fuel and empty fuel drums shall be stored outside of the main building in an approved storage enclosure. Coordinate with the local EH&S department if a specific location has not yet been determined.

Only one fuel container shall be handled at a time during operations. Keep all additional containers in the approved storage enclosure.

Only one container shall be open at a time during fuel transfer.

The area around the buoy shall be marked off with cones or safety tape and monitored during operations.

Only personnel directly involved with fueling should be within 25 feet of the mooring during operations.

A solvent spill kit capable of absorbing the entire contents of each shipping container (drum) shall be immediately adjacent to the mooring during filling.

No smoking or any sources of ignition within 50 feet of the mooring.

Personnel involved in fueling shall wear protective gloves and protective eyewear.

All equipment involved in fueling shall be grounded.

Stage a portable fire extinguisher (ABC) within 25-50 feet of fueling operations.

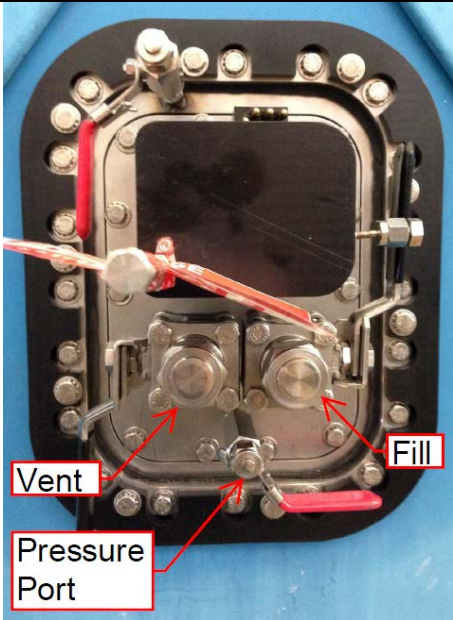
All down gradient storm drains (if present and located within 50 feet) shall be completely blocked or covered.


Safety Review to be reviewed and followed by all participants.

**7.0 Procedure**

Step	Instructions
<b>8.1</b>	<b>SAFETY REVIEW</b>
8.1.1	Read through this Safety Review prior to commencing fueling operations. Once completed, sign and date where indicated on <b>Attachment #3</b> .
8.1.2	Identify the nearest chemical wash-down station relative to the fueling operations. Ensure the path to the shower is clear and is no more than a 10 second walking distance away.
8.1.3	Ensure the solvent spill kit is located immediately adjacent to the mooring prior to filling.
8.1.4	Ensure protective gloves and eyewear is available for each person involved in operations. Only personnel directly involved in the operations should be present. Additional PPE should be available if additional personnel are necessary.
8.1.5	Find all storm drains that are within 50 feet of fueling operations and located downhill. These shall be blocked or covered for the duration of the fueling operations to prevent any spilled fuel from entering the drain system. Contact EH&S if assistance is necessary.
8.1.6	Ensure fire extinguisher is located within 25-50 feet of fueling operations and that the extinguisher is rated for ABC.

7.0 Procedure	
Step	Instructions
8.1.7	The area within 25 feet of the buoy shall be marked off with cones or safety tape during operations. Only personnel directly involved with fueling and wearing appropriate PPE should be within this area.
8.1.8	During operations, one person shall be in charge of the fuel pump, while the second person shall monitor the area for ignition sources. No one should be allowed within 50 feet of the fueling operation with an active ignition source (e.g. lit cigarette, welding torch).
8.1.9	Grounding of the fill equipment is important to ensure a spark is not generated during fluid transfer. Ensure an adequate ground location is available for use. If necessary, a grounding rod can be installed and utilized for this activity.
8.1.10	The SDS sheet for the Methanol Fuel is located at the end of this document in <b>Attachment #1</b> . Review the SDS sheet prior to handling of the fuel.
8.1.11	In the event of a spill of fuel, the following steps will be taken (see 3350-00004 for reference): <b>Small Spills</b> (containable) - Soak up spill with the non-combustible absorbent material found in the Spill Kit. Place the used absorbent material back into the Spill Kit container for disposal. Flush area with water. <b>Large Spills</b> (uncontainable) – Use the Spill Kits to absorb as much of the fuel as possible and contact local EH&S (for WHOI contact at 508-289-3347) for assistance.
8.1.12	Fueling operations should not be performed during inclement weather. Events such as thunderstorms, heavy rain or snow and extreme cold temperatures can affect the judgment of the operators and impede the response time of emergency personnel. High winds can introduce contamination into the fuel supply.
8.1.13	Move all empty fuel drums into the approved storage area when not in use. Having multiple drums in the operations area is not desirable.
8.1.14	Fueling operations shall always be conducted by two persons trained in methanol handling procedures. This is to ensure that if one operator is incapacitated, the second operator will be able to contact emergency personnel.
8.1.15	All personnel that will handle the methanol fuel (including contractors) at WHOI facilities are required to complete WHOI's hazard communication and chemical safety online training and follow WHOI's hazardous communication and chemical safety procedure. If training is necessary, contact the WHOI EH&S office for links to required training courses and documentation.
<b>8.2</b>	<b>Fueling Setup</b>
8.2.1	Ensure that the Buoy to be fueled is located in such a place as to satisfy the following: <ul style="list-style-type: none"> <li>- A minimum of 50 feet from the nearest building/facility.</li> <li>- A maximum of a 10 second walking distance away from the nearest chemical wash-down station.</li> <li>- Unit is within 10 feet of the nearest ground</li> </ul> If all of these conditions are not met, reposition the Buoy as required.
8.2.2	Mark off area surrounding the fuel storage system using cones or clearly visible tape. Ensure a radius of 25 feet around the buoy is clearly marked.
8.2.3	Ensure there are no active ignition sources located within 50 feet of the buoy location.
8.2.4	Notify any nearby personnel of the operations about to take place. This will ensure they do not enter the marked off area during the process.
8.2.5	Stage Spill Kit and portable fire extinguisher next to Buoy.
8.2.6	Block off any storm drains located downhill of the fueling location and within 50 feet.

7.0 Procedure	
Step	Instructions
8.2.7	Remove the Buoy Fueling Assembly from the transportation case. Locate all necessary items from the required tools and equipment list.
8.2.8	If a power outlet is not located near the Buoy, run an extension cord to the fuel pump location.
8.2.9	<p>Move a drum of Fuel within 20 feet of the Buoy and 10 feet of the ground location. Ideally, the drum should be located in front of the Buoy Fuel Flange (see picture). Ensure there is sufficient space to bring in the next drum of fuel once the first is empty.</p> 
8.2.10	Don Personal Protective Equipment (PPE) including chemical resistant gloves and splash protection goggles.
8.2.11	Remove both plastic bung caps from the methanol drum using drum wrench. Place both bungs in a plastic bag to ensure they stay clean and set aside.
8.2.12	<p>On the Flange Assembly, remove the metal caps from the Vent, Fill and Pressure Port valve. Place caps in a plastic bag to ensure they stay clean and set aside.</p> <p><b>[Note: Refer to Attachment #2 for a detailed schematic of the hose and port configuration for filling the fuel bladder.]</b></p>
8.2.13	<p>Insert the fuel drum grounding rod into one of the fuel drum's open ports. Attach one end of the grounding cable (10 feet long) to the fuel drum grounding rod and the other to the nearest ground location.</p> <p><b>[Note: Inspect all components prior to attachment for cleanliness. If necessary, wipe down a component with Kim Wipes and Isopropyl alcohol to ensure it is clean.]</b></p>
8.2.14	Ground the Buoy flange assembly by attaching the 30 foot long bonding cable from the Flange to the drum grounding rod.

7.0 Procedure	
Step	Instructions
8.2.15	<p>Attach the 10 foot long Fill Tube to the Intake side of the Drum Pump via the quick disconnect fitting. Insert the solid tube end of the tube into the open buttress port of the fuel drum and ensure that it is inserted such that the end of the tube is resting on the bottom of the drum.</p> <p><b>[Note:</b> All valves should be closed at this time.]</p> <p><b>[Note:</b> Refer to picture on right for connections to the Fuel Pump Assembly.]</p>
	
8.2.16	Attach the 15 foot Fill Tube to the Discharge side of the drum pump via the quick disconnect fitting. Attach the swaged end of the tube to the Fill Valve on the Buoy Fuel Flange using the 1-1/8" wrench.
8.2.17	Attach the 25 foot Vent Tube to the Vent Valve on the Buoy Fuel Flange using the 1-1/8" wrench. Insert the other end of the tube into the open buttress port of the fuel drum with the grounding rod. Ensure hose is secure utilizing zip ties so as not to slip out of the bung opening.
8.2.18	Attach the 25 foot Pressure Gauge and Pressure Sensor Tube assembly to the Pressure Port Valve using the 9/16" wrench. Attach the other end to the Pressure Switch located on the Fuel Pump assembly.
8.2.19	Ensure the Main Pump Switch is in the off position and plug the electrical cord into the nearest electrical outlet.
<b>8.3</b>	<b>Fueling Operations</b>
8.3.1	Open all valves in the assembly. There are a total of (5) valves, with (3) located on the Buoy Fuel Flange and (2) on the Fuel Pump Assembly.
8.3.2	Move the Main Pump Switch to the On position.
8.3.3	<p>The pump is operated by holding down the spring loaded momentary switch on the end of the gray cable attached to the Fuel Pump Assembly. The unit will not run unless the switch is held down. Once activated, the pump will take approximately 6 minutes to empty the contents of the drum into the fuel bladder.</p> <p><b>[Note:</b> 5-6 drums of fuel are necessary to completely fill an empty bladder (depending on the volume in each drum). Total volume of fuel bladder is 285 gallons.]</p> <p><b>[Note:</b> Overfill protection is provided by the Pressure Switch in the Fuel Pump Assembly. When the switch detects 1 psi of back pressure, it will disconnect electrical power to the Fuel Pump.]</p>
8.3.4	Once the drum is empty, release the momentary switch on the Fuel Pump Assembly and close all valves. <b>[Note:</b> A small amount of fuel will be left in the bottom of the drum as it is not possible to get it all out.]
8.3.5	Move a full drum into place next to the empty drum. Remove both plastic bung caps from the new methanol drum using drum wrench.

7.0 Procedure	
Step	Instructions
8.3.6	Move the Fill Tube, Vent Tube and Grounding Rod from the empty drum to the full drum. Ensure all components are secure using zip ties. Once moved, use the bungs just removed to seal up the empty drum. Prior to proceeding with the fill, remove the empty drum from the area and return it to the approved storage location.
8.3.7	Repeat the above steps starting with 8.3.1 until the bladder is full. Once full, the Pressure Switch will automatically disengage the pump. Close all valves. <b>[Note:</b> A small amount of fuel may be discharged through the vent pipe during fill operations. This is normal during this operation.]
<b>8.4</b>	<b>Fueling Break-down</b>
8.4.1	Unplug the Fuel Pump electrical power cord plug from the outlet and coil up the cord.
8.4.2	Detach the Pressure Gauge and Pressure Sensor Tube assembly from the Pressure Port Valve using the 9/16" wrench. Coil and bag the tube assembly for future use.
8.4.3	Detach the 25 foot Vent Tube from the Vent Valve on the Buoy Fuel Flange using the 1-1/8" wrench. Once removed, hold this end of the vent line higher than the top of the drum. This will allow any residual methanol within the tube to flow back into the drum. Coil and bag the Vent Tube and store for future use.
8.4.4	Detach the 10 foot Fill Tube from the Intake side of the drum pump via the quick disconnect fitting. Empty any residual methanol from the Fill Tube into the just emptied fuel drum. Coil and bag the 10 foot Fill Tube and store for future use.
8.4.5	Detach the 15 foot Fill Tube from the Discharge side of the drum pump via the quick disconnect fitting. Detach the swaged end of the tube to the Fill Valve on the Buoy Fuel Flange using the 1-1/8" wrench. Once removed empty any residual methanol within the tube back into the drum. Coil and bag the Fill Tube and store for future use.
8.4.6	Remove the grounding rod from the drum opening. Wipe dry and bag for future use.
8.4.7	Remove all grounding cables and coil for future use.
8.4.8	Replace the (2) bungs back onto the open drum. Tighten with the bung wrench.
8.4.9	Replace the (3) metal caps onto the Buoy Fuel Flange valves.
8.4.10	Move the final fuel drum back to the designated fuel storage area.
8.4.11	On the Buoy Fuel Flange, remove all handles from the ball valves. There are a total of (4) handles to remove. Place all handles into a small bag and place in the transport case of the Fuel Pump Assembly.
<b>8.5</b>	<b>Fueling Artifacts</b>
8.5.1	Post the signed fueling procedure ( <b>Attachment #3</b> ) to Vault and notify management that the buoy is fueled.

Attachment #1 – Methanol Fuel SDS Sheet



MATERIAL SAFETY DATA SHEET

**SECTION 1 - PRODUCT AND COMPANY IDENTIFICATION**

**Product:** 63% Methanol Fuel  
**Non-Emergency Tel:** +1.508.490.9960  
**Emergency Tel:** Consult local telephone directory for poison control or emergency number(s)  
**Manufacturer:** Protonex Technology Corporation  
 153 Northboro Road  
 Southborough, MA 01772  
**Product Use:** Fuel for reformed methanol fuel cell

**SECTION 2 – COMPOSITION / INFORMATION ON INGREDIENTS**

HAZARDOUS COMPONENT	% (w/w)	Exposure Limits*
Methanol (CH <sub>3</sub> OH) (CAS 67-56-1)	62-64	ACGIH TLV-TWA: 200 ppm, skin STEL: 250ppm, skin notation OSHA PEL: 200 ppm
NON-HAZARDOUS COMPONENTS	% (w/w)	
De-ionized Water (H <sub>2</sub> O) (CAS 7732-18-5)	Balance	

\* Check with local regulatory agency for the exposure limits in your area.

**SECTION 3 - HAZARDS IDENTIFICATION**

**Routes of Entry**

**Skin Contact: Moderate      Eye Contact: Moderate      Ingestion: Major      Inhalation: Major**

**Effects of Short-Term (Acute) Exposure**

**Inhalation:** Inhalation of high airborne concentrations can also irritate mucous membranes, cause headaches, sleepiness, nausea, confusion, loss of consciousness, digestive and visual disturbances and even death. NOTE: Odor threshold of methanol is several times higher than the TLV-TWA. Depending upon severity of poisoning and the promptness of treatment, survivors may recover completely or may have permanent blindness, vision disturbances and/or nervous system effects. Concentrations in air exceeding 1000 ppm may cause irritation of the mucous membranes.

**Skin Contact:** Methanol is moderately irritating to the skin. Methanol can be absorbed through the skin and harmful effects have been reported by this route of entry. Effects are similar to those described in "Inhalation"

**Eye Contact:** Methanol is a mild to moderate eye irritant. High vapor concentration or liquid contact with eyes causes irritation, tearing and burning.

**Ingestion:** Swallowing even small amounts of methanol could potentially cause blindness or death. Effects of sub lethal doses may be nausea, headache, abdominal pain, vomiting and visual disturbances ranging from blurred vision to light sensitivity.

**Effects of Long-Term (Chronic) Exposure**

Repeated exposure by inhalation or absorption may cause systemic poisoning, brain disorders, impaired vision and blindness. Inhalation may worsen conditions such as emphysema or bronchitis. Repeated skin contact may cause dermal irritation, dryness and cracking.

**Medical Conditions Aggravated By Exposure**

Emphysema or bronchitis.

**SECTION 4 – FIRST AID MEASURES**

**Note: Emergency assistance may also be available from the local poison control center.**

**Eye Contact:** Remove contact lenses if worn. In case of contact, immediately flush eyes with plenty of clean running water for at least 15 minutes, lifting the upper and lower eyelids occasionally. Obtain medical attention.

**Skin Contact:** In case of contact, remove contaminated clothing. In a shower, wash affected areas with soap and water for at least 15 minutes. Seek medical attention if irritation occurs or persists. Wash clothing before reuse.

**Inhalation:** Remove to fresh air, restore or assist breathing if necessary. Obtain medical attention.

**Ingestion:** Swallowing methanol is potentially life threatening. Onset of symptoms may be delayed for 18 to 24 hours after digestion. If conscious and medical aid is not immediately available, do not induce vomiting. In actual or suspected cases of ingestion, transport to medical facility immediately.

**NOTE TO PHYSICIAN:** Acute exposure to methanol, either through ingestion or breathing high airborne concentrations can



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result in symptoms appearing between 40 minutes and 72 hours after exposure. Symptoms and signs are usually limited to CNS, eyes and gastrointestinal tract. Because of the initial CNS's effects of headache, vertigo, lethargy and confusion, there may be an impression of ethanol intoxication. Blurred vision, decreased acuity and photophobia are common complaints. Treatment with ipecac or lavage is indicated in any patient presenting within two hours of ingestion. A profound metabolic acidosis occurs in severe poisoning and serum bicarbonate levels are a more accurate measure of severity than serum methanol levels. Treatment protocols are available from most major hospitals and early collaboration with appropriate hospitals is recommended.

**SECTION 5 – FIRE FIGHTING MEASURES**

**Flash Point:** 18°C  
**Auto Ignition Temperature:** 385°C (NFPA 1978)  
**Lower Flammability Limit:** 6.0% (v/v)  
**Upper Flammability Limit:** 36.5% (v/v)  
**Sensitivity to Impact:** Low  
**Sensitivity to Static Discharge:** Low  
**Hazardous Combustion Products:** Toxic gases and vapors; oxides of carbon and formaldehyde.  
**Extinguishing Media – Small Fires:** Dry chemical, CO<sub>2</sub>, water spray  
**Extinguishing Media – Large Fires:** Water spray, AFFF(R) (Aqueous Film Forming Foam (alcohol resistant)) type with either a 3% or 6% foam proportioning system.  
**Fire Fighting Instructions:** Methanol burns with a clean clear flame that is almost invisible in daylight. Stay upwind! Isolate and restrict area access. Concentrations of greater than 25% methanol in water can be ignited. Use fine water spray or fog to control fire spread and cool adjacent structures or containers. Contain fire control water for later disposal. Fire fighters must wear full face, positive pressure, self-contained breathing apparatus or airline and appropriate protective clothing. Protective fire fighting structural clothing is not effective protection from methanol. Do not walk through spilled product.

**NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) HAZARD INDEX:**

HEALTH	BLUE	1
FLAMMABILITY	RED	3
REACTIVITY	YELLOW	0
SPECIAL HAZARD	WHITE	None

**SECTION 6 – ACCIDENTAL RELEASE MEASURES**

**Overview:** Flammable liquid which can burn without a visible flame. Release can cause an immediate risk of fire and explosion. Eliminate all ignition sources, stop leak and use absorbent materials. If necessary, contain spill by diking. Fluorocarbon alcohol resistant foams may be applied to spill to diminish vapor and fire hazard. Restrict access to area until completion of cleanup. Wear adequate personal protection.

**Environmental Precautions:** Biodegrades easily in water. Methanol in fresh or salt water may have serious effects on aquatic life. Methanol will be broken down to carbon dioxide and water.

**Small Spills:** Dilute with water to reduce fire hazard. Soak up spill with non-combustible absorbent material. Prevent spills from entering sewers, confined spaces, drains, or waterways. Put material in suitable, covered, labeled containers and dispose in accordance with local regulations. Flush area with water.

**SECTION 7 – HANDLING & STORAGE**

**Handling Procedures:** No smoking or open flame in storage, use or handling areas. Handle open container with care. After handling, always wash hands thoroughly with soap and water. Keep away from children

**Storage:** Store and use away from heat, sparks, open flame and any other ignition source. Keep away from incompatibles. Keep in a cool, well ventilated area.

**SECTION 8 – EXPOSURE CONTROLS / PERSONAL PROTECTION**

**Engineering Controls:** For normal application, special ventilation is not necessary. If user's operations generate vapor or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit. Make-up air should always be supplied to balance air removed by exhaust ventilation. Ensure that eyewash station and safety shower are close to work-station.

**Eye and Face:** Eye protection (i.e., safety glasses, safety goggles and/or face shield) should be determined based on conditions of use. If product is used in an application where splashing may occur, the use of safety goggles and/or a face shield should be considered.





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**Body:** Wear appropriate clothing to prevent skin contact. As a minimum long sleeves and trousers should be worn.  
**Respiratory Protection:** NIOSH approved supplied air respirator when airborne concentrations exceed exposure limits.  
**Hands:** If this material may come in contact with the hands during handling and use, we recommend wearing gloves of the following material(s): fluoroelastomer, natural rubber latex, neoprene, polyvinyl chloride (PVC). Do not use: polyvinyl alcohol (PVA)  
**Feet:** Wear appropriate footwear to prevent product from coming in contact with feet and skin.

**SECTION 9 – PHYSICAL AND CHEMICAL PROPERTIES**

<b>Appearance:</b>	Liquid, clear colorless	<b>Boiling Point:</b>	73°C -74°C
<b>Odor:</b>	Mild characteristic alcohol odor	<b>Critical Temperature:</b>	239°C
<b>Odor Threshold:</b>	Highest known is 100 ppm	<b>Relative Density:</b>	0.88g/cc@20°C
<b>pH:</b>	Not Applicable	<b>Solubility:</b>	Completely soluble
<b>Vapor Pressure:</b>	58 torr@20°C		
<b>Vapor Density:</b>	1.1@20°C (air=1.1)		

**SECTION 10 – STABILITY AND REACTIVITY**

<b>Corrosivity:</b>	Not Applicable
<b>Stability:</b>	The product is stable under normal operating conditions.
<b>Incompatibility:</b>	Avoid contact with strong oxidizers, strong mineral or organic acids, and strong bases. Contact with these materials may cause a violent or explosive reaction. May be corrosive to lead, aluminum, magnesium, and platinum.
<b>Conditions of Reactivity:</b>	Presence of incompatible materials and ignition sources.
<b>Hazardous Decomposition Products:</b>	Formaldehyde, carbon dioxide, and carbon monoxide.
<b>Hazardous Polymerization:</b>	Will not occur

**SECTION 11 – TOXICOLOGICAL INFORMATION**

<b>LD<sub>50</sub>:</b>	5628 mg/kg (oral/rat), 20 ml/kg (dermal/rabbit)
<b>LC<sub>50</sub>:</b>	64,000 ppm (rat)
<b>Acute Exposure:</b>	See Section 3
<b>Chronic Exposure:</b>	See Section 3
<b>Exposure Limits:</b>	See Section 2
<b>Irritancy:</b>	See Section 3
<b>Sensitization:</b>	No
<b>Carcinogenicity:</b>	Not listed by IARC, NTP, ACGIH, or OSHA as a carcinogen
<b>Teratogenicity:</b>	No
<b>Reproductive toxicity:</b>	Reported to cause birth defects in rats exposed to 20,000 ppm
<b>Mutagenicity:</b>	Insufficient Data
<b>Synergistic Products:</b>	None Known

**SECTION 12 – ECOLOGICAL INFORMATION**

<b>Environmental Fate:</b>	Not Available
<b>Bioaccumulation Potential:</b>	Not Available
<b>Biodegradability:</b>	Biodegrades easily in water

**SECTION 13 – DISPOSAL CONSIDERATION**

**Waste Disposal:** Preferred waste management priorities are: (1) recycle or reprocess; (2) incineration with energy recovery; (3) disposal at licensed waste disposal facility. Ensure that disposal or reprocessing is in compliance with government requirements and local disposal regulations. Consult your local or regional authorities.



## MATERIAL SAFETY DATA SHEET

### SECTION 14 – TRANSPORT INFORMATION

<b>Transport of Dangerous Goods (TDG and CLR):</b>	Methanol, Class 3(6.1) UN1230, PG II Limited Quantity: ≤ 1 liter
<b>US Department of Transportation (49CFR):</b>	Methanol, Class 3, UN1230, PG II (RQ 5000 lbs./2270kg.) Limited Quantity: ≤ 1 liter
<b>International Air Transport Association (IATA)::</b>	Methanol, Class 3(6.1), UN1230, P.G. II Packaging Instruction: 305, Limited Quantity: ≤ 1 liter

### SECTION 15 – REGULATORY INFORMATION

<b>29CFR 1910.1200 (OSHA):</b>	Hazardous
<b>40CFR 116-117 (EPA):</b>	Hazardous
<b>40CFR 355, Appendices A and B:</b>	Subject to Emergency Planning and Notification
<b>40CFR 372 (SARA Title III):</b>	Listed
<b>40CFR 302 (CERCLA):</b>	Listed

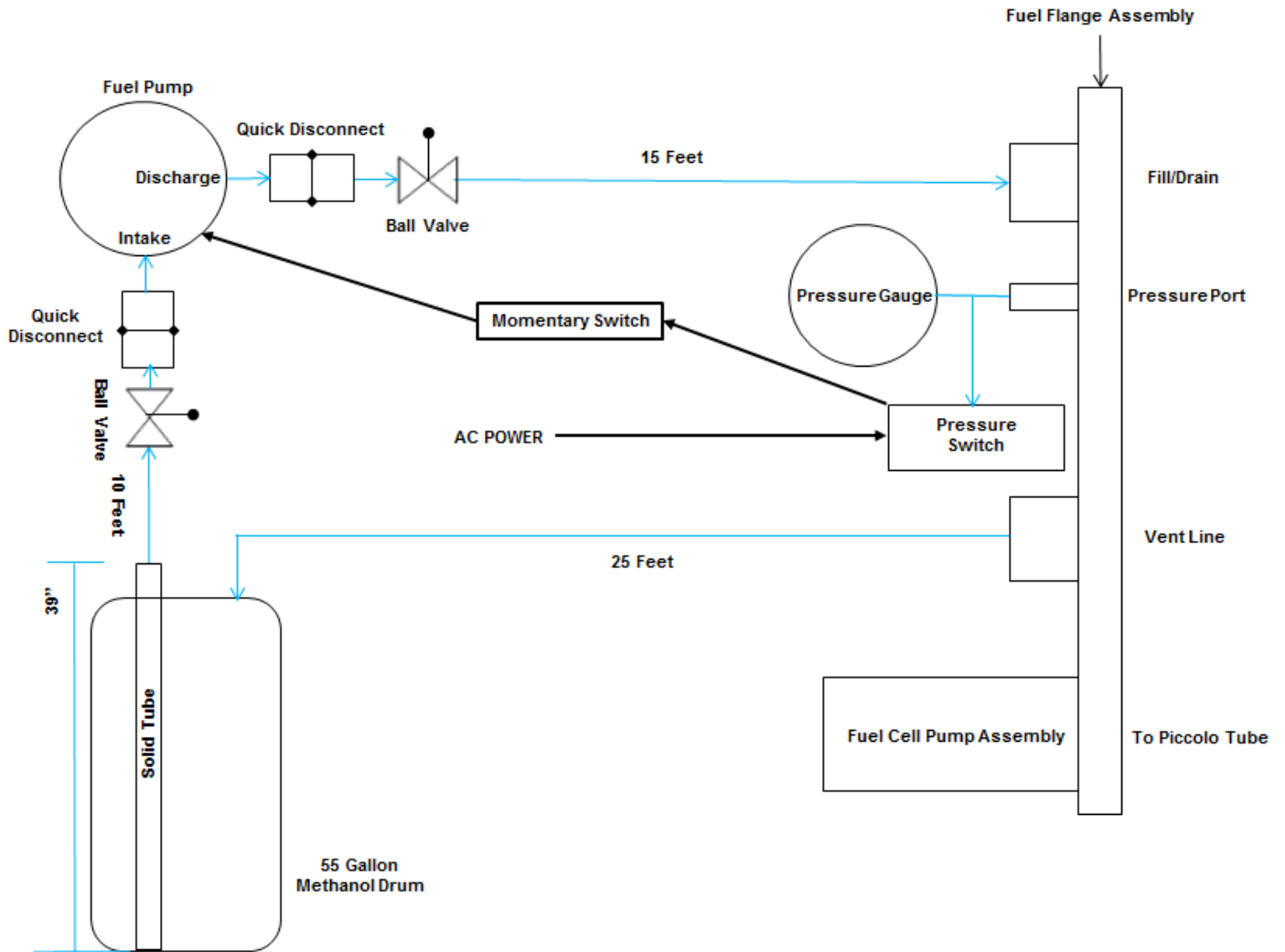
### SECTION 16 – OTHER INFORMATION

**Disclaimer:** The information above is believed to be accurate and represents the best information currently available to us. Users should make their own investigations to determine the suitability of the information for their particular purposes. This document is intended as a guide to the appropriate precautionary handling of the material by a properly trained person using this product.

Protonex Technology Corporation and its subsidiaries make no representations or warranties, either express or implied, including without limitation any warranties of merchantability, fitness for a particular purpose with respect to the information set forth herein or the product to which the information refers. Accordingly, Protonex Technology Corporation will not be responsible for damages resulting from use of or reliance upon this information.

Last Updated – 04 January 2010

Attachment #2 – Schematic of equipment configuration for filling



### Attachment #3 – Fuel Fill Sign-off

#### Safety Review

Personnel involved in filling the fuel cell bladder shall read Section 8.1 Safety Review and sign-off below.

I have fully read and understand Fuel Fill Procedure 3350-00002 and agree to comply to all required safety protocols.			
	Name	Signature	Date
Operator #1			
Operator #2			

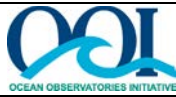
#### Fill Complete

Personnel involved in filling the fuel cell bladder shall sign-off below once the procedure is complete.

<b>NOTES:</b>			
	Name	Signature	Date
Operator #1			
Operator #1			

Once signed, scan this sheet and name the document **3350-00002\_Fuel\_Fill\_YYYY-MM-DD**.  
Post in Vault under:

*Project\_Files > Records > Safety Records*



# Fuel Cell Procedure

<b>Document No.:</b> 3350-00003	<b>Title/Description:</b> Fuel Cell Drain Procedure		
<b>Author:</b> Kurt Stiffel	<b>Approved by:</b>	<b>Revision:</b> 1-00	<b>Effective Date:</b>

## 1.0 Reference Documents

All released OOI documents in Alfresco  
 3161-20000 Fuel Cell Integration and Verification Plan  
 3350-00003 Fuel Cell Drain Procedure  
 3350-00004 Spill Response Procedure

Fuel cell reference documents are located on VAULT at:  
 Vault\Project\_Files\Documentation\Power\Power Notebook\Fuel Cell\

## 2.0 Definitions & Acronyms

See Section 3.0 of document 3161-20000

## 3.0 Training Requirements

All personnel that will handle the methanol (including contractors) at WHOI facilities are required to complete WHOI's hazard communication and chemical safety online training and follow WHOI's hazardous communication and chemical safety procedure. Contact the WHOI EH&S office for links to required training courses and documentation. Information can also be found at <http://ehs.who.edu/ehs/>.

## 4.0 Required PPE and Safety Notes

All personnel within a 25 foot radius of the buoy are required to don splash protection goggles and chemical resistant gloves. These can include polyvinyl plastic, neoprene or rubber.

Contact information for **WHOI EH&S** is 508-289-3347.

Ensure operations are performed in compliance with applicable WHOI/SIO/OSU safety protocols, OOI Safety Plan (1006-10002) and CGSN EH&S Plan (3101-00009). Read and follow all safety warnings in the MSDS. Once the Safety Review in Section 8.1 is complete, have each operator sign-off in the signature block.

## 5.0 Required Tools & Equipment

Buoy Fueling Assembly consisting of:

- 10' Fill Tube with valve and Quick Disconnect, 3/4" OD (1)
- 15' Fill Tube with valve and Quick Disconnect, 3/4" OD (1)
- 25' Vent Tube and Quick Disconnect, 3/4" OD (1)
- 25' Pressure Gauge and Pressure Sensor Tube, 1/4" OD (1)
- 55 Gallon Drum Pump on stand with Quick Disconnects (1)
- 55 Gallon Drum Wrench (1)
- 30' Drum-Buoy Bonding Cable (1)
- 10' Drum-Ground Grounding Cable (1)
- 55 Gallon Drum Premixed Methanol Fuel (6)
- 55 Gallon Drum Grounding Rod (1)

- 9/16" Wrench (1)
- 1/2" Wrench (1)
- 1-1/8" Wrench (1)
- 1-1/16" Wrench (1)
- Pipe Wrench (1)
- Isopropyl Alcohol (A/R)
- Large Plastic Bags (A/R)

Chemical Resistant Gloves (A/R)  
 Splash Protection Goggles (A/R)  
 PIG Spill Kit (1)  
 Kim Wipes (A/R)  
 Teflon Tape (A/R)  
 Fire Extinguisher, ABC (1)  
 Traffic Cones or Caution Tape (A/R)  
 Zip Ties, Large (A/R)  
 Extension Cord (A/R)  
 Handheld hydrogen gas sensors: RKI Eagle 2  
 Q size cylinder of nitrogen gas with pressure regulator  
 ½" ID Flexible tubing (length dependent on deck configuration, see Section 6.1))

**6.0 Draining Precautions**

Unused fuel and empty fuel drums shall be stored outside of the main building in an approved storage enclosure. Coordinate with the local EH&S department if a specific location has not yet been determined.

Only one fuel container shall be handled at a time during operations. Keep all additional containers in the approved storage enclosure.

Only one container shall be open at a time during fuel transfer.

The area around the buoy shall be marked off with cones or safety tape and monitored during operations.

Only personnel directly involved with draining should be within 25 feet of the mooring during operations.

A solvent spill kit capable of absorbing the entire contents of each shipping container (drum) shall be immediately adjacent to the mooring during filling.

No smoking or any sources of ignition within 50 feet of the mooring.

Personnel involved in draining shall wear protective gloves and protective eyewear.

All equipment involved in draining shall be grounded.

Stage a portable fire extinguisher (ABC) within 25-50 feet of draining operations.

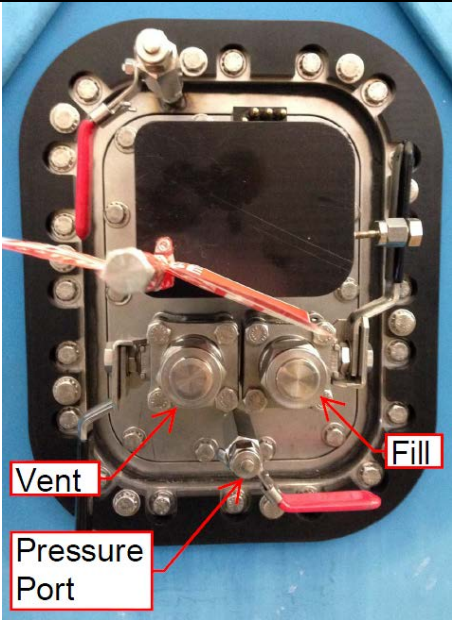
All down gradient storm drains (if present and located within 50 feet) shall be completely blocked or covered.

Safety Review to be reviewed and followed by all participants.


**7.0 Procedure**

Step	Instructions
<b>8.1</b>	<b>SAFETY REVIEW</b>
8.1.1	Read through this Safety Review prior to commencing draining operations. Once completed, sign and date where indicated on <b>Attachment #3</b> .
8.1.2	Identify the nearest chemical wash-down station relative to the draining operations. Ensure the path to the shower is clear and is no more than a 10 second walking distance away.
8.1.3	Ensure the solvent spill kit is located immediately adjacent to the mooring prior to filling.
8.1.4	Ensure protective gloves and eyewear is available for each person involved in operations. Only personnel directly involved in the operations should be present. Additional PPE should be available if additional personnel are necessary.
8.1.5	Find all storm drains that are within 50 feet of draining operations and located downhill. These shall be blocked or covered for the duration of the operations to prevent any spilled fuel from entering the drain system. Contact EH&S if assistance is necessary.

7.0 Procedure	
Step	Instructions
8.1.6	Ensure fire extinguisher is located within 25-50 feet of draining operations and that the extinguisher is rated for ABC.
8.1.7	The area within 25 feet of the buoy shall be marked off with cones or safety tape during operations. Only personnel directly involved with draining and wearing appropriate PPE should be within this area.
8.1.8	During operations, one person shall be in charge of the fuel pump, while the second person shall monitor the area for ignition sources. No one should be allowed within 50 feet of the draining operation with an active ignition source (e.g. lit cigarette, welding torch).
8.1.9	Grounding of the fill equipment is important to ensure a spark is not generated during fluid transfer. Ensure an adequate ground location is available for use. If necessary, a grounding rod can be installed and utilized for this activity.
8.1.10	The SDS sheet for the Methanol Fuel is located at the end of this document in <b>Attachment #1</b> . Review the SDS sheet prior to handling of the fuel.
8.1.11	In the event of a spill of fuel, the following steps will be taken (see 3350-00004): <b>Small Spills</b> (containable) - Soak up spill with the non-combustible absorbent material found in the Spill Kit. Place the used absorbent material back into the Spill Kit container for disposal. Flush area with water. <b>Large Spills</b> (uncontainable) – Use the Spill Kits to absorb as much of the fuel as possible and contact local EH&S (for WHOI contact at 508-289-3347) for assistance.
8.1.12	Operations should not be performed during inclement weather. Events such as thunderstorms, heavy rain or snow and extreme cold temperatures can affect the judgment of the operators and impede the response time of emergency personnel.
8.1.13	Move all empty fuel drums into the approved storage area when not in use. Having multiple drums in the operations area is not desirable.
8.1.14	Draining operations shall always be conducted by two persons trained in methanol handling procedures. This is to ensure that if one operator is incapacitated, the second operator will be able to contact emergency personnel.
8.1.15	All personnel that will handle the methanol fuel (including contractors) at WHOI facilities are required to complete WHOI's hazard communication and chemical safety online training and follow WHOI's hazardous communication and chemical safety procedure. If training is necessary, contact the WHOI EH&S office for links to required training courses and documentation.
<b>8.2</b>	<b>Draining Setup</b>
8.2.1	Ensure that the Buoy to be drained is located in such a place as to satisfy the following: <ul style="list-style-type: none"> <li>- A minimum of 50 feet from the nearest building/facility.</li> <li>- A maximum of a 10 second walking distance away from the nearest chemical wash-down station.</li> <li>- Unit is within 10 feet of the nearest ground</li> </ul> If all of these conditions are not met, reposition the Buoy as required.
8.2.2	Mark off area surrounding the fuel storage system using cones or clearly visible tape. Ensure a radius of 25 feet around the buoy is clearly marked.
8.2.3	Ensure there are no active ignition sources located within 50 feet of the buoy location.
8.2.4	Notify any nearby personnel of the operations about to take place. This will ensure they do not enter the marked off area during the process.
8.2.5	Stage Spill Kit and portable fire extinguisher next to Buoy.

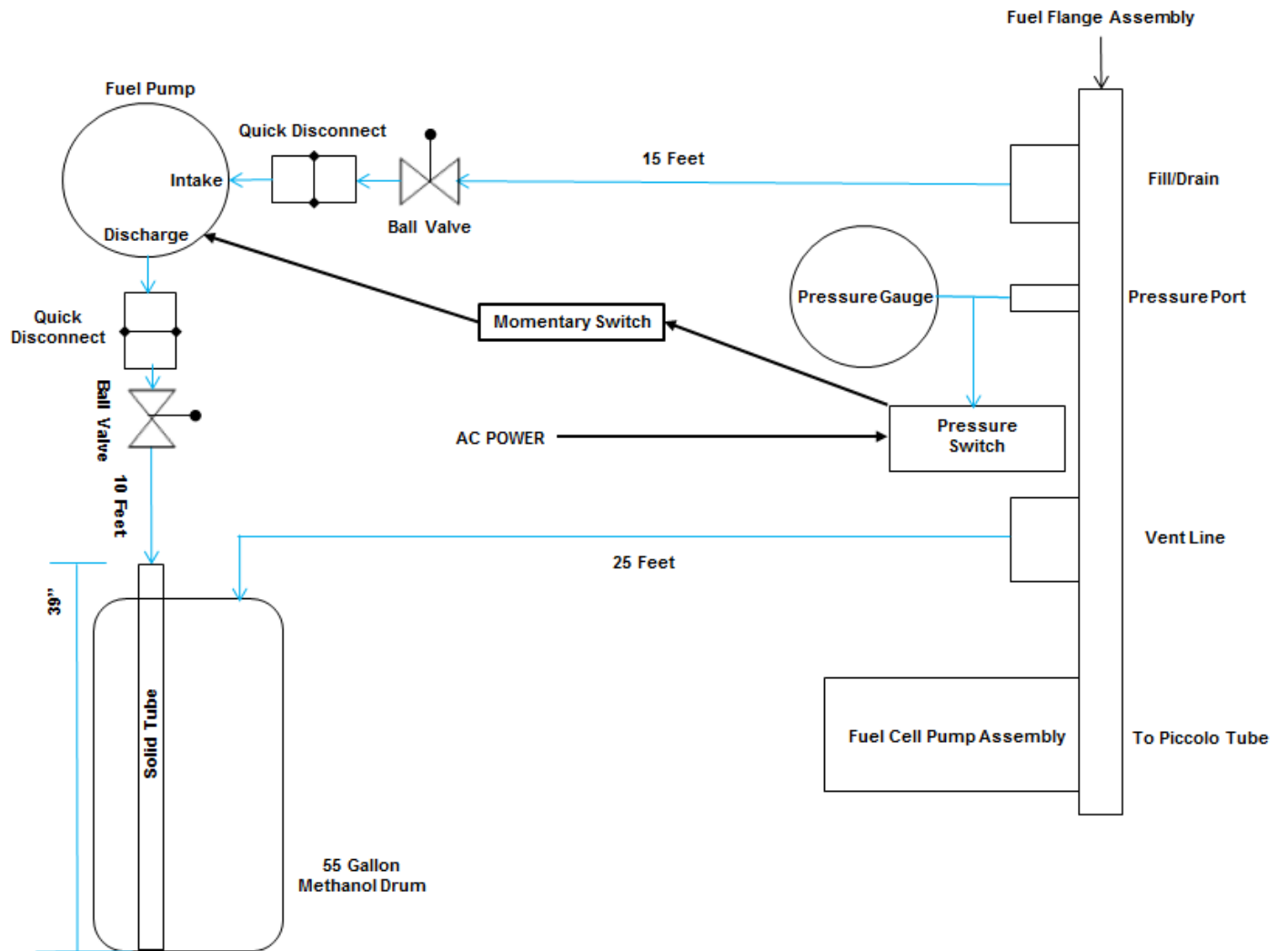
7.0 Procedure	
Step	Instructions
8.2.6	Block off any storm drains located downhill of the draining location and within 50 feet.
8.2.7	Remove the Buoy Fueling Assembly from the transportation case. Locate all necessary items from the required tools and equipment list.
8.2.8	If a power outlet is not located near the Buoy, run an extension cord to the fuel pump location.
8.2.9	<p>Move an empty drum within 20 feet of the Buoy and 10 feet of the ground location. Ideally, the drum should be located in front of the Buoy Fuel Flange (see picture). Ensure there is sufficient space to bring in the next drum once the first is empty.</p> 
8.2.10	Don Personal Protective Equipment (PPE) including chemical resistant gloves and splash protection goggles.
8.2.11	Remove both plastic bung caps from the methanol drum using drum wrench. Place both bungs in a plastic bag to ensure they stay clean and set aside.
8.2.12	<p>On the Flange Assembly, remove the metal caps from the Vent, Fill and Pressure Port valve. Place caps in a plastic bag to ensure they stay clean and set aside.</p> <p><b>[Note: Refer to Attachment #2 for a detailed schematic of the hose and port configuration for draining the fuel bladder.]</b></p>
8.2.13	Insert the fuel drum grounding rod into one of the fuel drum's open ports. Attach one end of the grounding cable (10 feet long) to the fuel drum grounding rod and the other to the nearest ground location.
8.2.14	Ground the Buoy flange assembly by attaching the 30 foot long bonding cable from the Flange to the drum grounding rod.
8.2.15	Remove the (4) valve handles from their storage bag located in the transit case of the Buoy Fueling Assembly. Reattach the valve handles to the appropriate valves on the Buoy Fuel Flange.



7.0 Procedure	
Step	Instructions
8.2.16	<p>Attach the 10 foot long Fill Tube to the Discharge side of the Drum Pump via the quick disconnect fitting. Insert the solid tube end of the tube into the open buttress port of the fuel drum and ensure that it is inserted such that the end of the tube is resting on the bottom of the drum.</p> <p><b>[Note: All valves should be closed at this time.]</b></p> <p><b>[Note: Refer to picture on right for connections to the Fuel Pump Assembly.]</b></p>
	
8.2.17	Attach the 15 foot Fill Tube to the Intake side of the drum pump via the quick disconnect fitting. Attach the swaged end of the tube to the Fill Valve on the Buoy Fuel Flange using the 1-1/8" wrench.
8.2.18	Attach the 25 foot Vent Tube to the Vent Valve on the Buoy Fuel Flange using the 1-1/8" wrench. Secure the other end of the tube to the side of the buoy, above the height of the drum. Ensure hose is secure utilizing zip ties.
8.2.19	Ensure the Main Pump Switch is in the off position and plug the electrical cord into the nearest electrical outlet.
<b>8.3</b>	<b>Draining Operations</b>
8.3.1	Open all valves in the assembly. There are a total of (5) valves, with (3) located on the Buoy Fuel Flange and (2) on the Fuel Pump Assembly.
8.3.2	Move the Main Pump Switch to the On position.
8.3.3	<p>The pump is operated by holding down the spring loaded momentary switch on the end of the gray cable attached to the Fuel Pump Assembly. The unit will not run unless the switch is held down. Once activated, the pump will take approximately 6 minutes to fill an empty drum.</p> <p><b>[Note: 5-6 drums of fuel are necessary to completely drain a full bladder. Total volume of a full fuel bladder is 285 gallons.]</b></p>
8.3.4	<p>Once the drum is full, release the momentary switch on the Fuel Pump Assembly and close all valves.</p> <p><b>[Note: Do not overfill the drums. Fill to indicator line on side of drum.]</b></p>
8.3.5	Move an empty drum into place next to the full drum. Remove both plastic bung caps from the empty methanol drum using drum wrench.
8.3.6	<p>Move the Fill Tube, Vent Tube and Grounding Rod to the empty drum. Ensure all components are secure using zip ties. Once moved, use the bungs just removed to seal up the full drum. Prior to proceeding with the draining, remove the full drum from the area and return it to the approved storage location.</p> <p><b>[Note: The full drum should be marked that it is full of removed fuel. The fuel is now considered contaminated and will not be used in future deployments.]</b></p>

<b>7.0 Procedure</b>	
<b>Step</b>	<b>Instructions</b>
8.3.7	Repeat the above steps starting with 8.3.1 until the bladder is empty. Close all valves.
<b>8.4</b>	<b>Bladder Purge</b>
8.4.1	Unplug the Fuel Pump electrical power cord plug from the outlet and coil up the cord.
8.4.2	Detach the Pressure Gauge and Pressure Sensor Tube assembly from the Pressure Port Valve using the 9/16" wrench. Coil and bag the tube assembly for future use.
8.4.3	Detach the 25 foot Vent Tube from the Vent Valve on the Buoy Fuel Flange using the 1-1/8" wrench. Once removed, hold this end of the vent line higher than the top of the drum. This will allow any residual methanol within the tube to flow back into the drum. Coil and bag the Vent Tube and store for future use.
8.4.4	Detach the 10 foot Fill Tube from the Discharge side of the drum pump via the quick disconnect fitting. Empty any residual methanol from the Fill Tube into the just emptied fuel drum. Coil and bag the 10 foot Fill Tube and store for future use.
8.4.5	Detach the 15 foot Fill Tube from the Intake side of the drum pump via the quick disconnect fitting. Detach the swaged end of the tube to the Fill Valve on the Buoy Fuel Flange using the 1-1/8" wrench. Once removed empty any residual methanol within the tube back into the drum. Coil and bag the Fill Tube and store for future use.
8.4.6	Set regulator on the Nitrogen cylinder to 1 psi.
8.4.7	Attach the 1/2" flexible tubing from the Nitrogen cylinder to the Pressure Port valve on the Buoy Fuel Flange.
8.4.8	Open both the Pressure Port Valve and the Vent Valve on the Buoy Fuel Flange. Turn on the Nitrogen gas.
8.4.9	Use the Gas Analyzer to monitor the Vent Valve. Flush the well with nitrogen until the Oxygen sensor records less than 10% LEL.
8.4.10	Turn off the Nitrogen and close all valves.
<b>8.5</b>	<b>Break-down</b>
8.5.1	Detach flexible tubing from Pressure Port and store in transit case.
8.5.	Remove the grounding rod from the drum opening. Wipe dry and bag for future use.
8.5.	Remove all grounding cables and coil for future use.
8.5.	Replace the (2) bungs back onto the open drum. Tighten with the bung wrench.
8.5.	Replace the (3) metal caps onto the Buoy Fuel Flange valves.
8.5.	Move the final fuel drum back to the designated fuel storage area.
<b>8.5</b>	<b>Draining Artifacts</b>
8.5.1	Post the signed draining procedure ( <b>Attachment #3</b> ) to Vault and notify management that the buoy is drained.

### Attachment #2 – Schematic of equipment configuration for draining



### Attachment #3 – Fuel Drain Sign-off

#### Safety Review

Personnel involved in draining the fuel cell bladder shall read Section 8.1 Safety Review and sign-off below.

I have fully read and understand Fuel Drain Procedure 3350-00003 and agree to comply to all required safety protocols.			
	Name	Signature	Date
Operator #1			
Operator #2			

#### Drain Complete

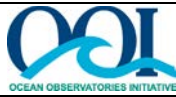
Personnel involved in draining the fuel cell bladder shall sign-off below once the procedure is complete.

**NOTES:**

<p><b>NOTES:</b></p>			
	Name	Signature	Date
Operator #1			
Operator #1			

Once signed, scan this sheet and name the document **3350-00003\_Fuel\_Drain\_YYYY-MM-DD**.  
Post in Vault under:

*Project\_Files > Records > Safety Records*



# Fuel Cell Procedure

<b>Document No.:</b> 3350-00004	<b>Title/Description:</b> Spill Response Procedure		
<b>Author:</b> Kurt Stiffel	<b>Approved by:</b>	<b>Revision:</b> 1-00	<b>Effective Date:</b>

**Required PPE and Safety Notes**

All personnel within a 25 foot radius of the buoy are required to don splash protection goggles and chemical resistant gloves. These can include polyvinyl plastic, neoprene or rubber.

Contact information for **WHOI EH&S** is 508-289-3347.

Ensure operations are performed in compliance with applicable WHOI/SIO/OSU safety protocols, OOI Safety Plan (1006-10002) and CGSN EH&S Plan (3101-00009). Read and follow all safety warnings in the MSDS.

## FUEL SPILL RESPONSE

AT SEA: Notify the ship's bridge that a spill has occurred.

ON SHORE: Notify the institutional safety office that a spill has occurred:  
 WHOI EH&S (508) 289-2911 or x2911  
 OSU EH&S (541) 737-2273

Attend to any person that has been exposed to the Methanol Fuel, utilizing emergency eye washes and showers.

Shut off all potential ignition sources in the immediate area.

Alert all other personnel that may be affected by the spill.

Review the Safety Data Sheet (SDS is attached) to familiarize yourself with the hazards, spill procedures and PPE required to deal with the spill.

**Incidental Spills:** For small, manageable volumes, clean up spill using absorbent mats and pillows from the Spill Kits (large fluorescent green barrels). Dispose of the used materials into the Spill Kit container.

**Hazardous Spills:** For larger spills that cannot be managed, limit the area of the spill as much as possible by using absorbent booms from the Spill Kits. Contact either the ship's bridge or local EH&S to report the spill and request assistance of the Emergency Response Team.

In cases where the Fuel Cell Bladder has a leak that is not possible to stop, refer to document 3350-00003 Fuel Cell Drain Procedure. This will instruct you on how to remove the fuel from the Fuel Cell Bladder and return it to the transportation drums.