FirstElement Fuel

Scaling Up the True Zero Network

Revised Hydrogen Safety Plan Incorporating Liquid Hydrogen Storage and Delivery

All Proposed Station Locations

GFO-15-605:
Alternative and Renewable Fuel and Vehicle Technology Program
Light Duty Vehicle Hydrogen Refueling Infrastructure

Date:
August 29, 2017

Applicant's Name:
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A. Safety Plan Requirements

1. Scope of Work for the Safety Plan

The FEFuel Inc (FEFuel) safety plan is incorporated into all aspects of work. The safety plan is focused on the hydrogen refueling stations and ancillary equipment projects and covers planning, engineering, construction and ongoing operation. The integrated approach facilitates a detailed look at every phase of the project with the same set of standards applied throughout. The intent of the plan is to protect personnel, equipment, and the environment.

a. Planning: In the planning phase, potential sites are identified and then qualified, amongst other things, for safety. This involves verifying that the site meets applicable setback distances per applicable codes such as NFPA-2 and California Building Codes. A qualitative hazard analysis is also performed to ensure risk mitigation. The integrated approach: who we are, what we do, aspects of our business, safety through design, construction, and operation.

b. Engineering: In the engineering phase, many aspects are analyzed and scrutinized for safety. This includes structural calculations, material suitability analysis, testing procedures, codes and standards safety checks, design for safe operation, and design integrity.

c. Construction: This is statistically where most industrial accidents occur. FEFuel has developed a 200 page long construction safety plan that has been successfully implemented during the 2014 CEC grant project in constructing 18 stations with ZERO accidents. For brevity, it was not included here, but the table of contents can be found in Appendix S.

d. Operation: FEFuel intends to operate the proposed stations for a minimum of 15 years. It is imperative that all personnel arrive and leave from work safely to their families. FEFuel is continually improving the safety of our service team through training.

2. Organizational Safety Information

a. Organizational Policies and Procedures

i. Training: FEFuel policies are intended to ensure that personnel have the right tools and experience for the job. No employee is put in a situation where their safety is compromised. For that reason, we have implemented a competence tracking system where employees are graded based on their competence in a specific field. The four major competence categories include:

- Observer: where the personnel can only assist in a task
- Supervised: where the personnel can perform the task only if supervised
- Independent: where the personnel can perform the work unsupervised
- Trainer: where the personnel can train others on the task

For an employee to work independently in the field they must meet the competent criteria after working with a trainer for a sufficient amount of time. This is typically 1-2 months or more. The FEFuel Training Matrix can be seen in Appendix N.

ii. Communication

In addition, the service team meets 3 times a week to discuss operational status and safety procedures. A new safety topic is introduced every week and discussed at least 3 times. The training includes some or all the communication methods; video instructions, group discussion, homework, quick phone quizzes and, when possible, practical hands-on practice. The attendance is tracked to ensure that, at a minimum, each employee attends two of these safety sessions. At these meetings, all new policies and procedures are introduced and the employee is told where this information resides within the company. Prior to every operational meeting a moment is taken to discuss a "Safety Moment".

iii. Special Work

When a new task is being conducted or the task does not have established procedures, pertinent employees are all trained on performing a Job Hazard Analysis (JHA) prior to conducting the work.

iv. Contractors

In some cases, where FEFuel requires the help of a contractor (for example in construction, refrigeration, or crane operation) FEFuel only employs contractors who are qualified to do the work, have similar vision for safety, and have a proven track record. These records are viewed through their OSHA form 300A for the past three years. If there are any major injuries, these are investigated to ensure that the contractor has the right culture and policies in place.

b. Hydrogen and Fuel Cell Experience

FEFuel prides itself on the experience of our team members. The team has many years of experience in the hydrogen station refueling field and collectively has experience with 50+ different fueling stations and technologies from manufactures such as Air Liquide, Linde, Air Products, Powertech, Proton Energy, and Hydrogenics for customers such as Chevron, Shell, BP, and the US military across the globe. The team has the skill and support system set to conquer any hydrogen related problem from construction, to PLC programing, to compressor repair. The experience of the team helps us make the best decisions from an efficiency and safety perspective. Tim Brown provides the academic perspective; Ghassan Sleiman provides the engineering perspective; and Andrew Youlio provides the practical perspective. This helps us answer the question of why, what, and how related to any activity. This extensive experience helps us perform well in identifying safety vulnerabilities.

Below is a list of the team and relative experience with hydrogen refueling stations.

i. Tim Brown

- Served as Project Manager for FEFuel's build out of 19 hydrogen stations awarded under the Energy Commission's PON-13-607
- Successfully completed and opened to the public 15 hydrogen stations at an unprecedented speed
- Experience with site acquisition, equipment procurement, design & engineering, entitlements and permitting, construction, commission and startup, operations and budget
- Managed the operation of the UC Irvine liquid hydrogen station and the Orange County Sanitation District hydrogen station.
- Helped lead the effort to develop the 68 hydrogen station plan for California

ii. Ghassan Sleiman, Bachelor of Engineering University of Toronto
   - 17 years designing, testing, building, commissioning, and maintaining hydrogen fueling stations for on-road vehicles
   - Led commissioning, service or engineering on 30+ hydrogen stations
   - Registered Service Agent in California for Weights and measure verification
   - Maintained Air Liquide's Culver City station for Shell

iii. Andrew Youlio
   - 10 years designing, testing, building, commissioning, and maintaining hydrogen fueling stations for on-road vehicles
   - 20 years of experience as a top tier technical expert in an industrial gas company including repair, maintenance, and operation of liquid hydrogen pump material handling equipment
   - Led commissioning on 28+ stations
   - Registered Service Agent in California for Weights and measure verification

iv. Michael Strada
   - World's foremost DMS testing agent with 18 stations tested and certified for FEFuel, APCI, Linde and Shell hydrogen stations
   - MS in Industrial Arts (expected Dec 2016)
   - Masters Theses: Evaluation of Hydrogen Generation
   - Led commissioning on 2 stations
   - Registered Service Agent in California for Weights and Measure verification

v. Denver Owens
   - United States Marine Core 11 years: Electrical System Technician; Gunnery Sergeant
   - Commissioned 2 Hydrogen Stations
   - Built Hydrogen panels for hydrogen stations
   - Assembled Point of Sale Panels for FEFuel stations

vi. Shane Drummond
   - United States Marine Core 11 years: Engineer; Chief Marine
   - Commissioned 2 Hydrogen Stations

vii. Tyler Furuya
   - BS in Mechanical Engineer from the Northern Arizona University
   - Instrumental in determining the root cause and repair of Point of Sale issues between Comdata and Air Products Dispensers
   - Coordinate IT and Point of Sale commissioning at FEFuel Stations

viii. Three additional Field Representatives have joined the team in May and July 2016. Logan Hart, Edgard Cruiel, and Tim McClary have just completed their training and are servicing hydrogen stations.

3. *Project Safety*

a. <u>Identification of Safety Vulnerabilities (ISV)</u>

For every project, the team conducts an ISV. Two preferred methods: the "What if Analysis" and the HAZOP. The What If Analysis looks at failures based on a process by which experts on the issue ask the question What If "something" behaves in an abnormal way. The HAZOP (Hazard and Operability) study is a structured and systematic examination of the project. Appendix A shows an example of an ISV done for a fueling station using the What If analysis. In Appendix B, a HAZOP study is illustrated for a piece of equipment used for the fueling station. The ISV does discuss the handling of hydrogen, ignition sources, and leak scenarios, as well as scenarios dealing with hydrogen delivery to the sites. An ISV is conducted for every hydrogen station equipment module (compressor, storage, dispenser, etc.) and/or as a site with equipment modules.

The aim of the ISV is to address the situations due to failures that can cause a dangerous hazard to personnel, whether public or private, as well as what vulnerabilities are most likely to occur. These can be found by looking at parameters such as; pressure, temperature, flow, power, software, maintenance, vibration, level, and then assessing deviations such as high, low, present, no, erroneous, reverse.

The ISV is conducted with the following involved

- Chair – FEFuel Designated employee or Consultant with sufficient background to understand the system and the hazard analysis process
- Scribe – FEFuel designated employee or higher facilitator
- Vendor – The vendor or the equipment who intimately know the equipment or a designator. Generally, a process engineer
- Maintenance / Operations – A representative from the Maintenance/Operations team
- Project Manager – This person knows the project and surrounding areas well. Also understands the local requirements

b. Risk Reduction Plan

Once vulnerabilities have been identified, a recommendation is made by the team. These recommendations are listed in the ISV study and an action plan to mitigate these vulnerabilities is created. An example of an action plan is listed in Appendix C.

The document is then put into the project or product file for reference. Any changes to the project/product must undergo the Management of Change Process (MOC). During this process the change requested is cross referenced with the ISV document to ensure that no vulnerabilities or safety items have been compromised.

c. Operating Procedures

i. Operating Steps:

All operating procedures to be followed by the maintenance personnel must be documented and familiarized with prior to performing the task at hand. At any time when the work to be done does not have an operating procedure or involves a new type of work, a Job Hazard Analysis (JHA) must be completed. A copy of FEFuel JHA is available in Appendix D. Figure 6A-1 shows a list of some of the standard operating procedures developed by FEFuel. They include safe work practices to mitigate or control hazard. These are in addition to procedures developed by the manufacture of equipment. FEFuel continues to develop standard operating procedures and communicates them to the service team.

Figure 6A-1: Sample of SOP list

SOP #	Type	Document	Description
MAINT_000	Maint	Copy of Task Descriptions	PM Instructions
MAINT_001	Maint	Shazam TDR Settings	This is how check for the chiller time delay. SHAZAM!
MAINT_002	Maint	Card Reader Installation	New card reader installation/replacement Instructions
MAINT_003	Maint	Slide-Catch Procedure	H70 Shaving Catch Instructions
MAINT_004	Maint	SSP Card Replacement Procedure	SSP Replacement or Upgrade Instructions
MAINT_005	Maint	HazMat Labeling	Hazardous Material Labeling Instructions
MAINT_006	Maint	Pre-Chiller Calibration SOP	Calibration of chiller
MAINT_007	Maint	Sample kit SOP	Sampling Instructions
MAINT_008	Maint	Dispenser Tower Clearance	Shaving dispenser shroud to allow access to towers
MAINT_009	Maint	Cooling Block Hotwork	Prepping cooling block for hotwork
MAINT_010	Maint	Thermistor SOP	Instructions to remove thermistor in dispenser
MAINT_011	Maint	Stage 2 Compressor Piston	Stage 2 piston swap instructions
MAINT_012	Maint	VFD Installation	Instructions to install VFD
MAINT_013	Maint	Cooling Block Thermocouple Troubleshooting Guide	Instructions to troubleshoot bad temp readings from thermocouple in cooling block zone
MAINT_014	Maint	Cleaning Cooling Water Strainger	Instructions on how to clean strainer in cooling water system
MAINT_015	Maint	Hydropac Check Valve Service	Instructions on how to service hydropac check valve
MAINT_016	Maint	Setting Gas Detector Latch SOP	Instructions on how to set gas detector to non latching
MAINT_017	Maint	Dispenser Gas Monitoring Thermocouple Troubleshooting	Instructions on how to troubleshoot dispenser thermocouples
MAINT_018	Maint	APCI Hydropac Flexi 2nd Stage Piston Ring Change	Instructions to swap rings on the 2 part APCI 2nd stage ring
MAINT_019	Maint	High Bank Leak Repair	Instructions on how to fix leak on one of the high banks
MAINT_020	Maint	Nozzle Clip Painting	Instructions on how to paint nozzle clip to match instructions on dispenser
MAINT_021	Maint	Nozzle Lubrication	Instructions on where to lubricate nozzles
MAINT_022	Maint	Chiller Filter Drier Replacement	Instructions on how to replace filter in upstairs chiller unit

The procedures listed above include some of the safety centric processes such as:

- Lock-out, Tag-out
- Purging
- Opening Hydrogen piping
- Hydrogen Venting
- Hydrogen Monitoring
- Fire and Emergency Response
- Hot Work Procedures (working in hydrogen areas)
- Cleaning and Leak Testing

An example of one of these standard operating procedures is included in Appendix E.

ii. Sample Handling and Transport:
Hydrogen samples must be collected on a periodic basis to assure the quality of hydrogen. While FEFuel has a portable sample analyzer, at times samples have to be sent to a third party lab for analysis. In this case, personnel must handle the hydrogen sample in the proper way. A complete sampling procedure is available in Appendix F (taken from the FEFuel SOP). Once the sample is taken, it is repacked in the same manner that it was received. This must be in the form of a “Pelican” case or equivalent. A packaging company is then called to pick up the sample, package it properly per DOT regulations, and then ship it to the appropriate testing lab. This is a proven process that has been in place in California for the past 5 years without incident (at FEFuel sites and others).

d. <u>Equipment and Mechanical Integrity</u>

As mentioned earlier, FEFuel has the team to be able to maintain the station's integrity via a robust Preventative Maintenance (PM) program. Appendix G shows the maintenance program and the philosophy behind responding to emergency situations requiring unscheduled service. The program is comprehensive and looks at maintenance, testing, calibration and inspection procedures. The program is administered by the Service Manager utilizing a Computerized Maintenance Management System (CMMS) tool.

In FEFuel's case, the CMMS is eMaint. eMaint has been improving the way 4,000+ customers and 50,000 users in 55 countries manage their maintenance operations to control costs and boost overall productivity. Thirty years ago, eMaint was founded, and soon became one of the first CMMS providers to develop a completely web-based, "Software as a Service" model. Today, eMaint continues with a proven track record of customer success. Utilizing this software and a few others, we are able to generate maintenance indices to help FEFuel address issues with the highest consequence.

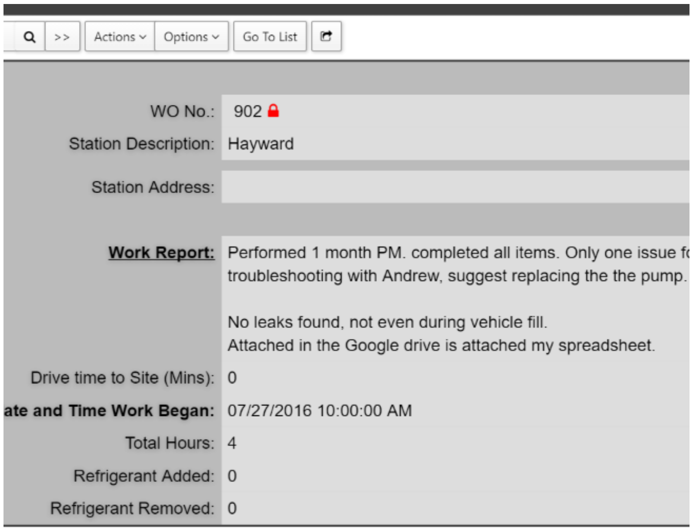
With many stations online, a simple MS Excel spread sheet is simply not robust enough to track all the maintenance activities. eMaint provides a system that can track all site maintenance activities (as shown in Figure 6A-2) and allows for the creation of KPI's to aid in improvements and predict where a hazard might become present (example; repetitive leaks on the same location could indicate a failing component). Figure 6A-3 shows some views of the eMaint program as well as maintenance related KPI's (Figure 6A-4). In the KPI figure, it is clear that the number of cooling issues dropped significantly after identifying that it was the most severe item and was addressed first.

Figure 6A-2: CMMS Work Order Overview

FILTER APPLIED : STATION DESCRIPTION STARTS WITH SHELL [CLEAR FILTER]

WO No.	WO Date	Station Asset ID (FE##)	Station Description	WO Type	Open / History	Job Status	Primary Tech	Job Stat
			shell					
935	07/31/2016	SHELLNPB	Shell - Newport Beach	Scheduled..	H	Completed	Mike Strada	Closed
940	07/29/2016	SHELLTORR	Shell - Torrance	Site Inspe...	H	Completed	Andrew Youlio	Closed
932	07/29/2016	SHELLNPB	Shell - Newport Beach	Corrective	H	Completed	Andrew Youlio	Closed
928	07/28/2016	SHELLTORR	Shell - Torrance	Corrective	H	Completed	Ghassan Slieman	Closed

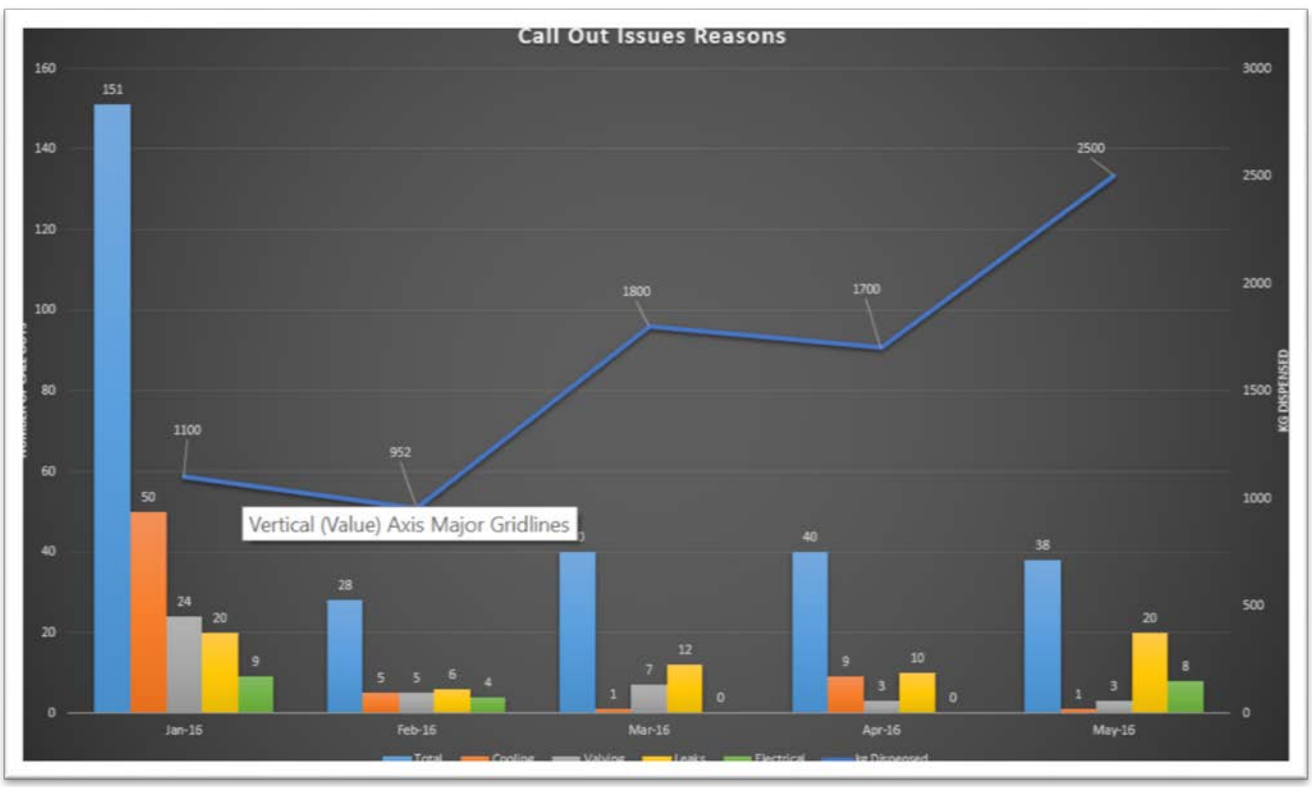
Figure 6A-3: CMMS Work Order report



Actions | Options | Go To List

WO No.:	902
Station Description:	Hayward
Station Address:	
Work Report:	Performed 1 month PM. completed all items. Only one issue f troubleshooting with Andrew, suggest replacing the the pump. No leaks found, not even during vehicle fill. Attached in the Google drive is attached my spreadsheet.
Drive time to Site (Mins):	0
ate and Time Work Began:	07/27/2016 10:00:00 AM
Total Hours:	4
Refrigerant Added:	0
Refrigerant Removed:	0

Figure 6A-4:POWER of CMMS. Identified issued with cooling and addressed first



Each service record includes reference to the work procedure, the proper methodology to do the testing, date, name of person, device identifier, description of the work completed and any outstanding items that need to be revisited. Once the work is complete, it is a requirement for the work order to be reviewed by the manager before closing the order.

In addition to the maintenance program, FEFuel completes an audit of all preventative maintenance to ensure that all have been completed and none have been missed.

e. Management of Change (MOC) Procedures
The Management of Change Program is available in Appendix H

i. Project Safety Documentation:
Every FEFuel station has a manual that contains information that is part of the safety plan. This manual is controlled by the project engineer and any modification to this information must be completed through the MOC process. Once the project is completed, the documentation is uploaded into the project file where any one of the team members can access the file for download, but not for modification. FEFuel uses a web based server that can be accessed from any internet connected device; this can be a computer, tablet, or a smart phone. In the case a team member does not know the location of the documentation, a search of the entire database is quick and easy, or they can call any one of the project engineers.

f. Project Safety Documentation
FEFuel has a list of project safety documentation that is available to all employees. The documents have a strict control system. All documents have control information and any changes to those documents can only be made with an MOC. These documents include.

- Emergency response procedures. Example is located in Appendix I
- Maximum Amount of hazardous material on site as shown in Appendix I ERP manual in Section 4. Hazardous Material Business Plan
- Safety Data Sheets (formerly MSDS)
- Process diagram of the station
- Inventory of hazardous Materials. An Example is located in Appendix I. Section 4. Hazardous Material Business Plan
- Maximum operating envelope (Temperature, pressure voltage, power consumption). Available in Station Operating Manual
- Required Material of Construction. Example Appendix J
- Electrical Area Classification. Example Appendix K
- Hydrogen Vent Stack Relief stack. Example Appendix L
- Design Codes and Standard. Example Appendix M
- Station Alarm and Alarm Codes. Example Appendix T
- Safety Review Documentation. Example in ISV document in Appendix A and Appendix B

4. Communications Plan

FEFuel prides itself on the continuous communication between all team members. We utilize the latest available technologies for communication. This includes web meetings, group messaging over smart phones (mandatory at FEFuel), and we are very proud to say that our operations team meets 3 times a week.

To ensure that all of the project team receives the right information, there is a focus within FEFuel on communicating:

a. Training

FEFuel has a formal training program. In Appendix M is the training program that every new employee must undergo before they are ready to work on a hydrogen stations. This is complemented by the Competency Matrix, also located in Appendix N, to ensure that anyone working on a project does in fact have the necessary skills to do so. Each technician undergoes a series of training where a competency level is assigned as described in Section 2: Organizational Policies and Procedures.

b. Safety Reviews

Each FEFuel project undergoes multiple safety reviews. The initial review is undertaken during site selection; where the site and surrounding area is compared with the codes and exposure setbacks in NFPA-2. At this stage we consult with internal and external experts to consider if the site encroaches on any safety setbacks (detailed in Appendix R). Should there be an encroachment, the responsible engineer would discuss this with the team to determine if there are feasible methods to mitigate the hazard to the exposure, such as including fire rated walls, moving to a different location on the site, or even placing equipment underground. If it is deemed that the project is to proceed, then an ISV is conducted. During this process, if more vulnerabilities are identified, the project would go through additional safety review to ensure that sufficient mitigation or controls are implemented to meet or surpass NFPA requirements. Once the design is completed, another round of safety review is conducted with the city to ensure that those who best know the area can provide input to the project.

c. Safety Events and Lessons Learned

Any incident within the company is directly reported to a supervisor. Based on the severity of the incident, the appropriate action is taken. For incidents that involve injury, the procedure in Appendix O is taken. For incidents that are categorized as a Near Miss (where injury could have happened) the form in Appendix P is completed and submitted. The safety committee reviews all incidents and near misses on a quarterly basis and suggest actions if needed. In most cases, it is expected that the appropriate action has already been taken prior to the safety meeting.

The project team clearly understands the importance of experience. For this purpose, safety events that require changes in operating procedures or equipment design are continuously monitored. Due to the size of FEFuel, quick action is easily adopted. For example; an approved change in software was completed on 15 operating stations in under a week. As we communicate formally multiple times a week, new ideas and lessons are implemented in a fluid fashion. This is contrary to the current industry standard of having the lessons learned meeting occur after a project. As we embark on new concepts and new strategies as being implemented for this project, the entire group meets for that purpose to try and incorporate all good ideas into any innovative new design.

d. Emergency Response
Every project proposed will have its own customized Emergency Response Procedure (ERP). An example of an ERP is located in Appendix I.

It is important to note that FEFuel is committed to providing current, timely and easily accessible information about the station to First Responders in the event of an emergency, including publicly available station maintenance plans. The information is available online through the California Environmental Reporting System (CERS). All of the proposed FEFuel projects' information to First Responders is available via this system. This system is available to all California Unified Program Agencies (CUPA) counties. All of the FEFuel projects reside in CUPA counties.

e. Self-Audits
Part of the Maintenance and Operations procedures is a self-audit. On a frequent basis, the responsible manager will review the Key Performance Indices (KPI's). These KPI's help determine if there are situations that require improvements. The KPI's are not only related to operational performance but also related to safety and Injury. The KPI forms for injury related instances are located in Appendix Q

B. Post-Award Requirements

1. Release and Incident Reporting

Any unintended hydrogen release or incident will be reported per California Health and Safety Code Section 25510(a). A copy of any related documents will be supplied to the California Energy Commission in timely manner.

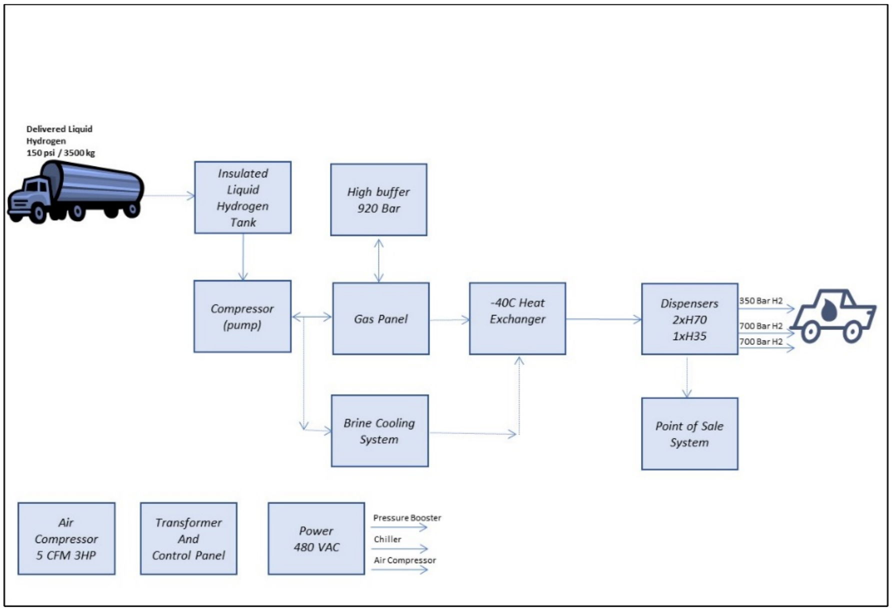
2. Annual Safety Evaluations

FEFuel is open to annual safety evaluations conducted by the Hydrogen Safety Plan for three years after the station becomes operational.

C. Additional Documentation

1. Process and Flow Diagram

Detailed Process Flow Diagrams and Piping and Instrumentation Diagrams contain proprietary information that is difficult to share in a publicly accessible proposal. Therefore, a simplified Process Diagram is shown below instead.



2. *Preliminary Design or Functional Description of each Component in the System*

The station is comprised of basic modules; Hydrogen fill port; vacuum insulated liquid hydrogen storage vessel; gas panel; cryogenic compressor/pump[1]; high pressure storage; brine cooling system and heat exchanger; Dispenser; point of sale; SCADA system, and safety devices.

Hydrogen Inlet: Hydrogen is delivered to the station via a purpose built liquid hydrogen trailer. The trailer connects to a fill port that is located onsite per NFPA standards. The station and the trailer will have a number of technology advances over traditional liquid hydrogen delivery systems including interconnection to the station emergency stop circuit, lower transfer pressure, substantially reduced venting, and vent interconnection to the permanent station vent stack. The truck will be on site for less than one hour per delivery.

Vacuum insulated liquid hydrogen storage vessel: This is where the hydrogen from the liquid trailer will be stored. Unlike most “generic” cryogenic tanks, the vacuum insulated tank is designed specifically for this application and eliminates unnecessary valving associated with bottom filling and try-cock level measurement.

Gas Panel: The gas panel directs the gas to the right storage module or dispenser. It is important for the station to direct gas in the most efficient manner. Proper direction of gas allows for better fueling performance for customers.

Compressor: The function of the pump/compressor is to increase the pressure of the hydrogen from roughly 60 psi to over 13,000 psi.

High Pressure Storage: This storage system holds enough gas to be able to fuel several vehicles before requiring to be replenished from the compressor.

[1] A pump is a device that moves a liquid; i.e., liquid in, liquid out. A compressor is a device that compresses a gas; i.e., gas in, gas out. The device used in this equipment is a hybrid that takes in liquid and outputs compressed gas. The conventional nomenclature does not work well, so some manufacturers use the term “pump”, and some use “compressor”.

Brine Cooling System and Heat Exchanger: Hydrogen entering the dispenser must be precooled to a minimum of -33C. The brine system transfers heat from the brine into the cold pump output. The large thermal mass of the brine maintains a cold temperature and then cools the heat exchanger as the hydrogen flows through it.

Dispenser: The Dispenser dispenses hydrogen gas at 10,000 psi to vehicles with J2601 compliant receptacles on vehicles.

Point of Sale (POS): The point of sale system is where the consumer enters payments; such as a credit card. The POS communicates with the dispenser to authorize fueling.

Safety Devices: These monitoring devices include flame detectors, gas detectors, ventilation systems and security cameras. Flame detectors shut down the entire station in the case of any flame detection. The gas detector also shuts down the station when more than 25% of the hydrogen lower flammability limit (LFL) is reached. The security cameras are used as a deterrent for vandalism. There are other Safety devices onsite such as pressure relief valves and temperature switches. It is important to note that a standard pressure transducer is not a safety device, but is used for control. The pressure relief valve is the device that protects from over pressurization.

SCADA: The supervisory control and data acquisition (SCADA) system monitors the station for 24/7. Should there be an alarm, SCADA will notify the FEFuel control center and initiate a response for the site.

3. Codes and Standards, See Appendix M

The Required Codes and Standards are listed in Appendix M. However, it is important to note that the various modules installed will come listed by a Nationally Recognized Testing Lab to a recognized U.S. standard such as UL or ETL to NFPA-2 or equivalent.

4. ***Layout***

a. Separation distances

   i. The separation distances per project will vary by site. FEFuel has developed a set of standard methods to assess Separation Distances. Those are "bubble" diagrams and exposure distance charts that comply with NFPA-2. Where encroachment is unavoidable, a set of mitigation strategies are implemented or further studies performed. Appendix R shows a brief example.

b. Vent consideration

   i. The equipment will include two vent stacks; a low pressure vent for liquid hydrogen and a high pressure vent for gaseous portions of the system. The vent stacks are designed per CGA G5.5 Hydrogen Vent System. Appendix L shows the vent consideration diagrams from NFPA-2. Dynamic computational fluid dynamics analysis will be generated to show the flow of hydrogen in venting situations. An Example is shown in Appendix R.

c. Electrical classification

   i. Electrical Classification is clearly defined in NFPA-2. An example of this Classification is shown in Appendix L

d. Ventilation requirements for enclosed space

   i. When required, the system will be ventilated for safe operation. FEFuel has engaged the world's top experts to aid in this study. Some of the design aspects include:

      - Minimum required flow
      - Redundant fans
      - Redundant hydrogen sensors
      - Positive proof of ventilation
      - Negative pressure operation
      - Visual alarms for persons involved

Appendix A – What If Analysis

Processes: 1. Generic Hydrogen Station

Nodes: 1. Process Hazards

What if	Consequence	Causes	Safeguard	Recommendations	Responsibility	Comment
1. Loss of Containment - Abnormal pressure/ temperature/ flow/ phase/ composition/ of a significant concern; Shutdown of a downstream unit	1. Increased pressure from the Compressor (maximum discharge is 15000 psig), potential to challenge the rating of the High Pressure Vessel (13500 psig). Potential to damage flanges or Vessel and release. Potential fire and exposure risk.	1. High pressure to the vessel	1. Dual hydrogen monitors, set at 25% hydrogen concentration, that are configured with one-out-of-two (1oo2) voting to shut down the Hydrogen System on high hydrogen concentration detection. 2. Real-time monitoring for leaks to a centralized location, which has remote-stop capabilities. 3. System is isolated by walls (13'), which would deflect hydrogen upwards.	In the case of a fire being released from the bulk storage. The best course of action is to cool any equipment or walls that the fire is impinging on, isolate the source of the hydrogen feeding the fire if possible. Or simply let the fire burn and it will extinguish once the hydrogen is burned. Contact FEFuel at 1-844-878-9376. The emergency response manual ERP is located on site.		1. The Team noted that the maximum overpressure scenario would still be within safe design allowances, and does not expect any release, even in a maximum discharge scenario. If there were a release, it would be a small leak at a flange (or other weak point) rather than a catastrophic vessel failure.
	2.	1. High temperature was considered, but no hazards were identified by the HAZARD ANALYSIS Team. The highest ambient temperature is below the rated temperature of the hadardous equipment.				
	3.	1. Low temperature was considered, but no hazards were identified by the HAZARD ANALYSIS Team. The lowest ambient temperature is above the rated temperature of the hadardous equipment.				
	4. Compressor ingressing air into the Vessel, potential for a combustible atmosphere. Potential for fire and exposure risk.	1. Open air source (e.g., compressor inlet air leak, incorrect delivery, or compressor seal leak) on the inlet to the Compressor.	1. Pressurized inlet to the Compressor 2. Low pressure switch on the Compressor inlet is configured to trip the Compressor on an inlet line leak. 3. Compressor design is such that, in the loss of inlet pressure, the Compressor would be unable to operate. 4. Real-time monitoring for leaks to a centralized location, which has remote-stop capabilities, and this remote stop is accessible to anyone that feels there is an unsafe condition.			
	5.	1. Backflow to the Medium Pressure Vessel was discussed, but was not considered to be credible by the HAZARD ANALYSIS Team. The Team noted that multiple failures would have to happen simultaneously (there are dual check valves and solenoid control valves that would shut in				

		when flow is not needed to/from the Medium Pressure Vessel).				
2. Loss of Containment - Seal, Gasket leak; exchanger tube leak	1. Potential for release of hydrogen. Potential fire hazard/exposure.	1. Compressor Seal Leak	1. Dual hydrogen monitors, set at 25% hydrogen concentration, that are configured with one-out-of-two (1oo2) voting to shut down the Hydrogen System on high hydrogen concentration detection.			
			2. Low pressure switch on the Compressor inlet is configured to trip the Compressor on low pressure (e.g., an inlet line leak).			
			3. Compressor design is such that, in the loss of inlet pressure, the Compressor would be unable to operate.			
			4. Real-time monitoring for leaks to a centralized location, which has remote-stop capabilities.			
			5. System is isolated by walls (8'6), which would deflect hydrogen upwards.			
	2. Potential to damage equipment was discussed, however, the Team noted that existing crash protection (walls / bollards) are in place and sufficiently spaced to avoid vehicles colliding with process equipment. Also, the location of equipment is such that would impede vehicles from high velocity impacts.	1. Vehicular impact				
3. Loss of Containment - Air ingress	1. No new hazards identified by the HAZARD ANALYSIS Team.					
4. Loss of Containment - Vibration, mechanical impact	1. Vibration at the compressor was discussed; however, the HAZARD ANALYSIS Team noted that this is a low-speed Compressor, and significant vibration is not a credible scenario. Any piping vibrations would be confined by the hazards listed in Scenario 1.1.					
5. Loss of Containment - Structural failure (foundation, weight, impact)	1. Structural failure was discussed; however, the HAZARD ANALYSIS Team noted that the system has a relatively low weight and is being placed on foundation specifically designed for the system. No credible hazards were identified.					
6. Loss of Containment - Erosion/corrosion	1. No hazards were identified by the HAZARD ANALYSIS Team. The Team noted that system piping is 316 stainless steel, and in a continuous conduit, and hydrogen is a low corrosively chemical at the temperatures and pressures during operation.					
	2. High Temperature Hydrogen Attack / Hydrogen Embrittlement phenomena were discussed,					

	however, upon reviewing the pressures and temperatures expected in the system, the HAZARD ANALYSIS Team determined the carbon steel vessels would not be susceptible to these phenomena. No hazards identified by the Team.					
7. Loss of Containment - Contamination	1. Incorrect delivery was not considered to be a credible scenario by the HAZARD ANALYSIS Team. The Team noted that high pressure hydrogen tubes are used solely for the purposes of high pressure hydrogen, and the system has unique connections to ensure that nothing but high pressure hydrogen is delivered into the system.	1.		1. Consider configuring a combination lock on the Stanchion. While there were no safety/environmental issues identified, the HAZARD ANALYSIS Team noted that it is a best practice to ensure that there is no unauthorized access to the stanchion.		
8. Inventory - Excess hazardous material (mitigation measure include: minimize hazardous inventory, alternate processes and utility systems)	1. No hazards identified by HAZARD ANALYSIS Team. The Team noted that the high pressure delivery relies on the principle of pressure equalization. Instead of delivering excess material, the loading would stop (both the Truck and the High Pressure Vessel are rated to the same pressure).	1.				1. Alternative processes and utility systems do not apply to the FEFuels Del Mar Station.

Processes: 1. Generic Hydrogen Station

Nodes: 2. Utility Systems Hazards

What if	Consequence	Causes	Safeguard	Recommendations	Responsibility	Comment
1. Abnormal Condition - Loss of cooling water, refrigeration, power, steam, instrument air, inert, HVAC	1. Loss of Compressor jacket cooling, resulting in increased hydrogen/compressor oil/cylinder temperature. Potential to damage the Compressor seal, resulting in a loss of containment. Potential for a release of hydrogen, fire hazard, and exposure.	1. Loss of cooling water	1. Two thermocouples (one on the compressor oil discharge, and one on the hydrogen gas discharge) that are configured to shut down the Compressor. 2. Dual hydrogen monitors, set at 25% hydrogen concentration that are configured to shut down the Hydrogen System on high hydrogen concentration detection.	2. Consider configuring a function to alarm if the Compressor is operating without cooling water flow. The concern is that, if cooling water is lost, there is potential to damage the Compressor, resulting in lost opportunity/asset impact.		
	2. Potential to send high temperature hydrogen to consumer vehicles. Potential to damage the consumer vehicle tank was discussed, but the HAZARD ANALYSIS Team determined this to be a long-term issue requiring numerous high temperature fills before propagating a hazard.	1. Loss of refrigeration	1. Thermocouple on the Station side is configured to shut down on a high temperature deviation. 2. Thermocouple on the vehicle side is configured to stop fill on a high temperature deviation. 3. Aluminum block is used to cool hydrogen, which would gradually heat, rather than a complete loss of cooling on failure, which is configured with three thermocouples, which independently may shut down the Hydrogen System.			

Processes: 1. Generic Hydrogen Station

Nodes: 2. Utility Systems Hazards

What if	Consequence	Causes	Safeguard	Recommendations	Responsibility	Comment
	3. Loss of solenoid valve control, resulting in valves failing into their fail-safe positions. No hazards identified by the HAZARD ANALYSIS Team, this is an operational issue.	1. Loss of instrument air supply				

Processes: 1. Generic Hydrogen Station

Nodes: 3. Operational Mode

What if	Consequence	Causes	Safeguard	Recommendations	Responsibility	Comment
1. Start-up	1. Potential for release of hydrogen. Potential for a flammable atmosphere and exposure.	1. Initial Start-Up - Potential for a leak in a factory connection.	1. Dual hydrogen monitors, set at 25% hydrogen concentration that are configured to shut down the Hydrogen System on high hydrogen concentration detection.			
			2. Leak testing per ASME Standards prior to start-up, which includes inert gas pressurization test, then gradual introduction of hydrogen coupled with leak checking.			
			3. Vessels are purged, prior to start-up.			
2. Shutdown	1.	1. No issues identified by the HAZARD ANALYSIS Team during short term shutdown.				
	2. Potential for increased hydrogen pressure due to ambient temperature changes was discussed, but the HAZARD ANALYSIS Team did not identify any hazardous consequences. The Team noted that the system is depressured to 75%, which is significant enough to avoid any issues with increased pressure (which was noted for the location to be roughly 4-5% at it's highest).	1. Long term shutdown during winter.				
3. ESD	1.	1. No issues identified by the HAZARD ANALYSIS Team. The Team noted that the system is rated above operational pressures, and that the Compressor would automatically shut down for ESD scenarios (the only source of increased pressure).				

Processes: 1. Gneeric Hydrogen Station

Nodes: 4. Health Hazards

What if	Consequence	Causes	Safeguard	Recommendations	Responsibility	Comment
1. Asphyxiation hazards - Asphyxiating atmospheres, failure to use appropriate PPE, vessel entry, working in confined spaces, smoke, exhaust	1.	1. No issues identified by the HAZARD ANALYSIS Team. The Hydrogen System is in an open roof setting, so any significant releases would float upwards, and vessels/PSVs are designed to fail/lift above 8'. Minor leaks would be expected to dissipate prior to creating an asphyxiation hazard.				
2. Carcinogenic - Chemicals in use	1.	1. No carcinogenic chemicals are in use.				
3. Toxic - Hazardous atmosphere, chemicals in use; chronic exposure	1.	1. No acutely toxic chemicals are in use. The Team discussed the refrigerant's long term toxicity, but noted that the small quantity on-site and the high concentration required for adverse health effects would render this as not a credible concern (some would vent during accumulation, and would not be able to attain the necessary concentration).				
4. Physical - Potential falls, noise, radiation (ionizing, e.g., radioactive scale or non-ionizing, e.g., flares, UV, sunlight), ergonomics	1. Potential for operator injury during ladder.	1. Fall from ladder	1. Ladder is built to OSHA Ladder Standards.			
			2. Ladder is within the secure access area to ensure that people do not access the ladder/process area that are not trained on the system.			
	2.	1. Noise from process was discussed; however, the HAZARD ANALYSIS Team noted that, to enter the process area, hearing protection is required, and that the enclosure muffles sound to an adequate level for the public.				
5. Working Hazards - Diving, working in water, working at heights, hazardous equipment, hot or hazardous surfaces, electricity	1. Potential for operator/technician injury due to hot pipe.	1. Hot surfaces on the Compressor discharge	1. Compressor is isolated from the rest of the enclosure, and there is no reason to enter the Compressor Area except to work on the Compressor.			1. Diving and working at heights do not apply to the FEFuels Del Mar Station.
			2. Procedures are in place for the technician to ensure that the piping is sufficiently cooled for any operations that do not require the Compressor to be running.			
			3. Signage is to be placed in appropriate locations to alert personnel to occupational/process hazards (e.g., high pressures/temperatures/noises) as well as advise personnel of hazardous area classifications (e.g., where non-spark tools are required).			

Processes: 1. Gneeric Hydrogen Station

Nodes: 4. Health Hazards

What if	Consequence	Causes	Safeguard	Recommendations	Responsibility	Comment
	2. Potential for operator/technician injury due to electrical hazards.	1. Electrical hazards	1. Hazardous Energy Control / Lockout/Tagout Program in place to ensure electricity is controlled prior to use.			
			2. Signage on panel to warn personnel of electrical hazards.			
			3. Signage is to be placed in appropriate locations to alert personnel to occupational/process hazards (e.g., high pressures/temperatures/noises) as well as advise personnel of hazardous area classifications (e.g., where non-spark tools are required).			
	3. Potential leak/rupture, resulting in a potential operator injury (e.g., high pressure to sensitive area).	1. High pressure hydraulic oil	1. Procedures are in place to check for leaks at the Compressor prior to entering the Compressor Area.			
			2. PPE in place (safety glasses, Nomex, safety shoes)			
			3. Signage is to be placed in appropriate locations to alert personnel to occupational/process hazards (e.g., high pressures/temperatures/noises) as well as advise personnel of hazardous area classifications (e.g., where non-spark tools are required).			
6. Transport - Excessive journeys, extreme weather, quality of roads (mitigation measures include: effective journey management)	1.	1. No significant hazards posed by transport. The HAZARD ANALYSIS Team noted that rigorous commissioning checks are in place to ensure that equipment is in good working order prior to commissioning.				1. Effective journey management was discussed; the Team noted that the trips required for construction and maintenance pose no logistical concerns.

Processes: 1. Generic Hydrogen Station

Nodes: 5. Maintenance Hazards

What if	Consequence	Causes	Safeguard	Recommendations	Responsibility	Comment
1. Access Requirements	1.	1. Access is restricted to authorized personnel through a controlled lock.				
2. Override Necessity - To conduct instrument proof tests	1.	1. Override is available in manual mode, which has its own procedures to ensure safe operation and return to automated state.				
3. Bypasses Required - For critical valves	1.	1. The Team discussed the need for bypasses; however, this was not considered to be necessary for safe maintenance activities on the system. No bypasses are configured in the system.				

Processes: 1. Generic Hydrogen Station

Nodes: 5. Maintenance Hazards

What if	Consequence	Causes	Safeguard	Recommendations	Responsibility	Comment
4. Non-Commonality of Equipment	1.	1. Commonality of equipment is expected at all the proposed facilities, with critical equipment spares being inventoried.				
5. Crane Use - Congestion, heavy lifts, dropped objects	1.	1. Cranes are only to be used during initial installation; reputable contractor is used, with a lifting plan in place to account for any hazards involved with crane use, including a traffic control/flow plan.				
6. Transport - Transfer of equipment etc. within the facility	1.	1. No transport is to take place beyond initial installation.				

Processes: 1. Generic Hydrogen Station

Nodes: 6. Fabrication/Installation

What if	Consequence	Causes	Safeguard	Recommendations	Responsibility	Comment
1. Complexity	1.	1. The system is configured in a relatively simple manner from an Operations standpoint. No hazards were identified by the HAZARD ANALYSIS Team.	The system is fully tested prior to startup to ensure that the installation is was done correctly. This include electrical checks and pressure testing.			
2. Modularization	1.	1. The system is completely modularized. No hazards identified by the HAZARD ANALYSIS Team.	The system is fully tested prior to startup to ensure that the installation is was done correctly. This include electrical checks and pressure testing. Modular design aids in quality control as the majority of the system is tested fully tested in a controlled environment. Field installed components are tested prior to start up.			
3. Transportation	1.	1. The system is modularized, so it is easily transportable. No hazards identified by the HAZARD ANALYSIS Team.	The system is fully tested prior to startup to ensure that the installation is was done correctly. This include electrical checks and pressure testing. This ensure that any componenets that may have failed during transportation are captured prior to station opening.			

Processes: 1. Generic Hydrogen Station

Nodes: 7. Natural and Environmental Hazards

What if	Consequence	Causes	Safeguard	Recommendations	Responsibility	Comment
1. Climate Extremes - Temperature, wind, dust, flooding, ice	1. No new issues identified by the HAZARD ANALYSIS Team.	1. Temperature				
	2. No significant hazards identified by the HAZARD ANALYSIS Team; the system is in an enclosed area. The canopy over the	1. Wind				

Processes: 1. Generic Hydrogen Station

Nodes: 7. Natural and Environmental Hazards

What if	Consequence	Causes	Safeguard	Recommendations	Responsibility	Comment
	dispenser was discussed; however, it was noted that the canopy was designed for maximum wind conditions in the area by a California PE.					
	3. Ice was not considered to be a credible hazard by the HAZARD ANALYSIS Team. The Team discussed icing due to process conditions, but it was not considered to be a hazard (piping is stainless steel).	1. Ice	All fuilds in the system are designed for low temperature. He highest freezing temperature is -10F.			
	4. The enclosure is rated for Class I, Div II, so dust was not considered to be an issue by the HAZARD ANALYSIS Team.	1. Dust				
	5. No issues identified by the HAZARD ANALYSIS Team. The lowest electrical source is 16" above the external grade; even if there were to be water in the enclosure, this is an asset issue due to potential electrical equipment/instrumentation damage.	1. Flooding				
2. Lightning	1. The equipment is grounded and protected from lightning; no issues identified by the HAZARD ANALYSIS Team.					
3. Earthquakes	1. The enclosure is designed with seismic events in mind, no further issues identified by the HAZARD ANALYSIS Team.		In the case of a leak or a line breakage due to earthquake the system will automatically detect the failure and close all valves in the system. All underground hydrogen piping is continuous. There are no welds or joints. This mitigates the effect of vibration due to earthquakes.	In the case of an earthquake the operation team from FEFuel will inspect the system to ensure that the integrity was not compromised. No action is required by first responders.		
4. Erosion - Ground slide, coastal, river	1. The solid enclosure is placed on solid pavement, thus erosion was not considered to be a credible scenario by the HAZARD ANALYSIS Team.					
5. Wild Fires	1. Open Flame near the hydrogen		The bulk hydrogen storage is surrounded by a 4 hour fire wall and two 3 hour rated doors that protects against wild fire. The 13,500psi storage is further protected by another 2 hour fire wall internal to the compression system. Should the wild fire increase the temperature of the compound or the storage cylinders; the cylinders are protected by relieve valves that will evacuate the storage system should there be a sufficient temperature rise. Additionally the storage tanks are rated to 180F. The dispenser is monitored by a flame detector to shut down all hydrogen valves and stop the	In such cases it is advised to maintain the walls of the compound cool with water. However, not action is needed. They system has the necessary safeguards to mitigate the effects of a nearby fire.		

Processes: 1. Generic Hydrogen Station

Nodes: 7. Natural and Environmental Hazards

What if	Consequence	Causes	Safeguard	Recommendations	Responsibility	Comment
			flow of hydrogen to the dispenser if any fire is detected in the vicinity of the dispenser.			
6. Subsidence - Ground structure, foundations, reservoir depletion	1. The solid enclosure is placed on solid pavement and is relatively lightweight, thus subsidence was not considered to be a credible scenario by the HAZARD ANALYSIS Team.					

Processes: 1. Generic Hydrogen Station

Nodes: 8. Escape, Evacuation and Rescue

What if	Consequence	Causes	Safeguard	Recommendations	Responsibility	Comment
1. Escape routes / Muster location	1.	1. Evacuation plan is in place with a muster point; enclosure includes multiple points of egress.				
2. Temporary Refuge	1.	1. N/A, this is a normally unmanned remote facility (NURF).				
3. Rescue	1.	1. Emergency Response Plan includes rescue, and any entrance during hazardous situations is prohibited.				
4. PPE/Breathing Air	1.	1. Standard PPE is in place; the facility is open to atmosphere, and no gases are on site that would accumulate sufficiently enough to propagate acute toxicity and/or asphyxiation hazards.				

Processes: 1. Generic Hydrogen Station

Nodes: 9. Created (Man-made) Hazards

What if	Consequence	Causes	Safeguard	Recommendations	Responsibility	Comment
1. Security Hazards - Internal and external security threats	1.	1. The Team discussed risks involving terrorism/sabotage, but felt that with the security measures in place (controlled access with controlled lock, and CCTV monitoring with warning signage) that no further risk reduction was feasible by the HAZARD ANALYSIS Team. The Team also noted that this is a relatively small, isolated system, and would not be considered a "high-value" target for such activities (it was also noted that the gasoline stored on-site via				

Processes: 1. Generic Hydrogen Station

Nodes: 9. Created (Man-made) Hazards

What if	Consequence	Causes	Safeguard	Recommendations	Responsibility	Comment
		the existing gas station would provide a more hazardous scenario).				
2. Terrorist Activity - Riots, civil disturbance, strikes, military action, political unrest	1.	1. The Team discussed risks involving terrorism/sabotage, but felt that with the security measures in place (controlled access with controlled lock, and CCTV monitoring with warning signage) that no further risk reduction was feasible by the HAZARD ANALYSIS Team. The Team also noted that this is a relatively small, isolated system, and would not be considered a "high-value" target for such activities (it was also noted that the gasoline stored on-site via the existing gas station would provide a more hazardous scenario).				

Processes: 1. Generic Hydrogen Station

Nodes: 10. Fire & Explosion

What if	Consequence	Causes	Safeguard	Recommendations	Responsibility	Comment
1. Layout - Equipment spacing to reduce congestion; layout considering wind direction; buffer zones between units; secondary containment; barriers; separate hazardous inventory, design building to withstand blast	1. Equipment has adequate spacing and walkways, per OSHA and NFPA Standards. No issues identified by the HAZARD ANALYSIS Team.	1. Equipment spacing				
	2.	1. Wind direction, buffer zones, secondary containment, barriers, and blast design were all considered, and no issues were identified. The HAZARD ANALYSIS Team noted that the system is built to regulatory and industry best practices.				
2. Stored Flammables - Improper storage, operator error (release), defect, impact, fire (mitigation measures include: substitute non-flammable, minimize and separate inventory)	1.	1. The system is largely storage; no new issues identified by the HAZARD ANALYSIS Team. Operations are trained on the hazards and know to use non-spark tools, the area is Class I, Div. II, and the inventory stored is small.				
3. Sources of Ignition - Electricity, flares, sparks, hot surface (mitigation measures include: identify, remove, separate), HV power supply	1.	1. No new issues identified by the HAZARD ANALYSIS Team. Operations are trained on the hazards and know to use non-spark tools, the area is Class I, Div. II, and the inventory stored is small.	The station is protected by a two hour fire wall such that if there are small fires or people smoking in the area the equipment is protected as well as public safety.			

Processes: 1. Generic Hydrogen Station

Nodes: 10. Fire & Explosion

What if	Consequence	Causes	Safeguard	Recommendations	Responsibility	Comment
4. Fire Protection and Response - Active/passive insulation, fire/gas detection, blow down/relief system philosophy, firefighting facilities	1.	1. Fire Response is coordinated as part of the Emergency Response Plan, passive insulation (fire wall) in place, PSVs on critical equipment, and gas detection is in place. No further risk reduction was considered necessary by the HAZARD ANALYSIS Team.				

Processes: 1. Generic Hydrogen Station

Nodes: 11. Effect of the Facility on Surroundings

What if	Consequence	Causes	Safeguard	Recommendations	Responsibility	Comment
1. Geographical & Infrastructure - Plant location, plant layout, pipeline routing, area minimization	1.	1. Plant is located in an optimal setting from an operational and safety location; layout, pipe routing, and area minimization are considered as compact as possible.				
2. Proximity to Population	1.	1. Worst-case modeling for dispersion and heat radiation have taken place and shown to have no adverse implications on the local population. No further risk reduction was considered necessary by the HAZARD ANALYSIS Team.				
3. Flaring	1.	1. Not applicable.				
4. Adjacent Land Use - Crop burning, airfields, accommodation camps	1.	1. Fire standard (NFPA-2) accounts for local fire impacts, and the location is set on a gas station lot, so fuel dispensing is already accounted for on the selected area.				
5. Proximity to Transport Corridors - Shipping lanes, air routes, roads, etc.	1.	1. No new issues identified by the HAZARD ANALYSIS Team.				
6. Environmental Issues - Previous land use, vulnerable fauna and flora, visual impact	1.	1. No issues identified by the HAZARD ANALYSIS Team; the Hydrogen System is being placed on an existing gas station site.				
7. Social Issues - Local population, local attitude, social/cultural areas of significance	1.	1. No significant impacts were identified by the HAZARD ANALYSIS Team. The Team noted that the goal of the Hydrogen System is to cut emissions and promote change to alternative fuels. The local population/culture is highly receptive to environmental stewardship.				

Processes: 1. Generic Hydrogen Station

Nodes: 12. Infrastructure

What if	Consequence	Causes	Safeguard	Recommendations	Responsibility	Comment
1. Normal - Road links, air links, water links	1.	1. No issues identified by the HAZARD ANALYSIS Team.				
2. Communications	1.	1. Active monitoring is installed, so if there is a communication failure, the centralized station would be immediately notified.				
3. Communications for Contingency Planning	1.	1. ERP in place, with communications planning.				
4. Supply Support - Consumables/spares holding	1. Spare parts will be housed in San Francisco and the Los Angeles / Orange County area to ensure ease of access for the sites to spares. No further action identified by the HAZARD ANALYSIS Team.	1. Sparing of parts				
	2. The chemical vendor (Air Products) has access to the active communications, and will be notified to bring additional hydrogen (which is readily available) to the site prior to emptying. Procedures are in place to notify Air Products when filling is needed. No further action identified by the HAZARD ANALYSIS Team.	1. Hydrogen Supply				

Processes: 1. Generic Hydrogen Station

Nodes: 13. Environmental Damage

What if	Consequence	Causes	Safeguard	Recommendations	Responsibility	Comment
1. Continuous Plant Discharges to Air - Flares, vents, fugitive emissions, energy efficiency	1.	1. No issues identified by the HAZARD ANALYSIS Team. Hydrogen exists in the atmosphere, and is non-toxic. Also, the site has a relatively small amount on-site.				
2. Continuous Plant Discharges to Water - Target/legislative requirements, drainage facilities, oil/water separation	1.	1. No discharges to water. The skid is housed on secondary containment, so no leaks of compressor oil were expected by the HAZARD ANALYSIS Team.				
3. Continuous Plant Discharges to Soil - Drainage, chemical storage	1.	1. No discharges to soil. The skid is housed on secondary containment, so no leaks of compressor oil were expected by the HAZARD ANALYSIS Team.				
4. Emergency/Upset Discharges - Flare, vents, drainage	1.	1. Not applicable.				

Processes: 1. Generic Hydrogen Station

Nodes: 13. Environmental Damage

What if	Consequence	Causes	Safeguard	Recommendations	Responsibility	Comment
5. Contaminated Ground - Previous use or events	1.	1. Not applicable; the Hydrogen System is being placed on an existing gas station, and does not own the land. Also, soil testing has been done on the area, and no issues were identified.				
6. Facility Impact - Area minimization, pipeline routing, environmental impact assessment	1.	1. Plant is located in an optimal setting from an operational and safety location; layout, pipe routing, and area minimization are considered as compact as possible.				
7. Waste Disposal Options	1.	1. No significant issues identified by the HAZARD ANALYSIS Team; the only waste being disposed of is the compressor oil, which has procedures already in place.				
8. Timing of Construction - Seasons, periods of environmental significance	1.	1. No issues identified by the HAZARD ANALYSIS Team; the Hydrogen System is a module, so the time of construction is minimized, and the proposed area is not prone to seasonal disruption or periods of environmental significance.				

Hazard and Operability Study (HAZOP)

Company:	FEFuel
HAZOP Manager:	Ghassan Sleiman
Project Name	Sampling System
Document Number:	Sampling System

Acronyms	NR	None Required
	PM	Preventative Maintenance
	NCI	No Consequence of Interest
	HV	Hand Valve
	PCV	Pressure Control Valve
	SF	Safety Fitting
	SV	Safety Valve
	FH	Fill Hose
	PI	Pressure Indicator
	CV	Check Valve

Deviations	High, Cycling, Low, Misdirected, No, Erroneous, Reversed	**Parameter**	Pressure, Temperature, Flow, Leak, Static

Revision History

Date	Personnel	Revision Description	Revision Number
3/16/2016	Ghassan Sleiman, Tyler Furuya	Initial draft	1
3/18/2016	Ghassan Sleiman, Tyler Furuya, Andrew Youlio	Final draft	2
3/29/2016	Tyler Furuya	Draft Formatting	3
3/30/2016	Ghassan Sleiman	Formatting	4

Comments:

HAZARD STUDY 1	Project No Sampling System	Title : FEFuel Sampling System		
	Author: Ghassan Sleiman	File: Sample PID	Meeting Date: Mar 16, 2016	
	Drawing Title: Sampling System	Drawing No. Sampling System		Drawing Revision 2

Team Members Ghassan Sleiman (GS) Tyler Furuya (TF)	Andrew Youlio (AY) Tim Brown (TB)		
Node: No 1 Description of Node Hydrogen inlet and hydrogen pressure regulation	Lines and Equipment No: What equipment is in the line: Hydrogen Receptacle (R_H2); Pressure Regulator(PCV_1);	Remarks:	

Item	Parameter	Deviation	Causes	Effect or Hazard	Safeguards	Action Required	Action by	Ref.
1	Pressure	High	1.1 Failure of regulation into dispenser.	A. High pressure into PCV_1	A. All components pre-PCV_1 is rated to 15,000 PSI or above. The dispensing system cannot dispense more than the highest rated pressure of Node 1	Need to generate pre-sampling checklist to ensure that dispenser pressure cannot exceed 15,000 PSI. Check spec sheets for max. operating pressure.	TF	1, 5
			1.2 Temperature	B. fire	B. If there is a fire, the dispenser flame detector will shut off all hydrogen	Need to generate pre-	TF	1

					flow. If pressure continues to rise, Node 2 has a rupture dsic that relieves pressure downstream of Node 1.	sampling checklist to ensure that station is outfitted with flame detector.		
2	Pressure	Low / No	2.1 Leak / Break in the lines / Tanks	A. Combustible gas in the environment	A1. Prior to any sampling, system is leak checked with gas detector.	Generate instructions to check the sampling skid prior to sampling.	TF	2
					A2. Prior to any sampling, all joints are pre-checked.			
				B. Possible Air Ingress causing a flammable mixture	B1. Volume is extremely small. Flammable mixture will be quenched instantly.	NR		
					B2. Grounding lug on sampler to eliminate sparking.	Provide ground system for sampler.	TF	3
					B3. System is purged with hydrogen prior to sampling.	Update sampling procedures.		
3	Pressure	Erroneous	3.1 Pressure from dispenser is incorrect.	A. High pressure	See Item #1 - 1.1	NR		
4	Pressure	Reverse	4.1 Node 2 pressurized and Node 1 not pressurized.	A. None	None	NR		
5	Pressure	Cycling	5.1 Normal operation	A. None	A. None. No cycle limitations on equipment.	NR		
6	Temperature	High	6.1 Fire	A. Compromise components	B. If there is a fire, the dispenser flame detector will shut off all hydrogen flow. If pressure continues to rise, Node 2 has a rupture dis c that relieves pressure downstream of Node 1.	From Item #1 - 1.2		
			6.2 Ambient above 65 C	A. Component Malfunction	A. All components rated higher than 65C or possible ambient temperature.	Check temperature rating of all components and in checklist, check ambient temperatures.	TF	1, 4

HAZARD STUDY 1	Project No Sampling System	Title : FEFuel Sampling System		
	Author: Ghassan Sleiman	File: Sample PID	Meeting Date: Mar 16, 2016	
	Drawing Title: Sampling System	Drawing No. Sampling System		Drawing Revision 2
Team Members Ghassan Sleiman (GS) Tyler Furuya (TF)	Andrew Youlio (AY) Tim Brown (TB)			
Node: No 1 Description of Node Hydrogen inlet and hydrogen pressure regulation	Lines and Equipment No: What equipment is in the line: Hydrogen Receptacle (R_H2); Pressure Regulator(PCV_1);	Remarks:		

Item	Parameter	Deviation	Causes	Effect or Hazard	Safeguards	Action Required	Action by	Ref.
7	Temperature	Low	7.1 Ambient or gas temperature below -40C	A. Compromise components	A. All components rated lower than -40C or possible ambient temperature.	Check temperature rating of all components and in checklist, check ambient temperatures.	TF	4
8	Flow	High	8.1 Rupture disc failure in Node 2	A. High flow of hydrogen into vent	A. Addressed in Node 2	NR		
9	Flow	Low/No	9.1 Blockage of PCV_1.	No hazard identified.	None	NR		
			9.2 Dispenser not sending gas	No hazard identified.	None	NR		
10	Flow	Reverse	10.1 Node 2 pressurized and Node 1 not pressurized	None	None	NR		
11	Flow	Misdirected	11.1 Flow into receptacle	Hydrogen flowing back into dispenser.	Check valve in the receptacle	NR		
			11.2 Seal failure in PCV_1	Combustible gas in the environment.	Gas detector and remote emergency stop	Checklist of required safety items/devices	TF	6
12	Leak	Present	12.1 Loose fitting.	Combustible gas in the environment.	Personal gas detector. Leak check at low pressure.	Create leak check procedures	TF	7
			12.2 Vibration during transport	Combustible gas in the environment.	Personal gas detector. Leak check at low pressure.	Create leak check procedures	TF	7
13	Static	Present	13.1 High flow	Ignition source	Grounding cable. Procedure to ground equipment prior to connection.	Create grounding procedure for equipment and self	TF	8
			13.2 Electric potential	Ignition source	Grounding cable. Procedure to ground self prior to connection.	Create grounding procedure for equipment and self	TF	8

HAZARD STUDY 1	Project No Sampling System	Title : FEFuel Sampling System	
	Author: Ghassan Sleiman	File: Sample PID	Meeting Date: Mar 16, 2016
	Drawing Title: Sampling System	Drawing No. Sampling System	Drawing Revision 2

Team Members Ghassan Sleiman (GS) Tyler Furuya (TF)	Andrew Youlio (AY) Tim Brown (TB)		`
Node: No 2 Description of Node Directional flow control, pressure safety components, hydrogen sampling storage, hydrogen ventlrelease control	Lines and Equipment No: What equipment is in the line Pressure Gauge (PI_1); Ball Valve (HV_1, HV_2, HV_3); Safety Head Fitting (SF_1); Rupture Disc (SV_1); Fill Hose (FH_1, FH_2); Hydrogen Sampling Cylinder (T_H2);	Remarks:	

Item	Parameter	Deviation	Causes	Effect or Hazard	Safeguards	Action Required	Action by	Ref.
1	*Pressure*	*High*	*1.1 Failure of PCV_1*	*A. High pressure into Node 2*	*A. Rupture disc*	*NR*		
			1.2 Temperature	*B. fire*	*B. If there is a fire, the dispenser flame detector will shut off all hydrogen flow. If pressure continues to rise, Node 2 has a rupture disc that relieves pressure downstream of Node 1.*	*Need to generate pre-sampling checklist to ensure that station is outfitted with flame detector.*	*TF*	*1*
			1.3 Wrong PCV_1	*A. High pressure into Node 2*	*A. Buy the correct regulator*	*NR*		
					B. Rupture disc	*NR*		
2	*Pressure*	*Low / No*	*2.1 Leak / Break in the lines / Tanks*	*A. None*	*A1. Prior to any sampling, system is leak checked with gas detector.*	*Generate instructions to check the sampling skid prior to sampling.*	*TF*	*2*
					A2. Prior to any sampling, all joints are pre-checked.			
				B. Possible Air Ingress causing a flammable mixture	*B1. Volume is extremely small. Flammable mixture will be quenched instantly.*	*NR*		
					B2. Grounding lug on sampler to eliminate sparking.	*Provide ground system for sampler.*	*TF*	*3*
					B3. System is purged with hydrogen prior to sampling.	*Update sampling procedures.*		
			2.2 Wrong adjustment of PCV_1	*A. None*	*None required.*	*NR*		
3	*Pressure*	*Erroneous*	*3.1 PI_1 not working*	*A. High pressure*	*A. Max outlet pressure is same as rupture disc rupture point.*	*Ensure sampling cylinder is rated above 1,500 PSI.*	*TF*	*1*
4	*Pressure*	*Reverse*	*4.1 Gas flow from vent line back into system.*	*A. Flammable mixture*	*A. Check valve*	*NR*		
5	*Pressure*	*Cycling*	*5.1 Normal operation*	*A. None*	*A. None. No cycle limitations on equipment.*	*NR*		

6	*Temperature*	*High*	*6.1 Fire*	*A. Compromise components*	*B. If there is a fire, the dispenser flame detector will shut off all hydrogen flow. If pressure continues to rise, Node 2 has a rupture disc that relieves pressure downstream of Node 1.*	*From Node 1 Item #1 - 1.2*		

HAZARD STUDY 1		Project No Sampling System		Title : FEFuel Sampling System				
		Author: Ghassan Sleiman		File: Sample PID		Meeting Date: Mar 16, 2016		
		Drawing Title: Sampling System		Drawing No. Sampling System			Drawing Revision 2	
Team Members Ghassan Sleiman (GS) Tyler Furuya (TF)			Andrew Youlio (AY) Tim Brown (TB)				`	
Node: No 2 Description of Node Directional flow control, pressure safety components, hydrogen sampling storage, hydrogen ventlrelease control			Lines and Equipment No: What equipment is in the line Pressure Gauge (PI_1); Ball Valve (HV_1, HV_2, HV_3); Safety Head Fitting (SF_1); Rupture Disc (SV_1); Fill Hose (FH_1, FH_2); Hydrogen Sampling Cylinder (T_H2);		Remarks:			
Item	Parameter	Deviation	Causes	Effect or Hazard	Safeguards	Action Required	Action by	Ref.
			6.2 Ambient above 65 C	*A. Component Malfunction*	*A. All components rated higher than 65C or possible ambient temperature.*	*Check Temp of Components and Ambient*	*TF*	*1, 4*
7	*Temperature*	*Low*	*7.1 Ambient or gas temperature below -40C*	*A. Compromise components*	*A. All components rated lower than -40C or possible ambient temperature.*	*Check Temp of Components and Ambient*	*TF*	*4*
8	*Flow*	*High*	*8.1 Rupture disc failure in Node 2*	*None*	*NR*	*A. Verify Vent sized properly to accept rupture disc.*	*Tim*	*9*
			8.2 PCV_1 Failure	*None*	*NR*	*A. Verify Vent sized properly to accept rupture disc.*	*Tim*	*9*
9	*Flow*	*Low/No*	*9.1 Blockage of PCV_1.*	*No hazard identified.*	*None*	*NR*		
10	*Flow*	*Reverse*	*10.1 Gas flow from vent line back into system.*	*A. Flammable mixture*	*A. Check valve*	*NR*		
11	*Flow*	*Misdirected*	*11.1 Improper operation of HV_1,2,3*	*None*	*None*	*NR*		
12	*Leak*	*Present*	*12.1 Loose fitting.*	*Combustible gas in the environment.*	*Personal gas detector. Leak check at low pressure.*	*Create leak check procedures*	*TF*	*7*
			12.2 Vibration during transport	*Combustible gas in the environment.*	*Personal gas detector. Leak check at low pressure.*	*Create leak check procedures*	*TF*	*7*

13	*Static*	*Present*	*13.1 High flow*	*Ignition source*	*Grounding cable. Procedure to ground equipment prior to connection.*	*Create grounding procedure for equipment and self*	*TF*	*8*
			13.2 Electric potential	*Ignition source*	*Grounding cable. Procedure to ground self prior to connection.*	*Create grounding procedure for equipment and self*	*TF*	*8*

HAZARD STUDY 1	Project No Sampling System		Title : FEFuel Sampling System					
	Author: Ghassan Sleiman		File: Sample PID		Meeting Date: Mar 16, 2016			
	Drawing Title: Sampling System		Drawing No. Sampling System				Drawing Revision 2	
Team Members Ghassan Sleiman (GS) Tyler Furuya (TF)			Andrew Youlio (AY) Tim Brown (TB)					
Node: No 3 Description of Node Backflow prevention, hydrogen vent outlet			Lines and Equipment No: What equipment is in the line Check Valve (CV_1); Vent Hose (FH_3);		Remarks:			
Item	Parameter	Deviation	Causes	Effect or Hazard	Safeguards	Action Required	Action by	Ref.
1	Pressure	High	1.1 If CV_1 is blocked	A. High pressure into Node 3 up to 1,500 PSI	Tubing is rated to 5,000 PSI	NR		
			1.2 Vent blocked	A. High pressure into Node 3 up to 1,500 PSI	Tubing is rated to 5,000 PSI	NR		
			1.3 Wrong PCV_1	A. High pressure into Node 2	A. Buy the correct regulator	NR		
					B. Rupture disc	NR		
2	Pressure	Cycling	2.1 Normal operation	A. None	A. None. No cycle limitations on equipment.	NR		
3	Temperature	High	3.1 Fire	A. Compromise components	B. If there is a fire, the dispenser flame detector will shut off all hydrogen flow. If pressure continues to rise, Node 2 has a rupture dsic that relieves pressure downstream of Node 1.	From Node 1 Item #1 - 1.2		
			3.2 Ambient above 65 C	A. Component Malfunction	A. All components rated higher than 65C or possible ambient temperature.	Check temperature rating of all components and in checklist, check ambient temperatures.	TF	1, 4
4	Temperature	Low	4.1 Ambient or gas temperature below -40C	A. Compromise components	A. All components rated lower than -40C or possible ambient temperature.	Check temperature rating of all components and in checklist, check ambient temperatures.	TF	4
5	Flow	High	5.1 None found	None	System designed for applicable flow.	A. Verify Vent sized properly to accept rupture disc.	TB	9
6	Flow	Reverse	6.1 Pressurized vent stack	None	NR	NR		
			6.2 Failure of CV_1	Possible air ingress if incorrect operation of HV_3	Operator training on how to purge a tank	Make sure instructions are in instruction set.	AY	10

7	Leak	Present	7.1 Loose fitting.	Combustible gas in the environment.	Personal gas detector. Leak check at low pressure.	Create leak check procedures	TF	7
			7.2 Vibration during transport	Combustible gas in the environment.	Personal gas detector. Leak check at low pressure.	Create leak check procedures	TF	7
8	Static	Present	8.1 High flow	Ignition source	Grounding cable. Procedure to ground equipment prior to connection.	Create grounding procedure for equipment and self	TF	8
			8.2 Electric potential	Ignition source	Grounding cable. Procedure to ground self prior to connection.	Create grounding procedure for equipment and self	TF	8

The partial Linde HAZOP shown in FE Fuel's original GFO submission pertained to the ionic gaseous hydrogen compressor. Full HAZOPs are underway for the new liquid pump equipment.

Example of Risk Reduction Plan After a HAZOP

HazOP Action Items				
#	Description	Action	Assigned To	Status
1	Need to generate pre-sampling checklist	Verify max. dispenser pressure. Verify functioning flame detector. Check ambient temperatures min/max. Verify pressure rating of sampling cylinder. Check coldest gas temperature.	TF	Complete
2	Need to generate operation procedure	Pre-sampling leak check.	TF	Complete
3	Provide grounding system	Purchase grounding system	TF	Purchased
4	Check max/min temperature rating on all components	Put in excel sheet and print out all spec sheets	TF	Complete
5	Check max pressure rating on all components	Put in excel sheet and print out all spec sheets	TF	Complete
6	Checklist of required safety items/devices	Each teach had a gas detector	TF	Complete
7	Create leak check procedures	Create a leak check procedure list	GS	Complete
8	Grounding of System		GS	Complete
9	Verify minimum line sizing	Calculations show that Pressure drop not significant at max flow	GS	Complete
10	Operation instructions set		AY	Complete

Appendix D - Job Hazard Analysis Form

FIRST ELEMENT FUEL

JOB HAZARD ANALYSIS

WORKERS: ______________________ DATE & TIME (YYYYMMDD 00:00):__________ (JHA #)

SUPERVISOR: ______________________ LOCATION: ______________________

NEAREST MEDICAL FACILITY: ______________________

SUMMARY OF WORK PLANNED FOR TODAY:

TASKS LIST TASKS REQUIRED TO COMPLETE WORK PLANNED	POTENTIAL HAZARDS LIST HAZARDS ASSOCIATED WITH EACH TASK	PREVENTATIVE MEASURES LIST PREVENTATIVE MEASURES TAKEN TO PREVENT INJURIES	PERSONAL PROTECTIVE EQUIPMENT (PPE)REQUIRED
If more space is required, continue on back of this page.			

Page 1 SOP #

Additional safety and health issues discussed during today's Job Hazard Analysis

Review/List safety issues discussed during previous day's work:

ATTENDANCE ROSTER			
By signing this document, I confirm that I have read all the Tasks being performed, been made aware of the Potential Hazards, taken the proper Preventative Measures, and utlized the proper PPE for each task. I agree to report all injuries and accidents immediatley as they occur.			
Print Name	Sign Name	Print Name	Sign Name

Worker Signature: ______________________

Appendix E - Example of Standard Operating Procedure

SOP #	DESCRIPTION
maint_019	Procedure to repair high pressure bank tube leak

REVISION			PURPOSE
			If high banks are leaking, use this procedure to troubleshoot and repair
A	6ƒ30ƒ20	Initial document	

MATERIALS REQUIRED		
Tools	Consumables	Materials
Torque wrench	Seat savers	
LOTO kit		
wrenches		

INSTRUCTIONS		
Step No.	Steps	Check Box
Warning	**Do not re-pressurize too fast or you will get a lot of ice, tank stress, and noise**	
Warning	**High flow can also scratch valve seats**	
	Check and record # of tube cycles in order to compare at end of procedure. If none of the high pressure storage tubes are vented down, the purge count should NOT	
1	Place station "out of standby" and fill a car in order to bring down station pressure.	
2	Isolate compressor by closing yellow handle valves on suciton and discharge lines (See Figure 2 and 3). Then, lock out and tag out the compressor in the electrical cabinet (Figure 1)	
3a	Empty leaking high pressure tank into two other tanks if they are at a lower pressure	
3b	Enter into S700 manual mode	
3c	Open 105, then AOV of tank to be emptied along with tube to be equalized with. The tank with the highest pressure should be chosen first to be filled. This will allow for the greatest overall transfer of hydrogen. Once first tank equalized, switch to the other	
3d	Once as much hydrogen as possible has been transferred from the tank to be worked on, it is time to vent the rest of the hydrogen from the tube. Do this slowly, about 1000psi every 2–3 minutes. This will reduce noise to surrounding area and stress on	
4a	Hand valve high pressure tubes won't be worked on. Lock out hand valves (See Figure	

4b	Shut HV102's that **<u>aren't</u>** associated with the tank being worked on (See Figure 4). This will prevent a false reading from occurring during depressurization of working area but not depressurizing the tubes, thus not counting towards a full tank cycle	
4c	Open all 101 valves from dispenser in order to depressurize working area. Open all 100 valves as well from the S700 manual mode.	

Warning	Be careful, when tank pressure is low, still a decent volume of hydrogen is coming out	
5a	Disassemble AOV105 assembly and check to ensure the cone and thread fittings are made properly (See Figure 6 and 7). When the collar on the cone and thread fitting does not have enough threads exposed, the fitting will leak (See Figure 8). Be sure to re−torque all fittings to spec.	
5b	Install copper seat saver into high pressure tank port (See Figure 9)	
5c	Reinstall AOV105 assembly by first threading nipple into tank while supporting the entire assembly (See Figure 10). Then attach 1ƒ4" vent line and line into bottom of AOV105 valve. Attach support back to bracket.	
5d	Ensure assembly support is tight including HV mount and 105 mount.	
5e	Ensure proper torque on all fittings that were loosened during work. Also check fittings that could have been looseened by secondary stress.	
6a	Close HV on repaired tube and pressure pump isolated system. Open 105 along with 101B, C, D. use one of high tubes that has pressure to pressure pump between 1000 and 50 psi.	
6b	Hand valve close ground storage. Then open 101 valve corresponding to desired bank, along with 101A. ** ENSURE BANK IN GROUND STORAGE USED FOR PURGING IS ABOVE 1500 PSI** Slowly open HV on repaired tube and allow to equalize. Slowly open yellow hand valve on storage and bring tube up to 500 psi. Use the hand valve on the ground storage in this strep as the throttle valve, that way the gauge at the repaired tank can be utlized to determine the pressure of the tank being filled. ** During this fill process begin leak checking** Close yellow handle valve on storage	
6c	Vent repaired tank to near zero. Be sure to vent slow enough to prevent icing. DO not allow tank to go to zero. Tip: When the venting of the tube is no longer audible from the vent stack, the pressure will be approaching the desired pressure. When the check valve on the vent begins chattering that is a good place to stop venting down. When near zero, close HV corresponding to repaired tank.	
6d	Cascade from ground storage now. With ground storage hand valve open, use manual mode to find which ground storage banks are lowest to highest. Then open lowest ground storage bank. Now use HV on repaired tank to throttle incoming gas. Using HV near tube will allow for reading of the pressure of the ground storage banks not allowing them to drop below 1500 psi. Flow gas until ground storage reaches no less than 1500 psi. Flow gas until ground storage reaches no less than 1500 psi. Switch banks accordingly in order to achieve a cascade fill	
6e	Once all ground storage banks have been cascaded into repaired storage tube, it is time to cascade the other two high pressure tubes into the repaired tube. It is critical this is done without going below 7200 psi on the two tanks that weren't repaired. Close HV on repaired tube, then close AOV101A and after open AOV of lowest pressure of the high pressure tubes. Once these equalize, switch to the remaining high pressure tube	
	Write with a sharpie a depressurized tabulation and add one on the face of the tube frame with sharpie.	
7a	Put all hydropac settings back to auto and run compressor	
7b	Keep eye on discharge heat TE203. Keep TE203 below 175C, let it cool if needed	
7c	Ensure station is out of manual mode on both S700 and dispenser. Carry out a zero	

Figure 1: Hydropac LOTO'd

Figure 2: Compressor suction valved out, LOTO'd

Figure 3: Compressor discharge valved out, LOTO'd

Figure 4: High-pressure storage tubes that will not be work on, LOTO'd

Figure 5: Location where high-pressure tube pressure transducers get their reading. They are shut in order to prevent false purge reading. They are also LOTO'd

Figure 6: Remove all connections from AOV105 assembly

Figure 7: AOV 105 assembly fully removed

Figure 8: In this case the problem was most likely the fact that there was only about one thread assembly showing on this cone and thread fitting

Figure 9: High-pressure tank port. Insert a 9/16" copper seat saver here

Figure 10: Reinstall of AOVI05 assembly. Be careful to support assembly during reinsertion of cone and thread connections.

Appendix F - Sampling Procedure

SOP #	DESCRIPTION
maint_007	System Sampling

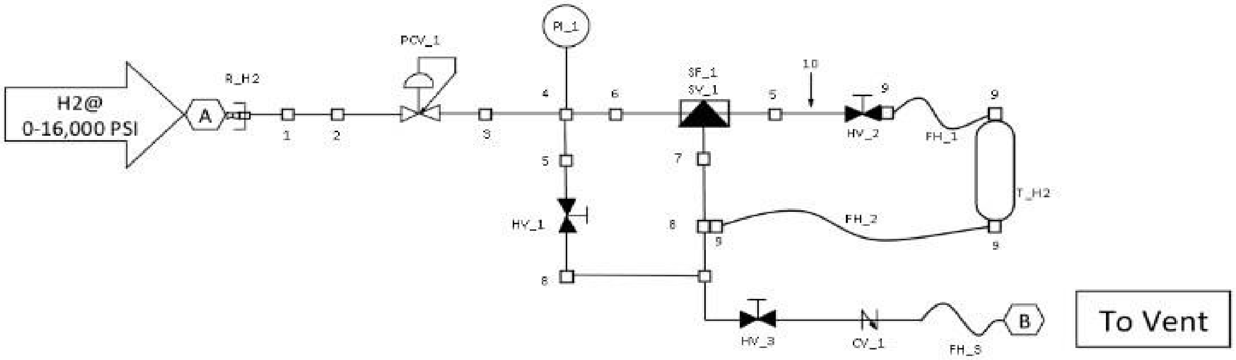
REVISION			PURPOSE
			Collect hydrogen and particulate sample at TrueZero stations.
A	5ƒ13ƒ20	Initial document	

MATERIALS REQUIRED		
Tools	Consumables	Materials
Sample Kit	Christo lube	
Tool kit	Teflon tape	
Combustable gas sniffer		
Sterile gloves		

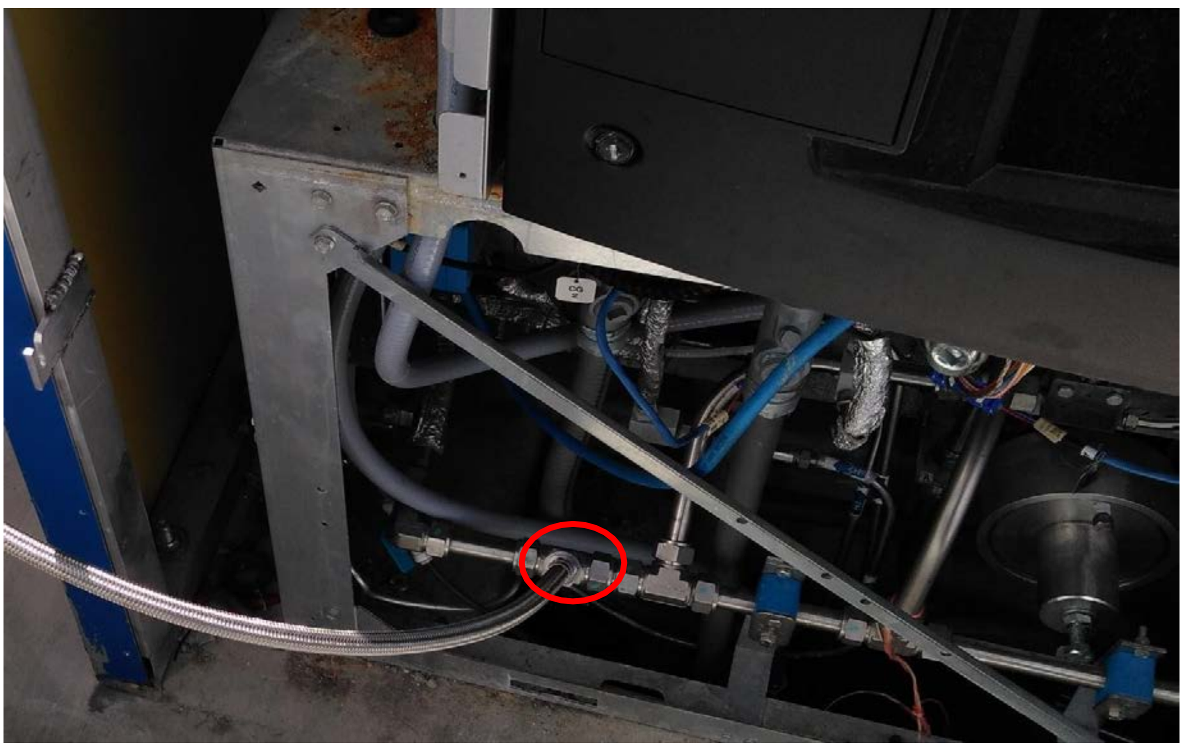
INSTRUCTIONS		
Step No.	Steps	Check Box
1	Place system into MIP.	
2	Place dispenser into manual mode on the dispenser node displays.	
3	On the dispenser node displays set 0.5 Ramp rate.	
4	Turn on ECV−120&112 as well as AOV−101C on the	
5	Open valve HV118 for 15 seconds to vent with valve fully open. Then close.	
6	Open valve HV128 for 15 seconds to vent with valve fully open. Then close.	
7	Turn on ECV−123B on the dispenser node displays.	
8	Turn on ECV−123A on the dispenser node displays.	
9	Turn off ECV−101C on the dispenser node displays.	
10	Open valve HV−118 till purged to 1 psi then close.	
11	Turn on ECV−101C on the dispenser node displays.	
12	Repeat steps 9−11 five times.	
13	Repeat steps 9−12 but replacing HV−118 with HV−128.	
Caution:	For an uncontaminated sample avoid touching the inside of the sample kit tubing, and the quick connect ends without sterile gloves.	
14	Set up sample kit in accordance with the P&ID ensure all valves are closed, also referance Graphic 1.	
15	Connect Sample kit FH_3 hose to vent port on the dispenser. Referance Graphic 2 for location of port.	
16	Connect H70 nozzle to Sample Kit recepticle R_H2.	

17	Ensure regulator valve PCV_1 is fully closed. (counter clockwise)	
18	Open sample vent valve HV_1 on the sample kit	
19	Set ramp rate to 5 on the dispenser node displays. Check rate at PI−120 in the S700.	
20	Turn on ECV 101 A, B, or C at the dispenser node displays.	
21	Open supply knob on the scylinder.	
22	At saple kit use PCV_1 to increase pressure to 250psi then close.	
23	Use sniffer to check for leaks on the sample kit.	
24	Open vent valve HV_3 to vent then close.	
25	Repeat steps 22 and 23 ten times.	
26	Open exit supply knob on the cylinder.	
27	Repeat steps 22 and 23 ten times.	
28	Open valves HV_2, HV_3, Cylinder inlet, and Cylinder outlet.	
29	Adjust PCV_1 to read 800PSI gradually over a two minute period.	
30	Close HV_3 and check for leaks with sniffer and by monitoring PI_1 on the sampling kit. PSI should read 900psi.	
31	Close cylinder inlet and outlet. Check for leaks with sniffer. Close PCV_1	
32	Remove cylinder from sample kit. Replace with cylinder two.	
33	Repeat steps 21−31.	
34	Remove Cylinder from the sample kit.	
35	Turn off ECV−120, ECV−112, AOV−101C on the display nodes.	
36	Remove FH_3 and H70 hose from the sample kit and attach to the particulate collector.	
37	Turn on ECV−120, ECV−112 as well as AOV−101C on the display nodes.	
38	Vent for 60 to 90 seconds.	
39	While venting observe selected pressure tube indicator (PI−105D, 105C, or 105B) drop 1,000psi.	
40	Depressureize hose and remove the particulate collector.	
41	Prepare both cylinders and collector for shipping.	
42	Return all station fittings back to normal configuration.	
43	Press F4 on display node 2 to bring system back into normal status.	
44	Perform Zero Fill, and report station back online and sample complete.	

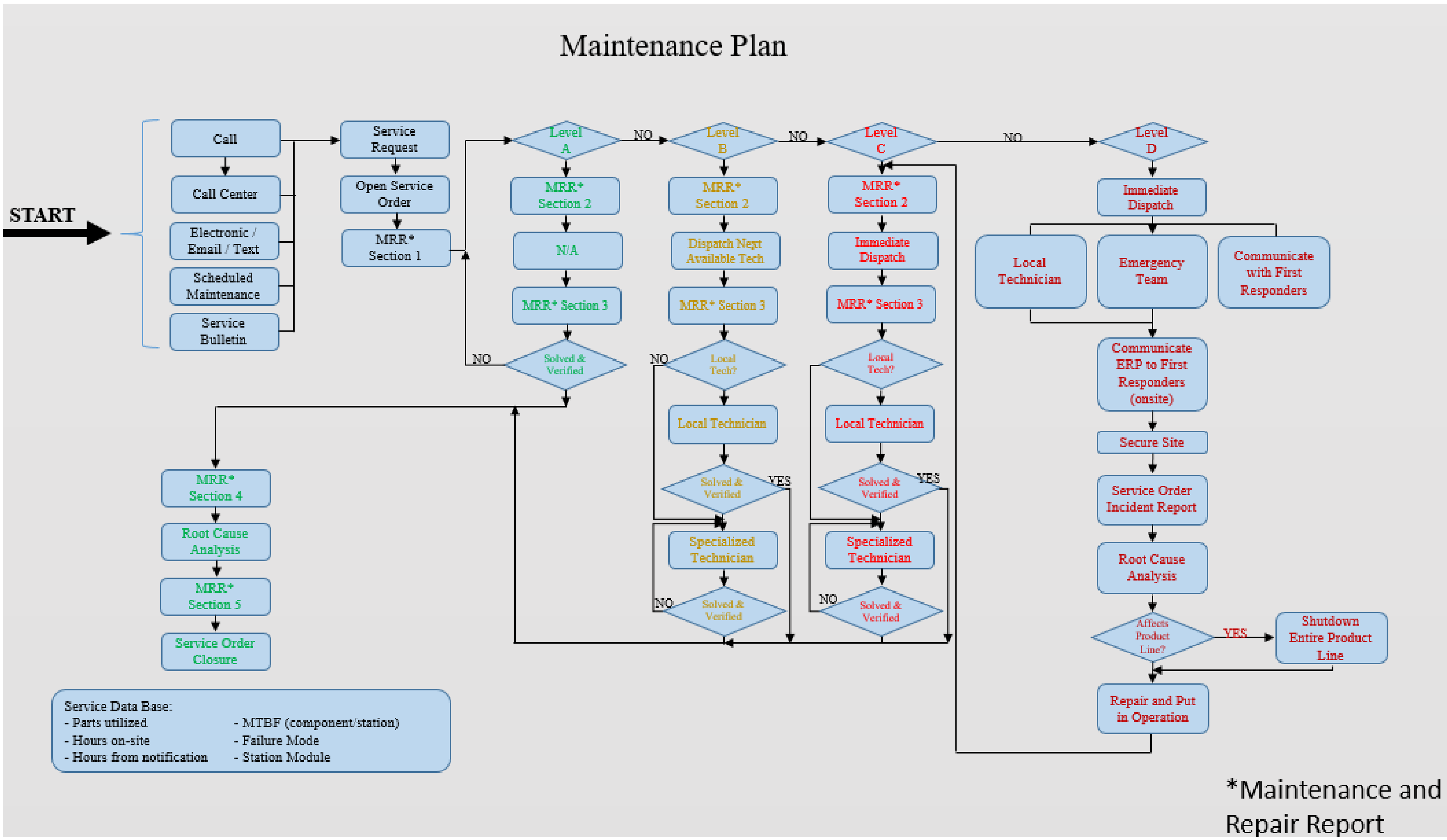
Graphic 1



Graphic 2



The Figure below illustrates the response philosophy to an event. Events can be generated by various means such as customers or service bulletins for example. The event is then categorized and the proper response is initiated. Once the work is complete a review is conducted to determine if a root cause analysis is needed to close the work order.



Appendix G (continued) - Mechanical Integrity – Maintenance Program

FEFuel has developed an extensive Maintenance Program that applied not just to equipment, but also to the site auxiliaries, permitting, licenses, documentation review, site audits, testing. Below is an example of one of the planned maintenance programs.

TASK NO	DESCRIPTION	Frequency (Months)
FEFuelT001	Review HMBP	12
FEFuelT002	Review ERP	12
FEFuelT003	Review training requirements	12
FEFuelT004	Verification of H2 equipment preventative maintenance inspection	6
SSP002	Check drain valves	1
FEFuelT006	Clean fire extinguisher cabinet	6
FEFuelT007	Verify leak detection process per NFPA 2	3
SSP004	Leak test	1
FEFuelT009	Clean exterior lights	3
SSP008	Vent stack flappers and caps in place on compressor and storage tubes	1
FEFuelT013	Annual Merit Review	12
SSP001	Check vent stacks	3
SSP010	Check air lines in storage tubes	1
SSP003	Are vent stacks properly grounded?	6
SSP011	Record any ground storage pressure	1
SSP005	Is the system properly grounded?	12
SSP006	Check pressure gauges	3
SSP007	Tubing and piping properly supported?	6
SSP012	Record instruments gas pressure	1
SSP009	Verify all regulators	6
SSP013	Area free of combustible obstructions?	1
SSP014	Emergency phone number displayed?	1
SSP027	Are the dispenser screens free of damage?	1
SSP028	Check control panel door for moisture or condensation	1
SSP029	Inspect fill and vent hoses	1
SSP015	Verify siting requirements	6
SSP016	Check medium pressure fittings	12
SSP017	Lubricate all door and cabinet hings and locks	12
SSP018	Check Tescom AOV valve cartridges	3

SSP019	Test flame detector	6
SSP020	Clean flame detector lens	3
SSP021	Calibrate and function gas detectors	3
SSP022	Combustible gas detection reception	12
SSP023	Function test all E-stops	12
SSP024	Verify annual dispenser alarm decal	12
SSP025	Coordinate annual fire alarm panel inspection	3
SSP026	Test all linear heat detection circuits	12
SSP036	Pressurize hose and perform leak test	1
SSP037	Function test the Ronan I/P	1
SSP038	Function test AOV120 pressure controller	1
SSP030	Replace H35 process hoses	36
SSP031	Replace H35 vent hoses	72
SSP032	Replace H70 MFR original hose	24
SSP033	Maintain hose and nozzle	3
SSP034	Inspect and leak check breakaways	3
SSP035	Inspect/Replace in line gas filter F125	12
SSP039	Function test and check setting of PCV 112 on dual hose dispenser	1
SSP048	Check oil level - fill as necessary	1
SSP049	Record compressor run time	1
SSP050	Clean up compressor area	1
SSP040	Verify ambient temperature reading on dispenser	6
SSP041	Take gas sample if required by contract per site specific conditions	6
SSP042	Visually inspect dispenser safety relief valve	12
SSP043	Verify pressure sensors	12
SSP044	Inspect all electrical panels and connections	12
SSP045	Replace dispenser safety relief valve	36
SSP046	Replace dispenser nozzles	36
SSP047	Replace break away	36
SSP051	Check coolant level	1
SSP053	Check oil temperature - adjust as necessary	1
SSP054	Check hydaulic oil pressure	1
SSP055	Check cooling rotometer for visual indication of flow	1
SSP052	Test low cooling water flow switch	3

SSP056	Drain accumulator of oil	1
SSP057	Clean fins on cooling water heat exchanger	1
SSP063	Verify temperatures are in range of setpoints	1
SSP064	Check refrigerant system for leaks	1
SSP065	Check refrigerant sight glass	1
SSP058	Disassemble clean, and replace if necessary suction and discharge valve	6
SSP059	With a calibrated gauge and a hydraulic hand pump. Verify correct settings of all pressure switches	12
SSP060	Verify accuracy of all pressure transducers	12
SSP061	Change compressor oil filter element	12
SSP062	Evaluate condition of hydraulic fluid	24
SSP070	Verify and record the number of cycles in each temperature range for all vessels (F8)	1
SSP071	Verify pressure has been above the minimum cycle pressure listed on the vessel nameplate during operation	1
SSP072	Record any pressure cycles < the minimum cycle pressure specified on the vessel nameplate on this sheet	1
SSP066	Inspect surface of condenser coil / clean as required	3
SSP067	Replace dryer core as required	6
SSP068	Ensure refrigerant compressor runs, cools off block, then shuts off	6
SSP069	Call service company for bi-annual checkout	24
SSP076	Visually inspect compressor	1
SSP077	Check compressor mounting bolts	1
SSP078	Inspect inlet air filter, replace as necessary	1
SSP073	Complete a visual inspection for corrosion or damage	60
SSP074	Complete a non-destructive internal vessel test	120
SSP075	Remove from service when cycle count reaches the maximum value	240
SSP079	Drain condensate from trap	1
SSP080	Verify operation of dryer	1
SSP090	Is transfer hose in good condition, rated for service pressure, and the installation date visible?	1
FEFuelT005	Inspect fire extinguisher and get recertified	1
FEFuelT008	Clean photocell	1
SSP081	Replace dessicant in dryer	24
SSP082	Check and compare load and unload set points	3

SSP083	Replace dryer air filter	6
SSP084	Change separator cartridge as required	12
SSP085	Replace inlet air filter	12
SSP086	Replace compressor safety relief valve	36
SSP087	Is the area around the system clear of hazards?	6
SSP088	Is the area adequately placarded to identify product and hazards?	12
SSP089	Is all piping in good condition and valves in good operating condition?	6
FEFuelT010	Clean security cameras	1
SSP091	Replace H2 stanchion hoses	36
SSP092	Test stanchion solenoid/valve operation	3
SSP093	Safety audit of station	12
FEFuelT014	Check cooling water strainer	1
FEFuelT015	Check hazardous waste container labels	1
FEFuelT016	Check MSDS and ERP	1
FEFuelT017	Check to see if stanchion is in Remote	1
FEFuelT018	Check status bollard and canopy lights	1
FEFuelT021	Safety Committee Meeting	3
FEFuelT022	Lube H70 nozzle with interflon	1
FEFuelT023	Check site keys	3
FEFuelT024	Post OSHA 300A	12
FEFuelT025	Spare Site Keys	3
FEFuelT027	DMS Test	12
FEFuelT028	Cooling Water Pump Hours (F7)	1

Management of Change Program FEFuel

Revision Control			
Rev #	Description	Date	Responsible
201512	Initial Release	Dec 2015	Ghassan Sleiman
201605	Revise Process Flow	July 2016	Ghassan
201608	Update to MOC Form		

1. **Scope**
   The scope of the document covers all and any changes whether permanent, temporary or emergency to any of all established procedures. The management of change process also covers changes to products line, procedures, inventory standards and any established work flow within the company.

2. **Management of Change (MOC) Work Flow**
   The workflow chart is on the following page and explanations on the following page. The MOC form is found in the Appendix of this MOC document.

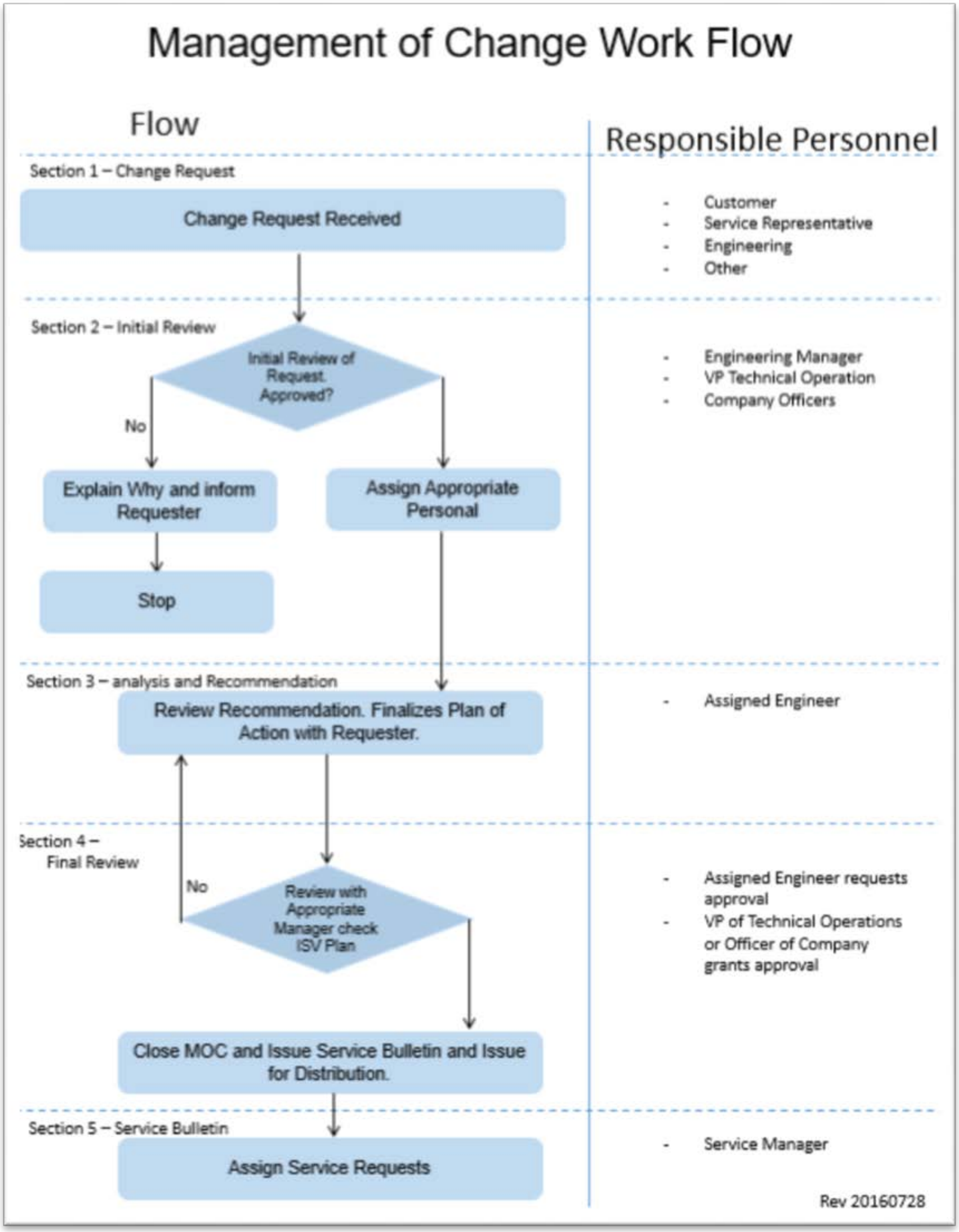


Figure 1: MOC Work Flow

3. **Change Request**
   The change request can be initiated by namely a Customer Request; Service Representative or Engineering. These changes can be due to any number of reasons such as:
   - Part Changes
     - Valves
     - Piping
     - Pump Compressors
     - Motors
     - Instrumentation
     - Chemicals and Catalysts
     - Materials
   - Maintenance
   - Procedures
   - Other/Miscellaneous

4. **Initial Review**
   In the review process the responsible manager reviews the change request and decides if the MOC request is approved or not. Possible reason for MOC rejection are the following.
   - MOC not applicable
     (i) In this instance the manager deemed the change not feasible for many reasons such as:
       - Cost
       - Benefit
       - Practicality
       - Safety

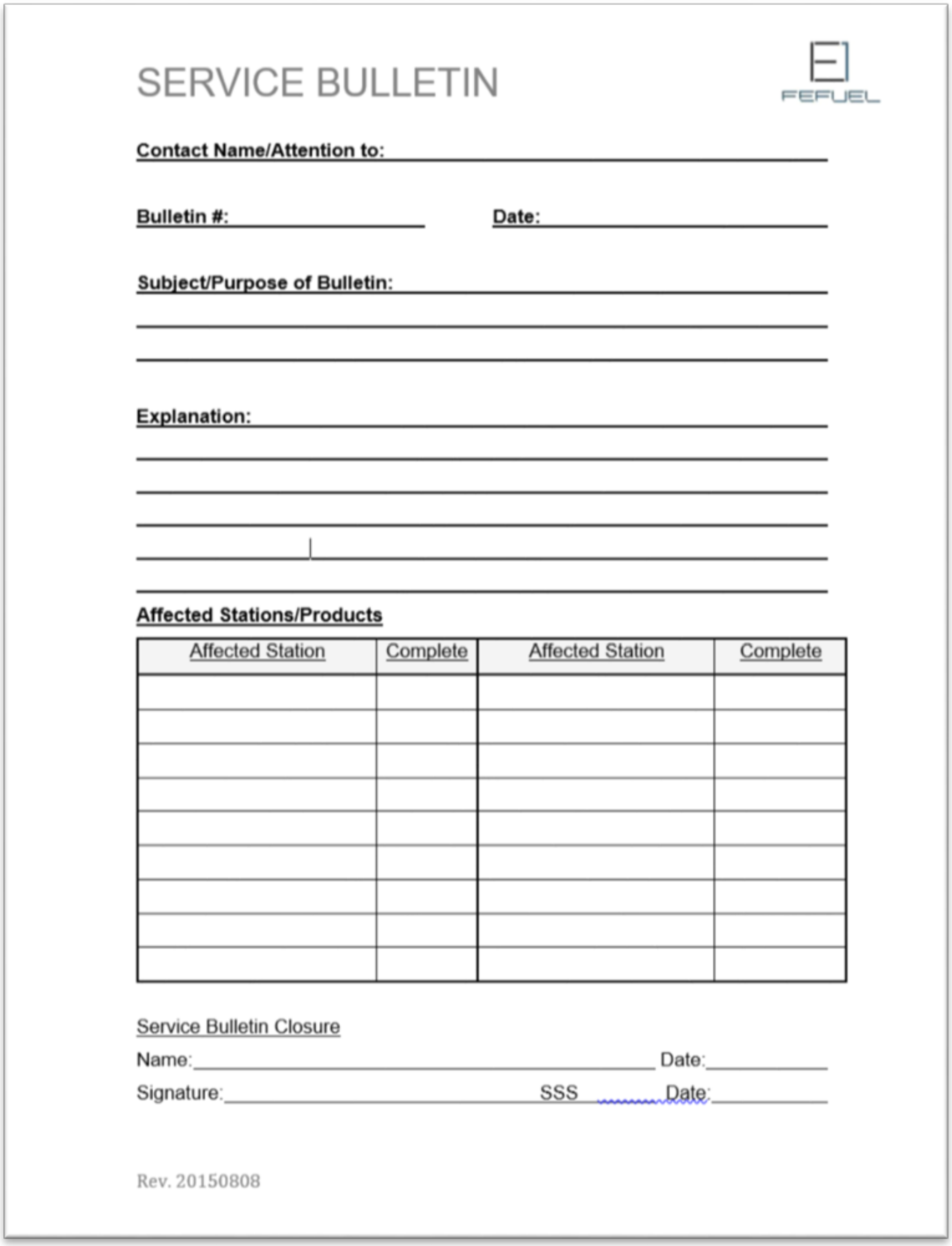
   - MOC not needed
     (i) If the change is for an in kind item or process, then the MOC is not needed. For example, if valve is changed for the exact same valve but from a different manufacturer or if the set point was changed from one unit to another but maintains the value. (e.g. psi to bar)

   In either rejection cases the reasoning must be communicated back to the requester.
   If the request is deemed feasible the Manager assigns the appropriate personnel to complete the MOC process.

5. **Analysis and Recommendation**
   The assigned person is to communicate with the requester to completely understand the request and the intent. A fully developed plan is then produced.

6. **Final Review**
   The recommendations are reviewed by the supporting manager. If acceptable a Service Bulletin is created. If rejected the MOC is sent back for another round of analysis and improvements to the plan of action created. During the review process the question of whether the MOC was referenced with the ISV document must be asked. This helps the engineer realize that all safety items have been maintained after this change.

7. **Service Bulletin**
   Service Bulletin is sent to the appropriate service manager for implementation. Service Bulletin Form Below



SERVICE BULLETIN

FEFUEL

Contact Name/Attention to: ______________________________

Bulletin #: ______________ **Date:** ______________

Subject/Purpose of Bulletin: ______________________________

Explanation: ______________________________

Affected Stations/Products

Affected Station	Complete	Affected Station	Complete

Service Bulletin Closure

Name:______________________________ Date:____________

Signature:______________________ SSS Date:____________

Rev. 20150808

Figure 2: Service Bulletin Form

Appendix - MOC Form

FIRST ELEMENT MOC

Section 1. Change Request

MOC Requested By:

Reason for Request:

Affected Items:

MOC Submitted to:

Section 2. Initial Review

Initial Review By:

MOC Rejected / Accepted. Explain and submit to requester. Close MOC if Rejected.

Section 3. Analysis and Recommendations

MOC Assigned to: Date:

Analysis and recommendations

Section 4. Final Review

MOC appropriate: Yes/No
Verify Change Against ISV: Yes/No Explain affect and mitigation:

MOC Approved: Name: **Signature:**
Date:

Section 5. Service Bulletin

Service Bulletin issued: Yes / No
Service Bulletin #:
Service Bulletin Assigned to:
Final Comments

MOC Closure

Name :

Date:

3. EMERGENCY RESPONSE PLAN

3.1 Introduction

3.1.1 Definitions

ERP – Emergency Response

Plan FEFuel – FEFuel

SSS – System Support Specialist: Person(s) trained in the operation and maintenance of the hydrogen refueling system. The FEFuel Equipment Support Specialist is responsible for monthly planned maintenance and any unplanned maintenance at the site.

CNG – Compressed Natural

Gas gCM – grams per cubic

meter

ESD – Emergency Shutdown Device (such as a push button)

SST –System Support Team

PPE – Personal Protective

Equipment FD – Fire Department

MSDS – Material Safety Data Sheet

3.1.2 Objectives and Scope

This ERP is specifically written for implementation at FEFuel's hydrogen refueling stations in California. The information contained within is used to communicate;

- Safe and effective procedures in the event of an accident or emergency by non–SSS personnel;
- Onsite Hazards and their mitigation;
- Equipment on site (Appendices E–H);

3.1.3 ERP Layout

This ERP details the general overall emergency plan with non–site specific information and site specific information. This plan provides introductory information about hydrogen and its hazards, all necessary contact information, the automatic alarm responses to various events, and the actions required for various events. Site specific maps are provided in Appendices E–H and detail the location of ESD Devices, location of hazardous materials, and location of the evacuation area.

3.2 Hydrogen and Hydrogen Refueling

FEFuel's fuel is made of the most abundant element in the universe, the first element, hydrogen. Hydrogen has been produced and used in enormous quantities in various industrial applications for decades. For example, hydrogen is used extensively in oil refining to enrich low– grade crude and to remove sulfur and in the manufacturing of several products that we use every day from ammonia to peanut butter to semiconductors. FEFuel produces its fuel entirely from domestic sources. Today at least one third of our fuel at an FEFuel station is renewable and we are working to get that number even higher. Hydrogen means cleaner air and fewer greenhouse gas emissions. Like gasoline or natural gas, hydrogen is a fuel that must be handled properly; it can be used as safely as other common fuels when simple guidelines are observed. Hydrogen is colorless, odorless, tasteless, nontoxic, and non–poisonous. As a fuel for fuel cell vehicles, the only byproduct is water vapor with zero harmful emissions. Hydrogen utilized as a vehicle fuel is invisible to the naked eye and has no odor. It is the lightest molecule on earth so it disperses and travels upward very quickly (65 feet per second). Our stations have state of the art safety measures implemented. In terms of station design and permitting, all applicable codes, standards and regulations apply as with any project in a given jurisdiction. In California the CA Fire Code applies as well as building and electrical requirements. They are all designed with an open roof concept eliminating the potential for accumulation of hydrogen to a hazardous concentration. The procedure to fill a hydrogen–powered vehicle is similar to that of filling a CNG vehicle. Pressurized hydrogen gas is delivered into the vehicle utilizing equipment manufactured in accordance to local, national and global standards. Hydrogen can be delivered to the retail dispensing site as pressurized gas or liquid; or it can be generated onsite. This hydrogen is then compressed and stored at a higher pressure up to 13,500 psi into multiple banks. During dispensing the pressurized hydrogen is cascaded through the various banks into the vehicle through the dispenser. The dispenser is activated in similar fashion to a regular gasoline dispenser; via a credit card. FEFuel is also releasing an APP that will allow clients to pay via their smart phones. Like any fuel hydrogen requires special handling to maintain its integrity and a safe environment for the public, SSS, first responders and the like. The following table illustrates the hazards and mitigating actions for hydrogen at FEFuel hydrogen refueling stations in general. (Specific site–by–site hazards and their mitigation are listed in Appendix D.)

3.2.1 Properties of Hydrogen

Color	Invisible
Smell	Odorless
Flammable limit in air	4%–96%
Auto Ignition temperature	523 C (978 F)
Density in the atmosphere	90 gCM (0.056 lbƒft3)
Density in vehicle	24 kgCM or 40 kgƒCM
Temperature of liquid hydrogen	−253 C (−423 F)
Toxicity	NONE
Velocity	Disperses at ~44mph upwards into the atmosphere

3.2.2 Approaching the Hydrogen Compound

Should a loud leaking sound or hydrogen fire be suspected understand that hydrogen burns with an invisible flame. However, it is likely that an observer will see a faint orange glow due to the combustion of other material such as dirt on a pipe or plastic around a hose. In any case, only those trained should approach the compound if a fire is suspected. Non–FEFuel personnel or non–First responders should NOT approach the compound if a hydrogen release is suspected. An SSS will be able to quickly diagnose the issue. However if a first responder, such as a Fire Fighter, is the first on the scene, use of the infrared camera can quickly determine if there is a fire.

3.2.3 Extinguishing a Hydrogen Fire

!Caution!: Only a trained professional should attempt to extinguish a fire such as first responders (FD) or FEFuel personnel. Local Employees must not attempt to extinguish a hydrogen fire or approach the hydrogen compound in case of an emergency.

The most practical method to stop a hydrogen fire is to stop the flow of fuel by closing a valve. This can be accomplished by a manual valve or through the ESD located on the site. Another option would be to allow the fire to burn all the fuel being supplied and wait until it is extinguished. The station is located within a 2–hour firewall and the hydrogen will have been fully released well before the rating of the walls is compromised. *Do not attempt to extinguish the fire using water.* It is safe, however, to cool down walls and areas where the hydrogen fire might impinge and cause integrity failure.

3.3 Alarm Response

3.3.1 Hydrogen Fueling Station – Non–Emergency/Operational Alarm Situation

If the Hydrogen Fueling Station faults due to operational issues, the equipment will default into failsafe mode. The station will automatically call the FEFuel service desk and an SSS will be dispatched from a local service location. FEFuel will notify the public of its status to avoid drivers arriving at a non–working station via FEFuel's smart phone app, email or text. FEFuel will notify the public after repairs are complete. A "Do Not Attempt to Use Dispenser" Will be displayed on the screen If the Fueling Station will be down for an extended period of time for maintenance or repair work, FEFuel will give notice of the downtime and planned start up time ƒ date in order to plan accordingly. The localoperators (such as service station staff) are not expected to provide customers with an explanation, rather they will be provided with instructions for how customers can contact FEFuel directly.

3.3.2 Hydrogen Fueling Station – Emergency Situation

If the Hydrogen Fueling Station shuts down due to an emergency situation, FEFuel equipment will default into failsafe mode. Observers at the site should contact appropriate authorities. The FEFuel equipment is outfitted with Flame and Gas Detectors. Should a detection of either occur, the system will shut down and default into a failsafe mode. A call will be initiated by the FEFuel equipment to the FEFuel SSS that an emergency has occurred.

3.3.3 Hydrogen Fueling Station – Spill Mitigation

All hazard material on–site is contained within a 4–hour fire rated wall. Any hazardous liquid that is spilt will be contained within the protective wall. All FEFuel technicians are also equipped with absorbent materials to collect any spilt liquid. Any hazardous gas that leaks will not be contained within the structure. The only hazardous gas on-site is hydrogen, which is non-toxic.

3.4 Appendix B – Emergency Contact Information

	Name / Address	Phone Number
Station Information	24505 West Dorris Ave. Coalinga, CA	(844) TRU-ZERO (844) 878-9376
Emergency	911	
Local Police Department	Huron Police Department 36389 Lassen Avenue	(559) 945-2046
EMERGENCY FIRE DISPATCH	(559) 294-2009	
Local Fire Department	Coalinga Fire Department 300 W Elm Avenue Coalinga,	(559) 935-1652
Local Hospital	Coalinga State Hospital 24511 West Jayne Avenue Coalinga, CA	(559) 935-4300
CUPA	Business Hours CUPA	(559) 600-3271
Sheriff's Office	After-hours CUPA	(559) 600-3111
Refrigerant Service	Servi-Tech	(559) 264-6679
Hazardous Material Removal		
Internet Provider	Access Point	(919) 851-4838
FEFuel Personnel and Liasons for Fire Department		
Field Service Manager	Andrew Youlio	(805) 428-9797
Operations Manager	Ghassan Sleiman	(310) 415-2189
Communications Director	Shane Stephens	(949) 922-3456
FEFuel Emergency	1 (844) TRU-ZERO	
Nearby Convenient Store	Shell	(559) 935-0717
APCI Account Number	1471445	

3.5 Appendix C – Emergency Response Procedures and Response Chart

3.5.1 Non–Hydrogen Fires

1.1.1 !CAUTION! – IF THE SOURCE OF THE FIRE IS UNKNOWN ASSUME IT IS HYDROGEN AND PROCEED TO THE NEXT SECTION. EVEN IF THE FIRE IS VISIBLE DO NOT ASSUME IT IS NOT HYDROGEN FUELED.

----

1. Only if safely accessible Press the Emergency Shut Down (ESD) button. Location of ESD is on the Evacuation Diagram (Next Page). If there is any doubt that the ESD can be safely accessed, do not approach the system.
2. Evacuate the H2 Refueling Station. Evacuation Diagram is located in Appendix H.
3. Call 911 and inform them of the emergency.
4. If safely possible use the available fire extinguisher on small fires (trashcan, etc.).
5. Report incident immediately to FEFuel Emergency Hotline.
6. Meet FD and give them FEFuel's Contact information located on the contacts page or preferably this document.

3.5.2 Hydrogen Fire

1.1.2 !CAUTION! NEVER ATTEMPT TO EXTINGUISH A HYDROGEN FIRE WITH A FIRE SUPPRESSANT.

____

Follow the Procedure Illustrated below:

1. Only if safely accessible Press the Emergency Shut Down (ESD) button. Location of ESD are in Appendices E–H. If there is any doubt that the ESD can be safely accessed, do not approach the system.
2. Evacuate the H2 Refueling Station. Evacuation Diagram is located in Appendix H.
3. Call 911 and inform them of the emergency. Inform them that it is a hydrogen fire.
4. Report incident immediately to FEFuel Emergency Hotline.
5. Meet FD and give them FEFuel Contact information, located on contacts page or preferably this document.

1.1.3 Instruction for Fire Department Only

1. The fuel contained within the compound is Hydrogen gas. There is no liquid hydrogen on this site. There is approximately 300 kg of hydrogen at various pressures up to 13,500 psi. The compound has an open roof such that hydrogen will not accumulate. The energy content of this fuel is approximately equivalent to 300 gallons of gasoline and another 105 gallons of compressor oil. The recommended course of action is to keep cool any area where heat is impinging and wait for the hydrogen in the storage to vent off. It is not recommended to extinguish the hydrogen fire with water or fire suppressant. Please Contact FEFuel for further support.

–Contact information is located in Section 1.2 and Section 3.4 Appendix B.
–MSDS's are located in Section 1.5.2.

–Station maps and hazardous material locations are located in Appendices E, F, G, H

3.5.3 Evacuation Location Map

See Appendix H

3.5.4 Medical Emergencies

In the case of a medical emergency please contact 911 immediately. Please note that the nearest medical center address is located in Section 1.2 or Section 3.4 Appendix B.

3.5.5 Threats

If there is any threat, whether to do physical harm to a person, or sabotage the station, follow these steps.

1. Ask the aggressor the following question:
   a. Who: Who is calling or making the threat (Male/Female)? ; Description of voice or look.
   b. What: What is the threat?
   c. When: When will this happen?
   d. Where: Where will this happen?
   e. Why: Why are they doing this? Why are they threatening?
2. Call 911 and give them all the information from the above
3. Contact FEFuel Emergency Hotline
4. Assume the threat is real and act accordingly

3.5.6 Earthquakes

The Station is designed to withstand the earthquakes at the location. If an earthquake occurs please contact FEFuel.

3.5.7 Leaks

<u>Dispenser Leak</u>

In the event of a leak at the dispenser, the dispenser is installed with smart controllers that test the integrity of the fueling hose before each fill. If the integrity test fails, the dispenser will be isolated from the storage system and enter an alarm condition where no fueling is permitted until the problem is solved. Contact FEFuel.

<u>Small Storage Leak</u>

In the event of a small leak at the storage compound, contact FEFuel. The storage tanks and tubing are designed such that sparks are limited and that the released hydrogen will dissipate into the atmosphere away from the public.

Large Storage Leak

In the event of a large leak or relief valve release at the storage compound, contact FEFuel. The storage tanks and tubing are designed such that sparks are limited and that the released hydrogen will dissipate into the atmosphere away from the public. It is expected that the hydrogen will evacuate entirely in less than an hour and dissipate into the atmosphere.

Hazardous Liquid Leak

In the event of a hazardous liquid leak of either Propylene Glycol or Compressor Oil, contact FEFuel. The compound is designed such that any liquid that leaks from the equipment will be contained within the walls. FEFuel technicians or a hazardous waste removal service will clean up the spill accordingly.

3.5.8 Response to Media

After an event or at any time the media might try to get information with regards to the stations. Do not give them any information as they might take your words out of context.

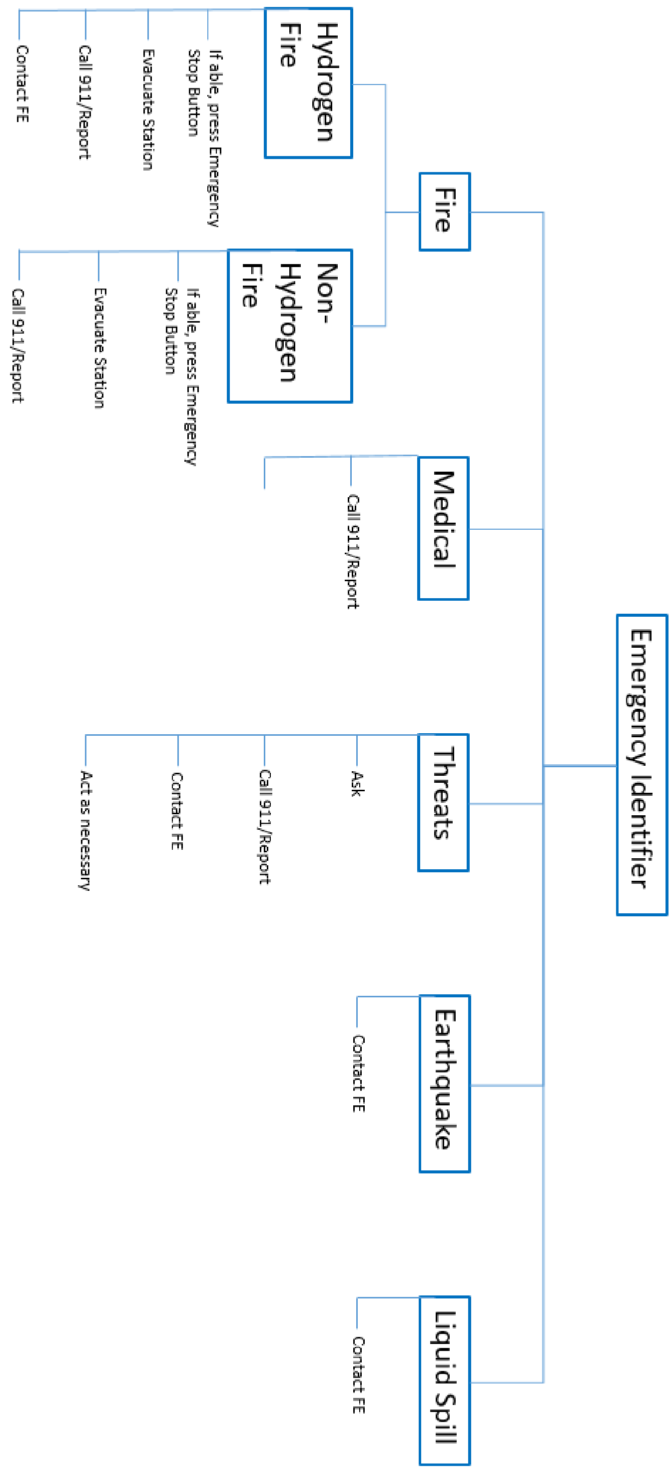
DO say, "I have no information to give out at the moment, but you can contact our communications director at " and give them the communication director's phone number.

At any moment **DO NOT give out:**

- Any information in this document (unless stated otherwise)
- The names of any person involved in the station or accident if any
- Your personal opinion on the station
- Speculation with regards to the station or any events
- Cost of equipment, damages or a fuel cell vehicle
- Speculation on liability or who will pay
- The status of any incident or the station
- Reasons for the station being offline or online
- Speculations on the number vehicles that fuel each day
- Comparison of hydrogen to any other technologies

3.5.9 Response Chart

The following chart is a brief overview of the required actions based on various emergency situations.



3.6 Appendix D – Station & Emergency Equipment and Hazard Mitigation

3.6.1 Station Equipment Description

The station consists of the following three areas:

- Hydrogen Equipment Compound
- Electrical Utility Cabinet
- Dispenser

Hydrogen Equipment Compound

Major Equipment

Quantity	Description
One (8' x 20' x 12' high) containerized hydrogen fuel station with integrated control system, consisting of:	
3	Gaseous high pressure hydrogen storage vessels; 15,000 psig maximum allowable working pressure, 15 kg of hydrogen capacity each
1	40 hp booster compressor with integrated cooling system
1	Cascade panel
1	Refrigeration unit (electric, 15 hp, commercial unit modified for hydrogen service)
1	Integrated ESD
One (8' x 4' x 8' high) non-classified utility island enclosure, consisting of:	
1	Air compressor
1	E–stop panel
1	Power distribution
1	Lighting control
1	Breakers
1	Power supply
1	Dispenser purge
One high pressure heat exchanger	
One automated dual H35/H70 (350/700 bar) gaseous hydrogen dispenser, with enterprise remote access monitoring (ERAM) system and integrated ESD.	
One (8' x 12' x 8' high) ground storage module, 250 kg total hydrogen storage at 7,500 psig	
One gaseous hydrogen supply system connection, consisting of:	
1	Tube trailer discharge stanchion
1	Telemetry remote monitoring system
Dispenser gas detector	

Controls

- All control valves fail in the safe direction (closed) after loss of utility power or instrument supply.
- Hose overpressure detection with automatic shutoff and alarm
- Hose leak detection with automatic shutoff and alarm
- Local (on dispenser and on compressor) and remote emergency stop switches (located and installed by FEFuel) (red palm buttons) that can be operated by the vehicle driver or others to stop the filling process.
- Redundant automatic shutoff valves that will close and stop the filling process in an emergency.
- All system alarms and shutdowns are displayed on the control panel face. Critical alarms are hard wired in addition to being connected through the PLC.
- Compressor will automatically return to last operating condition after return of power if no other alarms are present.
- Automatic restart of the compressor will not occur after abnormal, or "alarm condition" shut down to ensure safety of onsite personnel.

For information on the hydrogen dispenser, see Section 1.3.1 of instruction manual

3.6.2 Emergency Equipment List

See Appendix G for the location of all emergency equipment at the hydrogen fuel station.

The following is a table of all life-saving systems and a brief description about maintenance or testing. These descriptions are not sufficient for complete and proper maintenance and testing. For information on complete maintenance and testing of any of the equipment below, see the Maintenance Software.

Equipment	Maintenance ƒ Testing Description
STI Emergency Buttons	None
Shield Fire Protection Fire Extinguisher	Check pressure gauge, pull pin, and inspect for physical
Moxa Security Camera	Check to ensure camera is recording and saving
Draeger Gas Detector	Inspection and servicing per Draeger Operation
Honeywell Flame Detector	Test detection capabilities with Honeywell UVƒIR

3.6.3 Hazard Mitigation

Hazard	Mitigation
General Hazard	The station is located within a second compound surrounded by a 2–hour fire rater (or higher) walls and in some cases, doors. Entry is restricted to authorized personnel. The system is designed to fail in the safest condition possible.
Hydrogen Leak (Inside Compound)	Area is secured with at least a 2–hour fire rated wall. Small leaks or large jets will be directed at a fire rated wall and dissipate into the atmosphere due to hydrogen's high diffusion rate. The hydrogen will diffuse into the atmosphere and away from the public above the high walls. The tanks and tubing are grounded such that sparks are limited and will not allow a fire to begin. In the case of a large leak or relief valve release, it is expected that the hydrogen would have evacuated entirely in less than an hour.
Hydrogen Leak (Dispenser)	The dispenser is installed with smart controllers that test the integrity of the fueling hose before each hydrogen fill. If the integrity test fails, the dispenser is isolated from the storage system and enters an alarm condition where no fueling is permitted until the problem is solved.
Non–Hydrogen Fire (Inside Compound)	The station is equipped with fire barriers and flame detectors to sense fire and shut of hydrogen valves in case of a fire. There are also small fire extinguishers
Non–Hydrogen Fire (Outside Compound)	At the dispenser, there are flame detectors to stop the supply of fuel in case of a fire near the dispenser. There are also small fire extinguishers to aid in extinguishing small fires at the station.
Hydrogen Fire (Inside Compound)	There is less than 300kg of hydrogen on site at all times. This equates to a gasoline volume value of 300 gallons or 50– gallon drums. This amount will burn until the hydrogen is fully combusted, which should occur in no longer than 30 minutes. The firewalls will keep the hydrogen within the compound
Hydrogen Fire (Outside Compound)	Flame detectors are aimed at the hydrogen dispenser. Any fire detected will shut off the flow of fuel to the dispensing island.
High Pressure Gas	The station is designed to ASME code such that all high pressure release of gas is directed to a vent stack far away from the public, SSS, and first responders. It will also rupture in the dispensing system outside the compound and shut off the flow of fuel to the dispensing island.
Hazardous Liquid Spill	The station is designed with a 4–hour fire rated wall that will prevent the flow of hazardous liquids beyond the walls. All liquids will be contained within the wall.
Other Hazard	The station contains multiple emergency shutdown devices to manually shutdown the station.

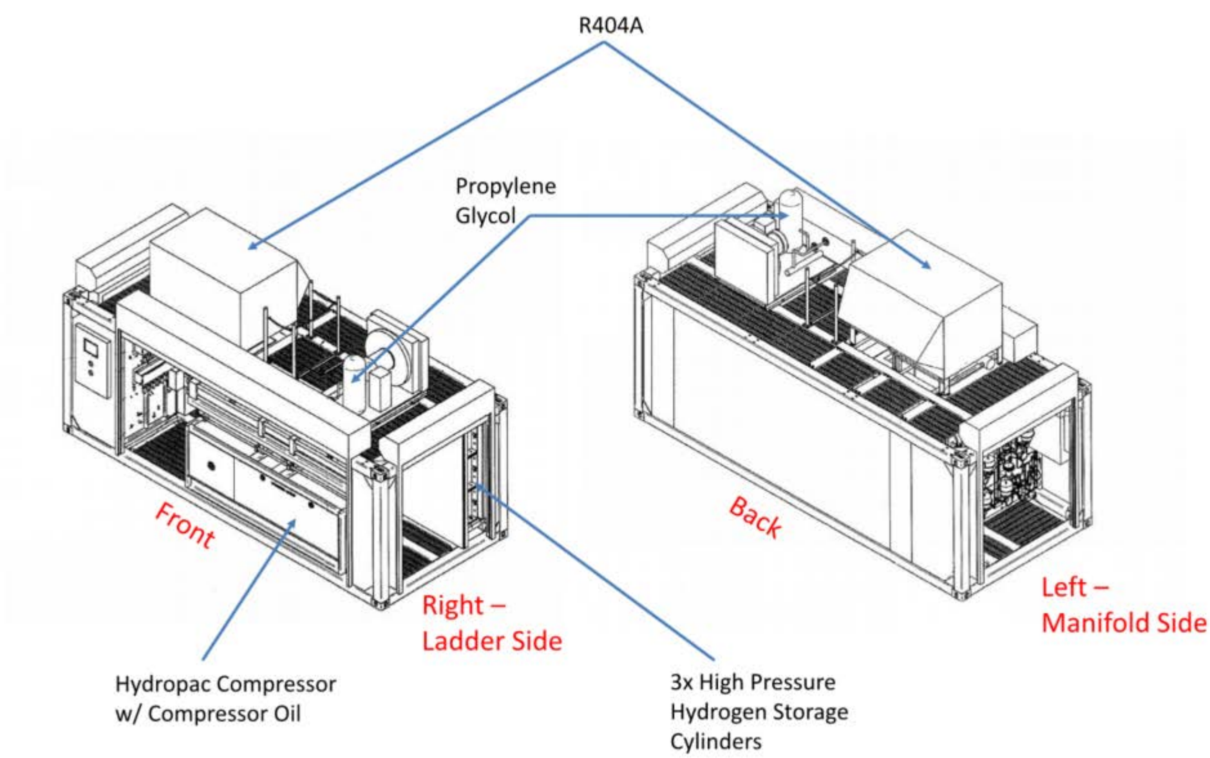
4. HAZARDOUS MATERIALS BUSINESS PLAN

Identification	
Facility ID #	CA-FEFuel1011
EPA ID #	CAL000406165
Business Name	FEFuel
Site Address	24505 West Dorris Ave. Coalinga, CA 93210
Business Phone	(949) 205-5553
Operator/Contact Name	Ghassan Sleiman
Operator/Contact Phone Number	(310) 415-2189
Operator/Contact Email	Ghassan.sleiman@fefuel.com
Mailing Address	5151 California Ave, Irvine CA, 92617
Emergency Contacts	See Sec 1.2 OR Sec 3.4
Declaration	
Hazardous Material	Site contains up to 300kg of H2; 102gal of hydraulic oil, 104lb of R404A refrigerant, 30 gal of polypropylene glycol
Regulated Substances	NONE
Underground Storage Tanks	NONE
Above Ground Petroleum Tanks	NONE
Above Ground Hydrogen Tanks	Yes, ~ 300kg
Hazardous Waste	Generate Oil waste from Compressor
Hazardous Materials Inventory Statement - Chemical Description	
Hydrogen Location	Compressor storage tubes; Storage Module
CAS#	1333-74-0
Name	Hydrogen; Pure
% Weight	100
Federal Hazard Categories	Fire; Acute Health
Fire Hazard Class	Flammable Gas (3.2)
Composition	Gas
Amount	300kg; 127,000 SCF
Storage Container	ASME pressure vessels (cylinder)
Storage Pressure	7500 psi (250kg); 12,500 psi (50kg)
Storage Temperature	Ambient
How is the material used?	Compressed as gas
What is the material used for?	Delivered to Hydrogen Vehicles
Compressor Oil Location	Hydrogen Compressor Module

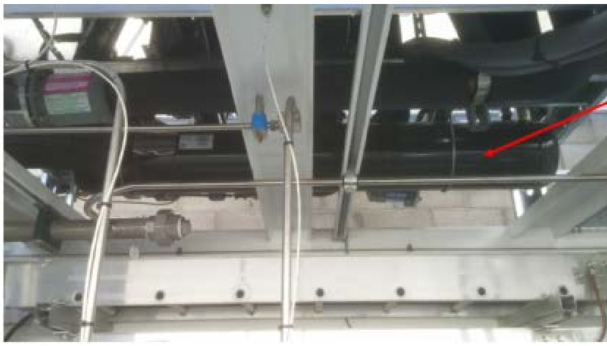
CAS#	64742–54–7
Name	Hydraulic Oil
% Weight	100
Federal Hazard Categories	Fire
Fire Hazard Class	Combustible Liquid, Class III–B
Composition	Liquid
Amount	105 gal
Storage Container	Steel tank (part of compressor)
Storage Pressure	Ambient
Storage Temperature	Ambient +10F
How is the material used?	Incompressors
What is the material used for?	Lubrication and Compression
Propylene Glycol Location	Hydrogen Compressor Module (roof)
CAS#	57–55–6
Name	Propylene Glycol
% Weight	30% (70% Water)
Federal Hazard Categories	Fire
Fire Hazard Class	Combustible Liquid, Class III–B
Composition	Liquid
Amount	30 gal
Storage Container	Steel container as part of coolant pump skid
Storage Pressure	Ambient
Storage Temperature	Ambient +10F
How is the material used?	Pumped into heat exchanger
What is the material used for?	Coolant
Refrigerant R404A Location	Hydrogen Compressor Module (roof); Cooling Block
CAS#	345–33–6; 420–46–2; 811–97–2
Name	HFC–125; HFC 143a, HFC 134a
% Weight	44%; 52%; 4%
Federal Hazard Categories	Compressed Gas
Fire Hazard Class	Non–flammable gas
Composition	Gas
Amount	104 lb
Storage Container	Steel container part of chiller system
Storage Pressure	400 psi
Storage Temperature	~ –58F – +140F
How is the material used?	Compressed and expanded
What is the material used for?	Chilled hydrogen gas

4.1 Appendix E – Hazardous Materials Location – True Zero Station

This map shows the devices containing hazardous materials, the hazardous materials in each device and their location on the site.



4.2 Appendix F – Hazardous Materials Location – Hydrogen Compressor



R404A
Storage

Compressor Oil Storage

Propylene
Glycol Storage
(second floor)

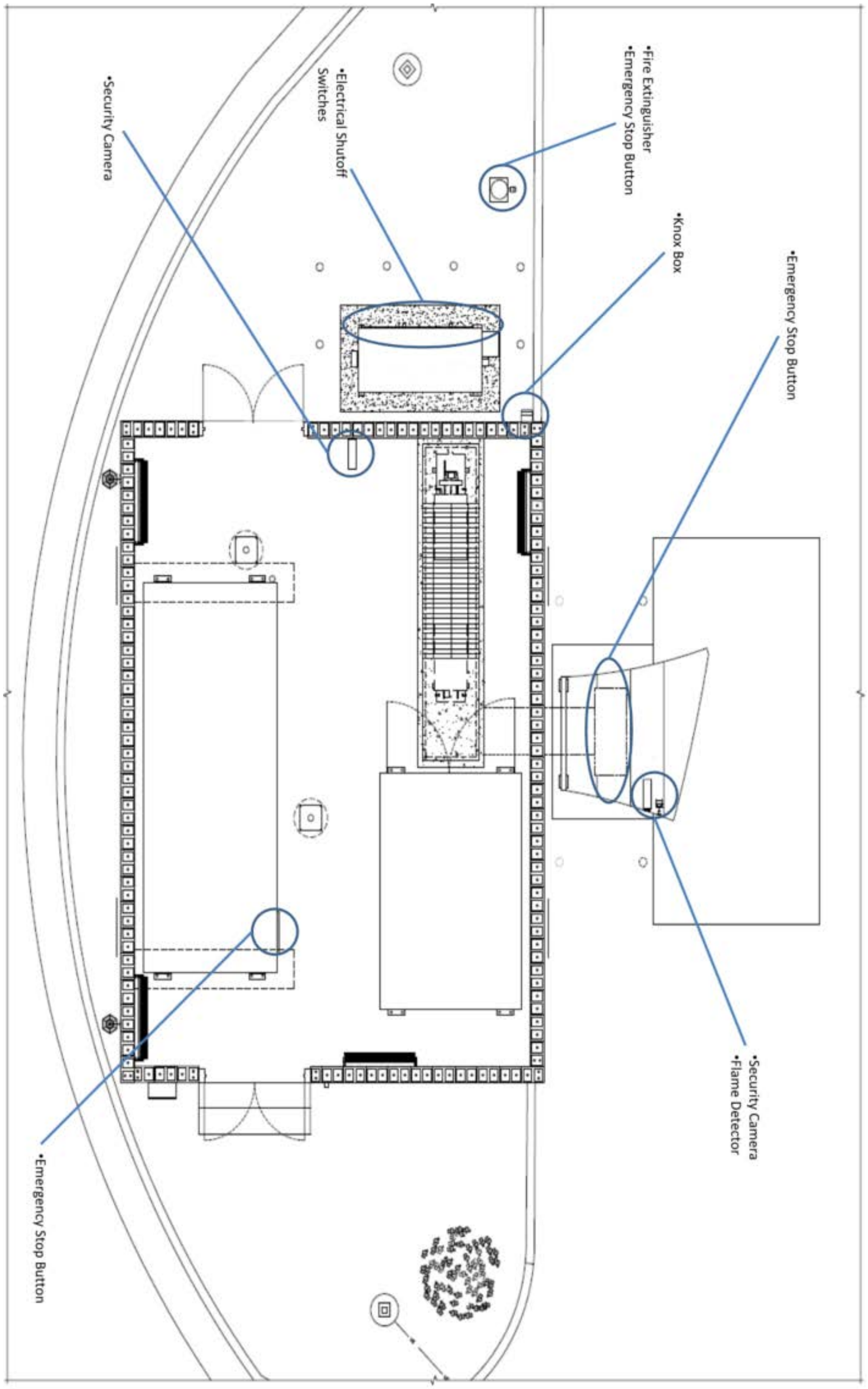
Location of 3x high
pressure hydrogen
storage cylinders

1 of 3 high
pressure
storage
cylinders

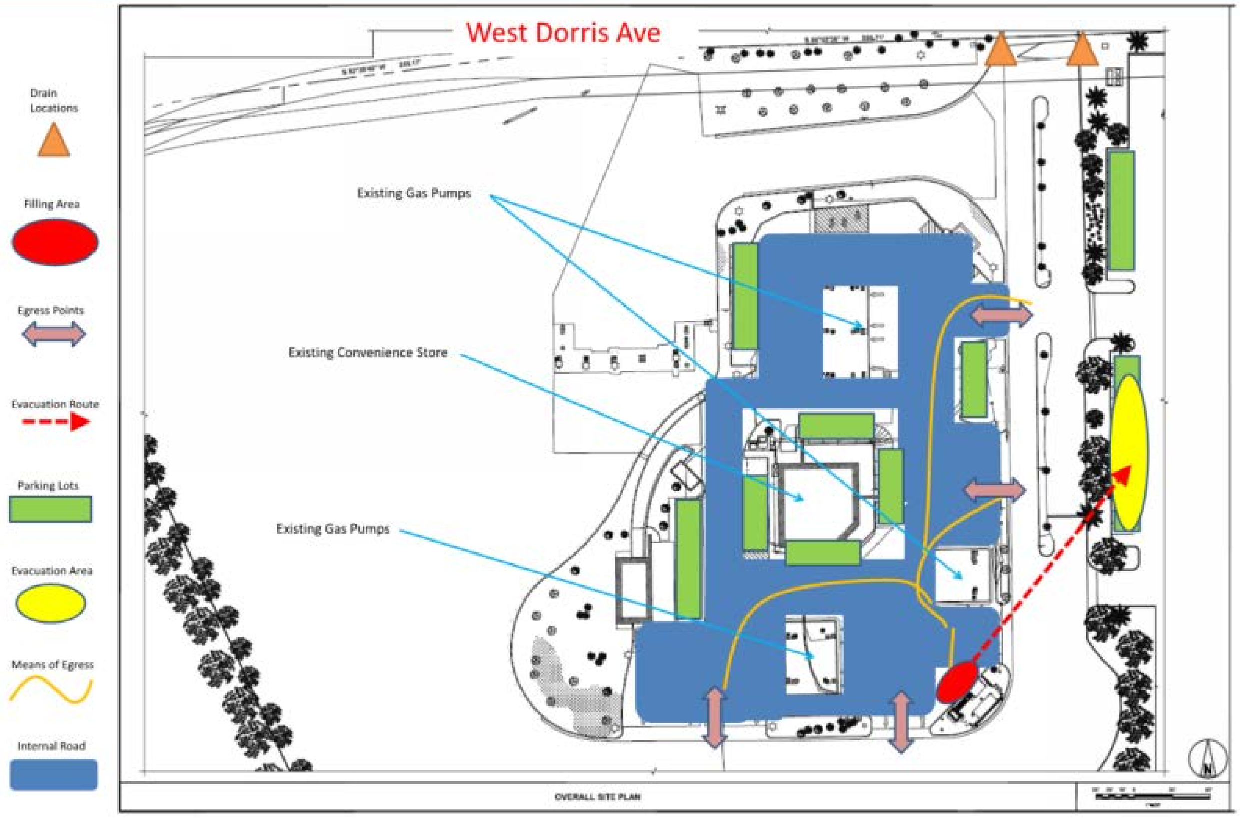
25x medium pressure
hydrogen storage cylinders

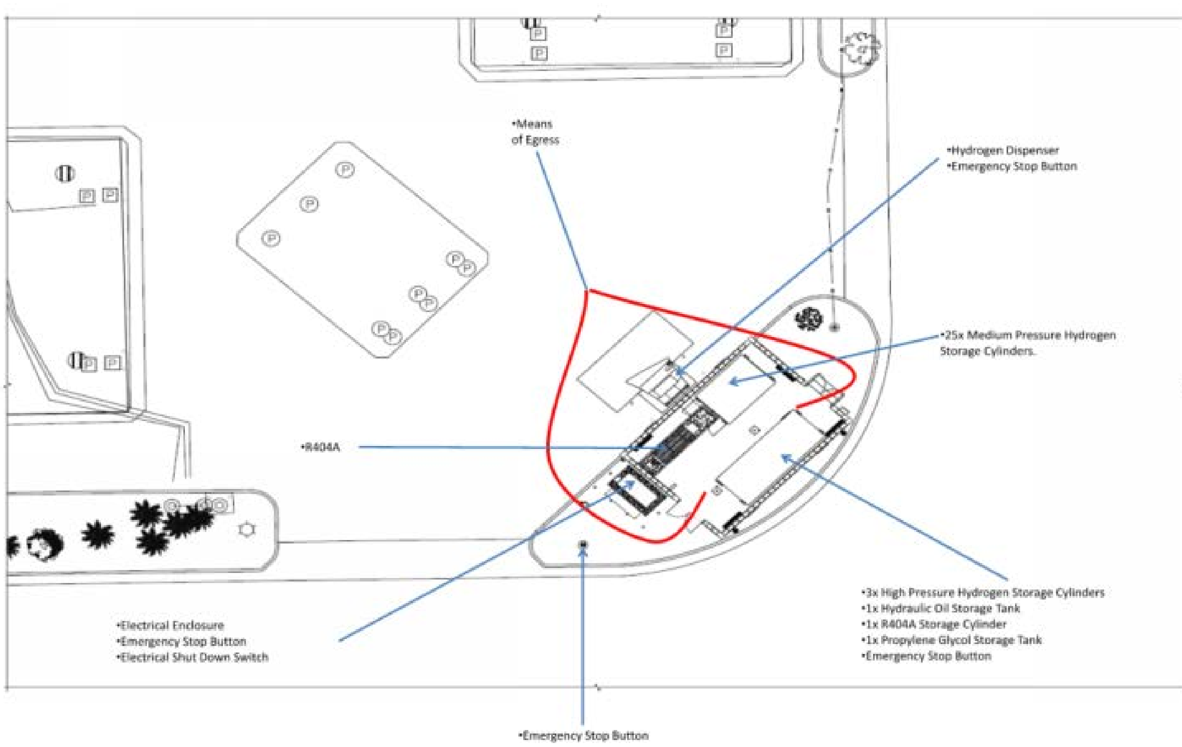
4.3 Appendix G – Life Saving Systems Locations

This map shows the location of all life-saving systems and devices in and around the hydrogen dispenser and hydrogen compound.



4.4 Appendix H – Evacuation Location Map





Appendix J – Required Material of Construction

Required Material of construction list is massive however some important excerpts of some important material is illustrated below. In this picture that Pipe Spec lists the material of construction for the tubing. This would refer to a document that shows what material is required. Since the Hydrogen tubing is critical. FEFuel purchase and supplies the tubing to the contractors. The tubing is made from 316 stainless steel. Aside from the storage tube all wetted parts are made of Stainless Steel conforming to ISO standards.

PIPE ID #	DESCRIPTION	FROM	ID #	TO	ID #	FLUID	SIZE (IN)	MATERIAL	PIPE SPEC
1	PROCESS HYDROGEN FEED TO S700 COMPRESSOR	FUEL STANCHION	-	COMPRESSOR - COMPRESSOR	A1A/A1B	HYDROGEN GAS	9/16	316 SS	4API - CAST1275
1A	PROCESS HYDROGEN FEED TO/FROM GROUND STORAGE MODULE	FUEL STANCHION LINE	A1A/A1B	STORAGE MODULE	B1	HYDROGEN GAS	9/16	316 SS	4API - CAST1275
2	FUEL TRAILER STANCHION VENT	FUEL STANCHION	-	COMPRESSOR - VENT SYSTEM	A8	HYDROGEN GAS	1/4	316 SS	4API - CAST1275
3	INSTRUMENT AIR (SUPPLY)	COMPRESSOR	A7	FUEL STANCHION CONTROL PANEL	NP-3	AIR	1/4	316 SS	NA
3A	FUEL TRAILER INSTRAMENT AIR (SIGNAL)	FUEL STANCHION CONTROL PANEL	NP-4	TRAILER	-	AIR	1/4	POLY TUBING	NA
3B	GROUND STORAGE MODULE INSTRAMENT AIR (SIGNAL)	STORAGE MODULE	B2	FUEL STANCHION CONTROL PANEL	NP-5	AIR	1/4	POLY TUBING	NA
4	HYDROGEN SUPPLY TO DISPENSER	COMPRESSOR - MANIFOLD	A2	DISPENSER	D	HYDROGEN GAS	3/8	316 SS	4API - CAST1275
5	HYDROGEN TO DISPENSER	HEAT EXCHANGER	D2	DISPENSER	C	HYDROGEN GAS	3/8	316 SS	28-4WPIINS006 28-4WPIINS008 4API-CAST1275
5A	HYDROGEN FROM DISPENSER	DISPENSER	E	HEAT EXCHANGER	D1	HYDROGEN GAS	3/8	316 SS	28-4WPIINS006 28-4WPIINS008 4API-CAST1275
6	REFRIGERANT SUPPLY TO MULTI-BLOCK HEAT EXCHANGERS	COMPRESSOR - CHILLER	A4	HEAT EXCHANGER	D3	REFRIGERANT	3/4	COPPER TYPE K	4WPI - CAKC030 DOC0000763916
7	REFRIGERATION RETURN FROM MULTI-BLOCK HEAT EXCHANGERS	HEAT EXCHANGER	D4	COMPRESSOR - CHILLER	A3	REFRIGERANT	1-1/2	COPPER TYPE K	4WPI - CAKC030 DOC0000763916
8	HYDROGEN VENT	DISPENSER	A	COMPRESSOR - VENT SYSTEM	A5	HYDROGEN GAS	3/4	316 SS	4API90641
9	INSTRUMENT AIR (SUPPLY)	ELECTRICAL ENCLOSURE - AIR COMPRESSOR	E1	COMPRESSOR	A6	AIR	1/2	COPPER TYPE K	NA
10	INSTRUMENT AIR (SUPPLY)	FUEL STANCHION CONTROL PANEL	NP-3	DISPENSER	B	AIR	1/4	316 SS	NA
11	PURGE GAS	ELECTRICAL ENCLOSURE - AIR BLOWER	E2	DISPENSER	PURGE	AIR	2	PVC PIPE, SCH40	NA

Statement on Materials of Construction from Equipment Provider

Linde selects materials and components for hydrogen service based on available data, experience at Linde R&D facilities, and recognized standards. When selecting materials for hydrogen service, Linde makes the following considerations according to the operating temperature and pressure, for example:

- Hydrogen Embrittlement
- Elastomer Pre–load (Tensile Strength vs. Elongation)
- Explosive Decompression of Synthetic Rubbers in Hydrogen Service
- Shore Hardness

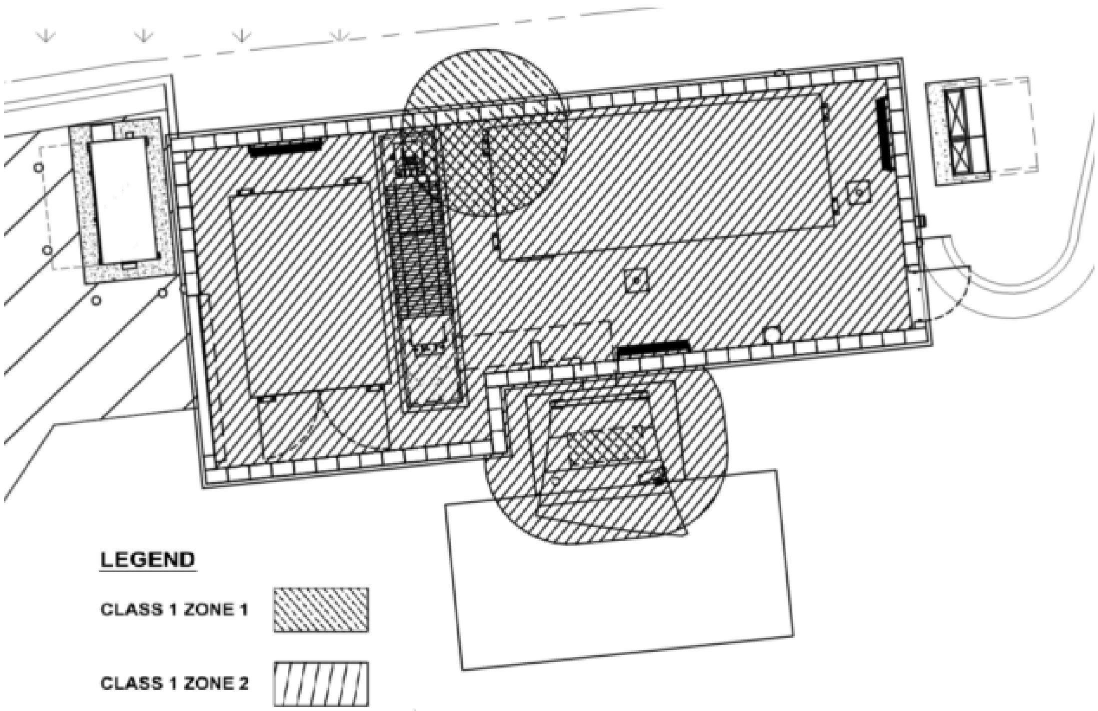
Linde is an active participant in the ISO TC 197 W¢24 that develops hydrogen fueling station standards, including the ISO 19880 standards for equipment in hydrogen service. Thomas Knocke is Linde's representative on WG24.

Standards, regulatory, & Publications

- ISO/TR 15916:2014 Basic Considerations for the safety of hydrogen systems
- API 941 Carbon Steel Degradation in Hydrogen Service
- ASME PV&BC Section VIII Division III, Sections KD-2 and KD-4 (FEFuelA and Fracture Mechanics for Div. 3 Vessels
- in Hydrogen Service)
- Pressure Equipment Directive 97/23/EC
- CSA HGV 4
- ISO 19880

Appendix K – Electrical Area Classification

Example of site Area Classification. Available to every employee

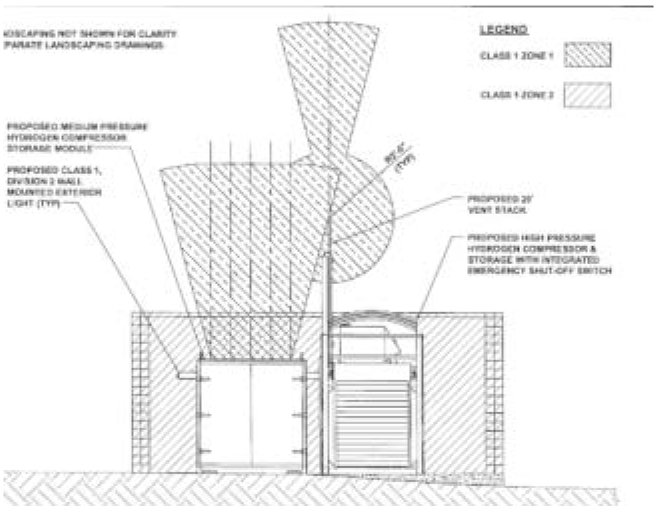


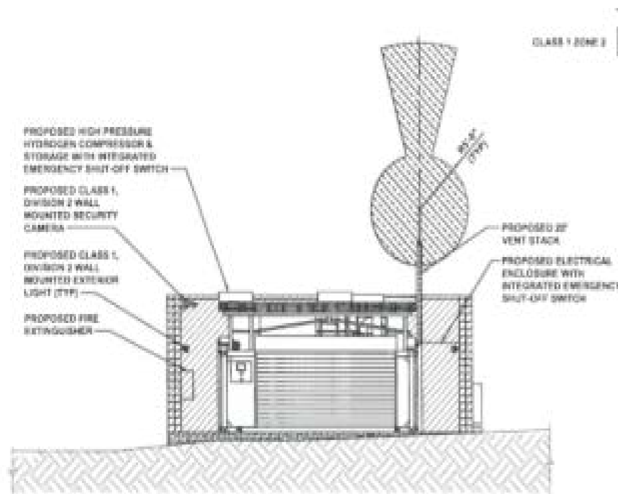
Appendix L – Hydrogen Vent Stack

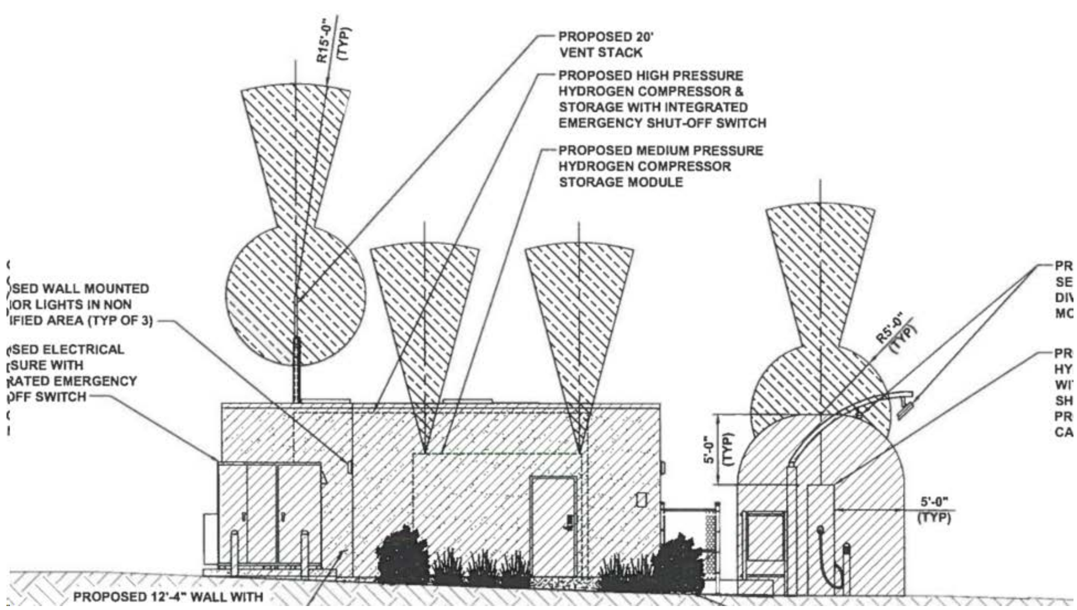
The design of the vent stack is done in accordance to local regulation, engineering best practice, international standards, and hazard analysis. Relief device and vent design considers, pressure drop, rated capacity, backpressure, line sizing, dispersion, grounding, weather protection, and heat flux in accordance with local regulation and industry standards. Vent system design is site specific. For hydrogen fueling stations in the United States, the following standards and regulations are applicable:

CGA G-5.5 Hydrogen Vent Systems
ASME PV&BC Section VIII – Pressure Vessels
ASME B31.3 Process Piping

Example of Hydrogen Vent Stack Drawing for location of classified area in case of release.


LEGEND
CLASS 1 ZONE 1
CLASS 1 ZONE 2
PROPOSED MEDIUM PRESSURE HYDROGEN COMPRESSOR STORAGE MODULE
PROPOSED CLASS 1, DIVISION 2 WALL MOUNTED EXTERIOR LIGHT (TYP)
PROPOSED 20' VENT STACK
PROPOSED HIGH PRESSURE HYDROGEN COMPRESSOR & STORAGE WITH INTEGRATED EMERGENCY SHUT-OFF SWITCH


PROPOSED HIGH PRESSURE HYDROGEN COMPRESSOR & STORAGE WITH INTEGRATED EMERGENCY SHUT-OFF SWITCH
PROPOSED CLASS 1, DIVISION 2 WALL MOUNTED SECURITY CAMERA
PROPOSED CLASS 1, DIVISION 2 WALL MOUNTED EXTERIOR LIGHT (TYP)
PROPOSED FIRE EXTINGUISHER
PROPOSED 20' VENT STACK
PROPOSED ELECTRICAL ENCLOSURE WITH INTEGRATED EMERGENCY SHUT-OFF SWITCH


R15'-0" (TYP)
PROPOSED 20' VENT STACK
PROPOSED HIGH PRESSURE HYDROGEN COMPRESSOR & STORAGE WITH INTEGRATED EMERGENCY SHUT-OFF SWITCH
PROPOSED MEDIUM PRESSURE HYDROGEN COMPRESSOR STORAGE MODULE
)SED WALL MOUNTED
IOR LIGHTS IN NON
IFIED AREA (TYP OF 3)
SED ELECTRICAL
SURE WITH
RATED EMERGENCY
OFF SWITCH
R5'-0" (TYP)
5'-0" (TYP)
5'-0" (TYP)
PROPOSED 12'-4" WALL WITH

- The following are the overriding codes and standards used for building and designing hydrogen station and necessary equipment.
- NFPA -2 – Hydrogen Technologies Code
- NFPA 70 – National Electric Code
- CSA / HGV 4.3 Test Methods for hydrogen Fueling parameter evaluation
- HGV 4.5- 4.10 – Various codes regarding design of pressure equipment
- UL 508A – Electrical Panel
- UL 698A – Industrial Control Panels
- California Building Code (includes California Fire Code section 23.09 Hydrogen Refueling Facilities)
- National Conference on Weights and Measures Publication 14 – Weights & Measures Certification
- SAE J2719 - Hydrogen fuel quality
- SAE J2601 - Fueling Protocols for Light Duty Gaseous Hydrogen Surface Vehicles
- SAE J2799 - Hydrogen surface to Vehicle
- ASME section 8 – Boiler and Pressure Vessel Code
- ASME B31.3 – Process Piping
- NFPA 496 – Standard for Purged and Pressurized Enclosures
- NFPA 497M – Manual for Classification of gases, Vapors and dusts for electrical equipment in hazardous classified locations.
- SAE J2600 – Compressed hydrogen surface vehicle fueling connection devices
- CGA G5.5 – Hydrogen Vent System

Portion of the FEFuel Training Matrix. There are currently 30 training modules and continuously growing. To have the best operating stations in the world demands the best trained hydrogen team.

TRUE ZERO

Training Matrix

Legend

Level	Operation Task Level
I	Observer
II	Supervised
III	Independent
IV	Trainer

Name	Title	Introduction to FirstElement Fuel	HSE Introuction	Employee Handbook	Trainer Certification (General)	HSE-MS Cert.	Office Safety	General Safety	High Traffic zone Training	Warehouse Safety	Site Operation	Logistic Safety	Piping service	Cleaning Skid Cert.	Dispenser Troubleshooting Cert.
Joel Ewanick	Chief Executive Officer	IV	IV	IV	IV		IV	IV			II				
Tim Brown	Chief Operation Officer	IV	IV	IV	IV		IV	IV	IV	IV	II				
Shane Stephens	Chief Development Officer	IV	IV	IV			IV	IV			II				
Patti Kohler	Director of Internal Project Management	IV	IV	IV			IV	IV	III						
Matt Meichtry	Director Of Construction	IV	IV	IV	IV	IV	IV	IV	IV	IV					
John Rapp	Director of Site Development and	iV	iV	iV			IV	III	III						
Ghassan Sleiman	VP of Technical Operation	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV
Andrew Youlio	Field Service Manager	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV
Pete Willette	Project Engineer	IV	IV	III	II	I	IV	IV	IV	III	IV	III	IV	IV	IV
Mike Strada	Field Service Representitive	IV	IV	III	II	I	IV	IV	IV	III	IV	III	IV	IV	IV
Denver Owens	Field Service Representitive	IV	IV	III	II	I	IV	IV	IV	IV	IV	III	IV	IV	IV
Shane Drummond	Field Service Representitive	IV	IV	III	II	I	IV	IV	IV	IV	IV	II	IV	IV	IV
Logan Hart	Field Service Representitive	IV	IV	III	I	I	IV	IV	II	II	II	I	II	I	I
Edgard Crueil	Field Service Representitive	IV	IV	III	I	I	IV	IV	II	II	II	I	II	I	I

POS System Training Certification

I have been trained on the POS System for level

I-Observer ______
II-Work with Supervision ______
III- Independent work certified ______
IV- Trainer Level (able to train others) ______

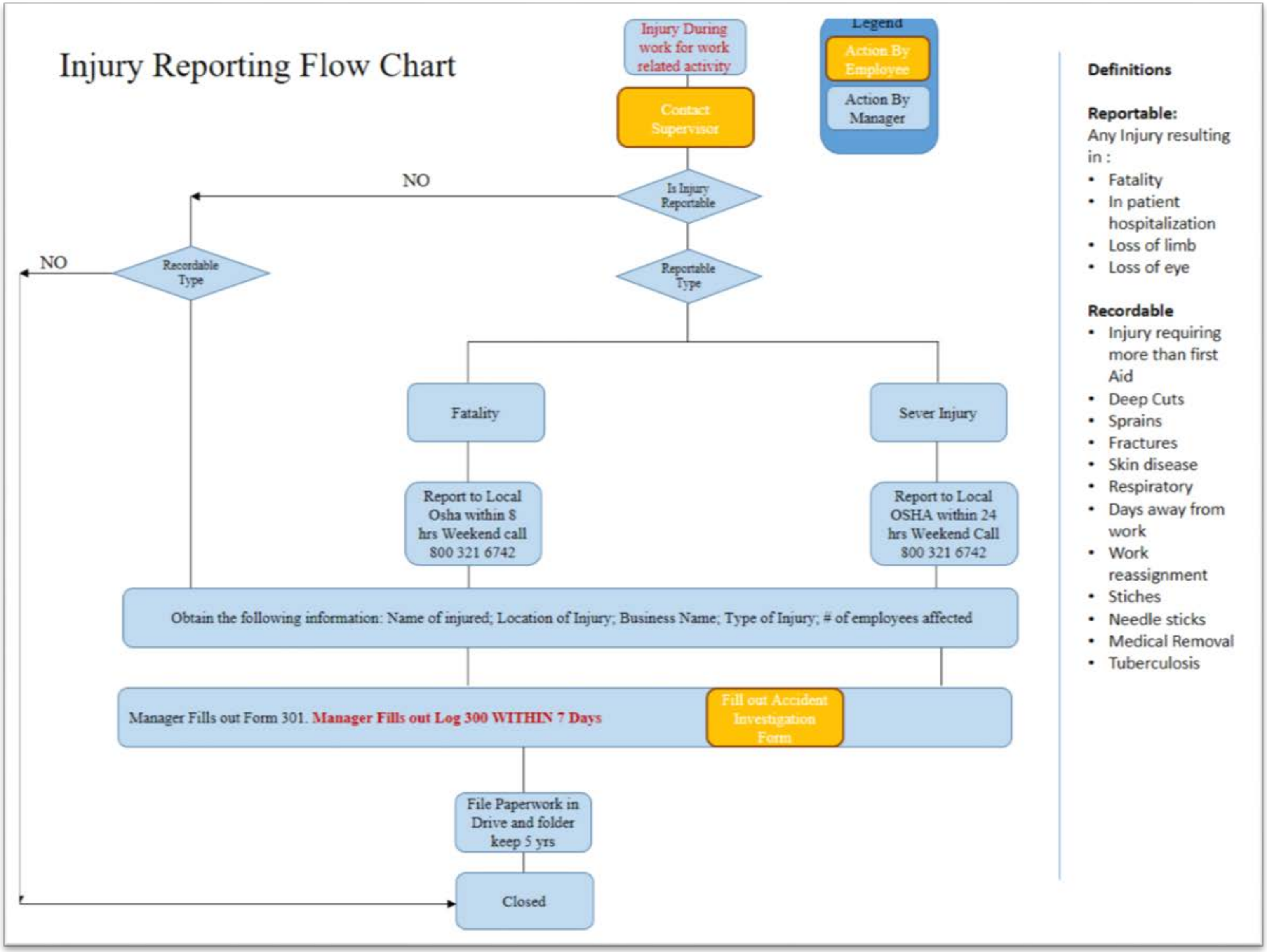
Training Topics Checklist:
System flow chart
Wiring Details
dispenser, 515, B+B wiring details
515 Dispenser signals
515 Troubleshooting
Addressing Card Reader

		DATE
Tech Name (printed)	____________	______
Tech Name (Signed)	____________	______
Trained by (printed)	____________	______

At the end of each training session the instructor and the student assess the effectiveness of the lesson and determine if a level upgrade is justified. The figure below shows a portion of the in-depth training for each module.

Overall North Training	
General Area	**Topic Title**
S700:	
	Overall flow/function of Priority Pannel
	PCV119/120 - working theory/rebuild/repair
	Piston replacement
	Check Valve Resurfacing
	Hydropac: oil temp/lvl switch, pds102, prox sensors, blowby, pushrods, cooling, sensor wiring via IS barriers
	Chiller: site glasses, bubbles in lines, pressure switches functionality, suction line, discharge line,
	Chiller cabinet: main breaker, main contactor, fan contactors, f222, tdr, oil protection switch, motor saver, fuse
	S700 PLC: modem, heat trace, psh202 IS barrier, force run, cycles, f3, f1, f2, run time
	Priority Panel: Ronan, PTs, isolation/LOTO
	Calibrating and function testing gas sensors
	AOV201/101A - packing is 45ftlb
	PDS102, LSL101, TSH103, ZS1, ZS2- alarm meanings
	Compression Ratio and P=F/A
Dispenser:	
	Watch Dog
	Site nodes/PLCs
	PLC communication wiring loop
	Card Reader and CPU
	Addressing Card Reader
	IS Barriers
	Flowmeter - Unit and Computer
	ECV solenoid valves
	Proper Dispenser power off
	Earthquake sensor
	Dispenser door sensor
	Dispenser Functionality: 112 valves, psv112, 123a/b, yellow HV for safety, vent valves, TC quick connects
	Depressurization - Dispenser for line work
	Depressurization - PCV120 for rebuild/repair
	Tightening packing on 123A valve
	Replacement of breakaway
	Cleaning filter in breakaway
	Calibrating and setting up gas sensors

Appendix O – Injury Reporting Procedure



Appendix P – Near Miss - Form

Incident/Near miss investigation form

The reason for investigating an incident or near miss is to determine: the cause or causes of the incident; to identify any risks, hazards, systems or procedures that contributed to the incident; and to recommend corrective action to prevent similar incidents.

Incidents should be investigated by people knowledgeable about the type of work involved at the time of the incident. Relevant workers should also be involved in the investigation.

An incident /near miss investigation report should answer the WHO, WHERE, WHEN, WHAT, WHY and HOW questions with regard to an incident.

Details of the incident/near miss:	**Date of incident:**	**Time of incident:**
Short description of incident / near miss:		
Area where incident / near miss occurred:		

Details of the incident/near miss investigation	
Name of injured person (if relevant):	Injury sustained(if relevant):
Name of person who reported incident:	Date of report:
Name of person completing this form:	
Telephone number:	Date report completed:

Witness details		
Name/s	Job title (if relevant)	Contact number
Name of person/s conducting investigation	Job title (if relevant)	Contact number

Immediate causes / Contributing Causes that may have been a factor to the accident/incident	
What preventative action could have been taken? Why was this action not taken?	
How much experience did the employee have in the task/s that was being performed when the accident / incident occurred? What training has been provided?	
What is the chance of the accident / incident occurring again?	

Full description of events.
Who was involved: Worker Student Visitor Contractor
Briefly describe what happened including the sequence of events, investigate scene of incident or near miss; conditions present at time of incident; what was involved, what activity (if any) was taking place prior and at time of incident. What hazards was the worker exposed to? What hazards may have contributed to the incident occurring? (Attach photos if available)

INVESTIGATION RECOMMENDATIONS Outline recommended corrective action/s (i.e. solution/s) to prevent the recurrence of the incident eg. new equipment, re-engineer, re-design work area, re-design work practices, review training standards, etc

Investigators Recommendation	Person to Action	Completion date

IMPLEMENTATION DETAILS

Date implemented	Action taken	Responsible person	Review Date

Investigators Name: ______________________ Date:______________

Attachments: e.g. photos, instructions, SWP etc.

The form below is utilized as a KPI to perform an audit on the health and safety aspect of the employees at FEFuel. This document is help indefinitely and is displayed and discussed on an annual basis with Management and all Employees.

OSHA's Form 300A (Rev. 01/2004)

Summary of Work-Related Injuries and Illnesses

All establishments covered by Part 1904 must complete this Summary page, even if no injuries or illnesses occurred during the year. Remember to review the Log to verify that the entries are

below, making sure you've added the entries from every page of the log. If you had no cases write "0."

Employees former employees, and their representatives have the right to review the OSHA Form 300 in its entirety. They also have limited access to the OSHA Form 301 or its equivalent. See 29 CFR 1904.35, in OSHA's Recordkeeping rule, for further details on the access provisions for these

Number of Cases

Total number of deaths	Total number of cases with days away from work	Total number of cases with job transfer or restriction	Total number of other recordable cases
(G)	(H)	(I)	(J)

Number of Days

Total number of days away from work	Total number of days of job transfer or restriction
(K)	(L)

Injury and Illness Types

Total number of...
(M)

(1) Injury		(4) Poisoning	
(2) Skin Disorder		(5) Hearing Loss	
(3) Respiratory Condition		(6) All Other Illnesses	

Post this Summary page from February 1 to April 30 of the year following the year covered by the form

Public reporting burden for this collection of information is estimated to average 58 minutes per response, including time to review the instruction, search and gather the data needed, and complete and review the collection of information. Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number. If you have any comments about these estimates or any aspects of this data collection, contact: US Department of Labor, OSHA

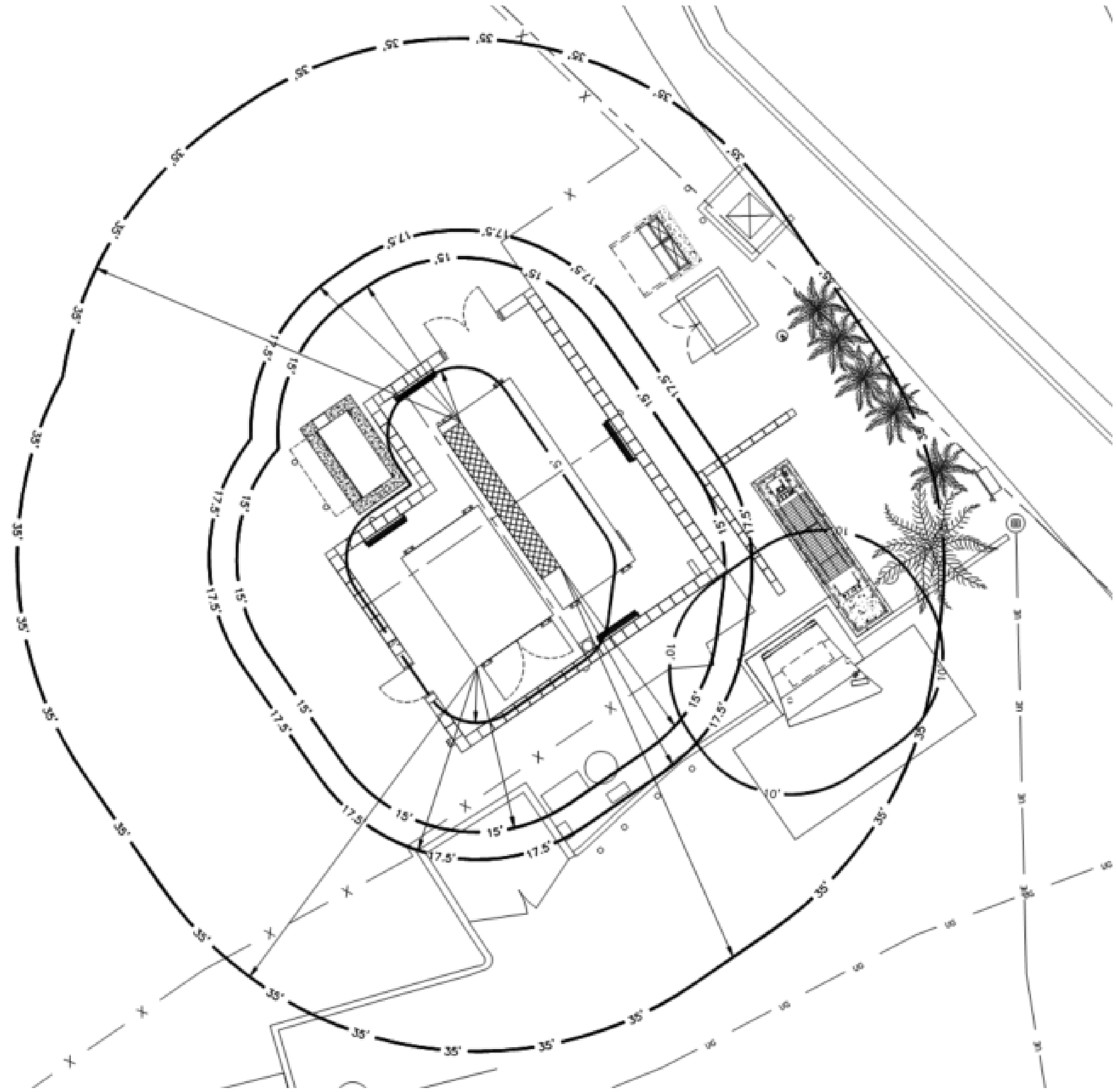
Of the more than 200 pages of fundamental safeguards spelled out in NFPA 2: Hydrogen Technologies Code, the most difficult to achieve for hydrogen fueling station equipment are the minimum separation distances for outdoor exposures prescribed in Chapters 7 and 8; the “setback distances”. Nearly every other part of the prescriptive hydrogen code can be achieved through thoughtful and rigorous equipment design. But, no amount of design can change the size and shape of existing gasoline stations sites where hydrogen equipment need be installed to serve customers.

The authors of the fire code foresaw potential challenges like these and included Section 1.5, Equivalency. “Nothing in this code is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this code.” Section 1.5 continues on to state that, “Technical documentation shall be submitted… to demonstrate equivalency.”

The final location of hydrogen equipment at each gasoline station site is an iterative process that accounts for fire safety, site owner interests, and city jurisdiction concerns. This process is actively underway at awarded hydrogen station sites. Though the final layouts are not yet determined, FirstElement anticipates a lack of space to meet some portion of the prescriptive NFPA 2 Outdoor Exposures at most locations.

FirstElement will therefore meet or exceed the safety of prescribed setback distances through the use of equivalency. Redundancy, active monitoring, and data driven analysis will be used to quantify and demonstrate the safety of the proposed equipment within the envelope of available gasoline station forecourt space. Rigorous analysis by hydrogen safety experts will form the detailed foundation of technical documentation upon which a Nationally Recognized Test Laboratory will classify the equipment and installation to NFPA 2 equivalency. Submissions to the local jurisdictions will be made by professional fire protection engineers.

Example of “Bubble” Diagram with setback distances per NFPA-2- that are submitted to the AHJ.


35'
17.5'
15'
10'

Appendix R – Set Back Distances - Continued

Example setback distances table that are submitted to the AHJ.

NFPA 2 Hydrogen Technologies code 2011 Edition

Table 7.3.2.3.1.2(a) Minimum distance From Outdoor [GH2] Systems to Exposures (Ft) (Bulk Storage and TTR offload connection)

		MinSeparation Distance (ft)		Seperation Distance (ft)
	Pressure	7500 -15000 psi		
	Pipe Diameter	0.282" ID		
	Exposure	Without 2hr Fire Barrier	With 2hr Fire Barrier	
1	Lot Lines	**35**	**17.5**	22
2	Exposed person other than those involved in servicing of the system	**15**	**0**	22
3	Building and Structures			
	Combustible Construction	15	0	N/A
	Non combustible non-fire rated construction	15	0	4
	Fire Rated construction with 2hrs	5	0	66
4	Opening in building of fire rated or non fire rated construction (doors, windows and penetrations)			
	Openable Fire rated or not fire rated	**35**	**17.5**	73
	Inoperable Fire-rated or Non-Fire rated	15	0	68
5	Air intakes (HVAC, compressors, other)	**35**	**35**	93
6	Fire barrier walls or structures used to shield the bulk system from exposures foot note:The minimum Clearance between the structure and the system required for access for service-related activities.	**5**	**5**	N/A
7	Unclassified Electrical equipment	15	0	10
8	Utilities (overhead)including electrical power, building services or hazardous material piping.	**15**	**15**	241
9	Ignition sources such as open flames and welding	35	0	N/A
10	Parked Cars	**15**	**0**	22
11	Flammable gas storage systems including other hydrogen systems above ground			
	Non Bulk	15	0	N/A
	Bulk	15	0	10
12	Above ground vents or exposed piping and components of flammable gas storage systems including other hydrogen systems below ground gaseous or cryogenic	15	0	219
13	Hazardous material (other than flammable gases) storage below ground. Physical hazard material or Health hazard material.	15	0	167
14	Hazardous material storage (other than flammable gases) above ground. Physical hazard materials or health hazard materials.	15	0	N/A
15	Ordinary combustibles, including fast-burning solids such as ordinary lumber, excelsior, paper and combustible waste and vegetation other than that found in maintained landscaped areas.	15	0	11
16	Heavy timber, coal, or other slow-burning combustible solids	15	0	N/A

	Table 10.3.1.16.1 Electrical Installation Area Classification	Class 1 Zone1	Class 1 Zone 2	
1	Area containing compression and ancillary equipment	N/A	up to 15 ft	>15
2	Outdoor dispensing equipment enclosure interior. Up to support mechanism or connection to the ground	N/A	N/A	N/A
3	Outdoor dispensing equipment enclosure exterior	N/A	up to 5 ft	>5
4	Outdoor discharge from relief valves or vents	5ft	15ft	>15
5	Discharge from relief valves withing 15 degrees of the line of discharge	15ft	N/A	>15

	Table 10.3.2.3.1.3 Separation Distances for Outdoor Gaseous Hydrogen Dispensing Systems	Required Separation (ft)	
1	Dispensing equipment to nearest important building or line of adjoining property that can be built upon or ignition source	10	38
2	Dispensing equipment to nearest public street or public sidewalk	10	22
3	Dispensing equipment to nearest rail or any railroad main track	10	N/A
4	Point of transfer to any important building other than buildings of Type I or Type II construction with 2 hour fire rated exterior walls	10	N/A

Appendix R – Set Back Distances - Continued

Appendix S – Construction Safety Plan

Construction Safety Plan

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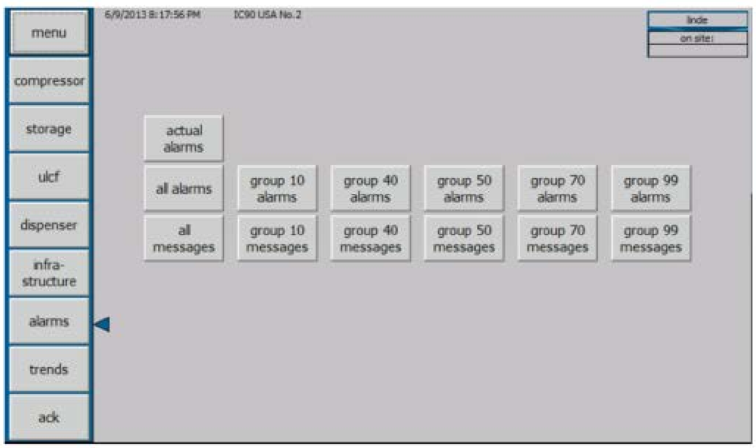
Appendix A 1
Checklists, Permits, Forms, and Training Records 1

The Alarms are categorized into a few district categories
Emergency – These alarms that need immediate attention as they are safety related such as Fire or Emergency stop. These alarms require onsite resets
Alarm - These are operational alarms that may cause an operational issue but are not safety related. These alarms can be reset remotely. This can be a high pressure alarm for example.
Warning - These are warning to indicate to the operator that the equipment needs some attention but maybe operating. An example is high compressor runtime without maintenance.

The control panel has multitude of alarm across many systems. Below is an over view of the alarm and alarm groups.

Alarm – and message window:

Picture Alarms:



The picture shows an overview of the selectable alarm list

The following sub pictures can be selected:

- Current active alarm
- All alarms
- All messages
- Alarms of group 10
- Messages of group 10
- Alarms of group 40
- Messages of group 40
- Alarms of group 50
- Messages of group 50
- Alarms of group 70
- Messages of group 70
- Alarms of group 99
- Messages of group 99

Alarms: Pictures of how the alarm and the history being tracked.

Picture all messages:

This picture shows all messages and alarms (history of all messages and alarms). The color of the messages and the remaining characteristics of the detection system are described in the chapter detection system.

Picture group 10 alarms: