Gas Ballooning Safety and Transportation

Launch

Set up – See attached schematic of set up requirements.
A. Grounding system will be installed and tested.
B. Field wire will be laid out and connected to ground.
C. Canvas tarp will be placed over field wire.
D. Filling nozzle will be placed in center of tarp and grounded.
E. Safety perimeter will be staked out.
F. Safety signs will be erected.
G. Fire extinguishers will be checked and put in place.
H. Canvas tarp will be placed on ground for gas tanks.
I. Canvas shade tarp shall be erected over gas tank area.
J. Hose will be laid in place and connected to nozzle but not the tanks.
K. Balloon will be set in place.
L. Safety Officer will check to make sure everything is in place
M. Balloon Filler, Balloon Holder, Tank Minder and Gofer take their positions.
N. Hose is connected to tanks and filling operations can begin.

Grounding system

Manned positions:

Safety Officer:
The Safety Officers job is to monitor all aspects of the balloon operation. They are to correct any breach of safety procedure and watch for potential problems. If the need arises they are to call a halt to all operations. If an emergency arises they are the ones that are in charge of the scene. Safety Officer will carry a fully charged cell phone. Safety officer will carry gas monitor. The Safety Officer will not be assisting in any part of the operation. Their sole responsibility is safety.

Balloon Filler:
The balloon filler is in charge of the fill nozzle for the balloon. They are to make sure that the balloon stays on the nozzle during filling operations. They are to operate the nozzle valve during operations. Once the balloon is full they are responsible for taking the balloon off the nozzle, tying off the balloon and attaching the payload. Balloon Filler must stay in their position until gas is turned off and balloon is launched.
Balloon Holder:

The balloon holder is in charge of holding the balloon in place during the filling operation. They are to watch the balloon for any defects, holes, tears or problems. If any problems are found, gas will be shut off and the situation will be assessed. Balloon Holder must stay in their position until gas is turned off and balloon is launched.

Tank Minder:

The tank minder will stay at the tank at all times during the filling operation. They are to monitor the tanks and shut off the gas when the need arises. Tank Minder must stay in their position until gas is turned off and balloon is launched.

Gofer:

The Gofer is to assist the Safety Officer, Balloon Filler, Balloon Holder and the Tank Minder. These positions cannot be left unattended. Therefore the Gofer is to assist and/or retrieve whatever is needed for the key positions.

Payload Crew:

The Payload Crew is responsible for preparing and setting up the payload. They are to stay out of the filling crew’s way and out of the safety perimeter.

Emergency procedures

In the event of any emergency the Tank Minder and the Balloon Filler shall shut off the gas at their position. All personnel will move to a safe area as directed by Safety Officer. 911 and local authorities will be called as necessary. In case of a gas fire, do not try to extinguish the fire. Let the fire burn out on its own. Any other fire should immediately be extinguished. First aid shall be given as necessary.
Fill sequence

Complete Area Set up.
A. Confirm Payload Crew is ready.
B. Safety Officer to confirm that Balloon Filler, Balloon Holder, Tank Minder and Gofer are in place and ready to go.
C. Tank Minder opens regulator.
D. Safety officer checks for leaks from tank to diffuser.
E. Balloon Filler places balloon over fill nozzle and turns gas on.
F. Balloon Holder makes sure balloon fills properly rises properly and keeps it in place while filling.
G. Nozzle shuts itself off at proper tear weight.
H. Balloon Filler manually shuts off nozzle.
I. Tank Minder shuts off gas at regulator.
J. Gofer brings payload connection line to Balloon filler.
K. Balloon Filler and Gofer seal balloon and attach payload.
L. Balloon in released.
M. Tank Minder puts tanks in to storage
N.

Environmental considerations

Prior to launch, local weather forecast should be checked. If any rain or thunder storms are predicted launch should be aborted. If winds are forecast to be over X MPH, launch should be aborted.

Argument for Hydrogen

Environmental
Cost
Performance

History of failure

Storage of gas and equipment
Equipment

All equipment should be inspected, cleaned and dried prior to going into storage. If any defects are found repairs or replacements should be made immediately. Equipment should be stored in a warm dry place out of direct sunlight where it will not be damaged. Special care should be taken not to damage the regulator, hose or filling nozzle.

Gas

Indoor? Will be storing gas indoors? There are a number of OAHA and NFPA requirements. It may be easier to have gas both delivered and picked up on site and not plan on storage.

Outdoors

Cylinders need to be stored in a cool dry place. Because we are planning on launching in Eastern Oregon we can expect lots of sun exposure and high temperature. Cylinders should not be exposed to temperatures over 125 F. A shade tarp should be erected over the Bottle storage area. The tarp should be set up in a “lean-to” style as to not create a pocket where gas could accumulate. Bottles shall be place on canvas tarp to keep them off the ground. OSHA recommends a minimum of 50 feet from fast burning solids. Location of trees, brush and grass should be taken into consideration. Hoses and regulator should be disconnected and safety cap replace when not in use. Signage should be in place, Hydrogen, No Smoking, Flammable. Caution tape should be set up around storage area outside of all storage equipment. Fire extinguisher should be in place.

Equipment list

Ground Wire
Ground Wire Connectors
?X? Canvas tarp for balloon filling
8X8 canvas tarp for gas tanks
12X12 canvas shade tarp
4 poles for shade tarp
8 stakes for shade tarp
100 feet of cord for canvas shade tarp
Knife
Filling Nozzle
X feet of “CAUTION” tape
16 stakes minimum 12 inches long
Hammer
Gas identification sign
X Flammable Gas signs
X No Smoking signs

Equipment list: continued

X No Open Flame signs
X Fire extinguishers
Gas tanks
Gas regulator
Gas hose
Balloon
Payload
Duct tape
First Aid Kit
Cylinder hand truck with fat outdoor tires.
Cylinder Floor Stand if cylinder is to be stored or used in upright positions
Gas monitor
Explosion proof light sources if setting up to launch in the dark

Tests
Balloon explosion test:

Monitor pressure and temperature at several locations near the balloon. Record explosions to get a general feel for what could happen.

Balloon flammability test:

We will need to obtain samples of balloon materials and subject them to conditions similar to a catastrophic failure. We need to now what will happen to these materials in the event of an explosion. A shower of burning balloon parts could be bad.
Calculations

The safety perimeter will be set up to indicate the minimum safe distance from the balloon filling operation. The diameter of the perimeter could be partly based on the following calculations: Radiant heat a person would receive in the event of an accident. Pressure wave created in the event of an accident.

Physical Properties

- Ignition temperature = 560°C
- Ignition energy = 0.02mJ, at 20°C and normal pressure
- Ignition limits = 4-76 vol. % in air
- Flame temperature = 2300°C, at 20°C, normal pressure and in air
- Combustion speed = 2.65 m/s, max at 45 vol. % H2
- Detonation limits = 10-65 vol. %
- Detonation Speed = 1.5-2.2 km/s
- Energy of explosion = 2 kg TNT/m^3 H2

Liability

Bibliography


Internet Links:
http://www.gasballooning.net/Hydrogen%20Safety.htm