



## Wellhead Blowout

### *Objective:*

The specific challenge of this contest is to build a computer controlled Robot that can move through a model floor plan structure of an oilfield, find a lit candle and then extinguish it in the shortest time (subject to a few operating factors). This is meant to simulate the real-world operation of a Robot performing a fire protection function in an actual oil field. The candle represents a fire that has started in an oil wellhead, which the Robot must first find and then extinguish. The goal of the contest is to advance Robotics technology and knowledge while using Robotics as an educational tool to enhance learning.

### *Dimensions and Specifications:*

This is a contest that simulates real world activities and capabilities. As such, there are many areas of uncertainty that a Robot must be able to handle in order to succeed. The goal of the contest is not to make a Robot that can perform only in the laboratory, but carry out its function in the real world with all the variations and problems that exist there. Therefore, all the dimensions and specifications listed in these rules are given as a general aid to the participants. None of them are meant to be exact and they will vary somewhat at the actual contest. Any Robot that is meant to function in the real world needs to be able to handle these uncertainties. This contest, like the real world, is imprecise and your Robot needs to be able to handle that.

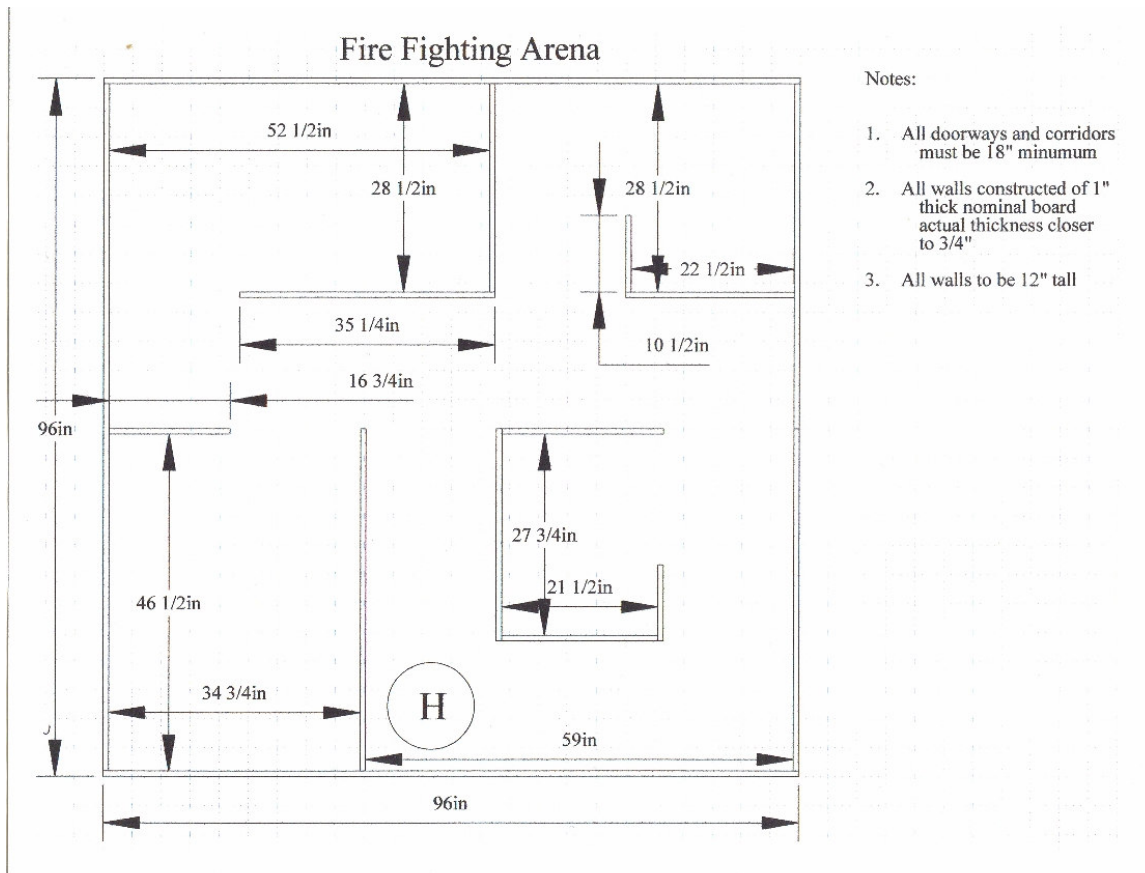
### *The Competition Platform: Oil Field Floor Plan*

The official floor plan of the contest arena for the ECRG Wellhead Blowout is shown below. The walls of the structure will be made of wood and will be 12 inches high. The walls will be painted with semi-gloss white paint.

The floor of the arena will be a smooth wood surface painted with flat black paint. The seams in the floor section may not be perfectly flat however. Make sure that your Robot can handle a discontinuity of up to 3/16 inch.

All hallways and doorways into rooms will be 18 inches wide. There will not be a door in the doorways, just an 18 inch opening. There will be a white  $\frac{3}{4}$  inch wide line made with white tape across each doorway to indicate the entrance to each room.

The Robot will start at the Home Circle location marked by the H in a circle on the arena floor plan. The actual Home Circle will be a solid white circle (without the H) on the floor. The 12 inch diameter white Home Circle will be in the center of the 18 inch hallway. The Robot must start within the Home Circle, but once started, it can go in any direction desired.



### Judges Decisions:

The judge's decisions will be the final word in all conflicts arising from interpretation of rules, running of robots and methods of scoring. We are making every attempt to provide rules that are clear and easy to follow.

## *Ambient Lighting:*

Contestants will be given time on the contest days to take ambient light level readings to calibrate their Robot. Once set, the lighting in the contest area will not be changed to suit individual competitors. Part of the challenge of the contest is to make a Robot that can operate in real world situations and that includes inconsistent lighting, shadows, glare, etc.

## *Robot Operation:*

Once turned on, the Robot must be autonomous self-controlled, without any human intervention. That is, they are to be computer controlled and not manually controlled devices.

Robot can bump into or touch the walls of the arena as it travels, but it should not mark or damage the walls in doing so. There will be no penalty for touching a wall other than the time lost in doing so. The Robot cannot leave anything behind as it travels through the arena. It cannot make any marks on the floor of the arena that aid in navigation as it travels. Any Robot that in the judges' opinion, deliberately damages the contest arena (including the walls) will be disqualified for that trial. This does not include any accidental marks or scratches made in moving around.

## *Putting Out the Candle:*

The Robot must, in the opinion of the judges, have found the candle before it attempts to put it out. For example, the Robot cannot just flood the arena structure with CO<sub>2</sub> thereby putting the candle out by accident. The Robot must not use any destructive or dangerous methods to put out the candle. It can use such items as water, air, CO<sub>2</sub>, Halon, etc., but any method or material that is dangerous or will damage the arena is prohibited. For example the robot cannot explode a firecracker putting out the candle by concussion. The robot cannot knock over the candle to put it out. If a robot accidentally knocks over a candle after it has put it out it is OK, the run still counts.

## *Competitor Design Parameters: Firefighter*

### **Robot Size**

Robot must be able to fit in a box 12 inches long by 12 inches wide by 12 inches high. If the Robot has feelers to sense an object or wall, the feelers will be counted as part of the Robot's total dimensions. The Robot cannot separate into multiple parts and must never extend itself beyond the 12 inches allowed. If contestants want to add a flag, hat or other purely decorative, non-functional items to the Robot that extends above the 12 inch height, they may do so as long as the item has absolutely no effect on the operation of the Robot.

## **Robot Weight**

There are no restrictions on the weight of the Robot.

## **Robot Construction Materials**

There are no restrictions on the types of materials used in the construction of the Robot.

## **The Candle**

The lit candle is supposed to represent a small oilfield fire that the Robot is attempting to find and put out. The candle flame will be between approximately 7 to 7 ½ inches from the floor. The candle used will be a standard approximately 7/8 inch thick white candle. The exact height and size of the flame is unknown and variable and will be determined by the specific conditions of candle and its surroundings. The Robot is required to find the candle no matter what the size of the flame is at that particular moment.

The candle will be placed at random in one of the rooms in the arena. The candle will not be placed in the same room more than once for any robot during the competition. On successive trials the rooms in which the candle were previously placed will be removed from the random choice possibilities. Thus every Robot will have the candle in 3 rooms out of 4 during its 3 trials

The candle will not be placed in a hallway, but it might be placed anywhere inside of a room. The exception is that a candle will not block the Robot from completely entering a room. This means that the front of the Robot will be able to move at least 12 inches into the room before it encounters the candle.

The contestants cannot measure or touch the candle before it is used. Violation will result in immediate disqualification of the team and the robot for that trial.

The candle will be mounted in a model wellhead that will allow the height of the candle to be set at approximately 7 inches at the beginning of each Robot's trial.

## **Sensors**

There are no restriction on the type of sensors that can be used as long as they do not violate any of the other rules or regulations.

Contestants are not allowed to place any markers, beacons or reflectors on the walls or floors to aid in the

## **Robot's Navigation**

Robot builders should be aware that many cameras transmit infrared light as part of their automatic focusing systems. All possible attempts will be made to prohibit the use of such cameras during Robot runs.

## **Start Button**

All robots will have an easily accessible, clearly marked start button to activate the robot.

## The Order of Running

The Robots will be assigned numbers to determine the order in which they will compete in the contest. Each Robot will make a trial run in the arena in the order in which it is assigned. The Robots will compete consecutively and when everyone is done with their first attempt the whole process will repeat for the second and third attempts.

Once the Robot running before you has completed its trial, then you will have 2 minutes to get your Robot in the arena and ready to start its trial. Any Robot that is not ready to run after 2 minutes will forfeit its chance at that trial and receive a score of 3600 for that trial. It may still compete in any other trials. Once assigned, the order of running will not be changed. If you are not ready, then you've missed your turn. The time between turns is undetermined and is controlled by how long the other competitors take to complete their trials. Be ready to run when it is your turn.

Once the Robot is ready, the location of the candle shall be determined and the candle will be put in the proper location. Contestants will not be allowed to touch the Robot once the candle has been placed.

The contestants will show a judge how to actuate the Robot. The judge will press whatever buttons necessary to start the Robot.

## Time Limits

In order to achieve the contest objective of building a Robot that can find and extinguish a fire in an oilfield, finding the fire within a reasonable period of time is very important. The maximum time limit for a Robot to find the candle will be 5 minutes. After 5 minutes the trial will be stopped. The maximum time for the Robot to return to the Home circle in the Return Trip mode will be 2 minutes. If in any trial, a Robot gets stuck in a loop and performs the same movement 5 times in a row, that trial will be stopped. Any time the Robot does not move at all for 30 seconds, the trial will be stopped. Stopping a trial run for any of the above reasons will have no impact on any of the other two trial runs made by the Robot.

## *Scoring Method:*

The Robot with the lowest Final Score (FS) is the winner. The Final Score is calculated from a number of different factors, which are explained below. The scoring process is really not as complicated as it might seem at first. It is intended to make the contest as realistic and as fair as possible.

## Standard Operation: (SO)

The Robot operates in the arena with no obstructions other than walls. The Robot finds the candle and extinguishes it.

SO = 1

The Robot operates in the arena with no obstructions other than walls. The Robot finds the candle but does not extinguish it

SO = 4

The Robot operates in the arena with no obstructions other than walls. The Robot does not find the candle within the allotted 5 minutes or the competitor deems his or her Robot is stalled and so signals the judges.

SO = 6

### **Actual Time: (AT)**

Score will include just the time (in seconds) the Robot takes to find and extinguish the candle. It will start when the judge signals the start and end when the candle flame is extinguished. It will not include the time for the Robot's return trip to the Home Circle. If the Robot fails to extinguish the candle or the trial stopped for any reason, the Actual Time will be considered to be 300. (5 minute Time Limit)

AT =(seconds elapsed)

### **Sound Activation: (SA)**

Instead of being manually activated by pressing buttons on the Robot, the Robot activates itself when it detects a sound signal between 3.0 kHz and 4.0 kHz. This is the frequency commonly used in smoke detectors and is created by piezo-electric devices available at Radio Shack and many other sources. Once turned on, the Robot cannot start to move until the sound signal is activated. If the Robot starts to move before the sound signal is activated, then the trial can still count, but the Robot will not get credit for operating in the Sound Mode. If the Robot does not start to move in response to the sound signal it will not be given a second chance (i.e. another press of the sound button) to run in the sound mode for that trial. The sound signal device can be held at any distance from the Robot that the contestants want and can continue for up to 5 seconds. The time for the trial will begin when the sound signal is created and not when the Robot actually starts to move in response to that signal. Contestants can bring and use their own sound devices operating within the proper frequency range. If Sound Activation is successful.

SA = 0.95 otherwise SA = 1

### **Return Trip: (RT)**

After extinguishing the candle, the Robot returns to the Home Circle. It does not have to retrace its path in returning to the Home Circle or even take the most efficient route, it just must get back once it has put out the candle. It must leave that room and return to the Home Circle without entering any other rooms.

The Robot will be considered to have returned to the Home Circle if the Robot stops with any part of the Robot inside the 12 inch white Home Circle. The Robot does not have to be in the same position that it was when it started the contest.

If a Robot finds and extinguishes the candle, but doesn't return to the Home Circle, the Robot will not be disqualified. Instead the Robot would just receive the Operating Score with no Return Trip mode factor reduction. If the Return Trip is successful.

RT = 0.8

otherwise RT = 1

### **Room Factor: (RF)**

In order to make the contest realistic and to encourage the creation of smart Robots, we have deliberately added uncertainty into the contest. The Robot does not know in which of the 4 rooms the candle has been placed. Sometimes a Robot gets lucky and the candle is in the first room it searches and sometimes a Robot is unlucky and the candle is in the 4th room searched. The unfairness of this is that finding the

candle in the 4th room you look in is a lot harder and takes longer than finding it in the 1st room you search. To reduce the impact of "luck" and give some credit to the more sophisticated Robots that can search multiple rooms successfully, there will be a Room Factor involved in the scoring that will be multiplied by the Time Score to get the Operating Score. The more rooms a Robot has to search before it finds the candle, the lower the Room Factor and thus the better the Operating Score.

If the candle is in the 1st room searched.	RF = 1.0
If the candle is in the 2nd room searched.	RF = 0.85
If the candle is in the 3rd room searched.	RF = 0.5
If the candle is in the 4th room searched.	RF = 0.35

It does not matter in which order the Robot searches the rooms. The only thing that matters is how many rooms the Robot has searched before it finds the candle.

Some Robots have extremely sensitive sensors and can tell if the candle is in the room by merely looking in the doorway as it passes by. The Robot does not have to enter a room to be considered to have searched it. Any Robot going past a doorway that it has not gone past before will be considered to have searched that room. If the Robot has already searched a room and then goes past the doorway again on its way to a different room, that room will not be counted twice.

## *Scoring Procedure:*

Trial score (TS) will be calculated by multiplying the Actual Time (AT) by Sound activation (SA) by Return Trip (RT) by Room Factor (RF) and then multiplying it by the Standard Operation (SO).

The Actual formula will be  $TS = (AT * SA * RT * RF) * SO$

Example

In a Robot's first trial it is sound activated, finds and extinguishes a candle in the second room searched in 37 seconds and then proceeds to return home successfully. Applying the above formula  $TS = (37 * 0.95 * 0.8 * 0.85) * 1$ , The Trial score would be 23.902

In its second trial the Robot is manually started, finds a candle in the third room searched but fails to extinguish it. It can not receive any score reduction for Sound Activation because it was manually started, it can not receive any score reduction for Return Trip because it must first extinguish the candle to qualify for a Return Trip and since it didn't extinguish the candle  $AT = 300$ . Applying the above formula  $TS = (300 * 1 * 1 * 0.5) * 4$ , The Trial score would be 600

In its third trial the Robot is sound activated, finds and extinguishes a candle in the first room searched in 42 seconds and then returns home successfully. Applying the above formula  $TS = (42 * 0.95 * 0.8 * 1) * 1$ , The Trial score would be 31.92

## **Final Score: (FS)**

The Final score will be the sum of the best (lowest) two out of three Trial scores. For the example above the Robot's final score would be 23.902 plus 31.92 or 55.822 discarding the highest Trial Score of 600