

# **WATERLOO** **ENGINEERING**

**Junior Team Design  
Competition Problem**

Spring 2012  
Waterloo Engineering Competition  
July 6 - 7

**SCHEDULE**

The schedule of the Junior Team Design competition is as follows:

Friday, July 6	5:30 p.m. – 5:45 p.m.	Check-In	RCH 302
	5:45 p.m. – 6:30 p.m.	Welcome/Briefing	RCH 302
	6:30 p.m. – 10:30p.m.	Design/Build	Various Assigned Classrooms
	10:30p.m. – 11:00p.m.	Submissions/Debriefing	RCH 302
Saturday, July 7	7:45 a.m. – 8:00 a.m.	Check-In	RCH 3 <sup>rd</sup> Floor Lobby
	8:00 a.m. – 12:00 p.m.	Prototype Presentations	Various Assigned Classrooms
	12:00 p.m. – 12:40 p.m.	Prizes and Closing Ceremony	RCH 302

Pizzas will be available to teams around 8:00p.m. – 9:00p.m., during the design and build stage. Please remind the competition coordinators and volunteers of your dietary restrictions and/or allergies.

**GENERAL RULES**

1. All questions regarding the competition problem must be asked during the welcome and briefing session, after the competition problem has been presented. No questions will be answered during the design and build stage.
2. All communication devices must be turned off throughout the duration of the competition.
3. Visitors are not allowed throughout the design and build stage. Violation of this rule will result in immediate disqualification.
4. Dress code for presentation and demonstration is business casual to business formal.
5. Competitors may not use the blackboard when delivering presentations.
6. All submitted materials must be labelled according to the following guidelines:
  - a. Prototypes must have the team number clearly labelled.
  - b. The team number and names of all team members must be written on the back of the poster.
7. Keep work spaces clean. Tidy up at the end.

**THEME**

The theme of the Junior Team Design competition is “Coastal Fire Fighting”

**SCENARIO**

The recent Deepwater Horizon oilrig fire has many large corporations concerned about fire safety on offshore oil drilling operations. Fires require oxygen; hence the best way to put out a fire is to deprive it of oxygen. Ordinarily water would be used to do so. However, as oil floats on water, oil fires cannot be put off by water alone.

Conventionally putting out offshore oil fires involves dousing the flames with high pressure water sprays and Purple-K powder (which is principally potassium bicarbonate). However this method creates a thick and crusty scum which is challenging to clean up and could cause environmental damage. In addition, Purple-K powder is very corrosive and when ingested by organisms in large amounts could cause alkalosis (increasing blood pH excessively).

Dr. Horatio D. Bigbrain III, an expert on offshore oilrig safety has suggested a radical alternative in the form of carbon dioxide. Carbon dioxide, when frozen, forms a solid that is slightly denser than water, known as dry ice. Dry ice exists at temperatures below  $-80^{\circ}\text{C}$  (approximately  $112^{\circ}\text{F}$ ). Dr. Bigbrain has theorized that upon dousing the flames with dry ice, the solid sublimates into carbon dioxide gas, which deprives the fire of oxygen thereby dousing the flames efficiently with few adverse effects upon the environment.

The US government has agreed to test dry ice as effective oilrig fire-fighting materials, and is calling engineers from all over to design prototypes to put out offshore oilrig fires. They have designed a test simulating a fire on an oilrig.

**OBJECTIVE, REQUIREMENTS & CONSTRAINTS**

- The major disadvantages with dry ice is that they are very heavy to transport. Dry ice blocks have to be transported in specialized containers in order to ensure that enough remains to put out the fire. Therefore your prototype has to float with the minimum required payload loaded.
- You will be using ice cubes (in place of dry ice) as fire-fighting material.
- As the goal of fire-fighting is to put out fires as quickly as possible, your prototype must travel as quickly as possible from the start point to the fire.
- You are allowed three touches for the operation of your prototype.
- Your prototype must ensure that the firefighting payload is secured up until you launch the fire-fighting material upon the fire. Points will be deducted for fire-fighting material that falls out of your prototype before you launch your payload.
- Your prototype must maintain a safe distance (designated by a line around the test setup) in order to ensure that your fire-fighting vehicle is not consumed in the inferno.

- Your prototype must put out as many candles as possible with your payload. Points are awarded for how many candles you put out and how accurate your prototype is in putting out the fire.
- Your prototype must be within the set budget.
- Your prototype must be realistic, with real scenarios in mind. Consider factors like payload capacity, distance from the start to finish point, fire-fighting personnel safety, etc. For example putting out an oilrig fire by flinging the material onto it from the shore is unrealistic (for instance how accurate is a catapult going to be over several hundred or thousand kilometres?). Points will be awarded for consideration for real-life situations.

**DELIVERABLES**

At the end of the development and build stage, each team is required to submit the following items:

1. A working prototype of the machine
2. A poster presentation as a visual aid

**PROCEDURAL RULES**

The following rules must be followed during the design and build stages of the competition. Any teams in violation of these rules may be disqualified at the discretion of the WEC staff.

1. Teams have four (4) hours to complete the design and construction of their prototypes.
2. Teams are not allowed to leave the competition premises unless they have submitted their prototypes and presentations to the competition staff.
3. Laptops are not permitted.
4. Teams may only use materials that they purchase from the shop.
5. Provided tools may only be used to construct the prototype and may not be used as part of the prototype. The tools must be returned at the end of the design and build phase of the competition.
6. Final prototype and presentation materials must be submitted to the submission desk prior to the end of the design and build stage. It is the team's responsibility to bring its deliverables from the design area to the submission desk.
7. Teams will receive a notification when there is one (1) hour remaining in the design and build phase.
8. Purchase Requisition Forms at the shop are to be completed by WEC staff only.

**PROTOTYPE TESTING RULES**

In the first 20 minutes of the design and build stage, the scenario setup is open to all teams to look at and take measurements. Afterwards, the scenario setup will be available for teams to perform prototype testing. Each testing period is 10 minutes, and is signed-up for on a first-come-first-serve basis. There will be two setups available.

**Reservations**

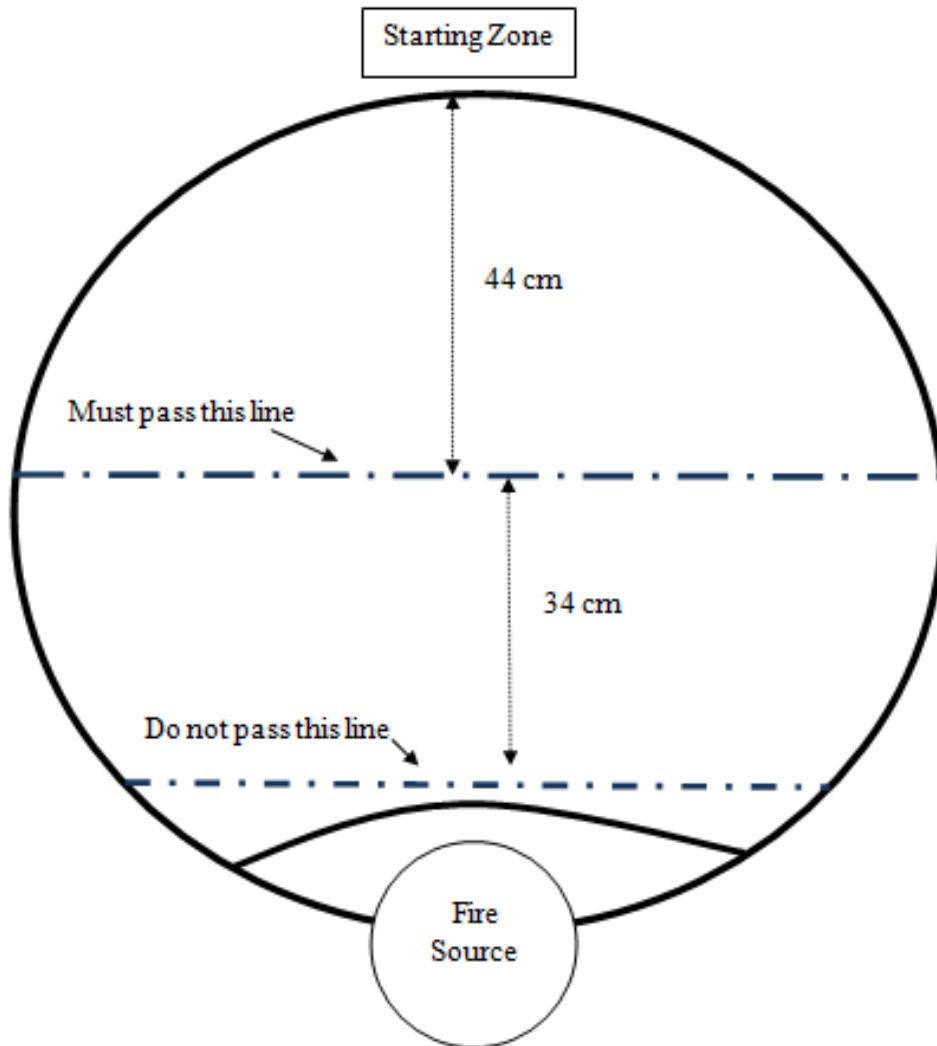
Each team may only have one reservation at any time, and must use up the testing period before reserving the next one. Teams may only reserve whichever time slot is available next (i.e. teams may not specify a time).

**Cancellations**

Teams are allowed to make cancellations to reservations. A cancelled time slot then becomes the next available testing period, and can be reserved by whichever team makes the reservation next. Time slots after the cancellation will not be bumped up.

**TEST SCENARIO MEASUREMENTS**

Bird's eye view of pool; Pool diameter: 98cm



Note: The drawing is not to scale.



**SHOP RULES**

1. A maximum of one (1) person per team may be in the shop at any time.
2. Building materials will be available for preview at the shop. Competitors may examine the materials, but are not allowed to leave the display table with unpaid materials.
3. Teams are allowed to take pictures of building materials with a camera, but not a cell phone.
4. Teams must purchase the quantity of items that they request. If a requested quantity is not available, the team may request a new quantity.
5. Teams must keep track of their purchases for their own records. The shop will keep track of the official purchase records. In the event that a team has lost track of their purchases, the team will not be told how much they have spent.
6. All sales are final. Be sure to verify purchased items and quantities before leaving the shop.
7. Teams may not trade building materials. Violation of this rule will result in immediate disqualification for both teams.
8. Please be courteous and professional to shop personnel. The shop reserves the right to refuse service to an individual who behaves unprofessionally.
9. The shop will close 30 minutes before the development and build stage ends.

**MARKING SCHEME**

The following marking scheme is specific to the Spring 2012 Junior Team Design competition and will be used by judges during presentation and demonstration.

<b>Design &amp; Performance</b>	<b>50%</b>
The prototype type passes the 1/2 line on the water	8%
The prototype reaches the platform	20%
Prototype successfully stops on the top platform	10%
Number of candles extinguished (2% per candle)	12%
The prototype is not able to carry the payload	-6%
Prototype does not move	- 40%
Prototype damages test setup	- 50%*
<b>Presentation</b>	<b>35%</b>
Poster	10%
Quality & Flow	7%
Real-life Feasibility	10%
Meet Constraints & Criteria	5%
Prototype Critique	3%
Cost is below 25% of budget	+ 2%*
Cost is under budget	+ 1%*
Cost is over 25% of budget	- 2%*
<b>Originality</b>	<b>10%</b>
Daring/Outside the Box	4%
Creativity	3%
Uniqueness	3%
<b>Teamwork</b>	<b>5%</b>
Knowledge	3%

Workload distribution	2%
Positivity	+ 1%*
Does not follow dress code	- 2%*
<b>TOTAL</b>	<b>100%</b>

In case of a tie in total marks, the teams will be ranked based on their points scored in Design & Performance.

Completed marking sheets will not be disclosed to competitors; however, if teams wish to know their strengths and weaknesses for improvement in future competitions, judges will be available after the competition for questions.

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\* The  $\pm$  signs denote bonus or penalty points, respectively. Lowest possible score for each marking category is zero (0) points.

† The WEC marking scheme explicitly states that a contraption not being able to move constitutes as a design fail. Be sure to keep this in mind when competing at the OEC, as the same rule applies but is not stated in the marking scheme.

**MATERIAL LIST**

	Unit Price (\$)
Foam Sheets **	150
Foam Board (per cm2)	175
Cardboard (per cm2)	2
Wood (20 x 10 cm section) **	600
Paper Plates	50
Pot Pie Pans	100
Dump Truck Scoop	100
Mouse Traps	300
Tensile Springs (assorted sizes) **	120
Elastics (assorted sizes)	50
Skewers	80
Dowels (2 sizes)	Small – 100 Big – 120
Popsicle Sticks (2 sizes)	Small – 20 Big – 40
Toothpicks	10
Plastic Spoon	20
Plastic Fork	20
Plastic Knife	20
Straws	30
Balloons	60
Paper Clips (2 sizes)	Small – 10 Big – 20
Thumb Tacks	50
Binder clips	Small – 80 Big – 100
Nails (assorted sizes)	50
Eye hooks (assorted sizes)	60
Clothes Pins	60
Wheels (2 wheels => free axel)	150
Styrofoam Cups	70
Styrofoam Balls (2 sizes)	Small – 80 Big – 100
Zip Ties	70
Steel Wire (per cm)	5
Twine (per cm)	4
String (per cm)	2
Pipe cleaners	100
Felt (per cm2) **	75
Playdoh (per cc)	3
Sponges	30
Duct Tape (per cm)	3
Masking Tape (per cm)	3
Double Sided Tape (per cm) **	60

Hot Glue Sticks	200
Super glue**	300
Electric tape	3
Ziplock bags	100
Tin foil (per cm)	20
Saran Wrap (per cm)	20

**PURCHASE REQUISITION FORM**

Team Number: \_\_\_\_\_

Team Member #1: \_\_\_\_\_

Team Member #2: \_\_\_\_\_

Team Member #3: \_\_\_\_\_

Team Member #4: \_\_\_\_\_

Item	Unit Price	Quantity	Total Price	Volunteer Initial

**PURCHASE REQUISITION FORM (continued)**

Team Number: \_\_\_\_\_

Team Member #1: \_\_\_\_\_

Team Member #2: \_\_\_\_\_

Team Member #3: \_\_\_\_\_

Team Member #4: \_\_\_\_\_

Item	Unit Price	Quantity	Total Price	Volunteer Initial