# Automated Response Time Measurement for Gas Detection Equipment

**ELECOMP Capstone Design Project 2019-2020**

***FM Approvals is continuing support of the Program for the 2nd consecutive year:***
***https://web.uri.edu/elecomp-capstone/project-details-by-team-2018-2019/fm-approvals/***

## Sponsoring Company:

### FM Approvals
1151 Boston-Providence Turnpike
Norwood, MA 02062
http://www.fmapprovals.com

## Company Overview:

FM Approvals is an international leader in third-party testing and certification services. The company tests property loss prevention products and services—for use in commercial and industrial facilities—to verify they meet rigorous loss prevention standards of quality, technical integrity and performance.

## Technical Director:

**Patrick Byrne**
Assistant Vice President, Technical Team Manager
patrick.byrne@fmapprovals.com
https://www.linkedin.com/in/patrick-byrne-6a5aba12/

## Project Motivation:

Gas detectors are commonly used for the protection of personnel and property by detecting the presence of either combustible or toxic gases. FM Approvals tests and certifies gas detectors to several national and international standards; all requiring the measurement of the response time of the gas detectors when presented with a specific gas. This is done by exposing the sensing element initially in clean air to a step change of a known quantity of a specific test gas. The output of the gas detector must reach 50% of the final reading within 10 seconds and 90% of the final reading within 30 seconds.

This process, as performed on the current test apparatus, is time consuming (requiring two people) and can be challenging when it comes to reproducibility. The motivation of the project is to automate this test apparatus to save time and improve the repeatability of the results.

## Anticipated Best Outcome:

A test apparatus with the following features:

1. Automated system for filling the apparatus with test gas
2. Automated system for exposing the gas detector to the test gas
3. Integrated data acquisition system to record the response time of the gas detector

## Project Details:

Gas detectors are commonly used for the protection of personnel and property by detecting the presence of either combustible or toxic gases. FM Approvals tests and certifies gas detectors to several national and international standards including FM 6320, FM 6340, ANSI/FM/UL 60079-29-1, CAN/CSA 60079-29-1 and ANSI/ISA 92.00.01. All gas detection standards require measurement of the response time of the gas detectors when presented with a specific gas. This is done by exposing the sensing element initially in clean air to a step change of a known quantity of a specific test gas. The output of the gas detector must reach 50% of that known quantity within 10 seconds and 90% of that known quantity within 30 seconds.

The existing test apparatus for performing the response time measurement as defined by the current standards is a shown in Figure 1 where the lower chamber (A) is full of water to just below the surface of the chamber. To perform the test, the gas detector (B) is installed just above the large valve (C). With the large valve (C) in the closed position closed, the test gas is pumped into the lower chamber at the gas inlet valve (D) in its open position. This forces water from the lower chamber (A) into the upper chamber (E). When the water level reaches a predetermined height (F) the gas inlet valve (D) is closed. The large valve (C) is then opened exposing the gas detector to the test gas and the gas detector output (typically 4 – 20mA) is recorded over time.

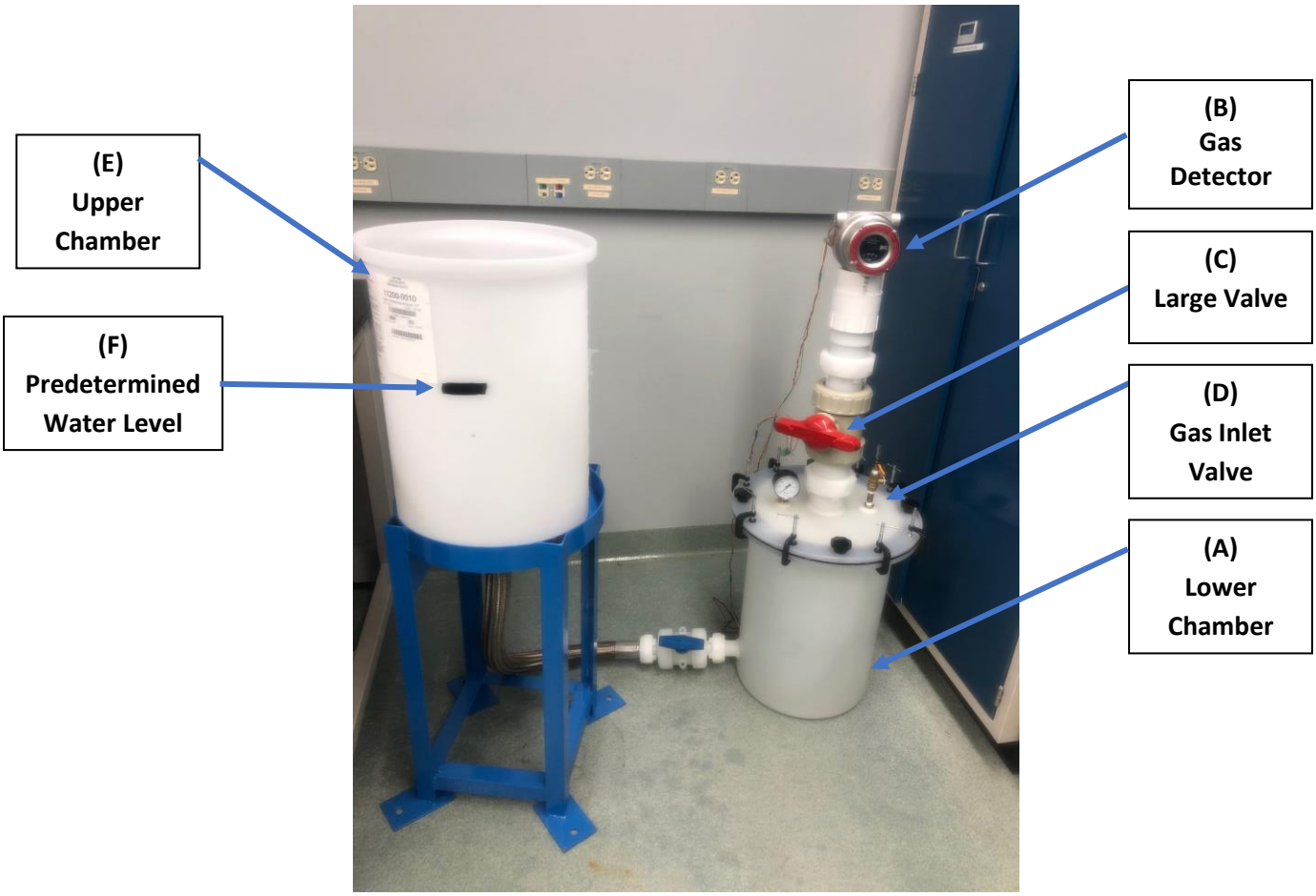


Figure 1

Gas Detector Response Time Test Apparatus

This process is time consuming (requiring two people) and can be challenging when it comes to the reproducibility of results. The motivation of the project is to automate this test apparatus to save time and improve the repeatability of the results.

***Overall System Concept***

1. Simplify and automate the testing process without compromising the technical integrity of the test.
2. Students will make recommendations as to the form, fit and function of the existing hardware.
3. Students will design and construct the necessary hardware for the test apparatus.
4. Students will design and construct a control system to monitor water level, control the valve(s), manage any other I/O required to operate the fixture and record the output of the gas detector (e.g. 4-20mA, RS-485 and other control system protocols).
5. Students will develop a software program to operate the control system, display and record the data and generate pass/fail indication.
6. Students will conduct comparative testing with the existing apparatus and the new apparatus to ensure consistent results.
7. Students will conduct a measurement uncertainty exercise with the new equipment to evaluate its repeatability.

**Hardware/Electrical Tasks**

1. Identify/select the necessary hardware for the project.
2. Construct the test apparatus.
3. Evaluate the performance of the test apparatus.
4. Develop/select the interface to the controller/PC managing the inputs/outputs

**Firmware/Software/Computer Tasks**

Develop a program to operate the operate/automate the Gas Detector Response Time Test Apparatus as defined in the ***Overall System Concept*** section above.

## Composition of Team:

2 Electrical Engineers and 1 Computer Engineer. (Preference will be given to one electrical engineer, who is also be able to undertake the mechanical engineering tasks. Consultants will be available to help, as needed; *write to Dr. Sunak immediately!)*

## Skills Required:

**Electrical Engineering Skills Required:**

- Motion control basics
- Sizing motor / driver and mechanical interface
- Circuit design

**Computer Engineering Skills Required:**

- PC Based applications
- Labview (possibly)

**Mechanical Engineering Skills Required:**

- Mechanical design
- Hardware selection
- Fabrication

## Anticipated Best Outcome's Impact on Company's Business, and Economic Impact:

The best outcome will reduce test time and improve the repeatability of the results. A reduction in test time will result in more competitive proposals to our customers and will shorten the total project duration.

The estimated savings are $15,000 – $20,000 per year.

The new automated test apparatus may also be incorporated in the various gas detection test standards in future editions.

## Broader Implications of the Best Outcome on the Company's Industry:

The new automated test apparatus may be incorporated in the various gas detection test standards in future editions allowing others to benefit from the automated features.