UNIVERSITY OF LOUISVILLE
J.B. SPEED SCHOOL OF ENGINEERING

CO-OP REPORT EVALUATION

NAME: Griggs (*Last Name*) Rachel (*First Name*) Submittal Date: July 11th, 2017

ACADEMIC DEPT.: Chemical Engineering Co-op Number: 1___ 2___ 3 X

EMPLOYER: Sandia National Laboratories Co-op Semester: Summer 2017

CO-OP COORDINATOR

Accepted __ Not Accepted __ Co-op Coordinator _____ Date _____

Remarks: _____

FACULTY EVALUATION

Writing: Critical Thinking:	**Clearly Evident**	**Evident**	**Occasionally Evident**	**Not Evident**
Clarity – *is information clear?*	4	3	2	1
Accuracy – *is the data accurate and precise?*	4	3	2	1
Information – *is it relevant and complete?*	4	3	2	1
Concise – *is it presented in appropriate depth?*	4	3	2	1

WRITING SKILLS: Excellent_____ Good _____ Satisfactory _____ Poor_____

ABET LEARNING OUTCOMES:
Rating Scale: 4 - Exceeds Expectations 3 - Meets Expectations 2 - Needs Improvement 1 - Unacceptable N - No basis for review

a)	The student applied math/science/engineering knowledge.	**4**	**3**	**2**	**1**	**N**
b)	The student conducted experiments and analyzed data.	**4**	**3**	**2**	**1**	**N**
c)	The student participated in designing a system, component, or process to meet desired needs within constraints.	**4**	**3**	**2**	**1**	**N**
d)	The student demonstrated the ability to work on teams.	**4**	**3**	**2**	**1**	**N**
e)	The student had experience solving engineering problems.	**4**	**3**	**2**	**1**	**N**
f)	The student increased his/her understanding of professional and ethical responsibility as an engineer.	**4**	**3**	**2**	**1**	**N**
g)	The student demonstrated the ability to effectively communicate.	**4**	**3**	**2**	**1**	**N**
h)	The student increased his/her understanding of the impact of engineering solutions on society. *(E.G. Recognize the harmful consequences of engineering errors and benefits of rapid economical solution to problems in business, the community and the environment.)*	**4**	**3**	**2**	**1**	**N**
i)	The student became aware of the need for lifelong learning in his/her/field.	**4**	**3**	**2**	**1**	**N**
j)	The student encountered contemporary issues in his/her field.	**4**	**3**	**2**	**1**	**N**
k)	The student experiences the use of techniques, skills, and modern engineering tools commonly used in engineering practice.	**4**	**3**	**2**	**1**	**N**

This Report is **accepted** _____ This Report is **not accepted** _____

Remarks: _____

Dept. Faculty: _____ Date: _____
Print Last Name Signature

UNIVERSITY OF LOUISVILLE
J.B. SPEED SCHOOL OF ENGINEERING

COOPERATIVE EDUCATION REPORT
CHEMICAL ENGINEERING
SUMMER 2017 / CO-OP #3 / SANDIA NATIONAL LABORATORIES

PERMISSION TO SHARE CO-OP REPORT (Sections I, II and III)	
Co-op Report (Sections I, II & III) Sharing and Electronic Storage Notes	
By granting permission to share the Co-op Report (Sections I, II & III) the student and employer respectively grant the University of Louisville the ability and license to use the Co-op Report (Sections I, II & III) to support the Speed School of Engineering Co-op program, engineering curriculum development and applicable engineering accreditation reviews/evaluations. For example, the sharing of the Co-op report is intended to help: • prepare future Co-op students about Co-op opportunities with the employer, • aid Speed faculty in continuously improving Speed's academic programs, and • support specific requests for accreditation of Speed Engineering Departments (e.g. ABET accreditation). Such permission by the Employer further indicates that these Co-op Report sections do not contain any employer Confidential Information. Such permission by the Student further indicates that the Student, to the extent the Co-op Report constitutes a Student record as defined by the Family Educational Rights and Privacy Act (FERPA), authorizes the release of the Co-op Report sections for the purposes outlined. Both Employer and Student by their permission, acknowledge that the Co-op Reports (Section I, II & III) will be stored on the University of Louisville and Speed School of Engineering Career Development system "Symplicity". To the extent that Symplicity controls access, access to the Co-op reports within Symplicity will be limited to: current Speed School students and current Speed School faculty and staff that have a specific and defined role with the Speed School Co-op reports.	
Co-op Student	
I grant permission (as outlined above) for the sharing of sections I, II and III of the Co-op Report.	_____Yes _____ No
Co-op Student's Signature	Date
Co-op Employer	
I grant permission (as outlined above) for the sharing of sections I, II and III of the Co-op Report.	___X__Yes _____ No
Christopher Shaddix	July 10, 2017
Co-op Employer's Signature	Date

I. EMPLOYER DESCRIPTION

Sandia National Laboratories is a United States Department of Energy (DOE) funded set of research laboratories located in Albuquerque, NM and Livermore, CA. Sandia maintains about 10,000 employees, most of which work in the Albuquerque location, but many of which work in the secondary Livermore location and at various other locations in the United States and abroad as needed. Sandia is owned and operated by National Technology and Engineering Solutions of Sandia, LLC., which is a subsidiary of Honeywell International Inc. Sandia is operated as a contractor for the DOE's National Nuclear Security Administration (NNSA) and is a designed Federally Funded Research and Development Center (FFRDC). Sandia mainly does research and development in four strategic areas: nuclear weapons, defense systems, energy/climate, and global security. Sandia can perform work for other federal agencies and for industry, but must meet certain requirements as set by DOE for FFRDCs to do so. For the most part, Sandia works on projects directly related to the four strategic areas mentioned above for the DOE/NNSA. Sandia has no real competitors from a business standpoint and is explicitly forbidden from competing with industry. In fact, the Sandia - Livermore location frequently collaborates with both the Lawrence Livermore National Laboratory (LBNL) and the Lawrence-Berkeley National Laboratory (LBNL), both of which are located in the San Francisco Bay area, on various projects.

I was employed at the Livermore location in the Combustion Research Facility working with a staff scientist. The DOE operates a Science Undergraduate Laboratory Internship (SULI) program, which

matches students' abilities and interests with various national laboratories in the United States, and hires applicants based on availability of positions in their areas of interest.

II. MAJOR RESPONSIBILITIES AND DUTIES

My main task as a SULI intern in the Combustion Chemistry Department was to organize flame testing data from various fuel sources into a cohesive database so that anyone could add new data, easily look up intermediate species data, and compare the compositions of different flames to determine how different fuels and flame conditions could affect formation of certain unwanted compounds. Biofuels are beginning to replace conventional petroleum fuels, and more alternative fuel possibilities are being studied than ever before. Combustion chemistry is basically comprised of sets of chemical reactions with hundreds of possible intermediates, and there are around sixty of those currently in the database. Consequently, constructing the database required a good working knowledge of combustion chemistry. Knowing that there are many isomerizations of certain species, such as C_5H_8, and being able to recognize reaction paths that create aromatic compounds like benzene aided in data manipulation and analysis. It was required that I determine what data was consistent with these reaction pathways, and decide to ignore certain data points if necessary to identify species correlations.

Many of the flame tests integrated into the database were done in different years, different locations, and by different people. Since combustion results in many isomerizations, I was required to determine whether similarly written species were the same compound and could be combined or isomers of each other and needed to be separated in the data sets. It was also required that I read and understand some of the research papers to retrieve certain information for the database. Once the database is completed, it can be used to determine which fuels produce flames with desirable characteristics, how characteristics of different fuels are related, and what fuels may need to be researched further. This

also enhances my learning experience, since, once the database was closer to completion, I could choose to compare some of these fuels and intermediate species myself and see the correlations between different flame conditions and fuels. Since I would like to one day work full time in a biotechnology sector and am interested in renewable energy, this is great initial experience.

I also completed various trainings unique to government employees. Many of the areas and sources of information on the Sandia – Livermore campus required DOE security clearances, and access to workspaces and computer systems required randomly generated passwords. Because of the sensitivity of Sandia's research, it is imperative that appropriate measures be taken to secure this information from phishing attempts, both foreign and domestic. I was trained on ways to determine whether an email, Facebook friend request, etc. was legitimate or an attempt to get sensitive information from me. On my third week at Sandia, I was sent an email from outside the Sandia network informing me that I had not completed all of my required intern training (I actually had) and to go to an external website to complete this training immediately. It was fairly convincing: they knew I was an intern, and they (probably) knew that I was required to complete a lot of online training. Fortunately, Sandia has a full time Counter-Intelligence (CI) office to look into and combat such attempts, however, it was important that I identify the phishing attempt so that the CI office could be notified. This experience and training provides preparation for future employment when I may have knowledge of trade secrets, designs, etc. that needs to be protected. Even if I don't end up working for the federal government, having firsthand knowledge of the ways in which people may try to extract sensitive information from you for their own personal gain is helpful for a future engineering career.

As part of the SULI program, interns must create a poster that details the project(s) that they are working on and present them on Sandia's campus so that other employees can come by and ask questions. Though I have done this in classes before, presenting a poster on work that I have done related to research in front of people, some of which may have conducted this research themselves, whose knowledge of the subject extends well beyond my own is daunting. However, this prepares me for future work presentations and proposals and is a good learning experience. It also increased my knowledge of chemistry/chemical engineering, because creating the poster required that I knew the ins and outs of what I was presenting well enough to convey the flame testing and correlation information that I mentioned previously to others.

III. EMPLOYER BENEFITS

The database I worked on created a centralized area where researchers could investigate similarities and differences between fuels and intermediate concentrations. Before this, there wasn't a place where data could be shared and easily accessible by those studying combustion chemistry. This enables researchers to see correlations that they may not have previously known existed. My mentor told me once that one of his post-doctoral researchers had discovered that two different compounds had a linear correlation, which was not known before he started looking at all of the disjointed flame testing data. This prompted the proposed need for the database that I worked on during my internship; if there was one correlation, then certainly there must be others. The database will set Sandia apart as a leader in the community for bringing it into existence, and will quite possibly save Sandia money in the long run by letting researchers determine which compounds they need to study further based on observed correlations or even inconsistent data that probably needs repeat testing. The database also allows for the use of machine learning techniques that can determine the statistical likelihood that observed correlations will hold and can possibly discover correlations that cannot be readily observed. It will certainly decrease the time needed for researchers to view data and information that they need. Rather than trying to find what they need in a mountain of separate files, they can look up and manipulate all of the information in one file, which greatly reduces the amount of time spent simply hunting for things.

Interns in general save Sandia money, since many may choose to work at Sandia permanently. Combustion research is generally done in labs rather than in universities because of the ongoing nature

of the project, so introducing students to the subject as interns is beneficial and this experience can be considered when looking for new hires. In addition, training someone who has never worked in a government facility before takes a bit more time, and gaining a security clearance may be easier if the person has a record of working with a government agency for a decent length of time and has already done the preliminary background, drug, and reference screenings. Even if I don't work at Sandia permanently in the future, I still created something that will be useful to future researchers, and probably at a lower cost than if someone above my paygrade had to take the time out of his/her schedule to create an extensive database instead of working on projects that needed attention.

IV. STUDENT BENEFITS

a) Discuss how you applied math/science/engineering knowledge.

When I was organizing raw data into the database, I had to determine which compounds were the same and which were isomers of each other to know whether to consolidate them as the same compound or keep them separate. (For example, Acetone was listed as “Acetone” “CH3COCH3” and “C3H6O” in separate documents). Larger compounds are especially likely to have a multitude of isomers that must be considered separately.

b) Discuss experiments you conducted and how the data was analyzed.

To create dynamic graphs, I wrote the Excel script in different ways and tested them by adding in new “dummy” data sets to determine which was the most efficient way to create the database with the least amount of manual manipulation of the formulas. I then used the graphs to analyze the data sets and determine whether there were correlations between different compounds.

c) Discuss your participation in designing a system, component, or process to meet desired needs within constraints.

One of the comparison charts I created needed to show maximum concentration data from all data sets for certain compounds that were products of combustion. This chart needed to extract data from the entire raw data list and also allow for one to turn certain points on or off on the graph to eliminate bad data points for more accurate trend line analysis. This took a bit of creativity to get the chart to be able to reference anything asked of it in the raw data and also turn single points on and off by user command.

d) Discuss examples of working on teams.

My mentor and I worked together to determine what was needed and wanted out of the database creation. We came up with new ideas of what to include and how to organize the information to make it the most user-friendly while still showing as much information as was needed. We also are in the process of working with and presenting the progress made on the database to a European counterpart, who can give insights into how to improve the database, glean more information from it, etc.

e) Discuss your experience solving engineering problems.

Many of the formula scripts I tried ended up failing or not working as intended. I hadn’t made a database that was as comprehensive as the flame test database before, so scripts were long and could get confusing quickly. I read up on structured references and VBA coding to automate basic tasks and make the database work better than it did initially which much shorter formulas that were much less confusing and labeled well.

f) Discuss how you increased your understanding of professional and ethical responsibility as an engineer.

When I got a phishing email trying to gain access to Sandia information, I was required to report it to the CI office according to the training I had received on how to spot and how to handle such correspondence. I also worked with some data sets that were very inconsistent with the majority of the data sets compiled, and there is always a possibility that data was manipulated to more closely match a model that ended up being incorrect. This kind of manipulation thwarts efforts to consolidate and compare data sets to find correlations, so this also increased my sense of ethical responsibility as an engineer.

g) Give examples where you had to effectively communicate.

If I didn't understand something that was asked of me, it was usually a problem of not understanding something about the experiment that was conducted. Since I didn't personally conduct the experiments from which I was getting the data, some things that were not explicitly stated were unknown to me. For example, some documents contained "volume percentages" of species within the flame while some documents just said "percentage". I did not know whether volume percentage was the basic metric or not, so I had to make sure I asked that question before I, possibly wrongly, consolidated that data into one category.

h) Discuss how your co-op experience increased your understanding of the impact of engineering solutions on society.

(E.g. Recognize the harmful consequences of engineering errors, and benefits of rapid economical solution to problems in business, the community and the environment.)

The flame testing research that Sandia conducts directly impacts society, since this information is used to determine what fuels may be used in renewable energy efforts that would reduce greenhouse gas emissions the most. The database I created will allow better comparison of these fuels to realize that goal.

i) Discuss how you became aware of the need for lifelong learning in your field.

Sandia hosts many speakers from different labs, universities, and countries around the world. They usually give talks on their specific area of expertise or research. Many employees go to these talks to learn about what others are studying and what their findings were. I learned that listening of others' findings and information can enrich your mind as well as your career.

j) Give examples of encountering contemporary issues in your field.

With the internet being so prevalent, it is now more important than ever to safeguard sensitive information and educate employees on what to look for in phishing attempts so that they don't give out confidential information to third parties. I received one of these phishing email while on co-op, and it reinforced this idea.

k) Discuss your experience in using techniques, skills, and modern engineering tools commonly used in engineering practice.

I enhanced my knowledge of data analysis procedures extensively by writing scripts that were more in-depth than any I had ever had to formulate before. I also brushed up on my limited knowledge of VBA, and learned some basic commands to make the database update automatically, so that anyone could add data to it easily and not scratch their heads wondering how to fix non-dynamic scripts.