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## General Information

1. As a condition of working at UCI, APEP, it is each person's (student, researcher, staff) responsibility to follow all rules and regulations.
2. All employees are required to know and understand the contents in this manual. Copies of this manual are available from the main office or online.
3. If there are any further questions or concerns, please ask Professor Samuelson or Jeff Wojciechowski

# Working in the Lab

## **A. Safety First**

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# Safety First

## A-1 General Safety Rules

- a. Safety is the highest concern of the University and the APEP. It is each person's responsibility to work in a safe manner and to use safe practices at all times. Additionally, each person is expected to recommend safety procedures and policies where those do not exist or where the current procedures and policies are out of date or incomplete.
- b. Upon coming to the laboratory, you will be required to participate in a safety orientation and sign a form that acknowledges your participation in this training. You may additionally be required to complete campus-sponsored training activities and participate in safety review committees.
- c. If you are working in a laboratory, always make sure that someone knows where you are and knows enough about the laboratory and testing to help you in the case of an emergency. It is important that this person know how to shut down the test. We call this "shepherding." Having a "shepherd" is necessary all the time but is **ABSOLUTELY REQUIRED** to have an active shepherd (one who checks on you periodically) when you are testing during non-business hours. If you have a test running early or late, you **MUST** arrange for another staff person to check in on you. That person **MUST** have key access to the lab you are working in and know how to shut down the test if there is a problem.
- d. If you have any questions about safety or security, please ask. Check with Max Venaas, Dr. McDonell, Dr. Brouwer, or Professor Samuelsen.
- e. If you are not comfortable with operating a piece of equipment, laser or a supply (chemical, for example) check with Max Venaas, Dr. McDonell, Dr. Brouwer or Professor Samuelsen
- f. If you are building a system, have the new work reviewed during construction and at regular intervals by APEP personnel assigned by Max Venaas for possible safety hazards.
- g. An excellent resource for campus safety is UCI's Environmental Health and Safety Group ([www.ehs.uci.edu](http://www.ehs.uci.edu)). Please check out their website.
- h. **THINK SAFETY!**
- i. **Ultimately, your safety is your responsibility.**

## A-2 Emergency Service

- a. In case of emergencies, dial 9-911 from a lab phone. From a cell phone program the UCI Campus Police number of 949-824-5223. Dialing 911 from your cell phone can delay response as all cell 911 calls do not automatically dial a local emergency response unit.

- b. Refer to Appendix B for a list of emergency numbers and contacts.

### **A-3 Reporting Injuries**

- a. If an injury arises out of **employment** and during the course of employment at APEP, you must understand that you are considered an **employee** of the University (not a student).
  - i. Immediately report the injury to the most immediately available APEP staff.
  - ii. APEP staff will conduct immediate triage of the injury and determine the course of action:
    - i. On site first aid treatment (i.e. first aid within the lab)
    - ii. Visit to off site clinic
    - iii. Immediate emergency response and transport to hospital emergency room or equivalent (CALL (9-911))
  - iii. To the best of your ability, follow the procedures outlined on EH&S's website (and choose a medical provider from that website:  
[https://portal.uci.edu/uPortal/p/webproxy-cms-file-view.ctf1/max/render.uP?pP\\_cmsUri=public/HumanResources/WorkersCompensation/mainMenuWorkersCompensation.xml](https://portal.uci.edu/uPortal/p/webproxy-cms-file-view.ctf1/max/render.uP?pP_cmsUri=public/HumanResources/WorkersCompensation/mainMenuWorkersCompensation.xml)
  - iv. As soon as the situation is under control, the injured person must contact Max Venaas or Jeff Wojciechowski. A report of Injury form will be completed and forwarded to the Workers' Compensation Office within 24 hours of the injury.

***If the injured person is unable to contact Jeff, the supervisor is responsible for contacting him.***

- b. If the injury causes or will cause you to be absent from work, please remain in close communication with your supervisor and with Jeff Wojciechowski. We will notify you of the required policies and procedures and work with campus Human Resources and Environmental Health and Safety to ensure compliance with all laws, regulations and procedures.

**NOTE** that it is vital to follow the correct procedure on reporting injuries as soon as practical to ensure appropriate handling of the situation. Worker's compensation claims cannot be processed without the initial Report of Injury.

Submission of a Report of Injury does not imply automatic approval of the claim.

## A-4 Protective Equipment

### Think Safety!

- a. Your body should always be protected when testing or handling hazardous materials.
- b. Know where protective wear is located or available. If you are uncertain about the location of protective wear, contact Max Venaas. APEP may periodically send new students to a protective gear fitting sponsored by EH&S.
- c. Glasses, goggles, and ear protectors should be returned to the designated central location in each lab cell or back to Max Venaas when not in use.
- d. Eye washes and showers are located in the hallways outside the laboratories. Additional, certain laboratories may have locally stored eyewash equipment. YOU ARE RESPONSIBLE for knowing the location of the closest eyewash and emergency shower to your working site.

### Lab / Testing Dress Code

- a. When working in any lab and/or testing environment, whether within the confines of an APEP laboratory or outside of the building or field work, protective clothing must include long pants (leg protection) and full shoes (feet protection). Shorts and sandals are not permitted when in any labs or research areas.
- b. Long sleeve shirts (arm protection) or lab coats are highly recommended. The exception to long sleeves is when working in the machine shop on the machine tools (lathe, mill, drill press, band saw).
- c. BE aware of safety risks associated with the equipment you are using. Ensure that hair, ties or other loose articles that may catch in equipment can lead to serious injury or death. You must ensure that hair is tied back, neckties are removed and that other potential hazards are removed or reduced.
- d. Steel toed shoes are recommended but not required. The department does not supply shoes unless those would be specifically required for the type of work you are performing.

### Injury Prevention

- a. Wear goggles or safety glasses where splash or shrapnel hazards exist (e.g., around combustors, drill press, power tools, liquids, glassware).
- b. Wear hearing protectors when around noisy experiments. Note that hear loss and damage is a cumulative effect; long term and repeated

exposure to moderate levels of noise can cause permanent damage.

When in doubt, use protection

- c. Wear protective gloves when working with chemicals (Nitrile gloves or other chemically compatible material)
- d. Wear protective gloves when working with glassware, high temperatures, and sharp objects.
- e. Tie back hair, remove neckties, and ensure that loose clothing or articles are removed or pinned or tapes so that they do not cause a problem.
- f. All of these items are available for the immediate needs. Some items are limited and must be returned to Max Venaas upon completion of need

#### In case of injury

Refer to Section II, A-3

### **A-5 Fire**

#### Think Safety

- a. Know the location of the fire alarm pull boxes in the hallways.
- b. Know locations and proper use of fire extinguishers.
- c. Know locations and use of fire blankets, showers, and eye washers.
- d. Know the appropriate fire extinguisher for specific fire types.

Fire extinguisher A – Wood and paper fires
Fire extinguisher B – Flammable liquid fires
Fire extinguisher C – Electrical fires

#### Fire Prevention

- a. Keep continual awareness and control of the large number of flammable substances in Lab. Store minimum amount of fuel next to test stands.
- b. Store all excess fuel in flammable storage cabinet in the Breezeway.
- c. Avoid the use of open flames.
- d. Use flameless strikers when possible.
- e. Become familiar with test stands before use.
- f. Monitor combustor exhaust duct temperatures. Temperature should not exceed 350-375°F.
- g. Always stop and correct unsafe conditions.

#### In case of fire

- a. If small, use proper extinguisher. Contact most immediate staff as soon as possible.
- b. If large, pull alarm, and proceed towards evacuation area. Notify the most immediate staff as soon as possible.



- c. Refer to Appendix for fire extinguisher and alarm locations.

## **A-6 Chemical Substances; Hazardous and Non-Hazardous.**

### Think Safety!

- a. It is the responsibility of each individual to know the proper handling and safe use for precautions for all chemicals that they utilize. This is especially germane when hazardous chemicals are used, whether flammable, toxic, or both.
- b. Information on all chemicals in the laboratory are contained within the Material Safety Data Sheets (MSDS) binders in Rm 114 (three bright red folders on the bookcase).
- c. Included in the MSDS summary is proper handling precautions, any toxicity issues including pertinent toxicological data, exposure limits, and first aid
- d. For the vast majority of chemicals used in the APEP, such toxicological data exists in detail, and a claim of ignorance of the harmful effects of a chemical substance is no consolation for the damage (sometimes irreversible) that can occur to one's health from either acute or chronic exposures.
- e. There is an on-going program within APEP to collect and collate toxicological data for easy and immediate access by APEP personnel. Individuals should be familiar with these data.
- f. In addition, Max Venaas should be informed before a new chemical substance is introduced into the lab so that pertinent toxicological data can be assembled and discussed with the personnel who will use the substance.
- g. It is a healthy practice to always minimize exposure to laboratory chemicals, especially when the toxicity of a chemical substance is unknown. All individuals should foster this attitude.
- h. A keen nose will alert a person to some problems (not CO or hydrogen).

### Injury Prevention

- a. Take action immediately to correct the escape of exhaust fumes in the lab.
- b. Utilize the HC and CO detectors. Make sure they are working properly.
- c. Close unused vents so that maximum suction occurs at vents in use.
- d. Use a respirator when working with volatile substances. See Max Venaas to arrange training and for special considerations.
- e. Utilize a dust mask when working with particulate matter.
- f. When appropriate dexterity is not compromised, use gloves when handling chemicals.

## **A-7 Compressed Gases**

### Think Safety!

Gas Cylinders must be treated with caution. They store gas at pressures up to 3000 psig. The uncontrolled release of gas from the cylinder can result in a 100-lb rocket capable of breaking block walls.

### Prevention

- a. Secure all tanks at 2 places along its length. Use lab cylinder racks for all but the most extreme needs.
- b. When a cylinder is being stored or not in relatively frequent use, remove the regulator and install cylinder cap.
- c. Never leave tank heaters on.
- d. Be aware of over-pressurizing a system due to regulator being set at too high of a pressure.
- e. Be aware of any leaks from valve stems.
- f. Always operated a cylinder with the valve full open (to minimize any chance of leakage).
- g. When not in use, always fully close the valve.
- h. Always use the lab supplied cylinder hand trucks. Do not carry nor try to "spin" on edge to move tank.
- i. Never transport uncapped tanks. All tanks should have the regulator removed and the valve stem should be capped prior to transport.
- j. Turn off all cylinders at main tank valve at days end or when finished with immediate task.
- k. Keep unused tanks in the breezeway

## **A-8 Laser**

### Think Safety!

- a. Complete the EH&S on line Laser Safety Course.
- b. Know how to operate the laser prior to use. You must be mentored by a graduate student already approved for using the lasers and/or Dr. McDonell.
- c. Lasers in the APEP lab are typically Class III and Class IV lasers with enough power to cause serious and permanent damage to eyes and skin tissue.
- d. Aside from direct exposure, scattered radiation from lasers can still be powerful enough to cause damage.

### Injury Prevention

- a. Always wear the proper protective goggles for the type of laser you are using
- b. Use care when aligning beams
- c. Everyone in lab should wear proper goggles.
- d. Avoid and control stray reflections in lab.
- e. At operator's discretion, keep extra people out of lab and post warning outside door when beam may be uncontrolled. People in lab must wear goggles under those conditions.
- f. Post "Laser in Use" sign on door when laser is in use.

- In case of injury/exposure
- g. Inform most immediately available staff.

## **A-9 Earthquakes**

### **A-10 Major Emergency Evacuations**

#### Be Prepared

- a. Have personal items in a singular location from which you can rapidly retrieve.
- b. Be sure to take all personal items with you when you exit. You may not be able to return for hours, days, or even weeks.

#### Location for Meeting in the event of a major emergency evacuation.

- a. Occupants of the ELF are directed to meet on the east side of Parking lot 18D on the grass lawn space.
- b. APEP staff will take note of personnel present and compare with expected attendance for the lab that day (to assess if anyone is still in the building).
- c. Be cognizant of and follow directions of APEP and/or HSSOE and/or Police and Fire authorities.

## **D. Familiarize the Lab**

### **B-1 Lab Tools**

- a. Lab Tools are color-coded as well as engraved with room numbers to show lab of origin.
- b. Tools removed from laboratories of origin should only be taken after notifying the personnel residing in that laboratory, and should be returned when the task is completed.
- c. Arrangements should be made to purchase individual tools when borrowing occurs frequently or for long periods of time.

### **B-2 Power Tools**

- a. A number of hand held power tools are available for lab related activities only..
- b. These are not specifically located in any one particular lab but in general areas such as the breezeway and machine shop.
- c. If you are unsure about the proper and safe use of a hand held power tool, Max Venaas can provide instruction.

### **B-3 Machine Shop**

- a. The machine shop is available for use for lab related activities only
- b. Use of the machine shop equipment (other than hand tools) is limited to those students that have successfully completed MAE 57 (Machine Shop) or equivalent instruction that can be demonstrated.
- c. Use of the machine shop equipment can be garnered by demonstrating knowledge of proper use, safety, and house keeping to Max Venaas.

## **E. Lab – Use**

### **C-1 Documentation:**

- Documentation is a critical element in the successful practice of engineering, and is essential in the conduct of research. Documentation serves the following purposes:
  - a. Documentation provides the researcher with **an archived memory**. The documentation of discussions, telephone conversations, decisions, and calculations can always be readily referenced weeks, months and years later.
  - b. Documentation provides a ready **resource** for the preparation of progress reports, final reports, papers and publications. If the documentation is prepared in a narrative format, it can be readily incorporated into drafts prepared at a later date for reports, papers and publications.
  - c. Documentation provides a ready reference for others who later assume responsibility for your experiment, or wish to use your experience in the conduct of their own experiment.
- In the APEP, we have three methods to ensure that documentation is maintained:
  - a. Each research project has at least one experimental logbook. The logbooks are used to document each experiment, as well as to document changes to the experimental facility. Check with the appropriate technical lead on the location and use of the logbook.
  - b. Each week a progress report is to be submitted. For each project, the following items are to be delineated: PROGRESS, PROBLEMS OUTSTANDING, and GOALS FOR THE NEXT WEEK. The reports are to be submitted by email on Friday afternoons (preferably by 5:00pm, but not later than midnight). The report is submitted to the appropriate technical lead.

### **C-2 Computer Usage**

- a. Computers are provided to students for research and activities related to the Center and generally NOT for personal activities.
- b. The campus and the Center monitor computer usage and block computers that may cause a threat to the campus through the acquisition of a virus.
- c. Network access is provided to you by Steven Lee. You should change your password after initial access is granted, any time you think your password is compromised and every 6 months.

- d. Do NOT ever provide anyone with your password.
- e. Your APEP/NFCRC/UCICL e-mail account is for business purposes only.

### **C-3 Shepherd**

- a. "Shepherd" is the arrangement by the researcher for an APEP colleague to be present during the operation of an experiment
- b. If a hot-flow or unusually demanding cold flow experiment is to be run, or construction projects attempted,
  - (i) Max Venaas must be notified
  - (ii) You must arrange for an APEP colleague to "shepherd" the activity.
- c. You must have pre-approval from Max Venaas and from the appropriate technical lead for any work outside of the normal working hours of Monday through Friday 8 a.m. to 5 p.m.,

### **C-4 Technical Support**

- a. Periodically additional staff support may be assigned to your research to (1) provide technical support and (2) assuring that your experiment and experimental protocol complies with laboratory standards.
- b. An undergraduate may be assigned to your project under the supervision of a staff member.
- c. Priorities and tasks of both the technical staff and undergraduate will be established at the research meetings and the weekly staff meeting.
- d. In between these meetings, needs may arise that were not anticipated. In such cases, these needs should be addressed by consulting directly with the appropriate technical lead

### **C-5 Security**

- a. Whenever in the laboratory after hours (evening and weekends), please check each and every door as you walk the halls to insure that all doors are secured.
- b. Be mindful of security and raise any unusual observations with Jeff Wojciechowski, Professor Samuelsen and/or Max Venaas.
- c. Lab doors can be propped open only under specifically authorized conditions (e.g., tours). When propped open, someone must be present in the lab.

# Special Formats

## **A. Presentation/Displays**

A-1 Presentations

A-2 Displays

## **B. Reports**

B-1 Trip Reports

B-2 Literature Reports

B-3 Thesis Requirements

## **C. Journal References**

### **A. Presentations/Displays**

A-1 Presentations

The Advanced Power and Energy Program, UCI Combustion Laboratory and National Fuel Cell Research Center are internationally-recognized organizations. Each has significant relationships with industry, educational and research institutions, governments, agencies and public interest groups. It is important that each person understand the importance of representing the Center professionally and that each presentation, paper, and display maintain the level of academic rigor, objectiveness, and accuracy that will add to the Center's efforts.

A-2 Displays and Posters

You may be asked to produce posters or displays of your work for the lab. You will need to work closely with Cynthia Dieudonne to develop any poster displays. She can provide templates, but you must receive prior approval from the technical lead and from Professor Samuelsen and Jeff Wojciechowski to work with her (unless she contacts you directly)."

### **B. Reports**

B-1 Trip Reports

- a. TRAVEL ALWAYS requires prior approval from Jeff Wojciechowski.
  - If you are traveling on business (e.g., to a conference, a meeting with an agency), you must request pre-approval from Jeff. This **MUST** be accomplished no less than two weeks prior to travel (and ideally should be more than 1 month out). Failure to obtain Jeff's prior approval will result in the cost **NOT BEING REIMBURSED**. This policy is strict because our funding sources often require that we obtain their approval. To obtain Jeff's approval, send an e-mail to Jeff (copy your technical lead) and provide the travel destination, the dates of travel, the expected cost, the purpose of the trip and the funding source (if known).
  - If you are going to be away from the lab for personal reasons (vacation, sick leave, etc.) please copy Jeff on your correspondence to your technical lead or e-mail Jeff if the approval for the leave was garnered in a personal meeting. Graduate students are allowed after the first year 1 week (M.S.) or 2 weeks (Ph.D) of vacation each year without an effect on the stipend.
- b. If requested, within two working days after a trip, a trip report must be submitted to Professor Samuelsen along with the travel voucher information.
- c. The trip report must include: an introduction, a summary of important findings and contacts, and a listing of action items.
- d. The University reimburses for actual costs, therefore you must provide detailed receipts to be reimbursed. Please see the travel section below for information.
- e. For an example of a trip report, see the appendix.

#### B-2 Literature Review Reports

- a. Graduate students should complete a least one literature review each week.
- b. The standard summary form is to be filled out for each paper or publication, and submitted with the weekly progress report. Professor Samuelsen, Dr. Brouwer, or Dr. McDonnell should be approached with respect to the correct format.

#### B-3 Thesis and Dissertation Requirements

- a. Provide to Professor Samuelsen (1) three copies on high-quality paper (paper to be provided by you) with two copies three-hole punched, and (2) a WORD and .pdf electronic version on a CD
- b. Since the production of the thesis is at your own cost, you must provide all supplies for the production of your thesis. If you use a Center printer to print, you must provide the same number of reams of paper to the Center as you used in the production of your Thesis. For example, if your Thesis would require you to use 2 reams of paper, you will purchase the two for yourself and another two that you will provide to Michelle for the Center. This "pays" for the cost of toner, etc.

If you have questions, contact Professor Samuelsen or Jeff Wojciechowski

# Administrative

## **A. Work Schedule/Time Sheets**

## **B. Purchasing**

B-1 Purchasing Gas Cylinders

B-2 Purchasing Process

## **C. Travel**

## **D. Meals and other Reimbursements**

## **E. Telephone**

## **F. Photocopies**

## **G. Keys**

## **A. Work Schedule/Time Sheets/Research Verification**

1. Students will submit a work schedule for approval at the beginning of each quarter. The assigned student will contact each student in the laboratory to receive the schedule.
2. If you anticipate any deviations from your schedule, notify Professor Samuelsen beforehand.
3. The general expectation for undergraduate students is that they will work at least 12 hours/week during the academic year and that they will generally work full-time during non-school periods. If you expect to deviate from these general guidelines, please contact Professor Samuelsen and the appropriate technical lead.



4. If you are going to be away (vacation, travel, etc.), you are responsible for ensuring that Jeff Wojciechowski knows. Copy Jeff on e-mail correspondence or, if approval was granted verbally, follow up with an e-mail to Jeff and a cc: to the technical lead.
5. Graduate students receive a monthly stipend. Timesheets are generated each month and you are required to sign. Michelle Mendez is responsible for these timesheets.
6. Undergraduate students are compensated for hours worked by submitting a timesheet through the University's online time reporting system. Below is the general procedure and the policy related to Time Reporting:

### **Time Reporting System for Undergrads Rev: 23 June 2011**

Time reporting is due every other Friday. You can enter your time before, but please do not complete your timesheet any later than Friday at 5 pm.

#### Things to check:

- If you are receiving academic credit for your time in the lab, you should NOT enter time on the timesheet. In most cases, NO timesheet will appear, but please do NOT enter time if you do see a timesheet in the system unless the hours are for pay rather than for academic credit.
- You may want to go into the system on the Monday morning after you submit your timesheet to make sure that the status changes from "sent to supervisor" to "sent to DTA." If you do not see this status change, contact your supervisor immediately. If you cannot reach your supervisor, contact your back-up supervisor or contact Michelle and/or Jeff to help you get in touch with your supervisor or back-up supervisor. *If your supervisor does not approve the timesheet by the close of business on Monday, you will not get paid.*
- Check to make sure that a supervisor is assigned. If no supervisor is assigned, please contact Jeff right away. When we make certain payroll changes, the supervisor assignment "falls off." This should not happen often, but please check.

#### Procedure:

- 1) Go to <https://timesheet.uci.edu>
- 2) Log on to the employee section using your UCINetID and password
- 3) Enter hours worked (generally by entering a start time, end time and any lunch)

- 4) Either save if this is interim reporting or submit to supervisor if you are ready for them to approve

Policy:

- You may NOT work before 7 am or after 5 pm without specific advanced approval from your supervisor. Please copy Michelle and Jeff on your e-mail requesting alternate work schedule or your e-mail confirming approval of that special schedule.
- You may NOT work any overtime (that is, more than 8 hours in one day or more than 40 hours in one week) without specific advanced approval from Jeff. To request approval, send an e-mail to Jeff with a copy to your supervisor.
- You may NOT work more than 5 ½ hours without a 30-minute (or longer) lunch unless your entire work for the day will be no more than 6 hours. There are no exceptions to this rule.
- You may NOT work any University holidays or weekends without special advanced approval. To request approval, send an e-mail to Jeff with a copy to your supervisor.
- For undergraduates, while you are welcome to attend the Friday morning meetings, these are not required. If you choose to attend for your own personal interest in the presentations, we do not compensate you for this time. You can only receive compensation for that time if you work.

Questions:

Contact in this order:

Your supervisor

Michelle

Jeff

## **B. Purchasing**

### **B-1 Gas Cylinder Purchases**

- a. *All gas orders* must be reviewed by Max Venaas prior to submitting to your advisor for approval. Please obtain Max's initials on your order form before submitting.
- b. If you are in need of a specific gas, please notify Max so he can confirm that we do not have a suitable cylinder of the desired gas in inventory.
- c. Note that delivery of gases can be as early as 1 day after order for pure, common gases, to 20 business days for mixtures. Plan your needs accordingly.
- d. Be sure to properly assess your needs based upon your research. Do not be afraid to order sufficient gas as reorders for coming up short delay projects. Alternately, over-ordering is wasteful of resources and if a custom blend gas, will likely not be applicable to other projects.

### **B-2 Purchasing Process**

Complete the following steps:

- a. Fill out a Purchase Order Request Form (Example Below). A Purchase Order Request Form must be completed for each purchase in a legible format with care to the following points:
  - Detailed description of material ordered, including stock number, color, size, etc.
  - Name of Company, address, telephone number and name of person giving quote or *information*
  - Name of person placing order
- b. Generally, you should receive a quote for purchases. Quotes should be provided as back-up to the PO Request. Alternately, other information that specifically identifies what is being ordered can be provided (for example, a print-out of the item to be order from a website).
- c. Plan ahead. Please do not expect the impossible. Because purchases may require interaction with various units on campus as well as the purchasing departments of the vendors, please provide ample time to complete the process.
- d. If there are any special instructions pertaining to the order or if any change is to be made make sure you discuss with Michelle prior to ordering. Failure to do so could delay the processing of the order, and it creates unnecessary complications in the purchasing department.
- e. After you have completed the forms and have the appropriate back-up, route the forms to Max Venaas (for any lab-related purchases) or to Steven Lee (for any software or computer hardware/peripherals). The forms are then provided to the technical lead for the program (Dr. McDonell, Dr. Brouwer, Brendan Shaffer, etc.). Once the technical lead has initialed and assigned a project to charge, the forms are placed in the "GSS Signature" box in the

main office. They will then be initialed for approval by Professor Samuelson and Jeff Wojciechowski before being provided to Michelle to order.

- f. If you have questions about any policy or procedure for purchasing, please contact Michelle Mendez.
- g. All orders should follow the procedure outlined above and should ALWAYS receive prior approval from the technical lead and from Jeff Wojciechowski. This includes “recharge” units on campus such as the copy center, physical sciences stores, the machine shop, Facilities orders, etc.
- h. The University generally does not want individuals to make purchases and get reimbursement (for example, ordering on Amazon or purchasing from a hardware store and asking for reimbursement). Reimbursements of these types can require exceptional approval from the Dean’s Office. If you must make a purchase personally and seek reimbursement, you must receive approval from your technical lead and from Jeff Wojciechowski prior to the purchase.
- i. Purchase Order Request forms are available in 221 ELF and electronic forms can be found on our website at <http://www.apep.uci.edu/3/businessforms/default.ASPX>All purchases shall be in accordance with all existing University purchasing policies. Complete information on University Purchasing policies and procedures can be found at: <http://procurement.uci.edu/>.

# Ex. 1 Proper Tracking Slip

## APEP, NFCRC, UCICL PURCHASE ORDER REQUEST FORM



KFS DOC ID #: \_\_\_\_\_

Date Submitted: \_\_\_\_\_

Person Submitting: \_\_\_\_\_

Payee/Supplier's Name: \_\_\_\_\_

Vendor Contact Name: \_\_\_\_\_

Vendor Phone Number: \_\_\_\_\_

Total Cost (including tax, shipping): \$ \_\_\_\_\_

Account: \_\_\_\_\_

APEP:  UCICL:  NFCRC:  Project Code: \_\_\_\_\_

Equipment/ Add Value? Y:  N:  If yes, prop. #: \_\_\_\_\_

Rush? Y:  N:

Purpose: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

PURCHASE TYPE:		_____
PALCARD USER:		_____
LOG NUMBER:		_____
AUTHORIZATION:	DATE:	
WD	/	
SWL/RLH	/	
VGM/JB	/	
GSS	/	
JSW	/	

Comm. Codes	Qty.	Units of Issue	Item Name & Description (Include Manufacturer, Name, Model, Type, Catalog #)	Unit Price	Total Cost
					\$ 0.00
					\$ 0.00
					\$ 0.00
					\$ 0.00
					\$ 0.00
					\$ 0.00
					\$ 0.00
					\$ 0.00

**Mandatory Purchasing Documentation includes:**  
 1) Internal requisition - complete itemization of item purchased, including vendor name, date, description, price, sales tax, subtotal, shipping/handling, and total dollar amount.  
 2) Merchant Receipt, email confirmation, fax, or actual sales receipt from merchant-detailing items purchased and pricing receipt provided for audit must include descriptions of item purchased.  
 3) Packing slips-if item was shipped.  
 4) For internet purchases- web confirmation screen and/or email confirmation from merchant.

Subtotal pg. 1:	\$ 0.00
Subtotal pg. 2:	\$ 0.00
Shipping & Handling:	\$ 0.00
Subtotal:	\$ 0.00
Sales Tax (8.00%):	\$ 0.00

### **Deliveries**

Our Delivery address is:

221 Engineering Lab Facility, Bldg 323  
University of California, Irvine  
Irvine, CA 92697-3550.

- a) Whoever is available will sign the delivery ticket, leave the ticket with the materials received, and place the material on the delivery bench in 114 ELF. The individual who made the order will check the delivery, assure manuals are properly logged, and evaluate the accuracy of the order as well as condition of the contents.
- b) If the contents are in order, the individual who made the order will write "O.K." on the delivery ticket (aka packing slip), sign, and date and give the ticket to Michelle Mendez. If not "O.K.", state the deficiency/problem on delivery ticket.
- c) The delivery ticket must be processed immediately upon receipt of your purchases so that accounting can properly process invoices from the vendors.

### **Returned Goods Memo (RGM)**

- a) In the instance of a need to return an item, you will need to complete the RGM form with the name, address, telephone number, and contact person at vendor. If vendor gives RMA number, please include. Once complete provide to Michelle Mendez.
- b) Give complete description of items being returned. Property numbers, serial numbers, model type, etc. must be included. It is very important to include the P.O. number from the original order. If packing slip is available, please include.
- c) Describe in detail why item is being returned ("It doesn't work," is not acceptable).
- d) It is your responsibility to prepare for shipping
- e) If an on-site repair is required, see Michelle Mendez for further details

## C. Travel Policy

### Travel Policy

*If you have suggestions to update this document or frequently asked questions that should be addressed here, please contact Jeff Wojciechowski or Michelle Mendez.*

**All travel must be pre-approved by Jeff. No travel expenditures may be incurred prior to Jeff's approval. Failure to get approval may mean we will NOT reimburse you for your expenses.**

For the complete University travel policy, please click on the following link:  
<http://policy.ucop.edu/doc/3420365/BFB-G-28>

For information on car rentals including the UCI Identification number of UC-approved rates, please follow this link:  
<http://www.accounting.uci.edu/travel/book/renting.html>

Please refer to the complete University policy (link provided above) for questions about University policy on travel. Consistent with University policy, the travel policy of individual units may be more restricted in order to accommodate the special requirements of the unit or of the contracts and grants that may fund the travel. The items below are meant to highlight the important items for travel reimbursement. They either add to University policy to ensure compliance with contracts and grants or other requirements we have or highlight particular areas of travel that require special attention.

1. **45 Days:** Travel Reimbursements must be submitted, approved, and received by UCI Central Accounting no later than 45 days after the end of trip date. A good rule of thumb for APEP travelers is to submit travel reimbursements to APEP main office *no later* than 30 days after the end of trip date. An exceptional approval memo from the traveler is required for all delinquent reimbursement requests.
2. The UC Office of the President announced that new limits for reimbursement of meals and lodging for business travelers will take effect on Oct. 15, 2017. The new limits apply to travel assignments of less than 30 days within the continental United States (CONUS) occurring on or after Oct. 15, 2017.

The new limits are as follows:

- **Meals and Incidental Expenses:** New cap is \$62 per day
- **CONUS Lodging Expenses:** New cap is \$275 per night

3. Travel Packages:

**Internet travel packages are NOT allowed if breakdown of charges is not included (e.g., Expedia, Travelocity, etc.):** Reimbursement of these packages is not allowed unless they provide a breakdown of the charges. If you are interested in obtaining a travel package, but are not sure if the vendor will provide a breakdown of the expenses, inquire with the vendor prior to purchase. You may need to call the vendor to obtain this information.

4. Foreign travel:

Foreign travel may have restrictions. Depending on funding source, you may be required to use a U.S.-flagged air carrier and there may be restrictions on the hotel or other costs. Please check with Michelle. She will need to know travel dates and the city/country travelled to.

5. MEAL Reimbursement:

The University will reimburse you for actual, documented expenses. You will need to provide all *itemized* receipts in order to get reimbursement.

6. The University does NOT reimburse for food costs unless you are traveling for more than 24 hours. For example, if you have flown to Sacramento in the morning and given a presentation and returned that afternoon, you will likely NOT get reimbursed for food costs.

7. Alcohol: APEP does not generally reimburse for alcohol purchases. Additionally, Contracts, grants and certain University funds do not allow the reimbursement of alcohol. If you purchase an alcoholic beverage, please expect that you will NOT be reimbursed for this expense.

**Reimbursement Procedure:**

- The University reimburses for actual expenses so you must submit itemized receipts to be reimbursed. To be properly reimbursed for travel expenses please make sure you have completed the following steps:



- A. Gather all travel documents including receipts, itineraries, and other pertinent information. All receipts must be taped to 8 ½" x 11" sheets of paper in such a way that the sheets can be fed through a photocopier or scanner. Make sure that the tape DOES NOT cover any of the text or numbers on the receipt. DO NOT HIGHLIGHT any receipts. All ORIGINAL information MUST be turned in to Michelle Mendez to insure you are reimbursed accurately.
  - B. Fill out the APEP Travel Reimbursement daily expense breakdown form. This form can be found in Rm 221 or an electronic version can be given upon request.
  - C. Complete a Tracking Slip
  - D. After you have completed the travel form and attached your receipts to paper, you must submit your Travel Reimbursement Request to Professor Samuelsen for approval.
- Once Jeff Wojciechowski has approved your request it will be given to Michelle Mendez for processing. Your travel reimbursement can be expected in 1-2 weeks.
  - Travel Advances are provided for students when travel will pose a financial hardship. Travel advances are coordinated through Jeff Wojciechowski and must be requested at least two weeks prior to the need for the money.

#### **D. Meals and other Reimbursements**

Meal reimbursement (not related to travel) is exceptional and requires prior approval by Professor Samuelsen or his designee AND Jeff Wojciechowski. Meal reimbursements are subject to University-mandated maximum reimbursement rates. Additionally, APEP's policy is to spend very modest (even frugal) amounts on entertainment or business meeting costs. APEP never reimburses for alcohol and generally will not reimburse for appetizers or desserts unless these are the only meal item for that attendee (e.g. an appetizer instead of dinner). For reimbursement, you must provide (1) a completed tracking slip, (2) an agenda listing all meeting attendees (a numbered list including name and organization/affiliation) and (3) **both** the receipt showing payment AND the itemized food receipt.

#### **E. Telephone**

The telephone is for business use only, both incoming and outgoing calls. University policy precludes the use of university phones for personal calls.

#### **F. Photocopies & Printing**

The photocopy machines, printers, etc. are for business purposes only. Personal printing (for personal purposes, class assignments, homework, etc.) should be completed on your personal printer at home. If you must use an APEP printer, contact Jeff Wojciechowski to make arrangements to reimburse the Center for the cost of your personal copies/printing.

Some printers allow color printing. These print jobs cost about \$0.05/side. We strongly discourage color printing. If you need access to the color printer, please contact Jeff Wojciechowski.

#### **G. Keys**

Keys may be issued to you while you work at the laboratory. Keys are generally issued for those office and labs for which you need regular access and upon completion of hiring or other personnel documentation and completion of safety and security training. Should you need keys

beyond the “starter” set, please make the request of your technical lead who will contact Max Venaas or Jeff Wojciechowski.

NEVER lend your keys to any non-Center person.

No visitors should ever enter any regularly locked space without prior approval from Max Venaas and Jeff Wojciechowski. For example, no visitors are allowed at your desk or in the kitchen area without prior approval and, in the case of laboratories, review of any potential safety or security ramifications.

If you lose your keys, contact Max Venaas and Jeff Wojciechowski immediately. We do not collect a key deposit, but you are responsible for the cost of any lock changes that may be required when keys are lost. Lock changes generally cost \$15. Keys generally open more than one lock, so the lost of a key can easily cost \$45 or more per lost key.

# Notes

## Appendix A

### APEP

*For Graduate Students, Professor Samuelsen will provide a document similar to the one below for your signature. This document is included here mostly because it highlights the philosophy of the program.*

*For Undergraduates, this document is primarily focused toward graduate students, but is included here as it provides information about the program mission, vision, etc.*

#### **I. Program Philosophy**

##### **A. Mission**

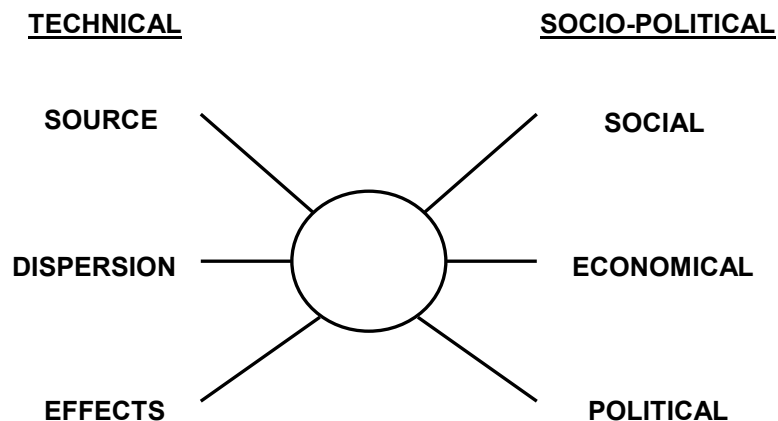
The Mission of the Advanced Power and Energy Program (APEP) is to accelerate the development and deployment of environmentally responsible advanced power generation technology. APEP focuses on combustion, fuel cell, and renewable technologies as they pertain to central and distributed generation, transportation systems, and the inherent and emerging interactions between and among these elements. APEP is built on four cornerstones: (1) Research, (2) Education, (3) Beta Testing, and (4) Market Dynamics. A key component to the Mission is the education of students, both graduate and undergraduate, who are in demand to provide a critical intellectual capacity in the emerging market. Students in APEP are purposefully introduced to the broad spectrum of energy and environmental technologies and issues in combination with a strongly directed research project of substantial importance. Professional skills, etiquette, and interpersonal dynamics are integral to the program philosophy and are encompassed in three I's (Innovation, Intuition, Initiative) and the three C's (Creativity, Communication, Cooperation).

##### **B. Vision**

The Mission is based on the Vision that the world is at a crossroads in addressing the provision of energy to support the economic health and public health of society, and the attainment and sustainment of environmental quality for the economic health and public health of society. In the last sixty years, the earth has presented evidence of the impact of energy generation on the environment at all three levels of the atmosphere (urban, troposphere, and stratosphere).

With the increasing “thirst” and need for energy, new technologies and conservation are required to protect and improve the existing environmental quality while producing the energy required. APEP, as a result, addresses power generation, power distribution, and power utilization in the context of the socio-economic-political realities of society. The Vision is grounded in the optimism that solutions do exist, but that the discovery will require a major and coordinated effort among the peoples of the world.

The model of this complex challenge is embodied in the “Buford” model (shown below). In other university programs, graduate student research in energy and the environment typically focuses on one element of the “Technical” column. For example, those studying combustion technology or fuel cell technology focus on the SOURCE element. A full appreciation for, and understanding of, energy and the environment require a solid knowledge of all the elements of Buford. On the energy side of Buford, for example, DISPERSION and EFFECTS are associated with the transmission and distribution of electricity (DISPERSION), and the utilization of electricity including conservation and building integration (EFFECTS). From the environmental perspective, DISPERSION and EFFECTS are associated with dilution and mixing in the atmosphere, and the chemical interactions in the atmosphere (DISPERSION), and the public health and other effects at the receptor site (EFFECTS).



The Buford Model shows a SOCIO-POLITICAL column in addition to the TECHNICAL column. The SOCIAL, ECONOMIC, and POLITICAL elements are intricately interwoven with the technical elements (as depicted by the abstract “spider web”). APEP assures, through selected courses (e.g., MAE 115 and 260) and lab meetings, that the SOCIO-POLITICAL aspects of energy and the environment are addressed, discussed, and respected for the role that these elements “play” in the total picture of energy generation, distribution, and utilization.

### **C. Educational Experience**

At the graduate level, research becomes the principal vehicle of education. Courses, which were pivotal at the undergraduate level, serve in a supportive role at the graduate level with the goal of strengthening and broadening the undergraduate course experience. In addition, graduate level courses provide the foundation for various capabilities required to fulfill the research challenges.

Research, by definition, provides a series of challenges. The goal of the researcher is to work through the maze of challenges, learn from each step, resolve the challenge and/or identify a path around or through the challenge, and move forward toward the goal. The Chinese proverb “Success cannot be accomplished without Failure” is the key descriptor to the research experience. “No risk, no gain.” Most derive “satisfaction” and “stimulation” from this experience and, through graduate study, decide that research will be a life-long goal. Others find, as a result of the graduate experience, that research is “frustrating” and decide that research will not be a life-long goal.

## **II. Program Resources**

The Monetary, Personnel, and Laboratory Resources that are established and maintained to support the graduate student degree activity must be recognized, respected, and regarded by each of the APEP Center participants, and not taken for granted. The funding to support these resources is derived from extramural sources, competitively sought, and awarded to the program based on proposals submitted to a variety of funding sources. An appreciation for these resources is fundamental to the success of the program: In particular, the resources need to be recognized, respected, and regarded in order to sustain their availability and quality.

### **A. Monetary Resources**

Financial support is provided by APEP for (1) supplies, materials, equipment, space, and other resources required for the conduct of the research, (2) provision of a monthly stipend, (3) payment of academic fees, and (4) payment of nonresident tuition (for non-resident students). The stipend is not “pay-for-work” but rather a means to offset some of the living expenses that you will experience in your graduate study. The degree is your responsibility and obligation. Monetary Resources are provided to facilitate your effort. Due to your degree goal and the APEP goal to excite your education through research, it is expected that you will become so engrossed in your research that every available moment will be focused in the conduct of your research. The more time you invest, the more you will derive. At the conclusion of your research, you are expected to be the “world’s expert” on the topic. To achieve this, you will want to devote in excess of 60 hours per week on your research.

### **B. Personnel Resources**

Staff resources are supported in the same manner, and undergraduate student researchers are compensated as well from the same resources. Both resources are integral to the education goal of your research effort and have been conscientiously established to provide you access to, and guidance from, the very finest in professional support and mentoring.

### **C. Laboratory Resources**

The third notable resource encompasses the experimental facilities, laboratory tools, machine shop, computers, LAN and support servers, and key software (e.g., Design of Experiments, CFD, equilibrium and kinetics). Extreme care is required to retain the status of these resources, return borrowed resources to the home location, and advise staff of systems in disrepair. Most important, you will want to take ownership in the laboratory resources and respect and protect the resources as if the resources are your own.

## **III. Expectations of Appointment**

### **A. Weekly Progress Reports**

Submit a progress report (Subject Line: "Progress Report: ma") to the foci lead with a copy to Professor Samuelsen and others designated on Friday (no later than midnight) each week that covers four topics:

- Progress During the Past Week
- Challenges that Precludes the Progress Desired
- Milestones Achieved
- Goals for the Next Week
- Publication Table (Proposed title, Proposed Journal, Proposed Authors, Percent of Completion)

### **B. Weekly Research Meetings, Bi-Weekly Individual Meetings, and Staff Communication**

Attend weekly research meetings, and bi-weekly individual meetings. Assume a responsibility in the weekly research meeting (e.g., meeting lead, meeting recorder). For the individual meetings, come prepared with an agenda and prepare and distribute a summary of the meeting. Respond immediately to any request or query (e.g., email) from your faculty advisor, research staff, and administrative staff.

### **C. Weekly Laboratory Meetings**

Attend weekly laboratory meetings and, when called upon, prepare and present a seminar on a topic assigned (typically associated with your research project, a diagnostic or modeling capability in which you have become expert, or an upcoming presentation at a national or international conference).

#### **D. Research Responsibilities**

This is the “heart” of your activity in the program. First, research represents the principal educational resource at the graduate level. Second, the funding support for your graduate degree depends on both productivity and accountability in fulfilling your research. Third, the opportunity for exploring, experiencing, and developing your creativity is integral to a successful graduate research degree effort. Fourth, the research provides the avenue for exercising the three “C’s” and the three “I’s.” And fifth, the research develops teaming, multi-tasking, goal-setting, and problem-solving attributes that are essential to the development of professional and personal skills. The teaming is tantamount to an eight-oar shell, where progress is accomplished by each pulling on an oar in unison and no one (1) failing to contribute equally, or (2) experiencing a “crab” (i.e., allowing the oar blade to inadvertently rotate due to a lapse of concentration and thrust of the oar handle into the chest...with associated personal pain...and destroy the momentum and coordination with the team).

Integral to the research experience is the regular assignment of fulfilling the contractual responsibilities for the Statement of Work that underwrites your funding. This includes timely productivity, achieving the contractual milestones on the dates prescribed, maintaining a Laboratory Log Notebook, writing reports (progress, annual, final), careful and systematic archiving, conduct of research at the Center during quarter breaks, and overall assuming the engineering, administrative, and supervisory responsibility for the contract.

In addition to the core research, your educational experience through research will be complemented by

- An active and sustaining literature review.
- Drafting publication manuscripts from prior work conducted in the Center.
- Reviewing publication manuscripts prepared by authors around the world.
- “Red-teaming” publications and proposals prepared internally for submission.
- Attending in their entirety APEP hosted colloquium (ICEPAG) and symposia (NFCS).

#### **E. Lab Tasks**

Assume responsibility for Lab Tasks by (1) participation on a “Color Committee,” and (2) conducting tours of the Center:

Color Committee. The Center is a resource for both students and staff that supports the research and educational experience of all, and the outreach of the program. Developing, maintaining, and improving these resources is critical to the success and function of the program. Participation in a Color Committee allows an investment in the program from which you derive benefit, provides a teaming opportunity that underlies one of the major objectives of the program,



and provides an opportunity for interaction with staff and students outside the research function.

Tours. The Center is visited by a variety of national and international audiences including grade-school and high-school students, industry, government agencies, professional societies, and university faculty from around the world. The APEP Outreach Director calls upon each of us to conduct tours of the laboratory from time-to-time. Such tours range from individual tours to organized tours for large groups. This provides you with an opportunity to learn more than otherwise about the program, to develop and use presentation skills, and to take pride in the program.

Student Profile and Research Summary. The Center web sites present a profile for each student and a summary of your research topic, both following a specific template. Upon arrival in the program, you will provide the information necessary to complete a student profile and either create or update the summary of your research topic. During your tenure in the Center, you will work to assure that the information is maintained in a current state.

#### **F. Critical Milestones**

- For the M.S., complete a M.S. Thesis proposal and the department M.S. Program of Study within three months of joining Center.
- For the Ph.D., write a Dissertation proposal within three months of initiating the doctoral program.
- Maintain and retain comprehensive research files (property of APEP) as well as personal files.
- Within the degree period, complete and submit the following number of archival publications
  - M.S.: At least one (if not two)
  - Ph.D.: At least three (if not four)
- For the Thesis (M.S.) or Dissertation (PhD):
  - Submit to Faculty Advisor(s) six weeks before University deadline for the quarter in which you are scheduled to graduate
  - Do not submit to other members of the committee without approval of Faculty Advisor.

#### **G. Hours**

Overall, it is expected that you are fully engaged in your graduate study, the excitement of discovery, the challenge of addressing and resolving research challenges, and the satisfaction of experiencing (and exploring) your innate creativity. Weekday mornings, afternoons, and evenings, and weekends are all utilized as an integral part of graduate study to address the research as well as fulfill the requirements of the courses in which you are engaged.

During the summer months, you are expected to be at the Center on weekdays from before 8:00am and into the evening. During the academic year, you are expected to be at the Center, with the exception of courses and seminars, from before 8:00am and into the evening. (Each academic quarter you

will be asked to specify the hours that you will be in the Center.) During the break between the Fall and Winter Quarters, you are expected to be present at the Center and fully occupied with your research. The break is one of the few times during the academic year that full-time attention can be directed to your research. During the quarter break between the Winter and Spring quarters, full time engagement at the Center is also expected. Requests for time away from the Center

(e.g., attendance to technical conferences, time off, internships, personal business) must be requested (to Professor Samuelsen via either Professor Brouwer, Professor McDonnell, Mr. Shaffer, or Dr. Rao), discussed, and reviewed for approval at least two weeks in advance of the absence.

#### **H. Grading**

Grades for research units (A, B, C, ...) are assigned each quarter based on research [productivity and engagement (e.g., initiative, creativity, proactivity, and passion)], and administration [progress reports and availability (e.g., office presence, and response to research staff and administrative staff queries)].

#### **IV. Acknowledgement**

As a graduate student in the UCI Advanced Power and Energy Program (APEP), I have read, understand, and agree to the (1) program philosophy, (2) the program strategy, (3) the program mission, and (4) the expectations of my appointment as delineated above: I understand that sustaining the research stipend, and the approval of the M.S. Thesis and/or PhD Dissertation anticipates that I consistently fulfill and satisfy these criteria and expectations.

I also understand that (1) my projected completion date for my M.S. degree is the end of the Spring Quarter, 2019, and (2) financial support beyond the M.S. degree depends on my performance during the M.S. course of study and research, and the availability of funding. In addition, I understand that, should the completion date not be met (as a result of circumstances beyond my control) and should I perform with a proactive best effort (with consistency and meeting the expectations of my appointment), all efforts will be made by Professor Samuelsen to sustain financial support beyond the date stated above. I further understand that continuation to the Ph.D. degree will be based on my academic and research performance in the conduct and completion of my M.S. degree. The projected completion date for the Ph.D. is the end of the Spring Quarter, 2022.

At the signing of my thesis and dissertation, I will submit:

- An electronic WORD and .pdf file on a CD of the thesis or dissertation.

At the conclusion of my program, I will submit:

- My Laboratory Log Notebooks

- All keys
- My local and grabbag drive files on a CD organized by:
- Research Files
  - Presentation Files
  - Publication Files
  - Proposal Files
    - Thesis
    - Dissertation
  - Contributions to agency/industry proposals
  - Miscellaneous Files
    - Notes from Conferences
    - Notes from industry/agency interactions
    - ....

Name: \_\_\_\_\_  
2017

Signed \_\_\_\_\_

Date 30 June

APPROVED:  
\_\_\_\_\_  
Professor Scott Samuelsen  
2017

Signed \_\_\_\_\_

Date 30 June

# Appendix B

## Example

### Trip Summary Report

From: Arash Ateshkadi  
To: Dr. Samuelsen  
Re: Penn State Conference  
January 27, 2xxx

#### **Introduction:**

This report is prepared to serve as an outlined summary of the highlights of the First International Symposium on Liquid Rocket Engine Combustion Instability attended on January 18-20, 2xxx at The Penn State University. The conference consisted of an international technical effort from the following countries: China, France, Japan, Korea, Taiwan, Ukraine, Russia, and the US. This report consists of three sections. Section 1 documents key points made during the following 5 sessions:

- Engine Phenomenology and Case Studies
- Instability Mechanisms
- Combustion Instability Analysis
- Engine and Component Testing
- Liquid Propellant Rocket Propulsion Research in China

Due to the vast number of topics covered during the 30 presentations only those issues related to UCI efforts are discussed. However, personal notes were taken on all issues discussed during the conference. Section 2 describes the general facility at the NASA Propulsion Engineering Research Center and the High Pressure Combustion Lab at Penn State. Section 3 consists of personal interactions made during the conference and Section 4 is a list of people at the conference who may be important to the research program.

#### **SECTION 1**

##### **Session A: Engine Phenomenology and Case Studies**

- It is fundamentally important to consider all driving and damping processes of combustion instabilities in a global framework of: supercritical spray vaporization & combustion; dynamic responses of various injector configurations; and damping associated with the liquid phase. analysis & numerical simulation should be more closely integrated in research and applications. The most likely sources driving instabilities are associated with the fluid mechanics of injected jets of propellants, enhanced further by unsteady (supercritical) vaporization and combustion. [*Fred Culick, California Institute of Technology*]
- No database correlation is developed yet between the injector element instability effect and drop size distribution or mass flux. It was found that fuel/oxidizer velocity ratio affects the development of instabilities. Work has also been completed on the occurrence of instability in various the oxidizer post lengths (recessed). [*James Hulka, Aerojet Propulsion Division*]
- LOX post recess relative to fuel post was the primary reason of interaction in the main chamber section of the RD-0110 LOX/Kerosene engine. Injector

element study on transverse mode instability was done by testing various injector peripheral lengths and swirl-coaxial atomizers. Longitudinal ribs made of combustible felt were effective in delaying the occurrence of high frequency oscillations by an order of magnitude. These ribs proved successful in achieving high frequency stability. [V.R. Rubinsky, *Design Development Bureau of Chemiautomatics, Russia*]

#### **Session B: Instability Mechanisms**

- France's effort involves LOX/Fuel coaxial injector atomization studies for the Ariane (5 Vulcain) Launchers. This includes the use of PDPA to characterize the atomizer at pressure ranges 1-30 bar. Effects of surface tension, viscosity, and liquid/gas density ratio on stability of the liquid surface are studied. [*Luc Menoret, SEP, France*]
- Penn State activities in the study of atomization as an instability mechanism involves atmospheric tests on impinging jets. Fan shape, breakup length, periodic structure, and drop size distribution are used to support modeling of aerodynamic instabilities. Correlation of Weber number vs breakup length and drop size verifies linear stability-based models. Future efforts include cryogenic and pressure testing. [*Robert J. Santoro, Penn State*]
- A theoretical study of acoustic waves in combustion chambers illustrated that the use of baffles does not always dampen the effect of instabilities. In fact, baffles have been shown to destabilize the system near the injector due to the strong variation in acoustic velocity and increased sensitivity to pressure oscillations. This results in varying atomization of the jet. Strong acoustic-wave-induced vorticity at the baffle tip also changes the combustion process. [*Vigor Yang, Penn State*]
- The current experimental diagnostics used to study instability phenomena include: DFWM, Rayleigh & Raman Scattering, LIF, PLIF, MDR, Laser Schlieren, and CARS using multiple Stokes Laser (multi-species wave mixing) [*Greg M. Dobbs, UTRC*]

#### **Session C Combustion Instability Analysis**

- Studies are being done on the affect of pressure oscillation on combustion response by oscillating the fuel/oxidizer flow. Numerical models are being developed to study the atomization process. Simulant fluid are used to match fluid properties, injector geometry, and pressure and mass flow rate conditions.
- Application of CFD techniques to engine instability studies requires a strong interaction with experiments and numerical analysis. The goal is to understand the mechanisms of unsteady atomization an its subsequent effect on instability. The role of diagnostics is to identify local response to unsteady perturbation, such as, atomization, local mass distribution, and mixing & combustion response.

## **SECTION 2: Facilities Visited**

## **NASA Propulsion Engineering Research Center and High Pressure Gas Combustion Lab:**

The facility at the NASA PERC has been designed to primarily study rocket combustion. Research is currently focused on chemical propulsion with an emphasis on combustion and turbomachinery. Facilities include: Cryogenic Combustion Facility, Laser Diagnostic Equipment and Instrumentation, Turbulent Combustion Laboratory, and Computational Research Laboratory.

Some current activities include:

- Supercritical behavior of liquid N<sub>2</sub> drops.
- Droplet behavior in a gas flow. (70 atm pressure chamber)
- Drop vaporization studies using Excimer laser to image the vaporization in the wake region
- Acoustic disturbance studies on impinging jets
- Coaxial injector characterization (PDPA)

The Combustion Laboratory is made of several test cells to facilitate high pressure testing; three of which are devoted to cryogenic studies. The cryogenic facility has been designed by NASA. All controls to the system are located in a separate room where many control consoles are located. The entire system has extensive safety features, many of which have been designed to duplicate NASA's facility. The current activities include:

- Full-scale LOX injector testing using PDPA.
- Real-time X-ray Radiography of dense spray regions under cold flow conditions
- Shock wave interaction on solid propellants. The facility includes an 80 ft. shock tube.
- LOX/H<sub>2</sub> reaction imaging using a 40W Oxford Copper Vapor Laser.

### **SECTION 3: Personal Interactions**

Below are a list of the people I met and aspects of my interaction with them.

*Gerard Faeth* (University of Michigan): Dr. Faeth is involved with studying droplet breakup behind shock waves. He uses pulsed holography to conduct quantitative analysis of secondary atomization. He did not conduct any experiments in high We and Oh numbers at trans- and super-critical conditions. His next area of focus is matching rocket engine conditions with respect to liquid/gas density ratio. He is not, however, conducting any primary atomization experiments using the shock tube.

*Bill Sirignano* (UCI): With regards to his work on supercritical combustion of a LOX droplet I did speak with Dr. Sirignano. As mentioned in his presentation a LOX droplet has to be subjected to an environment much higher than its critical pressure value to be truly supercritical. Any reduced pressure value upto 3-4 is still in the transcritical phase due to a change of the LOX-ambient composition as a result of H<sub>2</sub> diffusion into the droplet. True supercritical conditions consist of pressures up to 100 atm.

*Vigor Yang* (Penn State): In my opinion Dr. Yang solidified the need for a fundamental understanding of combustion instability by illustrating that the "band-aid" approach of installing baffles does not render the rocket engine "stable" under all flight conditions. In fact, baffles have been shown to destabilize the liquid propellant spray pattern due to acoustic fields alongside the baffle adjacent to the injector.

*Robert S. Levine:* Mr. Levine was one of the five people present at the conference who had worked on the F-1 Engine for the Apollo missions. He explained the aspects of his work in the late 50's and how rocket engines literally exploded or melted due to instabilities. He also showed footage of actual rocket failure during ground testing. It was interesting to discuss with him advances in technology made since then to help understand instabilities.

*Graduate Students:* I had an opportunity to meet several grad students of Dr. Kuo's, Dr. Santoro's, and Dr. Micci's. They provided me with a detailed tour of their combustion laboratory. In speaking with them I realized the following points: 1. Their imaging capabilities for their lab is rather poor. The 40W Copper Vapor Laser is only being used for low frame rate images. CCD cameras are seldom used to visualize the flow system. I did get to see a laser sheet set-up for the CVL laser to study droplet burning and it gave me some ideas about my own setup. 2. Funding is limited due to the upcoming expiration of the NASA Grants. There is little activity in the many test cells. Monies are being obtained from many different sources; mostly industry.

COMMENTS: This meeting was rather informal in its organization. There were approximately 50 people who attended. Much to my surprise the 10 people from Russia and Ukraine did not make an effort in meeting other people at the conference. They were more within their own inner circle. I found the presentations made by Russia and China to be not so informative. This is probably due to a language barrier and loss of technical content between translations. I did have the opportunity to meet several people and discuss their presentations with them. I have also requested several papers from the authors. At one particular presentation, films of combustion instability in rocket engines were shown, illustrating the 'explosion' of an engine during testing. It was very exciting to visualize the catastrophic damages that can be imposed on an engine. I had an excellent opportunity to gather useful information in preparation of my Thesis. The conference provided a broad perspective on the importance of our efforts at UCI. Proceeding to the conference will be published later this year. The next conference is tentatively scheduled for 1995 in Paris, France.

## Appendix C

### Statement

I have received and read a copy of the APEP Procedures Manual.

Print Name \_\_\_\_\_

\_\_\_\_\_  
Signed

\_\_\_\_\_  
Date

\_\_\_\_\_ I have carefully read and reviewed the safety section.