Energy Technologies Area

2017 Self-Assessment Project 1

A Self-Assessment of Laboratory Area Oven/Furnace Operation and Maintenance Practices

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Approved by:

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Introduction

Ovens and furnaces are used in lab areas for performing a variety of research tasks. This includes drying of lab ware, removing moisture, sintering of ceramics, and melting of chemical solids to create new compounds. In October 2015 an incident occurred in an ETA lab area involving the use of a defective oven and an unauthorized pressure vessel. This resulted in an explosion, which completely demolished the oven. A number of lessons were learned involving how to properly use the pressure vessels. There were other lessons learned in regards to ovens and furnaces used in lab areas:

1. The oven was not in good operating condition.
2. The oven/furnace was not taken out of service for repairs.
3. There were questions regarding calibration and maintenance of the oven.
4. The pressure reaction process only required a low temperature but was used in an oven with a far greater maximum temperature.
5. The oven did not have an automatic over-temperature shutdown feature. This is a requirement for unattended operations.

See LBNL Lessons Learned #LL16-0019 "Minimize Risk Through Selection of Proper Equipment" for further details: LL16-0019 .

As a result, a good next step is to evaluate how ovens and furnaces are used in other lab areas to ensure similar issues do not reoccur. The ETA Safety Committee has selected oven/furnace practices in laboratory areas as a self-assessment project. This is the first ETA self-assessment project for FY2017.

Requirements

Requirements for the safe use of ovens and furnaces are described in the following documents:

- PUB-3000, Chapter 45, "Chemical Hygiene and Safety Manual", Work Process H-Selection and Use of Engineering Controls"
- PUB-3000, Chapter 14, "Electrical Equipment Safety Program"
- LBNL Electrical Safety Manual- Part II "Electrical Safe Work Practices"
- LBNL Requirements and Policy Manual "Seismic Safety"
- NFPA 45 "Standard on Fire Protection for Laboratories Using Chemicals"
- ETA Integrated Safety Management (ISM) Plan- Section 10, "Identification and Assessment of Hazards"
- Manufacturer's equipment operation and maintenance manuals (Lindberg Blue-M, Thermo Scientific, VWR, etc.)

Activity Manager/Training

All ETA personnel are assigned to one or more Work Activities in the "Activity Manager" Work Planning and Control system. Each Work Activity identifies hazards and various controls for the types of work being performed. Related hazards/controls for high temperature equipment listed in Activity Manager include:

- Use of Autoclaves
- Operation of Heating Mantles, Heating Tapes, or Heating Baths
- Operation or Maintenance of an Oven in Lab Research Areas
- Operation or Maintenance of a Furnace or Kiln

- Operation or Maintenance of a Tube Furnace

Personnel who are assigned to Work Activities are required to read and understand the scope of work, hazards involved, and required controls. Once they understand the Work Activity, they "accept" the assignment in the Activity Manager system. Each Work Activity includes additional controls such as required EHS training courses, "On the Job " training, and emergency procedures.

Daily Integrated Safety Management (ISM)

All ETA personnel are required to maintain a safe work area, wear personal protective equipment when required, and report any safety issues immediately to their supervisor for follow-up and corrective action. Integrated Safety Management (ISM) is a core principle used within ETA for safely performing work. The five functions of ISM are: define the scope of work, analyze the hazards, develop and implement hazard controls, perform work within controls, and provide feedback/continuous improvement. The following practices must be followed on a daily basis:

- Actively perform ISM and work planning each day by making sure the chemicals, tools, machines and equipment are appropriate for the task.
- Check laboratory equipment prior to starting work, and make sure it is in good condition and functioning properly.
- Perform work within the parameters defined by their assigned Work Activity. This includes established pressures, temperatures, quantities, and set points.
- Ensure all safety controls required by their Work Activity are available and in use. This includes adequate personal protective equipment and engineering controls.
- Immediately report any equipment, machine or tool failures, deviations from normal operations, or other deficiencies to the Activity Lead or Principal Investigator.
- Decommission defective equipment immediately if the failure or deficiency may affect its safe operation. Attach a "DEFECTIVE DO NOT USE" tag to prevent use until repaired.

Electrical

All electrical equipment with electrical service >50 volts AC must be approved by a Nationally Recognized Testing Lab (NRTL) or have equivalent approval through the LBNL electrical Authority Having Jurisdiction (AHJ). This is indicated by the testing lab approval logo on the equipment data plate (UL, CSA, TUV, etc.) or a green "AHJ" approval sticker. Electrical equipment such as ovens and furnaces must be maintained in good condition. This includes electrical cords, controllers, heater elements, refractory, and doors.

Seismic

The following are requirements for seismically securing equipment:

- Bookcases, file cabinets, storage cabinets, electronics racks, and other furnishings that are more than 4 feet high, regardless of weight.
- All equipment and furnishings that are mounted at 4 feet or less above a floor level and weigh more than 400 pounds.
- All equipment that is mounted more than 4 feet above a floor level to a vertical surface and weigh more than 20 pounds.
- All equipment that is suspended below a floor and weigh more than 20 pounds.
- Bookcases and other furnishings regardless of height or weight where they might block doors or exit passages.

- Equipment that is mounted to a table top and weigh more than 100 pounds.
- 160-liter Dewars and compressed gas cylinders.
- Any equipment, storage cabinet, or container that contains hazardous materials.
- Heavy items on shelves where they might fall down on personnel below.

Methodology

The following methodology was used to conduct this oven and furnace self-assessment:

1. The self-assessment team made field observations in each ETA lab area. See Attachment 1 for the survey form used. The information collected included:
    a. Type of oven/furnace
    b. Brand/model
    c. Nationally Recognized Testing Laboratory (NRTL) approval status
    d. Maximum temperature
    e. Shut-off controls
    f. Chemicals/gases used
    g. Overall condition
    h. Seismic restraint
    i. Noteworthy practices

2. A researcher self-assessment survey was also generated and distributed to the Principal Investigators/Area Safety Leads. Personal interviews were conducted to collect information. See Attachment 2 for the survey form used. The information collected included:
    a. What are the typical uses of the various types of ovens and furnaces?
    b. How is the equipment calibrated for temperature settings?
    c. What type of equipment maintenance is performed?
    d. Is there any On the Job training required for oven/furnace users?
    e. Are there any issues/concerns regarding use of ovens and furnaces in the lab areas?
    f. Review of oven/furnace list and rank condition as "good", "fair", and "poor".

3. A summary spreadsheet of ETA ovens/furnaces and field observations is presented in Attachment 3 of this report.

4. The following personnel participated on the self-assessment team:
    a. Ron Scholtz- ETA Safety Manager
    b. Ari Harding- ETA Electrical Safety Officer (ESO)
    c. Researcher Interviews:
        i. Mike Tucker
        ii. Marca Doeff
        iii. Yanbao Fu
        iv. Guoying Chen
        v. Wang Hay Kan
        vi. Min Ling
        vii. Ning Li

5. The scope of this project applied to the following ETA lab areas:
   a. Building 62
      62-102, 62-220, 62-246, 62-305, 62-308, 62-310, 62-312, 62-314, 62-316, 62-320, 62-342, 62-348, 62-350.
   b. Building 70
      70-103, 70-108, 70-114, 70-123, 70-143, 70-166, 70-215, 70-218, 70-226, 70-263, 70-269, 70-279, 70-291, 70-295, 70-297, and 70-299.
   c. Building 75C
   d. Building 977
      977-271, 977-272, 977-274

6. The following were not included in the scope of this self-assessment:
   a. Non-ETA operated areas in Buildings 62 and 70 such as Facilities, Earth Sciences, and Nuclear Sciences.
   b. ETA lab areas that do not include ovens and furnaces
   c. Office and break areas that contain consumer-heating devices such as microwaves and toasters.

Summary of Findings, Observations and Noteworthy Practices

The following is a summary of findings, observations, and noteworthy practices identified by the self-assessment team. Significant items identified in the findings section are each entered into the Corrective Action Tracking System "CATS" to ensure these are addressed and completion documented. Detailed survey results are found in Attachment 3.

Findings:

1. There were 16 non-NRTL ovens/furnaces identified that do not have their Electrical Equipment Inspection Program (EEIP) tags (green dot) affixed. Inspections must be arranged and any issues identified corrected. (**CATS #10094**)
2. A number of ovens/furnaces should be seismically secured. This is due to the weight or location near exits. (**CATS #10095**)
3. Several ovens were observed with "do not use" signs affixed to the door. They were still plugged in and it was not clear why they could not be used. Several others had damaged doors or missing screws on the cover plates. A more formalized process needs to be identified for properly taking equipment out of service and preventing its use until repaired. A system of warning tags that are tie-wrapped to the equipment plug will be communicated to lab personnel. (**CATS #10096**)
4. At least two ovens were observed plugged into a multiple outlet strip. The high amperage of ovens can cause the power strip to fail and is a potential fire issue. Both instances were corrected immediately. A Safety Alert has been distributed to lab personnel about proper use of power strips and ensuring they are not overloaded. (**CATS #10097**)

Equipment Inventory Observation:

1. See Attachment 3 for a summary spreadsheet of the information collected during the field observations.
2. A total of 121 ovens, furnaces, and other heating devices were identified in ETA lab areas.
3. The types of furnaces and ovens observed can be categorized as follows:

   a. Lab Ovens: 29
   b. Vacuum Ovens: 21
   c. Box Furnaces: 23
   d. Muffle Furnaces: 9
   e. Tube Furnaces: 14
   f. Glove Box Antechamber Heaters: 8
   g. Environmental Chambers: 6
   h. Other: 11 (incubator, fuel cell test chambers, heat press, membrane tester)
4. Nationally Recognized Testing Lab (NRTL) Listing
   a. NRTL listed equipment: 37
   b. Non-NRTL listed but approved by LBNL (green dot): 68
   c. Non-NRTL, requires inspection: 16
5. Temperature
   a. Lab Ovens: (250-300 °C)
   b. Vacuum Ovens: (200- 300 °C)
   c. Box Furnaces: (1,100- 1,1700 °C)
   d. Muffle Furnaces: (1,200 °C)
   e. Tube Furnaces: (1,100 – 1,500 °C)
6. Chemicals
   a. Hydrogen: 11
   b. Nitrogen: 4
   c. Air: 3
   d. Oxygen: 1
   e. Acetylene: 1
7. Shut-off
   a. Thermal and Voltage Cut-off: 12
   b. Over Temperature: 8
   c. Timer: 3
   d. Note: Many ovens have digital temperature controllers. It is not clear if a built-in high temperature shut-off is provided. This is an area that requires further follow-up by the responsible PI's.
8. Seismic
   a. Seismically Secured: 34
   b. Not Seismically Secured: 87
   c. Located on the floor: 11
9. Hood Storage
   a. There are 7 box and muffle furnaces currently located inside fume hoods.
10. Condition
   a. Good: 91
   b. OK: 27
   c. Fair: 1
   d. Poor (Out of Service): 2

Researcher Survey Observations:

1. The uses for the various categories of ovens and furnaces identified can be summarized as follows:

   a. Lab Ovens- General uses such as drying glassware, regenerating desiccant, low temperature needs.
   b. Vacuum Ovens- Drying electrodes and other materials that need moisture removal prior to placing into a glove box. The glove box antechamber heaters provide a similar use.
   c. Box Furnaces- Making materials by reacting precursors. Sintering, ceramic processing. Uses of crucibles.
   d. Muffle Furnaces- Similar use as a box furnace. Different type of door.
   e. Tube Furnaces- Oxidizing metals such as nickel, sintering metals, synthesis of cathode materials
2. Calibration
   a. Lab ovens generally use a thermometer placed through a port on the top.
   b. Occasionally use a hand-held meter for higher temperature ovens.
   c. Temperature readings are normally stable and are rarely verified if thermocouples are secured and in correct position.
   d. Temperature can vary from one spot inside an oven to another. Depends on where thermocouple is placed.
   e. Biggest issue is a loose thermocouple or thermocouple that is not adequately secured and can fall out.
3. Maintenance
   a. Regular preventative maintenance is not normally performed. If operated in accordance with manufacturer's instructions, they can perform for a number of years without any problems.
   b. Vacuum pumps on vacuum ovens need to have oil changed every three months.
   c. Heating element and controller are the most common items that fail.
   d. Difficult to get repairs. Sometimes it is easier to buy a new oven instead.
   e. Ovens with damaged insulation can create temperature differences not sensed by the thermocouple.
4. Training
   a. Researcher gives overview of work to PI. The PI approves the work and then instructs the Lab Safety Lead to provide OJT on specific equipment.
   b. A responsible person is identified for each type of equipment and this person gives OJT to new workers.
   c. Equipment is fairly easy to use, so no formal training is given. Post doc to post doc interaction.
   d. Does not appear to be any written guidelines available.
   e. Need to consider routine uses vs. a new type of research that has not been performed.
5. Issues and Concerns
   a. Oven chambers can become contaminated with sulfur and solvents from previous users. Can contaminate samples. Need periodic cleaning.
   b. Ovens with soft insulation. It is possible to puncture and make contact with heating elements (electrical hazard).
   c. Ovens are placed inside fume hood to capture odors and/or heat. Takes up valuable hood space that could be used for other research purposes.

d. Ovens used for pressure reactor work must have a high temperature shut-off. This should be required.
e. Tube furnace vent lines leading into hood or duct must be adequately secured to prevent from falling out. Particularly important when using flammable or toxic gases. In these cases, the vent lines must be of metal construction. Many vent lines observed were plastic-type material.
f. Tube furnace vent line or bubbler can become plugged causing overpressure of furnace tube. Need to consider pressure relief valve.
g. Tube furnace can create vacuum if temperature is not ramped down properly. This can cause the contents of the bubbler to get sucked into a hot tube creating steam (pressure).
h. If using a handheld thermocouple with a metal sheath, and sticking it into an operating furnace to calibrate/check the correct temperature, it may be possible to contact the electrified heating element and produce a shock. Many, but not all, furnaces have exposed heating elements in the process area or in the vicinity of the built-in thermocouple. Ceramic-sheathed, or mechanically-fastened calibration thermocouple should be used to check furnace operation.

Electrical Safety Officer (ESO) Walkthrough Observations

1. Several ovens were observed with paper "do not use" labels taped on the door. The units were still plugged in. It was not clear if a safety hazard existed and it appears the labels had been affixed for a long period of time.
2. Several ovens observed had defective doors that did not seal completely. The latches need to be repaired. Poorly sealed doors could result in temperature reading errors.
3. Ovens in 62-314 and 62-342 were observed with cords stretched taunt to reach overhead outlets. The ovens either need to be relocated closer to a proper outlet or a longer replacement cord installed.
4. Two ovens were observed plugged into a multiple outlet strip. The amperage exceeds the rating of the power strip and presents a fire hazard.
5. Several ovens were observed with missing cover screws, loose covers, damaged refractory. These should be properly taken out of service until repaired.
6. Equipment manuals were not readily available in most lab areas.
7. Items were observed stored on top or near ovens that could melt or burn.
8. The 2-thermocouple input safety feature is recommended for the purchase of any new ovens/furnaces.
9. Several ovens were observed with the electrical cord touching the outer oven wall. In the event the wall becomes hot, this could result in damage to the cord.

Noteworthy Practices:

1. Many of the ovens in lab area 70-143 have labels affixed that indicate the maximum operating temperature. In addition, ovens that have the generic "0-10" temperature selection dials have signs affixed that indicate what temperatures each setting represents.
2. The Principal Investigator responsible for lab areas 62-312, 62-314, and 62-320 requires her personal prior approval for research by all new personnel prior to allowing OJT training by the Lab Area Safety Lead. This ensures that training is provided for the proper types of equipment.

3. Lab area 70-297 has purchased a hand-held thermal meter for verifying temperature calibration of their ovens and furnaces. This device works at higher temperatures seen for furnaces.
4. All ETA Work Activities that involve use of ovens and furnaces have specific oven operation and maintenance requirements built into the work description. Additional oven/furnace information such as Safety Alerts and equipment manuals are maintained in the attachments section.

Conclusions and Future Improvements

Conclusions

The following conclusions summarize the results of the ETA oven/furnace self-assessment project:

1. Overall, the furnaces and ovens observed were in good to fair condition. No serious hazards were observed such as frayed electrical cords or evidence of fires.
2. Ovens and furnaces are in widespread use throughout the lab areas. Nearly every worker very commonly uses these.
3. There is not a lot of maintenance required for ovens and furnaces if operated within manufacturer's requirements. When they do fail, it is usually involves the heating element or controller which requires a Qualified Electrical Worker (QEW) for repair. Those interviewed do not have an ongoing maintenance/calibration program. In addition, getting repairs made is difficult or expensive.
4. There is no formalized training for use of ovens/furnaces other than On the Job Training (OJT) some Principal Investigators may require. The amount of information available in PUB-3000 is very limited. Detailed hazards/controls for furnace and tube furnace use were only recently added into Activity Manager.

Recommendations and Suggested Future Improvements

The following recommendations and improvements should be made in order to enhance oven and furnace use in ETA lab areas:

1. The LBNL Engineering Division has confirmed that they are able to make electrical repairs to most types of ovens and furnaces. Lab personnel need to be made aware of how to obtain Engineering Division support through their on-line request system.
2. A formalized process needs to be implemented for taking defective equipment out of service. This includes "Danger- Do Not Operate" tags affixed to the equipment outlet to prevent use. This process needs to be communicated to lab personnel and supplies made readily available. The LBNL Electrical Safety Committee should also look at a process that can be used lab-wide.
3. The damaged or improperly energized equipment identified during the Electrical Safety Officer walkthrough needs to be addressed.
4. EHS and Protective Services Divisions should consider updating one or more of the PUB-3000 procedures to include detailed requirements for the proper use of ovens and furnaces. The current requirements are limited to consumer devices.
5. A centralized database of commonly used oven and furnace equipment manuals should be maintained by ETA and made available to lab personnel. Currently, equipment manuals

are attached to related Work Activities, but many workers are probably not aware these are available.

6. Additional training is needed for oven and furnace use to increase awareness. This could be incorporated into existing courses such as EHS0348 "Chemical Safety" and EHS0260 "General Electrical Safety Awareness". In addition, a simple on-line module specific to oven and furnace use could be developed and linked as optional training on applicable Work Activities.
7. Further assessments need to be made for ovens situated inside fume hoods. Ideally, these should be relocated to a bench top with localized exhaust. EHS can assist in assessing the hazardous nature of materials being vented (if any).
8. Tube furnace operations need to be further evaluated and proper set-up documented. There are potential hazards about tube venting, securing of vent lines, and potential overpressure of the tube.
9. Ovens that have "0-10" temperature setting dials should be more clearly labeled so that the approximate temperature is associated with the number on the dial. This can be in the form of a chart affixed to the oven or located nearby. In addition, each oven should have a label affixed that indicated the maximum operating temperature. This serves as a reminder to the lab worker what the equipment capabilities are.
10. Many of the ovens surveyed have digital controllers. It was not readily apparent if these controllers include an over-temperature feature. If there is an over-temperature feature included, it is recommended that the equipment has an identification label clearly affixed. In addition, the users need to be made aware of how to set-up this feature and ensure the settings are correct. If the equipment does not have an over-temperature feature, NFPA 45 does not permit unattended operation.
11. Purchase of any new ovens or furnaces should include the 2-thermocouple input safety feature or other automatic over temperature shut-off feature. This is usually an option only, but LBNL should consider this as a requirement for particularly high temperature equipment such as box and tube furnaces.
12. Principal Investigators should perform a walkthrough of their lab areas at least annually and assess the condition of their ovens and furnaces. This should include an evaluation of what types of work is being performed with the equipment and ensuring that their lab workers are familiar with proper operation.
13. The results of this self-assessment will be made available to ETA personnel so that they are aware of issues identified and future plans (**Completed**- Posted on ETA Safety website and announced in division communications).
14. A follow-up self-assessment should be performed in 2-3 years to determine if there have been any changes in oven/furnace use, overall equipment condition, and procedures.
15. Hot plates and similar devices were not within the scope of this self-assessment but are in very common use in all lab areas. A next logical topic for a self-assessment in 2018 should include hot plate use.

ATTACHMENT 1
ETA Oven and Furnace Field Evaluation Form

ETA Oven/Furnace Field Assessment Form

1. Building/Room:

2. Type:

3. Brand/Model:

4. Volts/Watts/Amps:

5. Typical Use:

6. Maximum Temperature:

7. Type of Shut-Off:

8. Chemicals/Gases Used:

9. NRTL Status:

10. Overall Condition:

11. Seismic Restraints:

ATTACHMENT 2
ETA Oven and Furnace Researcher Survey Form

ETA Oven/Furnace Survey

Researcher:

Lab Areas:

Date:

1. What are the typical uses for the following types of ovens/furnaces?
    a. Laboratory Oven:
    b. Vacuum Oven:
    c. Box Furnace:
    d. Muffle Furnace:
    e. Tube Furnace:
    f. Other

2. How do you calibrate the equipment temperature settings?

3. What types of equipment maintenance is normally performed?

4. Is there any On the Job training required for oven/furnace users?

5. Any issues/concerns regarding use of ovens/furnaces in lab areas?

6. Please review your list of ovens/furnaces and rank their condition as "good", "fair", and "poor".

ATTACHMENT 3
ETA Oven and Furnace Summary Sheet

Area	Researcher	DIV	Type	Brand/Model	Volts	KW	Amp	Temperature	Shut-off	Chemicals/Gases	NRTL	Condition	Seismic	Other
62-100B	Tucker	ESDR	Box Furnace	Thermo Lindberg Blue M	208/240	3.5	14.6	1700 C	No. Separate control console	None	Yes-LBNL	Good	Yes	
62-100B	Tucker	ESDR	Box Furnace	Thermo Lindberg Blue M	208/240	3.5	14.6	1700 C	No. Separate control console	None	Yes-LBNL	Tagged-"Out of Service"	Yes	Damaged refractory inside
62-100B	Tucker	ESDR	Box Furnace	Lindberg Blue M	208/240	4.5	16	1,500 C	None	None	Yes-LBNL	Good	Yes	
62-100B	Tucker	ESDR	Tube Furnace	Thermo Lindberg Blue M STF554433C-1	240	6	25	1,500 C	None	None	Yes-LBNL	Good	Yes	On cart
62-100B	Tucker	ESDR	Tube Furnace	Thermo Lindberg Blue M STF554433C-1	240	6	25	1,500 C	None	4% Hydrogen Bal Argon	Yes-LBNL	Good	Yes	
62-102	Tucker	ESDR	Box Furnace	Lindberg Blue M	208	3.5	30	1,700 C	None	None	Yes-LBNL	Fair	No	"Do Not Use- Brick Loose"
62-102	Tucker	ESDR	Box Furnace	Thermo Scientific Blue M BF51314C #1	208/240	3.5	14.6	1,700 C	None	None	Yes-LBNL	Good	Yes	
62-102	Tucker	ESDR	Box Furnace	Thermo Scientific Blue M BF51314C #2	208/240	3.5	14.6	1,700 C	None	None	Yes-LBNL	Good	Yes	
62-102	Tucker	ESDR	Box Furnace	Lindberg Blue M BF51848A-1	120	1.8	15	1,100 C	None	None	Yes- UL	Good	No	
62-102	Tucker	ESDR	Box Furnace	Lindberg Blue M BF51866A-1	120	1.8		1,100 C	None	None	Yes- UL	Good	No	
62-102	Tucker	ESDR	Furnace	Barnstead/Thermolyne 4800	120	1.8	15	1,200 C	None	None	Yes-LBNL	Good	No	
62-102	Tucker	ESDR	Lab Oven	Precision Econotherm	120	1.3	11.3	210 C	None	None	Yes-LBNL	Good	No	
62-102	Tucker	ESDR	Muffle Furnace	Barnstead Thermolyne	120	2.25	18.6	1.200 C	None	None	Yes- UL	Good	No	
62-102	Tucker	ESDR	Muffle Furnace	Vulcan 3-550	120			1,200 C	None	None	Yes- ETL	Good	No	
62-102	Tucker	ESDR	Muffle Furnace	Thermo Scientific Thermolyne	120	1	8.3	1,200 C	None	None	Yes- CSA	Good	No	
62-102	Tucker	ESDR	Oven	Binder	120	0.8	7	300 C	None	None	Yes- UL	Good	No	Not in Use-On Floor
62-102	Tucker	ESDR	Tube Furnace	Blue M TF55035A	120	0.8	7	1,100 C	None	None	Yes-LBNL	Good	No	
62-102	Tucker	ESDR	Tube Furnace	Lindberg LCC114RA/6	240		30	1,200 C	None	None	Yes-LBNL	Good	No	
62-102	Tucker	ESDR	Tube Furnace	Lindberg Blue M	120	0.8	7	1,100 C	None	None	Yes-LBNL	Good	No	

62-102	Tucker	ESDR	Vacuum Oven	Precision Model 19	120		4.2	0-10 Dial	None	None	Yes- UL	OK	No	Latch Doesn't Work
62-102	Tucker	ESDR	Vacuum Oven	Sheldon Lab 1410	120		4	0-10 Dial	None	None	Yes- CSA	OK	No	On Cart
62-220	Tong	ESDR	Rapid Temp Furnace	CM, Inc.	208/240			1,700 C	Yes- Overtemperature	Air	Yes- LBNL	Good	No	
62-220	Weitcamp	CY	Vacuum Oven	Precision	120			0-10 Dial	None	None	No	OK	No	Located in Hood
62-246	McCloskey	ESDR	Environmental Chamber	Thermotron SM-1.0-3200 #4	120	0.6	11.68	Key Pad	Thermal and Voltage Cut-off	None	Yes- LBNL	Good	No	
62-246	McCloskey	ESDR	Environmental Chamber	Thermotron SM-1.0-3200 #3	120	0.6	11.68	Key Pad	Thermal and Voltage Cut-off	None	Yes- LBNL	Good	No	
62-246	McCloskey	ESDR	Lab Oven	Lab-Line	120	0.1	0.83	0-10 Dial	None	None	Yes- LBNL	OK	No	
62-246	McCloskey	ESDR	Tube Oven	Buchi Glass Oven B-585	125	0.45	13	Digital Dial	None	Phosphorous Pentoxide	Yes- CSA	Good	No	
62-305	Chen	ESDR	Lab Oven	Cole Parmer 05015-50	120	0.8		0-9 Dial	None	None	Yes- LBNL	Good	No	
62-308	McCloskey	ESDR	Lab Oven	Lab-Line Model 120	120		0.83	0-10 Dial	None	None	Yes- LBNL	Good	No	
62-308	McCloskey	ESDR	Vacuum Oven	VWR 1470	120			0-10 Dial	Yes- Overtemperature	Vacuum	No	Good	No	44060
62-310	McCloskey	ESDR	Lab Oven	VWR	120			0-10 Dial	Yes- Over Temperature	None	Yes- LBNL	Good	No	Located on Floor
62-310	McCloskey	ESDR	Vacuum Oven	Thermo Scientific Labline	120			0-10 Dial (6=120 C)	None	Vacuum	Yes- LBNL	Good	No	
62-312	Chen	ESDR	Box Furnace	Lindberg Blue M BF51848A-1	120	1.8	15	1,100 C	None	None	Yes- UL	OK	No	Missing Cover Screws
62-312	Chen	ESDR	Box Furnace	Lindberg Blue M BF51848A-1	120	1.8	15	1,100 C	None	None	Yes- UL	OK	No	Missing Cover Screws
62-312	Chen	ESDR	Box Furnace	Lindberg Blue M BF51866A-1	120	1.8	15	1,100 C	None	None	Yes- UL	Good	No	
62-312	Chen	ESDR	Drying Oven with Forced Convection	Binder	120	0.8	7	0-10 Dial (300 C)	None	None	Yes- UL	Good	No	
62-312	Chen	ESDR	Lab Oven	Thelco	120	1.3	11.3	250 C	Yes- High Limit 40 C	None	Yes- UL	Good	No	
62-312	Chen	ESDR	Muffle Furnace	Barnstead Thermolyne 1400	120	1.45	15	1,100 C	None	None	Yes- LBNL	OK	No	Located in Hood
62-314	Chen	ESDR	Box Furnace	Lindberg Blue M	120				None	None	Yes- LBNL	Good	No	

62-314	Chen	ESDR	Drying Oven with Forced Convection	Binder 9010-0196	120			0-10 Dial (300 C)	None	None	Yes- UL	Good	No	Missing knob on temp dial
62-314	Chen	ESDR	Gravity Convection Oven	MTI Corp. OV-55-00AB	120	0.6		200 C	Alarm	None	Yes-LBNL	Good	No	
62-314	Chen	ESDR	Lab Oven	VWR 13054	120		7	0-10 Dial	None	None	Yes-LBNL	Good	No	
62-314	Chen	ESDR	Tube Furnace	Lindberg Blue M HTF55322A	120	2.87	23	1200 C	None	Hydrogen, Nitrogen	Yes-LBNL	Good	No	Separate temperature controller
62-316	Tucker	ESDR	Controlled Atmosphere Furnace (Tube) #1	Lindberg Blue M	208			1500 C	None	2% Hydrogen Bal Argon	Yes-LBNL	Good	Yes	
62-316	Tucker	ESDR	Controlled Atmosphere Furnace (Tube) #2	Lindberg Blue M	208			1500 C	None	2% Hydrogen Bal Argon	Yes-LBNL	Good	Yes	
62-316	Tucker	ESDR	High Temperature Furnace	GSL-1500X-OTF	220	6		1500 C	Yes- Manual	None	Yes-LBNL	Good	Yes	On cart
62-316	Tucker	ESDR	Muffle Furnace	Vulcan 3-550	120			1,100 C	None		Yes-LBNL	OK	No	Located in Hood
62-316	Tucker	ESDR	Muffle Furnace	Vulcan 3-550	120			1,100 C	None		No	OK	No	Located in Hood
62-316	Tucker	ESDR	Tube Furnace	Barnstead/Thermolyne F21135	120	1.4	11.3	1200 C	None	None	Yes- CSA	OK- Cord Issue	No	Not in Use
62-316	Tucker	ESDR	Tube Test Furnace	Applied Test Systems				1200 C	None	Hydrogen	Yes-LBNL	OK	Yes	Attached to rack
62-316	Tucker	ESDR	Tube Test Furnace	Applied Test Systems				1200 C	None	Hydrogen	Yes-LBNL	OK	Yes	Attached to rack
62-316	Tucker	ESDR	Tube Test Furnace	Applied Test Systems				1200 C	None	Hydrogen	Yes-LBNL	OK	Yes	Attached to rack
62-316	Tucker	ESDR	Tube Test Furnace	Applied Test Systems				1200 C	None	Hydrogen	Yes-LBNL	OK	Yes	Attached to rack
62-316	Tucker	ESDR	Tube Test Furnace	Applied Test Systems				1200 C	None	Hydrogen	Yes-LBNL	OK	Yes	Attached to rack
62-316	Tucker	ESDR	Tube Test Furnace	Applied Test Systems				1200 C	None	Hydrogen	Yes-LBNL	OK	Yes	Attached to rack
62-320	Chen	ESDR	Box Furnace	Thermo Scientific	120	1.8	15	1,100 C	None	None	Yes-LBNL	Good	No	Located in Hood
62-320	Chen	ESDR	Glove Box Antechamber Oven	VAC OC-HT	120		10		Oven Overtemperature	Vacuum	Yes-LBNL	Good	Yes	Attached to glove box

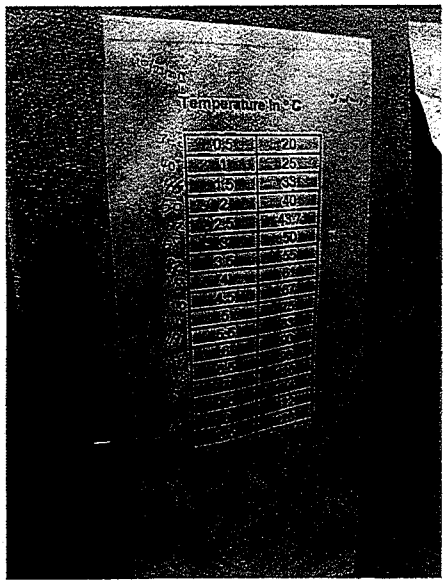
62-320	Chen	ESDR	Vacuum Oven	Precision Model 19	120	0.5	4.2	0-10 Dial	None	None	Yes- UL	OK	No	
62-320	Chen	ESDR	Vacuum Oven	VWR 1410				0-10 Dial	None	Vacuum	Yes- LBNL	Good	No	
62-320	Chen	ESDR	Vacuum Oven	Thermo Scientific	120								No	
62-342	Doeff	ESDR	Glove Box Antechamber Oven	VAC OC-1	240		20			Vacuum	Yes- LBNL	Good	Yes	Attached to glove box
62-342	Doeff	ESDR	Oven	VWR 1326	120		9	0-10 Dial	Yes- Set Over Temp	None	Yes- LBNL	Good	Yes	Extension cord used to reach outlet near ceiling
62-342	Doeff	ESDR	Tube Furnace	Lindberg Blue M TF55035A-1	120	0.8	6.8	1,100 C	None	Oxygen	Yes- LBNL	Good	No	
62-342	Doeff	ESDR	Vacuum Oven	Thermo Scientific 6500 Model 19	120		4.2	0-10 Dial	None	Vacuum	Yes- UL	OK	No	On Floor
62-348	Balsara	ESDR	Oven	VWR 1326	120			0-10 Dial	Yes- Over Temperature Dial	None	Yes- LBNL	Good	No	Seismic not connected
62-348	Balsara	ESDR	Vacuum Oven	Thermo Scientific 6500 Model 19	120		4.2	0-10 Dial	None	Vacuum	Yes- UL	Good	No	
62-350	Tong	ESDR	Box Furnace	Thermo Scientific Blue M BF51894C-1	208/240	3.5	14.6	1,100 C	None	None	Yes- UL	Good	No	
62-350	Tong	ESDR	Lab Oven	Quincy Lab Model 10	120	0.6	5.2	0-10 Dial	None	None	Yes- LBNL	Good	No	On Floor
62-350	Tong	ESDR	Oven Forced Air	VWR 89511-414	120	1.66	13.8	250 C	None	None	Yes- CSA	Good	No	
70-103	Destaillats	EAEI	Lab Oven	Fisher Model 15G	120		6.1	0-20 Dial (~220 C)	Connected to YSI-72 Proportional Temperature Controller	None	Yes- LBNL	Good	No	
70-108	Kostecki	ESDR	Glove Box Antechamber Oven	VAC OC-1	240		20	Digital controller	None	Vacuum	Yes- LBNL	Good	Yes	Attached to glove box
70-108	Kostecki	ESDR	Mechanical Oven	Lindberg/Blue M	120	1.6	13.5	260 C	None	None	Yes- UL	Good	No	
70-108	Kostecki	ESDR	Vacuum Oven	Precision				0-10 Dial (no operation >100 C)	None	Nitrogen	Yes-	Good	No	Vacuum - 30"
70-114	Liu	ESDR	Box Furnace	Thermo Scientific/Blue M	208	3.5	14.6	Max 1,100 C	None	None	Yes- UL	Good	No	
70-114	Liu	ESDR	Glove Box Antechamber Oven	VAC OC-22	220		10	Digital controller	None	Vacuum	Yes- LBNL	Good	Yes	Attached to glove box

70-269	Liu	ESDR	Muffle Furnace	Thermo Scientific Thermolyne	120	1.06	8.9	1200 C	None	None	Yes- CSA	OK	No	
70-274	Slack	BTUS	Gravity Convection Oven	NAPCO Model 5510	120	0.8	6.7	0-10 Dial	None	None	Yes- UL	Good	No	
70-274	Slack	BTUS	Tube Furnace	Lindberg	240	2.68		1200 C	None		No	Good	No	
70-279	Weber	ESDR	Vacuum Oven	Cole Parmer Hotpack 207360	240		4.7	40-280 C	None	None	Yes- LBNL	OK	No	
70-279	Weber	ESDR	Vacuum Oven	Binder				0-10 Dial	None		Yes- LBNL	Good	No	
70-289	Cairns	ESDR	Environmental Chamber	ESPEC BT2-133	120		16	180 C	Limit Control Fault	Compressed Air	No	Good	No	
70-289	Cairns	ESDR	Glove Box Antechamber Heating Tray	Red Lion T16	120			200 C	None	Vacuum	Yes-UL	Good	Yes	Attached to glove box
70-289	Cairns	ESDR	Lab Oven	Cole Parmer 05015-50	120	0.8		0-10 Dial	None	None	No	Poor	No	"DO NOT USE" tagged on cord
70-289	Cairns	ESDR	Vacuum Oven	NAPCO 5810	220			0-10 Dial	None	None	Yes- LBNL	OK	No	Remote temperature controller. Very old.
70-295	Battaglia	ESDR	Glove Box Antechamber Oven	VAC OC-22	208		10	Digital controller	None	Vacuum	No	Good	Yes	Attached to glove box
70-295	Battaglia	ESDR	Incubator	Thermoelectron Precision	120	0.2	1.7	70 C	None	None	Yes- UL	Good	Yes	
70-297	Battaglia	ESDR	Lab Oven	Thermolyne Series 9000	120			250 C	None	None	Yes- LBNL	OK	Yes	
70-299	Cairns	ESDR	Tube Furnace	Carbolite HTR 11/75	208	1.64	8.2	1,100 C	None	Acetylene, Hydrogen, Argon	Yes- LBNL	Good	Yes	Work Activity ED-0003
70-299	Battaglia	ESDR	Tube Furnace	Lindberg/Blue M STF55666C-1	240	11	46	1,100 C	None	Nitrogen	Yes- LBNL	Good	Yes	
75C	Rapp	EAEI	Lab Oven		120	0.75	6.3	250 C	None	None	No	Good	No	On Floor
977-271	Taynton	CY	Glass Oven	Buchi B-565	120	0.45		Digital	None	None	Yes- CSA	Good	No	
977-271	Taynton	CY	Heat Press	Power Heat Press OX-A	120	1.8		140 C	Timer	None	No	Good	No	
977-271	Taynton	CY	Oven	VWR	120		5	0-10 Dial	Yes- Over Temperature	None	Yes- UL	Good	No	On Floor
977-271	Taynton	CY	Oven	Thermo Scientific Heratherm OMH180	120			250 C	None	None	Yes- CSA	New	No	Still in Box

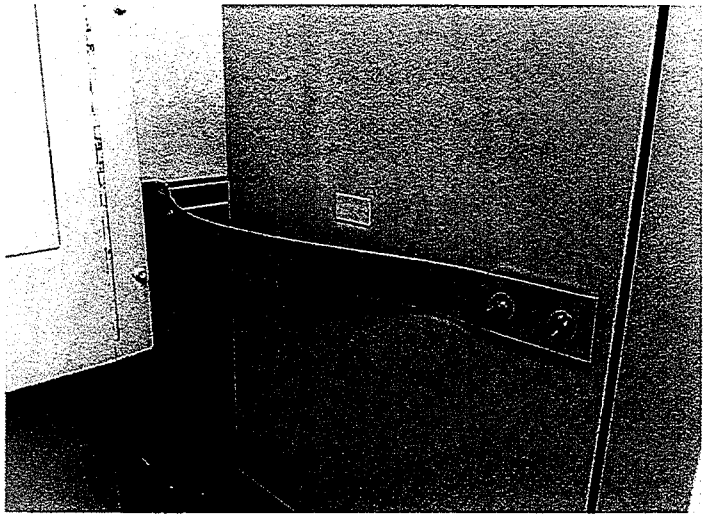
70-114	Liu	ESDR	Tube Furnace	Thermo Scientific/Blue M Mini Mite	120	0.8	6.8	Max 1,100 C	None	None	Yes-LBNL	Good	No	
70-143	Weber	ESDR	Environmental Chamber	Thermotron SM-1.0-3200 #2	120	0.6	5.2	25-95 C	None	None	Yes-LBNL	Good	Yes	RH= 20-95%
70-143	Weber	ESDR	Environmental Chamber	Thermotron SM-1.0-3200 #1	120	0.6	5.2	15-85 C	None	None	Yes-LBNL	Good	Yes	RH= 20-96%
70-143	Weber	ESDR	Environmental Chamber	Caron 6010-1	120			5-70 C	None	Compressed Air	Yes-LBNL	Good	Yes	RH- 20-80%
70-143	Weber	ESDR	Lab Oven	VWR	120			Min/Max Dial (Max 230 C)	None	None	Yes	Good	Yes	
70-143	Weber	ESDR	Membrane Test System	Scribner Associates 740				180 C	Yes- EMO	Hydrogen, Nitrogen	Yes-LBNL	Good	No	
70-143	Weber	ESDR	Vacuum Oven	NAPCO 5851	120			0-10 Dial (35-200 C)	None		Yes	OK	Yes	
70-166	Zormpa	ESDR	Box Furnace	Thermo Lindberg/Blue M	120	1.8		Max 1,100 C	None	None	Yes- UL	Good	None	Located in Hood
70-201	Destaillats	EAEI	Muffle Furnace	Thermolyne 1400	120	1.51	2.6	0-6 Dial (1200 C)	None	None	Yes-LBNL	OK	No	
70-215	Kirchstetter	EAEI	Furnace	Omegalux LMF-3550	120	1.44	12		None	None	Yes- ETL	OK	No	
70-218	Battaglia	ESDR	Vacuum Oven	NAPCO 5851	120			0-10 Dial (128 C)	None	None	Yes- CSA	OK	No*	Secured to cart. Cart on wheels.
70-220	Levinson	BTUS	Muffle Furnace	Thermolyne 1400	120	1.56	12.5	1200 C	None	None	Yes- UL	Good	No	Located in Hood
70-223	Maddalena	EAEI	Gravity Oven	VWR 1330G	120	1.55	13	0-10 Dial	High Limit Setting	None	Yes-LBNL	Good	Yes	
70-226	Liu	ESDR	Box Furnace	Thermo Lindberg BF51894C-1	208	3.5	14.6	Max 1,100 C	None	None	Yes- UL	Good	No	
70-226	Liu	ESDR	Lab Oven	VWR 1300U	120		4	0-10 Dial	None	None	Yes-LBNL	Good	No	
70-249	Gadgil	ETA	Lab Oven	VWR 1330GM	120			0-10 Scale	Timer (On-Off)	None	Yes-LBNL	Good	No	Not in Use
70-249	Gadgil	ETA	Lab Oven	Thermo Heratherm	120			250 C	None	None	Yes- CSA	Good	No	Located on Floor
70-263	Kostecki	ESDR	Glove Box Antechamber Oven	VAC OC-1	240		20	Digital controller	None	Vacuum	No	Good	Yes	Attached to glove box
70-263	Kostecki	ESDR	Lab Oven	Jojo Tech Lab Companion	120			300 C Max	Timer	None	No	OK- Issue with door knob	No	
70-269	Liu	ESDR	Lab Oven	VWR	120				None	None	Yes-LBNL	Good	No	

977-271	Taynton	CY	Vacuum Drying Oven	Hydrion Scientific VDO-23e	120			Digital	None	None	No	Good	No	
977-271	Taynton	CY	Vacuum Oven	Shel Lab	120		10	Dial with "dots"	None	None	No	Good	No	
977-272	Mansfield	CY	Incubator	VWR 1570	120		7	25 C	Yes- Over Temperature	None	No	Good	No	
977-272	Mansfield	CY	Oven	Thermo Scientific Precision PR305225	120	1	10	Dial (no #'s)	None	None	Yes- UL	Good	No	On Floor
977-274	Wang	CY	Vacuum Drying Oven	Hydrion Scientific VDO-23e	120			250 C	None	None	No	Good	No	On Floor
977-274	Wang	CY	Vacuum Drying Oven	Hydrion Scientific VDO-23e	120			250 C	None	None	No	Good	No	On Floor
977-274	Wang	CY	Vacuum Drying Oven	Hydrion Scientific VDO-23c	120			250 C	None	None	Yes- LBNL Conditional Approval	Good	No	On Floor

ATTACHMENT 4
Best Practices



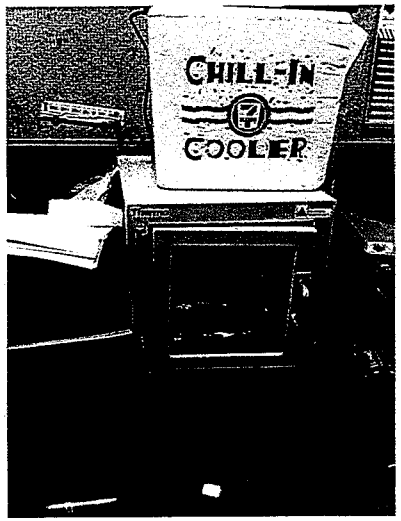
Temperature Chart for
0-10 Dial



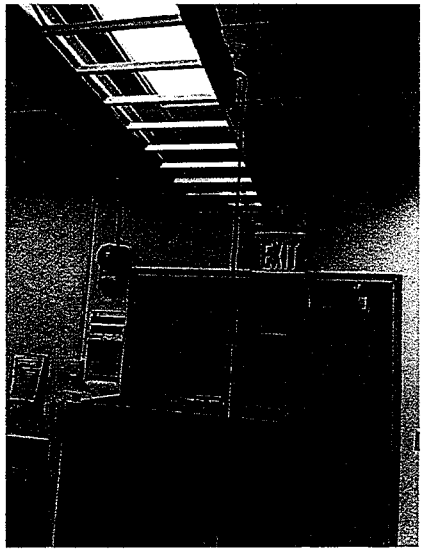
Good Seismic
Strapping

Good tagging out of defective

ATTACHMENT 5
ISSUES



Storage on and near ovens



Taut Electrical Cord