University of Arkansas College of Engineering

High Density Electronics Center
Policies and Procedures

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Section 1. High Density Electronic Center Overview

1.1. Program of Excellence

Since its inception, the University of Arkansas' High Density Electronics Center (HiDEC) has pursued a program of excellence in research and education that has earned the program a national and international reputation. Several U.S. patents have been issued on HiDEC inventions and a number are pending. HiDEC papers are regularly presented at every major conference dealing with electronic packaging or packaging materials.

Several HiDEC research projects have been funded by, and performed for, companies in the electronic, biomedical, and aerospace industry. Projects have ranged from simple MCM designs to an entire technology development and reliability evaluation.

UA graduate students have a unique opportunity to pursue a degree with an emphasis in electronic systems and multichip technology. Extensive hands-on laboratory experience has led graduates to exceptional jobs in industry with leading companies such as Advanced Micro Devices, Anadigics, Harris, IBM, Integrated Device Technology, Intel, Lucent Technologies, Micron Technology, Motorola, National Semiconductor, Northrop Grumman, Raytheon, Sheldahl, and Texas Instruments.

1.2. Brief History

The research center began as an outgrowth of work conducted on thallium-based high temperature superconducting materials and their subsequent application to superconducting multichip modules (MCMs). HiDEC research has expanded to include work on synthetic diamond MCM substrates, low cost MCM design techniques, flip chip die attachment, integrated passive components, and other aspects of high density electronic packaging. The thin film facility originated from a partnership between the University of Arkansas and nChip that involved renovating a Truck and Tractor repair building into a thin-film processing lab. Operational in 1993, the HiDEC facility includes nearly 4,000 sq. ft. of cleanroom space initially specified at class 1000/100 (ISO class 6/5 respectively) for conventional MCM processing on 125 mm wafers. The HiDEC complex also began with reliability, wideband electrical characterization, and CAD laboratories in the adjacent UA Engineering Research Center and has since expanded these capabilities.

1.3. Mission

HiDEC's mission is to:

1. Promote and support University-based, faculty-lead research by providing staffed research laboratories in which they can execute their research.

2. Promote education by supporting lab-based University courses and by the teaching of fabrication courses by HiDEC staff.
3. Provide opportunities for outreach to Arkansas high- and middle-school students to encourage them to pursue engineering and/or science careers.
4. Stimulate growth of high-technology businesses in Arkansas by making facilities available to small, Arkansas-based technology companies, thus allowing them to better leverage their own research funding.

1.4. Core Competencies

HiDEC's expertise can be organized under six general headings: MCM technology, LTCC technology, Integrated Passives, MEMS, Analysis/Reliability, and CAD/CAM. A limited list of skills in these areas is show below:

MCM Technology
- Silicon, ceramic, and polymer-based substrates
- MCM/Ball Grid Array/Flex
- MCM D/L and D/C Substrates
- 3-D MCMs
- Packaging of SiC-based power devices

LTCC Technology
- LTCC fabrication from design to testing
- Cavities
- Full tape thickness features

Integral Passives
- Resistors
- Capacitors
- Inductors

MEMS
- MEMS Design and Processing

Analysis/Reliability
- Thermal Stress Modeling and Evaluation
- Thermal shock / thermal cycling
- Wafer-level probing and yield analysis

CAD/CAM
- MCM/PCB design
- LTCC design
- Artwork conversion

1.5. Center Capability Overview

The Center consists of thin- and thick-film manufacturing labs, as well as satellite lab facilities that provide additional fabrication and characterization capabilities, including the following:

HiDEC Thin Film	HDEC 101	PECVD, PVD, RIE, Diffusion, Oxidation, Electroplating, Contact Lithography, ICP, Profilometer, Ellipsometer, Critical dimension tool, IR oven, Aerosol jet printer
HiDEC Thick Film	ENRC-4802	CNC via punching, Screen printing, Vacuum sealing and lamination, Hot knife cutter, Firing ovens
Thick Film (cont.)	ENRC-4501	Firing ovens, Fume hoods, Heated press
Assembly	ENRC-4514	Wire bonder, Dicing saw, Reflow station, Reflow ovens, Flip chip bonder

Reliability	ENRC-4312	Thermal Shock, Temperature cycling
Electrical Characterization	ENRC-4316	Flying probe tester, Thin film stress tool, Impedance analyzer, Network analyzer, Pull tester
Analytical	ENRC-4308	3D Printer, Scanning acoustic microscope, Cross-section lab & microscope, CNC milling machine, SEM sputter coater, Pull test & Die shear tester, Profilometer
Electron Microscopy Lab	ENRC-1960C	Scanning electron microscopy, E-beam evaporator, Differential pressure laminator
Nano-Synthesis Lab	ENRC-4607	Acoustic mixer, Ball mill, Centrifuge, Critical point dryer, Cryogenic probe station, Low humidity glove box, Magnetometer, Micropore physiorption analyzer, UV spectrophotometer, X-ray diffraction

1.6. Proposal Evaluation Criteria and Process

1.6.1. Standard Research Proposals

Review of all research proposals that anticipate utilizing HiDEC facilities is **strongly recommended**. The goal of this review is to improve the likelihood that the proposal will be funded by assuring that the necessary equipment and processes are available to execute the work specified in the proposal. The review process is shown below:

1. Potential user submits and presents the general aspects of the proposal to the HiDEC Director.
2. The proposal is reviewed by the HiDEC Director and Staff with regards to the availability of HiDEC resources/capabilities requested.
3. Feedback is given to the potential user with respect to changes to the proposed work that may be necessary, based on equipment and personnel availability. For work requiring a significant amount of creative effort from a HiDEC staff or faculty member, it is expected that the staff/faculty will be recognized for their efforts as a co-investigator on the project and/or as a co-author on any resulting publications.

Every effort will be made to complete the review process within two weeks after submission.

1.6.2. Preliminary Research Proposals (PRePs)

PRePs are useful for potential users seeking to improve their chances of securing a research contract by creating a proof-of-concept prototype. PRePs allow utilization of HiDEC facilities free-of-charge for prototype-based projects that qualify. The approval process is as follows:

1. A PReP proposal is presented to the HiDEC Director and Staff. In the proposal, the following information must be provided:
    a. A description of the type of deliverable to be produced and the time needed to create it.
    b. An indication of the funding agency the proposal is targeting.
    c. Information regarding the size of the award anticipated and the anticipated portion of the potential award that would be used to support efforts in one of the HiDEC facilities.
    d. An outline of the resources needed (in terms of staff assistance and equipment utilized) for the initial prototype work, as well those required if a contract is awarded.

2. The proposal is reviewed by the HiDEC Director and Staff with regards to the availability of HiDEC resources/capabilities requested, technical merit, and the likelihood of potential future funding.
3. The individual submitting the PReP is notified as to whether the proposal is:
    a. Approved
    b. Approved with suggested changes
    c. Denied (with full explanation)

PRePs will be limited to 300 lab hours or six months. **Researchers using HiDEC facilities under PReP guidelines are required to submit quarterly reports to the HiDEC Director that indicate progress towards the proposed prototype.** Appeals for extensions are allowed at the discretion of the HiDEC director when delays are caused by equipment failure, facility issues, or other unforeseen circumstances. **The cost of unique materials and supplies that may be needed to complete the project will not be covered by the Center; these are the responsibility of the user.**

1.6.3. PReP Proposal Content

A three- to five-page description of the proposed work should be provided for PReP proposals. The proposal should cover the same information that would be assembled for submission to a major sponsor; a full draft proposal would suffice as an alternative. Below is a list of items to cover in a NSF or NIH proposal, provided as a general guide:

1. [Aim] The specific goals of the project that details your plan of execution
    a. This section begins with a 2-3 sentence problem statement.
    b. Make sure you indicate the significance of the proposed research.
    c. The overall objective of this research should also be included to give a sense of how this effort relates to your long-term research goals.
2. [Problem] The significance of the research proposed is included in this next section.
    a. This section consists of about one page to describe the background details of the proposal. The goal is to demonstrate your understanding of the problem by analyzing pertinent work done by other investigators.
    b. Include key questions that have yet to be addressed or evaluated and suggest how your research will address these unanswered questions.
3. [Competency] Describe your current experience and knowledge on the proposal topic in this section
    a. If applicable, include publications or previous work that is related to the research effort.
4. [Research Design & Method]
    a. This section, the longest section of the research proposal, describes how stated project goals will be executed. A brief description of the approach should be given, followed by a description of the experiments to be conducted to achieve each goal. Sufficient detail should be provided to enable the reader to understand the scope of the proposal. However, the applicant is not expected to divulge any sensitive information.
5. [Resources]
    a. This section outlines the timeline for completion of the effort, the equipment set needed, and (if necessary) the HiDEC staff members required for training or direct assistance.

Section 2. Lab Access and Fees

2.1. Access

2.1.1. HiDEC User classification and Rates

HiDEC's fee schedule is shown below and addresses the lab rate for two different user types:

- **Academic users** are faculty and their associated students/post-docs employed by a state-run University, or HiDEC staff members performing work in HiDEC labs. The base lab rate shown does not include any F&A rates; any project that is handled by Research and Sponsored Programs (RSP) will be charged the current F&A rate on top of the base rate shown below. There is no cap on lab fees when the work is performed by HiDEC staff members.
- **External users** (direct billed) are all other users (including those employed at the Arkansas Research Technology Park (ARTP) or elsewhere) that utilize HiDEC facilities and are billed by HiDEC directly. They are charged the base plus the F&A rate.

It is important to note that the rates shown for Academic Users is the cost seen by the project PI, *not the cost seen by the project sponsor*. Ultimately, all users outside the University see the same rate.

Before utilizing any HiDEC facility, all lab users must undergo the HiDEC orientation (Phase II Right-to-know) session. More detailed information on the requirements of this Phase II orientation is given below under Section 3.3. Note that **external companies that have employees in the cleanroom will need to have proof of liability insurance on file with HiDEC before entering the cleanroom.**

Table 1: HiDEC Facility Rate Fee (*Rates shown are for fiscal year 2018 and are subject to change*)

Activity	Description	User Categories	
		Academic Users (Direct cost)	**External Users (F&A rate included)**
Laboratory Time	Base Time	Up to 30 hrs/mo.	**0 - 50 hrs/mo.**
	Time cap	30 - 60 hrs/mo.	**50 - 160 hrs/mo.**
	Excess hours	> 60 hrs/mo.	**>160 hrs/mo.**
Laboratory Rates	Base Rate	$54	**$80**
	Cap rate	$1,620/mo. per person	**$4,000/mo. per person**
	Excess hours rate	$5.40	**$8.00**
Staff support[1]	Fabrication, design, training[2]	Staff salary	**Staff salary + F&A rate[3]**
Misc. charges	Supplies	At Cost	Cost + F&A rate

[1] Staff support charges are in addition to lab charges calculated on an hourly rate that includes both salary and fringe.

[2] For all training, lab charges are billed for only one user. This applies when one student is training another student or when a staff member is training someone.

[3] As of July 2016, the *maximum* staff support charge for external users is approximately $100.00. The current F&A rate in affect for the University applies.

2.1.2. Laboratory Rates

Except where noted in section 2.1.7, charges are billed in quarter hour increments and are based on time spent in the cleanroom or lab as opposed to specific equipment utilized. Charges begin from the time the student enters the door of the facility and ends when he/she leaves. Therefore, it is important for everyone to log in and out. Typically, lab fees are collected on a monthly basis, although this schedule can be adjusted if warranted by the needs of a sponsor.

2.1.3. Logout Violations

For each instance where a user fails to provide a log out time they are charged a logout violation fee that is equivalent to four hours in the cleanroom at the user's scheduled lab rate.

2.1.4. Time Cap

The time cap denotes the upper time limit range in which charges switch from an hourly rate to a flat monthly charge. The monthly cap on cleanroom fees allows researchers to continue research that takes longer than anticipated and to simplify the development of a budget that accurately gauges laboratory usage. Time caps are on a per-individual basis, while **a user working on multiple projects has a time cap that is applied on a per-project basis**.

2.1.5. Excess Hours

Excess hour charges are to discourage inefficient use of equipment and the facility. The charge is 10% of the base rate.

2.1.6. Staff Support

Staff support charges are for process training and support. The HiDEC orientation session (Phase II Right-to-know) is free. Staff is available to answer questions and offer advice without charge within reason; however, projects that require major technical assistance (project consultation exceeding a cumulative two hours and/or hands-on support) will be subject to staff support charges. To facilitate better communication, researchers are encouraged to structure projects as joint research efforts with staff members whenever possible.

2.1.7. Reliability & Analytical Equipment Rates

Equipment in these two areas is generally covered by the standard hourly rate (i.e. scanning acoustic microscope (SAM), cross-sectioning microscope, Dage Bond tester, and Relative humidity chamber). For a few tools however, an individualized charge rate has been established. Please review the rates below for the system you are interested in using.

85/85 Relative Humidity Chamber is $2.00/hour ($3.00/hour for external clients). The time is determined by the amount of time the tool is reserved for the testing. Please budget accordingly as a 1,000 hour run can cost from $2,000 to 3,000.

Delta thermal cycling oven is $2.00/hour ($3.00/hour for external clients). If cycling is utilized, the hour rate is found by determining the duration associated with one cycle; with includes a ramp and soak times at each extreme. There is an additional charge for using liquid nitrogen (in liters) should that be needed and this amount is found by determining the number of cycles that can be run on a 180 L dewar. If staff is requested to prepare a dewar, a minimum 1 hour staff-assist charge will be applied for this service.

Tabai thermal shock system is $2.75/hour ($4.00/hour for external clients). The time is determined by taking the total number of cycles run times the amount of time required per cycle. Clients are welcome

to utilize any existing thermal shock liquid present in the two tanks, but new liquid will need to be purchased separately at the user's expense.

Makerbot 3D printer is $3.00/hour ($4.40/hour for external clients). The time can be obtained by the software once a design is loaded into the software by using the "Preview" option. A separate charge of $0.15/gram will be added if HiDEC supplied filament material is used, although users are welcome to provide their own filament.

Hirayama autoclave is $1.36/hour ($2.00/hour for external clients).

CNC milling machine is $10.00/hour ($15.00/hour for external clients). A separate charge (typically $40) will be applied per broken bit during milling if HiDEC supplied bits are used. Users are welcome and encouraged to provide their own bits or make arrangements for supplies to be purchased by HiDEC ahead of time.

2.1.8. Supplies

Supplies that are covered under the standard lab fee include general consumables such as commonly used chemicals, gloves, hair nets, and cleanroom paper. Supplies that fall under the category of "Miscellaneous Charges" include wafers, wafer tweezers, cleanroom notebooks, dicing blades, CNC bits and other similar items.

Training to fill a liquid nitrogen dewar is provided by process staff or maintenance staff on request. A log sheet is provided near the fill station and requires the name of the user, a fund code, and the weight of liquid nitrogen dispensed. **The charge for liquid nitrogen is $0.50/liter** ($0.76 for external clients); the scale and usage log is adjacent to the LN2 delivery station for the recording of the weight of liquid nitrogen in pounds.

2.2. Equipment transfer credit program

2.2.1. Overview

This program allows a customer to purchase a tool that is then "donated" to the Center to be utilized by the general HiDEC user community. In return, HiDEC provides cleanroom access credit tied to the value of the equipment. This allows the applicant to be assured that the equipment will be maintained daily by HiDEC staff members to assure maximum up-time and alleviates the need of the applicant to assume the often considerable cost of providing the necessary utilities for installation.

2.2.2. Acceptable equipment types

Since there is only a limited amount of space available for new equipment, the primary objective is to obtain equipment that promotes the general technology thrust of the Center as a whole. Therefore, credit under this program is only offered for equipment that replaces, upgrades, or augments heavily-used equipment at HiDEC. "Heavily-used" equipment might be defined as equipment that has the potential to be used by other HiDEC users on a weekly basis. Once a tool is deemed acceptable for credit, the contributor is given credit that is equal to the value of the system as shown in the University's property tag system.

2.2.3. Credit determination/depreciation

The credit given for the equipment tracks with the tool's "book value" and is determined using the general five-year depreciation straight-line method. This method of calculation assumes a scrap end-value equal to 10% of the original purchase price. Following this approach, a tool worth $100K would have book values of $82K, $64K, $46K, $28K, and $10K at the end of years 1, 2, 3, 4, and 5, respectively.

2.2.4. Application of credit

The HiDEC monthly charge cap does not apply to any effort utilizing credit under this program. The following costs will be applied against the credit:

1. Any HiDEC lab usage charges accumulated by users while working on the research effort.
2. Any normal tool maintenance costs (service or upkeep) associated with the donated equipment.
3. Any installation costs associated with the equipment.

Materials and supplies specific to the given research effort are not covered by the credit and are the responsibility of the applicant. Periodic statements will be provided to the applicant to provide updates on the status of their credit under the program. Credit may not be applied to HiDEC staff time under this policy.

2.3. Intellectual Property and Proprietary Research

The University of Arkansas and HiDEC pursue academic and research endeavors in an open environment. From the academic side, this means HiDEC will not exclude any individual based on nationality attending any scheduled lab courses run through one of our laboratories. From the research end, this means that HiDEC is committed to freedom of access by all interested parties to our facilities. While most work conducted at HiDEC falls under public scrutiny, a certain amount of proprietary research is also pursued. **By default, the University of Arkansas and HiDEC regard the nature of the work carried out by any external lab user as confidential and, thus, will not attempt to claim intellectual property developed independently by external clients using the lab.**

Both academic and industrial users can be present in HiDEC labs at any given time. **HiDEC does not generally provide secure storage locations for project supplies or materials, although some limited storage is available.** The Center makes any and all possible efforts to comply with export control concerns. However, **it is the responsibility of principal investigators to assure that any concerns regarding confidentiality or export controls be addressed for their respective project.**

For more specific details, all users are strongly encouraged to refer to the University of Arkansas' Policy on intellectual property.

2.4. Course Offerings

The table below shows a list of classes conducted using HiDEC facilities:

Classification	Course Description	Course Number
Transferred Courses	Integrated Circuit Fab. Lab	ELEG 5293L
	Solar Cell Fab. Lab	ELEG 4223
Staff Taught	ELEG 587V: Microfabrication	*ELEG 5243L*
Staff Assisted	ELEG 587: MEMS Fabrication	

2.4.1. Transferred courses

Transferred are those that were formerly taught in Bell Engineering's Texas Instrument's Research Facility that have now been transferred to HiDEC. An electrical engineering professor and his/her associated teaching assistant conduct these classes with departmental support in the form of a **$1,300 monthly fee** that serves to cover cost associated with the course.

2.4.2. Staff-taught courses

Staff-taught are those classes providing both a theoretical and hands-on training on equipment and capabilities at HiDEC. The current course offering, *ELEG 5243L: Microelectronic Fabrication Techniques and Procedures,* has been in place since 2004. In the near future, HiDEC envisions that similar classes will be taught covering LTCC, assembly, and design aspects of advanced electronic packaging. As with the course currently being taught, courses under this section would be taught by HiDEC research staff during standard working hours during the Fall semester with departmental support in the form of a **$1,300 monthly fee** that serves to cover cost associated with the course.

2.4.3. Staff-assist or Professor-led courses

These courses are regular lecture courses that wish to add a 'lab' portion to better improve the understanding of the material or to provide limited fabrication support. They are conducted by faculty with departmental support in the form of a **$1,000 flat fee for the semester** that serves to subsidize the cost of materials and supplies consumed during the course.

Regardless of the course type, these general rules apply when a class utilizes HiDEC facilities:

- The number of students in a class is not to exceed 10 at any one time.
- No more than one course may be held during the same time period; to insure the limitation is adhered to; instructors must consult with the HiDEC Director and Staff a semester in advance about potential scheduling conflicts with other courses.
- For liability reasons, all students in the course must take the HiDEC Phase II Right to Know orientation prior to entering any HiDEC facility.

2.5. Reporting & Acknowledgement

HiDEC generates periodic reports that provide comprehensive statistics on its research efforts and activities. In order to prepare this report, we ask that all users provide a general summary of their research progress annually. Reports should not only include the status of the work, but also technical obstacles that could be overcome with alternative resources; such information can be used to dictate and justify future spending on infrastructure and equipment.

We also ask that all users provide acknowledgement of all research efforts utilizing HiDEC in publications with a sentence that reads "This research was made possible through the use of the High Density Electronics Center (HiDEC) at the University of Arkansas, Fayetteville," or by using a similar statement. Presentations should acknowledge HiDEC as well, when appropriate.

It is requested that HiDEC staff be informed of the date and particular conference where research is presented that made use of HiDEC resources and that a copy of any publications be provided for inclusion in the HiDEC library.

2.6. MEMS Exchange

MEMS-Exchange uses a web-based interface to connect researchers to needed resources from a network of universities and commercial entities providing a comprehensive list of MEMS-related fabrication processes. The University of Arkansas/HiDEC has been a member since 2003.

Section 3. Laboratory Information

3.1 CAD Resources

The HiDEC Design Laboratory is capable of handling the entire process of mask fabrication. The lab can provide services that include (but are not limited to) design consulting, schematic capture, artwork conversion, design optimization, and production of printed circuit boards for prototyping purposes. Our tool set includes industry standards such as Mentor Graphics' Board Station™ (and MCM Station™), Autodesks' AutoCAD 2015™, and DownStream Technologies' CAM350™. We also possess GDS-to-DXF and GDS-to-Gerber conversion utilities and are able to generate the necessary data for automated testing. Our in-house dual-flying head probing system is capable of high-volume capacitance and resistance testing of substrates at the wafer level.

HiDEC's source for masks with improved resolution is Advance Reproductions, Inc. (http://www.advancerepro.com/). Their photo plots allow minimum feature sizes of approximately 15 microns; for features smaller than this, glass photomasks are needed. A specification and typical cost of these items is shown in the table below. Note that a photomask's minimum feature is usually one or two microns, but HiDEC's contact lithography capabilities are limited to two microns. Photo plots and glass photomasks are always shipped via FedEx Priority Overnight shipping, unless otherwise specified.

Mask Type	Specification (Min. Feature / plot size)	Cost Range
In-house photo plots	0.005" / 11 x 14" approx.	(staff standard labor rate, billed hourly)
Outsourced photoplots	15 microns min. feature / 20 x 24"	$50-$150 (plus taxes and shipping), depending on resolution
Outsourced photomasks	150 x 150mm or 175x175mm	$500 to $1500 (plus taxes/ shipping), depending on critical dimension in design and plate size

3.1. Electrical characterization resources

The HiDEC Electrical Characterization Laboratory contains the tools needed to electrically test structures and systems. The AT&T automated flying two-probe, double-sided tester is used to measure interconnect integrity and isolation on wafers and LTCC substrates up to 150mm in size. The manually operated L117 Gaertner ellipsometer is used to characterize transparent thin films and the Tencor FLX2320A analyzes thin film stresses. The Materials Development Corporation's CSM16 CV plotter is used to evaluate MOS parameters while the HP4291A RF impedance/material analyzer and HP8510 network analyzer are used to characterize integrated passives (capacitors, resistors and inductors), though the latter can also provide evaluation of active devices as well. Other measurement instruments are available as well. A HiDEC staff member should be contacted to answer questions regarding access, training, and certification.

3.2. Storage

3.2.1. Cleanroom

To facilitate equipment use in the cleanroom during the day, HiDEC provides blue process boxes and corresponding PFA wafer boats for both 100 and 125mm wafers. The wafer boats are composed of a material that can survive any hazardous chemicals present in the lab, and the spin rinse dryers have been balanced using the weight of these boats. These wafer boxes and boats are not to be used for storage at any time. Students will need to have their own storage boxes to keep their processed wafers at the end of every day. Although the cleanroom has limited space for long-term storage, areas have been set-aside for some of the long-term projects and for staff use. Users are encouraged to find alternative space for processed wafers or mask sets that require storage longer than one month. HiDEC staff will clean out old wafers and mask sets at the end of each year.

3.2.2. Warehouse

HiDEC utilizes a warehouse located off the ENRC premises for long-term storage of functional accessories for the current set of process equipment in the cleanroom. HiDEC staff members attempt to maintain an inventory of equipment accessories (such as vacuum pumps and chillers) readily available to replace units that fail to insure minimal downtime. The warehouse is not intended to store unused process equipment. A tool that cannot be utilized by HiDEC directly or by a sister laboratory on campus will be turned over to the University's surplus warehouse in a timely manner.

3.3. Certification

3.3.1. Overview

All users must attend the HiDEC orientation session, also known as the "Safety Training" or "Right-to-Know" session, before entering the cleanroom. This is the second part of a two-phase right-to-know program implemented by the University of Arkansas' Environmental Health and Safety department that details the hazards and safety concerns specific to the laboratories at the Engineering Research Center.

3.3.2. The HiDEC Orientation

The HiDEC orientation consists of a 40 minute PowerPoint presentation specific to the HiDEC facilities, a cleanroom gowning demonstration, and a tour describing the equipment and processes available in the cleanroom facility.

3.3.3. Handouts

A new user will be given a cost center form that details cleanroom fees. This cost center form is proof that the advisor/employer has read and understands the rates and agrees to support the user on either a cost center number or via external billing. External (Genesis/ARTP) clients need only to enter the word 'external' instead of a cost center number. Users can return this form any time before they need to enter the cleanroom.

3.3.4. Cleanroom Entry by Visitors

With prior arrangement, visitors may enter the cleanroom for touring purposes without undergoing the certification process, provided they are accompanied by a HiDEC staff member and/or approved tour guide at all times. Visitors should still be made aware of key safety information, including the location of fire extinguishers, telephones, and exits immediately after entering.

3.4. Equipment Use & Training

Before using a laboratory tool alone, ALL users must first complete the process of **certification**. To complete this process, a user must make an appointment with a HiDEC staff member and demonstrate to that staff member that they can operate the tool properly and safely. The certification process MUST be completed by any lab user (whether a student or an external user) before they use a tool on their own, either during regular office hours or after-hours. The staff member will then make a determination if the user is capable of operating the tool without supervision.

Users that use a tool on their own without first completing certification may risk being banned from the cleanroom temporarily or (if warranted by the flagrancy of the violation) permanently.

HiDEC staff members normally conduct equipment training sessions. However, a student that is proficient with a particular tool can demonstrate the tool's operation to new students and can even allow them to operate the tool in their presence. Similarly, external clients that are proficient with a tool may provide training for others, so long as they have been certified to use the tool themselves.

3.4.1. Reserving equipment

Reservation calendars are online at https://uasharepoint.uark.edu/sites/hidec/default.aspx to select process tools that require an extensive amount of time to use or that have a high demand. The following practices below apply when making reservations:

1. The user should attempt to accurately gauge use and avoid reserving large blocks of time. Students are not allowed to reserve a tool for more than 4 hours in a single day; exceptions to this rule must be approved by the HiDEC staff member in charge of the lab in which the equipment is located.
2. The user should cancel any reservation that they know they cannot keep.
3. There is a 15 minute window that begins at the scheduled reservation time during which a user must begin using the tool. If a user fails to begin using the tool during this time, the reservation is deemed forfeit and the tool becomes available to other certified users.

3.4.2. Reporting equipment problems

Any user who has a problem with a tool needs to contact a staff member either via email, phone, or in-person so that the problem can be resolved promptly. Some tools have the following identification markers to note its status:

1. **Up** indicates that a tool is functional and a certified user can begin operation.
2. **In Use** indicates that the tool is currently being utilized.
3. **Out of Order** indicates that the tool requires repair, preventative maintenance, or staff intervention before being utilized by users.

3.4.3. Accident/Incident/Unsafe condition reporting

Incident reporting is essential to ensure adequate preventative action is taken following an incident and is required by the University.

1. **Level I Incidents are those associated with violations that put only the offender at risk**
    a. Example;
        i. Personal attire violation (shorts & sandals)
    b. Prior notification structure;
        i. Proper procedure presented in HiDEC orientation session.
    c. Penalty;

i. First violation results in a written report to user, the associated advisor, HiDEC staff and director.
ii. Repeat violation results in access suspension of HiDEC facilities.

2. **Level II Incidents are those associated with violations that endanger not only the offending party, but possibly other lab users as well.**
    a. Example;
        i. Chemical handling violation, equipment/process usage violation
    b. Prior notification structure;
        i. Proper procedure presented in HiDEC orientation session.
    c. Penalty;
        i. First violation results in a written report to user, the associated advisor, HiDEC staff, and director.
        ii. Repeat violation results in access suspension of HiDEC facilities.

3. **Level III Incidents are those that endanger anyone through the circumvention of existing safety measures or by intentionally deviating from posted procedures intended to protect the safety of the offender or other lab users.** These incident types are considered the most serious, because they demonstrate an active attempt to dismiss safety concerns in an attempt to take "shortcuts".
    a. Example;
        i. Violating the Buddy System
        ii. Mixing chemicals without staff supervision and/or permission
        iii. Intentional circumvention of equipment safety interlocks
        iv. Using equipment unsupervised without first being "certified" by HiDEC staff
    b. Prior notification structure;
        i. Presented in the HiDEC policy, orientation, and posted on facility entryways.
    c. Penalty;
        i. A single violation warrants banishment from all HiDEC facilities.

3.5. Lab Policy

3.5.1. Card Reader Access

Access to the labs is obtained through a University-distributed ID card. Information on how to have a card encoded to access the various HiDEC facilities is available through the HiDEC orientation session.

External users (employees of companies in the Arkansas Research Technology Park and elsewhere) should apply for an "Affiliate" card at the ID card office in the Arkansas Union. **Users doing this should be certain to tell the person in the ID card office that they need their ID card encoded for card reader access.**

Due to safety and other concerns, card reader access to a given laboratory will only be issued after the lab manager for that particular laboratory has sent an email to the HiDEC staff member responsible for granting card reader access indicating their approval to grant access.

3.5.2. Keys

Access to most HiDEC lab facilities is controlled via the University ID card reader system. Office keys are acquired through the HiDEC key administrator after the HiDEC director and/or the Department Head of Electrical Engineering have given their approval.

Since access to practically all laboratories is controlled via card reader units, keys to laboratory areas will be issued only in special cases. Before a key can be issued, the lab manager for a particular lab MUST send an email to the HiDEC key administrator indicating the name of the individual to be issued a key.

Before keys are issued to an individual they must first sign a form acknowledging the keys that they have received and that they are liable for lock re-keying/replacement in the event a given key is lost.

For safety and liability reasons, **keys may not be shared with students or with other individuals**; t**here are no exceptions to this rule.**

3.5.3. Buddy System

For safety reasons, no user can work in the lab alone after 5:00 pm on weekdays or at any time during the weekends.

Any user found in the cleanroom alone after hours will be banned from using the facility ever again. There are no second chances.

A "buddy" is defined as another individual who has undergone the HiDEC orientation session and thus knows the appropriate procedures to take in the event of an emergency. It is the responsibility of each user to check and see if they are the last person in the area.

If a user's departure from the lab would result in another lab user being left alone, the person intending to leave should give the last person fair notice of their intent to leave BEFORE they intend to do so, so that the other user has time to shutdown tools or complete their activity.

3.5.4. Tour policy

Due to the sometimes sensitive nature of the research in Center facilities and to avoid possible interference with equipment installation or facility repairs, all tours must be cleared and supervised by the Director or (in his absence) a HiDEC staff member. If at all possible, at least 24 hours of notice should be given before the scheduled event. Tours should be arranged with a HiDEC staff member or through the office of the Director.

Section 4. Information for HiDEC Staff

4.1. Attendance and Accessibility

4.1.1. Absence from Work

(As per the University of Arkansas Staff Handbook):

If a HiDEC staff member must be absent from work for any reason, they are responsible for notifying the office of the Director directly or via email using the HiDEC Staff email distribution list at **hidecstaff@listserv.uark.edu** within the first hour of their regularly-scheduled time for reporting to work. If they fail to provide sufficient notification (or have someone notify the department for them if they are not able to do so) the absence will be considered unauthorized and may result in disciplinary action.

4.1.2. Work Hours

(AHRMS Policy Manual 200-1.3; Governor's Policy Directive #5)

The governor's policy directive requires all state offices to be open for business between 8:00 a.m. and 4:30 p.m., Monday through Friday. However, department administrators may establish other working hours, so long as all full-time employees work a forty-hour work week. At the University, work hours for most full-time employees are from 8:00 a.m. to 4:30 p.m., with one-half hour for lunch, although some departments require different work schedules. The standard HiDEC work schedule is indicated below.

HiDEC Standard work schedule			
	Start Time	Stop Time	Lunch Break
HiDEC Staff (Mon-Fri)	8:00 a.m.	5:00 p.m.	60 minutes

Occasionally, it may be desirable for a staff member to leave early for the day for personal (or other) reasons; this may be accommodated at the discretion of the Director by having the staff member arrive earlier or by reducing their lunch period, so long as the practice does not impact operation of the Center and so long as the employee still works eight hours for the day. **Any long-term time-shifting arrangement must be pre-approved by the Director.**

4.1.3. Accessibility policy

Employees are expected to be accessible during normal office hours. The office of the Director should be generally aware of where staff are currently located or have a means of contacting employees should the need arise. Below is the list of HiDEC personnel and their public contact preference information.

HiDEC Staff Contact Information		
Staff Member	***Contact Type***	***Contact Number***
Tom Cannon	Phone (forwarded to cell)	479-575-5031
Kaoru Porter	Cell phone	479-236-0693
Errol Porter	Cell phone	479-236-0693
Clinton Hardee	Office	479-575-4371

4.2. Purchasing

4.2.1. Standard Operating Procedures for Ordering Chemicals and Equipment

Staff members should receive approval on all purchases from the appropriate individual in control of the cost center number (CCN) being charged, typically the Principal Investigator (PI). The HiDEC Director has provided blanket authorization for HiDEC staff to make purchases up to $1,000 that are deemed necessary for operation and maintenance of the laboratories. For purchases above this amount, an email should be sent to the Director and HiDEC staff that includes details about what is being purchased, what CCN is being used, how much it will cost, why it is necessary, and (if applicable) the avenue for said purchase to be recovered through HiDEC login fees.

There are four approaches to purchasing equipment and materials depending on the cost of the item.

1. Purchases under $10,000: The staff member can contact one vendor, have them send a quote (including freight), and put together a requisition request using the blank Excel worksheet provided (the "standard" requisition form can be provided upon request). This document is then emailed to the appropriate purchasing contact begin the purchase order process.
2. Purchases between $10,000 and $50,000: The staff member is required to fax or email a Request for Quote form to a minimum of three vendors as well as a specification sheet detailing the requirements of the material or equipment (a blank form can be provided on request). If a

vendor cannot meet the desired specifications, they should still fill out the form and indicate NO BID, as this will still count as one of the three necessary quotes. Also, the vendor MUST include the freight cost on the form, even if it is an estimate. Once three quotes have been received, a phone bid requisition form must be created (a form will be provided on request). Care must be taken on the form to check off the vendor who has won the award. If the lowest bidder is not chosen on the bid sheet, an explanation must be given as to why the lowest bidder wasn't chosen. The explanation **must** show that some criteria in the specifications were not met by a vendor. A hardcopy of the phone bid request, the specification sheet, and a copy of the three quotes must then be provided to the appropriate UA purchasing contact so that they can begin the purchase order process.

3. Purchases at $25,000 or over: A detailed specification sheet of the item to be purchased must be prepared along with any vendors that the staff member specifically wants included in the bidding process. The specification sheet should be emailed to the appropriate purchasing contact to prepare a requisition request. The University of Arkansas's purchasing agent (Andy Fletcher) will review the specifications and may contact the staff member that requested the item if the information is not specific enough.
4. Sole Source requests: A sole source is used to acquire items that are only available from one source and thus are exempt from the normal bidding process. *This purchasing method is seldom required and should only be used when absolutely necessary*. The sole source process can be directly pursued under the following conditions:

    a. Equipment accessories that are available only from an Original Equipment Manufacturer for a piece of equipment currently owned or used by the University.
    b. Service calls or repairs from an original equipment manufacturer.
    c. Lastly, a sole source can be made for an item having unique properties. This one is the most difficult to fulfill as a thorough explanation of the unique property must be provided. In addition, an outside expert who can be contacted that supports your explanation must be provided. Further, it is necessary to show how due diligence has been applied in the search to insure that no other source makes something similar to what is required.

It is worth noting that by the time one collects all the information needed to complete item C for a sole source request, it generally would have been possible to prepare a phone bid and have the purchase already completed.