CAES STANDARD FOR WORK PLANNING AND DOCUMENTATION

Projects should be planned in accordance with the work planning requirements for the principal investigator's home organization. The level of rigor used to plan the work is a function of the type of task and risk inherent to its execution. In all instances the work planning process will systematically address:

- Activity/Task descriptions
- Risk and controls
- Waste generation
- Training
- Emergency Procedures
- Exit Strategy

Recognizing one size does not fit all, attached are examples of the level of documentation needed that may be appropriate based on risk and scope.

Working closely with the CAES point-of-contact, the PI should decide on the level of project documentation that is appropriate for their project. Also, the POC will familiarize the PI with the core set of hazards and mitigations that are in place for each lab, which are already accounted for and only need to be referenced in the project planning documentation.

Describe the project:

Identify the Hazards involved in project:

_____ Electrical
_____ Mechanical
_____ Flammable Gas/Liquid
_____ Compressed Gas
_____ Pressure or Vacuum
_____ Dangerous Chemicals
_____ Thermal Energy
_____ Radioactive Materials
_____ Radiation Source
_____ Lasers
_____ Confined Space/Limited Egress
_____ Other (specify below)

Briefly describe the primary hazards involved in the operation(s)

The primary hazards in project 213 are solvents, acids and bases, toxic/carcinogenic powders (nickel oxide), and compressed gases. Electrical, Mechanical, and Thermal hazards also exist.

Describe how hazards are controlled?

1. PURPOSE/SCOPE/APPLICABILITY

Research Activity Description (Provide a description to include the following):	
1.	**PROGRAM/PROJECT OBJECTIVES and Description:** Non-technical terms…what are you doing; Provide technical detail sufficient to describe physical conditions that will be presenting the hazards identified.
2.	**MAJOR EQUIPMENT USED IN ACTIVITY:** Major pieces of equipment, equipment that may pose a significant safety concern. Also state if manufacturer or in-house instruction will be followed for operation.
3.	**ACTIVITY LOCATION BY AREA or LAB ROOM NUMBER:**
4.	**ACTIVITY LAB LEAD, PRINCIPAL INVESTIGATOR AND RESEARCHERS:**

2. RISK AND CONTROLS

Table 2.01. Table format for risk and controls.

Task	Researcher Controlled Activity	Hazard	Engineering Control	Administrative Control	Personal Protective Equipment (PPE)
General chemical handling	☐	Inhalation, Ingestion, Eye or skin exposure to toxic or corrosive chemicals	Eyewash and emergency showers located in each lab Use exhaust hoods or local exhaust ventilation for handling particularly hazardous substances (carcinogens, reproductive toxins, or agents with high acute toxicity, volatile chemicals or chemical/materials that present a significant airborne hazard	Labs or areas within labs must be posted as designated work areas for handling particularly hazardous substances if applicable. Labs must be posted with specific PPE requirements if applicable. Monitoring of chemical hazards as identified by Industrial Hygiene (IH). Housekeeping will be used for the proper segregation of incompatible chemicals.	Nitrile gloves, lab coat, safety glasses with side shields
Handling carcinogens and	☐	chemical toxicity	Safety showers and eye washes	Post area as required.	Nitrile gloves, lab coat, safety glasses with side shields.

reproductive toxins			Use in fume hood.		
	☐				
	☐				
	☐				
	☐				

Table 2.02. AND/OR fill-in-field format for risk and controls.

Hazard scenarios that require mitigation. Such as chemical spills, acid burns to the skin, fume hood fire

Table 2.03. Waste generation.

Type of Waste	Generation Location	Anticipated Volume	Container Type	Disposal Method
i.e. RCRA organic	IF 603 Lab B-1	0.5L/month	poly bottle	Store in SAA. Notify WGS for disposal instructions.

List any special needs/requirements for storage and handling wastes.
If a spill occurs, how will it be cleaned up?
Describe anything else that may be relevant for waste disposal purposes.

2.1 Training Required

Training of Project Personnel			
Activity	**Training Required**	**Activity**	**Training Required**

Working with chemicals that requiring PPE	Personal Protective Equipment 00TRNXXX	Generating wastes	Satellite Accumulation Area 00TRNXXX
Working with chemicals	Chemical hygiene modules SMJSXXX series (B, E, N, P, Q, R, S, U, V and W)	Handling compressed gas cylinders	Compressed Gas Safety Training 0TRNXXX,
Working in lab (unescorted)	CAES Laboratory Awareness Training 00TRNXXX		
Working with chemicals	Chemical Hygiene Plan 000TRNXXX		

3. Work Control Documents

Identify and attach SOPs that control or supplement execution of this work: (e.g., Home institution work control documents, emergency procedures, CAES Laboratory SOPs, etc.)

Co-located Research Activities for this Work: Identify any hazards associated with co-located work that need to be considered in the execution of your project.

4. FACILITY CONDITIONS or POST START ACTIVITIES

I.e. Ensure that the laboratory fume hood, eyewash and safety shower are operating within acceptable limits and have up to date certification tags. Verify ventilation is functioning properly prior to performing laboratory work.

5. LESSONS LEARNED

Valuable Lessons Learned information gathered from another institution, researcher or laboratory to provide insight to process outcome and/or event prevention/mitigation.

5. POST-PERFORMANCE ACTIVITIES

Post-experimental clean-up and equipment dismantlement

6. ABNORMAL OPERATIONS

To include instructions for “operation under abnormal conditions **not** abnormal operating instructions.

RESEARCHER CONTROLLED ACTIVITY

Activity Scope:

Describe Ordinary Hazards and mitigations for this Activity including existing JHA/JSA, training or PPE:

Principal Investigator: Indicate the basis for granting Researcher Controlled Assessment by placing an "X" in one or more boxes, as applicable. Check-box 1 is for *knowledge* (see def.). Check-box 2 is for *mentoring* (see def.). Check-box 3 is for *demonstrated competency* (see def.) Names may be added or removed by the Principal Investigator. Only people whose names appear below may perform work on this activity.

Names of Qualified Personnel

		#1	#2	#3			#1	#2	#3
1.	_____	☐	☐	☐	11.	_____	☐	☐	☐
2.	_____	☐	☐	☐	12.	_____	☐	☐	☐
3.	_____	☐	☐	☐	13.	_____	☐	☐	☐
4.	_____	☐	☐	☐	14.	_____	☐	☐	☐
5.	_____	☐	☐	☐	15.	_____	☐	☐	☐
6.	_____	☐	☐	☐	16.	_____	☐	☐	☐
7.	_____	☐	☐	☐	17.	_____	☐	☐	☐
8.	_____	☐	☐	☐	18.	_____	☐	☐	☐
9.	_____	☐	☐	☐	19.	_____	☐	☐	☐
10.	_____	☐	☐	☐	20.	_____	☐	☐	☐

Principal Investigator and Laboratory Lead Approvals

	Signature:		
PI Name:	_____	Date: _____	Lab. _____
	Signature:		
Laboratory Lead Name:		Date:	Lab.

After the template is initially signed off, the PI may add additional names by initialing and dating the new name.

1 **SCOPE** *This document describes the standard operating procedures and practices encountered and to be practiced in MEC laboratory 213 as well as any research performed outside of 213 in support of Dr. Butt's research programs. Due to the scope of research, the various chemicals, processes, and waste types that can potentially be used or generated in our research group, this document is not intended to be comprehensive. It is a guide, primarily defining safe work practices. Depending on the operation that an employee or student is performing, a worker may be required to have additional instruction, procedures, and/or work permits. When unsure, employees are required to seek guidance from Dr. Butt and/or their appropriate subject matter experts. It is mandatory that all individuals who perform work in room 213 be fully aware of this document's existence, understand its contents, and abide by it. This burden of knowledge, therefore, is the responsibility of both Dr. Butt and the individual. A copy of this document must be prominently posted in room 213.*

2 **DESCRIPTION OFTHE OPERATION**

Room 213 serves as the central laboratory for research and development for Dr. Butt's programs, primarily in the areas of corrosion and materials processing. The operations may be classified as follows:

- Powder batching
- Catalyst coating
- Substrate cleaning
- Powder comminution
- Viscosity measurements
- Slip and ink degassing
- Aqueous based powder processing
- Solvent based powder processing
- Etching and sample preparation
- Thermal Gravimetric Analysis (TGA)
- Differential Thermal Analysis (DTA)
- Gas-solid reactions
- Electrochemical measurements
- Autoclave
- Furnaces

• Induction heating All or part of these operations may be carried out outside of room 213.

3.1 HAZARDS OF THE OPERATION

There are a variety of chemical, electrical, and mechanical hazards in room 213. The worker must understand the hazards and precautionary measures associated with:

- Acids and bases
- Solvents
- Fine particulate
- Potential carcinogens/toxins (e.g., nickel oxide and cobalt oxide)
- Pressurized gases
- Electro-mechanical equipment
- Radioactive Materials

3.2 STOP WORK PRACTICE

A worker should never perform a job if she/he believes it to be unsafe or if inadequate PPE is available. If a worker feels a job can not be performed

safely, she/he should see her/his supervisor immediately for resolution. If you feel pressured into performing a job that you believe to be unsafe, see Human Resources immediately.

3.3 PERSONAL PROTECTIVE EQUIPMENT (PPE)

Safety glasses must be worn at all times by all workers and visitors in room 213.

Workers must wear properly fitted, **approved respirators** whenever working with hazardous chemicals such as solvents (e.g., toluene), or fine or hazardous powders such nickel oxide and cobalt oxide.

It is recommended that **approved dust masks** be worn when working with course, non hazardous nuisance powders.

Workers must wear **face shields** and chemical resistant gloves when working with strong acids, bases or any other chemicals of similar toxicity.

Workers must wear **appropriate gloves** whenever handling hazardous chemicals.

It is recommended that workers wear **laboratory coats** whenever handling powders and chemicals, regardless of the hazards. **Other appropriate PPE may be required**, such as chemical resistant aprons, ear plugs, etc., when handling chemicals or performing certain operations.

NOTE: *Lab Safety Supply* is a good source for purchasing of and information on PPE. See your safety officer for information on and proper fitting of PPE.

3.4 ENGINEERING CONTROLS FOR HAZARDS

The laboratory is equipped with an exhaust hood. This **hood** must be used when ever handling hazardous materials that can become airborne at levels approaching or greater than OSHA limits.

Chemicals must be stored in **appropriate cabinets** with adequate ventilation.

It is recommended that all liquid chemicals be placed in **secondary containers** (e.g., pans) that are capable of holding at least 110% of the volume of liquid held in the primary container(s).

It is mandatory that liquid chemicals be placed in **secondary containers**when 1) incompatible chemicals are placed on the same surface or 2) when chemicals are placed on a flat surface level with or above a drain.

Incompatible chemicals must always be **physically segregated** by storing them in separate cabinets and/or secondary containers.

The laboratory must be equipped or have access to appropriate **chemical spill kits**.

A **safety shower and eye wash station** are located in the labortory.

3.5 ADMINISTRATIVE CONTROLS FOR HAZARDS

A catalogue containing **material safety data sheets** (MSDSs) of all the chemicals used in 213 must be maintained in 213. MSDSs describe the hazards, limits, and controls associated with a material or chemical. Workers must be familiar with the hazards of the materials with which they are working.

All chemicals, including those stored in temporary storage or process containers, must be **properly labeled**.

Personnel must have **pre-approval** by his/her direct supervisor in order to perform work alone.

Signs must be posted prominently describing the general hazards, PPE, and rules of 213. (Note, the number of signs should be kept to a reasonable minimum, be clear and concise.)

Before performing any work in 213, workers must have a thorough understanding of this document and those described at the end of this SOP, and must have received the prescribed training.

4.1 **WASTE** A variety of solid and liquid wastes can be generated in 213. The worker is required to understand how to safely handle, store, and dispose of these materials.

Once you determine a material:

- cannot be reused,
- cannot be used for it's intended purpose,
- has exceeded it's shelf life,
- has no known owner or generator,
- is no longer wanted or needed, or
- is an end product of a process or experiment that cannot be used as feedstock in an existing process,

IT IS A WASTE. (This may or may not mean it is a "hazardous waste".) Examples of **illegal waste** treatment include:

- Leaving solvent wetted wipes in a hood or on the bench top to air dry.
- Leaving a container open to allow the waste to evaporate.
- Pouring an unapproved waste into a drain.
- Diluting a waste to render it nonhazardous.
- Venting a pressurized aerosol can solely to remove the propellant.

4.2 ENGINEERING CONTROLS FOR WASTE

Hazardous waste must be disposed of properly, in accordance with BSU's **Working With Hazardous Waste Policy**. All workers in 213 must be fully familiar with this policy.

In addition to the engineering controls described above in section **3.4 Engineering Controls for Hazards**, the following additional controls apply for waste in 213.

Satellite waste storage is provided in 213. All stored waste must be in approved containers and WPFs (see attachment).

Approved aqueous based waste (i.e., waste with an approved WPF) may be disposed of in the sink.

4.3 ADMINISTRATIVE CONTROLS FOR WASTE

In addition to the engineering controls described above in section **3.5 Administrative Controls for Hazards**, the following additional controls apply for waste in 213.

WPFs must exist for all waste. WPFs must be kept on file in room 213.

Standard Operating Procedure
MEC 213

4.4 SEGREGATION OF WASTE

You must segregate your waste streams. Keep: • liquids and solids in separate containers;

	• hazardous and nonhazardous waste in separate containers; and You must physically segregate, by secondary containment, (separate spill trays, cabinets, etc.) your hazardous waste while in storage from: • nonhazardous waste, • drains, • incompatible waste, and • product chemicals.
4.5 HAZARDOUS WASTE CONTAINERS	Hazardous waste containers must be: • sealed/closed to manufacturer's specifications: o the only time a hazardous waste container can be open is when you are actively putting waste in the container; • and in good condition: o replace deteriorated or damaged containers immediately. NOTE: Make sure you **use containers that seal properly**, if they leak liquid from the lid when closed, they are considered open containers. Do not use zip-lock bags unless they have a physical means of sealing them to ensure they are sealed. Examples of open containers that are noncompliant are: • zip lock bags not completely sealed; • a Kimwipes caught in the seal of a zip lock bag; • a lid completely off the container; • a lid loose on the container; • the wrong lid on a container; • the container leaks from the lid when sealed properly; • a cracked container; • a pinhole in a bag; and • a torn bag.
5.0 HOUSEKEEPING AND LABORATORY HYGIENE	Good house keeping and laboratory hygiene are an essential part of safe work practices and greatly affect the quality of your work. These practices begin by taking **ownership** of your work area. Workers must abide by BSU's policies on housekeeping.

6.0 RECORD KEEPING Record keeping is a critical part of what you do. **Maintain a detailed laboratory notebook of all your work.**

As a waste generator, you are required to keep the following records for three years or as long as the waste stream is active:

- Copies of WPFs
- Copies of waste characterization documentation
- Copies of acceptable knowledge documentation for waste

Use log books to maintain records of equipment usage. It must be possible to correlate these records with entries in your laboratory notebook.

7.0 TRAINING AND The following is the minimum training required for an individual before

QUALIFICATION they may perform work in 213.

- Chemical Hygiene Plan (CHP)
- Hazardous Waste Tutorial
- Hazardous Waste Minimization Guide

8.0 **ATTACHMENTS** Attachment 1: Waste Profile Form Attachment 2: Steps to Obey for Safely Mixing Aqueous Solutions Attachment 3: Working with Solvents Attachment 4: Operating Procedure for Tape Formulation Attachment 5: Operating Procedure for Using the Autoclave Attachment 6: Operating Procedure for compressed gas cylinder change Attachment 7: Operating Procedure for the High Temperature 59300 Tube Furnace Attachment 8: Operating Procedure for the Three Zone Tube Furnace Attachment 9: Operating Procedure for the High Temperature Bottom Loading Furnaces Attachment 10: Operating Procedure for Ceria Sulfidation Reactor Attachment 11: Safety procedure for mixing pyrophoric powders Attachment 12: Operating Procedure for the synthesis of Depleted-UN Pellets by Carbothermic Reduction from Depleted-UO_2 Attachment 13: Operating Procedure for Handling Depleted Uranium (Uranium Tri-chloride)

9.0 SUPPORTING DOCUMENTS Laboratory Safety Manual

Equipment Operating Manuals

Material Safety Data Sheets

Hazardous Waste Minimization Guide

10.0 **DEFINITIONS Acceptable Knowledge (AK).** Includes process knowledge, supplemental waste analysis data, and facility records or analysis as applied to waste characterization.

Approved Users. Authorized users identified by the Hazardous Waste Satellite Accumulation Area (SAA) custodians, who have approval to use a specific SAA. SAA custodians may select all authorized users or a subset of the authorized user list.

Authorized Users. Waste generators, who have completed required training as specified by management or the waste management coordinator and documented in their employee files.

10.0 DEFINITIONS, continued

Hazardous Waste. As defined by the Resource Conservation and Recovery Act (RCRA), a solid waste is a hazardous waste if it is not excluded from regulation as a hazardous waste, exhibits any of the characteristics of hazardous waste (ignitability, corrosivity, reactivity, or toxicity), is listed in the regulations as a hazardous waste and has not been excluded, or is a mixture of a solid waste and a hazardous waste.

Hazardous Waste <90 Day Storage Area. An area where hazardous waste may be stored for up to 90 days.

Hazardous Waste Satellite Accumulation Area (SAA). An accumulation area for hazardous waste located to serve a process, a room, or a suite of rooms where hazardous waste is generated.

Laboratory Owner. The individual responsible for the safety and quality of operations in 213.

Orphaned or Unknown Waste. Any material or waste with an unknown origin, generator, constituent, or process; or any material or waste that was abandoned by personnel who have terminated employment or does not have a defined owner.

Waste Generator. Any individual, and his or her line management, having direct line responsibility for operations that generate waste (for example, a scientist, engineer, or project manager).

Waste Stream. A waste or group of wastes from one or more processes or facility with similar physical and/or chemical characteristics. These characteristics are usually grouped according to waste acceptance criteria (WAC) for treatment, storage, or disposal requirements.

Worker. A BSU employee or student, a contract worker, or anyone who works within BSU laboratories or facilities.

WPF. WPF stands for waste profile form. WPFs serve as your characterization documentation for your waste stream. See the document Working with Hazardous Waste for further information.

Attachment 1. Sample Waste Profile Form

Waste Profile Form (MEC 213)

Description of Waste	
Waste Generator	Waste Management Coordinator

Waste Accumulation ____ Satellite accumulation area location_____ Check as many as apply. ____ <90 day accumulation area location_____ ____ Neither of the above details _____

_____

Method of Characterization ____ Acceptable knowledge Comments (if any): Check as many as apply. ____ Analysis attached ____ MSDS attached ____ Requires analysis

Waste Type ____ Unused/unspent chemical Check only one. ____ Process waste or spent chemical

Waste Class ____ On-going generation Check as many as apply. ____ One-time generation ____ Wastewater (complete wastewater section)

Waste Matrix ____ Liquid Comments (if any): Check as many as apply. ____ Aqueous ____ Organic *If mixture, comment on* ____ Inorganic *estimated proportions of each.* ____ Solid ____ Powder ____ Solid ____ Absorbed Liquid

Waste /Process Description

Waste Identification Number _____ Cost Code(s) _____

Steps to Obey for Safely Mixing Aqueous Solutions

WARNING: Never add water to acids or bases. This may cause rapid boiling of the mixture and splattering of concentrated solution. Acids and bases should always be poured slowly into a larger volume of water.

WARNING: When adding acids or bases to water, considerable heat can be generated. Avoid contact with the container. To avoid explosion, do not seal the container until it has cooled to near room temperature.

WARNING: Mixing of multiple chemicals should never be done without full understanding of the

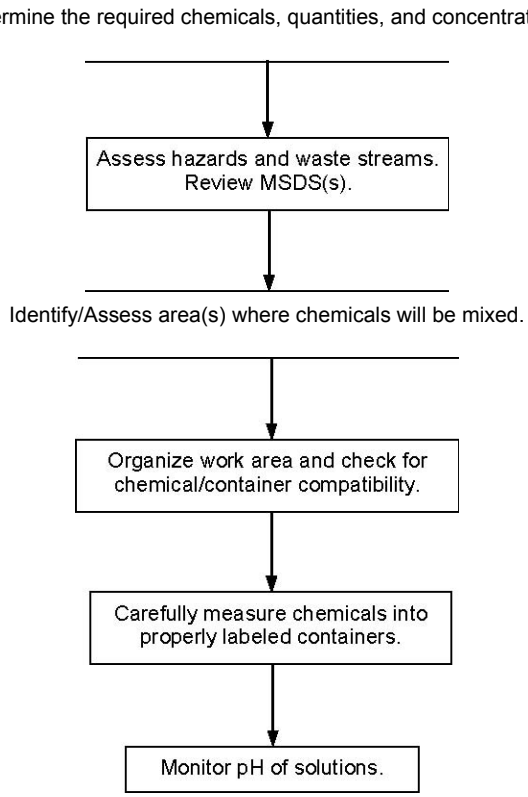
potential chemical reactions and MSDSs. Always consult a subject matter expert. Examples of unsafe practices include but are not limited to: combinations of oxidizers and flammables (e.g., acids mixed with alcohols), and combinations of acids with solids that can generate toxic gases (e.g., acids mixed with cyanide compounds).

WARNING: Some acids require extreme precaution, for example hydrofluoric acid. The use of some acids is strictly prohibited, e.g. the use of picric or perchloric acid is forbidden due to their explosion potential.

Step	Description	Safety Glasses*	Acid Resistant Gloves	Face Shield	Fume Hood	Laboratory Coat	Close-toe Shoes	SecondaryContainment
1	Determine the chemicals, quantities, and concentrations that you require.							
2	Confirm that the waste you will be generating has an approved WPF. If a WPF does not exist, generate one.							
3	Review the appropriate MSDS(s) - if an MSDS is not available, get a copy, review it, and add it to the manual in 213.							
4	If the work to be performed is non-routine, perform a hazards assessment (seek guidance from your supervisor and subject matter experts). A safe work permit may be required.							
5	Identify the area where you will mix chemicals. This area must be in a hood when handling concentrated acids.	x						
6	Organize your work area and the necessary supplies. All materials (e.g., beakers, flasks, etc.) must be fully compatible with the solutions you plan to mix.	x					x	
7	Using gravimetric or volumetric techniques, measure out the amounts of liquids (and solids) into properly labeled containers.	x	x	x	x	x	x	x
8	Measure and monitor the pH of your solutions using a pH meter or paper.	x	x		x	x	x	x

x = mandatory PPE r = recommended PPE

*

Safety glasses must be worn whenever working in the laboratory. Side shields are mandatory for this process.

Steps to Obey for Safely Mixing Aqueous Solutions, continued Flow Chart: