COLLEGE OF ENGINEERING
LABORATORY SAFETY MANAGEMENT SYSTEM (SMS) & HAZOP PROTOCOL
January 2018

CONTENTS

SUMMARY OF RESPONSIBILITIES

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- LSC documentation
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  - HAZOPS and Lab Shut Down SOPs
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- Inspection Checklists and follow up records
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- Building Emergency Response Plan
- Lab Postings:
  - Emergency Contacts
  - Chemical Inventory
  - Emergency Response
  - Required PPE
  - SOPs – post as needed

**Templates/forms found on CoE Safety Webpage*
http://engineering.usask.ca/service-and-support/safety-security.php
For assistance call Safety Resources 306-966-8838

UNIVERSITY

Chain of Leadership and Responsibility

1. President
2. Institutional Occupational Health Committee (the U of S **OHC**)
3. Body of Governors
4. Deans

COLLEGE

Chain of Leadership and Responsibility

1. Dean (College Leadership Team)
2. Local Safety Committee (**LSC**) (unresolved issues to **OHC**)
3. Department Heads
4. Faculty
5. Staff
6. Students

TEACHING LABS

Chain of Leadership and Responsibility

1. Dean
2. Department Heads
3. Lab Technician (Lab Manager, Lab Supervisor, Instructor, Activity Supervisor) – *LAB TECH*
4. Faculty (Instructor, Activities Supervisor, Academic Evaluator) – *FAC*
5. Graduate Students (Lab Assistants, trained, familiar with lab SMS) – *GS*
6. Authorized Visitors (PSSR, FMD, other students, researchers, visiting scholars, other?) – *V*
7. Undergraduate Students (academic learning, in training for SMS) – *UG*

Safety Documentation Creation/Use

- SOPs – portable equipment/tools (do not modify safe guards), fixed equipment – *LAB TECH* * **See SOP Policy**
- HAZOPs – modified fixed equipment, in-house manufactured equipment/tools – *HAZOP TEAM* * **See HAZOP Policy**
- Lab Activity ERP (Emergency Response Plan and Shutdown Procedure) – all in and out of lab academic activities – *LAB TECH* or FAC?* **See Lab ERP Policy**
- Permits (bio, rad) & Working Alone/After Hours Plans – *LAB TECH or FAC*
- Obtaining MSDS or SDS for controlled products – *LAB TECH or FAC*
- Labeling Chemicals (WHMIS), Managing Cylinders – *LAB TECH*
- Hazardous Lab Waste Forms – *LAB TECH or GS*
- Lab Inspections – *ANYONE (LSC, lab users, from other labs) to conduct, LAB TECH is responsible (monthly/bimonthly) (keep blank forms in binder, post on walls, also eyewash log as needed)*
- Lab/Dept Safety Meetings – Monthly – *LAB TECHS* (unresolved issues to Department and then to local LSC Member as necessary)

Training Acknowledgements and Documentation Retention

- SOPs – available in binder, training completed and Acknowledgement retained in binder – *LAB TECH*
- HAZOPs – available in binder, training completed and Acknowledgement retained in binder – *LAB TECH*
- Lab Activity ERP – available in binder, training completed and Acknowledgement retained in binder – *LAB TECH*
- Lab Inspections – posted (on wall) or retained (in binder) – *LAB TECH*
- Inspection Follow Up – *LAB TECH* (unresolved issues to local LSC Member, PSSR for immediate)
- Lab Tech (or Departmental) Safety Meetings – Monthly – *LAB TECH* (unresolved issues to Department and then to local LSC Member as necessary)
- SMS Monitoring – through the LSC, the OHC, and together with Safety Resources and Protective Services (PSSR)

RESEARCH LABS

Chain of Leadership and Responsibility

1. Dean
2. Department Head
3. Supervising Faculty Member (Principal Investigator) – *FAC*
4. IF APPLICABLE Lab Technician/Assistant (Lab Manager, Lab Supervisor, other?) – *LAB TECH or LAB ASST*
5. Graduate Students (Post Doc, PhD, Research Assistants) - *GS*
6. Authorized Visitors (PSSR, FMD, other students, researchers, visiting scholars, other?) – *V*

Safety Documentation Creation/Use

- SOPs – portable equipment/tools (do not modify safe guards), fixed equipment – *LAB TECH* * **See SOP Policy**
- HAZOPs – modified fixed equipment, in-house manufactured equipment/tools – *HAZOP TEAM* * **See HAZOP Policy**
- Lab Activity ERP (Emergency Response Plan) – all lab academic activities – *FAC or LAB TECH** **See Lab ERP Policy**
- Permits (bio, rad) & Working Alone/After Hours Plans – *LAB TECH or FAC*
- Obtaining MSDS or SDS for controlled products – *FAC, LAB TECH or GS*
- Labeling Chemicals (WHMIS), Managing Cylinders – *FAC, LAB TECH or GS*
- Hazardous Lab Waste Forms – *FAC or LAB TECH*
- Lab Inspections – *ANYONE* (LSC, PSSR, lab users, from other labs) to conduct, *FAC* is responsible (monthly/bimonthly) blanks in binder
- Lab/Dept Safety Meetings – Monthly – *FAC, LAB TECH and GS* (unresolved issues to Department Head, then as necessary to local LSC member for further follow up)

Training Acknowledgements and Documentation Retention

- SOPs – available in binder, training completed and Acknowledgement retained in binder – *FAC or LAB ASST*
- HAZOPs – available in binder, training completed and Acknowledgement retained in binder – *FAC or LAB ASST*
- Lab Activity ERP – available in binder, training completed and Acknowledgement retained in binder – *FAC or LAB ASST*
- Lab Inspections – posted (on wall) or retained (in binder) – *FAC, LAB ASST or GS*
- Inspection Follow Up – *FAC or LAB ASST* (unresolved issues to local LSC Member, PSSR for immediate)
- Lab Safety Meetings – Monthly – *FAC, LAB ASST and GS* (unresolved issues to local LSC Member)
- SMS Monitoring – *OHC, LSC, PSSR* (SMS Assessments – PSSR)

SHARED LABS (BOTH TEACHING AND RESEARCH USERS)

Whoever has the highest degree of control over the work, research or academic activities shall be responsible for managing applicable safety management system elements. Regular communication between shared users is expected to maintain safe environments, though one departmental safety meeting mechanism (participation based on department expectations)

FIELDWORK

Follow College protocol, and contact Safety Resources for more information and/or assistance. Generally, all fieldwork requires a current Off-Campus Activity Safety Plan (OCASP).

Policy for Creating Research Standard Operating Procedures (SOPs)

INTRODUCTION

Research in the College of Engineering is diverse, complex and often moderate to high risk in nature. Therefore, all research undertaken in laboratories and in the field must have a written Standard Operating Procedure (SOP) to facilitate effective training and to reduce the risk of injury.

SOPs should be reviewed every three years, according to provincial legislation.

SOP ELEMENTS

When and with what detail shall a standard operating procedure (SOP) be required:

1) SOPs must have creation and revision dates.
2) Hazards should be identified at the beginning of the SOP, under the title.
3) All Personal Protective Equipment (PPE) requirements must be listed in detail.
4) All equipment built in-house requires a detailed SOP and emergency shutdown procedure.
5) If purchased equipment has a manual that does not provide adequate safety and/or operations information or is hard to follow, then a more concise lab/research specific SOP must be composed, including an emergency shutdown procedure (see research ERP policy).
6) If utilizing purchased equipment provided manual, ensure a training acknowledgement log is completed for each piece of equipment which does not yet have or does not require a separate and distinct SOP.
7) For complex equipment, a SOP should be formatted in a chronological step by step process (see research HAZOP policy).
8) Use pictures or diagrams where necessary to fill in gaps.
9) For non-complex equipment, a short one-page SOP containing known hazards, PPE required, cautions and at the end of work day or work completion shutdown/cleanup processes.
10) A training log should be associated with all SOPs.

For assistance in SOP development, contact Safety Resources that have personnel to assist in SOP development or contact other departments in the college that have developed templates.

Mechanical Engineering and Chemical and Biological Engineering both have detailed SOP templates which can be used by any researcher in the College of Engineering.

Policy for Laboratory-Specific ERP and Shut-down Procedures

Introduction

The College of Engineering relies heavily on research and teaching laboratories. The operation of these labs often involves the construction and use of apparatus which use or produce hazardous materials or that involve hazardous processes. This policy sets out standards and procedures intended to assist personnel with the safe use of these apparatus.

Emergency Response Plans (ERPs) document the appropriate actions to take in the event of an emergency situation arising from the operation of an apparatus or piece of equipment.

ERPs are required for all apparatus or equipment where the hazards associated with their operation extend beyond the apparatus and its operator, to other areas of the building and / or other occupants or beyond.

The ERP policy covers the life-cycle of an apparatus with required action during the stages of; funding application (grant or departmental budget), apparatus planning and design, apparatus building and commissioning, apparatus use, and apparatus decommissioning.

All College personnel are required to understand and follow the policy contained in this document.

Policy

1. Where hazards may extend to the building or other building occupants, an alarm must be installed to signify an emergency, and an Emergency Response Plan (ERP) shall be provided with, as a minimum:

    a. Title page with Version and Date, Principal Research(s) Name, Apparatus Name, and Apparatus Location(s).

    b. Clear emergency shut-down procedure for all high risk apparatus and equipment.

    c. Clear emergency response instructions in response to relevant instances or alarms.

    d. Clear indication of when a building evacuation is to be initiated.

    e. Researcher signing block (exampled in Appendix I) with document version number; and

        i. Title, Name, Signature, Date, for each researcher signing, and

        ii. Signature of a Departmental Staff member certifying that each researcher has been properly trained.

    f. Document approval signing block (exampled in Appendix I) with document version number and;

        i. Approval and signature of, as a minimum, the person with the title, Principal Researcher(s), Departmental Staff Member and LSC Member.

2. Personnel aware of an apparatus being operated without an appropriate ERP are to advise the Department Head responsible.

3. Personnel shall not operate a piece of apparatus or equipment unit until they have completed the training on the apparatus ERP, if applicable.

4. Graduate students shall present an ERP (if applicable) to their advising committee when their work involves the construction or modification of research equipment.

5. The Principal Researcher and Department Head are to be aware of the existence and adequacy of the ERP for each apparatus or piece of equipment in their respective areas.

    a. The Principal Researcher(s) is (are) responsible for, and is (are) to approve and sign each document.

    b. The Department Head is responsible for the inventory of all research apparatus in the departments and their associated documents included.

Appendix I, Example of ERP Signing Blocks for Documents Requiring Approval

Researcher Signing Block

Apparatus: ___________________________________.

Document Version Number: _____.

The below signed researchers and department staff certify that the named researchers have been properly trained:

Title	Researcher Name	Researcher Signature	Department Staff Signature	Date
________	____________________	______________________	_______________________	__________
Title	Researcher Name	Researcher Signature	Department Staff Signature	Date
________	____________________	______________________	_______________________	__________
Title	Researcher Name	Researcher Signature	Department Staff Signature	Date
________	____________________	______________________	_______________________	__________
Title	Researcher Name	Researcher Signature	Department Staff Signature	Date
________	____________________	______________________	_______________________	__________
Title	Researcher Name	Researcher Signature	Department Staff Signature	Date
________	____________________	______________________	_______________________	__________
Title	Researcher Name	Researcher Signature	Department Staff Signature	Date
________	____________________	______________________	_______________________	__________
Title	Researcher Name	Researcher Signature	Department Staff Signature	Date
________	____________________	______________________	_______________________	__________
Title	Researcher Name	Researcher Signature	Department Staff Signature	Date
________	____________________	______________________	_______________________	__________
Title	Researcher Name	Researcher Signature	Department Staff Signature	Date

Document Approval Signing Block

Apparatus: _____.

Document Version Number: _____

Principal Researcher:

I, _____, approve of this ERP.

_____ _____

Signature **Date**

Departmental Staff Member:

I, _____, approve of this ERP.

_____ _____

Signature **Date**

LSC Member:

I, _____, approve of this ERP**.**

_____ _____

Signature **Date**

Policy for Hazard and Operability Study (HAZOP) for High Risk Apparatus & Equipment

Determining When a Formal Hazop Study is Required

Resident experts from the department and labs should create an inventory of in-house and modified equipment. Then (at a safety meeting) discuss the risks, needs and priorities to determine when HAZOPs will be conducted for research and teaching apparatus that has been constructed and/or modified in-house. **Use related form on page 13.**

HAZOP Study

A HAZOP Study examines hazards and operability of an apparatus or piece of equipment. It concludes with recommendations on the practices (actions) and safeguards to minimize risks and maximize its efficient operation.

HAZOPs are required for all apparatus or equipment except un-modified commercially produced equipment which is operated within the manufacturers specifications (the design and safe operating procedures for these apparatus remains with their manufacturer).

A HAZOP study breaks down each piece of apparatus under review into functional nodes and analyzes the operation and hazards of each node under normal and abnormal operating conditions. In order to perform a HAZOP study, an SOP must be complete with operating instructions and a detailed schematic drawing must be available.

In performing a HAZOP study, the SOP's main apparatus schematic is broken down to HAZOP study nodes, with the final study node always being the entire apparatus. A team with membership minimums listed in Table 2 (Policies section) are required to attend and participate in studies on the equipment.

After a researcher provides an overview of the purpose and operation of the apparatus, each of the nodes is studied. A worksheet is used to direct and record the results of the study. The minimum required columns for a HAZOP worksheet are detailed in Table 1, and exampled in Appendix I. For the instances where a single SOP covered multiple identical apparatuses, each apparatus is to be studied with the findings logged in a single HAZOP worksheet.

Table 1. HAZOP Worksheet Columns

Item Number	A serial number for future reference
Process Parameter	A particular aspect of the unit under study (e.g. flow, pressure, etc.)
Guide Word	A particular condition relevant to the process parameter (e.g., high, zero, etc.)
Possible Causes	Causes leading to this parameter in this condition
Possible Consequences	Consequences of this parameter being in this condition
Risk Severity	Severity associated with the consequences (1 – 3 scale)
Risk Likelihood	Likelihood associated with the consequences (1 – 3 scale)
Relative Risk	The severity multiplied by its likelihood (1 – 9 scale)
Safeguards	Safeguard that could be put in place to protect against these consequences
Actions	Actions that could be taken to protect against or avoid these consequences

Where appropriate safeguards or actions are not clear at the time of the study, a follow-up investigation is to be performed. Based on the safeguards, actions, and follow-up investigation, recommendations for the safe and efficient operation of the apparatus are to be made.

Apparatuses built in-house and modified commercial equipment shall have a Hazard and Operability Study (HAZOP) performed at the following times (depending on risk level of equipment or apparatus):

- **i.** At the end of apparatus design, and prior to the start of construction, Titled: Design HAZOP. This HAZOP is mandatory.
- **ii.** During the construction of the apparatus (if deviations from the original design are made).
- **iii.** At the end of apparatus construction, prior to commissioning. Titled: Commissioning HAZOP. This HAZOP is mandatory.
- **iv.** After any apparatus modification, where the modification changes the apparatus' key use or operation.
- **v.** Personnel aware of an apparatus at one of the above life-cycle stages that is not slated for a HAZOP are to advise the Department Head responsible.

Each HAZOP shall be performed in a manner consistent with the description in the method shown above. HAZOPs shall have a study team with membership minimums as listed in Table 1, where each person is to be counted only once (i.e., one person cannot cover 2 roles).

Table 2. HAZOP Team Membership Minimums

Researcher using the apparatus	1 minimum, 2 preferred
Researcher from other teams	1 minimum, 2 preferred
Departmental staff	1 minimum, 2 preferred
LSC and WSEP staff (chair)	1 minimum, 2 preferred

The HAZOP report shall contain the following:

- **i.** Researcher trained signing block (exampled in Appendix II) with document version number and;
- **ii.** Title (degree level of any researcher working on apparatus), Name, Signature, Date, for each researcher signing, and
- **iii.** Signature of a department staff member certifying that each researcher understands and will follow all recommendations made.
- **iv.** Document approval signing block (exampled in Appendix II) with document version number and;
- **v.** Approval and signature of, as a minimum, the person with the title, Principal Researcher(s), Departmental staff representative, and LSC member.
- **vi.** Approval to start work signing block (exampled in Appendix II) indicating that all recommendations coming from the study have been implemented with document version number and;
- **vii.** Approval and signature of, as a minimum, the person with the title, Principal Researcher(s), Departmental staff representative, and LSC member.

Personnel shall not operate a piece of apparatus or equipment unit until they have completed the following training:

- **i.** Safety Resources Lab Safety course(s) relevant to the lab in which the apparatus is to be operated, including WHMIS 2015.
- **ii.** General Laboratory Practices (GLP) training for the lab in which the apparatus is operated.
- **iii.** Training on the apparatus Standard Operating Procedures (SOP).
- **iv.** Training on the apparatus Emergency Response Plan (ERP), if applicable.
- **v.** Training on the apparatus HAZOP.

Appendix II, Example HAZOP Worksheet

HAZOP STUDY RECORD SHEET **Date:**

Hazop Team:

Process: **Study Node:**

Process Parameter	Guide Word	Possible Causes	Possible Consequences	S	L	RR	Safeguards	Actions	

Appendix I, Example of HAZOP Signing Blocks for Documents Requiring Approval

Researcher Signing Block

Apparatus: ___________________________________.

Document Version Number: _____.

The below signed researchers and department staff certify that the named researchers have been properly trained:

Title	Researcher Name	Researcher Signature	Department Staff Signature	Date
Title	Researcher Name	Researcher Signature	Department Staff Signature	Date
Title	Researcher Name	Researcher Signature	Department Staff Signature	Date
Title	Researcher Name	Researcher Signature	Department Staff Signature	Date
Title	Researcher Name	Researcher Signature	Department Staff Signature	Date
Title	Researcher Name	Researcher Signature	Department Staff Signature	Date
Title	Researcher Name	Researcher Signature	Department Staff Signature	Date
Title	Researcher Name	Researcher Signature	Department Staff Signature	Date

Document Approval Signing Block

Apparatus: _____.

Document Version Number: _____

Principal Researcher:

I, _____, approve of this HAZOP.

_____ _____

Signature **Date**

Departmental Staff Member:

I, _____, approve of this HAZOP.

_____ _____

Signature **Date**

LSC Member:

I, _____, approve of this HAZOP**.**

_____ _____

Signature **Date**

HAZARD AND RISK ANALYSIS FORM

Use this form to determine if a full HAZOP is necessary for equipment or apparatus

Title: _____ Location: _____ Date: _____

Brief Description: _____

Conducted by: _____

ACTIVITY (STEP #)	RELATED HAZARDS	RISK RATING (P X S = RISK)			HAZARD CONTROLS
		PROBABILITY	SEVERITY	RISK (CIRCLE)	
		1 2 3 4	1 2 3 4	1 2 LOW 3 4 6 MED 8 9 12 16 HIGH	
		1 2 3 4	1 2 3 4	1 2 LOW 3 4 6 MED 8 9 12 16 HIGH	
		1 2 3 4	1 2 3 4	1 2 LOW 3 4 6 MED 8 9 12 16 HIGH	
		1 2 3 4	1 2 3 4	1 2 LOW 3 4 6 MED 8 9 12 16 HIGH	
PROBABILITY (P) →	'1' Remote	'2' Low	'3' Possible		'4' High
SEVERITY (S) →	'1' Minor	'2' Medical Aid	'3' Serious		'4' Permanent

Other Considerations: *check appropriate boxes and provide details if available*

- ☐ New equipment, purchased and with operators manual
- ☐ Equipment apparatus constructed in-house; details _____
- ☐ Written procedures (SOPs) and emergency shut down procedure are completed and current
- ☐ Personal protective equipment is readily available and used; details _____
- ☐ All personnel using the equipment or apparatus have related training
- ☐ Required authorizations and/or permits needed; details _____

☐ **No HAZOP necessary – equipment or apparatus is determined to be low risk.**

☐ **HAZOP is necessary – equipment or apparatus is moderate or high risk: priority: _____**

☐ **Signed and dated: _____ _____ _____**

Name: Signed: Date: