# *Title Page*

**Russ College Safety Plan**

for the

**[Insert project name or apparatus here]**

part of the

**[Insert name of department, lab, center, or institute here]**

drafted by

**[Insert lead author’s name here]**

originally submitted on

**[Insert original date of submittal here]**

File name:

**[Insert complete file name here]**

Location on file server:

**[Insert complete file path here]**

|  |  |
| --- | --- |
| **From FMEA, highest initial severity rating:**  **[0]**  …number must be provided | **Approval:**  …box must be stamped “Approved” by safety officer |

# *Signatories Page*

*By signing and dating below you endorse this safety plan.*

Lead Author / Researcher Signature Date

Contributing Author Signature Date

Contributing Author Signature Date

Contributing Author Signature Date

Client / Principal Investigator (PI) Signature Date

Departmental Safety Officer Signature Date

*If the highest reported FMEA Initial Evaluation Severity Rating is:*

*If SEV < 7, the departmental safety officer may approve*

*If SEV > 7, a safety review committee will be necessary (additional signatures required below).*

Safety Review Committee (if required) Signature Date

Safety Review Committee (if required) Signature Date

Safety Review Committee (if required) Signature Date

Environmental Health & Safety (if required) Signature Date

Russ College Safety Coordinator (if required) Signature Date

*The department chair must be notified of all research operations within their department, and as such must be provided a copy of all approved safety plans. The chair is allotted five business days appraisal.*

Department Chair Initials of departmental receipt Date

*Please note that a complete signed and approved copy of this safety plan must accompany the research team on site before operations commence. Please see the Russ College Safety Coordinator for assistance with this process.*

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# *Design for Safety (DfS)*

*The first step in developing a successful safety plan is to fully understand all aspects of the research objective before you begin. To achieve this you should first locate and interpret scholarly research related to your research objective through a comprehensive literature review process. Compile all referenced literature in the appendix of this safety plan.*

*A well-developed safety plan will benefit the client/PI by providing a convenient template for training graduate students who are new to research. Through the use of this process students should progress more efficiently and be more effective in their work output. Graduate students benefit via a faster path to a successful thesis, as well as gain valuable industry relevant experience they will likely use after graduation. And finally, the application of a common safety review process benefits the college by helping to ensure the safety of its personnel and the community. Follow the guidelines set forth below to formalize your research objective.*

## Scope of Work (SOW)

|  |
| --- |
| Compose a brief paragraph below which describes the research objective. This paragraph should answer the questions: who will lead this work, what work is to be accomplished, when will this work be carried out, where will the work take place, and why is this work novel? This statement must also include what equipment will be required, what chemicals will be used, and under what operating conditions. Additional details such as expected hurdles and length of research endeavor are also helpful. |
|  |

## Chemical Inventory & Safety Data Sheets (SDS)

|  |
| --- |
| Provide, in the space below, a list of all chemicals and gases required. Compile the Safety Data Sheets (SDS) for all of these chemicals to the appendix of this document and evaluate each carefully. The SDS provides critical handling, safety, storage, disposal, and spill control information that the researcher team must understand before accepting and working with an unknown substance. |
|  |

## Calculations

|  |
| --- |
| Provide any calculations used to evaluate the concept of this research objective. |
|  |

## Codes, Standards, and Ethics

|  |
| --- |
| Cite the specific, and relevant, subsections of the applicable codes (OSHA, NFPA, ASTM, ANSI, NIST, etc.) that apply to this research objective. Interpret and use these codes to ensure you achieve, and maintain, compliance. |
|  |

## System Schematics

|  |
| --- |
| Illustrate the apparatus and/or process using a schematic representation and provide below. Common schematics include wiring diagrams for electrical systems, flow diagrams for gas/liquid systems, and Process & Instrumentation Diagrams (P&ID) to represent the interconnection of components and their controls. |
|  |

## Component Table

|  |
| --- |
| Identify all major system components, classify components by type, assign each component a unique identifier, and describe each components using a table format. The use of a component table ensures critical items are properly identified and a common terminology is used throughout the safety plan. |
|  |

## Design Models

|  |
| --- |
| Construct a model of the apparatus and/or process. CAD drawings are required when system components are to be fabricated. Models are necessary where loads are involved and/or structural analysis is required. Please note that in some applications drawings may need to be stamped by a professional engineer. |
|  |

# *Experimental Protocols*

## Test Methods

*For each set of proposed test conditions the researcher must establish clearly written test methods to ensure safe and consistent operation from trial to trial. Insert as many rows under each subheader as needed. Replicate the table below as many times as necessary for each unique experimental process.*

|  |  |  |  |
| --- | --- | --- | --- |
| **Test Method #1 for:** |  | | |
| ***Personal Protective Equipment*** *(PPE)* | | | |
| *Equipment* | | *Purpose* | |
|  | |  | |
|  | |  | |
|  | |  | |
| ***Consumables*** *(provide a list of all items required)* | | | |
| *Supplies (part #)* | | *Purpose* | *Quantity* |
|  | |  |  |
|  | |  |  |
|  | |  |  |
| ***Process Inputs*** *(provide a list of all chemicals used)* | | | |
| *Chemicals (CAS#)* | | *Purpose* | *Quantity* |
|  | |  |  |
|  | |  |  |
|  | |  |  |
| ***Equipment & Conditions Used to Process the Inputs*** *(provide a list of all equipment used)* | | | |
| *Equipment (model #)* | | *Purpose, settings, pressures, temps, ramp rates, etc.* | *Duration* |
|  | |  |  |
|  | |  |  |
|  | |  |  |
| ***Calculated / Anticipated Outputs or Materials*** *(what do you expect and how will you determine)* | | | |
| *Resulting Outputs* | | *Post Processing Instructions* | |
|  | |  | |
|  | |  | |
|  | |  | |

## Test Matrix

*Using the defined test method(s) above, the researcher (under the guidance of the Client/PI) must develop a test matrix which will be used to validate the process, apparatus, or research hypothesis. The researcher will need to consider sample sizes, the necessity of replicates, statistical significance, available research time, material process times, material costs, and material availability (or scarcity). Below is a simple test matrix outline, which should be modified to fit the researcher’s needs. Add and/or remove replicates and test methods as needed.*

|  |  |  |  |
| --- | --- | --- | --- |
| **Test Matrix for:** |  | | |
| *Results* | *Replicate 1* | *Replicate 2* | *Replicate 3* |
| *Test Method #1* |  |  |  |
| *Test Method #2* |  |  |  |
| *Test Method #3* |  |  |  |
| *Test Method #4* |  |  |  |
| *Test Method #5* |  |  |  |

# *Standard Operating Procedures (SOP)*

*Operational procedures are required when working in unsafe conditions which could result in permanent injury or death (FMEA initial severity >7). Standard Operating Procedures provide the benefits of improved efficiency, repeatability, reduced training costs, improved understanding of the process, and compliance with some regulatory codes and standards. For these reasons, many clients / PI’s require operating procedures be applied across all of their research efforts.*

*A properly written SOP will provide step-by-step instructions to cover all aspects of operation, cleanup, maintenance, and emergency response. When writing the SOP, do not overcomplicate the procedure with needless wording. The procedure should be written at an appropriate technical level and directions should be simple and easy to follow. Always refer to System Schematics and/or the Component Table from the DfS section to ensure consistent nomenclature is used throughout the procedure. Create a SOP for each unique operation; several smaller SOP’s are often preferred to one large procedure.*

|  |  |
| --- | --- |
| **SOP #1 for:** |  |
| 1. ***Operation***   *Provide instruction for the preparation and setup, calibration, system monitoring, startup, operation, and shut down of the apparatus and/or process. Use pictures to illustrate difficult operations. Is the operation attended or unattended? If unattended, are active controls in place to adequately manage the process in the absence of an operator?* | |
| 1. Preparation and setup 2. Calibration 3. Monitoring and/or data collection 4. Startup 5. Operation 6. Shutdown | |
| 1. ***Cleanup***   *Provide instruction for all aspects of cleaning the apparatus and/or work site when the process is complete. If used, the disposal of all hazardous, radioactive, or infectious waste must be specified.* | |
| 1. System cleaned and reassembled 2. Glassware cleaned, dried, and returned 3. Supplies & PPE replenished | |
| 1. ***Maintenance***   *Provide instruction for all maintenance requirements to ensure the apparatus and/or process runs safely and consistently. Is specific training required to perform any required maintenance? Unless otherwise specified, usage and maintenance logs are the responsibility of the research team.* | |
| 1. Provide maintenance procedures 2. Maintenance logs | |
| 1. ***Emergency Response***   *Provide instruction for handling emergency shutdowns as a result of power failure, fire, spills, leaks or ruptures, catastrophic failure of the system, or an injured employee. Practice ‘what if’ scenarios with all operators to ensure they react appropriately during emergency situations. This training is the responsibility of the research team and appropriate training records must be maintained. Remember, if it’s not documented, it didn’t happen.* | |
| 1. Power or electrical failure 2. Fire or system overheat 3. Spills, leaks, or ruptures 4. Catastrophic failure of system 5. Injured employee | |

# *Failure Mode and Effects Analysis (FMEA)*

*Strive to design the system to be intrinsically safe and to avoid hazards whenever possible. When hazards are unavoidable, you must evaluate them and consider ways to minimize their risk. All aspects and modes of operation of the system must be evaluated, including system setup, actual testing, post-test cleanup, etc. Depending upon the size and complexity of the system evaluated, an FMEA analysis could include tens, hundreds, or even thousands of hazards. Replicate the FMEA table below for each hazard you identify. Use the Risk Priority Number (RPN) to sort your hazards from highest to lowest risk. However, always address those risks with the highest severity ratings first.*

|  |  |  |  |
| --- | --- | --- | --- |
| **Hazard:** |  | Initial Evaluation  Rating | After Action Rating |
| ***Potential Effect of Failure*** *(Severity):* | | **0** | **0** |
| Reasoning for the initial severity rating: | | | |
| ***Potential Cause(s) / Mechanism(s) of Failure*** *(Probability of Occurrence):* | | **0** | **0** |
| Reasoning for the initial occurrence rating: | | | |
| ***Current Control Detection / Prevention*** *(Probability of Detection):* | | **0** | **0** |
| Reasoning for the initial detection rating: | | | |
| ***Risk Priority Number*** *(SEV x OCC x DET = RPN):* | | **0** | **0** |
| Actions taken (if any) to reduce the RPN for this hazard (include personnel and dates involved): | | | |
| Recommended actions for consideration to further reduce this rating (not applied to after action rating): | | | |

*Severity, Occurrence, and Detection are rated on a scale of 1 to 10. Please refer to the table below for suggested descriptions of each rating which may aid in the assignment of values for each failure scenario. Note, this is not a comprehensive list of descriptions and there are many variations of this tool available; therefore additional research may be required to tailor this tool to your specific application.*

*When assigning detection values, please remember that this is the probability of detecting the failure and avoiding it. You must ask yourself, what detection methods, or systems, are in place to properly detect and avoid the failure before it occurs?*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Rating** | **Severity** | | **Occurrence** | | | **Detection** |
| 10 | Death |  | multiple/day | -or- | 1 in 2 | Impossible to detect |
| 9 | ↓ | Building damage | once/day | -or- | 1 in 10 | Extremely unlikely |
| 8 | Permanent Injury | ↓ | once/week | -or- | 1 in 50 | Unlikely |
| 7 | ↓ | Room damage | once/month | -or- | 1 in 250 | Moderately unlikely |
| 6 | Temporary Injury | ↓ | once/3months | -or- | 1 in 1,000 | Slightly unlikely |
| 5 | ↓ | Equipment damage | once/6months | -or- | 1 in 5,000 | Slightly likely |
| 4 | Soft Tissue Injury | ↓ | once/year | -or- | 1 in 10,000 | Moderately likely |
| 3 | ↓ | Subsystem damage | once/3years | -or- | 1 in 50,000 | Likely |
| 2 | Minor Injury | ↓ | once/5years | -or- | 1 in 250,000 | Highly likely |
| 1 | ↓ | Supply damage | once/10years | -or- | 1 in 1,000,000 | Certain to detect |

Identify the hazard with the highest rated *Potential Effect of Failure (Severity)* and note that number on the bottom left corner of the title page.

# *Disposition & Safety Review Committee*

## Disposition

*In order to approve this safety plan, signatures and dates must be collected in the manner below:*

*If FMEA Initial Evaluation Severity Rating < 7, the departmental safety officer may approve the safety plan.*

In these instances, the lead author, the PI, and the departmental safety officer must sign and date the signatory’s page for the safety plan to be applicable. Once complete, the title page of the signed document is stamped “approved” by the safety officer and a copy of the safety plan will be provided to the applicable department chair for oversight purposes.

*If FMEA Initial Evaluation Severity Rating > 7, a safety review through committee will be required.*

In situations where a hazard may lead to permanent injury or death, an additional level of evaluation is required. The signatures and dates of three safety committee members, the Russ College safety officer, and a member of the Ohio University Environmental Health and Safety team must also approve of the safety plan. Once complete, the title page of the signed document is stamped “approved” by the Russ College safety coordinator and a copy of the safety plan will be provided to the applicable department chair for oversight purposes.

## Safety Review Committee (if required)

A safety review committee will be comprised of no less than three unaffiliated research consultants, who will be selected by the lead researcher and/or PI with consultation from the Russ College safety officer. Ideally, these consultants would possess experience in a related field or have specialized technical experience beneficial for the evaluation of the design. The duty of the committee is to review the safety plan and determine if it adequately addresses the scope of work in a safe and consistent manner. The completion of an onsite review of the experimental setup with the lead researcher is encouraged but not required; therefore, an onsite meeting will be held only if requested by the lead researcher, the PI, or if the safety committee concludes it is necessary to understand the complete process. If the safety plan is rejected by the committee, recommendations for improvement will be offered and the research team will be permitted to resubmit until the plan is accepted by the committee.

Please note, the Russ College encourages its faculty and staff to volunteer their time to serve on safety review committees for the purposes of increased safety awareness, knowledge sharing, and potential cross collaborations.

## Modifications (if required)

Unfortunately, we don’t always get it right the first time; therefore, modifications are an inevitable part of research. As this safety plan is a living document it should grow and adapt with our understanding of the process. Follow the four steps below to modify the safety plan whenever required:

1. Update the file name with the modification date and archive the outdated document (if no longer required). Never delete an old document! All documents should remain on the safety file share.
2. Update all sections where required to accommodate the modification(s).
3. Conduct a new FMEA and reorganize the hazards accordingly. Address any deficiencies or improvements that have been brought about through the modification(s).
4. Follow the approval stream as outlined above to collect the necessary signatures and dates.

# *Appendix*

*This section should include supporting literature research, related equipment manuals, affiliated safety plans, SDS forms, and any recommendations or directives from the Safety Review Committee (if required).*