Flammable Liquid "What-If" Example

Department: Chemistry	Description of Operation: Use of stirring hotplate with flammable liquid			By: Review Team Date:
WHAT IF?	**ANSWER**	**PROBABILITY**	**CONSEQUENCES**	**RECOMMENDATIONS**
Used on unventilated benchtop	Flammable vapors could accumulate and reach source of ignition causing fire	High	Extensive damage/downtime and costs	Use in fume hood
	Overexposure to toxic vapors	High	Adverse health effects	Use in fume hood
Mechanical failure of fume hood exhaust fan	Lack of exhaust but vapors still accumulate and ignition sources still present	Moderate	Adverse health effects	Interlock hotplate power to exhaust monitor
	Fire	Moderate	Damage	Use explosion proof hotplate
Power failure during use (see also loss of heat and loss of stirring below)	Lack of exhaust, vapors may accumulate but at lesser magnitude, potential fire	Very high	Damage/health effects	Connect exhaust fan to emergency power
	Reaction becomes unstable	Very high	Failed experiment, exposure to unknown products	Conduct a review of all possible reactions and outcomes
Hotplate malfunction, electrical arcing (switch/ thermostat)	Possible fire in hotplate and ignition of solvent vapors	Moderate	Equipment damage/personnel injuries	Check electrical connections (plugs and wires); pretest hotplate before starting; use explosion proof hotplate
Hotplate malfunction, supplies too much heat	Heat material above flash point	Moderate	Fire, damage, personnel injuries	Interlock hotplate to temperature feedback loop
	Reaction becomes unstable	Moderate	Personnel injuries	Do not leave reaction unattended; check temperature of reaction at regular intervals
	Unintended reaction occurs	Moderate	Hazardous byproducts	Conduct a review of all possible reactions and
Hotplate malfunction; supplies too little heat; if no heat, see loss of power above	Reaction unsuccessful	Moderate	Lost time and materials	Interlock hotplate to temperature feedback loop
	Reactants degrade/ evaporate	Moderate	Lost time and materials; hazardous byproducts	Do not leave reaction unattended; check temperature of reaction at regular intervals
Loss of Stirring	Superheating of portion of flask contents	Very high	Vessel fails/fire	Interlock hotplate to temperature feedback loop
	Unintended reaction occurs	High	Hazardous byproducts	Conduct a review of all possible reactions and outcomes

Department: Chemistry	Description of Operation: Use of stirring hotplate with flammable liquid			By: Review Team Date:
Loss of Stirring (cont)	Reaction unsuccessful	High	Lost time and materials	Do not leave reaction unattended; check temperature and stirring of reaction at regular intervals
	Flash fire	High	Fire/damage/ personnel	Do not handle hot vessel
Spill from container being heated	Reaction unsuccessful	High	Lost time and materials	Do not leave reaction unattended
	Open container boils dry	High	Failed reaction	Connect hotplate to timer and temperature feedback loop
Heating period is too long	Vessel breaks	High	Vessel fails/fire	See above
	Reaction unsuccessful	High	Lost time and materials	Do not leave reaction unattended
	Unreacted starting material	High	Hazardous byproducts	Connect hotplate to timer and temperature feedback loop
Heat period is too short	Unstable products	High	Personnel injuries	Conduct a review of all possible reactions and outcomes
	Reaction unsuccessful	High	Lost time and materials	Do not leave reaction unattended
	Flash fire	High	Fire/damage/ personnel injuries	Check container for signs of prior damage or use new container
Container breaks	Vessel breaks	High	Fire/Damage/ personnel injuries	Do not use a closed container; use container with a pressure relief device
Residual process gas in equipment when opened	Vessel cannot be opened	High	Lost time and materials	See above
	Unintended reaction occurs	High	Hazardous byproducts	Conduct a review of all possible reactions and outcomes

Hazardous Gas Example

Department: Chemistry	**Description of Operation:** Use of toxic or flammable gas in small cylinder in fume hood			**By:** **Review Team Date:**
WHAT IF?	**ANSWER**	**PROBABILITY**	**CONSEQUENCES**	**RECOMMENDATIONS**
Power to exhaust fan is lost	Possible exposure to toxic gas if gas flow	Very high	Serious	Provide emergency power and normally closed gas valve
Mechanical failure of exhaust fan	Same as above	Moderate	Serious	Same as above and consider using redundant fans
Regulator fails or creeps and allows full cylinder pressure to apparatus	Apparatus or tubing failure and gas release if not able to handle full cylinder pressure	Low	Serious	Use flow restricting orifice in cylinder valve
Cylinder regulator gauge blows	High pressure gas release and possible exposure	Low	Serious	Same as above
Gas leak downstream of regulator; hood face at 18 inches	Lower pressure gas release but potential exposure which increases with gas flow	Moderate	Serious	Same as above
Gas leak downstream of regulator; hood face at 30 inches with operator at hood	Same as above but high potential for exposure	Moderate	Serious	Same as above and restrict hood opening while gas flowing via interlock, or stop and consider use of a self-contained breathing apparatus (SCBA) if access during flow is
Cylinder contains wrong contents	Potential exothermic reaction or if not, ruined experiment and apparatus	Low	Serious	Check cylinder tag, not just cylinder stencil
Cylinder pressure is incorrect	Regulator gauge could fail; rapid release of high pressure gas	Low	Serious	Same as above
Apparatus contains oxygen when gas is introduced	Explosion potential if gas hits flammable range and ignition source is present	Moderate	Serious	Assure purge with inert gas before introducing flammable gas if ignition source may be present (consider automation)
Residual process gas in equipment when opened	Potential exposure to toxic gas	Moderate	Serious	Same as above; test atmosphere or use SCBA