Appendix C: Toolbox of Solutions Matrix

Solution	Cost to Implement	Annual Cost to Maintain	Time to Implement	Useful to Obtain Initial Compliance or Maintain Compliance	Effort to Implement (1 being lowest)	Effort to Maintain (1 being lowest)	Effect on Researchers (1 being smallest)	Relative Impact Towards Compliance (1 being high)
New Building Design and Construction								
Involve DCFM, Chemical Inventory Manager and other key stakeholders early in the building design process.	0	0	weeks	Both	1	1	1	1
Consider that open laboratory designs reduce allowable chemical loads which require greater coordination among users.	100k	$	years	Both	3	2	3	2
Plan for intended building occupancy in the design phase, costs of L versus B. consider H2/H3/H4 areas.	$$$	$	years	Both	4	2	2	1
Design and build more L occupancy. Offers the possibility of many more laboratory suites than control areas on upper floors.	$$$$$	$	years	Both	4	2	2	1
Design and build more H occupancy areas within laboratory buildings for chemical use. (H1 - H5).	$$$$$	$	years	Both	5	2	2	1
Include centralized H occupancy storage rooms on designated floors.	$$$$	$	years	Both	5	2	4	1
Design more control areas (or laboratory Suites for L) per floor.	$$$$$	$	years	Both	5	2	3	1
Design and build central chemical storerooms that researchers can easily access. (need multiple H rooms).	$$$$	$$$	years	Both	5	2	3	1
Add additional control areas per floor during initial construction.	$$$	0	No added time	Both	1	1	1	2
Install sprinklers in new construction.	$$$	$	months	Both	1	1	1	1

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Existing Building Renovation and Retrofit								
Retrofit sprinklers in existing construction.	$$$$	$	years	Both	4	1	4	1
Provide and use CFC-compliant hazardous materials storage cabinets.	$$	0	months	Both	1	1	2	1
Retrofit additional control area separations. (e.g., fire barriers or firewalls).	$$$$	0	years	Both	4	1	4	2
Add H-occupancy shared storage rooms on each floor.	$$$$	0	years	Both	4	1	4	1
Require MAQ compliance for affected control areas before new tenant improvement.	$	$	months	Maintain	1	1	2	1
Education								
Identify and communicate to PIs their allotted chemical capacity when onboarding.	$	0	weeks	Both	1	1	1	2
Provide MAQ awareness training for PIs, researchers, campus leadership, and building advisory committees.	$	$	weeks	Both	1	1	1	2
Develop MAQ primer for building advisory committees.	$	$	weeks	Both	1	1	1	2
Develop guidebooks and maps indicating the locations of control area delineations in buildings.	$	$	weeks	Both	1	1	1	2
Fast access to real-time Chemical Inventory and MAQ percentages data.	$	$	weeks	Both	1	1	1	2
Procurement								
Integrate MAQ updates into the procurement process so the threshold is not exceeded upon purchase.	$$$$	$$$	years	Maintain	4	4	4	1

Solution	Cost to Implement	Annual Cost to Maintain	Time to Implement	Useful to Obtain Initial Compliance or Maintain Compliance	Effort to Implement (1 being lowest)	Effort to Maintain (1 being lowest)	Effect on Researchers (1 being smallest)	Relative Impact Towards Compliance (1 being high)
Reconcile chemical inventories as chemicals are being removed as waste to ensure that any procurement holds are necessary.	$$$	$$$	years	Maintain	3	3	4	2
Reconcile chemical inventories when a laboratory is closed, and a laboratory group moves out.	$$$	$$$	years	Maintain	3	3	1	2
Waste Removal								
Do not recharge for waste disposal.	Net neutral cost	0	months	Both	3	1	1	2
Waste amnesty day.	$$$	0	months	Initial	3	1	2	2
Provide EH&S staff support for considerable laboratory clean-up and waste removal efforts.	$$	0	months	Both	3	1	2	2
Inventory Management Practices								
Assess MAQ compliance during laboratory move-in and move-out processes.	$	$	months	Both	1	1	1	5
Provide resolution for proration allotment of MAQs when laboratories share a control area.	$	$	months	Both	1	1	3	2
Establish procedures for maintaining and verifying an EH&S performed and managed chemical inventory.	$	$	months	Both	1	1	1	1
Reserve institutional funds for MAQ compliance at the start-up phase of a laboratory.	$$	$	months	Both	1	1	2	2
Reserve institutional funds for chemical disposal at the shutdown phases of a laboratory.	$$	0	weeks	Maintain	3	3	1	4

Solution	Cost to Implement	Annual Cost to Maintain	Time to Implement	Useful to Obtain Initial Compliance or Maintain Compliance	Effort to Implement (1 being lowest)	Effort to Maintain (1 being lowest)	Effect on Researchers (1 being smallest)	Relative Impact Towards Compliance (1 being high)
Assign spaces to ensure compliance with Fire Code.	$$	$$	months	Maintain	3	3	1	4
Assign or reassign large chemical users to laboratory spaces on lower floors of buildings, allowing for the storage of larger volumes of chemicals	$$	$$	months	Maintain	3	3	1	4
Add more Chemical Inventory and MAQ management staff.	$$$	$$$	months	Both	2	1	1	1
Provide a central chemical inventory reconciliation service.	$$$	$$$	months	Maintain	2	1	1	1
Incentivize the continuous updating of RSS Chemicals inventory. For example, positive incentives to promote a safety culture (for example, "Safest Lab" competitions) are also helpful in driving MAQ compliance.	$	$	months	Both	1	1	1	5
Provide Deans and Chairs with reports on available allowances to inform faculty recruitment efforts.	$	$	months	Both	1	1	1	5
Provide storage capacity in connection with recruiting new faculty.	$$	$	months	Initial	1	1	1	1
Require inspections of existing buildings to ensure occupants have not altered control areas (e.g., wall penetrations or additions).	$	$	months	Both	1	1	1	3
Establish funding to correct any identified deficiencies (e.g., penetrations or unapproved alterations) in installed fire barriers.	$$$$	$$	months	Both	4	1	1	3
Establish funding for installing, maintaining, and repairing new equipment and equipment upgrades associated with storing and using hazardous materials.	$$	$	months	Both	1	1	1	5

Solution	Cost to Implement	Annual Cost to Maintain	Time to Implement	Useful to Obtain Initial Compliance or Maintain Compliance	Effort to Implement (1 being lowest)	Effort to Maintain (1 being lowest)	Effect on Researchers (1 being smallest)	Relative Impact Towards Compliance (1 being high)
Implement redistribution programs to encourage sharing of surplus chemicals and reduce the amount of unused material disposed of as hazardous waste.	$	$	months	Both	1	1	1	3
Provide campuses with resources to streamline the chemical inventory review process by purchasing barcoding or RFID equipment and providing support staff to oversee and maintain chemical inventories for their campus.	$	$	months	Both	1	1	1	5

The relative cost scales and effectiveness measurements in the table are a bit arbitrary but were created by consensus by the task force members. Relative scales for the $ symbol are as follows

$ less than 1k USD
$$ between 1k - 10k USD
$$$ between 10k - 100k USD
$$$$ between 100k - 1M USD
$$$$$ greater than 1M USD

Appendix D: Flowchart of MAQ Management

Chemical Inventory Management

- All chemicals entered (chemical name, volume, units, physical state, inventory owner, physical location)
- Accurate assignment of chemicals to Fire Code hazard categories

Building Attributes

- Construction type
- Occupancy
- Location of control areas
- Fire sprinkler coverage
- Level of all floors relative to grade plane
- Use of approved storage equipment

MAQ Assessments

- Actual amounts compared to MAQ limits for each Building
- Fire Hazard Class
- Control Area or Lab Suite

MAQ Accuracy Hurdles

accurate container size

identification of contents

correct storage location

adequate library data

correct hazard classification

accurate calculations

correct fire code selection

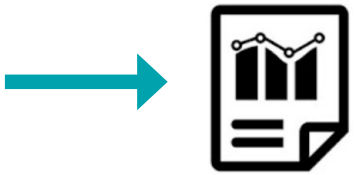
sprinkler coverage identified

accurate room occupancies

rooms placed into control areas

approved storage identified

floors arranged properly



RISK & SAFETY SOLUTIONS

Flowchart of MAQ Management