## Duke OESO Guidelines for Safe Use of AQUA REGIA

**Concentrated Nitric Acid and Hydrochloric Acid**

### Hazards

#### Potential Hazards

In addition to these guidelines, each lab using aqua regia must provide a customized SOP describing the preparation, maximum use quantity, and circumstances of use.

- Aqua regia is a powerful oxidizer that releases toxic gases that are fatal by inhalation (e.g. nitrosyl chloride (category 1), nitrogen dioxide (category 2), and chlorine (category 2)).
- It can **EXPLODE** if stored in a closed container.
- Solutions are **highly corrosive**: Causes burns to eyes, skin, or mucous membranes.
- **Relevant exposure limits**: nitric acid – 2 ppm, hydrochloric acid – 2 ppm, nitrogen dioxide – 0.2 ppm ceiling, chlorine – 0.5 ppm.
- See Safety Data Sheets (SDS) for specific hazard information.

### Selection & Purchase

Aqua Regia has many potential physical and health hazards. A less hazardous solution/process should be used if possible.

- Buy specific absorbent pads or pillows compatible with nitric acid for absorbing small spills.

### Storage & Transport

- **Never store Aqua Regia for later use; only make enough for immediate use.**
- Keep away from:
  
  - Organics
  - Reducing agents
  - Flammables
  - Combustibles
  
  - Ensure primary and secondary containers are free from organic chemicals/solvents.

### Engineering Controls

- Eyewash and safety shower required in immediate work area.
- Work in a chemical fume hood that contains **NO ORGANIC MATERIAL**.
- Keep sash down while reactions are in progress.

### Work Practice Controls

- Work with the smallest amount possible.
- **NEVER CAP** a container holding active aqua regia solution.
- Follow instructions on page 2 for dilution and neutralization of unused solution.
- Wipe work area with soap and water when work is complete.

### Personal Protective Equipment (PPE)

- Minimum PPE: gloves resistant to nitric and hydrochloric acids (e.g. 18-mil neoprene or laminate), safety goggles, and buttoned lab coat.
- **Change gloves immediately if contaminated; wash hands at time of glove change.**
- **Risk of splash or >100ml**, add: face shield, impervious apron and sleeves (or coverall)

### Emergencies

See Emergency Response Flip Chart and/or lab specific chemical hygiene plan.

### Waste

**Aqua regia waste MUST be neutralized by following the procedure on page 2 before disposal!**

**Disposal:** After neutralized solution has cooled to room temperature, submit waste to OESO. See also lab-specific chemical hygiene plan, Lab Chemical Waste Management Practice, and Drain Disposal Practice.

### Training

Sign lab-specific SOP to indicate review of this guideline and lab-specific procedures.

### Questions

Contact OESO Lab Safety at 919-684-8822 or labsafety@dm.duke.edu.
## Procedure for Neutralizing Aqua Regia

<table>
<thead>
<tr>
<th>Initial Screening</th>
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<tbody>
<tr>
<td>1. Calculate volume of <strong>water</strong> needed: ~ 7.5x dilution (e.g., 3L water for 400 ml Aqua Regia)</td>
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<tr>
<td>2. Calculate mass of <strong>magnesium hydroxide</strong> (<strong>Mg(OH)₂</strong>) needed: 0.533 g per ml of Aqua Regia</td>
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<tr>
<td>3. Prepare <strong>bromothymol blue</strong> (<strong>BB</strong>) solution: add 0.8 g BB to 100 ml water and a small drop of NaOH</td>
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<tr>
<td>4. Wear FULL PPE shown on previous page!</td>
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<tr>
<td>5. Place a stir plate inside a secondary container (with NO organic chemical residue in it).</td>
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<tr>
<td>6. Place a clean GLASS beaker on the stir plate. It must be big enough that it will never be more than 2/3 full (even after dilution is complete).</td>
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<tr>
<td>7. Add water as calculated in #1. Add stir bar and turn on stir plate.</td>
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<tr>
<td>8. Add Mg(OH)₂ as calculated in #2 and a dash of the bromothymol blue solution.</td>
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<tr>
<td>9. SLOWLY add Aqua Regia. Do not allow to overheat. If your solution turns yellow and there is still undissolved Mg(OH)₂, let solution stir longer. Test the pH and add more Mg(OH)₂ if necessary. (pH must be between 6 and 9 for waste pickup or drain disposal.)</td>
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<tr>
<td>10. Allow solution to cool before moving, capping, or transferring to another container.</td>
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