

Don't Get Steamed About Autoclaving-

Case studies and
recommendations

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It's a pressure
cooker!

Time

Temperature

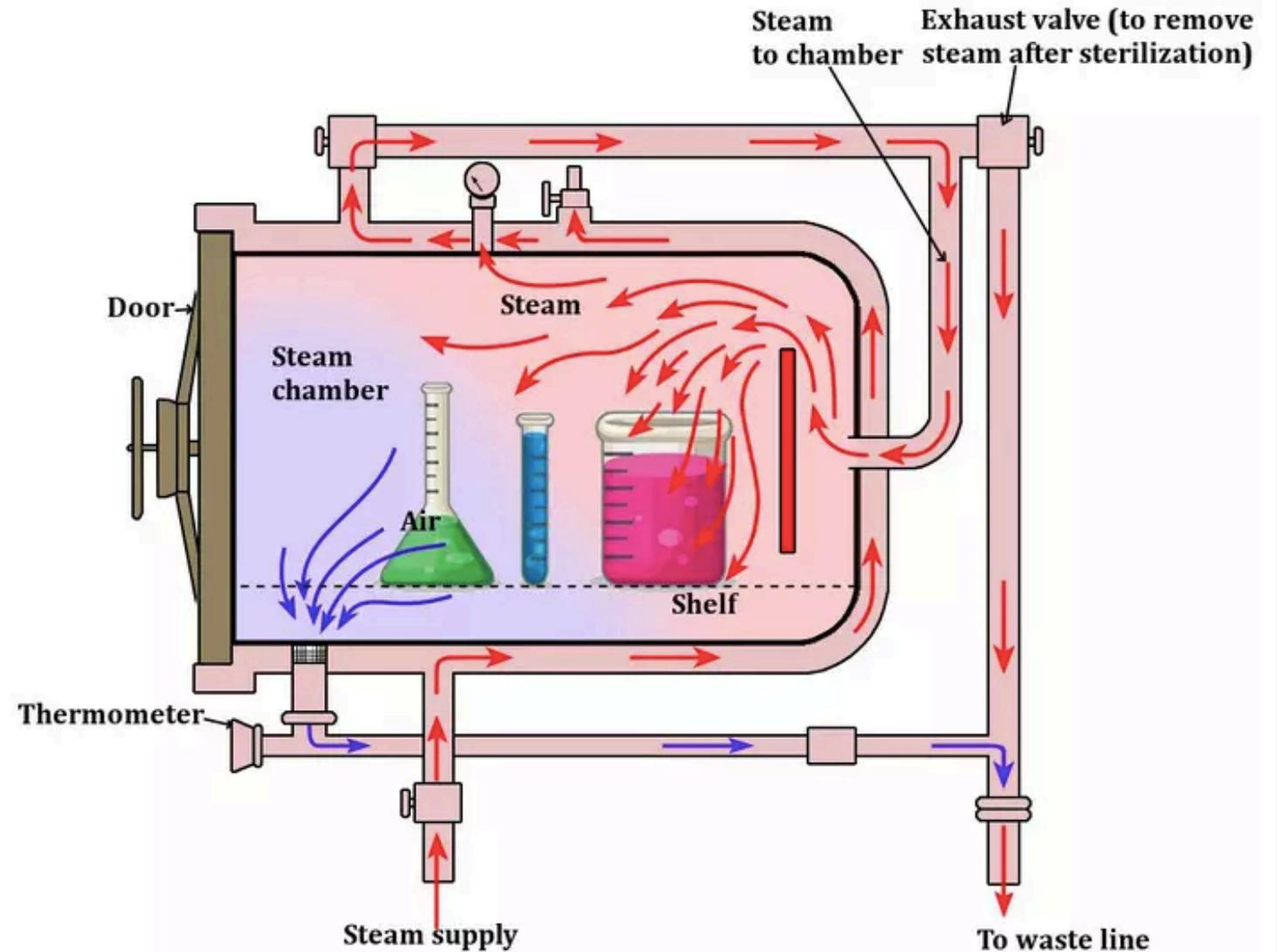
Pressure

Steam

A dangerous combination!

Gravity Displacement Autoclave

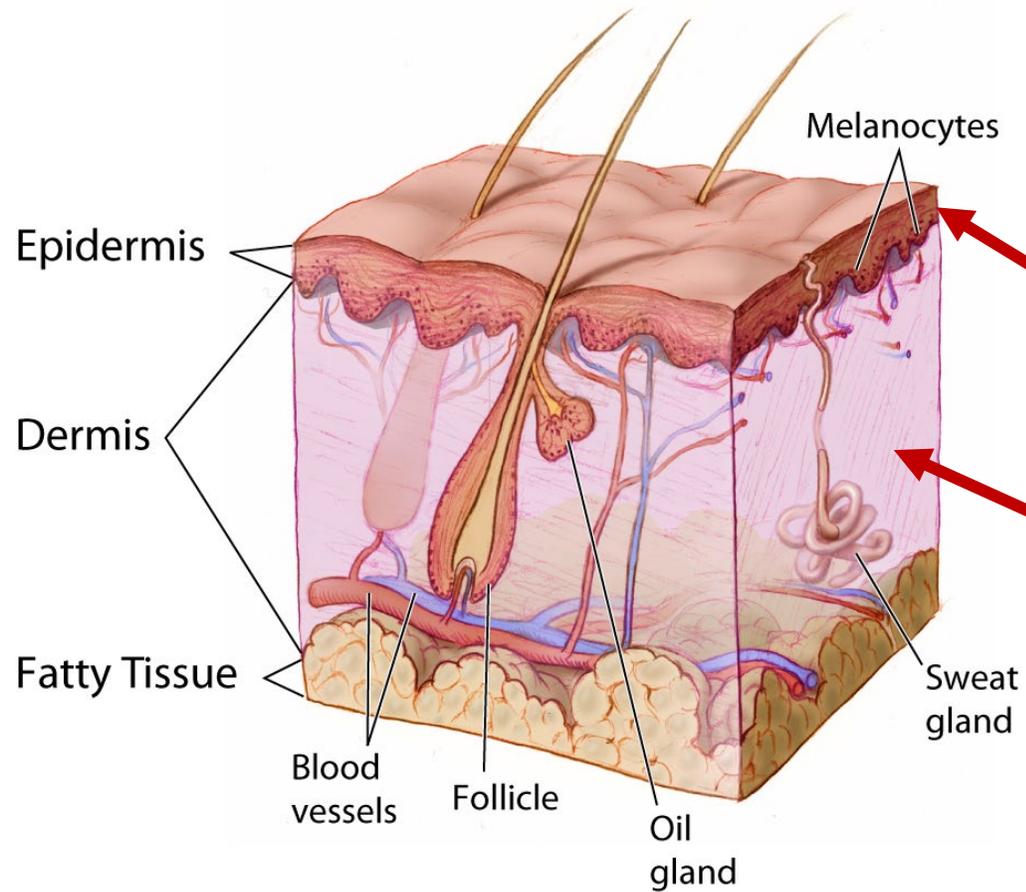
- Steam enters jacket
- Steam enters chamber
- Air is forced out
- Steam is forced into autoclave
- Pressure builds up
- Sterilization occurs



What Is An Autoclave? And How Does It Work?

Akash Peshin- Ashish-Hussain Kanchwala-Venkatesh Vaidyanathan-John Staughton -

<https://www.scienceabc.com/innovation/what-is-an-autoclave-and-how-does-it-work.html>



- Steam penetrates epidermis
- Dermis retains heat
- Damage occurs

Steam burns cause more damage than heat burns

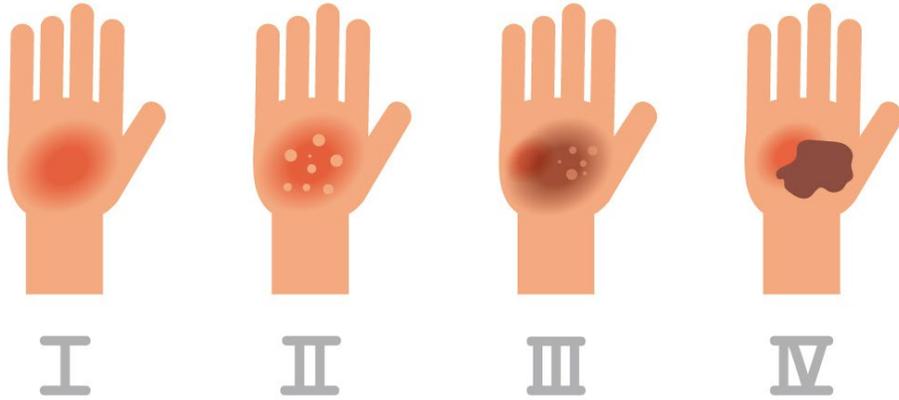
Skin burn parameters

Third-degree burns:
150°F, 2 secs
120°F, 5 min



Second-degree
burns: 140°F, 6 sec
130°F, 30 sec

Degree of skin burns



Recommendations for steam burns

- Remove all wet clothing
 - As steam condenses, energy transfer to skin
- Cool burn victim's skin with cool water
- Do not use ice

Autoclave Incident 1

- 2001, bottles in autoclave exploded
- Workers investigated
- Opened door
- Additional bottles exploded

Outcome – Incident 1

Glass flew 25 feet out of autoclave

Employee in front of autoclave – 2nd degree burns

Injuries to arms and face from glass shards

PPE – Safety glasses; donning thermal suit

Cause of Incident 1

CAPS on bottles were tightly closed!

Recommendations

Loosen caps!

Stand behind door when opening

Wear steam-proof PPE



Recommended PPE for steam protection

- Steam apron/rubber/nylon
- Protective gloves
- Face shield

Images from:

<http://www.burnguard.com/documents/TSP1004%20Prod%20Select%20Guide%2012-01-10%20Master.pdf>

Autoclave Incident 2

- Tower style autoclave
- Pan with media on top shelf
- Worker removed bin filled with water

Outcome of Incident 2



- *Scald burns on trunk and legs*
- Burns worse in areas where clothes remained
- *The person was wearing autoclave gloves*

Cause of Incident 2

- *Nalgene bins failed*
- *Scalding water in bin*
- *Materials not cooled down before removing*





Recommended: Jelly roll pans

- Use 'jelly roll pan'
- 1 inch sides
 - Don't degrade
 - Steam envelopes materials

Bread Pan: Loaf Pans: Meatloaf Pan. (OAD). Retrieved from <https://www.bedbathandbeyond.com/store/category/kitchen/bakeware-baking-tools/bread-loaf-pans/12045/>.

Recommendation for autoclaving liquids

- Place flask/bottle on rack
- Metal pan to catch boil overs
 - Reduces drain clogging
 - Eliminates pressure buildup



Recommendations



Use metal bins



Do not add water to bins



Cool materials before
removal

Remember

**Lab coats will not protect you
from steam burns**



**Use a steam protecting apron and
face shield**



**Remove ALL wet clothes and put
on a clean lab coat**

Autoclave Incident 3

- Researcher closed autoclave door and started cycle
- Locking mechanism not aligned
- Interior pressure blew door off

Door Failures



Image Credit: Uncehs Follow. "Autoclave Usage and Safety." *LinkedIn SlideShare*. N.p., 18 Nov. 2015. Web. 04 Aug. 2017.

America, Priorclave North. "Research Lab Autoclave Safety: Bad Doors and Autoclave Explosions." *Priorclave*, 30 July 2018, priorclavena.com/research-lab-autoclave-safety-bad-doors-and-autoclave-explosions/.

Outcome of Incident 3

**Autoclave operator 50 feet
away hit by door**

**Note: Several fatalities from
persons being struck by
autoclave door**

Cause of Incident 3

*Locking mechanism not aligned
causing pressure build up*

Metal fatigue?

User error?

**Some manufacturers say replace
doors every 5 years*



ABORT

Recommendation:
Know when/how to
abort a run

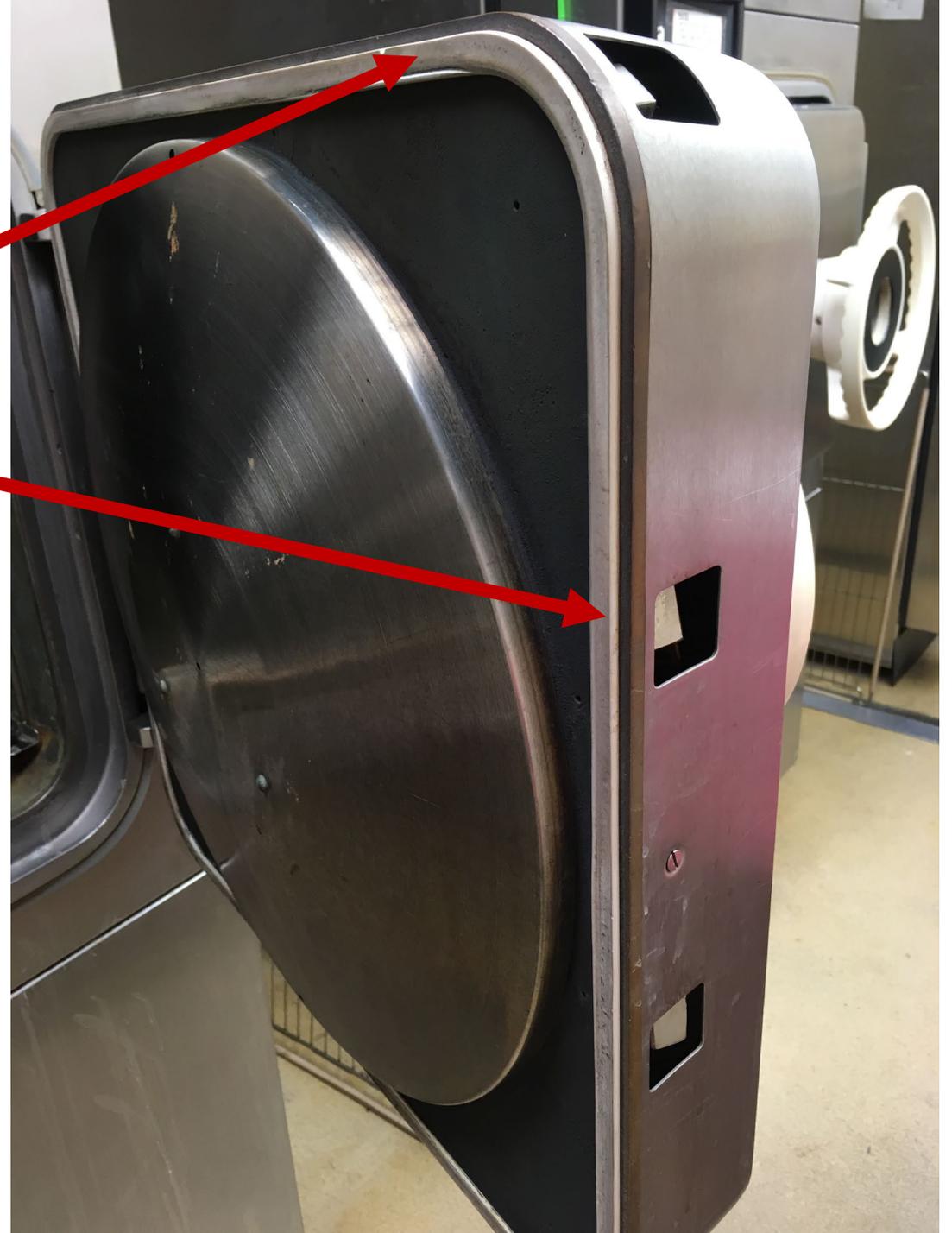
- Abort the run IMMEDIATELY if steam is escaping or if you hear whistling or screeching



Ensure door is closed and sealed

- Push door firmly at hinges first, make sure the door hinges are pushed in for a good fit
- All door rods must be inside the rim of the autoclave

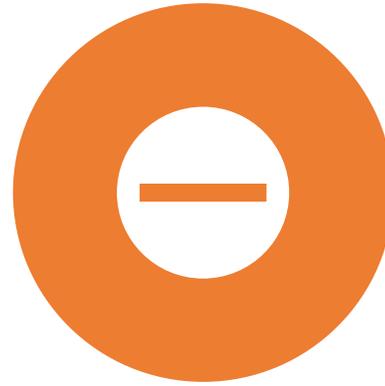
Check door seal
for cracks





Check the drain and make sure it is clear – no debris or dried media

Important!



BE SURE DOOR IS
ALIGNED AND
SEALED PROPERLY



PERIODIC AUTOCLAVE
MAINTENANCE IS
RECOMMENDED

Autoclave Incident 4

- Freezer failed and materials thawed
- All materials were autoclaved
- Tubes contained small volumes of phenol

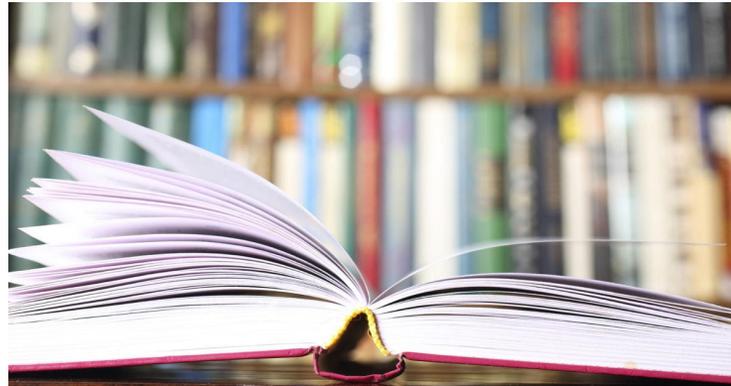
Outcome of Incident 4

- *Fumes released from autoclave*
- *Building was evacuated for half day*
 - *No reported long-term effects*



Cause of Incident 4

- Log of freezer contents not readily available



Recommendations



Check to ensure chemicals can be autoclaved

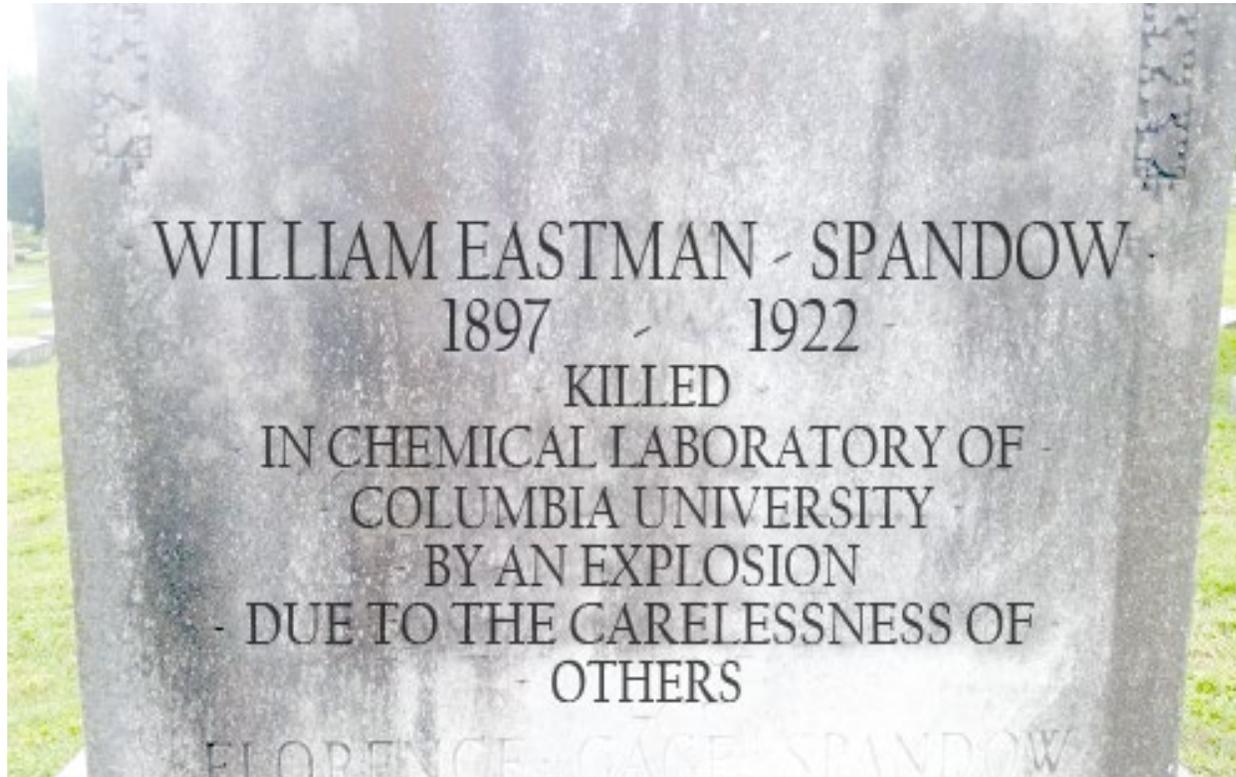


Check MSDS or call Chemical Safety Office



Keep log of all freezer materials readily available

Just a reminder that not all chemicals are autoclavable...



Diphenylamine in
autoclave

Michael, Connor. "1922 Lab Explosion with Clues for Today." *Lab Safety Institute*, 29 May 2019, www.labsafety.org/1922-lab-explosion-with-clues-for-today.

Autoclave Incident 5

- Workers unloaded autoclave
- One worker opened door while under pressure
- Autoclave exploded

Cause of Incident 5

- Safety mechanisms failed
- Locking arm failed
- Strainer missing from drain line
- Bottle stopper was blocking drain
- Drain temperature probe failed
- Indefinitely under pressure

Outcome of Incident 5



*ONE
WORKER
DIED AT
SCENE*



*SECOND WORKER SUSTAINED BACK
INJURIES FROM BEING PUSHED INTO
CARTS*



Additional recommendations
Train users! (More than once)

Don't be a
statistic.

Remember..

IF SCALDED BY STEAM, REMOVE WET CLOTHING
IMMEDIATELY

WEAR APPROPRIATE PPE

OPEN AUTOCLAVE DOOR ONLY IF PRESSURE IS
0 PSI

DO NOT REMOVE MATERIALS FROM THE AUTOCLAVE
UNTIL COOLED 10 MIN

KEEP YOUR FACE AND BODY AWAY FROM THE
AUTOCLAVE WHEN OPENING THE DOOR

LOOSEN CAPS ON BOTTLES

MAKE SURE THAT THE DOOR IS PROPERLY CLOSED

**Don't get
steamed!**



**Be safe!
Thank you!**

Sources

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