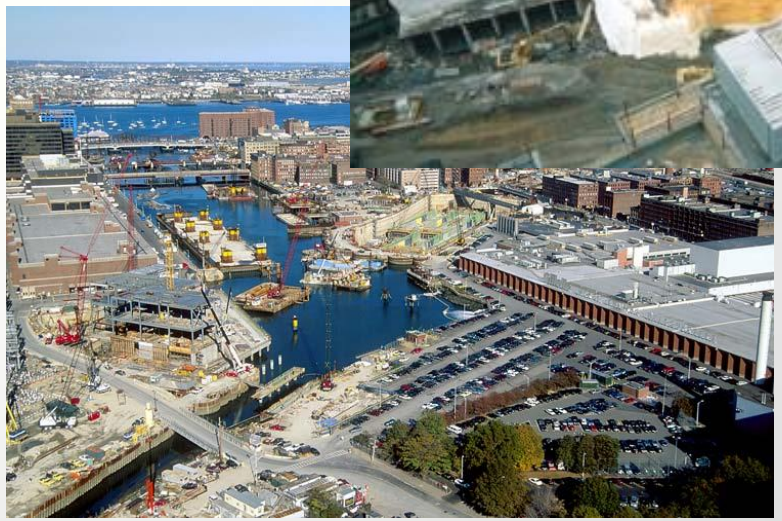
Henri is an architect and building envelope specialist with over forty years of experience in the construction industry. He was a pioneer in the solar industry, introduced the installation technique for field-applied closed-cell closed-cavity-fill polyurethane foam and has designed and constructed a net-zero energy research structure in Antarctica. He has four energy-related U.S. patents.



HCF foam experience

1. First spray foam project was in 1971
2. Foam manufacturing from 1973 to 1979
3. Foam contracting and BE consulting from 1979 to 2009
   - Developed the method for injecting closed-cell foam on site
   - Installed ~ 5 million pounds of foam
4. Foam and BE commissioning from 2009 to present
5. Noteworthy foam projects include:
   - 1977 net-zero solar project in Boston, The Big Dig, 4 American Ski Grande Hotels in the Northeast, Net-zero energy weather station in Antarctica, The Guggenheim Museum
6. Two US patents and numerous technical papers related to foam & foam QA




Quality Assurance for Low-Pressure Disposable Foam Systems (aka Kits and Cans)

by: Henri Fennell, CSI/CDT

Photo Courtesy BPI Newsletter

Copyright Materials

Introduction to Low-tech Polyurethane Foam Processing Systems, Methods, and How-to's

- Products
- Applications
- Personal protection
- Conditioning the product
- Quality control
- Review – Q&A
- Case studies

Products

Overview

There are several types of polyurethane foam available to meet various project requirements

- Foam sealant (FS)
- Spray-applied polyurethane foam (SPF)
- Injected polyurethane foam (IPF)
- Open and closed-cell foams
- Seasonal formulations

Polyurethane products and quality assurance/control

Polyurethane Product	Use (Does not include adhesive products)	Closed-cell foam	Open-cell foam	QA - Verify parameters before and during processing	QA - Verify preparation parameters	QA - Verify parameters during the installation	QC - Verify parameters after the installation
Single-component caulk/sealant	Seal cracks < 1/8"	NA	NA	Product temperature	Ambient and subtrate temp.; substrate dry; compatable	Technique; bead thickness, push vs. pull bead	Visual inspection*
Single-component foam (comes in colors)					Ambient and subtrate temperature; substrate clean and dry; verify compatability		
Expanding	Seal cracks 1/8" to 3/4"	Y	NA	Chemical temperature, well mixed		Full depth; any required bracing; moisten between lifts > 3/4"; technique	Visual inspection*
Non-expanding	Seal cracks 1/8" to 3/4"	Y	NA	Chemical temperature, well mixed		Full depth; moisten between lifts > 3/4"; technique	Visual inspection*
Two-part slow-rise foam kit	Seal cracks > 1/4" or fill cavities	Y	Y	Chemical temp., equal pressures, component weight; test shots	Ambient subtrate temperature and RH; substrate clean and dry (wood moisture content or metal and masonry surface moisture); verify compatability	Maintain preparation conditions; sheathing integrity and fastening	No pass thickness limit; use infrared to verify fill; maintain prep. conditions thru cure period
Two-part spray foam kit	Seal cracks > 1/4" or build up on open surfaces in lifts	Y	Y	Chemical temp., equal pressures, component weight; test shots		Lift thickness; time between passes; maintain prep. conditions; cure-lift prevention	Visual inspection*; pass thickness limit; thump test; maintain preparation conditions thru cure period
Injected two-part bulk foam	Fill closed cavities	Y	Y	chemical temperature, pressure, ratio; test shots	Ambient subtrate temperature and RH; substrate clean and dry (wood moisture content or metal and masonry surface moisture); verify compatability	Maintain preparation conditions during installation; sheathing integrity and fastening	no pass thickness limit; infrared to verify fill; maintain prep. conditions thru cure period
Spray-applied two-part bulk foam	Build up on open surfaces in lifts	Y	Y	Chemical temperature, pressure, ratio; test shots		Lift thickness; time between passes; maintain prep. conditions; cure-lift prevention	Visual inspection*; pass thickness limit; thump test; maintain prep. conditions thru cure period
Spray-applied two-part bulk roofing foam	Build up on open surfaces in lifts	Y	Y	Chemical temperature, pressure, ratio; test shots	Same as bulk wall foam above	Lift thickness; time between passes; maintain prep. conditions; cure-lift prevention	Visual inspection*; pass thickness limit; thump test; maintain prep. conditions thru cure period

* Assess cell color, uniformity, size, shape, odor, friability, strength, lift thickness, etc.

Closed-cell bulk polyurethane foam blowing agents

ODP ratings: All current products are zero ODP ← GWP →

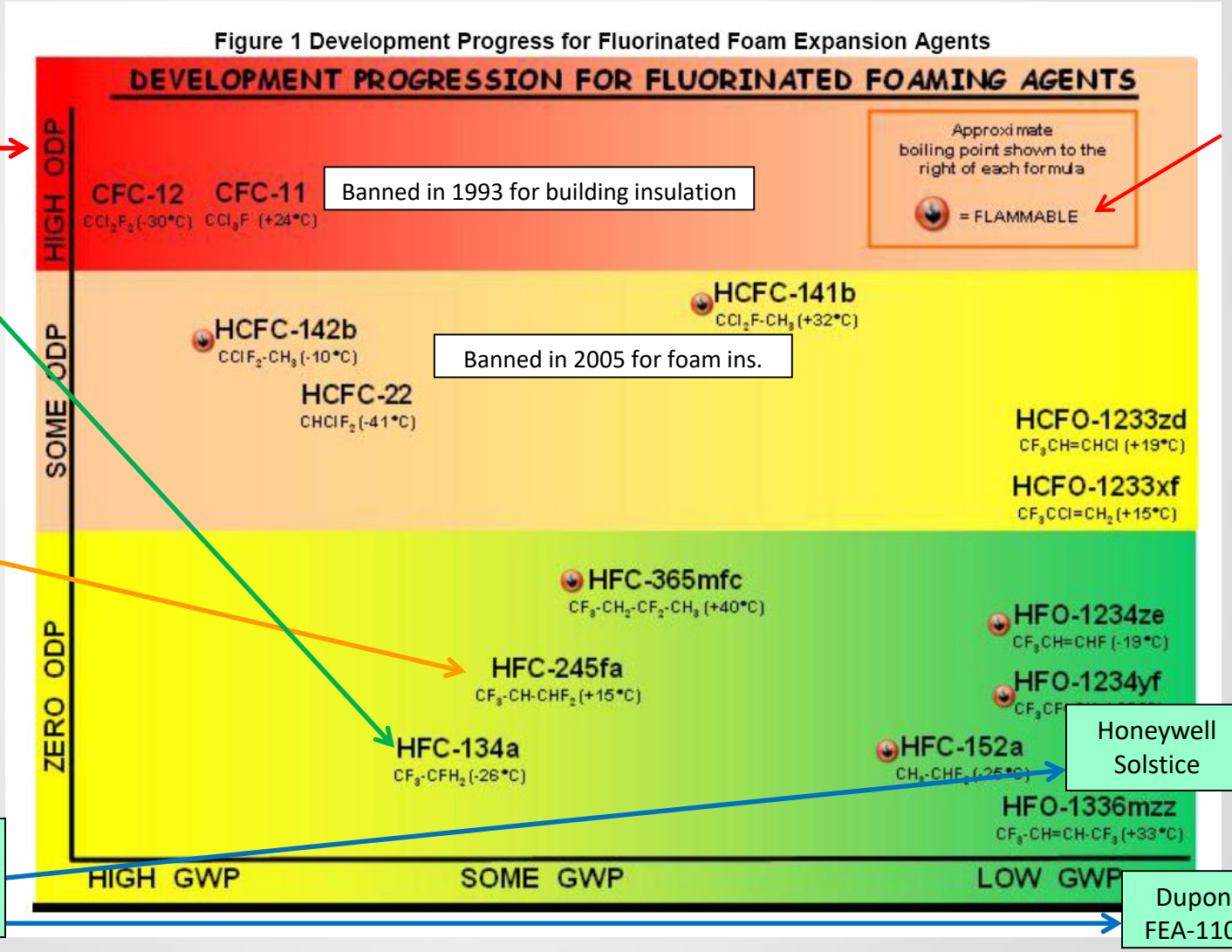
My first foam work (1971)

FOAM-TECH SUPERGREEN FOAM (1993)

"Low ODP (1993 - 2005)

The current technology (2003 - present)

The 4th generation (2013)



Honeywell Solstice

Dupont FEA-1100

Original source: Dupont Formacel 1100 paper

Personal protection

1.0 General

Personal protection

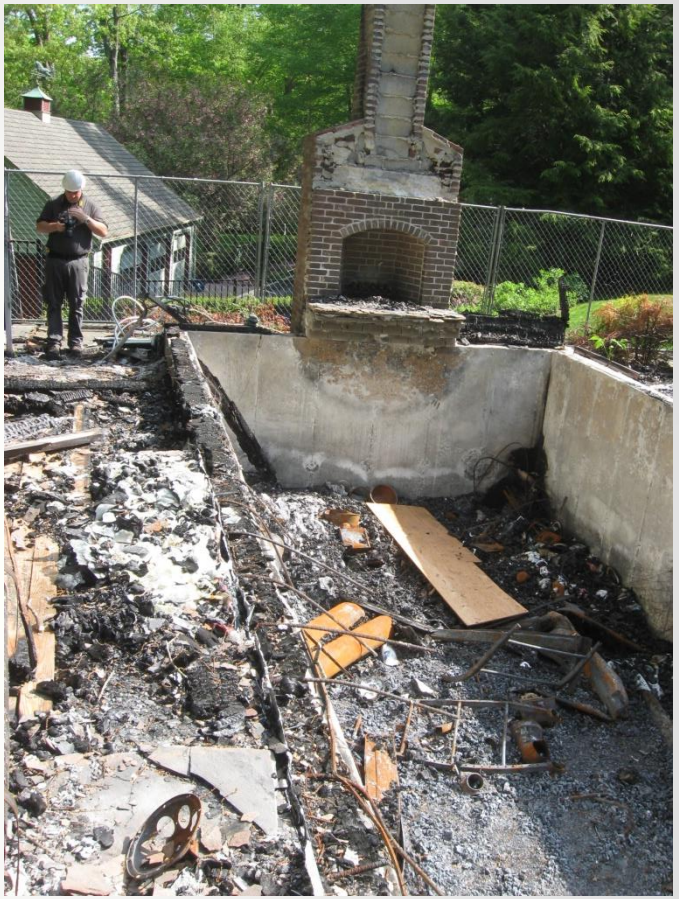
- Hazards related to pressurized systems
  - How to prevent an explosion – where to point the pressure relief vent (PRV)
  - What to do in the event of a chemical spill
- SDS = Manufacturer's safety recommendations for handling chemicals
- Respirators and ventilation measures
- Confined space implications

Safety First!

- Personal protection (95%)
- Site protection
  - Evacuation (5%)
  - Ventilation (balanced) (<1%)
  - CAZ safety (<1%)

Who is this?

Ventilate, but check the CAZ



Air sealing plus unbalanced ventilation can cause back-drafted combustion appliances

Safety and site protection

- Always use personal protection.
  - Gloves, goggles, respirator if in confined areas
- Never pressurize two-part tanks or hoses to more than 200 PSI. (Do not overheat the tanks.)
- All foam plastics must meet the IRC and IBC fire protection requirements.
- Prepare the substrate/surfaces.
  - Mist if required for one-part kits.
  - They must be clean and dry for two-part kits.
  - Use bracing when required.
  - Mask all finished surfaces and electrical boxes.

Products

One-part

Intro to 1-part Foam Sealant (FS)

- Use the right 1-part product for the application!
  - Expanding, low-expansion, and non-expanding
  - Adhesives
  - Fire rated products for sealing at fire separations
  - Various colors and sizes
  - Some manufacturers have seasonal formulations.

Pros and Cons

Foam Sealant (FS vs. SPF)

1. Kits and cans (FS) – portable and low tech
2. Higher per unit cost than bulk foam (SPF)
3. Cost effective where small volumes are used in large buildings (limited areas require slow rise to supplement bulk SPF)
4. Cost effective where work has to be done intermittently and scheduling bulk foam is difficult
5. Cost effective in small areas that are difficult to access with high-pressure hoses (too far, can't get there with a truck or trailer)

Delivery systems for field-processed materials using Low-output (3 to 10 #/minute) pressurized portable units (Kits and Cans)

Intro to 1-part FS

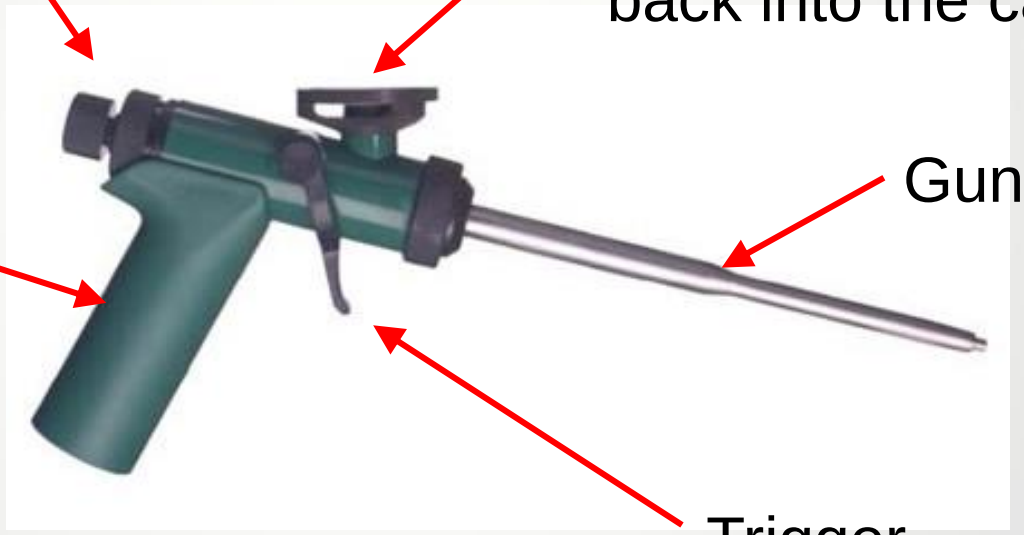
- There are a number of products - different colors, low or non-expanding sealants, and full-rise expanding sealants.
- There are a number of applications - air sealing, adhesive, bug stopping, and fire stopping.
- There are a number of typical locations where FS is used - windows and doors, cracks and penetrations, touch-up for SPF, fire separation walls, and floors.
- There are gun and straw delivery systems.
- This product can be an adhesive.

What's in a can

Capacity – Pur fill 1G 750

- 750 = ml
- 32 liquid oz.
- 12 Dispensed Gallons
- 1/2" Bead = 1,200 Linear Feet Long
- 2,820 Cubic Inches
- 1.6 Cubic Feet
- 19 Board Feet

Foam Gun Parts & Installation



Put petrolatum on the check valve and the foam can mount.
Thread the can onto the adapter on the top of the gun.
DO NOT OVER-TIGHTEN

Foam Can Installed

Straw system

Gun system

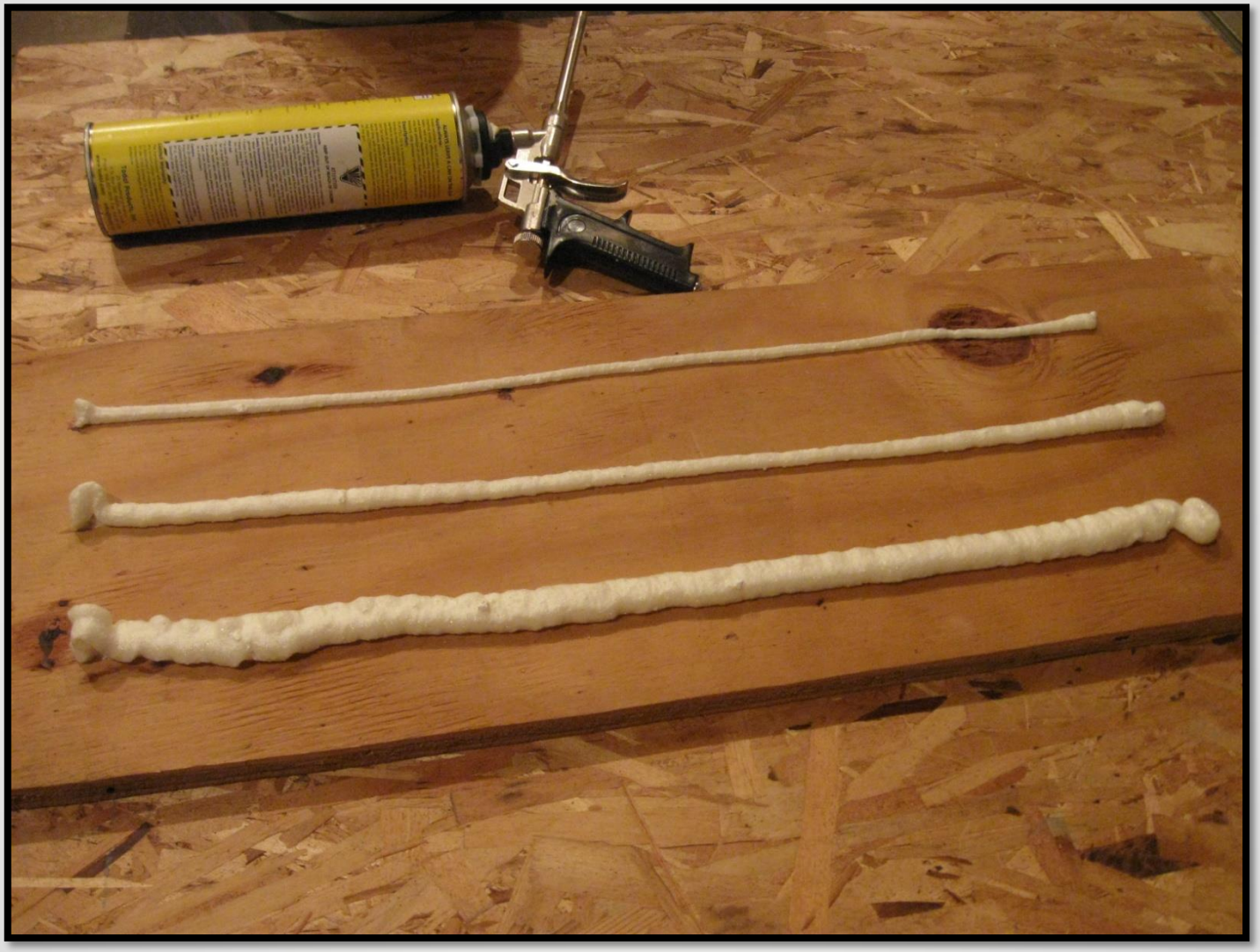
- There is no dip tube in a one-part foam system.
- Always keep the can above the gun – use a full can for more angle.
- Use an extension for out-of-position work.
- Always latch the safety when not in use.

Foam Sealant (FS)

1. Shake the can
2. 60° F minimum, 80° F recommended
3. Attach the foam can to the gun
4. Open the flow control valve
5. Dispense foam into a waste container
6. Adjust the valve to the right flow rate for the application

Foam sealant kit with gun, foam, cleaner, petrolatum, gloves, mister, and extensions/adapters

Adjusting Bead Size

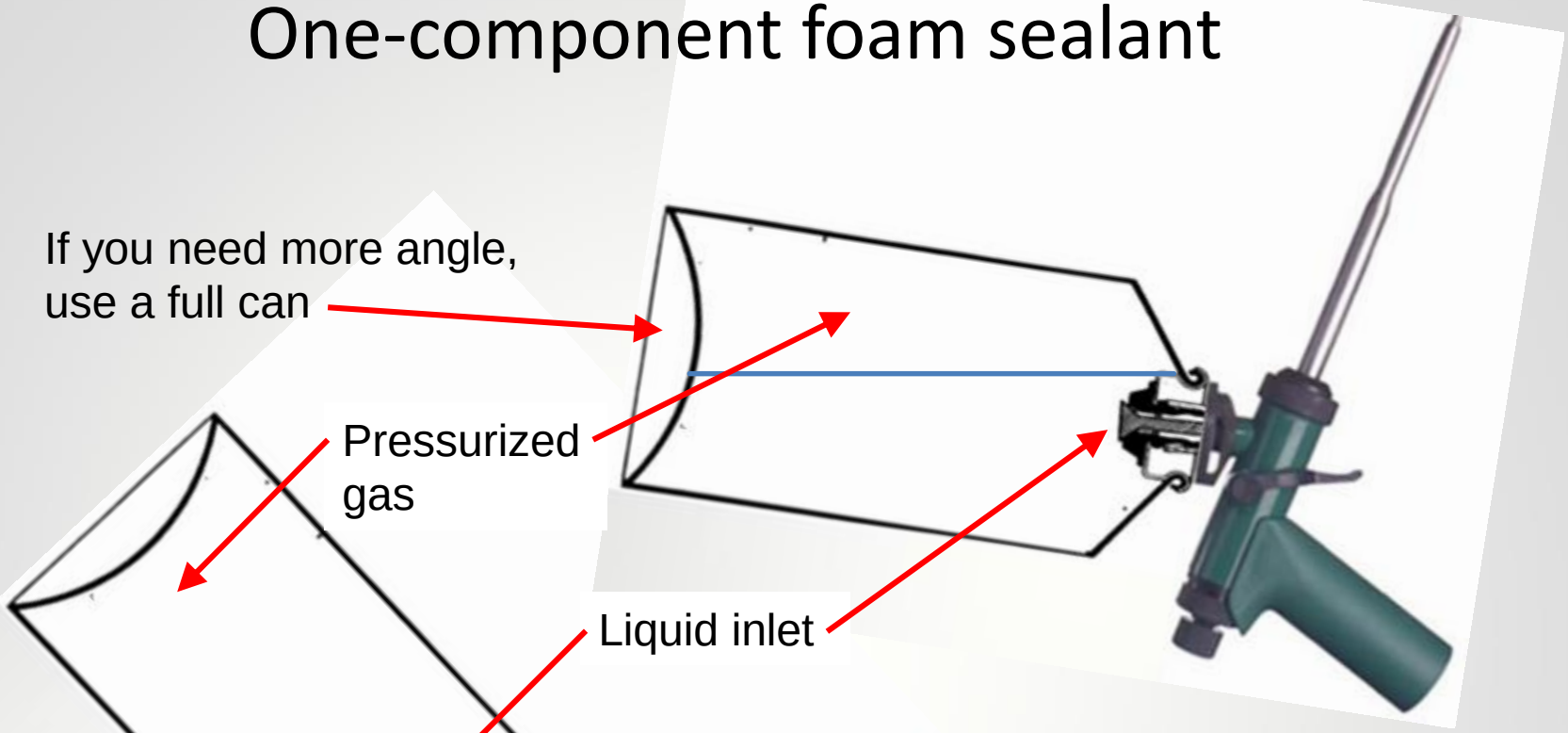


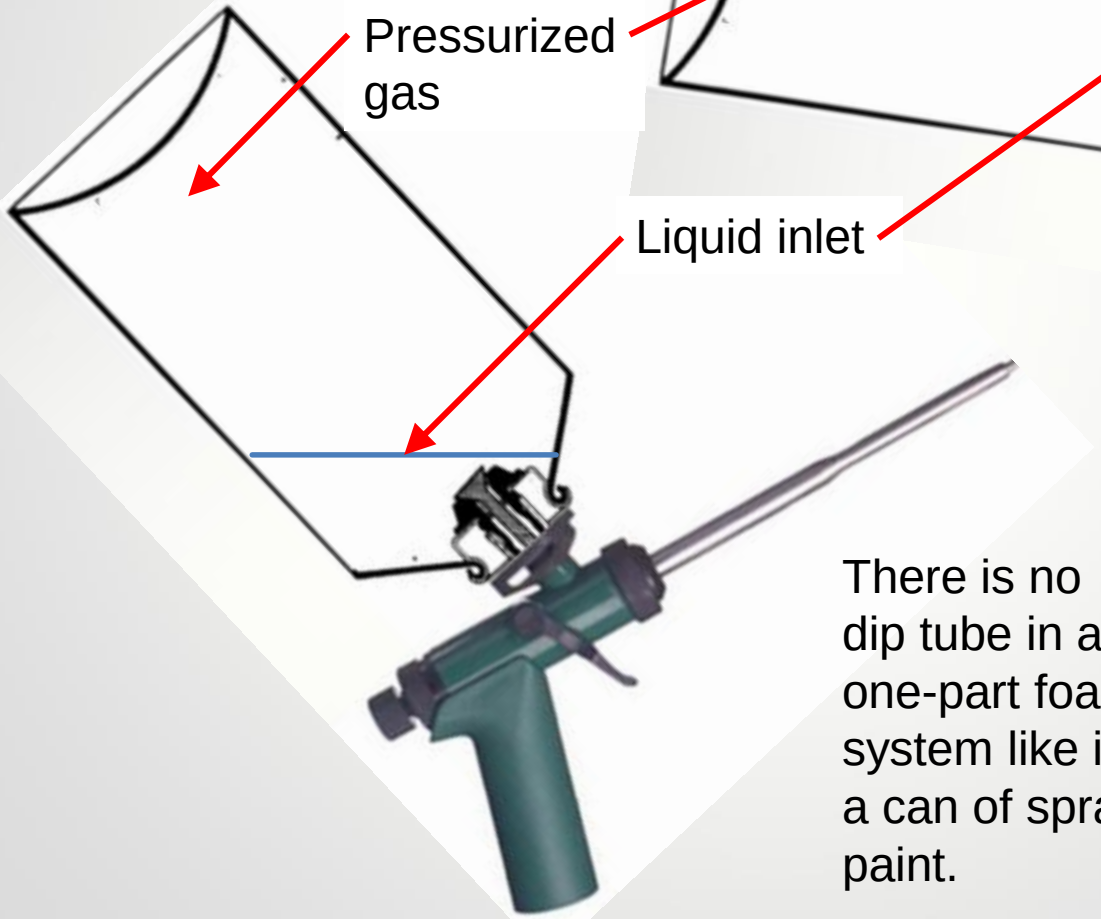
One-component foam sealant

If you need more angle, use a full can

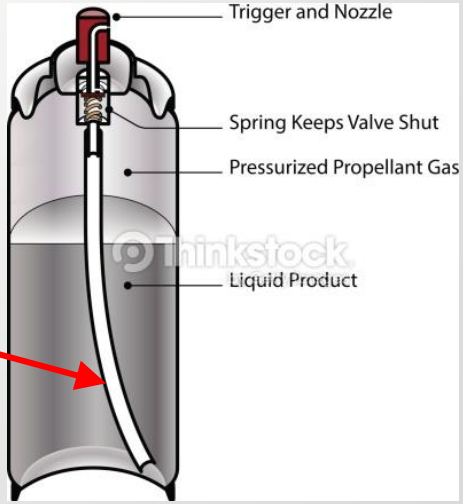
Pressurized gas

Liquid inlet





There is no dip tube in a one-part foam system like in a can of spray paint.



One-component foam sealant

Use an extension for out-of-position work

You can use an extension tube on most of these guns.

My gun takes ¼” OD by .170 ID Vinyl tubing

One-component foam sealant

- Provide the proper substrate and ambient conditions for the product.
- Always check to see what the manufacturer recommends.
- Consider temperatures, humidity, moisture content, compatibility, substrate conditions, etc.
- Do no expose chemical to temperatures exceeding 50 °C/122 °F.
- The recommended storage temperature is 59 - 73 °F. Storage above 73 °F will reduce shelf life significantly, depending on temperature and duration.
- Advice on disposal: Dispose of waste according to applicable legislation.

Preconditioning one-part FS

1. Shake the cans well.
2. Warm the cans to the proper temperature.
   - Minimum ambient is 40F
   - Recommended between 60F and 80F
3. Warm them safely.
   - Slowly with a low-flux heat source
   - Never allow the cans to get above 122F
   - They will explode!
4. Swap them out during the work if the weather is cold.

One-component foam sealant

Precondition the containers.

1. Shake the cans well. (How long is that?)
2. Bring the cans to the proper temperature.
   - Minimum is 40F for Pur fill 1G
   - Recommended between 60F and 80F
3. How do you warm them (slow, fast, etc.)?
   - Slowly with a low-flux heat source
   - Never allow the cans to get above 122F
4. How do you measure the temperature?

One-component foam sealant

Check the manufacturer's specifications for the product you are using

ACCESSORIES:

- 14 Gauge Needles
- Stuff-It
- Long Tubes

HOW TO USE:

1. Shake the can well.
2. Thread the can into the adapter on the top of the gun.
   DO NOT OVER-TIGHTEN
3. Pull the trigger for about 5 seconds to purge all air and moisture out of the gun.
4. Wipe or mist into the joint.
5. Select the bead size by interacting between the trigger and the flow adjustment screw.
6. The can should be in a vertical position over the gun when foaming.
7. Tighten the flow adjustment screw for storage.
8. To replace an empty can, unscrew the empty can and promptly screw a replacement can into the adapter. If no replacement is available, leave the empty can in place until a replacement is at hand. ALWAYS KEEP A CAN OF FOAM ON THE GUN. FAILURE TO DO THIS WILL ALLOW FOAM TO CURE AND RESULT IN PERMANENT DAMAGE TO THE GUN.

Color	Yellowish
Expanded Volume, Free rise @68° F relative humidity	9 gallons/can or 1.3 cubic feet
Density	1.2 lbs/cubic feet
Cell Structure	excessively closed, approximately 80%
Compression load deflection (10% compression)	8.5 lbs/in^2
Minimum can temperature	40° F (5° C)
Minimum surface temperature	32° F (50° C)
Temperature stability of cured foam	-40° F to +176° F(-40° C to +80° C)
Tack-free @68° F (20° C) time	10 Minutes
Cuttable Time @68° F (20° C) time	30 Minutes
Flammability test ASTM E 84	Flame spread index: 15 Smoke developed: 50 Class 1: fire rating construction
Thermal resistance: R factor ASTM C 518	6.0/inch

The misting mystery

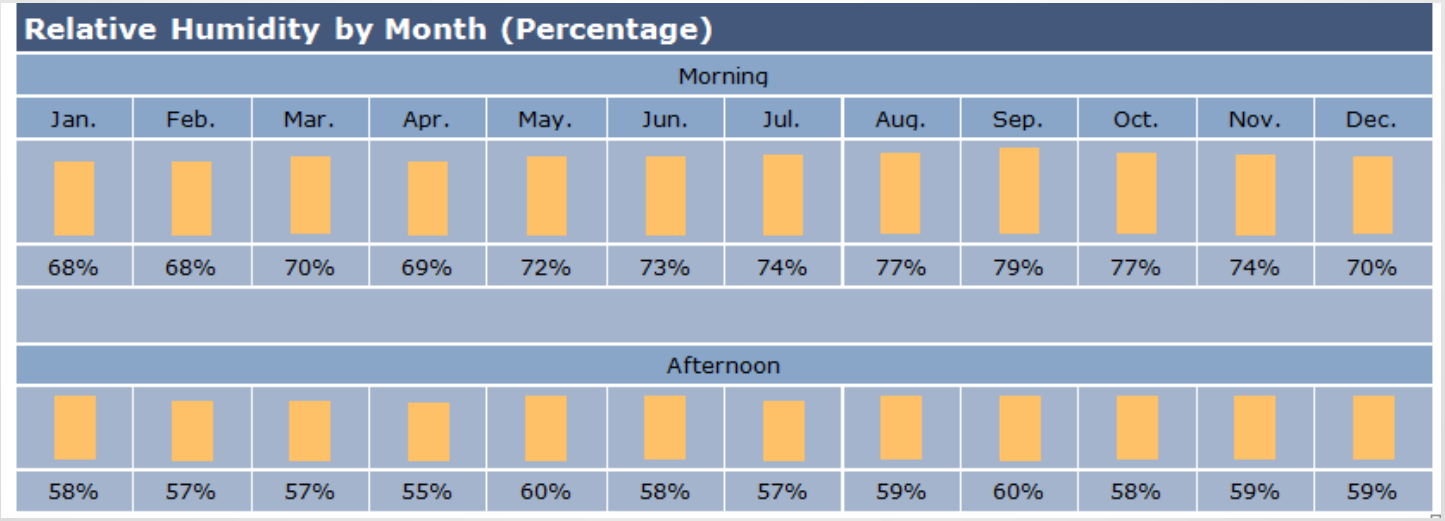
FS is a water-cured product. It will not set up if water is not available to the reaction.

Manufacturer's instructions:
"With a misting bottle, mist the area with water on the area to be foamed. If you are foaming in large sections, stop every two inches, mist water on the earlier foam and add another two inches."

In colder temperatures, the air is drier, hence the need to mist water to assure proper curing.

Misting Instructions from Todol

Mist the area with water before foaming: This is our most misunderstood instruction. None of our competitors mention this as often as we do but let me assure you, all one component moisture curing foams need moisture to properly cure. You only need an ounce of water to properly cure an entire can of our 750 ml cans of foam which dispense on average 12 gallons of dispensed foam. If you are foaming around a window (.5 inch to 1 inch diameter bead will easily match the R factor value of the window being installed) the small bead will get moisture from the wood frame and/or from the open air and should cure just fine. However if you are foaming a deep void with a large cross section of foam, say 6 inches, we recommend foaming 2 inches, mist with water, foam for 2 more inches, mist with water and foam etc. This layering technique will assure moisture will be present in the middle of the large cross section of foam. You should also be aware of the moisture content in the air when foaming, on most days plenty of moisture is in the air to cure beads of foam. Refer to the relative humidity of the day you are foaming, when foaming in beads like to seal around windows and doors, a relative humidity rating above 55% is adequate to assure product curing. Boston the average humidity is 73%, please see the nice chart l located on Boston's relative humidity.



One-component foam sealant

Without moisture

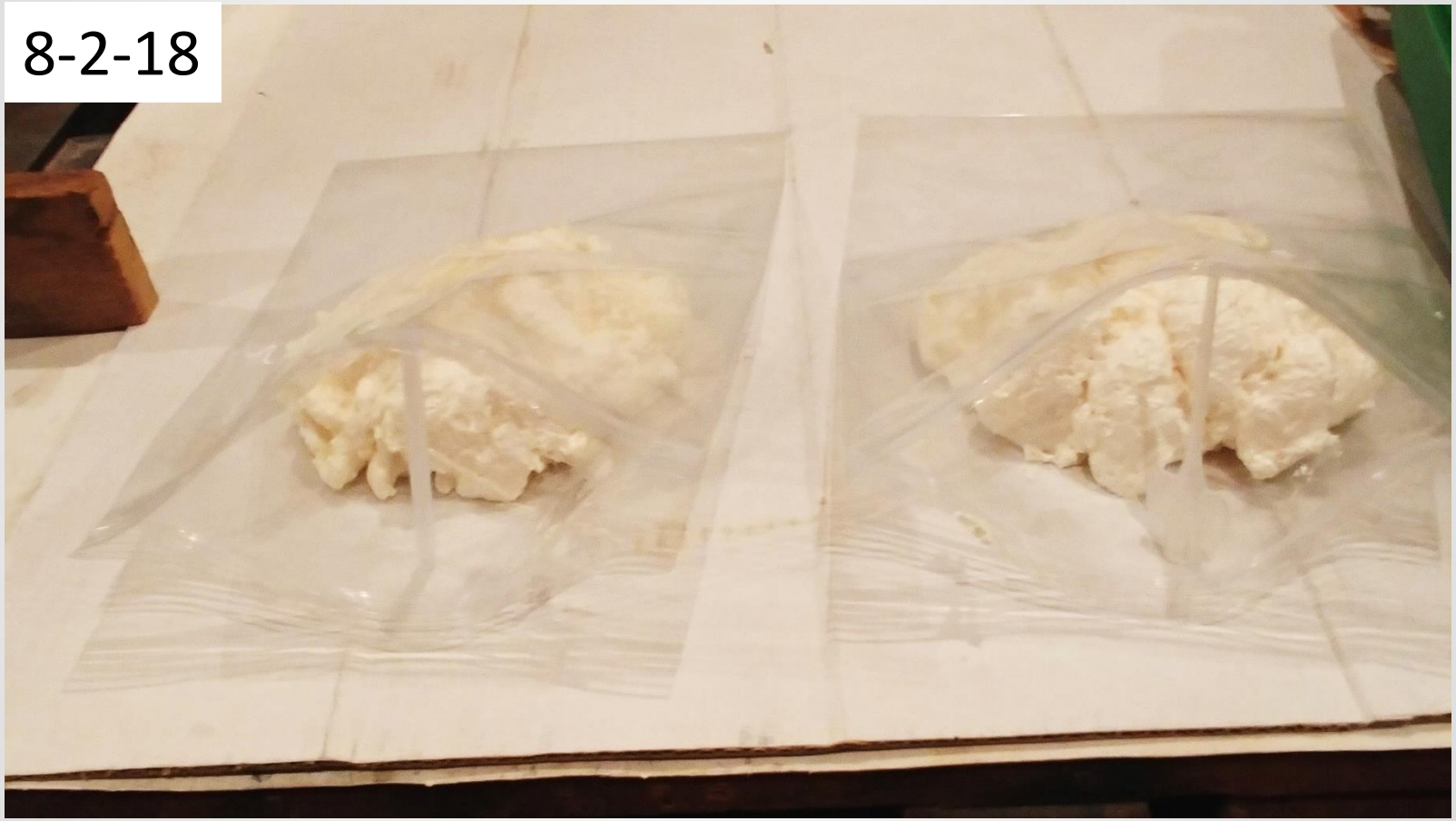
With moisture

One-component foam sealant

Without moisture

With moisture

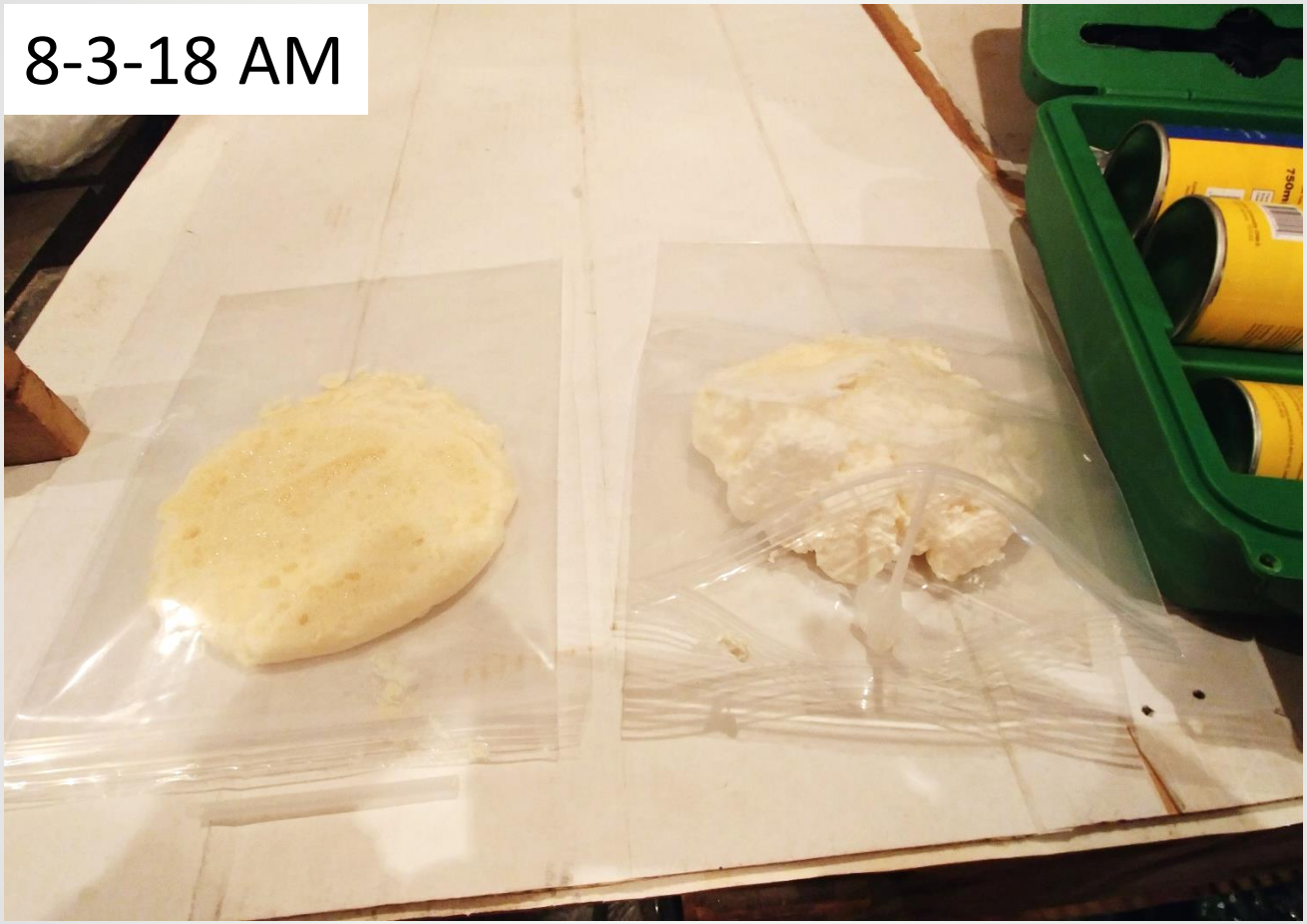
One-component foam sealant



Without moisture

With moisture

One-component foam sealant



Without moisture

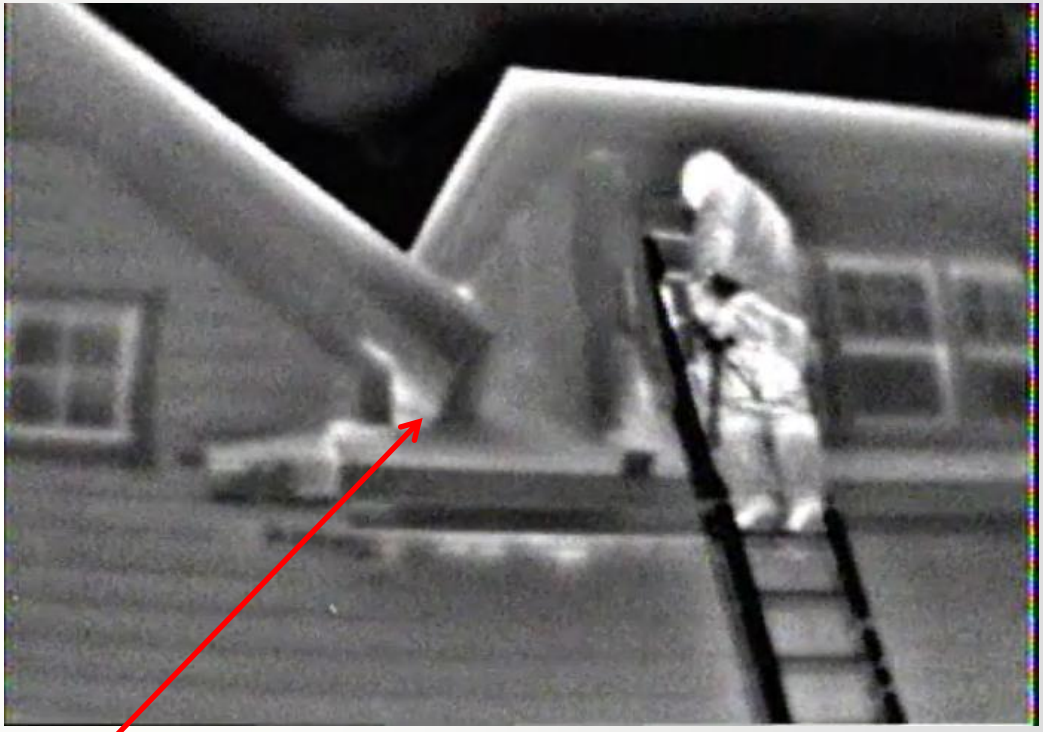
With moisture

One-component foam sealant

Without moisture

With moisture

Cold chemicals without moisture



Infrared and daylight frost patterns – failed panel joint air sealing

Cold chemicals without moisture

Frost due to air leakage

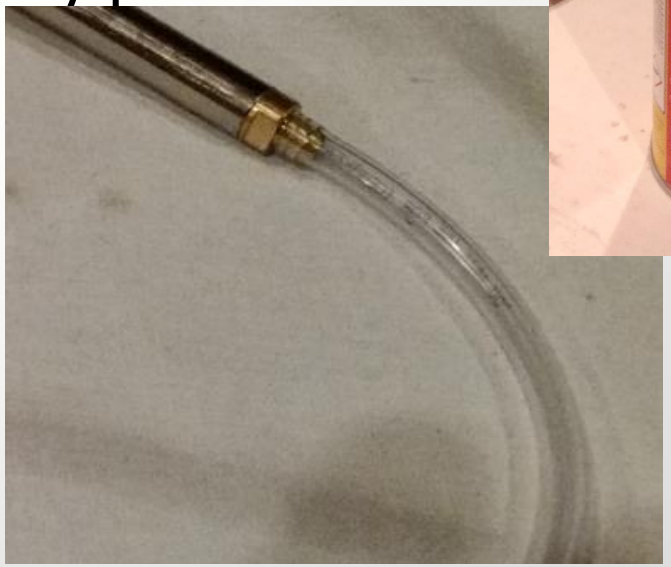
Quality control – one-part foam sealants

Keys to one-part FS quality

1. Select the right product for the application.
2. Require the installer to meet the manufacturer's requirements.
    - Warm the chemicals.
    - Shake the cans.
    - Moisten if the air is dry or foaming thick cross sections.
    - Close the gun valve when it is not in use.

Caring for a Foam Gun after the work

- Clean with gun flush only if needed. Overuse of cleaner will permanently damage the gun.
- Always keep a can on the gun.
- Keep the flow control valve closed when the gun is not in use.
- Wire brush the gun tip if possible.
- Store the cans in a cool, dry place.



Products

two-part

Kits and Cans

One-component foam cans and guns

Two-component kit foam

Bulk spray vs. 2-part kits

Low-pressure refillable systems

FROTH-PAK™ Refill Systems

Affordable

- Lower long-term cost of ownership compared to high pressure drum and rig system
  - Less capital investment
  - Minimal set-up time
  - Less equipment maintenance
  - Low-cost replacement parts
  - No specialized technician required to maintain/repair
  - Ability to work all year using heated hose option
- Avoid disposal fees; keep material out of landfills

Easy to Use

- Self-contained, eliminating need for generator or power cord
- Refillable cylinders avoid disposal fees
- Hose length up to 150'
- One hour re-entry period compared to 24 hours for drum/rig application

Low-pressure refillable systems

Pressure vessel systems come in all sizes (up to tank car size).

The larger ones are all “refillables.” Some small PVs are sold as “disposable” or “portable” kits.

2-part kits

(low pressure)

- These come in open and closed-cell formulations.
- They also come in spray and slow-rise formulations.

Product selection – 2-part kits

- Most of these products are comparably priced.
- None of the products are using the fourth-generation blowing agent yet.

Product selection – 2-part kits

- Most of the fast-rise systems are E84 compliant.
- Only some of the slow-rise products are E84 compliant.

Product selection – 2-part kits

- Most of the guns are variable flow (“metered flow”).
- One product manufacturer has colored the chemicals so that the foam comes out green. If it turns blue or yellow, it is off ratio.
- The slow-rise products have different “push” distances.

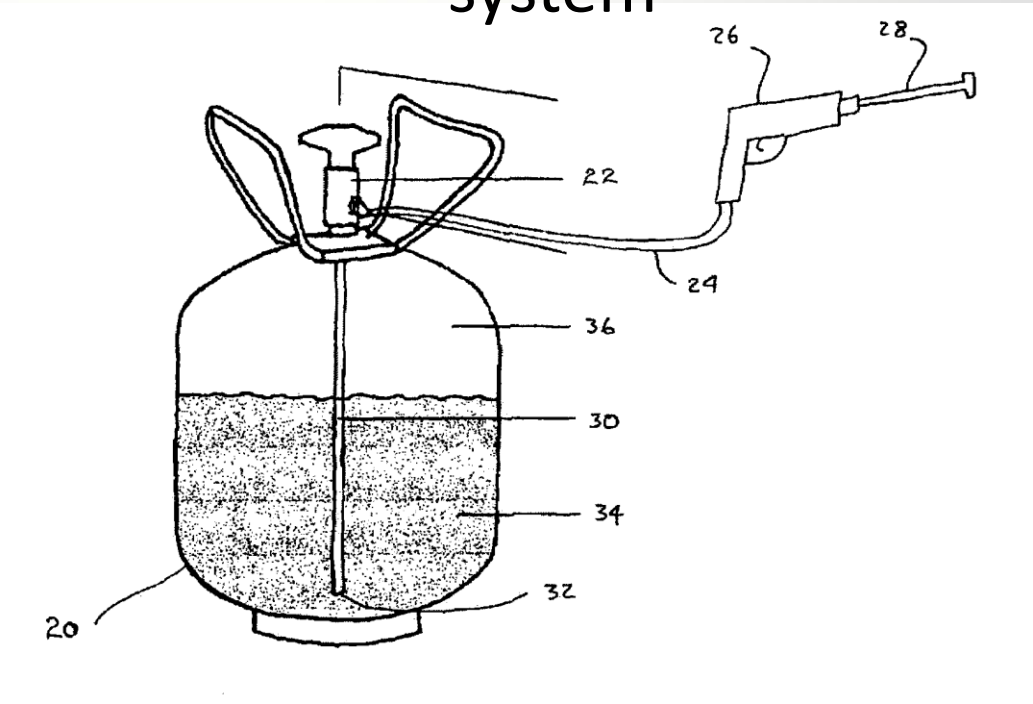
How do they work?

How do kits and cans work?

Pressure vessels and propellant

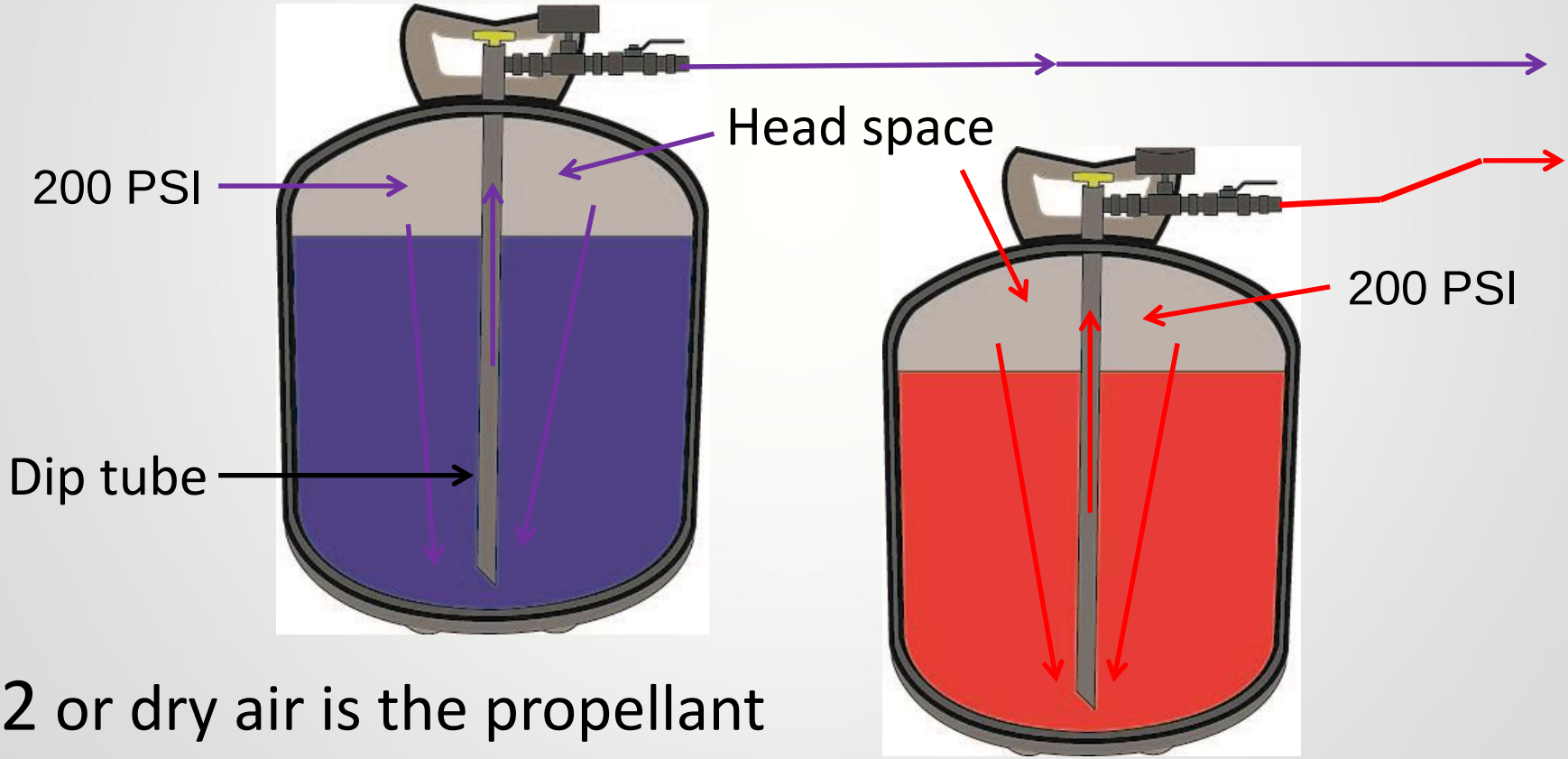
Garden sprayer – manual pump refillable system

Sealed disposable one-component pre-pressurized system



How do kits and cans work?

Two sealed disposable one-component systems are combined to make a two-component kit

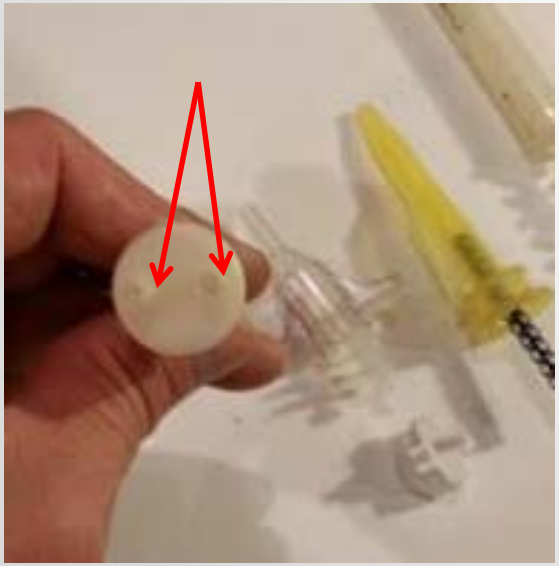


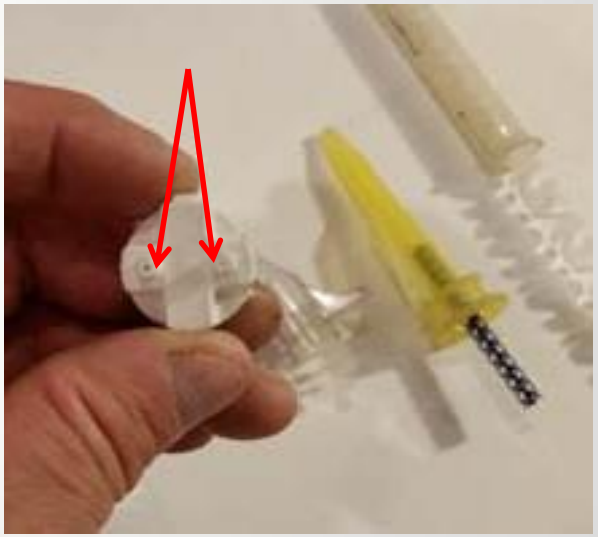
N_2 or dry air is the propellant

Always keep the cylinders upright when you are making foam!

How do kits and cans work?

1. In disposables, the A to B ratio relies on fixed-orifice flow control <u>at very specific temperatures, viscosities, and pressures</u>.
2. The fixed orifice may be in the gun or the disposable mixers.





Calibrating kits

CALIBRATION PROCEDURE

Acceptable ratios are 1.08 to 1.16.

Always calibrate the spray foam system prior to the start of spraying.
Recalibrate the spray foam system if the foam:

- is off color
- is too rubbery, crunchy or runny
- runs off the substrate
- does not cure

CALIBRATION INSTRUCTIONS

Equipment needed: Scale capable of weighing in grams, paper lunch bags, calibration nozzles, calculator, pen or pencil.

1. Ensure chemical temperature in tanks and hoses are 70°F (21°C) or higher.
2. Set nitrogen regulator pressures at 150 PSI and open all system valves.
3. Remove nozzle from foam applicator, disengage the foam applicator safety and dispense chemicals in an appropriate container to verify proper chemical flow while purging air from the hoses.
4. Weigh each empty bag and mark its weight on the bag so that its weight may be deducted

A. Purging

Calibrating kits

from the total weight of the filled paper bags.

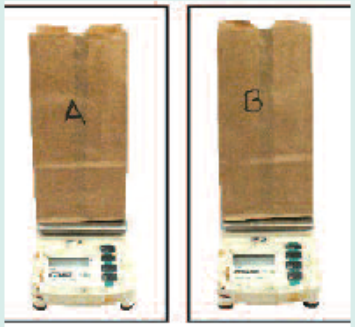
5. Clean front of spray applicator barrel and engage safety. Place calibration nozzle on the foam applicator.
6. Hold the two bags together, place one tube in each bag, disengage the foam applicator safety and engage trigger for six to eight seconds.
7. Engage foam applicator safety.
8. Weigh and record individual bag weights. Always divide the weight of bag B into the weight of bag A. If the ratio is too high increase the pressure of the B tank, and if the ratio is too low increase the pressure of the A tank. **Acceptable ratios are 1.08 to 1.16.**

Example
A: 208g (weight) – 8g (bag weight) = 200g
B: 190g (weight) – 8g (bag weight) = 182g
Ratio: 200 ÷ 182 = 1.10

NOTE: If verification of readings of the regulator is necessary, install pressure gauges in line with the regulator. Verify both sides. To verify corresponding pressures of tanks, install pressure gauges in line with each tank. Perform this task on the nitrogen inlet valve. Should pressure need to be reduced in a tank, slowly bleed off pressure. Never bleed any tank below 120 psi. For best results, perform pressure adjustments in 10 psi increments.

If at anytime during dispensing foam quality is suspect, first replace the nozzle. If nozzle replacement does not solve the problem, repeat the calibration process.

NOTE: If spraying has stopped more than 30 seconds, foam in the nozzle will begin to cure and clog. System performance will be compromised. Replace the used nozzle with an unused nozzle. Higher temperatures speed curing, while lower temperatures slow curing.



B. Weighing

C. Calibrating

Mixer options

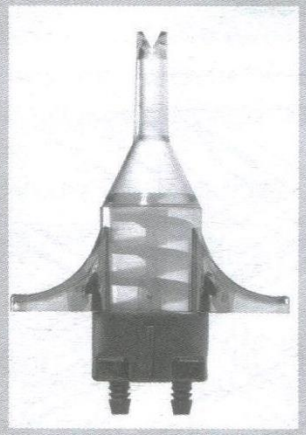
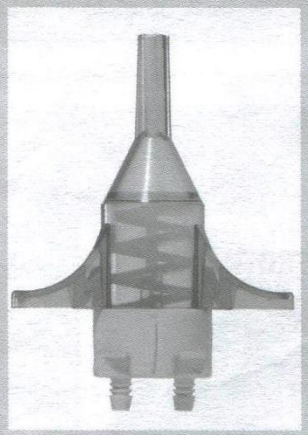
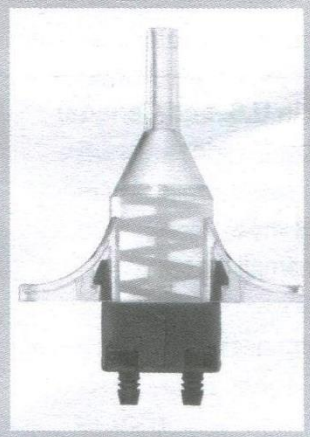
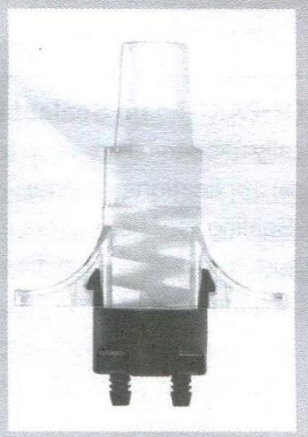
1.3 Anti-crossover Nozzles (25 Pack)

Part#	Output / Lbs. Min	Nozzle Type
259212	Low / 2lbs. Min	Caulking
259219	Medium / 4lbs. Min	Cone
259211	Medium / 4lbs. Min	Caulking
259216	Medium / 4lbs. Min	Fan
259218	High / 6-7lbs. Min	Cone
259215	High / 6-7lbs. Min	Fan
259217	Highest / 8-10lbs. Min	Cone
259214	Highest / 8-10lbs. Min	Fan
259220	Highest 8-10lbs. /Min	Pour

Outputs from 2 lbs./minute to 10 lbs./minute

Mixer options

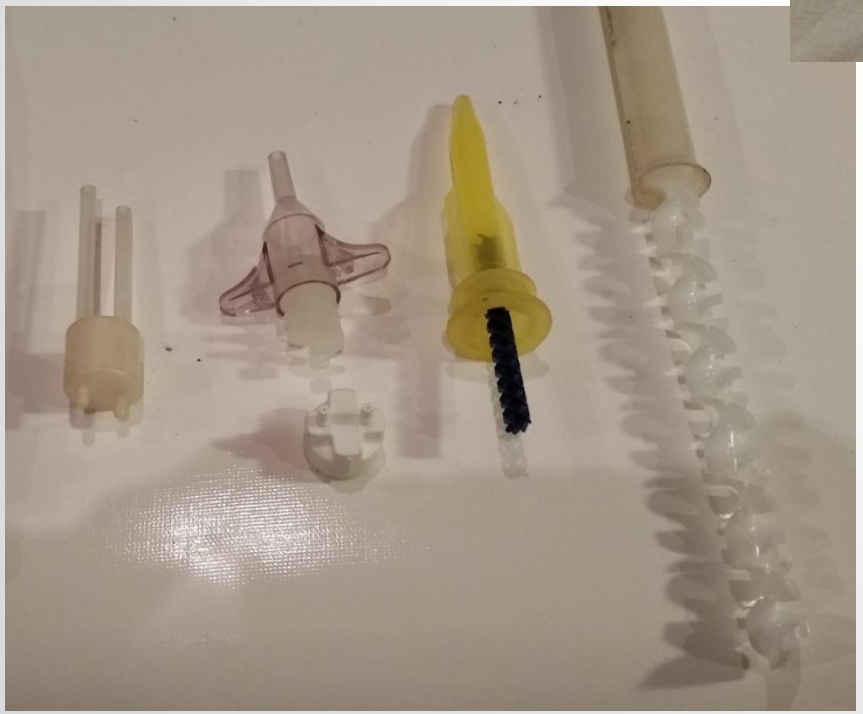
Anti-crossover Nozzles

Fan	Caulking	Cone	Pour
			
Nozzle Opening	Nozzle Opening	Nozzle Opening	Nozzle Opening
			
The fan type nozzle provides a fine fan spray pattern resulting in a smooth foam surface (paint spray finish).	The caulking type nozzle provides a bead pattern for ultra fine coverage and has less overspray.	The cone type nozzle provides a round spray pattern for multiple applications and surfaces.	The pour type nozzle is available through special order.

How do kits and cans work?

2. Proper mix relies on maintaining very specific viscosities and pressures to properly mix the chemicals with “static mixers.”

Kenex 6#/min. S.S. mixer



During the work

Flushing /cleaning mixers

- Use a container that won't dissolve.
- Most kit manufacturers recommend acetone.
- Transport solvents in leak-proof containers.
- Or: Flush mixers on a foam gun charged with acetone.

Kits and Cans

Flush mixers and guns?

Or, soak the mixers at the site and blow them out with air later.

You can buy extra mixers and guns separately, but only from the kit manufacturers.

Flushing mixers and guns

Use an old gun to flush used mixers.
The correct solvent depends on the plastic the mixer is made from. See the instructions.

Sure Shot and acetone

Equipment preparation

- Use valve sets to keep air out of the hoses and to avoid a mess when moving guns from set to set.
- Protect parts/hoses during trans-fill and pressure check operations.
- Trans-filling is possible, but complicated if you don't combine partial tanks frequently.
- 600 kits are heavy. Sometimes you need to separate tanks to move them individually. Valve sets address this.

Kits and Cans

1. Valve sets allow you to change your accessories with less mess.
   - Guns
   - Trans-fill hoses
   - Pressure gauges hose set
   - Hoses used during the repressurization of flat cylinders
2. Valve sets avoid getting air into the hoses.
3. Use a short hose to even up the hose/gun set.

A & B valve sets ($69 each)

Kits and Cans

A & B valve sets - #4 JIC

Equipment preparation

- Dedicate fittings to each of the A or B components.
- Use petrolatum to reduce “sticking.”
- Use guns on multiple kits with valve sets to save disposable guns.

Check the weights of the containers

Full-time or periodic use of platform scales

Periodic checks with luggage scales

Calibration of kit foam tanks - Meyers		Weights	Difference A to B	Before to after	Initial Pressure	Pressure change
Full set	Including tanks					
A side		54.94	53.04%		210	
B side		48.65	46.96%		190	90.48%
		103.59				
After use	Including tanks					
A side		47.00	56.08%	3.04%	110	100
B side		36.81	43.92%	3.04%	100	90
		83.81				

Quality Control - weight

Verify tank weights are within 5% to be sure pressures and flows are the same.

600 Kit

Small load cell platform scale – can be used alone or built into a tote ($27)

200 Kit

Quality Control

Verify tank weights are within 10% to be sure pressures and flows are the same.

Small luggage scales are quick and easy to use one at a time or in pairs ($14/pair).

Weighing a 600 Kit
14.8 lbs. to 17.2 lbs.
14% off ratio

Quality Control

Verify tank weights. They are typically within 10% to be sure pressures and flows are the same. Ask the manufacturer. Some kits start out at different weights – not 1:1.

Small luggage scales are quick and easy to use one at a time or in pairs ($14/pair).

Weighing a 600 board feet kit
14.8 lbs. to 17.2 lbs.
14% off ratio or 1 : 1.16

Quality Control - pressures

The pressures in the tanks are the driving force that moves the liquid through the hoses and the mixer.

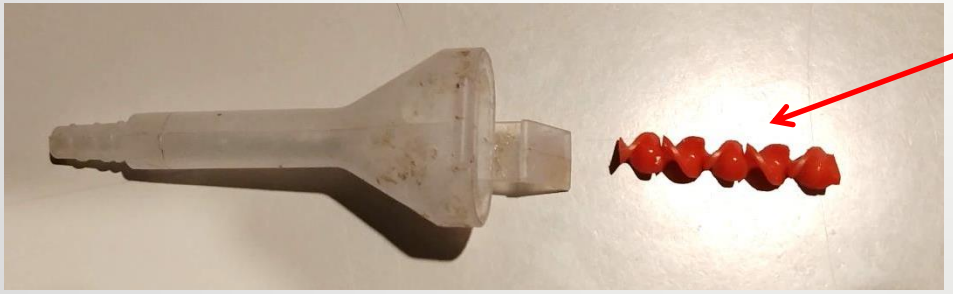
What are the right pressures - full, half full, nearly empty?

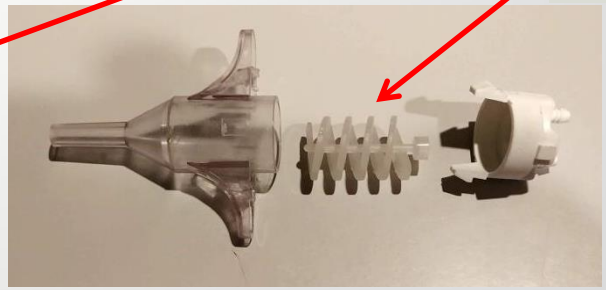
The two containers should always be at about the same pressure.

How do you verify that the pressures are correct?

Use pressure gauges to assure that tanks aren't "flat" or out of balance.

Is the cost of these quality assurance procedures worth it?





Quality Control - Pressures

If necessary, balance the pressures before using up a tank that is nearly empty.

1. Verify equal tank pressures.
2. Match/Balance the tank pressures.
3. Transferring chemicals from one container to another can be done using a pressure differential.
4. Never pressurize tanks to more than 250 PSI!

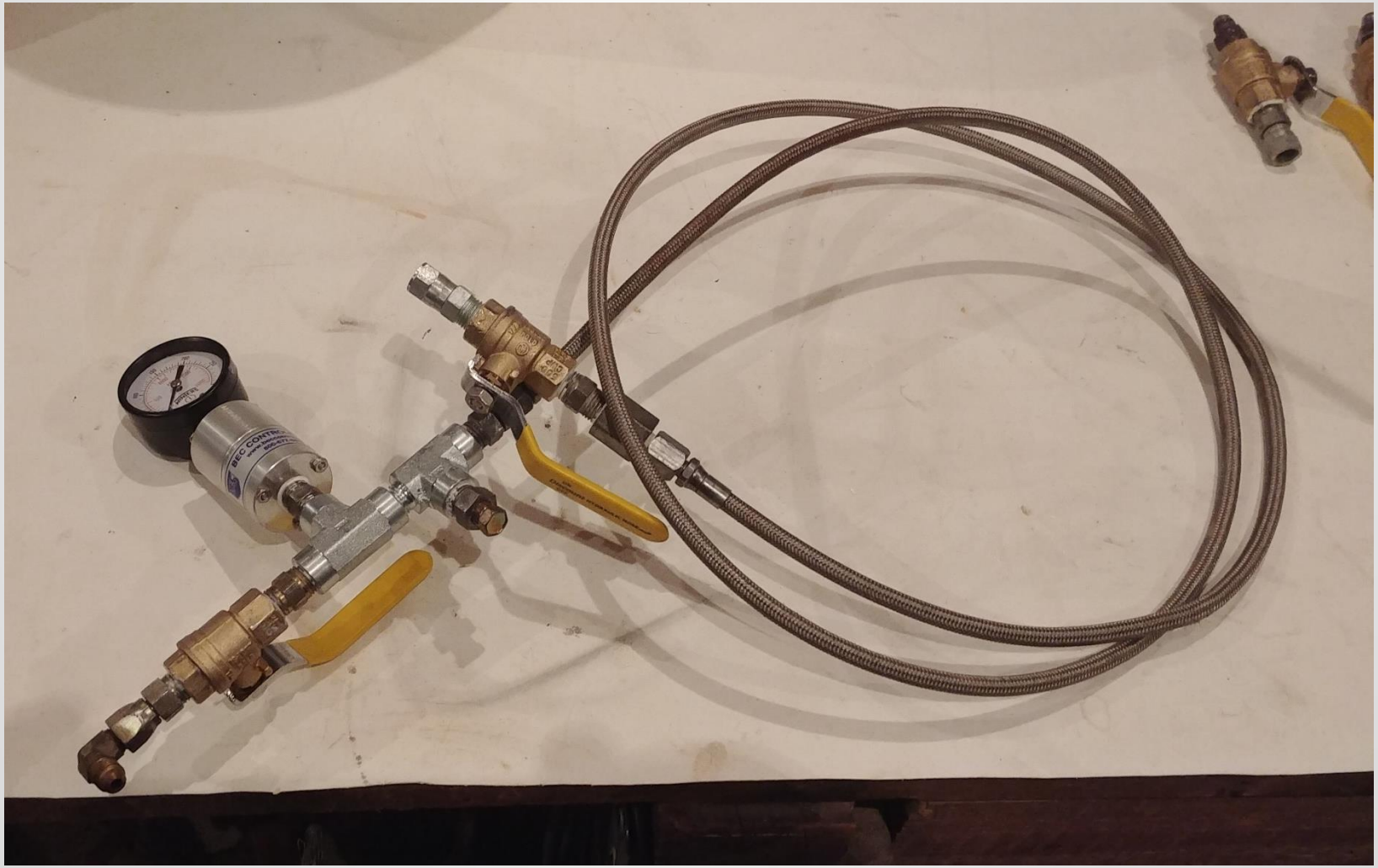
A & B pressure gauges on valve sets

Quality Control - Pressures

Small (16”) nitrogen bottle with regulator, hose, and quick couple

Quality Control - Pressures

Pressure gauge and transfer hose set



Quality Control - Pressures

Quality Control - Pressures

Pressure gauge isolator

Quality Control - Pressures

Pressure relief vents (PRVs)

Causes of over-pressuring

1. Overheating
2. When matching tank pressures
3. Never pressurize tanks to more than 200 PSI!

Conditioning the products

Precondition the containers/chemicals

1. Shake the pressure vessels or roll them (how long?).
2. Warm the chemicals up to the proper temperature.
   - How to warm them
   - Slow, fast, etc.
   - Products available for slow heating
   - How not to blow up the pressure vessels
   - Point out the location of the pressure relief plugs
   - Measuring the temperature

Start the work with the chemicals at the right temperature

Kits and Cans - Conditioning

1. Start with the kits or cans at the top of the manufacturer's temperature range so their temperature will stay within the acceptable range longer when working in cold ambient conditions.
2. It takes a long time to warm the chemicals through to the center of the tank. Pre-condition the kits and cans for several days prior to use to assure a through-and-through temperature.
3. Don't "cook" the chemicals with high-intensity heat sources. A thermostat controller with a low-flux heat source is the best way to prevent overheating.
4. Shake the can before measuring the temperature of the can.
5. When possible, measure the bottom where the dip tube is picking up the supply chemicals, or use a remote thermometer.
6. The Dow Froth Pak literature has information on setup for a number of heater systems.

Kits and Cans - Conditioning

Foam conditioning “hot box” for 200 kits

Temperature control

Heater

Water bed heater with controller ($52)

Igloo 60-Quart Ice Cube Roller Cooler ($25)

Kits and Cans – Pre-conditioning

Foam conditioning “hot box” for 200 board-foot kits

Temperature control

Heater

Water bed heater with controller ($62)

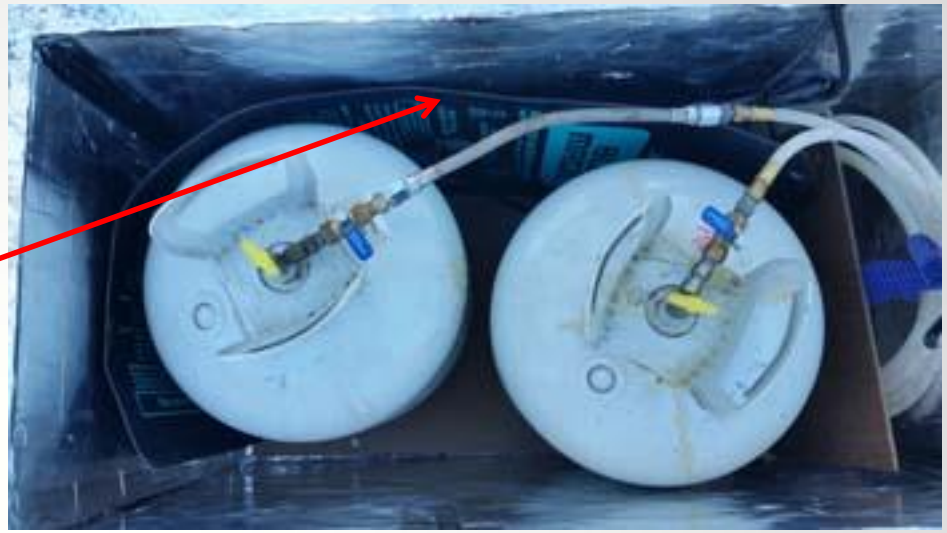
Igloo 60-Quart Ice Cube Roller Cooler ($27)

Kits and Cans - Conditioning

Foam conditioning “hot box” for 600 board-foot kits

Temperature control

Heater(s)



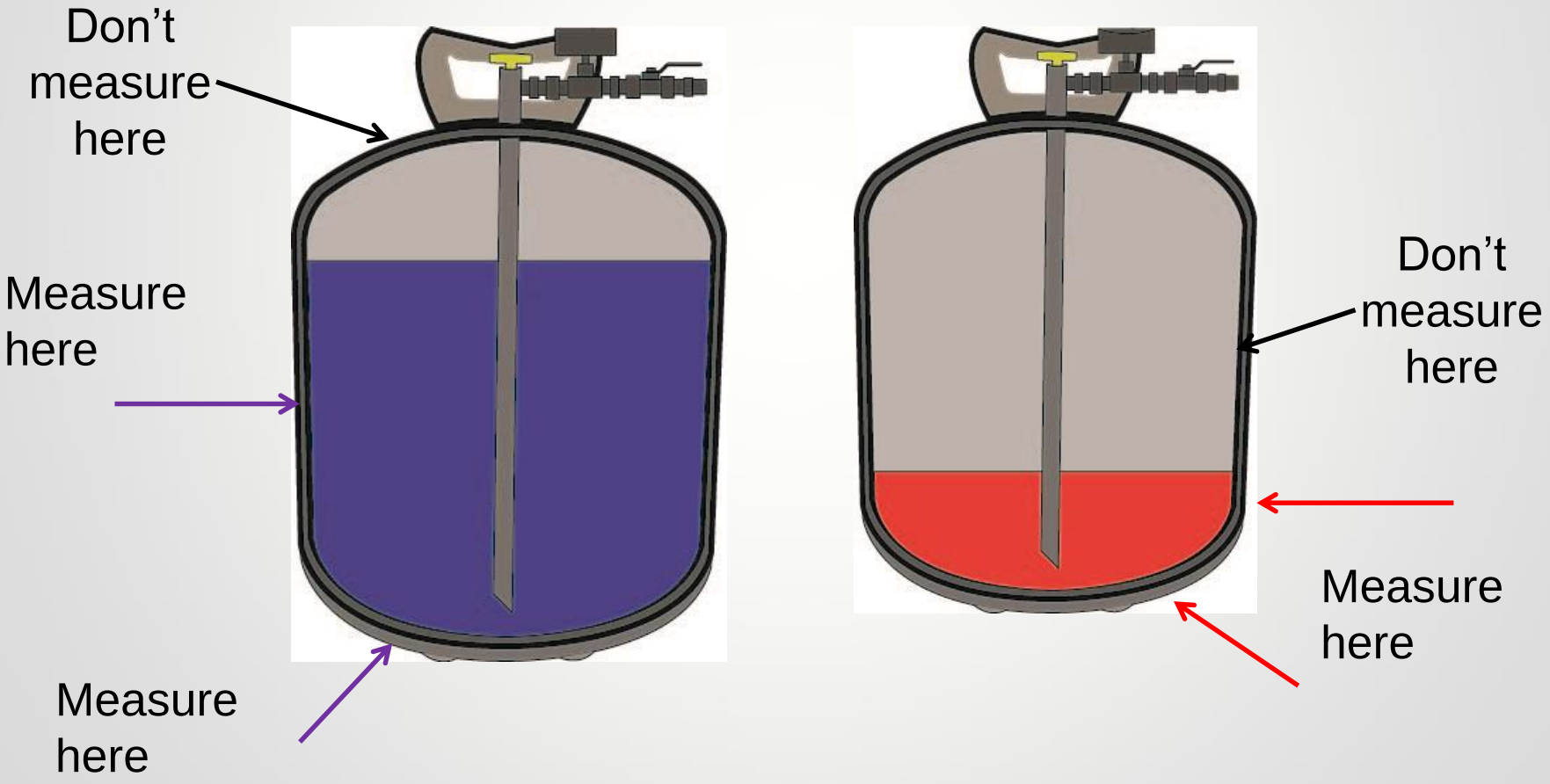
1 sheet of Thermax and foil tape ($30)

Water bed heater with controller ($62)

Husky Roller tool box ($69)

Quality Control - temperature

- Measure the metal containers where the liquid is in contact with the metal.



Kits and Cans

Verifying temperatures remotely

The probes can be down in the bottom of the hot box or taped to the tanks with the read-outs on top where they can be seen without lifting the tanks.

Battery operated digital probe Thermometers ($18.00 for two)

Kits and Cans - Conditioning

Foam conditioning with rolling “hot box”

Temperature control

Quality Control - volume

The ratio of A to B should be 1:1 by volume, so the volumes should remain the same as you use up the material.

This is true if:

1. We assume that the specific gravities will be close to the same, and they usually are in kits, so their weights should also be the same.
2. The starting volumes are about the same.
3. The pressures are about the same.

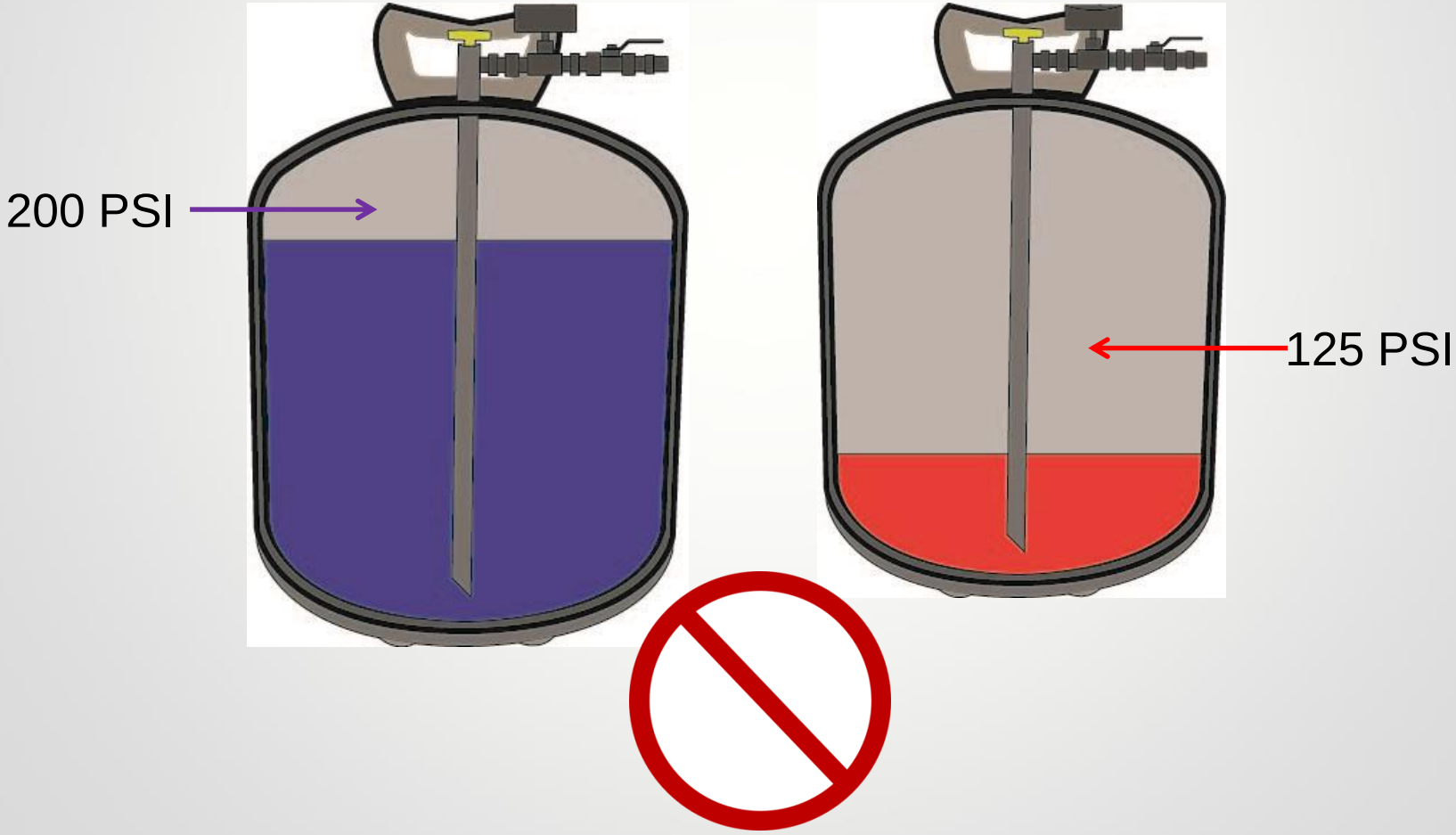
Quality Control - volume

The ratio of A to B should be 1:1 by volume, so the volumes should remain the same as you use up the material.

1. Compare cylinder volumes by comparing their weights using scales.
2. They should always start at about the same weight.
   - Weigh before use.
   - Stop and trouble shoot if the difference changes by more than 5%.
   - Check after use and record weights on the tanks.

Quality Control - weights

- Liquid levels need to be about the same for the pressures to be the same.
- If the levels are the same, the weights should be close.

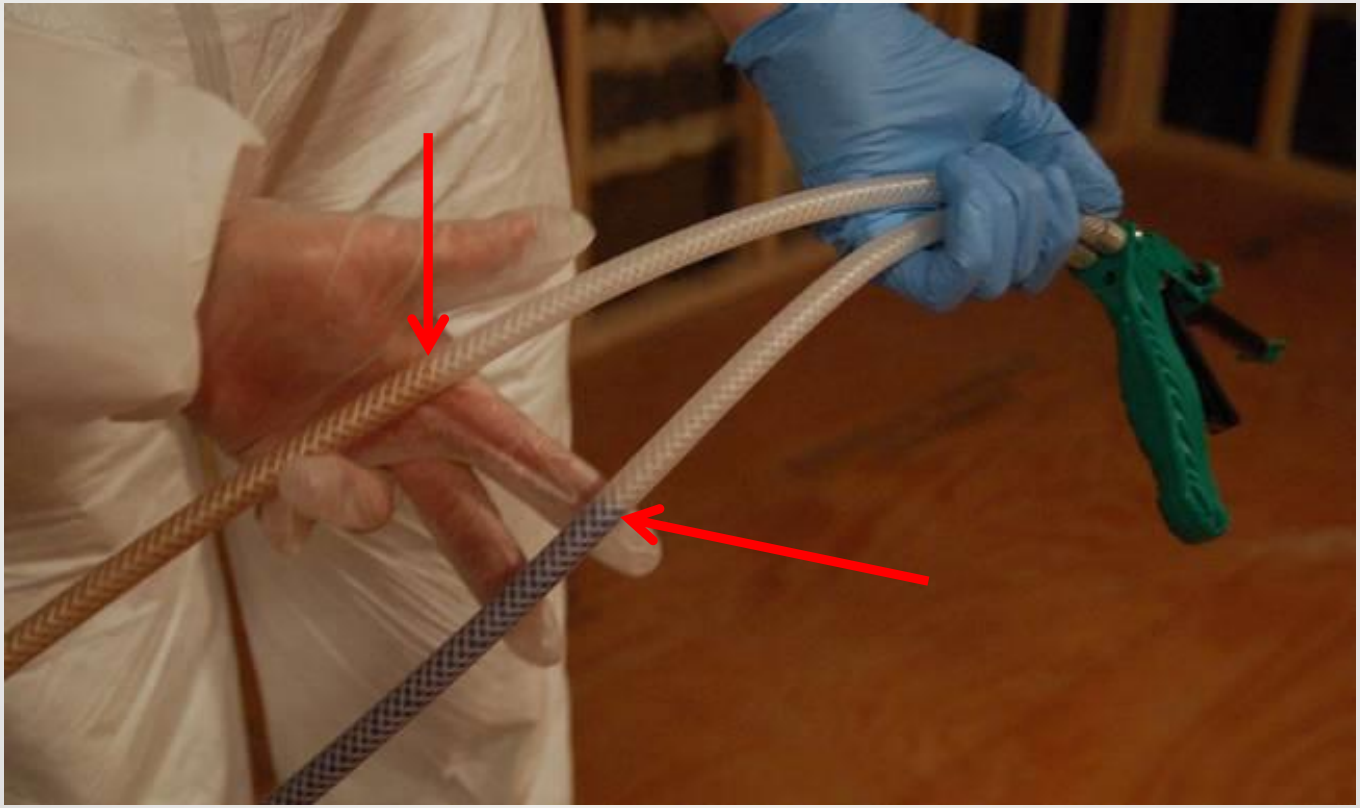


QA during and after the installation

During the work

How to know when a tank is about to run out

- Check the weights periodically, or
- Watch the hoses for an air bubble on its way to the gun



Never let the gun run out of material!

Structural tubes at the wall line

Change mixers and do a test shot every time you change sets or let the gun sit for ten minutes or more.

Bag shots for slow rise.

Once they are up to temperature, maintain the chemicals at the right temperature during the work

Kits and Cans

Foam temperature maintenance “totes” (Used with space blanket cover in winter)

For 200 kits

For 600 kits

Can be used with or without wheels for roofs and on staging

Kits and Cans

Verifying temperatures remotely

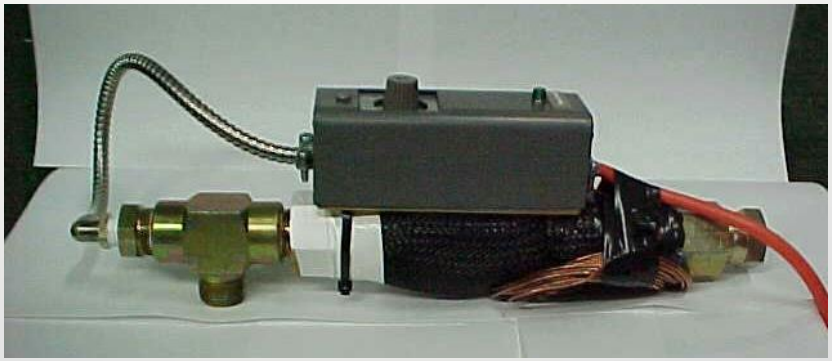
The probes can be down in the bottom of the totes or taped to the tanks with the read-outs on top where they can be seen without lifting the tanks.

Or, use thermometer stickers

Battery operated digital probe Thermometers ($18.00 each)

Kits and Cans

Foam temperature maintenance for large projects - “Hose heaters” can be used to warm chemicals on the fly, but effectiveness relies on dwell time.



Thank you for your time!

QUESTIONS??

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