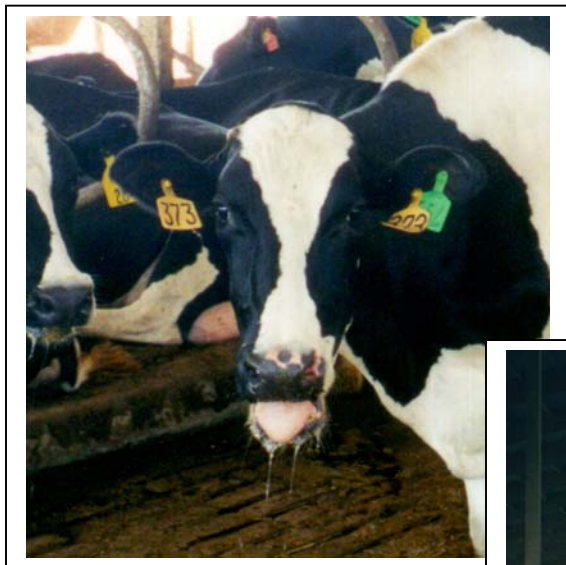


Heat Stress Relief For Dairy Cows



For additional information contact your local
Cargill Dairy Focus Consultant

Jeff Brose, DVM
Dairy Specialist,
Cargill Dairy Enterprise Group, Cargill, inc.
Fort Collins, Colorado
Mobile 970-215-4513 Office 970-232-9367
Jeff_Brose@Cargill.com



Dairy Cow Heat Production:

- Cows produce 4,500-6,000 BTU's per hour depending on milk production
- Heat production is similar to a 1,500 W hair dryer

Heat Stress consequences:

- Lower Production
- Rumen Acidosis
- Milk Fat Depression
- Poor Reproduction
- Laminitis/Lameness
- Lowered Immune System
- Mastitis
- Transition Disease (RP, DA, etc.)
- Low Body Condition Score
- Etc.....



Lactating Dairy Cow's optimal environmental temperature = 40-60° F

Heat Stress is a product of BOTH Temperature and Humidity

The THI threshold for reproduction is 65 which is lower than the THI of 72 for milk production.

Heat Stress Abatement:

- **Shade:**
- **Air:** Ventilation & Airflow: Open sidewalls, ridge, eaves, add circulation FANS!
Fans start at 68° F, run continuously
Provide 4-5 mph airspeed over cow beds and feed alley.
- **Sprinklers:**
Evaporative cooling by wetting the skin with low pressure, large droplet water soakers
 - Feed line Sprinklers
Sprinkler Nozzles deliver 0.5 - 1.0 gal./min. (.33 gal per cow per cycle)
Begin; **>72° F = 1-3 min. ON every 15 min.**
>80° F = 1-3 min. ON every 10 min.
>90° F = 1-3 min. ON every 5 min.
 - Holding Pen Sprinklers
Sprinkler Nozzles deliver 1 – 8 gal./min. (1 gal. per 150 ft²)
Begin; **>72° F = 1-3 min. ON every 6 min.**
- **Water (drinking):** Intakes increase - up to 50-60 gal./cow/day
2–3 ft. linear water space per 10 cows
Minimum 2 waterers per group

Priorities for heat abatement:

- Holding Pen: fans & sprinklers
- Maternity Pen: fans & sprinklers
- Pre-Fresh cows: fans & sprinklers
- Lactating Cows:
 - Water over Feed lines
 - Fans over double Freestalls
 - Fans over Feed lines
 - Fans over single Freestalls
- Hospital Cows: fans & sprinklers
- Processing Areas: Head chutes, foot trimming, palpation rails, etc.
- Travel Lanes: Shade

HEAT STRESS ABATEMENT:

SHADE: Use solid shade or $\geq 90\%$ shade cloth.

Open Lot & Pasture Shades:

Provide 40-45 ft² per cow, 20-32 ft. wide, 12-16 ft. height
North to South orientation,

Feed Lane Shades:

20-32 ft. wide, 12-16 ft. height
East to West orientation

Free-Stall Barn as shade:

4:12 roof pitch, Ridge opening 2"/10 ft. barn width, Eave opening 1"/10 ft.
12-16 ft. open sidewall height
East to West orientation

Holding Pens Shade:

Cover holding pen with solid shade, 4:12 roof pitch, Ridge opening 24"
12-16 ft. open sidewall height

AIR:

Maximize Ventilation (Air Exchange) & Airflow (Air Speed):

Open sidewalls, ridge, eaves, add circulation FANS!

FANS

- If you can't do BOTH fans & sprinklers, choose Sprinklers before Fans. Application of water with low pressure sprinklers cools cows more efficiently than fans alone. The use of water AND fans (5 mph air) is most effective.
- Fans start at 65-70° F, run continuously
- Provide 4-6 mph airspeed over cow beds and feed alley.
- Fan height <8', as low as possible but out of reach of cow & machinery
- **36" Fan spaced 20'-24' apart**
- **48" Fan spaced 24'-36' apart**
- Angle fan downward approx. 30° (aim toward floor at bottom of next fan)
- Fans should flow in direction of prevailing winds

Feed Lane Fans

800-900 cfm per headlock/feed space
36" fan every 20'-24' over cows backs when eating.

Freestalls Fans

800-900 cfm per stall
Double Row Freestalls: 48" fan every 24'-30' over center of stalls
Single Row Freestalls: 36" fan every 20'-24' over stalls

Holding Pens Fans

Provide approx. 1,000 cfm per cow
ex. One 36" fan per 10 cows or One fan per 150 ft²
Mount Fans in rows with airflow toward back of holding pen.
36" fan every 20-24 ft.
48" fan every 24 -36 ft.
3 ft. between fans (ex. 36" fan mounted on 6' centers)
Fan height <8', as low as possible but out of reach of cow & machinery
Narrow holding pens (<24') can have fans along side of pen
Move air across and toward the back of the holding pen.
Take advantage of prevailing winds.

FAN CHARACTERISTICS

FAN TEST RESULTS –

Bioenvironmental and Structural Systems Laboratory
University of Illinois, Department of Agriculture & Biological Engineering

<http://www.bess.uiuc.edu/>

<http://www.age.uiuc.edu/bee/research/handbook/handbook.html>

36" Fan = 6,400-13,000 cfm range of airflows

48" Fan = 14,100-23,000 cfm range of airflows

Operational costs & efficiency varies widely across brands (8.3-18.6 cfm per watt)

Generally:

- For a given airflow, larger diameter fan is more energy efficient than several small diameter fans
- Two fans with equal diameter and rpm; fan with lowest motor current rating is usually more efficient
- Two fans with equal airflow; fan with slower speed is usually quieter and more efficient
- Reasonable Fan Goals: 36" Fan = 11,000 cfm
48" Fan = 20,000 cfm

Fan Maintenance:

Poor maintenance can reduce fan efficiency by >40%

Before each cooling season:

Repair damage

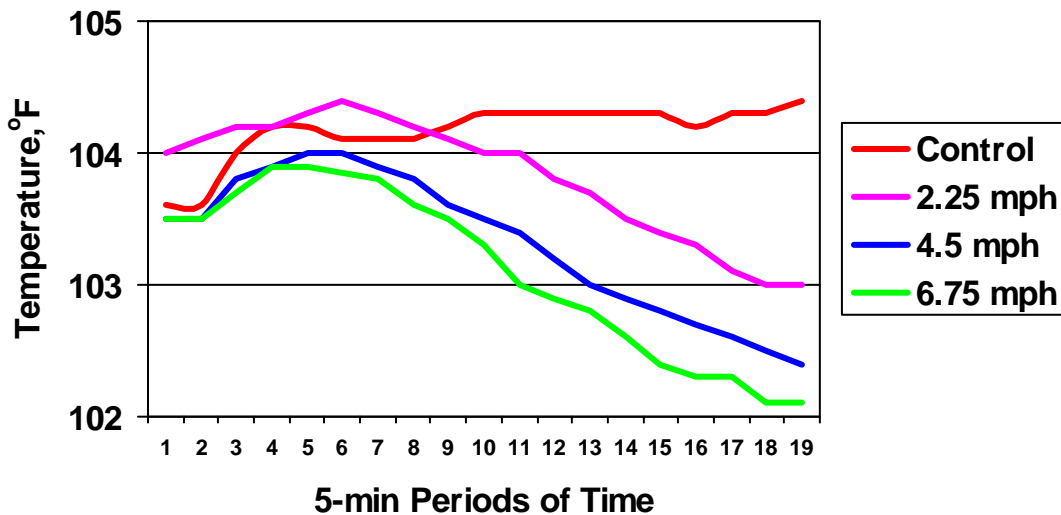
Check fan alignment & orientation

Clean fan guards & blades

Check and tighten belts

Clean & calibrate thermostat

AIR SPEED



Cow cooling measured by vaginal temperature at various airspeeds while using sprinklers every 10 minutes

Brouk, et al., 2004 ADSA

Optimum cooling is achieved with 4-6 mph continuous air speed combined with sprinklers.

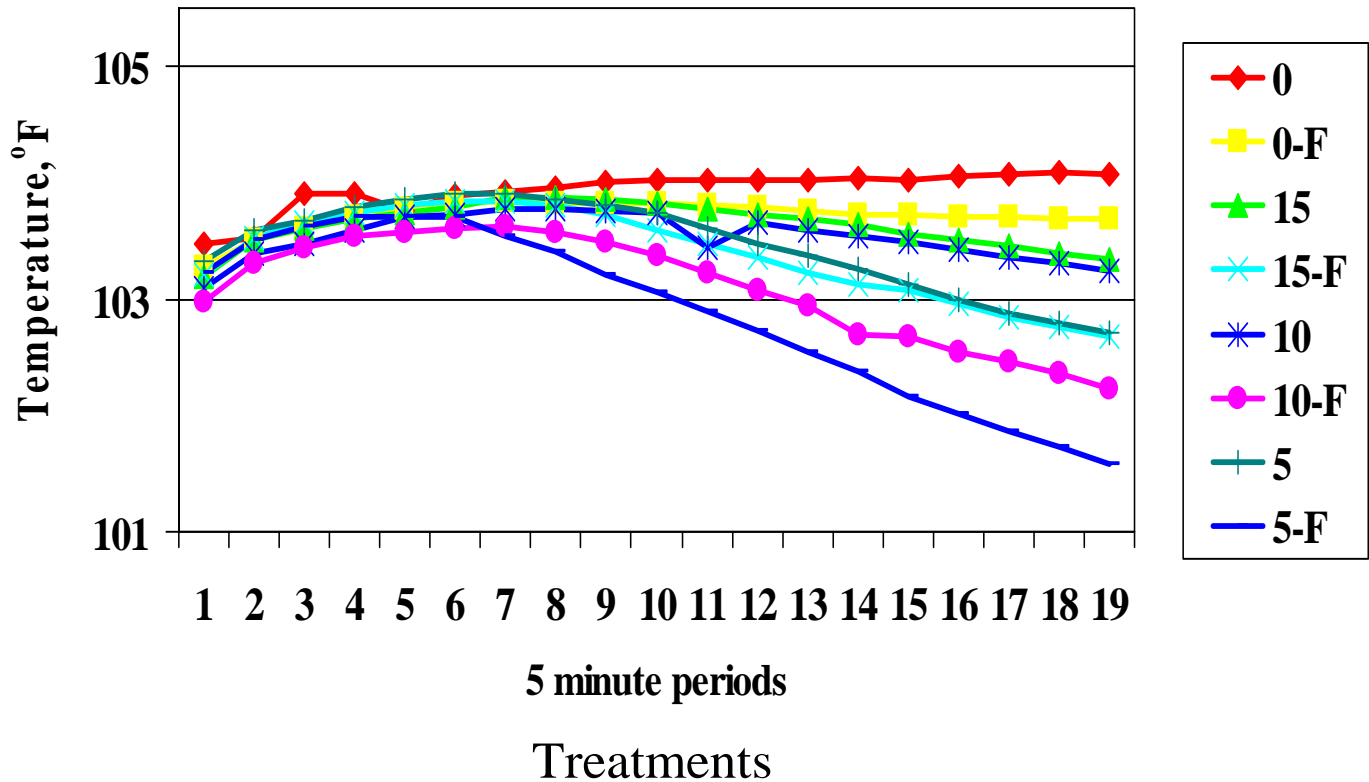
WATER (drinking):

- Water intake increases during heat stress (up to 50-60 gal./cow/day).
- Provide 2–3 ft. linear tank perimeter water space per 10-20 cows (3-4" per cow).
- Provide a minimum of 2 water locations per group.
- Provide water space at parlor exit alley, provide enough space for all cows to drink.
- Check flow rates during times of high water use.
- Keep waterers clean.

WATER SPRINKLERS - SOAKING:

- Sprinklers should wet the back and then stop to allow the water to evaporate prior to another cycle beginning. Evaporative cooling occurs by wetting the skin with low pressure large droplet water soakers.
- Sprinkler ON duration depends on nozzle water delivery rate.
- Sprinkler OFF duration (cycle) depends on temperature & humidity.
- Humid environments: set thermostat to begin sooner and use more frequent cycles.
- **Feed line Sprinklers:**
 - Sprinkler Nozzles deliver 0.5 - 1.0 gal./min. (.33 gal per cow per cycle)
 - Begin: **>72° F = 1-3 min. ON every 15 min.**
>80° F = 1-3 min. ON every 10 min.
>90° F = 1-3 min. ON every 5 min.
 - Application rate per cycle 0.04 inches/ft²
 - Space Nozzles every 6 –8 feet.
 - Mounting: small diameter pipe (1") can be supported by tight cable; larger pipe (>1 ½") can be supported by angle iron.
- **Holding Pen Sprinklers:**
 - Sprinkler Nozzles deliver 1 – 8 gal./min. (1 gal. per 150 ft²)
 - Nozzles to deliver .03 gallons per ft² per min.
 - Begin: **>72° F = 1-3 min. ON every 5-6 min.**
- Check for adequate water source pipe size and flow. Solenoids, valves, etc. must also be adequately sized to prevent restriction.
- For maximum cooling, **FANS** should provide constant airflow of >4-6mph over the cows backs for optimal evaporative cooling.

Effect of Sprinkling Frequency and Fan Cooling on Body Temperature



1. 0 - Control No Sprinkler or Fan
2. 0 + F - No Sprinkler + Fan
3. 5 - Sprinkler (1 min on & 4 min off)
4. 5 + F - Sprinkler (1 min on & 4 min off) + Fan
5. 10 - Sprinkler (1 min on and 9 min off)
6. 10 + F - Sprinkler (1 min on and 9 min off) + Fan
7. 15 - Sprinkler (1 min on and 14 min off)
8. 15 + F - Sprinkler (1 min on and 14 min off) + Fan

Sprinkler - .9 gal/min or .045 gal/ft² Fan - 650 to 700 CFM

KSU Cow Comfort Consortium 2001 (Brouk, M.J., J.F. Smith and J.P. Harner, III)

KSU Cow Comfort Consortium 2001 (Brouk, M.J., J.F. Smith and J.P. Harner, III)

If you can't install both fans & sprinklers, start with installing SPRINKLERS before FANS. Application of water with low pressure sprinklers cool cows more efficiently than fans alone.

• The use of FANS (5 mph air) AND WATER is most effective. •

SPRINKLER SYSTEMS for Feed Line Cooling

COW VIEW

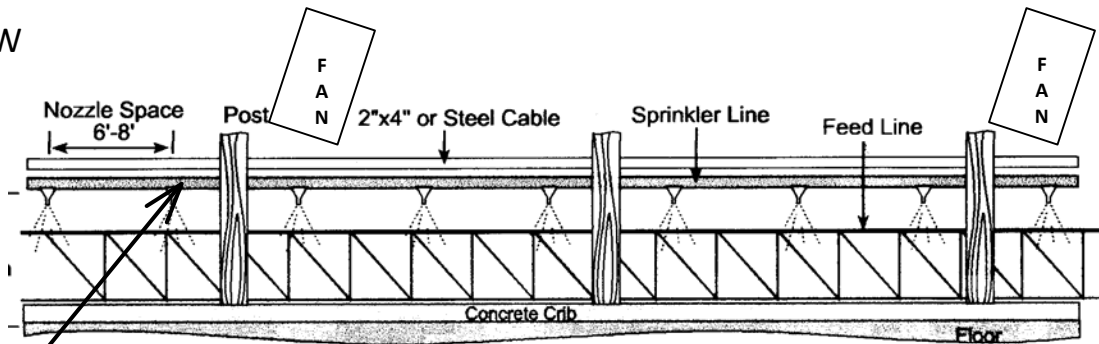


Diagram from KSU Extension Bulletin

- Mount sprinkler:
- 1) 5-6 ft above floor (High Line)
 - 2) Just above neckrail/headgate (Low Line)

TOP VIEW

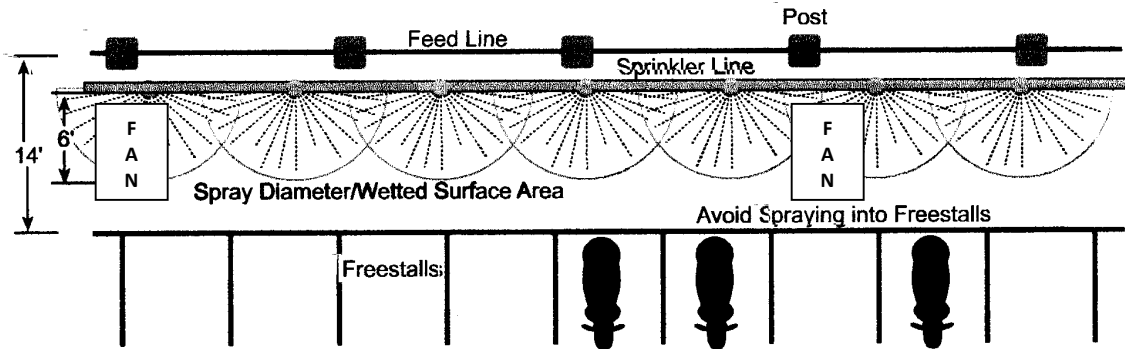
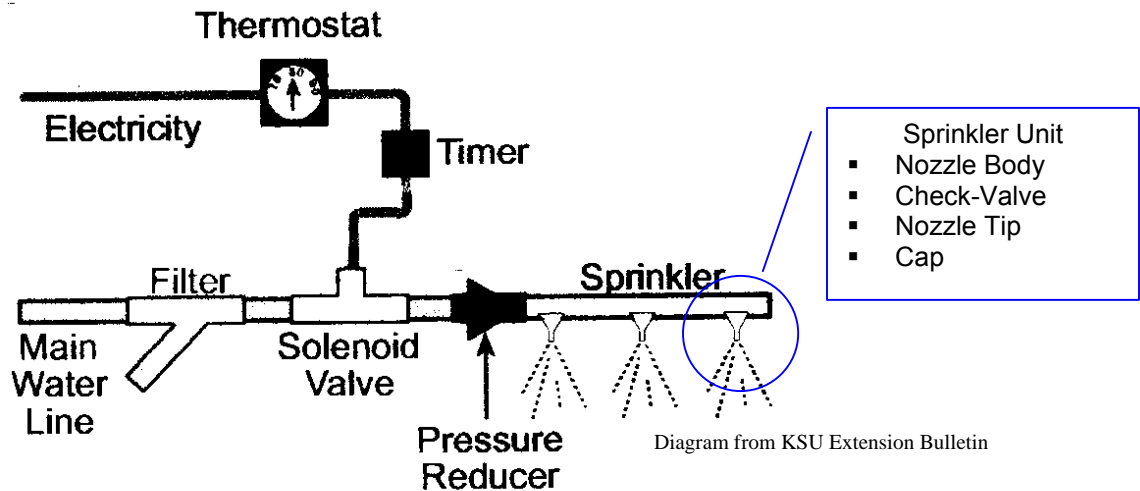


Diagram from KSU Extension Bulletin



Sprinklers should wet the back and then stop to allow the water to evaporate prior to another cycle beginning

SPRINKLER “SOAKER” SYSTEM COMPONENTS



Controllers (Timers/Thermostat):

Adjust On/Off frequency or cycle

Thermostatically controls start of sprinkler system

Controls multiple “zones” (1-4 zones)

Controllers available that will reduce freq. of on/off cycle as temp. increases.

- Feed line Sprinklers
 - Begin; $>72^{\circ}\text{ F} = 1\text{-}3\text{ min. ON every } 15\text{ min.}$
 - $>80^{\circ}\text{ F} = 1\text{-}3\text{ min. ON every } 10\text{ min.}$
 - $>90^{\circ}\text{ F} = 1\text{-}3\text{ min. ON every } 5\text{ min.}$
- Holding Pen Sprinklers
 - Begin; $>70^{\circ}\text{ F} = 1\text{-}3\text{ min. ON every } 5\text{-}6\text{ min.}$

Preset Delay (Optional):

Timer and preset delay for holding pens or freestall barns.

Allows you to turn water off while cows are away from freestall barn.

Automatically comes back on in a preset time. Up to 80 minutes.

Push delay switch, delays water-on cycle for 1 min to 80 minutes.

Dancon Products Model 191 - 120V.

Filter:

50 Micron Canister Filters, must meet required flow capacity

Electric Solenoid Valves:

Must match sprinkler pipe size, flow rate.

Would like solenoid to be “normally closed”

Need to know flow rate or gallons per minute needed thru solenoid

For example, calculate flow rate per minute on all nozzles in holding pen. No 13 Senninger nozzle is 3.75 gallons per minute times 16 nozzles = a demand of 60 gallons per minute through the solenoid and pressure reducer.

Need to know if timer control is 120V or 24V

24V solenoid with a 120V timer will require a relay or low volt reducer in the line between the timer and the solenoid

Pressure Reducer:

Low water pressure produces a larger water droplet size.

Adjustable pressure reducer, reduces line pressure to 15-20 psi

15 to 20 PSI – dependent on application in holding pen or freestall sprinklers

You can order based on “springs” in the brass pressure reducers.

6 to 10 springs for different PSI requirement.

Use a pressure reducer at 15-25 PSI for holding pen application

Use a pressure reducer or regulator at 15-20 PSI in freestall barn.

Nozzles & Tips:

Nozzle Tips to provide: Low pressure, large droplet size

Feedline Nozzles Tips:

Nozzle Tips to provide 0.5-1 gpm

Feedline Nozzle Body with checkvalve & cap:

Checkvalves in freestall barns are 10 psi.

IMPORTANT: *Checkvalves keep line full between cycles.*

- 1) Nozzle Body: Clamp-On “saddle”:
 - Clamps over pre-drilled 3/8” hole in S40 PVC Pipe
 - Available for 3/4” or 1” S40 PVC pipe
 - Maximum length sprinkler line 180 ft. (1” pipe with 0.5 gpm nozzles)
- 2) Nozzle Body: Threaded, screw directly into 1/4” pipe-thread tapped hole:
 - Drill & Tap 1/4” mpt (pipe thread) into S80 PVC or Steel Pipe
 - Use for low-line installation and large pipe sizes
 - Minimum pipe diameter 1.5”
 - Available in Brass: sturdy for low installation, more expensive
 - Ball & Spring check-valve/filter prone to lime build-up in hard water
 - Available in Plastic: cheaper
 - Diaphragm check-valve less problematic.
- Nozzle Cap:
 - 1) Threaded; requires wrench to clean nozzle, Cow safe
 - 2) Quick-Cap; No tools needed, Cows can lick off if low enough to reach

Holding Pen Nozzles:

- **Checkvalves** on nozzles in holding pen at 6 to 8 PSI.
- Approx. System capacity = 1 gallon per 150 ft² Pen.
- Mount nozzles 8-10 ft. above floor.

FEEDLINE SPRINKLER UNIT PARTS:

Nozzle Bodies

TeeJet Clamp On Nozzle Body *with Check Valve*

Drill 3/8" hole in PVC pipe to attach sprinkler nozzle body.
Diaphragm Check Valve stops water flow at 10 psi so pipes stay full for next cycle. Uses Quick TeeJet Caps

- **QJ17560A-1-NYB** – for 1" PVC Pipe



▪ TeeJet threaded Nozzle Body (screws into tapped 1/4" hole):

- Drill & tap 1/4" mpt threaded hole in 1" or larger pipe (S80 PVC or galv. Steel).
- Minimum 1" pipe diameter, thick wall PVC pipe
- BRASS (with internal screen & ball check-valve):
 - **CP1322**, TeeJet Body DR 1/4 mpt
 - **CP1325**, TeeJet Cap, Brass
 - **11750-PP-10**, Check Valve
- PLASTIC (with side diaphragm check-valve):
 - **QJ8360-NYB** TeeJet Body **w/check-valve** 1/4 npt (Quick Cap)
 - **25600-4-NYR**, TeeJet Quick-Cap, Plastic
 - **8360-NYB** TeeJet Body **w/check-valve** 1/4 npt (screw cap)
 - **CP8027-NYB**, TeeJet Cap, Plastic



Nozzle Tips

TeeJet Nozzle Tips 180° Spray pattern

Turbo FloodJet - Polymer Nozzle, large droplet size

- **TF-VP5** – 0.7 gpm @ 20 psi (0.5 gpm @ 10 psi)
- **TF-VP7.5** – 1.1 gpm @ 20 psi (0.75 gpm @ 10 psi)

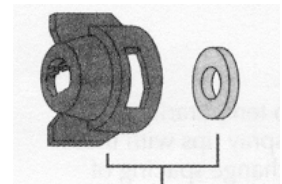


Turbo FloodJet®

Caps

Quick TeeJet Caps w/ gasket (for attaching Nozzle Tips)
Secure nozzle tips to nozzle body without tools

- **25600-4-NYR**



PVC Pipe Size:

Pipe Diameter (inches)	Feedline Length (feet) (maximum)	Max. Number Nozzles	Inlet Water Demand (gpm)
1.0 "	200	25	12
1.25"	320	40	20
1.5"	480	60	30
2.0"	800	100	50
2.5"	1600	200	100

- ✓ 0.5 gpm TeeJet FloodJet Nozzles, 8 ft. on center
- ✓ 20 psi water pressure

You can't overcome small pipe size with additional pressure

10% change in pressure only produces 5% change in flow (friction loss)

NOTES:

- Space Nozzles every 6 – 8 feet.
- Mounting Pipe: small diameter pipe can be supported by tight cable; larger pipe can be supported by angle iron.
- Provide drain valve at end of each line to prepare line for winter



1 ½ " PVC with threaded TeeJet Nozzle body mounted to angle iron bracket



1" PVC with clamp-on style TeeJet Nozzle body with Check-Valve attached to tight ¼" cable

Feed-line Soaker Nozzles

Low mount Nozzle above manger rail or headlocks (within cows reach).

- Wither height (5'-6') for fast, thorough soaking.
- Less "drift" of water spray.
- Needs to be sturdy to prevent cow damage
- Use regular hex screw caps, cow may be able to remove Quick-caps.



High mount Nozzle, out of cows reach.

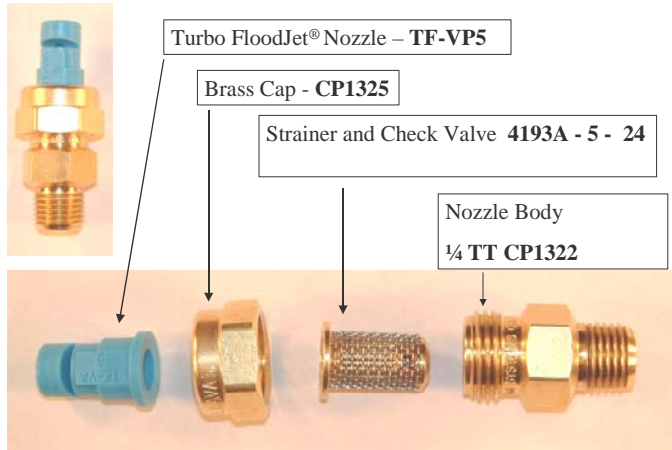
- Approx. 6-7 ft. height.
- More drift from wind possible.
- Use Quick-Caps for easy maintenance.
- Less vulnerable to cow & people damage.





Nozzle Supplies for Sprinkler Systems

TeeJet® Brass Nozzle Body, Check Valve and Cap



TeeJet® Turbo FloodJet® Nozzles

Tip selection determined by capacity of water supply

TF-VP5 or TF-VP7.5 most commonly used

Shorter cycle time with TF-VP7.5 but water supply is more critical

TF-VP5
0.7 gal/min @ 20 psi

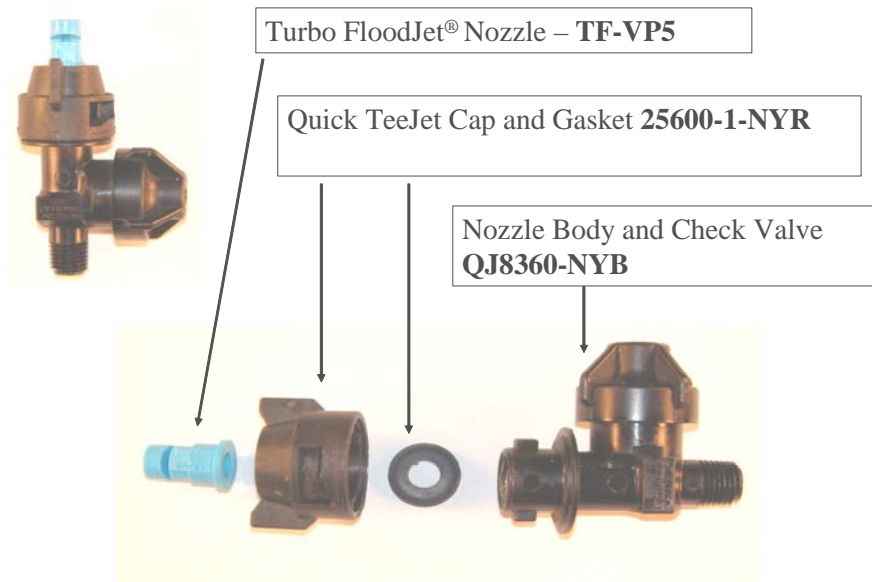
TF-VP7.5
1.06 gal/min @ 20 psi

TF-VP10
1.41 gal/min @ 20 psi

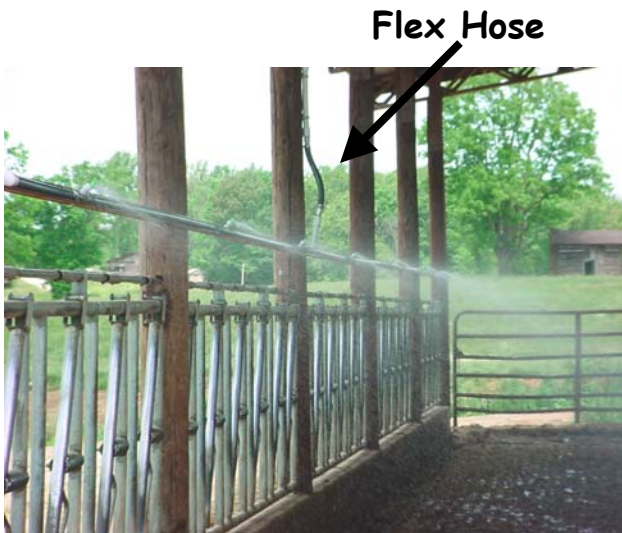


Quick TeeJet® with side *diaphragm* Checkvalve

Quick TeeJet® Nozzle Body, Check Valve and Cap



INSTALLATION TIPS & IDEAS



Use a flex hose or adjustable PVC union at water inlet so you can adjust angle of spray.



Make a drill bit guide jig for drilling holes in pipe. Weld plate steel with appropriate size hole to angle iron to make jig. Place over pipe and angle iron to keep holes aligned.



Tap threads. Use slightly undersized bit and only thread tap about half way for tight fit.



Use hose clamps to secure sprinkler pipe to angle iron support. Allows for spray angle adjustment

Parlor Exit Cooling

Exit Alley or Exit Platform Cooling:

Thoroughly wet the cows after milking.
Cool cow for return trip to pen.

Considerations:

- Lower pressure so cows don't object to the spray and large water droplets that wet the cow to the skin.
- Showerheads and watering wand spray heads work well.
- A wand or an electronic eye can be used to turn on the water flow.
 - trigger a closed solenoid to open and release water for a set time.
 - Control spray time with a timer.
 - Trigger when the cows is under the shower, so they don't hesitate to enter the water stream.
 - An eye beam can get dirty quickly. Putting a fan on the electronic eye will provide enough turbulence to keep flies off the electronic eye, thus not triggering it unnecessarily and keep the device from becoming dirty with fly specks.
 - a quick solenoid valve is critical.
- Nozzles should be located about one foot behind the control switch, so that each cow is sprayed just after her head passes the spray area. This avoids water from being sprayed into the ear cavity. If sprayers are installed properly to hit directly over the topline of the cow, then water will not wet the udder and rinse off post-milking teat dip.
- Be sure you still have good cow flow out of the parlor and don't create a bottleneck.



Fan type watering head.
Simple and inexpensive.



Large volume spray provides
good coverage



Wide exit alley coverage



Single alley spray



Single alley spray



PVC Pipe with holes drilled for shower



Large nozzles on exit platform



Coverage on top and sides

Holding Pen Cooling

Research Studies on Heat Stress in Holding Pen

- Study 1: Body temperature decreased 3.5°F and milk production increased 1.7 pounds per cow per day when cows were cooled
- Study 2: Milk production increased 5 lbs per day when cows were cooled for 30 minutes five times per day in the holding pen

Reduce time in holding pen, improve ventilation, install fans, and install sprinkler system.

Holding Pen Sprinkler Systems:

Operate at 15-20 psi Pressure

Mount >8 ft. above floor

System capacity 1 gallon per 150 ft² (10 Cows)

Thermostat and timer: operation depends on nozzle size, temp. & humidity.

Locate thermostat in holding pen near cows

Cycle: 1-3 min. ON, 5-6 min. OFF

Sprinkle cows when temp. >70° F

1) Grid of sprinkler nozzles over holding pen

Senninger Irrigation inc.

www.senninger.com 407-293-5555

Senninger Super Spray sprinkler head

Use #6-12 nozzle with convex deep groove pad.

10-15 psi water pressure, 1.4+ gpm

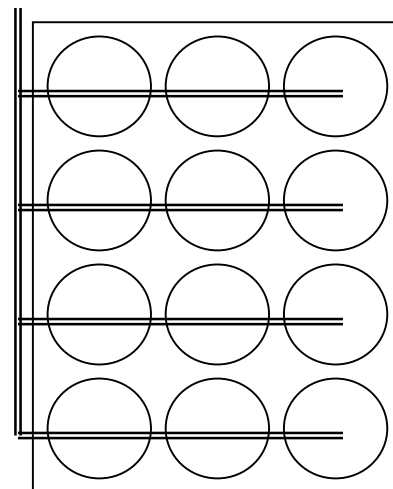
Sprays 16-20 diameter 360°

Large main (≥1 ½") with ¾" - 1" PVC Pipe drop hoses

8-10 ft on center, 8-9 ft above floor



Senninger Super Spray #6 nozzle



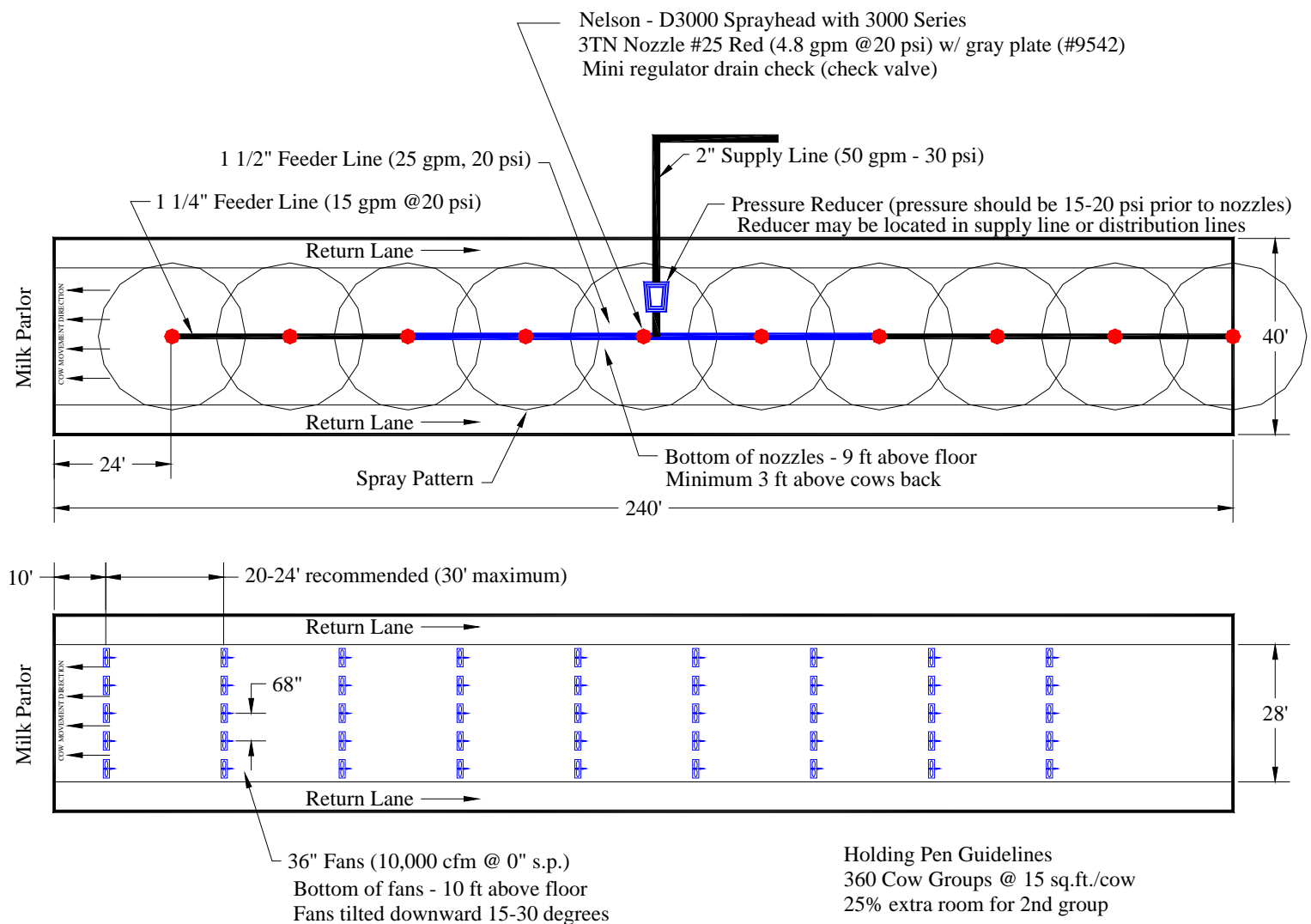
Holding Pen Cooling (cont.)

2) Single row of high capacity sprinkler nozzles: Nelson – D3000 Sprayhead

- with 3000 Series 3TN Nozzles #25 Red & #24 Gray plate (#9542)
- 4.8 gpm @20 psi
- mini regulator drain check valve
- install 24' on center, 9' above floor
- 360° - 28' diameter coverage (14' radius)



**Nelson D3000
Spray head**



Harner, J.P., J.F. Smith, M.J. Brouk and J.P. Murphy. 2000. Reducing heat stress in the holding pen.. Cooperative Extension Service. Kansas State University. Manhattan, KS.

Holding Pen Cooling (cont.)

3) Single row of high capacity sprinkler nozzles: i-wob Nozzle by Senninger

I-WOB nozzles

#14 (blue) Nozzle, 10psi = 4.39 gpm
Approx. 49' diameter, space: 30' on center
Up to 60' at higher pressure
Use with PR-10 HF Press Regulator

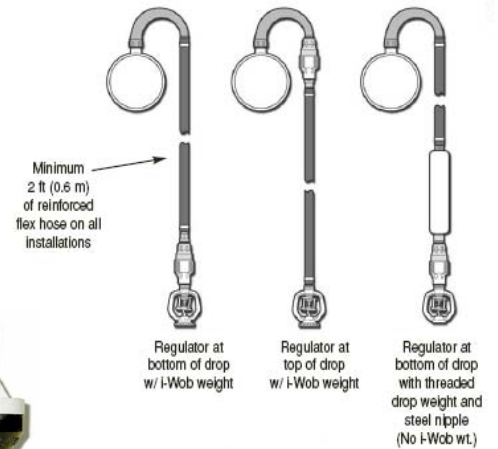


I-WOB nozzles



PR-10 HF high flow Pressure Regulator

Available in 10, 15, 20 psi operating pressure
10-32 gpm flow rate



i-mini wobbler nozzles

For holding pens <40'
#8 (dark lavender) Nozzle, 20psi = 1.95 gpm, approx. 35' diameter
Space: 15' on center
Use with Drain Stop Plus Check Valve



**i-mini wobbler
nozzles**



1/2" M NPT inlet x
1/2" F NPT outlet
P/N DSP2M2F

**Drain Stop Plus DSP2M2F
Check valve**

Holding Pen Cooling (cont.)

4) Row of high capacity sprinkler nozzles from each side of holding pen:

Rain Bird – Plastic Impact Sprinkler 2045-PJ low angle nozzle (LAN-1)

Rainbird Part# B46000-10-LA

2.20 gpm @ 25 psi,

22 ft. Radius, 23° trajectory angle

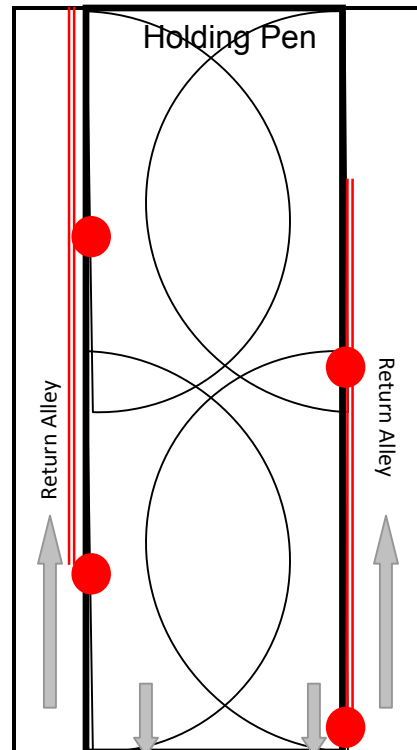
½" male NPT, Plastic

Spray from sides of holding pen

Install every 24' on centers, 6-7' above floor. Nozzles staggered on each side.



Rain Bird 2045-PJ low angle nozzle



Acknowledgements:

I gratefully acknowledge the dairy team at Kansas State University for the research they have completed to help us better understand and reduce heat stress in dairy cattle. Much of the information and many of the illustrations are from the KSU Dairy team: J.P. Harner, J.F. Smith , M.J. Brouk and J.P. Murphy. Cooperative Extension Service. Kansas State University. Manhattan, KS.

Many Technical and Sales professionals from Monsanto Dairy have contributed to this heat abatement guide with ideas, photographs, and research. I would like to acknowledge the contributions of the entire Technical Service team, Dr. Tom Bailey, Dr. Gene Boomer, John Sheets, and Jeff Kearnan.

Jeffrey Brose DVM

Suppliers of Parts and Equipment

Timers, Controllers, Solenoids, Pressure Reducers, Tips and Nozzles

(This list is not intended to omit any dealers; it offers a list of Northeast U.S. suppliers for your convenience. Please let me know if you have equipment that should be considered.)

Timers / Controllers:

Edstrom Industries

Edstrom Industries 819 Bakke Ave., Waterford, WI 53185 800-558-5913

Larry DePriest (Northeast Regional Ag Manager)

larryd@edstrom.com Voice Mail 800-345-8074 ext. 369, Mobile 479-685-4843

www.agselect.com

Edstrom C-440S Controller, 4 zone controller, 2 stage temp. or Smart Mode

Edstrom C-110S Controller, 1 zone controller, 2 stage temp. or Smart Mode

Solenoid/Filter/Pressure Reducer Kits (¾" & High Capacity 1 ½") Need one kit for each feedline.

Low Capacity ¾" (18 gpm capacity) ID#7400-8945-160

High Capacity 1½" (20-30 gpm capacity) ID#7400-8940-100

Solenoids for Edstrom Controller (24 volt) ½" to 2 inch solenoids

1 ½" solenoid Part Number will be ID# 2010-8946-150

Dancon Timer and preset delay for holding pens or freestall barns.

Meter-Man

2 South Main, P.O. Box 746, Winnebago, MN 56098 1-800-338-5756 (Paul)

www.meter-man.com

EC120R0 3 stage temp., 3 zone controller compatible with low voltage solenoid

EC110R0 3 stage temp., 1 zone controller

Analog controller 1 zone controller

Manufacturers:

TeeJet Agricultural Spray Nozzles

www.teejet.com

Sprinkler Nozzles (Feedlines)

Nelson irrigation nozzles

www.nelsonirrigation.com

Sprinkler Nozzles (Holding Pens)

Senninger irrigation nozzles

www.senninger.com

Sprinkler Nozzles (Holding Pens), Small ¾ to 1.25 inch pressure regulators

Rain Bird Agri-Products Co. - irrigation nozzles

www.rainbird.com

Sprinkler Nozzles (Holding Pens)

Dancon Products

Model 191 - Preset timers, push-button Delay Switch, 80 minute range, 120V.

<http://www.dancon.com/products/PresetTime/presettime4.htm>

also available at **Edstrom** www.agselect.com

Sprinkler Nozzles, Solenoids, Irrigation Parts Distributors:

QC Supply :

Schuyler, NE 68661-0581

800-433-6340

<http://www.qcsupply.com/>

Edstrom Dealer (Controllers, Solenoid & Filter Kits)

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