

MANAGEMENT GUIDELINES

Raising Commercial Turkeys




Aviagen[™]
Turkeys

Aviagen Turkeys is the premier supplier of turkey breeding stock worldwide, supporting the world-class brands of B.U.T. and Nicholas. We provide our customers with choice, presenting an extensive product portfolio. Unique among turkey primary breeders, Aviagen Turkeys is a truly global supplier, with pedigree breeding programs in the USA (Aviagen Turkeys, Inc.) and Europe (Aviagen Turkeys, Ltd.).

Multiple breeding programs and production centers provide a more secure, global supply source and the opportunity to maximize product improvement and new product development. Aviagen Turkeys utilizes innovative technologies and maintains diverse genetic lines to enable selection of turkeys that give the best performance in a wide range of environments. Investment and innovation are key to product development, producing the turkeys of the future.



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Management Guidelines for Raising Commercial Turkeys

Contents

Introduction and Animal Welfare 4

Biosecurity 5

Cleaning and Disinfection 7

Brooding..... 9

Growing..... 12

Feeding and Nutrition 14

Ventilation..... 16

Water Vaccination 21

Pest Management..... 22

Water 25

Post Mortem Examination 31

Appendix 34

Introduction and Animal Welfare

Aviagen Turkeys is a primary breeding company developing pedigree lines of birds for the global turkey industry. Through the application of advanced technologies and unique systems in the breeding program, Aviagen is able to utilize a balanced approach to genetic progress.

This allows for continuous improvement in both commercial traits such as live weight, feed efficiency and meat yield, as well as welfare traits such as robustness, cardiovascular fitness and leg strength. Achieving this genetic potential depends on:

- An appropriate environment, including temperature and air quality, which meets the birds' requirements.
- A dietary regime that provides nutrients, in both feed and water.
- An effective biosecurity and disease control program.

All of these are interdependent. If any of these elements are sub-optimal, performance will suffer.

The aim of this booklet is to assist producers of Nicholas turkeys to achieve optimum performance from their birds. It draws attention to essential management issues, which if overlooked may depress flock performance.

These management techniques will help maintain bird health and welfare, allowing your turkeys to perform well in both live and processing characteristics.

Information presented in this booklet combines the collective data derived from internal research trials, published scientific knowledge, and the expertise, practical skills and experience of the Aviagen Turkeys' technical service team.

While every attempt has been made to ensure the accuracy of the information presented, Aviagen Turkeys accepts no liability for the consequences of using this turkey management information.

For further information on raising Nicholas turkeys, contact your local technical service representative or an Aviagen Turkeys sales office.

Animal Welfare

Aviagen Turkeys is committed to the proper care of our animals. We developed this Best Management Practices guide to encourage and assist the industry as they develop their own management programs. Responsible management and good stockmanship are essential to good animal welfare practices.

The environment in which turkeys are grown must take into account their needs and protect them from physical and thermal discomfort, fear and distress. Continuing education of personnel who have daily contact with turkeys is one of the most important ways to ensure proper behaviors that support and promote good animal welfare practices.

Good management practices that avoid destructive behavior, prevent disease, and promote good health and production as set forth in this manual, are consistent with the generally accepted practices of animal welfare. At its basis are the five freedoms of animal welfare:

- Freedom from thirst and hunger
- Freedom from discomfort
- Freedom from pain, injury and disease
- Freedom to express normal behavior
- Freedom from fear and distress

Biosecurity

Producers must have a strict set of rules designed to prevent poultry from being exposed to infectious diseases to safeguard the health of the turkeys and consumers. An effective biosecurity program requires the identification of the most likely sources of disease, and the establishment of practices designed to suppress the introduction and spread of these pathogens into the flock. It is important to educate employees regarding sanitation procedures and disease risks.

Anyone who will be entering the facility should avoid contact with chickens, waterfowl, quail, wild turkeys, pheasants, companion birds, fighting cockerels, etc. He / she should not visit live bird markets (flea markets), pet stores, zoos, livestock labs, processing plants, etc. or those people in contact with them.

Do not share staff between different species farms and preferably not even between poultry farms.

Employees & Visitors

Maintain a Secure Facility

- Secure farm with a fence
- Keep gates and buildings locked at all times
- Post signs to prevent entry by unauthorized visitors
- Do not allow any visitors inside the secured area without approval from the farm owner or company. Persons coming from areas known to be a high risk disease area should not be allowed to enter the farm.
- Anyone entering the facility must adhere to all sanitation procedures.
- All visitors must sign visitor log indicating date and place of last livestock contact.



Sanitation Procedures

- Employees or growers must wear poultry house designated clean clothing and footwear.
- Visitors must wear clean coveralls, boots and hairnets.
- If a shower is provided, enter the shower room and shower (pay special attention to washing hair, hands and finger nails). Then enter clean room and put on clothing provided by the farm and re-wash hands.
- After entering the farm, at no time should the person return to the dirty room nor should any items such as towels, clothing or personal effects be transferred between the dirty and clean areas.
- Before entering and exiting turkey buildings, wash and disinfect boots and hands.
- Sanitize all items before entering the farms.
- Wash hands after breaks and lunch.



Vehicles & Equipment

- Limit traffic onto facilities as much as possible.
- Avoid using any equipment that has been used on other farms to prevent cross-contamination.
- Locate feed bins, gas tanks, propane tanks, generators, etc., such that they can be serviced from outside the farm.
- Provide a vehicle disinfection area at the gate entering the facility.
- Thoroughly disinfect all vehicles, equipment and tools entering the farm and before use.



Birds, Rodents, Insects, Mammals

- Do not allow the accumulation of materials, trash or other debris in and around the farm.
 - Maintain a “vegetation-free” zone at least 36 inches (1 meter) around all barns and control all grass and weed growth.
 - Avoid and immediately clean-up any feed spills.
 - Avoid and repair leaking plumbing or other sources of standing water.
 - Eliminate holes, cracks and other openings where rodents or birds might enter houses.
 - Eliminate nesting areas and destroy any nests that are found.
 - Pest proof buildings as much as possible.
- Put out rodenticides and insecticides.
 - Continually be on the alert for pests and eliminate them when seen.
 - Do not allow pets or other animals to enter the barns.



Cleaning and Disinfection

An essential element to keeping your farm free of disease is the proper cleaning and disinfection of your barns between flocks. Diseases and other pathogens can be introduced in numerous ways. Taking the time to clean and properly disinfect can help to reduce this risk and break disease cycles.

Brooder House

- Bait for rats and mice. Rotate types of baits used quarterly.
- Empty feed pans, hoppers, and feed bins.
- Remove litter, dust and debris from barn.
- Scrape/sweep floor down to bare floor.
- Dry clean house using backpack blower or broom paying special attention to screens, fan housing, vents, and louvers.
- Wash house down with water, preferably hot, and a detergent product using a pressure washer.
- After barn is dry, disinfect using an approved disinfectant. Spray to the point of run-off. *Remember, cleaning, washing and disinfection are three separate steps.*
- Wash and disinfect any supplemental brooding equipment before bringing it back into the barn.
- Treat for insects, e.g. flies, darkling beetles, etc., as required. Rotate insecticide products to avoid building resistance.
- Clean and disinfect waterlines and any supplemental



drinkers after every flock. Flush lines and drinkers (dump 2 – 3 times) with fresh, chlorinated water after line cleaning. (See *Water Line Cleaning*, page 26.)

- Do not enter clean building without proper biosecurity procedures. Keep doors closed and locked to keep unauthorized visitors and animals from entering barn.
- Bring shavings into the house after it is thoroughly dry. *Applying shavings to a wet floor can promote the growth of mold.*

Growout - Total Cleanout

Total litter removal is recommended every 12 to 18 months or after any disease issues.

- Bait for rats and mice. Rotate types of baits used quarterly.
- Empty feed pans, hoppers, and feed bins.
- Remove all litter.
- Scrape/sweep floor down to bare floor.
- Dry clean house using backpack blower or broom paying special attention to screens, fan housing, vents, and louvers.
- Wash house with water and detergent product using a pressure washer.
- After barn is dry, disinfect using an approved disinfectant. Spray to the point of run-off. *Remember, cleaning, washing and disinfection are three separate steps.*



- Treat for insects, e.g. flies, darkling beetles, etc., as required. Rotate insecticide products to avoid building resistance.
- Keep doors closed and locked to keep unauthorized visitors and animals from entering barn.
- Clean and disinfect waterlines after every flock. (See *Water Line Cleaning*, page 26)
- Remove drinkers from the barn to clean and sanitize them separately from the house wash down and disinfection process.
- Consider treating dirt or clay pad with acid type of litter treatment. This type of treatment can be effective in reducing such pathogens as E.Coli, salmonella and clostridium.
- Bring all cleaned and disinfected equipment back into barn.
- Add new litter onto dry pad.

Growout – Non-Total Cleanout

(**NOT** recommended for regions or farms with previous health issues)

- Bait for rats and mice. Rotate types of baits used quarterly.
- Dry clean house using backpack blower or broom paying special attention to screens, fan housing, vents, and louvers.
- Wash and disinfect barns annually following above wash-down and disinfection procedures, even if litter is not being removed.
- If time allows, litter can be composted in-house for pathogen reduction. (See *In-house Composting*, page 7)
- If not, remove all caked and wet litter. Tractor mounted litter forks work exceptionally well to remove caked litter and leave dry loose material underneath.



- Till up and level remaining litter. Top-dress with either new shavings or recycled brooder litter.
- Treat for insects, e.g. flies, darkling beetles, etc., as required. Rotate insecticide products to avoid building resistance.
- Clean and disinfect waterlines after every flock. (See *Water Line Cleaning*, page 26)
- Consider treating litter with acid type of litter treatment. This type of treatment can be effective in reducing such pathogens as E.Coli, salmonella and clostridium.

In-house Composting

When a total clean out is not feasible, in-house composting is a cost-effective method of reducing disease risk for the next flock. When done properly it will help to ensure a healthy environment.



- A 14 day down time is needed to properly execute this procedure.
- Litter should have a minimum of 25% moisture.
- Create windrows of litter 24 to 48 inches (60 – 120 cm) high.
- Treat the windrows with insecticide for darkling beetles as soon as beetles start to appear, usually within the first few hours after creating windrows.
- Ensure temperature reaches a minimum of 130°F for three days for maximum pathogen kill.
- In most situations, temperature will peak three to four days after pile creation.
- Piles should be turned three times to achieve optimum results and avoid excess ammonia.
- Peak temperature should be reached again within two days after turning.

Brooding

After hatch a poult has basic needs that must be satisfied if it is to survive and become a quality finished product. These basic needs are fresh air, clean water, quality feed, good litter and heat. To improve their chances of survival, the poult should be confined to an area where feed, water and heat are readily available.

This can be done by using a variety of brooder set-ups. The actual brooder ring setup will vary depending on house, stove type, brooding equipment, past experience, company preference and the time of year.

Shavings

- Use a clean, dry mixture of coarse and fine softwood shavings. Avoid hardwoods and wet sawdust.
- New shavings are recommended for every flock.
- Spread evenly at 3 to 4 inches (7.5 to 10 cm) depth.
- Smooth to level within rings prior to setting up equipment.

Water

- Water lines should be cleaned prior to placement (*See Water Line Cleaning, page 26*)
- No vitamins or antibiotic should be added at placement (unless for a specific known problem as prescribed by a veterinarian). Always use clean sanitized water.
- Provide one bell-type drinker per 100 poult.
- If using nipple drinkers follow the manufacturer recommendations.
- Level drinkers to avoid floods while making sure poult have good access to drinkers.
- Adjust automatic depth to $\frac{3}{4}$ inch (20mm); hand fill to lip prior to placement.
- If using nipple drinkers, double rings are recommended.



Feed

- Pre-starter crumble should be good and consistent in size with minimal fines.
- Provide one 48 inch (1.2m) trough-type feeder per 100 poult to equal 1 linear inch (25mm) per poult; or provide a combination of 18 inch (0.5m) red feeders and bucket type - 100 poult per one bucket and one 18inch (0.5m) red feeder.
- If using brooder rings, position feeders at least 12 inches (30 cm) from edge of stove and brooder guard.
- Fill feeders with fresh feed immediately prior to placement.
- Consider supplementing 48 inch (1.2m) trough-type feeders with 18 inch (0.5m) red feeders while poult are in rings for optimum feed consumption. Meat trays or egg flats may also be used.
- Keep feed clean and free from shavings, debris and manure.

Conventional Jet Brooder Stoves

- Confirm that each stove is operating properly.
- Stoves should be lit 24 hours prior to poult arrival to warm room and shavings. A minimum of 12 hours prior to poult arrival, set stoves to reach starting target temperature.
- Target a 3 – 4 foot (1.0-1.3m) “hot spot” of 100–105° F (38-40° C) in the center of the ring.
- Adjust all stoves to 24 inches (60 cm) above the litter.
- Confirm that the cycling of each stove provides a hot spot of no less than 100° F (38° C) and no more than 115° F (46° C) at any time.
- Set zone controlled systems so that the majority of stoves are within target range. Stoves that are hotter or cooler than target should be physically raised or lowered to achieve the desired temperatures.
- Use one 75-100 watt incandescent brooder light per stove to prevent shadows and draw poult to heat source. Use only while poult are in rings.
- Check propane level in tank.

Ventilation and Temperature Control

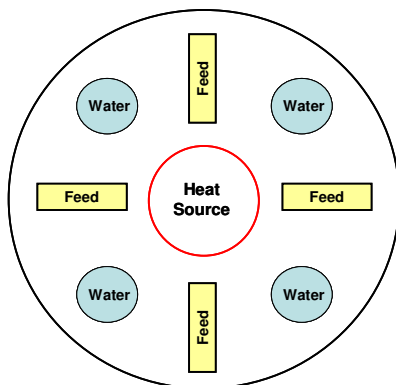
- Confirm that stoves are properly set and that all ventilation equipment is operational.
- Calibrate all thermostats to enable accurate settings.
- Set fan thermostats according to target temperature.
- Adjust ventilation to provide the minimum CFM's required according to the lowest anticipated outside temperatures.
- Adjust all vents to the same opening. For wintertime ventilation a portion of vents may need to be closed off completely.
- Use mixing fans to reduce temperature stratification and improve heating efficiency. Small 18-24 inch / 45-60cm fans are recommended hanging close to ceiling at approximately 50-60 feet (15-18m) apart.
- Seal cracks and areas where air can leak in causing drafts and heat loss. Pay close attention to end doors and curtains.

Lighting

- Provide a minimum of 8 footcandles (80 lux) of light in house.
- Provide poults with full light for the first one to three days. Afterwards, poults should have 8-10 hours of continuous darkness per night. Heavy hens require step down lighting. (See *Heavy Hen Lighting Program, page 13*)

Single Brooder Rings

- Brooder rings should be 12-15 feet (4-5 meters) in diameter
- Rings should be at least 2 feet (60 cm) away from the wall.
- Make rings with cardboard brooder guard 12-18 inches (30-45 cm) high. When the barn temperature is expected to drop below 70°F (21°C) or the barn is drafty, use 18 inch (45 cm) brooder guard.



- Place a maximum of 350 tom poults or 400 hen poults per stove.
- Feeders – For every 100 poults use one 48 inch (120 cm) feeder, or one bucket feeder, or two 24 inch (60 cm) plastic feeders.
- Drinkers – For every 100 one Plasson bell or mini drinker. Follow manufacturer's recommendation when using nipple drinkers.
- After three days combine rings to include up to four stoves.
- After five to seven days poults can be released from rings.

Multi-Stove Brooder Rings

- Brooder rings should include no more than four brooder stoves.
- Rings should be at least 2 feet (60 cm) away from the wall.
- Make rings with cardboard brooder guard 12-18 inches (30 – 45 cm) high. When the barn temperature is expected to drop below 70°F (21°C) or the barn is drafty, use 18 inch (45 cm) brooder guard.
- Place a maximum of 350 tom poults or 400 hen poults per stove.
- Feeders - For every 100 poults use one 48 inch (120 cm) feeder, or one bucket feeder, or two 24 inch (60 cm) plastic feeders.
- Drinkers - For every 100 one plasson bell or mini drinker. Follow manufacturer's recommendation when using nipple drinkers.
- After five to seven days poults can be released from rings.



Large Ring or Whole House Brooding

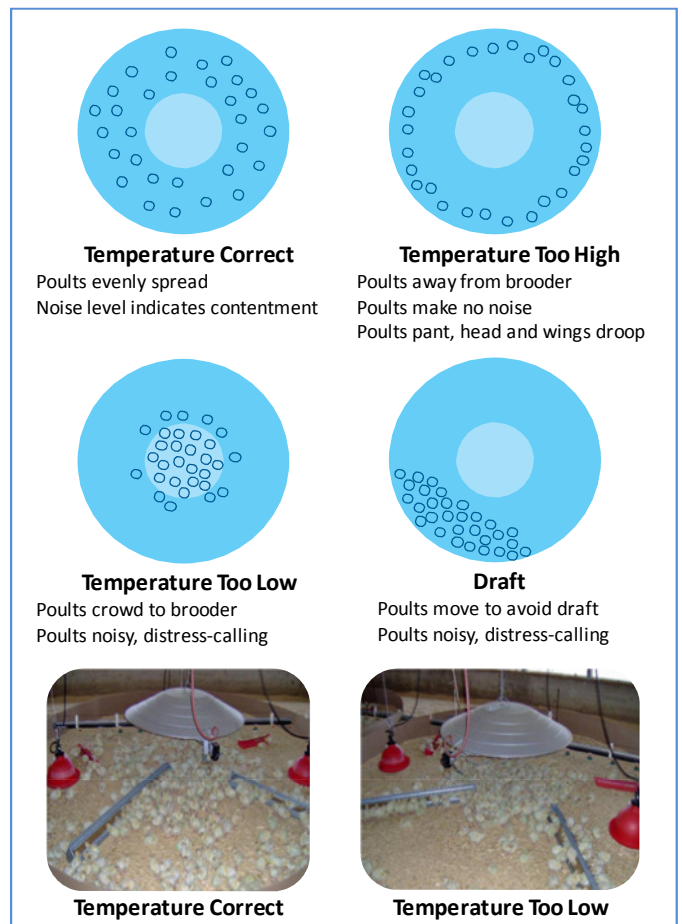
- One 80,000 BTU stove per 1,500 sq. ft. (460 sq.m)
- Two stoves are recommended per ring, with both stoves not being on the same circuit. It works best to have all even stoves on one circuit and all odd stoves on another circuit.
- Stoves work best on 40 foot (12 m) centers to prevent cold spots.
- Houses should be pre-warmed a minimum of 24 hours prior to poult placement and 48 hours ahead during cold months of the year.
- Stoves should ideally be located 7-8 feet (2.0 – 2.5m) off of the shavings, with floor temp under heater at 110-115°F (43 - 46°C) for day of placement; floor temperature near side walls on inside edge of cardboard should be 90°F (32°C).
- If piling becomes an issue, it is possible that more heat may be required. Let the flock dictate where the proper starting temperature needs to be.
- Rings should be at least 2 feet (60 cm) away from the wall.
- Make rings with cardboard brooder guard 12-18 inches (30 – 45 cm) high. If the house is drafty, use 18 inch (45 cm) brooder guard.
- All feeders and drinkers should be down and accessible to the poults.
- Utilize supplemental feeders and drinkers as necessary.



necessary. Careful observation of the poults behavior and barn conditions will determine what adjustments should be made. (See Figure 1)

In addition to visual examination, it is very important to listen to the poults. Excessive noise may indicate wrong temperature or lack of water or feed. Avoid exposure of the poults to sudden temperature or environmental changes.

Figure 1. Poult Distribution Under Brooders



For a weekly target temperature profile see *Table 2 on page 12.*

Once the poults are placed in the barn, they should be allowed a minimum of one hour to acclimate themselves to their new environment. After this time, further adjustment of the ventilation, stove height, stove temperature, drinkers or feeders may be

Growing

Litter

- Ensure a minimum litter depth of 4-5 inches (10-13cm).
- Tilling weekly or as needed during the flock will optimize foot pad and leg integrity.
- Consider using a litter amendment for ammonia control in extremely cold weather conditions.
- Do NOT compromise litter conditions for fuel savings.

Water

- Provide a bell type drinker per 100 - 150 birds.
- For bell type drinkers maintain depth at $\frac{1}{2}$ to $\frac{3}{4}$ inch (12-20mm), depending on drinker style, drinking activity, ambient temperature and litter conditions.
- For bell type drinkers maintain lip of drinker even with height of the average birds' backs.
- Continue to chlorinate to target 3 – 5 PPM free chlorine in the drinker furthest from the source.
- Clean drinkers daily.
- During hot weather, flush overhead lines to provide fresh, cool water.



Feed

- Ensure quality feed is available when the birds are delivered.
- When birds arrive have cones adjusted to flood feed level.
- Provide a minimum of one (1) feed pan per 50 toms and 60 hens.
- Maintain lip of feed pan even with the height of the average birds' backs.
- Check bins, augers, hoppers, etc. regularly for moldy feed.
- In extreme heat conditions consider withdrawing feed during the hottest part of the day to lower metabolic temperature and allow birds to handle heat better.

Lighting

- Toms and light hens should have a minimum of 4 hours of continuous darkness in a 24 hour time period, as per National Turkey Federation Animal Welfare Guidelines. Periods of 8-10 hours of darkness are recommended for optimum performance.

- **Heavy hens** require a step down lighting program. (See Table 1)

Table 1. Heavy Hen Lighting Program

Spring and Summer	
Days 0-3	24 hours on
Days 4-7	4 hours darkness
Weeks 2-6	4 hours darkness
Week 7	5 hours darkness
Week 8	6 hours darkness
Week 9	7 hours darkness
Week 10	8 hours darkness
Week 11	9 hours darkness
Week 12-mkt	10 hours darkness/or as natural day length allows

Fall & Winter	
Days 0-3	24 hours on
Days 4-7	4 hours darkness
Weeks 2-6	4 hours darkness
Week 7	5 hours darkness
Week 8	5.5 hours darkness
Week 9	6 hours darkness
Week 10	6.5 hours darkness
Week 11	7 hours darkness
Week 12-mkt	8 hours darkness

- Lighting can be increased to 24 hours during the week prior to market to prepare birds for loading.
- During periods of extreme heat, lighting should be monitored to make sure birds have adequate time to recover from the heat of the day.
- During periods of extreme cold, lighting should be monitored on younger flocks so that the temperature is not dropping too low in the barn.
- Light intensity and day length will influence activity, feed consumption, and cannibalism; adjust as needed.

Ventilation

- Confirm that all ventilation equipment is operational.
- Calibrate all thermostats to enable accurate settings.

- If power ventilating, adjust fan thermostats according to target temperature. Thermostat fans should begin to come on 2°F (1°C) above target temperature.
- Utilize heat as needed to reduce litter moisture (with increased ventilation).
- Do NOT compromise air quality for fuel savings.

Temperature

Target environmental temperatures for commercial stock are detailed in Table 2.

Table 2. Target Environmental Temperatures

Age	Sex	Conventional Brooding		Large Ring / Whole House Brooding	
		°F	°C	°F	°C
Day 1	M+F	86	30	94	34
Week 1	M+F	83	28	88	31
Week 2	M+F	80	27	84	29
Week 3	M+F	77	25	82	28
Week 4	M+F	74	23	76	24
Week 5	M+F	72	22	72	22
Week 6	M+F	70	21	70	21
Week 7	M+F	68	20	68	20
Week 8	M+F	66	19	66	19
Week 9	M+F	64	18	64	18
Week 10	M+F	62	17	62	17
Week 11	M+F	60	16	60	16
Week 12	M+F	58	14	58	14
Week 13 +	Females	58	14	58	14
Week 13	Males	56	13	56	13
Week 14 +	Males	55	13	55	13

Feeding and Nutrition

Aviagen Turkeys is the industry leader in part because of its turkeys' commercial growth rate and feed efficiency. This bird has a strong appetite and needs to achieve its early growth potential in order to develop the skeletal and cardiovascular systems necessary to support growth later in life.

Our technical team has evaluated different growth patterns to develop an understanding of the relationship between performance in the brooder stage and final flock results. Following are some of our observations and conclusions.

Minimize Stress during Brooding

Results show that getting birds off to a good start produces the best final results. During the first six weeks of a bird's life the fundamental development of the skeleton, immune system and cardiovascular system takes place. Exposure to stress during this period compromises the development of these vital systems. Good health status, housing, bird management, feed quality and feed intake allow birds to establish the foundation required to carry them through the finishing barn.

Achieve the 6 Week Target Weight

Birds that are below the weight target at the end of the brooding period tend to go through a rapid recovery phase in the finishing barn where there is typically more space and greater access to feed. Research indicates that slow early growth followed by a rapid growth period may result in a weakness in respiratory or skeletal development in a percentage of the flock. Stress later in life can then result in increased late mortality in this portion of the population. This late mortality can show up as leg weakness, cull birds and respiratory problems.

Flocks with weights close to target coming out of the brood barn do not have the same period of accelerated growth following the move and there are fewer resulting problems with late mortality. Turkeys that are closer to their genetic potential have less physiological push to alter their growth rate and consequently have a steadier growth pattern and stronger overall development.

Weigh Birds at Transfer

To achieve the best results when growing turkeys it is important to establish benchmarks to evaluate how flocks are performing. It is crucial to get accurate weights at transfer from the brooder barn. Ideally all flocks should be weighed at the same age and the sample size should be large enough to be meaningful – at least 50 birds.

Weighing all flocks allows a company to determine what birds typically weigh at transfer in its unique operation. Comparing flocks with an established benchmark is an essential tool to evaluate management, health and nutrition programs.

Identify Reasons for Under-Weight Flocks

If the target weight is not being achieved, the big challenge is to identify why and to make modifications to ensure goals are met. If an individual flock is underperforming, conditions on the farm should be reviewed. If flocks throughout the company are not meeting objectives then an evaluation of the overall management, health and nutrition programs is required.

Management practices in the brood barn can be as important as nutrition in achieving target weights. Therefore, conduct a thorough review of health, vaccination and cleaning programs, feed quality, feed

texture and gut health. Additionally, environmental factors like air quality, humidity and temperature regimes should be examined. Any of these factors or a combination of several can have a severe detrimental effect on growing birds.

Encourage Feed Consumption

The nutritional package that is fed also has a great deal of influence on weights at the end of the brood period. However, in the first weeks of life the amount of feed birds consume is even more critical. Diets with high levels of available energy allow the bird to get off to a good start; this can be achieved by adding at least 4-5% of good quality fat. This added fat increases the energy level and improves the feed form and palatability.

A consistent crumb size with less dust will improve feed consumption. In the early stages the crumble quality needs to be small enough to encourage consumption. Corn particle size should also be small enough to be edible but large enough to stimulate gizzard function. (See Table 3)

Table 3 Poultry Feed Particle Size

Particle Size (mm)	%
<0.5	20
1.0 – 0.5	20
1.5-1.0	25
2.0-1.5	15
3.15-2.0	15
>3.15	5

Manage Transition to Pellet Feed

The transition from crumbled to pelleted feed must be managed to ensure that the early benefits are not lost. Birds may back off feed if pellets are too large or too long as they may not be ready for the larger size. If feed intake is reduced for 12 to 24 hours birds can lose up to a day’s growth and will be more susceptible to enteric challenges.

Changing from first feed crumbles to second feed pellets at the same time as the move to the finisher barn can stress birds and reduce feed consumption. Therefore, it is best to wait for a few days after moving birds before changing feed presentation.



Ventilation



Ventilation control is the principle means of controlling bird environment. It is essential to deliver a constant and uniform supply of good quality

air at bird level. Fresh air is required at all stages of growth to allow the bird to remain in good health and achieve full potential.

Ventilation helps to maintain in-house temperatures within the birds' comfort zone. During the early part of the production period keeping birds warm is the primary concern, but as they grow keeping them cool becomes the main objective.

The housing and ventilation systems used will depend upon climate, but in all cases effective ventilation should remove excess heat and moisture and improve air quality by removing harmful gases and dust. Sensors that monitor ammonia, carbon dioxide, relative humidity and temperature are available commercially and can be used to monitor the ventilation system.

As turkeys grow they consume oxygen and produce carbon dioxide and water vapor. Combustion by stoves contributes additional harmful gases in the turkey house. The ventilation system must remove these harmful gases from the house and deliver good quality air.

Air Quality

The main contaminants of air within the house environment are dust, ammonia, carbon dioxide, carbon monoxide and excess water vapor. These contaminants can damage the respiratory tract, decreasing the efficiency of respiration and reducing bird performance.

Continued exposure to contaminated and moist air may trigger respiratory disease, reduce performance, affect temperature regulation and contribute to poor litter quality.

Target levels to maximize bird performance:

Carbon dioxide concentrations	below 3,500 ppm
Carbon monoxide concentrations	below 35 ppm
Relative humidity	50% - 70%
Ammonia concentrations	below 25 ppm

Housing and Ventilation Systems

There are two basic types of ventilation system: natural and power.

Natural (Open-sided Housing), which can be:

- Non-mechanically assisted
- Mechanically assisted

Power (Controlled Environment Housing), which can be:

- Minimum
- Transitional & Tunnel
- Evaporative Pad
- Fogging/Misting

Natural Ventilation: Open-Sided Housing

Natural ventilation refers to an open-sided house with curtains. Natural ventilation involves opening and closing the curtains to control the air flow and environment inside the house.



Curtain ventilation requires diligent management if house environment is to be satisfactorily controlled. The monitoring of conditions and adjustment of curtains is required to compensate for changes in temperature, humidity, wind velocity and wind direction.

The air exchange rate depends on outside winds, and fan assistance improves the efficacy of air circulation. On warm to hot days with little wind, fans provide a wind chill cooling effect. Foggers, misters or sprinklers should be used with circulation fans to add a second level of cooling.

In cold weather, when curtain openings are small, heavy outside air enters at low speed and drops immediately to the floor which can chill the birds and create wet litter. At the same time, warmer air escapes from the house which can result in large temperature swings. This can be reduced by using circulation fans help to mix incoming cold air with warm in-house air.

Power Ventilation Systems: Controlled Environment Housing

Power or negative pressure ventilation systems are becoming more popular for controlling house environment. Better control over air exchange rates and airflow patterns provide more uniform conditions throughout the house.

Power ventilated systems use exhaust fans to draw air out of the house and create a lower pressure within the house. This creates a partial vacuum (negative or static pressure) inside the house so that outside air can pass in through controlled vent openings. The speed at which air enters the house is determined by fan capacity and vent area.

Matching the vent openings to the number of exhaust fans in operation is the key to achieving correct negative (static) pressure. Mechanical controls will automatically adjust vent openings to the number of fans running. The amount of negative pressure generated can be monitored by a static pressure gauge.

Negative pressure ventilation can be operated in three different modes according to the ventilation needs of the birds:

- Minimum ventilation
- Transitional ventilation
- Tunnel ventilation

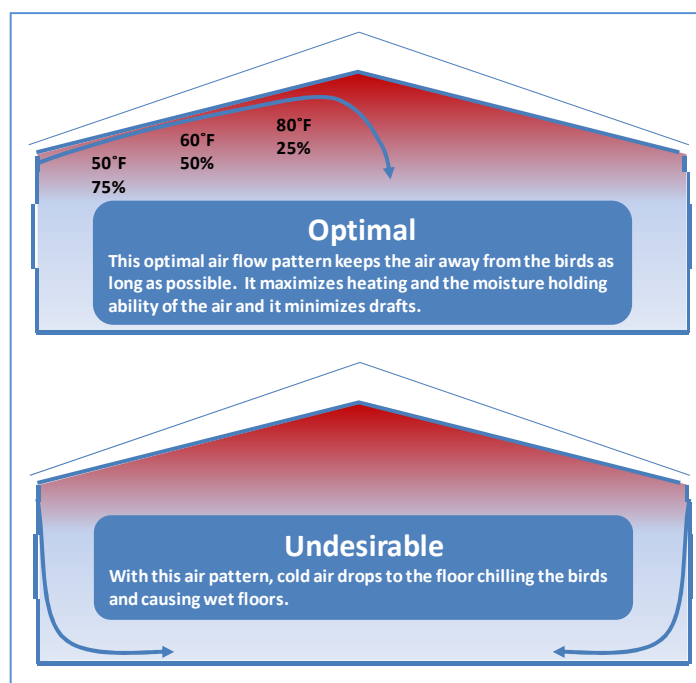
With any powered system, a standby emergency generator is required.

Minimum Ventilation Systems

Minimum ventilation is used for cooler weather and for young birds. The aim of minimum ventilation is to maintain required air temperature, bring in fresh air and remove excess moisture and harmful gases.

The key to successful minimum ventilation is creating a partial vacuum (negative pressure) so air comes through all vents and is directed across the ceiling. This will ensure that incoming air is mixed with warm in-house air above the birds rather than dropping directly onto the birds and chilling them (see Figure 2). This type of ventilation is preferably timer-driven.

Figure 2. Optimal Air Flow Pattern



Transitional Ventilation Systems

Transitional ventilation operates using two ventilation principles based on the outside temperature and the age of the birds. It is used where both hot and cold periods are experienced. Whereas minimum ventilation is timer-driven, transitional ventilation is temperature-driven. Transitional ventilation begins when a higher than minimum air exchange rate is required. That is, whenever temperature sensors or thermostats override the minimum ventilation timer to keep fans running.

Transitional ventilation works in the same way as minimum ventilation, but a larger fan capacity gives a larger volume of air exchange. Successful transitional ventilation requires vents linked to a static pressure controller so heat can be removed without switching to tunnel ventilation.

Tunnel Ventilation Systems

Tunnel ventilation keeps birds comfortable in warm to hot weather and where large birds are being grown by using the cooling effect of high-velocity airflow. Air movement is one of the most effective methods of cooling birds during hot weather. As air moves over a bird's hot body, heat is removed from the bird, making it feel cooler. The greater the amount of air movement, the greater the cooling effect produced. Birds will feel cooler when exposed to air movement during hot weather, and will continue to eat and grow.

Evaporative Cooling Systems

Tunnel ventilation is well-suited to the addition of an evaporative cooling system. Evaporative cooling is used to improve environmental conditions in hot weather



and enhances the efficiency of tunnel ventilation. Evaporative cooling systems use the principle of water evaporation to reduce the temperature in the house.

Evaporative cooling is best implemented to maintain a required temperature in the house, rather than to reduce temperatures that have already become stressfully high.

The three factors which directly affect evaporative cooling are:

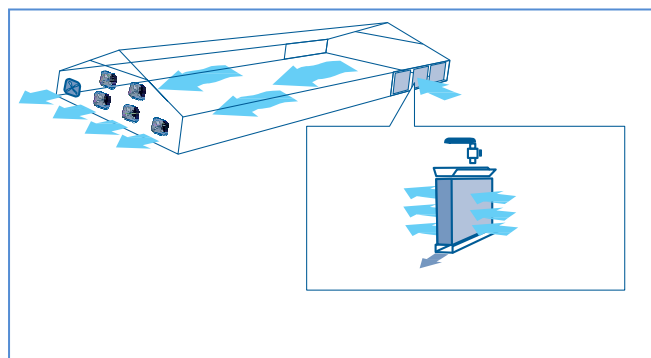
- Outside air temperature
- Relative humidity (RH) of outside air
- Evaporation efficiency

There are two primary types of evaporative cooling systems; pad cooling with tunnel ventilation and foggers, misters and sprinklers.

Pad Cooling with Tunnel Ventilation

Pad cooling systems cool air by drawing it through wetted cellulose pads (See Figure 3). The dual effect of pad cooling and air speed allows control of the environment when house temperatures are above 85°F (30°C). Excessively high house humidity can be minimized by making sure that evaporative cooling pads/fogging systems do not operate at temperatures below 80°F (27°C) in areas where the ambient humidity is high (greater than 80%).

Figure 3: Pad Cooling with Tunnel Ventilation



Fogging/Misting

Fogging systems cool incoming air by evaporation of water created by pumping water through fogger nozzles.

There are three types of fogging systems:

- Low pressure, 100–200 psi; droplet size up to 30 microns.
- High pressure, 400–600 psi; droplet size 10–15 microns.
- Ultra high pressure, 700–1,000 psi; droplet size 5 microns.

Pressure	PSI	Droplet Size
Low Pressure	100 - 200	Up to 30 Microns
High Pressure	400 - 600	10 – 15 Microns
Ultra High Pressure	700 - 1000	5 Microns

With low pressure systems, larger particle sizes can cause wet litter if house humidity is high. High pressure systems minimize residual moisture giving an extended humidity range. Fine droplet size will help avoid wet litter.

Cold Weather

During cold weather primary consideration should be given to the control of ammonia and humidity. Ventilating too little can lead to poor air and litter quality, resulting in bird health and performance issues. Ventilating too much can lead to drafty conditions and high heating costs.

Following are some tips to ensure proper ventilation during cold weather.

- Maintain ammonia level below 25 ppm. If ammonia levels become too high, increase minimum ventilation level. At times it may become necessary to add heat depending on age of flock and outside temperature. The amount of ammonia produced is a function of factors such as age of litter, litter moisture, amount of caked litter and length of downtime between flocks.
- Maintain relative humidity between 50% and 70%. If the barn becomes dusty add moisture. When humidity reaches 60% begin to increase minimum ventilation rates. At times it may become necessary to add heat depending on age of flock, outside temperature and humidity.
- Ensure house tightness, there should be no air leaks. The best way to evaluate house tightness is with a static pressure test. (See Figure 4) Seal all cracks with caulk or foam insulation as needed. A smoke emitter will be useful to identify leaks.
- Maintain minimum ventilation rate regardless of the inside or outside conditions. Without at least the minimum ventilation rate the inside air quality will deteriorate and litter moisture and ammonia problems will occur. If wet litter or ammonia becomes a problem, increase the minimum ventilation rate.
- Ensure that incoming air is mixed with warm in-house air above the birds rather than dropping directly onto the birds and chilling them. This requires matching the number of vents and fans to maintain static pressure.

Figure 4. Procedures for Static Pressure Test

Static Pressure Test

1. Close all vents, doors, curtains, etc.
2. Turn on enough fans to equal 1 CFM per square foot (1.7 cubic meters per hour per 0.093 square meters)
3. Static pressure should be 0.2 or better.
4. If the number is lower than 0.2, too much air is coming in through leaks and cracks. The higher the number, the better the tightness.

- Use stir fans to reduce temperature stratification. Do not direct airflow onto the birds.
- Make sure fans are well maintained and working properly. Fan belts should be tight and louvers should be clean and free of dust. Replace belts annually.
- If the house gets too warm, check the thermostat setting not the fan timer setting.
- Maintain cables to ensure proper opening and closing of vents.
- Maintain heaters to ensure efficient operation and to reduce carbon monoxide.
- Check plumbing fixtures for leaks.
- Upgrade insulation if needed. Heavy condensation can indicate areas of poor insulation.
- During down time, empty water lines to avoid freezing and breakage.

Hot Weather Ventilation



When turkeys are exposed to excessive heat they begin to suffer from heat stress. Some signs of heat stress are decreased feed consumption, increased water

consumption, gasping, open mouth panting, wing spreading, stupor, slowness and lethargy. The longer the flock is exposed to high temperatures, the greater the stress and its effects.

Following are some ventilation techniques to help control house temperature during hot weather.

- Ensure all fans are in working order, belts are tightened and fan housings are kept free of dust. Clean louvers and vent openings frequently as any dust accumulation will reduce air flow.
- Set and activate alarms. This is especially critical for barns using tunnel and static pressure ventilation.
- Temperature targets will vary with flock age.

- Test alarms weekly.
- Properly set thermostats on both fans and curtain machines according to flock age and outside temperature considerations.
- Direct hanging fans so air flows across the birds and not up to the ceiling.
- In open sided housing sidewall screens and end door screens should be kept clean at all times to maximum air flow.
- For static pressure barns, remember the goal is to pull enough static pressure to eliminate dead air spots in the center of the barn while still increasing air volume. *Not all barns are the same width and will have different requirements. Check with your service technician on recommendations for your barn.*
- Set up tunnel ventilated barns in stages based on outside temperatures and bird requirements.
- For curtain sided barns, keep screens clean of dust and feathers. Keep perimeter of building clear of tall grass, equipment and any other air flow obstructions.
- Test any foggers, misters or sprinklers prior to use each summer. Nozzles can become clogged; hoses and pipes can become cracked. Dripping nozzles will reduce mist onto birds and create wet spots. Watch for drips and repair as needed.
- Do not run foggers, misters or sprinklers without also using fans.

Generators, Alarms and Curtain Drops

Generators should be tested weekly, serviced and maintained as per manufacturer's recommendations. Both a service log and test log should be kept on site with equipment.



Additionally, alarms and curtain drops are to be tested weekly with logs kept.

Water Vaccination

Prior to Vaccinating

- Consult your veterinarian or flock supervisor for a vaccination schedule for your flock.
- Follow the manufacturer's recommendations regarding transport, storage and disposal of vaccine and containers.
- Remove chlorine, antibiotics, disinfectants and other additives from the water. Presence of these materials will interfere with the vaccine.
 - Two days prior to scheduled vaccination, turn off chlorine.
 - If water is chlorinated from the supply source use a charcoal filter to remove chlorine or let water stand in holding tank for two days.
 - Test water to ensure chlorine is removed. It may take longer than two days.
- Rinse and flush water tank or ensure you have a clean medication bucket for proportioner.
- Wash drinkers the day before vaccination.
- One day prior to scheduled vaccination, run vaccine stabilizer.

Day of Vaccination

- Only vaccinate healthy birds.
- Restrict water intake to ensure birds are thirsty for the vaccine water.

- Two hours prior to lights coming on (or prior to normal chore activities):
 - Flush water lines with clean water
 - Raise the drinkers
 - Turn off the water
- Mix correct number of vaccine doses into enough water to last 3-4 hours.
- Add vaccine stabilizer (with blue dye).
- Flush the water lines, ensuring that all the drinkers in the house have water with blue dye. Drinkers must be emptied to get vaccine water started.
- Lower the drinkers.
- Walk through the barn every 20-30 minutes.
- Resume chlorination 4 – 6 hours after all the vaccine is consumed.

Please note vaccination alone cannot protect flocks against overwhelming disease challenges and poor management practices. Develop programs for birds in consultation with a trained poultry veterinarian. Vaccination is more effective when disease challenges are minimized; good management and biosecurity will help reduce these challenges. Base your vaccination programs on local disease challenges and remember every bird must receive the intended dose of vaccine.

Pest Management

Controlling pests requires an Integrated Pest Management (IPM) system and utilizes multiple tools to manage pests. It includes planning and implementing proper sanitation practices, mechanical devices, pest behavior and pesticides to provide a foundation to prevent pest outbreaks and predict when and what types of treatment are most economically beneficial to the grower.

The primary pests that impact poultry production are darkling beetles, rodents, flies, wild birds and worms. Controlling weeds is a key part of a pest management program due to the impact on pest behavior.

Darkling Beetles

Darkling beetles are best controlled with insecticide.



- Apply the label recommended amount of each insecticide. **Using less than the recommended amount will lead to increased resistance to the insecticide.**
- If large populations of beetles are present, apply insecticide before placement of each flock to keep the beetle populations under control.
- If using an Organophosphate or Pyrethroid when the pH of the water is above 6, add 1 packet of Citric Acid or another acidifier to each insecticide tank mix before applying the material. These insecticides kill

more beetles when they have an acid added to the tank mix.

- If using a Spinosad, add 1-2 ounces of clear household ammonia per gallon of tank mix (8-16 ml/liter).
- If using a neo-nicotinoid class of insecticide, such as Imidacloprid no tank additives are necessary.
- Rotate products utilizing a minimum of four different classes of insecticide per year.
- Apply the insecticide using as little water as possible, as recommended by the manufacturer.
- Change nozzle tips to a flat fan, 04-08 nozzle tip, to get a fine mist instead of a coarse spray application.
- Do not apply insecticide to the entire house.
- Focus the insecticide applications to the areas where the beetles are living when the birds are in the house for much better control:
 - › 3 foot (1 meter) wide band under the feed lines
 - › 3 foot (1 meter) wide band along the walls, including the footing
 - › 2 feet (60 cm) up onto the wood above the footing
- Apply the insecticide on top of fresh shavings after clean out or on top of the litter after caking out. The beetles crawl on top of the litter as they are making their way to the feed line areas after bird placement. Results are not as good if insecticide is applied on the bare floor.
- Prior to clean out apply a wall treatment such as Permethrin 10% to prevent beetles from retreating to the walls during clean out.
- After clean out or caking out, apply the insecticide currently used in rotational program to any litter stored in the stacking shed. This will prevent the beetles from migrating back into the houses.
- The number of beetles killed in the first 24 hours is not the best indication of the insecticide's efficiency. Some insecticides may not work as quickly but have more long term consistent results.

- In many situations it may be necessary to use insecticide combinations in order to combat resistance issues in darkling beetles. Contact an expert for selection of the most effective combinations for your situation.

Rodents

Control Procedures at Cleanout

- Immediately after depopulating the houses:
 - › Use the most attractive baits in combination with a fast acting Bromethalin product for this process. The use of meal bait top-dressed with a small amount of Bromethalin based product has been very successful. Check with an expert to get specific instructions for this process.
 - › Place shallow trays (egg flats work well) 40 feet (12 meters) apart along the walls.
 - › Place one tray at each end door.
 - › Put bait in each tray as recommended by the manufacturer.
- Check and replenish the bait in the trays every day for at least 5 days.
- At any time during cleanout place bait in the attic space of the house.
- Liquid bait can be used if no water is present in the house during down time.
- Just prior to bird placement, pressure wash all bait stations, allow them to dry and replenish with fresh bait.

Rodent Prevention

- Do not allow the accumulation of materials, trash or other debris in and around the farm.
- Avoid and immediately clean-up any feed spills.
- Avoid and repair leaking plumbing or other sources of standing water.
- Eliminate holes, cracks and other openings where rodents might enter houses.

- Maintain a “vegetation-free” zone at least 36 inches (1 meter) around all barns and control all grass and weed growth.
- Rotate bait using different active ingredients at least three times per year to keep rodents from becoming “bait shy”.

Rodent Bait Station Placement

- For all turkey houses, place outside bait stations one every 40 - 60 feet (12-18 meters) and two on each end.



- If cool cells are being used, place 2 stations in each access area.
- Attach outside stations in an upright position to the footings or walls, ¾ inch (2 cm) above the ground. This keeps the stations in the most advantageous spots and allows them to be cleaned with a portable power washer.
- Place inside stations one for every 20 feet (6 meters) of exposed wall.
- Place stations in each building / room where rodents could enter, e.g. equipment room, storage shed, entry building, break room, etc.

Rodent Bait Station Maintenance

- Treat bait stations as if they are harboring disease – they should only be handled at the end of the day and when wearing gloves.
- Keep bait stations clean and free of insects and excessive dirt.
- Keep bait fresh and dry.

- Check stations at least monthly and keep a record of rodent activity and bait consumption.
- Monthly cleaning – caution should be used during cleaning, as rodents can carry salmonella and other diseases. Contents should never be emptied where it can come in contact with birds.
 - › Open all bait stations and remove the bait.
 - › Clean the inside of the bait stations using a dry rag or a stiff bristled paintbrush.
 - › Contain and carefully dispose of removed contents to avoid spreading disease.
 - › Replenish with fresh bait as necessary to maintain manufacturer’s recommended supply.
- All bait stations should be thoroughly cleaned or pressure washed at least once per year.

Fly Control

Management Techniques

- Clean up feed and water spills.
- Properly store feed.
- Dispose of dead birds promptly.
- Keep outside clear of any manure.
- Maintain a “vegetation-free” zone at least 3 feet (1 meter) around all barns and control all grass and weed growth.
- Keep perimeter vegetation short and tidy.
- Manage drinkers to minimize wet cake underneath drinkers and nipple lines.
- Maintain dry litter conditions.

Chemical Measures

- Apply an approved residual fly spray around perimeter and in the houses according to manufacturer’s recommendations.
- Use bait stations or traps in areas of heavy infestation, such as corners and around doors. Ensure they are out of birds’ reach.
- Apply larvacides directly to manure according to manufacturer’s recommendation to control fly larva.

Worms

Worms can have a significant detrimental effect on performance, including poor weight gain, increased feed conversion and increased mortality. Therefore worming should be done on a routine basis using a veterinary approved turkey worming program. The life cycle of a worm is 28 days, so worming should be done a minimum of every four weeks.

Acknowledgement: *Aviagen Turkeys thanks Robert Rowland from Ivesco, LLC for his contribution to this chapter.*

Water



Water is an essential ingredient for life. Water supplied to turkeys should not contain excessive amounts of minerals and should not be contaminated with bacteria. Test the water supply to check the level of calcium salts (water hardness), salinity and nitrates. After the house has been cleaned and before the birds have arrived, sample water for bacterial contamination at the source, at the storage tanks and at the last drinker. (See Table 4)

Table 4. Acceptable Concentrations of Minerals and Organic Matter in Water Supply

Contaminant, Mineral or Ion	Levels Considered Average	Maximum Acceptable Level	Comments
Bacteria			Total Bacteria is used as an indicator of system cleanliness, high numbers do not necessarily mean the bacteria present is harmful but it does mean that the system is capable of harboring pathogenic organisms. High bacteria levels can impact taste of water resulting in reduced consumption.
Total Bacteria (TPC) CFU/ml	0 CFU/ml	1000 CFU/ml	
Total Coliforms	0 CFU/ml	50 CFU/ml	Treatment -Shock well, then implement sanitation program such as chlorine, hydrogen peroxide or other sanitizers. Maintain a residual level of sanitizer.
Fecal Coliforms	0CFU/ml	0 CFU/ml	Presence of any fecal coliform means water is unfit for consumption.
pH	6.5-7.8	5-8	pH below 5 can be harmful to drinker equipment-causing corrosion to metal components with long term exposure. Treatment -If pH is lower than 5 use soda ash or caustic soda injection to raise pH. pH above 8 - impacts effectiveness of most water sanitizers. High pH associated with high alkalinity, may result in reduced water consumption due to “bitter” taste. Treatment - If pH is high acid injection will be required.
Total Hardness	60-180 mg/l	110 mg/l	Total Hardness (Calcium plus Magnesium) causes scale which reduces pipe volume and causes drinkers to be hard to trigger or leak. Treatment - Softeners can reduce hardness up to a practical limit of 100 gpg or 1710 ppm/mg/l. If the hardness is above 30 gpg or the sodium to hardness ratio is greater than 33% then the sodium level will be high after softening and reverse osmosis may be required.
Natural Elements			
Calcium (Ca)	60 mg/l		Birds are very tolerant of calcium but values above 110 mg/l may require water softener, polyphosphates or acidifier to prevent scaling. In areas of high calcium care must be taken to ensure proper calcium/phosphorus ratios for egg production.
Magnesium (Mg)	14 mg/l	125 mg/l	Higher levels of magnesium may cause flushing due to laxative effect particularly if high sulfate is present.

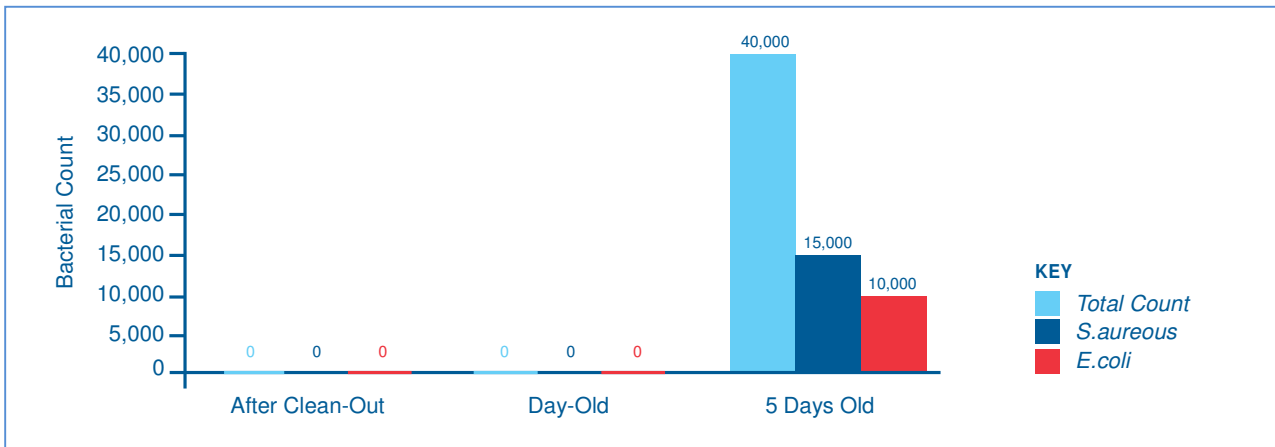
Contaminant, Mineral or Ion	Levels Considered Average	Maximum Acceptable Level	Comments
Iron (Fe)	0.2 mg/l	0.3 mg/l	Birds are tolerant of the metallic taste of iron . Iron can cause leaking drinkers and promote the growth of E coli and pseudomonas. Iron is linked to thick slime producing bacteria such as crenofoms. Treatment- Includes oxidation with chlorine, chlorine dioxide or ozone followed by filtration.
Manganese (Mn)	0.01 mg/l	0.05 mg/l	Manganese can result in black grainy residue on filters and in drinkers. Treatment- Includes oxidation with chlorine, chlorine dioxide or ozone then filtration. Green sand filtration and softeners will remove manganese. Pay close attention to pH when deciding what method to use. Farms with manganese in the water have been problematic.
Chloride (Cl)	50 mg/l	150 mg/l	Chloride , when combined with high sodium levels, creates salty water that can act as a laxative causing flushing. Salty water can promote the growth of <i>Enterococci</i> organisms that can lead to enteric issues. Treatment- Reverse Osmosis, anion exchange resin, lower dietary salt levels, blend source with non-saline water. Keep water clean and use daily sanitizers such as hydrogen peroxide or iodine to prevent microbial growth.
Sodium (Na)	50 mg/l	150 mg/l	Sodium , when combined with high chloride levels, creates salty water that can act as a laxative causing flushing. Salty water can promote the growth of <i>Enterococci</i> organisms that can lead to enteric issues or possibly kinky back. Treatment- Reverse Osmosis; lower dietary salt level; blend source with non-saline water; Keep water clean and use daily sanitizers such as hydrogen peroxide or iodine to prevent microbial growth.
Sulfates (SO₄)	15-40 mg/l	200 mg/l	Sulfates can cause flushing in birds. If rotten egg odor is present, then bacteria producing hydrogen sulfide (H ₂ S) are present. Treatment- System will require shock chlorination plus establishment of good daily water sanitation program, sulfates can be removed by reverse osmosis or anion resin. If H ₂ S is present (the rotten egg smell) then aerate water into a holding tank, treat with sanitizers then filtration.
Nitrates	1-5 mg/l	25 mg/l	High nitrate levels can result in poor growth and feed conversion. Presence of nitrates may also indicate fecal contamination therefore testing for bacteria is recommended. Treatment- Reverse Osmosis or anion exchange resin.
Lead	0 mg/l	0.014 mg/l	Long term exposure to lead can cause weak bones and fertility problems. Treatment- Reverse osmosis, softener or activated carbon will greatly reduce lead.
Copper	0.002 mg/l	0.6 mg/l	
Zinc		1.5 mg/l	

Water may have excessive nitrate levels and high bacterial counts. Where bacterial counts are high, determine the cause and correct the problem. Bacterial contamination can often reduce performance.

Water that is clean at the point of entry to the house can become contaminated by exposure to bacteria

within the house environment particularly with open drinker systems, (See Figure 5). To maintain clean water, clean and sanitize drinkers daily and keep free chlorine levels between 3-5ppm at last drinker. The chart below demonstrates the importance of keeping the water system clean through frequent drinker cleaning and water sanitation.

Figure 5: Increase in Bacterial Count in Open Drinkers



Water Line Cleaning

Successful water sanitation begins with a thorough water line cleaning program. The variability and dynamics of water systems can create cleaning challenges, but these can be overcome with proper water analysis, a little effort and the right tools.

Choose a Cleaner

Have water analyzed for scale-causing minerals: calcium, magnesium and manganese. If the water contains more than 90 ppm combined calcium and magnesium or 0.05 ppm manganese, you will need to include a “descaler” or an acid in your cleaning program. These products will dissolve the mineral deposits in water lines and fittings.

Choose a cleaner that can effectively dissolve any bio-film or slime in the system. Some of the best products for this job are concentrated hydrogen peroxides.

Prior to using any strong cleaners, make sure standpipes are working properly so air pressure buildup in the lines will be released. Consult equipment suppliers before using products to prevent unnecessary damage and always follow manufacturer’s recommendation.

Prepare the Cleaning Solution

For best results, use cleaning products at the strongest concentration recommended on the label. Most proportioners will only allow concentrations between 0.8 and 1.6% of the original material.

If you need to use higher concentrations it is better to mix the stock solution in a large tank and then distribute without use of a proportioner. For example, if a 3% solution is required, mix three volumes of the cleaner with 97 volumes of water for the final solution.

An excellent cleaning solution can be made up by using 35% hydrogen peroxide solution. Mix this as described for a 3% solution.

Clean the Lines

It takes 8-10 gallons (30 – 37 liters) of water to fill and clean 100 feet (30 meters) of ¾ inch (20 mm) water line. If your building is 500 feet (150 meters) long and has two water lines you should make up a minimum of 100 gallons (370 liters) of cleaning solution.

Water lines should be designed so that they can be opened to drain completely when the cleaning is complete.

Follow these steps to clean the water lines:

- 1) Open water lines and drain completely.
- 2) Begin pumping the cleaner through the water lines.
- 3) Watch the water as it leaves the drain line for signs of the product such as foaming or suds.
- 4) Once water lines are filled with the cleaner, close the tap and leave product in the lines for as long as the manufacturer recommends (over 24 hours if possible).
- 5) Additionally, it is recommended that all regulators be taken apart and cleaned at this point.
- 6) Flush cleaner from the water lines after the holding period. Water used to flush the lines should contain the level of sanitizer normally used in the drinking water.

In the absence of a standard water sanitation program add 4 ounces of 5% bleach per gallon (32 ml / liter) of stock solution and proportion at a rate of 1 ounce per gallon of water (0.8% or 1:128). This will provide approximately 3–5 ppm of free chlorine in the final rinse water.

- 7) Water lines from the source to the turkey barns should also be cleaned and sanitized between flocks. Do not flush the outside water lines through the water lines inside the buildings. Connect a water hose to the medicator faucet to drain the outside lines

Remove Mineral Build-up

After lines are cleaned, use a descaler or acid product to remove the mineral build-up. Use product according to the manufacturer's recommendation. Citric acid is one option:

- 1) Make a stock solution by mixing 4 – 6 packs of citric acid in one gallon of water. Proportion at one ounce per gallon (0.8% or 1:128). Fill water lines and let stand for 24 hours. It is critical that the water pH is below 5 for optimum scale removal.
- 2) Empty the water lines. Then refill the lines with clean water containing 8-12 ounces of 5% bleach per gallon (64-95 ml / liter) of stock solution proportioned at one ounce per gallon (0.8% or 1:128). Leave in the water lines for four hours. This concentration of chlorine will kill any residual bacteria, and further remove bio-film residue.
- 3) Perform a final flush of the water lines using water with a normal drinking water level of sanitizer (4 to 6 ounces of 5% bleach per gallon (32 – 48 ml / liter) of stock solution proportioned at one ounce per gallon). Continue flushing until chlorine smell is gone. Test the water in the lines to make sure it contains no more than 5 ppm of free chlorine.

Keep the System Clean

Once the system has been cleaned, it is important to keep it sanitized. Develop a good daily water sanitation program for your birds. The ideal water line sanitation program should include optimizing sanitizer residual which requires injecting an acid if chlorine is used. It is important to note that the procedure requires two injectors since acids and bleach should **never** be mixed in the same stock solution.

If only one proportioner or injector is available, then inject bleach (concentration of 5%) at a rate of 4 to 6 ounces per gallon (32 – 48 ml / liter) stock solution; proportion at 1 ounce of stock solution per gallon of drinking water.

The objective is to provide a clean source of drinking water with a continuous level of sanitizer (3-5 ppm of free chlorine) at the last drinker without over sanitizing the drinkers at the front of the barn.

Water Sanitation

Utilization of sanitizers approved for use in the drinking water of food animals provides protection from pathogens that may be naturally occurring in water sources or which get seeded into water systems by sick birds and other vectors. By maintaining residual levels appropriate for the different types of sanitizers commonly used, many operations can effectively limit disease challenges.

Chlorine is the most popular sanitizer because it is inexpensive to use and widely available. The three most commonly used forms are gas chlorine, sodium hypochlorite (liquid bleach) and calcium hypochlorite (dry or tablet form). Chlorine is most effective in the hypochlorous form which is the most prevalent when the pH is between 4 and 7. Therefore, optimal sanitation with chlorine typically requires additional injection with an acid.

Other commonly used water sanitizers are chlorine dioxide, iodine and hydrogen peroxide (*See Table 5, page 29*).



Table 5. Commonly Used Water Sanitizers

Sanitizer	Common Forms	Target Residual	Comments
Chlorine	Gas-(Cl ₂) Sodium hypochlorite (NaOCl) Calcium Hypochlorite (Ca(OCl) ₂)	3-5 ppm free chlorine	Chlorine is most effective when water pH is adjusted to 5-7. Effective in oxidizing manganese, iron and sulfur. Some pathogens are resistant to chlorine. Inexpensive
Chlorine Dioxide	Generated by reacting liquid sodium chlorite with an acid	0.8-2.0 ppm Per product recommendations	Effective against chlorine resistant pathogens and effective over a wide pH range (5-9). Also effective in oxidizing iron and manganese. Expensive
Iodine	Sodium Iodate-NaIO ₃	1-2 ppm	Not as effective as chlorine as a virucide. More effective at pH neutral to slightly basic. Expensive
Hydrogen Peroxide	H ₂ O ₂	25-50 ppm	Not as effective in oxidizing iron and manganese. Stabilized products provide residual longer than non-stabilized forms. Expensive
Ozone	O ₃		Unstable so must be generated at point of use. No residual. Very effective germicide and virucide. Must filter water post-ozonation. Expensive

Additional Considerations:

Drinker valves and pipes may become blocked if the water is hard and contains high levels of calcium salts or iron. If sediment blocks the pipes, filter the supply with a mesh of 40–50 microns.

Do not use acid as the sole method of water treatment since acids alone can cause bacterial or fungal growth in water systems.

When administering other products to your birds it is a good idea to stop the inclusion of chlorine (and other sanitizers) in the drinking water. Chlorine will inactivate vaccines, and reduce the effectiveness of some medications. Resume use of chlorine and/or other sanitizers after treatment is finished.



Aviagen Turkeys thanks Dr. Susan Watkins from the University of Arkansas for her contribution to this chapter and for her work with the turkey industry on developing water sanitation programs.

Post Mortem Examination

The objective of post mortem examination in the field (field necropsy) is to provide information that can be combined with flock history and field observations to help to determine the causes of performance problems, clinical signs and mortality.

Field necropsy should be backed up with laboratory diagnostic investigations on tissue samples, serology and live/dead mortality specimens, especially if the field problem persists. The technique of turkey necropsy in the field can vary, but the following can serve as a general guideline.

Case History of the Flock

A key to identifying health problems is understanding the flock history. Accurate records are important and should include the following information:

- Age
- Flock size
- Morbidity (sick birds and mortality numbers)
- Principal clinical signs noted and duration of clinical signs
- Previous flock/farm history
- Management factors:
 - Feeding & water systems
 - Housing
 - Ventilation
 - Litter conditions
 - Vaccination/medication program
- Unusual management changes
- Last handling of birds
- Performance records (egg production and weight gains)
- Breeder flock source
- Feeding regime

Observe Clinical Signs of Disease

Monitor the flock and note any abnormal behavior such as:

Respiratory: Gasping, nasal discharge, snicking, swollen sinuses, mouth breathing, coughing, blood in mouth.

Digestive signs: Diarrhea, soiled vent, excessive chirping.

Nervous signs: Head and neck held in an abnormal manner, tremors, spasms, paralysis, circling motion.

Locomotive signs: Unable to stand or walk, limping, poor gait, inability to use one or both legs, lying on side, swollen foot pads and swollen joints.

Observe the Bird in Question

Examine the exterior surface of the bird and note the following:

General condition: Thin, good flesh, trauma, dehydrated.

Examine the head: Eyes, sinus, eye lids, oral cavity.

Examine the legs, hocks and note mobility: Palpate legs, joints and feet.

Examine the skin for external parasites, particularly beneath the vent: Lice and mites.

Post Mortem Examination

There are a number of procedures used. What is important is to make sure that one proceeds with the necropsy in an orderly fashion. This will reduce the chance of overlooking something.

Necropsy Equipment to Have on Hand

- Sharp knife
- Scissors (blunt point)
- Bone shears
- Forceps
- Disposable or rubber gloves
- Vacutainers or plastic tubes for blood collection
- Whirl packs for tissue samples
- 10% buffered formalin solution in a wide-mouth plastic container
- Sterile swabs for bacterial culture
- Disinfectant to clean and disinfect equipment

1. Euthanize the bird according to your company's approved welfare standards.

2. Place bird on its back. Incise the loose skin on the inside of each thigh. Grab the leg in one hand and holding the body with the other hand, pull the leg down and outward from the body until the hip joint is disarticulated.
3. Cut the skin across the lower abdomen. Pull the skin over the breast, sternum and crop. Examine the breast muscle and subcutaneous tissue for any abnormal appearances such as blisters, hemorrhage, dehydration (darkening of the muscle), etc.
4. Poults, 1-7 days of age: Fold both wings over the breast muscle and hold both with one hand. With the other hand, hold the neck and work the thumb down between the crop and breast muscle to the thoracic inlet.
5. Pull the wings and breast muscle back towards the tail with one hand while the other hand holds the neck with the thumb pushing down against the thoracic inlet and cervical vertebrae, separating the breast muscle and wings away from the back bone.
6. Poults can also be opened by cutting the clavicular and coracoid bones (the thoracic inlet, wish bone area) and then through the rib cage and abdominal wall. The bird should then be opened by pulling on the wings and neck separating the breast from the back bone.
7. Using bone shears, cut through the ribs and under the clavicle and coracoid bones (on older birds, two cuts can be made above the shoulder area down through the breast muscle to the shoulder joint). This will assist you when reflecting the keel.
8. For fresh dead, break down the adhesions between the heart and breast bone prior to lifting up on the keel bone.
9. Pull the keel forward to allow access to the internal organs. Examine liver, heart, gizzard, intestines and air sacs without touching them.
10. Take bacterial cultures (liver, pericardial sac) or tissue samples and the whole bird for virus isolation and additional investigations.
11. Hold the gizzard and pull, along with the intestines, to the bird's right side.
12. Examine the spleen and air sacs. Take bacterial cultures from spleen and/or air sacs, if necessary.
13. Remove the lungs and examine. Note the consistency and color. Make several transecting cuts over the lung and examine lung tissue.
14. Hold proventriculus, cut esophagus near proventriculus junction and then pull out the entire digestive system including liver, spleen and small intestines and lay small intestines out.
15. Examine liver, kidneys, pancreas, surface of the intestines and gonads.
16. Examine the stifle, hock joints and tendons.
17. Examine leg bones (tibiotarsus) for rigidity by bending and breaking the bone to check for nutritional deficiencies in young poults (rickets). A healthy bone should make a snap when it breaks.
18. Examine the tibia (growing birds) by cutting longitudinally on the medial inside surface through the epiphysis to examine for abnormalities (TD, osteomyelitis and others).
19. Examine costochondral junctions (ribs) for enlargements (beading).
20. Cut through the left lateral commissure of the mouth (use heavy scissors) and continue the incision through the skin and esophagus to the thoracic inlet and pull the skin laterally.
21. Examine oral cavity and organs of the neck region (thymus, thyroids and parathyroids).
22. Make a longitudinal cut through the larynx and trachea. Examine for blood, congestion, etc.
23. Examine esophagus and crop. Note any abnormalities in esophagus and crop such as crop mycosis (candidiasis), trichomoniasis or capillaria worms.
24. Make a lateral incision through the wall of the infraorbital sinus and examine for exudates, etc.

25. To examine the brain (poults), remove the skin on the skull. Then remove the skull bone by cutting the bone all the way around the periphery of the cranial cavity with heavy scissors or heavy bone shears. Lift the loosened portion of the bony skull with forceps or scissors.
26. Examine the digestive system by making a longitudinal cut through the proventriculus, gizzards, small intestines, cecum, colon and rectum.

27. Examine the intestines by making a longitudinal cut through the wall of the intestines continuing to cut in order to inspect the bird for worms

In order to make the best use of information derived from field post mortem examinations, field supervisors/ managers should routinely post the flock mortality to gain experience in detecting the normal from abnormal tissue/ organ conditions.

Appendix

Stocking Density

Age Weeks	Square Feet / Bird		Birds / Square Meter	
	Hens	Toms	Hens	Toms
0-6	1.0	1.0	11.0	11.0
7-12	2.0	2.0-2.5	5.5	4.0-4.5
13-16	2.3	2.5-3.0	5.0	3.0-3.5
17 to end	2.5	3.0-4.0	4.5	2.5-3.0

Daily Water Consumption based on 1,000 Turkeys

(weight, diet & health may affect consumption)

Age Weeks	Gallons			Liters		
	Up to 75°F	75 to 90°F	Over 90°F	Up to 75°F	75 to 90°	Over 90°F
	Up to 24°C	24 to 32°C	Over 32°C	Up to 24°C	Up to 32°C	Over 32°C
1	11	11	11	40	42	42
2	23	28	28	87	107	107
3	35	39	44	131	147	167
4	47	57	61	179	215	231
5	58	67	86	219	254	326
6	75	89	108	282	338	409
7	90	105	124	342	397	469
8	111	137	141	421	517	533
9	139	163	182	525	616	688
10	149	173	207	564	656	783
11	166	205	234	628	775	886
12	191	219	263	723	831	994
13	196	254	278	743	962	1053
14	205	261	295	775	990	1117
15	207	265	299	783	1002	1133
16	209	267	300	791	1010	1137
17	210	269	302	795	1018	1145
18	213	272	307	807	1029	1161
19	215	275	310	815	1041	1173
20	217	277	313	823	1049	1184
21	221	280	316	835	1061	1196

CONVERSION DATA

WEIGHT

1 ounce	=	28.35 grams
1 pound	=	16 ounces
1 pound	=	453.6 grams
1 pound	=	7,000 grains
1 ton (USA)	=	2,000 pounds
1 metric ton	=	2,204.62 pounds
1 long ton	=	2,240 pounds
1 kilogram	=	2.2046 pounds
1 gram	=	1,000 milligrams
1 milligram	=	1,000 micrograms
1 microgram/gram	=	1 part per million
1 bushel of wheat	=	61 pounds / 0.0272 metric tons
1 bushel of corn	=	56 pounds / 0.0254 metric tons
1 bushel of soybeans	=	60 pounds / 0.0272 metric tons

AREA

1 square foot	=	0.093 square meters
1 square meter	=	10.764 square feet
1 acre	=	43,560 square feet = 0.405 hectare
1 hectare	=	10,000 square meters = 2.471 acres
1 square mile	=	2.6 square kilometers

LENGTH

1 centimeter	=	0.3937 inches
1 meter	=	3.2808 feet
1 foot	=	0.3048 meters
1 kilometer	=	0.6214 mile
1 mile	=	5,280 feet
1 mile	=	1.609 kilometers

TEMPERATURE

°Fahrenheit	=	(°Celsius X 9/5) + 32
°Celsius	=	(°Fahrenheit - 32) X 5/9

FLUID MEASURE

1 fluid ounce	=	30 ml
1 pint (U.S.)	=	473 ml
1 quart (U.S.)	=	946 ml
1 liter	=	1,000 ml
1 liter	=	1.057 quarts (U.S.)
1 gallon (U.S.)	=	3.785 liters
1 part per million	=	0.0001%

VOLUME

1 ml	=	0.061 cubic inches
1 cubic meter	=	35.3145 cubic feet



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