HATCHERY

B.U.T.

Nicholas®

MANAGEMENT GUIDELINES FOR TURKEY HATCHERIES

Aviagen® Turkeys

Driving innovation, research and performance

INTRODUCTION

The aim of this booklet is to provide a comprehensive overview of the critical hatchery processes and procedures necessary to optimize both hatchability and poult quality.

The manual will begin with biosecurity and progress through to egg receiving/egg storage, incubation, hatching and poult selection. Sections will cover embryology and mechanical aspects of each process. Technical suggestions and advice will be given throughout the document.

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' Customer Support Team. For further information on raising turkeys, contact your local Management Specialist or Aviagen Turkeys directly.

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

BIOSECURITY

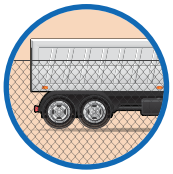
Biosecurity is a set of preventative measures designed to reduce the transmission of disease. There are three types of biosecurity that need to be considered; conceptual (location), structural (physical barriers), and operational (programs, protocols, and procedures). All three are required to successfully combat disease.

It is imperative that all hatcheries have a biosecurity plan in place that encompasses all three forms of biosecurity.

Conceptual – Although this parameter may be realized when hatcheries are initially constructed, this parameter may become very difficult to control as other industries and cities expand.

Structural – This parameter is one of the easiest parameters to control and consists of:

Maintaining a secure facility



- Secure hatchery with a perimeter fence.
- Keep gates and buildings locked at all times.

- Post signs to prevent entry by unauthorized visitors.
- Do not allow visitors inside the secured area without approval from the hatchery manager or company.

- Anyone entering the facility must adhere to all biosecurity procedures and sign the visitors' book or register, indicating the date, place of last livestock contact and contact details. This is to allow traceability of movements in the event of a disease outbreak.

- Connecting corridors between buildings can improve biosecurity.
- Regular monitoring and baiting of rodents and insects.

Proper hatchery set up and flow

- Air and traffic flow should go from the cleanest areas (egg receiving) to dirtiest areas (poult transport).

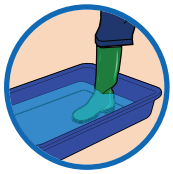
Operational – Relies on employees and personnel to make this parameter successful.

Hygiene procedures

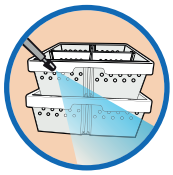
- The area prior to starting the on-hatchery hygiene procedures is considered dirty. The area after completing the hygiene procedures is considered clean.

- There should be a clear distinction between the dirty and clean areas when entering the hatchery, so personnel can easily identify this threshold.

- Anyone entering the hatchery must shower prior to entry and exit.
- Disinfect all items before entering the hatchery.



- Anyone entering the hatchery must shower and or change into specified clothing prior to entry and exit.
- Restrict the movement of people and equipment from dirty to clean areas, especially on hatch days.



- Disinfecting foot pans, hand wash stations, and use gloves and face masks.
- Disinfect all equipment and supplies that will be entering and leaving the facility.
- Disinfect egg trolleys and trays going back to the lay farms.
- Disinfection of delivery equipment coming back from brood farms, particularly poult boxes and dollies. Do not accept or allow used box pads/paper to be returned to the hatchery once used.
- Wash/sanitize areas between hatch days to reduce the risk of carry over.

Employees and visitors

- Anyone who will be entering the facility should avoid contact with other poultry, companion birds, pigs or other livestock where there may be a potential risk to the health of the birds. They should not visit live bird markets, livestock laboratories, processing plants, or similar facilities.
- Maintain traffic/visitor records.
- Restrict visitors into the facility.
- No-one should enter the hatchery if they have influenza, diarrhea or are otherwise feeling unwell.

Vehicles, equipment and facilities

- Permit only essential vehicles to enter the hatchery and ensure they are clean.
- Provide a vehicle disinfection area at the gate entering the facility. Thoroughly disinfect all equipment and tools entering the hatchery.
- All delivery vehicles and service personnel, irrespective of whether they enter the facility or not, must adhere to the relevant biosecurity procedures and sign the visitor register.
- Source biosecure supplies, such as cleaning and disinfecting supplies, poult box pads and tray pads.

ANIMAL WELFARE

It is essential that each company devises and adheres to a stringent Animal Welfare Program. A good basis for any Animal Welfare Program is the 'Five Freedoms' as defined by the National Turkey Federation (NTF). Although these 'freedoms' define ideal states, they provide a comprehensive framework for the assessment of animal welfare (see Table 1).

The "Five Freedoms" of animal welfare are:
Freedom from thirst and hunger
Freedom from discomfort
Freedom from pain, injury and disease
Freedom to express normal behavior
Freedom from fear and distress
In practice the 5 Freedoms are implemented by striving to ensure the following:
Caring and responsible planning and management
Skilled, knowledgeable and conscientious stockmanship
Appropriate environmental design
Considerate handling and transport
Humane killing/slaughter

Table 1. Animal welfare

Welfare Legislation and Codes of Practice (COP's)

Not only do we have a moral obligation to welfare, many countries also have sector codes or a legal obligation. Be aware of local legislations and codes.

Specifically with regards to hatchery operations:

Environment control

Areas of the hatchery used for poult holding should be environmentally controlled, with regard to temperature and humidity to maximize poult comfort.

Biosecurity

Biosecurity and cleaning & disinfection procedures should be adhered to at all times to reduce the likelihood of poults being exposed to harmful infections.

Incubators and hatchers

The incubators and hatchers should be maintained, operated, and monitored in a manner that optimizes hatchability and poult quality.

Culling/killing of poults

Poults being culled should be treated with care at all times. Only approved culling methods should be used. The personnel carrying this out must be appropriately trained and all equipment maintained and checked routinely to ensure proper functioning.

Back-up systems and alarms

The hatchery should be equipped with an automatic stand-by generator.

The hatchery should be equipped with alarms to notify the maintenance team of a problem in an incubator or hatcher.

Processes should be in place to routinely test generators and alarms.

Emergency response plan/emergency contacts

Have an up to date emergency response plan and emergency contact list for natural disasters and/or fires posted in the facility, on file, and available to employees.

MANAGING EGGS PRIOR TO SETTING

Egg receiving

Poult quality is directly correlated to egg quality. Therefore, it is critical that all eggs received into the hatchery are inspected to ensure they are of acceptable hatching egg quality (see Figure 1 for good quality hatching eggs). A routine auditing process is highly recommended, as is constant communication between the hatchery and breeder farms with regards to egg quality.

Figure 1. Good quality hatching eggs

Although not ideal, eggs with minor defects may be set, but they are at an increased risk of contamination and reduced hatchability (see Figure 2).

Minor defects include:

- Blood on the shell
- Slightly dirty eggs
- Elongated eggs

- Rough/poor textured eggs
- White shelled eggs

Figure 2. Eggs with minor defects

All eggs with major defects should be rejected and not accepted for hatching. Ideally, eggs with major defects should not be delivered to the hatchery (see Figure 3).

Major defects include:

Figure 3. Eggs with major defects

Egg storage

Storage conditions

Eggs should be stored under the optimum conditions prior to incubation to optimize hatch and minimize losses. See Figure 4 for guidance on egg storage conditions. Note egg storage conditions should be adapted to the age of the eggs.

- The humidity in the egg storage area should be kept at ~65% relative humidity.
  - Make sure that humidification equipment does not wet the eggs.
- It is good practice to record storage temperature and humidity at least twice daily.
- Do not store eggs directly in front of heaters, coolers and/or humidifiers.
- The use of gentle air fans can improve the uniformity of the temperature and humidity in the storeroom.
- Care should be taken not to have fans blowing directly on to the eggs.
- Doors to cooler rooms / areas should be kept shut to minimize the amount of external air moving in and out of the room.

Storage length

- Eggs can be stored between 2–7 days with minimal effects on hatch.
- Extending egg storage beyond 7 days will result in a lower hatchability, the longer the storage the greater the impact.
- Eggs stored for more than 7 days should have longer incubation times.
- Hatching can be delayed due to longer egg storage. In this case, some poults may not emerge in time to be counted, and poult quality may suffer because the poults are too immature when they are placed.
- Eggs that have been stored for extended periods of time, 7 days or more, tend to have higher embryonic mortality. The embryos that survive tend to be slower to develop and slower to hatch.
- Ensure all eggs are correctly identified with the day of production so that the oldest eggs can be set before the freshest eggs.
- The age of a breeder flock affects the ability of eggs to withstand long egg storage. Eggs from young (<3 weeks) or old (>19 weeks) breeder flocks are less able to tolerate long egg storage and therefore the impact of storage on hatch is greater.

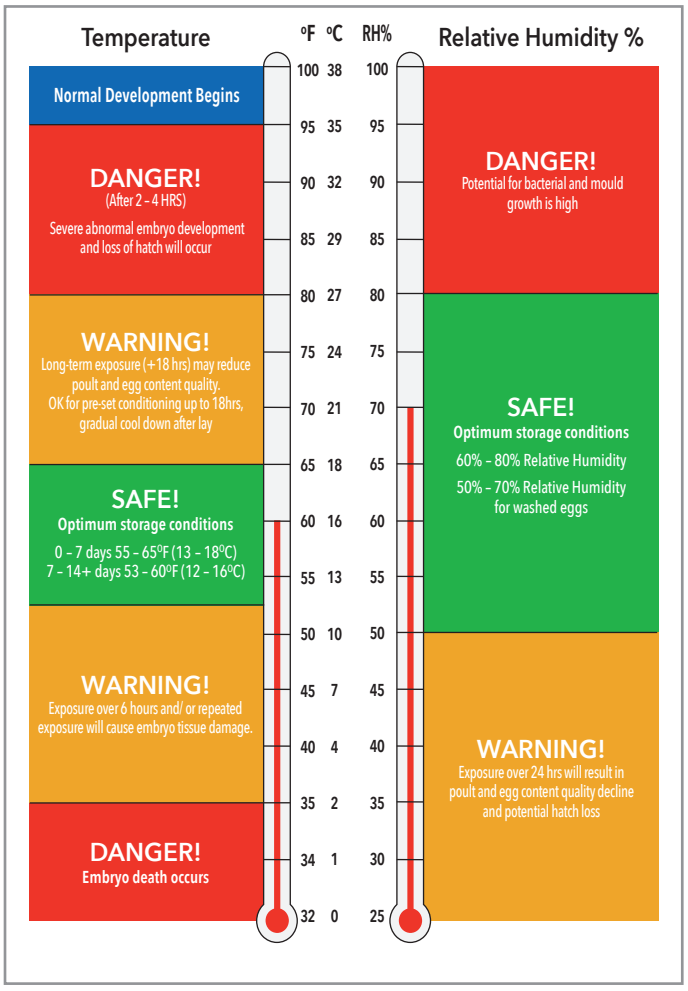


Figure 4. Hatching egg storage room recommendations

Extended storage procedures

Several techniques have been shown to improve the hatchability of eggs stored for more than 10 days. These precautions will not prevent a reduction in hatchability, but will simply slow down egg deterioration thus lessening the impact on hatchability and quality.

Storage interventions include:

- Reduced storage temperature.
- Storing the eggs under plastic covers (only once they are cooled).
- Flushing eggs with CO_2
- Turning the eggs during storage (see Figure 5).

Figure 5. Egg turning during storage

- Heating the eggs to 99.5°F (37.5°C) for 12 hours prior to storage (pre-storage incubation).
- Short Period of Incubation during Egg Storage (see our SPIDES management article) and has been found to be successful with turkey hatching eggs.

Preparing eggs for incubation – egg sets

Attention and planning must be taken when creating egg sets. Consideration with regards to the following must be done as individual incubation requirements will differ greatly:

- Breed.
- Week of Lay (WOL).
- Fertility.
- Equipment type.
- Machine capability or shortcomings.
- Egg Age.

When measuring egg moisture loss or poult yield, eggs need to be weighed at set. Refer to **The procedure for measuring moisture loss** (see page 52) and **Measuring poult yield** (see page 67) for information and details.

Incubation times

Incubation times/length will vary by:

- Breed.
- Week of Lay (WOL).
  - Young (weeks 1–3) and older (weeks 16+) require longer incubation times than prime flocks (weeks 4–15).
- Days of storage.
  - Incubation time increases as the number of days in storage increases.
- Incubation environment.
  - Temperature.
    - Lower machine temperatures tend to reduce embryonic growth, thus lengthen incubation times.

Higher machine temperatures, up to a certain point, accelerate embryonic growth and therefore tend to shorten incubation time. If the temperature exceeds what is required for normal embryonic growth, optimal liveability conditions may reduce and/or physical abnormalities will begin to develop.

- Humidity.
  - Moisture loss impacts and to a certain extent dictates hatch timing.
  - Excessive moisture loss accelerates hatch.
  - Low moisture loss slows down the hatch.

- Season.
  - Eggs laid in the summer tend to require less time than those laid in the winter.
- Pre-warming profile.
  - Temperature and the length of pre-warm.

Pre-warming

- Pre-warming consists of moving the eggs out of cold storage in to a warmer environment, 72–77°F (22–25°C) prior to set.
- Required duration depends on room temperature, air movement, and size of the egg set.
- The higher the temperature, increased air flow, and smaller the egg set, the quicker the eggs will come up to temperature.
- The lower the temperature, slower the air flow, and larger the egg set the slower the eggs will come up to temperature.
- Internal egg temperatures must be taken when devising pre-warming programs.
- To ensure uniform pre-warming is occurring, egg temperatures should be measured from top to bottom as well as left to right on the rack.
- Length of pre-warm should be long enough for the internal egg core temperatures, as reflected by the eggshell temperature, to reach that of the machine/room warming area.
- Care should be taken not to heat up the egg set too quickly as this may cause condensation/sweating and lead to increased contamination and a larger hatch window.
- Pre-warming can be accomplished using a single stage incubator or a separate temperature controlled room.

Advantages	Disadvantages
Uniform start incubation that helps keep narrower hatcher window.	If the program is not designed or carried out correctly, it may: ● Accelerate the hatch. ● If the program is not designed or carried out correctly, it may accelerate the hatch, causing a wider hatch window and temperature variation within the egg set.
Reduced chilling effect on eggs in multistage systems.	Increase the amount of early dead embryos typically from: ● If pre-warm temperatures increase too quickly, or the pre-warm lasts too long and or slow, the amount of early dead embryos is likely to increase.
Limits the condensation on eggs during warm-up thus reducing the potential contamination issue.	

Table 2. Advantages and disadvantages of pre-warming eggs

Depending on the type of equipment, pre- warming profiles can be programmed directly into the incubators alongside the predetermined start times (see Figure 6).

Figure 6. Pre-warming profiles programmed into an incubator

INCUBATION

Single-stage incubation

- Single-stage incubation is the preferred method (see Figure 7 and Table 3).
- All eggs in the machine are at the same age/stage of embryonic development.
- Machines are filled at egg set and completely emptied at each transfer.

Figure 7. Single-stage incubator

Advantages	Disadvantages
Easy to fully clean and disinfect machines between sets.	More floor space needed in the hatchery.
The incubation environment and profile can be optimized through-out each stage of incubation to meet the specific requirements of the given eggs.	Higher energy costs.
Able to isolate flocks.	Increased management to maintain optimized profile.

Table 3. Advantages and disadvantages of single-stage incubation

Temperature

- Typically a single-stage temperature profile will start between 100–100.5°F (37.8–38.0°C) and begin to decline by the second week of incubation. Through incubation, the machine temperature will need to drop below 99°F (37.5°C) to compensate for the metabolic heat production of the developing embryos.
- A typical single-stage profile will gradually reduce the temperature so that by the time of transfer the machine is operating at between 98.5–99°F (36.9–37.2°C).
- The exact temperature profile used will depend on the temperature control characteristics of the machine, flock fertility, flock age and egg age. The objective should be to maintain eggshell temperature (see Figure 8).

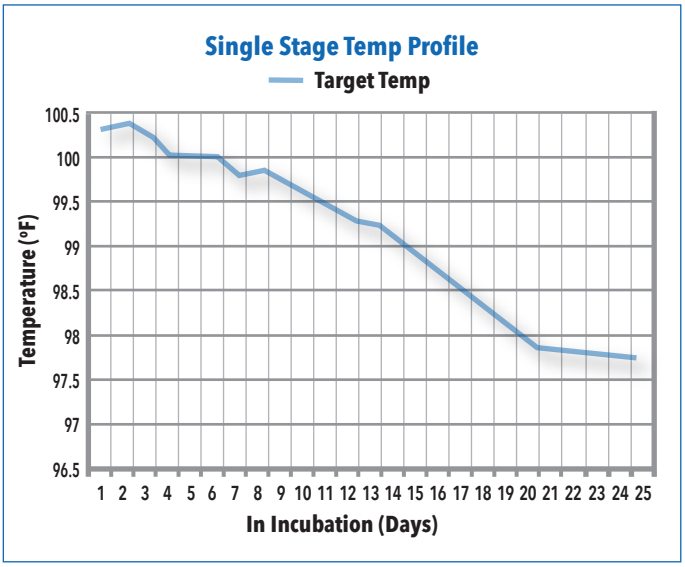


Figure 8. Example of a single-stage temperature profile

Humidity

- Multiple studies have shown that better results can be achieved when humidity is higher at the beginning of incubation and lower towards the end of incubation, as long as the adequate level of egg moisture loss is achieved at the time of transfer.
- Exact humidity set-points are based on targeted moisture loss for the given eggs.
- Humidification systems can cause localized cooling and result in large temperature variations within the machine. Therefore it can be beneficial to design a profile that minimizes the humidification demands.

Ventilation

- Ventilation in the single stage machines is necessary to supply oxygen (O_2) to the developing embryo and to remove carbon dioxide (CO_2).
- During the second half of incubation, ventilation may be used to supplement cooling.
- If ventilation is the only system used for cooling the incubator, then the cooling requirement rather than the oxygen requirement must determine the level of ventilation.
- The amount of ventilation required in the first 12 days of incubation is effectively zero. Therefore, the machine can be kept completely closed and CO_2 levels can reach up to 1% without any adverse impact on performance.
- Keeping the ventilation closed for the first 12 days will naturally raise the humidity and minimize the amount of heating and humidification required within the machine, thereby producing a more stable environment.
- However, if humidity levels reach the point where condensation begins to occur, the ventilation will need to be opened slightly prior to 12 days of incubation.
- Depending on the type of equipment used, it may be necessary to open up the ventilation prior to 12 days to achieve moisture loss targets. After day 12, the ventilation must be opened to provide sufficient O_2 and remove CO_2.
- The degree of ventilation should be set to maintain CO_2 levels optimally at 0.3% but must be below 0.8%.

Multi-stage incubation

- Multi-stage incubators operate continuously with eggs being set and transferred out once a week (see Table 4 and Figure 9).
- This system uses the heat generated from the embryonic development from eggs during the latter half of incubation to warm the eggs in the first stages of incubation.

Advantages	Disadvantages
Generally less space required. Lower operating costs.	Difficult to clean and disinfect due to continuous operation.
Simplicity of operation.	Difficult to conduct routine maintenance within the machines.
One set temperature and humidity target throughout incubation.	**Difficult to isolate flocks due to:** Disease. Contamination. Not able to optimize temperature and humidity set-points to meet the specific egg requirements.

Table 4. Advantages and disadvantages of multi-stage incubation

Figure 9. Multi-stage incubator

Incubation parameters

Temperature

- The exact temperature set point used will depend on the temperature control characteristics of the multi-stage machine, but the objective should be to maintain eggshell temperature.
- Typically multi-stage incubators operate at ~99.3–99.5°F (~37.4–37.5°C). However, if they are tunnel ventilated, they operate at a slightly cooler temperature, ~98.6–98.8°F (~37.0–37.1°C).

Humidity

- The basic incubator humidity requirements should be based on targeted egg moisture loss.
- Machine set points typically range from a relative humidity of 50–60% or a wet-bulb temperature of 81.5–86°F (27.5–30°C).

Ventilation

- Ventilation is necessary to supply oxygen (O_2) to the developing embryo and to remove carbon dioxide (CO_2).
  - Ventilation should be sufficient to keep the CO_2 level below 0.3%.
    - Care should be taken as to not over/under ventilate these machines as this will result in problems of temperature and humidity uniformity and control.
    - Air ventilation and humidification spray nozzles are typically the only cooling methods in the incubator, therefore the level of ventilation must be determined by the machine temperature control system.

Eggshell temperature management

- Correct incubation and eggshell temperatures are critical for the hatching of good quality poults.
- The temperature experienced by the embryo is **not equivalent** to the air temperature of the incubator.
  - It is the embryonic temperature that determines success.
- The difference between machine and embryo temperature depends primarily on the rate of heat transfer between the egg and incubator air (determined by airflow) and the amount of metabolic heat generated by the embryo (determined mainly by embryonic age and fertility).
- Eggshell surface temperatures are closely related to the internal egg/embryo temperature. It is therefore a useful non destructive tool for determining if the incubator temperature is correct.
- Optimum shell temperature for maximum hatch and poult quality is 100–100.5°F (37.8–38.1°C) throughout the incubation period (see Figure 10).
  - The minimum eggshell temperature should not be below 99.5°F (37.5°C).
  - The maximum eggshell temperature should not exceed 100.8°C (38.2°C).
  - The "at risk" temperature ranges depend on and vary with embryonic age (see Figure 10).

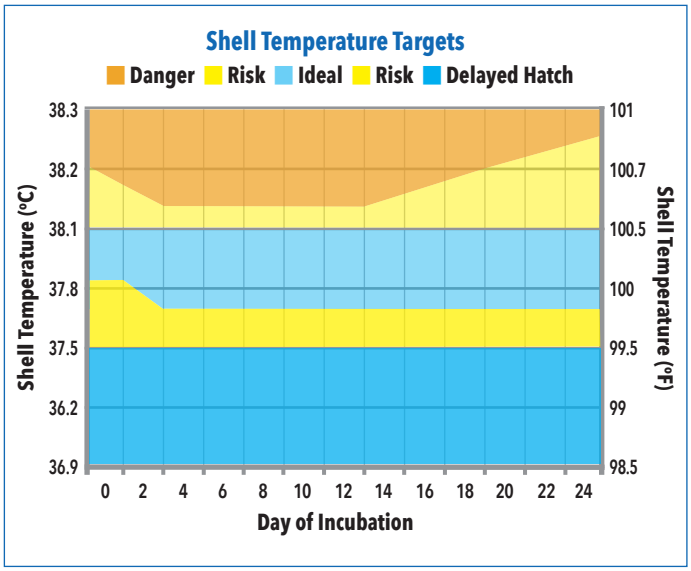


Figure 10. Eggshell temperature targets

In single-stage systems, optimal shell temperatures are achieved by adjusting the temperature profile for each age of incubation (see Figure 11).

In multi-stage systems, where only one temperature setting can be used, it may be necessary to compromise between the ideal requirements for the embryos at the beginning and end of incubation. For example, eggs at the start of incubation may need to be cooler than optimal to ensure that eggs at the end of incubation do not become too hot (see Figure 12).

Higher incubation temperatures are typically more damaging to the embryo than lower incubation temperatures.

Studies have shown that high incubation temperatures result in:

- Decreased level of embryonic liveability in the 16–24th day of incubation.
- Increased incidence of embryonic malposition, particularly upside-down.
- Increased incidence of eye cataracts, edematous heads, clubbed down, ruptured yolk sacs and residual albumen.

Low incubation temperatures tend to be associated with:

- Increased incidence of late hatching or live unhatched embryos.
- In most cases, there will be some egg-to-egg temperature variation so the objective is to get as many eggs as possible within the targeted range.

- Note that infertile and early dead germ eggs will have a lower temperature after day 12 of incubation, as these eggs are not generating any metabolic heat. This should be considered when checking temperatures.
- Eggshell temperatures can also be used to measure incubator temperature variations.
  - A wide spread of eggshell temperatures across one machine may indicate that maintenance is required.

Single stage vs. multi stage system eggshell temperatures

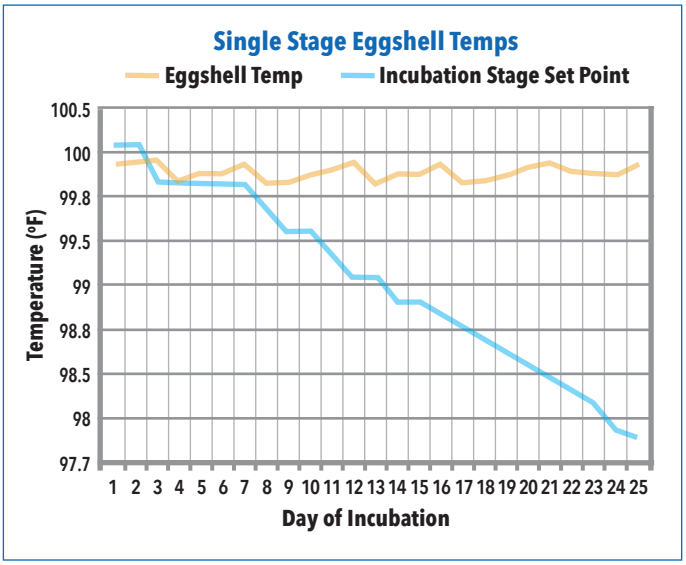


Figure 11. Single-stage incubation eggshell temperatures

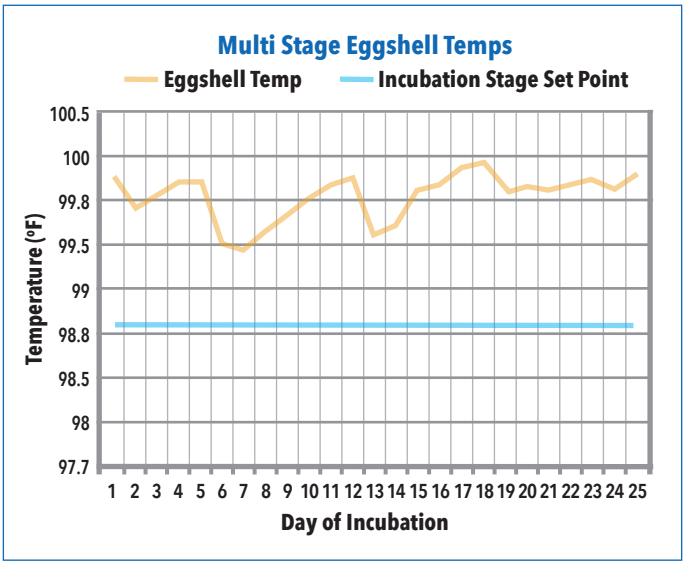


Figure 12. Multi-stage incubation eggshell temperatures

Measuring eggshell temperatures

Procedure for using the Braun thermometer

In incubators that are easy to work safely inside while the machine is still operating, eggshell temperature can be measured using a Braun ThermoScan® ExacTemp ear thermometer, or equivalent.

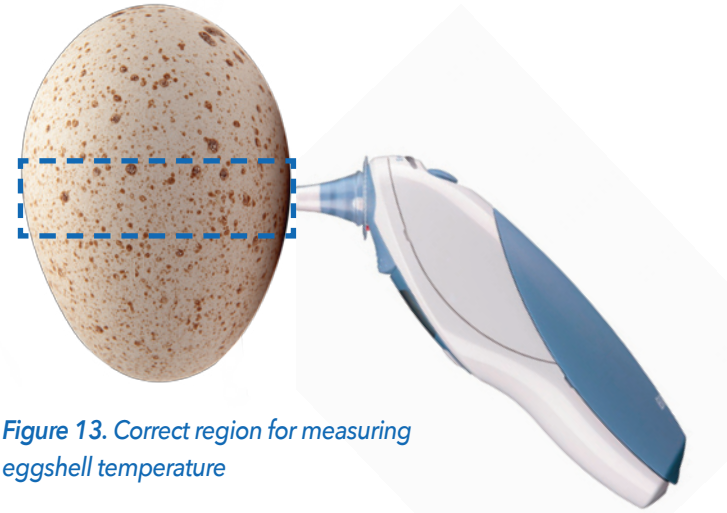


Figure 13. Correct region for measuring eggshell temperature

Step 1:
Check to make sure that the measuring tip of the thermometer is clean and that it has a new plastic cover on. (Some thermometer types may need to be at incubation temperature for 30 minutes prior to use to be accurate).

Step 2:
Before opening the incubator door, have a plan of where to sample eggshell temperatures so that you can work quickly once inside. Ensure each area of the incubator is monitored.

Step 3:
If it is not possible to work inside the setter safely while it is operating, turn it off and measure as many eggs as possible in 10 minutes or less. If it is not possible to measure eggs at all locations within 10 minutes, close and restart the machine and return after 30 minutes to complete the measurements.

Step 4:
The eggshell temperature must be measured where the embryo is located, avoid measuring at the air-cell at the top of the egg. The correct region for measuring shell temperature is at the equator of the egg (see Figure 13). Make sure the tip of the thermometer is flat against the eggshell surface.

Step 5:
Sample 3 eggs from the center of each setter tray. For eggs in the second half of incubation, reject any measurement that is significantly cooler > 0.7°F (> 0.4°C) than the other eggs on that tray, as it is likely indicates that there is no viable embryo present.

Step 6:
Record results to determine average eggshell temperature and spread of eggshell temperatures.

Step 7:
Compare results against the acceptable parameters to determine if the incubation temperature and/or profile are correct or if further investigation is needed.

Procedure for using data loggers

When it is difficult to access eggs in various locations once the incubators are running or additional data is desired, eggshell temperatures can be checked using a data logger with an external probe. (Tiny Tag Talk 2, Model: TK-4023, or equivalent) These loggers can record eggshell temperatures over time and to provide a more detailed representation of what is occurring inside the incubator.

Step 1:
Ensure that all data logger probes are reading accurately and uniformly before each use.

Step 2:
Following the manufacturer's instructions, program the data loggers to record temperature hourly.

Step 3:
Identify an egg toward the center of the incubator tray to be monitored. This can be done prior to egg set and or at any point during incubation.

Step 4:
Covering the entire metal tip, tape the tip of the data logger probe to the surface of the egg along the outer surface. Use quality tape so that the probe stays in place during incubation but do not use an excessive amount as to interfere with gas exchange (see Figure 14).

Figure 14. Correct attachment of data logger to the shell

Step 5:
Replace the egg and attach the logger to the incubator tray.

Step 6:
Allow the logger to record temperatures over a period of at least one day.

Step 7:
Download data from logger and graph/analyze the results.

Step 8:
Compare information acquired against the acceptable parameters to determine if the incubation temperature and or profile are correct.

Incubator locations for measuring eggshell temperatures

The objective is to sample eggs within the machine from the various locations in the incubator: left and right, front, back and top, middle and bottom. The exact location will vary based on machine design but one should attempt to cover all of the areas.

Choose eggs in the center of the incubator tray to monitor; those at the edges of the tray will be cooler (see Figure 15).

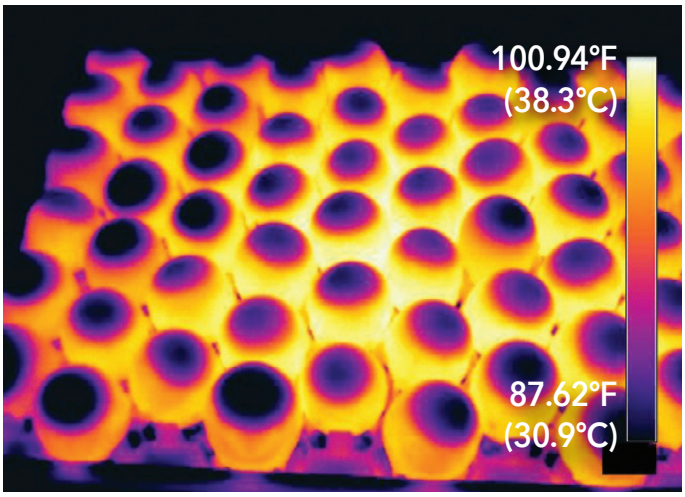


Figure 15. Thermal image of eggs on an incubator tray

Note: *The air cells are much cooler than the rest of the eggs and temperature of the eggs located near the edge of the tray are cooler then the those eggs located in the center of the tray.*

For a comprehensive analysis and understanding, eggs need to be monitored at each stage of incubation.

Interpreting results

- The measurement of eggshell temperature should be used to establish machine temperature profile to optimize conditions for differences in embryo heat production and machine design.

- **Eggshell temperatures should not be used for calibrating incubators!**
- Investigate temperatures that are out of range:
  - Candle the egg to ensure that it contains a viable embryo.
  - Take additional eggshell temperatures from the surrounding eggs to ensure the temperature taken was accurate.
  - If still out of range, compare to temperatures taken on eggs of similar development in the machine to verify whether it is a set-point or localized issue in the machine.
  - Conduct a thorough maintenance check of the machine and make necessary adjustments or repairs.

Procedure for measuring incubator temperature variation

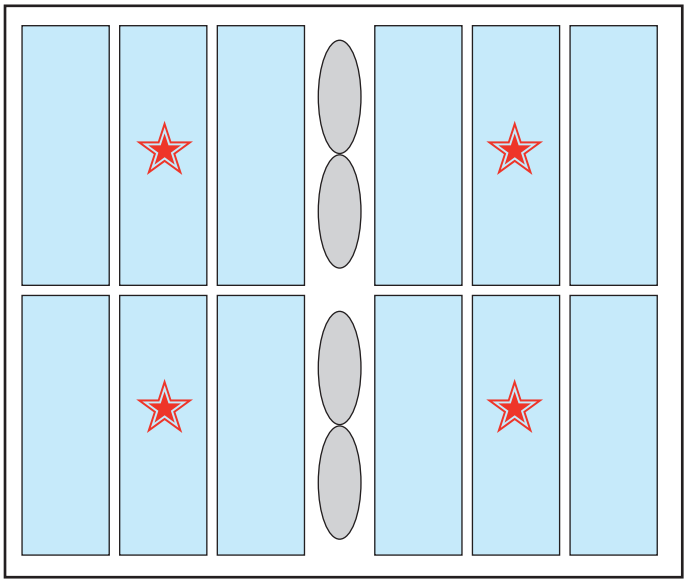
Incubator air temperature variation can be monitored by measuring the shell temperature of eggs that have little or no embryonic heat production (infertile eggs or eggs incubated between 2–7 days) across various locations within the incubator.

- It is important to use the same methodology every time.
- Make sure that test thermometers are properly calibrated and the same equipment is used to measure temperature in all incubators.
- Only test incubators that are fully loaded with eggs and that have balanced sets.
- Allow the machine to stabilize for approximately one day post set and/or transfer before taking temperatures.
- The frequency of testing should depend on how often problems are found.
  - If problems are often identified, incubator checks should be more frequent.
  - At a minimum, check incubators every 3 months; if more than 10% of setters have excessive temperature variation then increase the frequency of checks.

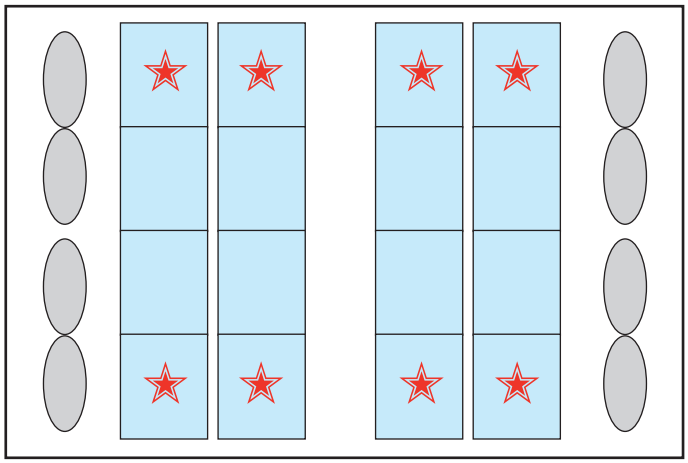
Where to monitor for temperature variation

- The best location to measure temperature variation depends on incubator type/design.
- The locations chosen should cover the different areas of the setter.
- In smaller incubators, 4 different areas of the setter should be monitored.
- In larger incubators, with multiple control zones, each zone should be monitored in at least two locations.
- In single-stage incubators, shell temperatures should be checked between 2–7 days of incubation before the developing embryo becomes exothermic.
- The following diagrams illustrate suggested locations for monitoring temperature (see Figure 16 for single-stage and Figure 17 for multi-stage).

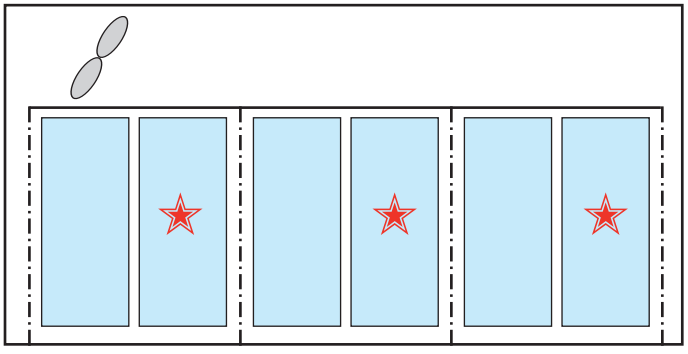
Single-stage trolley with vertical central fans



Single-stage trolley walk-in



Single-stage laminar flow cabinet



Single-stage with horizontal ventilation fans

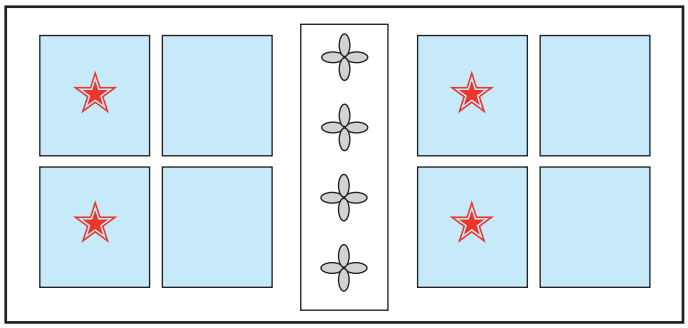
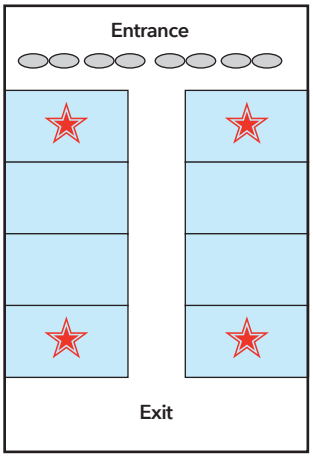


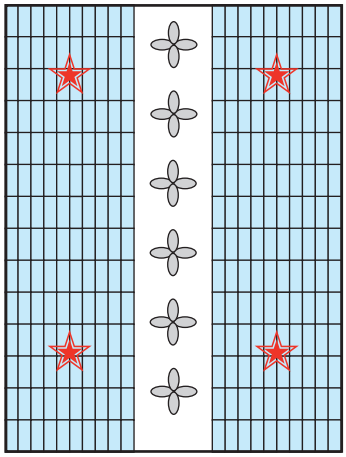
Figure 16. *Suggested locations for temperature monitoring in single-stage incubators*

All Single Stage eggshell temperatures should be within ± 0.2°F (± 0.1°C) of setter operating temperature and recorded from eggs between 2–7 days of incubation.

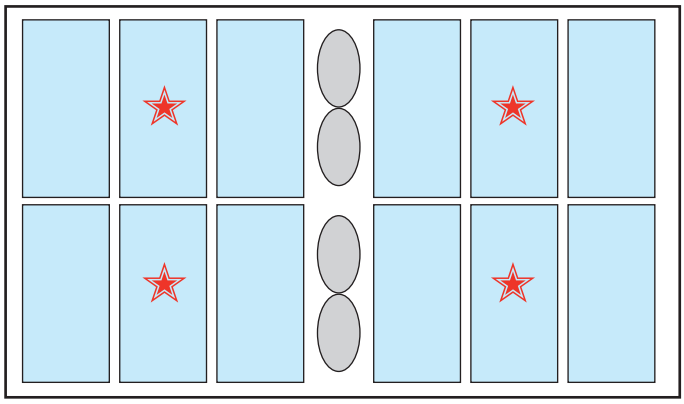
Multi-stage tunnel



Multi-stage fixed rack walk-in



Multi-stage trolley cabinet



Multi-stage trolley walk-in

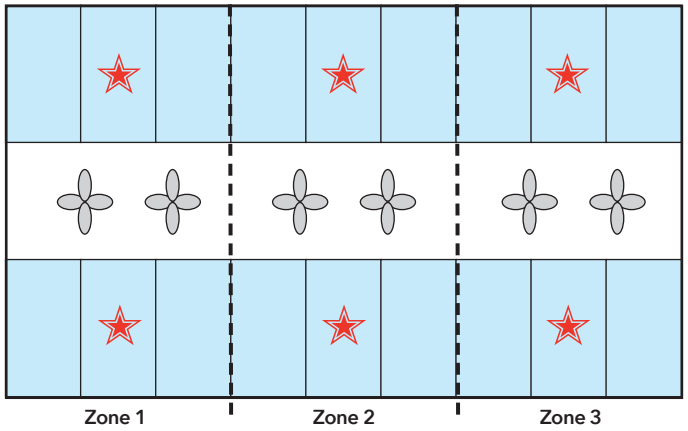


Figure 17. Suggested locations for temperature monitoring in multi-stage incubators

Interpreting results

- Eggshell temperatures will vary slightly based on flock age.
- Eggshell conductance affects eggshell temperatures.
- Excessive temperature variation within and between incubators or those outside the acceptable range may indicate that the machine is not functioning properly.
- Complete a thorough maintenance check on the incubator/ incubators including calibration.
- Make necessary adjustments and changes.
- Recheck the eggshell temperatures to evaluate if changes were adequate.

Causes of incubator temperature variations

- Humidity spray wetting eggs and/or floors.
- Blocked humidity nozzles.
- Temperature sensors out of calibration.
- Humidity sensors out of calibration.
- Incorrect ventilation fan speeds.
- Water cooling or heating solenoids stuck open.
- Incorrect chiller temperatures.
- Excessive cooling resulting in condensation (see Figure 18).
- Malfunctioning heat source.
- Too much cold air entering the incubator.
- Ventilation dampers not working correctly.

- Racks not properly positioned in the machine.
- After completing maintenance and calibration, re-check shell temperatures to ensure that all locations are within normal range.
- Keep records of results and any maintenance and or changes.

– Routine monitoring of temperature variation within and between incubators is a powerful tool when used as part of a hatchery maintenance program.

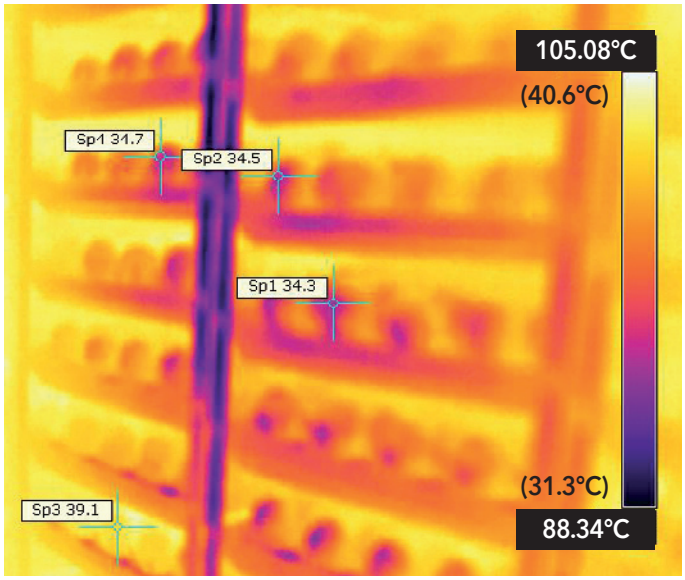


Figure 18. *Thermal camera image of eggs chilled by faulty humidity nozzles*

Turning eggs

Egg turning is required for normal embryo development such as:

- Promoting the formation of the chorio-allantoic membrane and sub-embryonic fluid.
- Preventing embryo adhesions to the shell.
- Stimulating heartbeat.

Eggs need to be turned routinely from day 0–21; if eggs are left unturned, or the turning angle is too shallow, embryo liveability will be decreased and hatchability reduced.

Depending on the equipment, turning may provide a critical role to directing and redirecting airflow throughout the incubator and help prevent and/or minimize hot spots from developing.

Factors important for turning

- **Angle** – egg should be turned ~42–45 degrees from the horizontal at each turn. A decrease in hatchability will occur if the turning angle is less than 38 degrees.
- **Frequency** – eggs should be turned at a minimum of once an hour.
- **Smoothness** – the turning process must be smooth as the embryo has very delicate blood vessels that easily rupture when the egg is jarred or shaken.

Signs of turning inadequacy

- Decreased early embryonic liveability (if turning is insufficient in days 0–7 of incubation).
- Decreased late embryo liveability (see Figure 19).
- Increased frequency of malpositions, particularly those that are upside down.
- Residual albumen in the hatch residue breakout.
- Sticky poults due to unabsorbed albumen (see Figure 20).

Figure 19. *Turning inadequacy can reduce late embryonic viability*

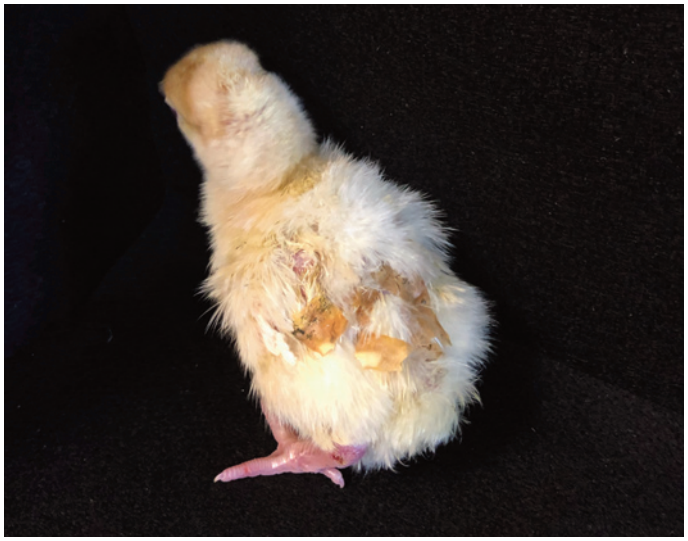


Figure 20. *Hatched poult with a sticky residue on feathers*

Checking turning angles

- Visually check the turning angle in loaded machines regularly.
  - Turning angles tend to drift and are difficult to spot unless regularly measured and noted.
    - Investigate all racks that do not appear to be at the proper angle.
    - **If in doubt, check it out!**
- Rack inspections can be done in the egg store prior to set.
  - Turning the eggs, regardless of storage time, is helpful in identifying rack issues prior to set and thus helpful in minimizing turning issues during incubation.
- To measure exact angle or to investigate issues the following procedure can be used:
  - Use a plastic template, angle meter, or digital angle gauge (see Figures 21a and 21b)
  - Check the middle tray in each incubator rack.
    - The angle of the plastic egg tray may differ from that of the metal rail, to make sure the angle being measured reflects what the egg is experiencing.
- Using the incubators turning mechanism, move the trays from one extreme to the other. Check the turn angle in both directions.
  - Do not move the trays by hand!
  - Document turning angle issues and include:
    - Date.
    - Incubator.
    - Position or Rack Number.
    - Angle measured.
    - Both directions.
    - Any actions taken.

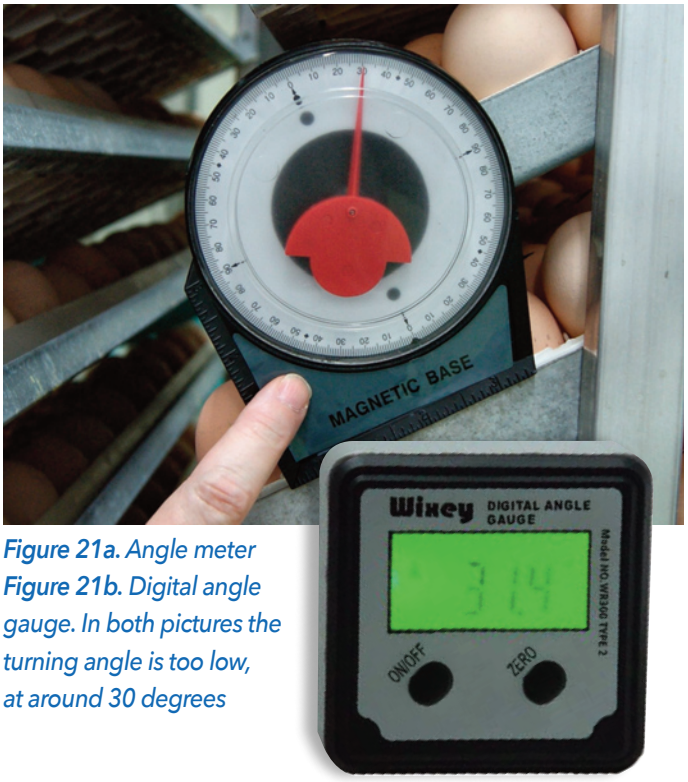


Figure 21a. Angle meter
Figure 21b. Digital angle gauge. In both pictures the turning angle is too low, at around 30 degrees

Troubleshooting – incorrect turning angle

If the turning angle is less than 42 degrees, which is too low, possible causes include;

- Bent turning bars.
- Wear and/or distortion of turning mechanism.
- Low air pressure in compressed air driven turning mechanism.
- Modifications to the machine which do not allow enough space to allow for the correct turning angle.

Checking turning frequency

- Always watch the first full turn after a machine is started up and note whether or not the turning mechanism is operating smoothly and covering turning full in both directions.
- All racks/trolleys must be visually checked at least twice a day.
- The time between checks must be consistent and should be an odd number of hours to ensure that the direction of turn alternates from left to right on successive checks.
- The direction in which the trays are tilted should be logged.
  - See **Example of a maintenance checklist** (Figure 70, page 102).

Troubleshooting – lack of turning

If sequential visual inspections do not show any change in the position of the egg trays the turning mechanism should be activated immediately to check that it is working correctly. If the eggs still do not turn it could be due to:

- Rack is not properly engaged with turning mechanism.
- Rack wheels worn leading to a misalignment with mechanism.
- Turning sensor failure.
- Software failure or incorrect programming.
- No air or power to turning mechanism.
- Faulty turning mechanism.

MEASURING FERTILITY AND EMBRYONIC LIVEABILITY

Measuring the level of egg fertility and embryonic liveability is an important task for several reasons:

- To determine whether hatchability issues are due to poor fertility or embryonic liveability.
- To monitor performance of the artificial insemination crew on the farm and allow remedial action to take place when fertility declines.
- To monitor egg handling, storage or incubation conditions and help focus investigative actions.
- If fertility is low (< 90%), removing the infertile eggs from the incubator may reduce the cool spots in the machine.

Fertility

- Flock fertility depends on the management of the males and females on the breeder farm.
- True fertility cannot be affected by egg handling, egg storage or incubation conditions.

Embryonic liveability

- Eggs identified as clear at candling may not be infertile and may contain embryos that died at a very early stage.
- The candling lamp is not normally able to distinguish between infertile and embryos that have died during the first 2–3 days of incubation.
- Typically in a good hatching flock, one-third of "clear" eggs are found to contain very early dead embryos when opened and examined closer. If fertility is a problem, then the proportion of infertile in the "clear" eggs will increase and the opposite is true if there is an early embryonic mortality problem.
- The action required to correct poor fertility is not the same as that required to correct excess early mortality, therefore it is important to distinguish between infertility and early mortality.
- Fertility testing is normally carried out at 10–14 days of incubation although sometimes it is carried out at transfer. For accurate results, a minimum of 10% of the eggs should be checked for fertility per flock.

Advantages	Disadvantages
Fertility problems are quickly identified and allows action to be taken on the farm sooner, thus minimizing the overall impact. Allows for time to make profile adjustments in the incubators to compensate for the decreased heat production.	It adds an extra handling procedure in the hatchery.

Table 5. Advantages and disadvantages of measuring fertility

Assessing flock fertility using egg candling

- Shine a strong light (candling) through the egg between 10–14 days of incubation.
  - An infertile egg will be seen as luminescent or clear when candled (see Figure 22).
  - A fertile egg containing a viable embryo will appear dark with noticeable blood vessels near the air cell (see Figure 25).
  - With some candling systems it is possible to detect embryos that have died in the first few days of incubation. Early embryonic mortality can be identified by the lack of structured blood vessels near the air cell (see Figures 23 and 24).
    - An early dead egg is one which has been fertilized but the developing embryo died in the first week of incubation.
    - After an embryo dies it will deteriorate over time, therefore the longer eggs are incubated, the more difficult it becomes to distinguish early dead from infertile.

- Examine and record cracked, rot, or misplaced air-cells (see Figures 26 and 28).
  - Since a clear egg may be infertile or contain an embryo that has died during the first few days of incubation, they must be broken open and examined to accurately identify.
  - In some multi-stage systems eggs are candled at 7 days, prior to being moved into the next stage in preparation for the next set.
  - Time and care must be taken when assessing fertility at this early stage of incubation as the infertile, early dead, and viable embryos are more difficult to differentiate.
  - Several manufacturers make equipment for candling that range from hand-held lamps for testing each egg individually to fully automated machines for testing entire egg trays at a time.

Figure 22. Infertile

Figure 23. Early dead

Figure 24. Early dead

Figure 25. Viable embryo

Egg candling

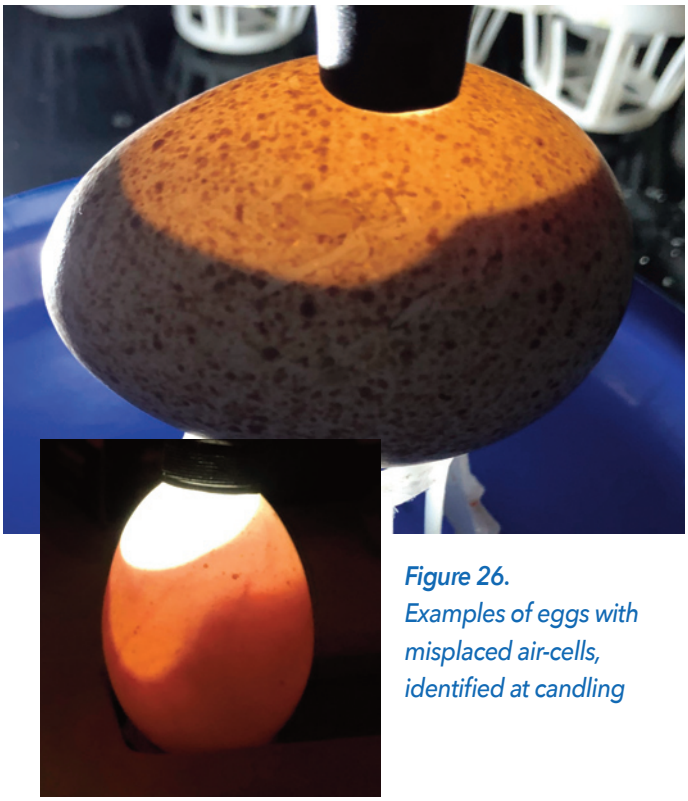


Figure 26. Examples of eggs with misplaced air-cells, identified at candling

Procedure for identifying infertile eggs from early dead embryos

- Remove the clear eggs candled between 10–14 days of incubation.
- It is not advisable to try and assess fertility on eggs candled any later than 14 days.
- It becomes difficult to distinguish infertile eggs from those with very early embryonic development due to the post-mortem degeneration.

Step 1:
Candle a minimum of three incubator trays per flock, between 10–14 days of incubation.

Step 2:
Remove and hold the clears, keeping them separate by flock and incubator tray.

Step 3:
Open the eggs with forceps at the air cell, taking care when removing the membrane that no egg contents are damaged or removed.

Step 4:
Identify fertility or stage of development, using figure 27. Record the results in the candling break-out worksheets (see Figure 29).

Early embryonic development and mortality

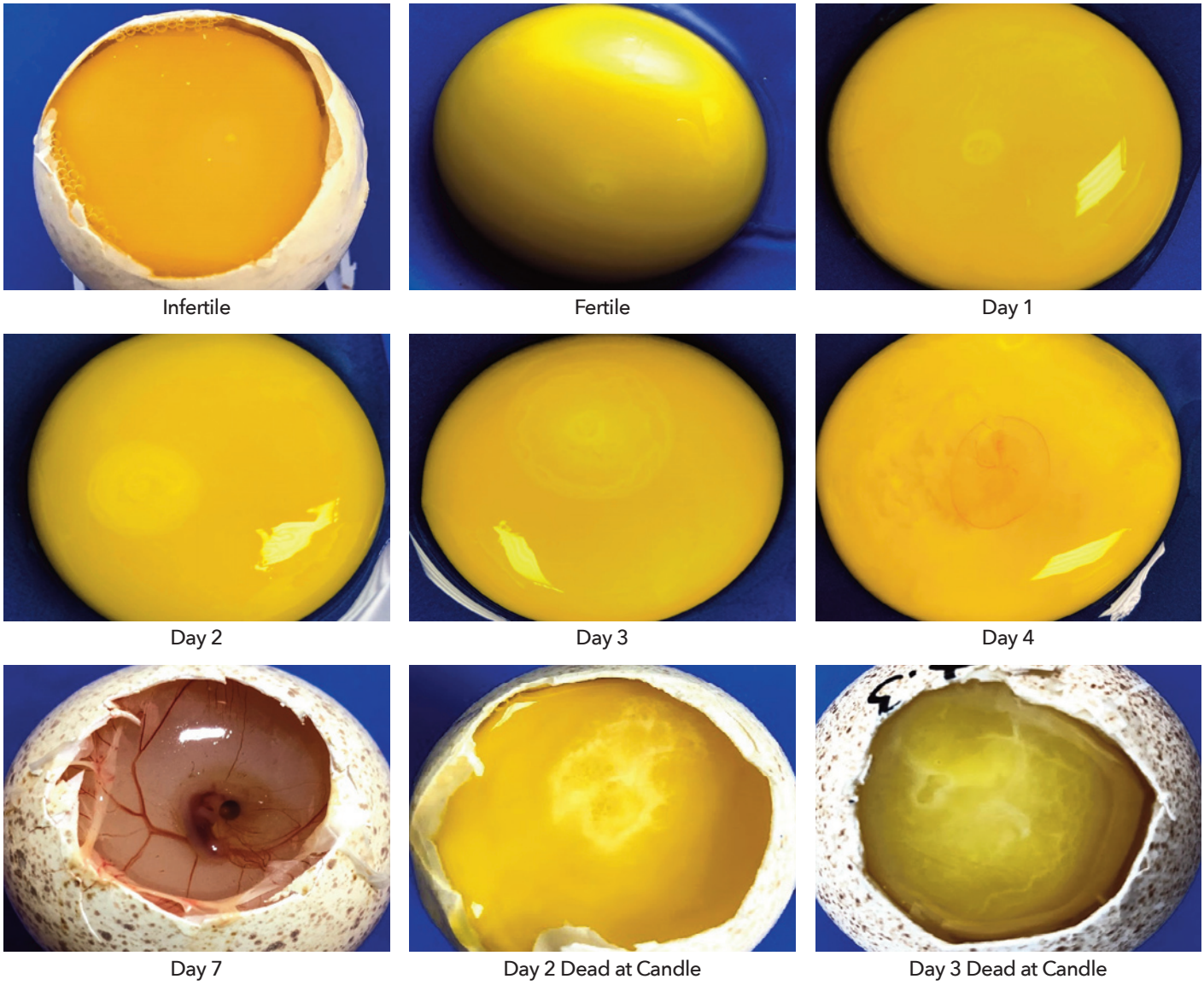


Figure 27. Early embryonic development and mortality

Example of egg candling worksheet

Date:			Set Date:			Hatch Date:		
Farm	**Incubator Number**	**Rack Number**	**Number of Eggs Candled**	**Clear**	**Early Dead**	**Cracked**	**Misplaced Air Cell**	**Rot**

Figure 28. Example of egg candling worksheet

Example of egg candling breakout worksheet

Date:			Set Date:			Hatch Date:		
Farm	**Incubator Number**	**Rack Number**	**Number of Eggs Sampled**	**Infertile**	**Days in Cycle (DIC) 1–2**	**Days in Cycle (DIC) 3–4**	**Days in Cycle (DIC) 5–6**	**Days in Cycle (DIC) 7–10**

Figure 29. Example of egg candling breakout worksheet

- Analyze results and compare within the flock, machine, and what was expected.
- Investigate outliers.
- Refer to table 6 for the **Candle breakout troubleshooting guide**.

Note: *It is very important that accurate records of egg candling and candling breakout data are kept and that laying farms are quickly informed of the results.*

Interpreting the results

Observation	Potential Causes
Infertile	Males or females older in age. Males or females under/over weight. Improper semen collection and handling. Improper insemination techniques. Nutrition. Drugs/toxins in feed. Disease. Low male liveability.
DIC 1–3	Poor semen quality. Improper egg handling – egg collection not frequent enough. Improper storage conditions at the farm or hatchery. Eggs stored for a prolonged period of time. Extreme overheating/chilling prior to or at set. Lack of turning at set. Too long pre-warm. Breeder nutrition.
DIC 4–6	Same as listed for DIC 1-3 but less severe of an insult. Floor or soiled eggs.
DIC 7–10	Pre-incubation. Too high temp during week 1. Lack of turning at set.
Rot	Floor or soiled eggs. Improper egg sanitation. Condensation on eggs. Faulty humidity nozzle resulting in wet eggs.
Cracked	Improper egg handling at the farm: Nest management. Egg collection. Toe holes. Egg packing. Rough transportation. Rough egg racking. Faulty rack rails.
Misplaced Air-Cell	Improper egg collection, not frequent enough. Rough handling. Transporting eggs within 24hr of being laid.

Table 6. Candle breakout troubleshooting guide

MEASURING EGG MOISTURE LOSS

For maximum hatchability and poult quality, one must determine the optimal humidity set-point during incubation. This can be achieved by measuring the moisture loss of the egg.

Egg moisture loss is the amount of water that is lost by diffusion through pores in the eggshell during the incubation process. The rate of egg moisture loss is controlled by the humidity of the incubator and the conductance (porosity) of the eggshell (see Figure 30).

Moisture loss can be visually evaluated by examining the size of the air cell at transfer, prior to the embryo pipping through the inner membrane, using a small torch (see Figure 31).

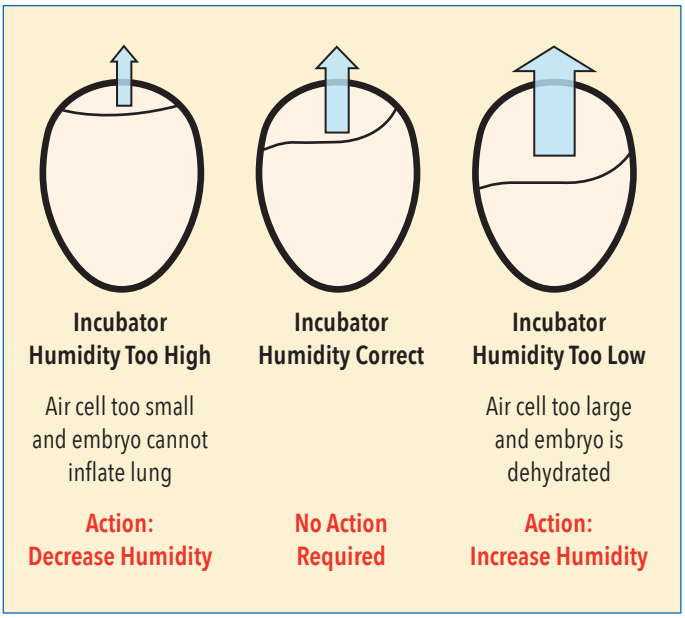


Figure 30. Effect of humidity on egg moisture loss

Changes in egg weight during incubation are due strictly to the loss of water from the egg. Therefore egg moisture loss can be easily measured by weighing eggs. Due to individual egg variation, it is important to weigh an aggregate of eggs. This can be achieved by weighing the entire tray before set and the same tray again at transfer rather than obtaining individual egg weights.

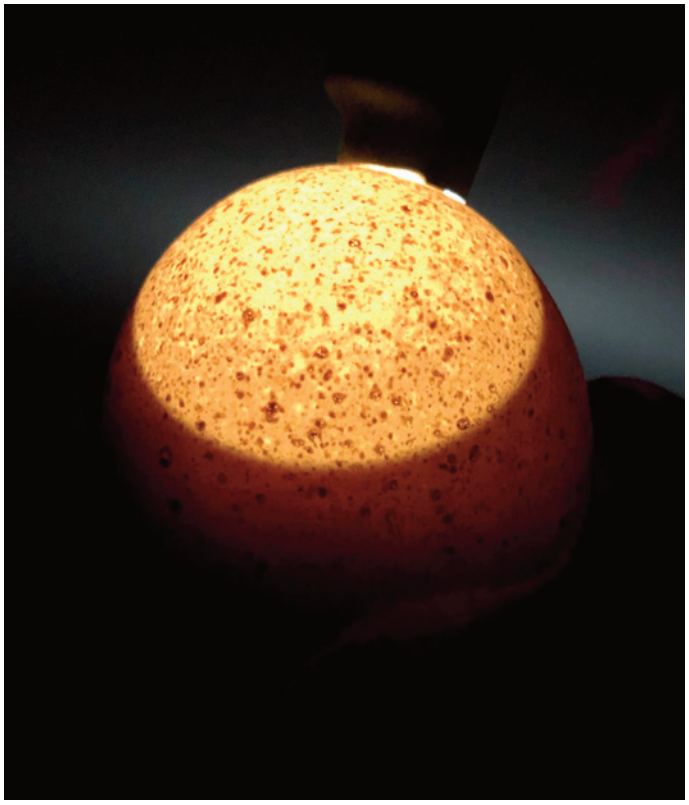


Figure 31. Assessing moisture loss by examining the size of the eggs air cell at transfer

Figure 32. A full setter tray on weighing scales

The procedure for measuring moisture loss

To accurately measure egg moisture loss:

- Monitor egg moisture loss from at least 2 incubator trays from each machine and/or each breeder flock.
- Use a scale that can weigh a whole incubator tray of eggs to an accuracy of at least 5g.

Step 1:
Fill setter tray with the fresh eggs – exclude any eggs with a poor shell quality.

Step 2:
Weigh a full setter tray – record weight and number of eggs on tray (see Figure 32).

Step 3:
Label the tray so that it can be relocated at transfer (see Figure 33).

Figure 33. Labelled setter tray

***Note:** Trays should be located in the incubator so that one is positioned near the top, one near the middle and one near the bottom of the incubator rack.*

Step 4:
If eggs are fertility tested prior to transfer, do not remove any clear or non-viable eggs.

Step 5:
At 25-day transfer, reweigh the tray of eggs and record weight. Reject any tray weights if there are cracked eggs on the tray.

Step 6:
Weigh empty setter tray and record the weight (see Figure 34 and 37).

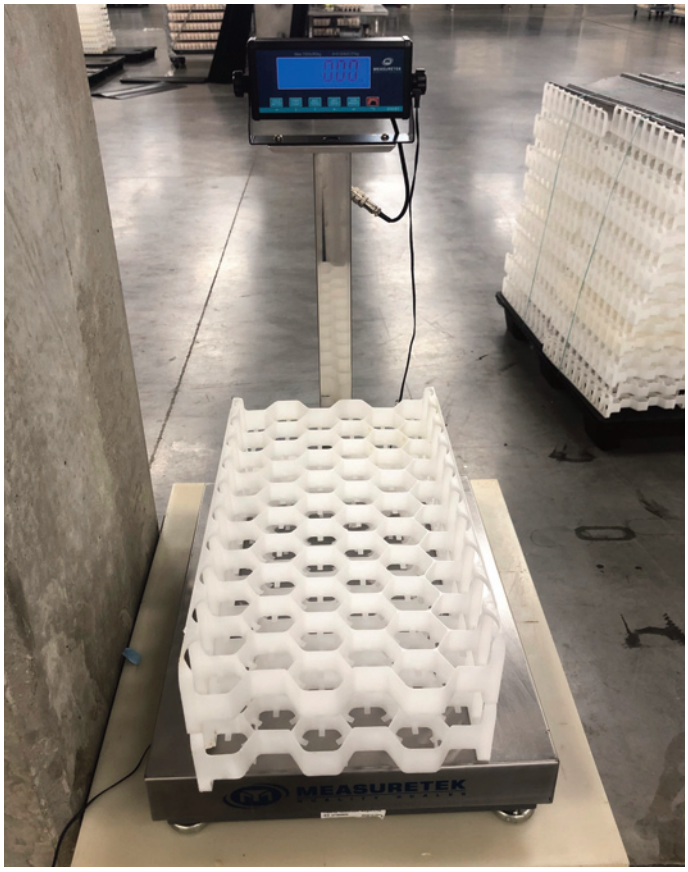


Figure 34. Empty tray weight

***Note:** It is important not to include any cracked eggs in the calculation of egg moisture loss – always check at setting and transfer, removing them before weighing and reducing the number of eggs accordingly in the calculation.*

Eggs that have been incubated correctly lose on average 11–12% +/- 0.5% of their weight from the time in which they are laid and the time the egg is transferred at 25 days of incubation. The weight loss targets depend on the age of the breeder flock (see Table 7).

Flock Age (weeks)	Egg Weight Loss Target
1–3	10–11%
4–15	11–12%
>16	12–13%

Table 7. Moisture loss targets

- If too much moisture is lost, it will cause the embryo to desiccate and dry out too early.
- If not enough moisture lost, the air cell will be too small when it comes time to pip and will prevent the embryo from fully inflating its lungs.
- Low incubator humidity will increase egg weight (moisture) loss and high incubator humidity will decrease egg weight loss.

Calculating moisture loss

$$\%\ \text{Moisture Loss} = \frac{\text{Full tray weight at set} - \text{Full tray weight at transfer}}{\text{Full tray weight at set} - \text{Empty tray weight}} \times 100$$

For Example: Empty tray = 1.03 Kg; Full tray at set = 10.51 Kg; Full tray at transfer = 9.35 Kg

$$\%\ \text{Moisture Loss} = \frac{10.51 - 9.35}{10.51 - 1.03} \times 100$$

$$\%\ \text{Moisture Loss} = \frac{1.16}{9.48} \times 100$$

$$\%\ \text{Moisture Loss} = 12.24\%$$

This calculation also applies to imperial measurements

Figure 35. Calculating moisture loss

***Note:** If eggs are not transferred and weighed at 25 days, the calculated moisture loss should be corrected to 25 days to allow for accurate and appropriate quality control. This can be done by dividing by the actual number of days at transfer and then multiplying by 25. If eggs are transferred at 24 days then moisture loss corrected to 25 days would be: (11.8 % ÷ 24) x 25 = 12.3 %*

Interpreting results

Figure 36 below depicts the moisture loss from 3 different incubators.

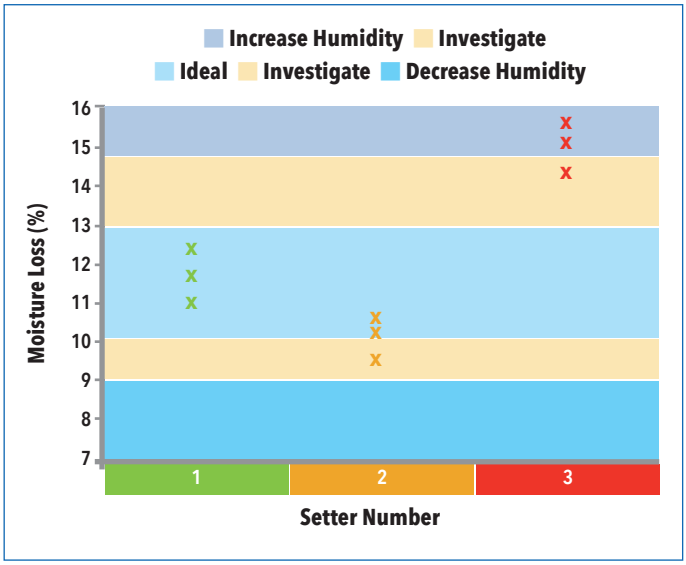


Figure 36. Example of moisture results in different incubators and subsequent actions

Incubator 1: Moisture losses are within the acceptable range. No action required.

Incubator 2: Slightly lower moisture loss but close to the acceptable range.

Action: Check the moisture loss from this incubator again; make sure humidifiers are working correctly and if it is still low decrease incubator humidity.

***Note:** this moisture loss would be normal for long stored eggs.*

Incubator 3: Very high moisture loss.

Action: Make sure there were no cracked eggs on these trays (these will lead to an artificially high estimate of moisture loss), make sure humidifiers are working correctly and increase incubator humidity.

***Note:** if cracked eggs are found, the data for that tray should be ignored and a repeat measurement taken.*

To alter egg weight loss by 1%, humidity should be changed by about 5% RH or 1°C wet bulb.

Hatch Information

Hatchery:		WV		**HOS Sellable:**		86.00%		**Average Yield:**		67.40%					
Set Date:				**HOF Sellable:**		89.73%		**Average Weight: Loss:**		12.12%					
Transfer Date:				**% Culls:**		1.93%		**Average. Out. 38 Hours:**		6.41%					
Hatch Date:															

Machine	Rack	Flock ID/ Complex	Number of Eggs Set	WOL	Egg Age	Fertility	Egg Wt at Set (Kg)	Trans. Wt. (Kg)	Empty Tray (Kg)	Wt. Loss %	Number of Poults Weighed	Poult Wt. (Kg)	Yield %	38 Hr. %	HOS Settable	HOF Settable
224	A	AA-178	11600	16.1	7	95.94%	26.40	23.90	7.050	12.92%	96	6.35	68.37%	6.67%	85.53%	89.15%
224	B	AA-178	11600	16.1	7	94.69%	26.60	24.05	7.200	13.41%	97	6.40	67.22%	9.00%	83.63%	88.32%
225	C	BB-214	5800	7.1	10	95.62%								5.67%	86.33%	90.28%
225	C	BB-214	5800	7.2	9	96.88%		23.75	7.950	12.22%	103	6.00	64.72%	5.67%	86.55%	89.34%
225	D	BB-214	3600	7.2	9	95.83%								14.00%	86.53%	90.29%
225	D	BB-214	600	7.2	9	94.17%	25.95							14.00%	89.00%	94.51%
225	D	BB-214	7400	7.3	8	95.00%		23.1	6.900	10.74%	103	6.50	69.54%	14.00%	84.24%	88.68%
226	E	BB-214	1800	7.3	8	98.75%								5.33%	87.78%	88.89%
226	E	BB-214	9800	7.4	7	96.50%		23.20	7.050	10.28%	98	6.10	69.16%	5.33%	86.47%	89.61%
226	F	BB-214	400	7.4	7	96.25%								1.67%	89.75%	93.25%
226	F	BB-214	5600	7.5	6	96.00%								1.67%	85.46%	89.03%
226	F	CC-3882	5600	10.5	8	94.79%	25.05	23.60	7.050	12.20%	100	6.45	68.44%	1.67%	78.41%	82.72%
227	G	CC-3882	11000	10.5	8	95.48%								3.33%	0.00%	0.00%
227	G	DD-0144	570	7.1	7	97.50%		22.90	7.200	12.53%	97	5.85	67.20%	3.33%	95.09%	97.53%
227	H	DD-0144	11600	7.1	7	94.79%		23.45	7.555	12.16%	92	5.60	67.28%	7.33%	90.09%	95.04%
228	I	DD-0144	11600	7.1	7	95.83%	25.05	23.00	7.050	12.60%	102	6.20	66.61%	5.67%	87.78%	91.60%
228	J	DD-0144	11600	7.1	7	95.42%		22.85	7.050	12.22%	100	6.20	68.89%	4.67%	88.41%	92.66%
Average/Total			115970	8.66	8	95.85%	25.61	23.38	7.206	12.12%		6.17	67.40%	6.41%	86.00%	89.73%

Figure 37. Example of a moisture loss record sheet. This sheet also records poult yield information as the two quality control processes can be easily combined – see Measuring poult yield

HATCHER MANAGEMENT

Transfer

Transfer is the process by which eggs are moved from the incubator racks into specially designed hatcher baskets.

Eggs need to be transferred into a hatcher for the last 3–4 days of incubation. The hatching phase is normally separated from the incubation phase for these reasons:

- The eggs need to be moved into baskets that can contain the poults once they hatch.
- The high quantity of poult down and meconium produced during the hatching process is associated with higher levels of bacteria. Hatchers should be located away from clean areas of the hatchery such as the egg store room and incubators to prevent the cross-contamination of these sensitive areas.
- The hatcher can provide the specific environment required for successfully hatching and preparing of the poults for the brooding farm.

Eggs are normally transferred into the hatcher at 24–25 days of incubation. Turkey eggs no longer require turning after the 21st day of incubation and therefore in theory could be transferred after this date. However, it is not advisable to transfer eggs earlier than the normal 24–25 day period without thoroughly testing whether the hatcher can maintain the correct incubation environment.

While it is advisable to minimize the time the eggs are out of the machines during transfer, the task should not be rushed as to risk damaging the eggs.

- Transfer in a pre-warmed area to minimize shock to the embryos.
- Eggs can be kept at room temperature 68–77°F (20–25°C) on days 24–25 of incubation for a few hours without any adverse effect on hatch, although there may be a slight hatch delay if the time out of the machine is longer than 2 hours.

The hatcher baskets are designed to keep the poults together with the eggshells once they have hatched. If the floor of the hatcher basket is too smooth, it can result in an increase in spraddled poults. The use of a hatcher pad/tray liner can alleviate this issue (see Figure 38).

Figure 38. Hatchery tray with liner

A wide range of equipment is available to assist with the transfer process including:

- Manual transfer with a metal paddle (see Figures 39, 40, 41 and 42).
- Simple hand-operated vacuum lifters.
- Complex automated systems.

– Where vacuum egg-lifters are used, particular care needs to be taken to ensure that eggs are picked up and released correctly to avoid the dropping and cracking of eggs.

– All equipment used to transfer eggs should be properly maintained following the manufacturers recommendations.

Whatever system of egg transfer is chosen, it must be done with care to prevent damage to the eggs. A high incidence of cracked eggs and/or hemorrhaging of the chorio-allantoic membrane in unhatched eggs can indicate rough handling during the transfer process.

- The poults are normally removed from the hatcher between days 27½–28 days of incubation.

– Poults should not be held in the hatcher for long periods after the hatch has completed, as this will rapidly dehydrate the poults.

– Similarly, the hatch take-off should not be so early that poults are still hatching.

Figure 39. During manual hand transfer, eggs are gently removed from the racks with a slide/paddle

Figure 40. A hatcher basket is then placed on top of the eggs, flats, and slide. The entire basket and eggs are then inverted

Figure 41. The slide and egg flats are removed

Figure 42. The hatcher baskets are then carefully stacked onto carts to be transported into the hatchers

Hatcher environment

The environment within the hatcher will go through three different phases; Incubation, Hatching and Drying.

Incubation

During the incubation phase, the eggs have not started to hatch and the hatcher environment needs to be managed as if it is the continuation of the incubator environment.

The hatcher is effectively a single-stage machine thus the principles of single stage incubation can apply.

If the eggs were incubated in single-stage incubators then it is likely that the temperature, humidity, and ventilation settings will be similar in the hatcher. This does assume that the hatcher and incubator are of similar design.

If the eggs were incubated in a multi-stage incubator then it is likely that the operating temperature of the hatcher will be lower than the operating temperature of the incubator.

Hatching

The hatching phase is when the poult starts to pip and make its way out of the eggshell and hatch from the egg. In a hatcher that contains eggs that are from one breeder flock and have not been stored for a long period, this phase will typically take less than 36 hours between the first and last poult hatching.

When poults begin to hatch, they are wet and release a lot of water vapor into the hatcher, and result in a natural rise in humidity. Once the rise in humidity starts, many hatcheries increase the hatcher humidity setting for the rest of the hatching phase to match the natural rise in humidity. There is little scientific evidence that supports this is necessary and it is likely to only prevent high humidity alarms.

It has been suggested that reducing the hatcher ventilation for a period of up to 12 hours to allow CO_2 levels to rise (up to a maximum of 2%), stimulates poults to hatch together and may improve poult quality. It should also be noted that good results can also be obtained without restricting ventilation.

Ventilation should never be restricted in hatchers where the principle method of cooling the machine is air.

Drying

Once the last poult has hatched, the humidity in the hatcher is decreased and the ventilation increased so that the poults dry ready for hatch take-off.

- Typically 6 hours is sufficient for the drying of the poults.
- Do not over extend the drying period as it will result in dehydrated poults.
- Once the hatch has finished and the poults are dry, it is best to remove them from the hatcher and hold them in poult boxes (see Figure 43).
- Poult yield is a strong indicator of poult hydration.
- It is recommended that poult yields are routinely measured as a way to assess poult quality/hydration.

See ***Measuring poult yield*** (Page 33).

Figure 43. Poults post drying phase, ready to be transferred into poult boxes

Monitoring hatch progress

It is important to monitor the progress of the hatch to determine when it is the best time to start take-off, examine the broadness of the hatch window, and when it is necessary to alter set times. Hatch progress monitoring can be done multiple ways:

A visual inspection of the poults hatching inside the hatcher can give an indication of the timing of the hatch. This is a quick and simple check that can be easily undertaken. Opening the hatcher for a short period of time should not adversely affect the hatch.

Measurement of the hatch window

Count the number of poults hatched on identified hatcher baskets and check those in 12-hour intervals starting 36 hours prior to hatch take-off. This method is more time consuming than a simple inspection but provides more accurate information.

Exact counts are recommended at both 36-24 hours prior to hatch. A simple visual check is recommended at the12-hour count.

Digital logging of the hatcher humidity levels throughout the hatch. This feature is available on many modern hatchers (see Figure 44). The timing of the hatch can be monitored by looking at the natural increase in humidity, which occurs when poults begin to pip, and the decline in humidity levels which coincides with the completion of hatch.

- Graphs should have a nice narrow and steep peak.
- A broad peak is indicative of a wide hatch window.

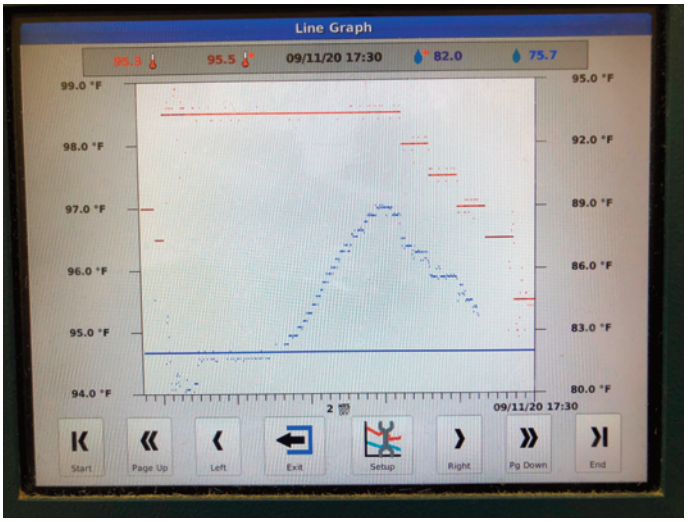


Figure 44. Example of the relative humidity trend in a hatcher

MEASURING POULT YIELD

Poult yield (the weight of the poult at hatch as a percentage of the egg setting weight) is a simple method to check whether hatch timing and incubation parameters are correct.

Poults with a low yield have either been:

1. Hatched for a long time before they were removed from the hatcher.
2. Incubated at a high temperature and/or a low humidity.

These poults are at risk of being dehydrated and performing poorly on the farm (see Figure 45).

Poults with a high yield have either:

1. Just finished hatching when they were removed from the hatcher.
2. Incubated at a low temperature and/or a high humidity.
3. If placed on the farm too quickly, these poults will tend to be lethargic and not ready to eat and/or drink (see Figure 45).

> 69% High This poult will be lethargic/ weak, not ready to feed and drink when placed.	
67 – 68% Optimum This poult will be active and ready to feed and drink when placed on farm.	
< 66% Low This poult will be dehydrated and have little yolk reserve. Often very active and noisy.	

Figure 45. How poult yield affects behavior

***Note:** If poults are to be placed onto the farm the day after hatch 1% should be added to the above ranges, i.e. optimum poult yield would be 69%.*

If eggs are stored 0.5% should be added for each week of storage i.e. for eggs stored for 2 weeks optimum poult yield would be 68-69%.

Procedure for measuring poult yield

To accurately measure poult yield and hatch timing of a specific flock, monitor the poult yield from at least 2 incubator trays per machine per flock. Use a scale that is able to weigh a whole incubator tray of eggs or a box of poults to an accuracy of at least 5g.

***Note:** This procedure can be easily combined with the monitoring of egg moisture loss.*

Step 1:
Weigh an empty incubator tray and record the weight (see Figure 46).

***Note:** This can be carried out at setting or transfer.*

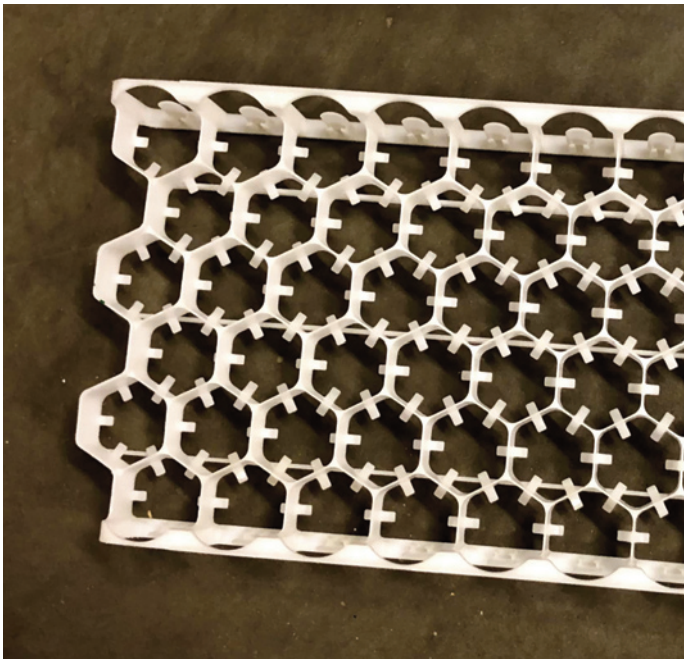


Figure 46. Empty setter tray

Step 2:
Fill the incubator tray with settable eggs. Exclude any cracked or poor quality eggs.

Step 3:
Weigh the full incubator tray and record the weight and number of eggs on the tray (see Figure 47).

Figure 47. Full incubator tray

Step 4:
Label the tray so that it can be identified when relocated at transfer from the incubator to hatcher.

***Note:** Trays should be located in the incubator so that one is positioned near the top, one near the middle and one near the bottom of the incubator rack.*

Step 5:
At transfer ensure the hatcher tray is labelled so that it can be associated with the correct egg tray.

Step 6:
At take-off, zero the balance with the empty poult box (see Figure 48).

***Note:** Weigh poults prior to sexing.*

Figure 48. Empty poult box

Step 7:
Count all of the good quality poults from the hatcher basket into the box and record the number.

Step 8:
Weigh the full poult box and record the weight (see Figures 49 and 51).

Figure 49. Full poult box

Poult yield calculation

$$\% \text{ Poult Yield} = \frac{\text{Average Poult Weight}}{\text{Average Fresh Egg Weight}} \times 100$$

Empty tray = 1.020 Kg Full tray @ set = 12.83 Kg; Number of eggs = 120; Full poult box @ hatch = 6.34 Kg; Number of poults = 96

$$\% \text{ Poult Yield} = \frac{6.34 \div 96 * 1000}{(12.83 - 1.020) \div 120 * 1000} \times 100$$

$$\% \text{ Poult Yield} = \frac{66.04}{98.42} \times 100$$

$$\% \text{ Poult Yield} = 67.1\%$$

This calculation also applies to imperial measurements

Figure 50. Poult yield calculation

Hatch Information												
Hatchery:					**HOS Sellable:**				**Average Yield:**			
Set Date:					**HOF Sellable:**				**Average Weight Loss:**			
Transfer Date:					**% Culls:**				**Average. Out. 38 Hours:**			
Hatch Date:												
Machine	**Rack**	**Flock ID**	**Eggs Set**	**WOL**	**Egg Age**	**Fertility %**	**Egg Wt at Set (Kg)**	**Trans. Wt. (Kg)**	**Empty Tray (Kg)**	**Wt. Loss %**	**Poults Weights**	**Yield %**

Figure 51. Example of poult yield recording sheet

This comprehensive sheet also records other pertinent hatch information such as fertility, egg age, and egg moisture loss.

Interpreting results

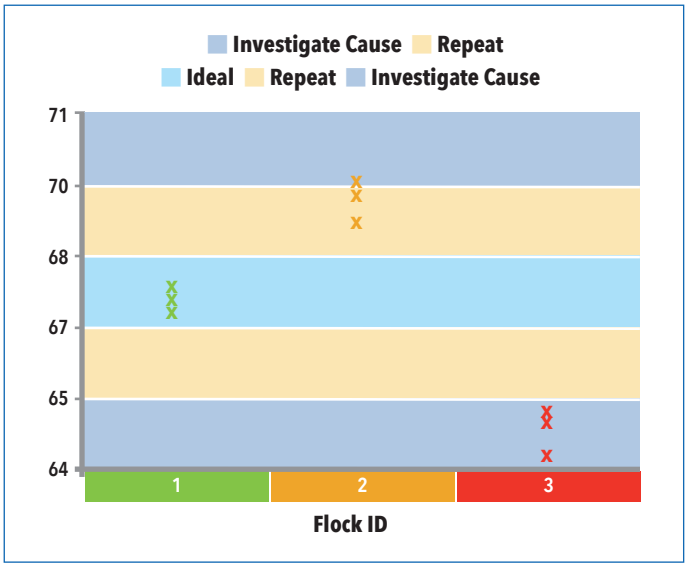


Figure 52. Shows the poult yield results and subsequent actions from 3 different flocks

Flock1 Poult yields are within the acceptable range.
No action required (see Figure 52).

Flock 2 Slightly higher poult yield but close to the acceptable range.
Action: Check the poult yield from this flock again and if it is still high, use the table below to investigate the cause of the higher poult yield (see Figure 52).

Note: This slightly higher yield would be acceptable if the poults are transported long distances and/or do not arrive on the farm on the same day as hatch.

Flock 3 Low poult yield. These poults will be at risk of dehydration.
Action: Use the table below to determine the cause of the low poult yield (see Figure 52).

Factors affecting poult yield

Low Poult Yield

1. Incubating the eggs for too long.
2. High incubation temperature.
3. Low incubator humidity.
4. Sub-optimal egg handling prior to set.

High Poult Yield

1. Incubation time too short. This may be as a consequence of long egg storage, or eggs from very young or old breeders.
2. Low incubation temperature.
3. High incubator humidity.
4. Sub-optimal egg handling prior to set.

ANALYSIS OF UNHATCHED EGGS

A hatch breakout analysis involves opening unhatched eggs to determine at what stage of incubation the embryonic mortality has occurred. A hatch breakout is a useful tool for solving hatch problems and investigating areas to improve hatch performance.

Quantify the number of embryos dying at the various stages of development and look for any indications of abnormal development and/or other potential causes of hatch loss (e.g. cracks and microbiological contamination).

It is normal that not all eggs hatch during incubation. Embryo losses tend to follow a pattern (although it will vary slightly with strain, flock age, and egg age) (see Figure 53).

Some embryonic abnormalities have been shown to be the result of specific problems.

Analyzing embryonic liveability patterns and abnormalities can help to identify which aspects of the incubation process or breeder farms need to be investigated to improve hatchability and/or poult quality.

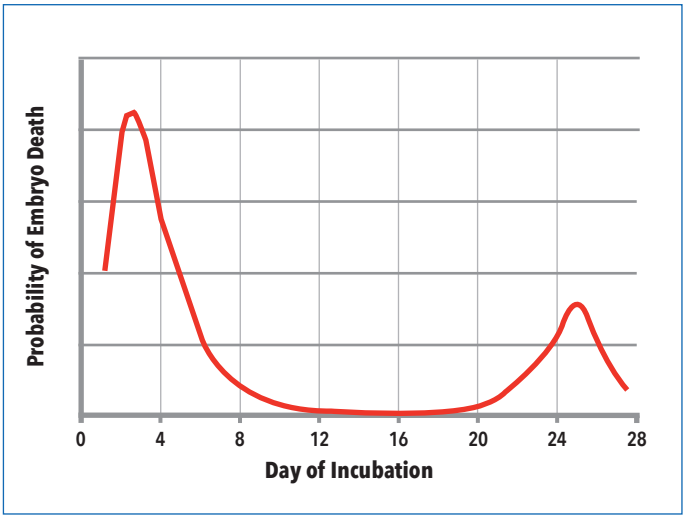


Figure 53. Pattern of embryo loss during incubation showing peaks in mortality during early and late incubation

Procedure for analyzing unhatched eggs

Identify 4–5 sample setter / hatcher trays per breeder flock and hatch.

- Choose the trays from different positions within the incubator.
- The eggs used for the sample trays should be clean nest eggs of known flock source, flock age and egg age.

At hatch take-off obtain the following from each tray:

- The number of viable good quality poults.
- The number of dead or poor quality poults.
- The number of unhatched eggs.

***Note:** The sum of the aforementioned categories should equal the number of eggs set, less any eggs removed at candling.*

It is advised that clear and or non-viable eggs are not removed from these trays at candling.

- If eggs are removed, it is important that the amount of infertile and early deads are recorded and the trays are not backfilled with eggs, as this will impact the true hatch of set and hatch of fertility information.

It may be difficult to distinguish between infertile and very early mortality at breakout; therefore a separate sample of eggs should be broken out at candling.

- Refer to **Measuring fertility and embryonic liveability** (see page 21)

Record whether the hatch residue was clean or dirty, the poults were still hatching (wet poults on tray) or if poults were very thin as this provides clues as to advanced or late hatch.

All unhatched eggs from all of the sample trays should be carefully opened and its' contents recorded on a standardized form.

- See the **Egg breakout analysis** sheet (see Figure 54) for an example of a breakout form.
- Results should then be expressed as percent of eggs incubated.

The stage at which the embryo died and any accompanying lesions should be recorded.

- Staging and lesions are described on the following pages.
- Refer to the **Candle breakout troubleshooting guide** (see Table 6).

Embryonic staging

- Infertile – clear albumen and yellow yolk with white dot. No sign of embryo development – lacks the presence of clear fluid accumulated behind the blastodisc and or blood vessels.
- DIC 1–2 – presence of larger white disc yolk, albumen may be cloudy, no evidence of blood vessels.
- DIC 3–6 – first sign of blood vessels, heart, eye, and embryonic tissue on the yolk.
- DIC 7–10 – limbs and pipping tooth start to develop and become visible.
- DIC 11–15 – feather pores and follicles can be seen. Snood, scales and, claws begin to form.
- DIC 16–20 – down begins to cover the body and fully covers the body.
- DIC 21–24 – development is complete and embryo simply grows in size.
- DIC 25–27 days – the embryo turns into the hatching position (head under right wing), the yolk sac is retracted, and pipping begins.
- Internally Pipped Dead – pipped through the inner membrane but embryo died.
- Externally Pipped Dead – pipped through the shell but embryo has died.
- Pipped Alive Late – shell pipped and embryo still alive.

– Membranes and feathers are wet and the inside of the shell has a reddish tinge.

  – This indicates that the embryo is late hatching.

- Pipped Alive Exhausted-shell pipped and embryo still alive.

– Membranes and feathers are dry. The birds will also smell of ketones.

  – This indicates the embryo has been pipped for a long time but has been unable to emerge from the shell.

- Record all cracked, contaminated eggs (bacteria or mold) as such rather than by stage of embryonic death.

– The presence of black liquid around the embryo is not a sign of microbial contamination – this is caused by the normal breakdown of tissues following death.

– Differentiate between farm/egg handling cracks and transfer cracks.

Embryonic staging-lesions

Recording and examining the accompanying embryonic lesions can help with the fine tuning of profiles as well as assist with troubleshooting of quality and hatch related issues. The occurrence of this malposition should not exceed 0.1% of eggs set.

Record all malpositioned embryos:

- Head between legs (normal position before day 25).
- Head in small end of egg.
- Head under left wing.
- Leg over head.
- Head on top of right wing.

Record all embryonic abnormalities such as: (See **Egg breakout analysis –** Figure 54, and the **Candle breakout troubleshooting guide –** Table 6, page 25 for more details)

- Body abnormalities – multiple limbs, deformed head, short legs, open body or cranial cavity.
- Residual albumen.
- Deformed legs.
- Dwarfed – small embryo for stage of development.
- Eye abnormalities – missing eye(s), eye cataracts.
- Leg or head trapped by yolk sac.
- Swollen head or body – edema.
- Beak deformities – short upper or lower, parrot beak, crossed beak or notch in upper beak.

***Note:** Occasional abnormalities are not a cause for concern. Further investigation is appropriate only if a single malformation occurs at levels over 0.5% of the eggs set.*

Egg breakout analysis

Date:					
Flock					
WOL					
Sample Size					
Breakout HOS					
Breakout HOF					
Breakout Fertility					

Day in Cycle

Infertile					
1 to 3					
4 to 6					
7 to 10					
11 to 16					
16 to 20					
21 to 24					
25 Day Dead					
Internally Pipped Dead					
Externally Pipped Dead					
Pipped Alive Exhausted					
Pipped Alive Late Hatch					
Exhausted Stuck to Shell					
Exhausted Late					
Cracked					
Malformations					
Cull Egg					
Rots					
Transfer Crack					

Lesions

Aspergillus					
Big Belly					
Blue Legs					
Deformed Legs					
Infected Yolk					
Malpositions					
Mottled Yolk					
Pipping Muscle					
Residual Albumen					
Ruptured Yolk					
Short Legs					
Skin Necrosis					
Thin Shell					
Urates					
Thick Membrane					

Tray Culls

Dead					
Exhausted					
Late					
Cull/Legs					

Figure 54. Egg breakout analysis

Interpreting and analyzing results

Compare and plot the results obtained against the targeted parameters shown by WOL in Figure 55. Investigate any results below the acceptable parameters.

Stage of Embryonic Cycle (DIC)											
WOL	Fert %	DIC 1-3	DIC 4-6	DIC 7-10	DIC 11-15	DIC 16-20	DIC 21-24	DIC 25	DIC 25+[a]	Alive Late[b]	Alive Exh[c]
1-4	3.44	3.09	0.87	0.58	0.35	0.29	0.27	0.35	0.20	0.94	1.19
5-10	3.67	2.29	0.92	0.48	0.29	0.29	0.27	0.51	0.46	1.69	0.91
11-15	3.71	2.35	0.87	0.43	0.27	0.33	0.35	0.65	0.45	2.02	0.79
16-20	3.98	2.10	0.76	0.39	0.27	0.34	0.41	0.72	0.36	2.17	0.71
21-25	5.00	2.88	0.96	0.49	0.36	0.39	0.55	0.96	0.42	2.71	0.60
26-30	5.48	2.79	1.04	0.46	0.39	0.59	0.73	1.29	0.59	3.65	0.63

Figure 55. Indicative estimates of embryonic liveability

***Notes:** Any assessment of infertility made at the end of incubation during a breakout is likely to be inaccurate as it is very difficult to distinguish true infertiles from early deads. If the fertility and early liveability numbers are less than expected, then follow the procedures in the **Measuring Fertility** section of this manual before taking further action.*

While hatch residue breakouts are a powerful tool, one should not rely on them alone.

Results should be combined with other pertinent hatch information such as fertility readings and or candling breakout results, hatchability records, breeder performance records, incubation records and hatch timing information.

- Lots of live pips, clean hatch residue, and wet, fat poults indicates a delayed hatch.
- Bangers (exploding eggs) at transfer and rots in the breakouts indicate a contamination issue. If excessive numbers are found, a thorough investigation should be made.
- Excessive amounts of cracks may indicate an egg handling problem.
- Long egg storage (>7 days) normally increases the incidence of early dead germs and pipped eggs.
  - It will also delay the hatch.
  - In a good hatching flock there are two main periods where embryonic liveability may be lower: between 1–7 days of incubation and between 25–27 days + pips as these are the most difficult times in embryonic development.
- Reduced liveability at other development stages is abnormal.
- A high incidence of mortality at a particular stage of development can indicate an acute problem during incubation caused by a machine failure or suboptimal incubation and or hatching profiles.
- A chronic problem, such as slight overheating, may result in mortality later in incubation.
- Specific embryo abnormalities can be associated with specific problems (nutritional, incubation, toxins and disease) but it is important to note that the same abnormality can be the result of more than one problem. Refer to the **Hatch residue troubleshooting guide** – Table 8.
  - For example eye cataracts have been associated with high incubation temperature, mycotoxins and vitamin E deficiency.
- Experience of hatch breakouts with good hatching flocks is important for differentiating between what is normal and abnormal.
  - Therefore it is very important to routinely conduct egg breakouts regardless of hatch.
  - One major pitfall is only breaking out the poor hatching flocks.

Hatch residue troubleshooting guide

Observation	Potential Causes
Infertile	Farm problem. Extreme overheating/chilling prior to or at set (early dead – not a true infertile).
DIC 1-3	Farm problem with egg handling, cooler conditions, semen quality. Too long pre-warm. Eggs Stored for a prolonged period of time.
DIC 4-6	Same as listed for DIC 1-3 but the insult was less severe.
DIC 7-10	Pre-incubation. Too high temp during week 1. Lack of turning at set.
DIC 11-15	Not very common. All previous mentioned hatchery issues but to a lesser degree.
DIC 16-20	Common if eggs are overheated during the 2nd week of incubation. More common in multi- stage systems.
DIC 21-24	Inadequate moisture loss. Lack of oxygen. Depends on accompanying lesions.
DIC 25	Common. Key is in accompanying lesions.
Externally Pipped Dead	Inadequate moisture loss. Hatcher temperature too high. Weak embryo.
Pipped Alive Exhausted	Can be similar to Ext pip dead but to a lesser degree. Larger hatch window – later hatching poults are not in sync with the hatcher profile.
Pipped Alive Late	Inadequate start time. Too long pre-warm. Too low of a temperature in incubator or hatcher. Humidity spray nozzle issues.
Exhausted Stuck to Shell	Moisture loss issues in incubation. Most common for overheating in hatchers. Low RH in hatchers.
Exhausted Late	Lower than optimal temps in hatchers. Embryo out of sync with hatcher profile. Uneven hatch timing.
Short Shanks	Overheating in the second and beginning of third week. Inadequate moisture loss.
Deformed Legs	Slight overheating over a long period of time.
Malposition	Severe overheating at any stage of incubation. Lack of turning. Eggs stored for prolonged periods of time.
Residual Albumen	Inadequate moisture loss. Overheating in the second and third week. Lack of turning at set and during the second and third weeks. Egg handling. Eggs did not have enough time to “breathe” prior to set. Eggs packed in paper.
No Visible Lesions	Depends on the level of mortality. Typically indicates a sudden severe problem.
Skin Necrosis	Overheating in hatchers with or without high humidity.
Urates	Cooling or overheating during the second half of incubation.
Ruptured Yolk	Overheating during the third and beginning of fourth week or too rough at transfer prior to or at set (early dead – not a true.
Malformations	Depends on the type of malformation: Eye abnormalities/ectopic viscera – High temps DIC 1-6. Brain abnormalities – High temp DIC 0-3. Parrot beak/Micromelia-Nutritional. Extra limbs – rough handling or jarring of the eggs during collection/transport prior to or at set.

Table 8. Hatch residue troubleshooting guide

MANAGING POULT COMFORT

- Poults are not able to control their own body temperatures when hatched so it is critical to manage poult comfort and monitor body temperature and poult behavior.
- The correct holding temperature for poults will depend on air speed and humidity.
- Poult vent temperatures highly correlate with core body temperatures.
  - The optimum poult vent temperature is 102.5–105°F (39.2–40.5°C)
- Poult comfort can be easily determined by measuring vent temperatures using a rectal thermometer or an ear temperature thermometer.
  - If an ear thermometer is used it is very important that the vent is dry.
    - If not entirely dry, evaporative cooling will occur at the tip and result in false lower vent temperature readings.
  - Since it is measuring surface temperature rather than internal temperature, all readings will be slightly cooler when compared to a rectal thermometer.
- Poults may become uncomfortable and utilize more energy if their core body temperature becomes too hot or cold.
  - Poults will change their behavior in an attempt to try to control their body temperature.
  - If poults are too hot, they will start to pant and try to move away from the heat source.
    - When poults pant, they lose moisture at a faster rate.
  - If poults are too cold, they tend to bunch together and potentially pile on top of each other.
    - If poults pile, it can impact negatively on lungs and hearts.
- Poults that are not at the correct temperature are known to have poorer performance in the field.
- Poult vent temperature should be routinely monitored in the hatchers, holding rooms, and poult trucks.
- Poults should be sampled throughout the area where they are being held and from near the top, middle and bottom of poult box stacks.
- Pay extra attention not to stack equipment next to doors or areas of higher air speeds.
  - Poults may pile due to drafts even when at the correct air temperature.

Poult behavior

Poults that are comfortable and have the correct body temperature generally will be quiet and evenly spread throughout the box (see Figure 56). Any noise will be low in volume and tone and sound like chatter.

Figure 56. Evenly distributed poults in a delivery box

Poults that are too cold with vent temperatures below 102.5°F (39.2°C), start to huddle and tend to have cold legs and feet. Poults often become louder and have a higher pitch chirp. These birds tend to sit still and appear inactive at the farm upon delivery (see Figure 57).

Figure 57. Huddling poults in a delivery box

Poults that are too hot, with vent temperatures above 105°F (40.5°C), start panting. Poults often become louder and have a higher pitch chirp. If birds are too warm for an extended period of time, they become acclimated, will stop panting, and begin to prefer warmer temperatures after that, whether it be in transport vehicles or the brooding house. These poults typically don't settle well when introduced to the farm environment (see Figure 58).

Figure 58. Poults panting due to high temperatures

Measuring poult temperatures

Equipment required:

- Medical grade small tipped quick rapid result rectal thermometer (see Figure 60).
- Alternatively a medical infrared ear thermometer such as the Braun ThermoScan® ExacTemp ear thermometer (Model IRT 4520, type 6022) can be used (see Figure 59).

Figure 59. Braun ThermoScan® ExacTemp ear thermometer

***Note:** If this type of thermometer is used the vent must be completely clean, dry, and entire tip must come into contact with bare skin. Because this measures skin surface temperature, the reading will naturally read 33.08°F (0.6°C) cooler than the rectal thermometer.*

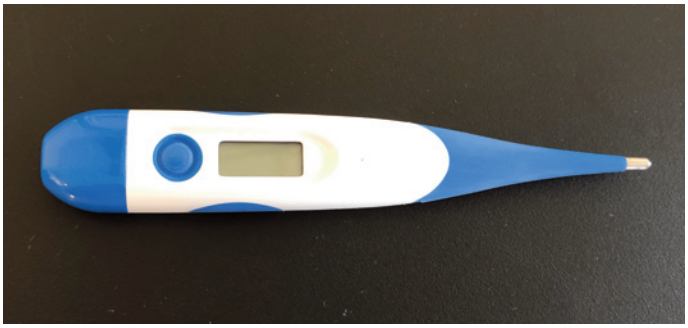


Figure 60. Medical grade small tipped quick rapid result rectal thermometer

Procedure for measuring vent

Temperatures

Step 1:
Make sure that the tip of the thermometer is clean and dry. Or a new tip is used in the case of the infrared thermometer.

Step 2:
Vent temperatures should be taken within 5 minutes of removing poults from the environment that you are checking such as the hatchers or poult transportation vehicle.

Step 3:
Measure a minimum of 3-5 poults per location. If poults are huddling, do not select poults from the center of the huddle as they are not a true representation of the environment. Reject any poults with wet or dirty vents.

Step 4:
Pick up one poult gently, and hold it so that you can see the vent. With your thumb, gently push the rump/ tail of the poult upwards, so that the vent is exposed (see Figure 61).

Figure 61. Correct handling of poults for measuring poult temperature

Step 5:

Gently insert the thermometer into the vent, making sure the thermometer is only inserted enough to cover the metal tip (see Figure 62). If using the infrared thermometer, press the tip of the infrared thermometer against the vent and make sure that you are making full contact with dry bare skin, no feathers. Press the button. Wait for the thermometer to stop changing or the light to flash. Record the temperature and location on a recording sheet (see Figure 63).

Figure 62. Correct insertion of a medical grade tipped thermometer

Poult temperature record sheet

Stack Location	Box in Stack	Poult Number						
		1	2	3	4	5	Mean	Comment
Front Right	Top							
	Middle							
	Bottom							
Front Left	Top							
	Middle							
	Bottom							
Back Right	Top							
	Middle							
	Bottom							
Back Left	Top							
	Middle							
	Bottom							

Figure 63. Poult temperature record sheet

***Note:** Target Poult Vent Temperature 103 – 105°F (39.4 – 40.5°C)*

Interpretation of results

	Vent Temperature less than 103˚F (39.4˚C)	Vent Temperature more than 105˚C (40.5˚C)
All Poults	• Increase holding temperature	• Decrease holding temperature
Some Poults	• Cold air drafts • Wet floors • Wet poults (e.g. after vaccination) • Uneven air circulation around boxes • Poults held too long on carousels	• Poor air circulation around chick boxes • Poult boxes – Too close together – Too close to the wall – Too near heater units

Table 9. Interpretation of poult temperature

POULT SERVICING

Day-old poults must be separated by sex at the hatchery for important reasons; the males and females have very different requirements from each other and need to be managed accordingly.

Differences include:

- Nutritional.
- Barn set-up/Equipment.
- Floor space.
- Markets and marketing age.
- Growth rates.
- Feed conversion ratios.

Sexing of turkeys involves the vent of the bird being inverted by a highly trained sexor to determine the sex.

Beak and or toe/nail treatment may be carried out depending on local regulations and or customer requirements.

Poults may receive a vaccination and or probiotic.

All poult services/processes should only be carried out by fully trained personnel.

Vent sexing

- Vent sexing is considered to be an art and must be done by very specialized, highly trained individuals in order to ensure poult health and well-being, and obtain sexing accuracy.
- Sexing must be done under a good, bright light source if it is to be accurate.
  - The set up may be very simple or fully automated. (See Figures 64 and 65).
- Sexors must gently handle, sex and place the sexed poult carefully into the correct boxes/location without discomfort to the poult.
  - Careful handling of poults is required to ensure their health and well-being.
- Sexor should be routinely checked for accuracy and poult injuries/damage.
- The ratio of males to females will normally be around 48:52 (48% females, 52% males) but will vary slightly by week of lay of the breeder hen.
  - If the ratio deviates from this, then action needs to be taken.

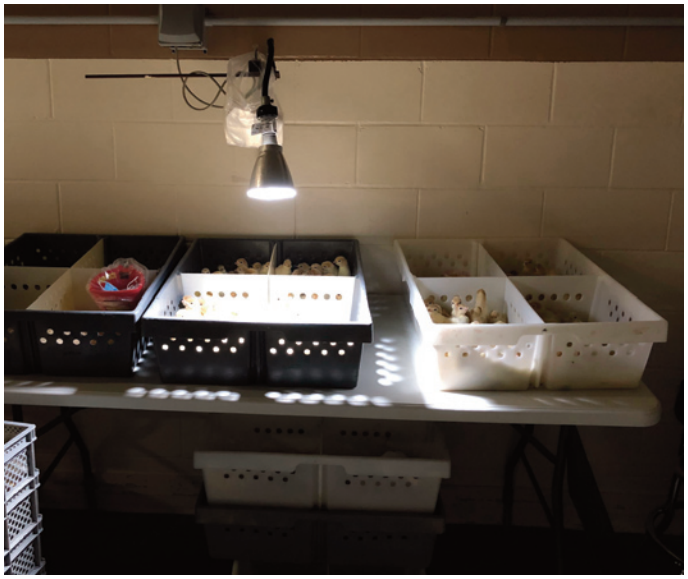


Figure 64. Example of a simple set-up for vent sexing poults

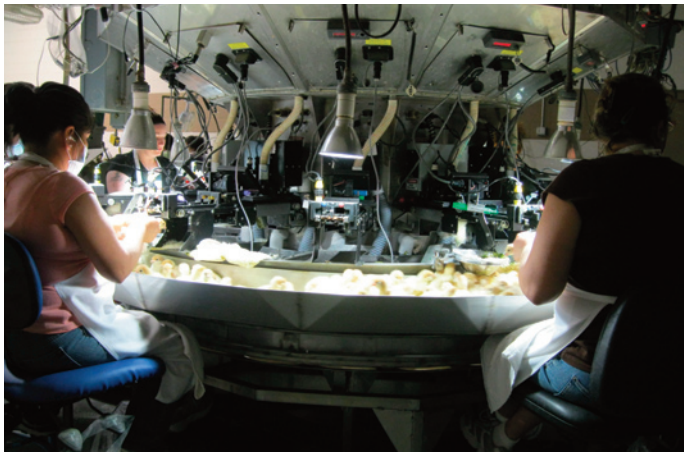


Figure 65. Example of an automated set-up for vent sexing poults

Simple Set Up

Sexing directly out of the poult boxes themselves after hatch take-off is a very simple setup. The males are placed directly into the grey boxes and the hens into the white boxes (see Figure 64).

Automated Set Up

A more automated setup includes the use of carousels and conveyor systems. The males and females are placed into their appropriate chute and conveyored to the next process or the sexed poult is given the next process before moving on (see Figure 65).

Servicing – beak and nail treatment, vaccination and probiotics

Further servicing of the poults is done with the welfare of the bird in mind. Poults may receive infrared beak treatment to blunt the tip of the beak to prevent/minimize injury due to pecking.

Depending on the markets, and or local rules and regulations, birds may or may not receive nail treatment to blunt or prevent the regrowth of the nail/claw.

Vaccinations may be given via injection and/or spray. Injection can be highly automated and done in combination with the beak treatment, or the bird can be vaccinated manually (see Figures 66 and 67).

Vaccines that require to be inhaled are given via spray as a very fine mist. Spray vaccination is done using a coarse spray allowing the vaccine to enter into the upper respiratory tract. Preening is important in promoting vaccine uptake (see Figure 68).

Vaccines and probiotics that require ingestion are given via gel droplet. After administration the poults are placed under bright lights to promote the preening and ingestion of the product (see Figure 68).

Figure 66. Fully automated injection with beak treatment

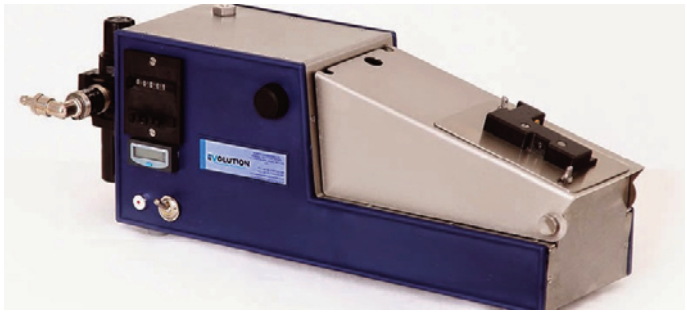


Figure 67. Semi-automated injection

Figure 68. Spray and gel bar application with lights to promote preening post application

The quality of the services that the poults receive can directly impact the birds' performance in the field. Therefore it is of utmost importance that rigorous quality control programs are in place to ensure servicing parameters are always met and if a parameter is to go out of range, it is important that it be quickly recognized and promptly corrected.

The following areas should be routinely checked:

Sexors

- Sexing accuracy.
- Any possible internal injury or damage.
- Toe Treatment.

Ensure that treatment levels are adequate per customer request and not over/under treated as this will result in potential welfare issues in the field.

Beak Treatment

- Ensure that treatment is appropriate.
- If treatment is too light, it will result in the regrowth of the sharp point of the beak potentially resulting in pecking and bird injuries later in life.
- If too severe, it may make the beak sensitive and make the poult reluctant to start on feed/water potentially resulting in a decrease in starting liveability.

Injection Site

- If spray vaccination is used, ensure poults can dry sufficiently in a comfortable area.
- Ensure that the correct dose is delivered.
- Partial doses may result in inadequate vaccine coverage.
- Bloody injection sites indicate that a needle has a burr, and/or misaligned.

- It is imperative that all injectables are mixed in a designated room away from the production area and mixed aseptically.
- Do not mix probiotics in the same area as the injectable.
- Be aware of "shelf-life" of injectables once mixed.

Ingested products

- Check the tongues for residual product dye to access uptake.
- Poor or low take up <85% can impact the vaccinations results.

Health Plan and Welfare Guidelines

- Ensure compliance.

HATCHERY MAINTENANCE

Hatchery maintenance is the process of checking that all equipment is working correctly to minimize the risk that a machine failure could adversely affect hatch performance and/ or poult quality (see Figure 69).

Hatchery maintenance also includes the upkeep of the hatchery structure and facilities to ensure that they can be cleaned and properly disinfected.

A good maintenance program is an essential part of hatchery management and is often what distinguishes good hatcheries from poor ones.

A good program is one that has a routine maintenance schedule that ensures all equipment is checked at the correct time interval as to minimize the risk of equipment failure. A good preventative maintenance program consists of the following information for each piece of equipment:

- The identity of the equipment.
- The preventative maintenance checks required.
- The equipment log of all and any repairs/changes made.
- Date of next maintenance.
- The expected frequency of preventative maintenance (daily, weekly, annually etc).

The recommendations of the equipment manufacturer should be used to set the minimum frequency of preventative maintenance checks. However, it may be necessary to increase the frequency of checks due to:

- Local regulations.
- The importance of the equipment to the functioning of the hatchery.
- Frequency of use.
- Past experience of the equipment, e.g. a history of frequent failure.

Performance monitoring of all equipment in the hatchery so issues can be quickly identified and rectified. The degree of monitoring required will depend on the importance to the incubation process.

Where critical processes are controlled by environmental sensors (e.g. thermometers, humidity and CO_2 sensors), calibration should be carried out frequently.

See **Hatchery calibration** (page 50)

** Sooner if in higher contamination areas such as the service or holding rooms.*

Equipment/ Machinery:	Recommended Frequency:	Recommended Actions to Take:
Incubators & Hatchers	Daily	Check temperature, humidity, ventilation setting, and turner operation. Top off wet bulb thermometers if necessary.
Egg Storage	Twice Daily	Check temperature and humidity
Incubator & Hatcher Rooms	Daily	Check temperature and humidity and static pressures (where required).
Water Chillers	Daily	Water temperature.
Standby Generators	Weekly	Test automatic changeover and run under load for 1 hour.
Hatchery Alarms	Weekly	Test all alarms and alerting systems.
Hatchers	After/Before Every Hatch	Properly clean and disinfect. Inspect for visual damage or faults. Inspect fan belts for wear, splits and correct tension. All fans and heater bars are working. Humidity sprays are working correctly, i.e. no droplets forming or leaks. Spray nozzles should be removed and cleaned to prevent build-up of deposits. Check for water leaks from cooling and humidification system. Covers to protect sensors during washing are removed after cleaning. Replace wet bulb wicks.
Sexing carousels/ tables/ conveyors	After Every Hatch	Properly cleaned and disinfected, including undersides of conveyor belts. Visual inspection for damage or faults.
Incubators	After/Before Every Set or Transfer	Properly cleaned and disinfected. Visual inspection for damage or faults. Inspect fan belts for wear, splits and correct tension. All fans and heater bars are working correctly. Humidity sprays are working correctly, i.e. no droplets forming or leaks. Spray nozzles should be removed and cleaned to prevent build-up of deposits. Check for water leaks from cooling and humidification system and leaking solenoids. Replace wet bulb wicks. Grease fan bearings and turning mechanism cogs. Check turner mechanism for correct angle and smooth operation. Inspect ventilation dampers and lubricate linkages.
Hatchery Ventilation	Every 1-3 months*	Clean and /or replace air filters – clean inside all air ducts.
Water chillers & Air compressors	Every 1-3 months*	Inspect and test.
Room Humidifiers	Every 1-3 months*	Inspect and clean spray nozzles.
Water Supply/ Systems	Every 1-3 months*	Check water treatment and parameters.
Incubators & Hatchers	Varied – Based on Manufacturer's Recommenda-tions	Calibration.

Figure 69. Typical hatchery preventative maintenance program

Figure 69 is an example of a hatchery maintenance program but it should not be treated as comprehensive. The program should be adapted to meet the requirements of each hatchery and the type of equipment installed.

Where machines are operated continuously (e.g. multi-stage incubators) it is important to schedule periods when the machines can be taken out of service for maintenance, cleaning and disinfection as required.

Properly trained personnel should always carry out preventative maintenance or repairs and comply with any local Health & Safety Regulations. If suitably trained personnel are not on the hatchery staff, ensure that trained contractors are used.

Keep a comprehensive stock of spare parts for all equipment.

The use of checklists such as Figure 70 can be helpful to ensure all items are properly checked during maintenance.

Pre-setting checks		
Item	**Checked Y/N**	**Staff Member**
Fan belt		
Heater bars		
Humidity nozzles		
Drip check		
Turning working		
Alarm working		
Clean & Disinfected		
Humidity sensor cover off		
Door thermometer check		

Figure 70. Example of a maintenance checklist

Incubators and hatchers require continuous monitoring, with alarms, to ensure temperature and humidity stay within the required limits. The alarm system should be independent of the machine control system.

Whatever automated alarm system is used, it is also recommended that manual temperature and humidity checks be carried out at least twice daily. In incubators it is also important to check that the eggs have been turned.

The temperature and humidity in egg storage, incubator and hatcher rooms should be checked at least twice daily. When incubators that require static pressure gradients between air inlets and exhausts are used, these should be checked at least twice a day.

See Figure 71 for an **AM/PM incubator checklist**.

If any monitored variable is found outside the acceptable range then prompt action must be taken to determine the cause of the problem and if necessary rectify the issue.

DIC	Temp Target	Temp Actual	RH Target	RH Actual	Rack Turn	Vent Position	Comments/Changes
0							
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							

Figure 71. AM/PM incubator checklist

Hatchery monitoring

Figure 71 is an example of an **AM/PM incubator checklist** for routine visual machine checks. Each incubator and/or hatcher should have its own log sheet with its specific checks/ requirements needed.

Do not rely solely on hatchery alarms to track/address machine function. The alarm system should be used as a backup system and not replace visual checks.

Once a machine reaches alarm status, it has already been out of parameters for a specified period of time. Machines may run out of parameter but just short of the alarm range.

Hatchery calibration

Routine hatchery calibration is required to ensure that incubators and hatchers function correctly (see Figure 72). All machine sensors should be calibrated minimally at the intervals recommended by the manufacturer.

Other equipment within the hatchery may also require calibration, e.g. sensors controlling room temperatures and humidities, and cooling water temperatures.

Where the equipment manufacturer provides instructions on how to calibrate a sensor, these instructions should be followed.

Thermometers used for incubator and hatcher calibration should be readable to at least 0.2°F (0.1°C) accurate to 0.4°F (0.2°C) and have a stability of less than 0.05°C per year. Thermometers with greater readability (<0.05°C) and accuracy (<0.1°C) are available and would be preferred but do tend to be expensive.

Equipment used to calibrate sensors should also be regularly calibrated to a national certified standard by an accredited laboratory. The manufacturer's recommended frequency of calibration should be followed, normally annually.

Protocols should be written to ensure that calibration is always done exactly the same every time.

For example, when calibrating incubator temperature in some machines the direction of ventilator movement and egg turning will alter the pattern of airflow within the machine and may affect the calibration procedure.

Therefore, it is important that the incubation equipment is calibrated according to the manufacturer's guidelines.

Ideally the calibrating sensor should be placed as close to the machine sensor as practical.

The calibration sensor should be placed in the machine and allowed to stabilize for a period before taking a reading.

Machine Checks

Data Checked	Heater bar/coils working	Fan secure belt tension	Humidity nozzles ok	Vents opening	Alarms working	Machine cleaned properly	Machine program correct	Initial & comment:

Incubator Checks

DIC	Temp Target	Temp Actual	RH Target	RH Actual	Rack Turn	Vent Position	Initial & comment:

Machine Calibration

Calibration Type	Machine	Meter	Machine off sett	Adj. Off set	Off set now	Date	Initial	Box Ident	Initial & comment:
Temp 1									
Temp 2									
CO_2									
Humidity									

Date/time loaded:	Loaded by:	Hatch/transfer date:

Date	Time	Temp 1	Temp 2	Humidity	Damper POS	Time period	CO_2	Turn POS	Turn count	Ok to profile	Initial & comment:

Figure 72. Hatchery machine calibration checklist

If any adjustments are made to the machine sensor following calibration, allow the machine to re-stabilize before checking the reading. Keep records of the results of the calibration.

These records should show:

- Identity of incubator or hatcher and the calibration sensor.
- Reading on the calibrating sensor.
- Incubator or hatcher sensor reading before any adjustment made.
- Incubator or hatcher sensor reading after adjustment (if necessary).
- Date of calibration.
- Date of next calibration.

Incubators and hatchers should be routinely calibrated, especially after any maintenance work carried out on the control systems.

However, the frequency of calibration should be modified by experience: for example, if large (>0.3°C) adjustments are required every incubator calibration then it may indicate that more frequent calibration is necessary.

Hatchery ventilation room static pressure

What is room static pressure?

"Room pressure" is the difference in pressure between the room itself and the reference it is being compared to.

If the room pressure is measured at +5 Pascals (Pa), and the reference is to the outside, this means that the air pressure in the room is 5 Pa higher than atmospheric pressure.

A room will show a positive pressure if it is well sealed, and the volume of air being supplied into the room is greater than the volume of air being extracted from the room through the incubators and other exhaust systems.

Why is room air pressure important?

Incubators are designed to operate with a certain pressure differential between the intake and the exhaust.

Too high or too low pressure differentials across the incubator can impair the flow of air through the incubator. This will affect the performance of the incubator and may compromise embryo development.

Most hatcheries operate on a slight pressure gradient between rooms to keep air from the dirtiest parts of the hatchery (poult and wash rooms) from getting into the cleaner areas (egg store and setters).

Units of measurement

The most common units used to measure room pressures are Pascals (Pa).

Pressure Meters

Pressure meters come in a variety of types and are known as manometers (see Figures 73, 74 and 75).

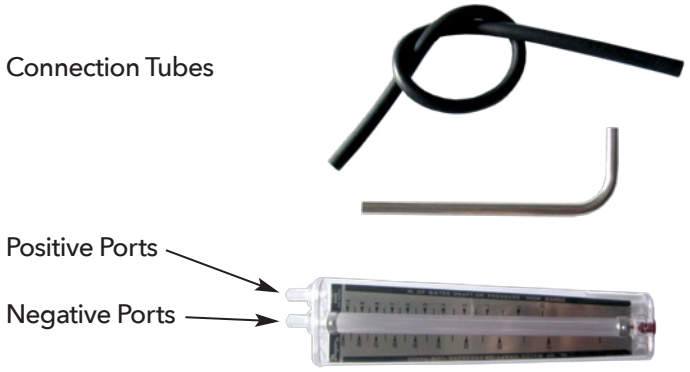


Figure 73. Floating ball meter. This portable and accurate meter can measure both positive and negative pressure

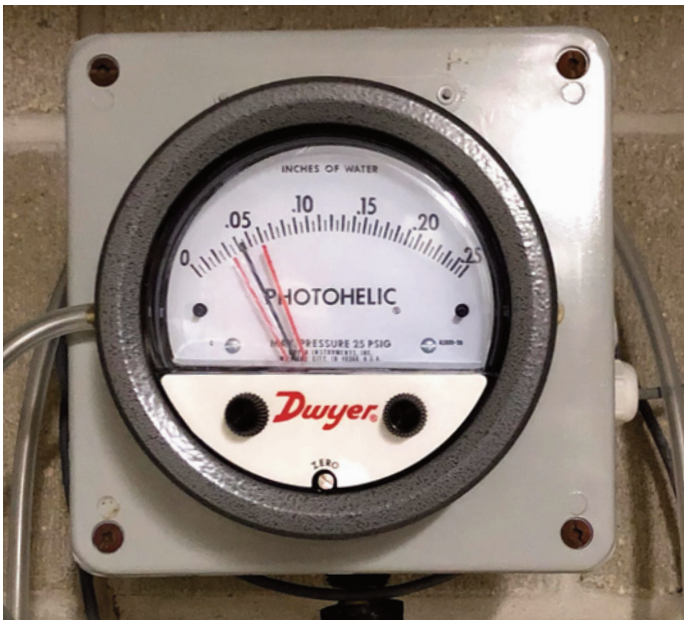


Figure 74. Dial meters can measure both positive and negative pressure

Figure 75. Digital meters are also suitable

Before buying a manometer, confirm the required pressure range of your specific incubator type.

For example, do not buy a manometer with a range of 0–60 Pa if your rooms are only going to operate at +5 Pa.

Reference point – outside air pressure

Room pressure should always be measured relative to the outside atmospheric pressure.

However, a room in the middle of a hatchery will often have several other rooms between it and the outside, all of them operating at slightly different pressures and none of them open to the outside. Here, measure room pressure relative to the roof or a passage, having first confirmed that the reference space is at ambient pressure.

***Note:** It may be impossible to have a reference room at equilibrium to the outside air, if so, find the reference room pressure relative to the outside air and then add this second measurement to the difference between the room of interest and the reference room. However, this method will increase the likely error in the measurement, so it is worth making every effort to create a proper reference room.*

Reference Point Options

1. Measure relative to the roof space

It is often easiest to use the roof space as a reference point.

Make sure the roof space is neutral by checking the pressure relative to the outside through a door or roof hatch.

If the pressure reading is 0, then the roof space is at atmospheric pressure.

If it is positive or negative relative to the outside, open doors in the roof space until the pressure is neutral.

Once the roof space is neutral, measure the pressure of the room of interest through a small hole in the ceiling of the room.

2. Measuring relative to a passage

First, check if the passage is at atmospheric pressure.

This can be done by opening all internal doors along the passage from the room to a point where the passage can open to the outside such as a window or door. Measure the passage pressure at this point.

If the pressure reading is 0, then the passage is at atmospheric pressure.

If the pressure reading is positive or negative, open an external door or window in the passage to equalize the pressure to the outside and then measure again.

Once the passage is neutral, go back to the room of interest (keeping all the inner leading doors along the passage open) and measure the room pressure through the door seal.

3. Measure directly to the outside

If the room has an outside wall, then a small hole can be made in the wall directly to the outside.

The outlet will need to be protected from the wind such that it is surrounded by still air.

Measure the room pressure directly relative to the outside through the hole.

How to use the Pressure Meter

Read the operating instructions, which will give directions on how to hold the meter while measuring, and how to calibrate. The meter will have both a positive and a negative port, and either one or both of these will have a plastic tube attached (see Figure 73 and 74).

Start by assuming that the rooms will be operating close to their design specification, and will be running at positive or negative pressure relative to atmosphere accordingly.

If measuring from within a positive room to the outside/roof then attach one end of the tube to the negative port and put the other end through the hole/door so that it is outside the room.

If standing outside a positive room (in the passage or roof) you want to measure, place one end of the plastic tube on the positive port and put the other end of the tube through the door/hole into the room.

In both cases above if the meter shows a positive reading or the dial moves to the right, the room is positive.

Connect the tubes opposite to the above if measuring a negative pressure room.

TAKE CARE!

- The outside reference point will need protection from the wind.
- The opening into the reference point should be small enough to prevent any airflow around the tube.
- If measuring across a door or window frame, make the opening as small as possible by closing the door or window against the tube, making sure not to pinch or squeeze the tube in the process.
- The manometer should be held vertically.

Static pressure troubleshooting

If the pressure reading seems to fluctuate or is otherwise unstable:

- Check the shield around the reference point opening to the outside air.
- Switch extractor fans off in rooms being used as a reference point and check that the room still has a neutral pressure to the outside.
- Make sure that the rubber tube of the manometer is not blocked from pushing it through the measuring hole.

If room pressure is not as expected:

- Ensure the reference point is correct.
- Check to make sure that air inlets and filters are not obstructed or dirty (see Figure 76).
- Check the fan speeds, fan belts and fan blades (bent or damaged fan blades will limit the effectiveness of the fan) (see Figure 77).
- Check to make sure that the ventilation dampers are working correctly.
- Check the Air Handling Unit (AHU) filters and fan settings.

Figure 76. Dirty air filters

Figure 77. Worn fan belt

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HATCHERY

Aviagen Turkeys, Inc.
31186 Midland Trail, East
Lewisburg, West Virginia 24901
USA
Tel: +1 304 793 2680
Fax: +1 304 793 2684
Email: turkeysinc@aviagen.com

www.aviagenturkeys.us

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