



# Cobb Hatchery

Management Guide

[www.cobb-vantress.com](http://www.cobb-vantress.com)



<b>01</b>	<b>—— Hatchability</b>	<b>2</b>	<b>11</b>	<b>—— Altitude</b>	<b>50</b>
<b>02</b>	<b>—— Hatchery Performance Indicators</b>	<b>5</b>	11.1	Oxygen Availability.....	50
<b>03</b>	<b>—— Hatching Egg Management</b>	<b>7</b>	11.2	Moisture Loss.....	51
3.1	Key Points of Egg Storage.....	8	11.3	Chick Quality and Mortality.....	51
3.2	Optimum Egg Storage Conditions.....	9	<b>12</b>	<b>—— Maintenance</b>	<b>52</b>
3.3	Impacts of Egg Storage .....	11	<b>13</b>	<b>—— Hatchery Automation</b>	<b>54</b>
3.4	Heat Treating Eggs.....	12	<b>14</b>	<b>—— Hatchery Design</b>	<b>55</b>
3.5	Pre-warming Eggs.....	13	14.1	Building Structure.....	56
<b>04</b>	<b>—— Incubator Operation</b>	<b>14</b>	14.2	.Hatchery Ventilation Configurations.....	58
4.1	Ventilation .....	15	14.3	Incubator and Hatcher Exhaust Plenum Configurations.....	60
4.2	Temperature Control.....	15	<b>15</b>	<b>—— Hatchery Sanitation</b>	<b>62</b>
4.3	Humidity and Egg Moisture Loss.....	21	15.1	Movement Through the Hatchery.....	63
4.4	Turning.....	26	15.2	Cleaning and Disinfection.....	65
<b>05</b>	<b>—— Egg Transfer</b>	<b>28</b>	15.3	Biosecurity.....	68
<b>06</b>	<b>—— Factors Influencing Chick Size</b>	<b>31</b>	<b>16</b>	<b>—— Records</b>	<b>69</b>
<b>07</b>	<b>—— Hatcher Operation</b>	<b>32</b>	<b>17</b>	<b>—— Embryo Diagnosis</b>	<b>71</b>
7.1	The Hatch Window.....	32	17.1	Recording Breakout Data.....	73
7.2	Temperature.....	36	17.2	Tracking Contaminated Eggs.....	75
7.3	Ventilation and Humidity.....	38	<b>A</b>	<b>—— Appendices</b>	
7.4	Adjusting the Hatcher Environment.....	39		Hatching Egg Grading Guide	77
<b>08</b>	<b>—— Chick Take-Off and Process</b>	<b>40</b>		Embryo Development Chart	78
8.1	Chick Yield Calculations.....	40		Common Causes of Embryonic Death	79
8.2	Feather Sexing Broiler Chicks.....	44		Diagnosis of Hatching Issues	80
8.3	Chick Grading.....	45		Chick Hatching Positions	81
<b>09</b>	<b>—— Hatchery Waste Disposal</b>	<b>47</b>		Chick Grading Guide	82
<b>10</b>	<b>—— Transportation</b>	<b>48</b>		Measurements and Conversions	83
				Formulas and Calculations	84

# Introduction

A sound understanding of the principles involved in incubating eggs and hatching chicks is vital for maximum hatchability and producing good quality day old chicks. This guide is designed to explain these principles as related to broiler breeding stock and to highlight the main aspects of hatchery management from egg production to chick delivery.

This guide is provided as a supplement to your hatchery management skills so that you can apply your knowledge and judgment to obtain the best results. This publication aligns with the Cobb Breeder and Broiler Management Guides and supplements (available at: <https://www.cobb-vantress.com/resource>) to provide technical information beginning with receiving breeding stock supply and continuing to the delivery of broilers for processing. Cobb also offers other technical resources including articles, posters, and videos that can be accessed from our website. Your Cobb Technical Representative is also available to answer questions you may have.

Our recommendations are based on current scientific knowledge and practical experience from around the world. You must be aware of local legislations, which may influence the management practices that you choose to adopt.



## Animal Welfare Tips

Look for this **Cobb Cares** symbol throughout the guide that highlights the Animal Welfare Tips and important aspects of management to improve poultry welfare outcomes throughout the hatchery and the welfare outcomes of the chicks being delivered to the farm.



*Cobb Hatchery Management guide is available online under  
**Resources > Management Guides***

## 1

# Hatchability

The measure of success of any hatchery is the number of chicks produced. This number, expressed as a percentage of all eggs incubated, is normally termed hatchability.

## Formula 1

The formula to calculate **percentage of hatchability** is:

$$\frac{\text{Number of Chicks Hatched}}{\text{Number of Eggs Incubated}} \times 100 = \text{Percentage of hatchability}$$

Hatchability is influenced by many factors. Some of these are the responsibility of the breeding farm and others are the responsibility of the hatchery. Understanding how each factor impacts hatchability can be used to improve production. Although the hatchery may have no control over certain factors, indicators at the hatchery can be used as feedback to the farm to improve fertility and hatchability. Thus, it is essential for the farm and hatchery to work closely together. Collecting and sharing data between farms and hatcheries is a good way to improve results and efficiency. Feedback to the farm should be communicated rapidly and consistently. Both positive as well as negative feedback are useful to consistently produce good results in hatching egg production and first-quality chicks.



*Each Cobb product line has specific standards for hatchability. Please refer to the corresponding product supplement for this information (see <https://www.cobb-vantress.com/resource>).*

## Farm Controlling Factors

**Breeder Nutrition** – Nutrition is fundamentally important to the production of eggs, which, in turn, will provide the embryo with all the requirements for development. Deficiencies as well as excess of certain nutrients can be detrimental to hatchability. Nutritional issues in the maternal diet tend to be associated with poor chick quality or mid-term embryonic mortality. Chemical additives including medications and toxins can also negatively impact hatchability.

**Disease** – Infection with specific avian diseases can cause abnormalities in egg shapes and/or shell (color and thickness) as well as reduce hatchability.

**Mating Activity** – Mating activity typically declines with age of the flock which can reduce the fertility and hatchability of eggs. Mating activity can also be influenced by male behavior, spiking events, and other environmental management factors (e.g. availability of food, space, ventilation, temperature).

**Egg Handling** – Eggs with cracks tend to lose moisture more rapidly than intact eggs and the moisture loss can decrease hatchability and chick quality. Cracks in eggs can also be a point of entry for bacteria leading to infection and embryonic mortality. The cuticle is the first line of defense from bacterial contamination and regulates gaseous exchange. Like cracks, damage to the cuticle can increase moisture loss and embryonic mortality. Placing eggs upside down (pointed ends upwards) and rough handling can also reduce hatchability.

**Genetics** – Hatchability may vary depending on the genetic line. Check our guides and supplements for data regarding hatchability of each genetic line (available at: <https://www.cobb-vantress.com/resource>)

**Correct Male and Female Bodyweight** – Over weight breeders are more reluctant to mate and this problem increases with age. Controlling bodyweight controls the rate of decline in female fertility and male sperm quality.

**Egg Sanitation** – There is a negative correlation between hatchability and floor eggs as well as washed eggs. Floor eggs are more prone to cracks, fecal contamination and higher bacterial counts on the shell. Floor eggs can also be a source of contamination to other eggs. Washing eggs can reduce the number of bacteria on the shell, but can also damage the cuticle leaving the egg vulnerable to contamination. In general, clean nest eggs have higher hatchability and produce better quality chicks.

**Egg Storage** – Temperature fluctuations and storage time can both negatively influence hatchability. Temperature data loggers can be used to determine storage times and temperatures, and in turn, can serve as auditing and troubleshooting tools.



### Animal Welfare Tips

Breeder flock health status is closely linked to egg quality. Good communication between the hatchery and production teams is critical to manage health, welfare and quality outcomes for chicks. If the hatchery reports egg defects, chick quality concerns, and embryo mortality results to production teams, this can help with breeder flock investigation and corrective actions.

## Hatchery Controlling Factors

**Sanitation** – A comprehensive sanitation program can lead to high hatchability. Microbial contamination is a leading cause of poor hatchability, reduced chick quality and early chick mortality. Proper containment of contaminated eggs, keeping equipment clean (in-ovo vaccinators, candling equipment, transfer equipment, etc.) and monitoring air quality are crucial factors of any effective sanitation program.

**Egg Storage** – Conditions should be dry as wetting eggs can increase the potential for bacteria, dirt and dust to stick to the eggs which may increase the risk of bacteria invading the egg and causing contamination. Temperature fluctuations i.e. raising and lowering the egg temperature around physiological zero (24 °C; 75 °F ) may lead to embryonic death. If air cooling and heating system vents are directed at the eggs during storage, eggs may lose moisture and are more susceptible to aerosolized contamination and temperature fluctuations. (see key points of egg storage section 3.1)

**Egg Damage** – Cracked and damaged eggs have a reduced hatchability over intact eggs as cracks and damage to the cuticle make the embryo more susceptible to bacterial contamination and desiccation. Care should be taken anytime eggs are moved, transported or transferred. If eggs are cracked or damaged, the number of eggs should be recorded in daily records. This type of data can help identify issues with hatchability that may relate to employee procedures, equipment maintenance and training.

**Management of Incubators and Hatchers** – Accurate environmental settings of the incubators and hatchers are crucial to achieving optimal hatchability. Temperatures that are too hot can cause early hatches, dehydrated chicks, reduced absorption of the yolk sac, and unhealed navels. Temperatures that are too cold can also reduce chick quality and cause delays in the hatch window. Likewise, humidity has a large impact on chick quality. Proper moisture loss increases the size of the air cell which allows the chick to pip in the proper position and consequently reduces red or injured hocks. Each manufacturer has variations in functions of their equipment. Be aware of the manufacturer's specifications for the equipment you are using in your hatchery.

**Maintenance and Equipment Management** – Equipment failures can be devastating to a hatchery and result in massive losses. A maintenance plan should include regular, scheduled and preventative maintenance to prevent equipment failures. Replacement and spare parts should be available to prevent delays in repairs.

**Ventilation** – Proper ventilation is central to achieve good hatch and produce quality chicks. Poor ventilation reduces the availability of oxygen necessary for embryonic development and may overheat the embryos causing overheated eggs or chicks, which may, in turn, predispose them to ascites.



### Animal Welfare Tips

Chick welfare and quality outcomes can be impacted from the early stages of incubation. Serious errors in temperature management at the farm, during transportation, during egg storage or in the incubator can have adverse consequences for embryo development and the welfare of the chicks.

# Hatchery Performance Indicators

The goal of a broiler breeding operation is to generate hatching eggs that will result in saleable chicks. Unfortunately, not all incubated eggs will hatch. When troubleshooting in the hatchery, an accurate account of where loss is occurring is necessary so that action can be taken to reduce loss from future hatches. There are several key performance indicators that can provide useful information to solve issues and optimize your hatchery protocols and settings.

Hatchery key performance indicators (KPIs) include:

- ✓ Hatch of fertile
- ✓ Eggshell temperature (Section 4.2)
- ✓ Egg moisture loss (Section 4.3)
- ✓ Hatch window (hatch window assessment) (Section 7.0)
- ✓ Chick cloacal temperature (Section 7.1)
- ✓ Chick yield (Section 8.0)



*Each Cobb product line has specific standards for percentage of hatch, percentage of fertility, and percentage of hatch of fertile. Please refer to the corresponding product supplement for this information (see <https://www.cobb-vantress.com/resource>).*



## Hatch of fertile

Because hatcheries have little influence over fertility, it is important to consider hatch of fertile in addition to hatchability. The percentage of hatch of fertile is a measurement of the effectiveness of the hatchery. Hatch of fertile considers the flock fertility as well as hatchability.

### Formula 2

The formula to calculate the **percentage of fertile eggs** is:

$$\frac{\text{Number of fertile eggs}}{\text{Number of eggs incubated}} \times 100 = \text{Percentage of fertile eggs}$$

An example calculation:

Number of fertile eggs 108

Number of eggs incubated 112

$$\frac{108 \text{ fertile eggs}}{112 \text{ eggs incubated}} \times 100 = 96.4 \% \text{ fertile eggs}$$

In Table 1, the percentage of hatchability, fertile eggs and hatch of fertile has been calculated for three hatcheries. Hatchery A has more hatching chicks, but a true measurement of hatchery performance is percent hatch of fertility and therefore, Hatchery B is performing the best of the three hatcheries.

Even though Hatchery B has the lowest % hatchability, it has the highest % hatch of fertile. This is because % hatchability was limited by fertility and not by the ability of the hatchery to effectively hatch eggs. Therefore, Hatchery B is clearly performing the best assuming chick quality is equal.

Using hatch of fertile will quickly identify the source of the problem as either fertility or hatchability. However, having both good fertility and good hatchability indicates a well performing farm and hatchery dynamic which is key to a good chick cost which is the ultimate goal.

### Formula 3

The formula to calculate **percentage of hatch of fertile** is:

$$\frac{\text{Percentage of hatchability}}{\text{Percentage of fertile eggs}} \times 100 = \text{Percentage of hatch of fertile}$$

An example calculation:

Percentage of hatchability 86.4 %

Percentage of fertility 96 %

$$\frac{86.4 \% \text{ hatchability}}{96 \% \text{ fertility}} \times 100 = 90.0 \% \text{ hatch of fertile}$$

Table 1. The percentage of hatchability, fertile eggs and hatch of fertile calculated for three hatcheries.

Hatchery	% hatchability	% fertile eggs	% hatch of fertile
A	86	97	88.66
B	82	91	90.11
C	84	94	89.36

## 3

# Hatching Egg Management

Optimum hatchability and chick quality can only be achieved when the egg is held under optimum conditions between laying and incubating. Remember that a fertile egg contains many living cells. Once the egg is laid, its hatching potential can, at best, be maintained, but not improved. If mishandled, hatching potential will quickly deteriorate. (See Appendices page 77 for hatching egg grading chart).

- ✓ Use of floor eggs decreases hatchability. Floor eggs should be collected and packed separately from nest eggs and clearly identified. If floor eggs are going to be incubated, they should be incubated in a separate incubator or on the bottom trays of the incubator.
- ✓ Keep the egg handling rooms clean and organized. Equipment such as humidifiers are prone to collecting dirt and water providing a suitable habitat for bacteria, mold and mildew to grow.
- ✓ Check for hairline cracks on eggs received from the farm. Hairline cracks are usually not visible to the naked eye. Furthermore, cracked eggs impact hatchability, chick quality, egg weight loss, and mortality.



Candling eggs from the farm and removing cracked eggs can reduce a source of contamination

and recording hairline cracked eggs can also help troubleshooting efforts and more accurately determine the source of hatchability issues.

- ✓ Use a rigid pest control program in egg rooms.

- ✓ Store the eggs in a designated room in which the temperature and humidity are controlled, monitored and recorded.
- ✓ Place hatching eggs carefully into the incubator or transport tray, small (pointed) end downward. This will keep the yolk centered in the middle of the egg and reduce the risk of any bacteria getting to the yolk.
- ✓ Grade eggs carefully. During the early production period, check the weight of marginally sized eggs to select hatching eggs. Using eggs that are less than 48 grams may produce a chick that is too small to reach water and feed. Using eggs that are over 70 grams may cause an increased number of cracks.
- ✓ Only keep the clean eggs for hatching. Washing or rubbing dirty eggs can damage the cuticle which is a protective layer around the egg. Damaging or removing the cuticle allows bacteria to enter the egg and rubbing can force bacteria into the pores of the egg. (See Cobb Breeder Guide for information on hatching egg disinfection available <https://www.cobb-vantress.com/resource>)
- ✓ Refuse to accept dirty egg containers and dirty buggies (trolleys). Keep them clean while they are on your premises.
- ✓ Prevent hairline cracks by handling eggs carefully at all times. Hairline cracks cause eggs to dehydrate and provide bacteria with an entrance into the egg.



Each Cobb line has specific standards for egg weights available at: <https://www.cobb-vantress.com/resource>

The Cobb Egg Grading Chart is available at the end of this guide in the appendices on page 77.



### 3.1 Key Points of Egg Storage

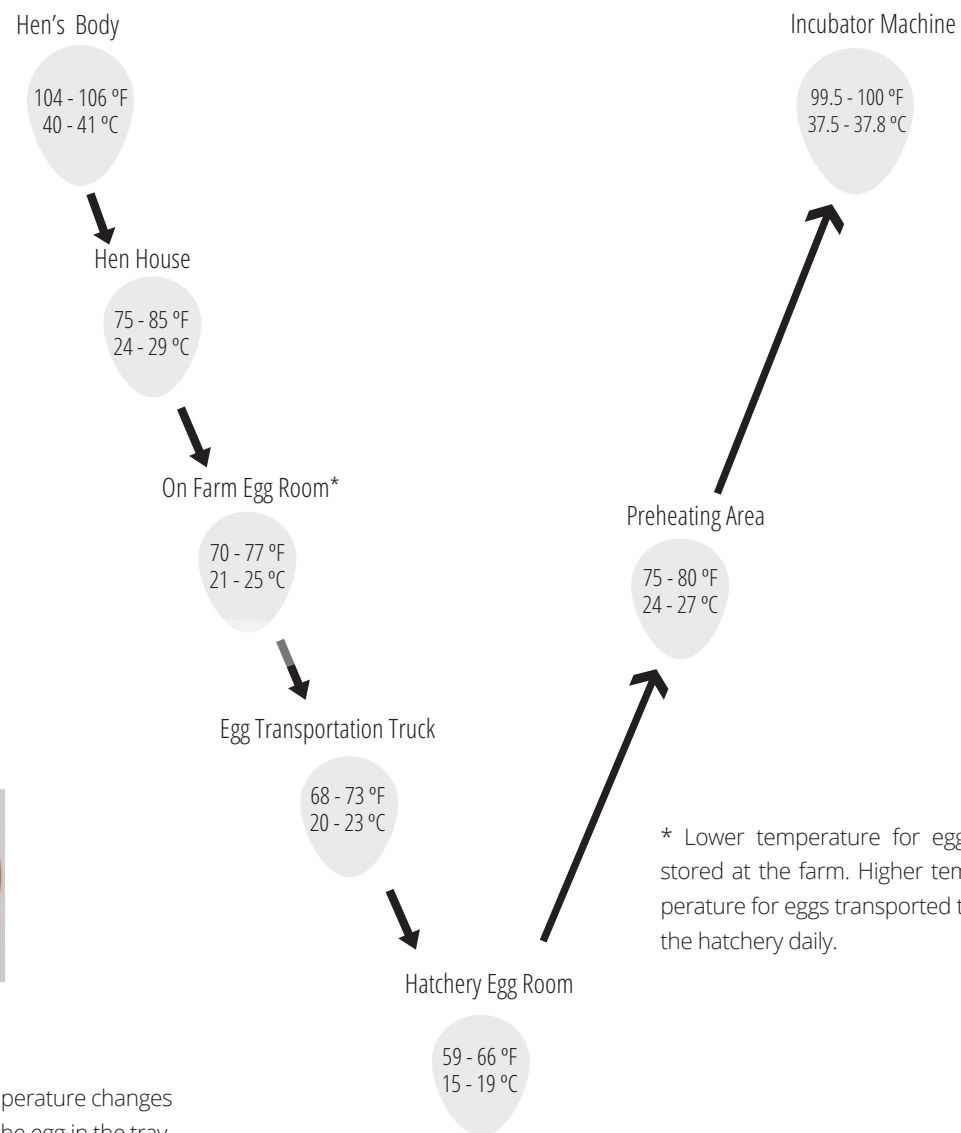
Eggs should be collected from the farms and transported to the hatchery at least twice each week. There are three main areas of egg storage: the farm egg room, transportation vehicles, and the hatchery egg room. It is important to match the conditions in each of these areas as closely as possible and to prevent sharp changes in temperature and humidity, which can lead to condensation ("sweating") on eggs. Sharp temperature changes can also lead to eggs being chilled or overheated. Condensation on the eggshell provides a place where bacteria and mold spores can stick to the shell and gives these microorganisms the water they require to sustain life. If microorganisms enter the incubator while on the shell, the chances of contaminating other eggs, embryos or newly hatched chicks increases significantly since eggs are incubated in a warm, moist environment.

Measure the egg temperature at receiving and evaluate the conditions of farm storage or egg supplier and transport conditions. Egg storage in the hatchery should be an environment with uniform, controlled temperature. The egg temperature at reception at the hatchery is a critical point of control so the conditions of storage on the farm or with egg suppliers should be audited. It is also important to perform regular audits of the room temperature and conditions in different parts of the hatchery egg storage room. Consider placing data loggers in each area of the egg storage room to determine if there are deviations from the optimal temperature.



The "crepe paper test" can be used to determine if eggs have been exposed to sharp temperature changes resulting in condensation on the egg. At the farm, wrap an egg in crepe paper and place the egg in the tray. At the hatchery, remove the egg with the crepe paper from the tray and check for dye stains which would indicate that condensation has formed on the egg at some point between the farm and hatchery.

The ideal temperature curve for eggs after laying through storage. The reduction of temperature occurs gradually until the storage temperature is reached with no elevation of temperature until preheating.



### 3.2 Optimum Egg Storage Conditions

There is a relationship between the length of time eggs are stored and the optimum temperature and humidity for best hatchability. In general, the longer eggs are stored, the lower the storage temperature should be and vice versa. The humidity during storage is not as important as the temperature. If eggs are stored up to 10 days, 50 to 60 % relative humidity is optimum. However, if eggs are stored for longer periods, the relative humidity should be increased (60 to 70 %) to prevent the egg from losing moisture. Regardless of storage time, humidity should be kept below 80 % as high relative humidity facilitates the growth and spread of fungi.

- ✓ Egg storage rooms should be kept clean to prevent eggs from being contaminated and subsequently contaminating the incubators as the incubators provide a very suitable environment for microorganisms.
- ✓ Prevent unnecessary traffic flow through the egg storage room. Movement in and out of the room can disturb storage conditions (temperature, humidity, ventilation and air flow patterns) and introduce microorganisms and contamination.
- ✓ The floors and walls should be free of cracks. The floors should be dry with no standing water which can increase humidity and provide areas for microorganisms to grow.
- ✓ Use a biosecurity design for the egg storage room with foot dips and hand sanitizers, preventing unauthorized personnel from entering, and cleaning and disinfecting the room on a regular basis. Use a rigid pest control program.
- ✓ Fans should pull air away from eggs and not blow air directly down onto eggs. Filters from air conditioning units should be cleaned or changed on a regular basis.
- ✓ Eggs should be stored in racks with ample space between trays or cartons of eggs to allow gaseous diffusion, air movement and uniform temperatures among eggs. Do not store eggs on the floor. Do not place eggs next to heaters.
- ✓ Do not use the egg storage room for storage of other equipment or materials as this may increase traffic to the room presenting a biosecurity risk and disrupting room environmental conditions.
- ✓ As part of a preventative maintenance program, calibrate thermometers to ensure the room temperature is correct. Consider using data loggers to monitor the room temperature.
- ✓ A temperature below 24 °C (75 °F) arrests development and is termed 'physiological zero'. Fluctuations around this temperature can cause intermittent embryonic development. For this reason, variations in temperatures within egg storage can result in embryos in various stages of development. Having embryos at the same developmental stage will produce a uniform hatch window, but requires keeping all eggs at a uniform temperature below physiological zero during storage.

Egg storage conditions based on storage time

Storage Time Days	Temperature °C    °F	Humidity
1 to 6	18 to 19 (64 to 66)	50 to 60 %
7 to 10	16 to 17 (61 to 63)	50 to 60 %
> 11	15 to 16 (59 to 61)	60 to 70 %

## Cooling System Guidelines for Egg Storage Rooms

Temperature range		BTU recommendation		HVAC tonnage recommendation	
		Tropical and Arid Climate	Temperate Climate	Tropical and Arid Climate	Temperate Climate
°C	°F				
20 to 21	68 to 70	32,000	27,000	3	2.5
19 to 20	66 to 68	32,000	27,000	3	2.5
18 to 19	64 to 66	33,000	28,000	3	2.5
16.5 to 18	62 to 64	34,000	29,000	3.5	3
16.5 to 15.5	60 to 62	35,000	30,000	3.5	3
15.5 to 14.5	58 to 60	36,000	31,000	3.5	3
14.5 to 13	56 to 58	37,000	32,000	4	3.5
13 to 12	54 to 56	38,000	33,000	4	3.5
12 to 11	52 to 54	39,000	34,000	4.5	4
11 to 10	50 to 52	39,000	34,000	4.5	4

*All calculations are based on a room size of 10,000 ft<sup>3</sup> (100 m<sup>2</sup> with 3M ceiling; 1000 ft<sup>2</sup> with 10 ft ceiling)*

- ✓ These recommendations are based on a storage room with good insulation, no ventilation leaks, and minimum heat load additional in the room.
- ✓ Storage of equipment in the egg room is not recommended as this can increase movement in and out of the egg room which can increase energy consumption.
- ✓ The recommended minimum insulation R values for walls is R19 and ceilings is R30.

### 3.3 Impacts of Egg Storage

- ✓ Hatchability is optimal with eggs stored between 3 to 6 days. At lay, the pH of the albumen is too low for optimal embryonic development, but protects the embryo from bacterial infection. During storage, carbon dioxide (CO<sub>2</sub>) is released increasing the pH of the albumen from 7.6 to a range of 8.8 to 9.2 (the optimal range). Therefore, incubating eggs within 48 hours of lay will result in a 1 to 2 % reduction in hatch.
- ✓ Prolonged storage decreases hatchability. The effect increases with storage time after the initial six-day period, resulting in losses of 0.5 % per day up to 10 days, and 1.0 to 1.5 % per day thereafter. Chick quality will be affected and hence broiler weights can be depressed in chicks from eggs that have been stored for an extended time frame.
- ✓ Extended periods of egg storage (8 days or more) result in albumen degradation which may cause the embryo to move close to the eggshell. Early embryonic mortality can then result from dehydration during the early stages of incubation. In this case, turning eggs that are stored for an extended period may be helpful to prevent losses in hatchability.
- ✓ The detrimental effects of long-term storage are more pronounced in eggs from old breeder flocks (>55 weeks of age) as these eggs have thinner shells, lower albumen quality at oviposition and increased rates of albumen degradation during storage.
- ✓ Gas exchange occurs through the pores in the eggshell during storage. CO<sub>2</sub> diffuses out of the egg, and the concentration declines rapidly during the first 12 hours after the egg is laid causing a reduction in the viscosity of the albumen. Eggs also lose water vapor while in storage. The loss of CO<sub>2</sub> and water contributes to the reduction in hatchability and chick quality during storage.
- ✓ Storage conditions must be designed to minimize hatchability losses. Most eggs are placed in open-sided cases/boxes or farm racks, but some are placed in solid covered cases. Allow covered eggs to cool down and dry thoroughly before casing to prevent condensation and subsequent growth of microorganisms.
- ✓ Storage prolongs incubation time. An increase in incubation time should always be added to the beginning of the incubation cycle.

#### Change in incubation time based on \*egg age

Egg Age	Incubation time
7 days or less	No change
8 to 9 days	Add 1 hour to incubation time (incubate 1 hour early)
10 to 11 days	Add 2 hours to incubation time (incubate 2 hours early)
12 days or more	Add 3 hours to incubation time (incubate 3 hours early)

\*egg age -defined as time from lay until incubation

### 3.4 Heat Treating Eggs

Performance losses in the hatchery are often due to egg age, especially for breeding grandparent and parent stock operations. For most operations, egg age is ideally less than 7 days of age, but with variations in orders, production volumes from different sized farms and market or seasonal conditions, increased storage time can be inevitable. Extended egg storage can result in reduced hatchability and chick quality, increased incubation time and increased 7-day mortality.

Eggs that are stored more than 7 days tend to develop slower during incubation. There is also a strong correlation between early embryonic death and increasing storage time. Heat treating eggs involves using short periods of Incubation during storage. The heat treatment promotes cellular division and short periods of embryonic development. With heat treatment, incubation hours do not need to be added to incubation time as shown in Section 3.3.

In practice, heat treatment leads to:

- ✓ Improved hatchability
- ✓ Reduces loss of fertile eggs during storage
- ✓ Improves chick quality
- ✓ Narrows the hatch window

Other methods of reducing negative impacts of extended storage:

- ✓ Reduce the temperature in storage. Do not go below 15 °C (59 °F)
- ✓ Store eggs small end up (remember to turn back to large end up before incubating)
- ✓ Turn eggs during storage
- ✓ Increase incubation time

### Heat Treatment Guidelines

Expected storage time (days)	Number of treatments	Treatment days (Age of egg)
9 to 11	1	day 5 or 6
12 to 16	2	day 6 and day 11
17 or more	3	day 6, day 11 and day 16

Heat treatment length (hours)	Incubation Temperature	Cycle
1	26.5 °C (80 °F)	Pre-warming
6*	35.0 °C (95 °F)	Incubation
3	23.9 °C (75 °F)	Cool down

\*If doing 3 treatments, shorten the length of the last heat treatment time to 4 hours.

### Key Points

- ✓ Heat treatment must be done using equipment designed for this purpose or using an empty single stage incubator.
- ✓ The embryo cannot be above 32 °C (90 °F) for more than 13 hours (eggshell temperature, not air temperature). If the heat treatment step is too long, embryonic loss can occur.
- ✓ The egg must be lowered to 26 °C (79 °F) after the treatment as quickly as possible.
- ✓ Place heat treated eggs back in the egg room in a place where they will not warm other eggs in the room.
- ✓ After the eggs are heat treated they must be stored for a minimum of 24h before incubation. If eggs rapidly increase in temperature during storage condensation can occur.
- ✓ Eggs should not be returned to the egg store until they are within 2 degrees C of the egg storage temperature.

## 3.5 Pre-warming Eggs

Prior to incubating, eggs should be removed from the egg room and pre-warmed. Pre-warming eggs provides several benefits that include:

- ✓ Reduces the risk of embryo shock.
- ✓ Prevents condensation forming on the shell. Condensation can allow bacteria to stick to the shell which increases the risk of contaminating the egg.
- ✓ Pre-warming eggs prior to incubation will reduce the variation among egg temperatures at the time of incubating. Similar egg temperatures will narrow the hatch window.

### Multi-stage incubators

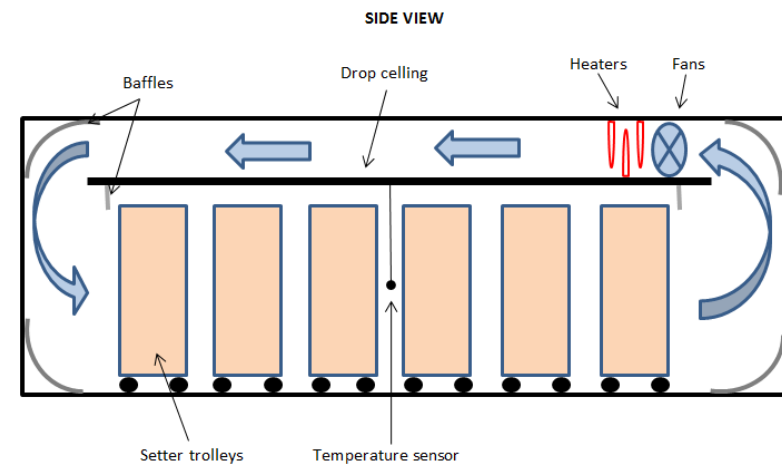
Multi-stage incubators rely on the heat production of the developing embryos that are in the later stages of incubation to heat the eggs that are in the early stages of incubation. However, placing eggs from storage directly into the incubator can cause tremendous fluctuations in the heat and humidity distribution and the overall temperature in the incubator can drop significantly. This can cause a variety of issues for the embryos at all stages in terms of hatchability and chick quality.

For multi-stage incubators, eggs should be pre-warmed in a purpose-built room or pre-heating chamber at approximately 24 to 27 °C (75 to 80 °F; see diagram right)). Effective air circulation that moves air throughout the egg rack and correct room temperature are essential to achieve the necessary and uniform pre-warming of eggs. Uneven pre-warming increases variation in hatch time, which is precisely the opposite of the desired effect of pre-warming.

Even with good air circulation, it will take 6 hours for eggs on a buggy to reach 26 °C (78 °F) regardless of their initial temperature. With poor air circulation, it may take twice as long. The pre-warming hours should not be added to total incubation hours. It is recommended to provide effective air circulation around the eggs and allow 6 hours for pre-warming.

### Single stage incubators

In single stage incubators, pre-warming can be accomplished inside the incubator, and the pre-warming hours should not be added to total incubation hours. See the manufacturer's specific guidelines and instructions. In general, a pre-warming time and temperature of 6 hours at 26.6 °C (80 °F) is typically used for single stage incubators.



For multi-stage incubators, eggs should be pre-warmed in a purpose-built room or pre-heating chamber as diagramed above.



# 4

## Incubator Operation

Energy consumption, labor usage, durability, maintenance, technical support, parts availability, and capital costs influence the choice of the incubator design. The optimum physical conditions for any embryo to grow successfully are **adequate gas exchange, correct temperature, correct humidity, and regular turning of eggs.**

The actual quantity of eggs to be loaded in each machine, the frequency of loading (once or twice a week) and the actual position of the eggs within the machine will vary with each manufacturer. Operate the equipment according to the manufacturer's instructions.

The total recommended incubation times are 504 to 510 hours for a multi-stage and 504 to 508 hours for a single stage incubator. However, some variation (+/- 2 to 4 hours) is expected according to flock age, egg age, breed, climate and hatch window.

### Commercial incubation systems fall into three main categories:

- ✓ Multi-stage fixed rack - incubates eggs at different development stages and is loaded using trays of eggs.
- ✓ Multi-stage buggy loading - incubates eggs at different development stages and is loaded using trays of eggs on preloaded buggies. Buggies are then loaded into the incubator.
- ✓ Single stage buggy loading - incubates eggs at the same development stage and is loaded using trays of eggs on preloaded buggies. Buggies are then loaded into the incubator.

### Four factors influence the total incubation time of eggs:

- ✓ Temperature of incubation: Normally fixed for any hatchery, but to achieve a desired take-off time for chicks, modifications to time can be adapted to age and size of eggs.
- ✓ Age of eggs: older eggs take longer to incubate. You will need to add extra incubation time if eggs are stored over 7 days.
- ✓ Size of eggs: larger eggs take longer to incubate.
- ✓ Moisture loss: Low moisture loss will slow the hatch cycle and decrease hatchability. Excessive moisture loss will decrease the number of incubation hours.

	Temperature	Humidity	Ventilation	Sanitation	Cost
Multi-stage	Relies on the mix between endothermic and exothermic producing embryos to balance temperatures throughout the incubation time frame	Typically set at 47 to 52 % depending on manufacturer and egg types	Constant air exchange rate of approximately 0.14 m <sup>3</sup> /minute/1000 eggs and adjusted for CO <sub>2</sub> at a maximum of 0.4 %	Cleaning and disinfection cannot be done in all locations without interrupting incubating schedules	Relatively lower energy and equipment cost
Single Stage	Temperature settings must be carefully monitored and adjusted to deliver more heat at the early stages and decreases as development progresses	Humidity is initially high to promote osmosis between albumen and yolk but is decreased at later stages during development of heart and blood circulatory systems	Air exchange rates are variable and adjusted according to humidity and egg moisture loss	Allows thorough cleaning and disinfection between egg incubations every 18 days	Relatively higher energy and equipment cost

## 4.1 Ventilation

Incubators normally draw fresh air from the room or fresh air plenum in which they are located. This fresh air supplies oxygen and moisture to maintain the correct relative humidity. Air leaving the incubator removes CO<sub>2</sub>, humidity and excess heat produced by the eggs. The air supply to the incubator room should be 5 to 8 cfm (8.5 to 13.52 m<sup>3</sup>hr) per 1000 eggs. (See table Hatchery Ventilation Configurations; Section 14.2). Most incubators have a humidity source that can vary the levels of relative humidity. The fresh air supplies relatively little moisture, and so to reduce the load on the internal humidification system, air entering the machines is pre-humidified to closely match the internal relative humidity. The temperature of this air should be 24 to 27 °C (76 to 80 °F).

**Multi-stage incubators** require constant air exchange. The ventilation should be adjusted so that the CO<sub>2</sub> level within the machine does not exceed 0.4 %. Most fixed rack incubators operate at 0.2 to 0.3 % and buggy incubators at 0.3 to 0.4 % but these CO<sub>2</sub> levels are not required.

**Single stage incubators** have specific air exchange rates that are required at different times during incubation. The damper will be completely shut or almost shut during the first stages of incubation. The damper will open gradually as the incubation cycle progresses and will be fully opened at the end of the incubation cycle. The manufacturer of each incubator can provide more detailed calculations for this operation.



## 4.2 Temperature Control

Temperature determines the metabolic rate of the embryo and hence it's rate of development. Modern broiler breeder genetics produce higher embryonic temperatures and therefore the risk of embryos overheating is higher. Research has shown that adverse incubation conditions can affect post-hatch performance at different stages of the life cycle.

Factors that can impact uniformity of temperature in the incubator:

- ✓ Incorrect ventilation – air volume supply, pressure, damper settings, exhaust ventilation
- ✓ Temperature calibrations - calibrate the temperature probes of the machine every 90 days for a multi-stage machine and every time a single stage machine is empty
- ✓ Cooling problems – water flow rates, sticky valves, incorrect water temperature, mineral deposits in the pipes
- ✓ Over or under utilization of incubator capacities – Machines are calibrated to be full and may not operate within calibrated temperature ranges if not full of eggs
- ✓ Poor engineering design
- ✓ Maintenance – door seals are worn, cracked, or broken
- ✓ Incorrect turning angle – calibrate every 90 days for a multi-stage machine and every time a single stage machine is empty. Adjust if necessary (See section 4.4)
- ✓ Incubation patterns (see next page)

## Balancing incubation patterns

In **single stage incubators**, temperatures can be modified to optimize embryonic growth and heat production, starting at a higher temperature and subsequently reducing the temperature in stages through transfer.

In **multi-stage incubators**, the temperature should remain constant. The optimum air temperature for both hatchability and chick quality will differ depending on the type of incubator. Using higher or lower temperatures than the manufacturer’s recommendations will lead to faster or slower embryonic development and consequent issues with the hatch window, hatchability and / or chick quality. Incorrect balance in loading multi-stage incubators can create major temperature variations. Partly filled incubators may not achieve the correct temperature and prolong incubation, while overloading can create overheating problems. Both conditions will adversely affect hatchability and chick quality.

Multi-stage incubators are designed to perform best when they have a mix of flock egg ages in the machine (Figure 2). However, placing young, prime, and older flocks in a block pattern can adversely affect hatchability and chick quality.

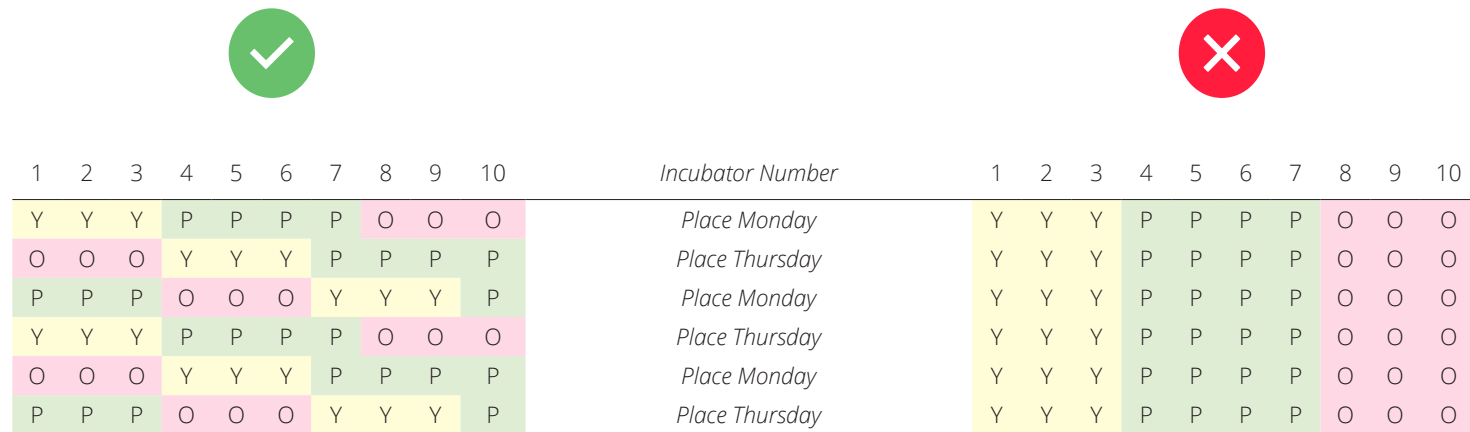


Figure 2. Correct (left) and incorrect (right) pattern of eggs in a multi-stage incubator. By mixing the flock ages (Left), a more uniform distribution of embryonic heat and temperature is created which prevents high/low temperature areas in the incubator. Y = eggs from young flocks; P = eggs from prime flocks; O = eggs from older flocks.

## Measuring eggshell temperatures

Undoubtedly temperature is the most critical factor in the incubation process. Several experiments and field trials have shown how small differences in air temperature influence embryo development, hatchability, navel quality and post hatch performance. The temperature during incubation influences organ weight, development of the cardiovascular system, muscles and tendons. However, the determining factor is not the temperature of the air, but the temperature of the shell which is a reflection of the temperature of the embryo. Eggshell temperatures of 37.7 to 38.0 °C (100 to 100.5 °F) are optimal for the development of embryos.

Measuring eggshell temperature can improve hatchability, but there are also numerous studies indicating that proper management of eggshell temperature can lead to reduced 7-day mortality and improve feed conversion and overall broiler livability. The data collected from eggshell temperatures will indicate management interventions required or specific locations that need to be addressed by machine or hallway. It can also help optimize incubating and transferring times.

Eggshell Temperature °C (°F)	Conditions	Results
36.6 to 37.7 (98 to 99.9)	Too cold	Slow / poor hatch and poor chick quality
37.7 to 38.0 (100 to 100.5)	Optimum	Good hatch and good chick quality
38.0 to 38.8 (100.5 to 102)	Too warm	Good hatch but poor chick quality
39.1 to 40.0 (102 to 104)	Too hot	Poor hatch and poor chick quality

Impacts on embryos with **high** eggshell temperatures (>38.8 °C; 102 °F) during incubation include:

- ✓ Chicks may have shorter tibias, femurs and metatarsus, poor navel scores, shorter body lengths, lower weights, higher residual yolks and smaller stomachs, livers and hearts.
- ✓ The immune system can also be negatively impacted as development of the bursa and thymus is reduced by elevated temperatures (greater than 38.9°C; 102°F) during incubation.
- ✓ Higher eggshell temperatures during incubation (38.9°C) negatively affect the development of the cardiac muscle and may cause right ventricular hypertrophy and increased mortality associated with ascites.

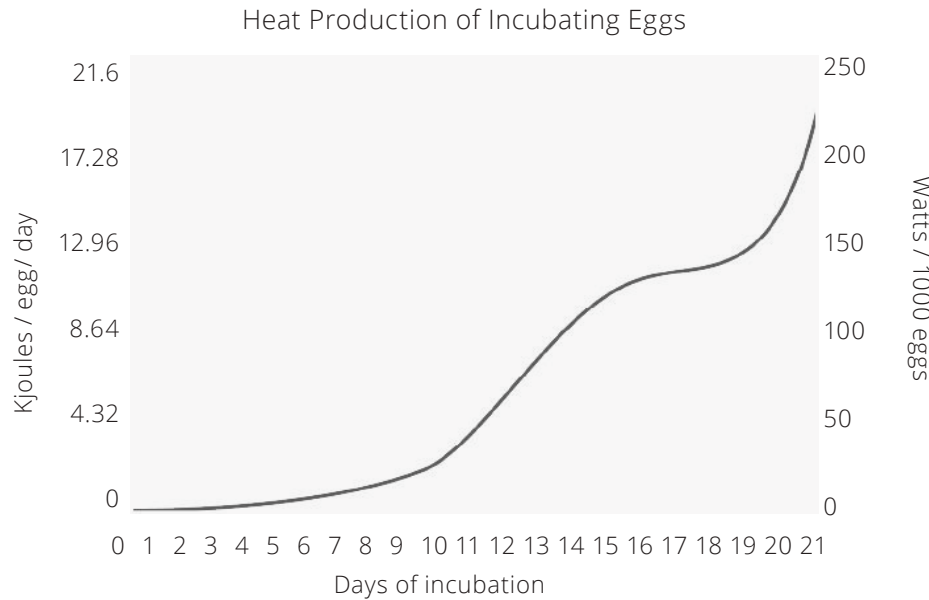
Impacts on embryos with **low** eggshell temperatures (< 37.7 °C; 99.9 °F) during incubation include:

- ✓ The total incubation time is extended and can cause an increase in embryonic mortality.
- ✓ Chicks may be wet making them more susceptible to chilling.
- ✓ Chicks may have poor navel scores.
- ✓ Hatchability may be reduced.
- ✓ Higher residual yolks, higher chick weights, and higher chick yield percentage

## Key points for measuring eggshell temperatures

Modern **single stage incubators** have thermal scanners that monitor shell temperature throughout the incubation process, modulating the machine to adequately meet the needs of the embryo.

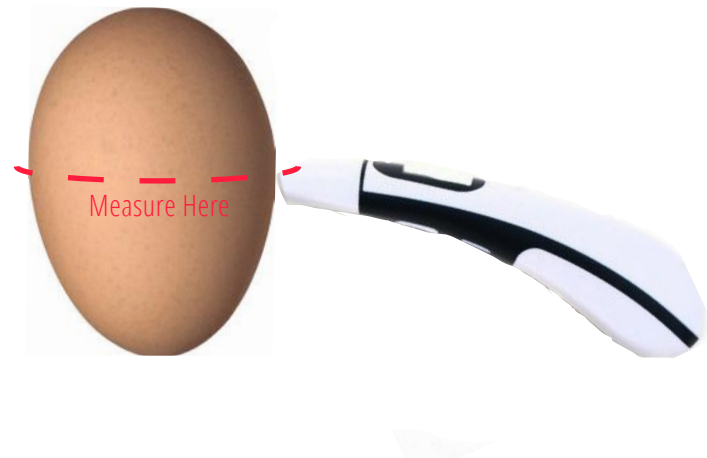
**Multi-stage machines** do not have this tool and eggshell temperatures must be monitored with a digital thermometer, taking measurements at the top, middle and bottom of the rack and in the back, middle and front of the egg trays to map temperature points and make any necessary corrections.



The best time to record the eggshell temperature is twelve hours before transfer. The eggshell temperature increases rapidly in the final stages of incubation. If the temperature is too high in specific locations in the multi-stage incubator, this could indicate mechanical issues or improper balance of egg incubation patterns. Measuring the temperature within 12 hours or less before transfer allows time to correct issues.

The eggshell temperature should only be recorded from eggs with living embryos. To ensure that the egg has a living embryo, use a flashlight to candle the egg. If candling indicates a fertile egg, but the eggshell temperature is low, this egg indicate a late dead embryo. Do not include this egg in your measurements.

The temperature is taken **just below** the equator of the eggshell during intervals of incubation to indicate correct embryo temperature. If the temperature is taken over the air cell, the reading will indicate egg temperature is too low. Candling the egg before taking the temperature can be done to ensure the embryo is living and that the temperature is taken of the embryo, not the air cell.



The device for measuring the eggshell temperature should be a thermal surface thermometer or infrared thermometer. These devices come in a variety of accuracy and price ranges. It is important to use the same device to ensure day to day consistency and overall accuracy in the data collected. Measuring eggshell temperature should always be done precisely and accurately.

A one-hour time frame is recommended for the time and day for measurements. It is important that a consistent set of procedures is used to record eggshell temperatures. This ensures that the most accurate information is being monitored and recorded.

## Measuring eggshell temperatures (cont'.)

For the best results, measure temperatures from six different locations throughout the machine. Measure 3 to 5 eggs with **viable embryos** per location. The ideal egg from to measure the temperature is in the middle of the egg tray. This egg is less influenced by air movement in the machine and will give the truest temperature indication. It is recommended to pull the flat of eggs out and record the temperature from the center of the egg pack.

Eggshell measurements should be taken from inside the setter with the machine running and door closed to prevent temperature deviations. For safety - be aware of moving parts especially fans. In single stage machines, keep trolleys in place next to the fans and measure other trolleys for eggshell temperatures.

In a **Chickmaster multi-stage fixed rack system**, measure the eggshell temperature of 3 to 5 eggs from the center of each of 18 trays (indicated in the photo) for a total of 54 to 90 data points.



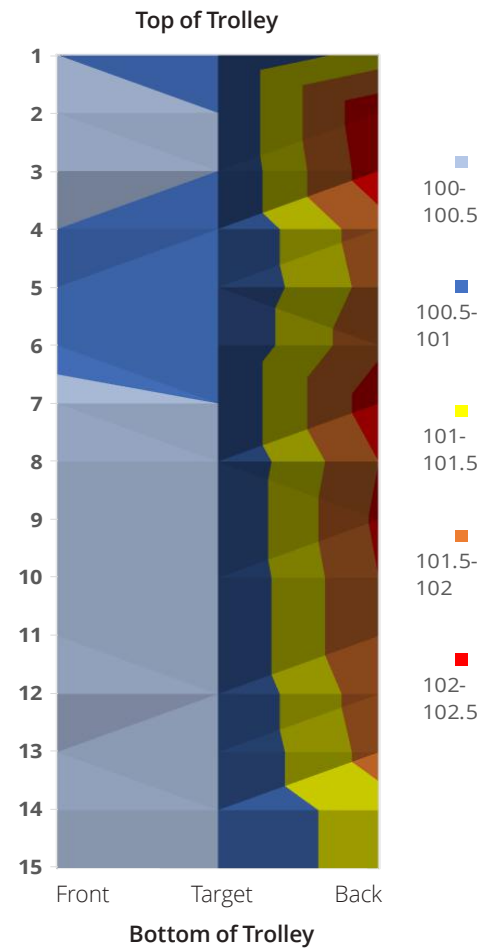
In a **Jamesway multi-stage tunnel machine**, the location of the recordings for the eggshell temperature should be taken straight down the middle of the racks as shown in the picture. For each buggy, take 15 temperature measurements down the front (one for each tray) and 15 temperature readings down the back of each buggy.



Record all temperatures and evaluate all the data after collecting it. Evaluate data in sets based on machine hallway and specific hatch day. Do not make swift judgements based on several or random measurement points. It is imperative to collect all the information consistently (time, collection points, number of data points) so that data can be compared among different dates in a meaningful way.

Charting the data can provide a diagram of the incubator heat patterns found throughout the machine. A diagram will show uniformity of the temperature inside the incubator and locate any temperature extremes. This is an excellent tool for isolating mechanical issues and trying to keep the heat load in the machine balanced.

Example of contour a graph created from eggshell temperatures measured on a Jamesway multi-stage tunnel incubator. Eggshell temperatures were taken from eggs in each tray(1 to 15) located in the front and back of the trolley. See preceding pages for further details on taking eggshell temperatures.



### 4.3 Humidity and Egg Moisture Loss

There are many factors involved with optimal moisture loss, and these can include humidity settings, damper positioning, variation in ventilation tolerances and atmospheric conditions. The percentage of moisture loss can vary according to the age of the breeder flock, seasonal influences or egg size. There are visual signs from the egg and the chick that can indicate moisture loss levels are adequate to achieve maximum hatchability and chick quality.

During incubation, water vapor is lost from the egg through the pores of the shell. The rate at which this moisture is lost depends on the number and size of the pores (the gas conductance of the shell) and the humidity in the air around the egg. Due to differences in shell structure and hence gas conductance, when all the eggs are incubated under the same humidity conditions, there will be a variation in moisture loss. With eggs from broiler breeders, this variation does not normally have any significant effect on the hatchability. However, when age, nutrition or disease reduces egg quality, it may be necessary to adjust incubator humidity conditions to maintain optimum hatchability and chick quality.

Percentage of moisture loss for eggs after 18.5 days of incubation

Breeder flock age (weeks)	Multi-stage incubator	Single stage incubator
25 to 30	10 to 11 %	10.0 to 10.5 %
31 to 40	11 to 12 %	10.5 to 11.5 %
41 to 50	12.0 to 12.5 %	11.5 to 12.0 %
51 to 60	12.5 to 13.0 %	12.0 to 12.5 %
61+	13.0 % or more	12.5 % or more



**Animal Welfare Tips**

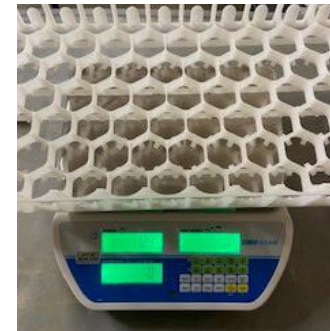
Egg moisture loss is very important for hatchability and hatch window, and also for chick quality. Incorrect egg moisture loss can result in chick welfare concerns (ex: red hocks, size, and bone structure) which can have long-term negative outcomes for chicks.



## Calculating egg moisture loss

Egg moisture loss calculations can be integrated with chick yield calculations since both begin with the weight of a tray of eggs before incubation (see section 8.0). To calculate moisture loss, clearly mark three to five trays of hatching eggs per flock or incubator. These hatching trays should be clearly marked throughout the incubation process to ensure accuracy and continuity. Place these trays in different locations throughout the incubator to achieve the best calculations on moisture loss. (i.e. in the top, middle and bottom of the incubator cart or fixed rack system). To increase accuracy of the data, try to place the trays in the same locations within the incubators each time for subsequent calculations.

1. Weigh an empty incubator tray.
2. Next, weigh each incubator tray with eggs before incubation. The eggs used in this calculation should be quality hatching eggs free of any shell quality issues, cracks or misshapen eggs.
3. Finally, each specific incubator tray will again be weighed at transfer to obtain the percentage of moisture loss.



### Formula 4

The calculation for determining the percentage of egg moisture loss is:

$$\frac{(\text{full incubator tray weight at incubation} - \text{full incubator tray weight at transfer})}{(\text{full tray weight at incubation} - \text{empty tray weight})} \times 100 = \text{percentage of egg moisture loss}$$

An example calculation:

Full incubator tray weight at incubation 6,250 g

Full incubator tray weight at transfer 5,650 g

Empty incubator tray weight 1,050 g

$$\frac{(6,250 \text{ g} - 5,650 \text{ g})}{(6,250 \text{ g} - 1,050 \text{ g})} \times 100 = 11.5 \% \text{ egg moisture loss}$$

## Calculating egg moisture loss (cont.)

The moisture loss table (page 23) is based on 18.5 days of incubation. However, if the transfer time is not at 18.5 days (444 hours), all figures should be calculated back to one day of incubation. This number then can be used to calculate moisture loss at 18.5 days.

### Formula 5

The calculation for determining the percentage of egg moisture loss at 18.5 days of incubation:

$$\frac{(\text{Moisture loss at X days})}{(\text{X days of incubation})} \times 18.5 = \text{percentage of egg moisture loss at 18.5 days}$$

An example calculation:

Egg moisture loss at 19 days of incubation is 13.5 % (as calculated using formula 4 on page 22).

$$\frac{13.5\% \text{ moisture loss}}{19 \text{ days}} \times 18.5 \text{ days} = 13.1\% \text{ egg moisture loss at 18.5 days}$$

- ✓ Calculating moisture loss should be done each hatch day, and, at minimum, should include one young, one prime and one old flock source. It is very important to know the moisture loss percentage by breeder age. The eggs from a breeder hen increase in weight and size as the flock ages. This increase in weight and size will dictate the percentage of moisture loss desirable by breeder flock age.
- ✓ Being able to obtain a moisture loss percentage each week for each flock source used at the hatchery is ideal. This data can be associated by flock, machine, incubation day or breeder flock age. The figures should be recorded in a database or spreadsheet so that the data can be referenced by hatch date, week, month or flock type. This information can produce trends which allow comparisons to be made from season to season, or year to year.
- ✓ Weighing each component in grams can improve accuracy and provide more detailed data.
- ✓ No eggs should be removed from the incubator tray before calculating the weight at transfer time.
- ✓ If an egg has been broken or removed for some mechanical reason, then and only then should the egg be replaced. A fertile egg with a viable embryo should be used as a replacement.

## Indications of egg moisture loss

The **single stage incubation** environment for hatching eggs is very precise based on the age of the embryo. To achieve optimal moisture loss there are 4 different factors that will influence how much and at what rate moisture loss is obtained:

1. **Relative humidity**- the relative humidity percentage setting according to the specific day of incubation will help promote moisture loss.
2. **Damper**- The removal of water is also influenced by the day that the incubator damper can open and to what extent.
3. **Heat**- the temperature can also influence the amount of moisture that is lost. High eggshell temperature will increase the amount of moisture loss.
4. **Ventilation rate**- the air exchange rate requirement is model/machine specific and the air exchange rate will determine moisture loss.

A flashlight or torch just prior to transfer can be used to determine the egg air cell size. An air cell that is too large, can be an indication of excessive moisture loss.

Chicks that are hatching early due to excessive moisture loss, may appear the same as if incubation temperatures are too high. Insufficient moisture loss will also cause the hatch window to shift to earlier than desired causing chicks to be dehydrated at the time of take-off. The moisture loss level needs to be evaluated to ensure the exact reason behind the shift in the hatch window. This is where the calculations of moisture loss can help with the diagnoses.

In the **multi-stage incubator**, the ability to make slight adjustments to the atmospheric conditions aid in obtaining correct moisture loss levels. There are two factors that can influence moisture loss rate in multi-stage incubation:

1. **Relative humidity**- The relative humidity level in the incubator.
2. **Air conditioning**- The atmospheric conditions of the incoming air.

When performing an egg residue breakout, it is important to look closely at the late embryonic mortality. When the chick has pipped through the inner membrane and not externally pipped, this can be a sign of too much moisture loss. Be sure to investigate these findings thoroughly to better assess the exact cause of embryo mortality.

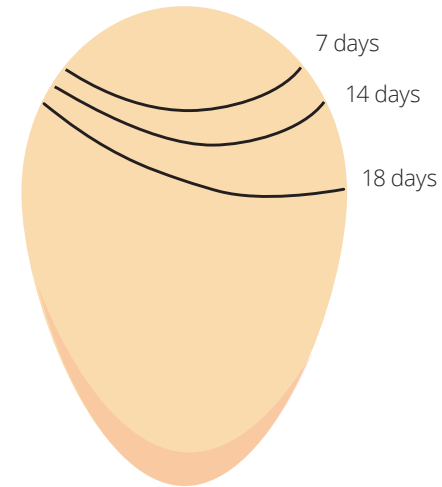
The air cell of the egg should be at least one-third of the egg or just above the equator of the egg at transfer. The location where the chick externally pips through the eggshell can be an indicator of proper moisture loss. The head of the chick should be level during the pipping process. If the head becomes inverted or tilted up in appearance, this is a sign of not enough egg moisture loss.



Correct pip location with enough egg moisture loss.



Incorrect pip location with not enough egg moisture loss.



Indications that the total percentage of egg moisture loss is too low:

- ✓ Air cell too small
- ✓ Sticky chicks with eggshell debris attached to them
- ✓ Chicks larger than normal
- ✓ Red hocks or abrasions to the beak or nostrils
- ✓ Enlarged abdomens
- ✓ Chicks with eggshell debris stuck to them

Indications that the total percentage of egg moisture loss is too high:

- ✓ Chicks pipping early
- ✓ Chicks hatching early
- ✓ Dehydrated chicks
- ✓ Chicks smaller than normal
- ✓ Air cell too large
- ✓ Embryonic death at 20 days (Internal pip)

## 4.4 Turning

There are several factors that are important for turning that include the angle, the frequency and the smoothness. The angle of turning should be between 39 and 45°. Turning at angles of less than 39° will decrease hatchability and chick quality. Turning should be conducted once per hour and should be very gentle as there are delicate membranes and vessels in the eggs that can easily rupture. If the minimum turning angle of 39° cannot be achieved in the incubator, then the eggs should be turned more frequently (every 30 minutes).

### Why turning is important

- ✓ Turning the egg prevents the embryo from sticking to the shell membranes, particularly during the first week of incubation, and promotes development of the embryonic membranes.
- ✓ When the turning angle is too shallow (less than 39°), the incidences of incorrect embryo position increase.
- ✓ As embryos develop and their heat production increases, regular turning will redirect airflow throughout the incubator and prevent specific areas from overheating.
- ✓ Turning failures that occur during the first week of incubation cause a reduction in hatchability, increase embryonic mortality, and increase the incidence of malposition. Furthermore, the impact of turning failures during the first week cannot be resolved later in incubation.
- ✓ Between 3 to 4 days of incubation, the yolk sac membrane is growing down around the yolk and actively moves water from the albumen to the sub-embryonic fluid. Turning allows the yolk membrane to absorb water by contacting a fresh area of albumen.

### How to check the turn angle

- ✓ Checking to see if the turning mechanism has turned should be done during the regular machine checks and recorded in a machine check log. Since the turning angle will be in the same position every 2 hours, be sure to check the mechanism every 3 hours or at an equivalent interval.
- ✓ Check the turning angle in both directions as failure to meet the correct turning angle in one direction but not in the other can still cause losses.
- ✓ The turning angle should be calibrated every 90 days in multi-stage or before each incubation in a single stage incubator. Adjust the turning mechanisms if necessary and record the adjustments in the incubator log. Calibrating the turning angle at the same time as calibrating the temperature is most efficient.
- ✓ In a fixed rack incubator, check the machine while it is loaded with eggs. Do not manually turn the eggs using the control switch before checking the angle. Instead, allow the machine to make a full turning cycle independently. Some machines will achieve the proper angle when turned manually, but fail to achieve the proper angle when turning automatically.
- ✓ It is important to check every trolley in the machine. In some cases, the trolley closest to the turning arm will turn correctly, while the trolley farthest away from the turning arm will turn less than 39°.
- ✓ In a fixed rack incubator, it is important to check both sides of the machine in the front, middle, and back section of the machine.
- ✓ In a machine with portable trollies, check the trolley when it is loaded with eggs. An empty trolley will often turn the correct angle, but when it is loaded with eggs it may fail to achieve the proper angle.



A digital device can be used to measure the angle in the incubator. Be sure to measure the angle of the egg tray and not the metal frame as it may measure slightly different than the egg tray. In the photo above, the turning angle is correct. If it is not possible to achieve the minimum turning angle of 39°, it is recommended to turn the eggs more frequently (every 30 minutes).



There are several phone apps available that can be downloaded and used to check the angle in the incubator. Key words including "leveling" and "angle finder" can be used for searches and will provide multiple apps that can be used. Some apps have features such as a memory database that can store your measurements according to specific locations within your incubators.

### Causes of turning failures

- ✓ Buggy (trolley) not properly positioned or the buggy wheels are worn so that the buggy is not engaged with the turning mechanism.
- ✓ Turning sensor, software or programming failures.
- ✓ Power failure to the incubator or the turning mechanisms.
- ✓ Turning mechanism failure.

### Causes of incorrect turning angle

- ✓ Bent turning bars.
- ✓ Poor maintenance, wear, or warping of the turning mechanisms.
- ✓ Issues with power or air supplying the turning mechanism.
- ✓ Buggy position in the incubator does not have enough space for the turning mechanism to move correctly.
- ✓ Buggy is not fully engaged with the turning mechanism in the incubator.
- ✓ Uneven floors
- ✓ Poor alignment of the turning limit switches

## 5

# Egg Transfer

Eggs are removed from the incubator after 18 or 19 days of incubation and transferred to the hatcher baskets. Transferring too early or too late can result in embryos being subjected to sub-optimal conditions which then can cause lower hatchability and reduce chick quality.

## Key points in egg transfer include

- ✓ The incubator can be single or multi-stage, but all eggs should be transferred to a single stage hatcher. Using a dedicated hatcher will contain fluff generated during hatch, which could be a source of contamination. In addition, in the single stage hatcher, temperature, humidity and ventilation can be optimized to prevent overheating and dehydrating the chicks.
- ✓ The incubator must remain operating until the last egg is removed from the machine.
- ✓ Ensure the hatcher and hatcher baskets are thoroughly washed and allowed to dry before eggs are transferred. Eggs in wet baskets will cool and make the control of temperature and humidity difficult.
- ✓ The hatchers should be turned on at least two hours prior to transfer with the buggies (trolleys) and hatcher baskets inside. Pre-warming will help dry the equipment and buggies (trolleys).
- ✓ Have all required materials ready and make sure the transfer machine is ready prior to beginning transfer. Being unprepared can delay the transfer causing the eggs to cool.



- ✓ The time between the eggs leaving the incubator and entering the hatcher should be less than 20 minutes to prevent the eggs from cooling.
- ✓ At transfer, eggs may be candled by hand to count and remove infertile, early embryonic mortality, and contaminated eggs. Candling the eggs will give more space in the hatcher baskets for chicks and improves ventilation. Replacing the empty spots in the basket after candling is not recommended. This will concentrate too many viable embryos in a basket and/or hatcher creating the possibility of overheating. Refill baskets for flocks with low hatchability (<60 %). However, refilling must not exceed 90 % of the basket capacity.
- ✓ If manually candling, take a sample of the clear eggs from young, prime and old flocks to check the accuracy of the personnel or equipment. Record these results and use them to track individual flocks and to predict hatch.



### Animal Welfare Tips

Verify the condition of hatcher basket during routine welfare audits. Hatcher baskets should not have holes, cracks or damage that can result in chick injury, chick escape, wing/leg/head/foot entrapment. A lid should always be present on the top hatcher basket to ensure that chicks cannot escape and fall to the floor of the hatcher.

- ✓ Audit transfer crews and check equipment regularly to reduce transfer damage. Check for transfer cracks in which the egg will have some drying but the contents are still soft. Earlier cracks usually result in very dry egg contents. Eggs from embryonic death are still moist. Excessive vacuum pressure typically causes damage to the large end of the egg.
- ✓ Prior to transfer, all contaminated eggs (“rots” and “exploder”) should be removed and placed in a receptacle with disinfectant. Carefully handle these eggs to avoid rupturing before placing in disinfecting solution, as these eggs are a serious contamination risk. For accurate hatchability records, be sure to include visibly contaminated eggs (rots, exploders, etc) into the total number of contaminated eggs from the breakout session when using an automatic transfer system (see section 17).
- ✓ Transfer eggs from younger flocks first and transfer eggs from older flocks and floor eggs last. When using automatic transfer, take special care with the hygiene of transferring suction cups and tweezers to prevent cross-contamination.
- ✓ *In-ovo* vaccinations can provide early immunity for the embryo and reduce the need for chick handling, manual labor and personnel errors. To prevent damaging or killing the embryo, the egg must be correctly oriented with the air cell at the top where the needle will be inserted. Vaccinating eggs upside down will most likely kill the embryos. If vaccinating eggs before day 18 or after 19 days, there is a higher risk of missing the correct site of injection which can reduce hatch and chick quality. Keep in mind, *in-ovo* vaccines are not compatible with oil emulsions. Detailed instructions from the vaccine manufacturer and the vaccination equipment manufacturer should be followed.
- ✓ If hatchers and/or baskets are not dry at transfer, open the hatcher damper fully for the first 3 to 4 hours after transfer to help reduce the humidity. High humidity levels in the hatcher after transfer can reduce the oxygen content to a point where embryos can suffocate and severely reduce hatchability.



Shells are more brittle at transfer because the embryos have absorbed some of the shell calcium for skeletal development. Therefore, care must be taken when transferring eggs to avoid breakages (top photo). Cracks in the eggshell can cause dehydration and the internal membrane to stick to the embryo, which will disrupt the movements of the embryo and may hinder hatch. Handling eggs roughly at this stage may cause egg damage that can cause embryonic mortality. Automated transfer equipment can transfer eggs more gently and faster than a manual system, but check and adjust the pressure as these systems can also cause shell damage (bottom photo).



## Disinfection during the hatching period

Many hatcheries add disinfectant to the hatcher during the hatching period. This can be helpful to reduce the microbial contamination load in the environment and prevent cross-contamination, especially when there are egg handling or incubation failures. Any disinfectant should be delivered evenly and consistently throughout the hatch process. Delivering the disinfectant in intervals can produce fluctuations in the dosage and concentration.

The use of any chemical requires formal training of employees and industrial hygiene safety to ensure chemical safety throughout the hatchery. Follow local legislation for chemical usage, train personnel rigorously, and ensure all personal protection equipment is being used correctly.

### Disinfectants

Disinfectants composed of glutaraldehyde and quaternary ammonium are available for agricultural applications that can be used in the hatcher. These chemicals can be administered at a concentration of 400 to 800 ppm based on the manufacturer's directions. Beginning at egg transfer, these disinfectants can be applied as 20ml doses every 30 minutes until the chicks are removed from the hatcher. In some operations, smaller doses at shorter intervals are used. Dosing volume and time can be adjusted for your operation and optimized according to your hatching equipment and other hatchery specific factors. Deliver the disinfectant as a 14 to 16-micron size particle to promote evaporation. Keep in mind that spraying larger particle sizes may cause moisture accumulation in the hatcher which can then increase humidity and temperature.

Peroxide based products have also been successfully used as disinfectants in the hatcher. **Do not use a solution greater than 3 % as this product is very corrosive.**

When preparing the solution, check the label and be aware that some variation in the concentration can be expected based on the quality of the manufacturer. Use clean water, preferably distilled, to prepare the peroxide solution. Follow the same dosage and timing guidelines given for the glutaraldehyde and quaternary ammonium mixes.

Glutaraldehyde/ quaternary ammonium mixes and peroxides can be used with formaldehyde, but not simultaneously. If using a combination of these chemicals, each one should be used at different time points during incubation. For example, where allowed by government regulations, formaldehyde may be used until 12 hours

before take-off. Glutaraldehyde/ quaternary ammonium mixes or peroxide then can be used for the last 12 hours before take-off.

### Formaldehyde

Formaldehyde, in the liquid form, can be a very effective antimicrobial. However, formaldehyde is carcinogenic and not all countries and regions permit the use of this chemical. Check with your local regulations before you consider using formaldehyde in your hatchery. It is important to note that formaldehyde changes the fluff color from white to yellow and that formaldehyde can be harmful to baby chicks if not administered properly.

The total amount of formaldehyde used in the entire hatch cycle should not exceed 0.062 ml/egg capacity of the hatcher. This total amount of formaldehyde should be administered evenly and consistently throughout the hatch process.

### Preventative Maintenance

The disinfectant system should be included in your hatchery preventative maintenance program to ensure that accurate and consistent doses of disinfectant at the correct particle size are delivered to each hatch. Be aware that many disinfectants contain surfactants and that surfactants can accumulate as a sticky residue. This residue can cause functional issues with pressure valves or solenoids used to regulate flow of disinfectants through the delivery system. Check the delivery system on a regular basis and clean, repair, or replace valves and solenoids as needed.



### Animal Welfare Tips

If using formaldehyde or a disinfectant to reduce bacterial contamination in the hatcher, the concentration (ppm) must be measured. If the ppm is too high, the chemical can have a negative impact on chick welfare and health. Specifically, high levels can negatively impact the trachea and respiratory tract of the chicks.

## 6

## Factors Influencing Chick Size

Egg size is the main factor associated with chick size. Chick weight is normally 66 to 68 % of egg weight. Thus, chicks from eggs averaging 60 grams will, on average, weigh around 40 grams. Individual chick weights are likely to range from 34 to 46 grams. Be aware that using eggs that are less than 48 grams may produce a chick that is too small to reach water and feed. Using eggs that are over 70 grams may result in an increased number of eggs with cracks. Each Cobb line has specific standards for egg weights (available at: <https://www.cobb-vantress.com/resource>).

Egg weight decreases due to moisture loss during incubation. Variations in moisture loss from eggs of the same weight during incubation contribute to variations in chick weight.

The hatch, take-off, and delivery time will collectively affect final chick weight. However, the total amount of time spent in the hatcher at higher temperatures will have a greater effect on chick weight due to dehydration compared to time at lower temperatures in the chick room or delivery vehicle.



## 7

# Hatcher Operation

Even though the hatcher period makes up only 14 percent of total incubation time, this period has a significant impact on chick quality. Since chick quality has an impact on broiler performance, providing an optimal hatcher environment (temperature, humidity and ventilation) will ensure high quality chicks that can reach their full genetic potential.

## 7.1 The Hatch Window

The hatch window is the time frame spanning from the first chick to the last chick hatching. If the chicks are hatching too early, they can become susceptible to problems such as dehydration, which can lead to increased 7 and 14 day mortality and poor broiler performance. Chicks hatching too late can result in poor quality chicks, increased pipped eggs, and live embryo unhatched eggs.

It is important to note that you cannot hatch all the chicks at the same time and it is normal to see a hatch window of 24 to 30 hours from first to last chick. Hatch time among eggs varies but is largely dependent on the rate of embryo development where higher incubation temperatures increase metabolism and promote increased embryonic development and lower temperatures reduce metabolism and delay embryonic development. For optimal hatch and chick quality, it is critical to maintain a uniform temperature and humidity across the hatcher.

### Factors causing early hatching include:

- ✓ Temperature fluctuations during storage
- ✓ Extended pre-heating periods
- ✓ Incubating eggs too early / too many hours of incubation
- ✓ Incorrect incubator/hatcher temperature and humidity
- ✓ Hot spots inside the incubator and hatcher
- ✓ Incorrect ventilation (air supply/damper calibration)
- ✓ Maintenance issues
- ✓ Seasonal temperature changes impacting the hatchery environment

### Factors causing late or delayed hatching include:

- ✓ Incubating eggs too late
- ✓ Incorrect incubator/hatcher temperature and humidity
- ✓ Incorrect ventilation (air volume/damper calibration)
- ✓ Seasonal temperature changes impacting the hatchery environment
- ✓ Eggs which have been stored for long periods
- ✓ Eggs which have been stored at too low a temperature
- ✓ Maintenance issues
- ✓ Incorrect incubation patterns in multi-stages machines
- ✓ Disease and fertility issues

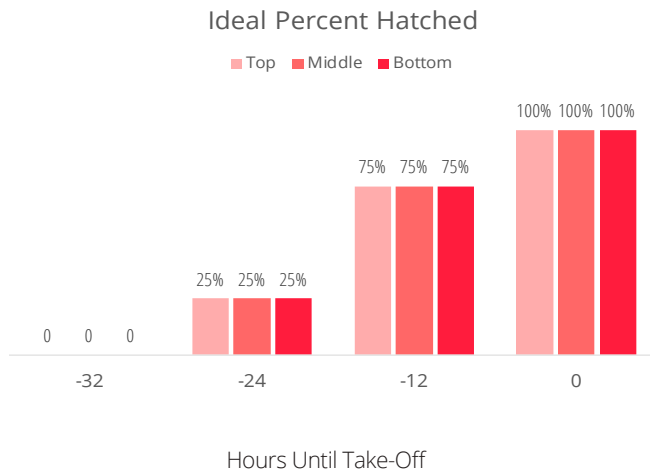


Figure 3

Eggs which were in the top, middle and bottom positions in the incubator and then transferred to the hatcher. The number of chicks hatched in each hatcher basket should be even throughout the hatcher. Ideally, there should be no chicks hatched 36h prior to take-off time, no more than 25 % should be hatched 24 hours before take-off and about 75 % should be hatched 12 hours before take-off. The percentages are cumulative totals of chicks hatched at each time point.

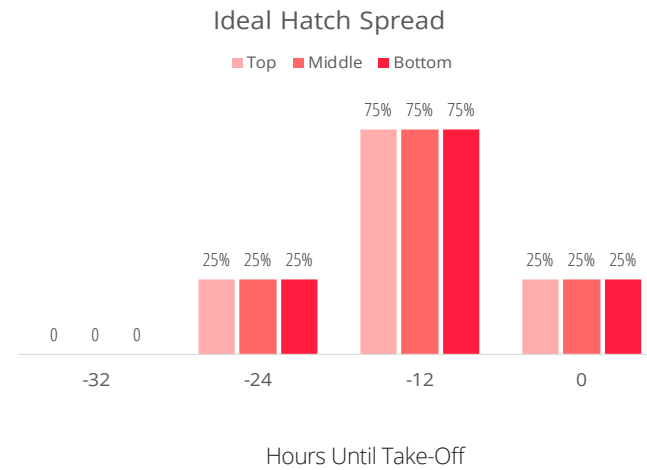


Figure 4

Eggs which were in the top, middle and bottom positions in the incubator and then transferred to the hatcher. The number of chicks hatched in each hatcher basket should be even throughout the hatcher. In an ideal hatching spread, 25 % of the chicks should hatch at 24 hours prior to take-off. At 12 hours prior to take-off, a total of 75 % of the chicks should hatch. The final 25 % of the chicks should hatch in the final 12 hours prior to take-off.



**Animal Welfare Tips**

A well-managed hatch window will result in good quality chicks that are active, alert, and less stress. If chicks hatch too early, they are more likely to experience thermal stress and dehydration. Both consequences can produce negative welfare outcomes and may result in chicks depleting yolk reserves more quickly.

## Hatch window assessment

It is important to count at least 3 baskets per machine when doing a hatch window assessment. These three baskets should be from the top, middle, and bottom of the hatcher. We recommend taking eggs from a top, middle, and bottom tray of the incubator and placing these in the top positions of the hatcher trolley at transfer. Placing these 3 baskets on top makes it easier to do the hatch window assessment. If chicks are hatching too early or too late, adjust incubation time to hatch the chicks as close to take-off time as possible.

When a chick is hatched, the ideal internal body temperature should be between 40.0 to 40.6 °C (104.0 to 105.0 °F). To measure this temperature, it is recommended that a digital rectal thermometer be used. Check the internal temperature of various chicks multiple times throughout the hatch process at 24, 18, 12, and 6 hours before actually removing chicks from the hatchers. Measure the temperature of a dry chick as temperatures of wet chicks will be inaccurate (lower).



## Formula 6

The calculation to determine the percentage of chicks that are expected to hatch 12 hours before take-off is:

$$\frac{\text{Number of chicks hatched 12 hours before take-off}}{\text{Number of chicks hatched in the same baskets at take-off}} \times 100 = \text{percentage of chicks hatched 12 hours before take-off}$$


### Animal Welfare Tips

Use a digital thermometer with a rapid-temperature reading to measure chick cloacal temperature. Be sure the end (tip) is clean before use. Only insert the tip of the thermometer as far as the edge of the silver/metal tip to avoid chick damage and injury.

In addition to chick temperature, the eggshells in the hatcher basket can be used to indicate if adjustments are needed to the time and temperature of chicks in the hatcher. When chicks have been in the hatcher too long, the eggshells can become soiled with green meconium (the first chick droppings). Clean eggshells can indicate proper hold time in the hatcher, but check chicks to ensure they are dry. Completely clean eggshells can also indicate the incubation time is too short.



Check several hatcher baskets for the cleanliness of the shells. If all eggshells are clean, the incubation time is correct. If all eggshells are very soiled, the chicks have been held for too long. If the level of eggshell soilage varies considerably among several baskets in the same hatcher, there may be a temperature or ventilation issue in the hatcher.

## 7.2 Temperature

Overheating the chicks in the hatcher during the first 24 hours post-transfer in the hatcher can lead to an early hatch, large navel buttons (photo on the left), dehydrated chicks, and high 7-day mortality. In contrast, hatcher temperatures which are too cool in the same period post-transfer can cause chick quality issues including small navel buttons (photo on right), an extended or long hatching window (time from first chick hatched to final chick), and in extreme cases reduced hatch associated with increased alive or dead pips and increased early mortality.



As chicks begin to emerge from the shell, the temperature in the hatcher must be gradually lowered to prevent overheating and dehydration of the newly hatched chicks. In even the best scenario, the hatch window in commercial operations will be at least 24 hours, and though the goal of every hatchery manager is to remove the chicks from the hatcher as soon as they are ready, it is not feasible. Instead, chicks are normally held in the hatcher for several hours until all hatchlings are ready. During this holding period, the temperature in the machine must be lowered consistently to prevent overheating the chicks. Cloacal temperature can be used as an indication of overheating with normal temperature range being 40.0 to 40.6 °C (104.0 to 105.0 °F).



It is critical to keep the cloacal temperature below 41.1 °C (106 °F). Once the temperature reaches 41.1 °C (106 °F) the chick starts to pant and dehydration starts to occur. Below 39.4 °C (103 °F) chicks begin to huddle and thermal stress will occur. Extended periods over 41.1 °C (106 °F) can cause an increase in 7-day mortality due to dehydration, pericarditis, and *E. coli* and other bacterial infections.

Cloacal temperatures should be checked 12 hours before take-off, in the hatcher at time of take-off, in the chick processing and holding rooms, and when the chicks arrive at the farm.

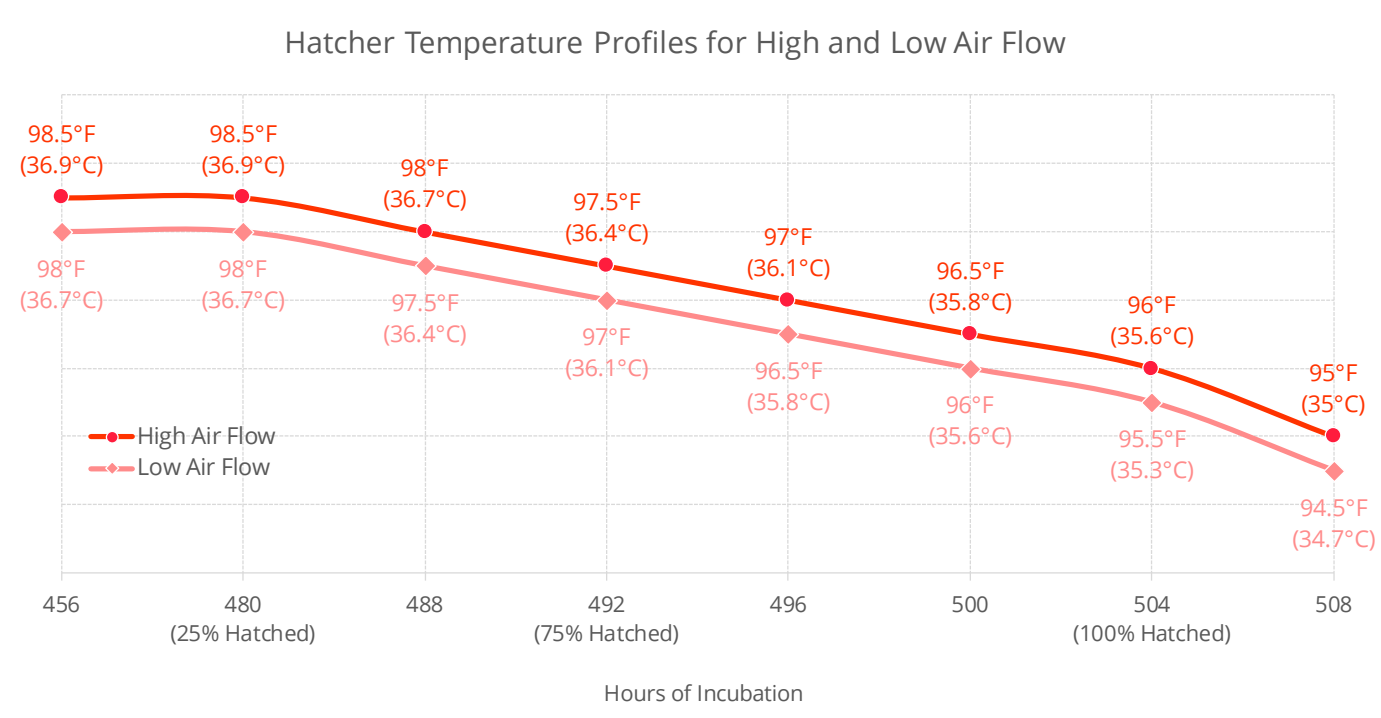


Figure 5 shows two possible scenarios for hatcher temperature profiles. The higher profile should be used for machines with high airflow within the hatcher. The cooler profile should be used in machines with lower air speeds. Almost all hatchers, regardless of manufacturer, fall into the range of 98 to 98.5 °F (36.7 to 36.9 °C) at transfer, with only the oldest machines with very poor air flow requiring a temperature below 98 °F (36.7 °C). The x-axis of the graph, given in hours of incubation, includes the ideal percentage of chicks hatched at 480, 492, and 504 hours of incubation. If the hatch window is advanced (75 % hatch at 488 hours instead of 492), the temperature is too high, and the profile should be shifted forward by a corresponding 4 hours. Conversely, if the hatch window is later, adjust the profile accordingly by delaying a temperature decrease. Other factors such as the hatch window spread in each hatcher or the total hatch percentage of chicks hatched at each time period will also impact the timing of the hatcher temperature curve. It is important to note that the strategy behind managing the hatcher profile is to prevent hatched chicks from getting too hot. The profile is not designed to cool chicks after overheating.



### 7.3 Ventilation and Humidity

It is impossible to correct moisture loss in the hatcher if it is not properly achieved in the incubator, because humidity must be maintained in the hatcher after transfer. Humidity is necessary during the hatching process so that the shell membranes remain soft and pliable allowing the chick to hatch easily. At extremes, a low relative humidity (RH) in the hatcher can delay the hatch window and, in some studies, has been correlated with higher 7 day mortalities, while a very high RH may lead to an increased incidence of exposed viscera. Adequate humidity will also prevent the yolk sac from drying too quickly, preventing strings or wicks from the navel.

During the first 24 hours after transfer, the relative humidity should be approximately 52 to 54 %. When pipping starts, the moisture level will rise causing the wet bulb temperature and absolute humidity to rise as well. After most of the chicks have hatched (around 75 % of the total hatch), the absolute humidity will decrease back to the set point of the machine, however the relative humidity should remain constant as the temperature profile is lowered. This will require lowering the wet bulb setting along with the temperature setting to maintain a constant relative humidity and avoid raising the heat index on the newly hatched chicks.

The hatcher room should have fresh air and exhaust fluff plenums, which should be completely sealed. Fresh air supplied to the plenum should be 10 to 17 cfm per 1000 eggs (17.0 to 28.9 m<sup>3</sup> per hr) or according to the manufacturer’s recommendation. In the hatcher, the CO<sub>2</sub> levels change over time due to chick hatching and respiration. However, it is important to note that high CO<sub>2</sub> levels can cause lethargic chicks and even negatively impact heart and lung development. In most hatchers, the opening of the damper will provide fresh oxygen and reduce the levels of CO<sub>2</sub>. Therefore, operation of the damper is critical to supplying the correct temperature, humidity and oxygen levels to the chicks.

While temperature and humidity are crucial to maintaining the hatcher environment, optimal air exchange is also critical. Correct hatcher ventilation can only be achieved by having the correct conditions in the plenum supplying air to the machines. At transfer the goal is to have enough temperature and humidity in the intake plenum to allow the hatcher damper to open quickly. Later as the temperature of the machine is lowered, the plenum temperature may need to be lowered as well to allow the machines to cool. However, enough temperature must be maintained in the plenum to achieve proper damper openings.

Timing and amount of hatcher damper opening based on chick take-off time

Time (hours before take-off)	Damper opening	Percentage of chicks hatched
24	50 %	25 %
18	75 %	50 %
12	100 %	75 %

## 7.4 Adjusting the Hatcher Environment

Below are guidelines for the hatcher hallway temperature and the plenum pressure. However, these guidelines may require adjustments specific for your operation.

Time (hours before take-off)	Hatcher Hallway Temperature	Plenum Pressure In inches of water column (Pascals)
At transfer	26 °C (79 °F)	-0.020 (-5.0)
12	25 °C (77 °F)	-0.025 (-6.25)
8	24 °C (75 °F)	-0.030 (-7.5)
4	23 °C (73 °F)	-0.035 (-8.75)

Using chick cloacal temperature is a good measure of how to adjust the hatcher environment. If the chick cloacal temperature is elevated, the hatcher temperature should be lowered as a first step. However, if the hatcher is lowered to its minimum setting, lower the temperature in the hatcher hallway to help provide cooler intake air. The hallway temperature can be decreased in steps to prevent a dramatic drop in the hatcher temperatures and allow the chick body temperature to remain between 40.0 and 40.6 °C (104.0 and 105.0 °F).

The last step is to increase the negative pressure setting in the exhaust plenum of the hatcher. This will force additional air into the machine providing additional cooling ability. Increasing this negative pressure too much can lead to a bypassing effect of the air to the chicks in the hatcher. In this case, air does not circulate through the hatcher machine as designed, but rather, air passes directly through the hatcher and is not distributed throughout the machine.

### It is important to follow these steps in this order

Adjusting hatcher air temperature, then hallway room conditions and last increasing negative plenum pressure. With this step-wise method, monitor the chicks closely, taking their internal body temperature to see whether you need to move to the next step or whether the step progression has been too fast.

## 8

# Chick Take-Off and Processing

Chicks are ready to be removed from the hatcher when most of them are dry and fluffed up, and a few (about 5 %) still have some moisture on the backs of their necks. When a chick is dry post-hatch the ideal cloacal temperature should be between 40.0 and 40.6 °C (104.0 and 105.0 °F).

A common mistake is to allow chicks to spend too long in the hatcher so they overheat and subsequently dehydrate. Overheating can lead to gut damage, reducing nutrient absorption ability, and subsequently impact growth. Dehydration of chicks may result from incorrect adjustment of incubation time for egg age, excessive egg weight loss during incubation or chick panting due to overheating. Similarly, if chicks are not ready, check incubation times and for eggs that may have cooled down during incubation reducing the rate of development.

## 8.1 Chick Yield Calculations

Chick yield is a calculation of the chick body weight as a percentage of the total egg weight at incubation. This number can be useful as a key performance indicator for the hatchery of incubation and hatching time. Chick yield percent is calculated from the average weights of eggs and chicks obtained from individual flock sources, and is not focused on individual egg and chick weights.

In general, a day-old chick should weigh two-thirds or 67 % of the initial egg weight. To achieve this egg weight loss, humidity in the incubator should be 11 to 13 % by transfer (See section 4.4). Chick yield is also an important factor when considering transportation duration. The hatchery should adjust incubation profiles to achieve a chick yield between 66 and 68 % if chicks are to be placed on close farms. If chicks are transported over long distances, a higher chick yield of 68 to 70 % is more ideal. Due to the natural weight loss that may occur during transit, a higher percentage of chick yield is recommended so that chicks with longer journey times will arrive at the farm with a yield close to the normal range of 66 to 68 %.

Chicks with a *low* yield ( <65 % ) may

- ✓ be dehydrated
- ✓ have a relatively small yolk reserve
- ✓ have been incubated at a high temperature or low humidity
- ✓ have spent too long in the hatcher

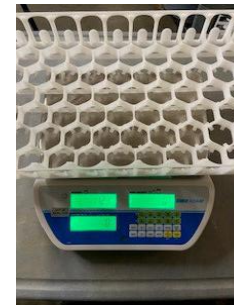
Chicks with a *high* yield ( >70 % ) may

- ✓ be late hatchlings
- ✓ have large yolk sacs
- ✓ have been incubated at low temperatures or high humidity

## Calculating Chick Yield

Chick yield calculations can be integrated with egg moisture loss calculations as both calculations begin with the weight of a tray of eggs prior to incubating (see section 4.4). Begin by clearly marking three to five trays of hatching eggs per flock or incubator. These trays should be clearly marked throughout the incubation process to ensure accuracy and continuity. Place these trays in different locations throughout the incubator to achieve the unbiased calculations (i.e. placed in the top, middle and bottom of the incubators). To increase accuracy of the data, try to place the trays in the same locations within the incubators each time for subsequent calculations.

1. Weigh an empty individual incubator tray. Weighing each component in grams can improve accuracy and provide more detailed data.
2. Next, each incubator tray with eggs should be weighed just before incubation. The eggs used in this calculation should be quality hatching eggs free of any shell quality issues, cracks or misshapen eggs.
3. Mark the hatcher basket with the same label as the incubator tray.
4. At transfer, ensure that the eggs are transferred from the incubator tray to the hatcher basket with the corresponding label.
5. At chick take-off, weigh an empty chick basket and record the weight.
6. Place all the chicks into the empty hatcher basket and weigh.



### Formula 7

To calculate average egg weight:

$$\frac{(\text{Full tray weight at incubation} - \text{Empty tray weight})}{\text{Number of eggs}} = \text{Average Egg Weight}$$

### Formula 8

To calculate average chick weight:

$$\frac{(\text{Chicks in chick box weight} - \text{Empty chick box weight})}{\text{Number of chicks}} = \text{Average Chick Weight}$$

### Formula 9

To calculate average percentage of chick yield:

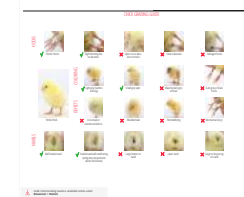
$$\frac{\text{Average chick weight}}{\text{Average Egg Weight}} \times 100 = \text{average percentage chick yield}$$

## Chick Processing

After separating chicks from egg debris, hatcheries will typically grade chicks for quality and count them into boxes. Additional chick services may be provided for broiler chicks that include feather-sexing and vaccination. For breeding stock chicks, additional chick services will include feather or vent-sexing, vaccination, beak treatment and toe conditioning. Depending on the vaccination, the vaccine may be applied via injection (manual or automated equipment) or via spray. (For more information on vaccinations methods, see the Cobb Vaccination Management Guide available at: <http://www.cobb-vantress.com/resources>).

- ✓ During processing, prevent overheating or chilling chicks by controlling the environment. Do not overcrowd chicks on conveyers, vaccination carousels, or in transportation boxes. To prevent chick weight loss, maintain the correct temperature (24 to 28 °C; 73.4 to 82.4 °F) and humidity (65 to 70 %) in the chick holding areas. Prevent drafts over the chicks in processing areas which can cause temperature related stress.
- ✓ Automated equipment used for separating chicks from eggshells, counting chicks, and vaccinating chicks can decrease chick processing time and the number of people involved in handling chicks. Chicks should be handled gently and securely. The body of the chick should be supported during handling and chicks should never be handled by the leg, head or neck.
- ✓ Carefully maintain the working order of all chick contact areas including conveyers and carousels. Equipment should be checked regularly for areas where mechanical pinch points, injury, or chick entrapment can occur. Gaps in transfer belts and conveyors can create areas where chicks can possibly be injured. Wet or smooth conveyor belts may also cause injurier including splayed legs.
- ✓ All equipment must be correctly and regularly maintained to prevent chick injury and to ensure accuracy of the process.
- ✓ Clean and disinfect all equipment and all chick contact areas including conveyers and carousels thoroughly after each hatch.

The Cobb Chick Grading Guide is available on page 82 in the Appendices section of this guide.



### Colibacillosis

Depending on hatchery hygiene and environmental conditions and chick quality, some chicks may be prone to Colibacillosis, a bacterial disease caused by *E. coli* that is common in poultry and occurs worldwide. Poor hatchery sanitation is a leading cause of Colibacillosis. Infection can occur via aerosols or oral routes, as well as contaminated shell membranes, yolks, navels and water. The incubation period is typically 3 to 5 days. Poor navel healing, mucosal damage due to viral infections and immunosuppressive challenges are pre-disposing factors to infections.

- ✓ Because the incubation period is 3 to 5 days, Colibacillosis cannot be detected at the hatchery. Signs and symptoms are typically identified after placement.
- ✓ Contaminated hatch debris and chick fluff in the hatchery are major sources of infection.
- ✓ Prevention includes good hygiene of hatching eggs and good hygiene in the hatchery.
- ✓ Disinfection in the hatchers with formaldehyde has shown good results in reducing bacterial load. (note: formaldehyde disinfection may not be permitted in all areas due to local regulations).



### Animal Welfare Tips

If transfer belts are inclined, use a rough or ridged belt to prevent chicks from slipping and tumbling. If using carousels, consider placing rubber padding or paper in the bottom of the carousel to provide additional cushioning and to prevent a wet or slippery surface. If using an automated chick counter, check the adjustment of guards covering rollers, the alignment of dividers, and the spacing between the dividers and the conveyor belts to prevent mechanical injuries to chicks. Slides, ramps and funnels should be cleaned, installed and adjusted on automated equipment before processing chicks to minimize drop distances for chicks. To minimize chick injury and loose chicks on the floor, these slides should be aligned so chicks use them efficiently as they transition from one area to the next and they should be positioned so that chicks are not crashing into or onto the slide. Ideally, drop distances should be no more than 15 to 30 cm (6 to 12 in).

## Chick Holding

- ✓ Newly hatched chicks are dependent on the environmental climate to regulate their body temperature. Good ventilation during holding is crucial to removing excess body heat and CO<sub>2</sub>. Keep in mind that humidity and air speed interact with the temperature and can cause the room temperature to fluctuate.
- ✓ Humidity should be set between 65 to 70 % and the room temperature should be adjusted to between 23.0 and 28.0 °C (73.4 and 82.4 °F) in order to maintain chick cloacal temperatures between 40.0 and 40.6 °C (104.0 and 105.0 °F). At higher air speeds, the room temperature should be set to temperatures in the higher end of the range. Pre-condition the chick holding room before take-off (pull) starts to prevent temperature stress. Ceiling fans should pull the air towards the ceiling and not down across the chicks which will create a chilling effect.
- ✓ Adequate space must always be provided between stacks of chick boxes or trolleys and between the chick boxes and a solid surface (walls, doors, equipment, etc.) so that air movement can keep the chicks comfortable and well-ventilated. If boxes are too close, there is an increased risk of overheating the chicks if the spacing or ventilation does not allow for the heat to dissipate. A good rule of thumb is that you should be able to easily walk between and around stacks of chick boxes in a holding room. If chicks are comfortable and not thermally stressed, they should be calm, resting and be evenly distributed throughout the box.



- ✓ Place lids or empty chick boxes on top of the chick box stacks to prevent air drafts on the chicks. Fans can result in thermal stress and chilling of the chicks if the air circulation creates a draft. If you see that chicks are huddled in the center of the box or on one side of the box, verify the angle, speed and direction of nearby fans.



### Animal Welfare Tips

- ✓ If the environmental temperature is too hot, chicks may open their beaks to pant which can cause moisture loss from the lungs and air sacs leading to possible dehydration. If the heat stress is not alleviated, chicks may become excessively noisy and spread their wings to try and release heat. Use fans to promote ventilation and air flow.
- ✓ If the environmental temperature is too cold, chicks may huddle together or pile on top of each other creating a smothering risk. Chicks are more prone to chilling if they are pulled from the hatchers when they are still wet or after spray-vaccination. It is especially important to hold chicks that are damp from vaccination or after take-off in a warm and draft free area.
- ✓ If the ventilation is not sufficient, the risk of CO<sub>2</sub> accumulation can increase. When CO<sub>2</sub> levels are increased, chicks may gasp for air and try to stick their heads outside of boxes. They may crowd around the edges of the boxes, which can reduce ventilation of fresh air making the issue worse. The CO<sub>2</sub> concentration should not go over 3000 ppm. Fresh air exchange at a rate of 68 m<sup>3</sup> per hour per 1000 chicks.
- ✓ If spacing and air flow are incorrect, heat produced by the chicks cannot dissipate from the box. This can cause the chicks to overheat. Good spacing with correct airflow will allow the heat to dissipate from the boxes and help the chicks to regulate their body temperature.

## 8.2 Feather Sexing Chicks

In some cases, chicks are separated by sex so that, at placement, the males and females can be managed according to their sex specific requirements. Feather sexing is a fast and non-invasive method of differentiating chicks. Broiler chicks in the feather sexable (slow feather) format can be feather sexed at day old as shown in the photos. In the non-feather sexable (fast feather) both males and females will show the same pattern of feather development of females shown in the photos.

Feather sexing should be conducted in a well-lit area. Chicks should be lifted by placing the neck between the index and middle finger and supporting the body of the chick with the ring and little finger. Using gentle pressure, spread the wing out like a fan. The feathers on the bottom row are the primaries and the top row of feathers are coverts. If the ratio of males to females deviates from normal (48 to 52), investigate the cause of any deviations.

### Female

The bottom row (primaries) of feathers is longer than the top row (coverts) of feathers.



At hatch, coverts are 1/2 to 3/4 the length of the primaries



After several hours, feathers have grown but coverts are still 1/2 to 3/4 the length of the primaries

### Male

The bottom row (primaries) of feathers is the same length or shorter than the top row (coverts) of feathers.



Coverts and primaries may be the same length



Coverts may be longer than primaries



### Animal Welfare Tips

The configuration for sexing chicks should allow accuracy and ease for team members. Chicks must always be held gently and wings spread with minimal pressure. Boxes for sorting must be close enough to team members so that chicks can be placed into the boxes, never thrown. Chicks should be lifted by placing the neck between the index and middle finger and supporting the body of the chick with the ring and little finger. Never pick up chicks by the wing.

## 8.3 Chick Grading

Traditional chick grading standards are done visually and may be subjective. See page 82 for chick grading guide. Guidelines for chick grading are usually based on:

### Appearance

Chicks should have clean and dry feathers. Dirty feathers can indicate that the chick has been in the hatcher too long and has become soiled with meconium. The meconium can be a source of bacteria that can cause navel infections. If chicks are wet or have sticky feathers (usually due to albumen) this indicates the humidity was too high or the egg did not lose enough moisture during incubation.

Chicks should be bright yellow. Overheated chicks have poorly absorbed yolk sacs and hence pigments are paler than normal. However, formaldehyde will mask white chicks by giving them a yellow color.

### Behavioral indicators

Healthy chicks should be alert and active. Alert chicks will respond vigorously to light, noise and movement. After spray vaccination and chick services, alert chicks may exhibit normal behaviors like preening, pecking, chirping, and actively move within the chick box. Conversely, weak and tired chicks are normally inactive, may have a hunched appearance, and may not stand or move after handling, processing or other stimulation. Multiple issues including overheating, late hatching, insufficient ventilation, disease or excessive disinfection may be related to chicks that are weak and inactive.

### Size

Smaller and short chicks can be a result of small eggs, high incubation temperatures or insufficient humidity. Small chicks typically have smaller hearts, and poorly developed digestive and immune systems. They are also more prone to Colibacillosis infections.

### Legs

Chicks should have clean legs with a waxy appearance and be well hydrated. Chicks may have splayed legs due to an injury or weakness of the tendons. These leg issues can be the result of physical injury such as a chick slipping in the hatcher basket. More commonly, they are a result of poor positioning inside the egg due to incorrect incubator temperature or high humidity.

### Feathering

Good feather development is synonymous with good chick development during incubation (chicks must look fluffy!). However, excess development of the wing feathers does indicate early hatching (overheating) and excessive time in the hatcher baskets.



### Animal Welfare Tips

Hatcheries should maintain a written report to note all chick injuries, loose chicks on the floor, and any processing/quality concerns on each hatch day. Based on the hatchery's quality assurance and welfare standards, corrective actions should be documented to ensure that any concerns are addressed and resolved in a timely manner.



## Chick Grading Characteristics

Characteristic	Reflex	Navel	Legs	Hocks	Defects
Excellent (A grade)	If placed on back, chick can flip over in 3 seconds	Clean and well healed	Clean waxy and well hydrated	Clean, no blemishes	Clean, no blemishes
Acceptable (B grade)	If placed on back, chick can flip over in 4 to 10 seconds	Closed but slight scabbing	Some dryness and / or pale	Slight blushing	Light blushing
Cull (C grade)	If placed on back, chick cannot flip over in less than 10 seconds	Not closed with string or black button attached or discolored	Dehydrated with vein protruding	Red color with heavy blushing	Missing eye / blind Legs with cuts or abrasions Splayed legs Cross beak Poor feathering Clubbed down

The Cobb Chick Grading Guide is available on page 82 in the Appendices section of this guide.



### Animal Welfare Tips

Chick grading is very important for the future welfare and performance of the flock. For example, while a grading defect (navel closure) may look very small at this stage, it can become more problematic for the chicken as it grows. The hatchery should provide staff responsible for grading with clear expectations about what quality defects are not allowed and should provide a cull box or disposal for cull chicks at each grading station.

## 9

# Hatchery Waste Disposal

Infertile and non-viable eggs, along with the eggshells that remain after chick take-off, constitute hatchery waste. Most countries have regulations regarding the disposal method and destination of hatchery waste. Where allowed, clear eggs collected at transfer may be sold for other byproduct industries such as pet food or fertilizer.

- ✓ Eggs remaining in the hatcher basket after chicks are removed should be macerated in accordance with relevant legislation. For welfare and biosecurity reasons, maceration is the preferred method of disposal since it is a humane method of euthanasia for live, unhatched embryos and it minimizes contamination in the take-off and processing areas of the hatchery.
- ✓ Chicks (cull chicks, byproduct chicks, and surplus chicks) and chicks in pipped eggs should be euthanized in accordance with relevant legislation that may specify the frequency of the process, the set-up and use of the equipment, and the training for the operator of the equipment. Euthanasia methods that are commonly used in hatcheries include maceration and gas.
- ✓ Macerated debris can be augured into a bin or trailer, or removed by vacuum into a sealed storage hopper. This should be disposed of according to local legislation and environment constraints.
- ✓ Eggs and shell debris should not be crushed inside the hatchery. Contaminated eggs and unhatched eggs can release mold and bacteria inside the hatchery if crushed.



## 10

# Transportation

Newly hatched chicks have a residual egg yolk that can provide food and water during transportation. However, if the environmental conditions (temperature, humidity, atmospheric O<sub>2</sub>) are outside the ideal range, the chicks must use the energy of the residual yolk to bring their body back to homeostasis. This energy could have been used for growth but is a loss for productivity. Stress during transportation can also impact health and increase the susceptibility of chicks to infection and, in turn, increase early mortality.

Transportation has the potential to impact feed conversion, growth rate, yield and the immune system. Given the impact of transportation on chick health and welfare, vehicles should be reliable, well-maintained, and equipped to provide the chicks' needs. This includes air handling units to control the chick environment during transportation from the hatchery to the farm. Check with local regulations for transportation as legislation may vary based on location.

## Preparing the transport truck

- ✓ Ensure that the truck has been cleaned and disinfected.
- ✓ Check the operation of the trucks cooling / heating system and fans.
- ✓ The temperature control system within the truck should have a filtration unit and the filter cleaned regularly. Filters in temperature control systems can accumulate dirt, mold and other microorganisms that can present infection risks to chicks being transported. Clean or replace air handling system filters on a regular basis.
- ✓ Check paperwork for delivery as issues with paperwork can increase the time the chicks are held on the truck. This can delay unloading and placement of chicks on farm and their access to food and water.
- ✓ Pre-heat or cool the truck prior to loading. Ideally, the correct temperature range (23 to 28 °C; 71.0 to 82.4 °F) should be achieved before the first box of chicks is loaded.
- ✓ The relative humidity of the truck should be set at 65 to 70 %.
- ✓ The duration of the trip should be considered and any necessary logistics (fuel, etc.) associated with the length of time and the planned route should be addressed prior to loading.
- ✓ Transport vehicles for chicks must be equipped with temperature-control capabilities, and with alarms should these systems fail during transport. If the chick truck driver is physically separated from the chick environment, the driver should have a display showing the temperature within the load and the driver should be able to adjust air temperature to meet chick needs. As part of the preventative maintenance program for chick delivery vehicles, the temperature monitoring equipment should be tested prior to each delivery and should be calibrated regularly.
- ✓ Ideally trucks with chiller units should have a back-up system (additional source of ventilation) should the chiller unit fail, as with most systems, ventilation air is sourced from the chiller unit. Additional air inlets or a diverter can be installed to prevent potential overheating/ventilation problems.



### Animal Welfare Tips

A complete inspection of the vehicle and the truck generator should be conducted prior to each delivery. Ideally, the hatchery should utilize a vehicle inspection form to verify truck conditions and settings prior to loading. Drivers should also have emergency guidelines and delivery paperwork in the vehicle to be able to respond to any delays or problems that may occur during the journey.

## Loading and transporting

- ✓ Chicks should be completely dry before loading into the truck.
- ✓ Take care when loading stacked boxes to avoid jarring or sudden movements as well as tilting the boxes. These types of movements can cause piling or cause chicks to become entrapped.
- ✓ The minimum ventilation rate should be 20 CFM (34 m<sup>3</sup> / hr) per 1000 chicks in the wintertime and double this in the summertime.
- ✓ The temperature inside the boxes should be approximately 32 °C (90 °F) and can usually be achieved with a vehicle air temperature of 24 °C (75 °F) in plastic boxes or 20 °C (71 °F) in cardboard boxes. Box temperature can be checked using a data logger.
- ✓ Chicks delivered in plastic boxes require greater care to prevent overheating or chilling than those in cardboard. Ensure the vehicle has adequate heating and cooling to accommodate plastic boxes.
- ✓ For long journeys, bad road conditions, or hot weather, it is recommended to reduce the stocking density per box. Check with local regulations as some areas legislate chick density.
- ✓ A rear plastic curtain in the truck can be used to retain heat while chicks are being unloaded.



Boxes must be correctly stacked and spaced to allow free air movement around them. Each row of boxes should be locked with a bar running the full width of the vehicle to prevent any movement during the journey.

## Delivery and unloading

- ✓ Once chicks are loaded and secured, drive directly to the farm and do not make unnecessary stops.
- ✓ During unloading, the doors of the truck should not be facing the wind to prevent chilling the chicks.
- ✓ Use a delivery logbook to record the temperature and condition of the chicks including any excessive panting, huddling, and mortality. If possible, without entering the house, note the conditions in the house including availability of feed and water, sanitary conditions, lighting and temperature.
- ✓ If more than one delivery is being made, chicks being delivered first should be loaded last.
- ✓ Only unload trolleys of chicks or chick boxes to meet the pace of the staff. Do not leave boxes or trolleys of chicks waiting outside the house.

## Biosecurity

- ✓ Chick delivery drivers must be well-trained and conscientious. Each driver should start the day with clean clothing and should change into fresh coveralls/ footwear for each delivery. Drivers should not enter the hatchery or enter the poultry house of a farm.
- ✓ Power wash delivery vehicles with detergent/disinfectant on each return to the hatchery. Vehicles should carry a disinfectant spray so that the wheels can be cleaned between farms if delivering to more than one location in a day.
- ✓ Chick boxes returning to the hatchery present a high biosecurity risk. They must be kept separate and thoroughly washed and disinfected before re-use.



### Animal Welfare Tips

Chick trucks should achieve the expected temperature before chicks are loaded to prevent thermal stress and to avoid exposing to large variations in environmental conditions. If regularly loading chicks during weather extreme (cold or heat), the hatchery should have a secure means of loading chick boxes to limit any negative impact on chick welfare from external climatic conditions.

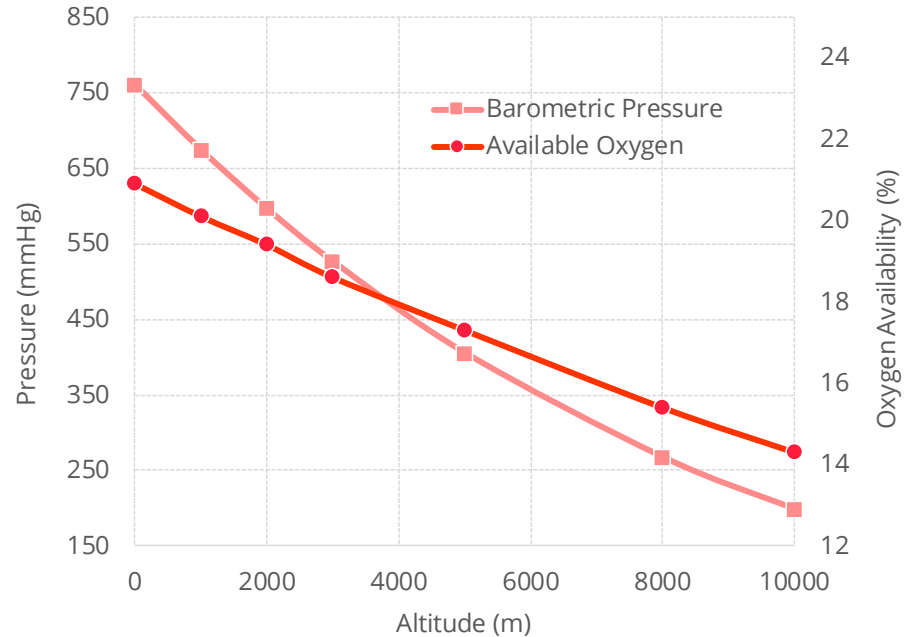
# 11

## Altitude

Hatcheries operated at high altitudes may experience reduced hatchability, with much greater effects above 2500 ft (762 m). Hatchability problems at high altitudes are due to reduced availability of oxygen in the air and increased moisture loss from the eggs. Barometric pressure declines with altitude, as does partial pressure of oxygen and absolute humidity. Fresh air ventilating will tend to be colder and drier than at sea level. Incubators with poor temperature or humidity control systems will have difficulty coping with challenging conditions.

### 11.1 Oxygen Availability

Air is always composed of 21 % oxygen regardless of the elevation, but partial pressure is reduced at higher altitudes which impacts oxygen availability. Partial pressure squeezes molecules together in air, so that reduced pressure results in molecules being further apart and hence fewer molecules of oxygen in each breath. Therefore, the reduced partial pressure at higher altitudes provides less oxygen for each breath of air. In addition, this pressure reduction means oxygen is more easily released from tissues resulting in lower blood and tissue oxygen levels. The oxygen availability in the incubators should always be at least 20 %. Proper ventilation can improve oxygen availability, but keep in mind that over-ventilation may cause issues with humidity and temperature control. Since high altitude areas often have lower temperatures and humidity, conditioning the incoming airflow will require specific adjustments.



To increase availability, oxygen can be directly added to the incubators. To achieve the levels of oxygen availability at sea level, the oxygen percentage in the air needs to be increased by roughly 2 % for every 500 meters (1640 ft) of increase in elevation (See table to right). This means hatcheries at 1,500 meters (4921 ft) would require more than 25 % oxygen availability. The use of pure oxygen, however, is typically cost prohibitive at very high elevations. Pure oxygen is also a safety concern, as concentrations of oxygen over 25 % are not recommended since oxygen is extremely flammable.

Oxygen concentrators are available as an alternative to using pure oxygen. Concentrators work by taking in ambient air and removing nitrogen, thereby increasing the concentration of oxygen and other gases in the air. For safety reasons, most concentrators can increase oxygen concentration to a maximum of 23 %. This will restore oxygen concentrations to those of sea level at altitudes below 1000 m (3281 ft) but can only partially restore concentrations when used above 1000 m (See table to right).

If planning to use an additional source of oxygen to increase the concentration, consult your incubator manufacturer for guidelines and technical assistance. Each incubator manufacturer has specific operation parameters and adjustments may be required for your machines.

Altitude Meters (feet)	Required Oxygen Concentration (%)
0 (0)	20.95
500 (1640)	22.34
1000 (3281)	23.84
1500 (4921)	25.47
2000 (6562)	27.24
2500 (8202)	29.16

## 11.2 Moisture Loss

Water loss from an egg during incubation is greater at high altitudes because water vapor diffuses through the shell more easily due to the decrease in atmospheric pressure. The conductance of the eggshell becomes extremely important at high altitudes because dehydration of eggs can significantly decrease hatchability. Adjusting the incubators to higher humidity settings may offset the rapid diffusion of water out of the eggs. However, be aware that when humidity is adjusted, the temperature may also change and will need to be adjusted as well.

Some evidence indicates that breeders kept at high altitudes produce eggs with lower porosity. A lower porosity egg would reduce conductance of gases and vapors across the shell and help prevent dehydration. However, it is recommended to adjust the humidity settings to reach the correct egg weight loss (see moisture loss section 4.3).

## 11.3 Chick Quality and Mortality

- ✓ At high altitudes, producers may have issues including nonstandard incubation periods and a decrease in hatchability.
- ✓ Bodyweight of chicks hatched at high altitudes may be reduced. This can be attributed to a reduction of embryonic metabolism but may also be a factor of dehydration.
- ✓ The embryo's oxygen consumption increases by 60 % around the time of hatching. With the reduced oxygen availability at high altitudes, late embryonic mortality may be an issue. To reduce late mortality, the correct oxygen concentrations in the hatchers are important.

## 12

# Maintenance

As hatcheries become larger and more automated, the need for preventative maintenance becomes crucial. Equipment can be a source of problems and variability when not functioning properly.

## General Maintenance

- ✓ Follow the manufacturers' directions for routine servicing and maintenance. The manufacturer should provide a schedule and time frame for maintenance of each piece of equipment. Keep accurate records of repairs outside of routine servicing. This information can be used to adjust the routine servicing and maintenance schedule if necessary.
- ✓ Perform a thorough inspection and cleaning at least twice a year on multistage incubators and after each transfer on single stage incubators. Having replacement parts and equipment ready in the event of equipment failure can save costs of lost hatches.
- ✓ Hatchers are emptied and refilled in a short time frame leaving little time for servicing and repair. Have extra hatchers available to enable essential repairs to be carried out when necessary.
- ✓ Keep a stock of spare parts. Maintain an accurate inventory of parts in the stock. When parts are taken from the stock, record the date and which piece of equipment they were used to repair. This information can be used to address reoccurring issues with parts and equipment.
- ✓ Ensure all safety practices are followed is a management responsibility. Before beginning equipment repairs, ensure the power supply to that equipment has been turned off. Provide the necessary guards and safety switches. Ensure all working practices comply with safety legislation.
- ✓ All maintenance records should be shared with the hatchery management.

## Alarm systems

Alarm systems can be used to indicate failures or issues with equipment. Make sure staff that operate incubators and hatchers are properly trained and have a procedure to follow in the event of equipment issues or failures. Alarm systems can be used to indicate:

- ✓ Temperature and humidity issues in incubators and hatchers
- ✓ Power failures of equipment
- ✓ Turning failures of equipment
- ✓ Pressure or ventilation settings out of range
- ✓ Doors opened

## Water and humidification

Spray nozzles for humidifying systems should be cleaned or replaced on a scheduled basis. Mineral deposits (scale) can accumulate on nozzles and reduce the water flow and increase droplet size. Scale accumulation can also increase the pressure on piping joints and cause water leaks. Water systems used for humidification should be cleaned to prevent microorganisms from contaminating the system and forming biofilms which can be challenging to remove.



## Calibrations

Exposure to high temperatures, humidity, dust and chick fluff can impact a sensors reliability. It is best to calibrate all sensors on an annual basis at minimum but more frequent for key monitoring devices (ie. temperature, humidity, CO<sub>2</sub> and ventilation sensors). Use calibration probes and keep records of the calibration. Calibrate equipment while operating and not at the beginning or ending of an incubation or hatch. Place the calibration probes as close to the sensors as possible. Each calibration should be done under similar conditions (i.e. calibrate with the probes at the same location on the machine while in the same incubation or hatching step). Allow the readings to stabilize before comparing the probe with the sensor. If the sensor is out of calibration, check maintenance records and determine if there are any mechanical errors before adjusting the sensor.

- ✓ Use a thermometer to calibrate temperature probes that is accurate to the tenth of a degree in Fahrenheit (0.1 °F) or to 5 hundredths of a degree in Celsius (0.05 °C). Single stage incubators should be calibrated on each setting. Multi-stage incubators should be calibrated at minimum every 90 days. If variations occur between calibrations, increase the frequency of checks.
- ✓ A hygrometer can be used to calibrate the humidity sensor.
- ✓ Carbon dioxide sensors can be checked against a carbon dioxide meter using the ambient concentrations. However, the sensors should be checked against several concentrations of carbon dioxide and can be done using prepared gas tube mixtures available in high concentrations (5,000 ppm and higher) that have been certified.
- ✓ Calibrating a pressure sensor to a full range will require special equipment. Calibrating the sensor to zero can be done by removing the tubes from the sensor, but leaving all the hose connectors vented into the same air space. The sensor can then be adjusted to zero if needed.

## Ventilation and air handling

In order to keep the air clean and moving through the hatchery, regular maintenance of fans, calibration of air volumes and maintenance of filters will be required. For a properly operating air handling system:

- ✓ Calibrate air volumes to rooms and individual machines. Refer to section 14.2 for recommended air volume and pressure to each room. Smoke emitters can be used to identify air leaks and damaged seals. Air leaks can create a significant amount of stress on air handling systems and reduce their life span and disrupt the differential pressure between areas.
- ✓ Clean or replace filters on a regular basis depending on the dust and dirt level in your hatchery. Clogged filters can prevent air flow which can disrupt temperature, carbon dioxide and humidity settings and create stress on equipment as well as air handling units. Air filters are meant to clean the air and dirty filters can collect and disseminate dirt and microorganisms creating contamination issues for the hatchery. Clean air conditioning coils on a regular basis to remove any chick down or dust which may accumulate and result in clogging of the coils.
- ✓ Fan belts, bearings and sensors should be included in a preventative maintenance plan. Fans that are not operating correctly can cause similar issues as clogged air filters. Stroboscopes and tachometers can be used to calibrate and check fan speeds. Bent fan blades will not deliver the correct airflow and should be replaced. Check that fans are positioned inside the housing correctly. Fans that are offset in the housing may leak air from the sides and can also blow air backwards. Clean fans regularly to prevent contamination issues.



### Animal Welfare Tips

The hatchery's preventative maintenance program should include a weekly review of all euthanasia equipment. Additionally, the maintenance department should have ample spare parts, motors, etc. to ensure that there will be no delays with achieving humane and timely euthanasia for cull chicks.



# Hatchery Automation

Because of increasing hatchery size and increased cost of labor, considerable opportunities may exist for automating many of the labor-intensive operations in hatcheries. As a broad guide, a staffing level of one employee per one million chicks per year (not including drivers) is the norm without automation, or one employee per two million chicks per year with automation.

Much of this equipment is precision made and very expensive and only very large hatcheries can justify its use. When selecting equipment, ensure that it can be disinfected easily, quickly and effectively. Egg and chick handling equipment should not contribute to cross contamination between eggs or between chicks.

## Available equipment

- Grade and pack eggs before incubating
- Candle and transfer eggs at 18 days
- Perform *in-ovo* vaccination
- Separate chicks from shell debris
- Count chicks
- Spray vaccinate and box chicks
- Stack and unstack boxes, baskets and flats
- Wash boxes, baskets and flats

A range of conveyors, elevators and carousels are available to increase speeds of grading, sexing, subcutaneous vaccination and other operations with manual components.

## Productivity improvements

- Gentler handling of eggs to reduce breakage
- More precise vaccination of the chicks
- More accurate counting of chicks
- Less time between hatch and rearing farm
- Less fatigue for operators to create a better working environment

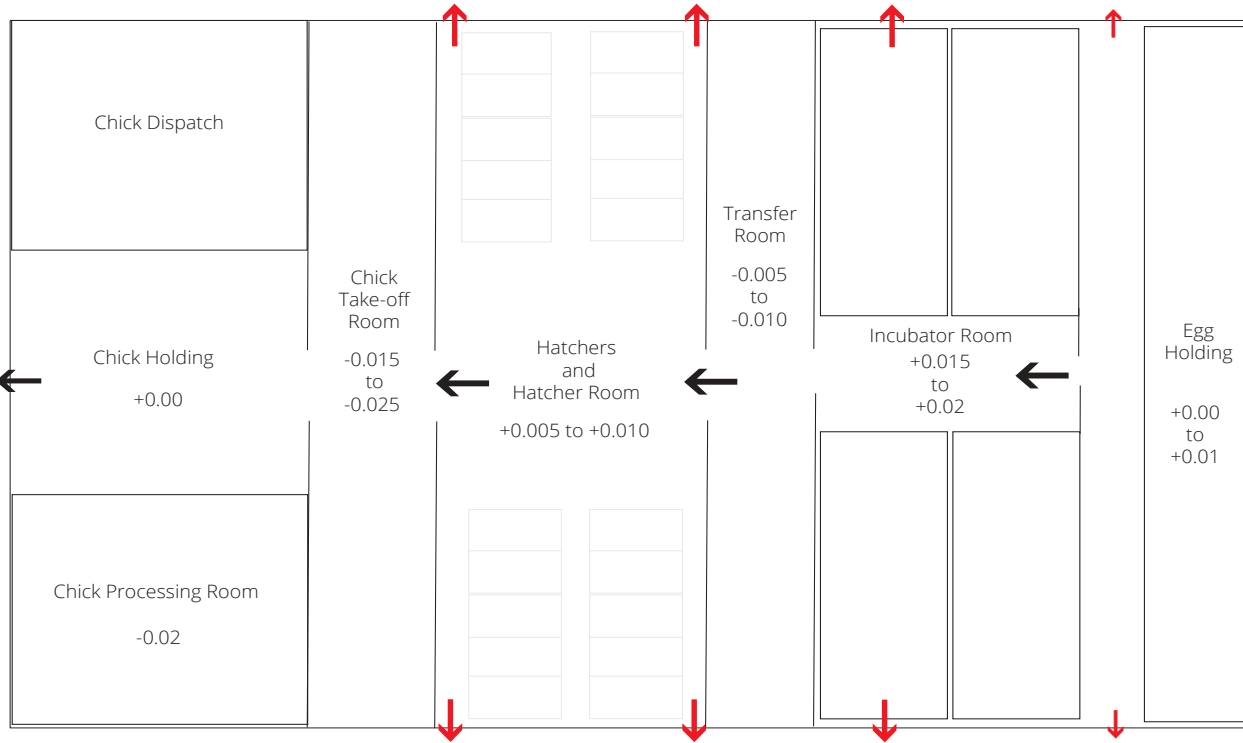
## Benefits of automation

- Labor reduction
- Increased production
- Improved quality
- Minimize human errors
- Standardization
- Flexibility



# Hatchery Design

Good design is essential for cost-effective hatchery operation. The conditions provided to maintain embryonic growth in the incubators can also promote growth of bacteria and molds. To prevent and reduce microorganisms, the outer surfaces of eggs must be free from contamination and all room surfaces, equipment and incubators must be designed to allow simple, regular and effective cleaning and sterilization.



Black arrows indicate the flow of product through the hatchery. Red arrows indicate the exhaust of air from a specific room.

## 14.1 Building Structure

### General hatchery infrastructure

- ✓ A good floor finish is necessary for regular cleaning and disinfection throughout the hatchery. A good floor finish can be obtained with a cement incorporating a hard stone aggregate or topped with a self-leveling epoxy which has certain advantages over the more traditional finishes. If re-finishing your hatchery floors, consult your incubator supplier for any specific recommendations regarding leveling and thickness of the floor. The floors must be sloped to the drains in each room of the hatchery but not to the extent that can impact the turning angles in the incubators. Likewise be aware that trolleys may roll and fall on sloped floors.
- ✓ Ceilings should be high enough that the tops of equipment are accessible for cleaning. High ceilings will allow air to be moved away from chicks and alleviate drafts. Ceilings can harbor dirt and dust and therefore should be constructed of material that is easy to clean.
- ✓ Clean and dirty areas must be separated to prevent cross-contamination by fluff that can be carried around the hatchery in air currents, on staff clothes and on equipment. The ventilation system must ensure that air moves from clean to dirty areas and never the reverse, e.g., from egg storage to chick dispatch. Ventilation systems need to be cleaned periodically. In this context, the polythene air duct offers many advantages over steel-based systems that are difficult to clean.
- ✓ All hatcheries must have an automatic standby generator to provide sufficient power to operate the hatchery should the main power supply fail. Alarm systems should indicate power or systems failure, and alert hatchery personnel to the problem so that it can be rapidly located and corrected.
- ✓ Wall surfaces should have minimal joints and fastenings that impede effective cleaning. Outside walls should be well insulated to prevent condensation from forming on the inside walls.
- ✓ All incubators should have secondary alarm systems to indicate high or low temperatures independent of either the main electricity supply or the machine's own control systems. This is particularly important with hatchers where component failure can lead to the complete loss of chicks very rapidly. To ensure that emergency power can be immediately provided when needed, the generator should be tested once every 7 days, under load, for a minimum of 30 minutes. All generator use (routine and emergency) should be recorded in a log.
- ✓ In addition to the generators and alarms, the hatchery should have written protocols related to emergency preparation for natural disasters that may disrupt transportation, loss of power and water, order cancellations, equipment failures, etc.
- ✓ All drains need to be trapped, particularly in hatching and take-off areas, to prevent blockages of eggshell and debris. The entire drainage system must be designed to handle large quantities of wash water and solid matter. Floors should be sloped to promote water flow to the drains. Trough type of drains facilitate cleaning and movement of large quantities of organic material. All drains in chick areas (hatcher hallways, take-off areas, processing and holding areas) should have a cover to allow for water flow but to prevent any loose chicks from being trapped in the drain or drain basin.



#### Animal Welfare Tips

Alarm records should be evaluated by hatchery management and maintenance staff to help identify reoccurring issues that can compromise chick safety and welfare. Corrective actions related to equipment maintenance, ventilation, staff training, etc. can all positively impact hatchability if addressed proactively.

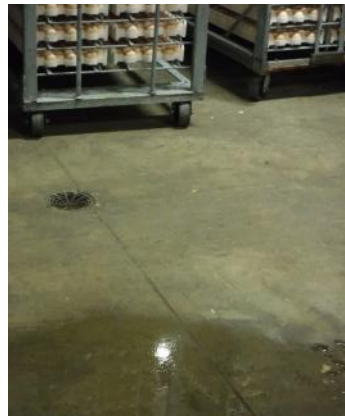
## Hygienic design

Hatchery location is inevitably a compromise between the disease risks of a populated poultry area, the transport costs of eggs and chicks, the availability of labor, and the overall transport network. Microorganisms can significantly impact hatchability and chick quality. However, good hatchery design and management can reduce the number of microorganisms entering, growing and surviving in the environment.

- ✓ Microorganisms need organic material (eggs, debris, and dirt) as a nutrient source to survive. To facilitate cleaning and prevent dirt and dust build-up, minimize any clutter and only keep essential equipment in each room. All surfaces should be smooth, impervious and hard. Rounded corners greatly facilitate cleaning. Rooms should have enough air flow and exhaust to remove moisture and prevent mold growth
- ✓ Microorganisms (bacteria, mold, mildew) thrive in wet and humid conditions. Keep all areas as dry as possible by preventing standing water on the floors. Seal cracks or holes into which water can seep. Repair all water leaks quickly. Prevent high levels of humidity and after an area has been washed, dry it as quickly as possible. Hang up mops, brushes, and other cleaning tools so they can dry quickly after use.
- ✓ Holes and cracks can collect organic material and moisture, which provides a suitable habitat for microorganisms. Ensure all surfaces are hard and impervious. Equipment should be built using hygienic materials and designed for easy and accessible cleaning.
- ✓ Personnel can cross-contaminate areas by carrying microorganisms on their clothing and shoes. Prohibit personnel from having contact with any avian species (other poultry, wild birds, pet birds, etc.) to prevent disease risk and possible contamination of eggs or chicks.
- ✓ Location of the hatchery can have a big impact on biosecurity. The hatchery should not be close to any natural water sources (ie. ponds, lakes, etc) which can attract wild or migrating birds. Businesses and operations can produce a great deal of dust which can enter the hatchery through ventilation systems. Dust can carry microorganisms, block air filters increasing maintenance and cleaning costs, and reduce air quality.
- ✓ The work flow design of the hatchery should be a one-way system starting with clean and ending with dirty. Egg and chick work and equipment should be completely separated. The air flow should be filtered (4 microns) and have positive pressure from clean to dirty. The air intake should be located on the clean side of hatchery.



Repair leaks to keep organic material and water contained. Microorganisms require these to survive.



Keep all areas as dry as possible by preventing standing water on the floors



The hatchery should not be located near open water sources or factories that produce a lot of dust.

## 14.2 Hatchery Ventilation Configurations

### Ventilation configurations

The ventilation configurations for each room will depend on several factors including, the incubator manufacturer's requirements, the number of eggs or chicks in the room and the type of pressure controlling system. Some general points for each room include:

- ✓ The rooms of the hatchery should be as air tight as possible. A well-sealed room will facilitate control over the air flow around the equipment. Cracks in seals, gaps between walls, and poor insulation will disrupt the flow of air and make temperature and humidity difficult to maintain and regulate.
- ✓ The type (chilled water, freon, evaporative cooling) and size of air handling unit used should be based on the total volume of air handled and the temperature range required.



- ✓ The delivery of fresh air should be through several points in the ceiling. This will minimize temperature differentials around the room.
- ✓ Most hatcheries use a spray system to provide humidity. Steam systems are usually cost prohibitive. Humidifying systems should use water filters and be disinfected regularly.
- ✓ There are several designs that can be used to create and control pressure. The ideal system uses a variable speed fan to supply air from an air handling unit with a return air system. These types of systems are the most energy efficient as supplied air is recycled. Plenums can also be used to control atmospheric conditions and provide hygienic solutions (see section 14.3).

### Common ventilation issues

- ✓ **Inadequate fresh air supply to the room** can be a result of the air handling system being too small and / or having too many incubators for the air handling system.
- ✓ **Inadequate heating and cooling capacity** can occur if the system isn't properly maintained. This issue can also occur if the system is too small to supply the demands of the incubators.



- ✓ **No preventative maintenance** can leave air filters clogged leading to malfunctioning air handling systems, poor air quality, and poor ventilation. Preventative maintenance should also address ventilation issues such as leaking door seals and fans not working properly.
- ✓ **Incorrect calibration of sensors** can lead to issues with ventilation. Calibrate temperature, pressure, and humidity sensors on a regular basis as recommended by the manufacturer.



#### Animal Welfare Tips

Ventilation equipment must be designed and set-up to avoid blowing air or water directly on chicks. If there are any condensation drips from equipment or the ceiling, avoid placing chick baskets in these locations to prevent chicks getting wet and chilled.



## 14.3 Incubator and Hatcher Exhaust Plenum Configurations

The use of a plenum gives flexibility to hatchery design because hatchers do not have to exhaust to exterior walls. Plenums also provide more control over atmospheric conditions that can cause the exhaust to malfunction on hatchers and incubators. Furthermore, the amount of ductwork is reduced which reduces difficult cleaning and improves hygiene. Finally, the plenum can improve the control of chick fluff contamination leaking into hatcher doors and exhausted to the atmosphere.

### The correct plenum configuration includes:

- ✓ A sloped roof at an angle of approximately 45° from the top of the machines to the wall for ease of clean up.
- ✓ Doors with good seals (air tight).
- ✓ Waterproof strip lights mounted horizontally for maximum lighting.
- ✓ A variable speed fan located as high as possible in the plenum to allow chick down to settle on the floor and as far away as possible from hatcher exhausts.
- ✓ A drain in each plenum (if possible) to facilitate cleaning.
- ✓ A gutter on the backs of the hatchers with a mounting bracket for vertical plenum panels. This will allow the sanitation crew to easily clean the tops of the hatchers. The gutter needs to have a slight pitch toward one end with drain plugs placed as needed.

### Pressure control fans

All pressure control fans must be fitted with a good back draft shutter. If the fan is installed on a chimney there must be a back draft shutter fitted at the base of the chimney to eliminate the chimney effect from altering the ability of the fan to accurately control the pressure. If the pressure control fan is installed on the wall, a back draft shutter and wind protection hood need to be installed to minimize the effects of outside wind.

### Pressure sensors

There are two options to mount the pressure sensing unit and tubes:

- ✓ from the plenum to the exterior of the building, *which is recommended* and called the atmospheric reference point.
- ✓ from the plenum to the respective hatcher or incubator room. When this is done, the pressure for the plenum must be set as negative as the room is positive to allow the plenum to be neutral to atmosphere.

The sensor reference tubes should never cover more than 25 feet (7.7 meters) from the plenum to the outside of the building. The sensor reference tube should only be used for one sensor unless the size of the tube is increased or collected into a PVC pipe running throughout the hatchery to the outside. The pressure reference tube should be installed in a way that will prevent the wind from interfering with the pressure measurements.

The correct location of these sensor reference tubes must be established by monitoring and recording the operation of the hatcher or incubators. However, the plenum itself needs to be sealed from the hatcher or incubator room as well as to outside to prevent a false reading from the pressurized room. Place the pressure controllers at eye height for easy reading and monitoring.

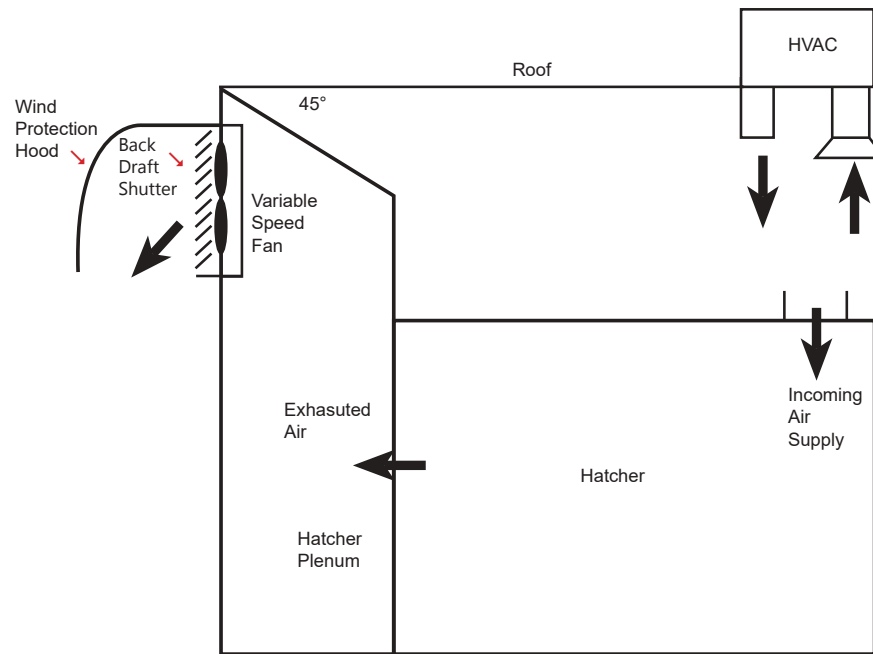
A pressure sensor (magnahelic) gauge should be installed alongside each electronic pressure control unit for comparative reference purposes.

### Incubator exhaust plenum

The incubator plenum should be above the machines and cover the entire top surface area of the incubators to facilitate heat removal from the machines. The air must be exhausted to the atmosphere away from the fresh air intake. In general, to determine the ventilation rate (fan capacity; cfm; m<sup>3</sup>/min) required to maintain a neutral pressure (0.00) to atmosphere in the incubator chamber, multiply the total number of machines by the air volume recommended to the type of machine. Because of the large variability, for single stage machines, the volume of air required should be obtained from the incubator manufacturer.

### Hatcher exhaust plenum

The hatcher plenum must be behind the machines at floor level and exhaust to the atmosphere. If an exhaust from a machine falls directly in front of the exhaust fan the exhaust from the machine should be turned down toward the floor. The air must be exhausted to atmosphere and away from any fresh air supply intake. To determine the ventilation rate (fan capacity; cfm; m<sup>3</sup>/min) needed to ensure the plenum is always maintained at a neutral (0.00) pressure to atmosphere or slightly negative multiply the number of hatchers exhausting into one plenum by the air volume recommended to the type of machine. Because of the large variability, for single stage machines, the volume of air required should be obtained from the hatcher manufacturer.



A diagram of the hatcher room with exhaust plenum showing the direction of air flow (black arrows).



## 15

# Hatchery Sanitation

The hatchery is susceptible to contamination with microorganisms including bacteria, viruses, and fungi (molds and yeasts). The main source of microorganisms is eggs that are brought into the hatchery from the farm. The incubators and hatchers are also a high risk area as they provide warm and moist conditions for many microorganisms to survive, grow, and thrive. A regular cleaning and disinfection schedule are required to produce high quality chicks. A validation and monitoring system can help reduce the risk of contamination and keep microorganisms under control. All hatcheries should have a carefully planned sanitation and disinfection program designed to address high risk areas within the hatchery.

For any sanitation program consider:

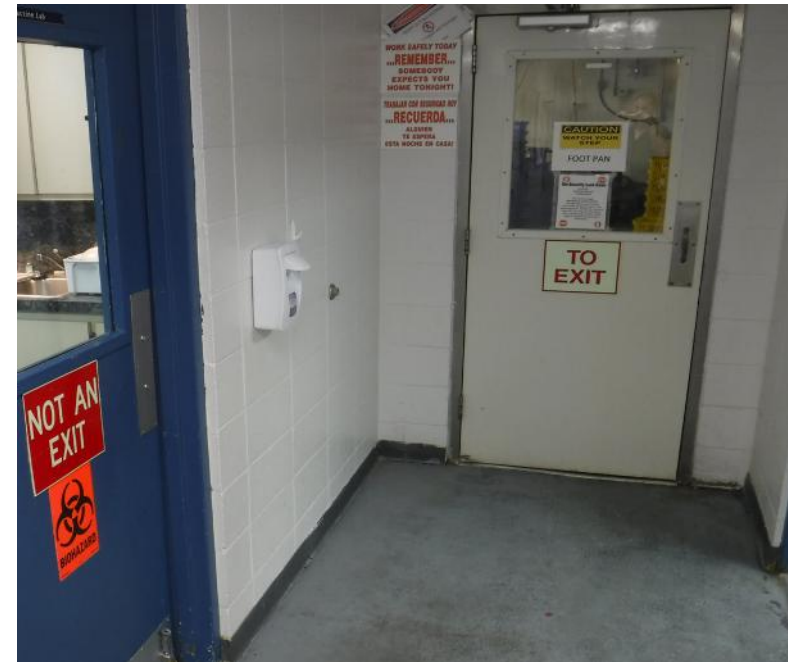
- ✓ **The production volume of the hatchery.** A larger volume of production will mean a larger volume of sources of contamination entering the hatchery (more farms, more people, more eggs, etc.). A larger volume of production can also increase the stress on biosecurity and hygiene control programs. The volume may also dictate the cleaning and disinfecting schedule as a heavy production volume may not leave a lot of open time for cleaning equipment.
- ✓ **The chemicals and equipment used for each cleaning and sanitation task.** Local regulations, commercial availability and cost will factor into which chemicals will be used. Always follow the manufacturer's instructions for chemical usage. Contact the chemical manufacturer for questions on application and usage.
- ✓ **The hatchery may be receiving eggs from multiple farms.** Along with the eggs, the hatchery will be exposed to any contaminants carried on that farm's egg flats, buggies, vehicles, and personnel. This means that one farm can be a potential source of infection to eggs and chicks from a different farm. The hygiene status of the farm and number of floor eggs delivered can all significantly impact the hatchery.
- ✓ **The amount and sources of contamination.** These can include infected eggs, chick fluff, air, water, people (both workers and visitors), rodents (rats and mice), wild birds, insects, equipment and other fomites such as boxes, trays and buggies.



## 15.1 Movement Through the Hatchery

### Personnel and visitors

Controlling movement of people within the hatchery can be challenging. Managers must strictly follow movement restrictions as leading by example will be very important to limiting the movement of people throughout the hatchery. A biosecurity and hygiene program should include requiring employees to wear clothing that is only for inside the hatchery. Employees should wash all areas of exposed skin prior to entering the hatchery. Ideally, a hatchery design should include showering and / or changing facilities. Provide handwashing areas throughout the hatchery and encourage frequent handwashing for employees. Soap and water, as well as, disinfectant should be available at these stations. Visitors should be provided with clean coverings for their clothing. They should follow the same hygiene and biosecurity policies as personnel.



### Restrictions for movement through the hatchery include

- ✓ Use and maintain a log book for visitors.
- ✓ Any movement through the hatchery should be in one direction starting in the egg room, moving to the incubators, then hatchers, and finally the chick room. Movement back through these areas should be prohibited. Color coding uniforms by sector and a different color for visitors is recommended.
- ✓ Personnel working in areas with eggs (storage, incubators, etc) should not enter the hatcher area. Likewise, personnel working in the hatching area, chick holding or sorting areas should not enter any incubator or egg areas. If necessary, any personnel moving between these areas should be required to change clothes and wash any areas of exposed skin.
- ✓ Telephones or intercoms should be available and used to communicate between areas to help limit movement.
- ✓ Drivers delivering eggs should not enter the hatchery. Eggs should be unloaded at a pace that is even with the hatchery worker to prevent eggs in cartons or buggies from standing outside.
- ✓ Use only one open entrance which leads to and passes through the showering and changing facility. The remaining entrances should be locked.
- ✓ Foot dips or shoe sanitizing stations should be available at the thresholds of doorways.



#### Animal Welfare Tips

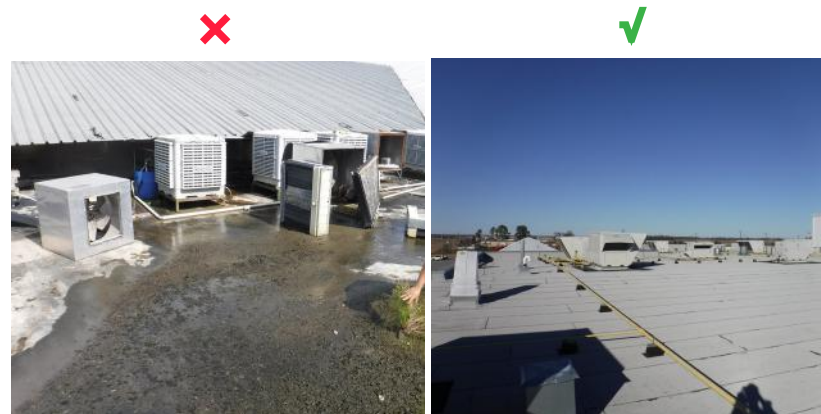
All staff and visitors should be required to notify management of any avian contact prior to entering the hatchery to minimize biosecurity risks and to prevent potential disease transmission to newly hatched chicks.

## Ventilation

Fresh air from air handling units should follow a biosecure movement through the hatchery (i.e from the egg areas, to hatcher, to chick rooms). Create pressure differentials between rooms to create an airflow in a biosecure direction and prevent air from flowing backward. If possible, each area of the hatchery should be ventilated separately and include the egg processing and storage area, incubation, hatchers, and chick rooms. The ventilation systems of these areas should exhaust in such a way that the intake for one area is not close to the exhaust of another.

Systems that exhaust outside to one wall on the sides of the hatchery, should exhaust in a way that minimizes the contamination of fresh intake air. If possible, the air should exhaust with the prevailing wind and the intake of fresh air should be upwind from the exhaust. The system should have a good filtration system where filters are cleaned and sanitized or changed on a regularly scheduled basis.

When water systems are used for humidifying or evaporative cooling, the water should be treated with chemicals such as chlorine to prevent microorganisms from being aerosolized. Cleaning and disinfecting water circulating systems are important as scale and biofilms can form and are very difficult to remove. Clean and sanitize or change filters for these systems on a regular basis.



Use drains and gutters to prevent accumulation of water and dirt on the roof. Accumulation of organic material can contaminate the hatchery through the ventilation intake but also by seeping in through cracks in the roof. Exhaust air from the hatchery may be very warm which will be conducive to growth of fungi, plants and bacteria. Any standing water on the roof mixed with warm exhaust air will provide a habitat that is very conducive to the growth of organisms.



Using mesh to prevent wild birds from roosting inside the roof is a good biosecurity measure. However, the mesh can become caked with dirt and debris if the exhaust is located underneath the roof.

## 15.2 Cleaning and Disinfection

### Dry cleaning

All cleaning operations should begin with the uppermost surfaces and proceed downwards to minimize possible re-contamination of previously cleaned areas. Dismantle all movable equipment and collect them in a specific area for cleaning.

Dry cleaning (i.e. brushing, scraping, vacuum cleaning, etc.) should be performed inside and outside incubators, hatchers, and other areas with chick fluff, eggshells and other large pieces of organic residue. While dry cleaning, pay special attention to the fans and air inlets, light system, beams (especially in corners), heating system and electrical equipment which cannot be removed (e.g. motors, switches).

### Wet cleaning

Wet cleaning involves thorough cleansing using water, detergents, and high-pressure washing to break down organic soilage, grease and fats. The water quality must be fit for animal consumption, and free of organic or inorganic material that may negatively interfere with chemical efficacy. Use warm water (60 °C, 140 °F) for all wet cleaning steps which will help liquify fats and other organic material for easier removal.

Electrical equipment including control panels and switches should be waterproof or covered with plastic sheets and tape. An International Protection Code (IP) of IP65 or higher is required for the lighting system to withstand high pressure washing procedures. High pressure spraying will facilitate the washing of hard to reach areas. Washing should be done systematically, starting from the top downwards and from the back of the area to the front moving carefully from one side to the other side. If a lot of water or dirt collects on the floor, remove it by pushing it with a brush towards the floor drains to prevent splashing and recontamination of cleaned areas.

### Moveable equipment

Many hatcheries use automated fixed tray and basket washers. The room where this washer is located can also be used as a location to clean moveable equipment.

Cleaned and sanitized equipment and materials should be placed in a separate storage location. The washroom should be considered a dirty area. Some of the equipment may require soaking to loosen dirt, but all of them should be staged above the floor with sufficient drying space.

### Fixed equipment

Regular cleaning and disinfecting schedules are necessary for fixed equipment as it may be more challenging to clean. These pieces of equipment will need clean-in-place protocols and usually require hand cleaning to remove organic material. A floor that slopes to a drain is necessary when clean-in-place protocols are used. Any large pieces of debris in the incubators such as eggshell should be removed prior to cleaning. The hatchers usually accumulate a large amount of chick fluff and debris. The hatcher can be vacuumed out and wetting dirty hatcher baskets before moving them will help control chick fluff and debris. Sanitizing of fixed equipment can be done using an aerosolizing system.



## Disinfectants

Disinfectants are useful for maintaining the sanitary status of a surface, but will not work unless that surface is clean. Some disinfectants are readily inactivated by organic materials. Disinfectants must be used strictly in accordance with the manufacturer's instructions. Not all disinfectants are compatible and some are toxic and must be handled with care.

Ensure that the hatchery staff is aware of the correct storage, handling, and mixing requirements of the disinfectants used. Obtain product data sheets from the manufacturers and follow their guidelines carefully. Safety aspects are covered by various codes of practices and safety legislation. It is the responsibility of the hatchery manager to familiarize himself with these matters and ensure that all workers understand and follow them. Specific training of staff in the correct use of disinfectants is essential. Know your local legislation and abide with local and national legal requirements and codes of practice in terms of safety and monitoring. Ensure any used, unused or spilled chemicals are disposed of properly. Keep accurate records including MSDS sheets and chemical purchases and usage. Constraints on usage and monitoring can be enforced by government legislation or customer codes of practice.

The choice of disinfectant will depend upon several factors including

1. efficacy
2. safety
3. residues
4. ease of application
5. availability
6. cost
7. service by supplier
8. target microorganisms

### Relevant characteristics of chemical disinfectants and their effectiveness against microorganisms

Chemical Type	Anti-bacterial	Anti-fungal	Anti-viral	Anti-spore	Toxicity	Corrosiveness	Surfactant ability	Cost
Formaldehyde	Good	Good	Good	Good	High	Low	Poor	Low
Chlorine Based	Good	Poor	Poor	Good	Low	High	Poor	Low
Quaternary Ammonium	Good	Variable	Variable	Not effective	Low	Low	Good	Low
Phenolic Based	Good	Good	Variable	Good	High	Variable	Poor	High
Iodine Based	Good	Good	Good	Good	Low	Low	Low	High
Glutaraldehyde	Good	Good	Good	Good	Medium	Low	Low	High
Hydrogen Peroxide	Good	Good	Good	Good	High	High	Low	Low
Ozone	Good	Good	Good	Good	High	High	Low	High
Peracetic Acid based	Good	Good	Good	Good	Low	Variable	Low	High

## Hygiene Monitoring Program

- ✓ Written procedures must be available for all cleaning protocols and schedules and the staff should be trained to use and comply with the procedures.
- ✓ Design a schedule with time frames that allow areas to be thoroughly cleaned and disinfected. Some areas may require more time than others to remove organic material prior to washing. Include time for any foaming surfactants and detergents to sit on surfaces. Disinfectants will also require time for biocidal activity.
- ✓ Install ownership of hygiene standards and routines to respective areas and supervisors.
- ✓ The performance of the program should be checked regularly using standard microbiological monitoring procedures (agar plates and swabs) to measure its effectiveness. This can be done by swabbing designated surfaces, taking air samples or evaluating the microbiological status of chick fluff. Identify any areas which may be contributing to issues with microorganisms and address procedures and cleaning application or chemical effectiveness. Use this evaluation to find the most effective hatchery sanitizer.

### An example of a hatchery hygiene monitoring and validation program

	Area	Item to be sampled	Frequency	Type of Test
All hatchers	Internal	10 internal swabs pooled	Monthly	<i>Salmonella</i>
Culls	-	All flocks	Biweekly	<i>Salmonella</i>
Water	Vaccinator	Water tank	Monthly	TVC*
Hatchery Audit (External)	All areas	All areas	Biannually	TVC/ Molds/ <i>Salmonella</i>
Dipslides	All areas	All areas	Weekly	TVC / Molds
Production Area	Take-off	Conveyors	Monthly	<i>Salmonella</i>
Production Area	Take-off	Macerator	Monthly	<i>Salmonella</i>
Production Area	Transfer	Hatcher baskets	Monthly	<i>Salmonella</i>
Production Area	Vehicle	Internal box	Monthly	<i>Salmonella</i>

\*Total viable counts

## 15.3 Biosecurity

A sanitation program should be designed to prevent and control contamination. Preventing contamination can be accomplished with a strict biosecurity program. Some critical control points in a biosecurity program include:

### People

Hatchery policy should prohibit employees from owning avian pets or poultry due to the risk of disease transmission. Some illnesses including Salmonella, can be transmitted from humans to avian hosts. For this reason, employees should immediately notify a supervisor when ill. Personal hygiene and protective clothing policies are also an important part of a good sanitation and biosecurity program.

### Contractors

Use a questionnaire to screen any visitors to determine biosecurity risks. Include questions about farm contact, avian pets, poultry contact and recent illnesses. Provide and require protective clothing as well as washing and disinfection of exposed skin areas. Vehicles should go through a washing and disinfection area prior to entry of the hatchery property. Any contractor equipment should be cleaned and disinfected prior to entering the facility or left outside the facility.

### Pest control

A rigid pest control program should be strictly followed. Rodent bait stations and traps should be checked, replenished, and emptied on a regular basis. A regular fumigation treatment can be used to prevent insect problems. Physical barriers should be put into place including door seals and netting to prevent wild bird roosts.

### Access

Security measures should be used to prevent entry onto the property and into the building(s). Keep only one door unlocked and any others locked. Use foot-dips at each doorway and empty and clean them daily. Have handwashing stations and hand sanitizers available in each room. Give non-essential visitors limited or basic access to areas in the hatchery.

### Restrict Movement

Keep those that work with eggs and those that work with chicks separated. Prevent personnel that work in dirty areas or areas with chick contact from accessing clean areas. Using color coded uniforms can help restrict personnel movement.

### High Risk Procedure

In the event of a high risk biosecurity issue, a standard operating procedure should be in place to contain any infectious materials. Procedures should include methods for containment and decontamination of infectious and potentially infectious materials.



## 16

# Records

Hatcheries keep records to assist in daily and weekly management decisions. Records can also be used for traceability efforts to monitor and control egg and chick flow through the hatchery. Finally, records can be used to make and verify policy decisions. Most records and data are stored in electronic form. It is more cost-effective in terms of efficiency to keep and store records in electronic sheets and databases. Automated equipment such as incubators and hatchers can be integrated with a record keeping system to improve efficiency and reduce human error associated with data input.

## The main purposes of the records include:

- ✓ Accurately locating the movement and transfer of eggs and chicks from receiving to delivery
- ✓ Complying with local legislation and regulatory agencies
- ✓ Collecting and storing data that provides a standard against which to measure flock and machine performances
- ✓ Providing records to customers may require them as part of auditing hatcheries
- ✓ Providing evidence in the event of issues or problems
- ✓ Accounting of finances and for administration purposes (costs for consumables, labor, overhead, indirect costs)
- ✓ Investigating and troubleshooting issues with hatchery performance

## Record sheets and electronic records should be:

- ✓ Easy to complete, understand and interpret
- ✓ Able to be reviewed to check for accuracy
- ✓ Have references or baseline values to compare with obtained data
- ✓ Searchable
- ✓ Secure



## Key points of record keeping

- ✓ Analysis of records is an essential part of monitoring the hatchery's performance. This entails measuring differences between actual and projected results and identifying issues that may have impacted performance. Evaluate and analyze both positive and negative performance results. Positive results can provide information about optimizing protocols while negative information can guide changes in protocols.
  - ✓ Review flock records after each hatch to identify problem areas. This will allow corrective action to be taken at an early stage. A typical embryo diagnosis report will supply some of the needed information for evaluating the hatchery. Additional data and records of key performance indicators should be used to support, confirm and create action plans.
  - ✓ Be sure to check with local regulations about keeping specific records and which are required.
  - ✓ Individual machines can be accurately logged using computerized equipment. In many cases, these logs can be integrated with other record databases.
- ✓ Some examples of record sheets in the hatchery include:
    - Egg receiving and storage
    - Incubator operation
    - Hatcher operation
    - Maintenance logs of equipment and building infrastructure
    - Sanitation
    - Chick processing



### Animal Welfare Tips

Records related to welfare outcomes (euthanasia log, chick injury log, maintenance records for generator and alarm system, internal quality audits, employee welfare training records, etc.) should be reviewed regularly during hatchery welfare audits. Records should be completed and maintained in accordance with local standards or company guidelines.

## 17

# Embryo Diagnosis

When troubleshooting in the hatchery an accurate account of where loss is occurring is necessary so that action can be taken to reduce loss from future hatches. Failed hatches can be attributed to multiple causes including temperature abuse, rough handling, male fertility, female nutrition and incubation issues. However, accurately identifying the cause can be challenging when data is not available to analyze. Conducting breakouts at several points during the incubation period and examining hatch residue can provide valuable information. In this way, the data can be communicated to the hatchery staff or farm personnel to make corrective actions in a timely manner which could translate to cost savings.

A routine quality control program should collect data at multiple time points and may include:

- ✓ Egg intake quality records - diagnose farm related issues associated with the quality of eggs sent to the hatchery. Records include farm specific frequency of cracked, upside-down, dirty and misshapen eggs.
- ✓ Fresh egg breakouts (unincubated) – these eggs can give evidence of fertility issues and indicate farm problems such as male fertility, female nutrition, temperature abuse or rough handling.
- ✓ Break outs of early incubation – at 3 to 5 days of incubation, can also help diagnose issues with fertility or handling and storage issues.
- ✓ Break outs of clears during candling– clear eggs can be used to differentiate between incubator and farm issues.
- ✓ Break outs and residue examination of 3 to 6 hatcher baskets per flock at take-off – at this point, late term incubation issues can be determined but it can be difficult to diagnose cause of death due to decomposition and contamination. Conducting breakouts at several time points can give additional information for diagnostics at take-off.
- ✓ Poor / abnormal baskets of chicks at take-off – staff should be trained to notify a member of management if this issue arises.
- ✓ Equipment performance - real time and historic record of equipment. Records include any mechanical failures and maintenance records of the incubators and hatchers.

An embryo diagnosis worksheet should be used when conducting a breakout. Always be accurate and detailed when recording the information. Hatchability, fertility, and hatch of fertile should always be calculated (refer to calculations in section 3). Hatch of fertile should be used because the hatchery has no control over the fertility of eggs coming into the hatchery, but it does have control over the hatch of the fertile eggs received. Hatch of fertile identifies where the opportunities lie and answers the question where to look for problems.

Before beginning an embryo diagnosis, a well-lit area should be selected. An embryo diagnosis worksheet, rubber gloves, an instrument for taking the tops off the eggs, a candling light, and a bucket for the waste will be needed.

### Key focal points to investigate include:

- ✓ Performance history/data capture – what is the normal performance of the flock.
- ✓ Embryo diagnosis (10 day and 21 day breakout data)
- ✓ Egg quality and storage
- ✓ Dramatic weather or seasonal changes that may have impacted the operational environment
- ✓ Incubator and hatcher operation and maintenance log
- ✓ Changes to personnel and / or management
- ✓ Ventilation
- ✓ Chick quality

It is important that the person performing the breakout be trained properly. This person should perform the breakouts all the time to maintain consistency. If there is more than one hatchery in an operation, those responsible for the breakouts should periodically meet to ensure the breakout procedure is standardized among the different locations.

To diagnosis and correct problem hatches or issues in the hatchery, gaining as much information regarding the problem can help focus management's time and attention for an efficient and effective response.

### Key questions to ask include:

- ✓ Has hatchability recently declined or had ongoing poor performance?
- ✓ Has hatchability been affected at any given time in the flock cycle? (young, middle age or older flocks).
- ✓ Is the issue consistent or variable and how long has it persisted?
- ✓ Has chick quality been affected?



#### Animal Welfare Tips

The hatchery should have a written protocol that includes the approved method(s) of euthanasia and disposal for unhatched eggs, pips and live embryos that may be involved in the breakout analysis. Live embryos should be euthanized before being placed in a bucket or waste disposal container.

## 17.1 Recording Embryo Diagnosis Data

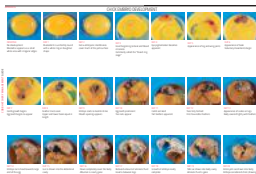
Cobb uses four categories to identify embryonic loss:

1. Infertile eggs
2. 'Early dead' (1 to 7 days of incubation)
3. 'Mid-term' death (8 to 14 days of incubation)  
There should be very few embryonic deaths between 8 and 14 days in normal flocks
4. 'Late dead' (15 to 21 days of incubation)  
This includes internal and external pipped, malposition, deformities, and transfer cracks.

Flock age		Tray position		Embryo						Condition of the Eggs/Chicks										Hatch% (of eggs set)			Fertility%		HOFF%			
Egg age	Days	1/2 Day	21 Day	Total	Infertile	Early	Mid	Late	Pipped	Dead	Egg	Egg	Egg	Egg	Cont	Cull	Chicks	Mal	Expos	Crack	No	Total	Salvab	Total	Condit	Turn	of true	
Sample No		Chicks	Debris	Chicks		(1-7)	(8-14)	(15-21)	or out	or out	up	up	up	up	m	up	up	posi	d	d	Hatch	Hatch	out %	in %	fe	of true		
Incubator		Card	Egg	id					chick	chick	side	side	side	side		side	down	ition	l bare	l bare	id	id	id	id	id	id	id	
24 weeks	5 days	450																										
Hatcher		Top	7	45	23	15	0	7	3	3	3	1	0	1	0	1	1	0	0	0	105							
Set Date		Middle	41	3	44	28	13	0	3	3	1	4	1	0	1	0	0	0	0	0	106							
Candle date		Bottom	42	3	45	29	11	2	3	0	1	2	1	2	5	0	0	0	0	0	105							
Break out date		Total	129	13	134	80	39	2	13	6	5	9	3	2	7	0	1	1	0	0	316							
		Percentages			17.9%	8.7%	0.4%	2.9%	1.3%	1.1%	2.0%	0.7%	0.4%	1.8%	0.6%	0.2%	0.2%	0.2%	0.2%	0.2%								
		Benchmark / Standard			12.0%	7.3%	0.5%	0.2%	0.7%	0.8%	0.2%	0.0%	0.2%	1.8%	0.5%	0.4%	0.7%	0.3%	0.3%	0.3%								
26 weeks	5 days	400																										
Hatcher		Top	30	6	44	20	10	0	0	3	3	3	1	0	1	0	1	0	0	0	95							
Set Date		Middle	41	2	43	10	20	2	2	3	1	4	1	0	1	0	0	0	0	0	100							
Candle date		Bottom	42	3	45	15	15	12	3	0	2	2	1	2	5	0	0	0	0	0	95							
Break out date		Total	111	11	119	45	45	20	11	6	6	9	3	2	7	0	1	1	1	0	290							
		Percentages			11.3%	11.3%	5.0%	2.8%	1.5%	1.5%	2.3%	0.8%	0.5%	1.8%	0.6%	0.3%	0.3%	0.3%	0.3%	0.3%								
		Benchmark / Standard			9.5%	6.0%	0.5%	0.8%	0.7%	0.8%	0.2%	0.0%	0.2%	1.8%	0.5%	0.4%	0.7%	0.3%	0.3%	0.3%								
26 weeks	12 days	450																										
Hatcher		Top	35	8	43	20	15	0	0	3	3	3	1	0	1	0	1	0	0	0	100							
Set Date		Middle	41	4	45	28	13	0	4	3	1	4	1	0	1	0	0	0	0	0	93							
Candle date		Bottom	50	3	53	23	25	2	3	0	1	2	1	2	5	0	0	0	0	0	100							
Break out date		Total	126	15	141	71	53	2	15	6	5	9	3	2	7	0	1	1	1	0	293							
		Percentages			15.8%	11.8%	0.4%	3.3%	1.3%	1.1%	2.0%	0.7%	0.4%	1.5%	0.6%	0.2%	0.2%	0.2%	0.2%	0.2%								
		Benchmark / Standard			7.2%	5.1%	0.5%	0.3%	0.7%	0.1%	0.1%	0.0%	0.3%	0.4%	0.4%	0.2%	0.1%	0.3%	0.3%									

### Some general guidelines of breakout analysis to determine embryonic mortality

- ✓ Allow eggs to sit with the large end up prior to break out which will promote movement of the embryo into the large end of the egg for easy visualization.
- ✓ When breaking open eggs, peel the large end since this is where the embryo will most often be located. Do not crack open an egg over a container because rupturing the yolk can cause the embryo to be lost in the yolk and difficult to locate. If the yolk ruptures, it will also be difficult to discern between early dead and infertile.
- ✓ If the blastoderm or blastodisc does not appear on top of the yolk, gently rotate the egg or pour off some of the albumen. If embryonic development is still not apparent, the yolk can be poured into a container for inspection.
- ✓ Comparing embryos in a breakout analysis to a developmental chart (see appendices) can be a very effective training technique.
- ✓ Size of the embryo and obvious changes in embryonic development are good indicators to use for determining embryonic age at time of mortality.



The Cobb Chick Embryo Development Chart is available on page 78 in the Appendices section of this guide.

### Embryo diagnosis after 10 days of incubation (candling breakout)

- ✓ A candle breakout is a good tool to provide accurate fertility data. If you have a type of incubator that does not lend itself to conducting a candle breakout, a complete residue breakout can still be performed. Residue breakouts can be accurate but need a lot of training to gain reliable data.
- ✓ Breaking out clears at 10 days can make troubleshooting more precise as distinguishing between early dead and infertile at transfer or later can be complicated by decomposition, exposure to heat, and bacterial contamination.
- ✓ At 8 to 10 days of incubation, early embryonic mortality is apparent as the extra-embryonic membranes that develop after the first two days of incubation should still be present.
- ✓ It is important to note any eggs that were incubated upside down or had cracks. Communicating these numbers to the farm team can help to reduce waste and costs.

### Embryo diagnosis procedure after 10 days of incubation

1. Select at least four trays from different locations within the incubator that will be tracked for residue breakout and be sure to include the top, middle, and bottom. This will give a wider sample in the incubator environment (temperature, humidity, air flow) and a better representation of the laying house. Never select consecutive trays.
2. Clearly mark the trays that were candled to indicate to the transfer crew that the eggs have been candled and need to be marked on the hatcher baskets so that the residue can be saved for a 21 day breakout.
3. Remove the clears and early dead embryos from the basket and place them in a separate tray with the large end up.
4. Breakout the eggs and record the results in a datasheet.

### Embryo diagnosis after 21 days of incubation

- ✓ In eggs incubated for 21-days, infertile eggs will usually have a brighter yolk and thicker albumen than a fertile yolk.
- ✓ The infertile yolk will usually be in the center of the egg and fertile yolks tend to sink to the pointed end.

### Embryo diagnosis procedure after 21 days of incubation

1. Select at least four trays from different locations within the incubator that will be tracked for residue breakout and be sure to include the top, middle, and bottom. This will give a wider sample in the incubator environment (temperature, humidity, air flow) and a better representation of the laying house. Never select consecutive trays.
2. Remove all unhatched eggs and place them in trays with the large end up.
3. Record the number of culls and dead chicks.
4. Breakout the eggs and record the results in a datasheet.
5. Dispose of eggshells and egg waste after break-out data is recorded.

## 17.2 Tracking Contaminated Eggs

Above average hatching egg contamination (> 0.5 %) is often traceable to the farm of origin. On-farm management decisions that may lead to hatching egg contamination include the use of floor eggs, poor detection of hairline cracks, dirty nests, belts and collection tables. Improper cooling and warming of eggs during on farm storage and transport to the hatchery may lead to condensation of moisture on the egg surface, allowing the movement of contaminating organisms through the shell pores. In general, older flocks generate more contaminated eggs than young flocks.

Rots, exploders, bangers or bombs are all terms used to describe eggs contaminated with microorganisms that can explode during the incubation process. These eggs start appearing around day 18 of incubation when contents may ooze out of the shell pores. When an egg explodes, it releases its contents and bacteria into the air as an aerosol that can be distributed across the incubator. This has an impact on the hatching chicks since hatches with a high percentage of contaminated eggs have been associated with increased 7-day chick mortality.

In order to ensure all contaminated eggs are counted a simple protocol can be followed using an index card and a permanent marker during the transfer process:

1. For those trays marked for residue analysis, the team member loading the transfer machine counts and removes the contaminated eggs.
2. The team member loading the transfer machine communicates the number of eggs removed to the team member at the exit of the transfer table (where hatcher baskets are removed).
3. The team member removing the basket writes the number of contaminated eggs on an index card and places the card inside the hatcher basket with the remaining fertile eggs. In the photos (right), the card indicates that these eggs are from the top tray of rack 13 and the eggs are from flock 20512. A total of 8 rots was removed from this tray at transfer.
4. The team member performing breakout analysis adds the number on the card inside the hatcher basket to the number of contaminated eggs found during the breakout session and the total is entered on the breakout sheet.
5. The hatchery residue breakout data sheet containing the accurate number of contaminated eggs is then shared with farm team.

Most hatcheries track contamination by performing hatchery residue breakout on predetermined trays of eggs after the hatch is complete. Unfortunately, a portion of the contaminated eggs are missed because they are removed at the beginning of the transfer process. In many cases, the team member loading the eggs into the transfer machine will remove the visibly contaminated eggs before placing the eggs into the machine. Trays predetermined for residue analysis usually have the “No Pick” option selected so that the clear eggs remain with the tray and are analyzed for fertility. Therefore, eggs removed prior to loading into the transfer machine are not counted in the breakout analysis and the breakout data is inaccurate and underestimated.



# Appendices

---

- Hatching Egg Grading Guide
- Embryo Development Chart
- Common Causes of Embryonic Death
- Diagnosis of Hatching Issues
- Chick Grading Guide
- Measurements and Conversions
- Formulas and Calculations

# HATCHING EGG GRADING GUIDE



IDEAL EGG  
Clean, free of cracks, correct  
shape, within acceptable  
weight range



CALCIUM DEPOSIT



BLOOD STAINED



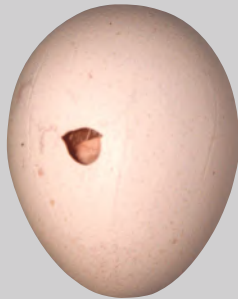
CRACKED



DIRTY



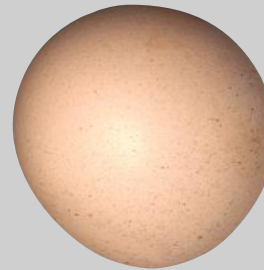
STAINED



TOE PUNCHED



MEMBRANE



ROUND



SLAB SIDED



SMALL



THIN SHELL



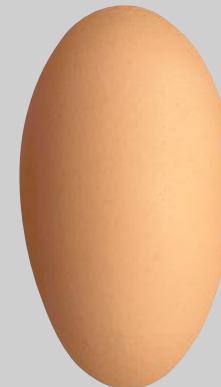
YOLK STAINED



WRINKLED



HAIRLINE CRACK



ELONGATED



DOUBLE YOLK

Eggs with defects (described with red text) should be discarded and never incubated



## CHICK EMBRYO DEVELOPMENT



**INFERTILE**  
No development  
Blastodisc appears as a small white area with irregular edges



**DAY 1**  
Blastoderm is uniformly round with a white ring or doughnut shape



**DAY 2**  
Extra-embryonic membranes cover much of the yolk surface



**DAY 3**  
Heart beginning to beat and blood circulates  
Commonly called the "blood ring stage"



**DAY 4**  
Eye pigmentation becomes apparent



**DAY 5**  
Appearance of leg and wing joints



**DAY 6**  
Appearance of beak  
Voluntary movements begin



**DAY 7**  
Comb growth begins  
Egg tooth begins to appear



**DAY 8**  
Feather tracts seen  
Upper and lower beak equal in length



**DAY 9**  
Embryo starts to look bird-like  
Mouth opening appears



**DAY 10**  
Egg tooth prominent  
Toe nails appear



**DAY 11**  
Comb serrated  
Tail feathers apparent



**DAY 12**  
Toes fully formed  
First few visible feathers



**DAY 13**  
Appearance of scales on legs  
Body covered lightly with feathers



**DAY 14**  
Embryo turns head towards large end of the egg



**DAY 15**  
Gut is drawn into the abdominal cavity



**DAY 16**  
Down completely cover the body  
Albumen is nearly gone



**DAY 17**  
Reduced amount of amniotic fluid  
Head is between legs



**DAY 18**  
Growth of embryo nearly complete  
Yolk sac remains outside embryo  
Head is under right wing



**DAY 19**  
Yolk sac draws into body cavity  
Amniotic fluid is gone  
Embryo occupies most space inside the egg (not in air cell)



**DAY 20**  
Entire yolk sac drawn into body  
Embryo considered chick (drawing air from air cell)  
Internal and external pips begin

## COMMON CAUSES OF EMBRYONIC DEATH

Causes of Infertile  
(eggs clear – no blood rings, no embryonic development)

Males sterile or poorly selected (flock may have poor fleshing, shrunken wattles and combs)  
Too many or too few males  
Inadequate feed and water space allowance or water too warm/cold  
Disease  
Wet litter causing foot problems  
Excessive beak treatment of males  
Leg or joint infections  
Excessive weight gain or loss  
Insufficient weight gain  
Seasonal effect (decline in fertility in late summer and fall)  
Poor sexual synchronization

Causes of Early Dead  
(Embryonic death from 0 – 7 days of incubation)

Chilling or overheating hatching eggs  
Incorrect incubation temperature or humidity  
Incorrect fumigation, washing or dipping of eggs  
High number of floor eggs, cracked eggs or contaminated eggs  
Disease- Newcastle, IB, Adenovirus, Salmonella  
Nutritional causes – lack of vitamin E  
Faulty turning in incubator  
Prolonged or improper egg storage  
Broodiness leading to embryo development  
Feed contamination – drugs, toxins  
Poor Ventilation  
Rough egg handling

Blood Rings  
(Embryonic death from 2.5 to 4 days)

Embryonic death at the blood ring stage can be caused by the same issues as early dead but also include:  
High temperatures during early incubation  
Excess vibration and/or jarring during transport  
Incorrect washing, dipping or 'buffing' of eggs  
Prolonged egg storage  
Improper fumigation

Mid Term Deaths  
(Embryonic death from 8 – 14 days of incubation)

Incubator temperature too high/low (most likely too high)  
Poor ventilation  
Incorrect turning of eggs  
Contamination  
Improper nutrition of the flock  
Incorrect humidity in incubators  
Disease  
Excess vibration and/or jarring during transport or grading of eggs

Late Deads  
(Embryonic death from 15 – 21 days of incubation)

Incorrect incubator/hatcher temperatures  
Humidity levels  
Lack of ventilation in the hatchery/incubators  
Faulty turning in incubators  
Prolonged storage and age of eggs  
Disease – Mycoplasmosis  
Nutrition – vitamin deficiencies  
Eggs incubated upside down

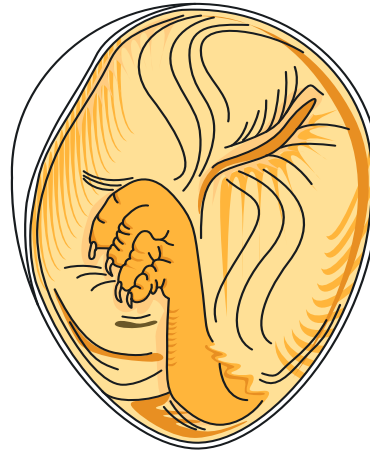
## DIAGNOSIS OF HATCHING ISSUES

Hatching early	High temperature - 1 to 19 days Small eggs
Hatching late	Low temperatures or humidity - 1 to 19 days Egg storage Large eggs Low hatcher temperature
Sticky chicks	Temperature too high - 20 to 21 days Egg storage Broken eggs in the hatch basket Inadequate turning
Malpositions	Eggs incubated upside down Odd shaped eggs Inadequate turning
Unhealed navels	High temperatures - 1 to 19 days High humidity - 20 to 21 days Egg storage
Red Hocks	Insufficient moisture loss
Abnormal chick	Crossed beak: Hereditary or virus infection Missing eyes: High temperatures (first week in incubator) or handling Wry neck: Nutrition Crooked toes: Temperature (16 – 21 days) and nutritional causes Splayed legs: Smooth hatching baskets/no paper/improper temperature
Incorrect pipping	Not enough moisture loss

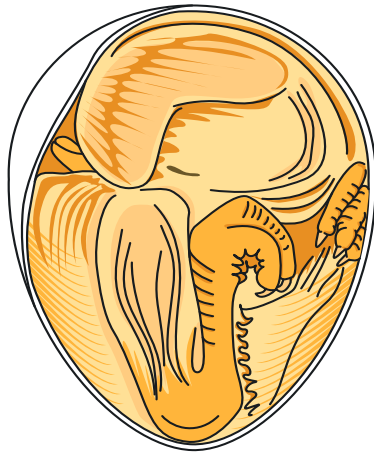
## HATCHING POSITIONS

**Malposition 1**

Head between thighs

**Malposition 2**

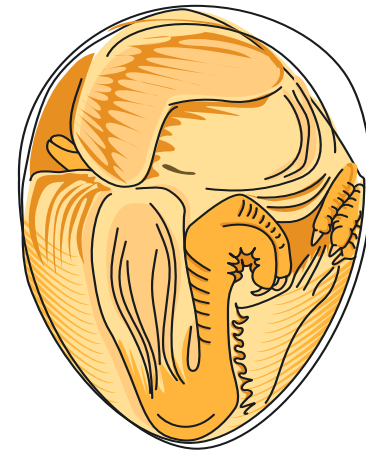
Head in small end of egg



**Correct hatching position.** Head twisted to the right and tucked under right wing with the beak pointed towards the air cell. The legs are in the trussed position.

**Malposition 3**

Head to left

**Malposition 4**

Head away from aircell

# CHICK GRADING GUIDE

## HOCKS



✓ Perfect Hocks



✓ Slight blushing but no abrasion



✗ Open cut or abrasion on hocks



✗ Severe abrasion



✗ Damaged hocks



Perfect Chick

## COLORING



✓ Light grey feathers and legs



✓ Small grey spot



✗ Majority dark grey or black



✗ Dark grey or black hocks

## DEFECTS



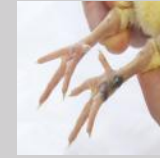
✗ Cross beak or anatomical defects



✗ Bloodied beak



✗ Poor feathering



✗ Mechanical injury

## NAVELS



✓ Well healed navel



✓ Healed navel with small string (string does not protrude above chick down)



✗ Large button on navel



✗ open navel



✗ Large or long string on navel



Cobb Chick Grading Guide is available online under **Resources > Posters**

## MEASUREMENTS AND CONVERSIONS

## Area

$1 \text{ cm}^2 = 0.155 \text{ in}^2$   
 $1 \text{ m}^2 = 1.196 \text{ yd}^2 = 10.7639 \text{ ft}^2$   
 $1 \text{ in}^2 = 6.4516 \text{ cm}^2$   
 $1 \text{ ft}^2 = 0.0929 \text{ m}^2$   
 $1 \text{ yd}^2 = 0.8363 \text{ m}^2$

## Length and distance

$1 \text{ mm} = 0.0394 \text{ in}$   
 $1 \text{ cm} = 10 \text{ mm} = 0.3937 \text{ in}$   
 $1 \text{ m} = 100 \text{ cm} = 1.0936 \text{ yd} = 3.2808 \text{ ft}$   
 $1 \text{ km} = 1000 \text{ m} = 0.6215 \text{ miles}$   
 $1 \text{ in} = 2.54 \text{ cm}$   
 $1 \text{ ft} = 30.48 \text{ cm}$   
 $1 \text{ yd} = 0.9144 \text{ m}$   
 $1 \text{ mile} = 1.609 \text{ km}$

## Weight and mass

$1 \text{ g} = 0.002205 \text{ lb} = 0.0353 \text{ oz}$   
 $1 \text{ kg} = 2.2046 \text{ lb}$   
 $1 \text{ ton} = 1000 \text{ kg} = 0.9842 \text{ long tons (British)} = 1.1023 \text{ short tons (USA)}$   
 $1 \text{ long ton} = 2240 \text{ lb} = 0.9072 \text{ ton} = 907.185 \text{ kg}$   
 $1 \text{ short ton} = 2000 \text{ lb} = 1.016 \text{ ton} = 1016.05 \text{ kg}$   
 $1 \text{ oz} = 28.35 \text{ g}$   
 $1 \text{ lb} = 0.4536 \text{ kg} = 453.5924 \text{ g}$

## Flow rate

$1 \text{ m}^3/\text{kg}/\text{h} = 16.016 \text{ ft}^3/\text{lb}/\text{h}$   
 $1 \text{ ft}^3/\text{lb}/\text{h} = 0.0624 \text{ m}^3/\text{kg}/\text{h}$   
 $1 \text{ m}^3/\text{h} = 0.5886 \text{ cfm}$   
 $1 \text{ m}/\text{sec} = 196.85 \text{ ft}/\text{min}$

## Energy

$1 \text{ kcal} = 3.97 \text{ BTU}$   
 $1000 \text{ kcal} = 4.184 \text{ MJ}$   
 $1 \text{ kcal}/\text{m}^3 = 0.1123 \text{ BTU}/\text{ft}^3$   
 $1 \text{ kcal}/\text{kg} = 1.8 \text{ BTU}/\text{lb}$   
 $1 \text{ ft candle} = 10 \text{ lux}$

## Volume

$1 \text{ liter} = 0.22 \text{ Imp gal} = 0.2624 \text{ US gal}$   
 $1 \text{ pt (Imp)} = 0.5682 \text{ liter}$   
 $1 \text{ pt (USA)} = 0.4732 \text{ liter}$   
 $1 \text{ qt (Imp)} = 1.1365 \text{ liter}$   
 $1 \text{ qt (USA)} = 0.9463 \text{ liter}$   
 $1 \text{ gal (Imp)} = 4.54596 \text{ liter}$   
 $1 \text{ gal (USA)} = 3.7853 \text{ liter}$

## Temperature

To calculate Celsius from Fahrenheit  $(X^\circ\text{F} - 32) \times 5/9 = X^\circ\text{C}$   
 To calculate Fahrenheit from Celsius  $(X^\circ\text{C} \times 9/5) + 32 = X^\circ\text{F}$

## FORMULAS

### Formula 1

To calculate **percentage of hatchability**:

$\frac{\text{Number of chicks hatched}}{\text{Number of eggs incubated}} \times 100 = \text{Percentage of hatchability}$

### Formula 3

To calculate **percentage of hatch of fertile**:

$\frac{\text{Percent hatchability}}{\text{Percent fertility}} \times 100 = \text{Percentage of hatch of fertile}$

### Formula 4

To calculate **percentage of egg moisture loss at 19 days of incubation**:

$\frac{(\text{full incubator tray weight at incubation} - \text{full incubator tray weight at transfer})}{(\text{full tray weight at incubation} - \text{empty tray weight})} \times 100 = \text{percentage of egg moisture loss at 19 days}$

### Formula 5

To calculate **percentage of egg moisture loss at 18.5 days of incubation**:

$\frac{(\text{Moisture loss at 19 days})}{(19)} \times 18.5 = \text{percentage of egg moisture loss at 18.5 days}$

### Formula 2

To calculate **percentage of fertile eggs**:

$\frac{\text{Number of fertile eggs}}{\text{Number of eggs incubated}} \times 100 = \text{Percentage of fertile eggs}$

## FORMULAS (CONT.)

## Formula 6

To calculate **percentage of chicks hatched 12 hours before take-off:**

$$\frac{\text{Number of chicks hatched 12 hours before take-off}}{\text{Number of chicks hatched in the same basket at take-off}} \times 100 = \text{percentage of chicks hatched 12 hours before take-off}$$

## Formula 7

To calculate **average egg weight:**

$$\frac{(\text{Full tray weight at incubation} - \text{Empty tray weight})}{\text{Number of eggs}} = \text{Average egg weight}$$

## Formula 8

To calculate **average chick weight:**

$$\frac{(\text{Chicks in chick box weight} - \text{Empty chick box weight})}{\text{Number of chicks}} = \text{Average chick weight}$$

## Formula 9

To calculate **average percentage of chick yield:**

$$\frac{\text{Average chick weight}}{\text{Average Egg Weight}} \times 100 = \text{Average percentage of chick yield}$$







[www.cobb-vantress.com](http://www.cobb-vantress.com)

L-015-01-20 EN