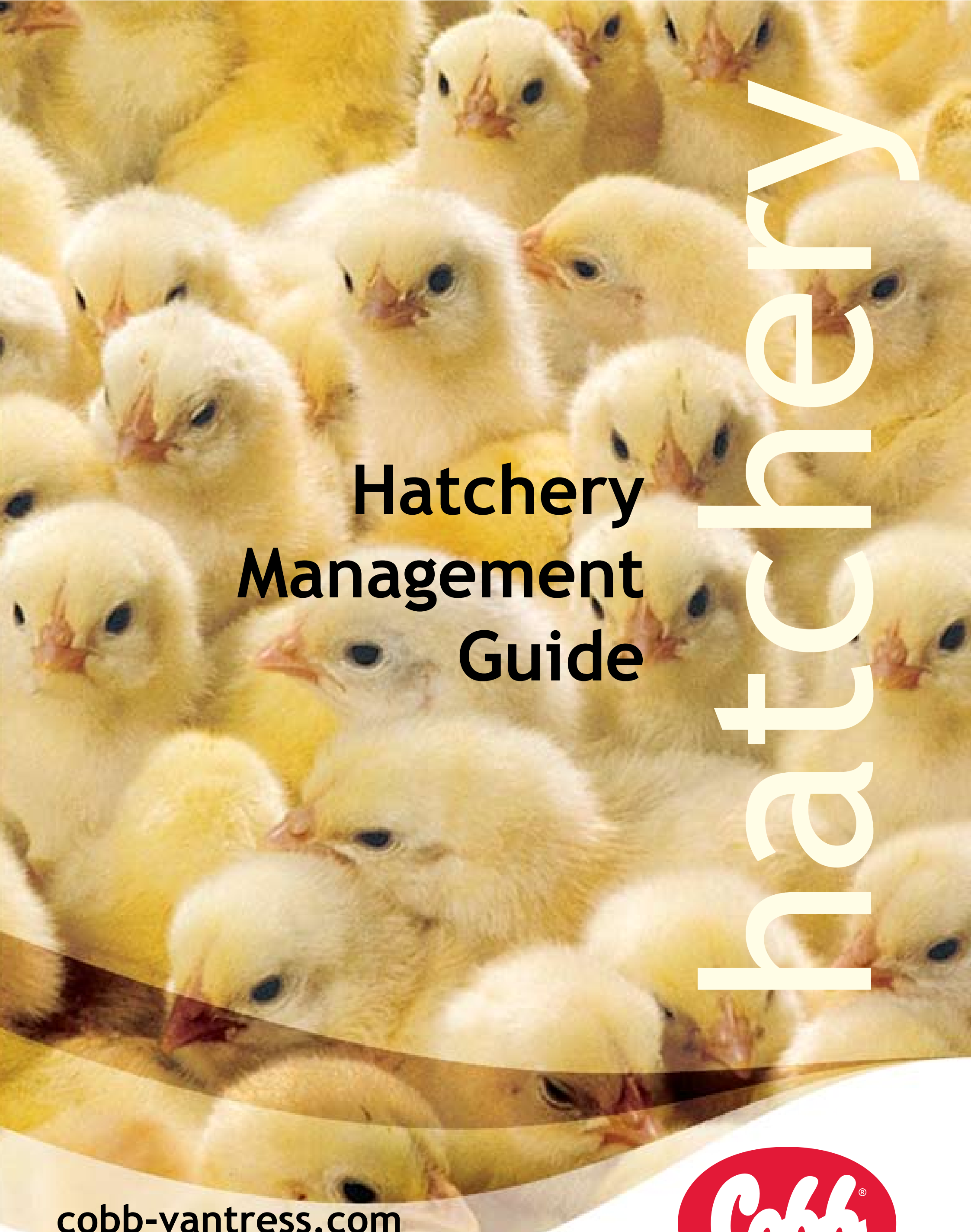

Hatchery Management Guide

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INTRODUCTION

Many changes have taken place in hatcheries in recent years, such as the introduction of computer monitoring and control of the machines, and automation of many day-to-day hatchery operations. Additionally, there is increasing awareness of the role of the hatchery in disease control.

A sound understanding of the principles involved in incubating eggs and hatching chicks is vital to coping with these changes.

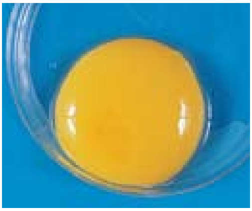
This guide is designed to explain these principles as related to broiler breeding stock and to highlight the main aspects of hatchery management from egg production to chick delivery.

We provide this guide as a supplement to your hatchery management skills so that you can apply your knowledge and judgment to obtain the best results. This publication links with the Cobb Breeder and Broiler Management Guides to provide technical advice from supply of breeding stock to delivery of broilers for processing.

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

Revised 2008

Chick Embryo

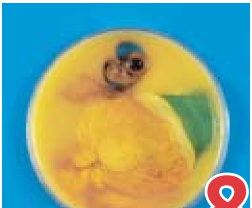


INFERTILE
- No development.

DAY 1
- Appearance of tissue development.

DAY 2
- Tissue development very visible.
- Appearance of blood vessels.

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 14
- Embryo turns head towards large end of egg.

DAY 15
- Gut is drawn into abdominal cavity.

DAY 16
- Feathers cover complete body.
- Albumen nearly gone.

Development

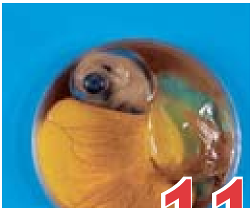
DAY 3
- Heart beats.
- Blood vessels very visible.

DAY 4
- Eye pigmented.

DAY 5
- Appearance of elbows and knees.

DAY 6
- Appearance of beak.
- Voluntary movements begin.

DAY 10
- Egg tooth prominent.
- Toe nails.



DAY 11
- Comb serrated.
- Tail feathers apparent.

DAY 12
- Toes fully formed.
- First few visible feathers.

DAY 13
- Appearance of scales.
- Body covered lightly with feathers.

DAY 17
- Amniotic fluid decreases.
- Head is between legs.

DAY 18
- Growth of embryo nearly complete.
- Yolk sac is still on outside of embryo.
- Head is under the right wing.

DAY 19
- Yolk sac draws into body cavity.
- Amniotic fluid gone.
- Embryo occupies most of space within egg (not in the air cell).

DAY 20
- Yolk sac drawn completely into body.
- Embryo becomes a chick (breathing in air cell).
- Internal and external pip.

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CONTENTS

1. HATCHABILITY - THE MEASURE OF SUCCESS

The measure of success of any hatchery is the number of first-quality chicks produced. This number expressed as a percentage of all eggs set for incubation is normally termed 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. Mating activity is a good example of a factor entirely influenced on the farm. The hatchery cannot alter it, although many other factors can be influenced by both the farm and the hatchery.

Controlling factors	
Farm	**Hatchery**
Breeder Nutrition	Sanitation
Disease	Egg Storage
Mating Activity	Egg Damage
Egg Damage	Incubation - management of setters and hatchers.
Correct Male and Female BW	Chick Handling
Egg Sanitation	
Egg storage	

Thus, the breeder farm has a major influence on results at the hatchery and it is essential for the farm and hatchery to work closely together.

2. HATCH OF FERTILE

Because hatcheries have no influence over fertility, it is important to consider hatch of fertile in addition to hatchability. The hatch of fertile percent is a measurement of the efficiency of the hatchery machinery. Hatch of fertile takes into account the flock fertility as well as hatchability; it is percent hatch divided by percent fertile times 100.

Example: (86.4% Hatch ÷ 96% Fertile) * 100 = 90% Hatch of Fertile

The following example clearly shows the value in calculating Hatch of Fertile.

Hatchery	% Hatch	% Fertile	% Hatch of Fertile
A	86	97	88.66
B	82	91	90.11
C	84	94	89.36

Even though Hatchery B has the lowest % Hatch, it has the highest % Hatch of Fertile. This is because % Hatch was limited by fertility and not by the hatcheries ability to effectively hatch eggs; therefore, Hatchery B is clearly performing the best, provided chick quality is equal.

At peak production, flocks should be achieving at least 96.7% fertility and 93.5% hatch of fertile. Fertility and hatch percent standards are set according to the age of the breeders.

Breeder age (weeks)	Hatch of fertile (%)
25 to 33	>90.2
34 to 50	>91.8
51 to 68	>88.6

The benefits of recording Hatch of Fertile are as follows:

1. Separates fertility and hatchery problems
2. Allows you to focus on the problem
3. Expedites troubleshooting

3. HATCHING EGG MANAGEMENT

Optimum hatchability and chick quality can only be achieved when the egg is held under optimum conditions between laying and setting in the incubator. Remember that a fertile egg contains many living cells. Once the egg is laid, its hatching potential can at best be maintained, not improved. If mishandled, hatching potential will quickly deteriorate.

1. Use of floor eggs depresses hatchability. They should be collected and packed separately from nest eggs, and clearly identified. If they are to be incubated, they should be treated separately.
2. Prevent hair-line cracks by handling eggs carefully at all times.
4. Place hatching eggs carefully into the setter tray or transport tray, small (pointed) end downward.
5. Take care with egg grading. During the early production period check the weight of borderlined sized eggs to select hatching eggs.
6. Store the eggs in a separate room in which the temperature and humidity are controlled.
7. Keep the farm egg handling room clean and tidy. Maintain good vermin control in your egg room. Refuse to accept dirty egg containers and buggies from the hatchery, and take care of them while on your premises.

Good egg

Remove and discard eggs unsuitable for hatching. These are:

- Dirty
- Cracked
- Small (According to Hatchery Policy)
- Very large or double yolk
- Poor shells - but any shell color should be acceptable for hatching
- Grossly mis-shapen

Blood stained

Cracked

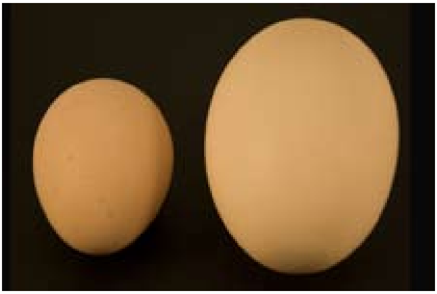
Dirty

Elongated

Rounded

Toe punched

Wrinkled

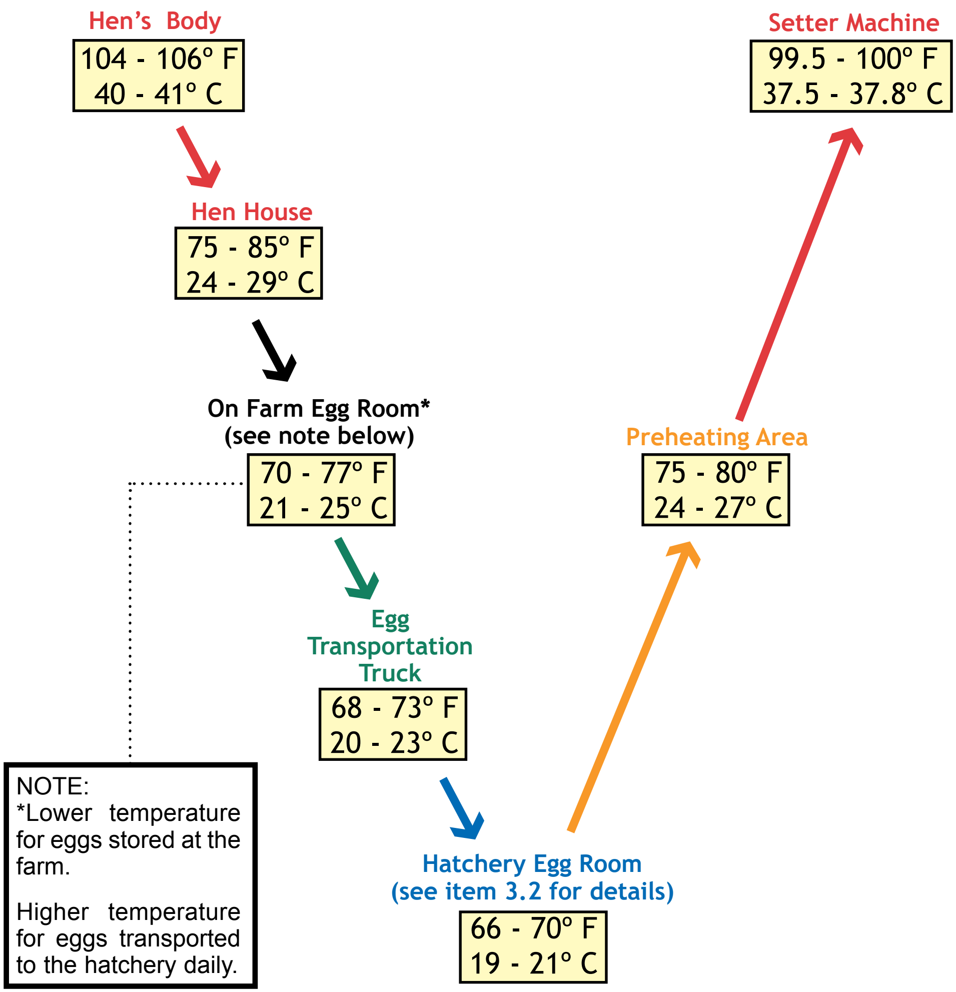


Small and double

3.1 KEY POINTS ON EGG STORAGE

Eggs should be collected from the farms and transported to the hatchery at least twice a week. There are three storage areas: farm egg room, transport, and hatchery egg room. It is important to match the conditions in each of these situations as closely as possible to avoid sharp changes in temperature and humidity, which can lead to condensation ("sweating") on eggs or eggs being chilled or overheated. Also, temperature fluctuations must be avioded during transport and storage. The temperature decrease must be a smooth transition when cooling the eggs from the hen house to the hatchery egg room, and also a smooth transition when warming the eggs from the hatchery egg room to the setter machine.

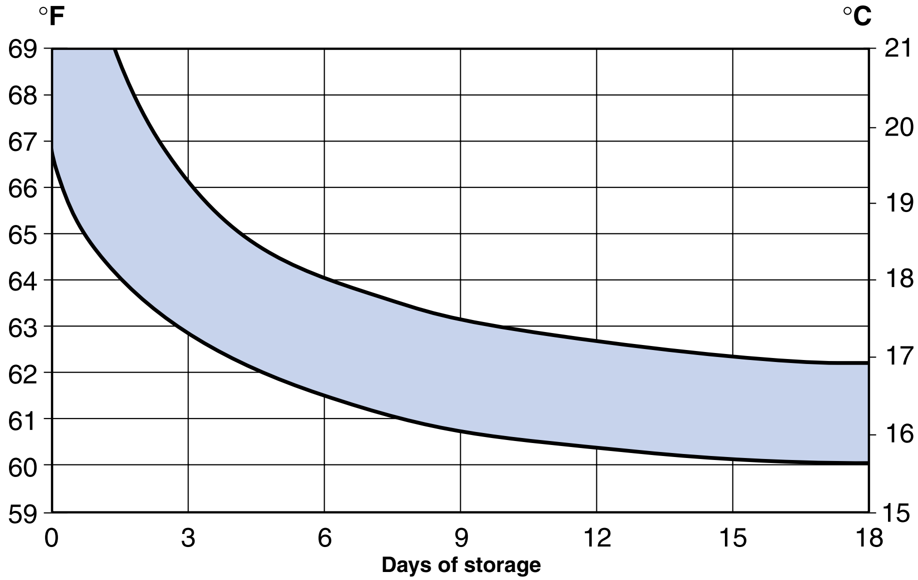
Egg Temperature Flow Chart (for fresh eggs)



3.2 OPTIMUM EGG STORAGE CONDITIONS

A relationship exists between the length of time eggs are stored and the optimum temperature and humidity for best hatchability. Generally, the longer eggs are to be stored, the lower the storage temperature and vice versa.

Optimum temperature range for egg storage



3.3 EFFECTS OF EGG STORAGE

The main effects of storing eggs are:

1. Storage prolongs incubation time. On average, one day's storage adds one hour to incubation time. This must be taken into account when eggs are set, so fresh and stored eggs should be set at different times.
2. Hatchability is depressed by prolonged storage. The effect increases with storage time after the initial six-day period, resulting in losses of 0.5 to 1.5% per day with the percent increasing as storage extends further.
3. Chick quality will be affected and hence broiler weights can be depressed in chicks from eggs that have been stored for 14 days or more.

Gas exchange can occur through the pores in the egg shell during storage. Carbon dioxide diffuses out of the egg, and its concentration declines rapidly during the first 12 hours after the egg is laid. Eggs also lose water vapor while in storage. This loss of both carbon dioxide and water contributes to the loss in hatchability and chick quality after storage.

Storage conditions must therefore be designed to minimize these losses. Most eggs are placed in open-sided cases or farm racks, but some are placed in solid covered cases. Allow covered eggs to cool down and dry thoroughly before casing to avoid condensation and subsequent mold growth.

3.4 SETTING EGGS

To avoid temperature shock to the embryo and consequent condensation on the shell, eggs should be removed from the egg room and pre-warmed before setting. Ideally, eggs should be pre-warmed in a purpose-built room at around 75-80 °F (24-27 °C) so that all can achieve the desired temperature.

Effective air circulation and correct room temperature are essential to achieve the necessary even pre-warming of eggs. Uneven pre-warming increases variation in hatch time - precisely the opposite of the desired effect of pre-warming.

Even with good air circulation, it will take 8 hours for eggs on a buggy to reach 78 °F (25 °C), irrespective of their initial temperature. With poor air circulation, it may take twice as long. So the recommendation is to:

- Provide good air circulation around the eggs.
- Allow 6 to 12 hours for pre-warming.

3.5 SETTING TIME

Three factors influence the total incubation time of eggs:

1. **Temperature of incubation:** normally fixed for any hatchery, but to achieve a desired pull time for chicks, variation in the time at which eggs are set can be modified according to age and size of eggs.
2. **Age of the eggs:** stored eggs take longer to incubate. You will need to add extra incubation time if eggs are stored over 6 days. (1hour per day of storage)
3. **Size of the eggs:** larger eggs take longer to incubate.

4. SETTER OPERATION

Energy consumption, labor usage, durability, maintenance and capital costs influence the design of incubators. The optimum physical conditions for any broiler embryo to grow successfully are:

- Correct temperature
- Correct humidity
- Adequate gas exchange
- Regular turning of eggs

Commercial incubation systems fall into three main categories:

- Multi-stage fixed rack
- Multi-stage buggy loading
- Single-stage buggy loading

The actual quantity of eggs to be loaded in each machine at each set, the frequency of loading (once or twice a week) and the actual position of the set within the machine will vary with each manufacturer. Operate the machine according to the rules laid out by the manufacturer. Do not abuse them.

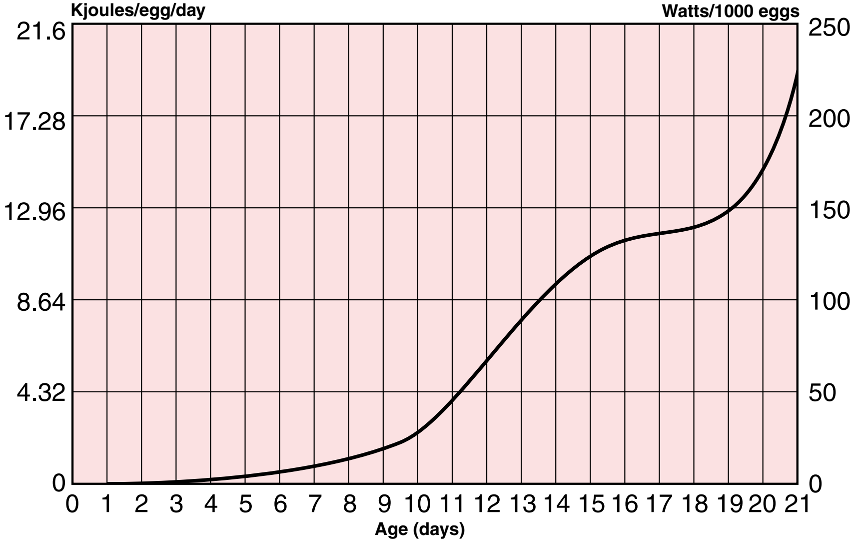
4.1 VENTILATION

1. Setters normally draw fresh air from the room in which they are situated. This fresh air supplies oxygen and moisture to maintain the correct Relative Humidity. Air leaving the setter removes carbon dioxide and excess heat produced by the eggs.
2. The air supply to the setter room should be 8cfm (13.52 cubic meters hr) per 1000 eggs. See chart on page 8 (Hatchery Ventilation - Correct set-up).
3. All setters have a humidity source that can control various 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 76-80 °F (24-27 °C).
4. Multi-stage setters require a constant amount of air. It should be adjusted so that the carbon dioxide level within the machine does not exceed 0.4%. Most fixed rack machines run at 0.2-0.3% and buggy machines 0.3-0.4% but these elevated CO_2 levels are not required.

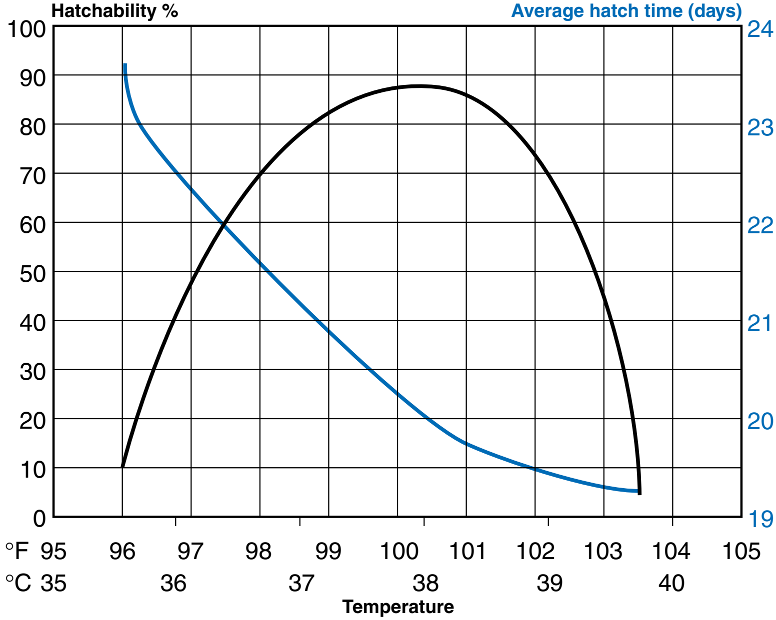
Hatchery ventilation - the correct set-up						
Areas	Ventilation Rate (cfm /1000)	(m³/hr /1000)	Temperature °F	°C	Relative Humidity (%)	Area Pressure in relation to atmosphere: (in H_2O)
Egg Receiving	(5 minute air exchange to room)		66-70	19-21	60-65	Neutral to +0.01
Holding Area	2	3.38	66-70	19-21	60-65	Neutral to +0.01
Setter Room	8	13.5	76-80	24-27	55-62	+0.015 to +0.02
Hatcher Room	17	28.7	76-80	24-27	55-62	+0.005 to +0.01
Chick Holding Rooms	40	67.6	72-75	22-24	65-70	Neutral
Chick Take-off	(0.5 minute air exchange to room)		72-75	22-24	65-70	-.015 to -.025
Wash Room	(0.5 minute air exchange to room)		72-75	22-24	65-70	-.015 to -.025
Clean Equipment Room	(1 minute air exchange to room)		72-75	22-24	N/A	Positive
Hallways	(5 minute air exchange to room)		75	24	N/A	Neutral

Pressure Conversion (0.01 in H_20 = 2.5 Pascal's, 0.01 mbar, 0.1016 mm H_20)

Heat production of incubating eggs



Relationship between average hatch time, hatchability and temperature



4.2 TEMPERATURE CONTROL

Temperature determines the metabolic rate of the embryo and hence its rate of development.

1. In a multi-stage machine, temperature should remain constant. The optimum temperature for both hatchability and chick quality will differ depending on the type of incubator. Higher or lower temperatures than the manufacturer's recommendations will lead to faster or slower development and consequent reduction in hatchability.

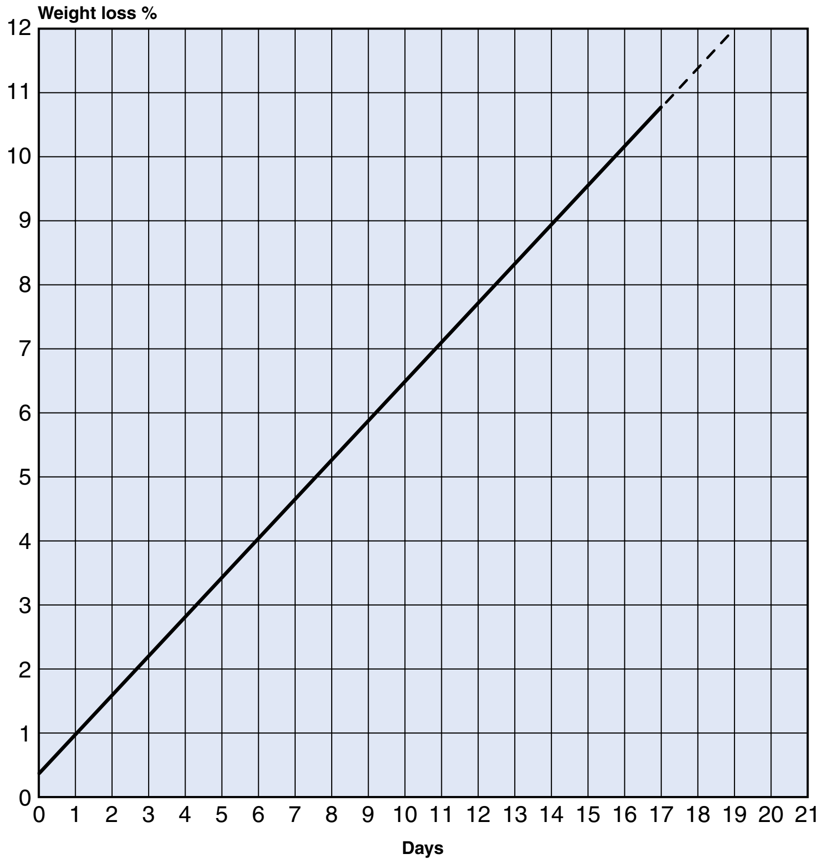
2. In single-stage incubation, temperature can be altered for the growth of the embryo and increased animal heat production, starting at a higher temperature and reducing in stages through transfer.

3. Incorrect balance in loading multi-stage setters can create major temperature variations. Partly filled machines may not achieve the correct temperature and prolong incubation, while loading double sets can create overheating problems. Both conditions will adversely affect hatchability and chick quality.

4.3 HUMIDITY

1. 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. For best hatchability, an egg must lose 12% of its weight by 18 days of incubation.
2. Due to differences in shell structure and hence gas conductance, when all 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 the eggs' quality, it may be necessary to adjust incubator humidity conditions to maintain optimum hatchability and chick quality.

Optimum weight loss of eggs during incubation (multi-stage)



4.4 TURNING

1. Eggs must be turned during incubation. This prevents the embryo from sticking to shell membranes, particularly during the first week of incubation, and aids development of the embryonic membranes.
2. As embryos develop and their heat production increases, regular turning will aid airflow and assist cooling.

5. EGG TRANSFER

Eggs are removed from the setter after 18 or 19 days and transferred to the hatcher trays. This is done for two reasons. The eggs are laid on their sides to allow free movement of the chick out of the shell at hatching. It also assists hygiene; large quantities of fluff are generated during hatching and could spread this potential contamination around the hatchery.

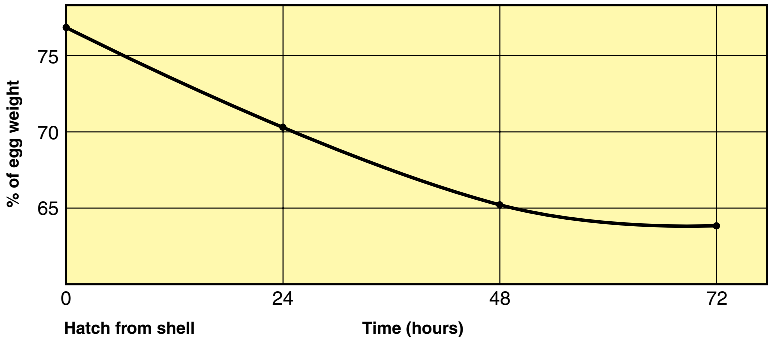
Transferring too early or too late will result in embryos being subjected to sub-optimal conditions causing lower hatchability. This should be considered in any decision to vary the transfer time. Transfer times will differ according to the different types of setters (18 to 19 days are usually the norm).

1. The transfer operation should proceed smoothly and quickly to avoid cooling the eggs as this will delay hatching.
2. At transfer, eggs may be candled to enable clears (infertiles and early dead germs together with rots) to be removed and counted.
3. Shells are more brittle at this stage because the embryos have withdrawn some of the shell calcium for skeletal development. Therefore, care must be taken when transferring eggs to avoid breakages. Rough handled eggs at this stage may cause ruptures and hemorrhages. Automated transfer equipment enables this task to be carried out more gently than a manual system.
4. Ensure the hatcher trays are properly washed and allowed to dry before eggs are transferred. Eggs in wet trays will cool down while the water is evaporating in the hatcher. Hatchers must be dry and up to proper temperature proir to transfer.
5. Dispose of ‘rots’ and ‘exploders’ in a container of disinfectant.
6. In-ovo egg injection systems are now available, which may be considered for Mareks protection and administration of other vaccines. Manufacturers’ recommendations for use must be followed.

6. FACTORS INFLUENCING CHICK SIZE

1. Egg size is the main factor affecting chick size. Chick weight is normally 66-68% 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.
2. Egg weight decreases because of water loss during incubation. This also contributes to chick weight variation from eggs of the same size.
3. Length of time between hatching, pulling, and delivery also affect final chick weight. Time spent in the hatcher will have a greater effect than time at the lower temperature of the chick room or delivery vehicle.

Related Chick Weight



7. OPERATION OF HATCHERS

Most broiler hatcheries hatch twice a week from each hatcher. The hatcher will be washed and disinfected between hatches, which means durability of construction and ease of cleaning are vital factors.

7.1 VENTILATION AND HUMIDITY

Air supplied to the hatcher fresh air plenum should be 17cfm per 1000 eggs (28.7 Cubic meters per hr). From point of transfer to pipping, airflow and humidity in the hatcher should be maintained the same as in the setter. Moisture is important during the hatching process to ensure the shell membranes remain soft and pliable so that the chick can escape unhindered. When pipping starts, the moisture level will rise causing the wet bulb temperature to also rise. At this point, the damper will require adjustment to maintain this level. Additional moisture may be required from the spray system. A few hours before take off the damper is opened to increase air supply for the chicks.

7.2 TEMPERATURE

Hatcher temperatures are usually slightly lower than those of the setter to reduce the risk of overheating.

8. CHICK PULL AND PROCESSING

Chicks are ready to be taken off when most of them are dry and fluffed up, with a few (about 5%) still having some moisture on the backs of their necks. A common mistake is to allow chicks to spend too long in the hatchers so they dehydrate excessively. Dehydration of chicks may result from incorrect adjustment of setting time for egg age or excessive weight loss during incubation. Similarly, if they are “green”, e.g., not yet ready, check setting times and also check for opportunities for the eggs to have become cooled down in incubation, reducing the rate of development.

Upon pulling chicks, they have to be separated from their debris, graded into first quality and culls, and counted into boxes. Some hatcheries carry out additional operations such as:

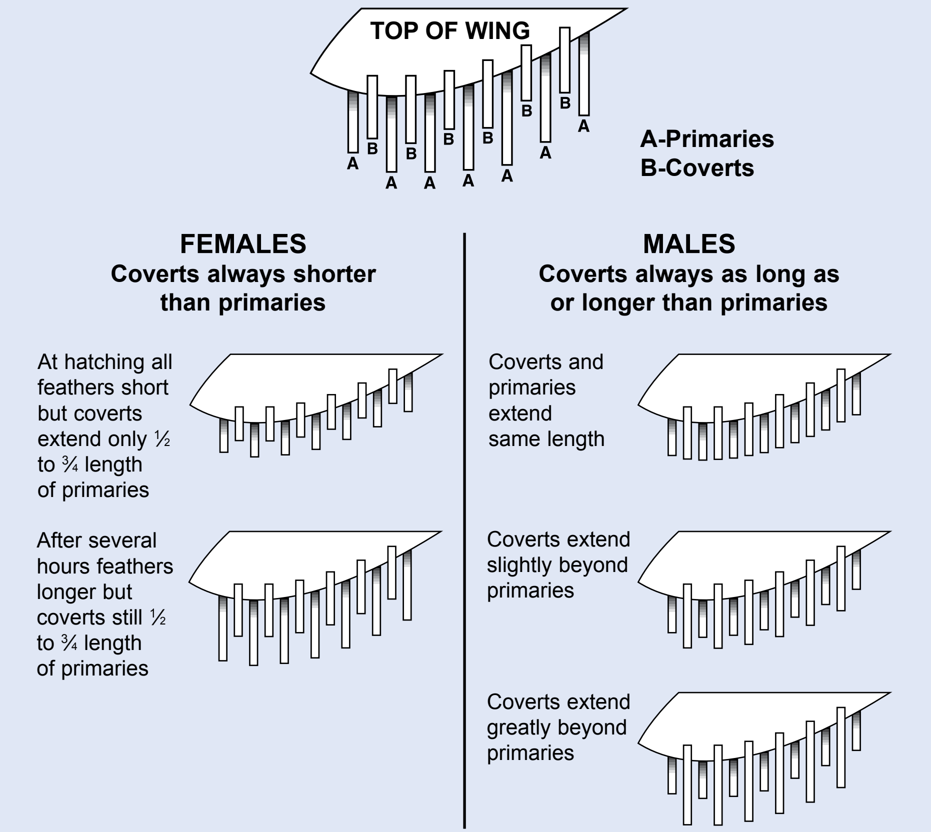
- Sexing, primarily using feather-sexing with broilers but also Vent sexing with breeding stock
- Vaccination, sprayed or injected, using hand or automatic vaccinators
- Beak conditioning

1. During processing, chicks must be held in a controlled environment that prevents overheating or overcooling. They must not be overcrowded in the boxes or while on conveyers. To reduce weight loss from the chicks, maintain the correct humidity in the chick holding areas. Aim for 23 °C (73 °F) with a relative humidity of 65 - 70%.
2. Automated equipment has been developed to improve chick handling while reducing the number of staff involved.
3. Avoid rough handling of chicks in manual operations and when equipment is used. Equipment must be correctly and regularly maintained.
4. Clean all equipment thoroughly after each hatch. All chick contact areas such as conveyers and carousel must be easily accessible for cleaning.

8.1 FEATHER SEXING BROILER CHICKS

Broiler chicks in the feather sexable - slow feather format, can be feather sexed at day old as illustrated below.

In the non-feather sexable - fast feather format, both males and females will show the same pattern of feather development illustrated by the diagram below relating to females.



1. Spread wing out like a fan.
2. Look at feathers on outer joint - bottom row of feathers are primaries, top row of feathers are coverts.
3. When the bottom row (primaries) of feathers is longer than the top row (coverts), the chick is female.
4. When the bottom row (primaries) of feathers is the same length, or shorter than the top row (coverts), the chick is male.

8.2 THE HATCH WINDOW

The hatch window indicates the number chicks hatched after the eggs have been transferred from the setter to the hatcher.

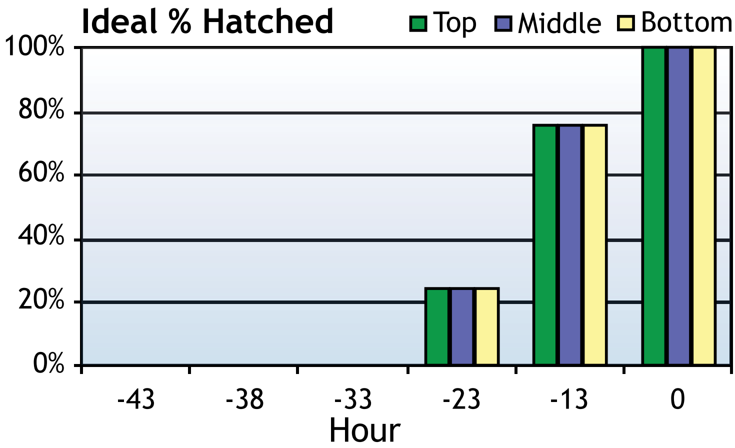
If the eggs are hatching too early, the chicks become susceptible to problems such as dehydration. Dehydration of chicks this early could lead to increased 7 and 14 day mortality and poor broiler performance. If the chicks are hatching too late the result could be poor hatchability, chick quality problems, increased pipped eggs and live embryo unhatched eggs.

Factors affecting early hatch include:

- Extended pre-heating periods
- Setting eggs too early. Too many hours of incubation
- Incorrect setter/hatcher temperature and humidity
- Hot spots inside the setter and hatcher
- Incorrect ventilation
- Seasonal temperature changes effecting the hatchery environment
- Too many fertile eggs in the hatcher
- Egg size

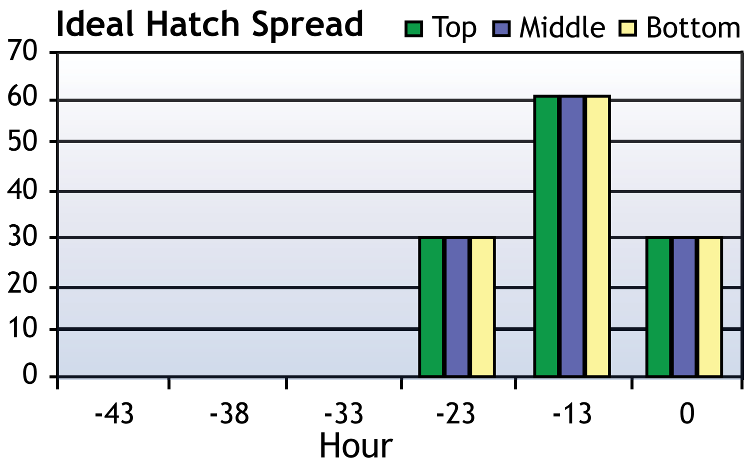
Factors affecting late or delayed hatching include:

- Setting eggs too late
- Incorrect setter/hatcher temperature and humidity
- Incorrect ventilation
- Seasonal temperature changes effecting the hatchery environment
- Eggs which have been stored for long periods
- Eggs which have stored at too low a temperature
- Incorrect setting patterns in multi-stages machines
- Disease and fertility problems



The bar graph above indicates eggs which were in the top, middle and bottom positions in the setter and then transferred to the hatcher.

Ideally, no more than 25% of the total hatch should be hatched 23 hours before pull and more than 75% of the total hatch should be hatched 13 hours before pull.



This bar graph indicates the correct number of chicks hatching spread over the 23 hours prior to pull. The number of chicks hatched in each hatcher basket / tray should be even throughout the hatcher.

9. HATCHERY WASTE DISPOSAL

With an average of 85% hatchability, 15% of the eggs will be either infertile or contain dead embryos. These eggs, together with the eggshells that remain after pulling chicks, constitute hatchery waste. Legislation in some countries now prohibits the incorporation of hatchery waste into by-product meal due to the risk of spreading pathogenic organisms. There are very few profitable outlets for this material and most hatcheries will have to dispose of this as waste.

1. Unhatched eggs from the hatcher tray should be macerated to destroy any unhatched embryos. Pipped eggs and cull chicks should be destroyed using carbon dioxide gas or other locally acceptable procedure.
2. 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 practice and environment constraints.

10. CHICK TRANSPORT

Specially designed vehicles must be used to control the chicks' environment throughout the journey from hatchery to growing farm.

1. The minimum ventilation rate needed to satisfy adequate oxygen is 20 CFM (34 m^3/hr) per 1000 chicks during winter weather, and twice this amount during hot weather. The vehicle should be equipped with an auxiliary heating system but may use fresh ambient air for cooling. If summer air temperatures exceed 86 °F (30 °C), cooling equipment is required.
2. The vehicle cab should have a display showing the temperature within the load to enable the driver to adjust air vents for cooling.
3. Chicks should be held at an in-box temperature of about 90 °F (32 °C) that can usually be achieved by a vehicle air temperature of 75 °F (24 °C) with plastic boxes or 71 °F (20 °C) with cardboard boxes.
4. 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 handle plastic boxes.
5. 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.
6. The vehicles can be provided with a rear plastic curtain to help retain heat while chicks are being unloaded.
7. 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. It is preferable for drivers not to enter the poultry house.
8. 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.
9. Chick boxes returning to the hatchery represent a high health risk. They must be kept separate and thoroughly washed and disinfected before re-use.

11. ALTITUDE

In several countries, poultry are produced at relatively high altitudes. Hatcheries operated at high altitudes experience reduced hatchability, with much greater effects above 2500 ft (762 m).

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 be less able to cope with these conditions. Hatchability problems at high altitudes are due to reduced availability of oxygen in the air and increased moisture loss from the eggs.

11.1 OXYGEN AVAILABILITY

The oxygen percentage of fresh air is always 21.6% and room/machine conditions must never go below 20%. The reduced partial pressure at altitude provides less oxygen from a given volume of air. This pressure reduction results in lower blood oxygen level and lower availability to the tissues.

11.2 WATER LOSS

Water loss from an egg during incubation is greater at high altitudes because water vapor diffuses through the shell more rapidly. The conductance of the eggshell becomes extremely important at high altitudes. Setters will need to be adjusted to ensure that the weight loss of the egg is 12% by 18 days of incubation.

12. MAINTENANCE

As hatcheries become larger and more automated, the need for preventative maintenance becomes crucial. Below are some suggestions:

1. Obtain manufacturers' recommendations for routine servicing and maintenance.
2. Carry out regular maintenance based on these guidelines and your own experience.
3. Perform a thorough inspection and cleaning at least once a year on multistage setters.
4. The turn-around time for hatchers is extremely rapid and leaves little time for servicing and repair. Have a spare machine to enable essential repairs to be carried out when necessary.
5. Keep a stock of regularly required spare parts and maintain an accurate inventory of items purchased and used.
6. Make sure staff who operate setters and hatchers are properly trained and familiar with their operation and have a procedure to follow in the event of machine failure.
7. Ensure adequate safety precautions are adopted. Provide the necessary guards and safety switches. Ensure all working practices comply with safety legislation. This is a management responsibility.

12.1 PREVENTATIVE MAINTENANCE

- Calibrate machines
- Calibrate rooms
- Check moisture loss
- Check pipping
- Check spread in hatch time (first chicks to final chicks)
- Verify that programs are yielding intended results
- Share information between management and maintenance personnel

13. HATCHERY AUTOMATION

1. Because of increasing hatchery size, and increased cost of labor, considerable opportunities may exist for automating many of the labor-intensive operations in hatcheries.

2. 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.

3. Machines are available to:

- a. Grade eggs before setting
- b. Candle and transfer eggs at 18 days
- c. Perform in-ovo vaccination
- d. Separate chicks from debris
- e. Count chicks
- f. Spray, vaccinate and box chicks
- g. Remove debris

A range of conveyors, elevators and carousels are available to speed up grading, sexing and other operations which need to be manually performed.

4. Much of this equipment is precision made and very expensive and only very large hatcheries can justify its use. Nevertheless, smaller hatcheries can achieve benefits from equipment such as vacuum transfer machines and chick-grading carousels, which are inexpensive but deliver considerable productivity benefits.

5. Productivity improvements are realized by:

- a. Gentler handling of eggs to reduce breakage
- b. More precise vaccination of the chicks
- c. More accurate counting of chicks
- d. Less fatigue on operators and the creation of a better working environment

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.

14. HATCHERY DESIGN

Good design is essential for cost-effective hatchery operation. Hatcheries form part of the food chain and their design must therefore incorporate food hygiene standards.

The conditions provided to maintain embryonic growth in the incubators are also ideal for the growth of bacteria and molds. The outer surfaces of eggs must be free from contamination and all room surfaces, items of equipment and incubators must be designed to allow simple, regular and effective cleaning and sterilization.

14.1 STRUCTURE

Hatcheries should have the following features:

1. Durable wall and floor finishes and easy-to-clean drains. Wall surfaces should have a minimum of joints and fastenings that impede effective cleaning. 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. The floor must be sloped to drains in each room of the hatchery. All drains need to be trapped, particularly in hatching and pull areas, to prevent blockages from eggshell and debris. The entire drainage system must be designed to handle large quantities of wash water and solid matter.

2. A biosecure flow of eggs, chicks and equipment through the building. Clean and dirty areas must be separated to prevent cross-contamination by fluff that can be carried around the hatchery on air currents, on staff clothes and on equipment. The ventilation system must ensure that air moves from the clean to the dirty areas and never the reverse, e.g., in the same direction as the eggs, from setters to hatchers. Ventilation systems themselves need to be suitable for periodic cleaning. In this context, the polythene air duct offers many advantages over steel trunking systems that are difficult to clean.

14.2 INSTALLATION OF HATCHER AND INCUBATOR PLENUMS

INTRODUCTION
With the introduction of a dependable variable speed fan and a pressure sensing and controlling device, it is now possible to successfully exhaust a hatcher or incubator into a controlled plenum.

ADVANTAGES
Creating a hatcher or incubator plenum offers several advantages:

1. Modifications of hatchery construction designs can now vary from the traditional "T" shaped building, because hatchers will no longer require an exterior wall to exhaust.
2. Controls the variable atmospheric conditions that may prevent the correct exhaust of the hatchers or incubators.
3. Eliminates all ductwork that must be balanced, monitored, and properly adjusted for consistent machine operation.
4. Aids in hatchery sanitation and cleanup and reduces man-hours needed for tedious duct cleaning.
5. Reduces or eliminates chick down exhausted into the atmosphere.

INSTALLATION
Following is a step-by-step guide to installing the plenum with variable speed fan and pressure control:

Setters
For the setter machine plenum take the total number of machines X 500 cfms to determine the cfms required to maintain a neutral pressure (0.00) to atmosphere in the chamber. The setter plenum should be above the machines and cover the entire surface area of the setters to help with heat loss from the machines. The air must be exhausted to atmosphere away from the fresh air intake.

Hatchers
For the hatcher machine plenum take the total number of machines that will be controlled by one plenum X 450 cfms per machine to determine the fan capacity needed to insure the plenum is always maintained at a neutral (0.00) pressure to atmosphere. The hatcher plenum must be behind the machines at floor level and exhausted to 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.

All pressure control fans must be fitted with a good back draft. If the fan is installed on a chimney there must be a back draft shutter fitted at the bottom of the chimney to eliminate the chimney effect from altering the ability of the fan to accurately control the pressure.

1. Properly locate the pressure sensing unit and tubes. There are two options:
   a. Measurement from the plenum to the exterior of the building. (Recommended) This is called the atmospheric reference point.
   b. Measurement from the plenum to the hatcher or incubator bay. (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 tubes should never be run more than 25 feet (7.7 meters) to the outside of the building or used for more than one sensor unless the size of the tube is increased or plumbed into PVC pipe running throughout the hatchery to the outside. The outside sensor should be installed in a manner that will take the wind influence away from the sensor.

The correct location of these sensors 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 bay as well as to outside to avoid the sensor getting a false reading from the pressurized bay.

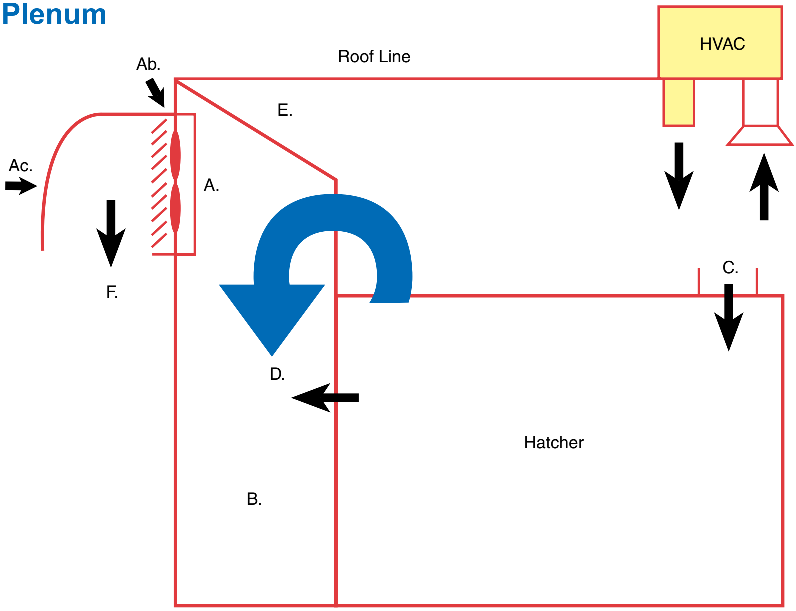
2. Construct the plenum carefully:
   a. Slope the roof at an angle of approximately 45º from the top of the machines to the wall for ease of clean up.
   b. Mount waterproof strip lights horizontally for maximum lighting.
   c. Locate the variable fan as high as possible in the plenum to allow chick down to settle out on the floor.
   d. Locate the fan as far away as possible from hatcher exhausts.
   e. Provide a drain in each plenum if possible for ease in clean up.
   f. Provide 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.
3. Provide a back-up pressure-monitoring device:

   A magnahelic shall be located on each plenum, sensing the same pressure that the controllers for the variable speed fans are sensing. Locate the magnahelic directly beside the controller, so comparative readings may be easily monitored.

SUMMARY

The exhaust plenum offers numerous advantages in the hatchery. Management of the exhausted air is a definite improvement. This concept should be considered for new construction or as a way to improve an older facility that is being upgraded.

Exhaust Plenum



Equipment Needs:

A. Variable speed fan incorporating a wind protection hood and back draft shutters
- Ab. Back draft shutter
- Ac. Wind protection hood

B. Plenum chamber
C. Input air supply
D. Exhausted air to the plenum chamber
E. 45 Degree angle
F. Exhausted air to the outside

14.3 LOCATION

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.

Standby and Alarm Systems

1. All hatcheries must be provided with an automatic standby generator to provide sufficient power to operate the hatchery should the main supply fail.
2. Alarm systems should indicate power or systems failure, and alert hatchery personnel to the problem so that it is rapidly located and dealt with.
3. 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.

15. HATCHERY SANITATION

1. A sanitation program should be devised to control contamination, and the results of the program should be checked regularly using standard bacterialogical monitoring procedures (agar plates and swabs).
2. Sources of contamination other than infected eggs and chick fluff are air, people (both workers and visitors), animals such as rats and mice, wild birds and insects, and equipment such as boxes, trays and buggies.
3. Ensure all workers and visitors wear suitable protective clothing. It is good practice to use different colored uniforms according to location (clean or dirty part of the hatchery) or task. This helps to identify incorrect movement of workers and hence possible cross-contamination.
4. Before using any disinfectant, it is important to remove all organic matter. For example, hatchers should be washed out thoroughly with water and detergent before disinfection.
5. Disinfectants must be used strictly in accordance with the manufacturer's instructions. Not all disinfectants are compatible; most are toxic and must be handled with care.
6. 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.
7. Disinfectants used must comply with government regulations.
8. Run sensitivity tests against your hatchery challenges to find the most effective hatchery sanitizer.

Properties of disinfectant chemicals used in hatcheries

Properties in normal use	Hypochlorites and other Chlorine based compounds	Quaternary Ammonium Compounds	Phenols	Formaldehyde		Iodophors	Glutaraldehyde	Peracetic acid
				Liquid	Gaseous			
Bactericidal	+	+	+	+	+	+	+	+
Sporicidal	+	–	±	+	+	+	+	+
Fungicidal	±	±	+	+	+	+	+	+
Virucidal	±	±	±	+	+	+	+	+
Toxic animals and humans	±	–	+	+	+	–	±	–
Activity with organic matter	–	–	±	+	–	–	±	±
Detergency	–	+	–	–	–	–	–	–
Staining	–	–	±	–	–	+	–	–
Corrosive	±	–	±	–	–	–	–	±
Cost	–	+	–	–	–	+	+	+

+ Positive Characteristic — Negative Characteristic ± Variable Property

16. RECORDS

1. Hatchery records have three (3) main purposes:
- to assist in daily or weekly management decisions
- to monitor and control egg and chick flow through the hatchery
- to assist in overall policy decisions

2. This necessitates two levels of record keeping.

Individual flock and incubator performance data on fertility, hatchability, number of culls, rots, etc.

The total cost of producing a chick, which should be broken down into labor, electricity, vehicles, etc.

3. Record sheets should be:
- easy to complete
- easy to understand and interpret
- easy to check for accuracy
- easy to compare with expected values

4. Analysis of records is essential in supplementing the manager's skill in monitoring incubator performance. This means searching for differences between actual and projected results.

5. Reviewing flock records after each hatch will highlight any problem areas and allow corrective action to be taken at an early stage.

6. Individual machines can be accurately logged using computerized equipment.

7. A typical embryo diagnosis report will supply the needed information for evaluating your hatchery.

8. The most important aspect of record keeping and data analysis:
KEEP IT SIMPLE!

17. TROUBLESHOOTING

Any investigation of the causes of poor hatchability must include examination of dead in shell. The main points to look for are:

1. Egg size and shell quality
2. Air space
3. Position of embryo within shell
4. Anatomical abnormalities
5. Nutritional abnormalities
6. Unused albumen
7. Age of embryo

The chart below shows the embryonic age distribution and mortality in normal flocks.

Candle and candle breakouts

1 2 3 4 5 6 7	8 9 10 11 12 13 14	15 16 17 18 19 20 21
Early	**Middle**	**Late**

- Candle eggs 10 - 12 days, and residue at hatch
- Look for the day that embryonic death occurred
- Check flock and machine again
- Check same flock in different machine
- Check different flock in same machine
- Look for mold
- Look for patterns

17.1 MAJOR CAUSES OF EGGS FAILING TO HATCH

- Egg storage
- Breeder nutrition
- True infertility (flock age)
- Diseases
- Bacterial and mold contamination
- Genetics
- Egg faults and shell damage
- Incubation faults

17.2 STAGES OF EMBRYONIC DEVELOPMENT

Stages of development	Troubleshooting	
DAY 1 • Appearance of tissue development	• Low fertility • Pre-incubation • Improper fumigation • Improper turning • Improper temperature • Improper humidity • Improper ventilation	• Inverted eggs • Rough egg handling • Insufficient egg holding time • Rough setting of eggs • Contaminated eggs • Nutritional / drugs / toxins
DAY 2 • Tissue development very visible • Appearance of blood vessels	• Low fertility • Pre-incubation • Improper fumigation • Improper turning • Improper temperature • Improper humidity • Improper ventilation	• Inverted eggs • Rough egg handling • Insufficient egg holding time • Rough setting of eggs • Contaminated eggs • Nutritional / drugs / toxins
DAY 3 • Heart beats • Blood vessels very visible	• Low fertility • Pre-incubation • Improper fumigation • Improper turning • Improper temperature • Improper humidity • Improper ventilation	• Inverted eggs • Rough egg handling • Insufficient egg holding time • Rough setting of eggs • Contaminated eggs • Nutritional / drugs / toxins
DAY 4 • Eye pigmented	• Improper turning • Improper temperature • Improper humidity • Improper ventilation	• Inverted eggs • Rough setting of eggs • Contaminated eggs • Nutritional / drugs / toxins
DAY 5 • Appearance of elbows and knees	• Improper turning • Improper temperature • Improper humidity • Improper ventilation	• Inverted eggs • Rough setting of eggs • Contaminated eggs • Nutritional / drugs / toxins
DAY 6 • Appearance of beak • Voluntary movements begins	• Improper turning • Improper temperature • Improper humidity • Improper ventilation	• Inverted eggs • Rough setting of eggs • Contaminated eggs • Nutritional / drugs / toxins

Stages of development	Troubleshooting	
DAY 7 • Comb growth begins • Egg tooth begins to appear	• Improper turning • Improper temperature • Improper humidity • Improper ventilation	• Inverted eggs • Rough setting of eggs • Contaminated eggs • Nutritional / drugs / toxins
DAY 8 • Feather tracts seen • Upper and lower beak equal in length	• Improper turning • Improper temperature • Improper humidity • Improper ventilation • Inverted eggs	• Insufficient egg holding time • Rough setting of eggs • Contaminated eggs • Nutritional / drugs / toxins
DAY 9 • Embryo starts to look bird-like • Mouth opening appears	• Improper turning • Improper temperature • Improper humidity • Improper ventilation • Inverted eggs	• Insufficient egg holding time • Rough setting of eggs • Contaminated eggs • Nutritional / drugs / toxins
DAY 10 • Egg tooth prominent • Toe nails	• Improper turning • Improper temperature • Improper humidity • Improper ventilation • Inverted eggs	• Insufficient egg holding time • Rough setting of eggs • Contaminated eggs • Nutritional / drugs / toxins
DAY 11 • Comb serrated • Tail feathers apparent	• Improper turning • Improper temperature • Improper humidity • Improper ventilation • Inverted eggs	• Insufficient egg holding time • Rough setting of eggs • Contaminated eggs • Nutritional / drugs / toxins
DAY 12 • Toes fully formed • First few visible feathers	• Improper turning • Improper temperature • Improper humidity • Improper ventilation • Inverted eggs	• Insufficient egg holding time • Rough setting of eggs • Contaminated eggs • Nutritional / drugs / toxins
DAY 13 • Appearance of scales • Body covered lightly with feathers	• Improper turning • Improper temperature • Improper humidity • Improper ventilation • Inverted eggs	• Insufficient egg holding time • Rough setting of eggs • Contaminated eggs • Nutritional / drugs / toxins

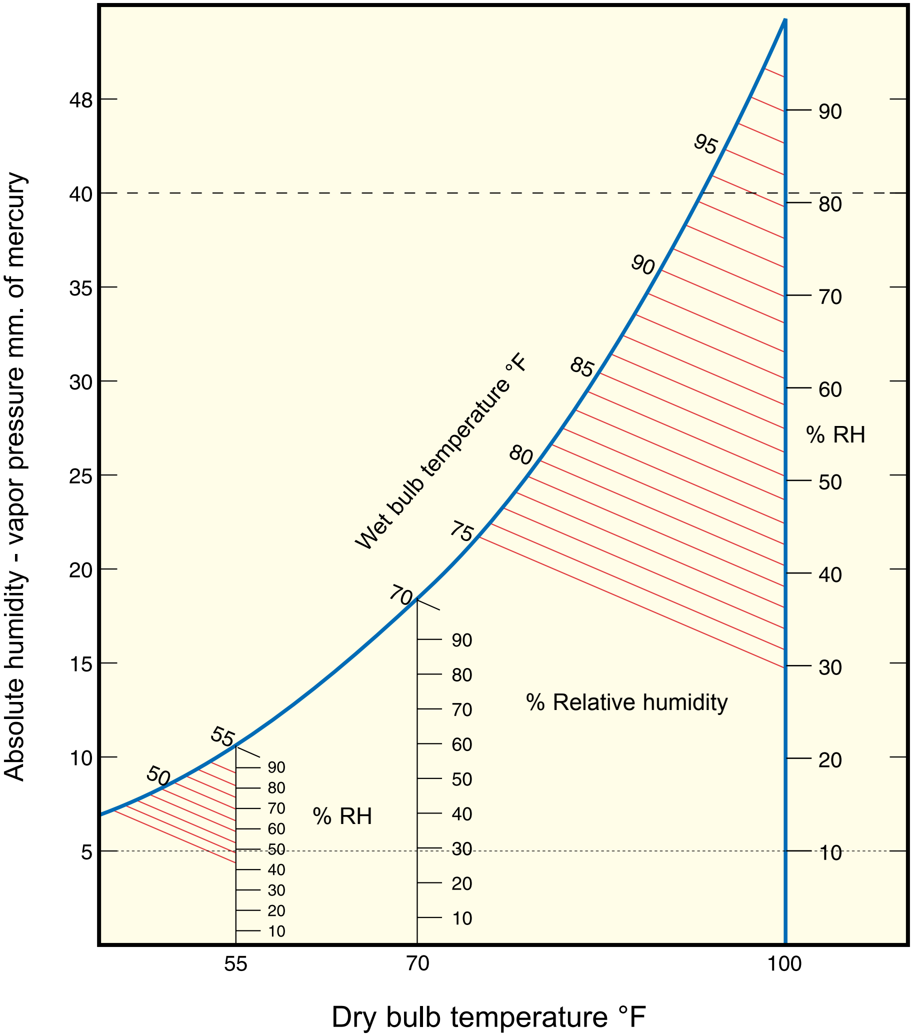
Stages of development	Troubleshooting	
DAY 14 • Embryo turns head toward large end of egg	• Improper turning • Improper temperature • Improper humidity • Improper ventilation • Inverted eggs	• Insufficient egg holding time • Rough setting of eggs • Contaminated eggs • Nutritional / drugs / toxins
DAY 15 • Gut is drawn into abdominal cavity	• Improper turning • Improper temperature • Improper humidity • Improper ventilation	• Inverted eggs • Contaminated eggs • Nutritional / drugs / toxins
DAY 16 • Feathers cover complete body • Albumen nearly gone	• Improper turning • Improper temperature • Improper humidity • Improper ventilation	• Inverted eggs • Contaminated eggs • Nutritional / drugs / toxins
DAY 17 • Amniotic fluid decreases • Head is between legs	• Improper turning • Improper temperature • Improper humidity • Improper ventilation	• Inverted eggs • Contaminated eggs • Nutritional / drugs / toxins
DAY 18 • Growth of embryo nearly complete • Yolk sac is still on outside of embryo • Head is under the right wing	• Hatcher opened too much during hatch cycle • Rough transfer • Transfer cracks • Wet trays and hatchers • Inconsistent transfer	• Improper turning • Improper temperature • Improper humidity • Improper ventilation • Inverted eggs • Contaminated eggs • Nutritional / drugs / toxins
DAY 19 • Yolk sac draws into the body cavity • Amniotic fluid gone • Embryo occupies most of the space within the egg (not in the air cell)	• Hatcher opened too much during hatch cycle • Rough transfer • Transfer cracks • Wet trays and hatchers • Inconsistent transfer	• Improper temperature • Improper humidity • Improper ventilation • Contaminated eggs • Nutritional / drugs / toxins
DAY 20 • Yolk sac drawn completely into body • Embryo becomes a chick (breathing in air in cell) • Internal and external pip	• Hatcher opened too much during hatch cycle • Rough transfer • Transfer cracks • Wet trays and hatchers • Inconsistent transfer	• Improper temperature • Improper humidity • Improper ventilation • Contaminated eggs • Nutritional / drugs / toxins

Diagnosis of hatch problems

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 tray • Inadequate turning
MALPOSITIONS	• Eggs set upside down • Odd shaped eggs • Inadequate turning
UNHEALED NAVELS	• High temperatures - 1 to 19 days • High humidity - 20 to 21 days • Egg storage
CRIPPLED CHICKS	• Temperature variation throughout incubation • Flock age • Egg handling first week of incubation
ABNORMAL CHICKS	• Crossed beak: Hereditary or virus infection • Missing eyes: High temperatures or handling • Wry neck: Nutrition • Crooked toes: Temperature and nutrition • Spraddle legs: Smooth hatcher trays

This chart describes the relationship between dry bulb temperature, wet bulb temperature, relative humidity and absolute humidity.

Simplified psychrometric chart for use in hatcheries



18. METRIC CONVERSIONS

1 mm	= 0.0394 in
1 cm	= 10 mm = 0.3937 in
1 m	= 100 cm = 1.0936 yd = 3.2808 ft
1 km	= 1000 m = 0.6215 miles
1 in	= 2.54 cm
1 ft	= 30.48 cm
1 yd	= 0.9144 m
1 mile	= 1.609 km
1 g	= 0.002205 lb = 0.0353 oz
1 kg	= 2.2046 lb
1 tonne	= 1000 kg = 0.9842 long tons (British)
	= 1.1023 short tons (USA)
1 oz	= 28.35 g
1 lb	= 0.4536 kg = 453.6 g
1 long ton	= 1.016 tonnes = 1.016 kg
1 short ton	= 0.9072 tonnes = 907.2 kg
1 cm^2	= 0.155 in^2
1 m^2	= 1.196 yd^2
	= 10.7639 ft^2
1 in^2	= 6.4516 cm^2
1 ft^2	= 0.0929 m^2
1 yd^2	= 0.8363 m^2
1 litre	= 0.22 Imp gal
	= 0.2624 US gal
1 pt (Imp)	= 0.5682 litre
1 pt (USA)	= 0.4732 litre
1 qt (Imp)	= 1.1365 litre
1 qt (USA)	= 0.9463 litre
1 gal (Imp)	= 4.54596 litre
1 gal (USA)	= 3.7853 litre
1 m^3/kg/h	= 16.016 ft^3/lb/h
1 ft^3/lb/h	= 0.0624 m^3/kg/h
1 m^3/h	= 0.5886 cfm
1 m/sec	= 196.85 ft/min
1 kcal	= 3.97 BTU
1 kcal/m^3	= 0.1123 BTU/ft^3
1 kcal/kg	= 1.8 BTU/lb
1 pascal	= 10^{-2} mbar = 0.021 lbf/ft^2

Temperature

°C	°F
45	113.0
44	111.2
43	109.4
42	107.6
41	105.8
40	104.0
39	102.2
38	100.4
37	98.6
36	96.8
35	95.0
34	93.2
33	91.4
32	89.6
31	87.6
30	86.0
29	84.2
28	82.4
27	80.6
26	78.8
25	77.0
24	75.2
23	73.4
22	71.6
21	69.8
20	68.0
19	66.2
18	64.4
17	62.6
16	60.8
15	59.0
14	57.2
13	55.4
12	53.6
11	51.8
10	50.0
9	48.2
8	46.4
7	44.6
6	42.8
5	41.0

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Flock #							
Incubator #		**Set Date**		**Egg Age**		**Flock Age**	
Hatcher #		**Candle Date**		**% Production**		**Fml. Breed**	
Eggs Set		**Breakout Date**		**% Actual Hatch**		**Ml. Breed**	

			Dead Embryos					**Cracks**				
Tray Position	#Eggs/Tray Unhatched	Infertile	Early	Mid	Late	Pipped	Cull Chicks	Early	Trans	Cont.	Cull Eggs	Up-Side Down
Totals												
Percent												

Sample Size		% Est. Hatch		% Fertility		% Hatch of Fertile	

19. NOTES

NOTES

NOTES

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