A good, sound health and safety program is an effective way to manage risks and productivity in your operation. Accidents are not only in human terms, but they can disrupt the flow of work and halt production. There are always hidden cost. The actual injury to an employee only the tip of the iceberg. Direct contact seems to be the most common mode of entry of infectious agent in the employees working in farms and processing plants. By increasing the safety awareness we can make our farms and processing plants a safer place for family member's employees and visitors to the farm. Here, you can find a wealth of knowledge about occupational hazards of poultry and dairy production facilities as well as the hazards of poultry processing plants.

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Veterinary Occupational Hazards
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Edited by
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Dr. Ahmed Rezk Mohammed EL-Dahshan
Dr. Samah El said El sayed Laban
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Occupational Hazards of Poultry Production Facilities

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Foreword

Poultry farms should not create any significant adverse impact, including denudation, erosion, pollution of the environment, nuisance, human health risk, bird welfare problems or loss of visual amenity. Poultry farms should be sited, designed and managed to ensure that odour emissions and noise are minimized.

All buildings and other ancillary structures should be sited as unobtrusively as possible. Suitable trees and shrubs should be planted and maintained around the sheds and other ancillary structures intended for animal husbandry, to visually screen these activities from adjoining roads and properties.

All effluent and other wastes must be properly managed and disposed of without adverse effects on public health and the environment,
including water resources. Solid or liquid wastes should not be spread on the property within the prescribed distance of dwellings, watercourses or roads.

Forward planning is an essential aspect of poultry farm development. Feed storage, drainage and effluent facilities all need to be sited in an appropriate manner. Experience has shown that poultry farms often expand in size within a few years. Therefore it is sensible to plan for future expansion.

**Acronyms and Abbreviations**

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**Volume** | **Concentration**  
---|---  
L | mg/kg bw/d  
mL | M  
μL | ppb  

**Terminology**  
OHS | Occupational Health and Safety  
PPE | Personal Protective Equipment  

**Organizations & publications**  
APVMA | Australian Pesticides and Veterinary Medicines Authority  
DHA | Department of Health and Ageing  
DPI&F | Department of Primary Industries and Fisheries  
DPSSC | Drugs and Poisons Schedule Standing Committee  
EFSA | European Food Safety Agency  
FAO | Food and Agriculture Organization of the United Nations  
FAISD | First Aid Instructions and Safety Directions  
GHS | Globally Harmonized System  
IPCS | International Programme on Chemical Safety  
FSANZ | Food Standards Australia and New Zealand  
JMPR | Joint WHO/FAO Meeting on Pesticide Residues  
NDPSC | National Drugs and Poisons Scheduling Committee  
NHMRC | National Health and Medical Research Council
**EXECUTIVE SUMMARY**

Modern methods of livestock housing require that the stockman works for a large proportion of the day in an atmosphere containing comparatively high levels of dust, gases and odour that increased the prevalence of respiratory problems in those work in poultry houses.

Poultry farm workers may contract from the fowl in their care, infectious diseases that are common to fowl and man where poultry farms. Significant levels of agricultural dust, toxic gases, some chemicals used for disinfection, etc., may cause harm to workers' health.

**Agricultural workers** can be exposed to high concentrations of dust, microorganisms and gaseous contaminants (ammonia, hydrogen sulphide), particulate contamination (dust), physical hazards. Exposure to agricultural dusts induce acute and chronic respiratory irritation and disease.

**Agricultural dusts** are primarily organic (feathers, dander, microorganisms etc.), while inorganic dust (crystalline silica) are found in confinement house dusts. The levels of respirable dust (RD) 0.1-10 μm were 1.28 and 1.44 mg/ m³ in typical broiler and layer growing facilities respectively. **The organic dusts** in livestock buildings comprise grain and
other plant-derived particles, animal hair, urine, faeces, microorganisms and other particles may carry hazardous material such as pathogenic bacteria, viruses, endotoxins. *The organic dusts and toxic gases* constitute some of the most common and potentially disabling occupational and environmental hazards. *Long-term exposure of workers to organic dusts and animal confinement gases* lead to respiratory diseases and syndromes (hypersensitivity pneumonitis, organic dust toxic syndrome, chronic bronchitis, mucous membrane inflammation syndrome, and asthma-like syndrome), result from ongoing acute and chronic exposures

*Dust particles* may carry ammonia in a concentrated form into the respiratory system. Deposition of inhaled particles in the respiratory system is a function of the size of particles. *The particle size* ranges with the largest percentage of deposition in the lungs is 1–2 μm in aerodynamic diameter.

*Respirable dust* accounts for ~18% of total dust mass. Particles smaller than 0.5 μm in mean aerodynamic diameter are Respirable, they are exhaled and not deposited in the lungs. It's imperative to control "modified" respirable dust, 0.5–5 μm, and "modified" inhalable dust >5 μm in mean aerodynamic diameter. In the Respirable range *dust particle concentrations* reached a maximum of 44 particles/ml towards the end of the growth cycle and less than 5% of the airborne particles were of non-fecal origin. Dust levels ranging from 1.9-7.6 mg/m³ have been reported to adsorb ammonia, allowing the ammonia to travel deep into the respiratory tract, and 5-50% are in the Respirable range. *Dust levels* depend on relative humidity. Less ventilated buildings have high relative humidity and lower dust aerosolization than highly ventilated buildings. Adjustment of relative humidity to 75% will have an effect on inhalable dust (the fraction that is below 20 μm), but not on respirable dust (the fraction below 5 μm).
The inorganic dust is composed of numerous aerosols originating from such building sources as concrete, mineral or fiberglass insulation, or material, such as soil particles, drawn into the barn by the fresh air supply. Average dust concentrations inside the facilities were consistently below 2 mg/m³. The threshold inorganic dust is 10 mg/m³ and 5 mg/m³ for organic dust.

Dust mixtures (vegetable and organic substances, biologically active substances and microorganisms, gaseous products) represent the major hazardous factors of labor conditions in modern poultry.

Factors affecting dust concentrations including houses with caged laying hens (percheries and aviary systems) showed the lowest dust concentrations. Also animal category, animal activity, excreta, bedding materials and season. An increased ventilation rate will not necessarily reduce overall dust concentrations since the dust production rate increases with increased ventilation.

Exposure to several toxic and asphyxiating gases common especially in confinement systems (ammonia (NH3)), carbon dioxide (CO2) and gas flame heaters; CO, H2S, CH4, SO2, and NO2). Levels of ammonia were 14 and 26 and of CO2 were 2360 and 3680 ppm in typical broiler and layer growing facilities respectively.

Hydrogen sulphide is the greatest concern with deep pit manure storage systems; carbon dioxide; carbon monoxide; dust bioaerosols; including bacteria, fungi, mold, virus or fragments of these organisms, and dust, fumes or vapors associated with pesticides, disinfectants, and litter treatments. In-barn manure agitation can release large amounts of H2S.
The pollutants effects of aerosol constituents are a function of concentration and particle size, which determines visibility reduction and degree of penetration and retention in lungs.

Odors are indigenous to all modern livestock production operations. Odors are generated primarily from the confinement buildings, from manure storage structures, from manure or storage effluent applied to cropland, and from disposal of dead animals. The 4 principle classes of odorants are (1) volatile fatty acids (VFA), (2) ammonia and volatile amines, (3) indoles and phenols, and (4) volatile sulfur containing compounds. The VFA are an intermediate product in the anaerobic fermentation of biological wastes to methane (CH4). The odour emission rate of manure (layer) was found to increase above 55%-moisture level while the odour emission rates of the litter (turkey and broiler) decreased with the increasing moisture level. The relationship between odor concentration and odor intensity is important to establishing the effect of the odor on the public and in determining effective abatement strategies.

Among all the gases present in the ambient barn air, the most dangerous ones to worker health are hydrogen sulphide (H2S), carbon dioxide (CO2), ammonia (NH3) and methane (CH4). Atmospheric emissions of methane are of concern because of their potential contribution to global warming.

The impact of odor on the public can be evaluated by the frequency, intensity, duration, and offensiveness of the odors.

Carbon dioxide levels increased above 1500 ppm are associated with a higher risk of respiratory disease in workers because of an association with elevated concentrations of other toxic substances in the air. Carbon dioxide levels in ambient air of barns usually do not exceed the
TLV of 5000 ppm unless there is a failure of the mechanical ventilation system.

*Ammonia is an odorant,* and conditions conducive to the production of ammonia may result in the emission of other odorants. *Ammonia* has characteristic strong odor makes it easily detectable as soon as levels reach 5 to 10 ppm. As little as 4 ppm of ammonia may cause eye irritation and as 25ppm, mild tissue irritation in some individuals. High levels of ammonia, between 20 and 50 ppm, irritate the eyes, nose and throat.

*Workers in floor-housed poultry operations* had significantly greater exposures to ammonia. Upper limits for acceptable ammonia concentrations in the UK is 25 ppm, in Sweden and Germany the limit is 25 and 20 ppm respectively, for an 8-hour working day. Sweden also has a second limit of 50ppm for a maximum of 5 minutes exposure.

*For broiler housing, ammonia emission rates* were higher from houses that reused litter for several flocks than from houses that used new litter for each new flock. *Emission rates varied greatly* between broiler houses at the same site. The average ammonia emission rates from the belt houses and high rise houses were 0.14 and 1.1 g NH₃/ d-hen (0.00032 and 0.0023 lb/d-hen), respectively.

*Ammonia emission rates for laying hens* were lower from housing using manure belt manure handling systems than from high rise houses, which use deep pits. *Ammonia emissions rates from both belt and high rise houses* varied widely both seasonally and diurnally. *Average ammonia emission rates* from the houses in which flocks were fed the low protein *diet* were slightly lower (0.99 g/d-hen or 0.0022 lb/d-4 hen) than the rates from the houses in which the *standard diet* was fed (1.1 g/d-hen or 0.0023 lb/d-hen).
Emission rates were higher during the warm weather due to higher ventilation rates.

An increase in susceptibility of respiratory system to airborne pathogens when combined with ammonia concentration below the occupational exposure limit of 25 ppm.

*The current recommendations* for continuous exposure of animals (not humans) are 20 ppm for ammonia, 3000 ppm for carbon dioxide, 3.4 mg/m3 for inhalable and 1.7 mg/m3 for respirable non-specific dust.

**Hazards of exposure to asphyxiating gases include** acute and chronic dermal, ocular and respiratory diseases from exposure to *several toxic and asphyxiating gases* common especially in confinement systems including ammonia (NH3), released during microbial degradation of manure; carbon dioxide (CO2) from animal respiration, manure fermentation, and gas flame heaters; other gases include CO, H2S, CH4, SO2, and NOx (manure decomposition and fuel combustion).

*The hazards effect of generated ammonia gas from litter* of broiler habitats and emitted across air, on both birds and workers, increases the surrounding environmental problems as acid rain and fertilizing nitrogen loss in surrounding soil and water.

**Respiratory function of poultry growers** may be impaired above concentration of 12 ppm of ammonia. Ammonia in combination with other respiratory hazards such as dust and bioaerosols may contribute to numerous health concerns. **Respiratory disorders in exposed workers** are, acute lower respiratory tract inflammation, asthma like syndrome, asthma chronic bronchitis, organic dust toxic syndrome, mucus membrane inflammation syndrome, hydrogen sulfide poisoning asphyxiation, carbon monoxide poisoning, infectious diseases and hyper sensitivity pneumonitis.
Outdoor neighbors who expect to attract the emitted air pollutants suspended and adsorbed on dust particulates with consequent respiratory disorders, asthma, bronchitis, and allergy, bacterial, fungal and viral infections. The major etiologic factor being such allergens as feathers down, blood serum, poultry excrements, bacteria and fungi. Higher prevalence of chronic cough, chronic phlegm, chronic bronchitis, and chest tightness than in non-smokers workers.

Exposure to disinfectants, detergents, formaldehyde, ammonia solutions, sodium carbonate and sodium hypochlorite. Formaldehyde, a suspect carcinogen, is often used as a disinfectant in hatcheries and brooder houses.

Control of both dust and ammonia in livestock facilities is extremely important to avoid the risk of respiratory dysfunction to all exposed to this environment.

An aerosol is a dispersion of microscopic solid and liquid particles suspended in the air. It includes airborne dust, microorganisms, spores, feed, bits of feathers, dead skin cells, dried feces and water droplets. The effects of inhaled aerosols on the respiratory tract may include 1) interference with mucus production and destruction of the ciliated epithelium of the trachea as occur with elevated concentration of ammonia, 2) binding, replication ,and invasion of the epithelial cells as seen with certain bacterial invasion ,3) germination and invasion of tissue as occur with Aspergillus organisms ,4) phagocytosis by macrophages as occur with most pathogens and inert particles ,and 5) elicitation of allergic responses.

Exposure to aerosols resulted in clinical characterization of a variety of hypersensitivity lung diseases. Lung, grain fever, and extrinsic allergic alveolitis or more commonly pigeon breeder’s disease. The poultry
industry should be aware of the potential respiratory health effect of occupational exposure to bioaerosols and preventive measures to protect workers, use of respirators by workers and spraying of canola oil to reduce dust exposure.

**Bioaerosol levels** increased significantly during the fattening period of the chickens. During the task of catching mature birds, the mean inhalable dust concentration for a worker was 26 ± 1.9 mg m⁻³ and endotoxin concentration was 6198 ± 2.3 EU m⁻³ air, >6-fold higher than the Swiss occupational recommended value (1000 EU m⁻³). **Airborne microorganisms** appeared regularly in livestock houses as part of settled dust and its quantity depend on air flow and equipment motility. Both animals and their keepers affecting negatively by the **bioaerosols**. Microbial bioaerosols have complex and varied organic structures and may be capable of reproduction, growth, and infection with more health impact.

**Farmer's health** may be harmed by regular daily exposure to heavy burdens of **aerial endotoxins**, which arise from Lipopolysaccharides membrane fragments different species of Gram-negative bacteria differ in their toxicity, non-specific nuisance dusts and irritant gases, particularly ammonia, at doses that approach and may exceed current long term occupational exposure limits (8-h time-weighted averages). These endotoxins are generally strong allergens causing immediate or delayed reactions in the respiratory system. **Exposure to endotoxin** causes episodic febrile reactions. Toxin fever generally occurs in the afternoon or evening of a working day. **Symptoms of toxin fever include:** headache, nausea, coughing, nasal irritation, chest tightness and phlegm. The minimum level of endotoxin required to produce a fever reaction in humans is 0.5 µg/m³ following a four-hour exposure period inhalation of endotoxin. **Endotoxin concentration of respirable dust**, 20 to 40 ng/mg, is considerably higher
than endotoxin concentration of total dust, 6 to 16 ng/mg, suggesting that endotoxin is enriched in smaller particle.

**Lack of sufficient ventilation in the cold season** cause the concentration of endotoxin in the air to rise. Endotoxin largely sticks to the fine particles. Bacterial endotoxins, fungal spores, and the inherent toxicity of grain dusts as causes of upper and lower airway inflammation and as immunologic agents in both grain and animal production.

**Chlorpyrifos** is one of the most widely used organophosphate insecticides in the United States. Although the toxicity of chlorpyrifos has been extensively studied in animals, the epidemiologic data are limited.

**Poultry meat and eggs may act as potential sources of food poisoning**, primarily because of *Salmonella infections*. Poultry products improper storage leads to *microbial spoilage* and consequent food poisoning.

**Poultry meat is infected** from its body system because of diseases, contamination of the carcass with gut contents, unhygienic conditions prevailing in the slaughter-houses and retailing units, long hours of exposure in an open environment at room temperature during display, and improper cold-storage conditions. Microbial pathogens (bacteria, viruses, parasites, and fungi) found in chicken flesh can and do cause illness and death in humans. The most common pathogens in chicken flesh are salmonella and campylobacter. **In the factories in which chickens are slaughtered and processed**, the fast pace and unsanitary practices associated with mass production expose chicken flesh to contaminants such as feces, bile, mucus, and partially digested feed, any of which might cause illness if ingested or even touched by humans. *Chicken flesh* must be cooked in order to be edible to humans. The process of cooking chicken flesh leads to the formation of *heterocyclic aromatic amines* in the meat.
The antibiotics feed to chickens stimulate the evolution of antibiotic-resistant pathogens within the birds. These pathogens remain in the flesh and can be contracted by humans through contact with the blood or the uncooked meat. These are cancer-causing compounds have long been known to be one of the reasons consumption of meat is linked to cancer, oven-broiled, pan-fried, or grilled chicken flesh actually contains more of these carcinogens than red meat. The longer the meat is cooked, the larger the load of carcinogens in the meat. Grilled chicken contains 480 nanograms per gram of the carcinogen PhIP. PhIP is suspected as a cause of both breast and colon cancer.

There are agricultural workers whose work brings them into contact with fertilizers derived from chicken manure and at the other end of the food chain hotel, restaurant and catering workers who handle uncooked chicken products. Since eggs seem to be a surface most likely to retain traces of feces (mainly dust), all those workers handling, cleaning and processing eggs must be added to the list of jobs involving occupational exposure to the H5N1 virus.

In terms of the occupational hazards posed by the H5N1 virus, workers must be concerned not only with direct contact with the blood, bodily fluids or feces of infected birds, but also any surfaces or dust that could be contaminated. Workers who handle infected live poultry, clean poultry houses/cages, catch poultry, slaughter poultry, clean slaughtered poultry, clean up after slaughtering, handle uncooked poultry carcasses, and handle uncooked meat on processing lines (and any of the other jobs in between). Poultry growers and their employees; service technicians of poultry processing companies; caretakers, layer barn workers, and chick movers at egg production facilities; and workers involved in disease control and eradication activities.
The H5N1 virus may be contracted by humans who inhale dust contaminated with the feces of an infected bird. On rare occasions, avian influenza virus can be transmitted to poultry workers or others who come in contact with infected poultry or contact contaminated surfaces. Certain avian influenza viruses are potential zoonotic disease agents that may be transmitted from infected birds to humans. Transmission to humans have resulted from contact with infected sick or dead poultry or their droppings, or contact with contaminated litter or surfaces (e.g., egg flats). The suspected routes of entry of the virus to humans are the mouth, nose, eyes, and lungs. Poultry workers at risk of exposure to AI viruses are people working in poultry production systems or sectors, (farmers and employees; service technicians of poultry-processing facilities; caretakers at poultry facilities; layer barn workers; workers in live bird markets; chick workers at egg production facilities; disease control and eradication workers; and workers in the bird-fighting industry).

Dust control, micro mist, evaporative cooling, high pressure and dust control system, cooling, an electrostatic precipitator and dust control system significantly lowered dust concentration. Adding animal fat or vegetable oil minimized feed dust. A short period of high ventilation (purge) reduced dust concentration. Using an internal recirculating filter improved air quality. Spraying a small quantity of plant oil (ca. 5-10 g oil / animal and spraying intermittently a fine mist of rapeseed oil. Wet scrubbing used water to capture particles or increase the size of dust particles and removing dust from the air. Adjustment of the relative humidity (RH %) of the air in a broiler house to 75% will have an effect on inhalable dust only. Cleaning ventilation fans and shafts will minimize odours that are absorbed and carried in through the air by dust particles.
Control Ammonia emission, daily or thrice-weekly removal of droppings from cages units to closed storage systems. Increase ventilation rates to control air and litter quality. Maintain desirable litter moisture by proper managing of drinker and cooling systems and maintain uniform bird density and adequate litter depth. Prevent water seepage into houses by correct outside drainage problems. Timely and effective cake removal. Clean out houses. Implement laborsaving technologies such as computer controllers which improve labor efficiency and reduce the hours spent working in houses.

Litter treatment. Litter treatment with alum (Aluminum silicate, ferrous Sulphate, phosphoric acid). The water cups have been replaced nipples to get rid of water spillage and wet litter.

Control of odours can be achieved by managing the odour generating processes (eg. maintaining optimum litter moisture) or removing odour from air before it is released from the sheds. Windbreak walls help to disperse odour and provide a means for controlling odour and dust emissions. Ventilation removes excess heat, water vapour and odorous compounds from the sheds. Adopting management practices such as use of pelleted food, routine entry into buildings and use of lighting cycles can control dust and ammonia levels.

Maintain Biosecurity, review procedures for dealing with sick or dead birds including availability of suitable personal protective equipment (PPE) and training in its use. All workers in the poultry and associated industries should strongly consider vaccination with the seasonal human influenza vaccine every year as soon as the vaccine becomes available (usually March). Cleaning and disinfection (C&D) of the entire poultry slaughter house premises at the end of each day’s production to ensure that the premises are free of manure, feathers and other debris that can
potentially harbor bird flu viruses. Wear a respiratory protection system (RPS) such as an adequate face mask or the more efficient positive pressure respirator, especially during feeding and animal handling times. Keeping poultry facilities clean has long been encouraged as a method to protect human respiratory health.

**Part I. occupational Hazards of poultry production facilities**

**Background**

**Health impact of occupational hazards**

Modern methods of livestock housing require that the stockman works for a large proportion of the day in an atmosphere containing comparatively high levels of dust, gases and odour that increased the prevalence of respiratory problems in those work in poultry houses.

The ambient air in the poultry confinements contains noxious and odourous gases and air-borne particles rich in various infectious, allergenic and toxic agents; which individually or collectively in a synergy can affect negatively the physical and psychological health of poultry workers

**Poultry workers** as a group had an overall excess of deaths from:-

1. Diabetes, anterior horn disease, and hypertensive disease, and a deficit of deaths from intracerebral hemorrhage. deaths from zoonotic bacterial diseases, helminthiasis, myasthenia gravis, schizophrenia.

2. Other diseases of the spinal cord, diseases of the esophagus and peritonitis were non-significantly elevated overall by all analyses, and significantly so in particular race/sex subgroups.
The Occupational Safety and Health Act 1984 states that:

a) An employer shall as far as practicable, provide and maintain a working environment in which employees are not exposed to hazards.

b) Issues to consider in a poultry farm work environment are zoonotic disease transmission; respiratory hazards from airborne particulates; chemical handling; manual handling; and vehicle and equipment safety.

10 % of the UK poultry stockmen had respiratory impairment and the layer stockmen were exposed to more hazardous environments due to the practice of * blowing out * cages with compressed air.

The workers in various areas of the poultry industry, (turkey growing, broiler production, egg laying and unloading/shakeling in poultry processing) were exposed to total and Respirable dust, ammonia, endotoxin and CO2.

The assessment of these pollutants in the work environment indicated:-

a) Synergy between ammonia levels and airborne dust explained up to 43% and 63% of the decline (respectively for Forced Expiratory Volume (FEV) in one second and Forced Expiratory Flow (FEF25-75) in pulmonary function over the work shift.

b) The proportion of health effect due to synergy between dust and ammonia is 35%-61%.

c) Control of both dust and ammonia in livestock facilities is extremely important.

d) Lack of control of both these contaminants will increase the risk of respiratory dysfunction to all exposed to this environment, including workers and veterinarians.
e) **The health risk** is recorded for birds and their keepers and even the outdoor neighbors who expect to attract the emitted air pollutants suspended and adsorbed on dust particulates with consequent respiratory disorders, asthma, bronchitis, and allergy, bacterial, fungal and viral infections.

f) Poultry farm workers may contract from the fowl in their care, infectious diseases, significant levels of agricultural dust, toxic gases, some chemicals used for disinfection that may cause harm to workers' health.

g) The health risk of poultry environment on their keepers and agricultural workers included significantly higher prevalence of chronic cough, chronic phlegm, chronic bronchitis, and chest tightness than in non-smokers workers.

h) Workers in floor-housed poultry operations had significantly greater exposures to total dust and ammonia, whereas workers from cage-housed poultry operations reported greater frequency of current and chronic symptoms overall and significantly greater current and chronic phlegm (39% Vs 18% and 40% Vs 11%, respectively).

i) Endotoxin concentration (EU/mg) was a significant predictor ($P = 0.05$) of chronic phlegm for all poultry workers.

j) The major etiologic factor being such allergens as feathers down, blood serum, poultry excrements, bacteria and fungi.

k) Many respiratory, pulmonary, blood vascular diseases and nervous disorders that birds suffered strongly correlated with environmental management and its resultant of dust, particulates containing vegetative, organic active matters, microorganisms and gaseous products.

l) Viable microorganisms contributing to bioaerosols production have been identified. The development of pulmonary diseases, particularly allergic alveolitis (hypersensitivity pneumonitis), had been shown to be a risk from exposure to airborne microorganisms.
m) Exposure to aerosols resulted in clinical characterization of a variety of hypersensitivity lung diseases. The clinical manifestations of the **hypersensitivity lung disease**, farmer's lung, grain fever, and extrinsic allergic alveolitis or more commonly pigeon breeder's disease are similar, and are characterized by Type 1 and/ or Type 111 immunologic response.

n) **High prevalence of wheezing and symptoms of chronic bronchitis as well as respiratory problems and musculoskeletal injuries** were recorded.

o) Poultry house workers, and most particularly those employed in the task of bird catching, are regularly exposed to very high levels of airborne bacteria, endotoxin and dust.

p) **Acute and chronic respiratory irritation and disease** from exposure to agricultural dusts. Agricultural dusts are primarily organic (feathers, dander, microorganisms etc.), while inorganic dusts, like crystalline silica, are also found in confinement house dusts. **Immunologically mediated diseases** (e.g. rhinopharyngitis, atopic asthma) and hypersensitivity (immediate and delayed) reactions (e.g. extrinsic allergic alveolitis/hypersensitivity pneumonitis) from exposure to dusts.

q) **Acute and chronic dermal, ocular and respiratory diseases** from exposure to several toxic and asphyxiating gases common especially in confinement systems including ammonia (NH3), released during microbial degradation of manure; carbon dioxide (CO2) from animal respiration, manure fermentation, and gas flame heaters; other gases include CO, H2S, CH4, S02, and NOx (manure decomposition and fuel combustion).

r) The occupational health community reported risks for respiratory illness in workers and veterinarians as they inspire a combination of bioaerosols and gases (mainly ammonia).
s) Long-term exposure of workers to organic dusts and animal confinement gases lead to respiratory diseases and syndromes, including hypersensitivity pneumonitis, organic dust toxic syndrome, chronic bronchitis, mucous membrane inflammation syndrome, and asthma-like syndrome, result from ongoing acute and chronic exposures.

t) Respiratory function of poultry growers may be impaired above concentration of 12 ppm of ammonia. Ammonia in combination with other respiratory hazards such as dust and bioaerosols may contribute to numerous health concerns.

u) Growers working in poor air quality poultry housing may show symptoms such as cough, phlegm, wheezing, nasal irritation, itchy eye, chest tightness, fatigue, headache, and fever.

v) The special health problems facing farm workers, farmers, miners, and loggers in USA are often ill and are affected by psychological illness, injuries, parasites, skin diseases, and the dangers of agrichemicals.

w) They are often injured on the job and suffer the highest rate of job related fatality of any work group.

x) Respiratory disorders in exposed workers are, acute lower respiratory tract inflammation, asthma like syndrome, asthma chronic bronchitis, organic dust toxic syndrome, mucus membrane inflammation syndrome, hydrogen sulfide poisoning asphyxiation, carbon monoxide poisoning, infectious diseases and hyper sensitivity pneumonitis.

y) The most dangerous ones to worker health are hydrogen sulphide (H₂S), carbon dioxide (CO₂), ammonia (NH₃) and methane (CH₄).
**Preventive measures**

- The poultry industry should be aware of the potential respiratory health effect of occupational exposure to bioaerosols and preventive measures to protect workers should be taken despite the present lack of well-defined legal limit levels concerning this biological hazard.
- Poultry farmer’s medical examinations revealed dependence off respiratory and pulmonary diseases, cardiovascular and nervous disorders on labor conditions.
- Methods to identify the contributions of non-viable microbes are required. These methods include the use of respirators by workers and spraying of canola oil to reduce dust exposure.

*Occupation concerned with the breeding, raising, gathering, and caring of domestic fowl and collecting their products:-*

- Removes chicks from shipping cartons and places them in brooder houses. Cleans and disinfects poultry houses, cages, and nests.
- Spreads bedding materials .Cleans droppings from floor. Fills feeders and water containers.
- Vaccinates via drinking water, injection, or dusting of air. Inspects poultry for diseases and removes weak, ill and dead poultry from flock.
- Sexes livestock. Candles, collects, inspects, and packs eggs; selects, weighs, and crates fryers and pullets; records total packed; and prepares breeding reports.
- Monitors feed, water, illumination, and ventilation systems. Cleans, adjusts, and replaces systems parts using hand tools.
➢ The physically difficult and handling heavy loads, uncomfortable postures and movements may cause traumas (including falls), back, arms and hands pains.

➢ Poultry inseminator; caponizer; poultry vaccinator; chicken sexer; poultry debeakers; poultry breeders; poultry hatchery worker; poultry tender and poultry abattoirs.

➢ Administering (vaccines, medicines); assisting; carrying; cleaning; collecting (eggs); disposing (waste); feeding; handling (birds); inspecting lifting; loading; maintaining; monitoring; packing; pulling/pushing; repairing; storing; transporting; watering. Crates; nebulizers (for vaccinating); fumigators; automatic feeding/watering devices; layer nests; hand tools (for repairing); heated trimmers (debeaking); incubators.

➢ Exposure to high noise levels particularly in confinement systems, heat exhaustion, heat-induced dermatosis, sun-induced dermatosis and cold exposure due to variable thermal conditions of year long outdoor work or high temperature/humidity in confined systems.

1.2-Kinds and sources of air pollutants emitted from poultry production facilities.

1.2.1-Common air pollutants

Gases in poultry confinements are produced by the bio-degradation of droppings, animal respiration and building operations. Exposure to several toxic and asphyxiating gases common especially in confinement systems including ammonia (NH3), released during microbial degradation of manure; carbon dioxide (CO2) from animal respiration, manure fermentation, and gas flame heaters; other gases include CO, H2S, CH4, SO2, and NOx (manure decomposition and fuel combustion).
Three air contaminants that may have serious health consequences to humans and poultry are ammonia, dust, and aerosolized bacteria. Common airborne contaminants in poultry barns include Respirable dust (RD), ammonia (NH₃) and carbon dioxide (CO₂). These contaminants at high enough levels can be objectionable to and adversely influence humans chronically exposed to them. The levels of RD 0.1-10μm were 1.28 and 1.44 mg/ m³; of ammonia were 14 and 26 and of CO₂ were 2360 and 3680 ppm in typical broiler and layer growing facilities respectively. Exposure to the confinement barn environment for chickens or turkeys can cause acute and chronic health problems mainly respiratory in the workers.

Respiratory disorders in exposed workers are, acute lower respiratory tract inflammation, asthma like syndrome, asthma chronic bronchitis, organic dust toxic syndrome, mucus membrane inflammation syndrome, hydrogen sulfide poisoning asphyxiation, carbon monoxide poisoning, infectious diseases and hyper sensitivity pneumonitis. The most dangerous ones to worker health are hydrogen sulphide (H₂S), carbon dioxide (CO₂), ammonia (NH₃) and methane (CH₄).

1.2.2 Gases and odors are produced from the metabolic processes of animals and from the anaerobic microbial degradation of wastes. Animal confinement gases, particularly ammonia and hydrogen sulfide, have been implicated as additional sources of respiratory irritants.

Among all the gases present in the ambient barn air, the most dangerous ones to worker health are hydrogen sulphide (H₂S), carbon dioxide (CO₂), ammonia (NH₃) and methane (CH₄).

Odors are indigenous to all livestock production operations. In modern production facilities, odors are generated primarily from the confinement buildings, from manure storage structures, from manure or
storage effluent applied to cropland, and from disposal of dead animals. Odors are the result of the generation of odorants from microbial degradation of a variety of chemical compounds in the litter.

Odor is defined by human olfactory perception of a mixture of chemical compounds in the atmosphere also known as odorants. The 4 principle classes of odorants are (1) branched and straight-chain volatile fatty acids (VFA), (2) ammonia and volatile amines, (3) indoles and phenols, and (4) volatile sulfur containing compounds. The VFA are an intermediate product in the anaerobic fermentation of biological wastes to methane (CH4). When conditions are such that an incomplete fermentation occurs, then VFA can be volatilized to the atmosphere.

Odors from broiler production facilities are the consequence of odorant molecules produced by microbial activity in the litter. Reported mean odor emission rates for 3 commercial operations in Ireland of 0.39, 0.58, and 0.66 OUE/s per bird (Odor Unit of Emission).

Odor concentration as measured by threshold olfactometry has been the primary method to quantify odors in poultry operations, although intensity, character, and hedonic tone are equally important criteria for public perception as well as frequency and duration of the odor. Odor plumes decrease exponentially with distance, but long distances are needed if no odors, gases, or dust are to be detected downwind from a source. Recommendations exist for separation distances of animal production facilities from residential developments and other public and private areas where people live and work. There is a nonlinear relationship between odor concentration and odor intensity, which compounds the difficulty in drawing conclusions about the effect of the odor on the public.
Because of the challenges and costs for sensory measurements, there have been some efforts to relate odor concentration to ammonia concentration or dust concentration but these have not been successful for broilers.

1.2.3- **Odour emissions** depend upon the animal species, the type of manure, dung handling and storage inside and outside the stable. The most common gases inside the animal houses are ammonia, hydrogen sulfide, carbon dioxide and methane.

**Emissions from animal production systems** originate from manure storage facilities, animal housing, and land application of manure. Feed production, processing centers, and silage storage. Many of the compounds emitted from animal production operations are byproduct of anaerobic decomposition of livestock and poultry wastes. Aerobic decomposing generally produces fewer odorous byproducts but can enhance volatilization of gaseous compounds.

**Factors affect emission of odors and gases**

- **Indoor climate elements**

  **Temperature and relative humidity** were participants of ammonia emission after generated from litter, where increased Ta .C° was positively correlated with increased RH% and litter moisture content, default drink system, leakage water pipes, accidental inadequate ventilation (fans rate, time off ), so it was difficult to disconnect all elements effect on ammonia production.

  **Emission rates** were higher during the warm weather due to higher ventilation rates. It varied diurnally, even when ventilation rates remained constant. This is due to variations in animal activity throughout the day.
**Ammonia emissions rates from both belt and high rise houses** varied widely both seasonally and diurnally.

The ammonia measurement trends inside of the facilities were affected by the temperature-dependent ventilation systems.

**Ammonia concentration** in the air of sliding door-type houses progressively increased during summer and winter sampling periods. **Highest ammonia concentrations** were evident during spring and summer at most sites of Delaware Inland Bays *when fertilizer application* and poultry house ventilation rates are greatest, and seasonally elevated temperatures induce increased rates of microbial activity and volatization from soil and animal wastes.

The ammonia immediate dangerous to life and health (IDLH) value (a US National Institute for Occupational Safety and Health parameter) is 300ppm, representing the maximum concentration of ammonia one can withstand for 30 minutes.

**b- Kind of housing, production, management**

**Ammonia emission rates for laying hens** were lower from housing using manure belt manure handling systems than from high rise houses, which use deep pits. The average ammonia emission rates from the belt houses and high rise houses were 0.14 and 1.1 g NH₃/d-hen (0.00032 and 0.0023 lb/d-hen), respectively. Although ammonia emission rates from the belt houses were much lower than those from high rise houses, it is important to note that the ammonia emissions from the belt house were merely “transferred” to either an open storage shed or to cropland to which the manure was applied.
For broiler housing, ammonia emission rates were higher from houses that reused litter for several flocks than from houses that used new litter for each new flock. Emission rates varied greatly between broiler houses at the same site. Studies evaluating different facilities and ventilation systems for the production of poultry (ducks, turkeys, breeders and broiler chickens), found a direct correlation between high rates of emission of ammonia and odors (OR, Odour Unit or Unit of Odor) in production of ducks (376 OR / LU and 40.6 g / h.LU) and turkey (138 OR / LU and 11.3 g / h.LU), in naturally ventilated facilities with high currents of air. For broilers, were found averages of 3.1 g / h.LU, of ammonia and 79 OR / Lu to smell with measurements of short duration, and the emission of ammonia has grown rapidly in the final stages of production when the mass of animal and the amount of manure produced increases.

The odour emission rate of manure (layer) was found to increase above 55%-moisture level while the odour emission rates of the litter (turkey and broiler) decreased with the increasing moisture level. The building odour emission rates are 0.90 ± 0.36, 0.44 ± 0.12, 0.60 ± 0.33 and 0.56 ± 0.23 OU/s/bird for turkey, broiler and broiler breeder and layer, respectively. The measured ammonia emission rates are 102 ± 44, 50 ± 7, 90 ± 26, and 15 ± 13 mg/h/bird turkey, broiler and broiler breeder and layer, respectively.

Ammonia levels were found to be particularly high during tilling of the confinement house when concentrations greater than 100 ppm were reached. The average outside ammonia concentration measurements decreased as the distance from the facility increased from 10 to 40 ft. The
measurements at 10 ft from the facilities were consistently higher than the average concentrations inside the facilities.

**The oxidation of SO2 at 3ppm concentration** is controlled by the quantity of particulate present in the atmosphere and humidity, resulting in the prevalence of multiple mechanisms for the formation of sulfate.

**c- Diet and layer age influence air emissions** from poultry operations where average daily egg production (81%), were unaffected by diet (P>0.05) over the study period (38-59 weeks old). **Age effects** were observed for all performance variables and NH3 emissions (P<0.05). **Daily ammonia emissions** from hens fed regular diets were less than emissions from hens fed commercial diet (P < 0.01). Ammonia emission rates from high rise layer houses in which flocks were fed two different diets: 1) a standard diet; and, 2) a low protein diet. Average ammonia emission rates from the houses in which flocks were **fed the low protein diet** were slightly lower (0.99 g/d-hen or 0.0022 lb/d- 4 hen) than the rates from the houses in which the **standard diet** was fed (1.1 g/d-hen or 0.0023 lb/d-hen). Emission rates from high rise houses were slightly lower from flocks fed a reduced protein diet than from houses where flocks were fed a standard diet.

**1.2.4. Emitted gases:**

**Ammonia, methane, and carbon dioxide** are considered contributors to global climate change and acid rain. It is estimated that one third of methane produced each year comes from agriculture, primarily animals and manure storage units.

**Ammonia is an odorant,** and conditions conducive to the production of ammonia may result in the emission of other odorants. **Ammonia** has characteristic strong odor makes it easily detectable as soon as levels reach 5 to 10 ppm.
The carbon dioxide concentrations which occur in poultry cannot be considered as the cause of any negative health effects. Carbon dioxide is present in all types of animal houses. This gas emanates from the animals respiration and microbial processes in the manure. Carbon dioxide levels increased above 1500 ppm are associated with a higher risk of respiratory disease in workers because of an association with elevated concentrations of other toxic substances in the air. Carbon dioxide and water are the primary by-products of respiration of every living animal.

Methane is not directly toxic to human, but it displaces oxygen and thus can contribute to asphyxiation of workers who enter the waste pit. It also is a potential fire hazard. Methane levels encountered in livestock operations are not normally a health hazard. Atmospheric emissions of methane are of concern because of their potential contribution to global warming; there is much interest in quantifying emissions from a variety of industrial, biological and agricultural sources.

The breakdown of sulphide containing compounds produces hydrogen sulphide, mercaptans and organic sulphide. It represent Human respiratory hazards in poultry houses. It included within other hazards, which is the greatest concern with deep pit manure storage systems such as carbon dioxide; carbon monoxide; dust bioaerosols; including bacteria, fungi, mold, virus, or fragments of these organisms, and dust, fumes or vapors associated with pesticides, disinfectants, and litter treatments.

Hydrogen sulphide is the most dangerous gas produced by the manure. Its odor is easy to detect even at very low levels. Normally, there is very little hydrogen sulphide inside livestock barns. In-barn manure agitation can
release large amounts of H2S which can be very dangerous. **Daily emissions of H2S** from hens fed the RE diet were 4.08 mg/bird compared with 1.32 mg/bird from hens fed CM diet (P < 0.01). Diet (P<0.05) and age (P<0.05) affected emissions of CO2 and CH4. A diet effect (P < 0.01) on NO emissions was observed. No diet or age effects (P >0.05) were observed for NO2 or non-CH4 total hydrocarbons.

**Sulphate particulates**, a major constituent of **urban aerosols**, one of which a size-dependent physiological effect had been found. Values of mass median diameter (MMD) i.e for equivalent spheres of unit density, hat averaged 0.3-0.4μ and varied according to location. Average **sulfate concentrations** were higher at the urban sites than at the suburban Fairfax location.

**1.2.5 The impact of odor on the public can be evaluated** by the frequency, intensity, duration, and offensiveness of the odors. Values for odor concentration in or near broiler production facilities, ranging from 80 to 2,000 odor units, and some researchers have reported odor emission rates.

The relationship between odor concentration and odor intensity is important to establishing the effect of the odor on the public and in determining effective abatement strategies. Odorous molecules (odorants) are adsorbed on particle surfaces and then desorbed in large local concentration in the nasal epithelium, where the olfactory nerve cells are located.

**The occupational threshold level for ammonia** during an eight-hour day is generally recognized as 25 ppm; for short-time exposure (15 minutes), the threshold is 35ppm. As ammonia concentration of 300 ppm is immediately dangerous to life, and greater than 2500 ppm can prove lethal. An increase
in susceptibility of respiratory system to airborne pathogens when combined with **ammonia concentration** below the occupational exposure limit of 25 ppm. As little as 4 ppm of ammonia may cause eye irritation and as 25 ppm, mild tissue irritation in some individuals. High levels of ammonia, between 20 and 50 ppm, irritate the eyes, nose and throat. Workers in floor-housed poultry operations had significantly greater exposures to **ammonia**, whereas workers from cage-housed poultry operations reported greater frequency of current and chronic symptoms overall and chronic phlegm. Because poultry growers are exposed to multiple respiratory hazards, it is sometimes difficult to single out the individual consequences of ammonia on human health. As little as 4 ppm of ammonia may cause eye irritation and as 25ppm, mild tissue irritation in some individuals.

Exposure to ammonia concentration of 50ppm for 180 minutes will produce almost the same health hazard effects that the IDLH value of 300ppm for 30 minutes NH3 will produce for 30 min. These values of ammonia concentrations are dangerous to health, especially in poultry confinements with manure accumulating in pits where values as high as 72 – 103 ppm NH3 were obtained. Ammonia is a water-soluble, toxic and irritant gas. **The hazards effect of generated ammonia gas from litter** of broiler habitats and emitted across air, on both birds and workers, increases the surrounding environmental problems as acid rain and fertilizing nitrogen loss in surrounding soil and water. **Ammonia concentration, thermal and humid conditions** in the building can influence the state of health of workers and animals, as well as the durability of building materials. **The atmospheric nitrogen compounds** emitted from livestock operations act as precursors to the formation of **secondary particulate matter (PM)**. For broiler, roaster, turkey and laying hen operations, the average number
of *dust particles* is generally below 100,000 particles/liter (1 mg/m3). Peaks of dust are always measured during feeding time when all the birds are very active.

*A potential health hazard can occur if too much carbon dioxide* is present in the barn. During the winter (outside temperature between (13-16 C), the maximum exposure level of 5000 ppm for carbon dioxide was exceeded in 24% of the barns studied. High levels exceeding the 5000 ppm of carbon dioxide are often found during winter in broiler barns. *Carbon dioxide levels* in ambient air of barns usually do not exceed the TLV of 5000 ppm unless there is a failure of the mechanical ventilation system.

*A potential health hazard of hydrogen sulphide* at high concentration levels, when overcomes the sense of smell, so workers do not smell this gas after a short period of exposure. Consequently, the pulmonary system of the victim is paralyzed and rapid death occurs. *Human respiratory hazards* in poultry houses are due to *hydrogen sulphide*, which is the greatest concern with *deep pit manure storage systems*; carbon dioxide; carbon monoxide; dust bioaerosols; including bacteria, fungi, mold, virus, or fragments of these organisms, and dust, fumes or vapors associated with pesticides, disinfectants, and litter treatments. Because poultry growers are exposed to multiple respiratory hazards, it is sometimes difficult to single out the individual consequences of ammonia on human health. *The current recommendations* for continuous exposure of animals (not humans) are 20 ppm. for ammonia, 3000 ppm for carbon dioxide, 3.4 mg/m3 for inhalable and 1.7 mg/m3 for respirable non-specific dust.
1.2.5- Standards levels of gases and odors Emission rate:

Table 1 U.S. and European emission factors for layer hens and broilers. Animal and Housing Type.

<table>
<thead>
<tr>
<th>Animal and Housing Type</th>
<th>U.S. Emission Factor (g/hen)</th>
<th>European Emission Factor (g/hen)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layers, belt houses</td>
<td>53 (0.12 lb/hen)(^a)</td>
<td>34 (0.075 lb/hen)(^c)</td>
</tr>
<tr>
<td>Layers, high rise houses</td>
<td>385 (0.85 lb/hen)(^a)</td>
<td>386 (0.86 lb/hen)(^c)</td>
</tr>
<tr>
<td>Broilers, litter</td>
<td>0 - 336 (0 - 0.74 lb/bird)(^b)</td>
<td>78 - 174 (0.17 - 0.38 lb/bird)(^c)</td>
</tr>
</tbody>
</table>

\(^a\) Liang et al, 2003. \(^b\) Wheeler et al., 2003. \(^c\) Groot Koerkamp et al., 1998.
<table>
<thead>
<tr>
<th>Reported odour and NH3 ER data.</th>
<th>Odour emission rate (OU/s/bird)</th>
<th>NH$_3$ emission rate (mg/h/bird)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turkey</td>
<td>0.320</td>
<td>155</td>
<td>Gay (2003)</td>
</tr>
<tr>
<td>Broiler</td>
<td>0.49</td>
<td>44</td>
<td>Casey et al (2004).</td>
</tr>
<tr>
<td></td>
<td>0.16</td>
<td></td>
<td>Ogink (2001).</td>
</tr>
<tr>
<td></td>
<td>0.45</td>
<td></td>
<td>Gay (2003).</td>
</tr>
<tr>
<td>Layers</td>
<td>0.43</td>
<td></td>
<td>Hayes et al (2003).</td>
</tr>
<tr>
<td></td>
<td>0.35</td>
<td></td>
<td>Ogink (2001).</td>
</tr>
<tr>
<td>Broiler breeder</td>
<td>0.53</td>
<td></td>
<td>Ogink (2001)</td>
</tr>
</tbody>
</table>

Table 3. Common air pollutants in poultry houses.

<table>
<thead>
<tr>
<th>Type of pollutant</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gases</td>
<td>Ammonia, hydrogen sulphide, carbon monoxide, carbon dioxide, 136 trace gases, osmogens</td>
</tr>
<tr>
<td>Bacteria/fungi</td>
<td>100 to 1 000 colony-forming units (CFU) / litre air 80 percent staphylococcaceae/streptococcaceae</td>
</tr>
<tr>
<td>Dust</td>
<td>Inhalable dust can reach levels of 10 mg/m³; approximately 90% is organic matter; particles can carry antibiotic residues</td>
</tr>
<tr>
<td>Endotoxin</td>
<td>339 to 860 ng/m³ inhalable endotoxin in poultry houses</td>
</tr>
</tbody>
</table>

Hartung and Schulz (2008).

1.2.6- Aerosols, bioaerosols, viable airborne particles and endotoxins

An aerosol is a dispersion of microscopic solid and liquid particles suspended in the air. It includes airborne dust, microorganisms, spores, feed, bits of feathers, dead skin cells, dried feces and water droplets. Aerosols interact with moisture in the air.

The pollutants effects of aerosol constituents are a function of concentration and particle size, which determines visibility reduction and degree of penetration and retention in lungs.
The effects of inhaled aerosols on the respiratory tract may include:

1) interference with mucus production and destruction of the ciliated epithelium of the trachea as occur with elevated concentration of ammonia, 2) binding, replication, and invasion of the epithelial cells as seen with certain bacterial invasion, 3) germination and invasion of tissue as occur with Aspergillus organisms, 4) phagocytosis by macrophages as occur with most pathogens and inert particles, and 5) elicitation of allergic responses.

**B- Bioaerosol levels** increased significantly during the fattening period of the chickens. During the task of catching mature birds, the mean inhalable dust concentration for a worker was 26 ± 1.9 mg m⁻³ and endotoxin concentration was 6198 ± 2.3 EU m⁻³ air, >6-fold higher than the Swiss occupational recommended value (1000 EU m⁻³). The mean exposure level of bird catchers to total bacteria and *Staphylococcus* species measured by Q-PCR is also very high, respectively, reaching values of 53 (±2.6) x 10⁷ cells m⁻³ air and 62 (±1.9) x 10⁶ m⁻³ air.

**Usually microorganisms and endotoxins** (lipopolysaccharides, LPS) are associated with dust particles and present a biologically active aerosol (bioaerosol). **Airborne microorganisms** appeared regularly in livestock houses as part of settled dust and its quantity depend on air flow and equipment motility. Both animals and their keepers affecting negatively by the bioaerosols. The airborne microbial concentration did not depend on indoor climatic conditions only but also on the workers and animal keepers activity or animal activities.
The viable airborne particle concentration was influenced by:-

The cleaning regime \((p = 0.067)\), ventilation type \((p = 0.006)\), age of buildings \((p = 0.006)\), bedding type \((p = 0.075)\) and temperature \((p = 0.002)\). The type of ventilation \((p = 0.008)\), bedding \((p = 0.045)\), temperature \((p = 0.023)\) and building age \((p = 0.04)\) had significant effects on inhalable particle concentrations.

The concentrations of airborne microorganisms in livestock buildings are between some 100 and several 1000 per liter. Staphylococcae, streptococcae, coli like bacteria, fungi, moulds and yeasts are regularly found. The highest bacteria concentrations were detected in broiler houses. Air average concentrations for broiler 6.43 log CFU per m³ during the day and night while in laying hens (average 4 and 5 log CFU per m³). For broiler and laying hens higher bacteria concentration recorded during day Vs. night as well Enterobacteriaceae (during day average 3 and nearly 4 log CFU per m³) with the exception of layers.

The emission rates of Enterobacteriaceae were much lower. Layers had the highest emission rate of 7.1 log CFU per h and 500 kg.

For fungi the range of emission rates was from 7.7 log CFU per h and 500 kg for broilers to 5.8 log CFU per hour.

The highest concentrations of dust, ammonia, and Aspergillum occurred during the winter months when dust levels averaged 9.3 mg/m³ and ammonia levels averaged 35 ppm. Aspergillus levels were lower than expected, never exceeding 73 cfu / m³. Fungal spores, bacteria, endotoxins and mycotoxins, dust and food grains, inorganic and organic dust were included in poultry environment. Numbers of airborne particles are affected by the husbandry system used, in particular the method of feeding and the type of floor.
Although there are many bioaerosols in the poultry barn environment, endotoxin is typically attributed with the negative respiratory symptoms observed in workers. These adverse respiratory symptoms have a higher prevalence in poultry workers compared to workers from other animal confinement buildings. Farmer's health may be harmed by regular daily exposure to heavy burdens of aerial endotoxins, which arise from Lipopolysaccharides membrane fragments of gram-negative bacteria, non-specific nuisance dusts and irritant gases, particularly ammonia, at doses that approach and may exceed current long term occupational exposure limits (8-h time-weighted averages).

D- Endotoxins derived from different species of Gram-negative bacteria differ in their toxicity. These endotoxins are generally strong allergens causing immediate or delayed reactions in the respiratory system.

Endotoxin main health problems with poultry workers occurred while moving or handling older birds; these symptoms could be attributed to exposure to the combined effects of dust, ammonia and endotoxins in animal housing, 70 to 90% of the dust is organic. This means that it is biologically active and will react with the defense system of the respiratory system, included in the organic barn dust are feed components, dried faecal material, hair and skin cells, feather particles, pollen, insect parts, molds, fungi, viruses and bacteria.

Exposure to endotoxin causes episodic febrile reactions. Toxin fever generally occurs in the afternoon or evening of a working day. Symptoms of toxin fever include: headache, nausea, coughing, nasal irritation, chest
tightness and phlegm. The minimum level of endotoxin required to produce a fever reaction in humans is 0.5 μg/m³ following a four-hour exposure period. Inhalation of endotoxin can cause many physiological airway responses including airflow obstruction, enhanced airway hyper reactivity and a reduction in alveolar diffusion capacity. Broncho alveolar lavage (BAL) fluid following endotoxin instillation shows increased numbers of macrophages and neutrophils along with increased concentrations of interleukin-6 (IL-6), IL-8, IL-1β, and tumor necrosis factor (TNF-α). Endotoxin levels are also typically higher for cage-housed versus floor-housed operations. Endotoxin concentration of respirable dust, 20 to 40 ng/mg, is considerably higher than endotoxin concentration of total dust, 6 to 16 ng/mg, suggesting that endotoxin is enriched in smaller particle. Endotoxin results show that its concentration in parent stock barns in winter is more than the other barns.

**The concentrations of endotoxins in the airborne dust** can range from 0.6 ng/m³ (cattle, respirable dust) to 860 ng/m³ (laying hens, inspirable dust). The presently discussed occupational health threshold at the workplace is around 5 ng/m³ (50 EU/m³).

**Inhalable Endotoxins** (ET) concentration ranged between 52.3 and 186.5 ng m⁻³ with related respirable ET concentrations of between 7.4 and 18.9 ng m⁻³. Concentrations were highest for poultry; mean values ranged between 338.9 and 860.4 ng ET m⁻³ air in inhalable dust fractions and from 9.6 to 58.1 ng ET m⁻³ air in respirable dust. The overall percentage of the (respirable dust / inhalable dust (RD/ID) ratio differed between species, ie.
8.6% for cattle, 8.8% for pigs and 5.7% for poultry. For the RN/IN ratio, values of 13.9, 12.2 and 9.0% were calculated, respectively.

**Greater endotoxin concentration** in the presence of significantly lower total dust, in conjunction with greater respiratory symptoms in workers from cage-housed poultry operations, as compared with workers from floor-housed poultry operations, appears to indicate that differences in environmental exposures may impact respiratory outcomes of workers.

**Lack of sufficient ventilation in the cold season** cause the concentration of endotoxin in the air to rise. The amount of endotoxin in total dust and respirable samples are 2.1 and 2.4 TLV, respectively. In other words, endotoxin extracted from respirable dust is approximately 1.2 times more than its amount in total dust samples. This shows that endotoxin largely sticks to the fine particles. The workers of poultry farming are exposed to incidences of systematic symptoms and respiratory diseases due to endotoxin. Since there are a combination of dust, ammonia and endotoxin, they could have significant effects on pulmonary functions.

**1.2.7- Airborne Dust is airborne emission concern from animal operations.**

Livestock housing is an important source of emissions of particulate matter (PM). High concentrations of PM can threaten the environment, as well as the health and welfare of humans and animals. Particulate matter in livestock houses is mainly coarse, primary in origin, and organic; it can
absorb and contain gases, odorous compounds, and micro-organisms, which can enhance its biological effect.

**Poultry farm dust contamination** was found to contain higher concentrations of particulate matter (PM) PM5 and PM10. Prevalence rate of obstructive pulmonary disorders (OPD) was higher in individuals with longer exposure regardless of smoking status. A high prevalence for asthmatic (42.5%) and nasal (51.1%) symptoms was noted in poultry workers.

**Levels of PM in livestock houses** are high, influenced by kind of housing and feeding, animal type, and environmental factors. Improved knowledge on particle morphology, primarily size, composition, levels, and the factors influencing these can be useful to identify and quantify sources of PM more accurately, to evaluate their effects, and to propose adequate abatement strategies in livestock houses.

Pathogens typically do not aerosolize but can be transported by dust particles. Dispersion of airborne emissions from an animal production facility is difficult to predict and is affected by many factors, including topography, prevailing winds, and building orientation.

**High concentrations of airborne particles** in poultry building can affect the environmental sustainability of the operation, production efficiency, and the health and welfare of the birds.

**The major hazardous factors of labor conditions** in modern poultry farms are presented by *dust mixtures* including both vegetable and organic substances, biologically active substances and microorganisms, gaseous products as well as unfavorable microclimate conditions and physical overload.
Dust is generated primarily from the feed and by animal activity and air movement causing re-entrainment of settled dust. Dust in houses for poultry originates from the animals themselves, faecal matter, litter, etc. Factors which affect the dust conditions in the buildings are mainly activity, density of animals and moisture conditions. Fecal matter was found to be the main constituent of airborne dust in turkey barns.

Air-borne dust concentrations of respirable size (>10μm) at breathing zone of poultry and feed mill working environments, were found to be much higher than the human indoor control. Values in the range of 0.27-1.60mg/m³ and 0.78-3.56mg/m³ were obtained in pens with birds in battery cages and with bids on deep litters, respectively. Significantly higher air borne dust concentrations were recorded during the dry season than the raining season (t = 2.838, P = 0.047). Air concentration of ammonia at breathing zone in poultry confinements were found in the range of 24 - 103 (52.5 + 23.56) parts per million.

The aerodynamic properties of airborne dust and fecal material were found to be similar with Anderson air sampler, and morphological characteristics were also similar when studied by Scanning Electron Microscope (SEM). Results of protein analysis and particle size distribution of ground fecal material and dust were also similar.

Particles in air are affected by a variety of forces (e.g, aerodynamic, gravity, buoyancy) and undergo turbulent coagulation, turbulent diffusive deposition, and gravitational sedimentation. Modern poultry facilities are highly contaminated with airborne dust. Dust is not uniformly distributed within a livestock building, and its behavior depends on the type and
location of dust sources, airflow characteristics, levels and distribution of animal activities.

**The particle size** range with the largest percentage of deposition in the lungs is 1–2 μm in aerodynamic diameter. *Respirable dust* accounts for ~18% of total dust mass.

**Dust particle concentrations** reached a maximum of 44 particles/ml in the Respirable range towards the end of the growth cycle and less than 5% of the airborne particles were of non-fecal origin. The SEM was found to be more superior to the light microscope in positively identifying particles.

**Organic dusts** in livestock buildings comprise grain and other plant-derived particles, animal hair, urine, faeces, microorganisms and other particles may carry hazardous material such as pathogenic bacteria, viruses, endotoxins.

For broiler, roaster, turkey and laying hen operations, the average number of **dust particles** is generally below 100,000 particles/litre (1 mg/m3). Peaks of dust are always measured during feeding time when all the birds are very active.

The **Chemical Composition of Organic Particulate** (CCOP) showed higher silicon oxide (SIO) % Vs Inorganic Particulate (IP). The indoor organic and inorganic particulates (IOP and IIP) were of big sizes and contained variable percents of non organic oxides of Si+4, AL+3 and Ca+2. IP was smaller than OP at early age but increased with age and contained variable percents of SI, Fe and Ca oxides. The dominancy of IOP and OOP with large sizes before admission baby chicks to 3rd week old may induce health risk for birds and keepers. Improper controlled system in stocked poultry houses and the outdoor climate positively affected the indoor one especially in winter.
The inorganic dust is composed of numerous aerosols originating from such building sources as concrete, mineral or fiberglass insulation, or material, such as soil particles, drawn into the barn by the fresh air supply. The threshold inorganic dust is 10 mg/m² and 5 mg/m³ for organic dust. Particles greater than 30μ tends to settle out of the air in minutes and accumulate on surfaces.

Mass medium diameter (MMD) of TSP increased with bird age. The mass fraction of PM₁₀ in the TSP samples was between 2.72 % and 8.40 % with a mean of 5.94%. Ongoing research has implicated bacterial endotoxins, fungal spores, and the inherent toxicity of grain dusts as causes of upper and lower airway inflammation and as immunologic agents in both grain and animal production.

Factors affecting emission rate of dust particles

Respirable particle concentrations in broiler buildings were affected by:–

1. Cleaning or not cleaning between batches of birds (p = 0.055), biological loading (kg birds per building airspace) of buildings (p = 0.008), ventilation levels (p = 0.005) and humidity (p = 0.016). The positive effects of cleaning and tunnel ventilation were clearly identified and the fact that older buildings appear to have reduced airborne particle concentrations is also noteworthy.

2. An improvement in air quality within poultry buildings should enhance production efficiency, the health of birds.

3. Live weight of poultry, respirable dust from poultry houses nearly 300 mg/h related to 500 kg.
4. **Ventilation** (natural or extremely high ventilation rates) buildings, dust levels drop. Adjustment of relative humidity to 75% will have an effect on inhalable dust (the fraction that is below 20 μm), but not on respirable dust (the fraction below 5 μm). Less ventilated buildings have high relative humidity and lower dust aerosolization than highly ventilated buildings.

5. **Height above the floor, dust concentrations** decrease in direct proportion to height above the floor, so that floor-reared birds are living in the dirtiest section of the environment. **Average dust concentrations** inside the facilities were consistently below 2 mg/m³. **Dust concentrations** in poultry houses vary from 0.02-81.33 mg/m³ for inhalable dust and from 0.01 -6.5 mg/m³ for Respirable dust.

6. **Houses with caged laying hens** showed the lowest dust concentrations i.e.; percheries and aviary systems, were often four to five times higher.

7. **Animal category**, animal activity, bedding materials and season. The most important sources of dust seem to be the animals and their excrements.

8. **The kind of building ventilation design** affected the indoor airspeed, temperature, relative humidity, gases, particle number, size and mass/ m³ of air; and colonies of bacteria, yeast, and other fungi in litter and feed.

9. In winter, **the total mass of particulate matter**, PM /m³ of air was higher in curtain-type houses Vs sliding door-type houses.

**Hazard risk of airborne Dust**

- **The health effects of dust particles** depend very much on the nature of the dust (organic, not organic), the compounds the particles are carrying (bacteria, toxins) and the diameter of the particles.

- Particles with aerodynamic diameters smaller than 5 μm can penetrate deep into the lung. The larger particles are deposited in the upper airways.
✓ High dust concentrations can irritate the mucous membranes and overload the lung clearance mechanisms. Together with the dust particles microorganisms can be transported into the respiratory system causing infections.

✓ Endotoxins can trigger allergic reactions in the airways of susceptible humans, even in low concentrations.

✓ Particles of all sizes may be deposited in the nose and pharyngeal region. Only particles with an aerodynamic diameter of less than 15 μm can enter the tracheobronchial tree and only particles with an aerodynamic diameter of less than 7 μm can enter the alveoli. Approximately 50% of particles less than 5 μm aerodynamic diameter entering the respiratory system will reach the alveoli.

✓ The fraction of dust including particles less than 5 μm aerodynamic diameter is the respirable fraction. Particles smaller than 0.5 μm in mean aerodynamic diameter are respirable, but it is more likely that they are exhaled and not deposited in the lungs.

✓ Dust particles may carry ammonia in a concentrated form into the respiratory system. Deposition of inhaled particles in the respiratory system is a function of the size of particles. In chickens larger particles (3.7-7μm) are captured in the upper respiratory tract while smaller particles (0.091-11 μm) are deposited uniformly throughout the remainder of the respiratory system.

✓ An increased ventilation rate will not necessarily reduce overall dust concentrations since the dust production rate increases with increased ventilation.

✓ Dust levels ranging from 1.9-7.6 mg/m³ have been reported to adsorb ammonia, allowing the ammonia to travel deep into the respiratory tract, and 5-50% are in the Respirable range.
✓ **In poultry houses** the highest inspirable resp. respirable dust concentrations (up to 10 mg/m³ resp. 1.2 mg/m³) were found. The main health problems with poultry workers occurred while moving or handling older birds; these symptoms could be attributed to exposure to the combined effects of dust, ammonia and endotoxins.

**1.2.8- Exposure to chemicals**

- **Disinfectants, detergents**, formaldehyde, ammonia solutions, sodium carbonate and sodium hypochlorite. **Formaldehyde**, a suspect carcinogen, is often used as a disinfectant in hatcheries and brooder houses.

- **Repeated exposure to low-level formaldehyde (FA)** increases the production of nerve growth factor, involving the survival and maintenance of neurons, in the hippocampus of immunized mice. The changes in the Bcl-2/Bax expression ratio, which occurs with low-level FA exposure and immunization and may follow enhancement of nerve growth factor production, exerts a protective effect against cell death by apoptosis.

- **An increased risk of mesothelioma** has consistently been detected among individuals experiencing residential exposure to **asbestos**, whereas results for lung cancer are less consistent. At least 14 good-quality studies have investigated lung cancer risk from outdoor air pollution based on measurement of specific agents. Their results tend to show an increased risk in the categories at highest exposure, with relative risks in the range 1.5–2.0, which is not attributable to confounders. Results for other cancers are sparse.
➢ A causal association has been established between exposure to environmental tobacco smoke and lung cancer, with a relative risk in the order of 1.2.

➢ Radon is another carcinogen present in indoor air which may be responsible for 1% of all lung cancers. In several Asian populations, an increased risk of lung cancer is present in women from indoor pollution from cooking and heating.

➢ The industrial agricultural system in the USA has consequences for public health owing to its extensive use of fertilizers and pesticides, unsustainable use of resources and environmental pollution.

➢ In industrial animal production there are public health concerns surrounding feed formulations that include animal tissues, arsenic and antibiotics as well as occupational health risks and risks for nearby communities. It is of paramount importance for public health professionals to become aware of and involved in how our food is produced.

➢ Women who reported agricultural pesticide exposure (mixing or applying pesticides to crops or repairing pesticide application equipment) during pregnancy were more likely to report GDM (odds ratio [OR] 2.2 [95% CI 1.5-3.3]). No association between residential pesticide exposure (applying pesticides in the home and garden during pregnancy) and GDM (1.0 [0.8-1.3]). Among women who reported agricultural exposure during pregnancy, risk of GDM was associated with ever-use of four herbicides (2,4,5-T; 2,4,5-TP; atrazine; or butylate) and three insecticides (diazinon, phorate, or carbofuran). These findings suggest that activities involving exposure to
agricultural pesticides during the first trimester of pregnancy may increase the risk of GDM.

➢ **Children encounter pesticide products and their residues** where they live and play in the food supply. Pesticide exposure affects pediatric health both acutely and chronically; effects range from mild and subtle to severe. Pediatricians play an important role in identifying and reducing significant pesticide exposure in their patients by taking an exposure history to clarify the extent and types of exposures that may have occurred during acute care and preventive care visits. Developing knowledge about the toxicity of various chemicals, identifying reliable resources for pesticide information, and providing a common-sense approach toward recommending the safest practical alternatives is necessary.

➢ **Chlorpyrifos is one of the most widely used organophosphate insecticides** in the United States. Although the toxicity of chlorpyrifos has been extensively studied in animals, the epidemiologic data are limited. Examined deaths among pesticide applicators in the Agricultural Health Study, a prospective study of licensed pesticide applicators in Iowa and North Carolina. Lifetime chlorpyrifos use was divided into tertiles. Poisson regression analysis was used to evaluate the exposure-response relationships between chlorpyrifos use and causes of death after adjustment for potential confounders. A total of 1,851 deaths (588 among chlorpyrifos users) were observed during the study period, 1993-2001. The relative risk (RR) of death from all causes combined among applicators exposed to chlorpyrifos was slightly lower than that for non exposed applicators (RR = 0.90; 95% confidence interval, 0.81-1.01). For most causes of death analyzed, there was no evidence of an exposure-response relationship. The findings of a
possible association between chlorpyrifos use and external causes of death were based on small numbers. The findings may reflect a link between chlorpyrifos and depression or other neurobehavioral symptoms that deserves further evaluation. Exposure to high levels of many pesticides has both acute and long-term neurologic consequences, but little is known about the neurotoxicity of chronic exposure to moderate pesticide levels. Applicators provided information on lifetime pesticide use, and 23 neurologic symptoms typically associated with pesticide intoxication. Increased risk of experiencing \( \geq 10 \) symptoms during the year before enrollment was associated with cumulative pesticide use, personally mixing or applying pesticides, pesticide-related medical care, diagnosed pesticide poisoning, and events involving high personal pesticide exposure.

- **Greatest risk was associated with use of organophosphate and organochlorine insecticides.** Use of pesticide application methods likely to involve high personal exposure was associated with greater risk. Groups of symptoms reflecting several neurologic domains, including affect, cognition, autonomic and motor function, and vision, were also associated with pesticide exposure. The neurologic symptoms are associated with cumulative exposure to moderate levels of organophosphate and organochlorine insecticides, regardless of recent exposure or history of poisoning. Evidence suggests that p,p' - dichlorodiphenyldichloro-ethene (DDE) affects neuro-development in infants, although a critical exposure window has not yet been identified. The prenatal DDE exposure window and its effect on the psychomotor development index (PDI) and mental development index (MDI) during the first year of life. 244 children whose pregnancies and deliveries were uncomplicated, and whose mothers were monitored throughout the pregnancy. Participating mothers were not
occupationally exposed to DDT (dichlorodiphenyltrichloroethane) but were residents of a zone in Mexico with endemic malaria. We adjusted for quality of the home environment and maternal intellectual coefficient (IQ). We used generalized mixed-effects models for statistical analysis. Third-trimester DDE level (7.8 +/- 2.8 ppb) was significantly higher than the level at baseline, first, and second trimesters, but the differences never exceeded 20%. A critical window of exposure to DDE in utero may be the first trimester of the pregnancy, and psychomotor development is a target of this compound. Residues of DDT metabolites may present a risk of developmental delay for years after termination of DDT use.

- **Residues of harmful substances** in poultry products might constitute a threat to human Welfare. The presence of residues of antibiotics and antibacterials, hormones, beta-agonists, anticoccidials, pesticides, anthelmintics, needs to be controlled through detection by laboratory analyses followed by appropriate legislative measures. This will aid in preventing related health hazards and also overcoming problems in marketing.

- **The antibiotics fed to chickens** stimulate the evolution of antibiotic-resistant pathogens within the birds. These pathogens remain in the flesh and can be contracted by humans through contact with the blood or the uncooked meat. In a recent survey published by the *New England Journal of Medicine*, researchers found 13 different strains of salmonella in samples of ground chicken, beef, turkey, and pork taken from supermarkets in the United States. Of those strains of salmonella, 83 percent were resistant to at least one antibiotic and 53 percent were resistant to three or more antibiotics; 6 percent of the bacteria were specifically resistant to the
antibiotic which is the treatment of choice for children with salmonella poisoning.

🌳 Chicken flesh must be cooked in order to be edible to humans. The process of cooking chicken flesh leads to the formation of heterocyclic aromatic amines in the meat. These are cancer-causing compounds and have long been known to be one of the reasons consumption of meat is linked to cancer. A recent report from the U.S. National Cancer Institute reveals that oven-broiled, pan-fried, or grilled chicken flesh actually contains more of these carcinogens than red meat. The longer the meat is cooked, the larger the load of carcinogens in the meat. Grilled chicken contains 480 nanograms per gram of the carcinogen PhIP. PhIP is suspected as a cause of both breast and colon cancer.

1.2.9 Exposure to sources of infections

- **Poultry meat and eggs may act as potential sources of food poisoning,** primarily because of Salmonella infections. Poultry products improper storage leads to microbial spoilage and consequent food poisoning. Immediately after laying, the eggs are almost sterile but can be contaminated by the environment within a matter of hours. Initial infection of the eggshell and a gradual penetration through the pores of the shell can lead to contamination.

- **Poultry meat is infected** from its body system because of diseases, contamination of the carcass with gut contents, unhygienic conditions prevailing in the slaughter-houses and retailing units, long hours of exposure in an open environment at room temperature during display, and improper cold-storage conditions.
• **Vector-borne diseases** are a global problem—a trend that may only increase if global temperature rises and demographic trends continue—and their economic and social impact are enormous.

• **Insecticides** play a vital role in the fight against these diseases by controlling the vectors themselves in order to improve public health; however, resistance to commonly used insecticides is on the rise. The development of novel insecticide classes for control of adult mosquitoes and other vectors becomes increasingly important.

• In addition, there are agricultural workers whose work brings them into contact with fertilizers derived from chicken manure and— at the other end of the food chain—hotel, restaurant and catering workers who handle uncooked chicken products. Since eggs seem to be a surface most likely to retain traces of feces (mainly dust), all those workers handling, cleaning and processing eggs must be added to the list of jobs involving occupational exposure to the **H5N1 virus**.

• In terms of the occupational hazards posed by the **H5N1 virus**, workers must be concerned not only with direct contact with the blood, bodily fluids or feces of infected birds, but also any surfaces or dust that could be contaminated. In addition to workers who handle live poultry, clean poultry houses/cages, catch poultry, slaughter poultry, clean slaughtered poultry, clean up after slaughtering, handle uncooked poultry carcasses, handle uncooked meat on processing lines (and any of the other jobs in between), we have to add all those workers who come into contact with surfaces and dust on poultry farms, vehicles used to transport poultry, slaughterhouses, breeding and hatching facilities, and poultry processing plants.

• **The H5N1 virus** may be contracted by humans who inhale dust contaminated with the feces of an infected bird. Avian influenza is a viral
disease that can cause sickness and death among poultry. On rare occasions, avian influenza virus can be transmitted to poultry workers or others who come in contact with infected poultry or contact contaminated surfaces. Examples of such workers who could be at risk include poultry growers and their employees; service technicians of poultry processing companies; caretakers, layer barn workers, and chick movers at egg production facilities; and workers involved in disease control and eradication activities, including state, federal, contract, and company employees. The virus is excreted in the droppings of infected birds and in their respiratory secretions. Certain avian influenza viruses are potential zoonotic disease agents that may be transmitted from infected birds to humans. Poultry workers are at risk of becoming infected with these viruses if they are exposed to infected birds or virus-contaminated materials or environments. **Transmission to humans** is thought to have resulted from contact with infected sick or dead poultry or their droppings, or contact with contaminated litter or surfaces (e.g., egg flats). The suspected routes of entry of the virus to humans are the mouth, nose, eyes, and lungs. Although the human health risk of low-pathogenic avian influenza viruses is not well established, protective measures should be taken by persons likely to have prolonged direct or indirect exposure to any avian influenza virus in an enclosed setting.

- **Poultry workers at risk of exposure to AI viruses** are those people working in the various poultry production systems or sectors, including poultry farmers and their employees; service technicians of poultry-processing facilities; caretakers at poultry facilities; layer barn workers; workers in live bird markets; chick workers at egg production facilities; disease control and eradication workers; and workers in the bird-fighting industry. Other workers at risk of exposure to potentially infected poultry include
veterinarians and their staff, poultry transportation workers, and slaughterhouse workers. Anyone who handles or works with AI-infected poultry or in environments contaminated with the secretions or excretions of AI-infected birds is at risk of exposure and potential infection.

- A HACCP program provides a seven principle systematic approach for identifying, monitoring, and controlling possible sources of microbiological, chemical, and physical contaminates starting with raw materials and ending with product consumption to improve food safety. Because there is no current HACCP regulatory requirement for the feed industry, feed manufacturers have no mandated hazards to address within a HACCP plan. Feed manufacturers who choose to third party certify implemented HACCP programs are certifying compliance to the standards of the third party certifying organization. HACCP is a program used to identify, evaluate, and control food safety hazards. HACCP focuses on preventing hazards that could cause food-borne illnesses by applying science-based controls throughout the manufacturing process, starting with raw material and ending with product consumption.

- *Microbial pathogens* (which include bacteria, viruses, parasites, and fungi) found in chicken flesh can and do cause illness and death in humans. The most common pathogens in chicken flesh are salmonella and campylobacter. Campylobacter is a bacteria which can cause diarrhea, cramping, abdominal pain and fever. Infection by either of these bacteria can be deadly for children, the elderly, and people with suppressed immune systems. All chicken flesh is at risk and must be handled as if contaminated. Techniques such as refrigeration and complete cooking can lessen, but not completely eliminate, the risk of transmission of these and other pathogens to consumers.
• **In the factories in which chickens are slaughtered and processed,** the fast pace and unsanitary practices associated with mass production expose chicken flesh to contaminants such as feces, bile, mucus, and partially digested feed, any of which might cause illness if ingested or even touched by humans.

• **Mass production and transport** introduces multiple opportunities for contamination. *Maggots and other insect larvae* have been found in the storage and transport equipment of U.S poultry producers. Shipments of meat have been contaminated with a wide variety of foreign matter such as grease, metal shavings, and dead insects.

NIOSH Finds Alarming 42 % Rate of Carpal Tunnel Syndrome (CTS) at South Carolina Poultry Processing Plant (*Jessica, et al,* 2015).
RISK ASSESSMENT FOR ELEMENTS INDUCE OCCUPATIONAL HAZARDS

EPA Risk Assessment

Risk assessment has been defined as "the characterization of the potential adverse health effects of human exposures to environmental hazards". In a risk assessment, the extent to which a group of people has been or may be exposed to a certain chemical is determined, and the extent of exposure is then considered in relation to the kind and degree of hazard posed by the chemical, thereby permitting an estimate to be made of the present or potential health risk to the population exposed. Regarding the primary inhalation exposures in CAFOs, the U.S. EPA has completed risk assessment evaluations for ammonia and hydrogen sulfide. Both are limited to chronic (24 hour/day lifetime exposure) health hazard assessments for noncarcinogenic effects. The completed risk assessments represent a consensus opinion of EPA health scientists representing various Program Offices and the Office of Research and Development.

Exposure-response studies in workers have included an assessment of the response to the amount of time exposed, for particulate matter (PM), endotoxin, NH3, and H2S. Endotoxin and PM concentrations have had the strongest and most consistent relationships to respiratory symptoms and decrements in pulmonary function tests (PFT). A significant relationship was seen between microbial concentration and bronchitic symptoms (cough and phlegm). A weaker relationship of bioaerosol concentrations to tightness of chest and febrile syndromes (flu-like illness with fever) was found. There was no relationship of bioaerosol to pulmonary function changes. Ammonia did show some relationship to decreased baseline
pulmonary function in four different studies. In one of the studies, the levels of microbes showed a significant dose response relationship to symptoms of hyper-reactive airways. A study in The Netherlands suggested that both endotoxin and Gram negative bacteria were related to reductions in pulmonary function, as measured by forced expiratory volume in one second, (FEV1) and forced vital capacity (FVC). Also, significant relationships were shown between symptoms of bronchitis, or Organic Dust Toxic Syndrome (ODTS) to endotoxin or Gram-negative bacteria exposure. There is little scientific doubt that disease symptoms and work-shift declines in pulmonary function are related to several components of the mixture of particulate matter, bioaerosols and gases found inside CAFOs. These components include dust, endotoxin, hydrogen sulfide, and ammonia. Knowledge of the appropriate exposure limits is extremely important for controlling the work environment.

**CHRONIC HEALTH HAZARD ASSESSMENTS FOR NON CARCINOGENIC EFFECTS**

2.1- The No-Observed-Adverse-Effect Level (NOAEL) is the highest exposure level at which there is no statistically or biologically significant increases in the frequency or severity of adverse effect between the exposed population and its appropriate control. Although some effects may be produced at this level, they are not considered adverse, nor precursors to adverse effects.

2.2-The Lowest-Observed-Adverse-Effect Level (LOAEL) is the lowest exposure level at which there are statistically or biologically significant increases in frequency or severity of adverse effects between the exposed population and its appropriate control group.
2.3- The Reference Concentration (RfC) is an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. The RfC is derived from a NOAEL, LOAEL, or benchmark concentration, with uncertainty factors (UF) generally applied to reflect limitations of the data used. The RfC is generally used in EPA’s noncancer health risk assessments.

For ammonia, an uncertainty factor of 10 is used to allow for the protection of sensitive individuals. Additionally, a factor of 3 is used to account for several database deficiencies including the lack of chronic data and the lack of reproductive and developmental toxicology studies. Based on these factors, EPA sets the limit for lifetime exposures to ammonia at 144 ppb. For hydrogen sulfide, the uncertainty factor of 1000 reflects a factor of 10 to protect sensitive individuals, a factor of 10 to adjust from sub-chronic studies to a chronic study, and a factor of 10 for both interspecies conversion and database deficiencies. Based on these factors, EPA sets the limit for lifetime exposures to ammonia hydrogen sulfide at 0.7 ppb.
Table 4. Environmental Protection Agency Reference Concentrations for Chronic Inhalation Exposure to Ammonia

<table>
<thead>
<tr>
<th>Critical Effect</th>
<th>Exposures</th>
<th>UF</th>
</tr>
</thead>
<tbody>
<tr>
<td>RfC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of evidence of deceased</td>
<td>NOAEL (HEC): 2.3 mg/cu.m</td>
<td>30 0.1</td>
</tr>
<tr>
<td>mg/cu.m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulmonary function or changes in ppb</td>
<td></td>
<td>(144</td>
</tr>
<tr>
<td>Subjective symptomatology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>{Occupational Study}</td>
<td></td>
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</tr>
</tbody>
</table>

*The NOAEL is based on an 8-hour TWA occupational exposure. (HEC) is the adjusted human equivalent dose. USEPA, last revised 1991.

Table 5. Environmental Protection Agency Reference Concentrations for Chronic Inhalation Exposure to Hydrogen Sulfide1

<table>
<thead>
<tr>
<th>Critical Effect</th>
<th>Exposures</th>
<th>UF</th>
</tr>
</thead>
<tbody>
<tr>
<td>RfC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inflammation of the nasal mucosa</td>
<td>NOAEL (HEC) 2: 1.01 mg/cu.m( 0.73 ppm)1000</td>
<td>0.001 mg/cu.m (0.7 ppb)</td>
</tr>
<tr>
<td>{Mouse Sub-chronic Inhalation Study}</td>
<td></td>
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</tr>
</tbody>
</table>

USEPA, last revised 1995.

2 NOEL (HEC) = No Effect Exposure Level, Human equivalent dose.
**PREVENTION AND TREATMENT**

The *Occupational Safety and Health Act 1984* states that an employer shall as far as practicable, provide and maintain a working environment in which employees are **not exposed to hazards through**:  
- Maintaining safe workplaces, plant and work systems;  
- Providing information, instruction and training enabling employees to work without hazards;  
- Consulting with employee-elected health and safety representatives and/or other employees about occupational health, safety and welfare;  
- Providing adequate personal protective clothing and equipment; and  
- Ensuring all work procedures are undertaken without exposing workers to hazards.  
- **Staff need to be educated on preventing infection** with Campylobacter, Salmonella and H5N1 by thorough hand washing after work and before eating and also by changing work clothes and boots.  
- **Disease transmission by other vectors** such as vermin and insects can be controlled with effective pest control management as required for biosecurity measures.  
- **Respiratory hazards** could be a potential source of disease transmission and infection of the lungs. Particular jobs, such as shed clean out or batch exchange of birds, should be completed using respiratory protection.  
- **Safe chemical handling** is often overlooked in the workplace.  
- Ensure chemicals are stored in a designated enclosed area, and material safety data sheets (MSDS) are within easy reach of these chemicals. MSDS provide advice on storage, emergency and first aid. Read the MSDS to find out if particular chemicals need special storage conditions. Ensure that there is basic.
✓ **Formaldehyde is regarded as a suspect human carcinogen**, and should only be applied by certified contractors.

✓ **Work Safe Australia** has currently assigned a draft time weighted air exposure standard (upper limit) of 1 ppm. First aid facilities for staff and clean up equipment for any spills that occur.

✓ **Ammonia needs to be minimized** for the health of the birds; there is a maximum permitted occupational exposure for employees, the occupational exposure standard (upper limit) for ammonia in air is 25 parts per million (time weighted average).

✓ **Training should be provided for all staff to ensure adequate knowledge of safe manual handling and correct use of equipment and vehicles.** The training should cover all other safety procedures to ensure that general work safety exists on the poultry farm.

**DUST CONTROL**

1. Micromist, evaporative cooling, **high** pressure and **dust control** system affecting the rearing environment characteristics and performance of broiler chickens.

2. **Cooling and dust control system** significantly lowered dust concentration. Food is one of the main dust sources .adding animal fat or vegetable oil minimized feed dust.

3. **Ventilation air** dilutes and removes indoor airborne contaminants at a rate dependent on the effective rate of ventilation and outdoor pollutant concentrations (C<sub>ss</sub>, the steady dust concentration= C<sub>a</sub>, the incoming air dust concentration + (S the dust generation rate kg/s-R, the dust removal rate by filtering /Q, ventilation rate, m<sup>3</sup>/s).

4. **High ventilation rate is not always desirable**, because it would result in increased heating costs, high air velocities and cold draughts .a short period
of high ventilation (purge) reduced dust concentration, but dust concentration increased rapidly after the purge.

5. **Removal of airborne dust using an internal recirculating filter** improved air quality, livestock health and productivity.

6. **Both dry filters, electrostatic precipitators and wet scrubbers** are impracticable, due to the large size needed to handle the large volumes of air in modern livestock buildings.

7. **An electrostatic precipitator reduced dust concentrations** with an efficiency of 40-60%.

8. **Using ionization to reduce the dust in alternative systems for layers** but this neither decreased total nor Respirable concentrations.

9. **The concentration of aerial dust can be reduced by spraying intermittently a fine mist of rapeseed oil.**

10. A rational way to reduce dust under increase animal activity during weighing is to make dust particles adhesive so that they are not dispersed.

11. **Spraying a small quantity of plant oil** (ca.5-10 g oil/animal) reduced dust concentration by 50-90%.

12. **Regular cleaning, perhaps once a week, with vacuum.**

13. **Wet scrubbing used water to capture particles** or increase the size of dust particles and is efficient at removing dust from the air.

14. **In modern livestock barns, proper indoor air quality is imperative to maintain the health and productivity of farm workers and animals.**

15. It is strongly recommended that you **wear a respiratory protection system** such as an adequate face mask or the more efficient positive pressure respirator, especially during feeding and animal handling times.

16. **There are three ways to reduce dust in livestock buildings;** reducing dust emission or generation from sources(S), removing airborne dust, and increasing the ventilation rate (Q).
17. Adjustment of the relative humidity (RH%) of the air in a broiler house to 75% will have an effect on inhalable dust, but not on Respirable dust.

18. A slight immediate effect on the Respirable dust was observed after fogging with pure water on water with rapeseed oil.

**ODORS**

Are controlled by reducing the amount of odorants in a given volume of air (concentration), but the reduction in the nuisance quality of the odor is related to the strength of the odor (intensity).

The control of odours can be achieved by:-

1. Managing the odour generating processes (eg. maintaining optimum litter moisture)

2. Removing odour from air before it is released from the sheds.

3. Windbreak walls help to disperse odour and provide a means for controlling odour and dust emissions between the source and the receiver.

4. Good practice, design and management and adequately managing the litter, providing optimum ventilation and controlling temperature.

5. The concentration of odorous compounds in the air depends on the degree of dilution of the odorous substances with air in the shed or in the ventilation system.

6. Maintaining the maximum possible airflow through the shed will assist in keeping the litter as dry as possible and promote aerobic conditions. It will also dilute odorous gases as they are released to the outside air.

7. Appropriate design and regular maintenance of ventilation fans will ensure that ventilation is adequate for the number of birds that are being housed.

8. Removing the dust, cleaning ventilation fans and shafts will minimise odours that are absorbed and carried in through the air by dust particles. 

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**A-Control Ammonia emission**

a. Daily or thrice-weekly removal of droppings from cages units to closed storage systems may lower the concentration of **gaseous ammonia**.

b. The reduction of N excretion by improvement of feed composition and feed conversion as one of eight principle to reduce ammonia emission from layer hen houses.

c. In broiler buildings the water cups have been replaced nipples to get rid of water spillage and wet litter to improve working conditions.

d. The depth of the litter has been minimized in order to make the chicken scratch in it .In this way it will be kept dry.

e. In deep layers of litter condensation will appear which increases the **ammonia emission** because of the moisture.

f. Better ventilation and control techniques had improved the air quality and the building technique has been better with increased insulation and better foundation.

g. Better ventilation and regulation techniques had improved the air quality.

h. The building technique had also became better with increased insulation and better foundations.

i. **Ammonia emission** from broiler litter can be minimized by litter treatment with alum (Aluminum silicate, ferrous Sulphate, phosphoric acid) .It had a significant lowering effect to ammonia gas emission from litter.

j. Litter treatment with disodium Sulphate and compound containing calcium-iron-silicate with phosphoric acid did not affect ammonia emission from litter compared to control non treated litter.

k. Ammonia emission from broiler litter can be reduced by feeding lower-protein diets to broilers.

l. Five types of litter amendments are available to manage ammonia: acidifiers; alkaline material; adsorbers; inhibitors; and microbial and
enzymatic treatments. Acidifiers, the most widely used type of amendment, lessen ammonia levels by converting ammonia to ammonium.

m. Reducing ammonia losses will also improve the fertilizer value of the litter. Odor complaints from neighbors may be reduced. Pathogen and pest levels may decrease, too.

n. Different amendments may require different application or activation methods.

o. Personal protective equipment should be worn while applying amendments at a minimum, protective gloves, long pants, a long-sleeved shirt, goggles, and a mask (to guard against “dust” from granular material).

A **key factor in controlling litter moisture** is:-
The minimization of spills from watering systems. Waterers should be carefully adjusted for height and water depth. Reducing water spillage has a number of benefits, including saving water, improving bird quality, improving the shed environment, reducing ammonia levels, reducing the volume of wet manure and extending the time between litter cleanout (if multi-batch litter is used). Ventilation removes excess heat, water vapour and odorous compounds from the sheds.

**To reduce a health risks associated with ammonia in poultry houses:-**
1) Increase ventilation rates to control air and litter quality,
2) Maintain desirable litter moisture by proper managing of drinker and cooling systems and maintain uniform bird density and adequate litter depth,
3) Prevent water seepage into houses by correct outside drainage problems,
4) Timely and effective cake removal,
5) clean out houses,
6) use litter treatment,
7) Implement laborsaving technologies such as computer controllers which improve labor efficiency and reduce the hours spent working in houses.
8) Using diets that reduce the level of urea and proteins,
9) Using nipple drinkers, maintaining densities based on the ventilation capacity of the building, using litter material with high water holding capacity,
10) Minimizing overdrinking by providing pecking substrates to the birds.

**Maintain good biosecurity**, poultry farmers should routinely **maintain good biosecurity** in their operations.
Maintain a barrier between wild and domestic birds and provide poultry with treated water, not untreated reservoir or dam water.
Normal workplace health and safety operations apply reinforce good hygiene. Ensure biosecurity measures are in place and poultry workers are on alert to identify sick or dead birds.
Review procedures for dealing with sick or dead birds including availability of suitable personal protective equipment (PPE) and training in its use.
All workers in the poultry and associated industries should strongly consider vaccination with the seasonal human influenza vaccine every year as soon as the vaccine becomes available (usually March).
Vaccination may avoid simultaneous infection with both human and avian influenza.
There is a small possibility that if a person is infected with both of these viruses at the same time, the viruses could share genetic material to
produce a new and highly transmissible virus that would pose a threat to the wider community.

**The CDC recommends** that:-
Workers involved in avian influenza disease control and eradication activities should get the current season's human influenza vaccine. Human influenza vaccine will not prevent infection with low pathogenic or highly pathogenic avian influenza A viruses, but this precautionary measure could reduce the possibility of dual infection with avian and human influenza viruses. Although dual infection is unlikely, it is plausible that such a situation might cause new and different viral strains to be created; such new strains might be transmissible among people and lead to more widespread infections. Although this CDC recommendation is only for workers involved in disease control and eradication activities, other poultry workers should consider getting the current season's influenza vaccine for the same reason.

**Prevent Avian influenza disease** introduction onto the farm by keeping a closed flock and practicing Biosecurity – disease prevention management – whether you have a commercial poultry farm or own a few backyard chickens: *Avoid visiting other poultry farms* or live-bird shows & markets. Change clothing and footwear before working with your birds. Don’t allow people who have birds to visit your farm without showering and changing clothes beforehand or have them wear protective clothing and footwear and vice versa. Do not loan or borrow equipment or vehicles from other farms. If you have to, wash and disinfect all equipment before and after use. Wash and disinfect your vehicle/trailers/crates (including tires and undercarriage) after leaving a poultry farm, show or market. Keep your
houses/pens, equipment and work areas clean and sanitary. The avian influenza pandemic reinforces this long-standing concern. Increased line speeds in poultry meat processing operations makes the safe disposal of the internal organs, blood and feces of poultry and adequate cleaning of carcasses impossible, increasing the risk of fecal contamination in processed poultry meat. In addition, the fast rate of the processing line can prevent workers from using safety equipment effectively (even gloves), as well as putting workers under immense stress.

Cleaning and disinfection of the entire poultry slaughterhouse premises at the end of each day’s production to ensure that the premises are free of manure, feathers and other debris that can potentially harbour bird flu viruses. Cleaning and disinfection of all vehicles transporting live poultry (including the bird crates), as well as disinfection of the wheels and undercarriages of all other vehicles (e.g. reefer trucks) before entry into, and exit from, the slaughterhouse premises. Limiting access into the slaughterhouse premises to only essential or authorized personnel and vehicles. Operators and their staff are strongly advised against visiting poultry farms or other poultry slaughterhouses. All workers in direct contact with live poultry are required to be properly fitted with personal protective equipment such as headgear, goggles, N95 facemasks, gloves and boots. Operators have to ensure that a pest management programme is in place for their slaughterhouses. Operators are required to monitor the health status of all their workers, provide their workers with an annual medical examination and vaccination against human influenza. Keeping poultry facilities clean has long been encouraged as a method to protect human respiratory health. Adopting management practices such as use of pelleted food, routine entry into buildings and use of lighting cycles can control dust and ammonia levels. Some practices may lower one
contaminant while increasing another. For example, dry litter reduces ammonia production but is aerosolized more easily by animal activity.

**Ozone is one of the most powerful oxidizing agents known.** This property of ozone is utilized to remove odours through oxidation of the odorous compounds in the air. During the oxidation-reduction reaction both the ozone and odorous gas are eliminated, and in theory neither the odorous compounds nor the ozone remain. Ozone is used in a number of industries to destroy airborne bacteria and to reduce and eliminate odours. Ozone kills micro-organisms by blocking their enzyme control system and deodorizes both gaseous and particulate matter by a process of oxidation. This technology also has the potential to reduce ammonia concentrations in animal sheds. Two methods have been used to treat poultry sheds with ozone. These include the use of high concentrations of ozone to sterilize sheds when they are empty following removal of birds and spent litter, and the use of low levels of ozone (0.1 ppm) to deodorize sheds and improve air hygiene when sheds are stocked with bids. Ozone treatment can be used in all types of meat chicken sheds and is claimed to oxidise the following odorous compounds: · Hydrogen sulphide, dimethyl sulphide, dimethyl disulphide;· Amines (primary, secondary and tertiary); Mercaptans, methyl mercaptan;· Aldehydes, formaldehyde; Olefinic hydrocarbons ; Acrylic ester, methacrylate;· Ammonia (gas phase only);· Phenol, toluene; · Methanol, ethanol, iso-propanol; and Skatoles, indoles.
Conclusion

1- **The development of pulmonary diseases**, particularly allergic alveolitis (hypersensitivity pneumonitis), had been shown to be a risk from exposure to airborne microorganisms, high concentrations of dust, gaseous contaminants, such as ammonia, hydrogen sulphide, particulate contamination (dust), aerosols and Physical hazards associated with animal interaction.

2- **Control of both dust and ammonia** in livestock facilities is extremely important. Lack of control of both these contaminants will increase the risk of respiratory dysfunction to all exposed to this environment, including workers and veterinarians.

3-Ventilation air dilutes and removes indoor airborne contaminants at a rate dependent on the effective rate of ventilation and outdoor pollutant concentrations.

4- **Removal of airborne dust** using an internal recirculating filter improved air quality, livestock health and productivity or micromist, evaporative cooling, high pressure and **dust control** system or Cooling and dust control system which significantly lowered dust concentration or an electrostatic precipitator reduced dust concentrations with an efficiency of 40-60% or using ionization to reduce the dust in alternative systems for layers or spraying a small quantity of plant oil (ca. 5-10 g oil / animal) reduced dust concentration by 50-90%. Adjustment of the relative humidity (RH%) of the air in a broiler house to 75% will have an effect on **inhalable dust**, but not on Respirable dust.

5-Wear a respiratory protection system such as an adequate face mask or the more efficient positive pressure respirator, especially during feeding and animal handling times.
**6-Control of odours** can be achieved by managing the odour generating processes (eg. maintaining optimum litter moisture) or removing odour from air before it is released from the sheds. The reduction of N excretion by improvement of feed composition and feed conversion as one of eight principle to reduce level of urea and proteins and so ammonia emission from layer hen houses. Water cups replace nipples to get rid of water spillage and wet litter. The depth of the litter should be minimized to decrease ammonia emission because of the moisture. Better ventilation and control techniques with increased insulation and better foundation will help in reducing ammonia emission. Litter treatment with alum (Aluminum silicate, ferrous Sulphate, phosphoric acid) to reduce ammonia emission.

**7-Poultry farmers should routinely maintain good biosecurity** in their operations. Maintain a barrier between wild and domestic birds and provide poultry with treated water, not untreated reservoir or dam water.

**8-Review procedures for dealing with sick or dead birds including availability of suitable personal protective equipment (PPE) and training in its use.**

**9- Prevent Avian influenza disease introduction onto the farm by keeping a closed flock and practicing biosecurity – disease prevention management.**

**10- Do not loan or borrow equipment or vehicles from other farms.**

**11- Good medical facilities should be attached to poultry farming as well as proper sanitation of the poultry environment should be mandated to poultry farmers by the government.**

**12- Proper handling of chemical such as germicides, vaccines etc and using of wheel barrow for carriage of heavy loads and poultry waste should be encourage by the poultry formers.**
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Part II. Occupational Hazards of Dairy Production Facilities

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**INTRODUCTION**

Most dairy farms do not have large numbers of employees. Often it is the owner/operator and one or two other individuals that do most of the work. Industries with large numbers of employees may actually find it easier to implement safety programs which include such things as safety committees, regular workplace inspections, standard training programs, etc. However, there are advantages to having a few steady employees. They become very aware of their surroundings, the equipment they operate and the job that must be done. By increasing their safety awareness we can make our farms a safer place for family member's employees and visitors to the farm.

**Develop Your Health and Safety Program**

A good, sound health and safety program is an effective way to manage risks and productivity in your operation.
Accidents are not only costly in human terms, but they can disrupt the flow of work and halt production. There are always hidden costs. The actual injury to an employee only the “tip of the iceberg”

A good health and safety program should include the following components:

**Written Safety Rules**

A set of basic rules for your operation as well as specialized safety rules for specific tasks, equipment or processes need to be developed. The list should not be long and unmanageable. Rules should be simple and easy to understand and may need to be translated into a worker's language. The rules should be reviewed with all new employees, as well as posted for all employees to see.

**Safety Director/Coordinator**

You need to appoint someone to look after safety as a part of their job. You may also want to have a safety committee or safety representatives from both workers and management. This will keep safety out front all the time.

**Employee Training**

Employees should receive periodic training as necessary to review safety procedures. New employees should receive safety training both before and on the job. Close calls or to accidents should trigger an immediate review of procedures and safety with employees.

**Workplace Inspection**

A system of workplace inspection should be set up so as to review hazards and practices in the workplace. Any time that there is a new process introduced or new machinery installed, an inspection should take place. Employees should be encouraged to report hazards, close calls or anything out of the ordinary that could lead to injury.
**Emergency Plan**

There should be an emergency plan for any accident, fire disaster or other unexpected event that may occur. Employees should know what their responsibilities are during an emergency. A plan could include what to do during fires, power failures etc.

**Documentation**

It is important to keep records of training, safety meetings/concerns, corrective actions, accident investigations etc. as “Due Diligence”.

**Sample safety Policy**

Management of Company name is committed to the health & safety of all its employees. Protecting employees and the public that we come into contact with from injury or occupational disease, is a major continuing objective.

Company name is dedicated to providing a safe and healthy work environment. All supervisors and workers continue to strive to learn and work together in the objective of preventing risk of injury.

We are committed to compliance with all applicable health and safety legislation as a minimum standard.

Company name, as employer, is ultimately accountable for worker health and safety. As owner/operator of Company name I give you my personal commitment that every reasonable precaution is taken to ensure the Health and Safety of our workers.

Supervisors are held responsible for the health & safety of workers under their supervision. Supervisors are required to make sure that machinery and equipment is safe and that workers receive appropriate training in their specific work tasks. All workers comply with established safe work practices and procedures and are responsible for their own safety which
includes wearing their Personal Protective Equipment (PPE) where required.
Every worker must protect his or her own health and safety by working in compliance with the law and with safe work practices and procedures established by the company. Each worker looks out for and is concerned with the health and safety of their fellow employees.
All subcontractors and visitors to our business must adhere to our health and safety policies the same as our employees. It is in the best interest of all parties to consider health safety in every activity. Commitment to health & safety is an integral part of this organization, from the President to the workers.
Signed (Management): __________ Date ______:
Signed (Employees): ____________ Date ______:

**Suggestions for Developing Employee Training Programs**

An employee who knows their job well and all of its hazards and safety precautions will be a more productive person. It is imperative that you have a written plan for training and orienting new workers. The plan should be applied consistently to all new employees. The plan should be in writing, even if you only have one employee.
Examine your operation and prepare a list of all the jobs that require employees, full or part-time. For each job develop a written job description which will include the major tasks that are performed in the course of their duties.
Each major job task identified should also identify possible hazards in that job and protective equipment that may be required. This will allow you to look at what type of instruction will be necessary as part of your training program.
 Portions of your operation may come under Provincial or Federal Health and Safety Legislation. You will need to examine legislation such as WHMIS (Work Place Hazardous Materials Information System), Occupational Health and Safety Act, Transportation of Dangerous Goods etc. to see if it applies. If in doubt, check with the Ministry that is responsible for a particular piece of legislation.

When training needs have been identified, a program of instruction should be implemented.

A written set of company safety rules, as well as terms of employment and conduct at work should be discussed with all new workers and distributed in writing. Set up a written format to document all training given to each individual and have that person sign or indicate that they have received the training. This is a part of due diligence. Training should be reviewed with employees on a regular basis. Even long time employees need a refresher course.

Every time that there is a transfer of employees from one area to another, or one job to another, training should occur. Accidents have occurred in operations when people were transferred to new jobs, due to shortages of manpower, without proper instruction. The results have often been tragic. A new employee unfamiliar with a machine or process must receive instruction.

Remind supervisors of their responsibilities.

**Work place inspections**

The primary purpose of a workplace inspection is to identify unsafe conditions and unsafe acts before an accident can occur, and to correct or remove these hazards. Inspections can be routine daily checks of equipment personal protective equipment, tools, etc. or a more formal type of
inspection conducted by an inspection team consisting of management and workers.

Who should conduct workplace inspections?
The inspection should be a joint effort, with management supervisors and workers involved. Each person may have a different point of view that can contribute to the inspection.

Workers will be more familiar with the operation of certain machines etc. It may be wise to rotate teams of people for inspections. Sometimes a second pair of eyes may spot something that was overlooked the first time.

**Conducting the inspection**
When doing an inspection, certain basic principles should be considered. Estimate the optimum required time to complete the inspection. It should not be rushed or take an extremely long time to do. There should be a pre-inspection briefing for the team to clarify duties, distribute necessary information and to clear up questions.

Try not to unnecessarily disrupt work activities. Ask only questions that are required to complete the inspection.

Do not attach any blame for hazards observed. Attention should be drawn to immediate dangers. Others of a more minor nature can be included in the report.

**Recording observations**
There are no regulations requiring that a particular inspection be used. You can design a form specific for your location. You should be able to record observations, to make recommendations and to ensure that corrective action is taken.
You should have a reporting and action procedure in place so that items can be dealt with. Responsibilities should be delegated to employees at various levels so that corrective actions can be taken.

**An Emergency Action Plan**

You should develop an emergency action plan that prepares employees for various types of disaster. Everyone should know what their responsibilities are. Your plan should include:

**Plan Emergency escape procedures:**

*Escape routes from each section of the operation.*

*Procedures to shut down critical operations such as powered equipment, etc.*

*Accounting for all personnel after evacuation, location of staging areas.*

*Train a person who performs rescue and medical aid before outside help arrives.*

*How will employees be notified of emergencies?*  

*Training of all employees including mock emergencies and evacuations.*  

*Location of all emergency equipment must be made known and well marked such as fire extinguishers, first aid, power shut off etc.*

**Why train?**

Proper orientation and training of new employees is one part of good human resource management in your agricultural operation.

*With a good training program the employee should:*

*Know the reason for the job they are doing.*

*Know more about the process than they did before.*

*Understand something not previously understood.*

*Develop new skills.*

*Know where to go for assistance if required.*
Know how to do the job safely and correctly.

**Checklist for New Employees and Employees in New Positions**

The following is a partial checklist which can be used as a part of your new employee indoctrination:

- Initial items to discuss with the new employee
- Where to park their vehicle?
- Where to keep personal belongings while at work.
- How to handle unsafe conditions & report them?
- What to do in the event of a non-injury accident?
- Location of first aid facilities.
- Review general safety rules and the reason for each.
- Review specific safety rules including the reasons for each rule.
- Review disciplinary action.
- Personal protective equipment required.
- Procedure for obtaining and caring for personal protective equipment.
- Location of fire extinguishers and staging area, test of warning signals.
- Safe re-entry times for sprayed areas. Special clean-up rules (with attention to personal hygiene areas clean-up rules (general housekeeping).
- Rules regarding lunch and break periods, use of cell phones, etc

**Employee name *******:**

**Signature *******:**

**Discussed by *******:**

**Date *******:**

**Working a lone**

Working alone on a dairy operation is often out of necessity rather than by choice, because there is no reasonable alternative. A plan should be in place and discussed with employees who may have to work alone or unsupervised.
Some of the factors that come in to place and should be discussed include:
Is the person medically fit and suitable to work alone?
What happens if he/she becomes ill, has an accident or in case of emergency?
Can one person control the risks of the job when alone?
What means of communication is available if there is an emergency?
Work of a clearly hazardous nature involving mechanical pneumatic, electrical and other energy sources should never be conducted alone. This also goes for entering and working in any confined spaces. Supervision arrangements for occasional check-ins or even frequent phone calls to monitor progress of the work may be required.

Worker Training Tips for the Supervisor
Before you assign any worker to a new job, you should assess the individual’s skills for performing the required task. Adequate training will be the key to safe, efficient job performance.
Following are basics that should be considered when training new workers:

Explain how and why a particular job is to be performed.
New surroundings can often distract.
Personally demonstrate the correct way of doing the work. You should go through the task first at a normal pace, then repeat it at a slower pace pointing out the various steps and answering any questions they may have.
Point out any hazards associated with the job.
Before leaving the new worker on their own, make sure that they can demonstrate their ability to perform the work in the correct manner. Have the trainee go through the process explaining to you what they are doing and why. Don’t leave workers until you are confident that they will carry out the required tasks as instructed. They may work at a slower pace at first, then gradually come up to speed.
Make frequent checks on the new workers. In most situations, positive reinforcement is considerably more effective than harsh criticism. If the employee is unable or unwilling to perform the work properly after a reasonable period of time it may be necessary to switch them to a different job or let them go.

All employees should be instructed in proper lifting techniques. Improper lifting is a major cause of accidents. Employees should be made aware of specific hazards and encouraged to report unsafe conditions or equipment on their specific job task.

Check if the employee remembers how they are to deal with emergencies such as fire or situations requiring first aid.

**Biosecurity Concerns**

The transmission of disease is one of the greatest concerns a modern dairy operation has to deal with. Any disease concerns can be extremely costly to an operator. Although there are a number of ways that disease can be introduced to your farming operation, we will look here at the situation as it pertains to employees.

Employees must be educated in the importance of maintaining bio security in their workplaces. It is also their livelihood at stake. Often it is human hands, feet and clothes that can bring unwanted disease to the farm. It is important that you have a plan for biosecurity and that it is communicated in writing to your employees. Check with your industry to see if they have standardized plans for your farm.

Biosecurity usually requires control of human traffic and movement throughout your operations. Locking doors and banning visitors is a must. Authorized personnel may and require use of sanitized foot wear, head gear, and coveralls for entry. Sanitizing human hands as well as footwear
when entering and leaving a farm is a must. Records should be kept of visitors and employees entering and exiting various locations.

**Handling Cattle Safely**

It doesn’t take long for a farmer or dairy employee to get to know their cattle since they are working with them on a daily basis, often calling them by name. Like people different, cattle react differently to various situations. Understanding how cattle perceive the world around them and how they react to various stimuli will help keep handlers safe when working with and moving them The Cow’s World:

Cattle really do see things differently. They have a panoramic field of vision in excess of 300 degrees.

Human vision by comparison is only 180 degrees. This means that cattle can see motion around them, except directly behind them. This is why it is important to approach animals from the side or front. If you step into their blind spot they could become startled. They also have limited vertical vision as well as poor depth perception for nearby objects. Because of this, simple things like shadows on the ground can appear to be a huge, deep crevasse or hole.
Cattle are able to hear lower volume and higher frequency sounds than humans can. Although they can hear well, they have difficulty in locating exactly where a sound comes from and may startle at noises that humans don’t hear.

It is often little things that we may not be aware of that cause problems with cattle. Sometimes something as simple as setting down a white styrofoam cup, or hanging a jacket simple on a fence that flaps in the wind can cause distractions while handling cattle, making them balk.

If someone you did not know walked up to you and stood six inches from your face, you would react. They are too far into your comfort zone. Cattle too, have a comfort zone.
This comfort or flight zone can be used to effectively move cattle. This works best when the handler works at the edge of the flight zone. These zones will vary from cow to cow and can be anywhere from five to twenty-five feet.

Deep invasion into the flight zone may cause panic and confusion. Learning the principles of using the flight zone will allow a handler to move the herd safely. The goal is safety for the worker and the animal. Reduced stress for the cow will lead to increased productivity.

Naturally Dangerous:
Animal behavior can range from docile to aggressive with differing degrees of nervousness and restlessness in between. There are a number of predictable situations that can always be considered dangerous when working with livestock. A cow with her new calf is instinctively more defensive and can be difficult to handle. If possible let the young stay as close as possible to the cow when handling. Dairy bulls are much more aggressive than cows and no matter how long they have been around or how gentle they seem, they should never be trusted and handled
accordingly. Bulls are the cause of most animal related deaths to farm workers. They are feisty when young and should have a nose ring put in by nine months of age. Bulls will use force to get to a cow in heat, so don’t get in their way. The weight and strength of a bull can crush an individual, so handling the “friendly” bull can be a danger.

Bulls seem to get grumpy as they get older, or if they have been teased or abused. Never scratch or pet a bull on the head as it encourages bunting. Cows in pain from injuries or affected by any illness are more easily agitated and may kick. Cows commonly kick forward and out to the side.

Workers around cows should wear steel toed boots to avoid injury if stepped on. When clipping old hair and tags off cows, wear a respirator to protect yourself from dusts and dander. Safety glasses should be worn during milking to prevent injury when a cow swings its tail.

When cattle lead their lives in a tranquil environment in reasonable comfort, they will be more productive and easier to handle. A lot of animals have an attachment to areas that they become familiar with such as pastures corrals and barn areas. This is why we often see well worn paths created in their environment. Removing the animals from their routine can result in behavioral changes and they may react unexpectedly. Some animals become very difficult to handle if they have had traumatic exposures.

These animals will react negatively to changes in their surrounding or new circumstances. These behavior changes also can occur when animals are being treated for medical problems. They do give subtle signs to handlers who pay attention. Some of these include snorting, pawing for the ground and tail switching. Animals “watch” with their ears.
Most cattle will respond positively if you as a handler are patient, never prodding the animal when it has no place to go. You should avoid loud noises and quick movements. Make your movements slowly and deliberately around the animals and respect them rather than fear them. Sudden loud noises may frighten or spook them and as a result they will move quickly away from the noise, crashing into anything in their way, including handlers. Often, touching animals gently can be more effective than shoving and pushing them. An agitated or irritated animal will take at least 20 minutes to calm down. It is better to use patience.

Special considerations should be taken when handling male animals if you have them in your operation. They are always potentially dangerous. We have seen numerous disabling injuries and deaths caused by bulls who were supposedly well behaved and calm. Handling strange or new animals on your farm should be approached with greater caution than you would normally exercise. In all situations for handling your herd, prepare and provide an escape route for all handlers should an emergency arise.

**Transmittable Diseases**

Animal handlers should be constantly conscious of their hygiene to prevent the possibility of transmitting diseases throughout the herd. Basic sanitation practices such as hand washing after working with animals will go a long way to reducing transmission. Some illnesses that can be transmitted back and forth from animal to human include rabies, leptospirosis, brucellosis, salmonellosis and ringworm. Some illnesses can be passed as the handler is treating an infected animal, or handling infected tissues. Brucellosis and Q Fever are diseases that humans can get from cattle. Though not prevalent we should never let our guard down, especially at
calving time. Both diseases are transmitted to humans through the infected animal’s womb afterbirth and birth fluids. If you get fluids on your skin, in your eye or ingest orally, flu-like symptoms may follow. In some cases it can result in long term complications such as hepatitis and infection of the heart’s lining in severe cases.

When calving cows, wear plastic gloves. Don’t eat or drink when in contact with animals. Avoid touching your face with your hands. Wash your hands and all contact surfaces if the cow doesn’t eat the afterbirth, dispose of it carefully.

Avoid a painful back injury from pulling a calf, by using a calving jack. Occasionally workers have been hurt using these. The steel pipe of the calving jack can swing wildly injuring the worker.

**Animal Handling Facilities**
Design and care for all facilities on your operation are a sign of good management. A well designed, clean facility will be a healthier place for both stock and employees.

Improper care and maintenance can lead to injuries for employees and could contribute to the spread of diseases and poor herd health. A well ventilated, dry, dust free environment is critical to animal and human health.

Inadequate facilities, equipment failures and poor building conditions can contribute directly to injuries. Properly designed, modern facilities do not have some of the inherent hazards that altered older buildings may have.

Older facilities or poorly designed newer facilities may have narrow or cluttered alleyways, tripping hazards such as uneven door sills, poor drainage on floor surfaces protrusions on surfaces, inadequate lighting and little or no proper animal handling equipment.
Concrete floors with roughened surfaces or grooves and good drainage will help prevent slips under wet conditions. Slatted floors will help keep animals drier in confinement systems.

Alleyways and chutes should be designed so that they are wide enough for an animal to pass but does not allow them to turn around. Solid walls in chutes are preferred to railings as they are less likely to cause a cow to balk.

Loading ramps should also be wide enough for mature animals to pass through them. They should be designed specifically for the type of stock you are dealing with. The surface should be of non-slip material and not have slope of more than 1 to 3.

Fences and gates should be of sufficient strength to contain animals in a crowded situation. A regular inspection should be made within the enclosure looking for protruding nails or objects, damaged boards or surfaces that can cause injury. Check to make sure that fence posts are solid and not loose or wobbly. Holding areas should be designed to minimize dust generation and eliminate muddy wet conditions. Animals always move easier from darker areas into well lit areas. They are reluctant to move into dark areas. Bright spots and shadows may make them skittish, so you should ensure that lighting is diffused and even.

**Stray Voltage and Animal Behaviour**

Farmers often wonder why animals appear to change their behavior or become skittish in various situations.

Sometimes, a minor unseen problem can be the culprit. One of these is “stray voltage”. This occurs when there is a small voltage difference between two animal contact points. A common example might be the difference in voltage between the floor of a dairy barn and the water bowl.
in a stall. When the animal touches the water bowl and completes an electrical circuit, a small amount of current flows through the body. These small shocks or tingles can change the behavior of the animal, making them reluctant to drink or consume feed, resulting in production losses or handling problems for employees. Cattle will be irritable, and more likely to kick.

Sources of stray voltage can be caused by both on farm or off farm sources. They can be caused by poor wiring improper installations or grounds or they can be related to primary neutral to earth voltages. Faulty equipment and poor or corroded connections can also lead to stray voltage problems. Should you suspect stray voltage as a problem bring in a professional to determine if there is stray voltage then isolate the causes of the problem.

**Eliminating the hazards**

A hazard is anything that can actually or potentially cause harm to an individual or animal. It can be an activity, a process, a circumstance or a situation. Hazards may have the potential to lead to injury or illness. However, there are degrees of hazard ranging from minor to serious. A serious hazard may lead to major injury such as an amputation, loss of consciousness, or even death.

There is a need to identify hazards on your farm by conducting a workplace inspection. Once you have identified major concerns, you can deal with them by eliminating the hazards, isolating them or minimizing possibly through use of protective personal equipment.

**Preventing Needle Stick Injuries**

Needle stick injuries can occur both while preparing a needle for injection or during the process. Exercise caution when exposing the needle tip by removing the cap or when recapping the needle. It is necessary that the cow
in question be properly restrained. In many situations it may be a trained vet that is injecting the animals. Used needles should immediately and safely be disposed of in puncture proof containers.

**Safe Handling of injectables and medications**

Care should always be exercised when handling any medications. You should wash your hands thoroughly after handling any such drugs. Some individuals may be more sensitive to some chemicals and react with skin rashes or localized inflammation due to absorption through the skin some people may suffer severe allergic reactions.

If you need to be treated for a reaction or an accidental injection.

Locate the MSDS (Material Safety Data Sheet), label or package insert from the product so that medical personnel know what they are dealing with.

Wash the area with antiseptic soap and water immediately if swelling or a reaction is occurring, elevate the body part and seek medical attention immediately! If necessary call the poison control center to get instructions on how to deal with the problem.

**Proper Hand Washing**

Employees should be familiar with proper hand washing techniques. This is important for their safety and health as well as preventing the spread of any disease among the herd.

**Steps in proper hand washing include:**

Wetting your hands with running water.

Applying soap from a dispenser.

Rubbing the hands together for 20 seconds.

Cleaning under the finger nails and between the fingers.

Rinsing the hands thoroughly under running water.

Drying the hands with individual use paper towels or a hand dryer.
Hanta Virus Potentially Lethal

The disease known as Hanta Virus Pulmonary Syndrome and associated with the deer mouse and other rodents can be potentially lethal. Although the risk of coming into contact be with the virus is low, of those that do, half usually die.

The virus is usually found in rodent nesting materials burrows, droppings and the surrounding environment where the mouse has taken up residence. The danger is greatest in enclosed environments such as feed rooms granaries and storage areas. Sometimes the rodents will nest over winter in combines and balers or other suitable machines.

Infection usually comes when the rodent droppings are disturbed and become air borne. The resulting dust is then inhaled. This happens often during spring cleaning when you are tidying up such areas.

It usually takes about three weeks after contact for the onset of the illness. Some of the symptoms include fever, muscle, ache, cough, headache, nausea and vomiting very much like the flu.

If you develop a respiratory illness that is rapidly worsening and includes shortness of breath, seek immediate medical attention and make the physician aware if you have been in contact with rodents and suspect possible Hanta virus.

Filling Horizontal Silos Safely

Horizontal silos are a safety concern primarily when packing the silage and when retrieving silage for feeding.

Any tractors used for packing the silage must be equipped with roll over protection and a seatbelt. Only an experienced operator should be allowed to do the job.

The material should be spread evenly and kept packed.
Uneven filling can lead to soft areas where a tractor may sink and roll over. The angle on the silage face should be kept shallower during the filling operation and built up gradually. This will reduce chances of tractor overturns. Consider the use of front end weights on the tractor to give added stability. Back up a slope and come down forward. This will reduce the chances of rear overturns.

**Silo gas Dangers**

Contact with deadly silo gases continues to occur wherever upright silos exist. Silo gas is formed by the natural fermentation of chopped silage shortly after it is placed in the silo. Though a variety of gases are released during this process the type of silo in which the forage is stored is important in determining which gas will be predominant. For instance in sealed silos both nitrogen and carbon dioxide gases are created but carbon dioxide is produced in far greater amounts. This is desirable because high carbon dioxide levels help to maintain high quality silage.

At the same time, however, this odorless and colorless gas is dangerous. This gas replaces the silo's oxygen, and in high concentrations, it gives a person little warning that he/she is about to be overcome by a lack of oxygen. Sealed silos are usually designed in such a way that entering them is necessary.

A variety of gases are also formed in conventional or open top silos with nitrogen dioxide being the most abundant. This highly toxic gas is characterized by a strong bleach like odour and low lying yellowish-red, or dark brown fumes. The gas actually starts forming within hours of the material being ensiled. Unlike carbon dioxide, nitrogen dioxide levels reach a peak about three
days after harvesting and rapidly begin to decrease thereafter, particularly if
the silo is ventilated.
Nitrogen Dioxide is harmful because it causes severe irritation to the nose
and throat and may lead to inflammation of the lungs. However, what
makes this gas especially dangerous is that low level exposure to it is
accompanied by only a little immediate pain or discomfort though death
can and has occurred immediately, after contact with high concentrations.
A farmer might breathe the gas without noticing any serious ill effects and
then die in his sleep hours later from fluid collecting in his lungs.
Many victims can suffer relapses with symptoms similar to pneumonia two
to six weeks after the initial exposure. For these reasons, it is extremely
important for anyone who is exposed to this gas, even for a short time, to
seek immediate medical attention.
Like carbon dioxide, nitrogen dioxide is heavier than air.
Because of this, as it is produced it tends to settle right on top of the silage
or flow down the silo chute and collect in the adjoining feed rooms or other
low lying areas near the base of the silo.
Gas may even flow into the barn itself and become trapped in corners,
under feed bunks, or lie low against the floor.
The threat that this poses to livestock is a serious one.
Warning signs should be posted on your silos to warn employees and
visitors about the potential danger of silo gases.
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visitors about the potential danger of silo gases.
Hydrogen sulfide (H2S) may be formed several ways, but the most common is during manure decomposition. It is toxic, and because it is heavier than air, it dissipates oxygen and can suffocate an unsuspecting farmer. Hydrogen sulfide also has a distinctive "rotten egg" stench that dulls the sense of smell, giving a false sense of security because the original odour disappears as exposure time increases. The gas irritates the eyes and respiratory tract. In low concentrations, hydrogen sulfide has been reported to cause headaches, nausea and dizziness before a person loses consciousness.

Hydrogen sulfide is considered the most dangerous gas in manure pits because it is highly toxic and is rapidly released from decomposing manure during agitation and pumping. Concentrations of hydrogen sulfide in parts per million (ppm) to more than 500 ppm in seconds after agitation begins. Concentrations of hydrogen sulfide above 600 ppm can kill an individual after taking only one or two breaths. The person falls immediately, apparently unconscious and dies without moving again. A safe evacuation of the individual can be made only if the rescuer is wearing a self-contained breathing apparatus (SCBA). Generally, a rescuer has about six minutes to
begin cardiopulmonary resuscitation before brain damage/death occurs. Unless the rescuer is wearing SCBA protective equipment, the rescuer will also succumb to the toxic gases or lack of oxygen. There have been numerous instances where several farmers have been killed while attempting to rescue a person who has succumbed to hydrogen sulfide gas. Hydrogen sulfide, because it is heavier than air accumulates above the liquid level of the pit. Individuals may be quickly overcome with hydrogen sulfide when working around a pit, whether it be climbing down a ladder to make repairs or when leaning down to take a manure sample.

![Danger and Deadly Gases Sign](image)

Liquid manure storage facilities should be secured against entry. Warning signs should be posted to make employees and visitors aware of the dangers. Open lagoons and ponds should be fenced to keep people and animals away from the area.

**Farmer's Lung Disease**

All dusts have the potential to cause health problems, but some organic or toxic dusts may permanently impair a farmer's health. Some dusts, especially dust from moldy forage, grain, or hay, carry antigens that can
cause severe irritation to the respiratory tract. Breathing dust from moldy feed materials can result in a permanent lung condition commonly known as "Farmer's Lung."

Farmer's Lung is one of the most disabling diseases among dairy farmers. Symptoms of Farmer's Lung are easily mistaken for bronchitis or pneumonia and may not be noticed for several hours after exposure to the dust.

Irreversible lung damage and sometimes death results when the disease is not diagnosed and treated in early stages. A long-term implication of the disease is shortness of breath which requires the farmer to take frequent rest periods and severely limits the amount of work that can be accomplished.

When hay is not dry enough, heat builds up and forms large amounts of mold and dust. When this moldy hay is later fed to cattle, a worker can inhale an average of about 750,000 dust particles per minute. Potentially, most of these fine dust particles can go deeply into the lungs.

The symptoms of farmer's lung disease are similar to a cold or flu: shortness of breath caused by congested lungs cough, possible fever and occasional nausea. Most importantly, the symptoms do not strike during or immediately following the exposure to the moldy hay.

Instead, they occur approximately 4 to 8 hours later. This is an allergic reaction and farmers with farmer's lung disease will have antibodies in their blood to one or more harmful spores found in moldy hay.

Although rare in comparison to bronchitis and non-allergic asthma, farmer’s lung disease is most commonly an affliction of dairy farmers and grain producers. It is more prevalent in farming areas where there is a high amount of rainfall, especially during harvesting season, and where there is a cold winter, resulting in farmers feeding their animals in barns with
minimum ventilation rates. Also, dust is released when silages are fed, mainly because many spores have accumulated during the storage period. This is also the time of the year that most farmers develop the classic symptoms of farmer's lung disease. Even in these dairy farming areas, however, not all farmers will develop the disease. Some are just more sensitive than others, but no one is really sure why this is.

There is no cure for farmer's lung disease. Once a person is known to be sensitive to this disease, he or she will always be sensitive. Since 10 to 30% of all patients diagnosed as having farmer's lung disease will die within 5 to 6 years from the time of diagnosis, and others will have permanent lung damage, it is important to avoid contracting it.

There is evidence that numerous farm workers involved with livestock production are directly affected by poor indoor air quality.

Between 2 and 10% of dairy farmers show lung disease and 0.5 to 1% have or will develop some critical reactions and pulmonary capacity reduction over their farming career.

Moldy hay, straw and grain produce large amounts of harmful dust but even good fresh hay contains some molds and produces some dust.

It is strongly recommended that producers wear a respiratory protection system such as an adequate face mask or the more efficient positive pressure respirator especially during feeding and animal handling time.
Pesticide Storage and Transportation

Following is a brief synopsis of requirements for storage and transportation of pesticides

**Transportation**

Never leave pesticides unattended in a parked vehicle unless it is locked or parked in an area to which public access is denied.

A sign indicating Chemical Storage Warning Authorized persons only must be displayed on unattended parked vehicles containing pesticides.

Vehicles transporting more than 500 liters of pesticides must be placarded with a chemical warning sign at all times.

**Storage:**

Pesticides must be stored in an area exclusive for this purpose to prevent cross Pesticides contamination and adjuvant (e.g. emulsifiers, diluents, etc) are the only items to be stored in this building room etc.

If the storage area is to ever be used for other purposes, it must be decontaminated.

Insecticides, herbicides and fungicides should be stored separately from each other.

Storage must be ventilated to the outside.

Chemical storage warning sign must be placed on the door to the area.
The storage must be lockable and access controlled to authorize persons only.
There will be no floor drains except to a separate holding area that can be pumped out. Such spills must be disposed of according to regulations.
Protective clothing must be available to handlers stored in a separate area.
Emergency phone numbers must be posted for doctor, poison control, Ministry of the Environment, etc.
Absorbent material should be available for spills.
Storage areas must be cool and dry to prevent product breakdown/activation.
Pesticides must be stored in original containers labeled.
New storage facilities should be built away from watercourses, wells etc.
Wash-up facilities with adequate supplies of soap and water should be available.
MOE must be notified of spills or fire where environment could be affected.
Only trained personnel with adequate protective equipment should clean up spills.
No feed or food of any kind should be stored with pesticides.

**Safety while Cleaning and Sanitizing Equipment**
All milking equipment, lines, etc must be cleaned and sanitized between milking. Bulk milk tanks must also be sanitized after milk pick up. There are a number of safety concerns around this operation which should be reviewed and shared with employees.
All cleaning chemicals should be properly labeled and stored in a locked area so that visitors, children, and others cannot access them. All chemicals
should be in original containers and material safety data sheets should be kept nearby should an emergency arise.

Keeping all cleaning chemicals isolated and away from children is extremely important. Children should not have any contact or access to areas where these chemicals are being used. There have been numerous incidences throughout North America where children have ingested cleaners and become severely ill.

Appropriate personal protective equipment should be available for all the chemicals being used as prescribed on the data sheets. The equipment should be worn if the label demands it. All personal protective equipment should be maintained in good condition and properly cleaned after use.

Mixing chemicals should be in an open, ventilated area.

Extreme caution should be exercised when handling caustics or acids. Chemicals should be added to water.

NEVER add water to chemicals.

Do not mix chlorine compounds with other detergents or acids since the result could be the production of deadly chlorine gas.

Directions for all cleaning programs must be available and posted in writing for those carrying out the operation.

Absolutely never climb into any tank where there could be a lack of oxygen or chemical residues present. Some people are more sensitive than others to various chemicals.

Post emergency phone numbers and procedures as well as the farm location and directions to the farm near the phone.

Have a supply of water or an eyewash station available should an accident occur and make employees aware of how long they should flush their eyes or skin.
Dispose of empty chemical containers according to your local environmental laws. Many dairy farms have their own liquid nitrogen tanks to store semen. Please consult the Material Safety Data Sheet to avoid injury or death.

**Workplace Hazardous Materials Information System**

WHMIS is an important word in the field of health and safety in the workplace. WHMIS stands for the Workplace Hazardous Materials Information System and also refer to the workers right to know. Federal and Provincial legislation makes WHMIS a Country-wide system, implemented to protect the health and safety of workers through the provision of information and education about the use of hazardous products that they may use or be in contact with in the workplace.

There are three components to WHMIS

- !labels and labeling
- !Material Safety Data Sheets (M.S.D.S)
- !worker education and training

Information and instruction about WHMIS must be provided to all workers who work with, or who are in proximity to, a hazardous product. A worker who works with a hazardous product is anyone who stores, handles uses or disposes of the product or who immediately supervises another worker performing these duties.

In proximity” means, in the area in which worker health and safety could be at risk during use, storage, disposal maintenance or during emergencies. On the modern dairy farm, workers use all types of machinery in the course of their work day. Many of these machines produce excessive noise levels that can permanently damage their hearing. Tractors, grain dryer’s lawnmowers, chainsaws can produce noise levels that worker at risk.
If the noise is loud enough that you must raise your voice to be heard above the noise at three feet from another worker then it is probably loud enough to damage your hearing. In most jurisdictions, workers may be exposed to noise levels up to 85 dBA (decibels) during an 8 hour period. Working in levels above the 85 dBA level can occur but for short periods of time with the amount of exposure depending upon the decibel level. As the levels go up the time one can work in that noise comes down. Some typical farm noise levels would allow a worker to be in that environment for as little as 15 minutes before damage can occur. The damage caused by noise involves nerve loss resulting in hearing loss. Once the hearing is damaged by noise, there is no treatment that can correct it. That is why it is important to use hearing protection.

You can prevent hearing loss by:

Limiting the amount of time spent near the noise using proper mufflers, silencers and other engineering methods to reduce noise using noise barriers or sound absorbing materials.

Reducing exposure to noise from recreational activities after work.

Remember, once you have lost your hearing, you can never get it back.

**Safe Lifting and Carrying Techniques**

Improper lifting techniques are responsible for a large percentage of back injuries among agricultural workers.

Proper methods of lifting and handling protect against injury, and make work easier. You need to “think” about what you are going to do before bending to pick up an object. Over time, safe lifting technique should become a habit.

**Following are the basics steps of safe lifting and handling:**

Size up the load and check overall conditions. Don’t attempt the lift by yourself if the load appears to be too heavy or awkward. Check that there is
enough space for movement, and that the footing is good. “Good housekeeping” ensures that you won’t trip or stumble over an obstacle. Make certain that your balance is good. Feet should be shoulder width apart, with one foot beside and the other foot behind the object that is to be lifted.

Bend the knees; don’t stoop. Keep the back straight, but not vertical. Tucking in the chin straightens the back.

Grip the load with the palms of your hands and your fingers. The palm grip is much more secure. Tuck in the chin again to make certain your back is straight before starting to lift.

Use your body weight to start the load moving, then lift by pushing up with the legs. This makes full use of the strongest set of muscles. Keep the arms and elbows close to the body while lifting.

Carry the load close to the body. Don’t twist your body while carrying the load. To change direction, shift your foot position and turn your whole body. Watch where you are going.

To lower the object, bend the knees. Don’t stoop. To deposit the load on a bench or shelf, place it on the edge and push it into position. Make sure your hands and feet are clear when placing the load.

Make it a habit to follow the above steps when lifting anything—even a relatively light object.

Team lifting must be coordinated If the weight, shape, or size of an object makes the job too much for one person, ask for help.

Ideally, workers should be of approximately the same size for team lifting. One individual needs to be responsible for control of the action to ensure proper co-ordination. If one worker lifts too soon, shifts the load, or lowers it improperly, either they or the person working with them may be injured. Lifting heavy objects.
Safe lifting of heavy items requires training and practice.
For example, we’ve probably all seen a small person move heavy feed sacks with apparent ease. The secret lies in taking the proper stance and grip.
When equipment is available, it should be used to lift and carry heavy objects. Loaders, forklifts, hoists, etc. are made for this purpose. Getting help, lift as a team.
Keeping loads small. Keeping aisles and walkways clear of tripping hazards.
Making changes in the work area to minimize bending, lifting, pulling, pushing etc.
Doing repetitive tasks in a comfortable position at a comfortable height.

**Preventing Slips and Fall**
(Be aware of the danger)
Slipping on an icy surface or tripping over some objects tackled in a walkway can have serious consequences. In fact, a substantial number of farm workplace injuries and even some fatalities have resulted from what we might think of as a simple fall.

**Following are some examples that we can all relate to:**
It’s the end of a long day in the field. The tractor driver shuts down his machine, then jumps from the platform to the ground. He twists his ankle upon landing, and is on crutches for several days.
An oil slick remains on the shop floor following repairs to a tractor’s hydraulic system. No one takes the time to cover it with sand or cat litter, or clean it up. A worker slips on the slick surface, and gashes his forehead on the edge of an adjacent work bench.
Freezing rain has knocked out the main power grid. A farmer is using a PTO generator to provide lighting.
While checking on the equipment, he slips on a patch of ice and falls onto the PTO shaft, with fatal results. These are the kinds of incidents that could easily happen in just about any farm workplace. Management definitely has a responsibility to eliminate “slip and trip” hazards to the greatest extent possible. Workers need to adopt habits that will reduce their chances of being injured in a fall. Learn to recognize potential “slip and trip” hazards. Take steps to eliminate the hazards. Check with your supervisor if you come across something that you feel could be a threat to sound footing. Stay alert, and think about your actions, remember to look before you leap

**Hazard Elimination**

Keep all aisles and walkways free of clutter and debris. Follow the principle of, a place for everything, and everything in its place Clean up oil spills and other slippery materials immediately. Set aside a few minutes to put tools away and clean up debris at the end of the day. Work is more efficient and enjoyable in a clean, well organized environment. Install guard rails around clean-out openings in multi floored buildings. Spread sand and/or salt on icy surfaces if work has to be done in the vicinity. If the weather is particularly bad, consider putting the job off until conditions improve. Keep steps and platforms of tractors and other equipment clean and dry. Take the time to clean off mud, ice, snow, manure, grease, and other debris that can accumulate on these surfaces. Don’t carry tools chains, etc. on the platform. Slip-resistant safety footwear is a must for all workers.
The above are but a few examples of “good house keeping practices that should be followed to minimize “slip and trip” hazards. You can probably think of several others. It is really important to develop an awareness of potential hazards, and take the necessary steps to eliminate them before someone gets hurt.

Take extra care around machinery.
Slips, trips and falls around farm equipment can have fatal consequences. We’ve already stressed the importance of keeping steps and platforms clean. Here are some additional points to consider when working with machinery.

Never jump from a tractor. There is always the danger of catching clothing on pedals, levers, or other protruding parts. You could land on an uneven surface and injure your ankles, legs, or back.

Always use handrails, handholds, and steps to mount or dismount tractors and self-propelled equipment. Follow the 3-point system--either two hands and one foot, or one hand and two feet on the machine at all times.

Never try to operate equipment from any position other than the seat! Maintain safe operating speeds, and take a break when you are tired. Never allow passengers to ride along! They are much more likely to fall from a moving machine.

Always shut the power off and pocket the key before making repairs and adjustments. That way, if someone does fall onto the equipment, they won’t become entangled.

Take extra care when operating stationary equipment grain augers, generators, grinder-mixers, etc.
Stay well clear of the machinery while it is running. Try to maintain good footing in the surrounding area.
Most falls are needless and preventable accidents. You need to be alert on the job, and develop awareness of what could constitute a “slip and trip” hazard.

It is vital to “THINK” about actions before you take them.
That way, you’ll be more likely to recognize hazards, and take the steps necessary to eliminate or avoid them.

**Silo Maintenance**
From time to time, older tower silos collapse. Structural components can be weakened by seepage and the corrosive effects of silage acids. If damage is not repaired and routine maintenance is neglected, silo collapse is a distinct possibility.
You should seek professional advice concerning silo repairs if you suspect that concrete deterioration has occurred.
Following is a checklist of silo components that need to be assessed during silo inspection:
Wooden doors should be checked for rot and physical damage.
Check bolts and bolt heads for tightness and degree of corrosion.
Evaluate corrosion and physical damage to door steps and latches.
Cast iron hinge eyes should be tightened and assessed for corrosion.
Concrete door frames should be checked for deterioration and physical damage.
Doors must seat properly in their frames for latch systems to work effectively.
Replace wire rope on the unloader if signs of wear are evident.
Outside ladders should be fitted with structurally sound safety cages to prevent falls
**Skid Steer Loader Safety**

Most farming operations today use skid steer loaders for a variety of purposes. This versatile piece of equipment is used inside farm buildings as well as outside. Accidents with skid steer loaders can occur when conditions have changed due to weather or when untrained individuals operate them.

Before you begin operations read the operator’s manual.
Recognize the dangers.
The first step to avoiding danger while operating a skid steer loader is hazard recognition. Read, understand, and follow instructions in the manufacturer's operating manual and safety decals on the loader. Identify specific hazards associated with the equipment.
Carefully evaluate each task you wish to perform before starting work. For example, a skid steer loader bucket is a poor choice for a human lift because the bucket is designed to dump its contents. It has no guardrails and no way to prevent the bucket from dropping if hydraulic power fails.
Recognize secondary hazards.
Many accident victims recognize hazardous situations, but they misjudge the seriousness of the hazard because of secondary factors. For example, icy, muddy or manure covered surfaces make the work area slick and increase the risk of injury. Children in the work area can distract the operator, or limit operator vision.
In many situations you can’t eliminate the hazard while working but you can reduce the hazard. Remove or eliminate secondary factors that are under your control.
Keep the work area clean and uncluttered.
Control access to the work area and shut down operations when others enter it.
Consider human factors.
Skid steer operators can misjudge their ability to stop or avoid a dangerous situation.
This is common when operators work around powerful equipment every day and become comfortable with their ability to control the machinery. However, operators are limited by their reaction time. Time varies by individual and with age and physical condition. Human reaction time is not quick enough to avoid accidents with machinery.

Gravity
Gravity also is faster than human reaction. For example, it is very dangerous to reach underneath the hydraulic loader arm of a skid steer loader. If the hydraulic line breaks gravity could pull the loader bucket to the ground at a rate of about 9 feet in three-fourths of a second, and crush the extended arm of the operator.

Operating the Skid Steer Loader
Adjust the seat, fasten the seat belt, set the brake, and place transmission in park or neutral before cranking the engine.
Riders must never be permitted on a skid steer loader it is a one-person machine.
Visually check for the presence of others in the area and warn them away.
Be especially alert for children.
If the machine is started indoors leave the door or some windows open for ventilating the exhaust.
Operate with caution on uneven surfaces. Avoid steep slopes completely
If it is essential to drive over a bumpy surface, travel slowly and raise the bucket just high enough to clear the ground. Always travel up and down slopes never across.
Try to go around obstacles, rather than over or through them. Typical hazards include ditches and curbs. If these have to be crossed, reduce speed to maintain control, raise the bucket just high enough to clear the obstacle and cross at an angle.

Carry the load as low as possible. Avoid sharp turns and slopes with a raised load.

Always keep skid arms down when traveling or turning.

Stability of the machine decreases as the loader arms are raised. Also you need to keep the arms down to be able to see the front and sides of the machine.

Keep the back of the machine pointed uphill. Back up and drive down.

Operate with extreme caution near areas with a sharp drop off. The earth could shear and send your machine crashing to the bottom. The general rule is to stay as far away from the edge of the drop off as possible.

Do not undercut banks or materials that are piled high to avoid falling rocks or cave-ins.

Be alert, when back-filling, for unstable soils that could collapse under the weight of the machine.

Keep your feet on the pedals when operating the loader.

Use only approved attachments and buckets. Do not over fill buckets.

Carry bucket or attachments as low as possible.

Most skid steer loaders feature a quick attach system.

Always make sure that locking devices are in place even if you are switching attachments for only a few minutes. Otherwise, the attachment could break free and roll back down the loader arms, or fall onto a bystander.

Drive with caution and check behind you before backing up.

Load, unload, and turn on level ground.
With a full bucket go up and down slopes with the heavy end of the loader pointed uphill. With a full load the front carries the most weight. With an empty bucket go up and down slopes with the heavy end pointed up with no load the front of the loader is the heaviest.

Keep skid steer road travel to a minimum. It is safer and often more efficient to transport a loader on a trailer. If it is necessary to go on the road, be sure to display a slow moving vehicle sign on the rear of the loader and obey all traffic rules and regulations.

Before starting maintenance work, you should lower the loader arms, engage the parking brake, shut down the engine, remove the key, and tag the loader as “out of service”.

If it is necessary to carry out repairs with the loader arms raised, be sure to lock the arms in place.

Never leave the machine without first lowering the bucket, stopping the engine, setting the parking brake and placing the shift in park or neutral.

If stopping for any length of time lock the ignition and remove the key.

Never ram the attachment in to a manure pack or pile of material. The greatest amount of power is transferred to the wheels with minimal steering lever movement.

Drive slowly into the material, then raise the front of the attachment. Back away from the load with the bucket or fork tilted up.

Drive to the unloading site with the arms down. Stop raise the lift arms and drive forward slowly until the bucket is just over the spreader or pile. Be ready to lower the load quickly if the skid steer becomes unstable. Use the hydraulics to keep the bucket level while raising the loader arms. This will prevent the material from falling over the back of the bucket. Tilt the bucket fully forward to dump the load.
Because hydraulic failure is always a possibility, a loader must never be used as work platform or personnel carrier.
To backfill a trench, lower the lift arms and put the bucket’s cutting edge on the ground. Drive slowly into the material; push it into the hole. Tilt the bucket forward as soon as it clears the edge of the trench.
Never lift, swing, or otherwise move a load over anyone. Material could fall from the bucket and strike a person. There is also a risk of hydraulic system failure.
Take care when handling loose materials, such as rocks.
Lifting the load too high and rolling the bucket back too far could cause the objects to fall into the cab. That’s why it is so important to keep the attachment level while the arms are being raised.
Avoid dumping over a fence or similar obstructions that could enter the cab if the loader were to tip forward.

**Manure Gases**

Storage, pumping, mixing, spreading and cleaning-out can release large amounts of gases from decomposing manure. There are four gases of primary concern:

1- Hydrogen sulphide is a highly toxic gas that is heavier than air. It can cause dizziness, unconsciousness and death. At low concentrations it smells like rotten eggs, but at higher concentrations it deadens the sense of smell, and no odour can be detected.

2- Carbon dioxide is an odourless, tasteless gas that is heavier than air. It displaces oxygen in confined spaces, which can result in asphyxiation.

3- Ammonia is lighter than air. It has a pungent smell and can irritate the eyes and respiratory tract.

4- Methane is also lighter than air. The main hazard is explosion within flammable limits (5%–15% CH4). Explosive concentrations can occur
during agitation or when the gas is trapped in an improperly ventilated space. As methane is odourless, you will not be able to detect dangerous situations by smell.

**System design to minimize hazards**

Consideration of likely hazards and risks at the design stage can prevent or at least minimize the hazards during subsequent system operation. This is particularly important with confined spaces. Refer to state-based confined-space regulations for further information on situations that constitute a confined space and the duties of designers in such situations.

Under state OH&S acts, designers are required to consider safety in their designs. Where a confined space cannot be avoided, designers are required to either eliminate the need to enter the space or reduce as far as practicable the need to enter it.

For example, manure solids will settle in pumped sumps if held for more than 30 min, so some form of mechanical or hydraulic agitation is required (and has traditionally been installed) to obviate the need for the operator to enter the pit to remove solids. A thorough risk assessment at the design stage should highlight the need for such pumps and agitators to be easily removed rather than require someone enter the pit to perform routine maintenance.

System designers should also seek to eliminate the need to use tractors near the edge of effluent ponds (e.g. for agitating or pumping). Where this is not possible, safe systems of work should be specified and adopted, such as using low barriers or chocks to prevent the tractor from moving backwards. A suitable barrier would be required at every access point.

All design plans should include a description of safety procedures for management and maintenance specific to the farm. Plans should include a statement reminding farmers of the need to adopt safe working practices for
activities involving dairy effluent. Safe work practices are based on ensuring that workers have appropriate training for the task, have completed a Job Safety Analysis before starting the task, and receive adequate supervision while completing the task. A general list of risks and control measures is provided below.

**Checklist of risk controls**

The following checklist is a compilation of points raised by state-based guidelines (*Dairy Catch 2006, McDonald 2006, NSW Dairy Effluent Subcommittee 1999*) with additional information from (*Work Safe Victoria 2006*). The list focuses on effluent specific issues and does not preclude any other requirements (e.g. guards to be fitted electrical work to be carried out only by a qualified electrician).

**Collection and Conveyance**

Where pit and platform wash is piped directly to the effluent pond, install a water seal or gas trap to prevent gases from entering the dairy.

Flood wash tanks must be installed on stable foundations and supports. Supply engineering computations or drawings certified by a structural engineer before construction.

Children and inexperienced staff must not handle hydrant wash systems, as the high pressures and resulting forces can cause the nozzle to swing wildly.

Sumps and solids traps must be covered or surrounded by fencing (including a lockable gate) to exclude children and stock. In some cases, standard swimming pool fencing could be used.

Observe the requirements of confined-space regulations.
Do not enter manure pits without a respirator and an emergency plan. An observer who understands safe rescue procedures should supervise any manure pit work.

Do not smoke, weld, grind or use an open flame in a poorly ventilated area. Ensure that any exposed moving part on an effluent pump is guarded.

**Storage and Treatment**

Effluent ponds can form a substantial crust that supports subsequent weed growth. Although the crust may look like solid ground, it may not support the weight of a person or animal. Fence ponds immediately after construction to exclude children and stock.

A warning sign must be mounted on the fence near the entry gates saying ‘Danger—Manure Storage’

Locate fences a sufficient distance from banks to allow machinery access around the toe of the batter.

Eliminate the need to use tractors near the edge of effluent ponds where possible. If this is not possible, use barriers or chocks to prevent the tractor from moving backwards.

Machinery may collapse unstable or narrow embankments.

Investigate and rectify any evidence of slumping or undercutting, or embankments may collapse.

Maintenance and dislodging operations require extreme caution, as clay surfaces can become slippery when wet. Topping the embankment with gravel (at least to designated access points) will help maintain vehicle and pedestrian traction.

Avoid the frequent use of pond embankments as laneways unless width and gravel surfacing are provided. Additional Place a rescue rope and float within the fenced-off area around the pond.
Owing to the risks of gas ignition and explosion, a specialized safety plan is required for any farm with a covered pond or other digester. All farm machinery must be regularly maintained according to manufacturer's instructions, and all controls must be clearly marked. Do not use faulty machinery. Observe appropriate hygiene practices: no smoking, eating or drinking around the dairy; wash hand following contact with effluent and manure. Provide appropriate clothing and protective equipment such as gloves, aprons rubber boots, goggles and other skin protection, and ensure that it is worn by staff who come in contact with animal effluent and manure. Maintain or replace all personal protective equipment regularly. Avoid inhalation of aerosols during reuse of effluent for yard or alley washing or spray irrigation. Follow effluent and manure management guidelines; poor practices increase the health risks associated with flies and insects. Supervise children visiting the dairy. Whenever chemicals are used, read and understand the Material Safety Data Sheet for the chemical involved and follow the safety precautions prescribed. Vaccinate people for Q fever. Vaccinate livestock for leptospirosis.
References

**ASAE 2005,** 'Manure storage safety', ASAE Standard EP470, American Society of Agricultural Engineers, St. Joseph, Michigan, USA.


Part III. Hazards of Poultry Processing Plants

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Introduction

Direct contact seems to be the most common mode of entry of infectious agent in the employees working in slaughter houses. The employees of meat industry are at particular risks of acquiring many zoonotic infections, due to the close contact that exists between them and animals/tissue of animals during slaughtering or processing specially abattoir workers who slaughter different types of food animals such as cattle, buffalo, goat, sheep, camel, horse, pig, deer, reindeer, kangaroo, rabbit, poultry and fish [Haagsma et al., 2011].

Usually chickens come into the processing plant by truck and in cages. Poultry slaughter and evisceration processes begin with off-loading live poultry from transport trucks after arrival at processing plants. Following off-loading, workers typically shackle the birds in a hanging room after which they are stunned, killed, bled-out, and de-feathered. Evisceration, or
removal of the birds’ internal organs, follows during which the birds are washed and inspected. After evisceration, the birds are placed in chiller baths of water and **anti-microbial agents** to reduce **pathogen** loading. A variety of chemicals are present in facilities where poultry slaughter and evisceration occur that may present an occupational hazard. Potential exposures include **ammonia** used in refrigeration systems, chlorine or other antimicrobial chemicals applied by spray cabinets and dip tanks, and sanitation chemicals used to clean equipment. Exposures to high levels of carbon dioxide (CO₂) may result from the use of CO₂ as an **acidifying agent**.

Reports of health effects during poultry slaughter and evisceration have often included eye and respiratory irritation, thought to be related to airborne **chlorine** or other anti-microbial-related compounds. Similar to reports from poultry catchers at poultry houses and confinement units, respiratory symptoms have also been associated with exposures to organic dust and bacterial endotoxins generated during poultry shackling and hanging operations.

Temperature extremes may be experienced at workers in these types of facilities as well as high noise levels. Musculoskeletal disorders and occupational injuries have also been reported.

**I- Biological Hazards:**

Biological hazards, mainly bacterial, can cause either food borne infections or intoxications. A food borne infection is caused by a person ingesting a number of pathogenic microorganisms sufficient to cause infection as a result of their multiplication, e.g., Salmonellosis. A food borne intoxication is caused by the ingestion of preformed toxins produced by some bacteria
when they multiply and release toxin into the food product, e.g., staphylococcal enterotoxin. Nine pathogenic bacteria are frequently implicated in food borne illness and should be considered in assessing hazards to human health from the consumption of meat and poultry products. The following identifies and discusses the nine pathogenic microorganisms of concern.

1- **Campylobacter jejuni Infection [Campylobacteriosis]**

*Campylobacter* infection, or campylobacteriosis, is an infectious disease caused by bacteria of the genus, *Campylobacter*. Most human *Campylobacter* infections are caused by *Campylobacter jejuni*. *C. jejuni* transmission typically occurs through consumption of undercooked poultry and/or the handling of raw poultry. Accidental ingestion of 1 drop of raw chicken juice, which can contain as few as 500 organisms can constitute an infectious dose. Most people who become ill with *Campylobacter* infection get diarrhea, cramping, abdominal pain, and fever within 2 to 5 days after exposure to the organism. The diarrhea may be bloody and can be accompanied by nausea and vomiting. The illness typically lasts 1 week, and most cases do not require the use of antibiotics. Some infected persons have no symptoms. In persons with compromised immune systems, *Campylobacter* occasionally spreads to the bloodstream and can cause a life-threatening infection.

2- **E. coli Infection:**

Antimicrobial-resistant bacteria including *Escherichia coli* are common contaminants of the industrial broiler chicken environment. Occupational epidemiology studies of European broiler farmers and turkey farmers, as
well as broiler and turkey slaughterhouse workers, indicated that these populations were at increased risk of colonization with antimicrobial-resistant *E. coli* and *Enterococcus* because of their occupational exposure to these birds. Hemorrhagic colitis is the name of the acute disease caused by *E. coli* O157:H7. Foods associated with illness include: undercooked or raw hamburger (ground beef); in sporadic cases, other meat products and raw milk.

3- **Salmonella Infection [Salmonellosis]**

*S. typhi* and the paratyphoid bacteria are normally septicemic and produce typhoid or typhoid-like fever in humans and are predominantly human bacteria. Other forms of salmonellosis generally produce milder symptoms. *Salmonella* spp. are found in the intestinal tracts of warm blood animals. Foods associated with illness include: raw and cooked meats, poultry, eggs.

4- **Listeria monocytogenes:**

Listeriosis is the name of the general group of disorders caused by *L. monocytogenes*. Foods associated with illness include: cole slaw, cooked poultry, cooked meat, and raw milk, supposedly pasteurized fluid milk, and cheeses (particularly soft-ripened varieties). Its ability to grow at temperatures as low as 3°C permits multiplication in refrigerated foods.

5- **Clostridium perfringens**

Perfringens food borne illness is the term used to describe the common food borne disease caused by the release of enterotoxin during sporulation of *C. perfringens* in the gut. Foods associated with illness include: meat and poultry products and gravy.
6- **Clostridium botulinum:**
Food borne botulism (as distinct from wound botulism and infant botulism) is a severe food borne disease caused by the ingestion of foods containing the potent neurotoxin formed during growth of the organism. Botulism has a high mortality rate if not treated immediately and properly. Foods associated with disease include: meat products, such as sausages, seafood products, improperly canned foods, and vegetable products.

7- **Bacillus cereus:**
B. cereus causes food borne illness. There are two types of toxins - diarrheal and emetic (vomiting). Foods associated with illness include: boiled and fried rice, custards, cereal products, meats, vegetables, and fish; food mixtures such as sauces, puddings, soups, casseroles, pastries, and salads.

8- **Staphylococcus aureus:**
Staphylococcal food borne illness (staphylococcal enterotoxicosis; staphylococcal enterotoxemia) is the name of the condition caused by the enterotoxins that some strains of *S. aureus* produce and release into the food product. Foods associated with illness include: meat and meat products; poultry and egg products; egg, tuna, ham, chicken, potato, and macaroni salads; sandwich fillings; milk and dairy products; etc.

9- **Yersinia enterocolitica:**
Yersiniosis is the name of the disease caused by pathogenic species in the genus Yersinia. The disease is a gastroenteritis with diarrhea and/or vomiting, fever, and abdominal pain. Foods associated with illness include: meats, oysters, fish, milk, and chitterlings.
Other zoonotic hazards:
Many occupational zoonotic diseases of multiple etiologies are encountered in abattoir workers who deal with the slaughter of different species of food animals or birds for human consumption. As a result, abattoir workers constitute a major group at risk of occupational zoonosis, due to the close contact that exists between them and animals/tissue of animals or poultry during slaughtering or processing. They can be classified as:

Bacterial zoonoses:

1- Chlamyophila psittaci Infection/Psittacosis:

Chlamydia psittaci is a biological agent endemic in nearly all bird species, thereby posing a huge zoonotic reservoir. The bacterium causes a respiratory illness in psittacine birds (parrots and parakeets) and humans best known as ‘psittacosis’ or parrot fever. In non-psittacine birds (pigeons and poultry), the disease is often called ‘ornithosis’ or more generally ‘avian chlamydiosis’. The term psittacosis refers to humans, while avian chlamydiosis will be used as a more general term describing the disease in psittacine and non-psittacine birds. People at risk for psittacosis are bird fanciers and workers having occupational exposure to poultry. Unlike avian influenza, psittacosis is relatively unknown in the poultry industry. Nevertheless, several outbreaks of psittacosis in ‘poultry processing plants’ (PPP) have been described in past and present literature. Chlamydia psittaci is shed in bird droppings and respiratory tract excretions. Certain stress factors such as transport, changes in ambient conditions, overcrowding, and handling could activate or aggravate shedding. Transmission to the human respiratory tract epithelium through inhalation of contaminated aerosols
originating from feathers (wing flapping), excreta (dried), or environment (sand and cages) is the most frequent transmission route. Handling the plumage, carcasses, and tissues (dissection/evisceration) of infected birds and, in rare cases, mouth-to-beak contact or biting also present a zoonotic risk.

2- **Staphylococcal infection:**
It is primarily Respiratory disorders in exposed workers are, acute lower respiratory tract inflammation, asthma like syndrome, asthma chronic bronchitis, organic dust toxic syndrome, mucus membrane inflammation syndrome, hydrogen sulfide poisoning asphyxiation, carbon monoxide poisoning, infectious diseases and hyper sensitivity pneumonitis. The most dangerous ones to worker health are hydrogen sulphide (H₂S), carbon dioxide (CO₂), ammonia (NH₃) and methane (CH₄). It caused by Staphylococcus aureus, a Gram positive, non-sporelated and non-motile bacterium. The disease is recorded in cattle, buffalo, camel, horse, goat, pig, rabbit and poultry. Abattoir workers usually contracts infection while dealing with carcass of food animals. Lesions may appear as boil, pustule, furuncle and abscess on hands and arms of the workers.

3- **Tularemia:**
Is a disease also known as Deerfly fever, Rabbit fever and is caused by Francisella tularensis, a Gram negative, non-sporelated, aerobic organism. The disease is reported in rabbit, deer, horse, pig and calf. It is an occupational disease of rabbit butchers. The skinning of infected rabbits and hares is the common means of human infections. The first sign in man is usually a papule at the site of initial infection, often a finger which ulcerates. The organisms are carried by lymph notes which enlarge,
become painful and may suppurate. The disease is accompanied by fever, headache, muscular pain and lasts for 2-4 weeks. Mortality rate in ulceroglandular form is 5%. Transmission occurs by direct inoculation of organisms into the skin, mucous membrane or conjunctiva with diseased animals or their excretions/ tissues.

**Viral zoonoses:**

1- **Newcastle disease** :

It is a fatal disease of chicken, caused by Newcastle disease virus (RNA) of Family *Picornaviridae*. Persons working in poultry slaughter house get the infection. Transmission occurs by handling diseased poultry or carcass. The affected person shows redness, watery discharge from eye, edema of eye lids, conjunctivitis and subconjunctival hemorrhage.

**Bird flu**:

It is an emerging viral zoonosis which resulted a loss of over US Dollar 10.0 billion to Asian poultry Industry. Infection can be contracted with sick or dead birds and also during slaughtering, feathering and dressing of diseased birds. Disease is caused by influenza type A virus (H5N1) belonging to family *Orthomyxoviridae* (RNA). Patient shows high fever, chest pain, respiratory distress and hoarse voice. Biosecurity measures at poultry farm and use of protective clothing can help in control of disease [Pal, 2007]

**Fungal zoonoses:**

1- **Aspergillosis**:

Commonly known as brooder pneumonia is a highly fatal fungal disease and is principally caused by *Aspergillus fumigatus*. Infection is mainly acquired by inhalation. Sick person exhibits signs of low grade fever,
productive cough breathlessness and haemoptysis. Pal and Torres-Rodriguez [Pal 1990] recorded pulmonary aspergillosis in a poultry worker who was occupationally exposed to fungal spores of *A. flavus*. Use of face mask in poultry processing industry can prevent *Asperillus* infection.

**Prevention and control of occupational biological hazards:**

In July 1996, the USDA FSIS implemented the Pathogen Reduction HACCP System final rule. HACCP is a management system that addresses food safety through the analysis and control of biological, chemical, and physical hazards from raw material production, procurement, and handling to manufacturing, distribution, and consumption of the finished product. The process includes:

1. Microbial testing and pathogen reduction performance standards.
2. Sanitation standard operating procedures, which significantly reduce contamination of meat and poultry with harmful bacteria and reduce the risk of food borne illness.
3. Improving PPE availability.
4. Training and enforcement of proper hand washing.
5. Chiller tanks should be held between 20–50 ppm of chlorine.
6. Avoidance of cuts, abrasion, wound, immediate medical attention to the skin injury
7. High standard of personal hygiene
8. Vaccination of high risk groups.
9. Strict meat inspection of food animals
10. Elimination of disease in animals- birds
11. Health education of employees in meat industry and good coordination among physician and veterinarian.
II Chemical Hazards:

There are some areas in a poultry processing plant where workers may be exposed to harmful levels of chemicals or air contaminants. Where there are high levels of chemicals in the work area, engineering controls must be used to prevent or limit employee exposure to them. Protective equipment must be used as appropriate.

Chemical hazards can originate from four general sources:

1. Unintentionally added chemicals
   a) Agriculture chemicals: pesticides, herbicides, animal drugs, fertilizers, etc.
   b) Plant chemicals: cleaners, sanitizers, oils, lubricants, paints, pesticides, etc.
   c) Environmental contaminants: lead, cadmium, mercury, arsenic, PCBs.
2. Naturally-occurring chemical hazards: products of plant, animal, or microbial metabolisms such as aflatoxins, etc.
3. Intentionally Added Chemicals: preservatives, acids, food additives, sulfating agents, processing aids, etc.

Examples for chemical hazards:

1- Carbon dioxide:
Used in the form of dry ice in many poultry processing plants to keep meat cold while in holding areas and to quick freeze meat for shipping. Carbon dioxide is an odorless gas. Inhalation of high levels of carbon dioxide may cause an increase in the breathing rate, which can progress to shortness of breath, dizziness or vomiting.
2- **Ammonia:**
Ammonia or Freon may be present in a poultry processing plant as chemicals used for refrigeration. Ammonia may cause irritation of the respiratory tract and the eyes. Freon is hazardous only at extremely high exposure levels. Periodic monitoring of the work areas will help detect these chemicals before they can cause a serious health effect.

3- **Chlorine:**
Chlorine is sometimes added to the water used for washing chickens. In a diluted form, chlorine is a disinfectant and usually does not present a hazard. In a concentrated form, chlorine is a respiratory irritant that can cause breathing difficulties. Even at low levels, the prolonged exposure to chlorine may cause skin irritation for some workers.

4- **Solvents or compounds used in cleaning and degreasing operations:**
They are potential health hazards. These materials are used in the maintenance of equipment and in housekeeping. When such materials are used improperly, there is the potential for:

1. Inhalation of vapors that may cause a lack of coordination or drowsiness. Workers showing these symptoms should be immediately removed to fresher air.

2. Skin contact with cleaning compounds and solvents may cause dermatitis, ranging from simple irritation to skin damage. Products designed to remove fat and grease from equipment will also remove the natural oil barrier from the worker’s skin, leaving the skin unprotected.

3. Cleaning compounds and solvents may pose the hazard of being splashed into employees’ eyes. Where strong concentrations or caustic solution agents are used, protective eyewear should be used and eye wash stations should be readily available.
- Workers who use such compounds should be required to use appropriate protective equipment, such as gloves or barrier creams.

5- Vats, tanks or other enclosed spaces that may contain organic matter (skin, feathers, fat, offal and so forth) should be tested for the presence of **hydrogen sulfide or methane** produced by the decomposing organic materials. When entering a confined space, specific work practices must be instituted and respirators must be worn. Ventilation controls should be in place.

**Control of chemical hazards:**

For many years the Food Safety and Inspection Service has conducted a National Residue Program to monitor the occurrence of residues from hazardous chemicals in meat and poultry products. Under a HACCP regime, frontline responsibility for control of residues from animal drugs or environmental contaminants will move from the government to the industry, although the agency will continue to verify that these controls and preventive measures are effective.

Companies that slaughter livestock and poultry will probably find the FSIS National Residue Program Plan to be a useful document. The plan contains lists of compounds that might leave residues in the tissues of animals or birds, and provides some information on their relative risk through the rankings in the Compound Evaluation System. It provides information on which compounds FSIS has included in its annual testing program. It also provides information on the methods that are used to test for the compounds. Another FSIS document, the Domestic Residue Data Book, presents the results of FSIS testing. These data can help a HACCP team understand the overall hazards presented by various residues, although each
company should gather information about the residue control performance of its own suppliers.

**Preventive Measures**

1- All workers who have the potential for exposure to chemicals should be medically evaluated prior to working in areas where they may be exposed to chemicals.

2- Work areas that may expose workers to chemicals should be frequently monitored to detect exposure levels.

3- Good ventilation and airflow is usually sufficient to protect workers from harmful exposure.

4- Heavier concentrations may require local exhaust ventilation.

5- When monitoring indicates the possibility of overexposure, workers should use appropriate respirators. Such respirators must be fitted to each individual, and employees must be trained to use the respirators.

6- Workers who handle chemicals such as dry ice should wear gloves to protect their hands and fingers from frostbite.

7- Gloves and barrier creams can protect workers by preventing skin disorders from frequent contact with chemicals.

8- Any time there is the potential for exposure to strong concentrations of chemicals, planned work practices should be followed to prevent overexposure.

9- Where strong concentrations and caustic agents are used, protective eyewear should be worn and eye wash stations should be readily available.

10- Any workplace that uses hazardous chemicals is required to have a written hazard communication program in place. Among other things, the hazard communication program requires a label and safety data
sheet (SDS) for each hazardous chemical. The label and SDS must
provide numerous specified items of information to employees.
11- Additionally, employee training is required. The hazard
communication program is required by the Hazard Communication
Standard, 1910.1200, which defines a hazardous chemical as “any
chemical which is classified as a physical hazard or a health hazard, a
simple asphyxiant, combustible dust, pyrophoric gas, or hazard not
otherwise classified.”

III Respiratory Irritants:

Poultry industry employees can be exposed to a variety of respiratory
irritants. Chicken handlers or chicken growers experience the greatest
exposure to airborne contaminants such as:
1- Dust from feed grains.
2- Gases from decomposing manure and waste rendering.
3- Dander and feathers.
4- In the past, chlorine use in the facilities’ chiller baths and evisceration
lines for anti-microbial treatment of poultry carcasses and equipment
sanitation has often been suspected as a culprit. While chlorine may be
responsible for some of the symptoms, chlorine-related by-products
called chloramines were often implicated as a more likely cause of the
irritation symptoms. These by-products are the result of interaction
between the chlorine source and nitrogenous material from the poultry.

Symptoms:

NIOSH’s Health Hazard Evaluation (HHE) Program has responded to a
number of requests to evaluate reports of eye and respiratory irritation
among workers in poultry slaughter and processing facilities. Symptoms commonly reported in these facilities include:

1- Stinging or burning eyes, nose, and throat.
2- Sneezing or coughing.
3- Sore throat.
4- Shortness of breath or asthma-like symptoms.
5- Headaches and nausea.
6- Cough, shortness of breath, wheezing.
7- There are other respiratory illnesses that are uncommon diseases but can occur from infectious pathogens. Some of these are believed to spread to humans from infected vapors from evisceration in poultry processing. Symptoms include fever, chills, aching muscles, headache and inflammation of the lungs.

Once the birds are killed and plucked, the potential for exposure decreases rapidly. After the birds are through the preparation areas and move to processing, there is no longer a problem with airborne respiratory irritants.

**Potential Factors Contributing to Irritation Symptoms**

Poultry slaughter and processing facility managers should be aware of the many contributing factors commonly found in facilities where symptoms are reported. Knowledge of the multi-factorial nature of the issues can allow prompt action to address such symptoms. Investigations conducted by industrial hygienists from both NIOSH and USDA have commonly found the following factors (either alone or in combination) that appeared to have contributed to the irritation symptoms. It is recommended that poultry processing facilities focus on addressing these symptom-
contributing factors despite a lack of environmental sampling data for specific contaminants.

1- **Chlorinated Wash and Chiller Bath Water**

- excessive chlorine concentration in water
- increased numbers of chlorine sources on the equipment line
- increased water pressures on sprays resulting in aerosolization of a chlorinated water mist
- use of chlorine-containing cleaning chemicals during the cleaning shift without adequate ventilation prior to the start of the next work shift
- mixtures of chlorine, other chemicals, and organic materials in floor drains
- close proximity of chiller baths containing large quantities of chlorinated water to workers in the evisceration area
- chiller fill pipes located above the surface of water in chill tanks
- the addition of chlorine to chillers prior to the birds
- using carbon dioxide or other acid-based systems to lower water pH

2- **Ventilation**

- under-designed ventilation systems resulting in stagnant evisceration line locations receiving little to no fresh air
- lack of ventilation upgrades as new plant renovations are introduced
- presence of comfort fans on the evisceration line that may disrupt air flows patterns or blow directly on workers’ faces resulting in eye irritation or dryness
- airflow patterns and pressure imbalances that draw air from the areas of high chlorinated water use to areas of lower or no use of chlorinated water
- Lack of enclosure cabinets around wash stations to provide adequate local exhaust ventilation.
- Dust and gas levels are higher in colder months because buildings are open during warmer weather.

3- *Flock Variations*

- presence of bird diseases such as air sacculitis
- Presence of large amounts of ingesta and fecal contamination.
- The level of air contaminants increases with older birds.

4- *Processing stage*:

- In the poultry processing operations, exposure to respiratory irritants is heavier in the receiving area because of the activity of excited, nervous birds.
- Exposure is heaviest when birds are removed from their cages and live hung on conveyor lines.

Additionally, it is possible that individuals with pre-existing asthma, allergy, or sinus symptoms may experience an aggravation of these symptoms due to the exposure of even trace amounts of airborne chlorine compounds, particularly in high humidity environments. Furthermore, poultry proteins, viscera, fecal material or feathers/dander may also prompt or aggravate allergic reactions in susceptible workers. POULTRY INDUSTRY WORKERS, Evaluating Eye and Respiratory Irritation in Poultry Slaughter and Processing Facilities.
**Preventive Measures of respiratory irritants:**

1- The receiving area should be kept as clean and free from trash as possible.

2- Workers who unload trucks and crates and live hang the birds should wear personal protective equipment such as nuisance dust respirators.

3- Protective clothing and boots will help minimize exposure in this area.

4- Eye protection is useful to prevent particles of dust and dirt from getting into the eyes.

5- As the receiving area is primarily mechanized, good housekeeping practices and protective equipment are usually adequate to prevent problems associated with dust exposure.

6- Workers with sensitivity to airborne contaminants should not work in this area.

**IV- Slips and fall**

Floors and work areas in poultry processing will be wet because of the wet process and frequent cleaning required for sanitary reasons. Similarly, grease or fat from the birds will make floors and work areas slippery. Standing and walking in work areas with slippery floors increases the potential for slips and falls.

**Preventive Measures**

Good drainage is essential for work areas where there is wet processing. Boots and nonskid soles and floor mats with nonskid surfaces can be used to reduce the potential for slips and falls. Routinely scheduled cleaning during the work shift helps maintain a sanitary work environment and
reduces the buildup of grease and fat. Aisles and passageways where mechanical handling equipment is used should be clearly marked and be of sufficient size for safe clearance.[Berry et al. 2013]

V- Physical Hazards:

1- Noise:

Excessive noise can cause permanent hearing damage. Occupational hearing loss is one of the most common work-related illnesses in the United States. In poultry processing plants the most common area known to have noise is the defeathering (plucking) room as the plucking machine result in loud voice. OSHA standards require employers to maintain a hearing conservation program when employee exposure to noise is at or above an 8-hour TWA (time weighted average) of 85 dBA (decibels). The hearing conservation program requires noise or sound level monitoring. If the exposure is above 90 dBA, the program requirements include administrative or engineering controls to try to reduce exposure to or below 90 dBA. Annual audiograms are required for all employees exposed at or above 85 dBA. For exposure between 85 and 90 dBA, use of hearing protection is required under certain conditions. Hearing protection is required if administrative and engineering controls do not reduce the exposure to 90 dBA or less.

- NIOSH recommends removing hazardous noise from the workplace whenever possible and using hearing protectors in those situations where dangerous noise exposures have not yet been controlled or eliminated.
Preventive Measures
There are several ways to protect against potentially harmful noise sources. Engineering controls, such as
- Muffling noise by enclosing noisy equipment or moving parts, are preferred.
- Administrative controls, such as the rotation of workers, may in some instances be used to limit the amount of time each individual is exposed to high levels of noise.
- Hearing protectors may be necessary to attenuate noise levels. Whenever hearing protectors are used, each employee must be provided a choice of protector, must be individually fitted, and must be trained to use the protector(s). Figure 2 depicts three

Types of hearing protectors:

Three Types of Hearing Protectors are available:

<table>
<thead>
<tr>
<th>Type</th>
<th>Characters</th>
<th>Image</th>
</tr>
</thead>
</table>
| 1- Disposable foam-type ear plugs. | ➢ One size fits most people.  
➢ Comfortable and easy to use  
➢ Disposable after use. | ![Image 1](image1.jpg) |
| 2- Insert protectors    | ➢ most commonly used.  
➢ Many types and sizes available to ensure fit.  
➢ Made of rubber or silicone.  
➢ Last up to six months. | ![Image 2](image2.jpg) |
3- Muffs

- fit tightly over ears with cushions to ensure comfort.
- Various sizes and designs available
- Cushions can be replaced.

- Whatever type of hearing protector is used, it must be properly fitted and used correctly to provide adequate protection. Hearing protectors must be kept clean and stored properly.

2- Cold/Wet Environment

As birds move along in processing, they are washed and cooled with cold water. Temperatures in the poultry processing facilities are kept cool to prevent meat spoilage and to conform to USDA requirements that meat of the chicken be kept at 40°F. This produces a work environment that is wet and cold. Workers with poor circulation to the extremities (hands and/or feet) may experience increased discomfort in a cold and wet environment because of the additional constriction of blood vessels caused by the cold. Long-term exposure to a cool, damp environment also produces more discomfort for individuals with musculoskeletal disorders such as arthritis. Other chronic diseases that affect the nerves and blood vessels on the hands or feet can be aggravated by cold and wet work areas. As previously noted, the cool and wet environment required for chicken processing contributes to chapping of the skin and may aggravate skin disorders.
Preventive Measures:
1- Workers should wear warm clothing.
2- Where possible, protective clothing such as rubber aprons should be worn to keep clothing dry.
3- Rubber boots with heavy socks will keep the feet warm and dry.
4- In some areas where there is frequent handling of very cold meat, cotton gloves can be worn under rubber gloves to keep the hands warm.

3- Cold Stress

Workers who are exposed to extreme cold or work in cold environments may be at risk of cold stress. Extreme cold weather is a dangerous situation that can bring on health emergencies in susceptible people, such as those who work in an area that is poorly insulated or without heat.

Types of Cold Stress

1- Hypothermia

When exposed to cold temperatures, your body begins to lose heat faster than it can be produced. Prolonged exposure to cold will eventually use up your body's stored energy. The result is hypothermia, or abnormally low body temperature. A body temperature that is too low affects the brain, making the victim unable to think clearly or move well. This makes hypothermia particularly dangerous because a person may not know it is happening and will not be able to do anything about it. This can affect workers in refrigeration and storage areas.
2- Cold Water Immersion

Cold water immersion creates a specific condition known as immersion hypothermia. It develops much more quickly than standard hypothermia because water conducts heat away from the body 25 times faster than air. This hazard affects workers that deals with the immersion chilling step of poultry carcasses.

**Frostbite:**

Frostbite is an injury to the body that is caused by freezing. Frostbite causes a loss of feeling and color in the affected areas. It most often affects the nose, ears, cheeks, chin, fingers, or toes. Frostbite can permanently damage body tissues, and severe cases can lead to amputation. In extremely cold temperatures, the risk of frostbite is increased in workers with reduced blood circulation and among workers who are not dressed properly.

**Trench Foot:**

Trench foot, also known as immersion foot, is an injury of the feet resulting from prolonged
exposure to wet and cold conditions. Trench foot can occur at temperatures as high as 60 degrees F if the feet are constantly wet. Injury occurs because wet feet lose heat 25-times faster than dry feet. Therefore, to prevent heat loss, the body constricts blood vessels to shut down circulation in the feet. Skin tissue begins to die because of lack of oxygen and nutrients and due to the buildup of toxic products.

**Chilblains**

Chilblains are caused by the repeated exposure of skin to temperatures just above freezing to as high as 60 degrees F. The cold exposure causes damage to the capillary beds (groups of small blood vessels) in the skin. This damage is permanent and the redness and itching will return with additional exposure. The redness and itching typically occurs on cheeks, ears, fingers, and toes.
Recommendations for workers to avoid types of cold stress:

Workers should avoid exposure to extremely cold temperatures when possible. When cold environments or temperatures can not be avoided, workers should follow these recommendations to protect themselves from cold stress:

1- Wear appropriate clothing.
   - Wear several layers of loose clothing. Layering provides better insulation.
   - Tight clothing reduces blood circulation. Warm blood needs to be circulated to the extremities.
   - When choosing clothing, be aware that some clothing may restrict movement resulting in a hazardous situation.

2- Make sure to protect the ears, face, hands and feet in extremely cold weather.
   - Boots should be waterproof and insulated.
   - Wear a hat; it will keep your whole body warmer. (Hats reduce the amount of body heat that escapes from your head.)
VI- Skin affections:

1- Dermatitis

Skin disorders, or dermatitis, may be the most frequently occurring occupational illness. The skin, as the largest organ of the human body, is one of our most valuable weapons in preventing illnesses. For example, the skin allows us to cope with extremes in the environment, including temperature, moisture, wind and weather. Yet responses of the skin to the season of the year sometimes contribute to skin diseases. In warmer weather workers tend to wear less clothing so that there is greater likelihood of skin contact with irritants. In cold weather there is more potential for chapping from exposure to cold and wind. Overheated workplaces can cause skin to become dry and more easily damaged or even burns as in case of workers near boilers and scalding tanks in poultry processing plants.

Most occupational skin disorders begin on exposed skin such as hands or arms. Skin disorders include callouses and blisters caused by pressure and/or friction. Other skin disorders are burns and frostbite, which are caused by extremes of heat or cold. Biological agents such as plants or animals or bacteria can cause dermatitis.

Skin disorders range from red, chapped hands to lesions and eruptions. People with pre-existing skin diseases are more at risk of developing occupational dermatoses. Individuals with skin allergies may react to very small amounts of a substance to which they are allergic. Some employees who work in poultry processing develop skin rashes and dermatitis. This may be caused by contact with the water used to clean and rinse the chicken during preparation of the birds. It is important to wash hands and arms frequently with soap and water and to dry them thoroughly.
Individuals with pre-existing conditions should not work where the disorder could be aggravated. Because people who work in the poultry preparation department frequently expose their hands to temperature changes, they may experience chapped skin.

**Preventive Measures:**
- Personal cleanliness is the most important measure for preventing skin irritations or rashes.
- Thorough washing and drying of hands, arms, and other involved skin.
- The use of hand creams or water-repellent protective barrier creams may help in the prevention of occupational dermatitis.
- Several times during the work shift, the creams should be removed by washing with soap and water. The skin should be dried, and the creams should be reapplied.
- Particular jobs may require the use of rubber gloves to keep the skin out of contact with water. Protective equipment should fit correctly to prevent additional irritation from too tight a fit or from rubbing when the fit is too loose.
- Protective equipment should be inspected frequently, kept in good repair and replaced when necessary.
2- Cuts and Lacerations

Saws, knives and scissors are the tools used in cutting and deboning chicken. Saws are used to cut chickens into quarters and pieces. In the deboning process, the chicken carcass is placed in a cone on a conveyor line. At each work station a different cut is made to remove the legs, wings, skin, breast meat and thighs. Each operator on the line makes one or more specific cuts with a very sharp knife to remove specific portions of meat. Scissors are used to trim bone, gristle and fat from the meat. Tools that are sharp enough to cut meat will easily cut fingers.

Preventive Measures:

1- Personal protective equipment such as metal mesh gloves and arm guards will help to reduce the number of cuts or lacerations workers may experience in the deboning process.

2- Employees can be trained in methods and techniques that produce clean cuts and prevent injuries.

3- Knives and scissors must be kept very sharp, so that the appropriate cut can be made. Sharp tools also help reduce the force required to make the cut. Accidental injuries can be reduced by keeping knives and scissors in scabbards when not in use.

4- Sufficient space between operators will help prevent employees from accidentally cutting each other.

5- Saws used to cut the birds into quarters should have appropriate guards on the blade to protect the operator from injury. Adjustments to the saw must be accomplished when the power is off and the machine is stopped. Particular saws should have a lower guard that retracts when the saw is in use then automatically returns to the guard position. Appropriate grounding and insulation of the saws (and all electrical equipment) are necessary to prevent electrical hazards.
6- Minor cuts and lacerations should immediately be thoroughly washed with soap and water and treated with an antiseptic and dressing. Deep cuts or lacerations with loss of motion to the affected area should be referred to a doctor for treatment. Prompt treatment will help reduce infection and promote early healing. All injuries should be reported to supervisors.

VII- Traumatic Injury and Safety Hazards:

- Studies show that workers with jobs requiring frequent hand exertion may develop cumulative trauma disorders. Cumulative trauma disorders are injuries that develop gradually from repeated stress to a particular body part. Such disorders are also called “overuse” or “wear-and-tear” repetitive strain disorders. They occur primarily in the upper extremity and include soft tissue injuries such as muscle strain, tendonitis, neuritis and carpal tunnel syndrome.

- A number of things contribute to cumulative trauma disorders. Standing in one position for long periods of time can cause discomfort or strain to muscles of the back and legs, because the muscles remain in a position of contraction without allowing for periods of relaxation or movement. Similarly, the height of a work area may contribute to muscle strain for a very short or very tall individual because he or she may be forced to reach beyond a comfortable point.

- Often work requires the active use of the hand or arm, making the upper extremity vulnerable to trauma. The upper extremity includes the shoulder, upper arm, elbow, forearm, wrist, hand and fingers. The arm and hand move through actions of the joints, muscles and tendons. Upper extremity movement can range from large, sweeping motion to
fine, precise manipulation. Hands and arms work best in a neutral or natural position.

**Hand-wrist positions.**

<table>
<thead>
<tr>
<th>Position</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td><img src="image" alt="Normal Hand" /></td>
</tr>
<tr>
<td>(Hand in neutral position)</td>
<td></td>
</tr>
<tr>
<td>Flexion</td>
<td><img src="image" alt="Flexion Hand" /></td>
</tr>
<tr>
<td>(Bending the wrist down toward the palm)</td>
<td></td>
</tr>
<tr>
<td>Extension</td>
<td><img src="image" alt="Extension Hand" /></td>
</tr>
<tr>
<td>Bending the wrist up and back</td>
<td></td>
</tr>
<tr>
<td>Radial deviation</td>
<td><img src="image" alt="Radial Deviation Hand" /></td>
</tr>
<tr>
<td>(Bending the wrist toward the thumb)</td>
<td></td>
</tr>
<tr>
<td>Ulnar deviation</td>
<td>![Image of hand in ulnar deviation position]</td>
</tr>
<tr>
<td>-----------------</td>
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</tr>
<tr>
<td>Bending the wrist toward the little finger</td>
<td>![Image of hand bending the wrist toward the little finger]</td>
</tr>
<tr>
<td>Suppine position</td>
<td>![Image of hand in suppine position]</td>
</tr>
</tbody>
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**Cumulative trauma disorders in poultry processing workers:**

- **Sprain:**
  The joints of the upper extremity include the shoulder, elbow, wrist and fingers. Joints are formed where ligaments connect the end of one bone to another. When joints are twisted beyond their normal range of motion, sprain occurs.

- **Muscles are fiber bundles that contract to produce movement. Aching and swelling can result from small strains to muscles. Other injuries may result from the tearing of muscle fibers or from a blow or crush that causes blood to seep out into a large area of the muscle. Such injuries can cause serious damage to the muscle.**

- **Tenosynovitis:**
  Tendons in the wrist and hand are surrounded by a sheath containing a lubrication called synovial fluid. With overuse this fluid can decrease in amount, causing rubbing or friction between the tendon and the sheath.
• **Trigger finger:**
  Is a condition that occurs when the tendon sheath in the finger becomes very swollen and the tendon locks and is unable to move. Trigger finger occurs on the palm side of the finger.

![Trigger Finger Image](image)

• **The carpal tunnel:**
  Is a very small (2–3 centimeters) tunnel in the wrist. The walls of the tunnel are formed by the bones of the wrist and a tough ligament that wraps around the wrist bones. Tendons to flex the fingers, blood vessels and a nerve pass through the carpal tunnel from the arm to the hand. If there is swelling of the tendons or other conditions that use up space in the carpal tunnel, the nerve can be pinched or compressed. This can lead to pain, swelling and numbness in the fingers. As symptoms get worse, weakness and clumsiness will develop in the hand.
• **Thoracic outlet syndrome:**
  It is a case occur when nerves and blood vessels between the neck and shoulder can be compressed, causing numbness and tingling in the hand and fingers. Thoracic outlet syndrome can frequently be corrected by early diagnosis and an exercise program.

• **Ganglion cysts:**
  Are smooth, firm, round lumps often noticed on the back of the hand or wrist. These lumps are the most common to form on the hand. Usually they are painless, but a mild aching may be associated with them, especially if the tendons are involved. These cysts have fibrous walls filled with mucous-like material. Ganglion cysts sometimes follow injury, but it is not always possible to know the cause of the cysts.
Factors help the appearance of cumulative trauma in workers:

• The speed of work may be determined by the speed of a conveyor belt. For example, in chicken processing, the faster the conveyor line, the more frequent is the requirement for the cutting of chicken (the repetition of a specific task). Jobs that require frequent repetition of the task cause muscles to contract frequently, requiring more muscle effort and less recovery time. Force, for example, required to make a particular cut, either with a knife or scissors, can contribute to cumulative trauma disorders. Increasing the applied force increases muscle effort, decreases circulation to the muscles and causes greater muscle fatigue.

• Effort required to make a particular cut, either with a knife or scissors, can depend upon the sharpness of the tool. A dull instrument requires more force or exertion and contributes to cumulative trauma disorders.

• Continuous muscle contraction can cause tendons in the fingers to swell and become irritated.

• Forceful gripping may cause pressure on nerves from muscles or tendons, as may repeated movement. Hand and arm motions may include grasping, turning, applying pressure and pinching. These movements frequently result in stressful hand and wrist positions.

• Compression or pressure to nerves (and blood vessels) can also occur when tool handles are squeezed in the palm. Awkward hand motions are sometimes used to separate meat from chicken bones. One hand may hold meat while the other hand is holding the knife to make a specific cut. Scissors can rub on the sides of fingers, causing pressure and compression of nerves of the fingers.
• Non-work-related factors may contribute to cumulative trauma disorders. A pre-existing condition such as arthritis or a joint injury resulting from sports activity may increase the risk of further injury at work.

• A worker recovering from illness or a worker with a chronic disease is at increased risk of developing cumulative trauma disorders. Age, sex and body build can all contribute to cumulative trauma disorders.

Preventive Measures:
- Early recognition of problems and treatment of complaints has been very effective in reducing and preventing cumulative trauma disorders.
- Work methods should be examined and corrections made where practical and appropriate.
- Workplaces may need to be redesigned to better accommodate the area to the worker (ergonomic necessities).
- Workplace redesign may necessitate adjustable foot rests and stand/sit props to help relieve muscle strain and back pressure for workers in fixed, standing positions.
- Cushioned floor mats or shoes with cushioned soles will also be more comfortable for workers standing in one position. Frequent walk-around periods also help relieve muscle strain.
- Stackable or adjustable work stands can raise shorter workers to a more comfortable work position. However, care must be taken to see that such stands do not create a fall or trip hazard. Conveyors should be designed so that the maximum reach for workers is no greater than 13”–18”. Upward reaches should be no higher than shoulder level (preferably even lower); the higher the upward reach, the shorter should be the forward reach. The important factors in deciding the proper
dimensions of a workstation are the kind of work being done, the height at which the work will take place, and the size of the worker.

- Good knife sharpening equipment should be readily available for each worker required to use a knife. As previously noted, sharper knives reduce the force needed to make a cut. Preferably, sharpened knives and scissors should be issued on a regular schedule. However, if the employee is to touch up the cutting edge of a knife that has been sharpened by a full-time sharpener, he or she should be trained to perform the touch-up properly. Handles on scissors, knives and other tools should be proportionate to the size of the worker and designed to keep hands or wrists in a neutral position.

**The effect of the shape of a knife handle upon the repetitive positioning of the wrist.**

A. Straight knife handle causing deviation of the wrist when making a cut.  
B. Curved knife handle keeping Wrist straight when making a cut.
VIII- Other Reported Health Effects:

Asthma & Allergies:

Millions of people suffer from allergies caused by everyday exposures to agents such as dust mites, cat dander, and pollens. Agents encountered by workers can also cause allergic problems such as asthma, nasal and sinus allergies, hives, and even severe anaphylactic reactions. Examples of these work-related agents include animal proteins, enzymes, flour, natural rubber latex, and certain reactive chemicals.

In poultry processing plants, this can occur during daily exposure to dust and feathers especially in the receiving, offloading and hanging areas. Asthma is one of the more serious problems that can be caused by work-related allergy. It can cause recurrent attacks of symptoms such as wheezing, chest tightness, shortness of breath, and coughing. In severe cases, these symptoms can be disabling. Fortunately, when potential hazards are recognized, work-related allergies and asthma can often be prevented or their effects minimized.
References


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