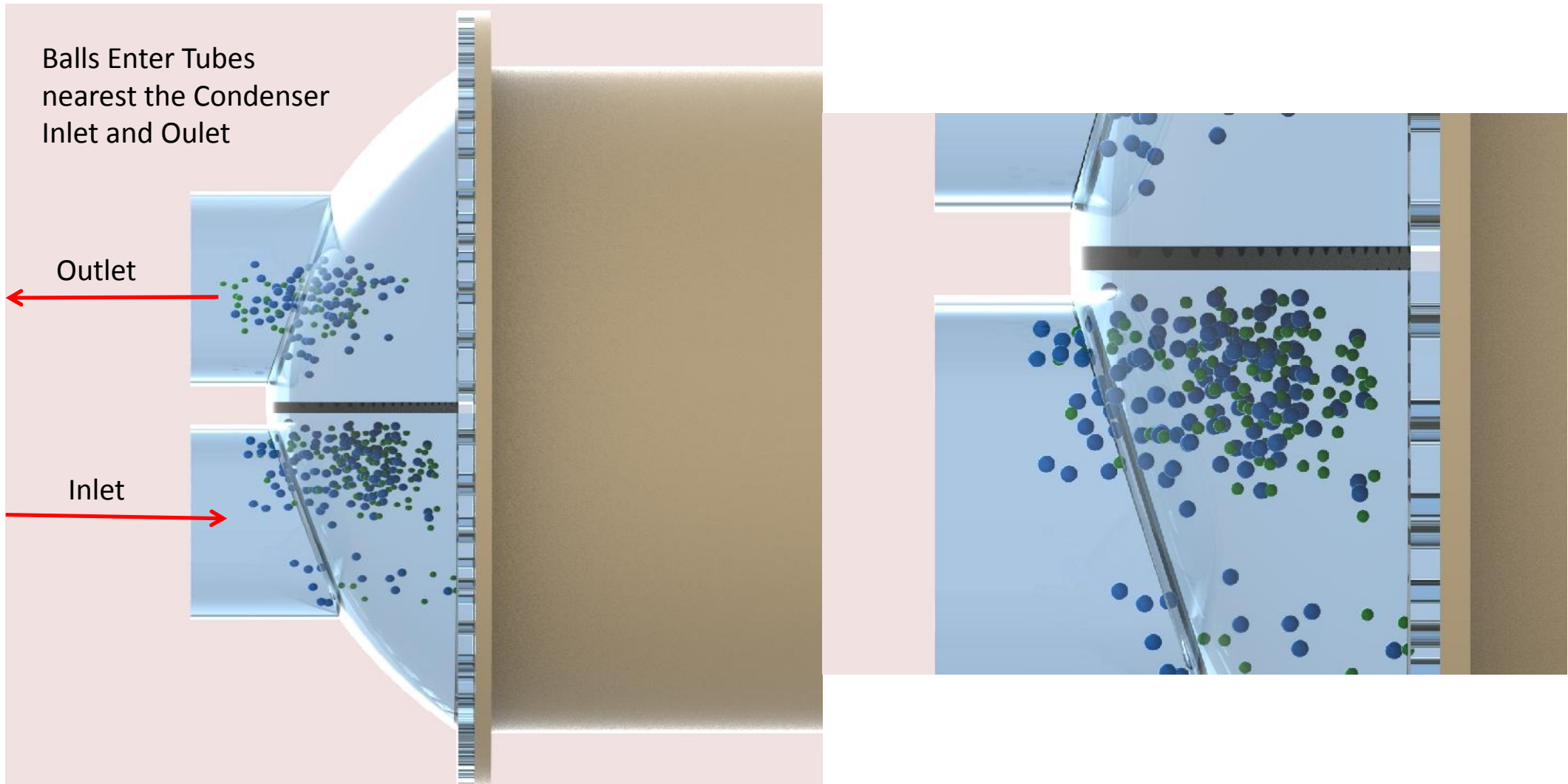


## Side view of Condenser

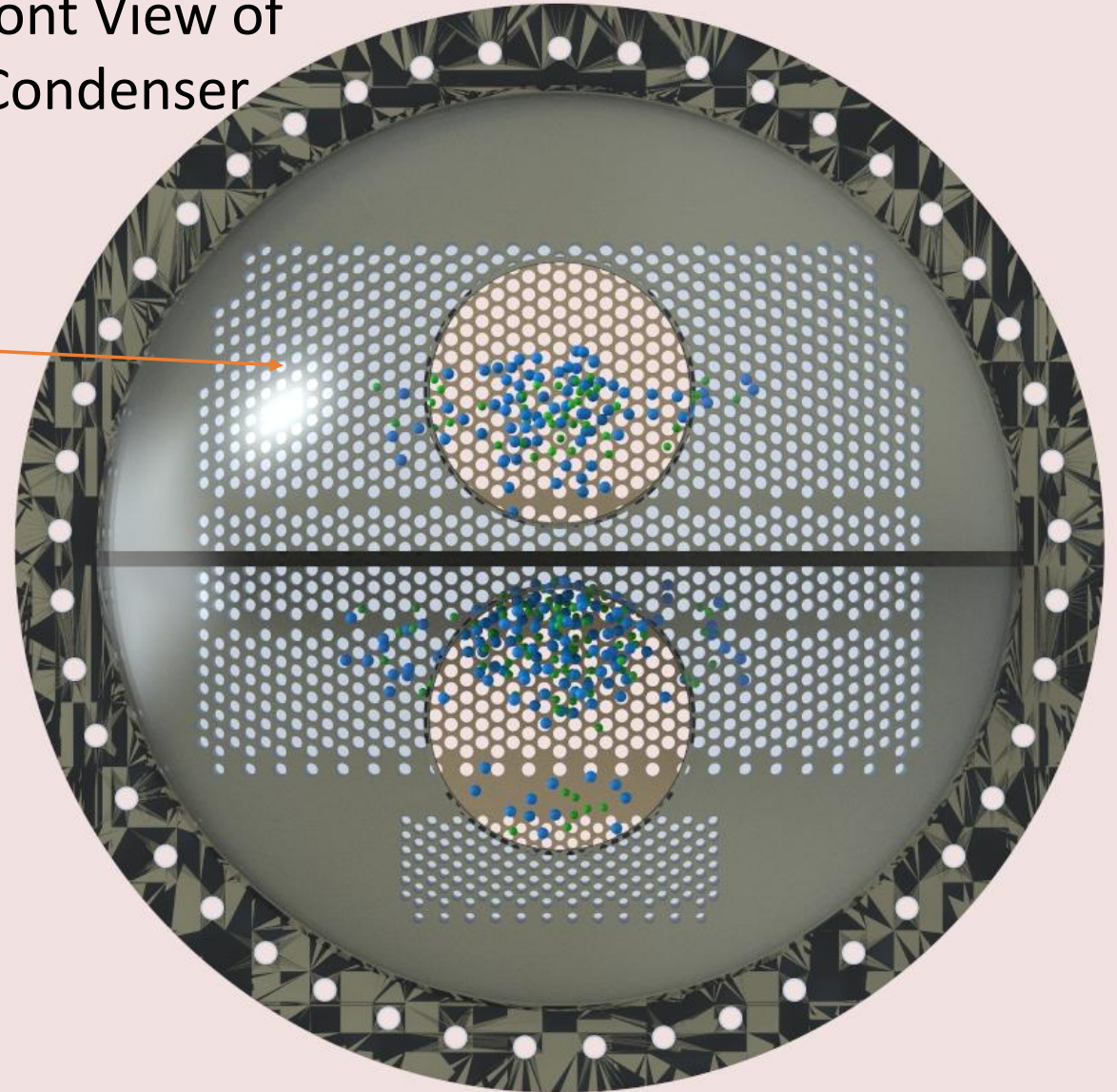


## Front View of Condenser

Tubes nearest the Condenser Inlet and Outlet Connection Receive Multiple Entries of Balls While **Tubes at Peripheral of Condenser Receive least amount of Ball Entries.**

**Peripheral Tubes** which comprise sometimes at least **60% of tube population** have low amount of Ball Entries gets **increasingly dirtier**.

Balls will have a hard time passing through tubes that are dirty and get **stuck in the tubes and prevent water from flowing resulting in reduction in heat exchanger efficiency**



# Heat Exchanger with 2 Different Sizes of Tubes

Bigger Main-Cooling Tubes 5/8 inch

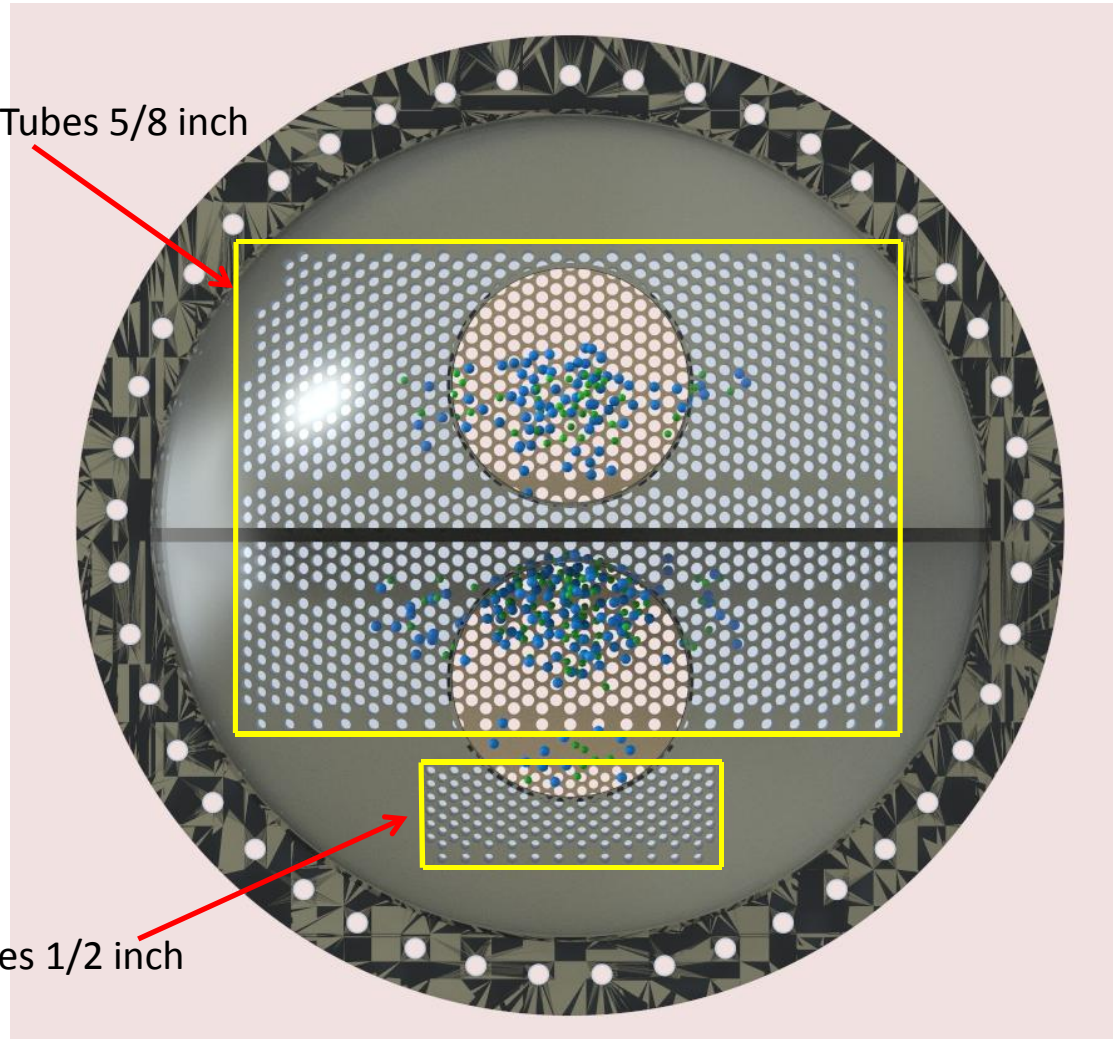


Blue Balls  
for 5/8 inch  
Main-Cooling  
Tubes

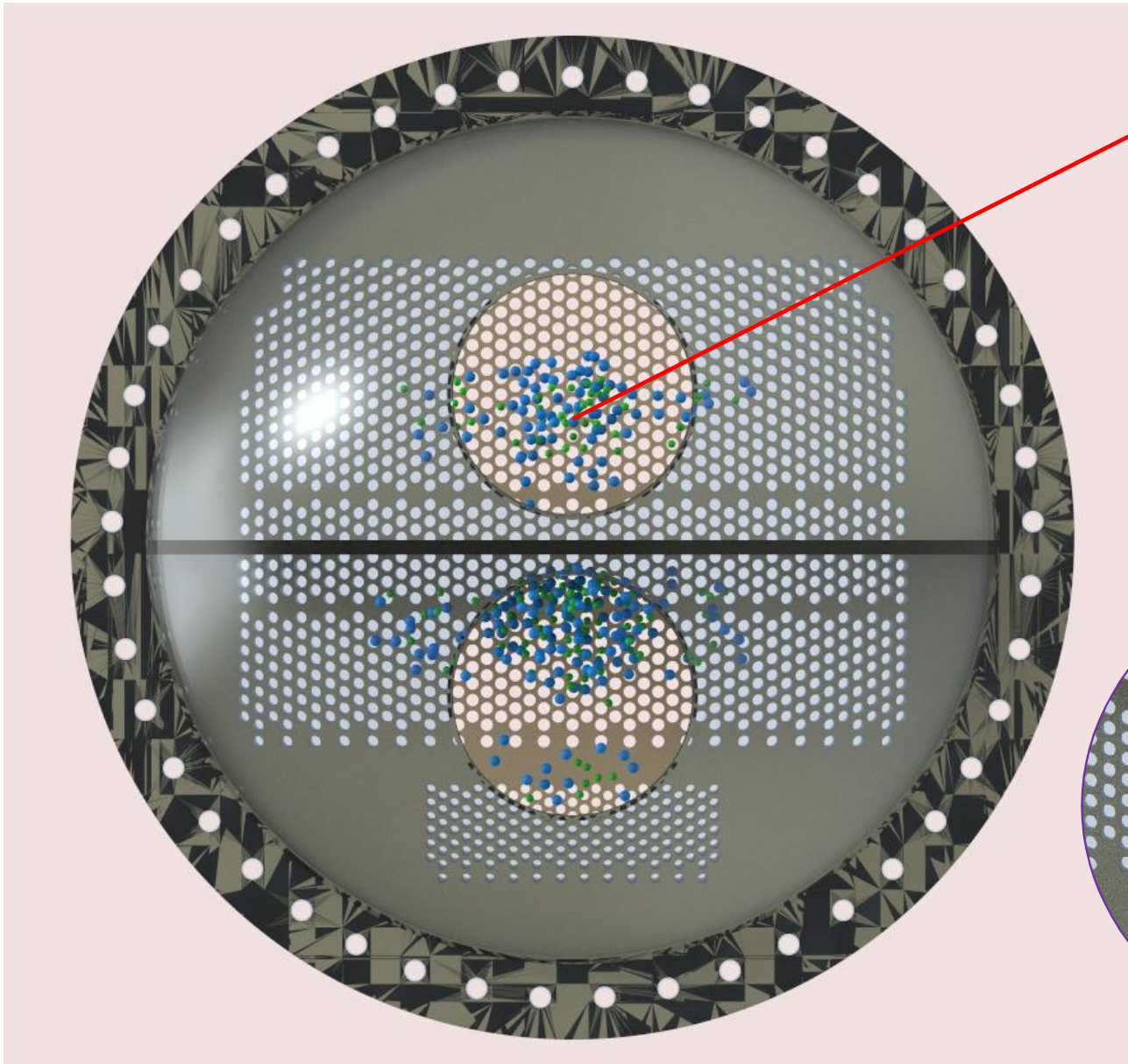


Green Balls  
for  
Sub-Cooling  
Tubes

Small Sub-Cooling Tubes 1/2 inch

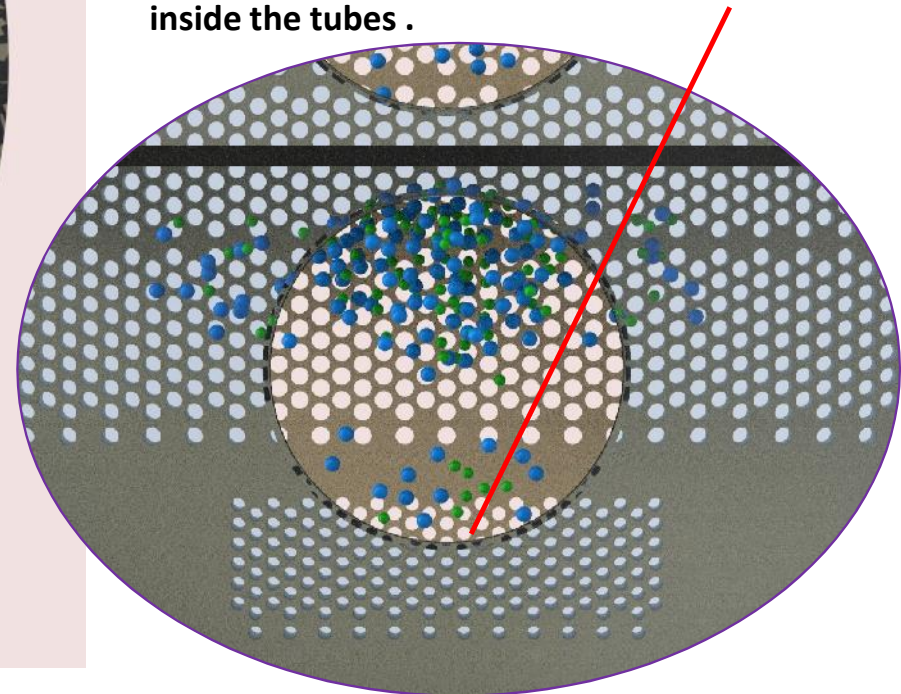






When Small Balls meant for subcooling tubes enter main cooling tubes – The small balls bounces inside the tubes and **cleaning of tube surface is sporadic**

When Bigger Balls meant for Main Cooling Tubes get worn out and attempt to enter the small subcooling tubes and **plugs up the mouth of the subcooling tubes. These balls though worn out are still too big for the smaller subcooling tubes. Balls there are even smaller and worn out move further into the tubes and get stuck inside the tubes .**



## **Random Movement and Probability Cleaning of Balls Result in Many Heat Exchanger Tubes Being Not Clean and Getting Dirty and Result in Balls Being Stuck in Tubes.**

There is no assigned ball for each individual tubes to ensure all tubes are **cleaned**. Tubes closest to condenser inlet and outlet receive many ball entries while tubes in peripheral area receive least amount of ball entries. When tubes are not cleaned regularly, fouling forms in these tubes that cause balls to clogged in these tubes.

Balls clean tubes by gathering dirt onto its own body. The dirty balls increase in size and are also unable to squeeze pass through the entire length of the tube.

### **Condenser with 2 Different Sizes of Tubes**

When condenser heat exchange have 2 different sizes of tubes, 2 different ball sizes can be use to match the different tube sizes.

Small balls match for small tubes when they enter the bigger tubes will result in no cleaning of the bigger tubes.

Bigger balls will eventually wear out and become small enough to enter small tubes but still not small enough to entirely pass through the length of the small tubes. This will result in in balls stuck in smaller tubes. The smaller tubes can be about 10% or more of the total tube population. When 10% or more of the tubes are obstructed and received no water flow, the heat exchanger will be severely compromised.

**Condenser Cover Divider Plate Partially Covering Part of Condenser Tubes in the Center Rows of Condenser Heat Exchanger resulting in Ball Being Jam at the Mouth of Tube Opening and Prevent Water from Flow Through These Tube**

Balls will attempt to enter the partially obstructed tubes by the condenser cover divider plate at the centre of the condenser. This balls that are jammed at the mouth of these tubes will cause water not to flow. The tubes population at the centre row of the condenser heat exchanger is often at least 10% of the total tube population. When water is not flowing through these tubes the heat exchanger will be severely compromise.

**Peripheral Tubes of Heat Exchanger will Receive Much Fewer Balls Resulting on Dirtier Tubes in Peripheral Area**

Balls enter and leave Heat Exchanger through the Condenser Water Inlet and Outlet. Tubes that are closest to the opening of condenser water inlet and outlet receive the most amount of entering balls as water nearest the condenser water inlet and outlet is the fastest moving. The peripheral tubes with slower moving water experience fewer and less frequent ball entry resulting in dirtier peripheral tubes.

Balls Entering Tubes that are dirty will result in balls being clog along the length of the tubes and block condenser water from being able to flow in these tubes.

Peripheral Tube quantity can be as much as 50% of the total tube population. When these tube are dirty not only will the heat exchanger effectiveness be compromised, it will result in balls not being able to fully pass through these tubes and obstruct the water flow of the tubes.

The random movement of the balls and not being able to target cleaning of all tubes results not only in unreliable cleaning but also results in affecting the proper heat exchanger function of the chiller and eventual increase in energy cost to operate the chiller failing the ball system original intended objective to reduce the energy use or at least keep energy increase at bay.

**Balls Clog at Ball Catcher Outlet and Rest of Balls Block the Rest of Opening of Strainer. Worn Out Balls Escaping Pass the Ball Strainer.**

Balls leave the Ball Catcher through a opening usually about 2 to 3 inch. Typically ball sizes are about 5/8 inch in diameter. As many balls rush out through this opening, it takes only a hand full of balls to clog an area of 2 to 2.5 inch. When the strainer outlet opening is obstructed the rest of balls will plug the opening of the strainer and result in reduce flow through the strainer and eventually reduction in water flow leaving the condenser heat exchanger.

The Ball Catcher is inline to condenser water outlet pipe. The Ball Catcher not only catches the balls but also catch large amount of dirt, cooling tower infill, rust bits etc that will reduce the condense water flow.

The Inline Ball Catcher will eventually need to be removed for cleaning.