# Normal operation

1. **Heating:** The model should be able to simulate a normal heating operation. It should be able to take in a charge, heat it and discharge it at a higher temperature than at which it entered the furnace. At any point during the heating operation, the model should be able to predict the temperature of the charge at that time.
2. **Uniformity:** Since the temperature uniformity within the charge is an important parameter which can effect the quality at the end use of the charge, the model should be able to track the variation of temperature within the charge as it undergoes heating.
3. **Movement:** If the charge needs to move through the furnace, then the model should be able to simulate such movement of the charge during the heating cycle.
4. **Heat balance:** The amount of energy consumed per ton of charge heated is an important KPI. Hence, the model should be able to estimate the heat to be added to the furnace at any time during the heating cycle, how much of it is going into the charge and how much of it is being lost from the walls of the furnace.
5. **L1 control:** The model should simulate an L1 controller which controls the furnace temperature. This includes taking in set temperatures for the furnace or the zones within the furnace and controlling the heat input so that the control action is always trying to maintain the furnace / furnace zones within a small band of the set temperatures.
6. **L2 control:** Since the discharge temperature and discharge uniformity are important quality parameters, there is benefit in having an L2 controller which sets the set temperatures in the furnace / furnace zones so as to achieve the discharge temperature and discharge uniformity so required. The L2 controller could also have an algorithm to choose the heating path based on a larger goal such as minimizing energy input.

# Scenarios

1. **Degradation:** The model should be able to simulate degradation of the furnace mainly by the increase of conductivity of the furnace walls thus causing more heat to be lost to the atmosphere and a concomitant drop in heating efficiency to the charge. Thus the amount of heat needed to be added to the furnace to achieve the same discharge temperature for the same charge in the same time should increase with time.
2. **Sensor failure:** The model should be able to simulate a sensor failure. This should be manifested in the L1 control system which should fail once erroneous sensor values start coming in.
3. **Actuator failure:** The model should be able to simulate a failure in the burner / heater. This should be manifested by an increase in the fuel / power rate to the burner / heater in order to achieve the same heat added to the furnace.
4. **Deviation in incoming charge:** The model should be able to simulate the downstream effects of a scenario when the incoming material is having variations in terms of its temperature or composition.
5. **Changes in productivity:** The model should be able to simulate changes in the rate at which the charge moves through the furnace and the effects due to the same.

# Overall

1. **Make sense:** The model should make sense it terms of the numbers it predicts under different scenarios. The temperatures, energy input, wall temperatures, charge temperatures as well as the changes in the same should make sense for the type of heating equipment under consideration. This should also be true for the changes that occur when different scenarios are simulated.