**Input:**

, Total Ship #

, Timestamp arrival of

, Ship volume of

, Ship docking cost of

, Total onboarding pipe # = Jetty #

, Total offboarding pipe # = Tank #

, Total transmission pipe # = pump #

, each pump capacity in unit time (15 mins)

, each jetty valve and each tank valve’s maximum capacity allowed

, each tank’s maximum capacity allowed

, each tank’s existing capacity

, the maximum timestamp that allowed for pumping any ship

, big M

**Decision Variables:**

five-dimensional binary matrix of dimension , each variable in the matrix represents if a ship is pumping from or to jetty , through pump , to or from tank , at time ;

three-dimensional binary matrix of dimension , each variable in the matrix represents if a ship is pumping from jetty at time ;

three-dimensional binary matrix of dimension , each variable in the matrix represents if a ship is docking at jetty at time ;

three-dimensional binary matrix of dimension , each variable in the matrix represents if a ship is pumping through pump at time ;

three-dimensional binary matrix of dimension , each variable in the matrix represents if a ship is pumping to tank at time ;

, one dimensional matrix of dimension , indicates the timestamp to start pumping for each ship;

, one dimensional matrix of dimension , indicates the timestamp to stop pumping for each ship;

two-dimensional binary matrix of dimension , each variable in the matrix represents if a ship is pumping at time ;

two-dimensional binary matrix of dimension , each variable in the matrix represents if a ship is docked at time ; has additional logistic time to dock and leave the jetty;

two-dimensional binary matrix of dimension , each variable in the matrix represents whether ship docks at jetty ;

two-dimensional binary matrix of dimension , each variable in the matrix represents whether ship exports to tank ;

**Objective Functions:**

**Constraints:**

1. Start to pump after arrival
2. The logic between and , ,
3. The logic between and , and , and
4. Jetty, pump and tank are activated if and only if within pumping time
5. During product transfer time, the ship must dock to one and only one jetty. Same for tank.
6. Total pump capacity through time is equal to the total volume of each ship
7. Pumping time should equal to the summation of time variable; Jetty docking time will be pumping time with additional logistic time 2
8. Pumping/docking time should be within start to stop
9. Each jetty, pump and tank can be only used by maximum one ship at any timestamp
10. Pipe pressure limit constraints
11. Maintenance constraint – unavailability of valves or pumps
12. Each tank has capacity limit

Additional Constraints:

1. Goods category differentiation, which means tank differentiation as well as pump flushing
2. Assume per day – we can set initial values