**BOROUGE TACTICAL PLANNING – MATHEMATICAL FORMULATION  
v4.0 – 1st July 2019**

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| **Parameters** | **Data to be specified** | **Units** |
|  | **Monomer production reactor, characterised by:** |  |
|  | Set of materials that can be used as raw materials for reactor | - |
|  | Minimum production rate of reactor when processing raw material | kte/d |
|  | Maximum production rate of reactor when processing raw material | kte/d |
|  | Mass of material produced/consumed when reactor processes unit mass of raw material | - |
|  | Operation cost of reactor per unit amount of raw material | k$/kte |
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|  | **Polymer lines, characterised by :** |  |
|  | Set of grades that can be produced on polymer line | - |
|  | Rate of production of grade in polymer line | kte/d |
|  | Minimum runtime for producing grade in polymer line | d |
|  | Operation cost coefficient of producing grade in line | k$/kte |
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|  | **Polymer grades, characterised by: , ,** |  |
|  | Conversion ratio between monomers and the grade polymer | - |
|  | Sale price of grade to customer | k$/kte |
|  | Demand of grade for customer during time period | kte |
|  | Inventory of polymer grade at IHP at start of horizon | kte |
|  | Minimum safety stock for polymer grade at IHP | kte |
|  | Minimum storage capacity for polymer grade at IHP | kte |
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|  | **Different types of materials including monomers, characterised by: ,** |  |
|  | Unit sale price of material to external customers | k$/kte |
|  | Unit purchase price of material | k$/kte |
|  | Maximum rate at which material can be sold to external customers | kte/d |
|  | Maximum rate at which material can be flared | kte/d |
|  | Inventory of material at start of horizon | kte |
|  | Minimum safety stock for material | kte |
|  | Maximum storage capacity for material | kte |
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|  | **Time periods, characterised by:** |  |
|  | Length of the period | d |
|  | Fraction of time available for actual production in polymer line for period | - |
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|  | **Customers, characterised by: and** |  |
|  | Penalty for incomplete delivery of order(s) to customer |  |
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|  | **IHP points, characterised by:** |  |
|  | Set of customers served from IHP |  |
|  | For lead time from Ruwais to the UAE Gateway  For to IHP | d |
|  | Amount of grade that arrives at IHP over period in shipments initiated before the start of the planning horizon | kte |

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| **Variables** | **to be determined by optimisation** | **Units** |
|  | Amount of material consumed in unit over period | kte |
|  | Production amount of monomer plant over period | kte |
|  | =1 if grade is produced on polymer line during period ; 0 otherwise | *binary* |
|  | Production amount of grade in polymer line over period | kte |
|  | Plant inventory level of material over period | kte |
|  | Amount of material purchased over period | kte |
|  | Amount of material sold by export over period | kte |
|  | Shipment of grade to IHP over period | kte |
|  | Inventory level of grade at over period | kte |
|  | Supply of grade from IHP to customer at period | kte |
|  | Amount of material flared over period | kte |
|  | Amount of grade ordered by customer at period that cannot be delivered | kte |

**Objective function**: maximise profit =

* + revenue from sales of polymers & materials produced by cracking
* - cost of raw materials
* - cost of operating monomer reactors & polymer lines
* - penalty of not fulfilling customer orders

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Production rate constraint for each monomer plant:

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Minimum runlength for producing grade in polymer line during period

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Zero production of grade in polymer line during period if not allocated:

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Total time allocated to grades in a particular polymer line over period cannot exceed the overall period duration:

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Inventory balance for monomer plant materials:

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Minimum safety stock and maximum storage capacity for raw materials:

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Bounds on purchases of raw materials for monomer reactors:

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Bounds on external sales of materials produced by monomer reactors:

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Bounds on materials that need to be flared:

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Polymer grade inventory balance at the UAE gateway ():

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Polymer grade inventory balance at other locations ()

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Minimum safety stock and maximum storage capacity for polymer grades:

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Demand fulfilment constraints:

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