A Knowledge Transfer Based Scheduling Algorithm for Large-Scale Refinery Production

——Supporting Materials

The Supporting Materials contain three parts, which are the mathematical formulation of the whole model (part A), parameters of refinery system (part B), and all model statistics and all order information of cases in Section IV-E (part C).

A. Mathematical Formulation of the Whole Model

Notation:

Binary Variables

$x_{u,m,m',\mathrm{t}} = 1$ if unit u is in the transition from operation mode m to m' during time interval t

$y_{u,m,\mathrm{t}} = 1$ if unit u is in operation mode m during time interval t

Continuous Variables

$INV_{oc,\mathrm{t}}$ = inventory of component oc at the end of time interval t

$INV_{o,\mathrm{t}}$ = inventory of product o at the end of time interval t

$PRO_{o,p,\mathrm{t}}$ = value of property p for product oil o during time interval t

$QI_{u,\mathrm{t}}$ = input flow of unit u during time interval t

$QO_{u,s,\mathrm{t}}$ = output flow of port s of unit u during time interval t

$QI_{u,oi,\mathrm{t}}$ = input flow of intermediate oil oi of unit u during time interval t

$QO_{u,s,\mathrm{t}}$ = output flow of intermediate oil oi of unit u during time interval t

$QI_{u,oc,\mathrm{t}}$ = input flow of component oil oc of unit u during time interval t

$QO_{oc,\mathrm{t}}$ = output flow of component oil oc during time interval t

$D_{l,o,\mathrm{t}}$ = delivery of product oil o for order l during time interval t

$Q_{oc,o,\mathrm{t}}$ = blending flow from component oil oc to product oil o during time interval t

$QI_{o,\mathrm{t}}$ = input flow of product oil o during time interval t

Auxiliary Binary Variable

$xy_{u,m,m',\mathrm{t}}$ = product of $y_{u,m',\mathrm{t}}$ and $(1-\sum_m x_{u,m,m',t})$

Auxiliary Continuous Variables

$xQI_{u,m,m',\mathrm{t}}$ = product of $x_{u,\mathrm{m},m',\mathrm{t}}$ and $QI_{u,\mathrm{t}}$

$xQI1_{u,m,m',\mathrm{t}}$ = auxiliary variable for linearization

$xyQI_{u,m,m',\mathrm{t}}$ = product of $xy_{u,m',\mathrm{t}}$ and $QI_{u,\mathrm{t}}$

$xyQI1_{u,m,m',\mathrm{t}}$ = auxiliary variable for linearization

Parameters

α = 75, inventory cost of component oil and product oil per period.

β = 30000, penalty for stockout of order per ton

OPC = 388, price of crude oil

$\mathrm{OpCost}_{u,m}$ = operational cost of unit u in the steady state of operation mode m

$\mathrm{tOpCost}_{u,m,m'}$ = operational cost of unit u in the transition from operation mode m to m'
$\mathrm{PRO}_{o,p}^{min}$ = minimum value of property p for product oil o
$\mathrm{PRO}_{o,p}^{max}$ = maximum value of property p for product oil o
$\mathrm{PRO}_{oc,p}$= value of property p for product oil oc
$\mathrm{R}_{l,o}$= demand for product oil o of order l
$\mathrm{TT}_{u,m,m'}$ = [3,2,1], time of the transition from operation mode m to m' of unit u
T_{l1} = start time interval for delivery of order l
T_{l2} = due time interval for delivery of order l

The model can be classified into two sets of constraints. The first set contains constraints for transitions between different operation modes. The second set describes the production constraints involving mass balance, capacity, blending, and delivery.

2.1 The first constraint set of operation mode switching process

Only one operation mode can run at any time for any unit.

$$\sum_{m \in M_u} y_{u,m,t} = 1 \qquad \forall\ u \in \mathrm{U}, t \in T \qquad (1\text{-}1)$$

The relationship between $x_{u,m,m',t}$ and $y_{u,m,,t}$ are as follows. If $x_{u,m,m',t}$ is equal to 1, it means that unit u is in the transition from mode m to mode m' during time interval t. Therefore, $y_{u,m,,t}$ must be equal to 1, and we have constraints (1-2). If $x_{u,m,m',t}$ is equal to 1, there must be a switch in the time period from $t - TT_{u,m,m'} + 1$ to t. Therefore, $y_{u,m,,t-TT_{u,m,m'}}$ must be equal to 1 and we have constraints (1-3). If $2 \le t \le TT_{u,m,m'}$, constraints (1-3) turn to constraints (1-4).

$$x_{u,m,m',t} \le y_{u,m',t} \qquad \forall\ u \in \mathrm{U}, t \ge 2, m \in M_u, m' \in M_u \qquad (1\text{-}2)$$

$$x_{u,m,m',t} \le y_{u,m',t-TT_{u,m,m'}} \qquad \forall\ u \in \mathrm{U}, t \ge TT_{u,m,m'}, m \in M_u, m' \in M_u \qquad (1\text{-}3)$$

$$x_{u,m,m',t} \le y_{u,m',1} \qquad \forall\ u \in \mathrm{U}, 2 \le t \le TT_{u,m,m'}, m \in M_u, m' \in M_u \qquad (1\text{-}4)$$

The operation units start in steady states, so the value of $x_{u,m,m',1}$ is 0.

$$x_{u,m,m',1} = 0 \qquad \forall\ u \in \mathrm{U}, m \in M_u, m' \in M_u \qquad (1\text{-}5)$$

If m equals to m', the value of $x_{u,m,m',1}$ is 0.

$$x_{u,m,m,t} = 0 \qquad \forall\ u \in \mathrm{U}, m \in M_u, t \in T \qquad (1\text{-}6)$$

The transition should be complete in the scheduling time horizon. This means that every unit is in a steady state at the last time interval.

$$\sum_{m} \sum_{m'} x_{u,m,m',T_{\max}} = 0 \qquad \forall\ u \in \mathrm{U}, m \in M_u, m' \in M_u \qquad (1\text{-}7)$$

It cannot start a new mode switching before a transition ends, therefore, the minimum stay constraints are needed.

$$TT_{u,m',m} y_{u,m,t-1} y_{u,m',t} \le \sum_{t'=t}^{t+TT_{u,m',m}-1} x_{u,m,m',t} \qquad \forall\ u \in \mathrm{U}, m \in M_u, m' \in M_u, t \ge 2 \qquad (1\text{-}8)$$

$$TT_{u,m',m} (y_{u,m,t-1} + y_{u,m',t} - 1) \le \sum_{t'=t}^{t+TT_{u,m',m}-1} x_{u,m,m',t} \qquad \forall\ u \in \mathrm{U}, m \in M_u, m' \in M_u, t \ge 2 \qquad (1\text{-}9)$$

2.2 The second constraint set of production

The general constraints of refinery scheduling are introduced as follows. Due to the consideration of transitions, some constraints become more complex than usual (for example, the constraints of mass balance constrain outflow ports for units).

This is mass balance constraints for outflow ports of units. If the units have more than one operation mode, the output of units is as follows.

$$QO_{u,s,t} = \sum_{m}\sum_{m'} x_{u,m,m',t} QI_{u,t} t Yield_{u,s,m,m'} + \sum_{m'} y_{u,m',t}(1 - \sum_{m} x_{u,m,m',t}) QI_{u,t} Yield_{u,s,m,m'}$$

$$\forall\ u \in \mathrm{U}, t \in T, s \in S \qquad (1\text{-}10)$$

Intermediate oil contains the output flow of each production unit and the mass balance constraints for intermediate oil are needed.

$$\sum_{u} QO_{u,oi,t} = \sum_{u} QI_{u,oi,t} \qquad \forall\ oi \in \mathrm{OI}, t \in T \qquad (1\text{-}11)$$

The inventory of each storage tank at the end of time interval t is equal to the inventory at the end of time interval $t-1$ plus the amount of flows entering the tank during time interval t and minus the amount of flows leaving during time interval t.

$$INV_{oc,1} = INV_{oc,ini} + \sum_{u} QI_{u,oc,1} - QO_{oc,1} \qquad \forall\ oc \in \mathrm{OC}, u \in U \qquad (1\text{-}12)$$

$$INV_{o,1} = INV_{o,ini} + QI_{o,1} - \sum_{l} D_{l,o,1} \qquad \forall\ o \in \mathrm{O}, l \in L \qquad (1\text{-}13)$$

$$INV_{oc,t} = INV_{oc,t-1} + \sum_{u} QI_{u,oc,t} - QO_{oc,t} \qquad \forall\ oc \in \mathrm{OC}, u \in U, t \geq 2 \qquad (1\text{-}14)$$

$$INV_{o,t} = INV_{o,t-1} + QI_{o,t} - \sum_{l} D_{l,o,t} \qquad \forall\ o \in \mathrm{O}, l \in L, t \geq 2 \qquad (1\text{-}15)$$

$$INV_{oc}^{\min} \leq INV_{oc,t} \leq INV_{oc}^{\max} \qquad \forall\ oc \in \mathrm{OC}, t \in T \qquad (1\text{-}16)$$

$$INV_{o}^{\min} \leq INV_{o,t} \leq INV_{o}^{\max} \qquad \forall\ o \in \mathrm{O}, t \in T \qquad (1\text{-}17)$$

The relationships between $QO_{oc,t}$ and $QI_{o,t}$ are as follows.

$$\sum_{oc} Q_{oc,o,t} = QI_{o,t} \qquad \forall\ o \in \mathrm{O}, t \in T \qquad (1\text{-}18)$$

$$\sum_{o} Q_{oc,o,t} = QO_{oc,t} \qquad \forall\ oc \in \mathrm{OC}, t \in T \qquad (1\text{-}19)$$

$$QI_{u}^{\min} \leq QI_{u,t} \leq QI_{u}^{\max} \qquad \forall\ u \in \mathrm{U}, t \in T \qquad (1\text{-}20)$$

The component oil used in blending has its minimum and maximum ratios

$$r_{oc,o}^{\min} \sum_{oc'} Q_{oc',o,t} \leq Q_{oc,o,t} \leq r_{oc,o}^{\max} \sum_{oc'} Q_{oc',o,t} \qquad \forall\ oc \in \mathrm{OC}, o \in \mathrm{O}, t \in T \qquad (1\text{-}21)$$

The properties of the product oil must lie between its minimum and maximum bounds. When calculating the product property in the blending process, the research octane number (RON), the cetane number (CN), and the sulfur content of gasoline and diesel are used linear models. By introducing the condensation point factor, the condensation point of blending diesel can also be calculated linearly. The properties of the flows entering the blenders are connected with the preceding production units.

$$PRO_{o,p}^{\min}\sum_{oc} Q_{oc,o,t} \le \sum_{oc} PRO_{oc,p} Q_{oc,o,t} \le PRO_{o,p}^{\max}\sum_{oc} Q_{oc,o,t} \quad \forall\ o \in \mathrm{O}, p \in \mathrm{P}, t \in T \tag{1-22}$$

Each order has a start time and a due time for the delivery. Product oil cannot be delivered before the start time and after the due time. The stockout penalty is calculated at the end of the scheduling time.

$$D_{l,o,t} \ge 0 \quad \forall\ l \in \mathrm{L}, o \in \mathrm{O}, t \in T \tag{1-23}$$

$$\sum_{t=1}^{T_{l1}-1} D_{l,o,t} = 0 \quad \forall\ l \in \mathrm{L}, o \in \mathrm{O} \tag{1-24}$$

$$\sum_{t=T_{l2}+1}^{T_{\max}} D_{l,o,t} = 0 \quad \forall\ l \in \mathrm{L}, o \in \mathrm{O} \tag{1-25}$$

$$\sum_{t} D_{l,o,t} \le R_{l,o} \quad \forall\ l \in \mathrm{L}, o \in \mathrm{O} \tag{1-26}$$

The bilinear terms are the product of a binary variable $x_{u,m,m',\mathrm{t}}$ and a continuous variable $QI_{u,\mathrm{t}}$. Two auxiliary continuous variables $\mathrm{x}QI_{u,m,m',\mathrm{t}}$ and $\mathrm{x}QI1_{u,m,m',\mathrm{t}}$ are introduced, and the following auxiliary constraints to realize the linearization.

$$xQI_{u,m,m',t} + xQI1_{u,m,m',t} = QI_{u,t} \quad \forall\ u \in \mathrm{U}, m \in \mathrm{M}_u, m' \in \mathrm{M}_u, t \in T \tag{1-27}$$

$$xQI_{u,m,m',t} \le x_{u,m,m',t} QI_{u,t}^{\max} \quad \forall\ u \in \mathrm{U}, m \in \mathrm{M}_u, m' \in \mathrm{M}_u, t \in T \tag{1-28}$$

$$xQI1_{u,m,m',t} \le (1 - x_{u,m,m',t}) QI_{u,t}^{\max} \quad \forall\ u \in \mathrm{U}, m \in \mathrm{M}_u, m' \in \mathrm{M}_u, t \in T \tag{1-29}$$

$$xQI_{u,m,m',t} \ge 0 \quad \forall\ u \in \mathrm{U}, m \in \mathrm{M}_u, m' \in \mathrm{M}_u, t \in T \tag{1-30}$$

$$xQI1_{u,m,m',t} \ge 0 \quad \forall\ u \in \mathrm{U}, m \in \mathrm{M}_u, m' \in \mathrm{M}_u, t \in T \tag{1-31}$$

The trilinear terms are the product of two binary variables, $y_{u,m',\mathrm{t}}$ and $(1 - \sum_m x_{u,m,m',t})$, and a continuous variable $QI_{u,\mathrm{t}}$. To try to linearize the trilinear terms, first an auxiliary binary variable $xy_{u,m',\mathrm{t}}$ is used to express the product of $y_{u,m',\mathrm{t}}$ and $(1 - \sum_m x_{u,m,m',t})$. The auxiliary constraints are as follows.

$$xy_{u,m',t} \le y_{u,m',t} \quad \forall\ u \in \mathrm{U}, m' \in \mathrm{M}_u, t \in T \tag{1-32}$$

$$xy_{u,m',t} \le 1 - \sum_m x_{u,m,m',t} \quad \forall\ u \in \mathrm{U}, m' \in \mathrm{M}_u, t \in T \tag{1-33}$$

$$xy_{u,m',t} \ge y_{u,m',t} + (1 - \sum_m x_{u,m,m',t}) - 1 \quad \forall\ u \in \mathrm{U}, m' \in \mathrm{M}_u, t \in T \tag{1-34}$$

$$xy_{u,m',t} \ge 0 \quad \forall\ u \in \mathrm{U}, m' \in \mathrm{M}_u, t \in T \tag{1-35}$$

$$xyQI_{u,m',t} + xyQI1_{u,m',t} = QI_{u,t} \quad \forall\ u \in \mathrm{U}, m' \in \mathrm{M}_u, t \in T \tag{1-36}$$

$$xyQI_{u,m',t} \le xy_{u,m',t} QI_{u,t}^{\max} \quad \forall\ u \in \mathrm{U}, m' \in \mathrm{M}_u, t \in T \tag{1-37}$$

$$xyQI_{u,m',t} \le (1 - xy_{u,m',t}) QI_{u,t}^{\max} \quad \forall\ u \in \mathrm{U}, m' \in \mathrm{M}_u, t \in T \tag{1-38}$$

$$xyQI_{u,m',t} \geq 0 \qquad \forall\ u \in \mathrm{U}, m' \in \mathrm{M}_u, t \in T \tag{1-39}$$

$$xyQI1_{u,m',t} \geq 0 \qquad \forall\ u \in \mathrm{U}, m' \in \mathrm{M}_u, t \in T \tag{1-40}$$

The objective function of the scheduling problem is to minimize the cost of production and material storage and penalties for stockout. The first term in the objective function is the cost of crude oil and the operational costs of units in transitions and steady states. The second term is the cost of material storages. The third term is the penalties of order stockout.

$$\begin{aligned}\min\ f = \min \sum_T (&QI_{ATM,t}OPC + \sum_u \sum_m \sum_{m'} x_{u,m,m',t} QI_{u,t} tOpCost_{u,m,m'} + \\ &\sum_u \sum_{m'} y_{u,m',t}(1 - \sum_m x_{u,m,m't}) QI_{u,t} OpCost_{u,m'}) + \\ &\sum_t \alpha(\sum_o INV_{o,t} + \sum_{oc} INV_{oc,t}) + \sum_l \sum_o \beta_l (R_{l,o} - \sum_l D_{l,o,t})\end{aligned}$$

Therefore, by the linearization expression mentioned before, the calculations of processing flow in the mass balance constraints of outflow ports for units and the objective function can be rewritten as follows.

$$\begin{aligned}\min\ f = \min \sum_T (&QI_{ATM,t}OPC + \sum_u \sum_m \sum_{m'} xQI_{u,m,m',t} tOpCost_{u,m,m'} + \\ &\sum_u \sum_{m'} xyQI_{u,m',t} OpCost_{u,m'}) + \\ &\sum_t \alpha(\sum_o INV_{o,t} + \sum_{oc} INV_{oc,t}) + \sum_l \sum_o \beta_l (R_{l,o} - \sum_l D_{l,o,t})\end{aligned} \tag{1-41}$$

B. Parameters of Refinery System

The operation modes, operational transitions, production costs, and yields for outflows of all production units are listed in Tables S1-S5. The production costs are measured by KgEo/t, and 1 KgEo is equal to 10000 kcal.

The parameter values involved in the scheduling problem are given in Table S6, which include transition times of production units, various upper and lower bounds, inventory and backorder penalty costs, initial holdup values, and crude oil price et al.

Table S1. Yields and production costs of ATM and VDU

State	ATM				VDU		Cost
	oil1(%)	LD(%)	oil 2(%)	oil 3(%)	oil 2(%)	oil 3(%)	(KgEo/t)
G	7.008	15.349	8.109	64.534	11.286	37.352	11
D	4.576	19.403	9.267	61.754	12.580	35.652	11.5
G-D	5.792	17.376	8.688	63.144	11.933	36.502	11.25
D-G	5.792	17.376	8.688	63.144	11.933	36.502	11.25

Table S2. Yields and production costs of FCCU

State	FCCU			Cost
	6(%)	2(%)	5(%)	(KgEo/t)
GG	45.664	22.216	5.02	58.
GD	42.583	23.104	5.01	57.
DG	42.261	23.418	4.15	56.5
DD	39.580	26.683	4.13	56.
GG-GD	44.12	22.66	5.015	57.5

GG-DG	43.96	22.82	4.585	57.25
GG-DD	42.62	24.45	4.575	57
GD-GG	44.12	22.66	5.015	57.5
GD-DG	42.42	23.26	4.58	56.75
GD-DD	41.08	24.89	4.57	56.5
DG-GG	43.96	22.82	4.585	57.25
DG-GD	42.42	23.26	4.58	56.75
DG-DD	40.92	25.05	4.14	56.25
DD-GG	42.62	24.45	4.575	57
DD-GD	40.92	25.05	4.14	56.25
DD-DG	41.08	24.89	4.57	56.5

Table S3. Yields and production costs of HDS and ETH

State	HDS	Cost	ETH	Cost
	HG(%)	(KgEo/t)	EG(%)	(KgEo/t)
GG	98.1	49.56	97.	28.98
GD	94.1	47.11	88.	27.18
DG	93.2	46.7	86.2	26.73
DD	90	44.66	79.	24.48
GG-GD	96.1	48.34	92.5	28.08
GG-DG	95.65	48.13	91.6	27.86
GG-DD	94.05	47.11	88	26.73
GD-GG	96.1	48.34	92.5	28.08
GD-DG	93.65	46.91	87.1	26.96
GD-DD	92.05	45.89	83.5	25.83
DG-GG	95.65	48.13	91.6	27.86
DG-GD	93.65	46.91	87.1	26.96
DG-DD	91.6	45.68	82.6	25.61
DD-GG	94.05	47.11	88	26.73
DD-GD	92.05	45.89	83.5	25.83
DD-DG	91.6	45.68	82.6	25.61

Table S4. Yields and production costs of HTU1 and HTU2

State	HTU1	Cost	HTU2		Cost
	RD1(%)	(KgEo/t)	RD2(%)	oil1(%)	(KgEo/t)
H	99.4	9	89	9	11
M	99.4	9	93	4	10
H-M	99.4	12	91	6.5	14
H-M	99.4	12	91	6.5	14

Table S5. Yields and production costs of RF and MTBE

MTBE	Cost	RF		Cost
mtbe(%)	(KgEo/t)	RD2(%)	oil1(%)	(KgEo/t)

120	13.84	90	10	83

Table S6. Parameter values in the scheduling problem

Parameter	Value
$TT_{ATM}^{m,m\prime}$, $TT_{VDU}^{m,m\prime}$	3 time intervals
$TT_{FCCU}^{m,m\prime}$	2 time intervals
$TT_{HDS}^{m,m\prime}$, $TT_{ETH}^{m,m\prime}$, $TT_{HTU1}^{m,m\prime}$, $TT_{HTU2}^{m,m\prime}$	1 time intervals
$r_{oc,o}^{min}$	0
$r_{mtbe,gaso}^{max}$	0.1
QI_{ATM}^{min}	200t/h
QI_{ETH}^{min}	5t/h
QI_{HTU1}^{min}	5t/h
QI_{HTU2}^{min}	300t/h
crudeprice	388 ¥/t
Stockout punishment	30000 ¥/t
apc	0.5
apo	0.7
aps	-20

C. Order Information

27 cases are used to validate the efficiency of the proposed algorithm in Section IV-E. These cases mainly show the efficiency of the proposed algorithm. There are nine kinds of scheduling lengths of 50, 70, 100, 120, 140, 160, 180, 190, and 200 time slots in this section. In the following tables, “Ini_OC” means the initial inventories of component storage tanks; “Ini_O” means the initial inventories of product storage tanks. The model statistics of all cases in Section IV-E are shown in Table S7. All order information is shown in Table S8.

The information of four cases in Section IV-C is cases 8, 9, 26, and 27 in Table S8.

Table S7 Statistic of reduced model scale in Section IV-E

Num. of slots	cases of Sec. IV-D	Num. of Cons	Num. of Vars	Num. of Binarys	Num. of nonzeros
50	1	23134	14706	2504	71144
	2	22970	14752	2504	71236
	3	23150	14842	2504	71416
70	4	32674	21158	3544	101348
	5	32690	20550	3544	100132
	6	32706	21070	3544	101172
100	7	47032	29832	5104	144646
	8	47048	32152	5104	149286
	9	47072	33776	5104	152534
120	10	56644	41660	6144	185602
	11	56652	41484	6144	185250
	12	56660	41500	6144	185282
140	13	66144	44912	7184	209406

	14	66160	45736	7184	211054
	15	66176	47400	7184	214382
160	16	75716	53332	8224	243546
	17	75732	50620	8224	238122
	18	75748	54964	8224	246810
180	19	85272	60032	9264	274246
	20	85228	59456	9264	273094
	21	85312	63024	9264	280230
190	22	90042	62302	9784	287436
	23	90057	62588	9784	288008
	24	90082	68246	9784	299324
200	25	94812	66892	10304	305266
	26	94828	66068	10304	303618
	27	94852	68980	10304	309442

Table S8 Order information of Section IV-E

Case	Order No.	JIV93	JIV97	GIII90	GIII93	GIII97	GIII0	GIM0	GIV0	starting slot	ending slot
1	1	29	21	20	30	21	162	91	198	25	47
	2	10	26	39	25	27	170	90	119	7	19
	3	15	20	35	30	39	191	102	149	20	46
	4	25	17	22	38	37	159	100	159	3	19
	5	28	11	21	29	11	99	128	145	16	34
	6	18	22	30	33	39	173	94	138	15	37
	7	25	31	35	31	22	127	116	102	1	16
	8	19	20	29	31	35	110	59	110	7	20
	9	27	10	19	27	22	111	98	101	23	49
	Ini_OC	17	16	0	15	6	17	12	34		
	Ini_O	5	0	1	0	6	5	15	21		
2	1	16	15	21	28	33	113	170	131	12	32
	2	47	28	29	58	43	218	109	120	9	46
	3	18	39	47	49	50	290	119	141	2	13
	4	15	27	37	32	22	192	110	163	3	16
	5	36	25	16	25	23	182	122	253	10	37
	6	47	53	56	51	46	134	131	82	14	29
	7	22	35	35	36	45	195	181	213	9	15
	8	49	45	46	46	59	219	110	207	20	49
	9	44	57	55	42	56	230	72	180	24	45
	10	45	69	67	36	46	219	129	228	14	39
	Ini_OC	0	0	0	0	0	0	0	0		
	Ini_O	0	0	0	0	0	0	0	0		
3	1	50	49	57	29	49	259	189	202	0	35
	2	39	58	43	50	45	175	88	223	13	39

	3	28	43	46	55	50	189	287	253	4	45
	4	37	43	49	60	51	263	106	263	15	38
	5	30	39	59	70	38	152	202	147	13	27
	6	40	45	58	45	72	280	104	241	15	37
	7	27	49	60	79	38	232	210	196	22	49
	8	41	37	32	49	46	198	50	187	7	31
	9	40	47	65	63	45	143	104	194	15	25
	10	4	58	45	47	52	98	150	123	24	29
	11	32	57	40	45	57	93	126	119	4	17
	Ini_OC	17	16	0	15	6	17	12	34		
	Ini_O	5	0	1	0	6	5	15	21		
4	1	33	42	38	52	49	252	199	279	3	52
	2	41	56	28	52	42	228	270	246	27	69
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	4	42	50	60	40	59	261	238	283	7	23
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	6	47	61	48	50	52	182	197	228	19	37
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	8	35	47	79	34	43	171	256	242	11	43
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	14	41	41	22	57	23	248	143	250	12	63
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	16	30	20	50	31	33	118	155	177	1	38
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	18	41	41	24	27	33	249	143	150	28	69
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	21	27	38	31	45	44	264	151	149	62	165
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	7	8	53	31	44	22	146	170	243	64	174
	8	35	42	16	35	43	169	228	153	24	78
	9	28	43	41	24	22	146	180	143	6	68
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	20	43	47	64	67	51	150	112	254	162	197
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	30	63	46	46	64	45	182	148	225	96	199
	Ini_OC	7	6	0	5	6	7	2	4		

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