

80	0	0	961.68987	0	3002	1667.00000	961.68987	42.3%	-	34s
81	0	0	962.09623	0	2676	1667.00000	962.09623	42.3%	-	35s
82	0	0	962.18511	0	2975	1667.00000	962.18511	42.3%	-	37s
83	0	0	962.21208	0	2997	1667.00000	962.21208	42.3%	-	37s
84	0	0	962.53494	0	3091	1667.00000	962.53494	42.3%	-	38s
85	0	0	962.60177	0	3046	1667.00000	962.60177	42.3%	-	40s
86	0	0	962.62358	0	2933	1667.00000	962.62358	42.3%	-	41s
87	0	0	962.85109	0	2834	1667.00000	962.85109	42.2%	-	42s
88	0	0	962.87949	0	2519	1667.00000	962.87949	42.2%	-	43s
89	0	2	963.01800	0	2479	1667.00000	963.01800	42.2%	-	46s
90	38	29	1015.75755	12	2725	1667.00000	965.05561	42.1%	269	50s
91	H 42	33			1601.0000000	965.05561	39.7%	243	75s	
92	268	268	1031.21054	69	2672	1601.00000	965.05561	39.7%	43.5	80s
93	469	454	1081.63996	118	2308	1601.00000	965.05561	39.7%	44.5	85s
94	714	705	1093.22176	164	2007	1601.00000	965.05561	39.7%	47.5	90s
95	H 1084	1030			1599.0000000	965.05561	39.6%	32.6	105s	
96	1085	979	1011.74125	23	48503	1599.00000	965.05561	39.6%	32.5	110s
97	1087	980	1042.04038	197	2403	1599.00000	965.05561	39.6%	32.5	130s
98	H 1087	931			1595.0000000	1518.00000	4.83%	32.5	166s	
99	1089	842	1518.00000	234	459	1595.00000	1518.00000	4.83%	32.4	208s
100	1090	842	1518.00000	197	366	1595.00000	1518.00000	4.83%	32.4	228s
101	1091	843	1518.00000	248	400	1595.00000	1518.00000	4.83%	32.4	235s
102	1092	844	1518.05886	80	405	1595.00000	1518.05886	4.82%	32.3	261s
103	1093	802	1518.05954	169	347	1595.00000	1518.05954	4.82%	32.3	270s
104	1094	803	1519.54559	144	391	1595.00000	1519.54559	4.73%	32.3	286s
105	1095	804	1521.91323	37	444	1595.00000	1521.91323	4.58%	32.2	291s
106	1097	805	1522.08874	187	524	1595.00000	1522.08874	4.57%	32.2	297s
107	H 1097	764			1594.0000000	1522.08874	4.51%	32.2	298s	
108	1099	765	1522.08914	131	779	1594.00000	1522.08914	4.51%	32.1	305s
109	1100	766	1522.08914	178	520	1594.00000	1522.08914	4.51%	32.1	313s
110	1102	767	1524.00000	236	727	1594.00000	1524.00000	4.39%	32.0	316s
111	1104	769	1525.04251	83	739	1594.00000	1525.04251	4.33%	32.0	337s
112	H 1104	730			1590.0000000	1525.04251	4.09%	32.0	354s	
113	1105	730	1526.42379	168	431	1590.00000	1526.42379	4.00%	32.0	359s
114	1106	731	1528.03505	148	373	1590.00000	1528.03505	3.90%	31.9	361s
115	1111	697	1529.38254	211	757	1590.00000	1529.38254	3.81%	31.8	369s
116	1112	698	1529.69464	121	723	1590.00000	1529.69464	3.79%	31.8	371s
117	1114	664	1529.73400	102	1076	1590.00000	1529.73400	3.79%	31.7	376s
118	1118	667	1530.96667	235	1082	1590.00000	1530.96667	3.71%	31.6	380s
119	1120	668	1531.07230	137	1075	1590.00000	1531.07230	3.71%	31.5	385s
120	1125	638	1531.55874	106	1177	1590.00000	1531.55874	3.68%	31.4	390s
121	1128	640	1531.57404	99	1172	1590.00000	1531.57404	3.67%	31.3	395s
122	1130	641	1531.57467	63	1153	1590.00000	1531.57467	3.67%	31.3	400s
123	H 1132	609			1587.0000000	1533.10301	3.40%	31.2	402s	
124	1136	581	1533.10301	234	922	1587.00000	1533.10301	3.40%	31.1	408s
125	1137	582	1533.10301	80	834	1587.00000	1533.10301	3.40%	31.1	410s
126	1146	588	1533.10301	204	918	1587.00000	1533.10301	3.40%	30.8	418s
127	1148	589	1533.15338	116	786	1587.00000	1533.15338	3.39%	30.8	426s
128	1153	592	1533.20040	104	845	1587.00000	1533.20040	3.39%	30.6	434s
129	1154	593	1533.29670	34	874	1587.00000	1533.29670	3.38%	30.6	436s
130	1157	595	1533.43770	12	1110	1587.00000	1533.43770	3.38%	30.5	440s
131	1161	598	1533.45828	42	1112	1587.00000	1533.45828	3.37%	30.4	448s
132	H 1161	567			1585.0000000	1533.58518	3.24%	30.4	455s	
133	1163	568	1533.61392	158	1111	1585.00000	1533.61392	3.24%	30.4	462s
134	1167	571	1533.62682	117	1105	1585.00000	1533.62682	3.24%	30.3	471s
135	1168	571	1533.71459	157	933	1585.00000	1533.71459	3.24%	30.2	476s
136	1171	573	1533.73514	50	1120	1585.00000	1533.73514	3.23%	30.2	480s
137	1174	544	1533.73818	37	1141	1585.00000	1533.73818	3.23%	30.1	490s
138	1175	545	1533.84934	73	1136	1585.00000	1533.84934	3.23%	30.1	504s
139	1176	546	1533.88012	129	1228	1585.00000	1533.88012	3.23%	30.0	518s
140	1177	546	1533.91223	155	1266	1585.00000	1533.91223	3.22%	30.0	534s
141	1178	547	1533.92122	61	1337	1585.00000	1533.92122	3.22%	30.0	539s
142	1179	548	1533.92478	26	1320	1585.00000	1533.92478	3.22%	30.0	547s
143	1180	548	1533.92755	107	1309	1585.00000	1533.92755	3.22%	29.9	561s
144	1182	550	1533.92904	174	1241	1585.00000	1533.92904	3.22%	29.9	566s
145	1183	550	1533.92925	259	1260	1585.00000	1533.92925	3.22%	29.9	600s
146	1184	551	1534.02624	196	1236	1585.00000	1534.02624	3.22%	29.8	614s
147	1185	552	1534.05255	23	1241	1585.00000	1534.05255	3.21%	29.8	628s
148	1186	552	1534.05880	220	1117	1585.00000	1534.05880	3.21%	29.8	632s
149	1187	553	1534.06053	197	1237	1585.00000	1534.06053	3.21%	29.7	643s
150	1188	554	1534.06152	222	1230	1585.00000	1534.06152	3.21%	29.7	647s
151	1190	555	1534.06276	197	1347	1585.00000	1534.06276	3.21%	29.7	652s
152	1191	527	1534.06286	248	1262	1585.00000	1534.06286	3.21%	29.6	678s
153	1192	499	1534.15174	80	1208	1585.00000	1534.15174	3.21%	29.6	710s
154	1193	500	1534.18216	169	1232	1585.00000	1534.18216	3.21%	29.6	731s
155	1196	502	1534.21059	93	1074	1585.00000	1534.21059	3.20%	29.5	738s
156	1197	503	1534.21256	187	1081	1585.00000	1534.21256	3.20%	29.5	740s
157	1200	505	1534.21553	178	1124	1585.00000	1534.21553	3.20%	29.4	749s
158	1201	505	1534.31788	70	1175	1585.00000	1534.31788	3.20%	29.4	758s
159	1202	506	1534.35638	236	1404	1585.00000	1534.35638	3.20%	29.4	764s
160	1203	507	1534.36800	124	1335	1585.00000	1534.36800	3.19%	29.4	765s
161	1208	510	1534.38057	163	1375	1585.00000	1534.38057	3.19%	29.2	776s
162	1209	511	1534.45447	195	1309	1585.00000	1534.45447	3.19%	29.2	791s
163	1210	511	1534.48307	176	1192	1585.00000	1534.48307	3.19%	29.2	802s

```

164 1211 512 1534.49565 211 1301 1585.00000 1534.49565 3.19% 29.2 811s
165 1213 513 1534.50459 139 1196 1585.00000 1534.50459 3.19% 29.1 816s
166 1215 515 1534.50646 141 1169 1585.00000 1534.50646 3.19% 29.1 822s
167 1216 515 1534.56168 106 1312 1585.00000 1534.56168 3.18% 29.0 825s
168 1218 517 1534.64667 235 1122 1585.00000 1534.64667 3.18% 29.0 832s
169 1221 519 1534.68531 100 1035 1585.00000 1534.68531 3.17% 28.9 835s
170 1223 520 1534.68618 208 1054 1585.00000 1534.68618 3.17% 28.9 841s
171 1225 521 1534.79251 106 1063 1585.00000 1534.79251 3.17% 28.8 848s
172 1226 522 1534.81811 37 1086 1585.00000 1534.81811 3.17% 28.8 850s
173 1228 523 1534.82966 99 1165 1585.00000 1534.82966 3.17% 28.8 857s
174 1232 526 1534.83237 233 1072 1585.00000 1534.83237 3.17% 28.7 865s
175 1233 527 1534.92946 227 1168 1585.00000 1534.92946 3.16% 28.6 870s
176 1235 528 1534.96605 13 1053 1585.00000 1534.96605 3.16% 28.6 881s
177 1236 529 1534.97194 234 1067 1585.00000 1534.97194 3.16% 28.6 890s
178 1238 530 1534.97534 48 1166 1585.00000 1534.97534 3.16% 28.5 897s
179 1239 531 1534.97572 123 1154 1585.00000 1534.97572 3.16% 28.5 930s
180 1240 531 1535.06497 50 1197 1585.00000 1535.06497 3.15% 28.5 962s
181 1241 532 1535.09974 11 939 1585.00000 1535.09974 3.15% 28.5 970s
182 1244 534 1535.22145 49 1075 1585.00000 1535.22145 3.14% 28.4 977s
183 1245 535 1535.24730 77 1102 1585.00000 1535.24730 3.14% 28.4 981s
184 1247 536 1535.24730 31 1124 1585.00000 1535.24730 3.14% 28.3 985s
185 1248 537 1535.89777 116 1121 1585.00000 1535.89777 3.10% 28.3 1013s
186 1249 537 1535.90753 96 1011 1585.00000 1535.90753 3.10% 28.3 1022s
187 1250 538 1535.91660 62 1270 1585.00000 1535.91660 3.10% 28.3 1033s
188 1251 539 1535.92315 37 1004 1585.00000 1535.92315 3.10% 28.2 1043s
189 1252 539 1536.03334 142 967 1585.00000 1536.03334 3.09% 28.2 1050s
190 1254 541 1536.03334 34 1101 1585.00000 1536.03334 3.09% 28.2 1057s
191 1255 541 1536.69378 198 1106 1585.00000 1536.69378 3.05% 28.1 1083s
192 1256 542 1536.80704 169 1435 1585.00000 1536.80704 3.04% 28.1 1096s
193 1257 543 1536.80704 12 1231 1585.00000 1536.80704 3.04% 28.1 1101s
194 1259 544 1536.80704 24 1225 1585.00000 1536.80704 3.04% 28.0 1107s
195 1260 545 1536.80704 240 1216 1585.00000 1536.80704 3.04% 28.0 1112s
196 1261 545 1536.80729 42 1221 1585.00000 1536.80729 3.04% 28.0 1115s
197 1263 547 1536.80729 158 1192 1585.00000 1536.80729 3.04% 28.0 1122s
198 1265 548 1536.84485 206 1080 1585.00000 1536.84485 3.04% 27.9 1125s
199 1270 551 1536.94555 49 1148 1585.00000 1536.94555 3.03% 27.8 1130s
200 1274 554 1536.94568 37 1303 1585.00000 1536.94568 3.03% 27.7 1137s
201 1275 555 1537.49183 73 1374 1585.00000 1537.49183 3.00% 27.7 1145s
202 1281 559 1537.59305 105 1466 1585.00000 1537.59305 2.99% 27.6 1150s
203 1283 560 1537.59342 259 1510 1585.00000 1537.59342 2.99% 27.5 1158s
204 1284 561 1537.66624 196 1441 1585.00000 1537.66624 2.99% 27.5 1161s
205 1286 562 1537.67705 220 1470 1585.00000 1537.67705 2.99% 27.5 1165s
206 1292 566 1537.67759 80 1343 1585.00000 1537.67759 2.99% 27.3 1174s
207 1293 567 1537.68657 169 1487 1585.00000 1537.68657 2.99% 27.3 1177s
208 1295 568 1537.69606 37 1232 1585.00000 1537.69606 2.98% 27.3 1180s
209 H 1295 536 1584.0000000 1537.69606 2.92% 27.3 1180s
210 1299 539 1538.42496 131 1361 1584.00000 1538.42496 2.88% 27.2 1188s
211 1300 539 1538.42496 178 1395 1584.00000 1538.42496 2.88% 27.2 1190s
212 H 1303 510 1582.0000000 1538.42496 2.75% 27.1 1193s
213 1306 512 1538.42496 148 1432 1582.00000 1538.42496 2.75% 27.0 1195s
214
215 Cutting planes:
216 Learned: 391
217 Gomory: 29
218 Lift-and-project: 25
219 Cover: 71
220 Implied bound: 133
221 Clique: 34
222 MIR: 804
223 Mixing: 1
224 StrongCG: 236
225 Flow cover: 1589
226 Zero half: 140
227 RLT: 41
228 Relax-and-lift: 3563
229 BQP: 2
230
231 Explored 1309 nodes (427718 simplex iterations) in 1200.36 seconds (511.97 work units)
232 Thread count was 8 (of 8 available processors)
233
234 Solution count 3: 1582 1584 1585
235
236 Time limit reached
237 Best objective 1.582000000000e+03, best bound 1.539000000000e+03, gap 2.7181%
238
239 Output one feasible solution with limited computation time
240
241 Optimization was stopped with status 9
242
243 Number of solution stored: 3
244 1582 1584 1585
245
246 Obj = 1582.0
247

```

248 Solutions:
 249 The total pi = 488.0
 250 The total duration time in berth stage = 192.0
 251 The total duration time in quay crane scheduling stage = 58.0
 252 The total departure time in berth stage= 858.0
 253 The total departure time in quay crane scheduling stage = 724.0
 254 The total wasted crane work hour according QC0= 10.0
 255 The last departure time in quay crane scheduling stage = 63.0
 256
 257 The specific solution are as follows:
 258 Vessel i: 0: li: 4, pi: 4-8, ai-di: 16-23, taoi-deltai: 16-22, periodi: 6, taoPi_SP-deltaPi_SP:
 16-18, periodPi: 2, c_i: 1581864, dowork: 1581864, fa_i: 3
 259 Vessel i: 1: li: 4, pi: 26-30, ai-di: 10-20, taoi-deltai: 10-19, periodi: 9, taoPi_SP-deltaPi_SP
 : 10-12, periodPi: 2, c_i: 2372796, dowork: 2636440, fa_i: 3
 260 Vessel i: 2: li: 4, pi: 30-34, ai-di: 13-18, taoi-deltai: 13-18, periodi: 5, taoPi_SP-deltaPi_SP
 : 13-14, periodPi: 1, c_i: 1318220, dowork: 1318220, fa_i: 3
 261 Vessel i: 3: li: 5, pi: 9-14, ai-di: 5-14, taoi-deltai: 5-12, periodi: 7, taoPi_SP-deltaPi_SP: 5-7
 , periodPi: 2, c_i: 1845508, dowork: 1845508, fa_i: 4
 262 Vessel i: 4: li: 5, pi: 29-34, ai-di: 21-24, taoi-deltai: 21-25, periodi: 4, taoPi_SP-deltaPi_SP
 : 21-22, periodPi: 1, c_i: 1054576, dowork: 1318220, fa_i: 4
 263 Vessel i: 5: li: 6, pi: 6-12, ai-di: 25-32, taoi-deltai: 25-34, periodi: 9, taoPi_SP-deltaPi_SP:
 25-27, periodPi: 2, c_i: 2372796, dowork: 2372796, fa_i: 5
 264 Vessel i: 6: li: 4, pi: 26-30, ai-di: 4-7, taoi-deltai: 4-9, periodi: 5, taoPi_SP-deltaPi_SP: 4-5
 , periodPi: 1, c_i: 1318220, dowork: 1318220, fa_i: 3
 265 Vessel i: 7: li: 5, pi: 18-23, ai-di: 21-29, taoi-deltai: 21-29, periodi: 8, taoPi_SP-deltaPi_SP
 : 21-24, periodPi: 3, c_i: 2109152, dowork: 2372796, fa_i: 4
 266 Vessel i: 8: li: 4, pi: 10-14, ai-di: 62-67, taoi-deltai: 62-66, periodi: 4, taoPi_SP-deltaPi_SP
 : 62-63, periodPi: 1, c_i: 1054576, dowork: 1186398, fa_i: 3
 267 Vessel i: 9: li: 5, pi: 4-9, ai-di: 7-14, taoi-deltai: 7-12, periodi: 5, taoPi_SP-deltaPi_SP: 7-9
 , periodPi: 2, c_i: 1318220, dowork: 1318220, fa_i: 4
 268 Vessel i: 10: li: 4, pi: 29-33, ai-di: 27-38, taoi-deltai: 33-42, periodi: 9, taoPi_SP- fa_i: 3
 deltaPi_SP: 33-35, periodPi: 2, c_i: 2372796, dowork: 2636440, fa_i: 3
 269 Vessel i: 11: li: 4, pi: 14-18, ai-di: 3-9, taoi-deltai: 3-7, periodi: 4, taoPi_SP-deltaPi_SP: 3
 -4, periodPi: 1, c_i: 1054576, dowork: 1054576, fa_i: 3
 270 Vessel i: 12: li: 5, pi: 24-29, ai-di: 28-34, taoi-deltai: 28-33, periodi: 5, taoPi_SP- fa_i: 4
 deltaPi_SP: 28-29, periodPi: 1, c_i: 1318220, dowork: 1581864, fa_i: 4
 271 Vessel i: 13: li: 6, pi: 18-24, ai-di: 31-38, taoi-deltai: 31-37, periodi: 6, taoPi_SP- fa_i: 5
 deltaPi_SP: 31-33, periodPi: 2, c_i: 1581864, dowork: 1845508, fa_i: 5
 272 Vessel i: 14: li: 4, pi: 0-4, ai-di: 10-18, taoi-deltai: 10-16, periodi: 6, taoPi_SP-deltaPi_SP
 : 10-12, periodPi: 2, c_i: 1581864, dowork: 1581864, fa_i: 3
 273 Vessel i: 15: li: 6, pi: 8-14, ai-di: 39-45, taoi-deltai: 39-47, periodi: 8, taoPi_SP-deltaPi_SP
 : 39-41, periodPi: 2, c_i: 2109152, dowork: 2109152, fa_i: 5
 274 Vessel i: 16: li: 4, pi: 30-34, ai-di: 8-14, taoi-deltai: 8-12, periodi: 4, taoPi_SP-deltaPi_SP
 : 8-9, periodPi: 1, c_i: 1054576, dowork: 1318220, fa_i: 3
 275 Vessel i: 17: li: 5, pi: 9-14, ai-di: 52-61, taoi-deltai: 52-61, periodi: 9, taoPi_SP-deltaPi_SP
 : 52-54, periodPi: 2, c_i: 2372796, dowork: 2372796, fa_i: 4
 276 Vessel i: 18: li: 6, pi: 0-6, ai-di: 21-28, taoi-deltai: 23-32, periodi: 9, taoPi_SP-deltaPi_SP
 : 23-28, periodPi: 5, c_i: 2372796, dowork: 2372796, fa_i: 5
 277 Vessel i: 19: li: 4, pi: 22-26, ai-di: 2-12, taoi-deltai: 2-11, periodi: 9, taoPi_SP-deltaPi_SP
 : 2-5, periodPi: 3, c_i: 2372796, dowork: 2372796, fa_i: 3
 278 Vessel i: 20: li: 4, pi: 0-4, ai-di: 2-9, taoi-deltai: 2-9, periodi: 7, taoPi_SP-deltaPi_SP: 2-5
 , periodPi: 3, c_i: 1845508, dowork: 1845508, fa_i: 3
 279 Vessel i: 21: li: 4, pi: 24-28, ai-di: 40-56, taoi-deltai: 40-48, periodi: 8, taoPi_SP- fa_i: 3
 deltaPi_SP: 40-42, periodPi: 2, c_i: 2109152, dowork: 2240974, fa_i: 3
 280 Vessel i: 22: li: 6, pi: 12-18, ai-di: 24-35, taoi-deltai: 24-28, periodi: 4, taoPi_SP- fa_i: 5
 deltaPi_SP: 24-25, periodPi: 1, c_i: 1054576, dowork: 1318220, fa_i: 5
 281 Vessel i: 23: li: 5, pi: 9-14, ai-di: 14-31, taoi-deltai: 14-19, periodi: 5, taoPi_SP-deltaPi_SP
 : 14-15, periodPi: 1, c_i: 1318220, dowork: 1318220, fa_i: 4
 282 Vessel i: 24: li: 6, pi: 14-20, ai-di: 11-29, taoi-deltai: 11-17, periodi: 6, taoPi_SP- fa_i: 5
 deltaPi_SP: 11-13, periodPi: 2, c_i: 1581864, dowork: 1581864, fa_i: 5
 283 Vessel i: 25: li: 6, pi: 12-18, ai-di: 28-62, taoi-deltai: 29-35, periodi: 6, taoPi_SP- fa_i: 5
 deltaPi_SP: 29-33, periodPi: 4, c_i: 1581864, dowork: 1581864, fa_i: 5
 284 Vessel i: 26: li: 4, pi: 25-29, ai-di: 51-80, taoi-deltai: 51-60, periodi: 9, taoPi_SP- fa_i: 3
 deltaPi_SP: 51-53, periodPi: 2, c_i: 2372796, dowork: 2504618, fa_i: 3
 285 Vessel i: 27: li: 5, pi: 29-34, ai-di: 27-46, taoi-deltai: 27-32, periodi: 5, taoPi_SP- fa_i: 4
 deltaPi_SP: 27-28, periodPi: 1, c_i: 1318220, dowork: 1318220, fa_i: 4
 286 Vessel i: 28: li: 6, pi: 23-29, ai-di: 21-45, taoi-deltai: 21-27, periodi: 6, taoPi_SP- fa_i: 5
 deltaPi_SP: 21-23, periodPi: 2, c_i: 1581864, dowork: 1581864, fa_i: 5
 287 Vessel i: 29: li: 4, pi: 24-28, ai-di: 29-55, taoi-deltai: 34-39, periodi: 5, taoPi_SP- fa_i: 3
 deltaPi_SP: 34-36, periodPi: 2, c_i: 1318220, dowork: 1450042, fa_i: 3
 288 TimeSolveModel: 1248.000000
 289
 290 TimeAll: 1252.000000
 291
 292