# Appendix

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| **Items** | **Variables** |
| Airspace | sectionA, sectionB, sectionC(35-10Nm), sectionC(10Nm-to-finals) |
| Entry | a, b, g, h, j (shown in **Fig. 3**) |
| Light aircraft | airspeed, minimum-airspeed, altitude, minimum-altitude, separation-with-preceding-aircraft, the-separation-of-succeeding-aircraft, deceleration-rate-l, descent-rate-l, extra-miles-travelled, fuels-burnt, the-time-for-being-transferred, the-frequency-of-reactive-action, heavy-traffic-mode(on/off; default: off) |
| Heavy aircraft | airspeed, minimum-airspeed, altitude, minimum-altitude, separation-with-preceding-aircraft, the-separation-of-succeeding-aircraft, deceleration-rate-h (equal to deceleration-rate-l \* 0.7), descent-rate-h (equal to descent-rate-l \* 0.7), extra-miles-travelled, fuels-burnt, the-time-for-being-transferred, the-frequency-of-reactive-action, heavy-traffic-mode(on/off; default: off) |
| **General function** | **Description** |
| Record-time | **Function** Record-time {  **Set** the-time-for-being-transferred = the-frequency-of-the-calculation-conducted  } |
| Calculate-fuels-burnt (refer to **Table 4**) | **Function** Calculate-fuels-burnt {  **Set** fuels-burnt = fuels-burnt + air-density\* 1 (Light) / 1.5 (Heavy)  }   |  | | --- | | 3000~4000 ft: 0.8194 *(*kg/m3) | | 4000~5000 ft: 0.7364 *(*kg/m3) | | 5000~6000 ft: 0.6601 *(*kg/m3) | | 6000~7000 ft: 0.5900 *(*kg/m3) | | 7000~8000 ft: 0.5258 *(*kg/m3) | | 8000~9000 ft: 0.4671 *(*kg/m3) | | 9000~10000 ft: 0.4135 *(*kg/m3) | | 10000~15000 ft: 0.1948 *(*kg/m3) | | 15000~20000 ft: 0.0889 *(*kg/m3) | |
| Calculate-reactive-actions | **Function** Calculate-reactive-actions {  **Set** the-frequency-of-reactive-action = the-frequency-of-reactive-action +1  **}** |
| Transfer-to-tower | **Function** Transfer-to-tower {  **Ask** aircraft **die**  **}** |
| Record-performance | **Function** Record-performance {  **Output** extra-miles-travelled, fuels-burnt, the-time-for-being-transferred, the-frequenct-reactive-action  **}** |
| **Agent function** | **Description** |
| Conflict-resolution | *\*When the separation is less than 2 Nm, an aircraft is detoured.*  **Function** conflict-resolution {  **If else** separation-with-preceding-aircraft <= 2 Nm [**Do** detour] [**Do** decelerate-for-avoiding-conflict]  **Do** Calculate-reactive-actions  } |
| Decelerate-for-avoiding-conflict *(light / heavy)* | *\*When the separation is no less than 2 Nm, an aircraft is requested to gradually decelerate. The airspeed of the preceding aircraft is set to be the minimum airspeed. The deceleration rate is determined by the weight of aircraft (light / heavy)*  **Function** Decelerate-for-avoiding-conflict {  **Set** minimum-airspeed = airspeed-of-the-preceding-aircraft  **If else** airspeed <= minimum-airspeed  **[Set** airspeed = minimum-airspeed**]**  **[Set** airspeed = airspeed – deceleration-rate]  **Advance** airspeed  **Do** calculate-fuels-burnt  **}** |
| Detour  *(light / heavy)* | *\*When the separation is less than 2 Nm, an aircraft is requested to be vectored out. To simplify the modelling, aircraft will not advance anymore, even though, the process of deceleration still continues. The deceleration rate is determined by the weight of aircraft (light / heavy)*  **Function** detour {  **Set** airspeed = airspeed – deceleration-rate  **If else** airspeed <= minimum-airspeed  **[Set** airspeed = minimum-airspeed  **Set** altitude = altitude- descent-rate**]**  **[Set** airspeed = airspeed – deceleration-rate]  **Advance** 0  **Set** extra-miles-travelled = extra-miles-travelled + airspeed  **Do** calculate-fuels-burnt  } |
| Hovering-around  *(light / heavy)* | *\*When the section C is congested. an aircraft is requested to hover around. While, the deceleration and descent process still continue to follow the STARs regulated. The deceleration and decent rate are determined by the weight of aircraft (light / heavy)*  **Function** Hovering-around {  **Set** airspeed = airspeed – deceleration-rate  **If else** airspeed <= minimum-airspeed  **[Set** airspeed = minimum-airspeed  **Set** altitude = altitude- descent-rate**]**  **[Set** airspeed = airspeed – deceleration-rate]  **Advance** 0  **Set** extra-miles-travelled = extra-miles-travelled + airspeed  **Do** calculate-fuels-burnt  **Do** Calculate-reactive-actions  } |
| Hover-at-high-altitude  *(light / heavy)* | *\*When the section C is congested. an aircraft is requested to hover around. An aircraft will keep decelerating. While, it can maintain the current altitude to save fuels. The deceleration and decent rate are determined by the weight of aircraft (light / heavy)*  **Function** Hover-at-high-altitude {  **Set** airspeed = airspeed – deceleration-rate  **If else** airspeed <= minimum-airspeed  **[Set** airspeed = minimum-airspeed**]**  **[Set** airspeed = airspeed – deceleration-rate]  **Advance** 0  **Set** extra-miles-travelled = extra-miles-travelled + airspeed  **Do** calculate-fuels-burnt  **Do** Calculate-reactive-actions  } |
| Follow-STARs | *\*As shown, regulated airspeed and altitude are shown based on the STARs. An aircraft cannot be slower than the minimum airspeed and lower than the minimum altitude.*  **Function** Follow-STARs {  **Check** route  **If** route(a-c) **or** route(b-c)  **Set** minimum-airspeed = 250 kt  **Set** minimum-altitude = 10000 ft  **Do** Adjust-flight-state  **If** route(c-d)  **Set** minimum-airspeed = 220 kt  **Set** minimum-altitude = 10000 ft  **Do** Adjust-flight-state  **If** route(d-e) **or** route(f-e)  **Set** minimum-airspeed = 200 kt  **Set** minimum-altitude = 7000 ft  **Do** Adjust-flight-state  **If** route(g-f) **or** route(h-f)  **Set** minimum-airspeed = 220 kt  **Set** minimum-altitude = 7000 ft  **Do** Adjust-flight-state  **If** route(e-i) **or** route(j-i)  **Set** minimum-airspeed = 170 kt  **Set** minimum-altitude = 3000 ft  **Do** Adjust-flight-state  **}** |
| Adjust-flight-state  *(light / heavy)* | *\*An aircraft will decelerate and descend to the STAR regulated in the Function of “follow-STARs”. In addition, an aircraft will decelerate to minimum airspeed before descending. The deceleration and decent rate are determined by the weight of aircraft (light / heavy)*  **Function** Adjust-flight-state {  **Heading** next-STAR  **Set** airspeed = airspeed – deceleration-rate  **If else** airspeed <= minimum-airspeed  **[Set** airspeed = minimum-airspeed  **Set** altitude = altitude- descent-rate  **[If** altitude = minimum-altitude  **Set** altitude = minimum-altitude]**]**  **[Set** airspeed = airspeed – deceleration-rate]  **Advance** airspeed  **Do** calculate-fuels-burnt  } |
| Late-descent | *\*As shown, late descent is conducted in section C. The minimum altitude will be 1000 ft higher than the STARs.*  **Function** late-descent {  **Check** route  **If** route(d-e) **or** route(f-e)  **Set** minimum-airspeed = 200 kt  **Set** minimum-altitude = 7000 ft + 1000 ft  **Do** Adjust-flight-state  **If** route(e-i) **or** route(j-i)  **Set** minimum-airspeed = 170 kt  **Set** minimum-altitude = 3000 ft + 1000 ft  **Do** Adjust-flight-state  **Do** Calculate-reactive-actions  } |
| Go-around | *\*The function is similar to the Function of “detour”, an aircraft is asked to go around to stabilize the aircraft. It can only be transferred to tower controller when the landing profile satisfy the STAR i (170 kt / 3000 ft)*  **Function** Go-around {  **Set** airspeed = airspeed – deceleration-rate  **If else** airspeed <= minimum-airspeed  **[Set** airspeed = minimum-airspeed  **Set** altitude = altitude- descent-rate**]**  **[Set** airspeed = airspeed – deceleration-rate]  **Advance** 0  **Set** extra-miles-travelled = extra-miles-travelled + airspeed  **Do** calculate-fuels-burnt  **Do** Calculate-reactive-actions  **}** |
| High-speed-clearance-current | *\*The speed restriction is 10 knots faster than STARs regulated.*  **Function** High-speed-clearance-current {  **Check** route  **If** route(a-c) **or** route(b-c)  **Set** minimum-airspeed = 250 kt + 20 kt  **Set** minimum-altitude = 10000 ft  **Do** Adjust-flight-state  **If** route(c-d)  **Set** minimum-airspeed = 220 kt + 20 kt  **Set** minimum-altitude = 10000 ft  **Do** Adjust-flight-state  **If** route(g-f) **or** route(h-f)  **Set** minimum-airspeed = 220 kt + 20 kt  **Set** minimum-altitude = 7000 ft  **Do** Adjust-flight-state  **}** |
| High-speed-clearance-improved  *(light / heavy)* | *\*The speed restriction is faster than STARs regulated. While, it is subject to the weight of aircraft. Light aircraft can be 20 kt faster due to better capability of deceleration, while heavy aircraft can only be 10 kt faster.*  **Function** High-speed-clearance-current {  **Check** route  **If** route(a-c) **or** route(b-c)  **Set** minimum-airspeed = 250 kt + 20 kt (Light) / 10 kt (Heavy)  **Set** minimum-altitude = 10000 ft  **Do** Adjust-flight-state  **If** route(c-d)  **Set** minimum-airspeed = 220 kt + 20 kt (Light) / 10 kt (Heavy)  **Set** minimum-altitude = 10000 ft  **Do** Adjust-flight-state  **If** route(g-f) **or** route(h-f)  **Set** minimum-airspeed = 220 kt + 20 kt (Light) / 10 kt (Heavy)  **Set** minimum-altitude = 7000 ft  **Do** Adjust-flight-state  **}** |
| Efficient-approach | *\*The aircraft will fly 10 kt slower and 1000 ft higher to save the fuels bunrt.*  **Function** Efficient-approach {  **Check** route  **If** route(a-c) **or** route(b-c)  **Set** minimum-airspeed = 250 kt - 10 kt  **Set** minimum-altitude = 10000 ft + 1000 ft  **Do** Adjust-flight-state  **If** route(c-d)  **Set** minimum-airspeed = 220 kt - 10 kt  **Set** minimum-altitude = 10000 ft + 1000 ft  **Do** Adjust-flight-state  **If** route(g-f) **or** route(h-f)  **Set** minimum-airspeed = 220 kt - 10 kt  **Set** minimum-altitude = 7000 ft + 1000 ft  **Do** Adjust-flight-state  **}** |
| Slower-approach | *\*The aircraft will fly 10 kt slower to create buffers for ATCOs to solve the congestion around section C.*  **Function** Efficient-approach {  **Check** route  **If** route(a-c) **or** route(b-c)  **Set** minimum-airspeed = 250 kt - 10 kt  **Set** minimum-altitude = 10000 ft  **Do** Adjust-flight-state  **If** route(c-d)  **Set** minimum-airspeed = 220 kt - 10 kt  **Set** minimum-altitude = 10000 ft  **Do** Adjust-flight-state  **If** route(g-f) **or** route(h-f)  **Set** minimum-airspeed = 220 kt - 10 kt  **Set** minimum-altitude = 7000 ft  **Do** Adjust-flight-state  **}** |
| Expedite-descent | *\*In order to solve the congestion in succeeding air traffic flow, pilots can flexibly deploy the configuration to simultaneously decelerate and descend.*  **Function** late-descent {  **Check** route  **If** route(d-e) **or** route(f-e)  **Set** minimum-airspeed = 200 kt  **Set** minimum-altitude = 7000 ft  **Do** [  **Set** airspeed = airspeed – deceleration-rate  **Set** altitude = altitude- descent-rate  **If** airspeed = minimum- airspeed **Set** airspeed = minimum- airspeed  **If** altitude = minimum-altitude **Set** altitude = minimum- altitude  **Advance** airspeed  **Do** calculate-fuels-burnt  ]  **If** route(e-i) **or** route(j-i)  **Set** minimum-airspeed = 170 kt  **Set** minimum-altitude = 3000 ft  **Do** [  **Set** airspeed = airspeed – deceleration-rate  **Set** altitude = altitude- descent-rate  **If** airspeed = minimum- airspeed **Set** airspeed = minimum- airspeed  **If** altitude = minimum-altitude **Set** altitude = minimum- altitude  **Advance** airspeed  **Do** calculate-fuels-burnt  ]  } |