Journal of Physics Special Topics
An undergraduate physics journal

P4_5 Atmospheric ODSTs

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December 7, 2016

Abstract

In this paper the maximum acceleration on the ODST and the pod was found to be $4.5g$, with a braking thrusters force of 14225 N during the last 50 m of descent. This deceleration brings the impact velocity of the pod to below velocity of 1 ms^{-1}, should the braking thrusters fail to fire the pod will hit the ground with a velocity of 43.3 ms^{-1} killing the trooper.

Introduction

In the Halo universe the Orbital Drop Shock Troopers (ODSTs) use a single seat drop pod to land on a planet from orbit or in atmosphere using only gravity to accelerate towards the planet's surface [1]. During the descent, the on board computer tracks the height of the pod above the planet's surface. When the pod reaches 1 km [1] above the planet's surface the computer deploys a drag chute to start slowing down the pod. After the pod has reached 50 m [1] above the planet's surface, the pod fires braking thrusters to slow itself down enough such that both the pod and its occupant can tolerate the landing. In this paper we will be considering the ODST drop in the video game Halo 3: ODST, in which the ODSTs are dropping into 'New Mombasa' [1], a mega city on Earth. During this we will calculate the accelerating forces on the occupant and try to ascertain if the ODST could go into combat upon completing the drop.

In the drop on New Mombasa the ship carrying the ODSTs is approximately stationary above the city at about 20 km, as in the scene the tops of the clouds could be seen. The pods are then ejected from the ship; from the footage we assume that the pods start with negligible horizontal and vertical velocity v. The pod is taken to be of area $A = 6.21$ m^2 and mass 499 kg [1] and the trooper inside is assumed to be 90 kg with equipment. The coefficient of drag, C_d, of the pod is assumed to be 0.15 [2] (as the pod is roughly an aerodynamic body) and is assumed to increase to 0.82 [2] after the drag chute is deployed, as the drag chute is roughly the shape of a circle, making the shape of the pod similar to that of a cylinder. We have taken the atmosphere to be isothermal and assume its density falls off exponentially (see equation (1)), all heating affects due to drag, F_d, are ignored.

$$\rho = \rho_0 e^{\frac{-s}{7.4\times10^3}} \tag{1}$$

$$F_d = \frac{1}{2}C_d A\rho v^2 \tag{2}$$

Using equations (1)[3] and (2)[2] we then ran three iterative simulations (recalculating drag and hence velocity after each iterative step), the first modeled the drop from 20 km to 1 km with only the changing density of the atmosphere to effect the speed of the pod. We then measured the change in velocity and acceleration over small change in displacement of 1 m until a height of 1 km. The second simulation modeled the drop from 1 km to 50 m with the drag chute deployed and using equations (1)[3] and (2)[2] again. For this simulation we took the deployment of the drag chute to be an instantaneous increase in the coefficient of drag, C_d, of the pod to 0.82. We then measured the change in velocity and acceleration over small change in displacement of 1 m until a height of 50 m. The third simulation altered the force of the braking thrusters until a 'safe' impact velocity was found, under the assumption that the thrusters give a constant thrust throughout the burn. The simulation was run with a small change in displacement of 0.1 m until the final velocity that the pod impacts the surface of the planet with is less than 1 ms^{-1}. This gave the force from the brake thrusters to be 14100 N. All data for the velocity and acceleration of the pod during its descent was then plotted in graphs of velocity against altitude and acceleration against altitude.

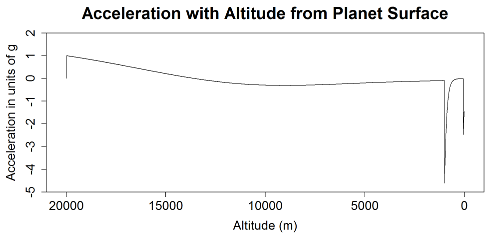

Figure 1: The 'gs' experienced by the ODST during the descent.

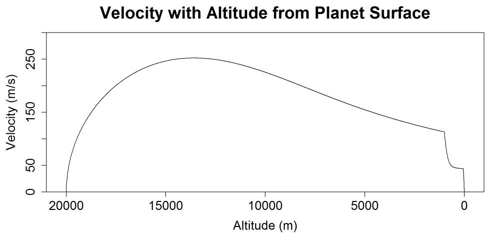

Figure 2: The velocity of the pod with altitude.

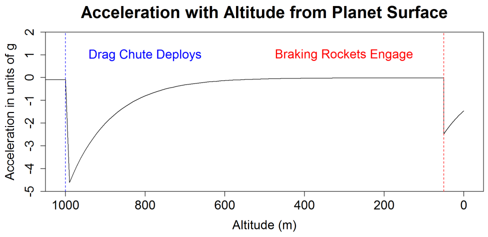

Figure 3: The acceleration of the pod on it's final descent.

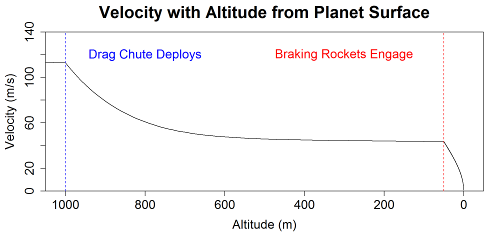

Figure 4: The velocity of the pod on it's final descent.

Conclusion

During the drop the ODST experiences an acceleration of just over 4.5 g as seen in Figure 3 with a braking thrust of 14225 N applied to slow the pod to bellow a velocity of 1 ms^{-1}. An acceleration of 4.5 g is perfectly safe for a highly trained and healthy trooper, this means that the trooper would be combat ready from the drop on New Mombasa. Should the pod braking thruster fail then the pod will hit the ground at a velocity of 43.3ms^{-1}, this is calculated using Figure 4; as you can clearly see that the pod is traveling terminal velocity before the braking thruster engages. If the pod were to hit the surface at terminal velocity the ODST would be killed on impact.

References

[1] `http://tinyurl.com/hkl479d`

[2] `http://tinyurl.com/njwh4rz`

[3] `goo.gl/wBe4WH`