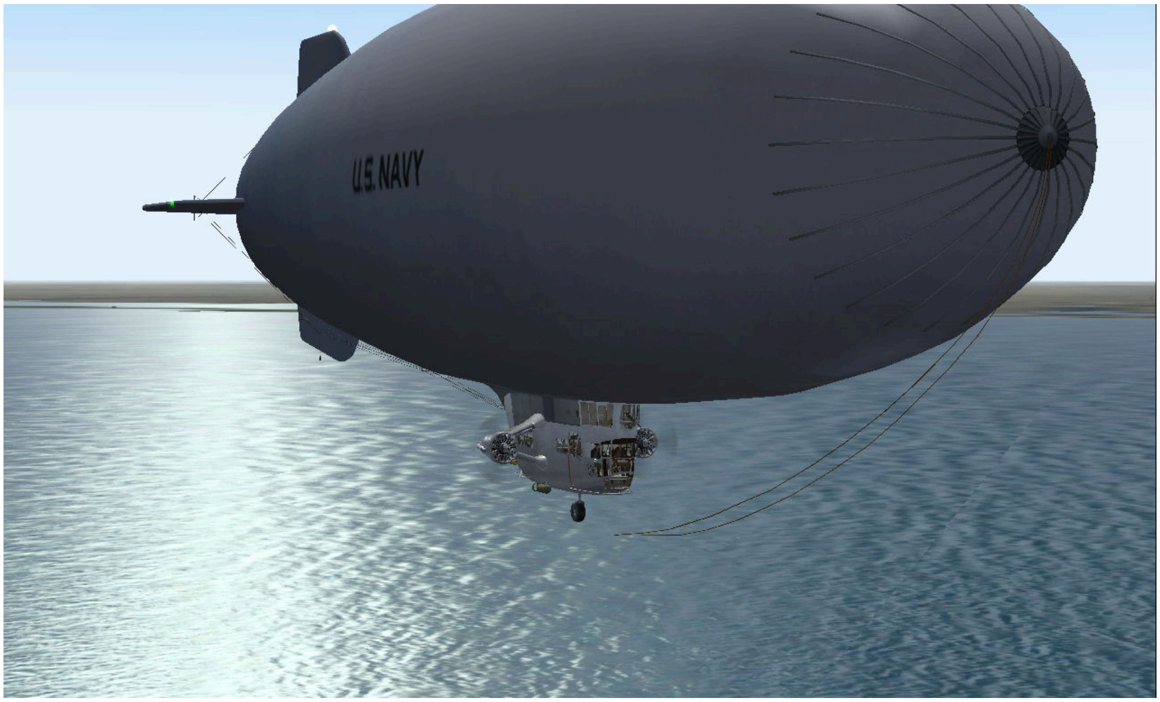
U. S. NAVY BLIMP - K-CLASS
FLIGHT SIMULATOR MODEL

BUILT IN FSDS 3.5.1 FOR FS2004



BLIMP K-28 CAR AS RESTORED AT NEW ENGLAND AIR MUSEUM

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FLYING THIS MODEL BLIMP - BASICS

Two Flight Modes -- Slow and Normal:

- Use the Flight Simulator flaps commands --
  - F8 (full flaps) is Slow Flight Mode
    - speeds between 8 and 27 mph
    - takes off in a very short distance
  - F5 (no flaps) is normal mode.
    - speeds between 20 and 75 mph
    - longer takeoff run, like an airplane

Throttle Settings:

You don’t need full throttle for takeoff. Expect to apply a fair amount of pitch trim when making large throttle changes. (See section on Flight Controls below.)

- Takeoff and normal cruise - 40 mph
  - 40% throttle (22 inches MP, 1750 RPM)
- High cruise - 50 mph
  - 50% throttle (25 inches MP, 1950 RPM)
- Max Speed - 75 mph
  - 99% throttle (40 inches MP, 2600 RPM)
- Min Speed - 8 mph
  - 5% throttle (10 inches MP, 900 RPM)

Fixed-pitch propellers, no prop speed control.

Weight Modes --Heavy and Light:

Actual Navy blimps normally flew heavy (1500 lbs) in operation. After a mission, when fuel was used up, they could return “light” (nearly neutral buoyancy) and landing became tricky.

Use the Flight Simulator fuel and payload menu to adjust gross weight from heavy (~1900 lbs) to light (~50 lbs).

Heavy mode requires less trimming. A little more forward speed is required, to provide more aerodynamic lift.

Light mode allows more of a floating effect, and requires more pitch trim input. More care is required when making sudden throttle changes.

Extreme Maneuvers

This model can be made to do unrealistic maneuvers such as rolls and loops, especially with full power. See section on Flight Dynamics Compromises below.

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FLIGHT CONTROLS IN THIS MODEL

The following picture shows the main directional and trim controls in the blimp cockpit. The big wheel attached to the left (altitude) pilot's seat is the elevator control. It is NOT an elevator trim wheel, as in some airplanes.

The wheel in front of the right (directional) pilot's seat is the rudder wheel only. It does NOT control ailerons or elevators as in some airplanes.

Pitch trim is applied using the simulated fore-and-aft ballonet trim controls. These are pull-out cables on the overhead panel. You can pull and retract the cables with a mouse, but it is easier to use the joystick buttons for up and down trim. The ballonet controls in real blimps were much more complex than the ones modeled here.

An inclinometer on the left cockpit frame shows the pitch attitude of the blimp in degrees. The gauges below the overhead panel are for monitoring trim and altitude. The vertical speed indicator is on top. Below that is an elevator position indicator. Below that is an altimeter, and at the bottom are simulated "manometers." In a real blimp, these displayed the gas pressure in three places: the forward ballonet, the helium envelope, and the aft ballonet. In this model the manometers display the degree of pitch trim.

TRIM NOSE UP

In this picture the blimp is trimmed nose up.

The Aft Air Open cable is pulled out, which means we are raising the nose by moving air aft, and thus moving helium forward.

The inclinometer shows the pitch angle of the blimp is positive.

The left manometer displays low and the right manometer displays high. In this model, this means up elevator trim.

TRIM NOSE DOWN

In this picture the blimp is trimmed nose down.

The Fwd Air Open cable is pulled out, raising the tail by moving air forward, and moving helium aft.

The inclinometer shows the pitch angle of the blimp is negative.

The left manometer displays high and the right manometer displays low. This means down elevator trim.

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SLOW FLIGHT MODE

Actually deploys high-lift, high-drag flaps which are not visible.
Only two settings:

On - [F7 or F8] - speeds 8 mph to 27 mph, quick takeoff
Off - [F5 or F6] - speeds 24 mph to 75 mph, longer takeoff run

EMERGENCY HELIUM RELEASE

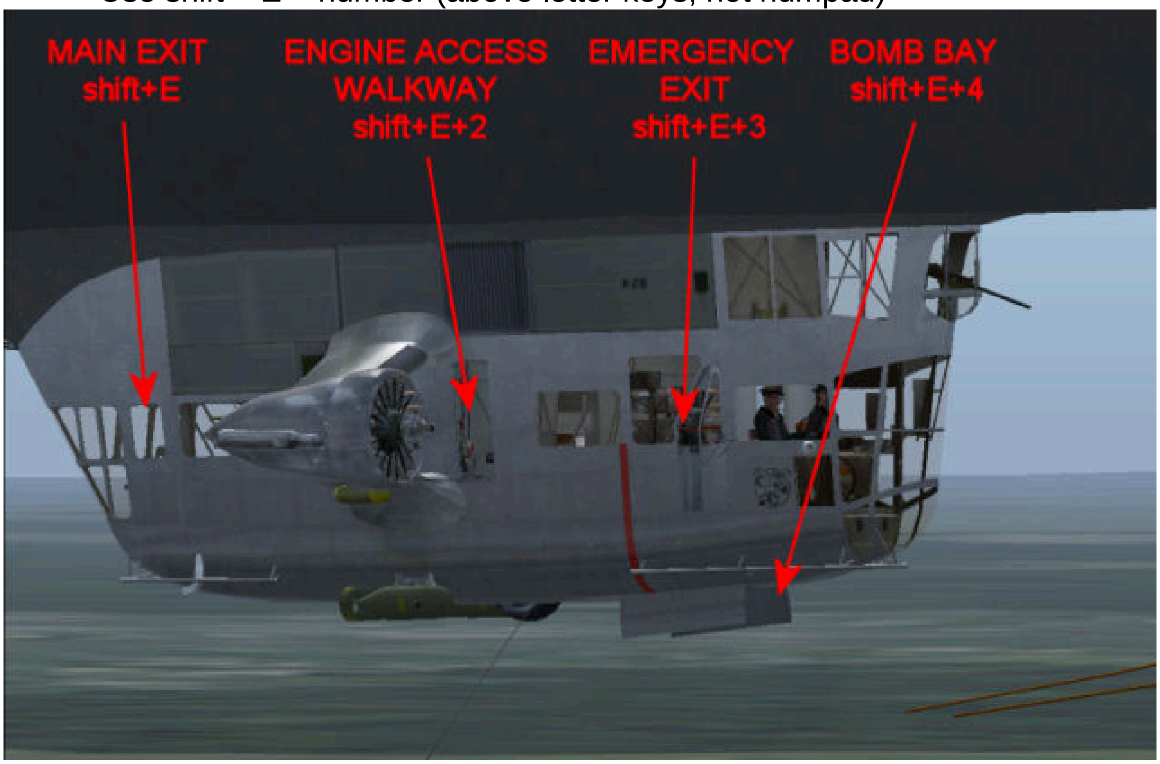
Actually deploys spoilers which are not visible.

Toggles on/off with spoiler key [/ - forward slash].
Reduces lift, simulating loss of helium.
Cannot be activated with speed over 40 mph.

OTHER ANIMATED FEATURES IN THIS MODEL

Exits and Doors

Use shift + E + number (above letter keys, not numpad)



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Outrigger Air Scoops for Ballonets

Operate individually in virtual cockpit using levers on walls.

Fuel Transfer Wobble Pump

Moves 1/5 gallon of fuel from tank Center2 to Center1 per cycle.

Landing Gear Crank Panel

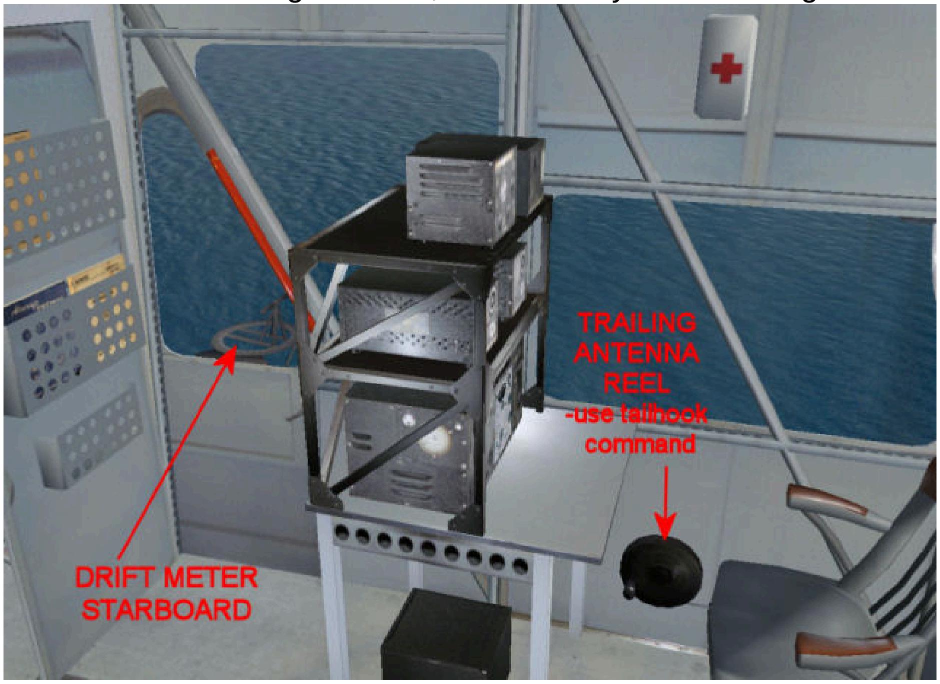
Opens when landing gear is lowered, using keyboard G command.

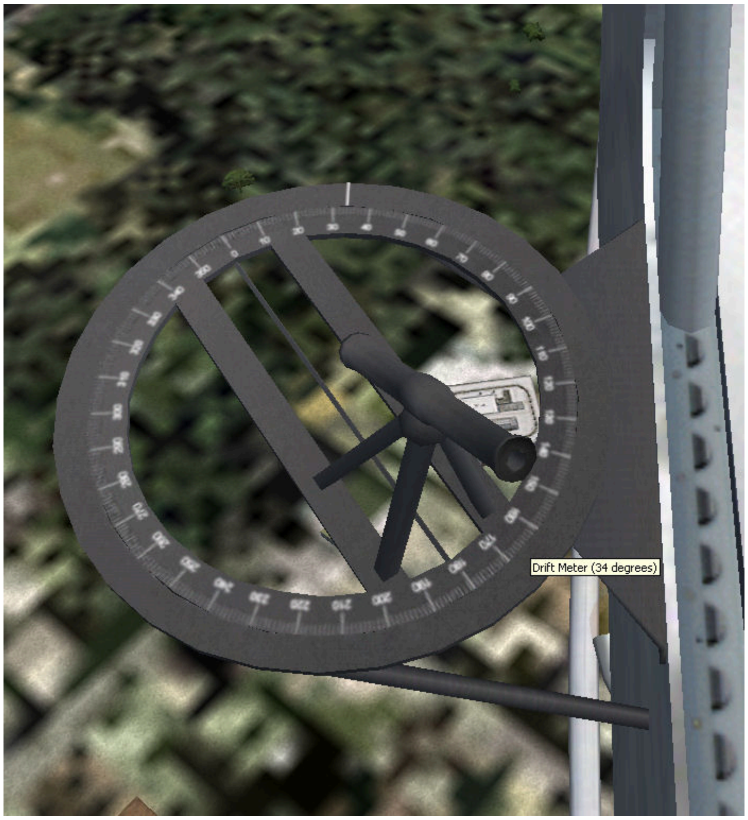
Trailing Antenna

Use tailhook command to extend/retract. Set command in Settings/Controls/Assignments.

Drift Meters Port and Starboard

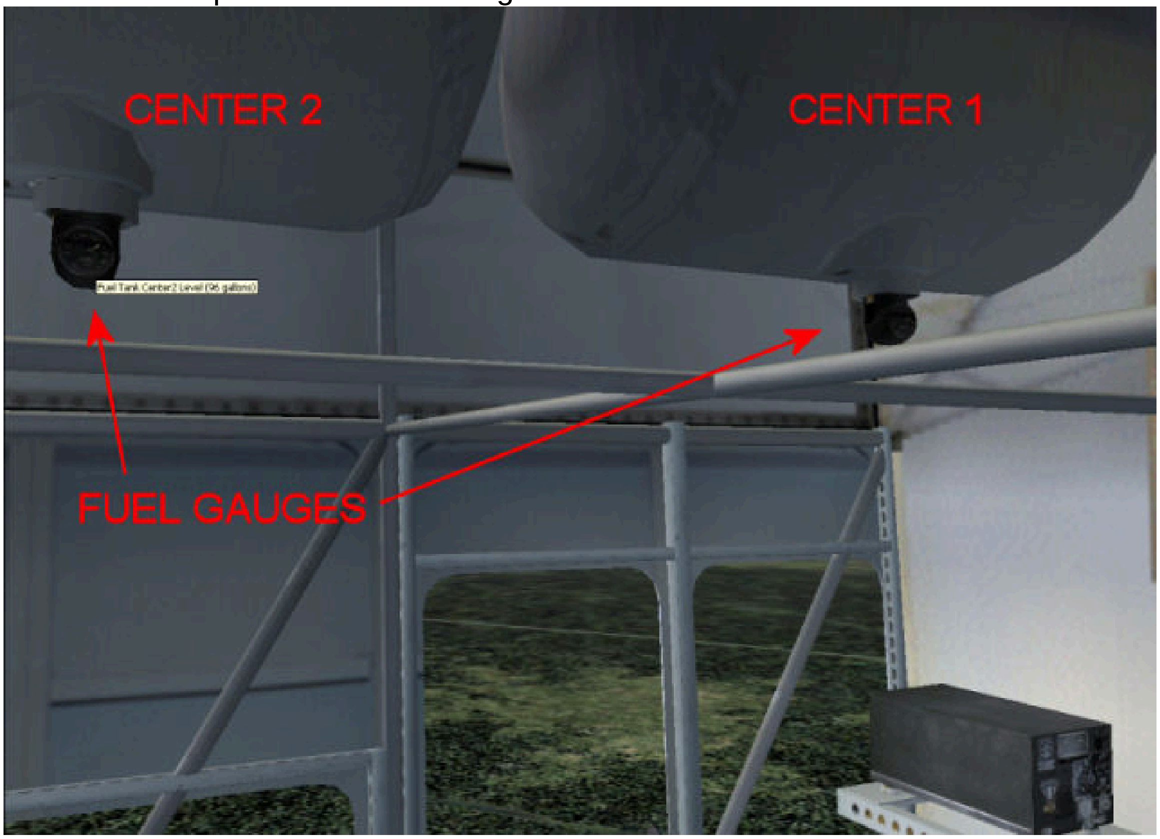
Click and drag to rotate, until scenery moves along center wire.



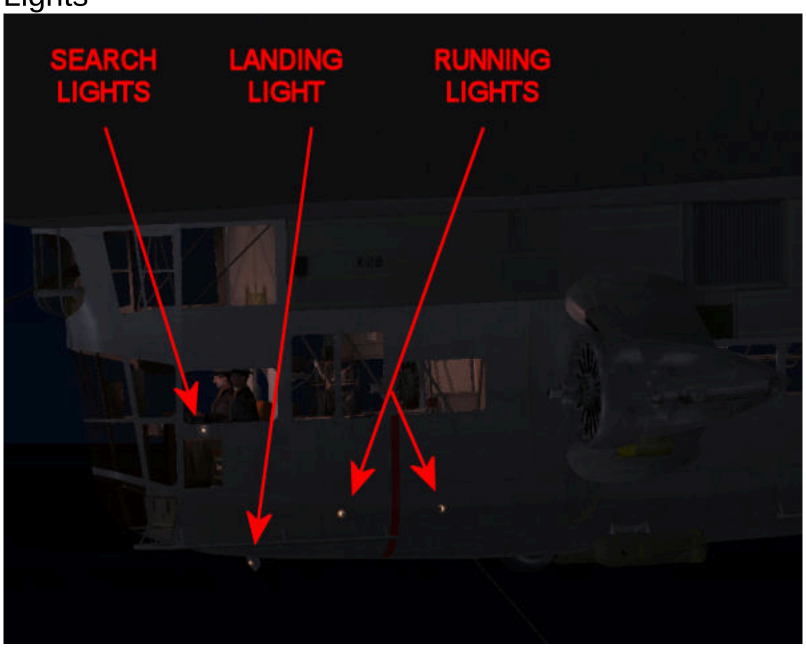


Fuel Gauges

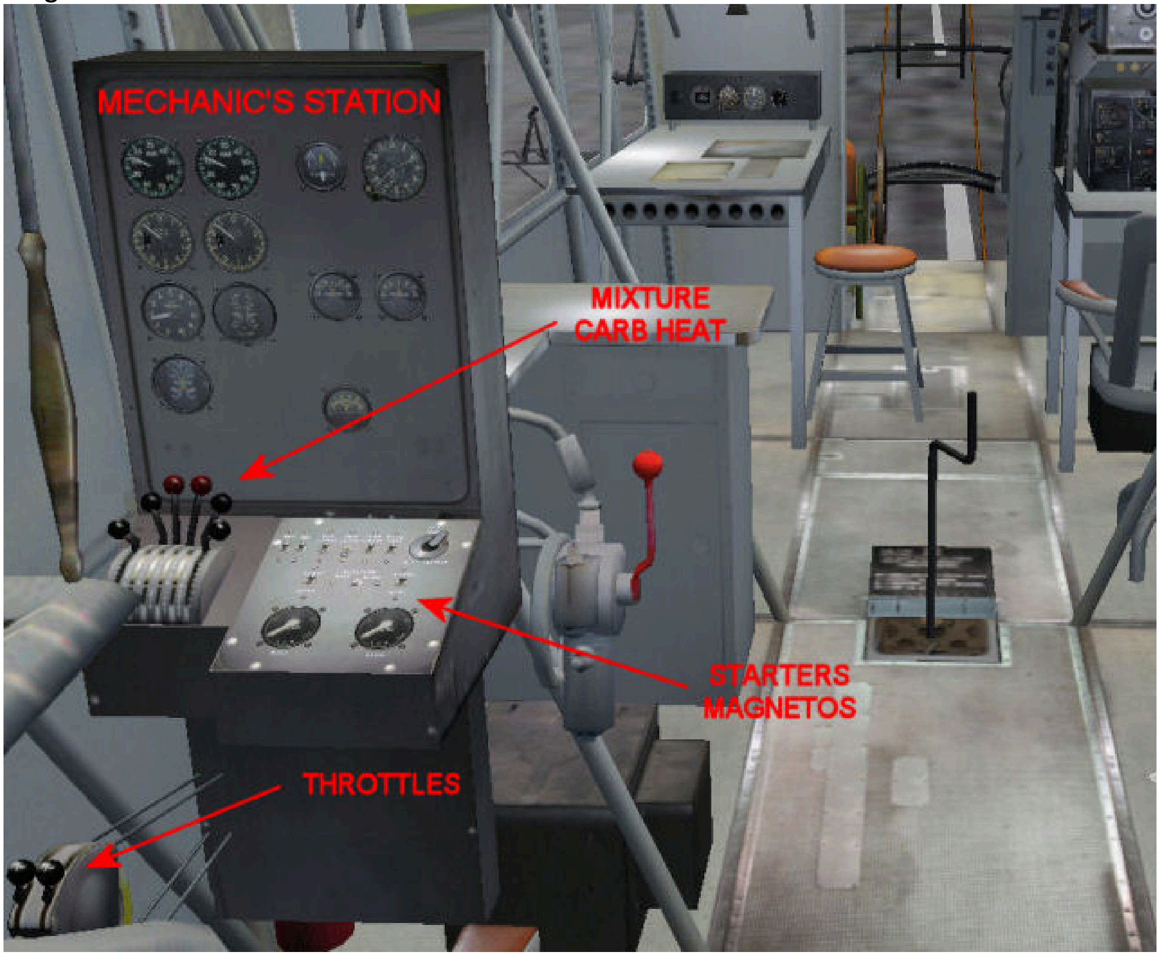
Under each overhead fuel tank in the car ceiling there is a fuel gauge. The forward left tank is Center1 and the second tank is Center2. All other tanks repeat Center2 readings.



Lights



Engine Controls - Mechanic's Station



MOVING AROUND IN THE VIRTUAL COCKPIT

You can shift the eyepoint in the virtual cockpit to see details from a different perspective. Here are the default key commands:

Forward	Ctrl - Backspace
Aft	Ctrl - Enter
Up	Shift - Enter
Down	Shift - Backspace
Right	Ctrl - Shift - Enter
Left	Ctrl - Shift - Backspace

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LIGHTER-THAN-AIR FLIGHT DYNAMICS

This Flight Simulator model blimp is designed to give a rough approximation of lighter-than-air flight. Flight Simulator does not support “static lift,” which is the lift provided by helium, so many compromises must be made. Many previous lighter-than-air (LTA) models based on Bill Lyons’s excellent work, were very light aircraft (gross weight 90 pounds or so) with tiny engines (10 hp and 10 gallons of fuel). I have tried a slightly different approach, to allow a gross weight of about 2000 pounds with bigger engines and a fuel load of 250 gallons. This is not really more realistic than the Lyons approach, but allows for some experimentation with weight and trim in flight. I wanted to start with a large, slow airplane model and modify from there. Dennis Simanaitis was kind enough to allow me to use his 1913 Russkii Vityaz (Le Grand) flight dynamics as a base. The files are heavily modified, however, so any flaws are purely mine.

FLIGHT DYNAMICS COMPROMISES

The first compromise with reality in a LTA craft is mass. Although the U. S. Navy K-class blimps flew with a flight “heaviness” of about 2000 pounds, the actual weight of the blimp was over 28,000 pounds. The difference of 26,000 pounds was the static lift of the helium. In Flight Simulator, the gross weight of the blimp is the smaller, net heaviness, about 2000 pounds in my model. So now almost all realism in the flight model must be compromised. Because of the basic physical law that f=ma, you can’t use full-powered engines with such a light aircraft. The speed would be wildly fast. So the engines must be de-rated, and power settings and fuel consumption will not be realistic. In my model, the actual 425-hp engines are modeled at around 200 hp.

The actual K-class blimps carried 1180 gallons of fuel in 10 tanks, which would weigh over 7000 pounds. In my model the fuel capacity is 250 gallons in two 125-gallon tanks. This is the actual size of the main K-ship tanks, so the fuel gauges appear realistic.

A real blimp has tremendous “pendulum stability.” With lift coming from a bag overhead and most of the weight in a car below, the blimp can’t be taken to extreme attitudes or perform rolls and loops. In Flight Simulator models, since 90% of the weight is missing, the aerodynamic forces can overcome the pendulum stability and you can do unrealistic maneuvers. Even Bill Lyons’s model can be made to do an outside loop. My model is less realistic in that regard, since it can do inside loops also, particularly at low fuel loads.

The next major compromise involves speed. Without static lift, all the lift in Flight Simulator models must come from aerodynamic lift, caused by forward speed. So true hovering is not possible. Very slow flight requires additional lift from “flaps” which don’t exist on the real blimp.

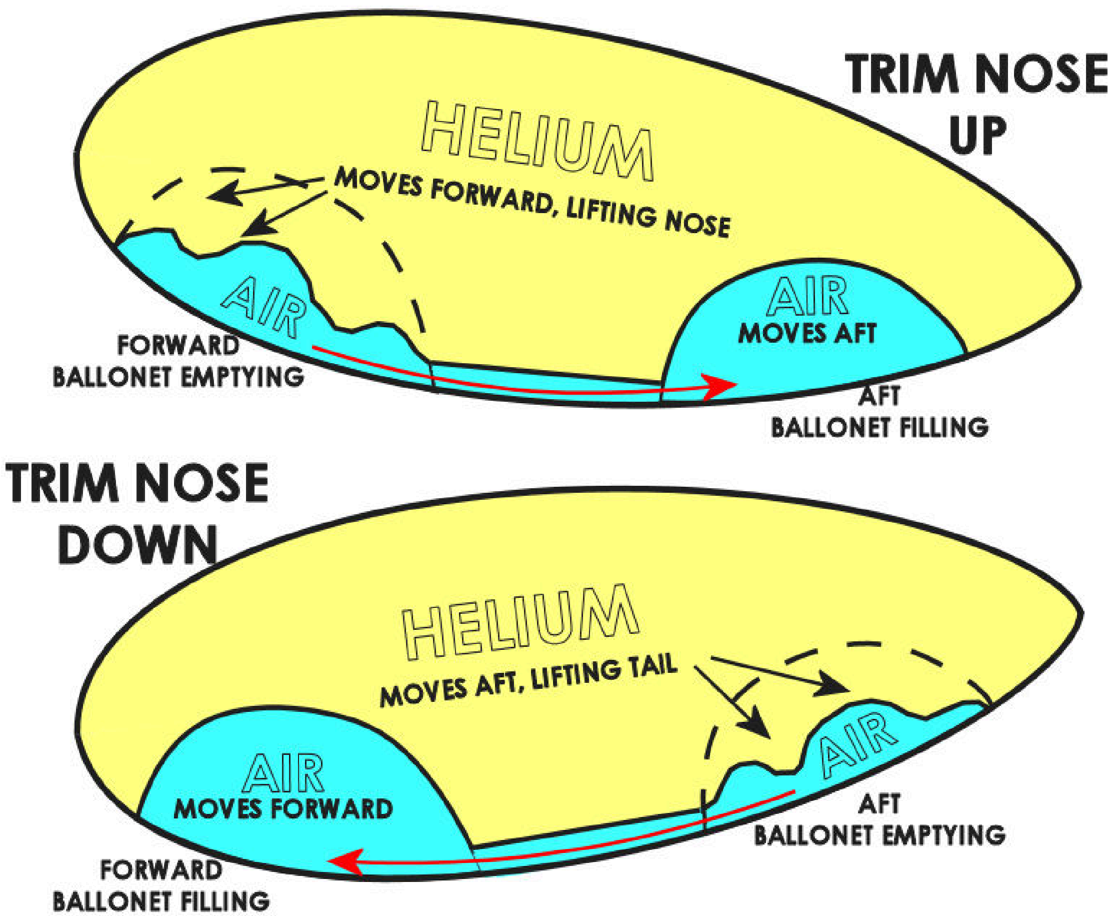
Another compromise is helium management. In emergencies, actual blimps could vent helium to descend. In my model, this is simulated with a “spoiler” function that reduces aerodynamic lift.

TRIM CONTROLS IN A BLIMP

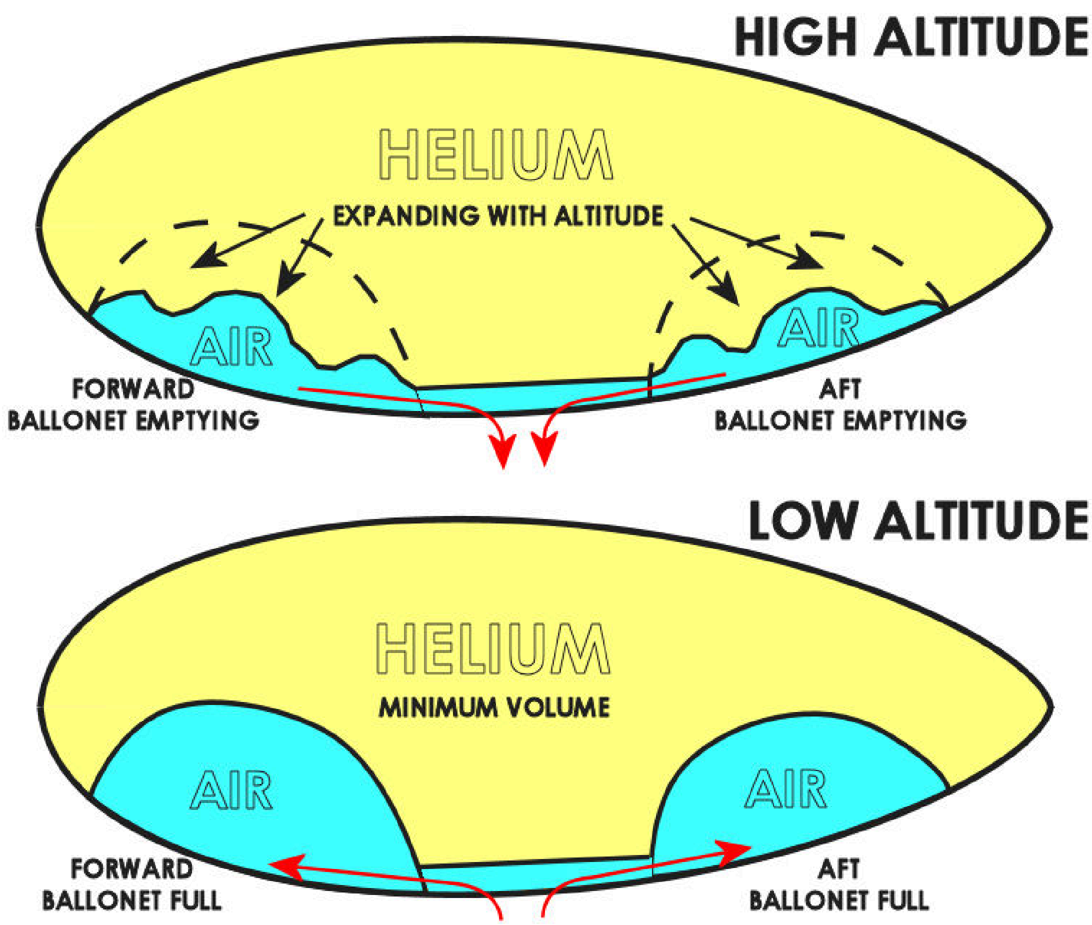
Actual blimps required a lot of effort to stay trimmed and level. Heat, rain, and altitude could cause gas to shift around in the envelope and make the blimp pitch up and down. It was the job of one “altitude” pilot, the elevator man, to manage that. The other pilot, the rudderman, controlled the direction of the blimp.

The altitude pilot used an elevator wheel to control the big elevators on the tail fins. These were effective when the blimp had some forward speed.

The altitude pilot also had controls to move helium forward and aft in the envelope, to control the pitch of the blimp even when not moving forward. These controls pumped air into or out of bags called “ballonets” inside the helium envelope. They took up over 1/4 of the volume of the envelope. The following diagram shows how the altitude pilot could move air from the forward ballonet aft to raise the nose, and vice versa.



The ballonets also handled the problem of gas expanding with altitude. The blimp's envelope is only partially filled with helium on the ground, and the ballonets are filled with air to make up the difference. As the blimp gains altitude, the helium expands to fill more of the envelope, and air is forced out of the ballonets. At a certain height called the "pressure altitude," the helium will occupy the entire envelope and the ballonets are flat. The following diagram shows how air can be pumped into or out of the ballonets to compensate for changes in helium volume.



Above the pressure altitude, when the ballonets are completely empty, helium must be vented to prevent the envelope from bursting. Helium was a precious resource, so this was to be avoided except in dire emergencies.

When blimps came back from a patrol they were often "light" from having used up fuel, and they could have difficulty getting down to the ground. Helium was so valuable that the blimps would make many attempts to dive to the ground under power, rather than vent helium to reduce buoyancy.

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BLIMP LANDING PROCEDURE DIAGRAM

Here is a diagram from a War Department technical manual showing a recommended method of landing an airship.

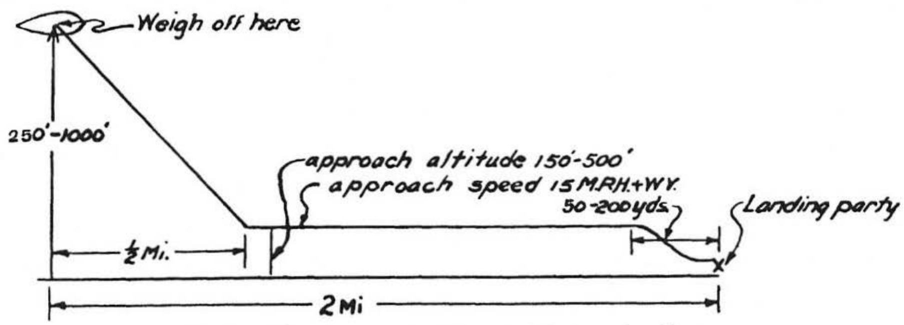

FIGURE 26.—Approach of an airship to a landing.

The first step, the "weigh-off," is performed to determine if the ship is heavy or light, and to determine further if the ship is bow-heavy or tail-heavy. These conditions may not be easy to discern, and it may require "dynamic" weighing off and "static" weighing off procedures to get the true answers.

Dynamic weigh-off involves flying the ship at constant speed and altitude and calculating approximate weight and balance from the pitch of the ship and the elevator deflection required to maintain the constant altitude, using charts of the ship's dynamic lift curves.

Static weigh-off involves reducing air speed to as low a speed as possible, bringing the ship to an even keel, and putting the elevator controls in neutral position. The pilot then determines if the ship is ascending or descending from the vertical speed indicator, for a short period. From charts it can then be determined how heavy or light the ship is.

Corrective action is then taken to trim the ship, by shifting weight around fore-and-aft, or dropping ballast.

The pilot then maneuvers the ship quickly down to the approach altitude and makes any further necessary trim adjustments. Nonrigid airships' approach altitude was low, about 150 feet.

The pilot then begins a long approach (2 miles at 15 mph takes 8 minutes) to arrive at the landing area where a final descent is made and the ship's trailing lines are captured by the ground crew. The easiest landings are made into a steady wind of 10 to 15 mph, with a ship slightly heavy, so ballast can be released at the last moment just as the ground handlers seize the lines. In gusty winds, it is better for the ship to be a little light, and at a little higher altitude, to guard against being slammed into the ground by a gust. In this case the ship is dived down under power at the last minute, using hard down elevator, to get down where the landing party can grab the lines.

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