1. AEROSTAT INTRODUCTION

INTRODUCTION:

The tethered aerostat, also known as a blimp or kite balloon, has been in use since the early 19th Century for a variety of observation purposes. The use of aerostats for signal intelligence gathering platforms has risen since 1954, when the Israelis pioneered the use of tethered aerostats as an electronic payload carrier by mounting a radar underneath an Airborne Industries aerostat. The latter half of the 20th Century saw an expansion in the use of tethered aerostats as electronic platforms, and today it is common practice to have radar-equipped models in use.

STRUCTURE:

The structure of the aerostat is designed for aerodynamic efficiency - to achieve maximum stability in flight and to minimise drag. To aid this, the modern aerostat employs a number of methods such as automatically-inflated inner structures and the latest advances in material technology.

The hull consists of three inflated structures - main hull, fins and ballonet. The main hull is filled with Helium to provide lift, and is made from fabric chosen for its ability to withstand the effects of the wind, rain, the sun's UV rays, and other environmental concerns. The fabric must also exhibit high tensile strength to carry the payload without structural failure, and act as a barrier film to contain the helium with a low loss rate.

The tail fins and smaller, variable-volume chamber called the ballonet, are inflated with air to maintain the hull pressurisation, and thus aerodynamic shape of the aerostat. An automatic pressurisation system consisting of air valves and blowers maintains the optimum internal pressure at all times.

PAYLOAD:

Carriage of the payload is the aerostat's main purpose.

The best stability is given by placing the payload at the confluence point of the main tether. In the case of cameras, this also has the benefit of giving a full 360° unobstructed view.

With payloads such as surveillance radar equipment, where line-of-sight through tether lines is not an issue, positioning on the under-belly, halfway between the tether and the tail, is preferred for ease of maintenance, being clear from tether lines and other rigging.

TETHER - main:

The tether is a key component of the aerostat system, acting as a means of securing the aerostat, providing it with power, and transmitting information to the ground station.

TETHER - main detail:

The main tether cable is made from strong Kevlar fibres, protected in a black PU outer sheath offering UV and weather resistance. Fibre optic cables, protected deep within the tether core, provide high resolution data transmission from the payload to the ground control station.

Also within the tether core are three copper conductors, supplying a three-phase 400Hz (Hertz) power link to the aerostat and its payload. Because the aerostat receives power via the tether rather than by on-board generators, flight times are not limited by fuel considerations. In the unlikely event of a ground power failure, emergency battery back-up power within the aerostat itself allows for safe inhaul and recovery.

TETHER - close haul lines:

The aerostat's side tether cables are used for close haul operations when the aerostat is within the docking station area. These cables are utilised to give extra stability and fine tune manoeuvrability to the aerostat during inhaul, outhaul and docked operations through manned connection and winching.

TETHER - nose tether:

The nose tether cable is used to guide the aerostat into the nose docking cone incorporated into the docking station mast which we shall see shortly. As the aerostat approaches the docking station this cable is manually connected to the emerging cable from the docking mast.

The cable is then automatically winched in through the docking mast and cone which in turn pulls the aerostat's nose into the docking connector.

2. MOBILE DOCKING STATION

INTRODUCTION:

The mooring station secures the aerostat when at ground level. It also contains the winch system for inhaul and outhaul of the aerostat, and for maintaining the correction altitude when in airborne operation. Depending on the application, the mooring station can be a permanent installation, or in this instance, a mobile unit based on a standard 40-foot truck trailer chassis.

SETUP:

The main advantage of the mobile docking system is the ability to place the aerostat where it is needed. Once the truck is in position, stabilising legs are unfolded from the docking station, and the truck is detached.

SETUP - ground anchoring:

Ground anchoring of the mobile docking station is also required to allow secure tethering of the aerostat. The earth anchors can generally be installed by hand or by using a lightweight hand held percussive breaker. The anchor system is driven into the ground to the required installation depth then the drive rod removed from the body of the earth anchor, either by hand or using rod removing equipment.

The anchor system is then loadlocked into its working position by applying a load to the wire tendon.

SETUP - conversion:

Conversion from container to an operational docking station is a relatively simple process. Container sides swing down creating a useful working platform. The docking mast is then raised into an upright position ready to accept the soon-to-be inflated aerostat. The maintenance lift table platform also extends out in position ready to give easy access to the payload area.

The aerostat, currently packed on the docking platform, can now be inflated, docked and ready for payload attachment, final checks and operation.

OPERATION:

Near the ground the aerostat, due to low-level turbulence and ground effect, must be held in the mooring station by the nose coupling and at the confluence point by the main winch. With the aerostat now inflated and moored to the docking station, the bearing brake can be disconnected, allowing the docking station and aerostat to rotate freely, maintaining the proper position, relative to the wind, while moored or in flight.

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OPERATION - mast and nose coupling:

When moored, the aerostat is mechanically locked to the mast at the nose and secured by its suspension lines to the platform under the aerostat payload.

The mast is able to extend in height, allowing the locked aerostat to be raised away from the working platform in outhaul or to safely lower in the locked aerostat during inhaul procedure. This means the aerostat nose coupling and decoupling can be carried out further away from the lower maintenance area.

The mooring mast incorporates an integral winch which connects to the aerostat's nose tether cable. When connected and the winch operated, the aerostat's nose is drawn into the docking cone on the mast, where it is then locked in position.

OPERATION - main winch:

Once the aerostat leaves its mooring station it is controlled only by the main winch. All in all there are typically four separate winches, the main winch for the tether cable, the mast winch which hauls in the nose of the aerostat, and two close haul winches that provide the control during early stages of launch and final recovery. The tether cable goes vertically from the aerostat down into the flying sheave and then along the horizontal boom into the winch machinery.

OPERATION - hydraulic lift platform:

To aid access to and maintenance of the payload, a hydraulic lift platform is incorporated into the docking station. This allows personnel and equipment to be raised to and lowered from the docked aerostat in a safe manner.

3. OUTHAUL

INTRODUCTION:

With the payload now secure and operational, and the aerostat automatically aligned into the wind, the outhaul sequence may now commence.

OUTHAUL SEQUENCE - close haul lines:

Firstly, the close-haul lines, which are used to stabilise the roll of the aerostat while docked, are detached from the winches in preparation for mast extension. The main winch now takes up the aerostat's floating weight along with the mast nose coupling keeping the aerostat secure and stable.

OUTHAUL SEQUENCE - mast extension:

To ensure safe movement of the aerostat away from the working platform and winch machinery, the docking mast extends upwards synchronous with the main winch to a safe de-coupling height.

OUTHAUL SEQUENCE - nose decoupling:

To disconnect the locked aerostat from the mast, the nose locking lever is disengaged, and the nose tether winch starts slowly to release the nose tether cable. The aerostat's weight is now taken up by the main winch and tether line alone. The nose tether cable is then winched down to platform level where it is manually de-coupled, allowing the aerostat to outhaul to the required altitude.

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OUTHAUL SEQUENCE - aerostat elevation

With the aerostat now free from the docking station, control of the main winch deploys the aerostat to the required working altitude where, weather permitting, it can remain for months without attention. When the aerostat is at altitude the tether cable is routed from the main winch through the boom to the flying sheave and then up to the balloon. The tether cable tension is generally strong enough to rotate the mooring system into direct alignment with the horizontal projection of the tether cable.

4. AIRBORNE SURVEILLANCE

INTRODUCTION:

Surveillance carried out from a tethered aerostat has many advantages over other means of surveillance. Maintenance and operational costs are relatively low, especially when compared to the expense of an aeroplane, where running costs after initial outlay is high, and only a small crew is needed to launch and in-haul the aerostat.

The technical aspects of the aerostat's engineering and construction mean that it is incredibly durable with a large aerostat able to withstand a high level of turbulence if flying away from the surface effect.

Being a stable platform also ensures optimum performance from the sensing payload.

One of the main advantages over ground-based systems is the wider range of coverage attained from being airborne. Not only that, the aerostat is able to detect targets that may be obscured from a ground-level perspective. Typically, at an altitude of 1000m the aerostat's sensing range is 130Km. Additionally, as a payload-carrier, the aerostat can easily be adapted to add to, or change the surveillance method.

SENSING:

As an airborne surveillance unit, the tethered aerostat is able to detect targets or objects within its wide coverage area. Any detection from the sensing equipment is instantly transmitted via fibre optic link within the main tether cable to the control centre at ground level; usually in a nearby auxiliary unit or a Lindstrand inflatable structure. Here, the information can be interpreted swiftly, reported and acted upon immediately and safely.

CONTROL:
In addition to radar information received at the control centre via the main fibre optic link, the aerostat is also capable of sending data wirelessly. This is vital as if a fault occurs with the main tether cable, operators are still able to monitor the aerostat and dock it safely.

This wireless signal performs a crucial health-check role, enabling the crew at the control base to monitor the aerostat's activity, including details about the hull and tail fin pressure, the ambient and helium temperature, the degree of the aerostat's pitch and yaw, and its direction.

The system also incorporates an automatic alarm if an anomaly in any of these readings is detected, alerting the crew at ground control that something needs attention, or possible inhaul.

5. INHAUL

INTRODUCTION:

For payload adjustment, routine maintenance or during severe storms it will be necessary to inhaul and dock the aerostat. The typical winching speed is 60 metres per minute. Winching speed is normally dictated by the required time to bring down and secure the aerostat when serious thunderstorm weather is detected. The required winch speed is therefore depending on detection range and aerostat flying height. The winching motor, when paying out cable, is normally operated in reverse, i.e. it is a braking motor where the heat rejection (whether it is electrical or hydraulic) is the limiting factor. The aerostat itself can normally handle much faster winching speeds without becoming unstable, typically 150 metres per minute is easily achievable.

INHAUL SEQUENCE - mast extension & nose docking

To ensure safe movement of the aerostat toward the working platform and winch machinery, the mooring mast extends upwards to a safe coupling height where the aerostat is collected. The aerostat's nose tether and the docking stations nose coupling cable are manually connected together when within reach. The mast winch will then reel in the connected nose tether line, pulling in the aerostat's nose cone to dock with the mast. At the top of the mast is a mechanical lock that automatically connects the nose mooring coupling on the aerostat nose to the mast when hauled in.

INHAUL SEQUENCE - mast down & close haul lines engaged:

After docking with the mast nose coupling the mast then lowers the connected aerostat, synchronous with the main winch, to a height where close haul lines can be connected. The close-haul lines are then winch tightened and used to stabilise the roll of the aerostat while docked and also allow for disconnection or maintenance of the main tether.

INHAUL SEQUENCE - docked:

With the aerostat now safely docked payload adjustments and maintenance checks can be carried out. The docking station and payload working platform will continue to automatically vane into the wind with the aerostat to ensure maximum stability at ground level. If required the aerostat and docking station can be quickly packed and ready within 4-6 hours to be transported to an alternative location.

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