Pennsylvania Department of Agriculture
Bureau of Ride and measurement Standards

Ride Approval Checklist

Name of the manufacturer of the Ride or Attraction
Lindstrand Technologies Ltd
Mile Oak Industrial Estate
Maebury Road
Oswestry
Shropshire
SY10 8HA, England Contact Person – Keith Goffin, Project Engineer
Telephone # +44 1691 672576
Fax # +44 1691 679991
E Mail - kgoffinlbl@aol.com

Manufacturers name of the Ride-
Lindstrand HiFlyer Captive Gas Balloons

Pet name of the Ride (if Applicable)-
HiFlyer Balloon

Name of Engineer providing certification-
Ed Pribonic, PE. Inc.

Telephone # 562 493 2946
Fax # 562 493 0127

First company to register the ride (if applicable)-
Zoological Society of Philadelphia
3400 West Girard Ave. Philadelphia, Pa. 19104
Kenneth L. Woodson, Senior vice President community Affairs and Regional Initiatives
Telephone # 215 243 5338
Fax # 215 243 5288
E Mail: woodson.kenneth@phillyzoo.org

Has the department received an owner's manual? -
Yes

Approved name and number of the ride or attraction-
Hi Flyer # 0833

Approved name and number of the manufacturer-
Lindstrand Technologies Ltd 1217

Notes: OK

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF AGRICULTURE
BUREAU OF RIDE & MEASUREMENT STANDARDS
AMUSEMENT RIDE SAFETY DIVISION
April 11, 2002

Philadelphia Zoo
Lindstrand Technologoes
Edward Pribonic P.E.

NEW RIDE TYPE HAS BEEN APPROVED

Dear Manufacturer:

Thank you for submitting your Amusement Ride of Attraction to the Pennsylvania Department of Agriculture Amusement Ride Safety Board for approval to operate within the Commonwealth.

This is to inform you that the attractions listed below have been approved by the Pennsylvania Ride Safety Board and has been added to list of approved ride types in Pennsylvania.

Name of Ride	Name of Manufacturer
Hi Flyer	**Lindstrand Technologies LTD**

The Department of Ride and measurement Standards Ride Safety Division congratulates you on your efforts to make Pennsylvania a "Safe Place to Ride" and wishes you good luck with your new venture.

If your customers have not already received a registration Plate for the equipment listed above, please contact this office to complete registration.

Sincerely Yours,

Joe Filoromo
Supervisor, Amusement Ride Division

E-mail: jfiloromo@state.pa.us

Room 206
2301 North Cameron St.
Harrisburg, PA 17110-9408

Amusement Rides & Attractions: Tel. 717-787-2291
Weights and Measures: Tel. 717-787-9089
FAX: 717-783-4158

LINDSTRAND BALLOONS LTD

OPERATIONS MANUAL

For use with HiFlyer Tethered Balloons

Lindstrand Balloons Ltd
Maesbury Road
Oswestry
Shropshire
SY10 8HA
TEL: (+44 1691) 671888
FAX: (+44 1691) 679991

LINDSTRAND BALLOONS LTD

This Operations Manual has been prepared for the following balloon system:

Serial No:

Volume: **$5790m^3$**

Type Designation: **LBL HiFlyer**

Build Standard:

I hereby certify that this Operations and Maintenance Manual (LBL TAOM and LBL TAOM MM), as prepared for the above balloon system and incorporating the amendments listed, conforms to the build standard of the above balloon at the time of delivery.

Signed .... Date ....

For Lindstrand Balloons Ltd
CAA Approval Ref. No. DA1/9400/92

Applicability:

Generally, this Operations Manual applies to all HiFlyer Tethered Balloons which incorporate a David Brown K830156 winch system. The system components which were delivered by Lindstrand Balloons Ltd are identified within the HiFlyer balloon weight sheet on Page iii. All operational limitations which are applicable to the equipment supplied must be adhered to. If any equipment is used within the HiFlyer system which has not been supplied by Lindstrand Balloons Ltd, then the instructions contained within this manual must be regarded as advisory only. It is the responsibility of the operator to ensure that the operational limitations for their hybrid system are established and published.

Furthermore, it should be noted that the Lindstrand Balloons Ltd warranty is based upon the exclusive use of Lindstrand Balloons Ltd supplied equipment. Lindstrand Balloons Ltd do not warranty equipment that they have not supplied and the warranty provided on Lindstrand Balloons Ltd equipment which is being operated with components supplied from elsewhere, will be limited.

HIFLYER BALLOON WEIGHT SHEET

Hi Flyer Ser.No.: Type: **LBL 575**

Modification Status: **NIL**

Approved By: Date:

			WEIGHT	
ITEM	DRAWING NO.	SER.NO.	KG	LBS
Envelope	EG-580-A-001			
Net	AD10-0255000			
Load Ring	GO-001-A-020			
Gondola	GO-003-A-001			
Battery 1	GO-001-A-023			
Battery 2	GO-001-A-023			
2 internal lighting batteries				
Lighting Generator				
Lighting Box				
Banners				

Record of Amendments

No.	Date	Affected Pages	Incorporated By
1	Oct. 2001	IV, V, VIII, 5, 14, 27, 33, 48 – 62 Appendix 4 (A4) Appendix 5 (A5)	John Ackroyd
2	Feb. 2002	Iv, v, 27, 28, 33, 34, 35, 37, 38, 39, 51, 54, 55, A1-2, A2-6 to A2-11	John Ackroyd

Amendments:-

This manual is kept up to date by amendments consisting of looseleaf pages, required to add new information or amend existing information. The pages affected by an amendment and the effective date are shown above. The pages themselves are identified by a change of the issue number at the bottom of each page. The number after the point in the issue number represents the amendment level of that page, e.g. a page marked Issue 1.4 is at Issue 1, modified by Amendment 4. The checklist of pages indicates the issue level of all pages included in this Operations Manual. Amendments are issued to all relevant operators of the Lindstrand Balloon Ltd HiFlyer System on a free of charge basis provided that the Inclusion Check Sheet is signed and returned to Lindstrand Balloons Ltd for each issued amendment.

Change of Ownership

If the ownership of this balloon changes, it is important for the new owners to contact Lindstrand Balloons Ltd to ensure that they receive Operations Manual Amendments and Supplements, as appropriate. This can be simply achieved by photocopying Page ii of this manual and writing your name and full correspondence address on the reverse side and sending to Lindstrand Balloons Ltd.

Checklist of Pages

Page No.	Issue	Page No.	Issue	Page No.	Issue
i	4.0	34	4.2	A1-1	4.0
ii	4.0	35	4.2	A1-2	4.2
iii	4.0	36	4.0	A2-1	4.0
iv	4.2	37	4.2	A2-2	4.0
v	4.2	38	4.2	A2-3	4.0
vi	4.0	39	4.2	A2-4	4.0
vii	4.0	40	4.0	A2-5	4.0
viii	4.1	41	4.0	A2-6	4.2
1	4.0	42	4.0	A2-7	4.2
2	4.0	43	4.0	A2-8	4.2
3	4.0	44	4.0	A2-9	4.2
4	4.0	45	4.0	A2-10	4.2
5	4.1	46	4.0	A2-11	4.2
6	4.0	47	4.0	A3-1	4.2
7	4.0	48	4.1	A3-2	4.0
8	4.0	49	4.1	A3-3	4.0
9	4.0	50	4.1		
10	4.0	51	4.2	A4	4.1
11	4.0	52	4.1		
12	4.0	53	4.1	A5	4.1
13	4.0	54	4.2		
14	4.1	55	4.2	S1-1	4.0
15	4.0	56	4.1	S1-2	4.0
16	4.0	57	4.1	S1-3	4.0
17	4.0	58	4.1	S1-4	4.0
18	4.0	59	4.1		
19	4.0	60	4.1		
20	4.0	61	4.1		
21	4.0	62	4.1		
22	4.0				
23	4.0				
24	4.0				
25	4.0				
26	4.0				
27	4.2				
28	4.2				
29	4.0				
30	4.0				
31	4.0				
32	4.0				
33	4.2				

Operations Manual Supplements

Supplement No.	Title	Tick if Applicable
1	Ground Fan Operating Instructions	√

CONTENTS

CONTENTS Cont'd

SECTION 1 - TECHNICAL DESCRIPTION

1.1 System Description

The Lindstrand HiFlyer Tethered Balloon is a system which allows up to 30 passengers and one operator to be lifted to a height of approximately 160m (488 ft) in order to provide an excellent view of the surrounding land. The system is designed to be able to operate in weather conditions which would not be suitable for a hot air balloon flight thus allowing for an increased operational duration and passenger throughput.

The system consists of three major sub-systems:-

- A balloon and net which provides the necessary lift to support all the equipment and passenger weights.
- A gondola which provides a safe carrying structure for the occupants.
- A winch system which allows the balloon to be tethered in position and winched back down at the end of each ride.

1.2 Balloon System

The balloon system is the main lifting body and is comprised of all the components which allow the regulation and control of the lifting gas. The only lifting gas approved is helium. The helium supplied must have a purity of 99.995%. The helium generates lift due to the fact that it is less dense than the air that surrounds the balloon. The quantity of lift generated is dependent upon the atmospheric conditions and the mass and purity of the helium contained within the balloon. The balloon is provided with a helium temperature indicator and a load cell which will give an indication of total free lift. By measuring these two quantities the state of the Helium may be established. The helium is contained within the envelope which itself is contained within the net which allows the generated lift to be transferred into the load frame.

1.2.1 Envelope Volume Control

The maximum envelope volume is fixed but the volume of helium contained within the envelope will change with changes in the helium temperature, and atmospheric pressure. To accommodate these helium volume changes a separated air filled chamber, called a ballonet, is provided at the bottom of the gas cell. The physical separation is achieved by the presence of a thin fabric membrane between the gas filled cell and the air filled cell or ballonet. The membrane is called the bladder.

1.2.2 Helium Pressure Control

The maximum envelope pressure is limited by the strength of the envelope fabric and the weld strength. To ensure that the maximum envelope pressure is not exceeded (40 mm WG) a helium valve is provided at the apex of the envelope. This helium valve may be opened to release helium to reduce the pressure in the envelope. Excessive helium pressure could cause the envelope to rupture, therefore constant monitoring of helium pressure is imperative and should be recorded.

1.2.3 Air Pressure Control

As mentioned in Section 1.2.1 changes in atmospheric conditions or helium temperature cause changes in the helium volume. If the volume of helium is reduced due to reducing temperature or increasing atmospheric pressure then the envelope fabric will become slack in the lower portions of the envelope. When the balloon is being operated in windy conditions with insufficient tension in the envelope fabric the fabric will tend to indent. This causes an increase in the drag forces generated by the wind which will cause the balloon to move in a downwind direction. To reduce the drag forces created by the wind it is best to preserve a certain level of envelope tension. This is achieved by introducing an air pressure control system which works in association with the ballonet. At the bottom of the envelope a ballonet fan and pressure relief valve are located. The ballonet fan allows air to be blown into the ballonet thus increasing the air pressure in the ballonet. The air progressively fills the ballonet which expands to occupy the space left by the contracting helium. Once the contracted helium volume is occupied the fan keeps on filling the ballonet to introduce a small amount of pressure. This pressure is also transferred into the helium cell through the bladder and results in the exterior envelope fabric being tensioned. This reduces the wind generated drag forces.

In association with the ballonet fan a ballonet Pressure Relief Valve (PRV) is fitted next to the fan at the bottom of the envelope. The PRV is set to open at a predetermined pressure of 14 mm (0.55") WG. This ensures that the process of pressurizing the ballonet does not cause the helium valve to open because of excessive helium pressure. In normal operation the Ballonet PRV is set to open before the helium valve.

To prevent accidental release of helium, switch the helium control valve to manual during storm mooring.

1.2.4 Detailed Description of Balloon System

Refer to Figure 1.2.4 for the location of all envelope hardware components.

1.2.4.1 Envelope Description

The envelope is manufactured from a heat weldable helium gas tight fabric. It is a sphere with a diameter of 22.28m (73 ft) giving a total envelope volume, including the ballonet of 5790 m^3 (203,059 ft). The envelope is constructed in vertical segments called "gores". The envelope is reinforced locally by the use of "doublers" for fitment of the various envelope components e.g. helium valve and filler valves. A ballonet is created by the addition of an internal membrane in the lower portion of the spherical envelope. On the outside surface of the envelope in the lower half a fabric drip ring is attached. This provides a measure of protection for the gondola from rain.

1.2.4.2 Ballonet

The ballonet is created by separating a volume at the bottom of the main envelope from the gas cell. The boundary is a lighter weight, non-load carrying helium tight fabric. When the ballonet is fully inflated with air it has a volume of 1,160 m^3 (41,000 ft^3).

When the balloon is initially inflated and subsequently topped-up with helium it is important that the gas envelope is not completely filled with helium as this will leave no room for subsequent

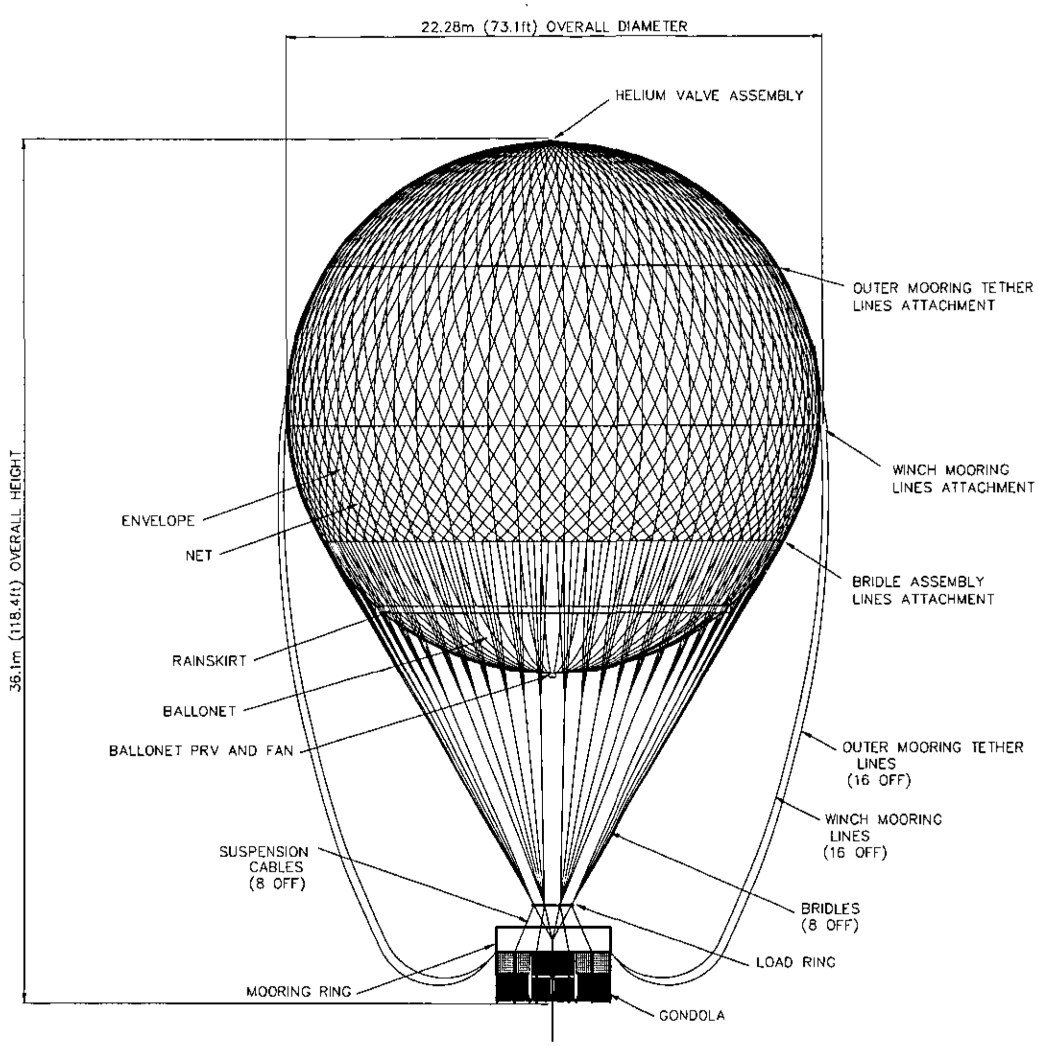

22.28m (73.1ft) OVERALL DIAMETER
HELIUM VALVE ASSEMBLY
OUTER MOORING TETHER LINES ATTACHMENT
WINCH MOORING LINES ATTACHMENT
BRIDLE ASSEMBLY LINES ATTACHMENT
36.1m (118.4ft) OVERALL HEIGHT
ENVELOPE
NET
RAINSKIRT
BALLONET
BALLONET PRV AND FAN
OUTER MOORING TETHER LINES (16 OFF)
WINCH MOORING LINES (16 OFF)
SUSPENSION CABLES (8 OFF)
BRIDLES (8 OFF)
LOAD RING
MOORING RING
GONDOLA

Fig. 1.2.4

expansion of the helium. If the helium cannot expand by contraction of the ballonet the helium pressure will rise. This may result in operation of the helium valve, to reduce the helium pressure, which is a waste of money. Full instructions for obtaining the correct fill level for helium are contained in Section 3.4.11.

On the outer envelope skin, in the lower envelope section a velcro entry flap is provided. This permits inspection of the condition of the bladder fabric and ballonet fill level. If included, there is a clear ballonet window to assist with ballonet fill level inspection.

Note: care must be taken when entering ballonet. This must be supervised and the ground fan must be working so there is plenty of fresh air inside.

1.2.4.3 Helium Valve Assembly and Control Loom

The Helium Valve Assembly is situated at the top of the balloon and consists of a flat plate into which is mounted a thermocouple probe, a helium valve, a pressure transducer and an access port. On top of the plate is mounted a lightning conductor, white stroboscopic anti collision warning light, a steady position light and a wind speed anemometer.

Power and control signals are provided between the items mounted in the valve plate and the control panel in the gondola via a Control Loom. This consists of a number of wires contained within a braided sleeve. During the inflation the control loom is attached to the net in numerous locations.

1.2.4.3.1 Lightning Protection

A collection rod is mounted on the valve assembly plate. The rod is a 1.4m (4.6 ft) long 6 mm (0.24") diameter stainless steel rod with a sharpened tip. Connected to this rod is a high current capacity copper braid, which is incorporated into the control loom. At the lower end of the control loom the two wires are connected to the stainless steel load frame. From the load frame there are multiple conduction paths into the main tether rope. Once charge has been conducted down the main tether rope it can dissipate to earth through the winch system. This lightning protection is to prevent the lightning causing damage to the envelope and to avoid injury to the gondola occupants. It is emphasized that whilst the above measures reduce the risks of a lightning strike the best protection is timely prediction of lightning activity and ensuring that the balloon is fully moored and safely grounded during all periods of atmospheric instability. See Operational Limitations 2.1.

1.2.4.3.2 Temperature Measurement

The lift created by the helium varies with changes in the helium temperature. Consequently it is useful to measure the temperature of the helium held within the envelope. To achieve this a thermocouple probe is provided within the valve assembly and connected to a read-out which is mounted in the control panel in the gondola. The relationship between helium temperature and lift is provided in Appendix 1.

1.2.4.3.3 Helium Pressure Measurement

As described in Section 1.2.2 there is a maximum envelope pressure which must not be exceeded. In order to prevent envelope over pressurisation the helium pressure is monitored by provision of a pressure transducer. This is mounted within the valve assembly at the apex of the envelope

This means that the maximum static pressure within the envelope is measured. The electric signal from the pressure transducer is fed via the control loom to the control panel.

1.2.4.3.4 Helium Valve

The helium valve is a circular aperture of approximately 355 mm (14") diameter which is covered by a mushroom shaped cap. The edge of the cap seats onto a circular silicone rubber seal which is mounted within the valve ring. A 24 Vdc linear electric actuator is mounted between the annular ring and the mushroom cap. When the actuator is energized it moves the cap outwards thus opening a gap between the annular ring and the cap. Helium is vented through this gap. The process is reversed to close the valve. Two limit switches are fitted to the movement of the actuator which define the upper and lower limits of actuator movement. When the limit switches are reached during the movement of the valve an indicator light, mounted in the control panel lights up. The red light indicates that the valve is open.

The helium pressure transducer and helium valve operate together to provide an automatic safe pressure limiting system for the envelope.

1.2.4.3.5 Access Port

A circular access port is also provided within the valve assembly plate. This port is provided for changing the optional internal illumination light. It is a circular disk of 150 mm (6") diameter held in place by 6 bolts and sealed with a gasket.

1.2.4.4 Pressurization Fan

The ballonet fan is located at the lowermost point of the envelope directly above the gondola. It consists of a ducted multi-blade 0.35 kW (0.5 hp) fan which when running, forces air into the ballonet. On the intake side of the ballonet fan is situated a flap valve. This valve automatically closes when the fan is not running to prevent air from leaking out through the fan. The flap valve opens when the fan starts. Power and control signals are supplied to the ballonet fan via a separate loom, which is attached to the lower portion of the net.

1.2.4.5 Ballonet Pressure Measurement

Ballonet pressure measurement is achieved by providing a pressure transducer which is mounted on the ballonet fan plate.

A one meter length of tubing is attached to the pressure transducer to ensure that the pressure that is recorded is not falsely affected by the dynamic airflow from the ballonet fan. The signal from the pressure transducer is fed, via the ballonet fan loom, to the control panel, where it is indicated to the operator.

1.2.4.6 Ballonet Pressure Relief Valve

The control valve is located at the base of the balloon, next to the ballonet fan and it is visible from the gondola. It consists of a mushroom shaped cap which seats on an annular sealing ring. The seal is silicon seal. The ballonet pressure control valve is spring loaded to open at a pre-set pressure level. This pressure setting level is adjusted prior to installation into the envelope. The valve operates automatically and no manual control is required. The normal pressure at which the valve opens is approximately 14 mm (0.55") Water Gauge (WG).

1.2.4.7 Helium Inflation Ports

Two inflation ports are provided on the envelope. These are 50 mm (2") bore Monsun Valves; which are mounted on the envelope just above the bladder line, diametrically opposite each other. The Monsun valve consists of a non-return valve which may be locked open for deflation purposes. *The filler hose must be equipped with the correct bayonet fitting which matches the Monsun valve.* Once filling has been completed the filler hoses are removed and the non-return valve flap is unlocked from the open position. A dust cover is provided for extra security.

1.2.4.8 Helium Replenishment

In the course of time the helium lifting gas will gradually diffuse through the envelope and be lost to the atmosphere. For this reason a method for topping up the amount of helium is provided. This consists of a small tapping which is situated just above the bladder line, in the helium gas section of the envelope. A pressure hose is attached to this tapping to permit top-up.

1.2.4.9 Internal Illumination System

As an option an internal illumination system can be used with the Hi Flyer System. This consists of a portable 2 kW (2.7 hp) petrol generator set which is mounted outside the gondola. Power is transferred up to the valve assembly plate via a special power cable which is attached to the net. At the apex of the balloon a connector is mounted on the valve plate which transfers the power into the helium cell where it is fed down a suspension cable attached to the inside of the valve plate, to a cluster of illumination bulbs.

1.2.4.10 The Net

The envelope net contains all the lift generated in the envelope and transfers the lift into the load ring. It consists of a series of interlinked ropes, formed into a diamond pattern, which are sized to fit over the envelope. The apex of the net is terminated in a metallic ring which is attached to the valve plate assembly. The bottom of the net connects onto the load ring via 8 bridal rope assemblies. A separate polar rope is provided which runs through the diamond net pattern in the upper half of the net. Attached to this rope are 16 mooring tether lines which are provided to allow the balloon to be moored to the high mooring anchor hard points. Another tether rope is fitted at the equator. This second rope is attached to 16 mooring lines which are used for attachment to the low mooring winches.

1.3 Gondola System

The Gondola system consists of the structure itself, the control panel, the load ring and associated attachments, the load cell and the battery powerpack. These items together comprise the means of safely conveying the passengers and operator to the target altitude and for controlling the whole balloon system.

1.3.1 Gondola

The Gondola consists of an octagonally shaped stainless steel welded framework as shown in Fig 1.3.1 (a). The winch cable passes through the centre space of the gondola. The two gondola frames are spaced 800 mm (31.5") apart, which creates a narrow walkway, sufficiently wide to allow people to pass each other but narrow enough to deter bunching of the passengers at one side of the gondola. The outer faces of the gondola are covered, to just below the handrail, by either woven wickerwork or PVC panels. The inside faces are covered to just below the handrail by double skinned and foam filled polyvinyl panels which are securely fastened in position with overbraided "Kevlar" cord. The sides above the handrail and the top face of the framework are covered by nylon netting with a 100 mm (4") mesh size. This netting provides full restraint of the passengers whilst affording good visibility.

Two doors are positioned in the outside face of the gondola and open inwards. This means that the doors cannot burst open due to excessive passenger pressure. When both doors are open a triangular space is created which is reserved for the balloon operator. From this position control over the doors, the control panel and battery packs, is achieved at all times.

The door latches are situated at the hinge end of the door and a door safety overlock is located on the central pillar between the two doors. Either door can be opened with the other door locked and the overlock open. See Fig 1.3.1. (b). The door latches consist of a solid sliding bolt which require a double action (pull up and slide) to open them. A single independent overlocking mechanism prevents accidental operation of both door latches. Both the overlock mechanism and the door latches can be operated from inside and outside the gondola. The doors are also equipped with position indicators. If either of the doors or the overlock mechanism are open the red indicator lamp lights up.

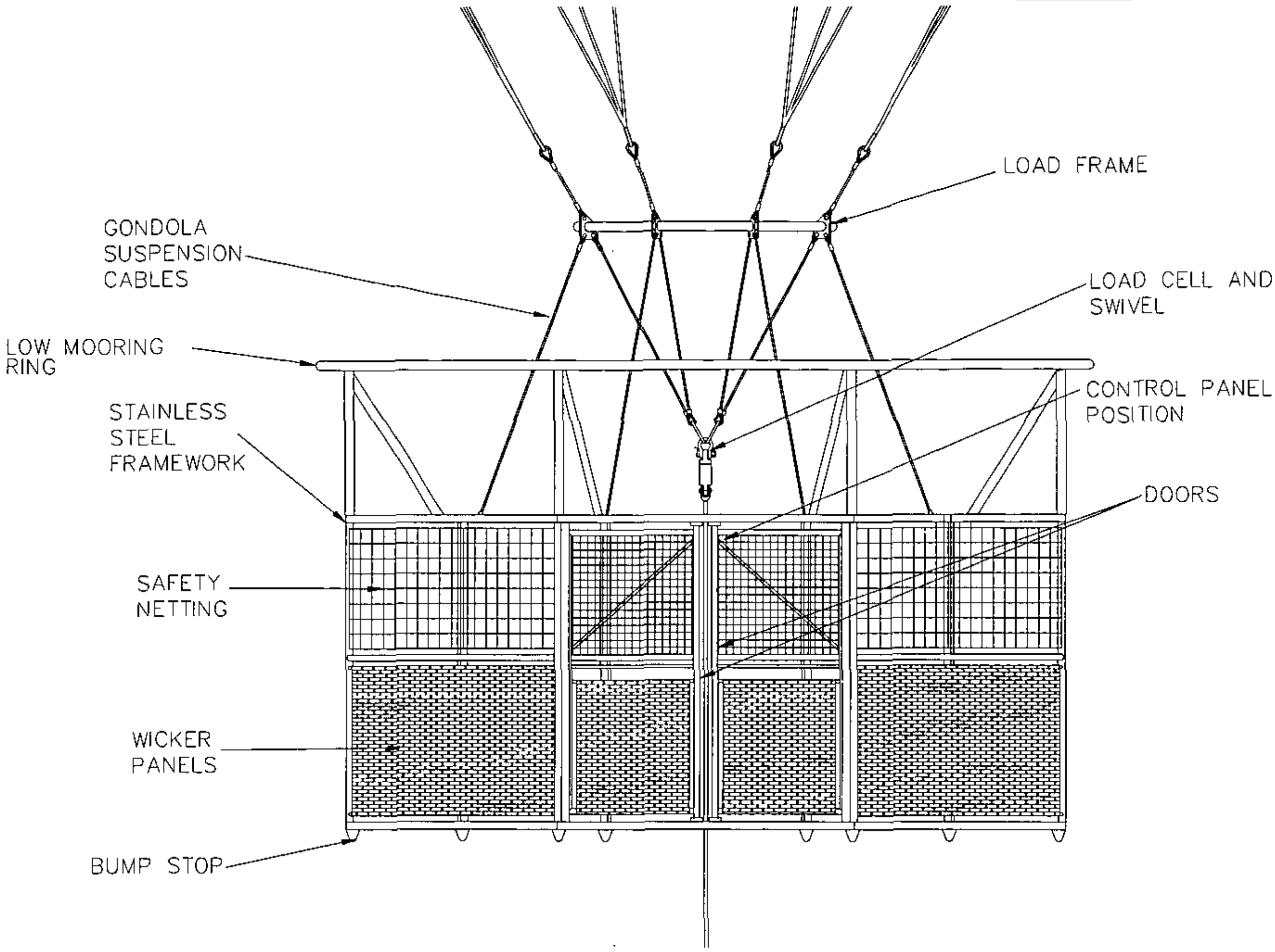
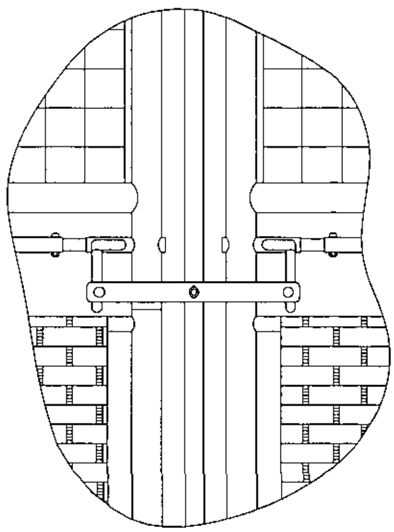
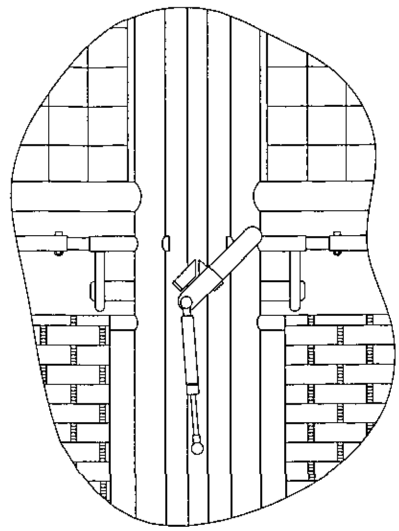


Fig. 1.3.1 (a) Gondola



INSIDE VIEW OF DOOR LOCKING ASSEMBLY

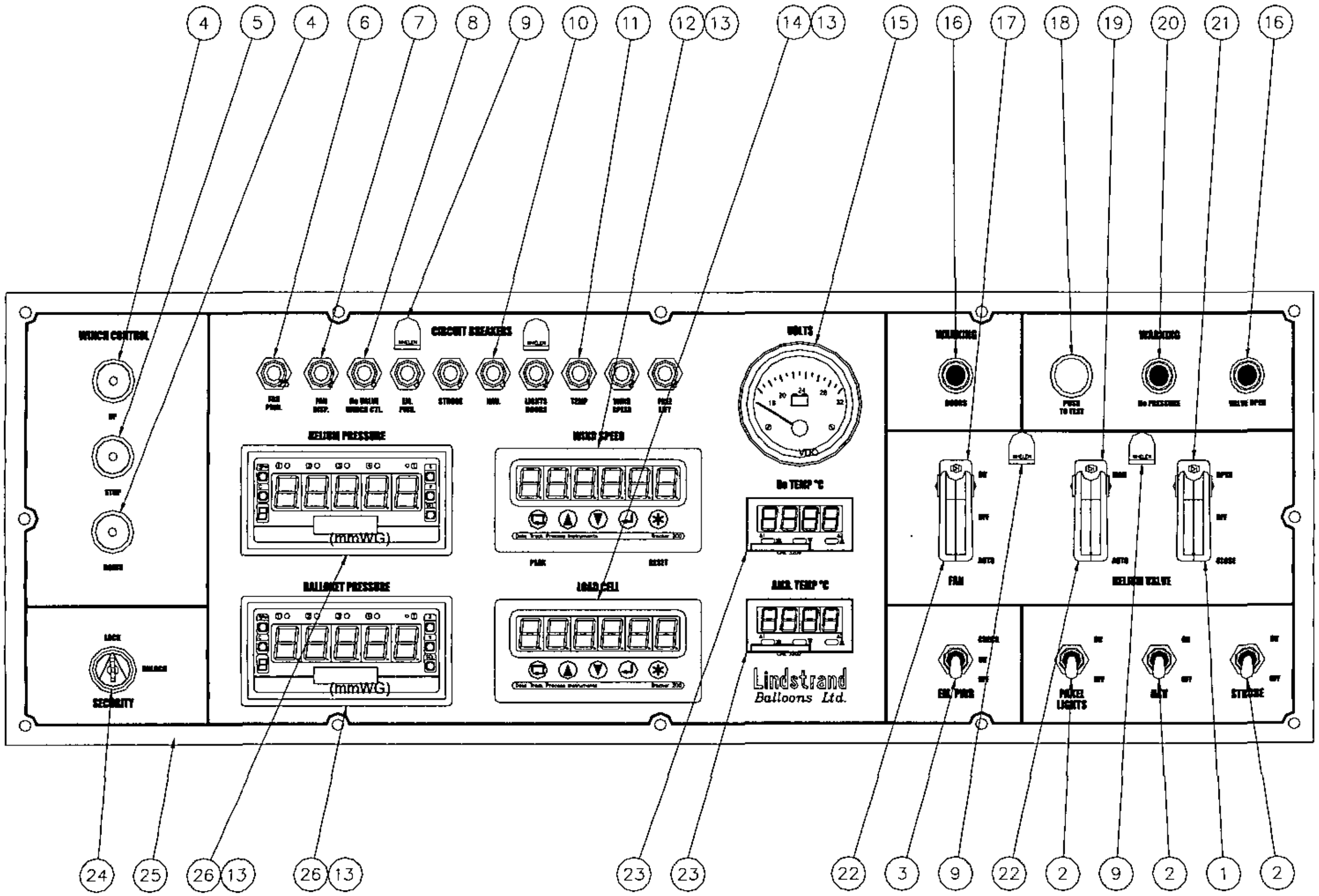


OUTSIDE VIEW OF DOOR LOCKING ASSEMBLY

FIG 1.3.1(b) GONDOLA DOORS

1.3.2 Control Panel

The Control Panel is situated on the inside face of the gondola structure, in the triangular space which is created when both of the gondola doors are open. The control panel is housed within a weatherproof box which is mounted on the main gondola structure. Within the panel are housed all of the instruments and switches which are necessary for the monitoring and control of the balloon systems. A schematic drawing of the control panel is shown in Fig 1.3.2. and the numeric references in the following text refer to the item numbers shown on this drawing.


WINCH CONTROL
CIRCUIT BREAKERS
VOLTS
WARNING
WARNING
HELIUM PRESSURE
(mmWG)
WIND SPEED
He TEMP °C
FAN
HELIUM VALVE
BALLONET PRESSURE
(mmWG)
LOAD CELL
AMB. TEMP °C
SECURITY
Lindstrand
Balloons Ltd.

1.3.2.1 Winch Control Area

This area is located on the left side of the panel and consists of three push button switches: Up, Stop, Down.

With the ground control unit set to "remote", the winch can be operated from the control panel. See 1.4.2.8.1.

1.3.2.2 System Monitoring Area

This area of the control panel contains all the instruments which provide information to the operator about the state of the balloon system. The system protective circuit breakers are positioned above the indicators.

1.3.2.2.1 Circuit Breakers

The Circuit Breakers are protective devices with selected current ratings to protect the circuits. If the current drawn by a circuit exceeds the nominal rating, the circuit breaker will pop out and prevent further current flow. When the circuit breaker is out a white ring is exposed. The circuit breakers may also be used as switches for the individual circuits. This is achieved by pulling the button out to reveal the white ring. If a circuit breaker has popped out due to current overload the circuit must be serviced prior to resetting the circuit breaker by pushing the button in.

The circuits protected by individual breakers are as follows:

		Current Rating
-	Ballonet Fan Main Power	(25A)
-	Ballonet Fan Pressure Display	(2A)
-	Helium Valve Power and Winch Control	(5A)
-	Emergency Power	(5A)
-	Stroboscopic Lights	(5A)
-	All Navigation Lights	(3A)
-	Panel Lights, Door Switches, Voltmeter	(2A)
-	Both Temperature Indicators	(1A)
-	Wind Seed Readout	(2A)
-	Free Lift Load Cell Readout	(2A)

1.3.2.2.2 Security Switch

The security switch (24) is located at the bottom left hand corner of the control panel.

When keyed to "LOCKED" the switch locks the helium valve and ballonet fan into "Auto" mode and disables the winch "Up" control. All other functions still operate.

To operate helium valve, ballonet fan or winch up, the key must be inserted and turned to "UNLOCKED".

The spare key should be labelled and stored separately in a safe location.

1.3.2.2.3 Monitoring Indicators

The following system monitoring indicators are provided:-

Item	Monitor	Readout Units
26 upper	Helium Cell Pressure	mm WG
26 lower	Ballonet Pressure	mm WG
12	Wind Speed	knots
14	Load Cell	Metric Tonnes
23 upper	Helium Temperature	°C
23 lower	Ambient Temperature	°C
15	Voltmeter	Volts

The Helium Pressure monitor activates the audible and visual warning at 38 mm WG. The helium valve automatically opens at a preset pressure of 40 mm WG to protect the envelope.

The yellow helium pressure warning lamp is tested by pushing the adjacent press to test button.

The Ballonet Pressure monitor activates the ballonet fan at preset pressure levels. The normal setting level is 'on' at 6 mm WG and 'off' at 8 mm WG. See Section 3.4.10 for setting instructions.

The wind speed indicator (12) incorporates a peak and peak reset button.

1.3.2.3 Balloon Control Area

Within the right hand side of the control panel are positioned the switches which control the envelope systems. These are as follows:

1.3.2.3.1 Door Warning Light

Item (16 left) lights up if the doors are not closed, or overlock latch is unlocked.

1.3.2.3.2 Ballonet Fan Switch

This is a guarded three position switch. When the guard is down, the switch is forced into the down position, which sets the ballonet fan to the automatic operating mode. This means that the ballonet fan operation is controlled by the pressure setting level programmed within the ballonet pressure monitor (26 upper). The ballonet fan will turn off at the set pressure level and will turn on when the pressure level has decreased by 2 mm (0.08") WG. If the switch guard is raised and the switch is placed in the centre off position the power supply is isolated from the ballonet fan. If the switch is moved to the upper manual position the fan will remain running until the switch is moved to another position.

1.3.2.3.3 Helium Valve Switches

The helium valve circuit is secured into the "Auto" mode by the security switch.

Before the helium valve switches will operate, the security switch must be keyed to 'UNLOCKED'.

Switches (1) and (22) and indicator light (16 right) are for the control of the helium valve. Both switches are of the guarded type and when both guards are in the down position the helium valve will be automatically controlled by the upper programmed pressure setting level in the helium pressure cell monitor. This means that when the upper pressure level is reached the helium valve will open automatically and will begin to close when the pressure level has dropped 1 mm (0.08") WG. If the switch guard on switch (1) is lifted and the switch raised to the upper manual position the helium valve may now be controlled manually by using switch number (22). If the manual helium valve control switch (22) is operated when switch (1) is in the automatic position nothing will happen.

When the manual over-ride switch (22) is down, the valve is in "Auto" mode.

When the manual over-ride switch is up to "Manual", the control switch is active.

The valve can now be operated manually.

The valve can be isolated by switching the control switch (1) to the mid "Off" position.

The valve can be opened by switching up to the open position and holding up.

If the switch is released, it will return to the "Off" position and the valve will remain stopped in the open position.

The red indicator light will illuminate immediately the valve starts to open and will remain on until it is closed.

To close the valve, depress the control switch to the close position and close guard. Ensure red indicator goes out to confirm valve is closed.

The red indicator is tested by pushing the adjacent "press to test" button.

Note: Returning the over-ride switch to "Auto" or the security switch to "LOCKED" will also close the valve if helium pressure is below 40 mm WG.
Before operating valve refer to Section 4.1.8

1.3.2.3.4 External Position Lights

Three switches (2) all control external position lights. The centre switch will turn on the two steady white navigation lights when in the up position. One of the navigation lights is located below the gondola and can be clearly seen during operation to check that it is alight. The upper navigation light is located on the valve plate and can only be seen from above or from a considerable distance away from the balloon. The right hand switch will turn on the flashing white stroboscopic anti-collision lights which are also located below the gondola and on the valve assembly plate.

The left hand switch will turn on the control panel instrument lights when in the up position. The upper and lower strobe will flash alternately. To check that the upper strobe is functioning, listen out for the four charging / discharging sounds made by the strobe power unit, located underneath the operators' floor space.

1.3.3 Load Ring

The load ring is a ring constructed from tubular stainless steel with eight equally spaced attachment points. It acts as a junction for all three major system components. The net transfers all the lift generated by the balloon into the upper side of the load ring. The gondola is suspended from the lower outer side of the ring and the main winch cable is attached to the lower inner side of the ring via eight steel wires which converge to a single point situated in the clear central area of the gondola.

1.3.4 Load Cell

The load cell is a device which is fitted between the confluence point at the bottom of the eight load ring attachment wires and the top of the winch cable. It measures the load applied to the winch cable with the readout located in the control panel (see section 1.3.2.2.2). The range of the load cell is 0 to 10 tonnes (22,000 lbs) with readings in 10 kg (22 lb) increments. A detachable cable runs from the side of the load cell to the control panel.

1.3.5 Battery Power

Power is supplied for all systems from a battery pack which is located on the floor of the gondola, which should be charged whenever the gondola is grounded for more than one hour, in the operator's position between the two doors. A spare battery pack is supplied, which should be charged up at all times. The pack consists of two 12 V dc 65 Amp hour batteries connected in series to produce a supply voltage of 24 Vdc. All on board systems operate at 24V dc. The pack is fitted with two flying leads, one terminates in a connector to supply power into the control panel when the pack is located within the gondola. The second flying lead terminates in a single connector for the charging unit. When the battery pack is connected to the control panel the voltmeter on the control panel gives a constant indication of the supply potential of the battery. There are four coloured zones on the voltmeter. These zones have the following meanings:

Low red arc 18V-20V
If the indication is in this sector, the battery must be changed over for the charged-up spare pack and then re-charged.

Red and green arc 20V-24 V
If the needle drops into this sector when the ballonet fan is operating but is in the green arc when the fan is off, then operations may continue. If the needle moves from the red and green arc into the solid red arc when the ballonet fan is operating, then the batteries require charging.

Green arc 24-30 V
Batteries are charged normally.

Upper red arc 30-32V
If the needle moves into this arc the batteries have malfunctioned and should be replaced.
If the charging unit is connected, it is faulty and should be replaced.

1.4 Ground Control System

The ground control system provides a secure method for controlling the balloon during the ascent phase and for winching the balloon back to the launch platform to complete the ride. It is comprised of a main winch, a launch platform, a ground mooring system and a low mooring system. The system layout is shown in figure 1.4.

1.4.1 Launch Platform

The launch platform, if used, is a 12 sided shape with a distance across the flats of 9.0m (29.5 ft). In the centre of the platform is mounted a steel ring of 1m (3.3 ft) diameter, through which the winch cable exits from the winch housing (container, pit or surface mounted housing) to attach to the balloon. The platform consists of a structural steel framework, which is covered with sections of marine ply which create the deck. The marine ply is covered with a non-slip surface. The maximum available height of the platform above the ground is 600 mm (24"). The inner end of each segment of the platform rests on the edge of the winch housing container/ pit (underground systems only) and the outer edge is supported by height adjustable legs. The individual plywood sections are bolted to the steel framework. A hinged access hatch is provided in one of the segments to permit maintenance and servicing. The outer vertical edge of the platform is left open to permit the maximum airflow under the platform and into the winch housing. This is to maximise the winch housing cooling.

1.4.2 Winch System –

The winch system layout is shown in fig 1.4.2. It consists of the following sub-components:

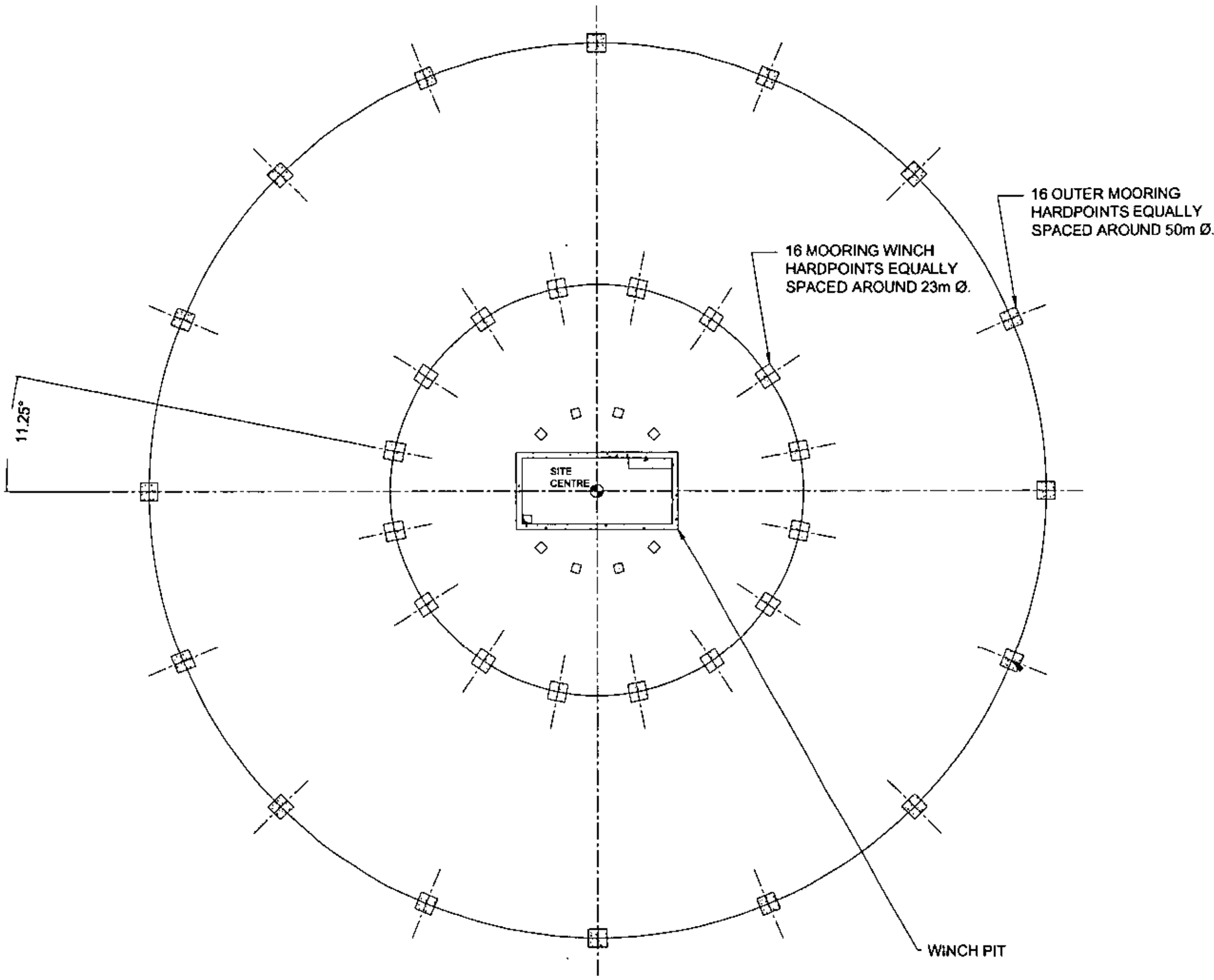
Winch cable
Gimballed sheave
Fleeting sheave
Main drum
Gearbox
Main Drive Motor
Auxiliary Drive Motor and Gearbox 15 kVA Generator
Control Panel
Environmental Systems (container, concrete etc)

Refer also to David Brown winch operations/ maintenance manual

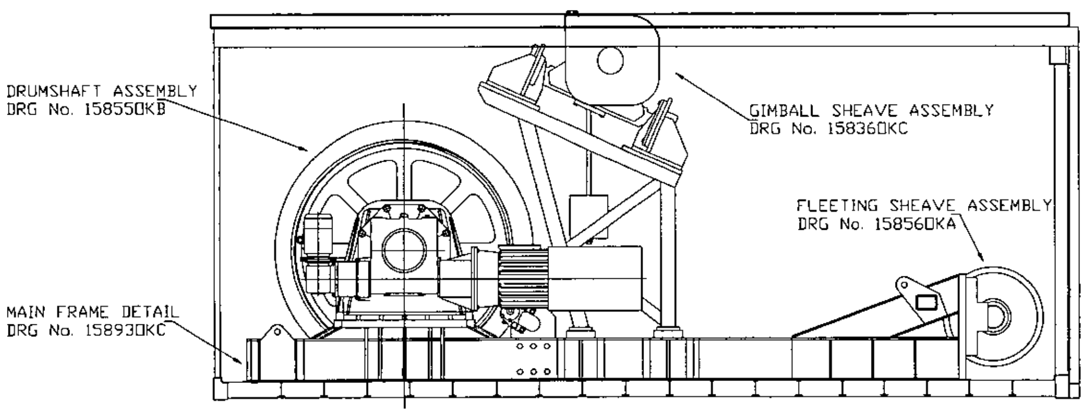
1.4.2.1 Winch Cable

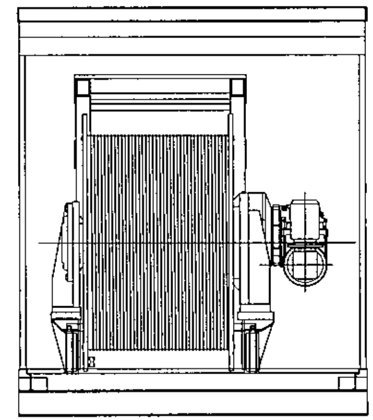
The winch cable is a 22 mm (0.87") diameter die formed 34 x 7 construction steel wire rope which is constructed so that when loaded there is a minimum of rotation created within the rope. At the upper end of the cable there is a conical epoxy bonded end fitting which incorporates a swivel which in turn is attached to lower side of the loadcell.

At a position approximately 700 mm (27.5") down from the eye of the swaged swivel a 300 mm diameter (11.8") disc is attached around the cable. This disc works in conjunction with two proximity sensors which are mounted on the upper surface of the gimballed sheave. If the plate approaches closer than 500 mm (19.7") from the sensors then an emergency stop is triggered. In addition, two trigger switches are located on the gimballed sheave. If the plate strikes the switches an emergency stop is triggered.

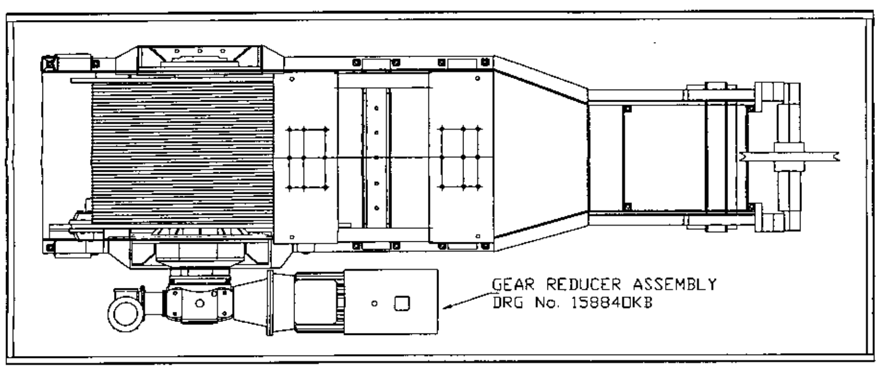


REFER TO SITE PREPARATION GUIDE FOR DETAILS ON FULL CIVIL WORKS





END ELEVATION
GIMBALL SHEAVE NOT SHOWN FOR CLARITY



PLAN VIEW
GIMBALL SHEAVE NOT SHOWN FOR CLARITY.

This protects the sheave from damage. The cable has a breaking load of 42.3 tonnes (93,000 lbs). The lower end of the winch cable is securely anchored to the side flange of the main winch drum using cable clamps.

1.4.2.2 Gimballed Sheave

The gimballed sheave is a mechanical device which allows the winch cable to move with the balloon wherever the prevailing wind takes it but controls the position of the cable on the winch side so that the cable will be stored correctly on the winch drum. This is achieved by allowing the sheave to gimbal, or rotate independently in two perpendicular axes. The sheave on underground systems is mounted onto the winch frame so that the cable exits the sheave in the approximate centre of the platform. The sheave on surface mounted systems has its own framework which is located in the concrete structure which forms part of the landing platform. Rotational motion of the sheave is dampened by the provision of an underslung weight which is mounted to the sheave frame. As the cable is payed out the sheave roller moves with the cable. An electrical measuring unit is mounted on the gimballed sheave, measuring pay out of the cable. The information is fed to the control panel and provides the method of altitude control.

1.4.2.3 Fleeting Sheave

The fleeting sheave is situated at the opposite end from the main drum and permits the cable to move horizontally perpendicular to the axis of the cable to allow the cable to correctly locate on the winch drum. This particular arrangement permits the use of a large diameter winch drum within the smallest volume possible. This has considerable benefits in terms of cable wear and overall system simplicity. The sheave has a diameter of 644 mm (25.3") and is smooth to allow the wire to locate itself.

1.4.2.4 Winch Drum

The winch drum is a 1.5m (59") diameter drum which can hold the whole cable in a single layer. The barrel of the drum is grooved to accept the cable. This ensures that the cable is located correctly and that the contact stresses between the cable and the drum are minimised. The fact that there is only one layer of cable on the winch drum also means that the full tractive effort can be applied over the entire length of the cable and that there are no speed variations during paying out and recovery. One of the drum flanges is fitted with a caliper brake. This is applied automatically. The system is fitted with an overspeed trip which engages the brakes when the payout speed of the cable exceeds the preset safe value of 35 m/min (1.9 ft/s).

1.4.2.5 Gearbox

On the end of the winch drum is the gearbox which is a worm/epicyclic unit. This permits the transfer of power from the main drive motor into the winch drum, also reducing the motor speed from 1750 rpm down to 7.45 rpm, the speed of the main drum. It can also accept power from the auxiliary drive motor which is located opposite the main winch motor. The auxiliary drive motor is normally de-clutched so that it is not driven by the main drive motor during normal operations. The gearbox is lubricated by a splash oil bath in the lower part of the gearbox casing.

1.4.2.6 Main Drive Motor

This is a 37 kW (49.5 hp) electric motor which may either be fed from a local 3-phase supply, or in the event of a power failure, a generator of suitable capacity may be linked into the motor. The motor is fed via a drive controller. This system permits the selection of the acceleration and deceleration of the motor.

Consequently, the changes of speed are imperceptible in the gondola. This system also controls the amount of cable that is payed out automatically. A small VDU is mounted on the winch control panel. The ride height is set between 20 m (65.6 ft) and 160 m (488ft) by pressing the F1 key. Consequently, the desired maximum gondola height can be preset.

The control system is capable of full dynamic braking. This allows the precise control of the payout speeds. The heat created during dynamic breaking is efficiently removed by the cooling system. Heat exchangers are located above the main winch control cabinets. Cooling is assisted by fans mounted within the heat exchanger cabinets.

The system is also protected from current overload. If the winch system was to become jammed by a foreign object, the current overload is detected and the motor is off-loaded to protect the drive train.

When the gondola is within 1 m (3.2 ft) off the ground the drive is automatically transferred to manual to allow the operator precise control over the speed and timing of final landing.

The motor is fitted with a spring operated, fail safe brake which, in the event of a power failure, is engaged on the motor to prevent freewheeling. The maximum tested breaking force is an equivalent of 9 tonnes (19,800 lbs) of cable tension.

1.4.2.7 Auxiliary Drive Motor

A 4 kW (5.4 hp) motor is located opposite the main drive motor. It may be manually engaged, through the epicyclic gearbox to provide control of the winch drum in the event of a total failure of the main drive motor. It should be noted that the auxiliary drive motor can only be used to winch down the balloon. It is not intended to be used for normal ride operations. The motor runs at 1750 rpm into a gearbox which reduces this speed to produce a 0.74 rpm winch drum speed. The power is passed through a manual clutch. This allows the auxiliary motor to be isolated from the main drive motor, when it is not in use. The motor is capable of recovering the balloon at a reduced speed of 3.5m/min (0.2 ft/sec). The controls for the auxiliary drive motor are located on the main control panel within the winch housing. These consist of:

a) An auxiliary On/Off button which introduces electrical power to the auxiliary drive motor.

b) A Start button which will move the winch drum so that the gondola is lowered.

c) A Stop button which stops the winch drum motion.

It should be noted that there is no automatic stop facility when using the auxiliary drive motor, so the stop button must be manually operated when the cable disc is approximately 500 mm above the gimballed sheave.

In the event of a mains power failure a 15 kVA diesel driven generator set is provided as a backup power source for the auxiliary drive motor.

1.4.2.8 Winch Controls

Primary control of the winch is through use of a radio link remote control unit in the gondola control panel. Back-up winch controls are provided in an auxiliary control panel which is located at the edge of the landing platform. This location permits the system to be operated from the ground with a good view of the final landing of the gondola. A main winch control panel is located within the winch housing. This panel contains all the system setting controls. For maximum safety the winch may be controlled from either the radio linked controller or from the auxiliary control panel at any time. It is therefore important for the ground operator to contact the gondola operator prior to controlling the winch from the ground. Two-way radios are used for this purpose. Irrespective of the control point being used, if the emergency stop button is pressed at any of the three control points, this overrides all other inputs. The controls on the radio linked unit and the auxiliary panel are largely identical in function.

1.4.2.8.1 Remote Control Unit

This is incorporated into the gondola control panel. It is linked to the main control panel through an encrypted radio transmission. There are three operational buttons:

a) Stop

This button initiates a controlled stop at any time during the ascent or descent. The controlled stop will have the same deceleration programmed response as the stop which occurs at the top of the ride.

b) Up

Before operation, the security switch must be turned to "UNLOCKED".

The Up button is pressed once and released. This will start a programmed paying out of the winch cable. Up to a level of 3 meters the winch accelerates up to a maximum speed of 14 m/min (0.77 ft/sec). When the 3 m point is passed the winch accelerates up to full speed. At a point of 10 m from the pre-set ride height, the winch will slow down until it stops at the ride height. If the ascend button is pressed whilst at the ride height, the command is ignored. After approximately 10 seconds the main hydraulic brakes are applied to off-load the winch.

c) Down

Pressing the Down button starts the descent. When the button is pressed the system latches on and the winch accelerates to its maximum speed. This continues until the balloon reaches a height of 3m (9.8 ft) where it will decelerate down to a stop when 1 m (3.2 ft) from the platform. From this height until landing, the button is non-latching and must be kept depressed to continue winch movement. If the button is not depressed for a period of 8 seconds, then the hydraulic caliper brakes will apply for safety. When the button is next depressed, there is a short delay while these brakes are removed.

The winch operates at a reduced speed of 14m/ min (0.77 ft/sec), to assist fine control of the gondola during landing.

1.4.2.8.2 Auxiliary Control Panel

This is situated at the edge of the landing platform, which permits a good view of the gondola. The majority of controls are identical to the remote control unit controls with the following additions:

a) Mains On

This lamp lights when mains power is supplied to the winch.

b) Local/Remote Key Switch

If it is necessary to control the winch from the ground station, then the key is inserted and turned to Local. This disables the gondola remote control unit. Turning the key back to Remote returns control to the remote control unit.

c) Emergency Reset

In order to recommence winch operations after an emergency stop has been used, the emergency stop button must first be pulled out fully at the location it was pressed. Then the emergency reset button, located on either the auxiliary control panel or on the main control panel, must be pressed in order to re-enable the main drive motor and to remove the braking system. If correctly re-set, the red re-set light, located on the main control panel, will illuminate.

1.4.2.8.3 Main Control Panel

This panel, located in the main winch housing, is the primary point for the overall system programming. The following controls are provided:

a) System Monitoring Screen

This screen provides information on the system settings, gives an indication of the status of the protection devices within the winch and allows the ride height to be adjusted. On the normal mode screen it presents the following:

i) Trip Counter

The trip counter indicates the total number of rides since the system has been commissioned and if re-set, will provide the number of rides conducted since the last re-set. This allows a daily ride count to be kept.

ii) Cable Pay Out Display
There are two readouts of the amount of cable, which has been paid out. These are calculated in different ways and should be the same. A visual indication is also provided in the form of a bar giving a percentage of the maximum cable which has been winched out.

iii) Ride Height Selector

This setting may be changed between 20 m (65.6 ft) and 160 m (488 ft) by pressing the F1 key. If any value outside this range is selected, the system will ask for a valid height to be input. The ride height must only be changed when the gondola is grounded and the disc mounted on the winch cable is within 500 mm of the photo-eye sensor which is mounted on the gimballed sheave.

iv) System Alarms

There are three screens which are accessed by pressing the F2 key. These screens list all of the protection devices and their status as either healthy or unhealthy. If any item is unhealthy, the screen will flash this item. Corrective action is provided within the Maintenance Manual.

b) Main "On" Light

This light indicates that mains power is being supplied to the system when illuminated. It should go out when the isolator switch is turned off.

c) System Fault

This is a red light and an associated warning buzzer which activates when a system fault is detected. Diagnosis of system faults is provided on the System Monitoring Screen.

d) Supply Source Key Switch

This switch selects whether power is received from the mains or from the 15 kVA generator which should be used with the auxiliary winch motor in order to recover the balloon in the event of a power failure.

e) Emergency Stop and Re-Set

These controls have the same function as their counterparts on the other two winch control points. In order to re-set the system, the emergency button which has been pressed must first be pulled out fully. This prevents the system being re-set without the original fault being rectified.

f) Emergency Recovery Key Switch

If part of the control system fails, or if a protection sensor malfunctions, but the main drive system and brakes are still operational, then this switch may be used to recover the balloon at a reduced speed.

1.4.3 Environmental Systems

The environmental systems protect the winch controls and hardware from damage. They consist of the following:

1.4.3.1 Winch Housing

The winch and all its controls and motors are housed either in a 6m (20 ft) standard ISO container or a concrete pit. If the winch is transported in the complete container, the whole unit is bolted down onto pre-made concrete foundations. The container is waterproofed as far as possible to restrict the ingress of water. A winch support frame carries all the forces from the main drum, fleeting sheave and the sheave block. This support frame in turn transfers the loads into the concrete foundations. The majority of sub-assemblies and the winch container itself, have been protected using Resistex K570. Unpainted metallic surfaces have been treated with Tectyl 506, to hinder the formation of rust.

If an onsite container is not used, the winch will be shipped in either a crate or container, and simply lowered into the pre-cast concrete pit. The winch is then directly bolted onto the floor of the concrete winch pit, using Lindstrand approved securing mechanism. For surface mounted winch systems, the winch is bolted directly on to a purpose made concrete base, and secured with Lindstrand approved securing methods.

1.4.3.2 Bilge Pump – not supplied

The entry of water into the container / pit is impossible to prevent totally because of the presence of the winch cable exit hole in the landing platform of underground systems. Consequently the container/ pit should be fitted with a bilge pump which is capable of removing 45 l/min (10 gal/min). The water is pumped from the base of the container/ pit and ejected into the local drainage system. The bilge pump is controlled automatically by a float.

1.4.3.3 Fire Extinguishers

A standard carbon dioxide extinguisher should be installed within the winch housing to combat any fires, as recommended by local fire regulations (site specific).

1.4.4 Balloon Mooring Systems

There are two independent mooring systems for the balloon, the high and low. The high mooring system is used for restraining the balloon in calmer conditions. When winds in excess of 24 knots are forecast the low mooring system should be employed.

1.4.4.1 High Mooring System

This consists of a ring of 16 concreted hard points equispaced around a circle of 50 m (164 ft) diameter. Spread around the polar rope on the envelope net are 16 ropes which are attached onto the hardpoints using ratchet straps. The ratchet straps are progressively tensioned, sufficient to restrict the motion of the envelope, and it is important that these are all of equal tension.

If extra outer mooring winches are to be used at the site, then the polar ropes are attached directly onto the winches. Ratchet straps will not be used in this situation. These outer mooring winches will be controlled by the same pendant controller that operates the low mooring winches.

This system comprises a ring of 16 concrete hard points spread around the balloon at a diameter of 24 m (78.7 ft). On each hard point is mounted a 1.5 kw (2 hp) electric cantilevered winch. At the equator are situated 16 mooring ropes. The ropes are attached to the winches and, using local controls on each winch, the slack on the lower mooring ropes may be taken up. Once equal tension has been achieved the winches may be operated simultaneously in order to lower the balloon down into the lower mooring position. During the descent the load ring is off loaded and it is supported by the bungee cradle. To restrain movement of the lower part of the envelope, 8 load patches are attached to the lower section of the envelope. Once the envelope is resting on the seating ring, securing lines are attached between the load patch ropes and the anchor hoops on 8 of the mooring winches. The balloon is lowered for mooring in winds in excess of 24 knots (27.6 mph) and should also be used whenever the qualified operators are not in attendance. It is also moored for maintenance to the envelope system and for helium topping up.

The low mooring winches are controlled by a pendant controller. This is also provided with an emergency stop button. This emergency stop button only applies to the mooring winches and will NOT affect the main winch system. To reset the system, the emergency stop button must be twisted in a clockwise direction.

SECTION 2 - OPERATIONAL LIMITATIONS

The following operational limitations prescribe the limits of the system. Exceeding these limits may result in a hazardous situation or damage to the balloon system. Other limitations may be placed upon the operation of the balloon by local statutes, or regulations.

2.1 The balloon must not be operated in the vicinity of thunderstorms, or unstable weather.

2.2 The balloon must be securely low moored in winds of speed in excess of 24 knots (44.5 km/hr or 27.6 miles/hr).

2.3 The balloon must be operated by a minimum crew of two, one balloon operator and one ground winch operator.

2.4 The balloon ride height (winch payout) must be restricted to leave a minimum of 4 full cable wraps on the winch drum. The ride height must not exceed 160m in any case. Local restrictions may impose a lower elevation.

2.5 The balloon must not be operated with a free lift at the maximum elevation of less than 900 kg (0.9 tonnes). The minimum free lift level is increased with increasing wind speed. See Appendix 3

2.6 The balloon must be operated with the doors closed and the overlock in the locked position. The indicator light on the control panel must be out.

2.7 If the balloon is being operated during the periods, defined by the local aviation authorities as darkness, the anti collision lights and navigation lights must be switched on.

2.8 The balloon must not be operated with an envelope pressure which is greater than 38 mm WG (1.57").

2.9 The balloon must not be operated if the indication of battery power falls below 20V.

2.10 The balloon must not be operated if the gondola is loaded such that it produces a hazardous attitude.

2.11 Smoking is not permitted in the gondola.

2.12 The balloon must not be operated if there is any unrepaired damage revealed by the daily inspection in Section 3.1.

2.13 The balloon must not be operated with the helium valve open.

2.14 The balloon must not be operated if the pressurisation fan is not fully functional

2.15 The balloon must not be operated if the PRV is not fully functional.

2.16 The daily inspections must be completed and the technical log signed off prior to operations.

2.17 The balloon must not be operated if it has been modified without the written approval of Lindstrand Balloons Ltd.

2.18 The winch system must be fully operational and tested by a proving ride with one operator only, prior to commencement of passenger rides. See 3.2.

2.19 Free Lift Limitations - The free lift is measured by a load cell linking the winch cable to the load ring.

The free lift indicates the tension at the top of the cable with a readout in tonnes displayed on the gondola control panel.

2.19.1 Operating Free Lift Limits - The operating free lift is the free lift measured when the gondola is loaded with passengers at its' maximum ride height.

The minimum allowable operating free lift varies with the peak indicated wind speed at maximum ride height.

Increased free lift is required at increased wind speed to reduce the balloon side drift.

Peak Wind Speed Knots	**Minimum Operating Free Lift Tonnes**
0 - 5	0.90
5 -10	1.20
10 - 15	1.60
15 - 20	2.20
20 - 24	2.80

Passenger payload must be calculated to maintain minimum operating free lift limitations as above (see Appendix 3).

Increased wind speed encountered during operations will require a reduced passenger load.

2.20 The wind tolerance of a storm moored HiFlyer is highly dependent on the topographical conditions surrounding the site. It has been demonstrated that HiFlyer systems have withstood wind speeds of 61 knots (70 mph or 113 km/hr). If wind in excess of 61 knots is forecast the balloon must be deflated.

2.21 The balloon must only be operated with banners made from approved HiFlyer fabric as recommended by Lindstrand Balloons. These banners should be fitted accordingly and inspected as part of the pre-flight daily checks.

2.22 The balloon must be operated in accordance with the current Lindstrand Operations/ Maintenance manuals.

2.23 The balloon must not be operated if it has been over filled with helium. This could cause the envelope pressure to rise above 40mm WG.

SECTION 3 - NORMAL PROCEDURES

3.1 Structural Inspection

The following structural inspection is to be conducted daily prior to commencement of passenger rides. Once completed the technical log is filled in and signed off.

Prior to inspection the mooring lines are to be removed and all gondola covers removed.

3.1.1 Envelope Inspection

Using a pair of binoculars (7 x 50) examine the envelope and net

Envelope	-	No damage
	-	No distortion
	-	No damage to banner patches
Banners	-	Not damaged and secured to envelope
Net and Rigging	-	Net centred on envelope
	-	Not distorted
	-	No broken strands
	-	No frayed bridles
Monsun Valves	-	No damage and sealed
Helium Top up Tube and Electrical Looms	-	Not damaged and secured to envelope

3.1.2 Rigging

Load Ring	-	No distortion
Load Ring Rigging	-	No frayed wires or damaged ferrules terminations and thimbles intact.
Eye Bolts	-	In place with nuts and split pins secured.
Master Links and Shackles	-	Secure and locked.
Load Cell	-	Attachments to master links and swivel secure. Lead connected and readout on control panel.
Load Swivel	-	Not damaged, secure and rotating accordingly.

3.1.3 Gondola

Frame and hand rails	-	Check for distortion, damage

Lugs (gondola/cable attachments)	-	Check condition
	-	Check welds for cracks
Doors	-	Check for distortion, latch operation
Wicker	-	Check condition
Bolts	-	Secure
PVC Panels	-	check condition
	-	no cuts
	-	no loose eyelets
	-	lacing intact
Safety Nets	-	no broken strands
	-	lacing intact
Start winch and raise gondola approximately 1.5m (5 ft)	-	Press the Emergency Stop to close down the winch and apply the brakes whilst the underfloor inspections are conducted.
Underfloor structure	-	check for distortion, damage
Floorboards	-	condition and security
Bump stops	-	intact

3.1.4 Winch and Cable

Refer to David Brown winch operation and maintenance manual

3.1.5 Balloon Control Panel

Battery Charger	-	Switch off and disconnect the lead from the battery box.
Battery Pack	-	Secured in place in the gondola.
	-	Control lead connected.
	-	Sufficiently charged.

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Helium Valve	-	Helium valve switch set to automatic.
	-	Manual control switch in closed position.
	-	Pressure limits correctly set.
Ballonet Fan	-	Fan switch set to automatic.
	-	Pressure limits correctly set.
Circuit Breakers	-	All in, no malfunctions.
Monitoring Instruments	-	Temperature indicators, wind speed and load cell readouts all working.
Doors	-	Indicators functioning correctly.
Connectors	-	All connectors firmly in place.
Emergency Power	-	Battery Check.
All Electrical Systems	-	All functioning correctly.

3.1.6 Mooring Equipment

Ratchet Straps	-	Check for excessive fraying or strap-wear. Check for damage/distortion/wear to ratchet mechanism.
Anchor Points	-	Fully secure. No damage or distortion.
Ground Fan	-	Functional.

Replace any faulty components

3.2 Daily Test Ride

Prior to embarking passengers a proving ride must be conducted with operator only in order to fully test all the sub-systems and to establish the operational limitations for the prevailing weather conditions.

Power is introduced to the winch by turning the isolator switch to the on position (clockwise direction). The control system will then run a 30 second test sequence during which, time system information will be displayed on the control screen. After this time, the display will revert to the normal readings. At the completion of the test, the winch remains in the emergency stop condition. The system must be reset by pressing either of the re-set buttons on the main panel or the auxiliary control panel.

3.2.1 Pre-Flight Checks

a) Charger lead disconnected and removed.

b) Operator on-board.

c) Two-way radios present and operational.

d) Door closed and locked.

e) Unladen Freelift within limits – see Section 3.4.11.1

f) Correct ride height set on main winch control panel.

g) Ground operator on station with a two-way radio.

h) Daily inspections completed.

i) Power to the winch is switched on.

j) Security switch turned to 'UNLOCKED'.

k) Ground control unit set to 'REMOTE'

3.2.2 Balloon Ascent

The balloon is elevated using the remote control button. The ascend button is pressed once and released. There will be a 5 second delay before the winch begins to move while the brakes are being removed. The first 3 m of motion is at a reduced speed. Once this point has passed, the winch will accelerate up to full speed. 10 m before the pre-set height, the winch will slow down until stopped. Approximately 10 seconds after motion has stopped, the main hydraulic brakes will apply. The ground operator should then contact the balloon operator to inform him that the winch has stopped.

Record the required data on the Technical Log Record. The ride duration should be approximately 15 mins to ensure an accurate assessment is made of the prevailing peak wind speeds. Wind speed and elevated free lift with operator only is required to calculate the allowable passenger load.

3.2.3 Balloon Descent

Once all observations have been completed, the descend button is pressed. It will latch-on immediately and the winch will accelerate up to its' maximum speed. When the balloon is 3 m from the platform the winch slows down, finally coming to a halt 1 m away from the platform. From this safety point, descent is continued by pressing and holding the descend button. If the button is released, the winch will stop immediately. This allows the balloon operator to pause the descent until the wind conditions are the most favourable for a smooth landing. If the descent button is not pressed for 8 seconds, then the hydraulic brakes will apply.

If this occurs, then the next time the descend button is pressed, there will be a short 5 second delay while the brakes are removed before the winch continues. It is recommended that the button should be pressed every 4 seconds or so during the landing phase.

In order to test the functions of the auxiliary ground control panel, it is recommended that this unit is used to control the balloon during the daily test ride, once a week. See Section 3.4.5.

3.3 Technical Log Record

The Technical Log Record sheet (or Tech Log) contains a record of all the prevailing conditions of the balloon system and weather at the start of a day's operation.

All sections must be completed and signed off prior to commencing passenger rides. The following information should be recorded:

a) Wind Speed Peak and Average

The peak wind speeds are used to establish the maximum passenger loads in accordance with Appendix 3

b) Ambient Temperature

This is recorded from the indication on the control panel.

c) Helium Pressure

The helium pressure is recorded at the top of the ride. If the pressure is close to 40 mm (1.57") WG when the ambient temperature in the morning is cold then the pressure should be monitored carefully as the temperature increases during the day.

d) Free Lift

The **Unladen Free Lift**, with the gondola grounded and the cables slack, must be recorded. This value gives a good indication of the helium fill in the balloon and is used to track helium loss rate and helium top-up requirement. See 3.4.11.

The **Elevated Free Lift** must be recorded on the test ride with the balloon at maximum ride height, with only the operator on-board. This value is used in conjunction with wind speed and operating free lift to determine passenger capacity. See Appendix 3.

The **Operating Free Lift** is the free lift indicated at maximum ride height with passengers aboard and must not fall below the minimum stipulated in limitation 2.18.1.

The operating free lift is not recorded in the Tech Log, but should be noted along with the number of passengers for each ride. See 3.4.2.3.

3.4 Normal Balloon Procedures

Once the daily start up procedures are completed and the Tech Log filled out then passengers may be embarked.

The maximum number of passengers to be carried is controlled by limitation 2.18 and is to be determined from the tables in Appendix 3.

Embarkation is normally achieved through one door in the gondola to simplify counting of passengers. Once all the passengers are embarked the doors must be closed. This is achieved by pushing the door closed until it hits the door stop. Sliding the handle over so that the bolt engages within the pillar.

The handle is situated halfway up the door on the hinge side. Once the bolt is correctly engaged the handle is rotated downwards so that the horizontal motion of the bolt is prevented. When both doors are closed they should be overlocked by swinging the metal bar into the horizontal position. Check the warning lights on the control panel have gone out.

3.4.1 Passenger Briefing

A short passenger briefing should be conducted prior to the start of the ride. It may be achieved prior to embarkation if this is more convenient. It should cover the following points as a minimum:

a) Spread evenly around gondola during the ride. Avoid bunching to one side.

b) Do not throw anything from the gondola.

c) If you feel concern for your well being or feel uncomfortable then inform the operator. He will terminate the ride.

d) Smoking is not permitted anywhere in the gondola.

e) Hold onto the handrails on the inner and outer faces of the gondola during take off and landing.

f) Follow any further safety instructions given by the operator.

3.4.2 Balloon Operations

3.4.2.1 Balloon Ascent

During normal operations the winch is controlled by the onboard operator. The ascent is started by pressing the 'ASCEND' or 'Up' button on the gondola remote control. The button is pressed once and released. There will be a 5 second delay before the winch begins to move while the brakes are removed. The first 3 m of motion is at a reduced speed. Once this point has passed, the winch will accelerate up to full speed. 10 m before the pre-set height, the winch will slow down until stopped. Approximately 10 seconds after motion has stopped, the main hydraulic brakes will apply. The ground operator should then contact the balloon operator to inform him that the winch has stopped.

3.4.2.2 Radio Procedures

It is necessary for the safe operation of the Hi Flyer system that the onboard and ground operators are always in communication with each other. The type of radio used is relatively unimportant provided they are of sufficient power, reliability and clarity and that all local regulations and requirements are met.

VHF 720 channel airband transceivers are recommended because of their relatively low signal traffic and for their access to other aviation users and information.

However, it should be noted that the use of these transceivers is controlled and normally will require that the operators hold licences and that a specific communications channel has to be assigned by the National Airworthiness Authority.

In addition, it is normal for the types of transceivers used to be regulated. Early discussion with the *appropriate authorities is recommended.*

The following instructions are intended as a guide to achieve maximum clarity. It is anticipated that these instructions will be translated into the local language. When choosing equivalent words, care should be taken to avoid words which have similar pronunciation, to avoid misunderstandings. For example, using the words ASCEND and DESCEND should be avoided because only the first syllable is different in both words. If a transmission is "clipped" the first syllable will not be transmitted and the recipient will only hear "SCEND". For this reason, the words UP and DOWN are better.

3.4.2.2.1 Radio Techniques

Before transmitting, you should monitor the frequency to ensure nobody else is using it. If both radios transmit at the same time, nothing is understood.

Think about what you want to say before transmitting.

Keep the length of transmission short and to the point.

Ensure that the transmit button is pressed before you start speaking and it is kept pressed until after you finish. This will prevent "clipping" of transmissions.

Speak in a normal voice at a steady rate of about 100 words per minute and pronounce each word clearly.

3.4.2.2.2 Recommended Phrases

The following phrases are recommended for use and to have the following meanings. If these phrases are translated into the local language and if any additional phrases are used, these should be recorded within the company's Operations Manual for future consistency when training new operators.

UP - I have pressed the ASCEND button.

WINCH STOPPED	-	The winch has stopped moving and the brakes have been applied (Ground Operator).
DOWN	-	I have pressed the DESCEND button.
STOP	-	I have pressed the STOP button.
EMERGENCY	-	I have initiated an emergency stop.
RESET	-	I have reset the winch system and you have control of the winch (Ground Operator).
OVER	-	My transmission is ended and I expect a response from you.
OUT	-	My transmission is ended and no response is expected.
NEGATIVE	-	No, or that is not correct.
AFFIRMATIVE	-	Yes, or that is correct.
SAY AGAIN	-	Repeat all or part of your last transmission.

3.4.2.2.4 Gondola Remote Control Unit Failure

If the gondola remote control unit fails and the balloon operator has contacted the ground operator in order to initiate a descent using the auxiliary control panel, it is important that the transfer of control is clear and unambiguous. Once the ground operator has selected local, they should contact the balloon and transmit "GROUND HAS CONTROL". Once informed of this, the balloon operator understands that the remote control unit is completely disabled. If the balloon operator wishes to initiate an emergency stop during this recovery, they should transmit "EMERGENCY, STOP". Upon hearing this, the ground operator will press the emergency button on the auxiliary control panel. If control is reverted to the balloon, the ground operator should transmit "BALLOON HAS CONTROL".

3.4.2.2.5 Radio Failure

If radio communications fail for any reason so that the messages cannot be passed, then the ride should be completed to the normal duration pattern. Once the balloon has landed, the radio failure must be corrected before rides recommence.

In the unlikely event of both the gondola remote control unit and the balloon radio failing simultaneously, the balloon operator should be equipped with either a loud whistle or air horn. These should be used to attract the ground controllers' attention with three short blasts. On hearing this alarm signal, the operator should proceed with a recovery using the auxiliary local controls. It is recommended that the ground operator should monitor the ride duration and if the ride time is longer than 30 minutes, they should firstly try to establish radio communication with the balloon. If this is not possible, they should then proceed with a recovery using the auxiliary controls. This is to cater for the possible incapacity of the balloon operator.

3.4.2.3 Balloon Monitoring

While the balloon is being operated the operator should monitor the following systems:

a) Helium Pressure

As the balloon ascends the atmospheric pressure will reduce by approximately 1.4%. This causes an expansion of the helium in the balloon and a slight reduction in the total lift. The expansion of the helium will normally be accommodated by the air filled ballonet reducing in size. However, if the helium cell has been overfilled and the ballonet volume is minimal prior to the ascent then there may be a possibility that there is insufficient space for the *helium to expand.*

This will result in the helium pressure increasing as the balloon ascends. If the pressure exceeds the warning level, the helium audible and visual alarms will set off and the helium valve will begin to open. The operator should monitor the helium pressure during the rides to ensure this situation does not occur. If the helium pressure is rising too much then the ascent should be stopped and the balloon lowered down to the platform. Investigate the reason for the excessive helium pressure and correct this. This will normally consist of a controlled opening of the helium valve to release some of the helium.

b) Helium Temperature

When the balloon is being operated in sunny conditions the envelope absorbs heat and the temperature of the helium will gradually increase above the ambient temperature. This difference in temperature between the ambient and the helium temperatures is called Superheat. Normally the extra heat will cause the helium to expand and the ballonet volume will reduce to accommodate this. However, similar to the above case if there is insufficient room for expansion of the helium the pressure will begin to rise and helium may be vented. Both an ambient air temperature probe and a helium temperature probe are provided so that the amount of superheat can be monitored, along with the helium pressure. 15°C (59°F) of superheat is not uncommon.

c) Operational Free Lift

The operational free lift is the lift that is indicated on the load cell readout when the balloon is being normally operated. The maximum number of passengers that may be embarked is firstly established at the completion of the test ride, at the beginning of the day. See Appendix 3. However it is the responsibility of the operator to further modify the maximum number of passengers in response to changing conditions within the operational limitations of the system. If the wind speed increases or slackens then the maximum passenger load must be modified so that the minimum operational free lift *requirements are met. It is recommended that the load cell indicator is reviewed just after* each ascent phase has started to ensure that the free lift figure is not below the required levels. For example is the wind speed is 3 knots the minimum free lift is 900 kg.

The operator is also responsible for reviewing the embarking passengers. The maximum number of passengers is based upon an average passenger weight of 77kg (169 lbs). If the embarking passengers are obviously heavier than this figure, the operator should reduce the maximum number embarked.

d) Weather

Before the day's operations commence a meteorological forecast must be obtained with particular reference to wind speeds and directions, expected precipitation and any thunderstorm activity. This information must be entered on the Technical Log Record Sheet. In addition the anemometer should be observed during each ride. If the wind speed increases then the maximum passenger figure must be reduced to remain within the limitations given in Appendix 3. Increasing wind will tend to drag the balloon in the downwind direction. The greater the free lift the more the balloon will stay vertical and the more comfortable the ride will be for the passengers. The main method for increasing the free lift is to reduce the passenger load.

For operations at higher wind speeds it is important to ensure that the ballonet pressure is maintained. If the ballonet pressure is not maintained then the envelope will become slack and the drag forces will increase. This will cause the envelope to move downwind. Care must also be employed when operating in gusty wind conditions. If the peak wind speed are significantly higher than the mean wind speed the motion of the gondola increases. This may be distinctly uncomfortable for the passengers. This effect may be reduced by decreasing the passenger load. The peak wind speeds are obtained from the wind speed indicator by selecting the peak switch, just above it.

With experience the operator should be able to notice changing weather patterns and to plan the day's operation based on this knowledge. A basic course in meteorology is strongly recommended for all operators. Attention should always be maintained to spot approaching squalls. If the balloon becomes wet the free lift can quickly be reduced by 200 kg (440 lbs) because of the weight of the water on the envelope and net. Other than this reduction in free lift the system is capable of being operated in the wet if the passengers should so desire.

3.4.2.4 Balloon Descent

The descent is started by pressing the "DESCEND" or "DOWN" button on the gondola remote control unit. The button will latch on immediately and there will be a 5 second delay while the hydraulic brakes are released. The winch will then accelerate for 5 seconds up to 50% of the maximum speed. It then accelerates to full speed. When the balloon is 3 m from the platform it decelerates until it stops when it is 1 m from the platform. From this point until the gondola is grounded, the descent is continued by pressing and holding the descend button. If the button is released the winch will stop immediately. This allows the operator to pause the descent until the wind conditions are more favourable for a smooth landing. If the descend button is not pressed for a period of 8 seconds, then the hydraulic brakes will be applied. If this occurs, then the next time the descend button is pressed, there will be a 5 second delay while the brakes are removed before the winch continues. It is recommended that the button should be pressed every 4 seconds or so during the landing phase.

It is important to ensure that when the gondola is grounded, the disc situated at the upper end of the cable is within 500 mm of the sensors mounted on the gimballed sheave. This process resets the ride height to zero after each ride to ensure that accumulative measurement errors are not introduced into the drive programme.

3.4.3 Ride Stop

If, for any reason the ride has to be stopped before it reaches the normal ride height the stop button should be pressed unless there is an emergency (see following section). Depressing the stop button will override the programmed ride profile and initial an immediate controlled deceleration and stop.

3.4.4 Emergency Stop

The emergency stop button may be pressed at any of the two control panel locations and this will over-ride all other ride programs. It is intended for use only when to continue winch motion would cause a hazardous situation for any person or if structural damage is imminent.

All system braking is used to bring the winch and also the balloon to a halt, as quickly as possible. This will produce a noticeable jolt in the gondola, which may cause passenger discomfort. If possible, in the available time the passengers should be warned to hold onto the handrails firmly and to brace themselves. Once the emergency stop has been used the button must be pulled fully out and the emergency reset button must be pressed on either the main or auxiliary control panels, in order to reset the system. The system cannot be reset from the gondola remote control.

3.4.5 Setting Helium Pressure Limits

Helium pressure limits are factory set. Lindstrand Balloons Ltd must be consulted prior to any alteration of these settings. Unauthorised adjustment could cause envelope failure.

3.4.5.1 Setting Alarm Pressure

This pressure level may be changed to accommodate any specific requirements the operator may have for advanced warning of the valve opening. However it is recommended that no changes are made to this level until the system has been operating for at least 1 month on site, to fully establish the necessity for change and the most effective new pressure level for the alarms within the local operating microclimate. Similarly the factory must be consulted prior to changing the alarm pressure level.

3.4.6 Auxiliary Control Panel Operations

If the remote control fails, it will be necessary to recover the balloon using the auxiliary control panel. The ground operator must first inform the balloon operator of the transfer of control, as described in Section 3.4.2.2.4. Then the key is inserted into the switch marked LOCAL / REMOTE and turned to LOCAL. This disables the remote control completely. The remainder of the controls on the auxiliary control panel have identical functions as those described for the remote control. Control of the balloon is returned to the remote control by turning the keyswitch back to the REMOTE setting.

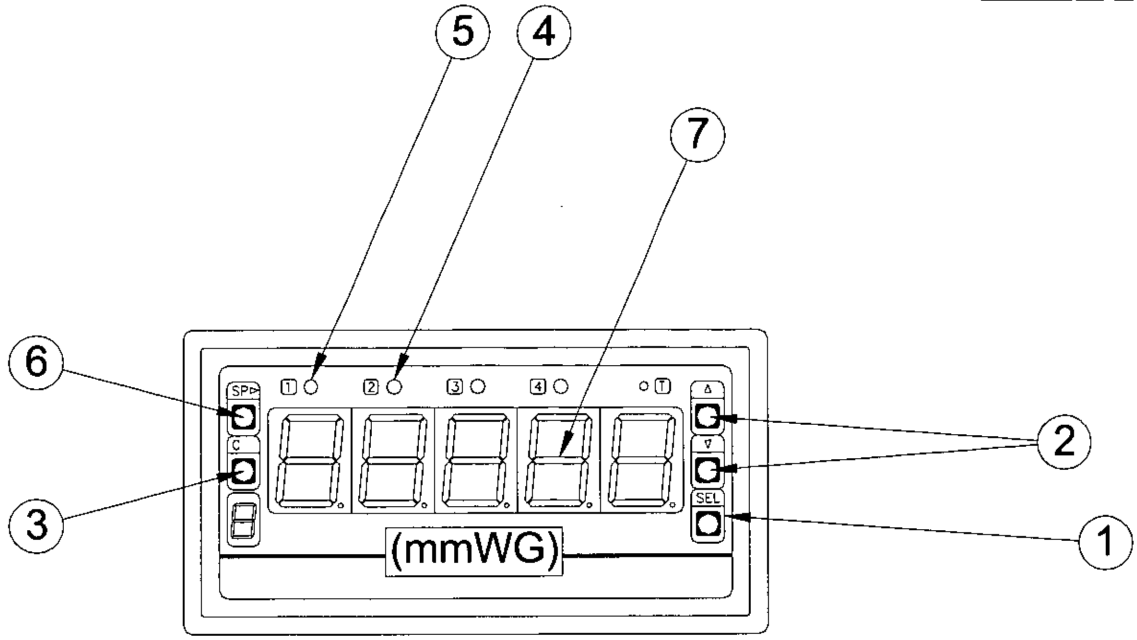


FIG 3.4.5 HELIUM PRESSURE READOUT

NOTE:
BALLONET PRESSURE READOUT
UNIT IS IDENTICAL

3.4.7 High Mooring System

This system is used for mooring the balloon for short periods of time when the wind is not greater than 24 knots (27.6 mph) and if operations are going to continue later in the day.

The 16 outer mooring ropes are attached to the polar rope around the upper part of the net and stowed on the outside of the gondola.

To high moor the balloon, the ropes are released one at a time from the gondola and attached to ratchet straps anchored to the 16 outer mooring blocks. Each rope is attached to the nearest ratchet strap with a karabiner to the highest rope loop within easy reach and then tensioned down.

This process is repeated for all 16 mooring ropes. Once all the mooring ropes have been attached, the ratchet straps may be further tightened if necessary. Care should be taken to ensure that when completed, the tension in each of the mooring ropes is equal.

Where there are extra outer high mooring winches the mooring ropes will be looped directly around the high mooring winch drums. The ropes will be wound on individually on each winch until they are at the same tension as the other mooring ropes.

If the wind is strong enough to move the balloon whilst trying to attach the mooring ropes, it is best to first secure the mooring ropes situated 90° to the general wind direction. These ropes can be tensioned to restrict the balloon's motion. The two adjacent upwind mooring ropes should then be attached and similarly tensioned to further reduce the envelope motion. Continue this process until all the upwind mooring ropes are attached and then repeat the process with the downwind ropes. When all the outer mooring ropes are attached, connect and tension the low mooring ropes.

The 16 low mooring ropes are attached to the net equator rope round the middle of the balloon and stowed on the outside of the gondola.

Release the ropes and loop around the drum so that winching down will tension the loop.

Set the mooring winch pendant control to “one” and “lower”.

Tension each rope one at a time and ensure that all ropes have equal tension.

Tighten outer mooring straps again.

The balloon is now high moored.

See HiFlyer Training Manual, Volume 1, for detailed procedure.

3.4.8 Low Mooring System

3.4.8.1 Mooring Procedure

This form of mooring is used whenever the expected winds are in excess of 24 knots (27.6 mph) or for overnight mooring.

In order to low moor the balloon, it must first be in the high moored position, as described in Section 3.4.7.

Before low mooring, confirm all winch ropes are under equal tension.

a) Switch the helium valve to "Manual" to prevent accidental operation of the valve if the pressure in the envelope rises as it is pulled down onto the mooring ring.

b) Switch the winch control pendant to "All" and "Lower".

c) *Winch the balloon down with all mooring winches simultaneously until the bottom of the* envelope is within 500 mm of the gondola mooring ring and stop.

As the balloon comes down, the outer mooring ropes will slacken and allow the balloon to move around in the wind. Where there are extra outer mooring winches, these will steady the balloon as it comes down. If outer mooring winches are not used, to stabilize the envelope, it may be necessary to fasten the outer straps to higher loops on the outer *mooring ropes and re-tension the ratchets, at the same time centering the* PRV and ballonet fan inside the mooring ring.

d) Attach the 8 lower apex mooring straps to the rope extensions on the bottom of the envelope to restrict the movement of the PRV and fan and prevent damage by contact with the mooring ring.

The apex mooring straps are anchored to alternate mooring winch blocks and passed over the top of the gondola mooring ring and connected to the envelope load patch rope extensions with karabiners.

Tension the ratchets to secure the envelope.

e) Lower the envelope onto the mooring ring until it indents the envelope approximately 500 mm, to prevent shuffle.

f) Ensure that all securing ropes are of equal tension.

g) Once the balloon is secure and ready for the weather, the main winch controller must be switched off.

h) Switch the helium valve back to "Automatic", except under the following conditions:

In extreme weather, the helium valve should be left on 'Manual' as the helium pressure will be artificially increased by the buffeting of the wind and the pressure could rise above the operating limit of 40 mm WG. ***The Security Switch must be in the 'UNLOCKED' position to operate the helium valve in the 'Manual' position***. Note that when the balloon is moored when there are thunderstorms in the local area, the mains power should be switched off at the main external circuit breaker and personnel must not enter the winch housing or approach any metallic components of the balloon or associated rigging.

3.4.8.2 Storm Mooring Procedure

This is the most secure form of mooring when winds in excess of 35 knots are forecast. In addition to low mooring, the following precautions must be taken:

a) **Mooring Cushions**

The 8 inflatable mooring cushions should be attached to the gondola to provide extra contact area for the envelope. The cushions should be inflated with the air blower supplied and attached to the gondola using the ratchet straps provided, before the balloon is finally lowered onto the mooring ring.

b) **Gondola Anchoring**

The gondola should be secured in 8 positions, with 5 tonne ratchet straps running from the corners of the gondola, at hand rail height, to the steel hoops on the mooring winch blocks.

c) **Ground Fan**

The ground fan has a higher pressure and flow rating than the ballonet mounted fan.

This speeds up envelope pressure recovery under gusty conditions and reduces envelope distortion and wind drag.

The ground fan should be installed on the decking, with the hose connected to the ballonet fan inlet.

Electrical power must be plugged in and the control system electric connection made.

Operating instructions are contained in Supplement 1.

The ground fan must be disconnected before the balloon is raised or operated.

3.4.8.3 Unmooring Procedure

The unmooring procedure is largely the reverse of the mooring procedure and involves two basic procedures:

- High Mooring from Low Mooring Position
- Operational Position from High Mooring Position

High Mooring from Low Mooring Position:

- Remove the outer mooring lines from the ratchet straps and reconnect to the last loop. If outer mooring winches are supplied, keep the tension the same as with the inner mooring winches, so that all winches raise the balloon at the same time.

- Take two turns through the ratchet, ready to re-moor if necessary.
- Remove lower apex straps and gondola securing straps if fitted.
- Switch mooring winch controller to "All" and Raise".
- Switch helium valve to "Automatic" on gondola control panel.
- Check all securing ropes are in their correct position.
- Raise balloon whilst observing the load ring and load cell for any entanglement.
- As the balloon picks up the main winch cable check that the cable is running through the correct path. The load cell will start to read and the free lift will rise. As the lift increases, stop raising the balloon.
- Remove storm mooring cushions if fitted.
- Re-tension outer and inner mooring lines if the balloon is to be held in high moored position.

Ride Ready from High Moored Position:

- Switch on main winch system.
- Remove tension from outer mooring ropes and keep secured to outer mooring position allowing enough slack for the balloon to rise to the operational position.
- Switch mooring winch pendant controller to "All" and "Raise".
- Raise balloon until ropes slacken.
- Remove inner mooring ropes and stow on outside of gondola.
- Remove outer mooring ropes and store on outside of gondola.
- Lay out ratchet straps with two turns through buckle, ready for re-mooring.
- Switch mooring winch pendant controller to "One" and "Lower".
- Record unladen (grounded) free lift.
- Balloon is now in the operational position.
- Commence pre-ride checks.

3.4.9 Battery Charging

A battery pack must be connected to the control panel and have sufficient charge at all times whilst the balloon is inflated. This is to keep the helium pressure control system operating and the ballonet fan working.

A battery charger is supplied so that whenever the gondola is moored the powerpack should be charged. During a long day of operations charging should be achieved during the day in between rides to maintain the battery charge level. A second battery powerpack is supplied, to be kept fully charged and available to exchange with the onboard unit, should that unit loose its power. The battery charger lead connects to either connector lead from the batterypack. Only the battery charger supplied should be used.

3.4.10 Night Operations

Provided local permissions have been secured and the correct navigation lights are fitted and working the balloon may be operated at night.

However care must be used when operating at dusk. The temperature drop can be quite rapid as the sun goes down and this has a major effect on the free lift. As the helium temperature drops the passenger load must be reduced to maintain the minimum operating free lift. The landing platform should be well illuminated with flood lights to assist the operator in judging the landing.

3.4.11 Helium Top-Up

During normal operations, helium will permeate through the gas balloon envelope. This slowly results in a loss of free lift.

When the unladen free lift drops to the lower recommended level, the helium should be topped up.

This is carried out when the balloon is in the low moored position. Turn the helium valve to manual. It should then be returned to the operational position once the top-up is complete.

A top-up hose is fitted into the helium cell and runs down one of the bridles towards the gondola. The hose terminates in a $^3/_8$" Tema connector, where it is accessible from the ground.

A supply hose is connected from the high pressure helium gas cylinder to the top-up hose with the mating Tema coupling.

The gas cylinder valve should have a regulator fitted (not supplied by LBL) and is opened to 50 psi until the cylinder is exhausted.

Further cylinders can be connected in turn until the unladen free lift reaches the desired level.

The position of the internal bladder may be checked through the velcro access flap provided in the exterior ballonet skin or the clear viewing panel if fitted. The amount of helium put into the balloon should be carefully judged. It is important that the balloon is not overfilled, such that there is insufficient expansion volume remaining within the ballonet to accommodate changes in helium volume as temperature rises.

Start to fill the envelope with the helium, but observe the position of the bladder regularly. If the bladder position indicates that the balloon is becoming full, then stop the helium supply. This situation may occur when the helium within the envelope has become impure. Air eventually enters the envelope and dilutes the helium. This will result in there not being sufficient room within the envelope to accommodate the helium required to restore the free lift.

Whilst filling with helium, the ambient temperature level should be monitored. If the temperature is low, it is more important to ensure that sufficient expansion volume remains within the envelope. If in doubt, it is better to underfill rather than overfill.

The helium may be purged pure again. Consult Lindstrand Balloons if the helium requires purging. Once helium filling has been completed, disconnect the helium fill hose and return to service. Complete the Technical Log with the final amount of helium put into the balloon.

For reference, the sea level lift of helium gas is approximately 1 kg/m^3.

A high pressure helium cylinder of 50 litres capacity at 200 bar pressure would contribute approximately 9 m^3 of free helium and 9 kg of free lift when discharged into the envelope.

3.4.11.1 Helium Fill Level

The helium fill is controlled by the envelope and ballonet capacity.

The helium cell should be filled with helium until half the ballonet volume is displaced, with the bladder in the mid position.

Ideally, the fill should be measured at average local operating temperature, so that both expansion and contraction of the helium cell with rise and fall in temperature can be accommodated.

The fill level can be measured in terms of free lift, as this is directly related to the volume and purity of the helium gas.

The free lift used as a basis for the helium fill level is the unladen free lift, that is the free lift with the balloon raised so that is restrained by the winch cable with the load cell under tension, but with the gondola on the deck with the cables slack.

The unladen free lift will measure the lift of the helium less the weight of the balloon assembly (envelope, net and load ring).

As the weight of the Hi Flyer balloon assembly may vary slightly according to the individual specification, the recommended unladen free lift range will be specific to each balloon.

The normal recommended range will be with the ballonet at 40% to 60% of its' capacity at standard atmospheric conditions, with 99% helium purity.

Recommended unladen free lift range:

Maximum:	4.20	Tonnes
Minimum:	3.90	Tonnes

The balloon may be operated below the minimum recommended free lift level, but the passenger capacity will be reduced.

Unladen free lift will vary with temperature, atmospheric pressure and helium purity.

The unladen free lift must be recorded in the Tech Log before and after helium top-up and on a daily basis in order to monitor the helium level.

3.4.11.2 Helium Capacity

The following data is included for reference.

At sea level standard atmosphere:

Helium Lift (99% purity)	-	1.034 kg/m^3
Envelope Volume	-	5790 m^3
Ballonet Maximum Volume	-	1160 m^3

SECTION 4 - EMERGENCY PROCEDURES

If any fault occurs whilst the balloon is on the landing platform, then operations must cease immediately until the fault is investigated and rectified. If a system fails whilst the balloon is operating, descend immediately and moor the balloon. System failures cannot be resolved with the balloon elevated.

4.1 Balloon System Failures

4.1.1 Gondola Power Failure

Indication: Low or no volts at voltmeter

Actions:

- Check battery pack connection.
- Switch emergency power "On" at control panel.
- Winch balloon down using gondola or ground controller.
- Switch ballonet fan "Off".
- Offload passengers.
- Change over battery pack for recharged unit
- Switch emergency power 'OFF'.
- Check volts in operating range.
- Switch ballonet fan "On".
- Check control panel readout is normal.
- Continue operations.

4.1.2 Helium Valve Open

Indications: Valve open indicator lamp "On".

Free lift readout - drops.

Helium pressure - drops.

Winch cable - slackens.

Actions:

If balloon is elevated - **Descend**.

This will:

- Reduce cable weight.
- Reduce helium pressure.
- Get passengers to safety.

During descent:

- Check helium valve switches are to "Auto" and "Closed" with switch guards down. Ensure the security switch is in the 'UNLOCKED' position.
- Switch off ballonet fan to reduce pressure.
- Advise ground crew to prepare for mooring.
- Monitor helium pressure and temperature.

With gondola landed:

- Unload passengers.
- High moor balloon (ground crew).
- Check helium valve status (it may have closed).
- Check ballonet fan "Off".
- Check helium pressure.

Helium Pressure: 40 mm WG or over

- Allow venting to continue.
- When pressure falls below 40 mm, the valve should close automatically.

Valve closes automatically - investigate causes for venting:

- Gas cell overfilled - ballonet bottoming out.
- Helium temperature abnormally high - ballonet bottoming out.

Valve does not close and helium pressure falls below 38 mm WG:

- Push to test valve closed indicator lamp.

- Switch helium valve to "Manual" and "Closed".
- If valve does not close.
- Cycle manual switch "On" and "Off".
- Check loom and connector intact.
- Confirm helium pressure and free lift falling.

Valve stuck open:

- Conduct 'Emergency Valve Closure' – see Section 4.1.8
- Low moor balloon.
- Clear decks and cover platform.
- Access valve, inspect and rectify.
- Repair valve or operating system.

4.1.3 Ballonet Fan Failure

Indication: Fan does not run when ballonet pressure drops below 6 mm WG.

Actions:

- Check fan switched to "Auto".
- Switch fan to "On".
- If fan does not run.
- Check battery power on voltmeter.
- Check electrical connection to loom.

If balloon is elevated, terminate ride, land gondola and unload passengers.

Low moor balloon and fit ground fan while fault is investigated and rectified.

If fan is faulty, change for spare unit.

Note: Access to fan is possible through velcro access flap into ballonet.

4.1.4 Pressure Relief Valve (PRV) Failure

Indications: PRV does not open when ballonet pressure exceeds 14 mm WG and continues to rise. Helium pressure rises in unison.

These conditions will normally occur when helium temperature is rising.

Actions:

- Winch balloon down and offload passengers.
- Check ballonet and helium pressure.
- Low moor balloon.
- Tie cord to valve cap ring and pull open.
- If valve is stuck, free and repair.
- If opening pressure is incorrect, adjust springs.

Note: Access to PRV is possible through velcro access flap into ballonet.

4.1.5 Helium Pressure Exceeds Limit

Indications: He pressure warning triggered at 38 mmWG
He pressure exceeds automatic valve opening limit of 40 mmWG
He 'Indicated Pressure' continues to rise above 40 mmWG

Actions:

- Winch balloon down
- Unload passengers
- Switch ballonet fan 'Off'
- Check He 'Valve Open' indicator light.

If light is 'On' (lit)

- Helium valve has automatically opened
- Monitor He pressure
- If pressure falls below 38 mm WG
- Switch He valve to 'MANUAL' and 'CLOSE'
- Confirm 'Valve Open' light goes out, indicating valve closed.
- If 'Valve open' light stays 'ON' proceed with 'Emergency Valve Closure' as detailed in 4.1.8.

If light is 'OFF' (unlit)

- Valve is closed
- Vent helium as detailed in 4.1.8

4.1.6 Rapid Freelift Loss

Freelift is the difference between helium gas lift and balloon weight. The balloon depends on freelift to keep it aloft. The freelift is restrained by tension in the winch cable, which provides the freelift display readout. If helium is continuously leaked or vented the freelift will fall to zero after which the cable will slacken and the balloon descend. The descent will be softened by the reduction in cable weight on the way down.

Indications:

- Freelift display readout falls
- Helium pressure falls
- Ballonet fan comes on
- Winch cable slackens

Actions:

- Alert ground crew
- Winch down
- Check He valve is closed (indicator 'OFF')
- Switch He valve to 'Manual' and 'Close'
- Switch ballonet fan 'OFF'
- Scan envelope for damage
- Land gondola and unload passengers
- Moor balloon
- Investigate source of helium loss

4.1.7 Onboard Fire

a) Move the passengers away from the source of the fire.

b) Winch down and alert the ground crew.

c) Use the fire extinguisher on source of fire.

d) Evacuate the gondola after landing.

e) Make good all damage before recommencing operations. Record incident on Tech Log.

4.1.8 Helium Overfill

If the envelope helium gas cell is overfilled, the ballonet can 'bottom out' leading to envelope overpressure. See 3.4.11.1. The excess helium can be vented manually by the Helium valve. See 1.2.4.3.4

Do not operate the valve when the balloon is elevated

Helium Overfill Indications:

- low ballonet
- high freelift
- high helium temperature
- high helium pressure

Before venting

Measure ballonet height and record (with balloon in low moored position)

Unmoor balloon in calm conditions

Connect battery charger to maintain power

Record unladen freelift, temperatures and pressures

Turn panel key to 'UNLOCK'

Ballonet fan switch to 'AUTO'

Manual Helium Valve Operation

OBSERVER TO COUNTDOWN 'OPEN' TIME AND MONITOR FREELIFT

OPERATOR TO CONTROL HELIUM VALVE SWITCHES

PRESS TO TEST HELIUM VALVE INDICATOR LIGHTS

L.H. HELIUM SWITCH UP TO 'MANUAL'

R.H. HELIUM SWITCH UP TO 'OPEN'

RED INDICATOR LIGHT 'ON'

COUNTDOWN – 6 SECONDS

R.H. HELIUM SWITCH DOWN TO 'CLOSE'

RED INDICATOR 'OFF' AFTER 4 SECONDS TRAVEL TIME*

L.H. HELIUM SWITCH TO 'AUTO'

RECORD OPEN TIME (INDICATOR 'ON' TO 'OFF') IN SECONDS

RECORD NEW (REDUCED) FREELIFT

WAIT FOR FAN TO FILL BALLONET

REPEAT VENTING PROCEDURE UNTIL TARGET FREELIFT ACHIEVED

LOW MOOR BALLOON

MEASURE (INCREASED) BALLONET HEIGHT AND RECORD

* **EMERGENCY VALVE CLOSURE**

IF VALVE DOES NOT CLOSE:

RED INDICATOR REMAINS 'ON'

ARM EMERGENCY BOX ON TOP OF CONTROL BOX

SWITCH ARMING SWITCH UP TO 'ON'

PUSH RED CLOSE BUTTON

This bypasses the control box systems.

CONFIRM RED VALVE OPEN INDICATOR 'OFF'

4.2 Winch System Failures

Refer to:

David Brown – balloon winch system' Operations & Maintenance Manual' Section 5
HiFlyer Operations Manual – Appendix 4 and Appendix 5

4.2.1 Remote Gondola Control Failure

The 'remote' winch control unit is mounted on the gondola control panel. Signals from the remote control modem antenna in the gondola are relayed to the winch via a ground antenna. In case of remote control failure:

1. Inform ground operator by radio
2. Switch ground control unit from 'REMOTE' to 'LOCAL'.
3. This transfers control authority from gondola to ground.
4. Operate the balloon from the ground station.
5. Identify and repair fault as soon as balloon is out of operation.

4.2.2 Power Supply Failure

4.2.2.1 Mains Power Failure

The winch will stop leaving the balloon stranded. Use the auxiliary generator and motor to recover the balloon.

For recovery procedure see:

David Brown Balloon winch system Operation and Maintenance Manual section 5.7

If the winch cable disc is inadvertently winched down onto the 'E' stop trigger switches – see Section 4.2.2.2.

4.2.2.2 'E' Stop Locked by Cable disc

During emergency recovery the winch has to be manually stopped at the correct level normally triggered by the 'photo eye' proximity switches. If the stop is left too late the cable disc will descend onto the telescopic 'ear' switches on the gimbal sheave triggering an 'E' Stop, which will then remain locked on by the disc.

The indications of an 'E' Stop lock are:

1. Cable disc contacting trigger switches
2. Winch 'NOT ENABLED' on display panel
3. Winch will not 'RESET'

Procedure to release 'lock'

1. Mark position of disc on cable with tape.
2. Unscrew disc clamping screws
3. Slide disc up cable to clear trigger switches
4. 'RESET' winch
5. Winch cable up approximately one meter
6. 'E' stop
7. Slide disc down cable to marked position
8. Reclamp disc
9. 'RESET' winch
10. Make unmanned test ride

NOTE! DO NOT ATTEMPT TO LIFT DISC OFF TRIGGER SWITCHES BY RELEASING BRAKES

4.2.2.3. Mains and Generator Power Failure

This is a very unlikely combination of events. A manual recovery is long and laborious, avoid it if possible. The generator should be started every morning and the battery charged regularly. Get help to get the generator working before attempting a manual recovery.

If the battery is flat, change it. Find out when mains power will be reconnected. If the fault is in the site mains connecting station call in electrical engineers to fix it. Call in service agents to work on the generator during the manual recovery. They may get it working to take over the recovery. Call in the full ground crew to take shifts. Call in supplies of snacks and drinks to be reeled up to the passengers in the gondola. Keep the balloon operator informed of events by radio.

Operators

A minimum crew of three will be required:

- one to operate hydraulic brake
- one to operate motor brake
- one to crank winch handle

The crew should take turns at operations without releasing the crank handle during changeover. The hydraulic brake operator should be ready to open the relief valve at a moment's notice to apply the disc brake.

Equipment

Disc Brake – can be operated by hand. Turn the selector valve to 'Hand' position and pump handle to release brake. Open vent valve (anticlock) to apply brake.

Motor brake – can be operated by hand. Screw in handle and push toward auxiliary motor to release brake. Let go of handle to apply brake.

Auxilliary motor coupling – connects auxiliary motor to winch drive transmission. Turn the auxiliary motor handle until the 'teeth' align. Slide the coupling long its shaft until the 'teeth' are fully engaged.

Manual handcrank – locates over the hexagon head drive bolt at the top end of the auxiliary motor. Turning the handle (clockwise) will turn the motor shaft, and drive the main transmission through the auxiliary coupling. The gearing is extremely low and descent very slow.

Procedure

1. Switch winch mains power 'OFF'
2. Engage auxiliary motor coupling
3. Fit hand crank lever and hold securely
4. Turn hydraulic selector to 'HAND' pump
5. Release disc brake with hand pump until it just clears disc
6. Ease motor brake 'OFF' with handle.
7. Take strain on hand crank

NOTE! If cable starts to pay out (balloon ascends):

- RELEASE brake handle immediately to apply motor brake
- OPEN hydraulic vent immediately to apply disc brake

8. Hand crank down balloon until gondola is landed
9. Open hydraulic vent – apply disc brake
10. Release brake handle – apply motor brake
11. Ensure load is off crank, then release
12. Disembark passengers
13. Moor balloon

4.2.3 Winch Control Inoperative

The winch will not respond to gondola or ground controls. Display screen is blank and PLC disabled.

The balloon can be recovered using the main motor on mains power, at reduced speed.

For recovery procedure see:

David Brown Balloon winch system – Operation and Maintenance manual section 5.5. page 21

If the winch cable disc is inadvertently winched down onto the 'E' stop trigger switches – see 4.2.2.2

4.2.4 Main Drive Motor Failure

The balloon can be recovered using the auxiliary motor on mains power.

For recovery procedure see

David Brown Balloon winch system – Operation and Maintenance Manual section 5.6 page 22

If the winch cable disc is inadvertently winch down onto the 'E' Stop trigger switches see 4.2.2.2

4.2.5 Winch Transmission Gear Failure

If the main winch transmission fails it will be necessary to recover the balloon without reeling in the cable. An emergency descent can be made by 'venting helium' to descend the balloon or pulling it down with snatch blocks and a vehicle.

4.2.5.1 Valving Helium

The balloon can be descended by venting helium to reduce lift. The loss of gas will reduce envelope pressure and increase wind drag. The landing area could be up to 120 meters downwind from the platform centre.

Ensure the landing area is clear of obstructions before proceeding. If the area is not clear use the snatch blocks recovery (see 4.2.5.2). Control of operation with balloon operator.

Preparations

1. Confirm actions with the ground crew (by radio)
2. Inform Emergency services
3. Arrange for heavy (4 tonne or more) recovery vehicle at landing site.

Procedure

1. Switch winch mains power 'OFF'
2. Switch ballonet fan 'OFF' to reduce helium pressure
3. Helium valve to 'MANUAL'
4. Helium valve 'OPEN' and 'CLOSE' in 30 second increments until FREELIFT reduces to ZERO
5. Continue valving in increments as balloon descends to counteract lost cable weight.
6. When balloon lands leave valve 'OPEN' until all passengers are disembarked.
7. Secure load ring to recovery vehicle.
8. Offload passengers one at a time as helium is vented or balloon will lift again.
9. 'CLOSE' helium valve when all passengers are disembarked.

4.2.5.2 Snatch Block Recovery

This technique will land the gondola back on the platform. The operation can be undertaken in moderate wind. Control of operation with ground crew.

Preparations:

1. Confirm actions with balloon operator (by radio)
2. Establish all equipment is available and serviceable
3. Inform Emergency services
4. Arrange heavy commercial recovery vehicle, with hydraulic, or power take off driven winch. Minimum winch pull of 10 tonnes is required.
5. The recovery vehicle will need a clear path of 60 meters from the platform.

Procedure:

1. Switch winch mains power to 'OFF'

2. Open the two snatch blocks

3. Locate blocks one above the other over the main winch cable, above the gimbal sheave

4. Close both the snatch block cheek plates, over the cable, secure finger nuts, and lock with 'R' clips.

5. Shackle the upper snatch block to the dedicated chain tether attached to the winch or gimbal frame, with 10 tonne shackles.

6. Select a chain link approximately one meter above the platform deck.

7. Station the recovery vehicle with a clear path of at least 60 meters.

8. Shackle the lower snatch block to the winch cable or tow hook of the recovery vehicle.

9. Tighten all shackle the nuts and fit split pins.

10. Instruct gondola operator to vent helium. Manually 'OPEN' and 'CLOSE' helium valve in 30 second increments until freelift reduces to 0.3 to 0.5 tonnes.

11. Winch or tow the lower snatch block away from the platform approximately two meters to take up slack. Check that the winch cable is flowing smooth through the blocks and there are no snags.

12. Winch or tow lower block away from platform slowly and steadily to descend balloon, until gondola is landed on platform.

13. Disembark passengers

14. Moor balloon with ratchet straps

<u>4.2.6 Winch Pit Fire</u>

<u>Prevention</u>

Familiarise local Fire Service with winch installation.

No oil, paint, rags, paper or flammable material to be left in the winch pit.

No smoking or naked lights

Clean up any oil spills or debris immediately.

<u>Protection</u>

Smoke detectors with alarms should be fitted in winch pit and inside electrical control cabinet.

CO_2 fire extinguishers – one in pit and one outside platform

Disc and motor brakes applied 'on' if fire disrupts hydraulic or electric supply (fail safe)

<u>Potential Fire Risk</u>

Ignition source – mains electric power to electronic control cabinet

The sealed metal cabinet has low combustible content and limited oxygen.

Flammable material – oil in fully enclosed gearboxes and hydraulic system.

Negligible vapours

The platform decking is fire rated to Class 3 Surface Spread of Flame to BS 476 Part 7: 1987.

Fire Warning

The winch pit is not manned during balloon operation, so the first indications of fire will be:

- Fire alarms triggered by smoke detectors
- Winch stops without operator control
- Smoke from winch pit

Actions

- Alert balloon operator
- Stop winch (if still working)
- Call Fire Service (urgent response)
- Evacuate winch pit (if occupied)
- Discharge CO_2 fire extinguisher through platform hatch or center ring at source of fire if safe to do so.
- Close hatch and evacuate deck
- Isolate mains supply at junction sub station
- Stand back and assess severity of fire

If fire appears to be extinguished:

- DO NOT enter pit, fire may resurrect, and CO_2 can suffocate
- Await Fire Service, and warn them of CO_2 presence in pit
- Get 'All Clear' from Fire Officer

If fire perseveres or increases:

- Await Fire Service
- Extinguish fire
- Get 'All Clear' from Fire Officer

NOTE! DO NOT reconnect mains power supply to winch or site until electric circuit has been checked and certified safe.

4.2.6.1 Balloon Recovery

Emergency medical services on site.

1. Control System (PLC) – inoperative (no power)
   Winch mechanism – undamaged
   Auxiliary power supply – apparently undamaged
   - Follow procedure in Section 4.2.2

- Ventilate CO_2 from winch pit
- Check auxiliary power circuit is intact and NOT damaged

2. Control System (PLC) – inoperative (no power)
   Winch mechanism – damaged
   Auxilliary power supply – damaged

- Recover balloon by 'venting helium' or using 'snatch block' pull down
- Follow procedures in Section 4.2.5

Appendix 1

<u>Effect of Temperature on Free Lift</u>

The amount of lift generated by the Hi Flyer envelope depends upon the volume of helium contained within it. Changes in the temperature of the helium will affect its volume and therefore the amount of lift. As its temperature rises, the helium expands and the amount of lift increases. Conversely, a drop in its temperature will reduce the amount of lift.

If the temperature of the helium and the amount of free lift at any instant are know, it is possible calculate the change in free lift that will result from a change in temperature.

It is important to note that when calculating changes in lift, all temperature must be expressed in degrees Kelvin. To convert degrees Celsius (°C) to degrees Kelvin (K) just add 273.

The following table shows the conversion of °C and °F into K over a range of temperatures.

°C	°F	K
0	32	273
2	36	275
4	39	277
6	43	279
8	46	281
10	50	283
12	54	285
14	57	287
16	61	289
18	64	291
20	68	293
22	72	295
24	75	297
26	79	299
28	82	301
30	86	303

The procedure for calculating changes in lift due to changes in helium temperature is as follows:-

Say for example that the free lift is 4000 kg (1818 lbs) when the helium temperature is 16°C (60.8°F), what would the free lift be if the helium temperature fell to 10°C (50°F)?

Firstly, convert the temperatures into degrees Kelvin:

16°C (60.8°F) = 16 + 273 = 289 K
10°C (50°F) = 10 + 273 = 283 K

Then apply the formula:

$$\text{New free lift} = \frac{\text{New temperature}}{\text{Old temperature}} \times \text{old free lift}$$

$$= \frac{283}{289} \times 4000$$

New free lift = 3916 kg (8635 lbs)

The same formula can also be used for temperature rises.

Appendix 2 – Daily Log Keeping

A technical log (LBL-TA-1) must be filled out each day and signed off by the supervisor prior to commencement of passenger rides. The form is divided into three sections as follows:

Section 1

A daily inspection of all components of the HiFlyer system should be carried out. Refer to Maintenance Manual

A daily balloon inspection form (LBL-TA 2) and daily winch inspection form (LBL-TA 3) should be completed in full

Remedial action should be taken to repair any defects. The supervisor must be satisfied that the repairs carried out are satisfactory and that the HiFlyer is in a fit state for passenger service, otherwise operations must be suspended until a full repair scheme has been undertaken.

The crew member who has carried out the inspection should state whether the HiFlyer is fit for service sign the clearance box at the end of section 1.

Section 2

Weather conditions and balloon status must be within the operational limitations specified in the operations manual.

The test pilot is to ensure that all the relevant information is filled in before the test flight can commence. i.e.

- Weather forecast
- Unladen free lift (i.e. with gondola grounded)
- Battery voltage

When the balloon is at ride height, the test pilot fills in the remaining data i.e.

- Elevated Freelift
- Helium Temperature
- Peak windspeed
- Helium Pressure

Section 2 of the operations manual specifies minimum free lift requirements at various wind speeds up to the max. operating windspeed.

Freelift and windspeed govern how many passengers may be carried per ride. See Appendix 3

Freelift and Helium temperature/pressure data can be used to estimate the volume/purity of Helium. This should be monitored carefully as it will highlight any increased Helium loss through valve leakage, envelope damage etc.

The battery voltage must be between the limits specified in the Operations Manual

The test pilot should state if the conditions are within operational limits and sign the clearance box at the end of section 2

The supervisor must sign that he/she is satisfied that the balloon is cleared for operations and that weather conditions and balloon status are within operational limits before passenger rides are allowed to commence.

Section 3

Provides data for calculation of helium usage and information for maintenance schedule of winch.

APPENDIX 3

HIFLYER PASSENGER LOAD CHART

Elevated free lift – recorded on operator only test ride

Operating free lift with passengers limited by wind speed as Table 1

Passenger payload is elevated free lift minus operating free lift

Maximum passengers (at 77 kgs each) for payload as per Table 2

Table 1

Peak Wind Speed (knots)	**Minimum Operating Free Lift (tonnes)**	**Elevated Free Lift (Operator only) (tonnes)**	**Passenger payload (tonnes)**	**Maximum passengers from Table 2**
0-5	0.90			
5-10	1.20			
10-15	1.60			
15-20	2.20			
20-24	2.80			

Table 2

Passenger Payload (tonnes)	**Number of passengers (at 77 kgs)**	**Passenger Payload (tonnes)**	**Number of passengers (at 77 kgs)**	**Passenger Payload (tonnes)**	**Number of passengers (at 77 kgs)**
2.16	***28***	1.47	***19***	0.77	***10***
2.08	***27***	1.39	***18***	0.70	***9***
2.00	***26***	1.31	***17***	0.62	***8***
1.93	***25***	1.24	***16***	0.54	***7***
1.85	***24***	1.16	***15***	0.46	***6***
1.77	***23***	1.08	***14***	0.39	***5***
1.70	***22***	1.00	***13***	0.31	***4***
1.62	***21***	0.93	***12***	0.23	***3***
1.54	***20***	0.85	***11***	0.15	***2***

Check wind speed and operating free lift at the top of each ride and confirm operating free lift does not fall below minimum limit. Reduce passenger load on next ride if necessary.

Worked example of Passenger loading using hypothetical values

Peak wind speed recorded on test ride – 12 knots

Elevated free lift with operator only on test ride – 2.80 tonnes

<u>From Table 1</u>

Minimum operating free lift at 12 knots = 1.60 tonnes

Passenger payload = elevated free lift minus operating free lift

2.80 – 1.60 = 1.20 tonnes

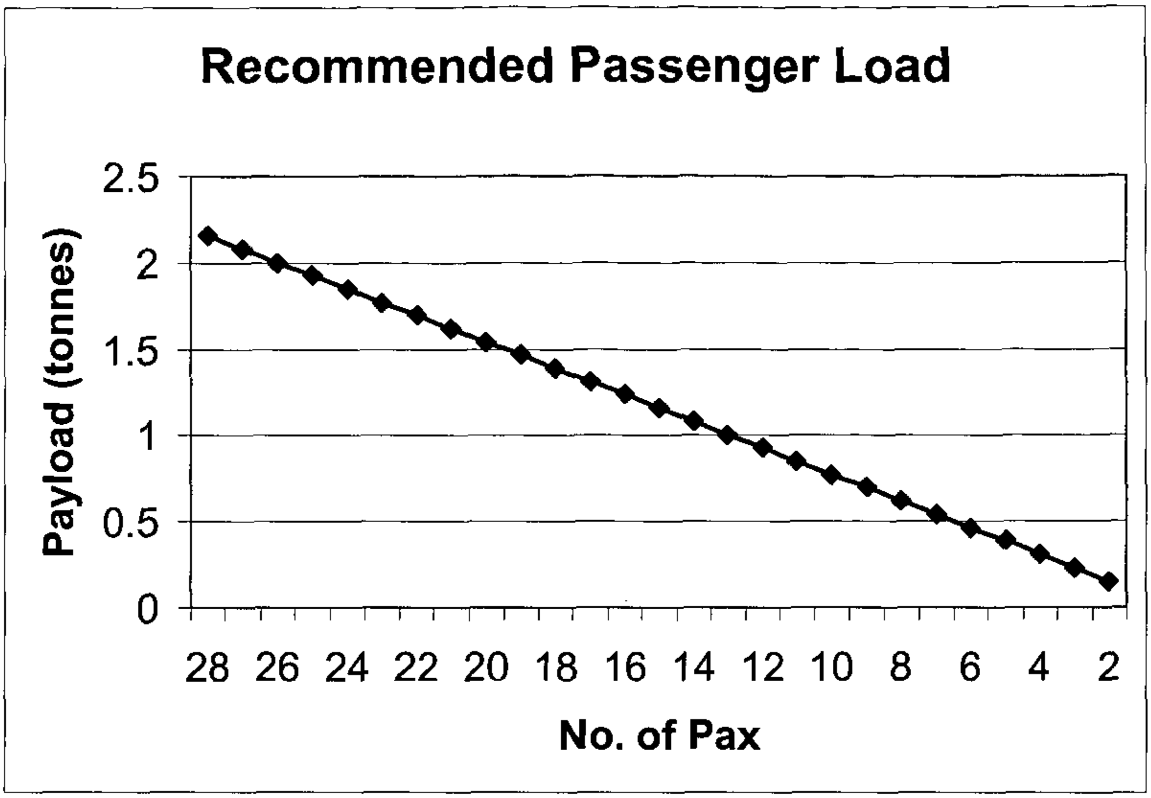
<u>From Table 2</u>

1.20 tonnes payload is equivalent to 16 passengers

Peak Wind Speed (knots)	Minimum Operating Free Lift (tonnes)	Elevated Free Lift (Operator only) (tonnes)	Passenger Payload (tonnes)	Maximum Passengers from Table 2
0-5	0.90			
5-10	1.20			
10-15	***1.60***	***2.80***	***1.20***	***16***
15-20	2.20			
20-25	2.80			

Note:

- standard passengers taken at 77 kgs each. Reduce numbers if the passenger group is obviously overweight.
- numbers may be increased if passenger group is obviously underweight, for example a group of children.
- Confirm minimum operating free lift does not fall below limit at the top of every ride.


Recommended Passenger Load
Payload (tonnes)
2.5
2
1.5
1
0.5
0
28 26 24 22 20 18 16 14 12 10 8 6 4 2
No. of Pax

APPENDIX 4

WINCH EMERGENCY RECOVERY PROCEDURES

Please refer to Issue of the David Brown Winch Manual supplied (Section 5) and the LBL Training Manual Volume 1 (TATM)

APPENDIX 5 - SPECIAL HELIUM VALVE OPERATIONS

Refer to Section 4.1.8 – Helium Overfill and Training Manual Volume 1 (TATM)

SUPPLEMENT 1

GROUND FAN OPERATING INSTRUCTIONS

INTRODUCTION

The ground fan is used to pressurise the ballonet and hence maintain the balloon envelope shape when the balloon is moored.

It is essential to maintain pressure when the balloon is moored during windy conditions, to prevent the envelope from indenting and reduce wind drag and balloon movement.

To speed up pressure recovery in gusty conditions when ballonet air is blown out of the pressure relief valve, the ground fan has a higher performance than the ballonet mounted fan.

If the ground fan is operated continuously, there is a danger that the balloon could be over-pressurised and helium vented. To prevent this, the fan is linked into the pressure sensing system displayed in the instrument box which switches the fan on and off to limit pressure.

The ground fan is powered by mains or generator A C supply.

The ground fan must be disconnected before the balloon is flown or raised to the high mooring position.

GROUND FAN INSTALLATION

Locate fan on the platform outside the gondola.

Lead the duct over the top of the gondola and under the mooring ring.

Couple the duct up to the connection under the ballonet fan. See Figure HF.GF.1.

GROUND FAN CONNECTION

- Select fan switch, located on instrument box, to OFF position (switch guard up, toggle switch centre position).
- Connect ground fan lead into controller socket located on left hand side of instrument box.
- Power supply mains lead plugs into mains (or generator) supply socket

GROUND FAN OPERATION

Select control switch, located on ground fan, to **AUTO** (toggle switch up)

Select Fan switch, located on instrument box, to **AUTO** (toggle switch down – switch guard down)

The ground fan will now operate automatically, switching on at the pre-set pressure of 10 mmWG and off at 12mmWG.

The fan switch, located on the instrument box does not operate the ground fan, but selecting **AUTO** will enable the ballonet fan, in the event of a mains supply or ground fan failure, to automatically start up to re-pressurise the envelope once the ballonet pressure has dropped to the ballonet pressure of 6 mmWG. Due to the increased air resistance over the ground fan, the ballonet fan will be overworked resulting in possible ballonet pressure loss and battery supply failure. Remedial action must be taken immediately by uncoupling the ground fan ducting to ensure that unrestricted airflow is maintained until the problem is rectified.

EMERGENCY OPERATION

The ground fan, in severe storm conditions or automatic switching failure, may be set to operate continuously be selecting the control switch located on the ground fan to its **ON** position (toggle switch down).

In this case, an operator should monitor the ballonet and helium pressure. If the ballonet pressure exceeds 16 mm WG, or helium pressure exceeds 38 mm WG, the fan should be switched off until the pressure drops below 35 mm WG, before switching on again.

GROUND FAN RE-CONNECTION

Before the balloon is flown or raised from the low mooring position, the ground fan must be disconnected.

Ballonet fan will operate automatically.

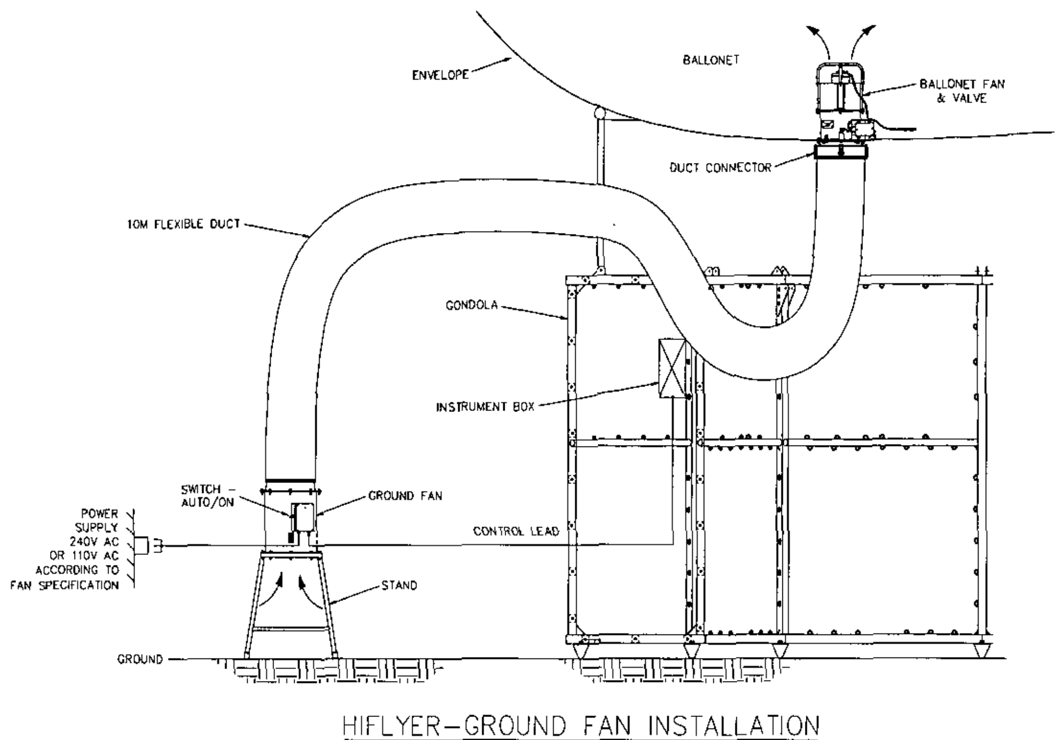


Fig. HF- GF- 1 – Ground Fan general arrangements

Balloons Lindstrand

HiFlyer

SITE PREPARATION GUIDE

UNDERGROUND WINCH OPTION

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Contents

1. INTRODUCTION

This document outlines the site preparation, logistics and documentation which need to be in place before inflation can take place. The customer should budget for the extra costs and time associated with site preparation when planning the project.

It should be pointed out that this document is only intended as a guide to clients preparing the site for the installation of the Lindstrand HiFlyer. It may need adapting depending on the local requirements at each site.

2. PERMITS TO OPERATE

There are various permissions to have in place prior to being able to operate the HiFlyer.

These will vary from country to country, but will usually include:

- Planning permission
- Operations permission
- Insurance

Some local authorities may impose restrictions on operating hours, operating height, lighting, etc. It is important that these are resolved for a specific site before time and money is invested in actual site preparations.

3. SITE REQUIREMENTS

When looking at specific sites the following issues should be taken into account.

3.1 Site Profile

The site needs to be at least 50 metres in diameter to accommodate the full low mooring system, which protects the balloon during high winds

The launch platform must be located on level ground. If the local slope is greater than this, then the area within a 6-metre circle of the cable exit point must be levelled by earthmoving.

A specially adapted platform can be constructed at extra cost as an alternative option (Lindstrand Balloons must be informed at least 3 months in advance).

3.2 Conflicts

3.2.1 Underground Obstructions.

The maximum depth of excavation is approximately 2.6m (8.5ft), depending on the ground type. Consequently it is important to establish that no other underground services are going to be disturbed. It is both expensive and time consuming to discover underground services once digging has commenced.

3.2.2 Surface Obstructions.

The site should be clear of buildings, trees, electricity pylons and other surface obstructions within a 25m (82ft) radius of the landing platform. Short bushes and plants are acceptable but must not obstruct the landing platform, mooring points or passenger entry/exit routes. A 70° 'cone of airspace' from the winch cable centre position must be clear of all obstructions to accommodate the flight 'envelope' of the balloon.

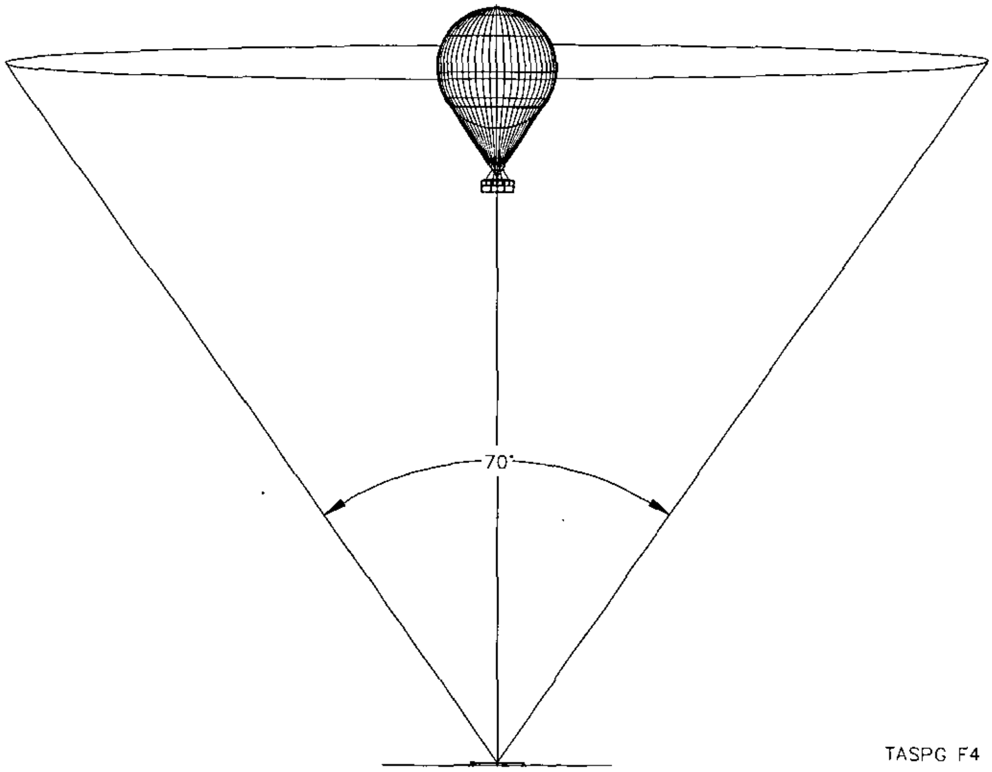


Figure 1 Cone of airspace

3.3 Services

The following services will be required on site:

- Electrical (refer to section 5.5) - *Lindstrand Balloons must be informed of the electrical voltage and frequency supplied to your site.*
- Drainage for sewage and surface water including sump pump for winch pit.
- Vehicle access for helium supply, crane, emergency vehicles, etc.
- Water
- Telephone/Fax

It is also important that you advise Lindstrand Balloons of the elevation of your site, i.e. altitude above sea level.

4. SHIPPING REQUIREMENTS:

Lindstrand Balloons Ltd. deliver the HiFlyer System "Ex-Works". Therefore the responsibility for insurance of the system and shipping the system to the installation site is the client's responsibility.

Lindstrand Balloons Ltd. are able to arrange all freight issues and pass the costs onto the client. However, if you wish to make separate shipping arrangements, the following procedural description is intended to assist you in ensuring all issues are covered and that the quotations received are as representative as possible:

4.1 Transportation

4.1.1 From Lindstrand Factory, Oswestry.

One 40 ft ISO long container is required at LBL.

The container should have the following internal dimensions:

Length	=	12.20m (40 ft)
Width	=	2.40m (8 ft)
Height	=	2.40m (8 ft)

The container must be delivered to Lindstrand Balloons Factory 2, at least three days before the ex-works delivery date specified on the contract, so that it can be loaded.

If possible, you should enquire whether the shippers will be supplying a container on a trailer, or if the container requires a crane to lift it off. If a crane is required, then please let us know in good time so that a crane can be arranged.

4.1.2 From David Brown Special Projects Ltd., Huddersfield.

The main winch system may be transported in a 6.1m (20 ft) standard ISO container (Option A) or a specially made crate (Option B).

The container must be an open-topped type. It is important to mention this fact to your shipping agent, as open topped containers require special arrangements when shipped by sea.

A second 6.1m (20ft) container holds the landing platform, the 16 mooring winches and other equipment.

These containers need to be hired by the customer for shipping these goods.

The container is to be supplied by the shipping agent to the David Brown factory in Huddersfield, at least 3 days prior to the ex-works delivery date.

Address: David Brown Special Products Ltd.
Park Gear Works
Lockwood
Huddersfield
HD4 5DD
England

Contact: Light Industrial Products – Project Manager

Telephone: (0044) 1484 465500 Fax: (0044) 1484 465683

4.1.3 Weights

LBL HiFlyer system			8,000 kg (8 tonnes).
DB Winch			
	Option A	In container	12,000 kg (12 tonnes)
or	Option B	Crate/pallet	9,600 kg (9.6 tonnes)
DB Landing platform container			8,000 kg (8 tonnes)

The above weights are approximate. Final weights will depend on system specification and other equipment required for the inflation.

4.1.4 Customs arrangements

Irrespective of who takes care of the shipping arrangements, the customs liaison must be undertaken by the client. The best way of achieving smooth importation is to retain the services of a clearing agent in the destination country.

The clearing agent is then shown as the consignee on all the shipping documentation.

All importation duties are the responsibility of the client.

For convenience, it may be necessary to ship the containers at separate times. If this is done, then the value of the whole system has to be sub-divided into each container.

A specimen list of contents is attached in Appendix D.

Containers will not be loaded until payment for the third instalment has been made.

Loading will only take place:

Monday – Thursday	07:30 – 16:15
Fridays	07:30 – 12:00

The following values are suggested:

	% of Sales Value
Container 1 **Balloon**	54%
Container 2/ or crate **Winch**	27%
Container 3 **Landing Platform**	19%

At the time of shipping, Lindstrand Balloons Ltd will provide a shipping invoice for customs declaration.

A copy of the 'Airway Bill' or a 'Bill of Loading' will be provided if Lindstrand Balloons Ltd. are arranging transportation. Your shipping agent will provide you with this information if you are arranging your own shipping.

4.1.5 Transportation insurance

Whilst *title* for the HiFlyer passes to the customer on receipt of payment (i.e. on handover after installation), *risk* in the equipment passes to the customer on *delivery* (i.e. ex-works - refer to section 4 of contract).

It is essential, therefore, that insurance is obtained by the customer ex-works and LBL will seek proof of such cover.

5. SITE PREPARATION:

All civil and electrical work should comply with local regulations

The exact details of the civil work required are site dependent (soil/climate/water table/local regulations etc.). The customer must contract a local consulting civil engineer to arrange details.

5.1 Scope of work

The basic order of site preparation is as follows:

Concrete
- Winch pit
- 12 plinths for the landing platform
- 16 mooring winch hard points
- 16 outer mooring hard points

Installation – Phase 1
- Main Winch
- 16 mooring winches + isolator boxes

Electrics
(refer to section 5.5)

Installation – Phase 2
Assembly of the landing platform

Further consideration should also be given to the following and their implications to groundworks: -

Hard standing for back-up generator	Toilet facilities
Emergency recovery access	Crew rest area
Ticketing booth	Helium storage area (top up)
On-site storage	Passenger access
Telephone/fax line access	Access for wheelchairs

5.2 Extra equipment

The following is not under the scope of supply for the HiFlyer system, but will be necessary for the installation.

- Electrical cable (refer to section 5.5)
  Cable lengths will vary depending on individual site layouts
  Main 3 phase power supply
  Single phase power supply
  3 phase back up generator supply
  Mooring winch power supply and control cables

Pit lighting

Sump pump (size and voltage to suit local conditions and regulations)

4 socket outlets in pit and at edge of platform (for battery chargers, ground fan etc.)

- M16 anchor bolts for mooring winches and landing platform feet.
- Chemical fixing resin for winch locating bolts
- Mounting brackets for ground station and R/C aerial
- Silicon sealant for sealing platform decking
- 2 metre 5-step ladder to access the ballonet, through the ballonet flap
- Lockable key cabinet
- Hand held radios – two way
- Rechargeable torch
- Binoculars (7 x 50)
- Grease gun and grease (spheerol MP3 Castrol – 1 box of 12 cartridges)
- Hydraulic oil, mineral based, 2 litres off
  - COMMA LHM + CODE LHM 1L, part number: CT214PB or equivalent
- Gear box oil Castrol Alpha SP320 – 5 litres off
- Diesel engine oil for generator 10w/ 4D API – C or D or E or F, 5 litres off

5.3 Concrete

The figure below shows the basic site layout.

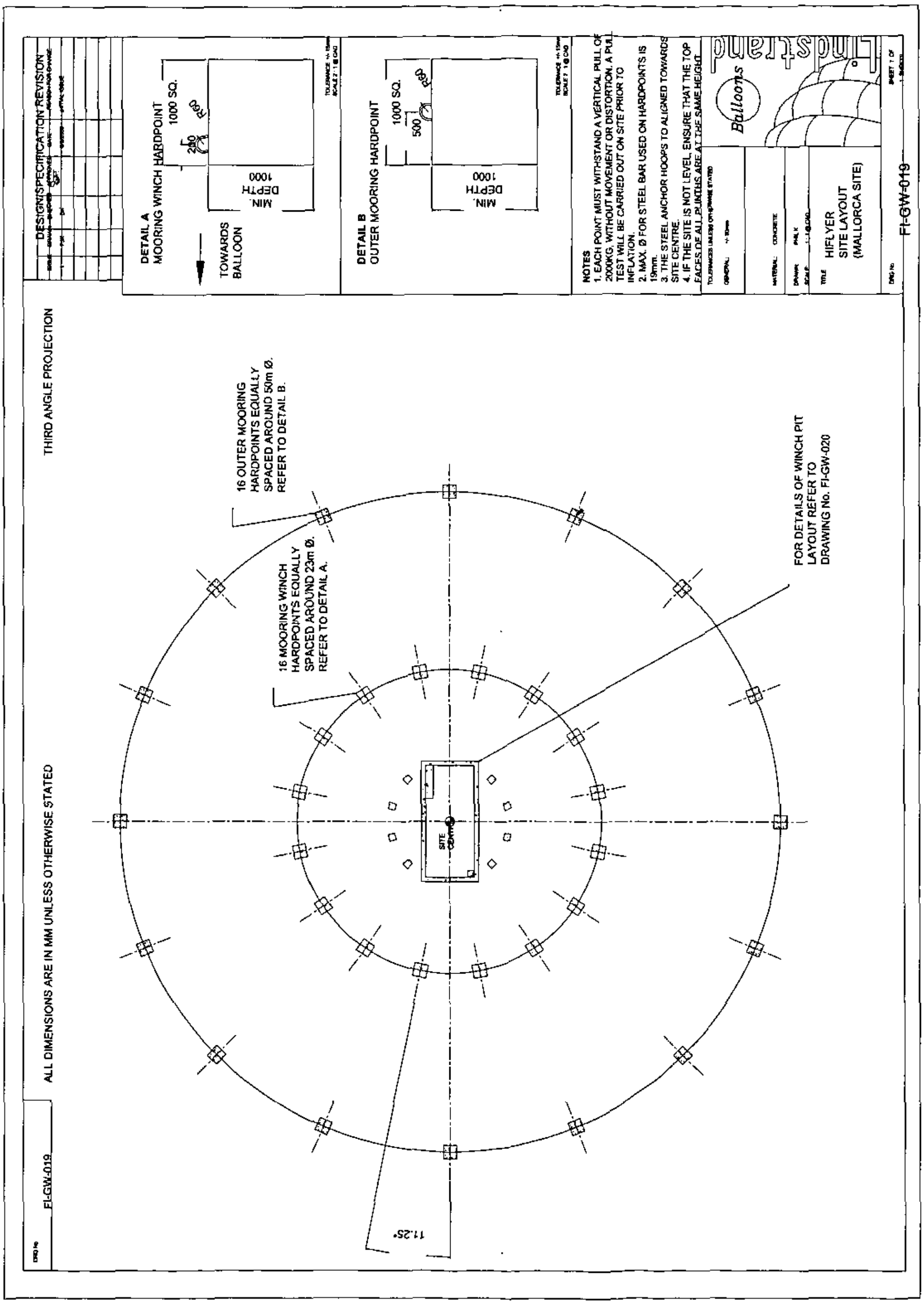


Figure 2 General site layout

5.3.1 Winch pit

The balloon winch is built into a standard 6.1m (20ft) ISO container for ease of transport. In some cases however, it may be necessary to have the winch crated or boxed for shipment, if the container is not required on site. The *winch support frame is bolted into the concrete below and secured* by 14 M24 bolts supplied. These bolts need to be anchored with resin (Epoxy resin which can be obtained from any good local building suppliers). The following type of Epoxy resin has been used at various sites:

Chemset® Resin Systems
Ramset House
Galleymead Road
Colnbrook
Slough
Berkshire SL3 0EN
UK

Tel: +44 1753 682277
Export: +44 1753 732320

or HILTI
internet access: www.hilti.com (global distributors)

Figure 3 shows the winch pit civil works

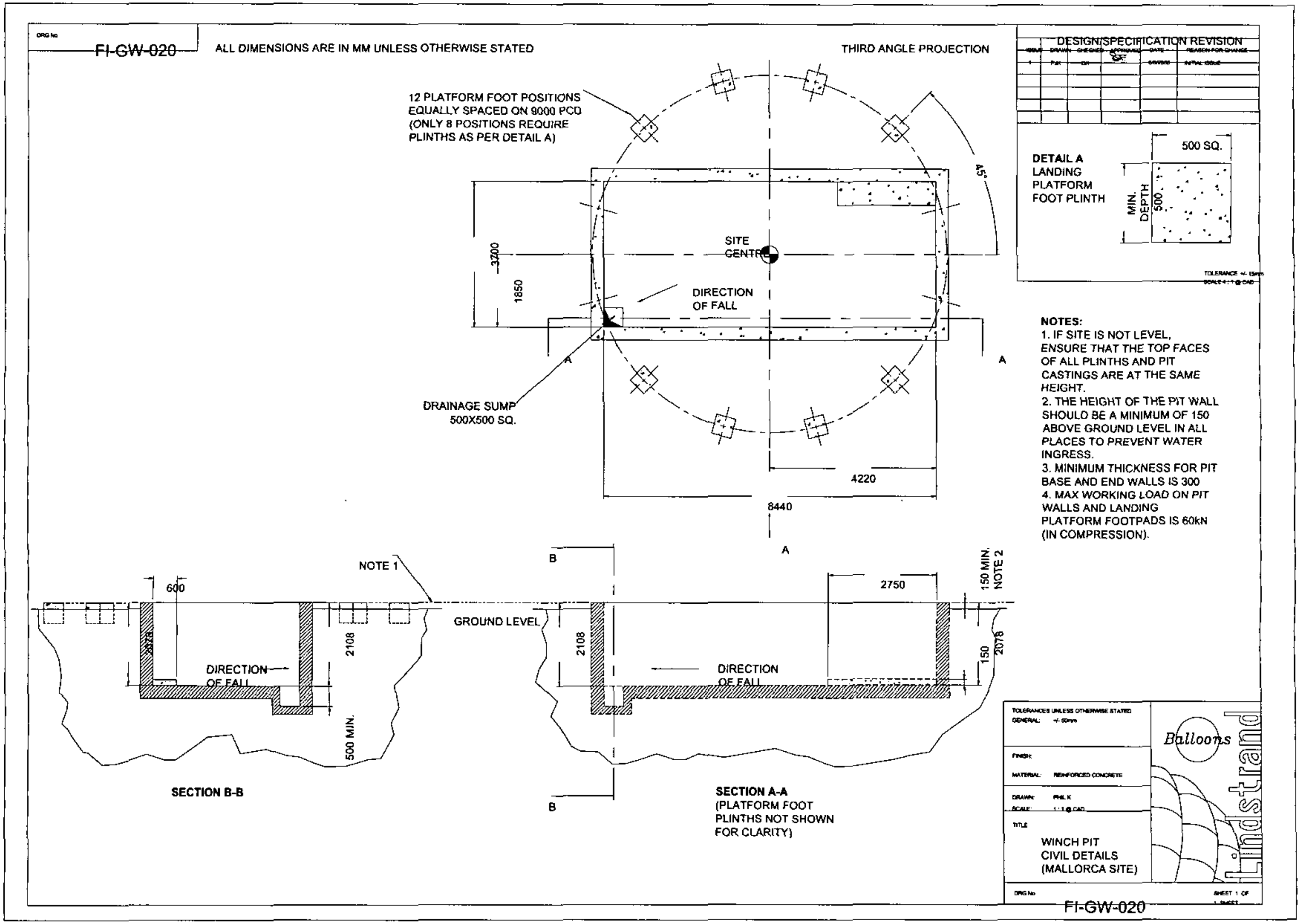


Figure 3 Winch pit civil works

The winch pit should be completed as shown above. The base of the pit should be suitable for drilling and resin anchoring 14 of M24 bolts. The hole diameter and depth should be in accordance with resin manufacturer's recommendations (the customer should liase with the consulting civil engineer).

The pit base should have a slight slope of approximately 30mm down towards the end where the sump is located. Rainwater will then drain towards the sump pump

NOTE: The manufacturer's recommended curing time for the concrete must not be compromised

5.3.2 Landing Platform foot pads

The landing platform is a metal-framed wooden deck, which is supplied with the winch and is supported in the centre by 'I' beams (not supplied by LBL) across the pit walls and at the outer extremities by metal legs supported on pre-cast concrete pads. The deck forms part of the low mooring system and is subjected to both compressive and tensile loads. Care should be taken to ensure the concrete supports are capable of sustaining a tensile force of 500Kg (1100lbs). The deck is normally set 610mm (24") above ground level (this height is set by the length of the legs on the decking frame and the depth of the pit) but the height may be varied if there are specific site reasons for doing so. However, this should be specified to Lindstrand Balloons Ltd at the point of order.

The actual size of the leg support pads is dependent on the nature of the site. The 12 feet are each 250mm (10") square and are drilled for bolting down using 4 off M12 bolts (not supplied). The decking feet form a load bearing part of the balloon low mooring system and should be capable of withstanding 500Kg (1100lbs) in both compression and tension.

5.3.3 Mooring winch hardpoints

Supplied with the main winch are 16 small mooring winches and isolator boxes, which are installed around the balloon on a 23m (75ft) diameter circle. Each winch is mounted on a concrete block. These winches are used for mooring the balloon.

Mooring winches are ideally 1 metre above ground level. It is better for all of them to be at the same level for operational purposes. But this is not absolute.

These should be generally as shown in Detail A of Figure 2. It is not essential to use the exact dimensions but the pad must be capable of sustaining a vertical pull of 3,000kg (6,600lbs).

The anchor hoops may be cast into the concrete block or bolted to it - the whole assembly, however, must be capable of withstanding the test load.

5.3.4 Outer Mooring Hard Points.

To further stabilise the balloon, ropes are led to 16 anchor hard points installed on a 50m (164ft) circle. These hard points are offset from the mooring winch mounting blocks.

They should be generally as shown in Detail B of Figure 2. The anchor hoops may be cast into the concrete block or bolted to it - the whole assembly, however, must be capable of withstanding a vertical pull of 3,000kg.

The blocks must be sunken into the ground.

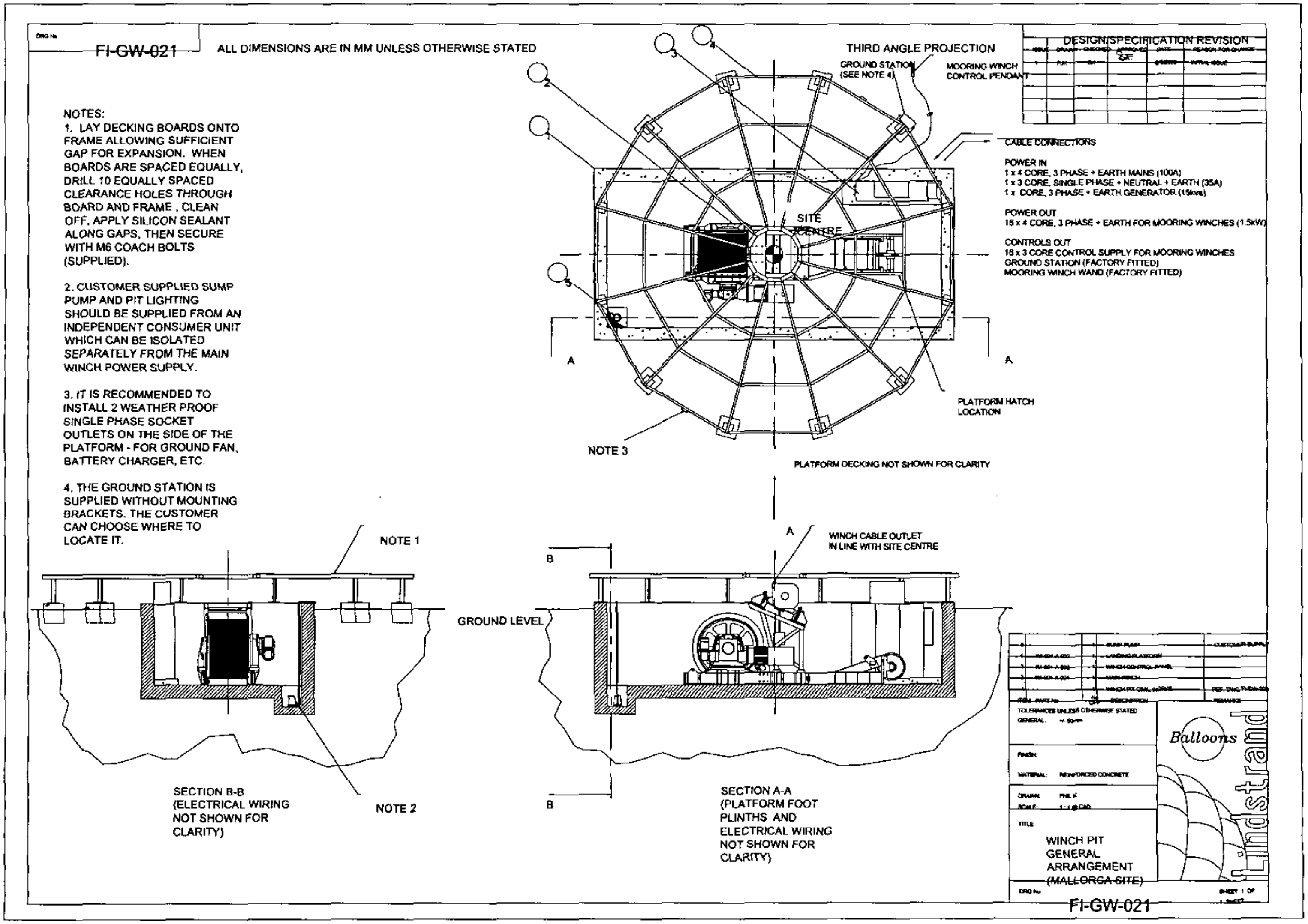


Figure 4 Winch pit general layout

5.4.1 Installation of the main winch

NOTE: *The installation of the main winch will be supervised by LBL and will require 4-5 days depending on weather and the skill of the subcontract manpower.*

Refer to Figure 5

The installation requires a crane capable of lifting 10 tonnes and lowering it under control at a radius of approx. 3m (10ft). Note the ground may have been disturbed during the site civil works, and care should be taken when positioning the crane outriggers.

At least 5 people will be required to assist in the positioning of the winch as it is lowered down.

Once the winch has been lowered into position, the 14 foundation bolt positions should be identified and marked using the long metal spike provided.

Specifically this can be achieved by offering the spike through the location channels and then hammering the spike to mark the concrete underneath.

Remove the winch from the pit and check that all holes can be located. If this is difficult, they should be re-marked using tags or paint.

The M24 studding and nuts are supplied with the system, but the chemical anchoring resin should be bought locally under the instruction of the consulting engineer.

Operators can then begin to drill the holes for the foundation bolts. These holes should be sized according to the tolerance specified by the resin manufacturer.

Note: If the chemical resin is not applied in the correct manner, it will not sustain the pull of the foundation bolts and the whole of the above process will have to be repeated. It is the contractors' responsibility to use the resin in accordance with the manufacturer's instructions.

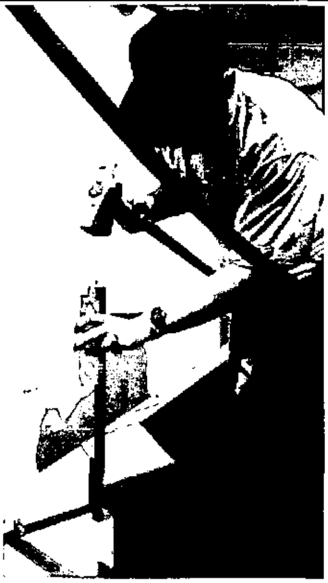
 Lower winch in pit and mark hole locations in concrete using spike	 Lift winch back out of pit and drill holes in concrete
 Locate mounting bolts in holes and fix using resin	 When resin is cured and has been tested (see text), protect the bolts with 25 mm id plastic tube.
 Lower the winch back into pit guiding it onto the bolts. Tighten nuts to specified torque and trim down bolt excess.	

Figure 5 Installation of the main winch.

Once the resin (not supplied) has been allowed to set for the recommended period, a physical pull test up to 1 tonne should be made using the crane on-site, to ensure the resin has set. If the pull test is successful, the winch can be located onto the screwed bar with the aid of plastic tube which is not supplied with the system. This tube is used to guide the winch onto the foundation bolts. Once the winch has been located, the crane can be disconnected, and using the nuts and washers supplied, the frame can be torqued down.

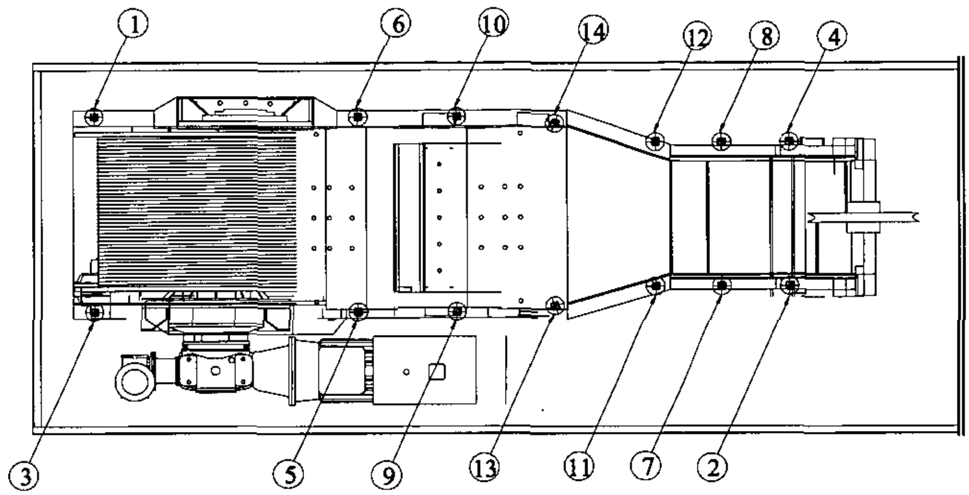


Figure 6 Bolting down sequence for main winch

Due to the large area of the winch system and the significant compressive force of the M24 bolts, the pattern shown above should be used when torquing down the nuts. Once the nuts have started to 'pull', move to each bolt in turn and tighten by one full revolution until the required torque of 325 Nm is reached.

5.4.2 Location and mounting of the mooring winches

The 16 mooring winches are bolted to the concrete bases in alignment with the centre of the main winch system. They are secured using 4 off M16 ground bolts (not supplied).

The holes for the grounding bolts can be marked-off and drilled from the base of the mooring winch, or can be measured and drilled using the sketches (Refer to Appendix C for mooring winch dimensions).

The ground bolts, when correctly fitted, are capable of sustaining the full 3,000kg tension that can be generated by each mooring block, which will be pull tested by the crane to check correct installation.

Due to differing site layouts and electrical regulations, the mooring winch isolator boxes are supplied loose, and will require a suitable mounting position. It is recommended that local electrical regulations are consulted regarding the location of the isolator boxes.

Note: The mounting method should be designed to ensure that the mooring ropes cannot be trapped or snagged on the box or the mountings.

The position, orientation and bolt positions for the mooring winches are shown below. Each mooring winch requires 4 off M16 ground bolts.

Note: chemical anchoring (Resin supplied locally) can also be used for the winch mooring system.

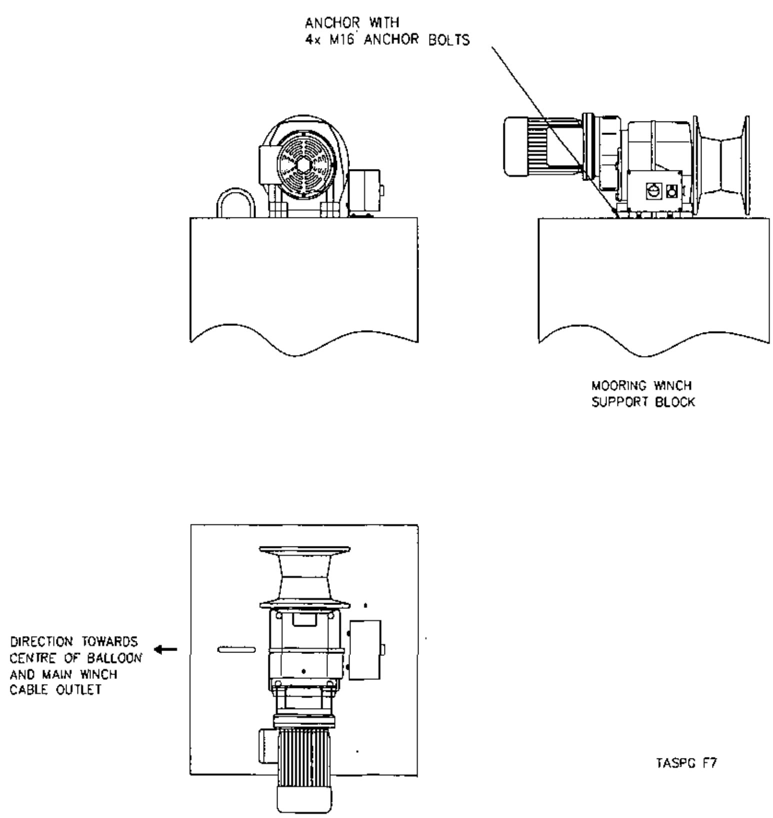


Figure 7 Mounting of mooring winches

5.5 Electrical

All electrical work should be carried out by a qualified electrician and is the sole responsibility of the client.

No attempt should be made to power up the system until an LBL representative is on site.

5.5.1 Power supply – Mains or Generator?

A mains electricity supply is the preferred method of delivering power to the system.

We do not recommend the use of a generator for use during normal operation because of difficulties involved in using a generator power supply for an inverter controlled system.

NOTE: the back up generator does not use the main motor and inverter.

The generator must be capable of supporting a harmonic rich, non linear load such as those presented by an inverter. One particular consequence of these harmonic currents is the possibility of over-heating of the generator damper winding.

If the use of a generator cannot be avoided then the key advice is to liase closely with the generator supplier at an early stage of the project.

One technical report has indicated that the generator should be sized at over three times that of the required mains supply to avoid the possibility of burning out the generator damper winding (i.e. > 300amp supply).

The minimum size of generator recommended is 270 KVA.

If a generator is used it will be required for an LBL engineer to check the inverter has been set up correctly and recalibrate it should you go back on main power at a later date.

Please inform Lindstrand Balloons at point of order, if you propose to use a generator.

5.5.2 Main power supply

Typical cable size: 50mm depending on length cross sectional area (consult with local regulations)
1 x 4 core, 3 phase + earth mains (380 – 440 volts, 100A).

Supply should be fed from 100A rated breaker in sub-station, the cable size will depend on the length of the cable run. The supply should be connected to the main isolator on the right had door of the control panel.

It will be necessary to drill a suitable hole at the base of the cabinet and fit a gland. The cable should then be routed up to the isolator and connected using suitable crimped terminations. The cable should be buried at least 600mm (2ft). (Warning tape should be laid 200mm above the cables). Consult with local regulations.

5.5.3 Single phase power

1 x 3 core, single phase + neutral + earth (35A)

This extra power supply is necessary for lights, sump pump (not supplied by LBL), battery charger, internal illumination (if ordered), leaf blower if supplied (for low mooring airbags). The consumer unit must be able to be isolated separately from the main system, so that the sump pump etc. can still operate with the main system off. It is the responsibility of the customer to provide pit lighting, sump pump and socket outlets.

5.5.4 Auxiliary power supply from generator

Typical size cable: 6mm cross sectional area (consult with local regulations)
1 x core, 3 phase + earth for generator (15 kVA)

Sizes: 130 cm L x 80 cm H x 70 cm W
Weight: 400kg

The back up generator which is supplied with the system can be located anywhere on the site. The cable size will depend on the length of the cable run

The 3-phase supply should be fed from the outfeed of the generator to terminals L4, L5 and L6 at the base of the control panel. It will be necessary to drill a suitable hole at the base of the cabinet and fit a gland. The cable should then be routed up to the terminals and connected using suitable crimped terminations

We recommend that the generator has a weather proof cover if it is to be located outside. It must also have a concrete base to be sited on.

5.5.5 *Mooring winches x 16*

Each mooring winch needs a 3 phase power supply and 3 control wires which are all fed from the control cabinet in the winch pit. The cables should be laid and connected as per Figure 9 by a qualified electrician and is **the sole responsibility of the client to arrange.**

Figure 8 shows suggested cable routes. It will be necessary to drill 32 holes in the winch control box and 64 at the winches for the glands.

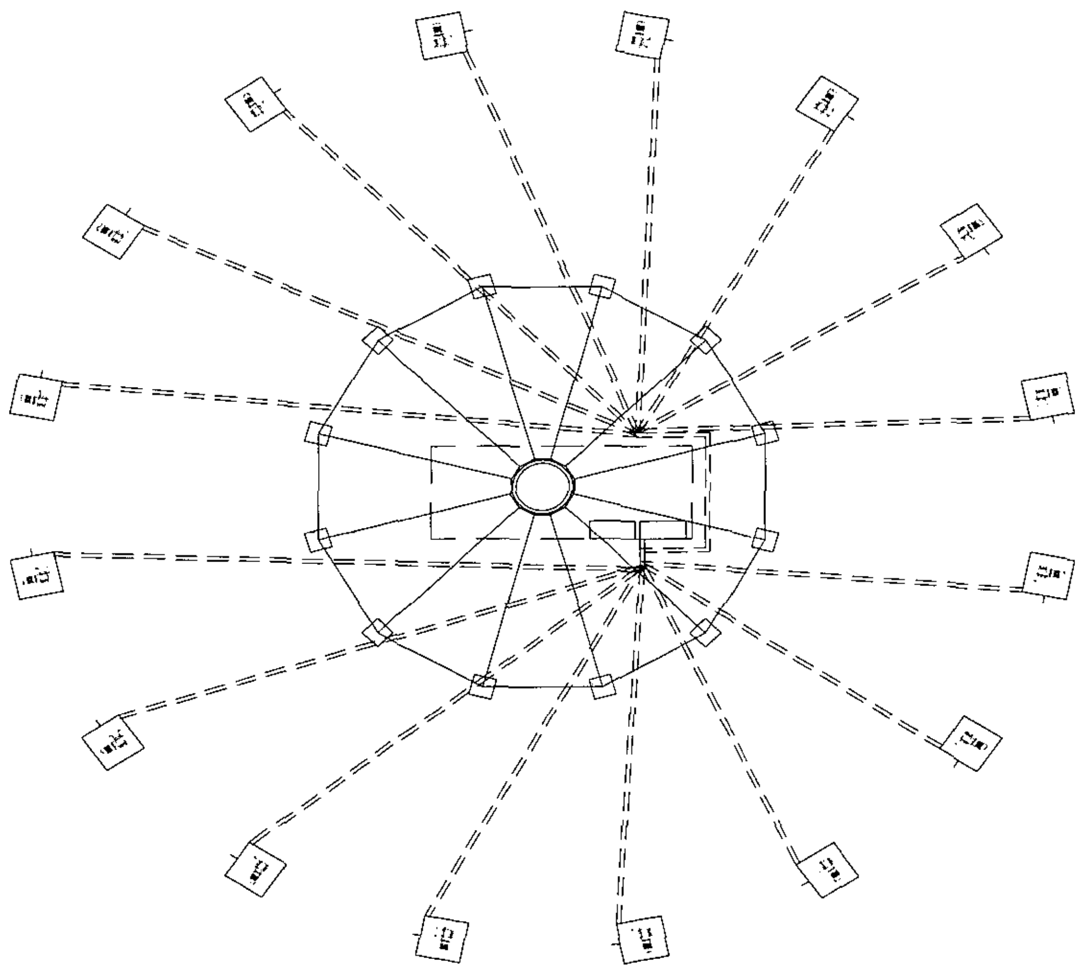


Figure 8 Cable routing suggestions

1 x 4 Core power cable minimum 2.5 mm, maximum 6.0 mm cross sectional area (consult with local regulations)

1 x 3 core signal cable minimum 1.5 mm, maximum 2.5 mm cross sectional area (consult wit local regulations)

Preferably use multicore steel wire armoured PVC coated copper conductors. Metal glands should be used to terminate the cables in the winch control box so all armoured cables are grounded. Plastic glands can be used on the winch isolator boxes. All terminators should be crimped and a suitable colour coding or numbering system should be used throughout the installation

Mooring winch panel connections

The wiring connections to the mooring winches are as follows:

	Three phase power supply				Control supply		
Mooring winch	phase 1	phase 2	phase 3	Earth	common 1	common 2	return
1	U1	V1	W1	Earth	50	51	52
2	U2	V2	W2	Earth	50	51	54
3	U3	V3	W3	Earth	50	51	56
4	U4	V4	W4	Earth	50	51	58
5	U5	V5	W5	Earth	50	51	60
6	U6	V6	W6	Earth	50	51	62
7	U7	V7	W7	Earth	50	51	64
8	U8	V8	W8	Earth	50	51	66
9	U9	V9	W9	Earth	50	51	68
10	U10	V10	W10	Earth	50	51	70
11	U11	V11	W11	Earth	50	51	72
12	U12	V12	W12	Earth	50	51	74
13	U13	V13	W13	Earth	50	51	76
14	U14	V14	W14	Earth	50	51	78
15	U15	V15	W15	Earth	50	51	80
16	U16	V16	W16	Earth	50	51	82

The pre-run wires can now be connected into the mooring winch isolator boxes. The 3-phase supply should be connected into the isolator terminals and the control wires connected into the push button. A link should then be wired from the isolator box to the motor terminal box. It is prudent to follow a set pattern when connecting the 3-phase supply as this will ensure that phase rotation is the same on each winch. The mooring panel can be wired-in as the mooring winches are being connected, with the main 3 phase supply wires connected into the terminal rail at the top of the main panel - i.e. winch 1 wires are connected to U1, V1, W1 and winch 2 to U2, V2, W2 etc.

The common control wires (51 & 52) are connected to the terminal rail which runs vertically up the right hand side of the panel, and the control return wires are connected to the relevant terminal on the same rail (52, 54, 56, 58 through to 82).

WIRING FOR MOORING WINCH 1

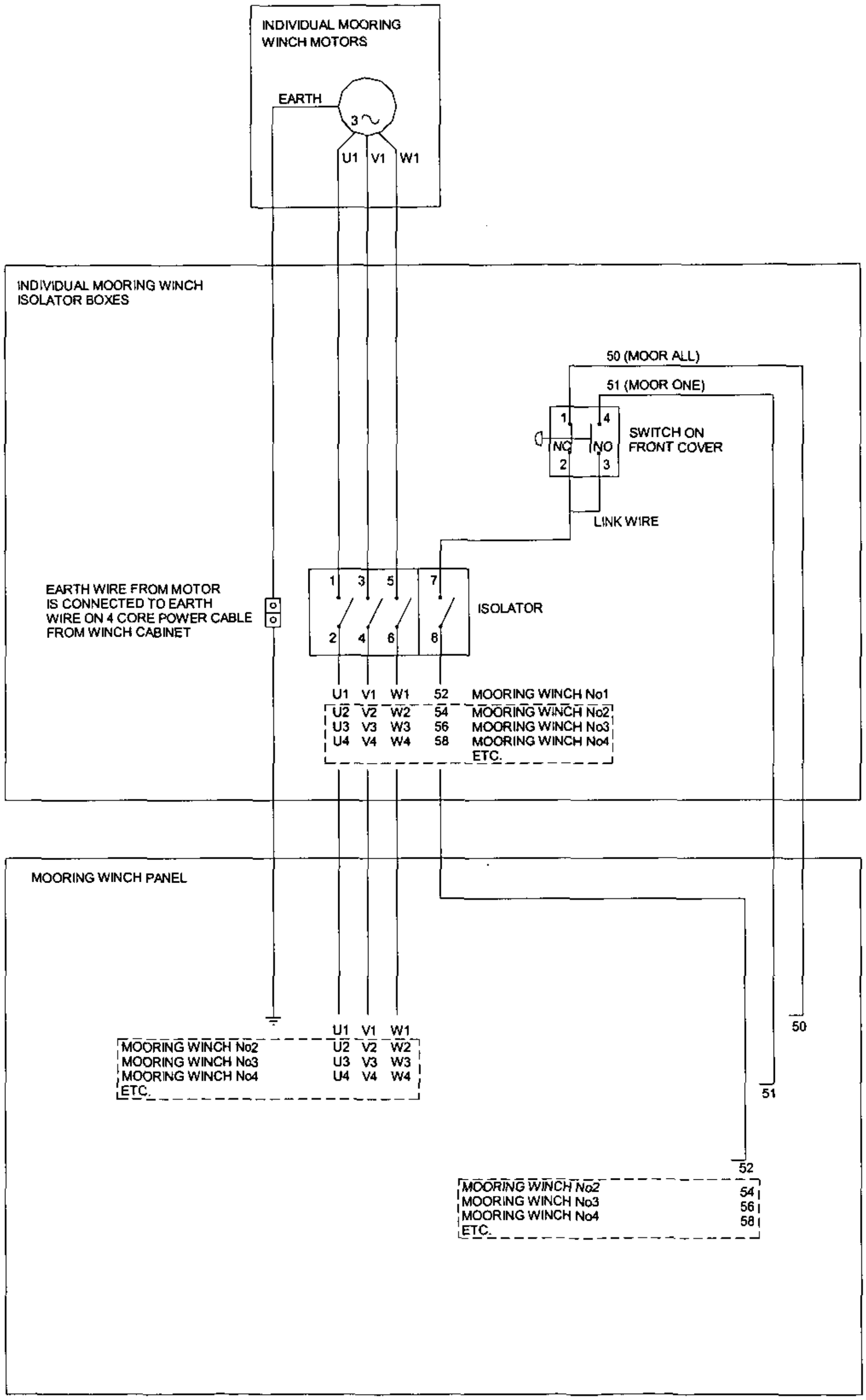


Figure 9 - power supply and controls wiring for mooring winches

5.5.6 Other controls

- Ground station
- Mooring winch wand
- R/C aerial

These are pre-wired in the factory, but the mounting of them is the responsibility of the customer. Figure 4 gives an indication of where these should be located.

5.6 Installation – phase 2

5.6.1 Construction of the landing platform decking.

The decking is of a relatively simple design. However, due to the number of similar parts used in its construction it is advisable to lay the parts out in the correct order on the ground next to the winch. Assembly drawings are provided with the decking and particular attention should be paid to the orientation of the small angle brackets and the main centre ring used to fix each channel to the next.

Fit and level subframe first. Pack so structure is level and weld later.

Note: Prior to fixing the decking support frame in place, the ground operator station, which is pre-wired on SY Cable, should be passed out of the container and taken to roughly the position where it will be fitted. If this is not done it will be necessary to disconnect the wiring and pass just the wire over the small gap between the container and frame.

Once the frame has been completed the boards can be trial laid starting with the innermost boards and working outwards. If large gaps (more than 10mm) are present, this would indicate that the decking has been constructed with the angle brackets the wrong way round. If smaller gaps are present, it may be possible to reduce these by slackening the bolts holding the decking and taking up any slack in the boltholes. This will effectively reduce (or increase) the size of the decking frame.

Due to the number of boards and the accumulative build up of errors, it is inevitable that slight gaps between some of the boards will result. These gaps should be distributed around the decking so that there is not one large gap in any one place.

Once the boards are in place they can be fixed into position using the screws provided. Again, start with the innermost board by removing it and applying silicone sealant (black or brown in colour) to the surface on which the board mounts and also in the gaps between each board. Replace the board and pilot drill through the board and decking frame, then secure using the screws. Due to the number of screws which need to be applied it is strongly recommended that a battery powered screwdriver of a good quality is obtained.

Once all boards are located and fixed into position another run of silicone sealant should be made along the gaps. This will aid in the waterproofing of the deck and improve the visual appearance. If possible, the boards should be mounted so that the slope is away from the central hole, this should prevent excessive surface water draining into the winch pit

When the decking has been constructed and the boards secured the feet can be bolted to the concrete bases with 4 off M12 ground bolts (not supplied).

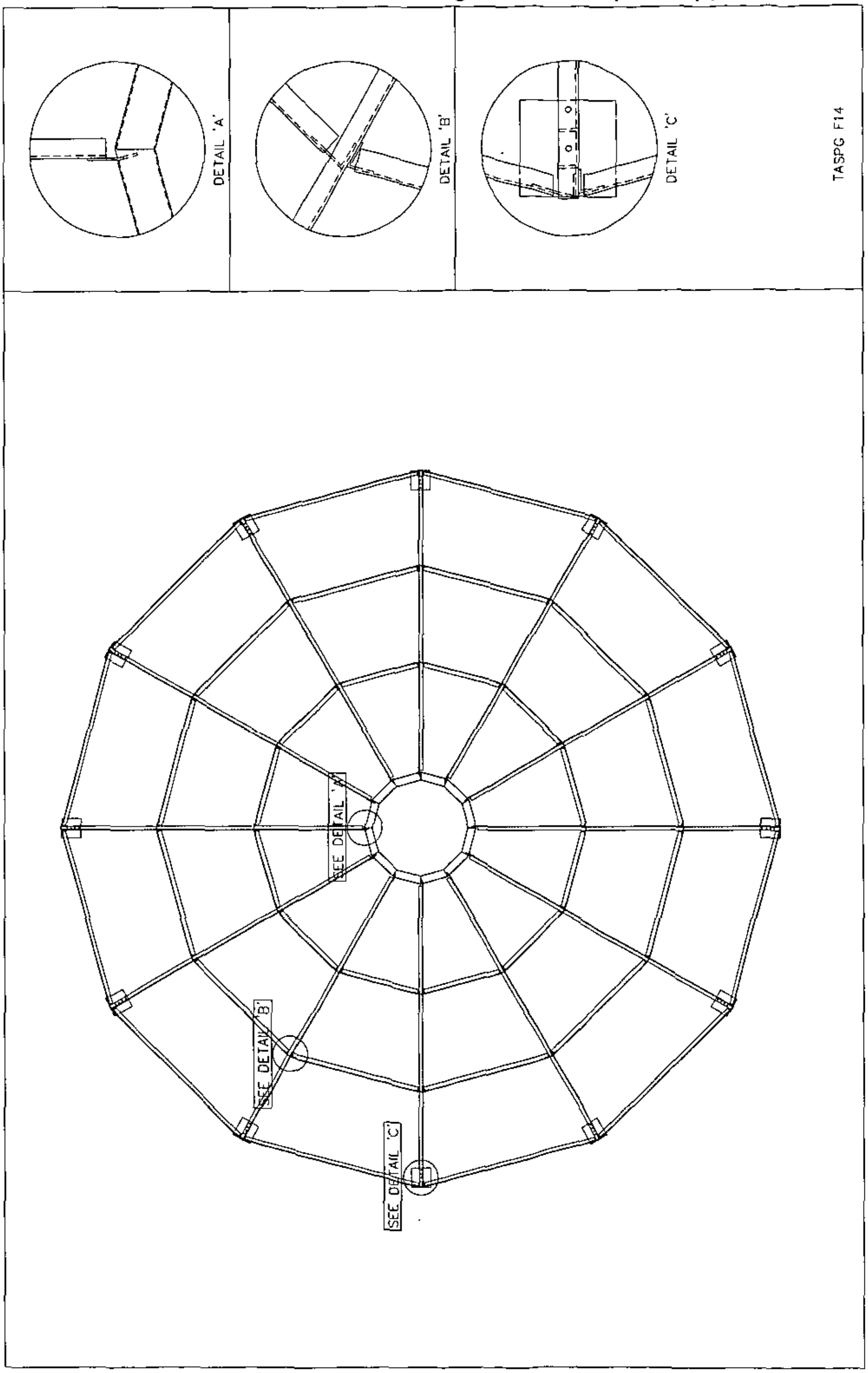


Figure 10 - Landing platform decking frame assembly

6. INFLATION

NOTE: The inflation procedure will be supervised by LBL.

Once the installation has been completed and the mooring system has been tested for correct functionality, Lindstrand Balloons Ltd will commence with the inflation, which will, of course, be subject to the weather. The inflation normally takes place overnight during calm or near calm conditions.

6.1 General Requirements:

6.1.1 Training

Lindstrand Balloons will undertake all staff training to a competent level for your crew for safe operation of the system. There is the need to undertake a written test for all operators. There are two levels – level 1 and level 2. A certificate is issued at the end of successful training.

A training manual will be issued for both Level 1 and Level 2 operators.

6.1.2 Hotel Accommodation

Single rooms for 7 people should be arranged in a hotel (4* standard or equivalent) near to the site, preferably within walking distance. If the hotel is located more than 10 minutes walking from the site then private transport must be arranged for the installation team, i.e. hire cars.

Anticipated Duration on site (Subject to weather and progress on site)

Lindstrand Balloons		*David Brown (for commissioning of winch system)*	
1 Launchmaster	10 days	1 design engineer	3 days
3 Site Engineers	5 days	1 electrical engineer	3 days
1 Staff trainer	14 days		

These times are approximate.

There should be onsite conveniences, i.e. toilets, for use by the crew, as well as a suitable crew room such as an office. This is required for storage of equipment, leaving personal belonging while working on site, and for meal/ refreshment breaks.

6.1.3 Telephone / fax

A telephone line should be installed on site for use by the installation crew, with fax and telephone available.

6.1.4 Car Hire

Contact names and numbers for car hire, if required.

6.1.5 VHF radios

We recommend the use of VHF radios during installation / inflation of winch and envelope, as well as for the operation of the balloon rides.

6.1.6 Vehicle access to site

Access will be required for the helium tanker and crane.

6.1.7 Storage

A lockable storage facility for tools and equipment must be available on site.

6.2 Envelope inflation checklist

The following must be available on site prior to inflation

6.2.1 Helium

6,000 cubic metres (7,177 cubic yards) of high purity helium (99.999%) in the form of compressed gas is required on site for the duration of the inflation. If liquid helium is to be used, extra equipment will be required – this is usually supplied by the helium provider, and is the responsibility of the client. Lindstrand Balloons are not responsible for this.

Please inform Lindstrand Balloons at least three weeks before the inflation date, of whether the helium will be delivered in compressed gas or liquid form.

We will also need to know the type of hose fitting on the helium tanker. We generally use one of the following:

7/8" POL female right-hand
Linde Gas 5/8" BSP bull nose right-hand
3/4 " male NPT right-hand
Air Products BS3 right-hand
Iwatani Japan – PT special adapter
3/4 inch JIC male connections

Flow rate required from helium tankers is 1500 cubic meters per hour minimum.

There will be a regular requirement for 'top up' of helium. It is appropriate to initiate the supply at this stage. We recommend keeping 160 cubic metres (7,000 cu ft) on site for this purpose. This is equivalent to a 'titan' of helium.

Refer to Appendix B - Helium procurement

6.2.2 Crane

An "all terrain" type crane with a main boom length of at least 35 metres (115 ft) and maximum radius of at least 25 metres (82ft) is essential. The crane should be supplied with a man cage and driver for the duration of the inflation (minimum 24hrs).

The crane needs to be capable of lifting a 12 tonne, 6.1m (20 ft) open top container at a 3 metre (10ft) radius.

The crane needs to load test the main winch to 8 tonnes. Load test all mooring winches to 3 tonnes each.

6.2.3 Lights

Portable lighting (usually in the form of a self-contained light with generator unit) will be required for overnight inflation. A minimum of 6 x 500W halogen lights are required.

6.2.4 Crew

In addition to LBL personnel, 8 extra people will be required for the duration (16 - 18 hours). It should be noted that these people must be motivated and physically fit to actively participate in the inflation.

We would recommend your balloon operators to attend the inflation as it is a useful training / familiarity exercise.

6.2.5 Weather forecasts

A detailed daily local meteorological report will be required to identity the inflation weather window when appropriate. Lindstrand Balloons also require detailed weather history along with the microclimate data on the area around the HiFlyer site.

We recommend met reports be faxed or e-mailed over to us one week before our on site visit. This will help to familiarise us with local weather patterns.

The installation of a local weather station is recommended.

6.2.6 Amenities

Due to the lengthy nature of the balloon inflation, and the importance of keeping personnel on site for the duration, it is beneficial for food and drink to be readily available.

It will be advantageous to have easy access to toilets i.e. to arrange portable ones to be on site or obtain permission to use a local hotel facility.

6.2.7 Power

It is imperative that the local electricity supply company has the mains electrical power on site before the arrival of the winch and envelope installation team, in order to avoid any unnecessary costs or delays

When all these factors are in place, Lindstrand Balloons can proceed with inflation (subject to the weather), commissioning and training.

6.3 Penalty fee

Please note the LBL purchase contract (clause 8.6) provides provision for a daily penalty fee of £2,000 to be paid by the customer for each and every day the Lindstrand (DB) crew cannot work on site for reasons beyond their control (excluding reasons of *force majure* or weather).

NOTE: IF IN DOUBT, PLEASE ASK BEFORE WE ARRIVE ON SITE

APPENDIX A – INFLATION GUIDE

All timings are approximate

Day 1

No.1 crate/ container arrives with HiFlyer winch
No. 2 container arrives with decking frame and panels, mooring winches and back up generator.
No. 3 container arrives with gondola, valves and envelope.

Crane must be on site ready to unload containers and lower winch into winch pit. Mark off holes for winch bolts then cranes remove winch from pit.

Drill winch bolt holes
Epoxy resin bolts into place. Leave over night to set.
Position mooring winches.
Start to assemble gondola.
Position generator
Weather update and forecast

Note: Site personnel require one crane all day.

Day 2

Lower winch into pit with crane and bolt down.

Start on electrical supply to main winch and mooring winches in pit. Wire up back up generator.

Start to assemble decking. Place ground control station into position and mooring winch pendant controller. Drill off mooring winches and isolator box (supplied by LBL).

Weather update and forecast

Note: Site personnel require one crane morning

Day 3

Fix 16 mooring winches to concrete blocks and 16 mooring winch control boxes. Start on electrical supply to mooring winches.

Tighten up galvanised structure for decking and assemble decking boards starting with innermost decking boards first.

Finish gondola assembly.
Weather update and forecast

Day 4	Finish off electrical supply to mooring winches and test Check main winch wiring is completed and test Check back up generator and test All decking to be completed Test gondola control box and valves Weather update and forecast
Note:	**The crane will need to be onsite at 16:00**
Day 5	Test main winch cable to 8 tonne using crane/load cell Test all 16 mooring winches and 16 outer mooring points to 2 tonne each Safety briefing for crew for inflation and weather update (8 crew plus LBL staff) Layout plastic ground sheets Position envelope with crane on platform Layout envelope on platform Attach gas valve to envelope Attach artwork banners if applicable Attach fill hoses to monsun valves / bulk helium tanker supply Elevate net with crane over envelope Lower net into position over envelope Fit helium valve to envelope Attach gas valve to net Elevate gas valve slightly with crane Attach net to 16 low mooring winches Attach electrical wiring loom to net Connect up control box and test helium valve Purge helium through fill hoses and check helium purity Purge helium through envelope, close valve Ready to inflate – refreshment break
21:00	Gas on weather permitting Elevate valve with crane as necessary during inflation Release crane as appropriate and continue fill Continue to attach loom to net throughout the fill Allow balloon to rise on mooring winches to fit PRV/ fan/ top up hose Fit electrical supply to ballonet fan
01:00	Stop the fill and leave attachments connected Elevate envelope Remove plastic ground sheets Move gondola into position underneath envelope Attach gondola ring to envelope and main winch Settle envelope down on the gondola and low moor securely Continue to attach loom to net Attach loom to gondola and control box

Complete top up and remove helium fill hoses
Using man basket on crane, climb to valve plate on top of envelope
Install lighting system if applicable
Check helium purity and test for leaks around helium valve area
Install lightning rod and anemometer
Check balloon is low moored
Test systems

05:00 Inflation complete

NOTE: The above schedule for inflation is approximate and heavily dependent on favourable weather conditions and the correct flow rate of helium supplied

APPENDIX B - HELIUM PROCUREMENT

Filename: EG-GEN-C-015
Date: 02.07.98
Written: S Forse

TITLE: HELIUM PROCUREMENT FOR HI FLYERS

INTRODUCTION

It is of assistance to provide HiFlyer clients with as much information as possible about helium for the HiFlyers. This is to help them negotiate with helium supply companies for the purchase of the initial helium fill and for subsequent top-up.

1. Quantity

We specify that a minimum of 6,000 m^3 (7,177 cubic yards) is available for the initial fill of the HiFlyer. This can be supplied in a variety of different cylinder types, but normally for this quantity, it will be contained within long cylinders mounted on articulated lorry trailers. Two trailers are normally necessary, but sometimes three trailers are required. It is important that the type of cylinders used are established and that this information is available during the inflation (see Flow Rate Measurement).

Another consideration when discussing delivered quantities with a gas supplier, is over-supply. It is rare to find a supplier who can provide exactly 6,000 m^3 to the site for inflation. Consequently, more helium is shipped to the site than is necessary. It is best to have an agreed "sale or return" policy with the gas supplier, so that unused helium is returned and not charged for.

2. Measurement of Helium Quantity

Following on from the above "sale or return" issues, the methods used to measure the quantities of helium are of interest. Measurement is achieved by utilising Boyles Law which states that if the temperature remains constant, then the volume that an ideal gas occupies is inversely proportional to the pressure. This comes down to the following equation:

$$P_1V_1 = P_2V_2$$

Where:

- P_1 = Gas pressure in high pressure cylinders
- V_1 = Volume of the high pressure cylinder
- P_2 = Atmospheric pressure
- V_2 = Volume the gas occupies in the balloon

So for example, if one gas cylinder has a volume of 10 m^3 and the gas is at a pressure of 200 bar, then when this gas is put into the balloon it will occupy the following volume:

P_1 = 200 bar V_1 = 10 m^3

P_2 = 1 bar (atmospheric pressure)

$$\Rightarrow V_2 = \frac{P_1 V_1}{P_2} \Rightarrow V_2 = \frac{200 \times 10}{1} = 2000 \text{ m}^3$$

Consequently, when the helium arrives on site it is important to establish the pressure of the gas in each cylinder and the volume of the cylinder. This procedure should be undertaken with the helium suppliers' representative and the delivered amounts agreed.

Similarly, once the inflation has been completed, the same process should be followed to establish how much helium is to be returned. The used amount is then the difference between the two amounts and this is what we will be charged for.

It should be noted that this procedure should be followed for any gas supplied, whether for initial fill or for subsequent top-ups.

For the initial inflation, Lindstrand staff will be making the above calculations and will pass this information to the client.

3. Helium Quality

Helium is available commercially to many different levels of purity. As with most things, the higher the purity the greater the cost. The recommended purity level is 99.995% pure helium. This is also sometimes called four 9-5 helium, which refers to "four" nines in the number. Using less pure gas reduces the free lift of the balloon. This will have an adverse effect on the maximum number of passengers that may be carried.

Be careful when discussing helium quality with suppliers, because one of the commercial helium grades is called "balloon gas". This is normally only 98% pure and is used for filling toy latex/mylar balloons.

4. Flow Rate

We require a minimum flow rate of helium of 1,500 m^3 per hour. This results in an inflation time (gas on period) of approximately four hours. If the helium is being supplied as a high pressure gas, then this is not a problem (see Type of Helium).

If lower flow rates are to be considered, then Lindstrand Balloons must be consulted in advance. Slow flow rates increase the inflation time, which is the period when the balloon is most vulnerable to deteriorating weather.

5. Type of Helium

As already mentioned, high pressure gaseous helium is strongly recommended.

The other form of supply is in the liquid helium form. The helium is pressurised and cooled so that it liquefies. Consequently, when it is released from its' container, it has to first be converted into a gas. This requires a lot of heat from the atmosphere and this process takes time.

The gas suppliers are capable of providing the heat exchanger equipment, but this must be large enough so that the helium is heated fast enough such that the 1,500 m^3 / hour flow rate is maintained. In addition, the minimum helium gas temperature once the helium exits the heat exchanger is 0°C.

6. Helium Connection

Lindstrand Balloons require written confirmation of the type of connection that the gas supplier will provide on the end of the high pressure hoses. Lindstrand Balloons will be supplying all required expansion chambers and low pressure filling hoses which attach to the balloon. The usual connections are either a ¾" JIC M, or a right hand thread bullnose connector with a $^7/_8$" F BSP thread. Basically, we do not mind what the connector is as long as we receive confirmation, preferably in the form of a drawing, before the inflation team arrive on site.

7. Personnel On Site

It is normally a good idea to have at least one knowledgeable member of staff from the gas supplier on-site for the beginning and end of the inflation. This is to assist in the measurement of helium used. Lindstrand staff are perfectly capable of controlling the flow of high pressure helium ourselves and normally we prefer to undertake this task as there are periods during the gas-on inflation process which require a good knowledge of balloon inflations in order to control the gas flow.

If liquid helium is to be supplied, then the supplier will have to provide staff to set up and operate the heat exchanger equipment. In this case, the supplier should be informed that the inflation will take approximately 14 hours and this is normally during the night.

If there are any specific local operating permits or licences necessary to operate high pressure gas equipment, then it would be most appropriate for the supplier to provide suitably qualified staff for the initial inflation. However, if this is the case, the client should establish whether it is in their own best interests to obtain such permission for themselves, since there will be a continuing requirement for topping-up with helium during the operational life of the balloon, which they will want to have control over.

8. Period of Notice

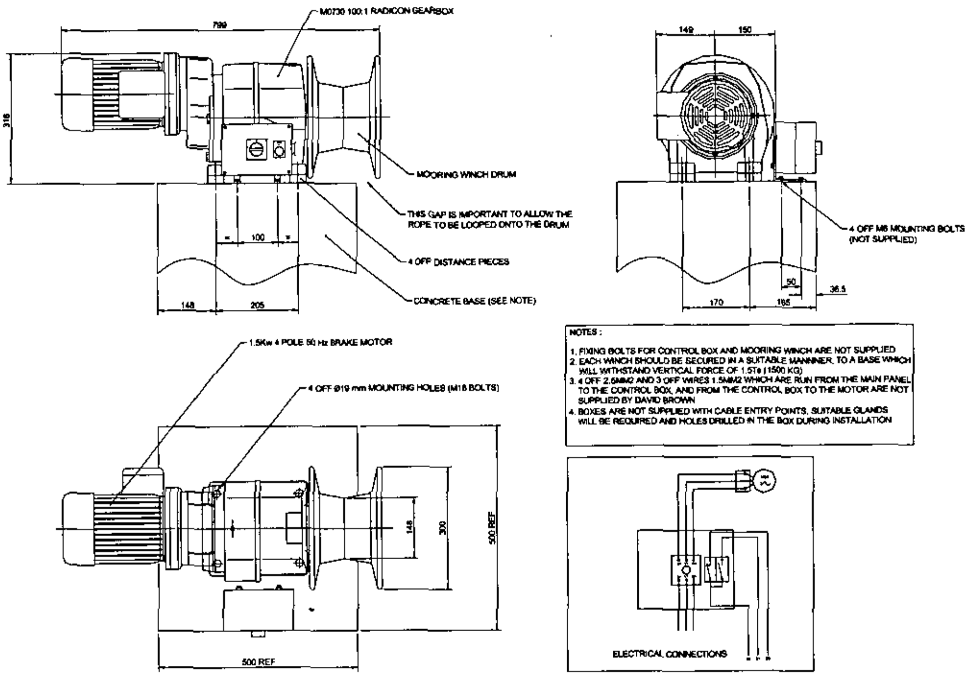
The minimum period of notice should be discussed with the supplier. This is important to establish because it will dictate how long in advance of inflation the weather forecast must be obtained and planned upon.

In most countries, weather forecasts which are longer than 72 hours only have a 50% reliability level. This means that alternative arrangements would have to be made, such as positioning the helium on site prior to an inflation date being decided upon.

9. Site Access and Planning

On some sites with restricted access through security fencing, the order of events needs to be considered. If two articulated lorries cannot gain access at the same time through the gate, it is important that the other required equipment is introduced into the site before the helium tankers arrive, eg cranes, cherry pickers, balloon system delivery, etc. Normally, we find that the helium trailers block the entrance to the site, effectively trapping everything in the site.

APPENDIX C – MOORING WINCH MOUNTING



APPENDIX D – SHIPPING CONTENTS LIST

DESCRIPTION	QUANTITY
NET BALLOON ASSEMBLY	**1**
LOW MOORING AIR BAGS IF SUPPLIED	9
5T RATCHET STRAPS	32
1T RATCHET STRAPS - 2.5m Blue	32
1T RATCHET STRAPS - 3.5m Red	16
WIDE MOUTH KARABINERS	72
2.7mm POLYESTER CORD (500m)	1
4mm POLYESTER CORD - 20m	1
19mm HEAVY DUTY SHOCK CORD - 25m	1
ROPE BAGS	16
CONTROL BOX COVER	1
CORDURA FENDER COVERS	1
LBL TANK STRAPS	10
INTERNAL LIGHTING ACCESS SOCK	1
MANUALS/ DOCUMENTS	**1**
CONTROL BOX	**1**
BATTERY BOX	2
BATTERY CHARGER	1
GROUND FAN ASSEMBLY	1
GROUND FAN CONTROLLER	1
HONDA EM2200 GENERATOR or BATTERY SYSTEM (OPTIONAL)	1
INTERNAL LIGHTING CONTROL BOX (OPTIONAL)	1
LOADSHACKLE	1
LOADSHACKLE SPACER - S/S	1
LOADSHACKLE CABLE	1
BALLONET FAN ASSEMBLY	1
FAN LOOM ASSEMBLY	1
He VALVE PLATE ASSEMBLY	1
MAIN LOOM	1
ANEMOMETER POLE & FIXINGS	1
ANEMOMETER 3 CUP SENSOR	1
LIGHTENING ROD & FIXINGS	1
STROBE LIGHT/COVERS - HeV PLATE	1
NAV. LIGHT/COVERS - HeV PLATE	1
STROBE LIGHT/COVERS - GONDOLA	1
NAV LIGHT/COVERS - GONDOLA	1
16mm CONDUIT	2

20mm CONDUIT	2
SELF AMALGAMATING TAPE	2
INTERNAL LIGHTING WIRING HARNESS	1
ENVELOPE	**1**
ENVELOPE BAG	1
INTERNAL LIGHT POLY KEVLAR CORD (11.5m) – Already installed in envelope	3
INTERNAL LIGHT PATCHES – already installed in envelope	3
GONDOLA ASSEMBLY	**1**
LOADRING ASSEMBLY	1
LOW MOORING FENDER RING	1
ARMAFLEX	8
NON-SLIP FLOOR BOARDS	8
FIRE EXTINGUISHER	1
E2000 305mm BORE DUCTING - 10m	1
DUCTING ATTACHMENT CLIP	2
BALLONET FAN TO DUCTING ATTACHMENT	1
PRV ASSEMBLY	1
INTERNAL LIGHTING SUSPENSION CABLE ASSY	1
INTERNAL LIGHTING BULB CAGE	3
INTERNAL LIGHTING GLASS FIBRE SOCK	3
FILL HOSE & FITTINGS	1
POL MALE (BULL NOSE FITTINGS)	2
3 800 SERIES TEMA FEMALE	1
JUBILEE CLIP	4
LOCKING WIRE	1
s/s 304 WELDING ROD	12
ASSEMBLY KIT - GONDOLA (RS TRAY)	**1**
M6X35 DOMED SHCS	30
M6X60 HEX HEAD	6
M6 WASHER	50
M6 NYLOC	6
M8X15 HEX HEAD	35
M8 WASHER	40
10X3/4 POZI CSK S/TAPPER	70
M8 WING NUT	3
M8X40 SHCS	5

ASSEMBLY KIT - GONDOLA (STEEL BOX)	**1**
M10X75 BOLT	75
M10 NYLOC	75
M10 WASHER	150
GUSSET JOINT PLATE	8
ASSEMBLY KIT - GONDOLA (CRATE)	**1**
CONNICAL STOP (CUT 2 STUDS DOWN 25mm)	17
POLY KEVLAR CORD - FOR PVC PANELS	10
STUD LOCTITE	1
ASSEMBLY KIT - LOADRING	**1**
AN8-30 BOLT	9
AN8-17 BOLT	9
AN310-8 CASTLE NUT	20
AN960-816 WASHER	120
SP60/EG SPLIT PINS	20
SUSPENSION ROLLER	9
SUSPENSION CABLE SPACER	18
19.8mm ROLLER	9
21.8mm ROLLER	1
ASSEMBLY KIT - BALLONET FAN & PRV	**1**
M8 NYLOC	60
M8 WASHER	60
M8X35mm STUD	5
M8 NUT	2
RTV SILICONE SEAL - 80mL	2
ASSEMBLY KIT - He VALVE PLATE	**1**
M8 NYLOC	55
M8 WASHER	55
M8 EYENUT	3
CROWN EYE	23
16mm "P" CLIP	4
10mm "P" CLIP	4
M6X15 BOLT	8
M6 WASHER	8
M6 NYLOC	8
SMALL "R" CLIP	1
INTERNAL LIGHTING ACCESS SOCK	1

LOCTITE SUPERGLUE	1
POLY CORD - 4mm (1.1m LONG)	30
WHITE RTV SEAL - 310ml	1
LOCKWIRE	0.5
INTERNAL LIGHTING CAGE AND LOOM	3
INFLATION AND TOP UP KIT (CRATE)	**1**
DPM POLYTHENE SHEET	12
LARGE CAULKING GUN	1
RTV 102 SEAL - 310mL	1
LEAF BLOWER FOR LOW MOORING AIRBAGS	1
VALVE LIFTING RIG	1
MALE MONSUN BAYONET ADAPTERS	2
2" BORE PVC SUPERFLEX HOSE – 30m	2
DIFFUSERS WITH PRESSURE GAUGE AND VALVE	2
25-30M 1/2" INFLATION HOSES WITH 1/2" BSP M	2
PRESSURE GAUGE - 30PSI	2
HOSE CLIPS - 60mm	14
INFLATION AND TOP UP KIT (BLACK TOOL BOX)	**1**
1/2" T ADAPTER (1/2" BSP M - 1/2" BSP M - 1/2" BSP SWIVEL F/M)	1
1/2" BSP F/M - 1/2" BSP F/M	1
1/2" BSP F/M - 1/4" NPT F/M	2
R/H POL	2
1/2" BSP F/M - 1/2" BSP F/M	2
1/2" BSP M - 1/2" JIC M	2
1/2" JIC F/M - 1/2" JIC F/M	2
1/2" BSP M - 3/4" JIC F/M	2
1/2" DOWTY SEALS	10
TEMA 3800 F/M	1
3/8" BSP M - 1/2" BSP SWIVEL F/M	1
3/8" DOWTY SEALS	3
NONE RETURN VALVE	1
AL. WASHERS 57mm O/D 16mm I/O	2
3/8" BULKHEAD FITTING	1
3/8" GOODRIDGE 90` ELBOW	1
3/8" GOODRIDGE STRAIGHT	1
GOODRIDGE HOSE	1
BOSTIK 3206 - 5L	**1**
BOSTIKURE D200	1
210D FABRIC (HULL)	5

FABRIC (BALLONET) SINGLE COATED NYLON	5
PAINT BRUSH	2
50M 2MM WHITE CORD	1
50M 4 MM WHITE CORD	1
EMPTY BOTTLES	2
LOCKTITE GLUE	1
DECALS	1
SCISSORS (PAIR)	1
GAFFER TAPE	2
MASKING TAPE	1
COLOURED REPAIR TAPE (ROPE MARKING)	8
TOOL BOX	**1**
SPANNERS - 8,10,13,17 mm	2
COMBINATION SPANNERS - 5.5 - 24mm (18)	1
ADJUSTABLE SPANNER – SMALL 4/8	1
ADJUSTABLE SPANNER – LARGE 12"	1
3 " PHILLIPS SCREWDRIVER - 0,1,2	1
3 " POSI SCREWDRIVER - 0,1,2	1
FLAT SCREWDRIVER JEWELERS	1
8 " X 3/16 FLAT SCREWDRIVER ELECTRICIANS	1
3 " FLAT SCREWDRIVER SMALL	1
4 " FLAT SCREWDRIVER MEDIUM	1
FLAT SCREWDRIVER LARGE	1
"RAIL " 3/8 SOCKET SET 5.5-24mm	1
LONGREACH 10, 13 3/8" SOCKET	1
SPEED BRACE - 3/8"	1
OIL FILTER REMOVER (STRAP TYPE)	1
ALLEN KEYS - 1.5 - 10mm	1
PLIERS	1
SIDE CUTTERS	1
12" HACKSAW & BLADES 12,24, & 32 TPI	1
COPPER & HIDE MALLET NO.1	1
ALUMINIUM TORCH AND BATTERIES	1
ROCOL LEAK DETECTOR SPRAY 300ML	1
SILVER "GOOP"	1
85GM SAPPHIRE AQUA-SIL GREASE	1
20GM 406 PRISM CYANDACRYLATE ADHESIVE	1
BOX OF LONG CABLE TIES	1
19MM X 33M BLACK PVC INSULATION TAPE	1
INTERLOCK 9MM TRIMMING KNIFE	1
LIGHTERS	1
MARKER PEN	1
TAPE MEASURE - 3m	1
22 " 5 TRAY CANTILEVER TOOL BOX	1

ASSORTED BIG s/s SPLIT PINS	1

CRATE OR CONTAINER 2

HIFLYER WINCH SYSTEM, COMPLETE.	1

CONTAINER 3

DECKING FRAME AND PANELS:

LARGE 26 MM PLYWOOD PANELS	12
MEDIUM 26 MM PLYWOOD PANELS	11
MEDIUM 26 MM PLYWOOD PANEL, COMPLETE WITH TRAP DOOR	1
SMALL 26 MM PLYWOOD PANELS	12
4" OD TUBE RING, FABRICATED IN 12 SEGMENTS	1
RSA 80 X 60 X 6 X 1020 LONG	11
RSA 80 X 60 X 6 X 1674 LONG	11
RSC 102 X 51 X 2332 LONG	12
RSC 102 X 51 X 3909 LONG	12
RSC 102 X 51 X 6058 LONG	2
RSC 102 X 51 X 2320 LONG	2
SUPPORT LEGS, COMPLETE WITH BASES	12
BRACKETS, 65 X 6 FLAT BENT	36
BRACKETS, 65 X 6 FLAT BENT	36
RSA 80 X 60 X 6 X 1133 LONG	2
RSA 80 X 60 X 6 X 1020 LONG	1
RSA 80 X 60 X 6 X 1674 LONG	1
RSA 80 X 60 X 6 X 580 LONG	2
BRACKETS, RSA 60 X 60 X 6 X 60 LONG	8
M12 BOLTS	316
M12 HEX HEAD SETSCREWS	24
M12 PLAIN WASHERS	304
M12 TAPER WASHERS	72
MOORING WINCHES (1.5 KW, 2 HP)	16
BACK UP GENERATOR (15 KVA)	1

The above list may be subject to change without notice. Please contact Lindstrand Balloons nearer the time of shipment for the current list.

U.S. Department of Transportation
Federal Aviation Administration

Eastern Region
Air Traffic Division

1 Aviation Plaza
Jamaica, NY 11434

July 03, 2001

Sky High of Maryland, L.L.C.
Attn: Mr. Lee Raskin
P.O. Box 60
Brooklandville, MD 21022

Dear Mr. Raskin:

Conditions for Amusement Ride (Similar to a Moored Balloon) operation north of the Inner Harbor, Baltimore, Maryland

410-979-0672
410-864-2996 FAX

Our office has reviewed your letter faxed 17 May 2001. Thank you for informing us of your intent to operate an amusement ride. The type of device is a Lindstrand HiFlyer Tethered Aerostat System. The proponent states the device has been certified as an amusement ride. It is described as a 30-passenger Lindstrand HiFlyer Tethered Aerostat Amusement Ride. The proposal is for the sponsor to operate this amusement ride as a permanent structure, at this location, on a daily basis, (450 feet above ground AGL, 500 feet above sea level, AMSL).

The proponent states that this device has been certified in the United States as an amusement ride, similar to a ferris wheel or a roller coaster. This device is not ever intended for free flight through the air. However this amusement attraction looks like and operates similar to a large gas or hot air balloon. It is secured to the earth by a mooring line on a cable drum. It is intended to go up, using the internal gas for lifting, and down by means of the mooring cable and drum system. The body of the amusement device is like a balloon in appearance. The amusement attraction is approximately 110 feet high, including ropes and gondola and the cable is 400 feet long. This device could penetrate 500 feet into the airspace. To study this device as a building structure similar to a ferris wheel or roller coaster would not give consideration to the potential adverse affect on other users of the airspace. This amusement attraction has been studied similar to a moored balloon operation, which it resembles both in appearance, and operation.

There are several structures in that area at approximately 350 feet AMSL, with a taller structure, less than one half mile west of this site at 650 feet AMSL.

This location will create a tethered viewing platform over-looking the City of Baltimore and the Harbor Area. With the top of the amusement device at approximately 450 feet above the ground, less than 500 feet AMSL. The device would go up and down at some interval, driven by the demand for the amusement ride. It will operate when wind and weather are favorable, and during normal tourist hours, both day and night.

This area is subject to normal aircraft operations over a large city area. At lower altitudes, Police and Media Helicopter operations with some EMS helo activity. At times there is banner towing activity in the area. Transient light aircraft and helicopters overfly this congested area at higher altitudes (Normally more than 1,000 feet AMSL). This site is approximately 200 feet southeast of the Roof Heliport used by Baltimore City Police. This is 3 miles northwest of the Maryland Police Heliport.

The proximity of the Downtown Police Heliport and this site make simultaneous operation of this amusment device and active operations at the heliport imprudent. This device will not be operated when active helicopter operations are being conducted at this rooftop heliport. When notified this amusement device will return to its mooring for the duration of the operation of the heliport. The necessary times, means, and method of notification will be worked out and agreed to, in writing, by the sponsors of this amusement devise and the sponsors of the Downtown heliport, prior to any operation of this Amusement device at this site.

All of these heliports should get individual notification from your coordinator, prior to operation of the amusement device. This notification is in addition to the NOTAM that is required. A review of the proposed activity disclosed that it would not be objectionable in terms of effect on navigable airspace, provided the above factors are considered and it is conducted as described below:

1. That all Regulations, except for those waived, be strictly adhered to, including any industry safety guidelines. That all equipment meets recommended conditions and is maintained and operated in accordance with established criteria.

2. Times of operation are for operation of this amusement device on any given day, seven days per week. Both day and night operations are intended. The body of this amusement attraction (looks like a hot air balloon) is lighted and readily visible. The mooring lines will require obstruction banners any time this device is raised higher than 150 feet above the surface. The mooring line will also have obstruction lighting when operated at night. Please note that the only chance the aviation users of the airspace have, to visually acquire the mooring lines portion of your amusement device, is for

you to properly maintain good marking and lighting devices and practices. It is essential for safe operation that you do so.

The nature of the operation is to operate an amusement attraction (similar to a moored balloon) with attached gondola used as an amusement ride. This device will be connected to the earth by a mooring cable on a cable drum. Any certifications needed for operating an amusement will be obtained by your organization, from appropriate reviewing authority, prior to any operation of this device, This will include any certification which may be required for your amusement device lifting portion with its rigging, gondola and winch equipment. This equipment will be inspected and maintained in accordance with the industry standards. This device is retrievable upon demand, but takes several minutes. The times of operation will be published in Notice to Airmen (NOTAMS) prior to each day's launch.

3. It is agreed for planning purposes that the site north of the Inner Harbor Area, at East Baltimore and President Streets, Baltimore, Maryland, up to 450 feet AGL, 500 feet AMSL is to be used. This site is approximately the BALTIMORE VORTAC, BAL 033° radial at 7.6 NM DME.

4. The clearance from cloud criteria means that you will require a minimum of a 1,000-foot ceiling to operate with three miles visibility. This site is just north of the Class B Surface Area; this is an area used by low flying helicopters and other aircraft. Insure your obstruction marking is readily visible any time you are operating at heights greater than 150 feet above ground level.

5. This site is less than five miles from an airport; the operating height will not exceed 450 feet above the ground.

6. This device is not intended for free flight through the air. No rapid deflation device is required.

7. Advise the Supervisor of the Baltimore International Tower, 410-859-7256, 2 hours before the day's operation, and then again 10 minutes prior to actual operation and immediately upon termination of actual operation.

8. The launch supervisor agrees to terminate such operations immediately at the request of the Air Traffic Supervisor. A contact telephone number at the launch site shall be provided to the Air Traffic Facility prior to any launch. A minimum of a tested, working, cellular device is required. You list Mr. Lee Raskin as the project coordinator, 410-979-0672.

9. In addition, After reviewing the forecast and insuring that a launch is probable, notification will be made to the Leesburg, Virginia Automated Flight Service Station, 800-468-6621 or 703-779-4604/4606, 6 hours before the launch and request the issuance of a Notice to Airmen (NOTAM). A suggested text is as follows:

"An Amusement Attraction similar to a Moored Balloon will be conducted north of the Baltimore Inner Harbor Area, Baltimore, Maryland, at altitudes up to 500 feet above sea level, 450 feet above ground. Location approximately: BALTIMORE VORTAC, BAL 033/7.6.

Latitude 39° 17' 24" Longitude 076° 36' 28"

This letter disposes of the Federal Aviation Administration interest in the matter but should not be construed as superseding or invalidating any existing rules or regulations promulgated by any other federal, state, county, or municipal government, which may be required for this operation.

Sincerely,

Michael J. Sammartino
Manager, Airspace Branch

ROBERT L. EHRLICH, Jr., Governor
MICHAEL S. STEELE, Lt. Governor
JAMES D. FIELDER, Jr., Ph.D., Secretary

Division of Labor and Industry
Robert L. Lawson, Commissioner

DLLR Home Page • http://www.dllr.state.md.us
DLLR E-mail •dli@dllr.state.md.us

Incident Report:

Involving the "Hi Flyer" Balloon

July 17, 2004

Balloon Over Baltimore, Inc.

Baltimore, Maryland

1100 N. Eutaw Street, Room 606
Baltimore, Maryland 21201

DIRECT: 410-767-2241 FAX: 410-767-2986

Contents

Appendices

INCIDENT SYNOPSIS

On July 17, 2004 at approximately 3:45 PM during a routine flight, the helium filled observation balloon operating at the Baltimore Children's Museum, Inc., was subjected to extreme wind bursts. The balloon was forced out of its normal trajectory (northeast) and the balloon's passenger platform (gondola) was pushed almost due north to an acute angle causing it to strike an adjacent building resulting in four of the sixteen passengers requesting medical evaluation.

The wind bursts exerted increased tension on the winch mechanism (see page 9), which tripped an over-speed safety device, shutting the winch system down and applying the main drum brake. It took operators approximately 90 minutes after the initial alarm and shutdown to recover the balloon.

GENERAL INFORMATION

OWNER INFORMATION

Sky High of Maryland, LLC (Sky High) was the original owner and operator of the "Hi Flyer" a tethered, helium filled observation balloon. In 2001, Sky High began operations of the "Hi Flyer" in conjunction with the Baltimore Children's Museum, Inc. Balloon Over Baltimore, Inc. acquired the "Hi Flyer" on December 31, 2003, and it is still operated in conjunction with Baltimore Children's Museum, Inc. at Port Discovery.

MANUFACTURER INFORMATION

Lindstrand Technologies Ltd. (Lindstrand) is the manufacturer of the "Hi Flyer". Lindstrand, based in England, is run by Per Lindstrand, the man who holds the world balloon altitude record and became famous for his flights with Richard Branson. The Lindstrand team has been building lighter than air vehicles on the same site for almost 21 years. The Lindstrand "Hi Flyer" can carry up to 30 passengers to heights of 500 feet. "Hi Flyers" have operated at sites in Sweden, Spain, England, Zimbabwe, and the United States. Lindstrand reports that "Hi Flyers" have carried millions of passengers.

HISTORY OF BALTIMORE OPERATION

During the planning phase of the "Hi Flyer" installation, Lee Raskin, of Sky High who was working with the Baltimore Development Corporation (BDC), realized that the City of Baltimore did not have regulatory authority over amusement rides. After further inquiry, Raskin determined that the Department of Labor, Licensing and Regulation (DLLR) has regulatory oversight of amusement attractions operating in Maryland. Sky High notified DLLR of its intent to operate an amusement attraction and submitted specific information relative to the ride, along with the manufacturer's literature. Due to the fact that the "Hi Flyer" could be penetrating 500 feet into airspace, Sky High also notified the Federal Aviation Administration (FAA) of its intent to operate. DLLR was responsible for compliance with the Maryland Amusement Ride Safety Law while aviation safety issues were to be addressed by the FAA.

In a July 3, 2001 letter to Raskin, the FAA acknowledged the proposed operation of the tethered balloon, and its close proximity to a police heliport and outlined conditions for its operation. (Appendix B). As one of the FAA's operating conditions, Sky High and the Baltimore City Police Department (BCPD) had to jointly develop operating and notification procedures. The outcome of this requirement was a July 13, 2001 Memorandum of Understanding (hereinafter referred to as the July 13, 2001 MOU, Appendix C) between Sky High, the Baltimore Children's Museum, Inc., and the BCPD. DLLR was not a party to this agreement. The July 13, 2001 MOU detailed the procedures by and between the BCPD and Sky High.

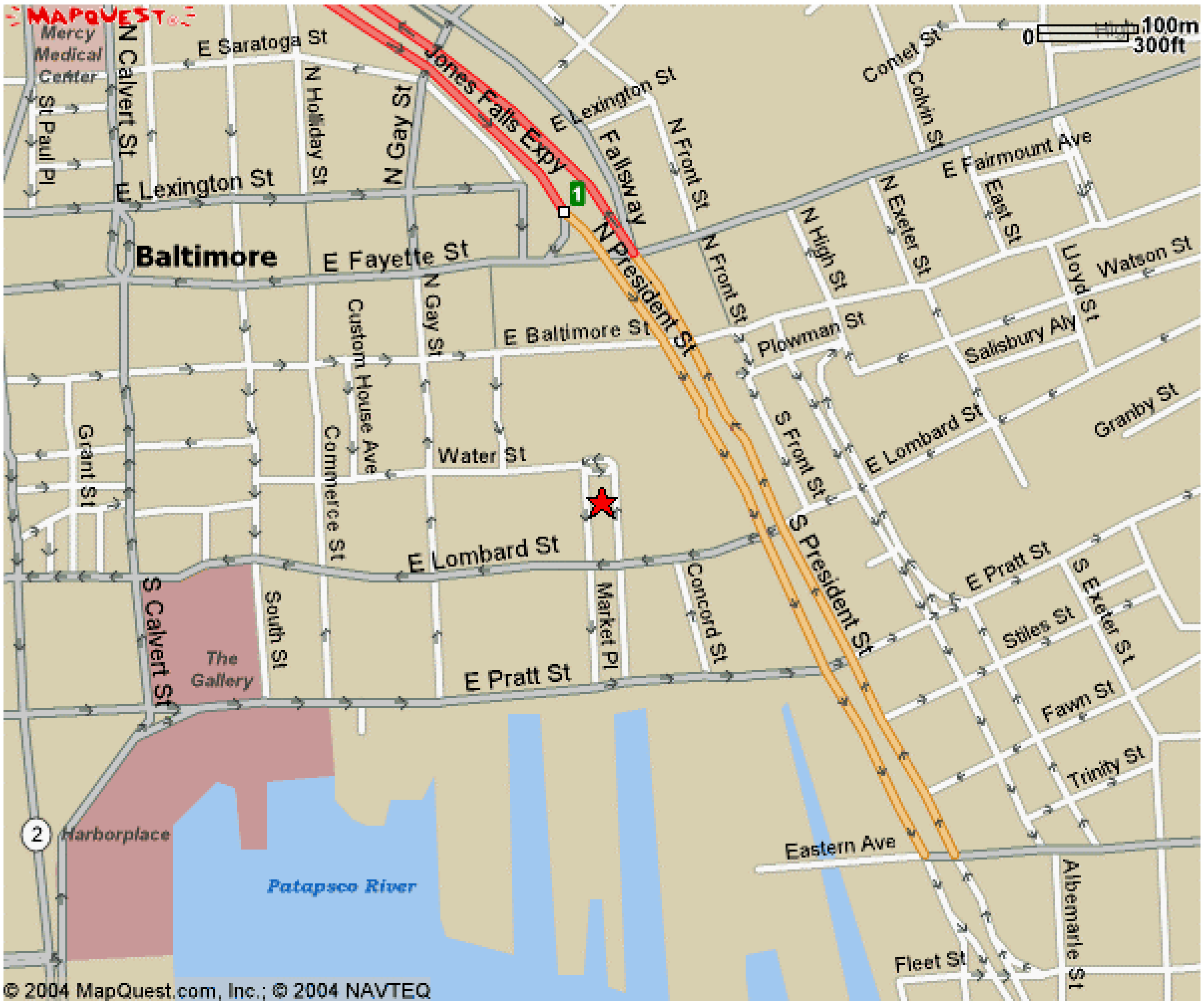
During planning of the "Hi Flyer" system project, DLLR Inspectors verified that construction and operating parameters were approved by an independent registered professional engineering firm and that the site met design specifications and manufacturer's operational parameters.

Inspectors from DLLR evaluated all equipment to ensure manufacturer's approval and specification compliance. Site construction activity, including equipment assembly, were also monitored. Working with Sky High and the manufacturer, safe working parameters were defined. The location of nearby buildings and other physical structures as well as prevailing wind direction were considered. Engineers and manufacturer's representatives inspected the ride and its installation and determined that it was compliant with the manufacturer's design and operational criteria. All equipment and operations were found to be consistent with the requirements of Lindstrand and on July 17, 2001 DLLR issued a "Certificate of Inspection" for operation.

Since the initial inspection, operators have conducted over 7,380 flights without a reported incident.

SITE DESCRIPTION

The “Hi Flyer” balloon is located in an area adjacent to and north of Baltimore Children’s Museum, Inc. in downtown Baltimore. (North of the star pictured below) East Baltimore, North President, and Water Streets border the “Hi Flyer”.



As part of the site planning, Lindstrand required that the site be clear of buildings, trees, and other surface obstructions within an 82 ft (25m) radius of the landing platform. A 70-degree obstruction free "cone of airspace" must be provided to accommodate the flight envelope of the balloon. The site where the balloon operated adjacent to Baltimore Children's Museum, Inc. is compliant with the manufacturer's recommendations. (See Appendix H)

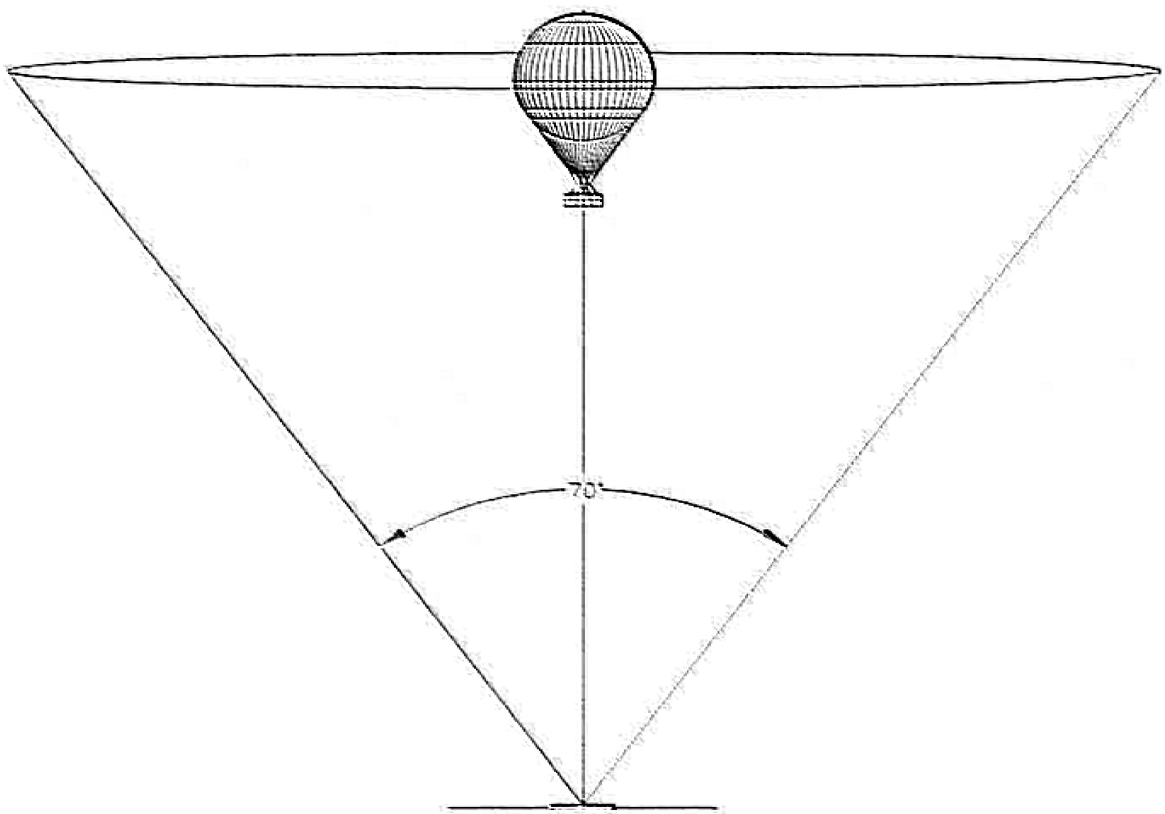


Figure 1: Site Planning -70 degree cone of airspace

SITE OPERATIONS PERSONNEL

Mark Rosenberg - General Manager – Supervising Balloon Operator

Level 1 training certificate dated June, 2001
Level 2 training certificate dated June, 2001
Rosenberg was the Trained Operator on duty at the time of the incident. Rosenberg was operating the balloon from the operating station positioned at the landing platform outside of the machine room.

Matt Lidinsky – Supervising Balloon Operator

Level 1 training certificate dated July, 2001
Level 2 training certificate dated December, 2001
Lidinsky was the Trained Operator that performed the preflight inspections and test flight on July 17, 2004.

Benjamin Schmitz - Attendant

No training certificate on file.
Schmitz assists in mooring operations, customer service, and narration presentation while aloft.

Christopher Gorman - Attendant

No training certificate on file.
Gorman assists in mooring operations, customer service, and narration presentation while aloft.

Chris Yeazel - Attendant

No training certificate on file.
Yeazel assists in mooring operations, customer service, and narration presentation while aloft.

TRAINING

Rosenberg is a Level 2, Trained Operator. He received his training from John Ackroyd, a Lindstrand representative. Lidinsky is a Level 2, Trained Operator. He received his training from Rosenberg. According to Lindstrand, only Level 2 Trained Operators are qualified to operate the “Hi Flyer”.

Level 2 Trained Operators receive training in the following subjects:

- “Hi Flyer” configuration function and terminology
- Tethered helium balloon theory and principles, wind speed, free-lift, and passenger payload calculations
- Control panel monitoring and log keeping
- Test ride data and defect recording
- Emergency recovery procedures
- Balloon mooring and unmooring
- Balloon operating procedures
- Emergency generator operating procedures
- Passenger handling, distribution, and information
- Weather forecasting and awareness
- Inspection and maintenance procedures

Lindstrand's Training Manual, Section 5.1.2 Weather, states the following:

> It is the responsibility of all operators to be fully aware of the predicted weather conditions and it's [sic] affect on the operation of the "Hi Flyer". A basic course in meteorology is strongly recommended for all operators. It must be noted that a weather forecast is only a scientific prediction. All operators should have a basic knowledge of meteorology and be able to spot changing weather patterns and make amendments to the flight plan. Forecasts are by nature not always accurate and it is important that any conditions encountered that do not match the predicted pattern are reported immediately to the supervisor.

The recovery systems are tested as part of the Annual Airworthiness Inspection performed by Lindstrand. Balloon operators review the recovery procedures each year but do not perform an actual recovery exercise. According to Rosenberg, there is no continuous training program in place. Level 2 Trained Operators are familiar with the recovery procedures but they did not periodically train in or actively practice the recovery process.

EQUIPMENT DESCRIPTION (Source: manufacturer's reference material)

The balloon system consists of three major sub-systems:

1. A Balloon and Net System which provides the necessary lift to support all the equipment and passenger weights.
2. A Gondola System that is the carrying structure for the occupants and equipment.
3. A Winch System that allows the balloon to be tethered at various positions and winched back down at the end of each flight.

1. THE BALLOON AND NET SYSTEM, (FIGURE 2)

The balloon system is the main lifting mechanism and is composed of all the components which allow the regulation and control of the lifting gas. The only lifting gas approved for use by the manufacturer is helium. The helium generates lift due to the fact that it is less dense than the air that surrounds the balloon. The quantity of lift generated is dependent upon the atmospheric conditions and the mass and purity of the helium contained within the balloon. The helium is contained within the envelope which is itself contained within the net which allows the generated lift to be transferred to the load frame.

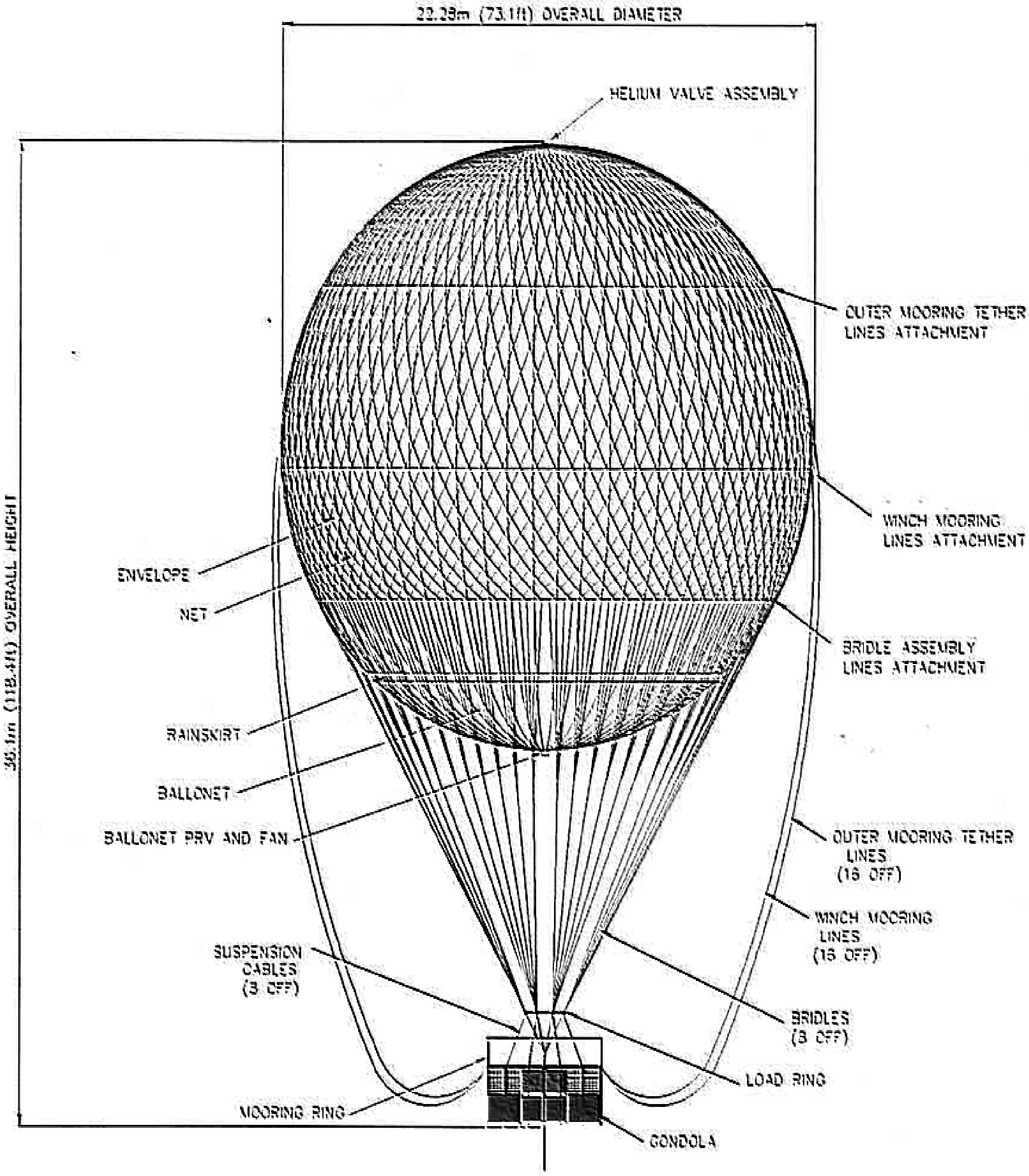


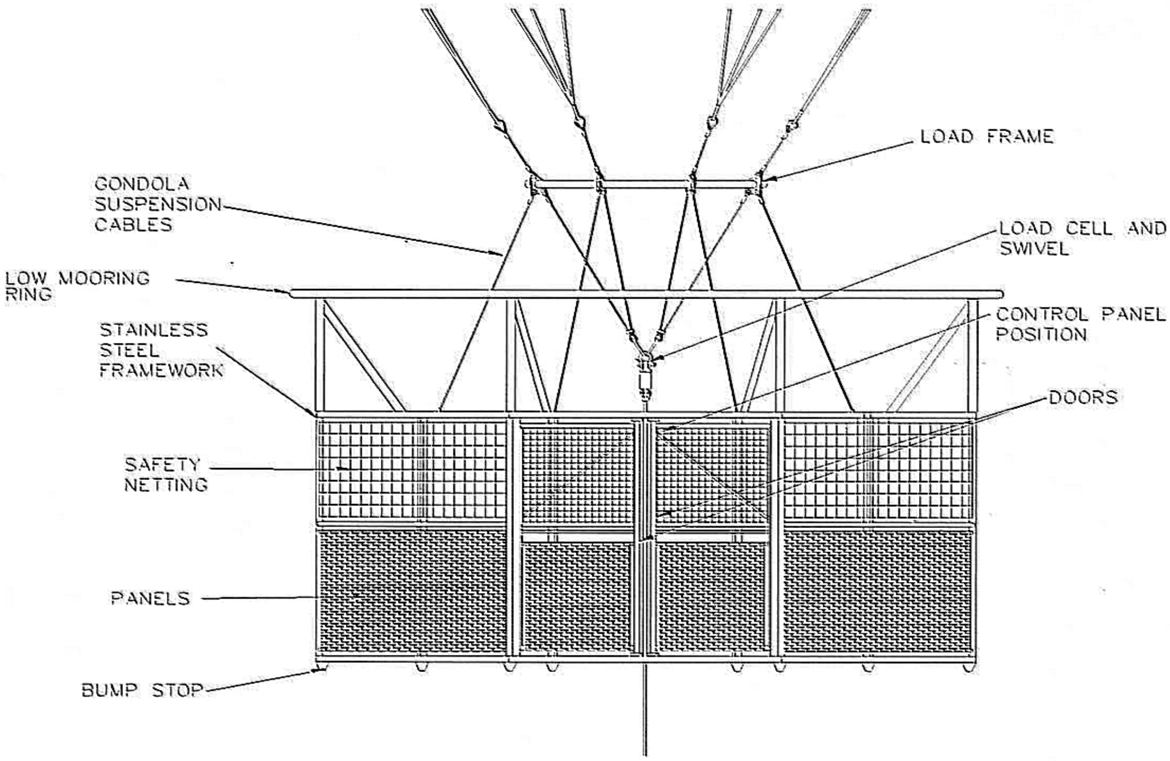
Figure 2: Balloon and Net System

The envelope is manufactured from a heat weldable helium gas tight fabric. It is a sphere with a diameter of 73 ft (22.28m). A ballonet is created by the addition of an internal membrane in the lower portion of the spherical envelope. The ballonet is created by separating a volume at the bottom of the main envelope from the gas cell.

The boundary is a lighter weight, non-load carrying helium tight fabric. The envelope net contains all the lift generated in the envelope and transfers the lift to the load ring. It consists of a series of interlinked ropes, formed into diamond patterns, which are sized to fit over the envelope. The apex of the net is terminated in a metallic ring that is attached to the valve plate assembly. The bottom of the net connects onto the load ring via eight bridal rope assemblies.

2. <u>THE GONDOLA SYSTEM (FIGURE 3)</u>

The Gondola system consists of the structure itself, the control panel, the load ring and associated attachments, the load cell, battery power pack and a generator. These items together comprise the means of conveying the passengers, attendant or operator to the target altitude. The Gondola consists of an octagonal shaped stainless steel welded framework as shown in Figure 3.



. Figure 3: Gondola System

The winch steel wire rope passes through the center space of the gondola. The two gondola frames are spaced 31.5" (800 mm) apart, which creates a narrow walkway, sufficiently wide to allow passengers to pass each other. The outer faces of the gondola are covered to just below the handrail by PVC panels. The inside faces are covered to just below the handrail by double skinned and foam filled polyvinyl panels which are securely fastened in position with over braided Kevlar cord. The sides above the handrail and the top face of the framework are covered by nylon netting with a 4" (100 mm) mesh size. This netting provides containment of the passengers while still affording visibility. Two doors are positioned in the outside face of the gondola and open inwards

3. THE WINCH SYSTEM (FIGURE 4)

The winch system layout consists of the following sub-components:

Winch wire rope

The winch wire rope is a 0.87" (22 mm) diameter die formed 34 x 7 construction steel wire rope which is constructed so that when loaded there is a minimum of rotation created within the rope. At the upper end of the wire rope, there is a conical epoxy bonded end fitting which incorporates a swivel which in turn is attached to the lower side of the load-cell.

Gimbaled sheave

The gimbaled sheave is a mechanical device that allows the winch wire rope to move with the balloon wherever the prevailing wind takes it but controls the position of the wire rope on the winch side so that the wire rope will be stored correctly on the winch drum.

Fleeting sheave

The fleeting sheave is situated at the opposite end from the main drum and permits the wire rope to move horizontally perpendicular to the axis of the wire rope to allow the wire rope to correctly locate on the winch drum.

Winch drum

The winch drum is a 59" (1.5m) diameter drum which can hold the whole wire rope in a single layer. The barrel of the drum is grooved to accept the wire rope, this ensures that the wire rope is located correctly and that the contact stresses between the wire rope and the drum are minimal. One of the drum flanges is fitted with a caliper brake (the drum brake), which is applied automatically.

Like a car's emergency brake, the drum brake is a critical safety feature of the winch system. The drum brake is capable of stopping and holding the balloon should all other systems fail. The drum brake can also be released manually if the need should arise.

The winch system is fitted with an over-speed safety device (a speed encoder) that monitors the speed of the winch drum. The encoder is mounted directly to the winch drum shaft and converts rotary movement of the shaft into electrical pulses. Should the speed of the drum exceed the preset safe value of 1.9 ft/s (35 m/min), the encoder will detect this inconsistency and initiate a fault of the emergency stop (E-stop) circuit. The E-stop circuit removes power from the main drive motor and automatically applies the drum brake.

Gearbox

On the end of the winch drum is the gearbox which is a worm/epicyclic unit. This permits the transfer of power from the main drive motor into the winch drum, also reducing the motor speed from 1750 rpm down to 7.45 rpm, the speed of the winch drum. It can also accept power from the auxiliary drive motor which is located opposite the main drive motor. The auxiliary drive motor is normally de-clutched so that it is not driven by the main drive motor during normal operations. The gearbox is lubricated by a splash oil bath in the lower part of the gearbox casing.

Main Drive Motor

A 37 kW (49.5 hp) electric motor, which is fed from a local 3-phase power supply and is used as the main drive motor. The drive motor control system is capable of full dynamic braking, which allows precise control of the wire rope payout speeds. The drive motor is fitted with a spring operated fail-safe brake, which in the event of a power failure is engaged to prevent freewheeling.

Auxiliary Drive Motor

A 4 kW (5.4 hp) motor is located opposite the main drive motor. It may be manually engaged, through the epicyclical gearbox, to provide control of the winch drum in the event of a total failure of the main drive motor. In the event of a power failure, a generator is used to power the auxiliary drive motor. It should be noted that the auxiliary drive motor can only be used to winch down the balloon. It is not intended to be used for normal flight operations. The power is passed through a manual clutch. This allows the auxiliary motor to be isolated from the main drive motor when it is not in use. The motor is capable of recovering the balloon at a reduced speed of 0.2 ft/sec (3.5m/min). Additionally, a hand crank can be attached to the auxiliary motor shaft and used to manually turn the motor. This manual method can be used as an alternative recovery method in cases involving total drive failure of the main and auxiliary motors.

THE OPERATING CONTROLS

The control and operation of the “Hi Flyer” can be activated through either the ground operating unit or the remote operating unit. The remote operating unit is located on the gondola and is linked to the control panel via an encrypted radio transmission. A keyed switch located on the remote operating unit controls activation of the unit.

For the first three years of operation, the “Hi Flyer” was controlled via the remote operating unit. During the 2004 operating season, the “Hi Flyer” was controlled exclusively via the ground-operating unit. This change in operating control was made due to inconsistencies with radio transmissions and the need to continuously change out batteries in the remote unit. Additionally, this provided operators enhanced control of the balloon during the landing process.

The ground-operating unit is located at the edge of the landing platform with a good view of the operating and landing area. The control panel is located in the winch machine room and is the primary point for the overall system programming. The Program Logic Controller (PLC) is an industrial computer used to control the balloon during normal operation. The PLC consists of the main microprocessor, input slots which detect signals from relays and other devices, and output slots, which sends electrical signals to devices within the system.

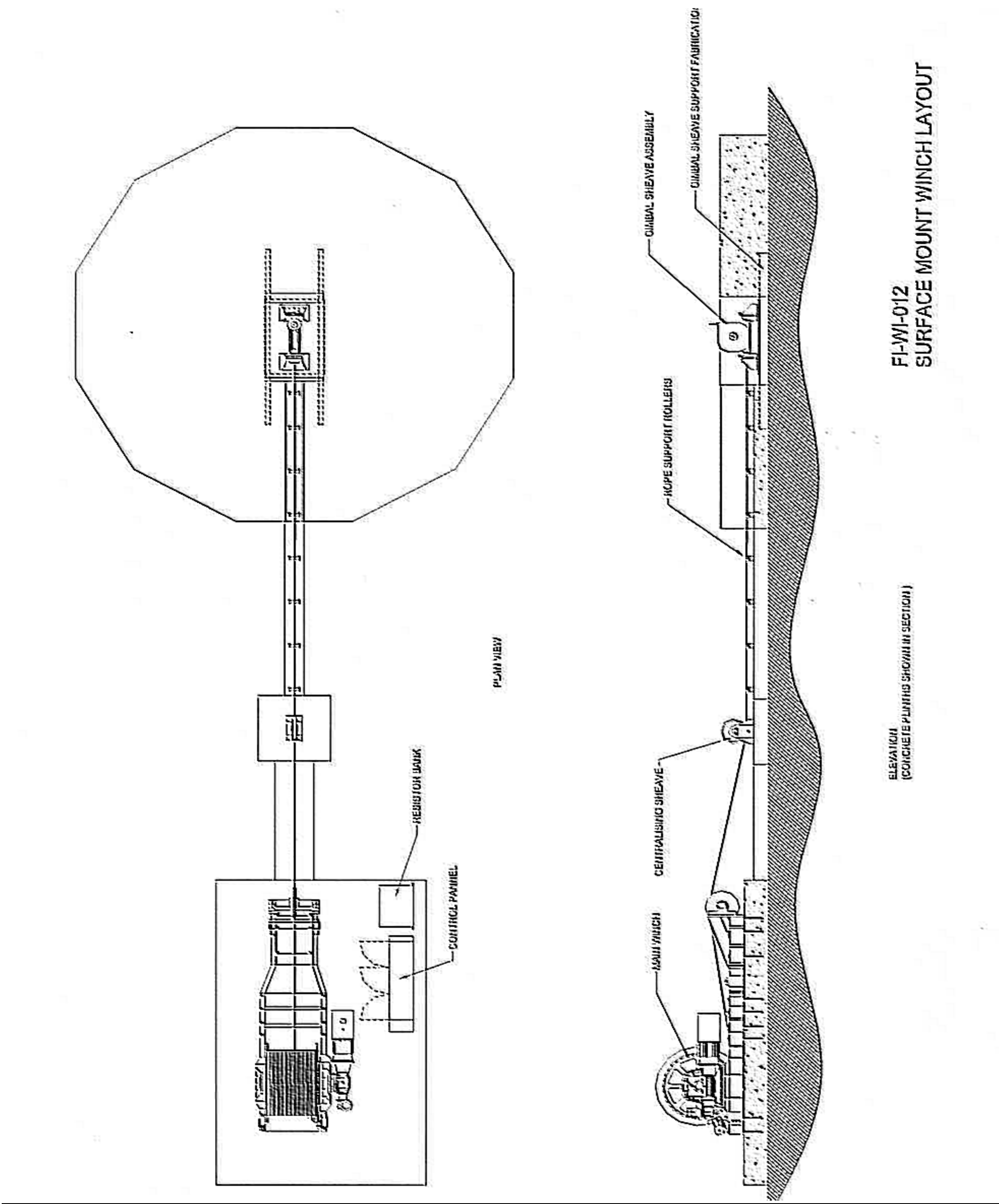


Figure 4: Winch System

OPERATIONS INFORMATION

AVIATION SAFETY

FAA LETTER AND JULY 13, 2001 MOU

The FAA, in a letter to Mr. Raskin dated July 3, 2001 (Appendix B), stated that operating a tethered helium filled observation balloon in downtown Baltimore would not be objectionable to the FAA, subject to certain conditions. The conditions as described in the July 3, 2001 letter are:

- Balloon operators notify the Leesburg, Virginia Automated Flight Service Station, and request a Notice to Airmen (NOTAM) be issued.
- Notify the Baltimore International Tower of intent to operate.
- Attach visual obstruction banners during operation.
- Require a ceiling of 1,000 feet with three miles of visibility to operate.
- Because the balloon would operate so close to the Baltimore City Police Department (BCPD) heliport, simultaneous operation of the balloon and the heliport would be imprudent. Operational conflicts between the BCPD heliport and the observation balloon were resolved and agreed to in writing. This resulted in a July 13, 2001 Memorandum of Understanding (Appendix C) between the BCPD, Sky High, and the Baltimore Children's Museum, Inc.

According to Rosenberg, at the beginning of each operating season, most recently May, 2004, a call would be placed to the Leesburg, Virginia Automated Flight Service Station with a request that a "standing NOTAM" be issued for the operation of the balloon from May through the end of the year. Additionally, each day a call would be placed to the Potomac Approach (FAA 540-349-7541) to confirm the "Hi Flyer's" intent to fly.

INSPECTIONS: MARYLAND AMUSEMENT RIDE SAFETY LAW

The "Hi Flyer" system is inspected annually by DLLR Inspectors for compliance with the Maryland Amusement Ride Safety Law and regulations. DLLR Inspections are performed at the beginning of each season and in conjunction with the Annual Airworthiness Inspection. The Annual Airworthiness Inspection and DLLR Inspection were last performed on May 19, 2004. DLLR Inspectors focus the compliance inspection on the manufacturer's operating limitations, equipment, and operating specifications.

The "Hi Flyer" system must also undergo an Annual Airworthiness Inspection performed by an approved Lindstrand Inspector and witnessed by DLLR Inspectors. This inspection process validates all vital components of the balloon system, test emergency recovery components, and processes. Flight tests are also performed. Since the start of flight operations, the system has satisfactorily completed four Annual Airworthiness Inspections.

Preflight inspections are performed on the balloon system daily and recorded on the Technical Log Sheet. Normal inspection procedures require a visual inspection of the following components: the envelope, rigging, gondola, winch and steel wire rope, control panel, and the mooring equipment. In addition to the visual inspection of the structural components, a test flight is completed. During the test flight, operational limitations for the prevailing weather conditions are established. Elevated free lift obtained during the test flight and wind speed are required to calculate the allowable passenger payload. Throughout each flight, the anemometer is observed. If the wind speed increases then the maximum passenger payload figure must be reduced to remain within the prescribed limitations.

WEATHER

Before each day's operations, a meteorological forecast is obtained with particular reference to wind speeds and directions, expected precipitation, and any thunderstorm activity. This information is recorded on the Technical Log Sheet. Operators and attendants must pay close attention to meteorological conditions with balloon operations. According to Lindstrand, if winds exceed 27.6 mph (24 knots), then balloon operations must cease. According to Rosenberg, during the first three years of operation, balloon operators would utilize the services of the FAA’s preflight weather forecasting service based in Williamsport, Pennsylvania. (1-800-992-7433). The FAA’s preflight weather service provided several types of forecasts, two of which are the Aviation Terminal Forecast (TAF) and a Meteorological Surface Report (METAR).

TAF is a forecast for a specific airport location and covers a five-mile radius from the center of the runway complex. The forecast contains information on expected ceilings, cloud coverage and height, visibility, weather, obstructions to vision and surface winds. METAR is an hourly weather report which is specific aviation weather observations taken at designated reporting sites located at airports. Observations are usually made 50 minutes past each hour and are generally available within 20 minutes. Special observations are taken whenever changing weather conditions warrant.

Each morning before “Hi Flyer” operations began and as part of the preflight inspection procedure, the FAA’s preflight weather forecast service was contacted. Information provided from the weather service, along with other pertinent data gathered during the test flight provided the Operator with the information needed to determine the operational limitations for flights that day.

According to Rosenberg, at the start of the 2004 season Balloon Over Baltimore, Inc.’s Board of Directors required that a weather monitoring system be installed that would provide the operator with the latest weather information. Using a lap top computer, and employing an online weather service, operators would then be able to continuously view local weather conditions and Doppler radar images. After the laptop computer system was up and running, balloon operators rarely used the FAA’s preflight weather forecasting service.

NORMAL OPERATION

After the daily preflight inspection process is complete, the information is recorded on the Technical Log Sheet. Once the daily operational limitations are established and fall within the parameters as prescribed by Lindstrand, passengers may embark.

During the ascent, the first 9.8 ft (3 meters) is at a reduced speed. Once past that point, ascent speed accelerates to full speed. Just prior to arriving at the pre-set height, ascent is again slowed until the final height is reached. During descent, the winch will accelerate to 50% of maximum speed for 5 seconds then increase to full speed. The balloon will continue until the platform comes within 9.8 ft (3meters) of the ground, and then decelerate. The platform will stop automatically within 3.3 ft (1 m) of the ground. Then, operation reverts to manual control to safely bring the platform to the ground.

RECOVERY

In the event of a winch failure, Lindstrand lists several recovery methods that can be used to retrieve the balloon. The appropriate method depends upon which winch system components are affected by the fault.

The following is a brief description of the various recovery methods:
(Source: manufacturer's reference material)

Recovering the Balloon using the Emergency Recovery Mode

In the event that a part of the system should fail that does not affect the main drive system or brakes, the balloon can be recovered using the main drive at a reduced speed. This mode of operation will override parts of the E-Stop circuit and must only be conducted by a Trained Level 2 Operator.

Recovering the Balloon using the Auxiliary Motor & Main Power

This method of recovery is used in the event the main control or drive systems fail. This will be the most likely method of recovery required due to a fault on the winch system. This mode of operation will override parts of the E-Stop circuit and must only be conducted by a Trained Level 2 Operator.

Recovering the Balloon using the Auxiliary Motor & Generator

This will be the most likely method of recovery during a main power failure. At all times throughout any of the emergency recovery operations, the operator should act as the final failsafe by monitoring all winch operations. Upon starting the recovery, the operator should check that the main drum is rotating in the correct direction (i.e. pulling the balloon down) and monitor the system for abnormal noises or operation. This mode of operation will override parts of the E- Stop circuit and must only be conducted by a Trained Level 2 Operator.

Recovering the Balloon using the Manual Hand Crank

This will be the most likely method of recovery when there is a failure in the main and auxiliary drive motors or when there is a main and emergency generated power failure. Recovering the balloon using this method will take a considerable amount time because of the gearing ratio.

Recovering the Balloon when experiencing total Winch Drum Failure

There are two recovery methods available if the winch drive has been jammed, or is inoperable, and no other means is available to retrieve the balloon. They are outlined as emergency descent methods in the "Hi Flyer" operations manual. The first method involves allowing the helium gas to escape by manually opening the helium valve. Venting off the helium gas will cause the balloon to descend. This process may also increase the potential for wind drag and should only be considered in calm winds.

A second method requires the use of two large tow vehicles, and twin snatch blocks, to pull the balloon down using the tethered wire rope of the balloon. This method can be used with heavy winds by adjusting the towing power of the vehicles being used. The procedure calls for the use of two manufacturer's approved, snatch blocks to be attached to the steel wire rope at the location where the steel wire rope exits the winch controller. Using the snatch blocks prevents the steel wire rope from being damaged. Each snatch block is connected to a large tow vehicle, one vehicle remains stationary, and the other vehicle is used to pull the balloon down.

With the exception of venting the helium gas and pulling the balloon down using tow vehicles and twin snatch blocks, the recovery procedures are tested each year. During the Annual Airworthiness Inspection conducted by Lindstrand, simulated failures are initiated and the equipment is tested to validate effectiveness and operation. The manufacturer specifically indicates that only personnel trained and qualified by the manufacturer should attempt recovery procedures and emergency descents.

INVESTIGATION INFORMATION

DAILY INSPECTION JULY 17, 2004

At 11:00 AM, after performing the daily preflight inspection and test flight, Matt Lidinsky recorded the results on the Technical Log Sheet. The log does not indicate that any defects were found during the inspection and test flight. The Technical Log Sheet does indicate that current weather conditions were obtained using an Internet based weather service accessed through a lap top computer maintained on site.

The "Hi Flyer" started operations at 11:30 AM on Saturday, July 17, 2004.

INCIDENT

On July 17, 2004, the "Hi Flyer" balloon was being prepared for a routine flight which would be the 14th ascension of the day. General Manager, Mark Rosenberg, arrived at 3:30 PM relieving Lidinsky of his duties as the morning shift supervising balloon operator. According to Rosenberg, when he arrived at work, he checked with the ground crew as to current wind conditions and conditions on previous flights. Rosenberg stated to DLLR that he used a laptop computer connected to the Internet, accessing an on-line weather service known as "Weather Underground", to obtain Doppler radar images and other weather information for the Baltimore area. Rosenberg also indicated that his discussion with other employees and his observations of the existing conditions, along with the weather service information, gave him no reason not to proceed as normal. No problems being noted, he proceeded with flight departure.

Sixteen passengers and one attendant, Christopher Gorman, boarded the gondola and prepared for the flight. Rosenberg was the operator in control of the ride and was operating the balloon from the ground-operating unit. After the incident, some of the passengers commented that as the flight started it was a hot breezy summer day. Rosenberg said that the winds were between 10 and 15 knots at the time the ride started. As the balloon ascended to a height which was above the surrounding buildings, passengers reported seeing dark storm clouds over the Key Bridge and the winds began to pick up very quickly.

According to Gorman, the attendant on the balloon, prior to the start of the ride, winds were relatively calm, blowing from the South at 11 to 15 knots. This had been the beginning of Gorman's fifth flight for the day and as the balloon ascended the wind speed continued to climb. Gorman was able to view on the gondola's control panel the rising wind speed and began relaying this information over the radio to Ben Schmitz, the ground attendant. In his statement to investigators, Gorman recounted that he observed the wind speed go from 15 knots, to 20, then 22, to 26, and then 35 knots in a matter of seconds. Gorman also reported that a wind gust forced the balloon downward from 200 ft in the air, to within 70 to 80 ft of the road surface of President Street. He also instructed the passengers to sit on the floor and hold on.

The additional tension on the steel wire rope tether, created by the wind burst, caused an over-speed safety device to activate. When, by design, the over-speed sensor identified a fault, it signaled the operating system to shut the winch system down and automatically applied the drum brake. The balloon continued to be subjected to extreme wind gusts forcing it into the Police Headquarters Building. The balloon wire rope scraped the side of the building and the gondola struck the roof top air handling unit, damaging the building.

INJURIES

At the time of the incident, there were 17 people onboard the "Hi Flyer", 16 passengers and one attendant. Of the 16 passengers, six were adult male, four were adult female and six were children, three male and three female. Although no serious injuries were reported among the children, DLLR has future concerns regarding adults holding infants and young children in their arms, if the balloon were subjected to sudden wind bursts. If an adult was not able to maintain their stability and was tossed around, an infant or toddler could potentially be crushed between the adult holding them, and the gondola structure. The initial police report indicated that four passengers were taken to area hospitals. Two passengers complained of injury to their wrist. One passenger complained of injury to their left knee, and one complained of scrapes and bruising.

WEATHER

On July 17, 2004 at 11:00 AM, current weather and wind conditions were obtained using the lap top computer and the online weather service. This was documented on the "Hi Flyer" Technical Log Sheet. "Current" was described on the Technical Log Sheet, indicating current weather conditions and not a forecast. If operators checked weather conditions subsequent to the 11:00 AM initial check, it was not recorded. There were no indications on the Technical Log Sheet that the FAA's preflight weather forecasting service was used.

The balloon operated from 11:30 AM until approximately 3:30 PM without incident. Rosenberg indicated in his statement that at approximately 3:30 PM, he checked the weather using the laptop computer and the online weather service weather underground. He then proceeded to direct passengers for the next lift. The passengers boarded and the balloon started to ascend. Beginning at approximately 3:40 PM the balloon was subjected to wind gusts including two, that were extreme. The first gust forced the balloon downward to within 70 to 80 feet of the road surface of President Street (See figure 5-A). The second gust caused the balloon to be taken out of its normal (northeast) trajectory, and the passenger platform was pushed to an acute angle (north, see figure 5-B) causing it to strike an adjacent building (See figure 5-C).

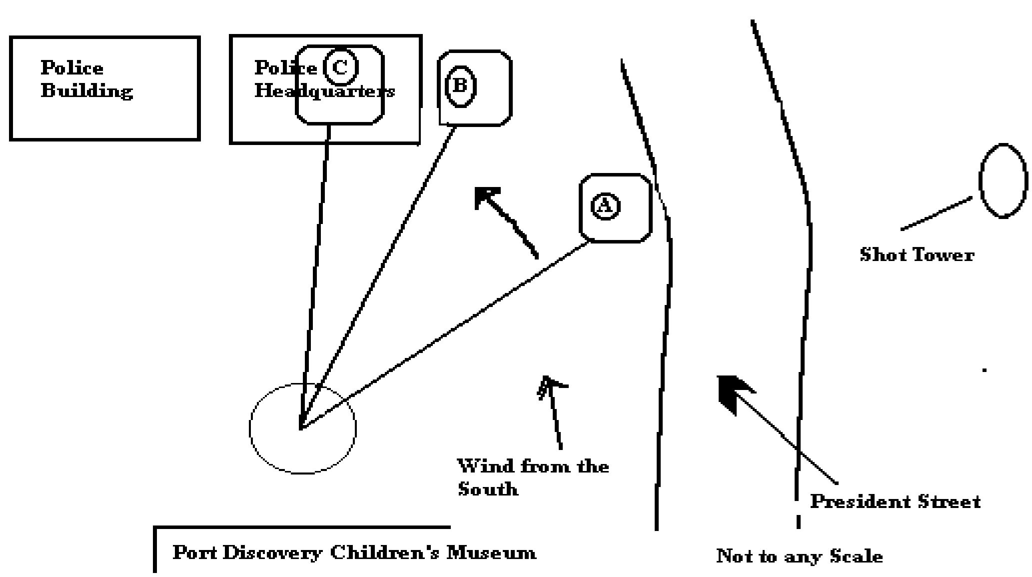
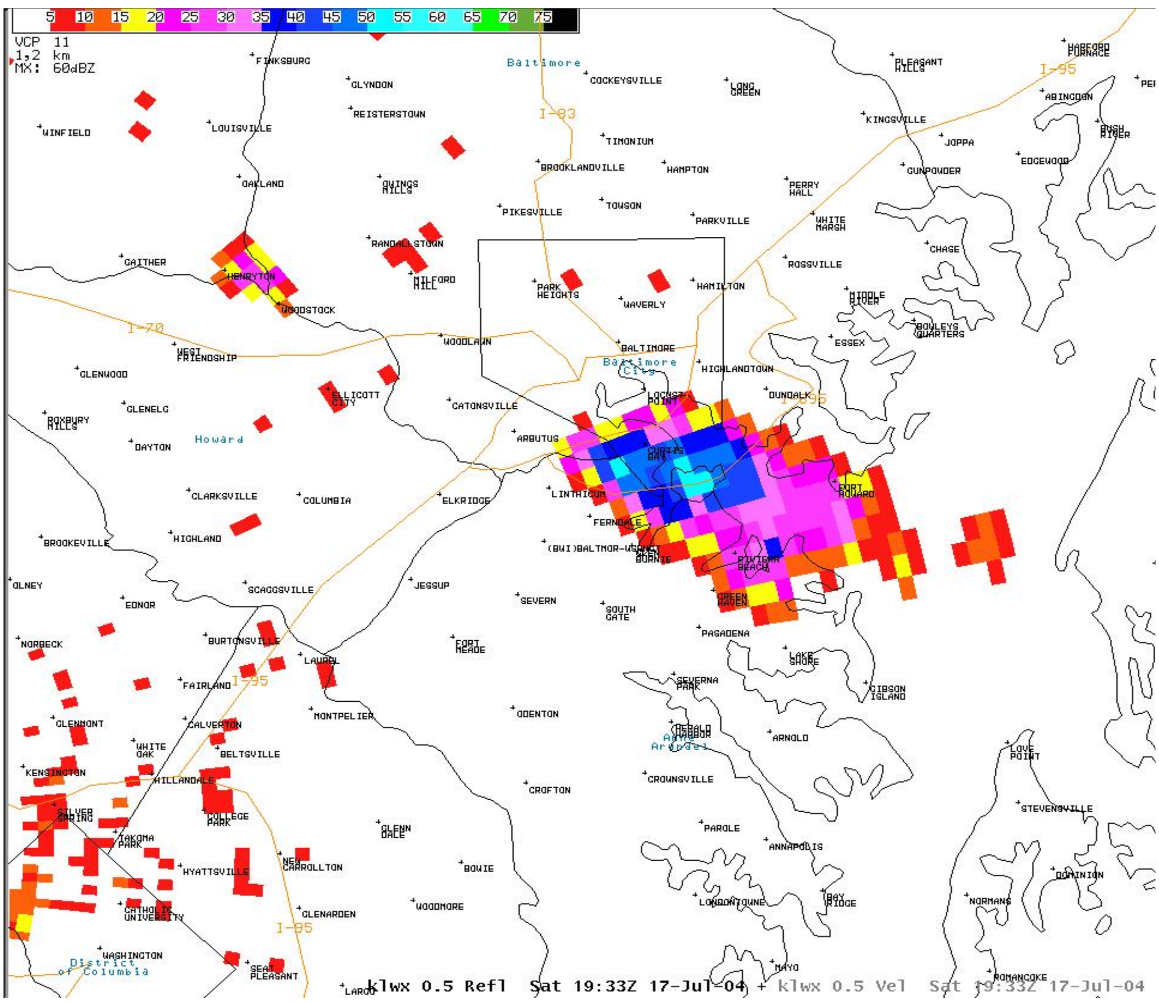


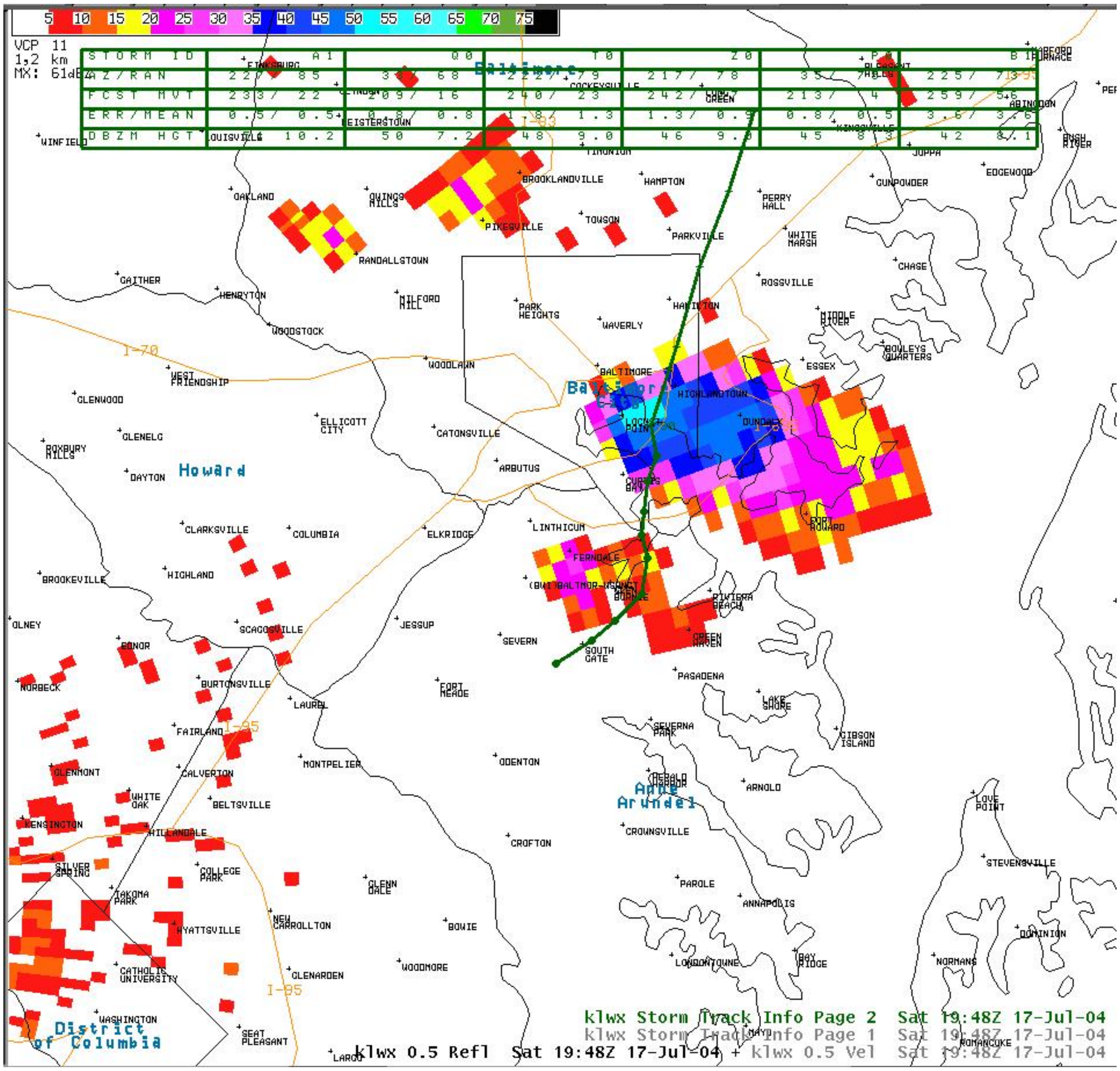
Figure 5

In interviews, employees Gorman and Rosenberg stated that the winds at the time of ascension were between 10 and 15 knots. They saw the storm to the south of the city but conditions on site were relatively calm. Rosenberg stated that the radar showed storms south of the city, down towards Washington D.C. In a written statement from one of the passengers on the balloon at the time of the incident, he recalls, “It was a hot summer day with occasional winds. As soon as we got above the buildings we saw a big dark storm near the Key Bridge. We started getting hit by severe wind gusts within minutes”.

Radar images obtained by DLLR on September 13, 2004 from the National Weather Service clearly indicate severe weather conditions over south Baltimore on July 17, 2004 at 3:33 PM, the approximate start time of the ascension. (see below)



The radar image below indicates the severe weather conditions over Baltimore at 3:48 PM on July 17, 2004, the approximate time of the incident.



In addition to these radar images, at 3:45 PM on July 17, 2004, the National Weather Service posted a Special Weather Statement for the Baltimore area indicating that thunderstorms were entering the southern portions of Baltimore, and that heavy rain, frequent lightning, and wind gusts to 25 mph should be expected.

According to forecasters at the FAA's preflight weather service, high winds and lightning from storms located 25 miles away can affect local weather conditions.

<u>WITNESS STATEMENTS</u>

On September 13, 2004, DLLR mailed letters along with witness statement forms to all adult passengers and minors who were onboard the "Hi Flyer" at the time of the incident. The letter requested that passengers assist DLLR in the investigation by describing what they witnessed.

Two passengers returned witness statement forms describing their version of the incident. Two attorneys responded on behalf of their clients who were passengers, but failed to submit any signed statements.

Of the two statements that were returned, both passengers noted that a storm was over the harbor, or over the Key Bridge and that the winds increased very quickly as they ascended above the buildings. Both passengers noted that at the beginning of the ride, it was a hot day with occasional winds. One passenger described the afternoon as breezy.

One passenger stated "The staff had no idea what to do" and that "there was no training or safety plan". The other passenger stated "No one explained any safety rules or no one seemed concerned about safety".

EMERGENCY RESPONSE AND RECOVERY

The Baltimore City Fire Department Emergency Communications Call Center received a 911 call at 3:53 PM, alerting BCFD of the situation, and emergency rescue personnel were dispatched to the scene.

On August 2, 2004 and October 25, 2004, DLLR sent letters to the BCFD requesting copies of reports regarding the incident and their rescue response. In addition, numerous phone calls were made during the month of November in an effort to ascertain the status of the request. On December 2, 2004, BCFD provided the reports they prepared following the July 17th incident. Copies of the reports from BCFD are included in Appendix D. Based upon eyewitness accounts and interviews, DLLR has learned the following.

Upon arriving at the scene, BCFD worked with the operator, Rosenberg, to learn why the system would not operate to bring the balloon down. Rosenberg explained that when the alarm sounded and the winch system shutdown, he entered the machine room and the Program Logic Controller (PLC) reported "Winch Over-speed". He made them aware that the balloon manufacturer had developed an emergency recovery system and the PLC report for "Winch Over-speed" called for the application of the following procedure:

1. **Check that no personnel are in or around moving parts of the winch.**
2. **Turn the operation mode key-switch to emergency.**
3. **Reset the control by pressing the reset button.**
4. **Allow the drive approximately 20 seconds to come "on-line".**
5. **Turn the emergency recovery key-switch clockwise to the emergency position. The brakes will release and the balloon will begin to descend. Note: The key is non-latching and must be held in the emergency position for the duration of the ride.**
6. **When the disc is approximately 500 mm away from the photo eyes release the key-switch and the brakes will re-apply and the balloon will stop.**
7. **E-Stop the system by pressing an E-Stop button.**
8. **Turn the operation mode key-switch to normal.**

Using these emergency recovery procedures and following the required sequencing steps, Rosenberg twice attempted to recover the balloon. Rosenberg noticed that when the emergency recovery mode was initiated, the main drum brake failed to release. Applying a secondary recovery method provided for by the manufacturer, he then connected the auxiliary motor and twice attempted to recover the balloon using the auxiliary motor and main power. This procedure required the application and sequencing of an additional ten steps. Again, Rosenberg was unable to get the main drum brake to release.

According to witnesses, while Rosenberg was working in the machine room trying to recover the balloon utilizing the manufacturer's recovery methods, the BCFD cut out a section of the steel fence surrounding the balloon system to allow access for their emergency vehicles. BCFD then attempted to recover the balloon by attaching a shackle to the balloon's steel wire rope between the gimbaled sheave and the idler plate in the wire rope trough. The shackle was then attached in some fashion to a fire department vehicle in an attempt to pull the balloon down. According to Attendant Ben Schmit, as the BCFD pulled on the tethered steel wire rope holding the balloon, pieces of concrete began to fly as the increased tension was placed on the supporting components. BCFD then stopped pulling on the steel wire rope holding the balloon.

Rosenberg was asked if he had ever worked in conjunction with the BCFD to provide them with basic knowledge and understanding of the "Hi Flyer" system and emergency recovery procedures. He said that representatives of the BCFD stopped by during the first year of operation and talked to him about the system but no other action took place prior to the July 17, 2004 incident.

Inside the machine room, Rosenberg continued. With the auxiliary motor still connected, he switched from normal building power to emergency generator power and attempted recovery once again. The winch system responded and the main drum brake released. Recovery using the auxiliary motor was slow, bringing the balloon down at a speed of 0.2 ft/sec.

Recovery of the balloon took approximately 90 minutes after the initial alarm and shutdown.

As a note of interest, when the "Hi Flyer" controller is in the recovery mode there is a seven second delay between the time a command is initiated and the time it takes for that command to be processed by the computer system.

On July 20, 2004, DLLR Inspectors tested the main drum brake manual release system and found it to be fully functional. Subsequently, Rosenberg was asked to demonstrate the operation of the main drum brake manual release system. Inspectors found that when he demonstrated the manual brake release system, he failed to change the position of a valve which would direct hydraulic fluid from the manual pump to the brake cylinder. Additionally, if the hydraulic fluid pressure is released from the hydraulic hose, which connects the hand pump to the brake cylinder, it will take a minute or two of constant pumping to pressurize the line and cylinder before the brakes will release.

BALLOON SYSTEM EQUIPMENT DAMAGE

The steel wire rope directly below the gondola and a portion of the gondola structure were damaged when the edge of the police building was struck. A lower section of steel wire rope, gimbaled sheave and associated mounting components, gimbaled sheave pit enclosure, and exterior fencing were damaged during the rescue operations. The recovery steps initiated by the operator did not contribute to the damage of the equipment. All of the damaged components will require repair or replacement to return the equipment to its manufactured condition, intended functionality, and safety rating. A visual inspection of the balloon, gondola and associated rigging by Per Lindstrand on November 1, 2004, revealed that the damage was minor. However, a more thorough inspection and testing will be required by a certified Lindstrand Inspector to determine the complete extent of damage and necessary repair of the "Hi Flyer" system.

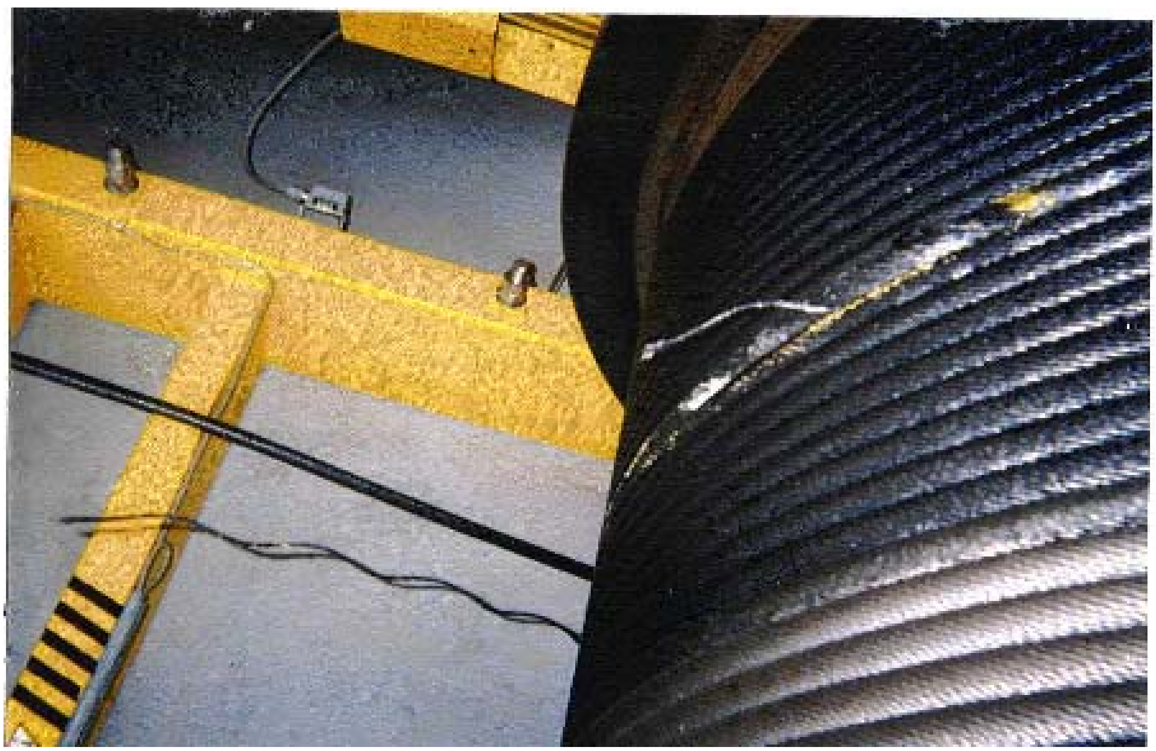


PHOTO: Damage to the steel wire rope.

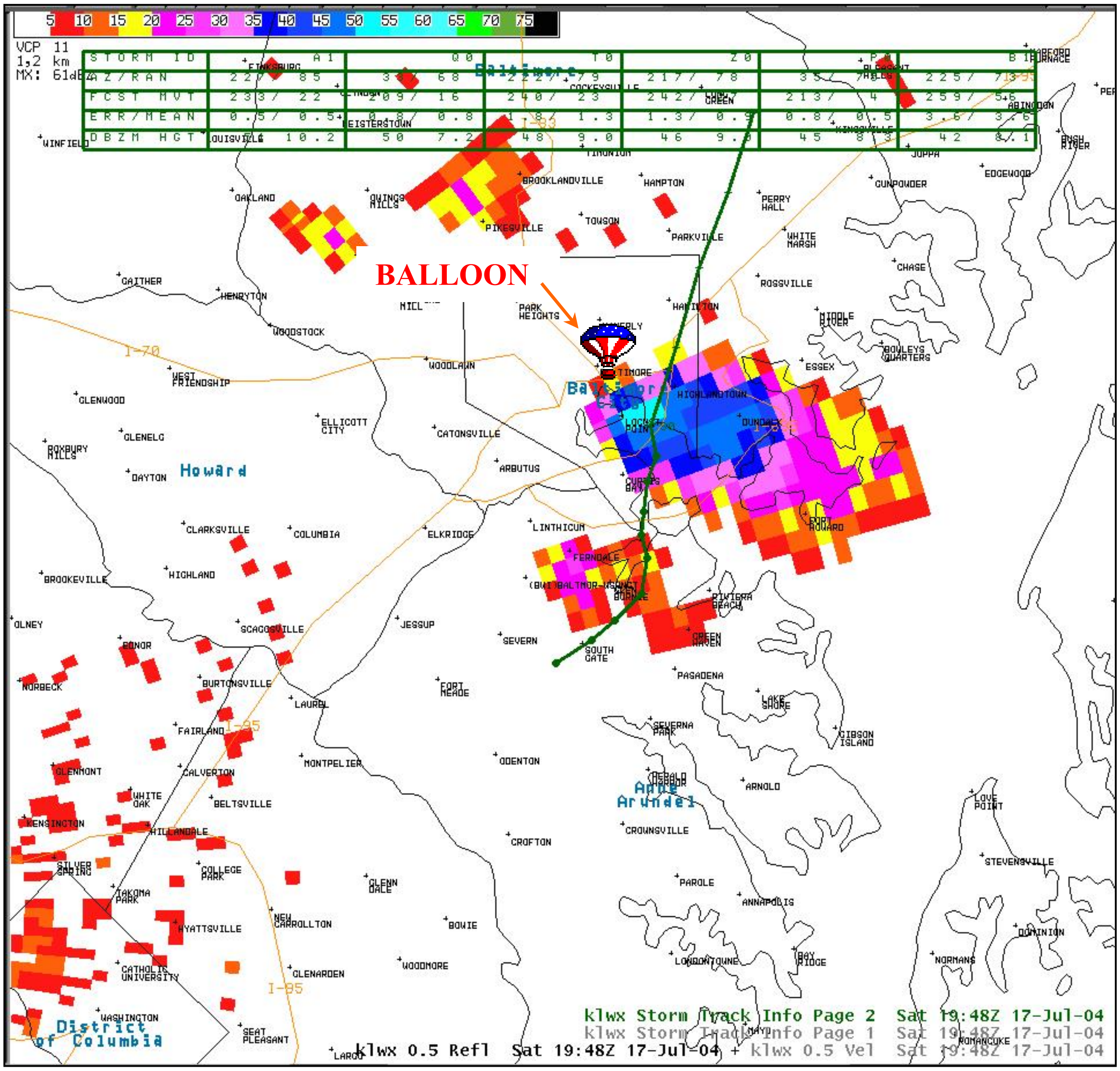
PHOTO: Damage to the gimbaled sheave pit and rope guide.

PHOTO: Damage to inner ring, support member and rope guide.

INCIDENT ANALYSIS AND FINDINGS

WEATHER

- On the map below, the balloon indicates the approximate location of the "Hi Flyer" with respect to the downtown Baltimore area. The weather conditions displayed on the National Weather Service radar images obtained by DLLR on September 13, 2004 indicate the close proximity of the storm to the "Hi Flyer" on July 17, 2004 at 3:48 PM.



- "Hi Flyer" operators stated that they relied on an online weather service and known site conditions. There is no documentation indicating how often operators referred to this online weather service other than the original notation recorded on the Technical Log Sheet at 11:00 AM.

TRAINING AND EMERGENCY PREPAREDNESS

- Education in meteorology is lacking for all employees, and more specifically the operators. It is critical that balloon operators are properly instructed and capable of interpreting the influence of changing weather conditions on flights. Attendants should be capable of identifying key meteorological indicators for storms and follow a standard procedure to report them to the operator.
- Testing of the recovery components were performed only once each year during the preseason Annual Airworthiness Inspection and were performed exclusively by the Lindstrand Approved Inspector.
- Balloon Over Baltimore, Inc. did not have an active reoccurring operator training program focusing specifically on recovery plans and procedures.
- Recovery systems were not tested by the balloon operators and prescribed testing intervals were not established to validate their effectiveness and operation.
- Balloon Over Baltimore, Inc. did not take the initiative to develop a working relationship with the BCFD Emergency Rescue Team in preplanning and exercises involving emergency recovery in the event of an incident.

FREELIFT

- Passenger payload is dependant upon free-lift and wind speed. The greater the free-lift, the more stable the balloon becomes in windy conditions. Therefore, as winds increase the passenger payload must decrease to maintain the allowable free-lift. If the elevated free-lift remained unchanged from the 11:00 AM reading of 2.89 tons and the wind speed at time of liftoff was between 10 and 15 knots, the passenger payload would be limited to 16 passengers. Considering this information, the maximum acceptable passenger limit was not exceeded.

- The aerodynamic (wind) drag on the balloon increases as the wind speed squared. For example, the drag at a wind speed of 2 m/s = 4, the drag at 6 m/s = 36. The effect of wind on the balloon creates a force on the envelope indenting it out of shape and increasing the drag force even more. To resist this deformation, it may be necessary to maintain super-pressure in the envelope. This can be accomplished by switching the ballonet fan to the manual mode and increasing the pressure in the ballonet from the normal operating pressure range of between 6 and 8 mm water gauge (WG) to the maximum pressure 14 mm WG when the pressure relief valve opens. From information provided, nothing indicates that this procedure was attempted or was required to be performed.

DRUM BRAKE

The main drum brake pictured below was tested on August 24, 2004 by DLLR Inspectors and was found to be in proper working order. The brake functioned properly when operated through the normal operating mode, it also functioned properly utilizing the manual system. According to Lindstrand, when the system is in the recovery mode, there is a seven second time delay between initiating an operating command and activation of that command.

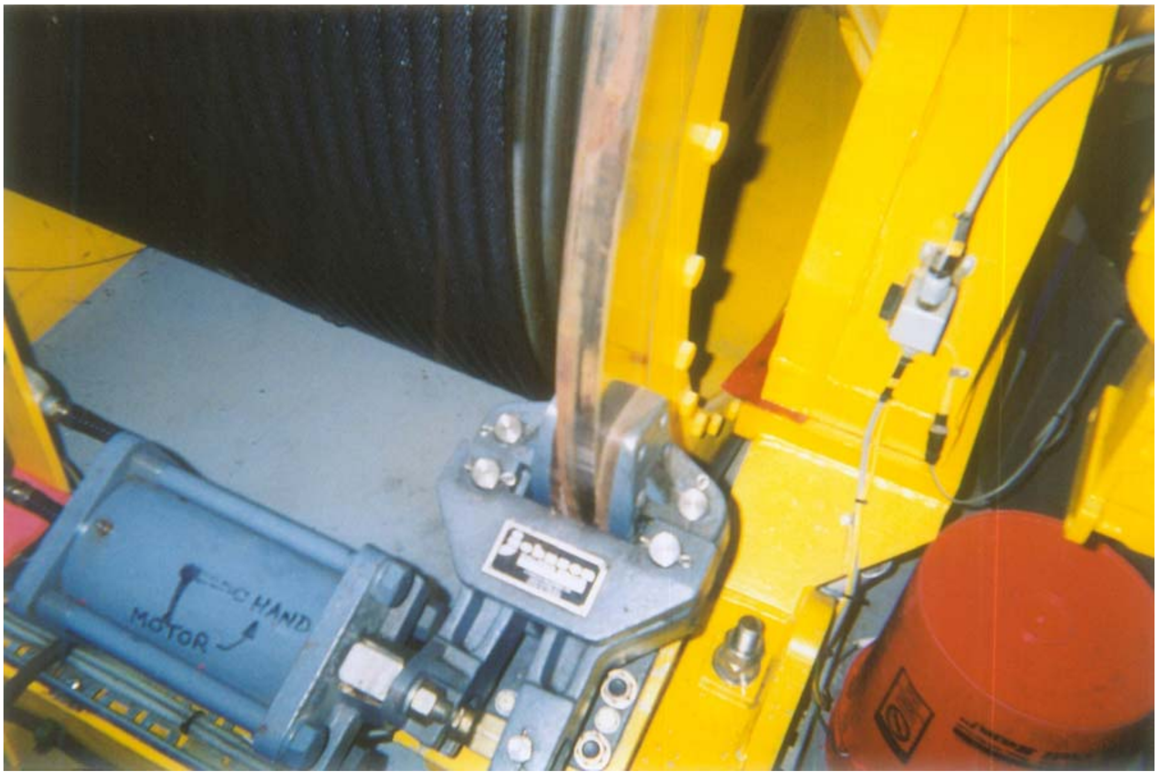


PHOTO: Drum Brake Assembly

SITE CONDITIONS

The extreme wind bursts experienced on July 17, 2004 caused the balloon to exceed it's anticipated cone of operation and in doing so to strike the adjacent police building. According to Lindstrand, the anticipated cone of operation is when the balloon is at a height of 400 ft (121.92m) with winds of 28.77 mph (25 knots). This will result in a balloon angle of 23.8 degrees from vertical. Lindstrand also refers to an area that is defined as the Maximum Theoretical Displacement of the Balloon in Stormy Winds. This area is developed when the balloon is 246 ft (75m) horizontal from the winch center point at a height of 394 ft (120m) vertical, this results in a balloon angle of 32 degrees from vertical. Anticipating balloon operations up to 32 degrees, during site planning operations, Lindstrand required an area with a 70 degree obstruction free cone of airspace to accommodate the flight envelope of the balloon. Operationally, the balloon was permitted to fly in winds up to 25 knots, creating a cone of normal operation. By extending the cone of clearance beyond 23.8 degrees from center, the installation provided an additional safety factor. The site where the balloon operated adjacent to Baltimore Children's Museum, Inc., provided sufficient space exceeding the manufacturer's recommendation stated above and as exhibited below. (Figure 6)

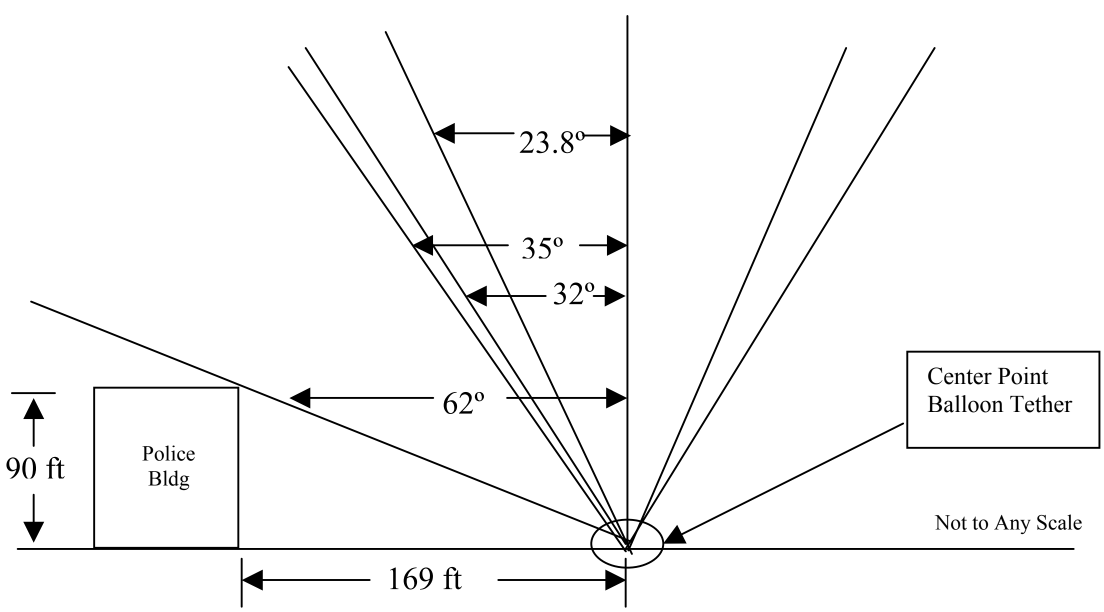


Figure 6

Anticipated Cone of Operation with Winds of 25 knots or less = 23.8 degrees
Maximum Theoretical Displacement of Balloon with Winds up to 35 knots = 32 degrees
Site Requirements for Balloon installation = 35 degrees
Approximate Angle of Balloon Displacement on July 17, 2004 = 62 degrees

The corner of the building that was struck by the balloon is located 169 ft (51.5m) horizontal from the center point of the steel wire rope tether. The roof of the building is at a height of 90 ft (27.5m) vertical. This places the building sufficiently outside of the operating cone and the

Maximum Theoretical Displacement of the Balloon in Stormy Winds. The Balloon was pushed to angle of approximately 62 degrees when the extreme wind bursts forced it into the police building.

CONCLUSION

WEATHER

The balloon operators used the FAA preflight weather forecasting resources prior to this season and Internet based weather services during the 2004 operating season. Both methods include a forecasting report and provide data about meteorological conditions. The Internet based systems provide Doppler radar images and storm reports. Rosenberg indicated in his statement that at approximately 3:30 PM, he looked at the radar images and weather using the laptop computer connected to the online weather service Weather Underground. He then discussed the weather observations with the operator he was relieving, Lidinsky. Rosenberg then proceeded to direct passengers for the next ride. The Doppler radar images from the National Weather Service, for the same time period, show storms in the area. The radar images for the National Weather Service and Weather Underground come from the same source, so the images should have been consistent with one another. The Weather Underground maintains a satellite dish which continuously ingests the NEXRAD radar data directly from the National Weather Service Doppler radars and is updated every 6 to 10 minutes. The images generated for Baltimore came from the National Weather Service Doppler radar site in Sterling, Virginia. The Technical Log Sheet reflected the current weather conditions as of 11:00 AM only and not an outlook or long range forecast. Furthermore, this information was obtained and recorded 4 ¾ hours before the incident. No other documentation exists indicating that weather conditions were checked throughout the day. Although employees indicated that they had looked at the laptop at other times, there was no consistent or standardized monitoring and documentation of those radar images or weather observations.

As indicated previously, the radar images obtained by DLLR on September 13, 2004 from the National Weather Service clearly identify storm conditions that were in the area at the time of the incident. This investigation has concluded that the operator had access to the aforementioned information and should have considered the potential influence of the storms and the probability for high winds before proceeding with the 3:33 PM ride.

TRAINING AND EMERGENCY PREPAREDNESS

DLLR Inspectors made specific requests of "Hi Flyer" operators for training documentation. The only documents received indicate that only Rosenberg and Lidinsky received the training to be Level 2 Trained Operators. The training certificates are dated 2001. There were no documents indicating that the other three employees, Schmitz, Gorman or Yeazel had received any training.

Employees have had minimal meteorological training regarding weather conditions and observations. Balloon Over Baltimore, Inc., changed the method used to obtain meteorological information during the 2004 operating season. No additional training was provided to aid in analysis of information obtained by the new method or how to integrate observations into the flight decision making process.

Both Level 2 trained operators stated that the emergency recovery procedures were only "reviewed" annually by them. They did not engage in testing the procedures or testing their knowledge concerning implementing the procedures for emergency situations. It was a Lindstrand representative who tested the recovery components and process during the Annual Airworthiness Inspection. The operators stated that they did not participate in training exercises of the emergency recovery process other than the original certification three years ago (2001).

An active training program should be established that focuses on emergency recovery plans and procedures. The program should be exercised including prescribed intervals for testing. Balloon Over Baltimore, Inc., and the BCFD should establish a relationship and work together to develop an Emergency Response and Recovery Plan.

EQUIPMENT

DLLR Inspectors found no evidence to indicate that any component of the Balloon System equipment malfunctioned.

RECERTIFICATION

REQUIREMENTS FOR FUTURE BALLOON OPERATIONS

In addition to the existing regulatory and manufacturer requirements, the following are the minimum requirements to obtain a DLLR "CERTIFICATE OF INSPECTION" for future operations. Other safety protocols may be necessitated as development of balloon operations and rescue procedures are implemented.

TRAINING

- Owner/Operator must provide additional documented meteorological training for Level 2 trained Operators and attendants.
- Owner/Operator must develop, implement, and document a continuous training program detailing operating procedures, employee position description, and responsibilities.
- Owner/Operator must develop, implement, and document a continuous training program focusing on emergency recovery process and procedures.
- Owner/Operator must develop an emergency action plan consistent with the anticipated emergencies that may arise from operations. Owner/Operator must coordinate, practice, and implement the plan with the BCFD.

OPERATIONS

- Owner/Operator must prohibit passengers on the ride who are required to be held in the arms of another passenger during the duration of the ride. (Example: infants and toddlers)
- Owner/Operator must have at least two Level 2 Trained Operators on site during flight operations.

- Owner/Operator must ensure that the weather forecast (FAA Preflight Service) is evaluated and recorded each morning and local conditions (laptop and METAR) are evaluated and recorded before each flight.
- Owner/Operator must ensure passenger payload is evaluated, calculated and recorded on the Technical Log Sheet before each flight.
- Owner/Operator must develop specific (go, no-go) parameters dictating acceptable weather conditions. (i.e. balloon cannot operate if a weather system of X value, is within Y miles of the balloon.)
- Owner/Operator must implement and document operational safety briefings. Safety briefings ensure employees communicate critical information pertaining to safe operations prior to and throughout their shift or as conditions change. Briefings provide each employee with a clear understanding of the task to be performed, individual responsibility, and situational awareness concerns.

REPAIRS

- Owner/Operator must repair or replace damaged equipment to the manufacturer's specifications.
- Owner/Operator must ensure that any component that was subjected to an additional load/shock during the incident, and was not replaced, undergoes appropriate non-destructive testing to determine structural integrity.
- Owner/Operator shall ensure that the "Hi Flyer" system undergoes an Annual Airworthiness Inspection conducted by Lindstrand Approved Inspectors.

MEMORANDUM OF UNDERSTANDING

THIS MEMORANDUM OF UNDERSTANDING ("**MOU**") IS ENTERED INTO THIS 13th DAY OF JULY, 2001 AMONG BALTIMORE POLICE DEPARTMENT ("**BPD**"), SKY-HIGH OF MARYLAND, LLC ("**SKY-HIGH**") AND BALTIMORE CHILDREN'S MUSEUM, INC. ("**BCM**").

RECITALS

A. The Mayor and City Council of Baltimore leases certain property (the "**Property**") located at the corner of President Street and Baltimore Street to BCM pursuant to a certain Land Development and Lease Agreement dated as of July 1, 2000 (the "**LDLA**"). The LDLA authorizes BCM to operate, directly or through a subtenant, a balloon operation on the Property.

B. BCM subleases the Property to Sky-High pursuant to a certain Sublease and Use Agreement dated as of October 31, 2000 (the "**Sublease**") for the purpose of developing and operating a high-flyer, tethered, helium balloon attraction (the "**HiFlyer Balloon**").

C. The Aviation Unit of the BPD operates several helicopters as part of the public safety program of the BPD (the "**Aviation Activity**"). One of the certified locations at which the helicopters take off and land is the roof of the Police Headquarters Building located at East Fayette Street in Baltimore City (the "**Police Building**").

D. In order to maximize the safe operation of the HiFlyer Balloon and the Aviation Activity, the parties have agreed to enter into this Memorandum of Understanding.

E. This Memorandum of Understanding is in furtherance of the determination by letter dated July 3, 2001 (the "**FAA Determination**") from the Federal Aviation Administration ("**FAA**") that the HiFlyer Balloon project can be operated and is not to be regarded as BPD support or belief in this project. The BPD does not intend for this MOU to have any effect on the independent judgment of the FAA as expressed in the FAA Determination (other than to meet the express requirements contained therein).

NOW THEREFORE, THE PARTIES HAVE AGREED AS FOLLOWS:

1. Guiding Principles. All parties to this MOU agree that the Aviation Activity at the certified helipad located on the Police Building is vital to the public safety of the citizens of Baltimore City, and that upon the occurrence of any matter of urgency (meaning that a public safety emergency exists, as determined by the BPD, and that the operation of the Balloon can be reasonably expected to interfere with that situation), notwithstanding any protocols or procedures to the contrary, the interests of public safety

shall be paramount, and the operations of the HiFlyer Balloon will be deferred until the BPD determines that public safety would not be compromised by the reinstitution of operation.

1.1. The BPD acknowledges that this provision is not intended to block or stop the ordinary operations of the HiFlyer Balloon, and that operations should be re-instituted as soon as practicable.

1.2. This MOU , which incorporates and includes the recitals set forth above, constitutes the written agreement required by the FAA Determination. As to other matters addressed by this MOU, the parties intend that such provisions set forth operational guidelines to be followed in the interests of public safety.

2. Exchange of Information. In order to maximize the understanding of all parties regarding the operations to be conducted under the terms of this MOU, certain information has been exchanged, and certain agreements have been reached regarding changes to that information.

2.1. The HiFlyer Balloon: Sky-High has provided information to BPD regarding the nature and operation of the HiFlyer Balloon, including such matters as the size, dimensions and critical features of the balloon and its gondola, the projected hours and methods of operation, and the staffing. Sky-High agrees that it will notify BPD whenever there are significant modifications to be made to one or more of these elements, including changes in the color or design on the balloon, modifications to the operating procedures or other features that could impact on the Aviation Activity.

(a) The HiFlyer Balloon is a Lindstrand HiFlyer Tethered Aerostat System that has been classified by the FAA as not constituting an aircraft. Should a different system or device be used, Sky-High must obtain a determination that the replacement is classified as an amusement device and not as an aircraft prior to operation.

(b) Sky-High has provided drawings of the HiFlyer Balloon, showing its appearance during the initial period of operations. All parties acknowledge that Sky-High and BCM will be making periodic changes to the design to reflect (i) changes in sponsorship, or (ii) special events being promoted, or (iii) normal "refreshing" of the design or colors. BPD acknowledges that the more visible the design, the more in keeping with this MOU the HiFlyer Balloon will be; accordingly, unless Sky-High or BCM propose to operate without color or design on the surface of the balloon, this MOU is not intended to grant to BPD review authority over design or content on the surface of the balloon or its gondola.

2.2. The Aviation Activity. BPD has provided information to Sky-High and BCM regarding the operation of the Aviation Activity in order to make Sky-High, as the owner and operator of the HiFlyer Balloon, aware of such matters in devising an operating protocol for the HiFlyer Balloon. BPD agrees that it will in good faith attempt to keep Sky-High advised of any significant modifications being considered to the Aviation Activity, including an increase in the number of vehicles operating at any one time, however BPD can and will make such decisions in the best interests of public safety and without the need for consent or approval from Sky-High.

3. <u>Communication</u>. The parties agree that on-going communication between and among the Aviation Activity, the operators of the HiFlyer Balloon, local tower controls and other aircraft in the area is vital to the safety of all concerned. Furthermore, Sky-High will purchase communication equipment, which enables direct contact with Aviation Activity in the local area on Air-to-Air Frequency 123.025. In the interest of public safety, Sky-High will monitor this station at all times during operation and will yield the right-of-way upon notice by public safety operations. . In accordance with the FAA Determination, the Hi-Flyer will not ascend when active helicopter operations (meaning lift-offs and landings) are being conducted at the BPD heliport. When notified, the amusement device will return to its mooring for the duration of the active operations at the heliport.

4. <u>Illumination and Warning Devices</u>. The parties agree that the HiFlyer Balloon must implement and maintain a methodology by which both the envelope of the balloon, the gondola and the cable can better be seen and noticed by not only the Aviation Activity, but by others using the airspace above the Property. The use of multi-colored streamer cable attachments spaced evenly in fifty foot increments starting at 150 feet , along with night-time illumination devices, which work to help identify the cable from all directions, spaced evenly in fifty foot increments on the cable at heights above 150 feet will satisfy this requirement. To the extent, in BPD Aviation Unit's reasonable judgment, the illumination and warning provisions provided in this paragraph are not adequate, Sky-High, in furtherance of public safety, agrees to discuss in good faith and, if appropriate, make modifications to the illumination and warning measures.. Both parties agree to discuss issues of visibility in good faith before seeking to suspend or terminate operations. Any illumination or warning enhancements must meet or exceed any applicable FAA standards. The guiding principle and standard utilized to determine what modifications will be necessary to increase visibility will be aviatior safety, public safety, and the effective illumination of the Hiflyer operation.

5. <u>Weather Information</u>. The parties agree to share information on a regular basis regarding weather conditions within the vicinity of the Property and the Police Building as available and as requested. In addition, upon further consideration, review and approval by each party, Sky-High and the BPD will evenly split costs (individual costs not to exceed $3000.00) to establish and maintain a permanent weather station on the roof of the Police Building within six months of the signing of this MOU. In any event, Sky-High agrees that the HiFlyer Balloon will not be operated when wind speeds equal or exceed twenty-five (25) knots or are likely to cause the HiFlyer Balloon to sway within 75 feet of the Police Headquarters Building.

6. <u>Cooperation</u>. The parties agree to cooperate with each other in seeking to promote the safe and continuous operation of the HiFlyer Balloon as a major new

attraction for the economic development of Baltimore City without jeopardizing or impeding the public safety mission of the BPD aviation unit.

6.1. In order to maintain and promote the spirit of cooperation between the parties, Sky-High and BPD agree to establish a schedule of meetings and to use those meetings as an opportunity to evaluate performance under this MOU.

6.2. To the extent any dispute arises with regard to the implementation of this MOU, deference shall be accorded to the BPD determinations with regard to matters of public safety.

7. The parties agree that in the event FAA sends written notice to BPD that continued simultaneous operation of the BPD helipad and the HiFlyer Balloon will result in the loss of certification by FAA of the BPD helipad on the Police Building, Sky-High will modify operation of the HiFlyer Balloon to the extent necessary to avoid decertification of the BPD helipad. Sky-High will be permitted to challenge such FAA decertification, however, during such a challengeSky-High will suspend operations if necessary to keep the helipad operational. Notwithstanding the other provisions of this paragraph, a threatened or actual decertification based primarily on reasons other than the operation of the HiFlyer Balloon shall not have any effect on the operation of the HiFlyer Balloon; however, in such event Sky High shall use its commercially reasonable best efforts to assist the BPD Aviation Unit in maintaining its FAA certification of the BPD helipad on the Police Building.

TO CONFIRM THE AGREEMENT OF ALL PARTIES TO THIS MOU, EACH HAS SIGNED IN THE SPACE PROVIDED BELOW ON THE DATE INDICATED BY THE SIGNATURE LINE.

BALTIMORE POLICE DEPARTMENT

BY: ____________________

SKY-HIGH OF MARYLAND, LLC

BY: ____________________

BALTIMORE CHILDREN'S MUSEUM, INC.

BY: ____________________