"The First Portable Hyperbaric Chamber for the Treatment of Acute Mountain Sickness"

TRAINING AND REFERENCE MANUAL

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REQUIRED READING

PURPOSE

This manual explains and discusses all functional aspects of The Gamow Bag and is to be used for training and reference.

INTRODUCTION

Welcome to The Gamow Bag Training and Reference Manual. This manual is designed to take you step-by-step through each functional aspect of the Gamow Bag and to serve as an outline for Distributors and Trekking Coordinators/Leaders.

INTENDED AUDIENCES

- Distributors
- Trekking Coordinators/Leaders
- Trekking Guides
- Medical Personnel

CAUTIONS

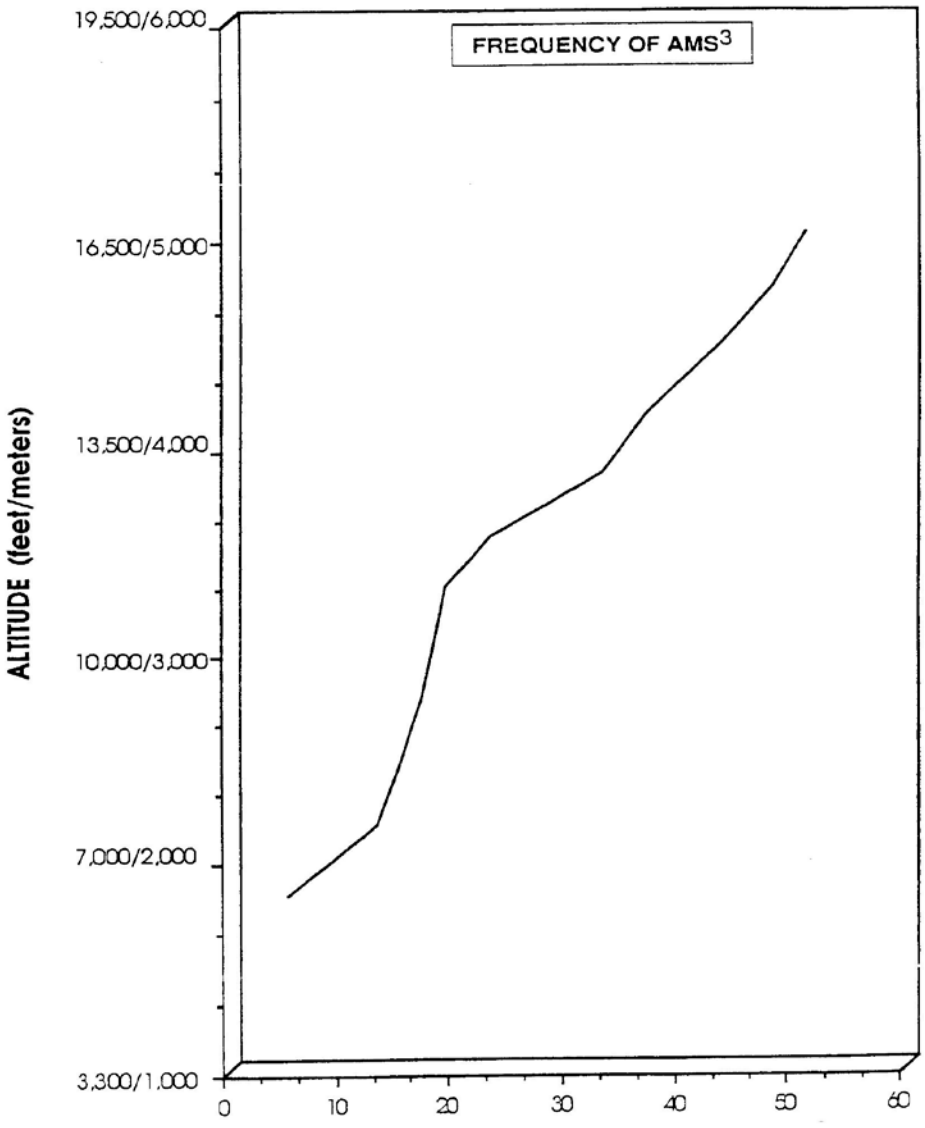
The Gamow Bag has been designed as a portable device to provide temporary first aid treatment to patients suffering from varying degrees of acute mountain sickness on location, and is to be used ***only*** by trained users. Because most first aid devices are used in unpredictable environments, a controlled set of conditions is not possible. With that key point in mind, use The Gamow Bag ***only*** as prescribed in this manual. **This product has not been tested in accordance with ASME PVHO standards. This chamber is a Class II medical device. Caution: Federal law restricts this device to sale by or on the order of a physician.**

The training and reference material contained in this manual should be used in conjunction with standard medical protocol and ***is not*** intended to supersede any established medical protocol for standard victim care.

Although the use of hyperbaric therapy as an effective first aid treatment is well established, The Gamow Bag should ***only*** be used on a temporary or emergency basis when standard medical care ***is not*** available.

WARNING: This device is intended for use with ambient air. DO NOT use with enriched oxygen concentrations.

FREQUENCY OF AMS

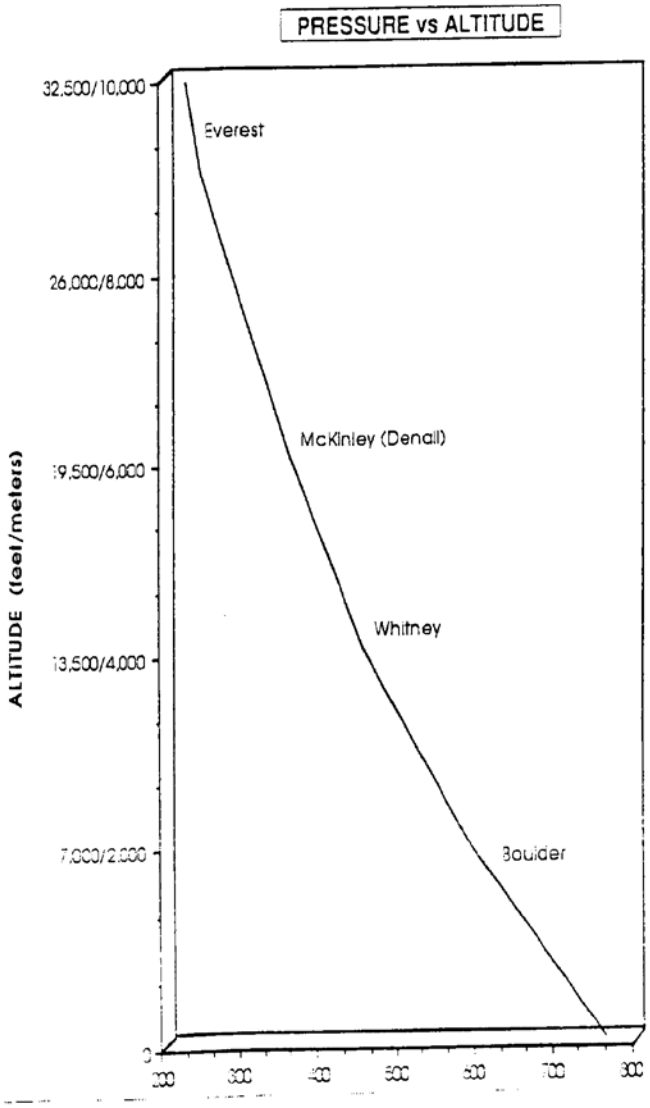


PHYSIOLOGY

The complex sequence of physiological changes that lead to all types of altitude illness is not yet fully understood. It is felt, however, that a low oxygen pressure combined with a low total barometric pressure is the initial inciting event.

The decreased pressure at 3000m (9843ft) results in an arterial PO_2 (PaO_2) of less that 60 mm Hg, a level generally regarded as hypoxic. Above 6000m (19696ft) the PaO_2 can drop to as low as 30mm Hg.

A gradual ascent of 300m (984ft) per day at altitudes over 3000m (9843ft) is usually effective in reducing the chances of suffering from AMS.



PHYSICS OF ALTITUDE

It is common knowledge that as one ascends in altitude the air becomes "thinner" and the barometric pressure drops. This is due to the fact that air has weight and that the air pushing down from above makes up the barometric pressure.

However, the change (Δ) in the barometric pressure with increasing altitude is not even. This uneven increase is described in theory, by the gravitational distribution law[4] which calculates the change (Δ) caused by the mass of air above you. The graph on the left illustrates how pressures changes as you increase in altitude.

Depending on weather conditions, seasons, and geographic locations barometric pressures can vary significantly.

An equation such as the gravitational distribution law is quite useful in predicting approximate changes in altitude that are simulated when using The Gamow Bag portable hyperbaric chamber.

Simulated Descent

The following table shows the altitude that is simulated when using a Gamow Bag that is pressurized to 2 psi (103 mm Hg). It can be seen that the maximum possible descent would be from the top of Everest at about 9000m (29,529ft) to about 6198m (20,334ft); **a descent of about 2800m (9195ft):**

AMBIENT CONDITIONS			**INSIDE GAMOW BAG**			
Meters	Feet	mm Hg	Meters	Feet	mm Hg	Δ Change (ft)
0	0	760	-1022	-3353	863	3353
300	984	731	-751	-2464	834	3448
600	1969	705	-495	-1624	808	3593
900	2953	679	-232	-761	782	3714
1200	3937	654	24	78	757	3859
1500	4921	630	288	945	733	3976
1800	5906	607	535	1755	710	4151
2100	6890	584	798	2618	687	4272
2400	7874	562	1054	3458	665	4416
2700	8859	541	1310	4298	645	4561
3000	9843	522	1555	5102	626	4741
3300	10827	503	1805	5922	607	4905
3600	11812	484	2053	6736	588	5076
3900	12796	466	2299	7543	570	5253
4200	13780	449	2544	8347	553	5433
4500	14765	433	2787	9144	537	5621
4800	15749	417	3028	9935	521	5814
5100	16733	401	3268	10722	505	6011
5400	17717	387	3505	11500	491	6217
5700	18702	372	3741	12274	476	6428
6000	19686	359	3975	13042	463	6644
6300	20670	345	4206	13800	449	6870
6600	21655	333	4436	14555	437	7100
6900	22639	320	4664	15303	424	7336
7200	23623	309	4890	16044	413	7579
7500	24608	297	5113	16776	401	7832
7800	25592	286	5335	17504	390	8088
8100	26576	276	5554	18223	380	8353
8400	27560	266	5771	18935	370	8625
8700	28545	256	5986	19640	360	8905
9000	29529	246	6198	20334	350	9195

Simulated Descent

CHAPTER 2:
THE GAMOW BAG
AS TREATMENT

This is **The Gamow Bag as Treatment** chapter and it discusses the following aspects of The Gamow Bag:

- Acute Mountain Sickness (AMS)
- Typical Treatment
  - Victim Capability
  - Rescuer Capability
  - Transportation Availability
  - Methods
  - Transportation Difficulty/Conditions
  - New Treatment: The Gamow Bag
  - Use Precautions

INTRODUCTION

The Gamow Bag has been designed as a portable device to provide temporary first aid treatment to victims suffering from varying degrees of acute mountain sickness on location, and is to be used ***only*** by trained users.

The training and reference material contained in this manual should be used in conjunction with standard medical protocol and ***is not*** intended to supersede any established medical protocol for standard victim care.

Although the use of hyperbaric therapy as an effective first aid treatment is well established, The Gamow Bag should ***only*** be used on a temporary or emergency basis when standard medical care ***is not*** available.

WARNING: This device is intended for use with ambient air. DO NOT use with enriched oxygen concentrations.

ACUTE MOUNTAIN SICKNESS (AMS)

Acute Mountain Sickness affects thousands of people each year who ascend rapidly to altitudes above 2500m (8202ft). AMS is usually characterized by:

- Headache
- Nausea
- Dizziness

TYPICAL TREATMENT

Up until now, after a person had been diagnosed as having AMS, the ***only*** safe and reliable method of treatment was for the victim to be physically moved to a lower altitude. However, physically moving an Acute Mountain Sickness victim is often not very easy nor very practical. Why?

TYPICAL TREATMENT

At high altitudes there are several factors that significantly influence physically moving a victim.

Rescuer Capability

Since in most cases an Acute Mountain Sickness victim cannot help themselves to lower altitudes, someone else, or a team of other climbers, must assist this person. Again, remember that this rescue is taking place at high altitudes, the rescuer(s) are exerting a great deal of energy in a low oxygen content atmosphere, and that they too are possibly suffering from some of the same symptoms as the Acute Mountain Sickness victim that they are trying to rescue. Because of these problems, the rescuers capability to help the victim diminishes very quickly; many times leaving the rescuer as another victim.

Transportation Availability

After a person is diagnosed as having some type of Acute Mountain Sickness, a descent to lower altitudes is imperative to survival. The problem is how to get them to these lower altitudes.

Methods

- An escorted descent to lower altitudes if the victim is capable (rarely) of walking/moving; if the victim is not capable (most cases) of walking/moving, this victim must be carried by another climber, or carried on a litter by several climbers.

- Emergency pickup by airplane or helicopter, provided that there is a vehicle available, that there is suitable landing field, and that the pickup point is not too high for a helicopter to land/takeoff.

Although the two methods described above are possible, they are rarely accomplished without extreme difficulty, personal hardship, danger, and uncertainty.

Transportation Difficulty/Conditions

While an escorted descent to lower altitudes, a litter, or an emergency pickup are possible transportation solutions, consideration and respect must be given to the ambient conditions tin which the rescue will take place.

Depending on ambient conditions:

- additional cases of Acute Mountain Sickness
- cold/dark
- ice
- snow
- extreme fatigue
- rescuer injury
- disorientation
- victim’s condition deteriorating
- lack of a suitable landing field; altitude too high for a helicopter
- burden of the litter

Transportation difficulties and problems can greatly increase.

APPROVED TREATMENT: THE GAMOW BAG

Up until now, after a person had been diagnosed as having AMS, the ***only*** safe and reliable method of treatment was for the victim to be physically moved to a lower altitude. As evidence by information in the earlier part of **CHAPTER 2**, physically moving an acute mountain sickness victim is often not very easy nor very practical.

However, The Gamow Bag has been designed as a portable first aid device that provides temporary treatment to victims suffering from varying degrees of acute mountain sickness on location.

The Gamow Bag works on the simple, yet extremely effective principle of increasing the atmospheric pressure around the victim. The increased atmospheric pressure inside of the Gamow Bag effectively simulates a several thousand foot decrease in altitude, ***without requiring*** the victim to perform any physical movement. (*see* **CHAPTER 1: INTRODUCTION TO ACUTE MOUNTAIN SICKNESS**; *page 4 for actual descent figures*). The Gamow Bag is simply a low pressure, portable version of a normal hyperbaric chamber.

USE

Using the Gamow Bag is easy. The victim can be placed into The Gamow Bag (or they can crawl into it if possible) just like into a sleeping bag. Using a simple foot operated pump to produce pressures of up to 2 psi, The Gamow Bag can be inflated quickly and easily, affording the victim a safe, reliable, and life saving temporary first aid device. If electricity is available the Gamow Bag is equipped with a shraeder valve where as an option a ¼ hp Gast Oil-Less compressor may be connected for continuous venting at 2 psi. The relief valve will control the pressure so it does not exceed 2 psi. (CAUTION: DO NOT use any other compressor other than DAA-P.103EB. May cause over inflation)

PRECAUTIONS

Although the use of hyperbaric therapy as an effective first aid treatment is well established, The Gamow Bag should ***only*** be used on a temporary or emergency basis when standard medical care is not available.

The Gamow Bag ***is not*** intended to be used as a cure for acute mountain sickness. If a victim ***does not*** respond to The Gamow Bag treatments, and the symptoms persist, immediately evacuate the high altitude area for a lower altitude. ***DO NOT*** continue to a higher altitude.

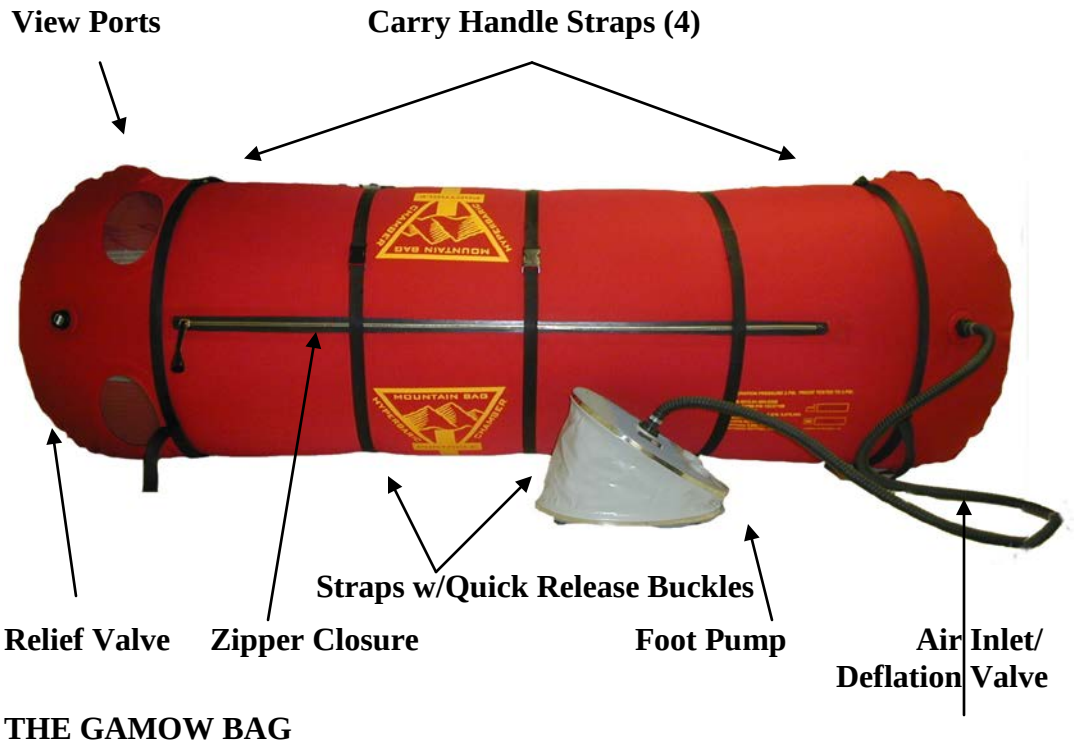
However, if a victim responds well to the The Gamow Bag treatments, and is relieved of all acute mountain sickness symptoms, cautiously climbing back up to the higher altitudes can be done, making sure that the climber is constantly monitored for any recurrence of symptoms.

CHAPTER 3:
GAMOW BAG COMPONENT DESCRIPTION

This is the **Gamow Bag Component Description** chapter and it discusses all of the different pieces that make up The Gamow Bag and how they work together. In this chapter we will be covering the following aspects of The Gamow Bag.

- The Gamow Bag
- Foot Pump
- Intake Valves
- Relief Valve
- Zipper

THE GAMOW BAG



THE GAMOW BAG

The Gamow Bag is constructed out of an acoustically transparent and non-permeable urethane coated nylon material that is:

- durable;
- light weight, and;
- **not compromised** by temperature extremes.

Around The Gamow Bag are five nylon web straps. These straps:

- add structural rigidity;
- limit movement, and;
- tether The Gamow Bag.

Two windows have also been incorporated into the nylon shell of The Gamow Bag to allow:

- victim observation;
- victim/trained user communication;
- ambient light into the Gamow Bag, and;
- a reduced sense of claustrophobia.

FOOT PUMP, INTAKE VALVE

FOOT PUMP

To effectively simulate physical victim's movement to lower altitudes, The Gamow Bag incorporates a simple foot operated air pump that is capable of producing pressures up to 2 psi (103 mm Hg).

This 2 psi pressure increase, can, depending on altitude, effectively simulate to a victim inside The Gamow Bag, an altitude change (decrease) of up to 2802m (9195ft).

INTAKE VALVE

Pressurizing The Gamow Bag is accomplished by first attaching the foot operated pump to the black intake valve located at the foot portion of the nylon bag. (For use with air compressor- use accessory compressor hose)

OPERATION

Insert the foot pump hose by firmly pressing the end connector into the intake valve. Then screw on the end of the hose into the **Center** port of the foot pump marked "pressure". This **Center** hose port will produce **increased volume** of air and makes pumping easier. After initially filling the Gamow Bag fully with air, disconnect the hose from the Center port and attach to the **Lower** port marked "Inflate" . This lower port will produce **increased pressure** to allow a 2 psi inflation.

Caution: Always disconnect hose from Gamow Bag first before disconnecting from foot pump, to prevent air from escaping.

RELIEF VALVE

To limit pressure build-up inside of The Gamow Bag, a pressure relief valve has been incorporated to relieve pressure at 2 psi.

Note: In the unlikely event the relief valve fails to function, simply crack open the zipper slightly to create an exchange of air.

Caution: Check to see if the relief valve is functioning prior to use. If it is not, call for replacement. (1800-382-2491)

Continue pumping at 10 – 20 pumps per minute (ppm) to maintain air flow through The Bag. (**Note:** The chamber is not air-tight and some air loss is expected through the pass-throughs and zipper, however, the foot-pump will maintain 2 psi pressure at the designated ppm)

ZIPPER

The Gamow Bag is equipped with an easy to use and conveniently located aerospace type zipper that allows easy victim ingress and egress to The Bag.

This zipper is:

- durable
- essentially leak-proof, and;
- remains flexible at temperature extremes.

Note: It is recommended that the zipper be stored in the open position when not in use, to avoid taking a compression set. Also, occasionally clean zipper and lubricate with lubricant provided.

CHAPTER 4: SETTING UP AND OPERATING THE GAMOW BAG

This is the **Setting Up and Operating The Gamow Bag** chapter and it discusses the following operational aspects of The Gamow Bag:

- Preparation
- Removal from the Carrying Bag
- Set-Up
- Operating The Gamow Bag (continuous venting)
  - Important Procedures
  - Removing the Victim

PREPARATION, REMOVAL FROM CARRYING BAG, SET-UP

1. Before removing The Gamow Bag from its carrying bag, prepare the surface that The Bag will set on so that it is:
    - Smooth
    - flat as possible
    - free of sharp or jagged edges

2. Carefully unfold the Gamow Bag and lay it on the prepared surface with the zipper and window facing up.

3. Attach the hose from the foot operated air pump to the gray intake valve located near the foot of the Gamow Bag by firmly pressing the hose into the fitting.

OPERATING THE GAMOW BAG (continuous venting)

4. Carefully help the victim get into The Gamow Bag. Have victim sit in the bag with their feet all the way up in the end of the bag. Then lay the victim back in the supine position, being careful not to overstretch the zipper closure.
   NOTE: Depending on ambient conditions, a blanket or sleeping bag may be used for added warmth.
5. Pull the zipper closed until it contacts the end stop. Just prior to full closure have victim, if able, extend arms and legs to enlarge the Gamow Bag, which will reduce the amount of air required for full inflation.
   NOTE: Failure to close the zipper will decrease the effectiveness of The Gamow Bag by not allowing it to attain or maintain full pressure.

NOTE: Two hoop straps have quick release buckles which can be disengaged to allow for ease in entering and exiting chamber. (Reattach prior to inflating)

6. Pump the foot operated air pump to begin inflation.

NOTE: Pump up The Gamow Bag with steady pump strokes for maximum effectiveness.

OPERATING THE GAMOW BAG (continuous venting)

Important Procedures

7. After checking to be sure that the nylon web retaining straps ***are not*** twisted and that they are in their proper locations, you ***must*** now be concerned with establishing and maintaining the inlet volume to be pumped into The Gamow Bag:

Pumps/Minute	Cubic Feet/Minute	Liters/Minute
20	2	58
30	3	87

NOTE:
Since the volume of air delivered by the foot operated air pump varies with both the abilities of the pumper and the altitude, a pump per minute rate of 10 to 20 must be maintained at all times to ensure adequate victim protection from excessive carbon dioxide concentration.

OPERATING THE GAMOW BAG (continuous venting)

Removing the Victim

8. Removing a victim from The Gamow Bag is easy. With your finger, depress and turn the internal valve stem of the air inlet to the lock down position. When in the lock down position, the valve stem will be *locked* open and will allow the pressure inside of The Bag to be released. After the bag has deflated, open the zipper until it contacts the end stop and remove the victim.

CAUTION

After locking down the internal valve stem and removing the victim from The Bag, **MAKE SURE THAT** you return the valve stem to its ***original, not locked down (closed) position*** to prevent any loss of air pressure the ***next*** time The Bag is used.

CHAPTER 5:

VICTIM CONSIDERATIONS

THINGS TO CONSIDER BEFORE USING THE GAMOW BAG

NOTE: *The following list of victim considerations should be addressed* ***before*** *closing the zipper on The Gamow Bag.*

- Make sure that the victim has taken care of personal needs.
- Make sure that the victim is as comfortable as possible.
- Explain, to the victim, that they will be able to communicate normally.
- Establish, with the victim, an emergency visual or oral signal indicating a need to get out of The Bag.

  NOTE:
  In the unlikely event that the zipper cannot be opened, any sharp object, such as a knife, can be used to cut open The Bag. If this need occurs, be careful ***not*** to injure the victim when cutting The Bag.

- Make sure that the victim knows that The Bag will take a few minutes to fully inflate. It should be stressed that The Bag will not inflate instantly. *This is normal.*
- Explain, to the victim, that the air inside of The Bag will be continually exchanged, and that they will have ***no*** difficulty in breathing. **BREATHE NORMALLY**
- Make sure that the victim knows that a momentary stop in pumping is part of the typical operating procedure and that there is ***no*** need to be concerned. *This is normal.*
- Make sure that the victim knows that as the pressure in The Gamow Bag increases, their ears may "pop". If this is the case, instruct them to clear their ears by swallowing. *This is normal.*
- Depending on ambient conditions, a blanket or sleeping bag may be used to keep the victim warm while inside of The Bag.
- Always maintain visual or oral communications with the victim.

- If the victim is capable, ask them to extend their arms and legs outward to partially inflate The Bag prior to closing the zipper. This action will save time and effort when inflating The Bag up to the 2 psi maximum.

CHAPTER 6: SAFETY CONSIDERATIONS

This is the **Safety Considerations** chapter and it discusses the following aspects of The Gamow Bag:

- Safety and The Gamow Bag
  - Otic Barotrauma
  - Decompression Sickness
  - Pulmonary Hyperexpansion
  - Excessive Carbon Dioxide Exposure

SAFETY AND THE GAMOW BAG

Otic Barotrauma

Def. increased (not equilibrating) pressure on the tympanic membrane causing rupture

If the ear canal was blocked, the increase in pressure would not equilibrate across the tympanic membrane, causing ear pain to increase as the pressure increases. If the pressure increase continues, tympanic membrane rupture could occur. This condition, when using The Gamow Bag, is very rare, as pain usually alerts the victim long before any rupture can occur. As a preventative measure against this condition, try to exclude victims with:

- blocked ear canals
- upper respiratory infections

If the victim's mountain sickness is very serious, try treating the victim by very slowly pumping up The Gamow Bag while constantly asking/monitoring the victim for any signs of pain or discomfort.

However, if pain or discomfort persists, stop pumping The Gamow Bag immediately. DO NOT continue treatment.

Pulmonary Hyperexpansion

Def. uncontrolled expansion of a volume of air in the lungs that is caused by a rapid pressure drop

If The Gamow Bag looses pressure rapidly, there is concern that Pulmonary Hyperexpansion could occur. This is possible only under the following circumstances:

- The victim would have to have completely filled their lungs with air, and be holding their breath at the time of decompression. This would cause the air in the lungs to expand, and possibly cause damage.

Because breath holding is a natural tendency while underwater, most cases of Pulmonary Hyperexpansion have been reported by divers. Fortunately, breath holding is not a usual response during rapid decompression in a hyperbaric chamber, as the expanding air would stimulate exhalation. ***Keeping this in mind, all victims that are treated in The Gamow Bag must be informed that, in the unlikely event of a rapid decompression, they must exhale.***

SAFETY AND THE GAMOW BAG

Excessive Carbon Dioxide Exposure

Def. a disorder caused by excessive carbon dioxide inhalation

The victims inside of The Gamow Bag are in an enclosed structure and are expiring carbon dioxide. This carbon dioxide is concentrated to a level that is determined by the rate at which fresh air is pumped into The Bag.

By strictly following the pumping rate given in this manual, the equilibrium value for carbon dioxide concentration will remain at less than 1%.

CHAPTER 7: PRODUCT SPECIFICATIONS

VOLUME OF GAMOW BAG

- 17 cubic feet

WEIGHT

- 6.9 lbs— The Gamow Bag w/o carrying pack/air pump
- 13.4 lbs—The Gamow Bag w carrying pack/air pump

PRESSURE RELIEF VALVE

- 2 psi (103mm Hg) maximum

TIME TO INFLATE

- approximately 8 minutes

PUMPS PER MINUTE (PPM) TO MAINTAIN PRESSURE AND TO FLUSH CARBON DIOXIDE

- approximately 10 to 20 pumps per minute (ppm)