DEPARTMENT OF THE AIR FORCE
42D AIR BASE WING (AETC)
MAXWELL AIR FORCE BASE ALABAMA

12 OCT 2009

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Mr. John Greenewald, Jr.
[redacted]

Dear Mr. Greenewald

We have processed your Freedom of Information Act request (FOIA), for a copy of the document Space Race in the 1930s. All releasable information responsive to your request is enclosed.

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Sincerely

Gerald Yap

GERALD T. YAP, Major, USAF

Attachments
Space Race in the 1930s

REPORT NUMBER 83-0350

TITLE SPACE RACE IN THE 1930's

AUTHOR(S) MAJOR RANDALL F. CANNON, USAF

FACULTY ADVISOR MAJOR DENNIS M. GORMAN, ACSC/EDCW

SPONSOR MR. R. CARGILL HALL, AFSHRC/RI

Submitted to the faculty in partial fulfillment of requirements for graduation.

AIR COMMAND AND STAFF COLLEGE
AIR UNIVERSITY (ATC)
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Presents a historical account of 1930's high altitude balloon flights to the stratosphere conducted by the US and the Soviet Union. Compares life-support systems used and emergency/safety design features employed to recover the crew capsules.

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PREFACE

When the subject of a "space race" is mentioned, most thoughts turn to the 1960's race between the United States and the Soviet Union. There was, however, a less notible space race. This first space race began in the 1930's. The primary contestants in this race were, as one might expect, the United States and the Soviet Union.

This paper is a historical account of stratospheric balloon flights launched by the US and the USSR. Each country launched three manned flights to the stratosphere. The technology developed in both life-support systems and emergency design features was used in the 1960's space race.

I am grateful to Mr. R. Cargill Hall of the Simpon Historical Research Center for introducing me to this most interesting phase of aviation history. Dr. Maurer Maurer, Senior historian of the Historical Research Center, has my gratitude for steering me in the direction of little known, otherwise difficult to locate, research documents. My faculty advisor, Major Dennis M. Gorman was most helpful in providing me with feedback on both the literary and the technical aspects of this paper. Finally, I express my heart felt appreciation to my wife Shirley. Without her encouragement and typing support, this paper may well have been an arduous academic exercise rather than an enjoyable learning experience.

ABOUT THE AUTHOR

Major Randall F. Cannon is an Air Force senior pilot with over 3500 hours of flying time. During his career, he has served in both operations and wing staff positions. He holds a Bachelor of Arts degree in Biological Science and a Master in Public Administration degree in Administrative Organization and Management. His professional military education includes Squadron Officers School and Air Command and Staff College.

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EXECUTIVE SUMMARY

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"insights into tomorrow"

REPORT NUMBER: 83-0350

AUTHOR(S): MAJOR RANDALL F. CANNON, USAF

TITLE: SPACE RACE IN THE 1930's

I. Purpose: To review the stratospheric balloon flights conducted by the US and USSR in the 1930's and compare the life-support systems and emergency equipment on board.

II. Historical Data: Although it is not widely known, the US and USSR entered into a space race in the 1930's. The race was conducted through the use of high altitude balloons. The first stratospheric altitude record was set by the Soviet balloon "USSR". The Soviets, however, were denied the official altitude record due to political reasons. The first US entry into the race was the balloon "A Century of Progress". Even though the Soviet balloon reached a higher altitude, the US balloon was awarded the official altitude record. This began a race whereby altitude records bounced back and forth between the US and the USSR. The official world altitude record finally went to the US in 1935. As a result of these flights, several advances were made in the areas of life support systems and emergency equipment design. The pressurized sealed crew compartment, pressurized oxygen breathing system and emergency capsule recovery systems were first used in high altitude balloon flight. The technological breakthroughs made during these flights carried over after WW II and into the 1960's space race. With the outbreak of WW II, both countries ceased stratospheric exploration.

III. Comparisons: The US and the Soviets used similar life-support systems and emergency equipment. They both used oxygen under pressure for breathing and capsule pressurization. The differences

CONTINUED

were only liquid oxygen verses compressed gaseous oxygen and the chemicals used to absorb the carbon dioxide and moisture. In the area of safety devices, both countries relied on parachutes and inflated rubber shock absorbers to recover the crew capsules.

V. Summary: The US and the Soviet Union entered the first space race in the 1930's. Their life-support systems and safety design features were very similar. The technology developed during this initial space race carried over and provided the foundation for the 1960's space race.

CHAPTER ONE

INTRODUCTION

Throughout history mankind has been fascinated by the prospects of flight. This fascination dates back to the mythical Greek story of Icarus. You may recall that Icarus escaped imprisonment by fashioning wings from feathers secured by wax and flying away. In the excitement of his new found flying experience he flew too high and too close to the sun. By flying so high, the heat from the sun melted the wax fastening his feathers. Icarus fell to the earth and now has the distinction of being one of our first air fatalities. (1:5) The mythical story tellers of the day relating Icarus' fate could be considered the forefathers of the modern day accident investigation board. In their findings they learned something about the melting point of wax. Throughout aviation history similar aircraft accident investigation boards have made technological discoveries. More often, these technological breakthroughs resulted from detailed in-flight experimentation. The in-flight experimentation often led to direct competition between scientists. When these scientists were from different countries, heated competition to be the first or the best took on an international flavor. This was the case in the 1930's between the United States and the Soviet Union. The successes of Swiss Professor Piccard, Capt Gray of the US Army Air Corps, and Gorgio Prokofieff of the Soviet Union helped launch the United States and Russia into a race to the stratosphere. (2:183) The competition, in conjunction with this race, fostered several technological advances. Some of these technological advances included a pressurized oxygen breathing system, a pressurized aircrew capsule, and a safety capsule recovery system. Several of the basic principles learned from these early flights are still valid and, in some cases, were even used on space flights of the 1960's. The 1960's space flight crews were kept comfortable in pressurized crew capsules of the type developed by Professor Piccard. (45:6) Parachutes, first employed by the US Army Air Corps as a safety feature, were used to recover the US space capsules. Huge inflated rubber shock absorbers, first used by the Soviet Union to recover their balloon gondolas, were used to recover Soviet space capsules in the 1960's. Before addressing the actual US and Russian balloon flights

conducted in the 1930's, a review of some of the more memorable early balloon flights leading to this early space race is in order.

CHAPTER TWO

BACKGROUND

Balloon flight as we know it began in the 1700's. The Montgolfier brothers from France launched a hot air balloon in 1783. The first air passengers were suspended below the balloon in a wicker basket. The passengers were a sheep, a duck and a cock. (1:97) In that same year, J.A.C. Charles successfully launched a balloon filled with the newly discovered gas, hydrogen. (1:99) Again in 1783 French balloon pioneer Jean-Francois Pilatre de Rozier launched a combination hydrogen/hot air balloon. The creator apparently was not concerned about the explosive hydrogen gas since his design called for the hot air portion of the balloon be heated by an open flame. At an altitude of 4,920 feet, while releasing hydrogen from the balloon, it exploded costing de Rozier his life. Those in the military did not wait long to seize a golden opportunity. An enterprising French military officer, Guyton de Morveau, suggested using observation balloons during military campaigns. (1:106) Balloon designs and size varied little in the next ninety years. Since balloon flights, during that time, were restricted to only a few thousand feet in altitude, there was no need for any supplemental oxygen.

In 1875 the French team of Sivel, Croce-Spinelli and Tissandier attempted a balloon flight in an open gondola using supplemental oxygen. The team used a pressurized gasious oxygen and nitrogen system. The proportions of oxygen and nitrogen would be varied depending on altitude. Below 18,000 feet the proportion was 40% oxygen and 60% nitrogen. Above 18,000 feet the proportion was changed to 70% oxygen and 30% nitrogen. (45:4) Two of the aeronauts lost consciousness during their ascent to 28,280 feet and died after losing their oxygen mouth pieces. The third team member, Tissandier, also used the supplemental oxygen and lost consciousness. His survival was contributed to his excellent physical condition. (1:123) During the time he was conscious, he kept detailed notes. His records were one of the earliest first hand accounts of hypoxia which greatly helped the study of aviation medicine. (45:4) Seeing that man could reach

altitudes of over 28,000 feet and survive created interest in conquering the unknown. The area to be conquered was the stratosphere. The first real exploration of the stratosphere was by the U.S. Army Air Corps in 1927.

The U.S. Army Air Corps launched its study of the stratosphere using a hydrogen filled balloon and an open gondola. The pilot for this momentous flight was Capt Hawthorne Gray. Equipped with supplemental oxygen, Capt Gray began his ascent to the stratosphere on November 4, 1927. The flight was apparently normal up to approximately 40,000 feet. During the ascent he kept detailed notes on altitude, atmosphere, and his own physical condition. His records show his physical condition deteriorated while breathing unpressurized supplemental oxygen. With what must have been his last conscious effort, he opened the balloon gas relief valve at approximately 40,000 feet. The balloon continued to climb to 42,470 feet before it began to descend. Sometime during the descent Capt Gray died of hypoxia. (41:109) His body was later found by a teenager near Sparta, Tennessee. Capt Gray's detailed notes and his autopsy also contributed greatly to aviation medicine. (45:4) One dramatic breakthrough was the discovery that blood is unable to absorb oxygen at higher altitudes without pressure. Armed with this knowledge, Professor Piccard designed a metal gondola for balloon flight.

In 1931 the Swiss physics professor Augusto Piccard designed a spherical, pressurized sealed gondola. Within the gondola he installed a breathing apparatus that supplied breathable oxygen for the crew and at the same time pressurized the gondola. The gondola pressure was needed to force the supplemental oxygen into the bloodstream. In addition to the oxygen system, he added an apparatus to absorb the carbon dioxide given off by the crewmembers. Professor Piccard reached an altitude of 51,775 feet. The flight was not, however, uneventful. During the ascent, a leak developed in the capsule. It was quickly remedied with a cork and some vaseline. (45:4,5) Professor Piccard conducted several more balloon flights and dominated the stratosphere until 1933 when the U.S. Navy launched a balloon establishing a new official world altitude record.

CHAPTER THREE

US FLIGHTS

The first successful attempt to explore the stratosphere in a free balloon was by Navy Lieutenant Commander T.G.W. Settle and Marine Major Chester L. Fordney. (17:89) Apparently there were no allocated government funds to support stratospheric exploration. This venture was supported by private industry. The government did, however, provide manpower services. The Navy agreed to supply the pilot and observer along with some ground support personnel. (42:4) The balloon itself was provided by the Goodyear-Zeppelin Company of Akron, Ohio (17:89), the hydrogen gas used to fill the balloon was provided by the Union Carbide and Carbon Corporation (17:89), and the gondola was built by the Dow Company. (18:10) With 600,000 cubic feet capacity the balloon was filled with only 110,000 cubic feet of hydrogen to allow for expansion during the ascent. (32:3) Less than half that amount would be needed for the descent. (32:3) The gondola was constructed of a magnesium alloy, commercially known as Dowmetal, one-third lighter than aluminum. (18:10) All production schedules for the balloon and gondola were met with no problems. The originally scheduled flight was to be a major attraction at the Century of Progress International Exposition in Chicago. (17:90)

Wind and weather conditions in Chicago initially were unfavorable for a safe launch. The first attempt resulted in the balloon rising only a few thousand feet and landing in a nearby railroad yard. (17:90) This unsuccessful attempt did not discourage the crew nor the civilian sponsors. The balloon was repaired and made ready for another launch; however, wind and weather conditions did not cooperate. The Exposition closed November 12, 1933 and the balloon, "A Century of Progress", was still not launched. (17:90) The decision was then made to transport the balloon to Akron, Ohio and launch it from the Goodyear-Zeppelin Dock. (17:89) "A Century of Progress" was launched November 20, 1933 reaching an unofficial altitude of 59,000 feet. (32:3)

During the flight, Commander Settle and Major Fordney

were so busy conducting experiments they hardly spoke except to talk on the radio. They saw themselves as technicians operating machines on behalf of the scientists. (19:3) They were allowed to operate these machines in a rather unencumbered environment due to the pressurized sealed gondola. Within the gondola was a primitive, by current standards, life-support system. Liquid oxygen carried in tanks was released into the gondola as required. (18:11) Carbon dioxide was absorbed by an unannounced substance used by the Navy in submarines. (19:3) The only problem encountered was that of excess humidity. The gondola quickly became saturated with moisture from perspiration and breathing. (33:17) Upon completion of the onboard experiments and expiration of the planned time aloft, descent was begun.

The "Century of Progress" landed in a New Jersey marsh shortly before dark. The crew felt it was too dangerous to attempt to walk out during darkness. Commander Settle and Major Fordney spent the night wrapped in the balloon fabric. (32:3) The crew did not, however, escape unscathed. Commander Settle sustained a cut on his forehead when the barograph, used to confirm the attained altitude, swung loose from its bracket upon landing impact. Major Fordney received a bump on the top of his head when he was hurled through an open porthole into the mud at the moment the gondola settled and rolled forward about 45 degrees. (32:3) This first attempt to explore the stratosphere was indeed a success. All the planned experiments were completed and, more importantly, the crew and machine returned safely. Commander Settle predicted, after the flight, that a balloon with a 1,500,000 cubic feet capacity could be built to attain an altitude of 75,000 feet. (19:3) These two heroes of the day were praised by the civilian and military communities as well as by the Soviet Union. They received a telegram from the Soviet Commissar for Foreign Affairs which stated: "Hearty congratulations on your great achievements. I am sure your collegues in the Soviet Union have watched with greatest interest your flight. May both our countries continue to contest the height in every sphere of science and technique." (32:3) The word "collegues" did not surprise the "Century of Progress" crew. They were informed shortly before their launch a Soviet balloon had reached an unofficial altitude of 62,000 feet. (17:90) It was unofficial because the Soviet Union did not recognize the "Internation Aeronautic Federation" which confirmed all world altitude records. It was understandable the Federation would not recognize the Soviet Union altitude record. The Internation Aeronautic Federation did, however, accept the US official altitude record of 61,237 feet. This was about 2,000 feet higher than originally thought. (24:9)

With this altitude record, the "contest" mentioned in the Soviet telegram was begun. (2:183) Both the US and the Soviet Union downplayed the altitude record aspect of all the stratospheric exploration flights. Scientific discovery was the official primary purpose of these flights.

There was, indeed, a need for scientific experimentation in the stratosphere. The stage of aircraft development and lack of high altitude life support equipment kept aircraft below 50,000 feet as late as 1934. In the summer of 1932, a year before the Soviet flight of "USSR", Capt Albert Stevens came to Major William Kepner with a proposal to complete the job started by Capt Hawthorne Gray in 1927, Major Kepner was enthusiastic and agreed to help, but felt he needed some time to decide whether he would go along. After the tragic loss of Capt Gray and the cost of $60,000 to the government, Major Kepner felt it would be difficult to get support from the Army Air Corps. Capt Stevens' persistence and determination paid off. After gaining a tentative commitment from the National Geographic Society to sponsor the entire flight, he wrote a proposal to the Chief of the Army Air Corps. In his letter, he assured the Chief that the National Geographic Society and civilian businesses and individuals would finance the entire expedition. The Air Corps would provide only the crew and some support personnel. He went on to state the gondola would take about 90 days to build and construction of the balloon would take only 120 days. The total cost to the Air Corps, including a pilot and plane to calibrate the instruments, would be not over $5,000.00. Although he stated an altitude record would only be a secondary objective, he expected to exceed all previous altitude records by reaching 80,000 feet. He goes on to recommend Major Kepner as the pilot with Capt Orvil Anderson as the backup pilot and himself as the scientific observer. (43:18) B/G Pratt, Chief of Materials Division, indorsed Capt Stevens' letter agreeing with his assessment. Gen Pratt, However, gained a commitment from National Cash Register to provide storage space for the balloon and gondola, thus reducing the cost to the Air Corps to an estimated $2,500.00. (39:1) B/G Oscar Westover, the acting Chief of the Air Corps, approved the joint venture. General Westover went further to officially designate it the National Geographic Society-Army Air Corps Stratosphere Flight. (46:1) With the approval of the Chief, Capt Stevens began supervising the construction of the balloon known as "Explorer."

The balloon itself was again constructed by the Goodyear-Zeppelin Company. This balloon was five times larger than "A Century of Progress" and three and a half times larger than

the Russian balloon. (34:588) The spherical gondola was constructed of Dowmetal and welded together in eight sections shaped like orange peels. (35:107) It was 100 inches in diameter, 1 and 1/3 times larger than the Settle/Fordney gondola, and slightly less than 1/5 of an inch thick. (34:590) Vertical tubular posts strengthened the shell and maintained the globular shape. (36:590) Other design features included a separate parachute for the gondola designed by Major E.L. Hoffman and a partially inflated pneumatic bumper on the base of the gondola. (31:411) Oxygen and pressure for the crew were provided by evaporating a liquid oxygen/nitrogen mixture and circulating the air with a small electric fan. Carbon dioxide was absorbed by chemicals held against the gondola walls by steel screens. (15:127) During the construction phase, Major Kepner and Capt Stevens flew around the country looking for the ideal sight from which to launch the "Explorer."

The sight selected for the launch was "Moonlight Valley" near Rapid City, South Dakota. (15:125) The valley was over 400 feet deep with almost perpendicular walls, ideal for inflating the balloon. After consulting historical wind and weather conditions, it also appeared to be the ideal sight for the launch. Once support equipment was brought in and new road construction began, Moonlight Valley was then known as "Stratobowl." (15:125) During the construction at Stratobowl, Major Kepner periodically briefed General Westover on the progress. At one of these briefings, General Westover suggested that a two man crew might be too busy conducting the planned experiments and thought it might be prudent to have the backup pilot, Capt Anderson, go along. He left the final decision to Major Kepner. (15:126) After discussing it with Capt Stevens, Major Kepner decided to add Capt Anderson to the crew. With all construction and coordination for support equipment complete, "Explorer" was ready to be inflated.

The 2 and 1/3 acres of cotton cloth were filled with about 230,000 cubic feet of hydrogen. A mere 1/13 of the 3,000,000 cubic feet capacity. (34:588) Explorer launched from Stratobowl on July 28, 1934. The crew conducted their experiments on schedule and found time to talk to the entire nation over a radio link set up by NBC. (15:126) The Explorer flight was not, however, uneventful.

All went well until a strange tapping noise was heard coming from the top of the gondola. Upon looking out the top observation window, it became obvious what was making the noise. There was a rip in the balloon fabric about 30 feet long. The crew immediately decided to begin a descent

from their present 60,000 feet altitude. Their momentum and the fact the sun was heating the hydrogen almost as quickly as it could be vented, carried the crew to an altitude of 60,613 feet. (16:113) During the descent, the balloon tore half loose and became a 3,000,000 cubic feet parachute. At about 18,000 feet the crew depressurized the gondola and Major Kepner climbed out to inspect the balloon. He immediately determined there was a considerable amount of hydrogen still under the canopy. (16:113) It was at this time Major Kepner ordered the rest of the crew to jump. (16:113) At about 5,000 feet the hydrogen exploded and the gondola began to free fall towards the earth. (16:113) Major Kepner then jumped and watched the gondola as it landed in a field about 4 miles north of Loomis, Nebraska. (16:113) The data collected from Explorer was used in preparing for the follow-on flight of Explorer II. (16:113)

Several changes were made to the co-sponsored National Geographic Society-Army Air Corps follow-on balloon and gondola for Explorer II. The balloon fabric was strengthened and increased to 3,700,000 cubic feet capacity adding only 65 pounds to the total payload. The explosive hydrogen gas which almost caused a tragedy for Explorer was replaced with the more stable helium gas. Finally, a small Dowmetal platform was placed under one of the portholes and the portholes were widened by 2" to facilitate jumping in the event of an emergency. (40:2) Since the life-support oxygen and pressurization systems worked well, only minor changes were made. These changes were more along the lines of refinement and sophistication. The only other change of any consequence dealt with the crew. The entire Explorer crew was scheduled again to crew Explorer II. The chief of the Air Corps, however, felt he could not spare Major Kepner. He wanted him to attend the Air Corps Tactical School at Maxwell AFB, Alabama. (40:6) The crew of Explorer II consisted of only Capt Orvil Anderson as the pilot and Capt Albert Stevens as the observer. This two man crew reached a new official world altitude record of 72,395 feet on November 11, 1935. (41:114) During this flight, experiments were conducted in composition of stratospheric air, conductivity of electrical current, observations on cosmic rays, and survivability of micro-organisms in the stratosphere. (45:6) Explorer II put the US solidly into the business of space research. (15:128) During this same period, as mentioned earlier, the Russians were also exploring the stratosphere.

CHAPTER FOUR

SOVIET FLIGHTS

The previous chapter discussed the US successes and failures in stratospheric exploration. During this same time, the Soviet Union was also exploring the stratosphere. The first indication the Western World had of this Soviet exploration came during a news conference in February 1933. M. Molinovski, secretary of the Soviet Air League, revealed the fact the Soviets had been studying Professor Piccard's work for the past two years. He went on to state the Soviet Air League was in the process of constructing, in Leningrad, their own version of Professor Piccard's balloon. (8:1) The Soviet aerostat, as it was called, would have several modifications. To begin with, the gondola would be cylindrical rather than sperical and would be enclosed in a basket for ease of attachment to the balloon. The gondola would be constructed of riveted non-magnetic metal and have space for three passengers. A pilot, a radio man, and a scientist. (8:1) There was to be one window at the bottom of the gondola with four upper windows. Two of these upper windows projected out so the crew could read the external instruments. The balloon, designed by Chertofsky, had a 88,375 cubic feet capacity and was to be filled with hydrogen gas. (28:1) The life support system was a Dreager breathing apparatus similar to those used in submarines. It consisted of compressed oxygen periodically released into the gondola. The cabin air was then passed through a potash cartridge to absorb carbon dioxide and moisture. During the entire news conference, only the scientific aspect was stressed. There was no mention of an altitude record. (8:1) Between February and August of 1933, the design plans for the first stratospheric aerostat were changed.

The gondola was now to be welded rather than riveted, spherical rather than cylindrical, and measure 94 inches in diameter, slightly smaller than Explorer. The window arrangment was now to be seven windows on the side, one on the bottom, and the entrance on the top with none projecting. The gondola would also have a rubber shock absorber on the bottom

to lessen the landing impact. (26:19) The aerostat now was to look much more like Professor Piccard's original. Shortly after these design changes were announced by the Soviet Air League, the Red Army announced they had constructed there own balloon in Moscow Military Factories #3 and # 39. (27:26)

In their announcement, the Red Army stated they were ready to launch their balloon, "USSR", from Koontseva which was about five miles southwest of Moscow. (27:26) The differences in the two free air balloons were minor. The "USSR" gondola was made of aluminum rather than non-magnetic metal and had two manholes for entrance and exit. The aluminum was 2mm thick and riveted with 5,000 aluminum rivets, rather than welded. (44:1) Rather than compressed oxygen gas, liquid oxygen was used in the life-support system. (10:36) The Soviet government would now have to decide which balloon would be launched first. The decision was made in early September that the Red Army balloon, "USSR" would be the first to launch. (20:12)

When announcing the decision to launch the Red Army balloon, Staff Commander Khripen of the Red Air Fleet stressed, once again, the scientific and technical aspects of the flight and downplayed the altitude record. (20:12) The Soviet press, at the same time, stated there was no "stunt" between the Army and civilian agencies. The western world was led to believe it was a unified effort. In an effort to show unity, the civilian balloon was brought from Leningrad to Moscow for its launch. The official reason for changing the civilian balloon launch site was to use the experience gained from the "USSR" launch and incorporate it in the subsequent civilian balloon launch. (21:11) On September 30, 1933, "USSR" was successfully launched from Koontseva.

The balloon "USSR" reached an altitude of 62,000 feet. (10:1) Only the press and government officials were allowed at the launch site. (22:14) The Soviets attempted to launch the balloon eight previous times, but each time the launch was aborted due to overcast sky, temperature drops and an additional 500 pounds of moisture from a heavy morning dew. (9:17) Once the balloon was finally launched, all the experiments were conducted as planned and the "USSR" landed near Kolomna, about 60 miles southeast of Moscow. (10:1) The three man crew of Georgio Prokofieff (pilot), Ernst Birnbaum (navigator) and Konstantin Gudonoff (chief of construction) received a hero's welcome upon their return to Moscow. (11:11) During this hero's welcome, several observations were made by Western journalists. One civilian in Red Square remarked, "It is ours, our balloon, our record

our proof that we no longer are behind Western industry and technique." (11:11) The western journalists felt this balloon had the same psychological effect in Russia as Lindbergh's flight had on the US. (11:11) With this kind of reaction, it is hard to deny the US and Soviets were embarking on a race to the stratosphere.

In the US, Rear Admiral Ernest J. King, Chief of the Naval Bureau of Aeronautics, described the feat as a "very marvelous performance." He was quick to add the altitude record was subject to confirmation by the Federation International Aeronautique. (10:1) You will recall the altitude record was not recognized by the Federation. With the Settle/Fordney flight of November 20, 1933 recognized as the official world's altitude record, the Soviets made plans for the civilian balloon launch.

The Soviet Civil Aviation Authorities maintained tight security about their balloon launch. They made no previous announcements about the launch site, the crew, or the planned date. (23:6) The Western World could expect a news release only after a successful launch.

On January 30, 1934 Ossoviakhim-1 was launched from Mazilovo, 8 miles from Moscow, and reached an altitude of 72,178 feet. (5:13) It had on board a three man crew. Paul Fedeseemko was the pilot, Ilya Oususkim the scientist, and Andrey Vasenko the balloon constructor. (12:1) The initial part of the flight went well as confirmed by radio transmissions from the crew. Radio contact with the crew was lost in the late afternoon. The destroyed gondola was found the next day near Potisky Ostrog about 150 miles east of Moscow. All three crewmembers were dead. (13:1) Air Officer Prokofieff, pilot of "USSR" reported the crash was a result of recklessness on the part of the crew in expending more ballast than wise in order to reach a higher altitude. In attempting the higher altitude, they stayed aloft in excess of the planned time. Without the heating rays from the sun, the hydrogen gas began to cool quickly. Since there was no instrument to indicate descent rate, the crew relied on computing descent rate from the altimeter. What the crew did not know was the altimeter had malfunctioned. (37:8) While the crew thought they were descending slowly, they were actually descending at a dangerous rate. The ropes holding the gondola to the balloon broke due to the stress from the fast fall. The gondola broke lose at 39,370 feet above the ground. (37:1) From the recovered log, it was apparant the crew was unaware of their pending doom until the gondola

broke away from the balloon. (5:13) (see appendix two) The effect of this crash was to spur on Soviet stratospheric exploration with even more vigor. (30:1)

The Soviets began to build a balloon in Leningrad twice as large as those previously built. They added a metal parachute to the top of the gondola, strengthened the shock absorber on the bottom and secured the gondola to the top of the balloon rather than by a belt around the middle. (30:1) This third Soviet balloon attempt at exploration of the stratosphere was June 26, 1936. The new balloon "USSR-1-bis" had a three man crew. Commander Kristop Zille, Professor Verigo, and Engineer Prilutski. (47:1) Although this flight was a success scientifically, it did not break the altitude record held by Anderson/Stevens in Explorer II. It reached only about 42,000 feet. (47:1) The flight was not without its tense moments. During the descent, the balloon fabric was damaged causing the balloon to descend rapidly. At an altitude of about 22,700 feet the balloon began to accelerate. Commander Zille ordered Professor Verigo to jump at about 11,300 feet to lighten the load. The rate did not slow down appreciatively. At 8,100 feet above the ground Engineer Prilutski jumped. At 6,500 feet Commander Zille climbed to the top of the balloon to monitor the balloon skin and landed the balloon safely. (47:1) There was no other serious attempts at stratospheric exploration by either the US or the Soviets until the 1950's.

During this race to the stratosphere between the US and the Soviet Union, new life-support systems and safety design features were developed.

CHAPTER FIVE

LIFE SUPPORT AND SAFETY EQUIPMENT

As mentioned in Chapter Two, the lack of high altitude life support equipment kept aircraft below 50,000 feet as late as 1934. In the attempts by the US and the Soviet Union to explore the stratosphere, improved life-support systems were needed. The early systems consisted of compressed oxygen in metal cylinders, a hose, and some type of mouth piece or mask. (41:109) This type of breathing apparatus proved to be inadaquate on Capt Hawthorne Gray's flight in 1927. Although he was tied to a hose and mouth piece for breathing, it was discovered oxygen alone was not enough to sustain life at altitude. After his fateful flight, the theory of partial pressure for respiration was studied. The result was the development of a sealed capsule providing both oxygen for breathing and pressure to get the oxygen into the bloodstream. (2:181) This new airtight capsule allowed the aeronauts to conduct inflight experiments unencumbered. In addition to sustaining life at altitude, life threatening emergency situations had to be considered. Tragedies such as the Soviet flight of "Ossoaviakhim-1" and near tragedies as those of "Explorer" and "USSR-1-bis" lead to the development of life saving emergency systems. Those systems in "Explorer II" and "USSR-1-bis" are typical. These were perhaps the most sophisticated systems used by the US and USSR respectively.

In the "Explorer II" flight, the gondola was left open until reaching 15,000 feet. At that time, the hatch was closed and the air conditioning system was started. (7:260) A small electric fan was located above a vertical column of metal coils. This fan recirculated the air within the gondola downward over a tower of cotton gauze bags filled with sodium hydroxide pellets. Carbon dioxide and moisture were abosrbed as the air passed over the pads. (7:260) The source for breathable air and gondola pressure was a mixture of 46% liquid oxygen and 54% nitrogen released from cylinders compressed with helium. (7:261) Scientists felt the potentially explosive nature of a pure oxygen system was too dangerous. (31:433) The pressure within the gondola was controlled with

a needle valve venting the excess pressure overboard. The cabin was kept at a constant 13,500 feet pressure altitude. (7:262) Complementing the life support system, several safety devices were designed into the "Explorer II".

The basic safety device was the individual parachute for each aeronaut. A small metal platform was constructed below one porthole to facilitate jumping if the parachutes were used. An 82 feet diameter parachute was attached to the top of the gondola should it become detached from the balloon. (1:203) A more subtle safety feature was the use of helium gas to inflate the balloon as opposed to the more explosive hydrogen gas. (1:203) The Soviet systems were remarkably similar.

The Soviet oxygen system was based on the Dreager breathing apparatus used in submarines and by Professor Piccard in his balloon flights. (10:36) The system used compressed oxygen in metal cylinders. The gas was automatically released into the sealed gondola every two minutes from three gas valves. (3:68) The air within the capsule was passed through a potash cartridge at the rate of 75 liters per minute. This potash cartridge absorbed the carbon dioxide and moisture in the air. (3:68) Absorbing the carbon dioxide and moisture provided a more comfortable environment in which the aeronauts could perform their experiments. Early flights were hampered with stale air and extremes in humidity. (10:1) As for safety devices, the "USSR-1-bis" aeronauts each had a parachute. The portholes were designed to be opened quickly with only one handle. This design feature was used after it was discovered the "Ossoaviakhim-1" crew tried to open one of their hatches which had 24 bolts and only one key with which to loosen them. Before they impacted the ground, they had loosened only seven. (3:106) "USSR-1-bis" had a large metal parachute secured to the top of the gondola to be used if the gondola broke loose from the balloon. The gondola also had a large rubber collar on the bottom to lessen the landing impact. In the opinion of competent Soviet authorities, the metal parachute and the shock-absorber would save the lives of the crew no matter what happened. (30:1)

Even though the exploration of the stratosphere was interrupted by WW II, the US and Soviets used what they learned in the 1930's to explore the realm of space in the 1950's and 1960's.

CHAPTER SIX

SUMMARY

There has always been a fascination with manned flight throughout history. From mythical story tellers to exploration of the stratosphere in the 30's to space exploration of the 60's. When man began to leave the earth's breathable atmosphere new life sustaining systems had to be developed. The compressed air cylinder with a hose and mouthpiece was not enough. New discoveries in aviation medicine dealing with partial pressure for oxygen exchange during respiration lead to the pressurized sealed capsule. As these technological advances made stratospheric exploration feasible, the US and the Soviet Union began a race to the stratosphere.

The US launched three high altitude balloons studying the stratosphere. The US balloon "A Century of Progress" crewed by Lieutenent Commander Settle and Major Fordney set a new official world's record of 61,237 feet in 1933. In July 1934, "Explorer" reached an altitude of 60,613 feet before experiencing a tear in the balloon. The balloon crashed, but all three aeronauts were saved. The next year, "Explorer II" exceeded all previous world altitude records with an altitude of 72,395 feet and held that record until 1956.

The Soviet Union had technically set a world's altitude record of 62,000 feet in 1933, just prior to the flight of "A Century of Progress". The record was, however, denied them for political reasons. That technicality did not stifle their enthusiasm for a race. The flight of "Ossoaviakhim-1" set a new world's record of 72,182 feet in 1934. This exceeded the altitude reached by "A Century of Progress" by 10,000 feet. Unfortunately, in setting the new altitude record, "Ossaviakhim-1" crashed and killed all three aeronauts. The third and final Soviet Union balloon flight prior to the on set of WW II experienced technical difficulties and barely averted disaster.

During the attempt to study the stratosphere safety design features and life support systems went through an

evolutionary process. Parachutes were attached to the metal gondolas in the event the gondola broke loose from the balloon. Pneumatic rubber bumpers were attached to the bottom of the gondolas to lessen landing impact. Breathing systems evolved from releasing compressed oxygen into the gondola to a sophisticated system whereby liquid oxygen was released into several coils causing evaporation. The cabin air was then recirculated through sodium chloride pads to absorb carbon dioxide and moisture. This allowed the aeronauts to complete scientific experiments in an unencumbered environment.

In this bicentennial year of the first manned balloon flight, it seemed appropriate to reflect on the balloon space race between the United States and the Soviet Union. This early competition to explore the stratosphere in the 1930's led to technological breakthroughs in life-support systems and emergency design features which carried through to the space race of the 1960's.

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APPENDICES

APPENDIX ONE

CHRONOLOGY OF FLIGHTS

DATE	BALLOON NAME	ALTITUDE
Sept. 30, 1933	USSR	62,000'
Nov. 20, 1933	Century of Progress	61,237'
Jan. 30, 1934	Ossoviakhim-1	72,178'
July 28, 1934	Explorer	60,613'
Nov. 11, 1935	Explorer II	72,395'
June 26, 1936	USSR-1-bis	42,000'

APPENDIX TWO

OSSOVIAKHIM-1 CREW LOG ENTRIES (37:7)

2:01 - Inside pressure unchanging; the gondola is tight. We are probably drifting southeast, but impossible to tell exactly. We hear the Morse apparatus; the receiver functions.

2:07 - Morale excellent. Eating apples and chocolate; altimeter, 21,200 m (69,544 ft.).

2:20 - Radio functions feebly; descent continues. The envelope contracts. The gondola supports the pressure very well. We descend from the stratosphere.

2:24 - Altimeter, 21,200 m (69,544 ft.). 21,150 m (69,390 ft.): the receiver functions. We cannot hear you. Answer. Sirius. Here, the earth. Answer.

2:36 - We descend slowly; receive radio from ground.

3:15 - We descend; morale excellent; descent slow. Temperature inside, +22°; altimeter, 17,400 m (57,086 ft.). The altimeter sticks and lags. We shall tap it.

3:28 - Altimeter, 17,000 m (55,774 ft.); still going down; altimeter lags. Radio communication stopped. We continue the observations of the cosmic rays.

3:40 - We feel fine. Altimeter, 14,300 m (46,916 ft.) (Time not indicated.)

4:05 - We are dropping fast; considerable discharge of the ....

4:07 - The bright sunlight
The gondola...
Beautiful sky...
...The ground...
...This...
...The sky...
...The balloon...
...It...
Altimeter, 12,000 m (39,370 ft.).

4:13.5 -

The notes stop here. At 4:23 The gondola crashed to the ground.

M-U 43122