

Proton Launch System Mission Planner's Guide

SECTION 1

Introduction

1. INTRODUCTION

The Proton Launch System Mission Planner's Guide (PMPG) is the most comprehensive resource guide available about the Proton Launch Vehicle (LV), the Breeze M Upper Stage (US), and Spacecraft (SC) integration and launch services provided by International Launch Services, Inc. (ILS). Accessible in both electronic and print format, the PMPG allows the user to thoroughly assess the compatibility of the SC payload with the Proton LV system.

The PMPG includes the following planning and technical data:

- Performance and Enhancement data for the Proton LV
- Spacecraft (SC) Environments and Interfaces
- Mission Integration and Management
- Launch Facilities and Campaign
- Quality System
- Customer Data Requirements
- Proton Launch System History

The complete electronic version of the PMPG can be found at www.ilslaunch.com.

Figure 1.1 shows the Proton M Breeze M during launch.

Figure 1.1: Proton M Breeze M Launch



1.1 INTERNATIONAL LAUNCH SERVICES: WHO WE ARE

International Launch Services, Inc. (ILS) is a U.S.-based company with exclusive rights for worldwide commercial sales and mission management of satellite launches on Russia's premier vehicle, the Proton. ILS is headquartered in Reston, Virginia, a suburb of Washington, D.C. The majority shareholder is Khrunichev State Research and Production Space Center (KhSC) of Moscow. The Proton vehicle launches both commercial ILS missions and Russian government payloads from the Baikonur Cosmodrome, which is operated by the Federal Space Agency (Roscosmos) under lease from the Republic of Kazakhstan. We are a complete launch service organization, committed to long-term relationships with our customers. We are at the customer's side from contract signing through mission completion.

The ILS team has accumulated an extensive experience base, with decades of combined expertise, having launched most commercial satellite platforms and worked with all major satellite operators. This breadth of experience helps ILS keep integration times and launch campaigns short, maintaining a steady launch pace.

Proton launch vehicles are designed and built by KhSC in Moscow, the majority owner of ILS. KhSC is home to all engineering, assembly and test functions for Proton production. And now, with the recent consolidation of Russian space enterprises, KhSC has oversight and control of the majority of all Proton manufacturing from suppliers and manufacturers. The consolidation directly supports Khrunichev's ongoing efforts for vertical integration of Proton production and the future Angara launch vehicle. Each Proton commercial mission is assigned to a Khrunichev program director who, in partnership with the ILS program director, personally manages each aspect of the mission from kick-off through launch.

ILS and KhSC provide a single source of comprehensive knowledge and support for:

- Mission Design
- Quality Management
- Mission Management
- Proton Manufacturing
- Marketing & Sales
- Integration
- Licensing Support
- Launch Operations

1.2 RUSSIAN SPACE INDUSTRY CONSOLIDATION

Announced in the summer of 2006 and confirmed by Presidential Decree in February 2007, the first phase of the consolidation of the Russian Space Industry infrastructure is well underway with much of the first phase nearing completion. The consolidation plan is being overseen by Roscosmos, the Federal Space Agency, one of the partners in the International Space Station (ISS) program.

The first phase of the consolidation is scheduled to be complete in 2010, with 8 - 10 organizations merged. The second phase is scheduled to be finalized by 2015 with four remaining core centers: KhSC, RSC Energia, ISS Reshetnev and Progress. Upon completion, 90% of the current 112 Russian space enterprises will be consolidated.

The result of the consolidation is significant for KhSC and ILS. The entities merged under KhSC directly support KhSC's ongoing efforts for vertical integration of Proton production and the future Angara launch vehicle. This includes the suppliers, subcontractors and manufacturers of all Proton engines ensuring additional streamlining and enhancement of systems, processes and hardware, as well as increased access and production capabilities.

Some of the major space enterprises that have been merged under KhSC to date are:

The Isayev Chemical Engineering Design Bureau (Khim mash) - Khim mash is the leading Russian designer of liquid propellant rocket engines that are used in ILS's Proton's Breeze M, Breeze KM for Rokot, and the Fregat upper stages used on Soyuz and Zenit. The Khim mash-made rocket boosters are also used in anti-aircraft rockets, manned spacecraft and space stations.

Voronezh Mechanical Plant (Voronezh) - This mainstay research and production complex has produced aerospace engines since 1940 and began producing rocket engines in 1957. As well, Voronezh has served many of today's Russian and international space programs with Proton's 2nd and 3rd stage engines, rocket engines for the Soyuz 3rd stage, Block DM upper stage and ILS's next generation Angara launch vehicle.

Joint Stock Company Proton-PM (Perm) - KhSC is the major stockholder in Perm, the manufacturer of the 1st stage main engines for Proton since its first launch in 1964. Perm is also the manufacturer of components for aircraft engines and the diagnostics of the gas-turbine electric power supply stations. Perm is also the planned manufacturer of the first stage RD-191 main engines for the next generation Angara launch vehicle.

The Polyot Production Corporation (Polyot, Omsk) - In addition to being the manufacturer and supplier of the Proton first stage riveted modules, Polyot has a long heritage as the single source provider for Russia's aerospace hardware industry. Its state-of-the-art production facility also produces the multi-purpose booster modules for ILS's next generation Angara launch vehicle. Polyot's other product lines include small spacecraft, high-powered engines for military and civilian aircraft and the Kosmos 3M launch vehicle.

The Design Bureau Khimavtomatika (KBKhA) - On August 7, 2009, the merger of the Design Bureau Khimavtomatika under KhSC was announced after an order was signed by Russian President Dmitry Medvedev to transfer one hundred percent of the federal ownership to KhSC. This merger of the Voronezh-based open joint stock company is another major step in the effort to consolidate the space center industries that contribute to the development of the Proton and future Angara launch systems under KhSC. KBKhA is one of the world leaders in the development of liquid rocket engines and major participant in all of the Russian-based manned space flight programs. KBKhA's liquid rocket engines (LRE) are developed in state of the art production facilities for use in military rockets as well as scientific and commercial launch vehicles. Currently in process is the development of the second and third stage engines for the future Angara vehicle.

Initial results from the consolidation are apparent in terms of the changes associated with Khimmash and Breeze M engine production. Under the direction of the new director general from KhSC, improved facilities and major refurbishment of production lines have allowed a significant increase in the production of the Breeze M engines, with capacity doubled in three years to ten Breeze M engine deliveries in 2008.

KhSC has been in business for over 90 years, supporting a rich heritage in groundbreaking innovation and success in the global space industry. The consolidation of these five key space enterprises not only diversifies the KhSC product offering but also provides a solid foundation for continued growth. The centralization and availability of resources will further ILS's ability to meet ongoing launch demands and provide schedule assurance for its customers worldwide.

1.3 THE QUALITY INITIATIVE: PROVEN COMPREHENSIVE PROGRAM TO IMPROVE PROTON DESIGN, PRODUCTION AND MANUFACTURING SYSTEMS

In the Spring of 2008, ILS announced a Khrunichev-led top-to-bottom quality assessment and overhaul called the Quality Initiative — a complete review and assessment of Proton design processes and standards, production and management. This top-to-bottom assessment includes immediate and long-term objectives developed to improve Proton and streamline standards across the board.

All of the Quality Initiative activities are designed to provide lasting, long-term benefits in the design, manufacture and launch of Proton vehicles and our approach to quality for years to come.

Working together with our customers, ILS and KhSC are committed to the Quality Initiative's success and the increased reliability and performance of Proton. We will continue to provide routine updates on the status of our progress as the Quality Initiative evolves. ILS also considers regular reporting of our progress to be crucial to our quality efforts, and we are committed to providing continued insight and transparency to our customers.

The ILS and KhSC Quality Initiative Program:

- New positions at KhSC and ILS that are specifically focused on quality.
- Establishing a unified Khrunichev Quality Management System (QMS) across all subsidiaries.
- Recertification to the latest international quality standards and continued yearly audits.
- Re-evaluation of all factors to improve the launch vehicle design quality.
- Enhanced customer visibility into product and process quality.

Factory production is at its highest level in commercial history. Figure 1.3 shows the interior of the Proton final assembly and test area.

Figure 1.3: Proton Final Assembly and Test Area



1.4 HISTORY OF PROTON: RUSSA'S PREMIER HEAVY LIFT WORKHORSE

The Proton has a long and distinguished history, with a record that includes a number of significant firsts.

The first test launch of the original two-stage Proton took place on July 16, 1965, when it was used to launch the four "Proton" satellites for which the launch vehicle was named. Last flown in 1966, the two-stage Proton was succeeded by the three-stage Proton K and four-stage Proton K/Block DM and Proton M/Breeze M launch vehicles.

Since the mid-1960s, Proton has served as the primary heavy-lift launch vehicle for Russian unmanned space programs, orbiting the Salyut series space stations and MIR space station modules, as well as two of the first elements of the International Space Station, the Zvezda and Zarya modules.

The Proton has launched the Ekran, Express, Raduga and Gorizont series of geostationary communications satellites, Russia's GLONASS navigation satellites and the Zond, Luna, Venera, Mars, Vega, and Phobos interplanetary exploration spacecraft. These missions produced the first samples of the lunar surface to be returned by an unmanned spacecraft, and the first soft landing on the surface of Venus. Its debut as a commercial launch vehicle occurred on April 6, 1996, when Proton injected the Astra 1F satellite into orbit. It also was the first flight under the auspices of ILS.

Utilizing an evolutionary approach, Khrunichev developed a "modernized" version of the Proton — the Proton Breeze M. It provides an increase in performance with the lift capability of over 6 metric tons to Geosynchronous Transfer Orbit (GTO), greater Payload Fairing (PLF) usable volume and increased payload structural capacity. In February of 2009, Proton demonstrated its enhanced lift and performance capabilities with the launch of the dual Express mission. This Proton configuration will be the baseline for all missions beginning in 2010.

The upgraded first stage engines were phased in over a span of three years, while the Breeze M Upper Stage is based on the propulsion system and core module of the Breeze KM unit currently flying on the Rokot lightweight class launch vehicle. The Proton launch vehicle family has become the principal heavy launcher in the Russian space program and one of the premier launch vehicles in the world.

1.5 ILS/PROTON: THE TOTAL VALUE SOLUTION

ILS/Proton has consistently created real value for all of our customers across the globe from major satellite operators, as well as new ventures who are seeking to support their business plans.

Why customers choose ILS/Proton:

- High performance vehicle with a flight proven system.
- Dedicated launch vehicle.
- Proven flight tempo — ILS has launched over 50 commercial missions through July 2009.
- Over 340 as of mid-2009 missions launched by Proton since its maiden flight in 1965.
- Proton flexibility to meet launch dates is unmatched.
- Highly reliable engineering design
- Validated launch environments for customer's SC (e.g., shock, vibration, acoustic and thermal).
- Mission design optimization and flexibility.
- Multiple launch pads.

Why customers choose ILS/KhSC:

- ILS and KhSC are dedicated to the success of our customers — from contract signing to on-orbit delivery.
- Vertically aligned and efficient organization with no conflicting interests.
- Experienced commercial launch organization with demonstrated performance.
- Full range of quality services from satellite integration to launch.
- Mission integration process designed to maximize the production and engineering talents of ILS/KhSC team.
- Streamlined production systems with KhSC having direct control over the majority of all suppliers and manufacturers for Proton due to Russian Space Industry Consolidation.
- Robust hardware production in the factory ensuring flexibility and reliability.
- ILS Europe office created to enhance our level of service and availability across Europe.

1.6 THE PROTON LAUNCH SYSTEM

The Proton Breeze M has more than 6 metric tons of lift capability to GTO with precise delivery to orbit. Proton launch performance is discussed in detail in Section 2 and Appendix F. Because of its compatibility with all major SC platforms (see Table 1.6) the Proton Breeze M has the flexibility for geosynchronous and Supersynchronous Transfer (SST), highly elliptical and direct geostationary insertion missions. The Proton Breeze M has a long heritage of solid performance with over 40 years of experience and over 340 flights since mid-2009.

Table 1.6: Proton LV/SC Platform Compatibility

Satellite Bus	Compatible	Launched
601	✓	✓
702	✓	✓
A2100	✓	✓
E2000/3000	✓	✓
LS-1300	✓	✓
SB3000/4000	✓	✓
Star2	✓	✓
DS2000	✓	
Express	✓	✓

ILS and KhSC have adopted a common nomenclature to identify various components of the Proton Breeze M configuration. These terms are used throughout this PMPG and are summarized in Figures 1.6-1 and 1.6-2.

Figure 1.6-1: Proton LVs Flight-Proven Hardware

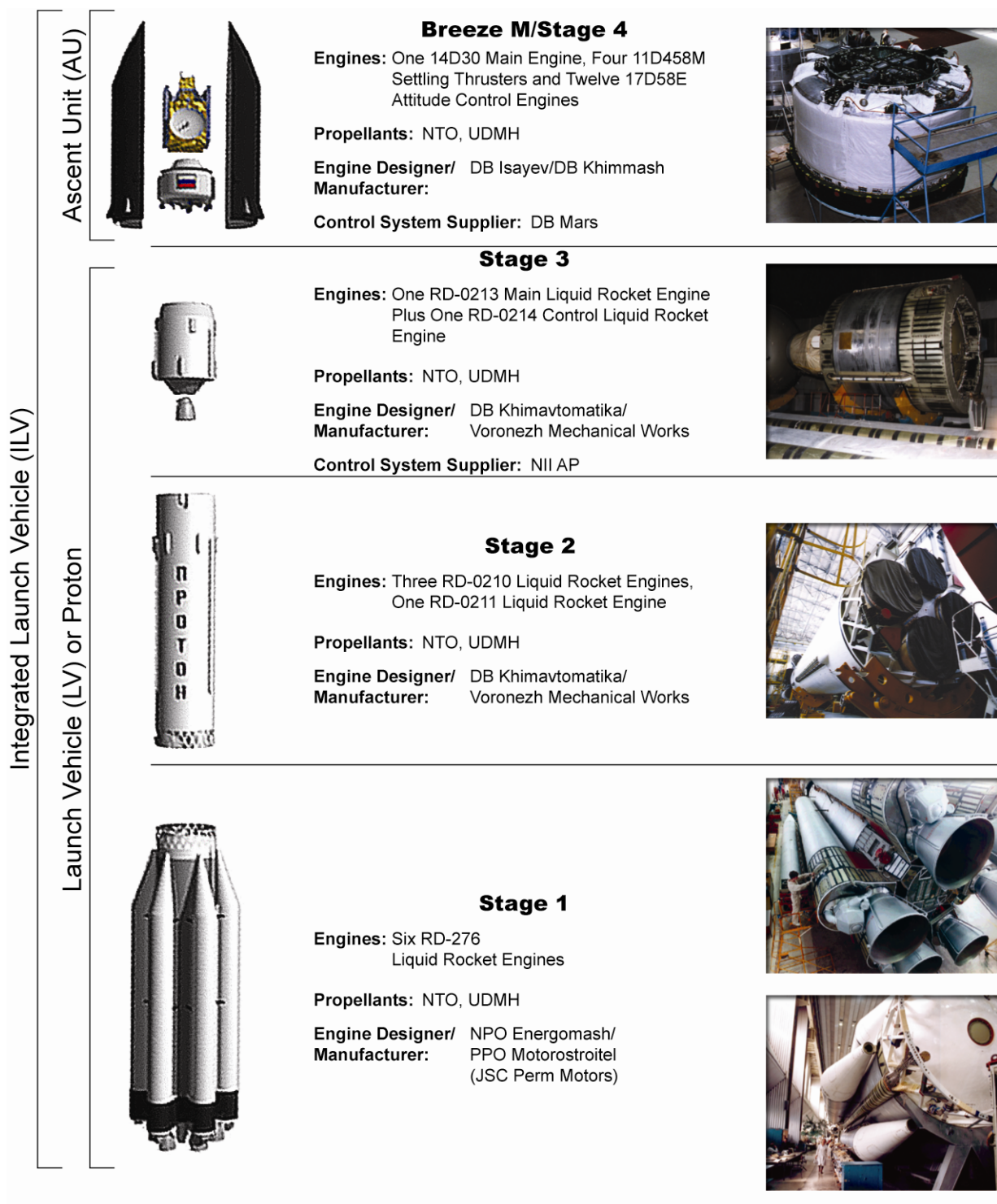
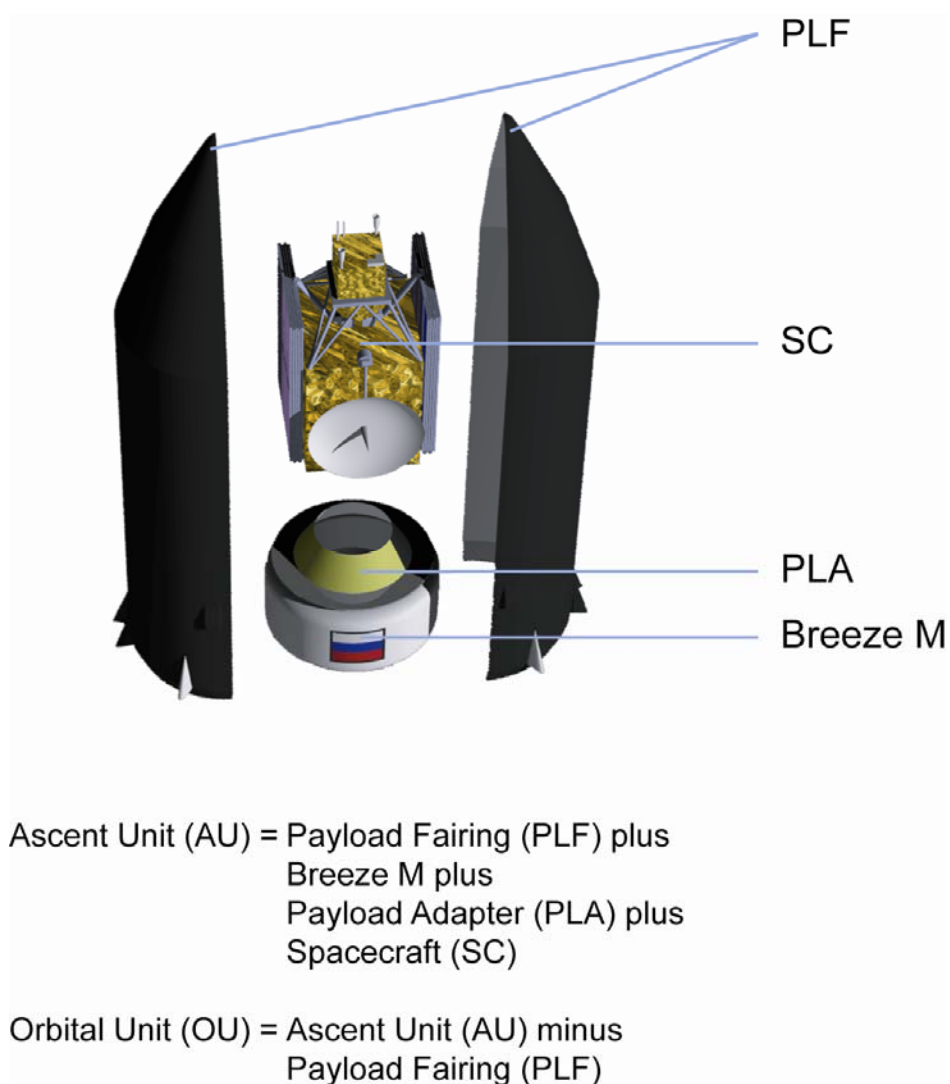


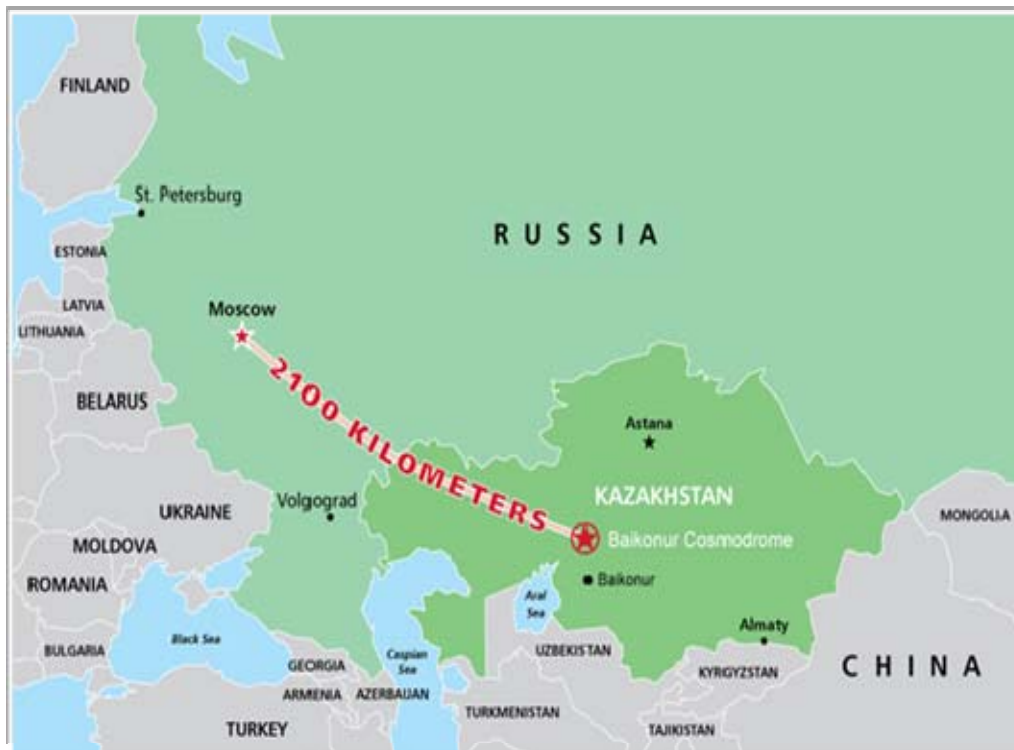
Figure 1.6-2: Proton LVs Flight-Proven Hardware



1.7 PROTON LAUNCH OPERATIONS: THE BAIKONUR COSMODROME

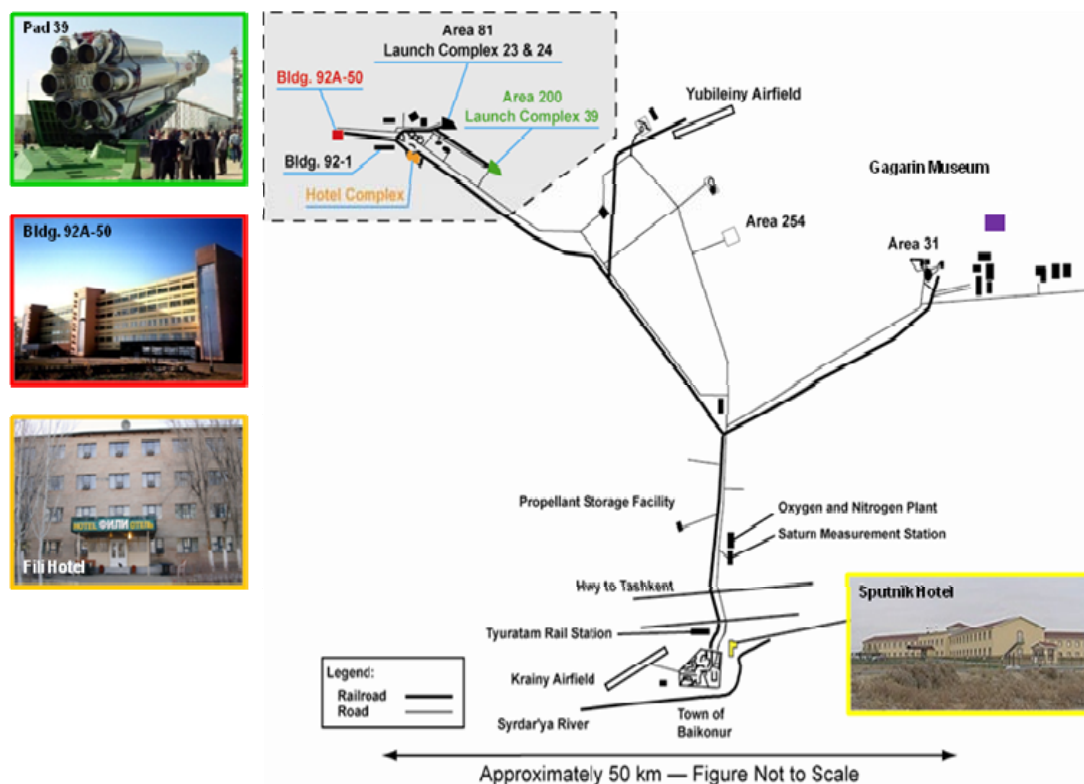
The Baikonur Cosmodrome is one of the Russian Federation's two major space launch complexes. As shown in Figure 1.7-1, Baikonur is located in the Republic of Kazakhstan approximately 2100 kilometers from Moscow. Baikonur has been the launch site for Soviet, and later Russian, human spaceflight programs, geostationary satellites and scientific missions to the moon and planets. It is also the site of the first launch of a satellite (Sputnik 1 on October 4, 1957) and the first human into space (Yuri Gagarin in April 12, 1961). The earliest achievements in space exploration have been made at historic Baikonur.

Figure 1.7-1: Location of Baikonur Cosmodrome



Baikonur is a large Y-shaped complex, shown in Figure 1.7-2, that extends about 160 kilometers (100 miles) east to west and 88 kilometers (55 miles) north to south. The vehicle processing and launch areas are connected to each other and to the city of Baikonur by 470 kilometers (290 miles) of wide-gauge railroad lines. The rail system is the principal mode of transportation. Rockets are carried from their vehicle assembly buildings to their launch pads horizontally on railcars and erected onto the launch pad.

Figure 1.7-2: Baikonur Facilities Map



The SC is transported to the Baikonur Cosmodrome by air and is offloaded at the on-site Yubileiny Airfield. It is then transported to the state-of the-art processing facility in Area 92 for testing, fueling, mating to the Breeze M Upper Stage and encapsulation with the payload fairing.

- Weather conditions in Baikonur have very few launch restraints, offering additional schedule assurance for customers.
- Two launch pads are available for commercial missions.
- Launch vehicle and SC time on pad is five days.

1.8 ILS LAUNCH SERVICES: WORKING WITH THE ILS TEAM

At ILS, we take great care and pride in the relationships that are fostered with our customers. With ILS and KhSC, customers receive, and have full access to, a wide range of launch services through ILS's dedicated account team. The account team is designed to provide the most focused attention and highest quality services to each customer led by a single source of contact throughout the life of the program, primarily, the account executive. Team members specialize in the areas of sales and marketing, program management/technical operations, contracts and finance and licensing/government compliance. The account team works with each customer to identify the optimal launch solution for their business and program objective and tirelessly guide the process from initial marketing consultations through launch and post-flight activities.

The ILS Team:

- The account executive is the customer's voice within the ILS organization and has direct access to both ILS and KhSC senior management.
- The sales and marketing team provide coordinated support for the launch viewing event in Baikonur and all publicity and marketing collateral associated with the campaign.
- The business and finance team member assists the customer with all contractual, insurance and financing matters.
- Program and launch operations management is led by the program director who provides technical advice, development and control of the mission-specific Interface Control Document (ICD), managing the necessary resources for the launch mission, and acting as liaison between the suppliers, manufacturers and subcontractors to the launch campaign effort.
 - Working with the ILS program director, a dedicated KhSC program director and team is assigned to each customer mission. This team ensures that all customer needs are met from program inception through post-launch activities and reporting.
- Licensing and traffic management team members handle the U.S. government requirements as they relate to obtaining the appropriate authorizations to perform the launch services and ensure compliance with applicable U.S. government laws and regulations.