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SUMMARY FINDINGS // BAIKONUR VISIT // JAMES OBERG

TASK: Evaluate the level of threats
to Proton launch capability in mid-1997:

FINDINGS

Finding 1-1: The Proton-specific facilities at Baikonur appear entirely adequate for near-future operations, but mere visual inspection is not sufficient to prove this is really true. Recent top-level Russian space officials' comments about the need for major upgrades (to avoid disastrous accidents) probably reflect both inside operational experience not shared with Western partners, along with an appreciation of the "exaggeration factor" needed to get the Russian government's attention. Meanwhile, caution is required in assessing adequate functionality based solely on episodic visual observations, and long-term performance monitoring is the only sure way to reliably gauge a facility's true dependability. Since non-Russian specialists do not have such access, efforts must be made to assess the candor level of Russian officials, and measures must be taken to elevate that level by catching and complaining about incidents of coverup and distortion. [1.0, 1.1, 1.2]

Finding 1-2: The support infrastructure around the launch facilities is seriously strained and is vulnerable to unpredictable long-term breakdown (during which launch operations would become extremely difficult) which could require major investments to ameliorate. In particular, the water supply is threatened by equipment and staffing collapse. [1.3]

Finding 2-1: The technical staffing of the Proton launch facilities appears adequate for near-future operations. There now seems to be sufficient personnel inflow to replace attrition and maintain staffing at about 50% of "normal". [2.3]

Finding 2-2: Although no signs were detected of social tensions, the conditions which led to conscript riots three years ago, and to increased pilferage of unguarded equipment, have not eased. Top cosmodrome officials have publicly warned that "social explosions" could result if massive financial relief does not arrive, yet there is no indication that the Russian government has either the means or the intentions of spending such funds. [2.0]

Finding 2-3: Threats to physical health of visitors have been eased by the construction of the water plant, although the ILS intention not to pay for follow-on water quality testing is disturbing. Attempts to gauge the health level of Baikonur natives were turned aside by Russian medical officials who did not want to talk about such topics.

Finding 2-4: Physical safety and security appeared inadequate. Fences were generally incapable of even slowing down intruders. Safety standards in the VIP hotels were far below minimal Western standards for alarms, escapes, and prevention practices. [2.1, 2.2]

Finding 3-1: The issue of the 1994 Moscow-Almaty lease agreement and the \$115 million annual payment stands out as the greatest near-term political threat of launch service disruption. Although Kazakstan would not benefit from a permanent shutdown, in the absence of Russian compliance, they will have temptations to motivate Russian payments by resorting to additional brief but intentionally timed shutdowns of utilities. One of the most embarrassing and inconvenient targets for such a gesture would be a commercial Proton launch. Meanwhile, both ILS and Khrunichev officials are in a state of extreme denial (even deception) about this issue [3.1]

Finding 3-2: The boundary between commercial Proton activities and other Russian military space operations at Baikonur is much hazier than ILS or the Russians admit, and the possibility that ILS-funded facilities could wind up supporting some purely Russian needs (particularly military needs) is a serious mid-term threat to the

international commercial regime which allows US payloads on Russian rockets. Any suspicion of Russian application of ILS-funded resources for domestic space purposes can be expected to lead to enormous political pressures in Washington to terminate licenses for such activities. My discussion of related subjects (such as Tsiklon ops) with ILS and Russian experts provides no comfort that the Russians would not try to "get away with" (and cover up) such a seemingly minor (to them) infractions of the Proton commercial arrangements. [1.2.5, 1.2.6, 2.3.1, 3.3]

Finding 3-3: Access and photography constraints were enormously damaging to the development of trust and good will required to establish reliance on other Russian/ILS verbal assurances. These "old-fashioned" Soviet-style restrictive measures were severely counterproductive, even if their only intent was to prevent acquisition of negative information and impressions. If -- as can be logically construed -- these constraints indicate there really is more information at Baikonur which commercial customers should not be allowed to see, the implications are even more damning. The Russian policy should be vigorously complained about, and the degree of its amelioration on the launch campaign this fall should be deliberately measured and discussed. [2.4]

Finding 3-4: Factual information provided regarding Proton booster reliability, when checked against independent sources, was quite good. This goes a long way toward establishing at least limited degrees of trust in Russian-provided factual data. [3.3.3]

1.0 Physical Facilities and their functional capabilities.

The fundamental question remains not how adequate any facilities LOOK, but how adequately they WORK. Can we be confident in continuing reliable and safe operations at Baikonur? Two types of incidents -- one small-scale and superficially trivial, and the other large-scale and obviously serious -- reflect on this question:

1.0.1 Small-scale: At the Yubileyniy field, just after we had arrived, we inspected a row of emergency vehicles. We innocently asked the ambulance crew to open the back door and show us the insides (there was only room for a stretcher, but no emergency equipment of any kind). However, the left-hand door was jammed and would not open despite the best efforts of three big men. And when the shiny-looking well-maintained fire truck tried to show off its water-cannon, it, too, failed to function. The ambulance door was opened after fifteen minutes and a bloody gash on one Russian's arm; the cannon finally fired after about five minutes of cajoling. It would have been funny if it hadn't been so embarrassing (and we KNEW somebody was going to be in deep trouble over it). The moral of the story was that the Russians had lined up these and other vehicles to be LOOKED at, since they LOOKED good, but they probably didn't expect to actually have to OPERATE the hardware.

1.0.2 Large-scale: On May 14 and again on June 20 (while we were at Baikonur), two unmanned Russian "Soyuz" rockets failed during launching and crashed back to Earth.

1.0.2.1 The conditions under which the rockets have been manufactured have been known to be risky for some time. In February 1995, on Moscow's Ostankino TV First Channel, Vladimir Pishistov, production unit chief, "Progress" plant, Samara (where the Soyuz boosters are built), said: "The disintegration of economic ties and of the financial systems has resulted in our having to build these launchers in the most difficult of conditions. This means that with the few workers who remain here -- only true patriots have remained -- we have to build each launcher on a very tight schedule." Plant director Anatoliy Chizhov says wages are not high enough and are not being paid on time, and urges a return to "old values".

1.0.2.2 In response to the failures, "The military insist that 'old' rockets flew well, whereas 'new' ones are good for nothing. Workers

are paid low wages, everything is done in haste, and so forth."

Moscow newspaper "Segodnya" ("Today"), June 22, 1996, page 1.

1.0.2.3 General Shumilin (Baikonur commander) interview (June 21), question: "Has there been a noticeable drop in the quality of space hardware?" Shumilin: "Yes, there has. . . .I believe the quality of the work has declined in the plants where space hardware is assembled."

1.0.2.4 "A hungry worker at a rocket plant is more dangerous than any potential enemy." Unnamed RKA official quoted in 'Aviation Week', July 8, 1996, "Russian Booster Quality Questioned", by Craig Covault.

1.03 The moral of these two stories is that visual inspection alone was inadequate to make any reliable judgment about functionality of the hardware. The implication for assessing Proton functionality at Baikonur is that merely occasionally visiting and viewing is NOT going to be adequate to provide a reliable assessment: A much more long range broad-based and in-depth effort is required, involving general background research, specific strategies for occasional site visits, careful monitoring of peripheral but connected features, and specific interrogations of ILS representatives (and through them, Khrunichev and VKS experts).

1.1 AREA 31

Area 31 is far out on the eastern leg of the cosmodrome (Area 92 is at the opposite end, far out on the western leg -- see map).

1.1.1 Why are the areas for Proton preparation so far apart? It is a one hour twenty minute bus ride between them (71 kilometers by the bus's odometer). See discussion in appendix on "Baikonur".

1.1.2 This area contains the second Soyuz-booster launch pad. In Moscow, we met with "Videokosmos" specialists who told us the original "Gagarin Start" Soyuz pad in Area 2 was nearing the end of its service life and would soon be shut down to await major refurbishment (which might never be funded); all manned and man-related Soyuz-booster launches would be moved to Area 31.

1.1.2.1 This is supported by NASA visitor comment that the spacecraft processing hall in Area 2 (the MIK, building 2-1) has already been shut down, at least for payload processing, and that Progress and Soyuz space vehicles were now being prepared for launch in the Buran Hangar, Bldg 254.

1.1.2.2 When directly asked, one of the senior Russian officials with ILS agreed that indeed it was possible to use Area 31's pad for man-related launchings but that this would not impact the payload processing planned in support of the commercial Proton launches. Since the man-related payloads are reportedly being processed elsewhere, this claim appeared to be credible.

1.1.3 In Area 31, "Building 100" contains the clean rooms and other processing halls. From Russian space documents we know that Area 31 also contains "Building 40" for preparation of Soyuz rockets for launch, and "Building 124" with "special equipment", but we did not have access to them.

1.1.3.1 The internal conditions of "Building 100" appear pretty good at first. Then on closer inspection a few deficiencies showed up. On the wall there was a recessed peg which is turned by an inserted crank. The peg is also painted, so the inserted crank scrapes off the paint, leaving flakes on the floor (and possibly anywhere else that officer uses that tool). There were dead bugs -- of considerable size -- in the floor grooves. All of these features could be controlled by

active measures, and we were told the metal walls are mechanically scrubbed between processings.

1.1.3.2 Humidity and temperature control.

1.1.3.2.1 The Russians asserted they kept temperature "stable" while humidity was controlled within the range of 35% to 60%, and normally just 40%-45%-50%, all regulated and adjustable.

1.1.3.2.2 They were asked to tell how tight was the temperature control: if you set it to 20 degrees, what is the range of control. They responded by asking what was the requirement, and were told it was plus-minus 1 degree. They then answered that they could accomplish plus-minus 2 degrees. They asserted there were no sharp changes in either temperature or humidity. They stressed that there is always manual monitoring and control, that the human is the most reliable controller.

1.1.3.2.3 The American side continued to press the issue: have the Russians tried controlling temp/humidity in the summertime, since Astra was here in the winter? They replied they would use Inmarsat to baseline the payload area, and would share the results.

1.1.3.2.4 They were asked if they had run a characterization of the room in the summer. They replied they had done an evaluation based on the design. When pressed, they finally admitted, "We are just starting".

1.1.3.2.5 Referring to humidity levels again, they explained that the deadband was very large. Early in the morning it can be as high as 60%, then decreasing (it was pointed out that over 60% humidity can cause spacecraft damage which cannot be repaired here). They again stressed: "We will never allow humidity greater than 60%", normally it is in the 35% to 40% range. They claimed that they had just run a test with the limit set at 60%, "but if we don't need that value we don't do it" since some other customer may only need to maintain less than 80% humidity.

1.1.3.2.6 The method of humidity measurement is "wet/dry", although they asserted they could do relative humidity as well.

1.1.3.2.7 But as for temperature, they just said that "We have some work to do here to guarantee stability".

1.1.3.3 All Proton 4th stage (Block DM) matings are done here, or so we were told (this was in conflict with the assertion that there are also Block DM fuelling capabilities in Area 92 -- see para 1.2.6.2).

1.1.3.4 When the hall clears out its "next payload", the Mars probe slated for launch in mid-November, the next ILS payload can come in. Since there are OTHER Proton payloads between now and then, mainly geosync communications satellites and 12-hour GLONASS navigation payloads, they must clearly be processed elsewhere.

1.1.3.5 A large hall had about one quarter of its floor space taken up with new enclosure for high cleanliness processing (it had a secure lock on the door). The rest of the hall was typical Baikonur: brick walls, hefty-looking overhead crane, amateurish warning signs. The concrete floor was solid, there was no recessing for cable runs. Cabling to payloads came out from walls and would be suspended on swing-arm racks.

1.1.3.6 The north end of hall had one large door with RR tracks leading to fueling hall. There were several other sets of tracks, including one leading to a smaller door at the east side of the north wall. Later, on observing the outside of that wall, we could see that the center door's tracks really led to the fueling hall, but the northeast set of tracks did not extend outside beyond the small door.

1.1.3.7 The outside of the entire building was undergoing a complete reconstruction of the first floor facade, with old brickwork being covered with a continuous cement surface. The utility of this was not clear to me.

1.1.3.8 However, the outer walls of the upper two floors retained their traditional "crumbling brick" style, with large sagging areas and occasional sizable gaps, and within a space of five minutes I observed two different spots where birds flew in and out to their nests inside the building.

1.1.4 We visited the fuelling hall ("hazardous processing") north of the processing hall (see photograph).

1.1.4.1 Interior inspection -- covered in Mr. Muller's report.

1.1.4.2 On the outside of the fuelling hall was a billboard devoted to fuel leak incidents impacting air quality.

1.1.4.2.1 However, it was apparently no longer maintained, and the last dated entry was July 13, 1992.

1.1.4.2.2 Three types of chemical fuels were listed: Geptil ("Heptyl"), AK-27-I, and Amil. A Khrunichev source explained that Geptil was UDMH (unsymmetrical dimethyl hydrazine), and AK-27-I and Amil were different forms of nitrogen tetroxide (N₂O₄), although nobody could explain the difference.

1.1.4.2.3 When I asked the source about the other commonly used space fuel, monomethyl hydrazine (MMH), he replied that Proton used UDMH and spacecraft themselves often used MMH. However, he continued, there was "a lot of trouble in transporting MMH from Leningrad" where it is apparently produced.

1.1.4.2.4 This off-hand comment becomes more significant when it is realized that the MMH for US payloads will be shipped to St. Petersburg (Leningrad) from which the Russians will transport it by rail to Baikonur.

1.1.4.2.5 In discussing the danger of hydrazine, our side explained the NASA acronym for a fuel spill, "BFRC", meaning "Big Frigging Red Cloud". The Russians laughed and said that they called their hydrazine spills by a more metaphorical term: "fox tails", after the reddish-brown coloration of the cloud.

1.1.4.3 We may have observed remains of a fuel spill in Area 200 (See paragraph 2.1.4).

1.2 Proton Facilities (Area 92) -- The Proton booster "processing facilities" are west of the residential area of Area 92, in a zone called "Complex 25921". On Thursday, June 20, we visited the Proton Booster Preparation Hall, the VIP Viewing Stand, the launch bunker and launch pad areas, and a larger hall being proposed for conversion into a payload processing facility.

1.2.1 The Proton Booster Preparation Hall, designated Bldg 92-1, was built in 1962 (it is shown on the recently declassified 1963 CIA map of Baikonur), although it has reportedly since undergone "capital repairs" several times. The bricked end wall at the northern end was in pretty good shape for being more than 30 years old -- there were no signs of sagging or settling so common in other brick facades at Baikonur. But in the NE corner there were extensive water stains below the windows, indicating inadequate water tightness against rain or melting snow.

1.2.1.1 There are two processing areas, one at each end of the long hall (designated the "north" and "south" areas, although the hall runs NW to SE). There is also floor space for more boosters in storage: although people have reported up to four vehicles in the hall (apparently the maximum), there were only two during our visit.

1.2.1.2 High along both long walls were tall windows, with small panes of thick glass. Below each window and jutting out at an angle were frames with screens, similar in fineness to chicken wire, apparently to catch breakage. All the windows appeared to be in good shape, although the western wall's two northernmost-but-one windows were draped with canvas (this was even noticeable in the aerial photos taken during the approach to landing at Yubileyniy). Curiously and perhaps not by accident, these two windows were directly over the first stage engine area of a Proton booster lying there in storage. These drapes were explained as being due to "painting" (I think the interpretor got it wrong and what really was meant was "cleaning") but the exact meaning of this was never clear.

1.2.1.3 The only environmental protection appeared to be canvas covers over the mouths of the rocket engine bells. There were no shoe-scrubbers at the door, and no positive pressure air flow.

1.2.1.4 Despite the integrity of the windows, there were birds INSIDE the hall. At first I heard a chirping sound off behind us, and asked a

worker if it was machinery or birds. "Swallows" he replied with a grin. Sure enough, I then spotted one swooping along the floor at high speed, then saw another higher up. But there was no sign of bird droppings on the floor. There were also numerous moths high in the air, some quite large. The workers did not seem to be at all upset by the birds' and bugs' presence.

1.2.1.5 An extensive collection of fire-fighting equipment was stored near the personnel entrance, midway along the eastern wall. There were sand piles and shovels along with a handcart loaded with a nozzle connected to six tanks of CO₂.

1.2.1.6 Conditions in wintertime inside the halls is said to be below freezing. "It is here that the rocket stages are put together, equipment and gear is checked, and spacecraft are assembled and equipped. Enormous resources had been spent some time ago on their construction and equipment. But all of this infrastructure is now falling into disrepair. Work goes on at below-zero temperatures at the assembly and testing complex in which the famous Proton rockets are assembled (and these are the most stably working complexes). Not much is needed to get things working -- hook up the pipes, and supply normal heating, but there isn't enough money even for this. Expensive, highly sensitive instruments are installed under the shelter of nothing more than plastic sheeting." "Sovetskaya Rossiya", Moscow, February 27, 1996, p. 2. "Outcasts: The Greatness and Poverty of Baykonur Cosmodrome", by State Duma Deputy Vladimir Toporkov.

1.2.2 Proton Launch Bunker: We were taken to the Proton area 81 launch pads to physically inspect the control bunker and one pad.

1.2.2.1 According to signs along the road, the pad was declared operational on Feb 6, 1964 (a year and a half before the first known orbital launching); Proton launches are performed by "Unit 93764".

1.2.2.2 Launch Control Blockhouse: We visited "Bunker 84", the facility lined up with Pad 81 L (I did not discover if pad 81 R had its own bunker or used this one too). Three new UPS units were in place next to it.

1.2.2.3 We made our way via a long series of halls and stairways (with mostly adequate head clearance) to the control room. It was quite clean, all lights worked, air flow looked and felt good.

1.2.2.4 The floor is raised about two feet, then is carpeted over with holes cut for cables. The elevated floor is level with the next-door office and with the hall, which also has a raised floor. Metal spines came up the walls carrying phone lines, data, power -- some frames were empty and more lines could be installed.

1.2.2.5 Three fire extinguishers stood on the floor in the corner (not by the door, the room's only exit).

1.2.3 Launch Pad: We visited the pad at area 81-L. According to the Russians, one of the two area 81 pads was operational (81-L) for commercial payloads, and the other (81-R) was being serviced (it had supported 36 flights and needed "an extensive rebuilding", which will be completed next year when it too will be used for commercial launches), and both area 200 pads were in use for Russian federal payloads.

1.2.3.1 The servicing connections to the rocket are all through the base. There are six support points, with propellant transfer connectors at five of them (three for loading, two for unloading). There was also a large central umbilical plug mechanism which mates to a large rectangular connection array at the base of the central core of the rocket.

1.2.3.2 The six support points had active clamps which are engaged when the rocket is installed, to hold it in place. Once propellant has been loaded, the rocket is heavy enough not to be disturbed by winds, so the clamps are retracted. The rocket then rests secured only by its own weight.

1.2.3.3 At liftoff a counterweight mechanism causes the central umbilical mechanism to drop, which activates two protective steel clamshells that close close over the mechanism. The clamshells and other protective shields (around the propellant loading lines, for example) appear to be made of half-inch steel.

1.2.3.4 When we asked VKS officers about replacement parts, they claimed that the steel covers have never need to be changed out (this could be true -- there are no records of any on-pad Proton failures). As to the source of other equipment that needs replacement, they replied only that it was made "in Russia" and was available. This is doubtful based on other sources but there seemed no point in making an issue of it at the pad where no straight answer seemed likely.

1.2.3.5 The access platforms which encase a booster on the pad had bare metal edges, with no padded bumpers (or obvious attachment points for them).

1.2.3.6 The ground was littered with small slag fragments from the previous launch (vitrified concrete and sand). We were allowed to

pick up a handful. I also located one plastic umbilical cap, the standard covering for booster umbilical lines during roll-out from the processing building to the pad (they are discarded when pad umbilical lines are hooked up). These covers are common in the Soyuz pad area (I picked up about two dozen in the flame trench in March 1995), but the Soyuz booster covers are red and are smaller than the single black plastic cover I found at the Proton pad. At the Buran test area, meanwhile, I located one badly damaged plastic cover of the same type, but that one was white.

1.2.3.7 There was a large amount of bird droppings all over the pad and equipment. I did not observe birds nesting in the gantry towers. Perhaps they are attracted by the flying insects drawn at night by the lights of the surrounding towers.

1.2.3.8 Good safety observation: The edges of the pad structure over the flame trenches were lined with sturdy, removable safety fences. According to an officer, they are installed immediately after a launch and are removed shortly before the next launch. A stack of extra fence sections was seen tied together behind one of the concrete bunkers near the pad.

1.2.3.9 Mr. ~~██████~~ posed a question about Block DM LOX loading. An officer replied that the LOX was in a railway car off to the side, and was loaded through a separate line up the gantry to the Block DM. The line was manually disconnected "one hour before launch", and the subsequent boil-off was tolerable.

1.2.3.10 Note that official Russian evaluations of Proton facilities seem much more pessimistic than our eyeballing could confirm (see below). To some extent this may be just "squeaky wheeling" for funding, but the credibility of the officials is high. Attempts to acquire more specific information about the basis on which they have made these assessments have not been successful to date.

1.2.3.10.1 The INTERFAX wire service in Moscow sent out this English report at 13:55 GMT 5 Feb 1996, entitled "Space Agency Sees Need to Update Launch Pad at Baykonur". The first two paragraphs were:

"The General Director of the Russian Space Agency Yuriy Koptev says Russia faces the task of seriously updating the launching pad for Proton booster rockets at the Baykonur Cosmodrome, Kazakstan, soon. He told INTERFAX that the program of launching satellites into

outer space with the help of this type of delivery vehicle, admittedly one of the most efficient and reliable in the world, might be jeopardized if not.

"Rough counts say the pad will cost 400 billion rubles [about US\$100,000,000] to update, but no such money is envisaged in the 1996 budget. The space agency head said the existing pad, intended for 30 launches, had almost exceeded its lifetime. Any further use of the complex without repairs carries the risk of accidents, little short of an explosion of the booster on the pad, he said."

1.2.3.10.2 An interview with cosmodrome commander, General Shumilin (June 21) quoted him as saying: "There is no need to build anything new at Baykonur at present. It will be good if we are able to restore whatever has already exhausted its technical resources. The service life of the Proton rocket launch complexes is now coming to an end."

1.2.4 Viewing Areas

1.2.4.0 Note: Both viewing areas we visited had surrounding ruins draped in desert camouflage nets. This evidently esthetic effort was sort of counter productive since the nets (which were not seen anywhere else) only served to draw attention to the broken walls and other structures beneath them.

1.2.4.1 VIP Viewing Stand: The VIP viewing stand is 3 km from the pad (actually, the hotel is closer!). There is another area 8 km away for all other team members (see below). We had a good view of pad 81L (to the northeast) and also of two pairs of tall towers to the northwest, probably the nearby Tsyklon pads (see section 1.2.5).

1.2.4.2 Second Viewing Area: We were taken to the second viewing area, some distance southeast along the main access road from Area 92 to the rest of the cosmodrome.

1.2.4.2.1 It is clearly co-located with some other facility, which is labeled "Area 182", located on a hilly knoll about 3 to 4 acres in size.

1.2.4.2.2 The area had a large number of conscripts at work (it seemed they actually live there as well), had many large air vents which implied underground bunkers, had the obligatory "encouragement slogans" and propaganda displays (characteristic only of areas where lots of conscripts work), and had what looked like two now-sealed missile silo holes.

1.2.4.2.3 We were told that Gorbachev himself had watched a Proton launch from here, from atop the hill, in a small viewing building (this checks out -- his only visit to Baikonur was in 1987 when, according to press reports in my archive, he viewed the Proton launching of the Gorizont-14 on May 11).

1.2.4.3 ASTRA Viewing Area: There was a third viewing area, used by the bulk of the ASTRA (non-VIP) workers during the launch in April. That site has now been closed with no explanation.

1.2.5 Tsyklon ("Cyclone") booster facilities: From independent information I had determined that the Tsyklon medium-lift booster pads are nearby to the Proton facilities and their pre-launch processing is co-hosted within and just adjacent to the Proton area. Yet ILS officials assured me that all the facilities we saw were fully dedicated to Proton processing alone.

1.2.5.1 The Tsyklon booster has high military sensitivity, and the degree of Russian candor (or lack of it) about it is a good clue to how trustworthy and complete their other data may be.

1.2.5.1.1 In the late 1960s, Tsyklon boosters (from pads near here?) were used for the FOBS "partial orbit" H-bomb first strike tests, and for "killer satellites". They also launched the nuclear-powered RORSAT radar satellites like the one that fell on Canada back in 1978.

1.2.5.1.2 Although these projects have long been scrapped and the booster now also carries civilian satellites into orbit, its continuing sensitivity can be gauged by the reaction of a Khrunichev official at the Proton VIP viewing area. When I asked innocently (but with foreknowledge) "Where is the Tsyklon pad?", he stumbled in his walk, his smiling face went blank, then he flicked his left hand near his chest with one finger pointing off to the northwest (correct), then dropped his hand to his side and walked on.

1.2.5.2 Tsyklon is the only other Russian space booster that uses the same propellant combination as Proton, that is, UDMH and N₂O₄. It is based on the SS-9 ("Scarp") ICBM designed in the early 1960s by the "Chelomey" bureau which also designed the "Proton" and which evolved into what is today the Khrunichev Center. This commonality probably explains the proximity of facilities and hints at undisclosed "dual use" facilities being displayed as "exclusively Proton".

1.2.5.3 Chelomey's (and Khrunichev's) only other big military ICBM project has been the SS-19, so it is reasonable to assume that test launch pads are also near the Proton area and may share facilities.

1.2.5.4 ISSUE: Customers deserve to know if there are other undisclosed demands on these facilities supposedly reserved for Proton, or if improvements funded by ILS for Proton commercial customers are also going to be utilized by Tsyklon vehicles and payloads (largely military in application).

1.2.6 Processing Building 92-50.

1.2.6.1 This building is MUCH LARGER than 92-1, the Proton booster processing facility (paragraph 1.2.1), probably twice as large in all dimensions. It was located west of the Proton hall, it was easily visible from the Proton pads and elsewhere in Area 92, and was clearly shown on the stylized cosmodrome map in the museum in Area 2 (it has the distinctive crenellated profile with four "towers"). It appeared in quite good condition (we were told it was built beginning in 1970, for an undisclosed program), but it is currently unused. See photo.

1.2.6.2 This building is supposed to house a new payload processing and propellant loading facility, by next year, to replace those in Area 31. The specific location is supposed to be "Hall 101", located inside Bldg 92-50. A sign states that the hall was the zone of preparation of "section 11-F-664".

1.2.6.3 The Russians stressed that the VKS owns this building (as far as we could tell they owned every other building in area 92, except perhaps a few hotels and the water processing plant).

1.2.6.4 An annex on the northwest side of the building will duplicate the Area 31 facilities. There will be yet another functionally equivalent facility in the Buran hangar, bldg 254, "later this year". The Russians said it was a "top priority" to upgrade these facilities to be able to support commercial launchings.

1.2.6.5 All three payload processing/fuelling facilities will have their own teams of specialists, which will not move from facility to facility ("Each of the three areas will have their own peculiarities"). The Russians were confident they could fully staff three separate teams.

1.2.6.5 I asked if the Block DM stages will be fuelled in this new facility. No, I was told, Block DM stages would still be fuelled either in Area 31 or "nearby" (in Area 92) in a facility called "Complex 141". The annex will support only spacecraft fuelling, which "doesn't take too long".

1.2.6.6 We were assured that this building has always been associated ONLY with the Proton program. However, official Russian government documents on Baikonur, in my possession, refer to use of

this facility for the space apparatus "Gran", which is completely unfamiliar to me and to my Western colleagues. It may be a code name for a still-classified Russian military space project.

1.2.6.7 Just prior to arriving at the building we passed four rail lines headed north, and a large sign of the type that elsewhere boasted of the type of rocket handled here. This sign was totally whitewashed, although there was later graffiti that seemed to indicate it had been blank for some time, not just in honor of our visit. Speculation: This was the entrance to area 90, the Tsiklon support area.

1.2.6.8 When we entered the hall (of 92-50) it was completely dark (there were no windows, unlike bldg 92-1), with the smell of burned insulation suggesting they had tried to turn on the lights but had blown some circuits. The lights gradually came on over the next few minutes.

1.2.6.9 We entered at ground level into a long hall with generic Russian space art paintings on the walls. There were two wide staircases leading DOWN into an underground section (this was highly unusual). The elevator at the end of the hall was sealed off. There were both men's and women's rest rooms next to the elevator.

1.2.6.10 Along an elevated walkway a third of the way up the north wall, there was a line of manually-aimed fire-fighting nozzles. We'd never seen anything like this in any of the other halls, on any of my visits.

1.3 Infrastructure

1.3.0 The most significant technical issue with potential impact on future operations is the cosmodrome's reliance on external sources of electricity and water.

1.3.0.1 NASA source told me that during a visit early this year, the power and water had been shut off by the Kazakis for several days as background to negotiations with Russian space officials (specifically, Yuri Semyonov of RKK Energiya) on schedules for the agreed-on lease payments (isolated high-priority facilities such as Bldg 254 apparently had their own local sources and never lost power).

1.3.0.2 ISSUE: Scaled-back utilization of existing (but aging) utilities may lead to inefficient operation of facilities with significant overcapacity (output cannot be easily cut to 20% of previous levels with any significant savings). See the discussion of the Dalniy water wells, below.

1.3.1 POWER:

1.3.1.1 Electricity is provided mostly from the Kazaki national power grid. Official records claim there is on-site gas turbine generating capacity of 72 megawatts, but how much of this is operational today is not known. The need to install foreign UPS hardware for short-term supplements in area 31 and area 81 suggests it is either not reliable or not significant. Official records claim there are 6610 kilometers of power lines -- we saw a large portion of them in our bus trips!! They also catalog 600 transformer substations.

1.3.1.2 At night the Area 92 Proton "processing area" was totally blacked out except for a line of high street lights.

1.3.2 WATER

1.3.2.1 All water used in Area 92 (and as far as could be determined, everywhere else on the cosmodrome) is piped in through underground aquaducts. Official records state there are 1240 kilometers of aquaducts for the cosmodrome and the city of Leninsk.

1.3.2.2 These aquaducts run alongside the main roads and they often leak, leading to isolated strips of green along the road. Once and

awhile there are large ponds, where livestock (horses, cattle, sheep, goats) congregate.

1.3.2.3 Any excessive leaks could probably be repaired by the military work brigades. As we observed at Area 92, the bulk of their work appeared to be digging holes, pulling out or putting in pipes, and sometimes filling in the holes.

1.3.2.4 Prior to the installation of the water treatment plant for the VIP hotels, ILS reportedly tested the Area 92 water supply and found high bacterial contamination. The longterm effect of such water quality (or lack of it) on local residents would be important to forecasting future functioning in the Proton area.

1.3.2.5 There is no usable natural sources of water in Area 92, although there is a beautiful spring-fed pool about 12 km away, where workers walk to swim and picnic (no drivable road reaches there).

1.3.2.6 All green areas in the residential zones are artificially watered. We saw water spraying from special irrigation pipes in the small lot in front of Hotel Polyot. The Russians spoke emotionally of their need for green areas and the animals -- mostly birds -- they attracted.

1.3.2.7 "No launching can proceed without water. But at Baykonur, with its snowy winters and hundred-degree heat, the price of water rises many times, because it has to be delivered from dozens of kilometers away. The water intakes are getting old, and the water pipes are breaking like matches. And even under these conditions, normal launchings with precision in the seconds are made possible only because people are able to work selflessly day and night to fix broken pipes." "Sovetskaya Rossiya", Moscow, February 27, 1996, p. 2, "Outcasts: The Greatness and Poverty of Baykonur Cosmodrome", by State Duma Deputy Vladimir Toporkov.

1.3.2.8 The main source of cosmodrome water is called the "Dalniy" ("Distant") facility. It consists of dozens of boreholes to a depth of 300 meters with automatic pumps, plus twin pipelines one meter in diameter which run for 144 kilometers and can deliver 50,000 cubic meters of water per day. According to an interview with Dr. Moyrbek Moldabekov, deputy general director of the Kazak space agency (in "Red Star", Dec 23, 1995), the facility will probably have

to be mothballed because it is too expensive to be maintained. Due to its lack of branch aqueducts, other non-space towns in the region cannot tap into it. Moldabekov: "The city does not need as much water as it did when it had to provide backup for the launch of 'Energiya-Buran' space systems."

1.3.3 HEATING

1.3.3.1 The Area-92 heating plant appears to be gas fuelled. I could not determine how it arrived.

1.3.3.2 The network of elevated piping systems is for the hot water. In general the insulation on these pipes is in poor condition and the heat loss in winter must be very high.

1.3.4 COOLING:

1.3.4.1 Aside from the VIP hotel with room air conditioners, several other hotel buildings in the area were also well equipped with new window units.

1.3.4.2 However, in the more distant buildings which appeared to be inhabited by VKS personnel and perhaps civilian families, window units were few and far between and looked old.

1.3.4.3 We were surprised by the apparent absence of evaporative cooling systems (such as used in the American Southwest). Is water more precious than electricity? Or is the water so salty that evaporative systems soon "silt up"?

1.3.5 FOOD:

1.3.5.1 I was told that the Americans were being billed \$25 for the same meals at Polyot that the Khrunichev visitors were billed 5000 rubles (about one US dollar) for.

1.3.5.2 Food for sale in the area store was plain but apparently adequate.

1.3.5.3 One odd feature I noticed as I walked around the hotel was that on cement slabs in front of other residence buildings there were signs of recent small campfires.

1.3.5.3.1 This struck me as "cute" -- I imagined that the temporary residents in these buildings, here for the most recent Proton launching (a Gorizont payload on May 25), had gathered in the evenings for social pleasures. Or so I thought.

1.3.5.3.2 What is probably the more accurate -- and more significant -- meaning of these campfires was revealed in a long article in "Rossiyskaya Gazeta" on June 21, describing at length the woes of the Russian communications satellite industry, based on interviews with top officials of the "Applied Mechanics" association in Krasnoyarsk, where Russia's communications satellites are built.

1.3.5.3.3 "The famed space center is a pitiful sight today," the article wrote about Baykonur. "Kazakhstan, which charges Russia a huge sum for the lease, is doing nothing to maintain the infrastructure in a more or less decent condition. On the contrary, it has created all the conditions for its ruin. There is no light, water, or heating in apartment blocks, matters have reached the point where association staffers who go there for a launch cook for themselves on a campfire in front of the hotel. They are forced to live in these conditions for three months at a time." We probably saw the remains of those very campfires!

1.3.6 HOUSING

1.3.6.1 Hotels -- A wide variety of hotels support launch campaign workers. There is a wide range of quality, from the VIP facilities in Kometa (each one-person suite had a bedroom, sitting room, bathroom (toilet plus shower), and clean-up room, to the more crowded Polyot, to the spartan-looking nearby apartments.

1.3.6.2 These nearby residence halls for visiting Russian specialists on launch campaigns appeared completely deserted during our stay, at least by day. Nobody was seen coming and going, or hanging around these buildings (although they all had new-looking air conditioners installed). But late at night, some lights were seen in a few of the apartments SE of Kometa, and in one other -- on the top balcony of the totally unlit dormitory building west of Kometa. I watched a match flare and a low, red pulsing glow of a cigarette as some unseen resident sat in the cool dark night air.

1.3.7 Transportation:

1.3.7.1 ROADS -- These were laid down in the 1960s and hardly repaired since then. The drivers knew every pothole and would swerve or slow expertly. Top bus speed was about 35 mph. Nobody passed us. The total length of the cosmodrome's automobile roads is given as 1281 kilometers.

1.3.7.2 Railway: The primary means of transporting personnel and heavy equipment around the site is by rail. Separate special rail lines transport booster carriers from processing buildings to launch sites.

1.3.7.2.1 The new spur to the Yubileyniy parking apron, promised in the July 1995 video, has been completed (see photos and Map-1).

1.3.7.2.2 From Yubileyniy Field to Area 31 is a 8 hour train ride; from area 31 to area 92 is an 8-9 hour train ride (at 5 mph).

1.3.7.2.3 We observed no railway repairs under way, nor did we see any rail maintenance equipment. We did not have the opportunity to see if there were traces of any recent rail accidents. We did observe a possible result of a rail car fuel spill (paragraph 2.1.4).

1.3.7.2.4 Russian press accounts speak of problems with the rail lines, and with transporter vehicles on them. The Moscow newspaper "Sovetskaya Rossiya" on February 27 of this year had an article on page 2 by State Duma Deputy Vladimir Toporkov, entitled "Outcasts: The Greatness and Poverty of Baykonur Cosmodrome", which wrote: "The condition of the material base raises special concern among both the military and the scientists servicing the cosmodrome. Today's Baykonur consists of dozens of launch pads and assembly and testing complexes, and hundreds of kilometers of paved roads and rails. As we know, the cosmodrome receives a great deal of oversized freight, and many sections of the rail bed are no longer fit for use. "The Lord God is our only hope," the officers lament. The railroad to Baykonur is a vital artery. Hundreds of people travel to the facilities daily in trolley cars. And if emergencies haven't occurred, it is for one reason only: in the conditions of impecunity, Baykonur railroaders find creative ways to keep the tracks serviceable, and they work days on end on the right-of-ways, especially during snowstorms."

1.3.7.2.5 A reliable source tells me that Baykonur has 470 kilometers of railway line.

1.3.7.2.6 Numerous freight cars were seen at the launch preparation areas. A string of cars were labeled "Light-Weight Cargo" and were

parked on a spur in Area 31. Tank cars were common, sometimes just parked out on a spur along a road miles from any facility. Most tank cars were labeled: "No brakes -- Do not push off hillock".

1.3.7.3 Commuter aircraft. We detected NO air traffic between areas, nor observed any ground airstrips or helipads, nor did I hear any low-flying aircraft in the hours I spent outside. Even General Shumilin, the cosmodrome commander, apparently came to the farewell banquet via an hour or more drive each way from Leninsk. There should be helicopters somewhere, but I've never seen them on any of my visits.

1.3.7.4 We noticed that people seemed to walk everywhere, both along the roads, across open areas (sometimes ducking under the elevated heating pipes), occasionally out into the steppe. We saw no signs of bicycles or motorcycles.

1.3.8 Rocket Propellant: We did not observe any production facilities but did observe storage in parked railway tank cars.

1.3.8.1 LOX is produced locally in an area south of where we traveled. The plant also supports Soyuz booster launches.

1.3.8.2 Kerosene and variants, for the Soyuz and Zenit vehicles, arrives by rail from an unknown distant manufacturing plant.

1.3.8.3 Hypergolics (UDMH and N₂O₄) arrive by rail car from an unknown source. Propellant transport and storage is a potential bottleneck for cosmodrome operations. It is not known how much reserve supply is kept on the cosmodrome.

1.3.8.4 MMH apparently is imported by train from St. Petersburg.

1.3.8.5 Liquid hydrogen was once manufactured on site for Energiya but is no longer used in any operational booster.

1.4 Visit to Area 2 ("Gagarin Start") -- One afternoon the ILS and Khrunichev teams held a private discussion, so we joined the bus tour to the cosmodrome museum.

1.4.1 Route -- Instead of driving the long route directly to the north-south mainroad, then turn north, we took a more roundabout course with slightly better (newer) roads. We headed for the airport, then turned east and passed the Energiya test stand, then the pads and other buildings of the Energiya/Buran project, and eventually we drove into the Area 2 village.

1.4.2 Cosmodrome Museum -- The cosmodrome museum is a nice collection of old hardware, models, photographs, and public relations displays.

1.4.2.1 Lt. Col. Nechyosa, the director, was on vacation (which explained why nobody answered his home telephone when I called), but the Deputy Director gave us the tour (and showed us the case with my "Uncovering Soviet Disasters" book I'd given him the year before!).

1.4.2.2 There were historical photographs of "original pads", and Mr. Muller noticed that the Proton pad photo from 1965 or so showed it looked old and beat up even back then, thirty years ago.

1.4.3 Although we were supposed to visit Bldg 254, the Buran hangar (where payload processing facilities are being developed to support commercial activities), we got there too late and the escort officers had already left. So we went to see the "outside Buran".

1.4.3.1 The boiler-plate Buran was sitting in a revettment about 600 meters northeast of the hangar.

1.4.3.2 We were told that RCS jet firing tests had been conducted with it, but it must have been long ago.

1.4.3.3 Its conditions were poor, with dummy tiles peeling off, exposed metal rusted, and the two aft RCS pods entirely missing.

1.4.3.3 It is apparently slowly succumbing to cannibalization and theft. It "...is standing out in the open and being pilfered little by little 'for fishing weights'." Toporkov, op. cit..

1.4.4 Miscellaneous Observations

1.4.4.1 Bus trips in summer at Baikonur can be beastly, with the sunward side of the bus radiating uncomfortable levels of heat inwards even through the curtains. The bus's air conditioning moved the air and did slightly cool it, making conditions barely tolerable.

1.4.4.2 On the other hand, it is much easier to take good pictures out of windows that are not frosted or fogged over, as they generally are in winter time.

1.4.4.3 We got good views of the early 1970s N-1 moonrocket payload shrouds in the junkyard in Area 2, plus views of workers waiting for buses, of a few trains, and closer to the Yubileyniy Field a view of a blown-up old ICBM silo test complex and nearby some Kazaki yurts and camels. See photos.

2.0 Human issues

2.0.1 According to a long article in "Rossiyskaya Gazeta" on June 21, Krasnoyarsk communications satellite officials want to eliminate pre-launch payload testing at Baykonur entirely because of atrocious living conditions at Baikonur for their specialists during launch campaigns. Before shipping, the payload undergoes stringent tests, many of which are then repeated at the launch site. "The duplication of them at the launch site has not once uncovered any malfunctions", the article asserts. So under the scheme proposed by the specialists, tests would be conducted only in Krasnoyarsk, then a four-hour plane flight to Baykonur (which airfield was not specified), then ten days for assembly and fitting to the rocket, and then launch.

2.0.2 This is corroborated by a very recent newspaper quotation from cosmodrome commander Shumilin (June 21), from the point of view of the cosmodrome processors: "It used to be customary to conduct all tests at the cosmodrome. Now most have to be done in the plants, and we bring in hardware that is already ready. But it happens that we finish it off here just the same."

2.1 Safety Issues --

2.1.1 During discussions in the Area 31 payload processing building, the Russians were asked how alarm indications were processed.

2.1.1.1 They reported that alarm indications go to a duty officer (one is constantly on duty) and that he in turn activates countermeasures and warns all personnel to leave.

2.1.1.2 There is no activation capability in the work area, neither automatic nor manual ("Too many false alarms", the Russians insisted).

2.1.1.3 They were adamant about requiring man-in-the-loop countermeasure control: "Any spontaneous activation of processes brings only harm".

2.1.1.4 Regarding the duty officer, it was never made clear just what the duration of each operator's duty shift was: many others in the space industry, from the desk clerk at the Kometa Hotel to the flight controllers in Mission Control in Moscow, work long shifts of 24 hours

straight (followed by 3 days off), which might not allow alertness standards desired by Western customers.

2.1.2 Smoking

2.1.2.1 Some facilities (e.g., area 92 Proton hall) had specific smoking areas outside the main door, with metal cans for butts. Inside, there was sometimes a checkpoint for turning over all smoking materials for later retrieval. Others did not appear to have such measures. In area 31 bldg 30 it was interesting to see "No Smoking" and "No matches" signs INSIDE the main hall -- one might think such admonitions were superfluous.

2.1.3 Fire Fighting: In area 92 we drove past the local fire station four times. There were four inoperative fire trucks in front of the building each time. One was parked diagonal in front of the doors, with three flat tires. Another was up on a makeshift ramp, and a third was draped in tarpaulins.

2.1.4 We may have observed signs of a propellant handling accident at the Proton pad 200 area. Along the curving railway embankment where tank cars full of propellant are transported to the pad 200-L area, we saw what looked like scorch marks flowing down the slope, from 15 to 20 feet below the tracks, along a stretch about 200 feet long. It did not seem like a brush fire because even in the unmarked areas there was scanty if any brush. Besides, the flow pattern appeared to be downward rather than upward. Perhaps there are repeated small spills or leaks as the trains make the turn. Or perhaps there was one large recent spill, although there was no sign of any physical soil disturbance. The tracks did not appear to have any damage.

2.2 Physical Security:

2.2.1 For the most part, the fences all over the site appeared to be to discourage intruders, not to really stop them.

2.2.2 At "Bunker 84" at the Proton pad 81, there were lots of barbed wire fences but they did not appear to be particularly effective. The new UPS equipment set up outside late last year was surrounded by a new barbed wire fence that seemed designed to look twenty years old. The wire was simply strung around the posts, not tightened, so the lower strands could easily be lifted to allow passage. The front

gate was locked, but there was no wire above it, so an intruder could easily climb over the gate's horizontal slats. The outermost fence line appears effective against casual camels, horses, or cows, but not human intruders; many intermediate fence lines were not even continuous along a perimeter; where there are thorough fences (8-10 tight strands, with chickenwire along the bottom), the gates are not wired and intruders could easily climb over them.

2.2.3 The same standards apply to the security fence surrounding the new water processing building next to Hotel Kometa. It is an impressive structure, but along much of its length it only reaches down to about 12 to 18 inches above the ground, making it simple for an intruder to roll or crawl under it.

2.2.4 The chains at the road checkpoints were of the same "symbolic" nature: they were hardly thicker than an average dog chain, and any vehicle which wanted to could easily drive right through them. Some main checkpoints had bars which raised, but they too looked mostly for show. It was only the presence of the guards which made the barriers "secure".

2.2.5 These implementations may reflect the Russian reliance on human presence to actually perform the security function. The fence lines themselves merely serve to define the "line to guard", to provide public notice against "casual walking".

2.2.6 On the other hand, the inadequacies of the physical barriers may also be indicators that the cosmodrome workers are just "going through the motions" to build a fence where regulations require a fence, whether or not the fence actually really functions or not.

2.3 Demographics: Makeup and morale of the workforce.

2.3.0 On the occasion of "Cosmonaut Day" earlier this year, there was major Russian media attention to the status of their space program. On April 14, Moscow's "Radio of Russia" network ran a special program by correspondent Andrey Kondrashov in Almaty, on conditions at Baikonur. Just prior to the holiday, "the coordinating council of the Baykonur complex -- which includes the town's mayor, the head of the space center, and the Kazak president's representative in this part of Russian territory -- made a joint appeal to first deputy prime ministers Oleg Soskovets [of Russia] and Nyghmetzhan Yesengharin [of Kazakstan], who handle the affairs of the space center on behalf of the two governments. The appeal says that social tension is spreading from Baykonur to the whole of Kzyl-Orda Region and, unless the governments provide funds to meet the space center's debts, the coordinating council states, a public social explosion will be added to the constant disruptions to the launchings of rockets.... The list of problems at Baykonur at present is such that the staff themselves at the space center are surprised at times that in these conditions they have managed over the past year to carry out 44 launches." This commentary was before the double Soyuz booster failures in May-June, and before Soskovets was summarily fired by the new Lebed team in the Kremlin (during our stay at Baykonur).

2.3.1 Who is there. In early 1995, the VKS had about 16,000 personnel at Baykonur: about 4800 officers, about 2000 civilian contractors, and about 9-10,000 conscripts. By September 1995 that total was down to 14,500, and I don't have any newer figures. Warrent officers and non-commissioned officers seem very rare: here as elsewhere in the Russian armed forces, junior officers do the work of American sergeants and chiefs. There are also about 700 civilian employees of the RKA, and an unknown number of Leninsk municipal employees. Together with their families, a few retirees, and an unknown but large number of Kazak squatters, the population of the entire area is somewhere above 50,000 people, many of them at sites actually on the cosmodrome (between three and five thousand people were said to live in Area 92).

2.3.1.1. Officers (4500-4800 men):

2.3.1.1.1 The officers who escorted us were mid-level (Majors to Colonels) who had been at Baykonur for ten to fifteen years or more, and most had families in Leninsk (this meant a LONG daily commute by train). Their uniforms were sharp, they appeared well fed. Their manner was alert and energetic and self-assured.

2.3.1.1.2 When I asked an ILS interpreter where were the lieutenants, he replied that they were on duty supervising the enlisted men. I confirmed this by direct observation at Area 92.

2.3.1.1.3 Another Khrunichev employee, aged 30, who had spent half his life at Baykonur, reported that about 500 junior officers per year are assigned to Baykonur by the VKS ("Every year we have a new contingent", an 11-year veteran officer had assured me).

2.3.1.1.4 I had the opportunity to observe junior officers around and inside the Polyot restaurant, but not to talk with any. They appeared to be well groomed, talkative, and cheerful. As far as I've ever been able to determine, all VKS officers are male.

2.3.1.1.5 The demographic crisis, by consensus, will come in several years when the older officers depart. If enough junior officers with the right experience, intelligence, and dedication chose to stay -- and raise families in Leninsk -- operations could continue.

2.3.1.1.6 Some of the military retirees are now going to work for commercial groups such as Khrunichev. It's not known how widespread this is now, or how often it used to happen in the past.

2.3.1.2 Conscripts -- Perhaps 8,000 to 9,000.

2.3.1.2.1 Most of them are probably 18-19 years old (the ones I talked to in 1995 were 19 or 20), but they looked 16 or 17. They spend between one and two years here.

2.3.1.2.2 While working in uniform, they each had a small canteen attached in small of back, carrying two hours supply of drinking water. It didn't look enough.

2.3.1.2.3 At the Area 92 store, where we found that all of the pins bought by Laryssa Sharvan (ILS) last time had still not been restocked, we were approached by a soldier who asked if we wanted to buy any souvenirs. He offered his collar pins signifying the VKS.

silver Soyuz rockets with wings. How much, we asked? "Five" -- we presumed 5000, not 500, and I gave him a bill. As we walked away, the two civilian security types who had been following us pounced on him, demanding to know what he had sold us. He denied everything, and they never asked us directly.

2.3.1.2.4 The soldiers' work detail at the Kometa was laying the small cement slabs for the outdoor barbecue area, and as I walked by I explained I was looking for some military hats for my son. They were all willing to swap or sell, and all asked to return in the evening, but that was the day we were leaving so that was impossible. The lieutenant in charge walked over and I greeted him with my "need conversation practice" spiel. Later, as they were being marched away for lunch, I saw them and waved, and half of them cheerfully took off their hats and waved them in the air. But the lieutenant glowered, and they all turned to follow him, one with extreme reluctance.

2.3.1.2.5 There were lots of training facilities both in Area 92 and in Area 2 where I wandered in March 1995. These included mainly obstacle courses.

2.3.1.2.6 I saw no playing fields for soccer or any other outside entertainments. They could be closer to the conscript barracks, which we did not see.

2.3.1.3 Civilians --

2.3.1.3.1 I was surprised by the large range of civilian employees. They drove the airfield emergency vehicles, performed major maintenance (such as the new power station for the Hotel, installed while we were there), staffed the hotels and restaurants. All ages were represented. I talked to many of them.

2.3.1.3.2 The Kometa hotel cleaning staff were all women, of assorted ages, reasonably well dressed, and all were ethnic Russians. Several of the Polyot cleaning staff were Kazakis, and one Korean-Kazaki young woman worked in Polyot (there is even a Korean restaurant in Leninsk, by the way -- tens of thousands of Koreans were deported by Stalin from around Vladivostok, to Kazakstan, in the 1930s). The Polyot manager is a sweet-tempered old Russian woman named Raisa, with flaming red died hair, and we snuck several pleasant conversations when the cops weren't watching.

2.3.1.3.3 Although there were supposedly many civilian families living in Area 92, I saw no children or any evidence of them (such as playgrounds).

2.3.1.3.4 Some people at Area 92 kept dogs, sometimes quite large dogs. The old friendly dog kept by Raisa at Hotel Polyot was named Rzhenn.

2.3.1.4 Kazakis --

2.3.1.4.1 Despite some initial questions about whether we would encounter any natives of the area, they were well represented among the civilian workforce. They were seen as drivers, laborers, and employees of the Polyot Hotel (although not the Kometa Hotel).

2.3.1.4.2 Russians always addressed them in Russian, and they responded in a proud, liesurely fashion, with no signs of subservience or hostility. When I addressed them in Kazaki they showed first astonishment, then delight.

2.3.1.4.3 There seem to be Kazaki herdsmen at large on the cosmodrome, watching the livestock. We spotted several hobbled horses (probably stallions) with other horses keeping company. We saw one horseman cantering after a hobbled horse who had figured out how to do a rough canter with his front legs still tied. There was a round yurt a half mile north of the airport road, with five or six camels nearby; the next day, as we drove to our departure flight, there was a second yurt and two caravan wagons next to it, with more livestock.

2.3.2 Municipal status

2.3.2.1 People on the cosmodrome used Russian rubles, even though it is officially in Kazakstan.

2.3.2.2 Area-92, the residential area for the Proton activity, has the mail code "Leninsk-7", according to the mailbox in front of one of the residential halls.

2.4 Access Constraints: Significant limitation on our access to locations and to people, and our ability to photograph even approved facilities, was one of the most notable features of this visit, but the implications of this feature are unclear.

2.4.1 Upon landing at Jubilee the group was almost immediately lectured on camera policy: no photographs in the airport area or on the drive to Area 92. At the hotel, the policy was elaborated on: each group would be allowed to carry one camera but all photographs were to be made in the presence of and with the permission of a local security official. These officials were all older men, and they were civilians, not VKS officers.

2.4.2 Physical access was decreed by limiting walking around the hotel. Morning jogging was forbidden with the explanation that there were packs of wild dogs in the area. That may actually be true; however, early in the morning I observed from hotel windows many civilian individuals walking into the area from out on the steppe with no apparent concern for wild dogs!

2.4.3 During facility tours, security officials kept sharp watch on stragglers. Examples. I walked up to a partition to look over it (my height brought my eyes above its upper edge) and was brusquely directed to get away from it. When I wound up behind a test stand, separated from the group, an escort walked around the stand to where he could see me and waved me back. Soldiers on guard duty reported they had been ordered not to talk to us.

2.4.4 In order to get the exterior photographs of the hotel and the water processing building, we had to ask permission at the hotel desk and have the desk clerk walk around with us to watch that we pointed the cameras only back toward the approved structures, not away toward forbidden views of pads and processing buildings.

2.4.5 This was kind of silly, anyway, since there were better views of them from the hotel windows, anyway, especially the top floor of the Hotel Polyot, or from the roof of the Hotel Kometa (access was through the second floor NW end-of-hall window-doors out onto a balcony, then up the attached metal ladder).

2.4.6 At least some of the photo-sensitivity was due to simple shame: they did not want pictures taken of ruins, which could embarrass their program. At the outside Buran area, we were allowed to freely

take photographs -- even pointed AWAY from the Buran and towards other facilities -- but when returning to the bus through the amazing ruin of the turnstyle shack, I stopped to aim the camera at the wooden door lying collapsed against the wall, and was grabbed on my arm by an escort who forbade further photography.

2.4.7 In terms of concealing things from us, another impression was the bizarre round-about way of driving to the hotel (see map-2). The bus approached the Area 92 settlement along the main road, toward the main gate, which led directly into the heart of the settlement. But short of the town, the bus turned right onto the road to pad 81, then soon turned left to skirt the north edge of town, then left again at the far edge of town, then two lefts to reverse course, then right behind the hotel, then 2 more rights to get to the parking lot. The impression was given that there was something along the more direct route that we weren't supposed to see, since from one turn on the route we could see straight down the unblocked main road through town, all the way to the main gate we had been heading for at first.

2.4.8 Also striking (and unpleasant) was their consistent policy of interfering with contacts with local inhabitants. Whether it was a discussion with a passerby, or with an amiable drunk in the Polyot Hotel pool room, or with the hotel's hostess, it was never more than a few minutes before a security official spotted the transgression and ordered the Russian away. These officials, by the way, were older (50ish) civilians, some local from Leninsk and some travelling with the Khrunichev party. Their devotion to preventing visitors from talking to anyone except pre-screened and approved officials left a very bad impression. See also 2.3.1.2.3 for another such incident.

2.4.9 Even on the way home, at the Yubileyniy field, this tight control continued. While I was chatting with a 30ish civilian driver of one of the firetrucks (he gladly donated his cloth cap to me for my son, and refused all offers of swaps or payment), as he was autographing the cap "To John from a fireman at Baikonur", he received a radio call on his headset demanding to know what we were talking about. He brusquely told the caller he was giving me a gift for my son, and then returned to the inscription.

2.4.10 In the Proton launch control bunker, the large wall-mounted bulletin boards were empty, and the presumption is they had been stripped of their notices.

3: Political Environment

3.1 The Cosmodrome Lease. In December 1994 Moscow and Almaty reached an agreement on the status of Baikonur as a Russian area within Kazastan, requiring an annual payment of \$115 million.

3.1.1 There are some claims that the lease payments are no problem:

3.1.1.1 When I specifically raised this issue with Mike Hill of ILS, he was adamant that the payments were being made on time and in full and that there were no outstanding issues related to this question.

3.1.1.2 At the farewell banquet, General Shumilin's comments about how the lease agreement solved the status question about Baikonur was mistranslated and widely misunderstood to have claimed that Russian cash payments, already made, had solved that problem.

3.1.1.3 In face-to-face discussions with Khrunichev personnel, in their hotel rooms in Polyot, the lease payment issue was clearly a "hot button". When I described how it was my impression that no payments had yet been made, one of them angrily and forcefully stated that the payments were not a problem and there was nothing to worry about, and further that they had actually already been made. When I challenged him on this fact, he modified his claim to aver that the payments were now being made in merchandise, such as cotton shirts made in Russia of raw cotton from Kazakstan, and services, such as training Kazak military officers in Russian military equipment. When I challenged him again on the current state of such proposals, he backed down further and admitted they were only ideas, but ones that he was certain would prove adequate.

3.1.2 Russian media statements are unanimous that no payments have been made and that no agreement has been reached as to how to make modified payments.

3.1.2.1 Moscow's "Kommersant-Daily" newspaper last January 25 had a page 3 article by Ilya Bulavinov entitled "Debt Forgiven, Rent Still There: Military Cooperation Between Russia, Kazakstan," which described in detail a visit to Almaty of a military delegation led by Russian Defense Minister Pavel Grachyov. The article asserts: "The most crucial and tricky problem is the maintenance and operation of the Baykonur space center. This problem is set to be the centerpiece

not only of the military ministers' meeting but also during Pavel Grachyov's talks with Nursultan Nazarbayev." In discussing the cosmodrome lease agreement and original plan to "pay" it out of credits from the Almaty-Moscow debt, the article continues: "The debt has already been officially forgiven, however, in exchange for Almaty's waiving its claims with regard to environmental damage caused by the operation of Baykonur -- there is a corresponding agreement between the Russian and Kazakstani presidents and an intergovernmental protocol to that effect. There are legal nuances, however, that keep alive Moscow's hope that this debt will somehow be taken into account in the payment of the Baykonur debt." The author concluded that Russia's going-in proposal would probably be to arrange some non-cash payment plan, or to ask for a reduction in the lease payments in exchange for a serious Russian payment schedule. No such resulting agreements were subsequently announced, however, and note that Grachyov, the guy in charge of these Baykonur negotiations on behalf of the VKS, was fired by Lebed the week of our visit to Baykonur.

3.1.2.2 Moscow's "Komsomolskaya Pravda" newspaper, on April 2 of this year on page 1, carried an article by Yevgeniya Dotsuk in Almaty, entitled "Baykonur by Barter: Nursultan Nazarbayev answers questions of who owes whom how much in Kazakstani-Russian relations". The article quotes Nazarbayev directly as saying: "Boris Yeltsin and I signed an agreement to the effect that all the debts as of early 1994, that is, the time that the agreement on Baykonur was signed, were deemed to have been paid. As for Russia's leasing of Baykonur in 1994-1996, the debt is still up in the air. Under the agreement, the annual fee for the leasing of Baykonur is \$115 million. When talking about mutual settlements we realize that Russia's budget situation is currently complex, therefore we are amenable to the Russian side paying not in money but in those kinds of output that Kazakstan's enterprises need. The Kazakstani side will stipulate the range of goods and the size of the deliveries. Let me add that Russia currently owes \$230 million for the leasing of Baykonur in 1994-1995." Comment: there's not much ambiguity in this quoted statement, assuming the newspaper article is authentic (which I do)!

3.1.2.3 Moscow, "Radio of Russia" network, April 14, 1996: "The space center is at present experiencing a very severe power crisis, and the problem of interstate payment arrears is affecting the space installations themselves and also the people who maintain them.... "

3.1.2.4 There are half a dozen other Russian press reports in my archives, from the first half of 1996, which also refer to the totally unresolved nature of the lease payment disagreement.

3.1.3 Both Russian and Western private specialists on Russian space activities, contacted during and after the Baykonur visit, were unanimous that there has been neither formal announcements nor informal rumors about ANY payment of the debt, in any form. They all agreed with my original assessment, that the ILS/Khrunichev claims of "settlement" of the lease payment issue were entirely false.

3.1.4 There thus remains a potential for serious Moscow-Almaty conflict over lease payment. The present Kazakstan government (Nazarbayev himself) does not want to shut Baikonur down permanently (they want the cash, as much as they can practically get), and they may ultimately come to a compromise regarding a plan of lowered payments. The fact that they have recently failed to find a non-Russian pipeline route for export from their spectacular new Tengiz oil field (the originally planned Iranian route proved to be unfinanceable thanks to US diplomatic pressures), probably makes them reluctant to overplay their squeeze on Baikonur. However, well-timed outages of power and water to the cosmodrome have already been used to encourage Russian cooperation on this question and can be expected to happen again, especially before some highly-publicized and high sensitivity (read: Western commercial) launching. Delays of a few days or weeks might be the result, but as long as the installed UPS capabilities maintain environmental quality, no lasting damage (aside from financial losses from the delay of capabilities) is likely.

3.1.5 The above dispute deals only with the lease payment. The Russian payments to Kazakstan utility ministries for water and electricity delivered to the cosmodrome appear to be entirely separate.

3.1.6 I expect to learn more about this subject because by chance I spent a portion of my return leg from Moscow to Houston sitting next to a retired World Bank official, a Turkish citizen, who is a top financial advisor to the Kazaki government and visits Almaty monthly. He was fascinated by the issue of the cosmodrome leases and promised to verify the exact status of the issues during a forthcoming trip.

3.2 Legal and environmental issues -- We made no direct observations on this visit relevant to this issue, but it is a common theme in the Kazaki and Russian newspapers. Another potential outside interference with Baikonur operations is the growing concern about pollution and poisonings from Baikonur launchings, particularly Proton launchings. Effects of the leftover UDMH at first and second stage impact zones (in Kazakstan and further downrange) is becoming a big issue in the news media. People are moving into these areas for pasturage and other economic activities, as the Russian government's ability to keep them out has vanished. Just a single spectacular casualty event from any Proton launch could result in a major diplomatic and litigious confrontation, especially since grandiose Russian promises a few years ago to "clean up" the debris from impact zones were never fulfilled.

3.3 Khrunichev's role vis-a-vis VKS

3.3.1 We were told that Khrunichev contracts directly with VKS for launch support services and pays them with dollars obtained through the ILS contracts.

3.3.2 Khrunichev has acquired the title to the Jubilee airfield (the original owner was probably either Energiya or VKS). Just how or even why this was done was never explained. Kazakstan wants to develop the renovated airfield as a trans-Asia air cargo staging area, but VKS is resisting the idea of western aircraft regularly flying through Baykonur airspace.

3.3.3 Understanding the boundaries of Khrunichev candor is important in estimating what questions about the Proton can be expected to be answered, and what areas may transgress still-in-force military secrecy regulations.

3.3.3.1 ITEM 1: Proton reliability data. As described in Appendix TBD, a detailed comparison of the ILS data (from Khrunichev) shows it to be very accurate and nearly (but not totally) complete. This is an encouraging observation.

3.3.3.2 ITEM 2: Proton versus Tsylkon.
"Where Tsiklon"? See section 1.2.5. above.

3.3.3.3 ITEM 3: The Proton "Six-Shooter".

3.3.3.3.1 ILS engineer Laryssa Sharvan told me of a remarkable model of the Proton she was shown at the Khrunichev plant in Moscow. It showed six Proton rockets mounted on an underground carousel, designed to swing them one by one into position for launch through a silo to the surface. She said the Russians told her they cancelled the program when they figured out it would bankrupt the country.

3.3.3.3.2 EVALUATION: This is consistent with estimates that the Proton rocket was originally (1961-1962 era) designed and built as a carrier vehicle for Khrushchev's 100-megaton H-bomb, and only later (1964-5) converted to space use. Since the pads and industrial area were already essentially complete by 1963 (per the declassified CIA map), the project must have gone on for awhile in its military form.

3.3.3.4 ITEM 4: The "Polyus-Skif" payload. During the homeward airplane trip, as we all relaxed and socialized with our Russian colleagues, I thought to see just how far their openness would extend. I had brought along a copy of a painting of the 100-ton Polyus-Skif payload developed by Khrnichev for the first Energiya booster launch in 1987. Significant uncertainty still surrounds the object, widely thought to have been a "Star Wars" anti-satellite laser. I handed the picture to Igor, who took one look at it, dropped it on a nearby seat as if his fingers had been singed, then mimicked a zipper running along his lips. Whether this was really going too far, or was helpful in reminding them we knew a lot they hadn't realized we knew so they'd better be scrupulously honest about their data they give us, it's too early to tell.

3.4 Transfer of partial control from VKS to RKA -- In a major structural change, in 1995 the RKA has announced that it will be taking over operational control of many of the Baikonur launch complexes from the VKS. It would start with the old Area 2 "Gagarin Start", then expand to the other Soyuz pad in Area 31, and eventually include one of the Proton pads. The VKS and RKA would share authority and expenses for numerous support facilities.

3.4.1 Sources in Moscow (NK) and at Baikonur now assert that this plan has been a total flop. The blue-uniformed "RKA Space Workers" which were photographed at the Soyuz site last fall were never much more than VKS personnel under contract to RKA, with a few civilians. NK quoted VKS chief General Ivanov as saying they would let the RKA try it first on a small scale and fall on their faces. There are no current plans for any RKA takeover of Area 92 Proton-related facilities

3.4.2 We saw no evidence of RKA authority or even presence at any of the facilities we visited.

Glossary and Terminology

The Buran airfield, "Yubileyniy", is sometimes spelled "Jubilee"

- DM M-modification to "Block D" 'kick-stage' for Proton (4th stage)
- ILS International Launch Services, San Diego
- LOX Liquid Oxygen
- RCS Reaction Control System, small attitude-control jets
- RKA "Russian Space Agency", Russian-language initials
- RKK "Rocket and Space Complex", term like "Inc." for space group
- RSA Russian Space Agency
- UPS Uninterrupted Power Source
- VKS "Military Space Forces", Russian-language initials

Pairs of launch pads at Baykonur are designated "Left" and "Right", such as 81L and 81R. In Russian it is "Leviy Start" and "Praviy Start", so they would be designated 81L and 81P.

Baykonur numbered areas/sites

- 1 Original Sputnik/Vostok pad, now Soyuz
- 2 Support area for pad #1
- 3 "KAZ" LOX plant (also called "3-G")
- 31 Second Soyuz vehicle pad (unmanned so far)
- 42 Zenit booster pads
- 81 First pair of Proton pads (operational 1964)
- 90 Tsyklon booster pads
- 92 Proton Residential/Industrial Area
- 110 N-1 moon rocket pads, then Energiya/Buran pads
- 112 Vertical dynamics test facility
- 113 Ghost-town ("Energiya Village") for moon rocket workers
- 130 N-1 (now Energiya) booster assembly hall
- 200 Second pair of Proton pads (operational 1976)
- 250 Energiya static test and launch pad
- 251 Yubileyniy Field (formerly Buran shuttle landing field)
- 254 Buran Hangar, now modified for Proton payload.
Soyuz processing, possibly commercial processing