Collecting Mir Source and Reclaimed Water for Postflight Analysis

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INTRODUCTION

Approximately fifty percent of the potable water supplied to the Russian cosmonauts, American astronauts, and other occupants of the current Russian Mir Space Station is produced by the direct recycle of water from humidity condensate. The remainder comes from ground supplied potable water that is delivered on a Progress resupply spacecraft, or fuel cell water that is transferred from the Shuttle. This experiment is being conducted to determine the potability of the recycled water, to assess the reliability of the water supply systems, and to provide inflight testing of water collection hardware.

Hypothesis

Detailed analysis of reclaimed waters will confirm that the Mir water reclamation system and the ground supplied water system deliver water for crew consumption that meets established water quality requirements.

Objectives

Characterize the chemical composition of the ground-resupply water prior to launch and on orbit to determine potability.

Characterize the chemical composition of Mir recycled water to determine potability.

Evaluate the efficiency of on board water processors to aid in the development of ISS water processing and monitoring technology.

Characterize the chemical composition of Mir humidity condensate to support development of the water recycling and monitoring systems for the International Space Station (ISS).

Provide inflight testing of water collection hardware being developed to collect water samples on ISS.

Background/History

Historically, water provided for crew consumption during U.S. space missions has either been launched from the ground or produced as a byproduct of fuel cell operation. Reclamation and purification of spacecraft wastewaters as practiced on the Russian Space Station Mir, will be required for supplying crewmembers of the International Space Station with potable and hygiene water.

METHODS/RESEARCH OPERATIONS

Functional Objectives

FO1. Preflight collection of ground-supplied water at RSC Energia, Korolev (formerly Kaliningrad), Russia

FO2. Water Sampling Hardware Setup

FO3. Inflight collection of hot, cold, and SVO-ZV (ground supplied) water

FO4. Inflight collection of humidity condensate

FO5. Postflight analysis of samples

Hardware Items

Major hardware items used inflight for this experiment:

HW1. Water Experiment Kit - NASA provided

HW2. Disinfectant/Antiseptic Wipes - NASA provided

HW3. Potable Water Samplers (with Mir port adapter interfaces) - NASA provided

HW4. Waste bags and Chemical Archive Sample Bags - NASA provided

HW5. Self Sealing Storage Bags - NASA provided

HW6. Atmospheric Condensate Sampler - RSA provided

Major hardware items used postflight for this experiment:

HW7. HP 5890 Gas Chromatograph (GC) with HP5971A Mass Spectrometer (MS) - NASA provided

HW8. Waters Quanta 4000 Capillary Electrophoresis System - NASA provided

HW9. OI 700 Carbon Analyzer - NASA provided

HW10. Sievers Model 800 Total Organic Carbon Analyzer - NASA provided

HW11. HP 7694 Headspace sampler with a HP 5890 GC and 5972 Mass Selective Detector - NASA provided

HW12. HP 5989 Mass Spectrometer (MS) with a 1090 Liquid Chromatograph with Particle beam & Thermospray interfaces - NASA provided

HW13. pH meter - RSA and NASA provided

HW14. conductivity meter - RSA provided

Method/Protocol

During inflight water sampling sessions on board Mir, the water experiment kit was unstowed from its storage location. The water experiment kit contained the disinfectant wipes, potable water samplers, waste bags, chemical archive sample bags, and storage bags needed for water sampling. A prepackaged disinfectant wipe containing 1 ml of benzalkonium chloride in 250 ml of water, was retrieved from the kit and used to disinfect the Mir galley-hot, galley-cold, or SVO-ZV water port. Next, a potable water sampler was connected to the port. A waste bag was then connected to the potable water sampler. Using the waste bag, 50 ml of water was collected and discarded. Next, 750 ml of water was collected into the chemical archive sample bag. The chemical archive sample bag was placed in a self sealing storage bag and stowed for return on the Shuttle. These procedures were used to collect galley-hot, galley-cold, and SVO-ZV (ground supplied) water for postflight chemical analysis for this experiment. Following the collection of the chemical samples, microbiological samples were obtained for a separate experiment.

Postflight chemical analysis of samples occurred at Johnson Space Center (JSC) and the Institute for Biomedical Problems (IBMP). Following recovery of the samples on the ground, the samples were allocated (See Table 2) for distribution to the water analysis laboratories at JSC and IBMP. Parameters tested at JSC included total carbon (total inorganic carbon, purgeable organic carbon, nonpurgeable organic carbon and total organic carbon), specific organics (alcohols, organic acids, semivolatiles, volatiles, nonvolatiles, formaldehyde), and silver. Parameters tested by IBMP included conductivity, pH, color, chemical oxygen demand, total solids, calcium, magnesium, total hardness, and silver.

RESULTS

List of Pre-, In-, and Postflight Anomalies

Preflight Anomalies

None.

Inflight Anomalies

Mir 21

On June 14, 1996, and July 21, 1996, Mir 21/NASA 2 crewmembers reported a “metallic” aftertaste in the potable water from the Mir condensate water processor system. This system produces potable water from humidity condensate. Ground personnel instructed the crewmembers to turn off the condensate water processor until the problem could be evaluated. As a consequence, the crew relied on either Russian ground supplied water or water transferred from the Shuttle for drinking during this period. The condensate water processor was returned to operational status on October 17, 1996. As a result, all samples collected between July 21, 1996, and October 17, 1996, were ground supplied water instead of recycled water.

One additional session for water collection was performed on July 22, 1996, when hot and cold water were collected as a response to the comments by the crew. These samples were not received on the ground upon return of STS-79 and have not been found to date.

Mir 22

During the time that the condensate recovery system (CRS) was not operational, humidity condensate was collected in EDV tanks. Two EDV tanks were filled during the respective periods of September 10-12, 1996, and September 16-18, 1996. Samples from each EDV tank were collected in water sample bags containing a microbial preservative (thioglycolate) which could interfere with the chemical analysis of these samples.

Postflight Anomalies

Two condensate samples were collected from June 18-22, 1996, and July 23-26, 1996, but were not returned on STS-79. These samples were subsequently found and returned on STS-81 in January 1997. The results are included in this report.

Completeness/Quality of Data

Data for this experiment are derived from analysis of water samples returned from the mission. Two water samples

(one cold on Mir 21 MD177, one SVO-ZV on Mir 22 MD38) were not collected inflight as planned. For these samples, no data will be available. Also, no data will be available for those samples not returned to the ground (1 hot water, 1 cold water) that were collected on July 22, 1996. All sample analyses have been completed on those samples received.

DISCUSSION

Status of Data Analysis

All sample analyses have been completed.

Final Research Findings

Regenerated Water

Six recycled water samples were collected during Mir 21, five in March and one in July 1996. Two of these samples were collected near those times when pressure dropped in the Mir Thermal Control System and when crewmembers detected unusual tastes in the recycled water. Analytical results for these samples are reported in Table 4.

Physical Parameters - Conductivity in the Mir 21 regenerated water samples ranged from 15.0 to 81.3 μS/cm, compared with 36.5–140.1 μS/cm in samples collected from Mir 18 and Mir 19 [3]. Turbidity in all of the Mir 21 samples exceeded the U.S. maximum contaminant limit of 1 NTU specified in the Joint U.S./Russian Potable Water Specifications for International Space Station (Table 3). Turbidity in these samples ranged from 1.04 to 5.50 NTU; turbidity in samples collected during Mir 19 ranged from 0.95 to 1.91 NTU [3]. The pH range was consistent in samples collected during Mir 18 through Mir 21, and ranged from 6.08 to 8.0 for all samples analyzed [3].

All of the Mir reclaimed water samples analyzed since Mir 18 measured 10 degrees of color, including those collected during Mir 21. For odor, ratings of 1 (on a 5-point scale) were assigned to two Mir 21 samples; this rating corresponds to a very low odor threshold, one that cannot be sensed by the user but can be detected under laboratory study [5]. No other samples collected during Mir 18 and Mir 19 had odor levels above 0 points [3]. Although crewmembers reported unusual tastes while drinking reclaimed water during Mir 21, taste was not assessed after flight in any of the Mir 21 samples received. Instead, a taste study was conducted using solutions with known concentrations of 1,2-ethanediol (ethylene glycol) to determine if the metallic taste identified by the crewmembers was due to 1,2-ethanediol contamination. The Mir thermal control system utilizes a 37% ethylene glycol solution as coolant.

Chemical oxygen demand values for the Mir 21 samples ranged from 7.5 to 85 mg/L, compared with 32-50 mg/L for the Mir 18 and Mir 19 samples. These values were within the 100 mg/L limit outlined in the Russian potable water specifications for the International Space Station (Table 3).

Inorganic Parameters - Ionic species identified in the Mir 21 samples include chloride (ranging from none detected to1.11 mg/L), sulfate (none detected to 0.40 mg/L), calcium (4.42–20.0 mg/L), lithium (none detected to 0.42 mg/L), magnesium (none detected to 0.32 mg/L), potassium (none detected to 1.02 mg/L), and sodium (none detected to 1.73 mg/L). Lithium was detected only in the sample collected on July 15, 1996; no other sample from Mir 18, 19, or 20 had detectable levels of lithium [3]. Metals detected in the Mir 21 reclaimed water samples include silver, barium, chromium, copper, iron, manganese, nickel, lead, and zinc. None of these inorganic parameters exceeded the joint U.S./Russian potable water specifications.

Organic Parameters - Nearly 250 organic compounds were tested for in the Mir 21 samples. These compounds were classified as volatile organic compounds, semivolatile organic compounds, carboxylates, alcohols, aldehydes, and urea. Total organic carbon (TOC) also was performed. Volatile organic compounds detected in the Mir 21 samples include acetaldehyde, acetone, carbon disulfide, methylene chloride, and trichloroethene. Acetone was detected in much lower concentrations in the Mir 21 samples (17.1–39.3 μg/L) than in the Mir 19 samples (78.2–131.7 μg/L) [3]. Chloroform, detected in Mir 19 samples, was not detected in the Mir 21 samples analyzed. Moreover, acetaldehyde, carbon disulfide, and trichloroethene, detected in Mir 21, were not detected in the Mir 18, 19, or 20 regenerated water samples previously analyzed [3]. Acetaldehyde (50 μg/L) was detected in only one of the Mir 21 reclaimed-water samples.

Twenty-seven semivolatile organic compounds were detected in samples collected during Mir 21. Of these, n-butylbenzenesulfonamide, di-n-butyl phthalate, indole, and 1-tetradecanol had not been detected in samples collected during Mir 18, 19, and 20 [3]. However, n-butylbenzenesulfonamide and dibutyl phthalate have been detected in the condensate samples from Mir 18-Mir 21. Total phenol levels exceeded the NASA maximum contaminant level (MCL) of 1 μg/L in five of the samples analyzed. Hot water collected on July 15, 1996, had no detectable levels of total phenols, whereas the remaining samples ranged from 1.2-132.4 μg/L of total phenols which includes amounts of 3-t-butylphenol, 2,6-di-t-butyl-4-methylphenol, di-t-butylphenol, phenol, and 2-phenylphenol. The highest concentration of phenols was seen in the galley-cold sample collected on March 27,Ê1996.

No alcohols were found in the samples collected during Mir 21, except for one sample collected on March 27, 1996, which had 160 μg/L of ethanol. In addition, one sample collected during Mir 21 had a very high level of 1,2-ethanediol, (ethylene glycol is used in a 37% solution in the Mir thermal control system) of 45.5 mg/L. There is no NASA, U.S. Environmental Protection Agency (EPA), or Russian maximum contaminant level for this compound. However, the EPA Lifetime Health Advisory for 1,2-ethanediol is 7 mg/L and the EPA Long Term (up to 7 years) Health Advisory is 20 mg/L. No other samples collected had detectable 1,2-ethanediol concentrations. No 1,2-propanediol was detected in any of the Mir 21 samples analyzed.

Acetate was detected in three recycled water samples collected during Mir 21, at concentrations of 215 μg/L, 131 μg/L, and 1.49 mg/L. No other carboxylates or amines were detected in any other Mir 21 samples. Formaldehyde levels in the Mir 21 samples ranged from none detected to 63.4 μg/L. Other samples collected during Mir 18, 19, and 20 ranged from none detected to 57.3 μg/L [3].

The mean concentration of TOC in the Mir 21 samples was 10.2 mg/L (range 5.15–23.7 mg/L). As samples collected during Mir 18, 19, and 20, none of the Mir 21 reclaimed water samples met the U.S. potable water specification for the International Space Station (0.5 mg/L), although they did meet the Russian specification of 25 mg/L [3]. Higher TOC levels in the sample collected on July 15, 1996, can be attributed to 1,2-ethanediol contamination from the thermal coolant leaks aboard Mir. With regard to recovery of organic carbon from the Mir 21 samples, an average of 17% of the organic content could be identified using present analytical techniques. This percentage is considerably higher than that obtained for the Mir 18, 19, and 20 samples, which averaged only 3.7% [3].

Stored Water Results

Stored water sources on the Mir include U.S.-provided Shuttle fuel cell water, Russian ground-supplied water, or a mixture of these two sources. Ground supplied samples were collected preflight and inflight for Mir 21 and Mir 22. Preflight samples were collected from RSC Energia in Korolev (formerly Kaliningrad), Russia, on November 2, 1995, and June 3, 1996. Inflight samples of water were collected on March 27 and September 23, 1996, from the backup water supply system (SVO-ZV), and on August 15, September 5, and September 23, 1996, from the Condensate Recovery System (CRS) when stored fuel cell water was used instead of humidity condensate as the source water to the CRS. Fuel cell water treatment was limited to mineralization and heating by the CRS. [9]. Results from stored water samples are included in Table 5.

Physical Parameters - The pH of the stored water samples collected ranged from 5.86-8.09 and were comparable to those found in previous investigations [3]. Conductivity was slightly higher than previous measurements of 164 to 296 μS/cm [3]. Conductivity levels in the samples analyzed ranged from 175-389 μS/cm. Turbidity levels in five of the eight samples analyzed exceeded the U.S. water quality specification of 1 NTU. These samples showed turbidity levels ranging from 3.09-11.14 NTU. These values, however, are consistent with those measured in samples collected during Mir 18, 19, and 20, which ranged from 0.4 to 11.4 NTU [3].

Inorganic Parameters - Ionic constituents identified in the stored-water samples include chloride (none detected to 17.0 mg/L), fluoride (none detected to 2.14 mg/L), nitrate (none detected to 6.1 mg/L), sulfate (none detected to 22.8 mg/L), ammonium (none detected to 3.05 mg/L), calcium (25.3–80.0 mg/L), magnesium (6.3–20.0 mg/L), potassium (none detected to 3.15 mg/L), and sodium (1.2–13.2 mg/L). The fluoride concentration in the sample of SVO-ZV water collected on March 27, 1996, exceeded the joint U.S./Russian potable water specifications for International Space Station of 1.5 mg/L. This sample had 2.14 mg/L of fluoride. A sample collected preflight on November 2, 1995, exceeded the specification of 2 mg/L for ammonium; this sample contained 3.05 mg/L of ammonium (as nitrogen).

Metallic species identified in the stored water samples include silver, barium, cadmium, chromium, copper, iron, manganese, nickel, zinc, and lead. Cadmium, silver, and nickel were the only metals analyzed that did not meet the joint U.S./Russian specifications for the International Space Station. The specification for cadmium is 5 μg/L and the maximum contaminant level for silver is 500 μg/L; the SVO-ZV sample collected on March 27, 1996, contained 22 μg/L of cadmium and 889μg/L of silver. In addition, the stored water sample collected on August 15, 1996, had 121 μg/L of nickel; the specification is 100 μg/L. Ground-supplied water samples collected during Mir 18, 19, and 20 showed trace amounts of copper, iron, manganese, nickel, and lead, but not cadmium [3].

Organic Parameters - Acetone, chloroform, bromo-dichloromethane, methylene chloride, toluene, and tetrahydrofuran were detected in the stored water samples. All of these compounds, except for tetrahydrofuran, had been detected previously in samples collected during Mir 18, 19, and 20 [3]. Chloroform levels in three samples exceeded the EPA maximum contaminant level of 100 μg/L and were 184.9 μg/L, 142.84 μg/L, and 112.4 μg/L in the November 2, 1995, preflight sample, June 3, 1996, preflight sample, and the September 5, 1996, galley cold sample respectively. Chloroform levels ranged from 125.5 - 205.5 μg/L in samples collected during Mir 18, 19, and 20 [3].

Eight semivolatile compounds were detected at concentrations greater than 5 μg/L, namely benzothiazole, caprolactam, 2-ethylhexanoic acid, dioctyl phthalate, pentacosane, phenol, and tricosane. These compounds were not detected in appreciable amounts in the regenerated water or the humidity condensate samples. The total phenol levels in four of the eight samples analyzed exceeded the U.S. specification of 1 μg/L.

Ethanol levels ranged from none detected to 22.4 mg/L in stored water samples collected during this mission. High ethanol levels seen in the samples collected during this mission are believed to have resulted from the use of ethanol tincture to iodinate water for preflight servicing of the Shuttle water tanks [2]. The first several contingency water containers (CWCs) filled and transferred to Mir typically contain some ethanol. The presence of formate in the samples collected from the SVO-ZV on September 5, 1996, and the galley cold sample collected on September 23, 1996, is also indicative of water supplied by the Shuttle since the water is mineralized on the Shuttle side using a solution of calcium and magnesium formate [2].

Methanol levels ranged from none detected to 502 μg/L in the samples collected. 2-Propanol was present at 430 μg/L in the SVO-ZV sample taken on March 27, 1996, and none detected in the other samples analyzed. In comparison, most samples collected during Mir 18, 19, and 20 showed no significant levels of methanol or ethanol, although one preflight ground-supplied Korolev sample had 1800 μg/L of ethanol. 2-Propanol was not detected in earlier samples [3].

Formaldehyde levels ranged from none detected to 12.6 μg/L in the Mir 21 samples analyzed. By comparison, levels detected in samples from Mir 18, 19, and 20 ranged from none detected to 9.2 μg/L.

Both the preflight and inflight ground supplied water samples exceeded the U.S. standard of 0.5 mg/L for total organic carbon. TOC levels ranged from 5.36 mg/L to 31.2 mg/L in these samples. Two of these samples also exceeded the RSA specification of 25 mg/L for TOC. These samples, collected on September 5 and September 23, 1996, contained 27.6 mg/L and 31.2 mg/L of total organic carbon. Recovery of organic carbon for the stored water samples collected this mission averaged 29.1% (range 0.35-103.64%). Organic carbon recoveries for samples collected during Mir 20 were 0.79% and 25.26%, respectively [3].

Humidity Condensate Results

Four humidity condensate samples were collected during Mir 21 using Russian supplied hardware; two were returned on STS-79 and two were misplaced and returned several months later on STS-81. In addition during Mir 22, two condensate samples were collected from Russian water storage tanks known as EDVs using the U.S. provided water experiment kit. Analytical results for these samples are reported in Table 6.

Physical Parameters - Conductivity levels for Mir 21 condensate samples were consistent with levels observed during Mir 19 and Mir 20 [3], and ranged from 134-173 μS/cm. These levels are similar to the levels found in condensate samples collected on Space Shuttle missions STS-45, STS-47, and STS-68 [1,10]. However, conductivity levels in the Mir 22 samples were higher, ranging from 375 - 506 μS/cm. Turbidity levels ranged from 4.19–19.0 NTU in the Mir 21 and Mir 22 samples, compared with 7.4–12.2 NTU for samples collected during Mir 20 [3]. Turbidity levels in Shuttle condensate samples were much lower, ranging from 1.0–3.1 NTU (mean 1.67 NTU) [1,3,10]. The pH levels ranged from 6.30 to 7.59 (mean 6.78) in the samples analyzed. Shuttle pH levels were similar, ranging from 6.41–7.08 [1,3,10].

Color ranged from 10-15 degrees, and odor was rated 3 points out of a possible five for the six samples analyzed [5]]. Samples from Mir 19 and Mir 20 were not analyzed for color or odor [3].

Inorganic Parameters - Inorganic constituents measured in the humidity condensate samples included anionic species, cationic species, and metals. Ionic species identified in the humidity condensate samples include chloride (0.18 - 6.20 mg/L), fluoride (nondetectable - 0.24 mg/L), sulfate (nondetectable - 114 mg/L), lithium (nondetectable - 4.7 mg/L), sodium (0.12 - 123.4 mg/L), potassium (nondetectable - 9.8 mg/L), magnesium (nondetectable - 0.1 mg/L) and calcium (nondetectable - 3.33 mg/L). Significant levels of barium, iron, copper, nickel, and zinc were present in the Mir humidity condensate. Zinc levels on Mir reached a maximum of 5.3 mg/L in one of the condensate samples (range 3.5 to 5334 μg/L, mean 1668 μg/L). Greater amounts of zinc (10.3 - 28.5 mg/L) have been detected in Shuttle condensate [1,10]. Other metals identified in the condensate were chromium, manganese, silver, and cadmium.

Organic Parameters - Several classes of organic compounds were detected in the condensate samples collected. Volatile organic compounds detected include acetone (range 44–114 μg/L), carbon disulfide (11.0–1425.2 μg/L), 2-butanone (from none detected to 35.18 μg/L), methylene chloride (from none detected to 5.32 μg/L), tetrahydrofuran (from none detected to 30.4 μg/L) and o-xylene (from none detected to 3.76 μg/L). Acetone, methylene chloride, and carbon disulfide also have been found in previous Mir and Shuttle samples [1,3,10]. Tetrahydrofuran and o-xylene had not been previously detected in the Mir samples.

Approximately sixty different semivolatile organic compounds were present in the Mir humidity condensate. Semivolatile organic compounds found in the greatest

concentrations were benzothiazole (range 28.7-159.0 μg/L), 3-t-butylphenol (98.0-867.6 μg/L), n,n-diethylformamide (34.3–109.9 μg/L), n,n-dimethylacetamide (from none detected to 664.7 μg/L), n,n-dimethylformamide (from none detected to 3098 μg/L), 4-ethylmorpholine (none detected –393.0 μg/L), 2-hydroxybenzothiazole (5.3–102.0 μg/L), caprolactam (from none detected to 3572 μg/L), 1-methyl-2-pyrrolidinone (33.0–198.9 μg/L), 2-phenyl-2-propanol (12.7–99.5 μg/L), tetramethylthiourea (9.1–1291.4 μg/L), and tetramethylurea (11.7–226.1 μg/L).

Detectable levels of methanol, 2-propanol, 2-methyl-2-propanol, and 1-methoxy-2-propanol were found in the Mir 21 and Mir 22 samples analyzed. 1-Methoxy-2-propanol concentrations ranged from none detected to 1760 μg/L.

Significant amounts of 1,2-ethanediol (ethylene glycol) were detected in condensate samples collected on March 19-22, 1996, (62 mg/L), July 23–26, 1996 (41.5 mg/L), September 10–12 (12.4 mg/L) and September 16-18 (20.6 mg/L) indicating the presence of thermal coolant in the raw condensate during those times. 1,2- Propanediol (propylene glycol) also was detected in these samples at levels ranging from none detected to 1690 μg/L. The Mir 22 samples were collected during a reported 1,2-ethanediol coolant leak in Kvant. At that time, no condensate was being recycled, instead the condensate was routed to several water storage tanks known as EDVs.

Formaldehyde levels ranged from 10.1 to 32.7 μg/L. Samples collected during Mir 19 and Mir 20 had more formaldehyde, with concentrations ranging from 19.5–60.4 μg/L (mean 32.5 μg/L) [3]. Significantly higher levels of formaldehyde have been detected in Shuttle condensate samples [2,9]. No detectable levels of organic acids or urea were found in the condensate samples. Only one amine, methylamine, was detected.

Accountability of organic carbon was calculated by summing the concentration of organic carbon for each organic compound analyzed and comparing this result to the total organic carbon value. This comparison gives an indication of the theoretical yield of all organic compounds in the sample. On average, 27.8% of the organic constituents in the Mir 21 and Mir 22 humidity condensate samples could be accounted. This level is somewhat higher than levels previously observed in Mir condensate samples, primarily because of higher concentrations of 1,2-ethanediol.

Conclusions

The quality of the regenerated and stored waters, as determined through postflight chemical analysis, continues to be acceptable. The analysis of samples has provided important data for assessing the potential risks of consuming recycled water, especially during the off-nominal conditions experienced with the Mir thermal-cooling system. Other conclusions based on the analytical data are as follows:

One regenerated water sample contained a very high level of 1,2-ethanediol (45.5 mg/L) indicating significant contamination of the regenerated water during periods of the Mir coolant system leakage.

Turbidity levels in the regenerated water continue to exceed the U.S. specification for the International Space Station of 1 NTU.

Total organic carbon levels in the regenerated water do not meet the U.S. specification of 0.5 mg/L, although they do meet the Russian standard of no more than 25 mg/L.

Five of six samples analyzed from the NASA 2 mission did not meet the U.S./Russian Joint Specifications for International Space Station for total phenols.

No compounds have been detected at medically significant levels thus far in the regenerated water samples.

Total organic carbon levels in the stored water do not meet the U.S. specification of 0.5 mg/L. Two samples also did not meet the Russian specification of 25 mg/L.

Some of the stored water samples did not meet the U.S./Russian Joint Specifications for International Space Station for fluoride, nickel, cadmium, silver, and total phenols. The U.S. specification for turbidity was also not met.

U.S. Environmental Protection Agency (EPA) maximum contaminant levels for chloroform were exceeded in three of the stored water samples. The EPA Long Term Health Advisory of 400 μg/L was not exceeded in these samples.

Humidity condensate has proven to be an effective "sink" for water-soluble air contaminants, since air pollutants such as formaldehyde and 1,2-ethanediol have been identified in the condensate.

Investigation Results

Based on this investigation, the following lessons were learned:

Water collection hardware was redesigned to provide more reliable sample collection bags. (Mir 18 sample bags leaked during flight.)

Silver concentrations were much lower than anticipated in some of the regenerated water samples (~50 μg/L vs. 500 μg/L).

More methods development work is needed to increase the percent organic carbon recovery. For Mir 18 - Mir 21, 0.47 - 28% of the organic constituents in the regenerated water could be identified using present analytical methods.

There is a need to develop inflight monitoring capabilities to respond to operational problems (like the ethylene glycol leaks).

Condensate collected during Mir 18 - Mir 21 had significantly lower total organic carbon levels than previously measured in Shuttle condensate. The amount of alcohols and organic acids were also much lower in the Mir condensate than in the Shuttle condensate.

Collection and analysis of condensate samples was critical in planning the operational response to the ethylene glycol leaks on board Mir.

Chloroform and methylene chloride levels in the Russian ground supplied water samples exceeded EPA maximum contaminant levels in some instances.

Investigation Applications

This research will provide benefits on Earth through:

Improvements in methods development for the analysis of drinking water, and in particular, recycled potable water

Development of better wastewater treatment technologies

Increased knowledge of recycled potable water contaminants

Practical support to the eventual recycle of water on the Earth.

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TABLE 1. DATA COLLECTION SESSIONS/FUNCTIONAL OBJECTIVES

Session Name	FO#	HW#	Scheduled Day	Actual Day	Samples/ Parameters
Mir 21					
ground supplied water collection at RSC-Energia, Korolev, Russia	1,5	7-14	N/A	L-120 2 Nov 95	1000 ml of water Split: 1000 US, 0 ml RSA
galley-hot water collection	2,3,5	2-5 7-14	MD10	MD10 1 Mar 96	860 ml of water Split: 517.5 ml US, 342.5 ml RSA
humidity condensate collection	4,5	6-14	MD10-13	MD10-13 1-4 Mar 96	25 ml of condensate Split: 21 ml US, 4 ml RSA
galley-hot water collection	2,3,5	2-5 7-14	MD28	MD28 19 Mar 96	770 ml of water Split: 517.5 ml US, 252.5 ml RSA
galley-cold water collection	2,3,5	2-5 7-14	MD28	MD28 19 Mar 96	855 ml of water Split: 517.5 ml US, 337.5 ml RSA
humidity condensate collection	4,5	6-14	MD28-31	MD28-31 19-22 Mar 96	89 ml of condensate Split: 58.5 ml US, 30.5 ml RSA
galley-hot water collection	2,3,5	2-5 7-14	MD35	MD36 27 Mar 96	747.9 ml of water Split: 487.5 ml US, 260.4 ml RSA
galley-cold water collection	2,3,5	2-5 7-14	MD35	MD36 27 Mar 96	309.5 ml of water Split: 196.5 ml US, 113 ml RSA
SVO-ZV (ground supplied) water collection	2,3,5	2-5 7-14	MD35	MD36 27 Mar 96	24 ml of water Split: 22 ml US, 2 ml RSA
humidity condensate collection	4,5	6-14	unknown	MD 120-124 18-22 June 96	80 ml of condensate Split: 55 ml US, 25 ml RSA
galley-hot water collection	2,3,5	2-5 7-14	MD146	MD146 15 Jul 96	748 ml of water Split: 520 ml US, 228ml RSA
humidity condensate collection	4,5	6-14	unknown	MD154-157 23-26 Jul 96	73 ml of condensate Split: 50 ml US, 23 ml RSA
galley-hot water collection	2,3,5	2-5 7-14	MD177	MD177 15 Aug 96	768.5 ml of water Split: 520 ml US, 248.5ml RSA
Mir 22					
ground supplied water collection at RSC-Energia, Korolev, Russia	1,5	7-14	N/A	L-74 3 Jun 96	1000 ml of water Split: 1000 US, 0 ml RSA
galley-hot water collection	2,3,5	2-5 7-14	MD19	MD19 5 Sep 96	250 ml of water Split: 186 ml US, 64 ml RSA
galley-cold water collection	2,3,5	2-5 7-14	MD19	MD19 5 Sep 96	309.5 ml of water Split: 196.5 ml US, 113 ml RSA
SVO-ZV (ground supplied) water collection	2,3,5	2-5 7-14	MD19	MD19 5 Sep 96	862 ml of water Split: 520 ml US, 342 ml RSA
humidity condensate collection	4,5	6-14	unknown	MD24-26 10-12 Sep 96	214 ml of condensate Split: 131 ml US, 83 ml RSA
humidity condensate collection	4,5	6-14	unknown	MD30-32 16-18 Sep 96	347 ml of condensate Split: 211 ml US, 136 ml RSA
galley-cold water collection	2,3,5	2-5 7-14	MD35	MD38 23 Sep 96	789 ml of water Split: 520 ml US, 269 ml RSA

TABLE 2. SAMPLE ALLOCATION TABLE

Mission	Mir 21	Mir 21	Mir 21	Mir 21	Mir 21	Mir 21	Mir 21	Mir 21	Mir 21
Sample Description	Regenerated Water	Condensate	Regenerated Water	Regenerated Water	Condensate	Regenerated Water	Regenerated Water	Stored Water	Condensate
Sample Location	Galley-Hot	CRS	Galley-Hot	Galley-Cold	CRS	Galley-Hot	Galley-Cold	SVO-ZV	CRS
Sample Date	3/1/96	3/4/96	3/19/96	3/19/96	3/19-22/96	3/27/96	3/27/96	3/27/96	6/22/96
JSC Sample No.	96-0401-03	96-0403-01	96-0401-04	96-0401-05	96-0403-02	96-0408-02	96-0408-03	96-0408-04	97-0124-21
Analysis/Aliquot	mL	mL	mL	mL	mL	mL	mL	mL	mL
pH, conductivity, Turbidity	Semivol split	Before alloc	Semivol split	Semivol split	Before alloc	Semivol split	Semivol split	Before alloc	Semivol split
Alcohols	15	1	15	15	1	5	1	1	2
Formaldehyde	15	1	15	15	1	5	1	1	2
Glycols/Nonvolatiles	15	1	15	15	1	5	1	1	2
Organic Acids, Amines, Anions, Cations	2.5	2	2.5	2.5	2.5	2.5	2.5	2	5
Semivolatiles	250	5	250	250	40	250	50	5	25
Metals	50	3	50	50	5	50	25	4	10
TOC	125	2	125	125	2	125	100	2	3
Volatiles	45	6	45	45	6	45	16	6	6
U.S Total	517.5	21	517.5	517.5	58.5	487.5	196.5	22	55
Russian Chemical analyses	342.5	0	252.5	337.5	26.5	258.5	104.5	0	21
Russian Microbiological analyses	0	4	0	0	4	4	4	2	4
RSA TOTAL	342.5	4	252.5	337.5	30.5	262.5	108.5	2	25
Total (mL)	860	25	770	855	89	750	305	24	80

Mission	Mir 21	Mir 21	Mir 21	Mir 21	Mir 21	Mir 21	Mir 22	Mir 22	Mir 22
Sample Description	Stored Water	Condensate	Stored Water	Stored Water	Stored Water	Stored Water	Condensate	Condensate	Stored Water
Sample Location	Galley-Hot	CRS	Galley-Hot	Galley-Hot	Galley-Cold	SVO-ZV	EDV	EDV	Galley-Cold
Sample Date	7/15/96	7/23-26/96	8/15/96	9/5/96	9/5/96	9/5/96	9/10-12/1996	9/16-18/1996	9/23/96
JSC Sample No.	96-0927-03	97-0124-22	96-0927-04	96-0927-08	96-0927-05	96-0927-06	96-0928-02	96-0928-03	96-0927-07
Analysis/Aliquot	mL	mL	mL	mL	mL	mL	mL	mL	mL
pH, conductivity, Turbidity	Semivol split	Semivol split	Semivol split	Semivol split	Semivol split	Semivol split	Semivol split	Semivol split	Semivol split
Alcohols	15	2	15	5	5	15	5	5	15
Formaldehyde	15	2	15	5	5	15	5	5	15
Glycols/Nonvolatiles	15	2	15	5	5	15	5	5	15
Organic Acids, Amines, Anions, Cations	5	5	5	5	5	5	5	5	5
Semivolatiles	250	25	250	50	100	250	50	100	250
Metals	50	5	50	25	50	50	25	50	50
TOC	125	3	125	75	100	125	25	25	125
Volatiles	45	6	45	16	45	45	16	16	45
U.S Total	520	50	520	186	315	520	131	211	520
Russian Chemical analyses	228	19	248.5	64	111	342	83	136	269
Russian Microbiological analyses	0	4	0	0	0	0	0	0	0
RSA TOTAL	228	23	248.5	64	111	342	83	136	269
Total (mL)	748	73	768.5	250	426	862	214	347	789

TABLE 3. JOINT U.S./RUSSIAN POTABLE WATER SPECIFICATIONS FOR INTERNATIONAL SPACE STATION

Water Parameter	U.S. Maximum Contaminant Level (MCL)	Russian Maximum Contaminant Level (MCL)
pH[1]	5.5-9.0 pH units	5.5-9.0 pH units
Color[2]	15 Pt-Co units	20 degrees
Taste[2]	3 TTN	2 grade
Odor[2]	3 TON	2 grade
Total Dissolved Solids[3]	100-1,000 mg/L	100-1,000 mg/L
Turbidity[2]	1 NTU	1.5 mg/L
Total Gas	5% volume @1 ATM, 20°C	5% volume @1 ATM, 20°C
Ammonia (NH3-N)	2 mg/L	2 mg/L
Arsenic	0.01 mg/L	0.01 mg/L
Barium	1 mg/L	1 mg/L
Cadium	0.005 mg/L	0.005 mg/L
Calcium	100 mg/L	100 mg/L
Chlorine-total (includes Cl-)	200 mg/L	200 mg/L
Chromium	0.1 mg/L	0.1 mg/L
Copper	1 mg/L	1 mg/L
Fluorine	1.5 mg/L	1.5 mg/L
Iodine-total (includes I-)	15 mg/L	15 mg/L
Iodine-residual[4]	1.0-4.0 mg/L	1.0-4.0 mg/L
Iron	0.3 mg/L	0.3 mg/L
Lead	0.05 mg/L	0.05 mg/L
Magnesium	50 mg/L	50 mg/L
Manganese	0.05 mg/L	0.05 mg/L
Mercury	0.002 mg/L	0.002 mg/L
Nickel	0.1 mg/L	0.1 mg/L
Nitrate (NO3-N)	10 mg/L	10 mg/L
Selenium	0.01 mg/L	0.01 mg/L
Silver	0.5 mg/L	0.5 mg/L
Sulfate	250 mg/L	250 mg/L
Zinc	5 mg/L	5 mg/L
Total Hardness (Ca & Mg)	7 meq/L	7 meq/L
Total Bacteria[2]	100 CFU/100 ml	10,000 CFU/100 ml
Coliform Bacteria	<1 CFU/100 ml	<1 CFU/100 ml
Virus	<1 PFU/100 ml	<1 PFU/100 ml
Cyanide	200 μg/L	200 μg/L
Total Phenols	1 μg/L	1 μg/L
Total Organic Carbon (TOC)	500 μg/L	25,000 μg/L
Uncharacterized TOC	100 μg/L	no limit
Oxygen Consumption-COD	no limit	100 mg/L

[1]pH range applies only before iodination

[2]Parameters have different values for U.S. and Russian supplied water because of different analytical methods used

[3]The 100 mg/L limit applies to the water before mineralization. After mineralization, this parameter will not exceed 1,000 mg/L

[4]Range of required level if iodine is used as a biocide

TABLE 4. REGENERATED WATER RESULTS

Mission Sample Location Sample Description Sample Date Analysis/Sample ID	Units	Test Conducted by	Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	Mir 21 galley-hot regenerated water 3/1/96 96-0401-03	Mir 21 galley-hot regenerated water 3/19/96 96-0401-04	Mir 21 galley-cold regenerated water 3/19/96 96-0401-05	Mir 21 galley-hot regenerated water 3/27/96 96-0408-02	Mir 21 galley-cold regenerated water 3/27/96 96-0408-03	Mir 21 galley-hot regenerated water 7/15/96 96-0927-03
Conductivity	µS/cm	U.S.			32.2	43.5	44.8	42.7	81.3	15.1
Conductivity	µS/cm	Russia			NA	NA	NA	NA	NA	15.3
pH	pH units	U.S.	5.5-9.0	NASA/RSA	6.40	6.48	6.50	6.98	6.56	6.08
pH	pH units	Russia	5.5-9.0	NASA/RSA	NA	NA	NA	NA	NA	6.1
Turbidity	NTU	U.S.	1/1.5 mg/L	NASA/RSA	3.27	5.50	4.10	4.50	2.90	1.04
Color True	degrees	Russia	15 Pt-Co units/20	NASA/RSA	10	10	10	10	10	10
Odor at 20°C	grade	Russia	3 TON/2	NASA/RSA	0	0	1	1	0	0
Taste at 20°C	grade	Russia	3 TTN/2	NASA/RSA	NA	NA	NA	NA	NA	NA
Total Solids	mg/L	Russia	1.5	NASA/RSA	NA	NA	NA	NA	NA	NA
Total Hardness	meq/L	Russia	7	NASA/RSA	0.109	0.14	0.16	NA	NA	0.2
Chemical Oxygen Demand	mg O_2/L	Russia	no limit/100	NASA/RSA	7.5	10	10	15	30	85
Anions										
Bromide	mg/L	U.S.			ND	ND	ND	ND	ND	NA
Chloride	mg/L	U.S.	200	NASA/RSA	0.39	0.32	0.39	0.34	1.11	ND
Fluoride	mg/L	U.S.	1.5	NASA/RSA	ND	ND	ND	ND	3.68	ND
Nitrate as Nitrogen (NO3-N)	mg/L	U.S.	10	NASA/RSA	ND	ND	ND	ND	ND	ND
Nitrite as Nitrogen (NO2-N)	mg/L	U.S.			ND	ND	ND	ND	ND	ND
Phosphate	mg/L	U.S.			ND	ND	ND	ND	ND	ND
Sulfate	mg/L	U.S.	250	NASA/RSA	ND	0.16	ND	0.15	0.396	ND
Cations										
Ammonia as Nitrogen (NH3-N)	mg/L	U.S.	2	NASA/RSA	ND	ND	ND	ND	ND	ND
Calcium	mg/L	U.S.	100	NASA/RSA	8.76	11.5	12.8	9.74	20.0	4.42
Lithium	mg/L	U.S.			ND	ND	ND	ND	ND	0.42
Magnesium	mg/L	U.S.	50	NASA/RSA	0.24	0.32	0.26	0.26	0.50	ND
Potassium	mg/L	U.S.			1.02	ND	1.02	ND	0.31	ND
Sodium	mg/L	U.S.			1.28	0.13	0.30	0.39	1.73	ND
Minerals										
Ammonium (NH4)	mg/L	Russia	2	NASA/RSA	NA	NA	NA	NA	NA	0.78
Calcium	mg/L	Russia	100	NASA/RSA	NA	NA	NA	NA	NA	2.0
Magnesium	mg/L	Russia	50	NASA/RSA	NA	NA	NA	NA	NA	1.2
Metals										
Calcium	µg/L	U.S.	100000	NASA/RSA	NA	NA	NA	NA	NA	NA
Magnesium	µg/L	U.S.	50000	NASA/RSA	NA	NA	NA	NA	NA	NA
Sodium	µg/L	U.S.			NA	NA	NA	NA	NA	NA
Potassium	µg/L	U.S.			NA	NA	NA	NA	NA	NA
Silver	µg/L	U.S.	500	NASA/RSA	131	316	294	240	99	35
Silver ion	µg/L	Russia			<50	<50	ND	80	ND	NA
Aluminum	µg/L	U.S.		NASA	NA	NA	NA	NA	NA	NA
Arsenic	µg/L	U.S.	10	NASA	ND	ND	ND	ND	ND	ND
Barium	µg/L	U.S.	1000	NASA	5.0	5.2	3.2	3.2	6.4	ND
Cadmium	µg/L	U.S.	5	NASA	ND	ND	ND	ND	0.9	ND
Chromium	µg/L	U.S.	100	NASA	0.6	0.5	0.5	ND	ND	0.3
Cobalt	µg/L	U.S.		NASA	NA	NA	NA	NA	NA	NA
Copper	µg/L	U.S.	1000	NASA	6.3	14.3	9.0	16.7	7.8	14.1
Iron	µg/L	U.S.	300	NASA	20.5	23.0	38.8	26.5	30.5	9.3

TABLE 4. REGENERATED WATER RESULTS

Mission Sample Location Sample Description Sample Date Analysis/Sample ID	Units	Test Conducted by	Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	Mir21 galley-hot regenerated water 3/1/96 96-0401-03	Mir21 galley-hot regenerated water 3/19/96 96-0401-04	Mir21 galley-cold regenerated water 3/19/96 96-0401-05	Mir21 galley-hot regenerated water 3/27/96 96-0408-02	Mir21 galley-cold regenerated water 3/27/96 96-0408-03	Mir21 galley-hot regenerated water 7/15/96 96-0927-03
Metals contd.										
Mercury	µg/L	U.S.	2	NASA	NA	NA	NA	ND	0.8	NA
Manganese	µg/L	U.S.	50	NASA	3.9	4.8	3.7	3.5	4.0	1.6
Molybdenum	µg/L	U.S.		NASA	ND	ND	ND	ND	ND	ND
Nickel	µg/L	U.S.	100	NASA	5.6	16.6	16.4	8.8	9.3	8.1
Lead	µg/L	U.S.	50	NASA	0.9	2.7	2.4	4.8	4.0	1.7
Selenium	µg/L	U.S.	10	NASA	ND	ND	ND	ND	ND	ND
Zinc	µg/L	U.S.	5000	NASA	34.2	32.8	23.0	27.4	46.0	19
Palladium	µg/L	U.S.		NASA	NA	NA	NA	NA	NA	NA
Silicon	µg/L	U.S.		NASA	NA	NA	NA	NA	NA	NA
Total Organic Carbon										
TIC (OI 1010)	mg/L	U.S.			1.28	1.55	1.42	0.773	0.263	1.04
POC (OI 1010)	mg/L	U.S.			NA	NA	NA	NA	NA	NA
NPOC (OI 1010)	mg/L	U.S.			6.35	8.64	8.74	8.39	5.15	23.7
TOC (OI 1010)	mg/L	U.S.	0.5/25	NASA/RSA	NA	NA	NA	NA	NA	NA
TIC (Sievers 800)	mg/L	U.S.			NA	NA	NA	NA	NA	2.68
TOC (Sievers 800)	mg/L	U.S.	0.5/25	NASA/RSA	NA	NA	NA	NA	NA	25.1
Total Organic Carbon										
TOC (Sievers 800)	mg/L	Russia	0.5/25	NASA/RSA	NA	NA	NA	NA	NA	NA
Volatile Organics										
Acetaldehyde	µg/L	U.S.			ND	ND	ND	ND	ND	50.85
Acetone	µg/L	U.S.			17.1	ND	ND	49.6	39.3	8.89
Acryloniltrile	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Benzene	µg/L	U.S.	5.0	EPA	ND	ND	ND	ND	ND	ND
Bromodichloromethane	µg/L	U.S.	100	EPA	ND	ND	ND	ND	ND	ND
Bromoform	µg/L	U.S.	100	EPA	ND	ND	ND	ND	ND	ND
2-Butanone	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Carbon disulfide	µg/L	U.S.			8.0	5.2	9.6	5.8	ND	ND
Chloroform	µg/L	U.S.	100	EPA	ND	ND	ND	ND	ND	ND
Dibromochloromethane	µg/L	U.S.	100	EPA	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	µg/L	U.S.	75	EPA	ND	ND	ND	ND	ND	ND
Dichlorodifluoromethane	µg/L	U.S.	1000	EPALifetime HA	ND	ND	ND	ND	ND	ND
Diethyl ether	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Iodomethane	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Linolool	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Methylene chloride	µg/L	U.S.	5	EPA	ND	ND	ND	ND	4.5	ND
4-Methyl-2-pentanone	µg/L	U.S.			ND	ND	ND	ND	ND	ND
alpha-Methyl styrene	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Perfluoro-1,3-dimethylcyclohexane	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Tetrahydrofuran	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Toluene	µg/L	U.S.	1000	EPA	ND	ND	ND	ND	ND	ND
Trichloroethene	µg/L	U.S.	5	EPA	1.8	2.0	2.3	ND	ND	ND
1,1,2-Trichlorotrifluoroethane	µg/L	U.S.			ND	ND	ND	ND	ND	ND
m&p-Xylene	µg/L	U.S.	Total Xylenes 10000	EPA	ND	ND	ND	ND	ND	ND

TABLE 4. REGENERATED WATER RESULTS

Mission Sample Location Sample Description Sample Date Analysis/Sample ID	Units	Test Conducted by	Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	Mir 21 galley-hot regenerated water 3/1/96 96-0401-03	Mir 21 galley-hot regenerated water 3/19/96 96-0401-04	Mir 21 galley-cold regenerated water 3/19/96 96-0401-05	Mir 21 galley-hot regenerated water 3/27/96 96-0408-02	Mir 21 galley-cold regenerated water 3/27/96 96-0408-03	Mir 21 galley-hot regenerated water 7/15/96 96-0927-03
Volatile Organics contd.										
o-Xylene	µg/L	U.S.	Total Xylenes 10000.0	EPA	ND	ND	ND	ND	ND	ND
Semivolatile Organics										
Acetophenone	µg/L	U.S.			ND	ND	ND	0.1	41.0	ND
2-Aminonaphthalene	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Aniline	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Azobenzene	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Benzaldehyde	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Benzoic acid	µg/L	U.S.			ND	ND	ND	4.6	ND	ND
Benzothiazole	µg/L	U.S.			3.5	3.7	5.0	8.5	110.7	1.6
Benzyl alcohol	µg/L	U.S.			1.9	0.9	ND	1.0	ND	ND
Benzyl butyl phthlate	µg/L	U.S.	7000	EPA DWEL	1.0	1.0	ND	ND	ND	ND
2-Butoxyethanol	µg/L	U.S.			ND	ND	ND	ND	ND	ND
2-(2-Butoxyethoxy) Ethanol	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Butylated hydroxyanisole (BHA)	µg/L	U.S.			ND	ND	ND	ND	3.5	ND
N-Butylbenzenesulfonamide	µg/L	U.S.			0.5	0.5	0.5	ND	2.7	ND
3-t-Butylphenol	µg/L	U.S.			ND	ND	ND	ND	113.4	ND
Caffeine	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Caprolactam	µg/L	U.S.			ND	ND	ND	ND	27.4	ND
tris-2-Chloroethyl phosphate	µg/L	U.S.			ND	ND	ND	0.9	5.8	ND
Cyclododecane	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Cyclohexanone	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Decamethylcyclopentasiloxane	µg/L	U.S.			ND	0.8	0.8	ND	5.6	1.1
1,4 Diacetylbenzene	µg/L	U.S.			ND	ND	ND	ND	5.6	ND
1,3- Dichlorobenzene	µg/L	U.S.	600	EPA	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	µg/L	U.S.	75	EPA	ND	ND	ND	ND	ND	ND
Di-n-butylamine	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Di-n-butyl phthalate	µg/L	U.S.	4000	EPA DWEL	0.4	0.2	0.1	0.6	1.4	0.2
N,N-Dibutylformamide	µg/L	U.S.			ND	ND	ND	ND	8.8	ND
2,6-Di-t-butyl-1,4-benzoquinone	µg/L	U.S.			3.7	ND	2.0	ND	ND	ND
3,5-Di-t-butyl-4-hydroxybenzaldehyde	µg/L	U.S.			0.1	ND	ND	ND	ND	ND
2,6-Di-t-butyl-4-methylphenol	µg/L	U.S.			ND	ND	ND	ND	15.8	ND
2,4-Di-t-butylphenol	µg/L	U.S.			1.0	1.1	1.3	ND	ND	ND
N,N-Diethylformamide	µg/L	U.S.			ND	ND	ND	ND	30.9	ND
N,N-Diethyl-m-toluamide	µg/L	U.S.			ND	ND	ND	ND	0.5	ND
Diethylene glycol monoethyl ether	µg/L	U.S.			ND	ND	ND	ND	25.0	ND
Diethyl phthalate	µg/L	U.S.	5000	EPA Lifetime HA	0.1	0.1	0.1	0.1	3.4	0.2
Diisopropyl Adipate	µg/L	U.S.			ND	ND	ND	ND	ND	ND
N,N-Dimethylacetamide	µg/L	U.S.			ND	ND	ND	ND	43.9	ND
N,N-Dimethylbenzylamine	µg/L	U.S.			ND	ND	ND	ND	2.1	ND
Dimethylcarbamyl chloride	µg/L	U.S.			ND	ND	ND	ND	3.2	ND
N,N-Dimethylformamide	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Dimethyl phthalate	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Dimethylthiocarbamoyl chloride	µg/L	U.S.			ND	ND	ND	ND	ND	ND

TABLE 4. REGENERATED WATER RESULTS

Mission Sample Location Sample Description Sample Date Analysis/Sample ID	Units	Test Conducted by	Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	Mir21 galley-hot regenerated water 3/1/96 96-0401-03	Mir21 galley-hot regenerated water 3/19/96 96-0401-04	Mir21 galley-cold regenerated water 3/19/96 96-0401-05	Mir21 galley-hot regenerated water 3/27/96 96-0408-02	Mir21 galley-cold regenerated water 3/27/96 96-0408-03	Mir21 galley-hot regenerated water 7/15/96 96-0927-03
Semivolatile Organics contd.										
Dipropylene glycol methyl ether	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Dodecamethylcyclohexasiloxane	µg/L	U.S.			ND	ND	ND	ND	1.4	ND
Eicosane	µg/L	U.S.			ND	ND	ND	ND	ND	ND
2-Ethoxyethanol	µg/L	U.S.			ND	ND	ND	ND	7.7	ND
2-Ethylhexanoic acid	µg/L	U.S.			ND	ND	ND	ND	ND	ND
2-Ethyl-1-hexanol	µg/L	U.S.			1.5	ND	ND	ND	ND	ND
bis-2-Ethylhexyl adipate	µg/L	U.S.	400	EPA	ND	ND	ND	ND	ND	ND
bis-2-Ethylhexyl phthalate (Dioctyl phthlate)	µg/L	U.S.	6	EPA HA	1.8	3.1	11.3	1.9	27.9	0.4
4-Ethylmorpholine	µg/L	U.S.			ND	ND	ND	ND	31.8	ND
4-Ethylphenol	µg/L	U.S.			ND	ND	ND	ND	ND	ND
1-Formylpiperidine	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Heneicosane	µg/L	U.S.			ND	ND	ND	ND	ND	ND
2-Heptanone	µg/L	U.S.			ND	ND	ND	0.4	ND	ND
2-Hexanol	µg/L	U.S.			ND	ND	ND	ND	ND	ND
2-Hydroxybenzothiazole	µg/L	U.S.			1.1	1.1	1.3	1.4	6.8	ND
4-Hydroxy-4-methyl-2-pentanone	µg/L	U.S.			ND	ND	ND	ND	11.4	ND
Indole	µg/L	U.S.			0.2	0.2	0.3	0.1	ND	ND
Isophorone	µg/L	U.S.	100	EPA Lifetime HA	ND	ND	ND	ND	6.3	ND
Menthol	µg/L	U.S.			ND	ND	ND	ND	ND	ND
2-Mercaptobenzothiazole	µg/L	U.S.			10.2	8.8	12.7	41.0	41.8	ND
3-Methyl-2-cyclohexen-1-one	µg/L	U.S.			ND	ND	ND	ND	6.1	ND
Methyl-4-hydroxybenzoate	µg/L	U.S.			5.1	ND	ND	ND	ND	ND
2-Methyl-2,4-pentanediol	µg/L	U.S.			ND	ND	ND	ND	ND	ND
4-Methylphenol	µg/L	U.S.			ND	ND	ND	ND	ND	ND
2-Methylpyrazine	µg/L	U.S.			ND	ND	ND	ND	6.1	ND
1-Methyl-2-pyrrolidinone	µg/L	U.S.			ND	ND	ND	ND	11.4	ND
Methyl sulfone	µg/L	U.S.			ND	ND	ND	ND	0.6	ND
2-Methylthiobenzothiazole	µg/L	U.S.			2.5	2.2	3.2	12.0	48.5	ND
Monomethyl phthalate	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Neomenthol	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Nicotine	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Octadecanol	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Octamethylcyclotetrasiloxane	µg/L	U.S.			1.0	0.9	0.9	ND	ND	ND
Octanoic Acid	µg/L	U.S.			ND	ND	ND	ND	ND	ND
4-t-Octylphenol	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Oxindole	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Pentacosane	µg/L	U.S.			ND	ND	ND	ND	ND	ND
s-Phenethyl alcohol	µg/L	U.S.			ND	ND	ND	ND	8.4	ND
Phenol	µg/L	U.S.	1/4000	NASA/EPA Lifetime HA	1.2	1.1	0.9	1.0	ND	ND
Phenoxyacetic acid	µg/L	U.S.			ND	ND	ND	ND	ND	ND
2-Phenoxyethanol	µg/L	U.S.			ND	ND	ND	ND	ND	ND
N-Phenyl-2-naphthylamine	µg/L	U.S.			0.2	0.2	ND	6.3	11.7	ND
2-Phenylacetic Acid	µg/L	U.S.			ND	ND	ND	ND	ND	ND

TABLE 4. REGENERATED WATER RESULTS

Mission Sample Location Sample Description Sample Date Analysis/Sample ID	Units	Test Conducted by	Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	Mir 21 galley-hot regenerated water 3/1/96 96-0401-03	Mir 21 galley-hot regenerated water 3/19/96 96-0401-04	Mir 21 galley-cold regenerated water 3/19/96 96-0401-05	Mir 21 galley-hot regenerated water 3/27/96 96-0408-02	Mir 21 galley-cold regenerated water 3/27/96 96-0408-03	Mir 21 galley-hot regenerated water 7/15/96 96-0927-03
Semivolatile Organics contd.										
2-Phenylphenol	µg/L	U.S.			ND	ND	ND	0.2	3.2	ND
2-Phenyl-2-propanol	µg/L	U.S.			ND	ND	ND	ND	30.6	ND
Phenyl sulfone	µg/L	U.S.			ND	ND	ND	0.1	75.1	ND
Phthalide	µg/L	U.S.			ND	ND	ND	ND	2.8	ND
Squalene	µg/L	U.S.			ND	ND	ND	ND	ND	ND
1-alpha-Terpineol	µg/L	U.S.			ND	ND	ND	ND	24.5	ND
1-Tetradecanol	µg/L	U.S.			5.8	2.3	1.8	ND	6.2	ND
Tetramethylsuccinonitrile	µg/L	U.S.			ND	ND	ND	ND	31.7	ND
Tetramethylthiourea	µg/L	U.S.			ND	ND	ND	0.3	24.6	ND
Tetramethylurea	µg/L	U.S.			ND	ND	ND	ND	6	ND
Toluene	µg/L	U.S.	1000	EPA	0.9	1.0	1.0	0.8	1.9	ND
o-Toluic acid	µg/L	U.S.			ND	ND	ND	ND	ND	ND
1,3,5-Triallyl-1,3,5-triazine-2,4,6(1H,3H,5H)-trione	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Tricosane	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Triethyl Phosphate	µg/L	U.S.			ND	ND	ND	ND	4.6	ND
Triethylamine	µg/L	U.S.			ND	ND	ND	ND	11.8	ND
2,2,4-Trimethyl-1,3-pentanediol diisobutyrate	µg/L	U.S.			0.1	0.1	0.1	0.1	ND	ND
Undecanoic Acid	µg/L	U.S.			ND	ND	ND	ND	ND	ND
2-Undecanone	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Urethane	µg/L	U.S.			1.4	1.3	1.3	1.9	ND	0.4
Vanillin	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Alcohols										
Ethanol	µg/L	U.S.			ND	ND	ND	160	ND	2447
Methanol	µg/L	U.S.			ND	ND	ND	ND	ND	489
1-Methoxy-2-propanol	µg/L	U.S.			NA	NA	NA	ND	NA	ND
2-Methyl-2-butanol	µg/L	U.S.			ND	ND	ND	ND	ND	ND
2-Methyl-2-propanol	µg/L	U.S.			ND	ND	ND	ND	ND	ND
2-Propanol	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Alcohols/Acetone										
Acetone	µg/L	Russia			NA	NA	NA	NA	NA	NA
Ethanol	µg/L	Russia			NA	NA	NA	NA	NA	NA
Isoamyl alcohol (3-Pentanol)	µg/L	Russia			NA	NA	NA	NA	NA	NA
Propyl alcohol	µg/L	Russia			NA	NA	NA	NA	NA	NA
Glycols										
1,2-Ethanediol	µg/L	U.S.	7000	EPA Lifetime HA	ND	ND	ND	ND	ND	45530
1,2-Propanediol	µg/L	U.S.			ND	ND	ND	ND	ND	ND
Glycols										
1,2-Ethanediol	µg/L	Russia	7000	EPA Lifetime HA	NA	NA	NA	NA	NA	NA
1,2-Propanediol	µg/L	Russia								
Organic Acids										
Acetic acid	µg/L	U.S.			NA	NA	NA	NA	NA	NA
Acetic acid	µg/L	Russia			NA	NA	NA	NA	NA	NA
Lactic acid	µg/L	U.S.			NA	NA	NA	NA	NA	NA
Propanoic acid	µg/L	U.S.			NA	NA	NA	NA	NA	NA

TABLE 4. REGENERATED WATER RESULTS

Mission **Sample Location** **Sample Description** **Sample Date** **Analysis/Sample ID**	Units	Test Conducted by	Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	Mir21 galley-hot regenerated water 3/1/96 96-0401-03	Mir21 galley-hot regenerated water 3/19/96 96-0401-04	Mir21 galley-cold regenerated water 3/19/96 96-0401-05	Mir21 galley-hot regenerated water 3/27/96 96-0408-02	Mir21 galley-cold regenerated water 3/27/96 96-0408-03	Mir21 galley-hot regenerated water 7/15/96 96-0927-03
Aldehydes										
Formaldehyde	μg/L	U.S.	1000	EPA LifetimeHA	ND	ND	ND	ND	22.4	63.4
Acetaldehyde	μg/L	U.S.			NA	NA	NA	NA	NA	NA
Carboxylates										
Acetate	mg/L	U.S.			0.215	ND	0.131	1.49	ND	ND
Formate	mg/L	U.S.			ND	ND	ND	ND	ND	ND
Lactate	mg/L	U.S.			ND	ND	ND	ND	ND	ND
Amines										
Methylamine	mg/L	U.S.			ND	ND	ND	ND	ND	ND
Urea	mg/L	U.S.			ND	ND	ND	1.13	ND	ND
Organic Carbon Recovery	percent	U.S.			2.00	0.23	0.94	11.73	12.19	76.25

TABLE 5. STORED WATER RESULTS

Mission Sample Location Sample Description Sample Date Analysis/Sample ID	Units	Test Conducted by	Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	Mir 21 preflight RSC supplied water 11/2/95 95-1128-01	Mir 21 SVO-ZV stored water 3/27/96 96-0408-04	Mir 22 preflight RSC supplied water 6/3/96 96-0625-02	Mir 21 galley-hot stored water 8/15/96 96-0927-04	Mir 22 galley-hot stored water 9/5/96 96-0927-08	Mir 22 galley-cold stored water 9/5/96 96-0927-05	Mir 22 SVO-ZV stored water 9/5/96 96-0927-06	Mir 22 galley-cold stored water 9/23/96 96-0927-07
Conductivity	µS/cm	U.S.			227	219	335	339	380	389	181	175
Conductivity	µS/cm	Russia			NA	NA	NA	350	387	391	188	178
pH	pH units	U.S.	5.5-9.0	NASA/RSA	7.68	7.74	7.58	7.68	8.07	8.09	6.96	5.86
pH	pH units	Russia	5.5-9.0	NASA/RSA	7.68	NA	7.58	7.7	7.9	8.0	7.10	5.9
Turbidity	NTU	U.S.	1/1.5 mg/L	NASA/RSA	11.14	NA	0.425	4.24	5.47	3.09	5.32	0.61
Color True	degrees	Russia	15 Pt-Co units/20	NASA/RSA	NA	NA	NA	10	10	10	10	10
Odor at 20°C	grade	Russia	3 TON/2	NASA/RSA	NA	NA	NA	0	0	1	1	0
Taste at 20°C	grade	Russia	3 TTN/2	NASA/RSA	NA	NA	NA	NA	NA	NA	NA	NA
Total Solids	mg/L	Russia	1.5	NASA/RSA	NA	NA	NA	NA	NA	NA	NA	NA
Total Hardness	meq/L	Russia	7	NASA/RSA	NA	NA	NA	3.0	NA	3.4	1.9	1.7
Chemical Oxygen Demand	mg O_2/L	Russia	no limit/100	NASA/RSA	NA	NA	NA	53	60	68	80	95
Anions												
Bromide	mg/L	U.S.			ND	ND	ND	NA	NA	NA	NA	NA
Chloride	mg/L	U.S.	200	NASA/RSA	9.14	10.1	13.5	15.3	15.0	17.0	ND	ND
Fluoride	mg/L	U.S.	1.5	NASA/RSA	0.20	2.14	0.1	ND	ND	ND	ND	ND
Nitrate as Nitrogen (NO3-N)	mg/L	U.S.	10	NASA/RSA	ND	ND	0.6	5.3	0.8	6.1	ND	ND
Nitrite as Nitrogen (NO2-N)	mg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Phosphate	mg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Sulfate	mg/L	U.S.	250	NASA/RSA	7.5	9.68	14.2	21.5	18.6	22.8	ND	ND
Cations												
Ammonia as Nitrogen (NH3-N)	mg/L	U.S.	2	NASA/RSA	3.05	ND	ND	ND	ND	ND	ND	ND
Calcium	mg/L	U.S.	100	NASA/RSA	25.3	34.8	40.5	66.1	75.2	80.0	41.7	36.5
Lithium	mg/L	U.S.			ND	ND	NA	ND	ND	ND	ND	ND
Magnesium	mg/L	U.S.	50	NASA/RSA	6.51	8.32	10.8	16.4	20.0	18.3	6.3	6.7
Potassium	mg/L	U.S.			2.40	1.73	2.23	3.15	3.1	2.7	ND	ND
Sodium	mg/L	U.S.			7.48	5.67	6.63	12.0	13.4	13.2	1.4	1.2
Minerals												
Ammonium (NH4)	mg/L	Russia	2	NASA/RSA	NA	NA	NA	NA	NA	NA	NA	NA
Calcium	mg/L	Russia	100	NASA/RSA	NA	NA	NA	50	NA	54	30	28
Magnesium	mg/L	Russia	50	NASA/RSA	NA	NA	NA	6.0	NA	7.2	4.8	3.6
Metals												
Calcium	µg/L	U.S.	100000	NASA/RSA	30800	NA	NA	NA	NA	NA	NA	NA
Magnesium	µg/L	U.S.	50000	NASA/RSA	7650	NA	NA	NA	NA	NA	NA	NA
Sodium	µg/L	U.S.			4900	NA	NA	NA	NA	NA	NA	NA
Potassium	µg/L	U.S.			1820	NA	NA	NA	NA	NA	NA	NA
Silver	µg/L	U.S.	500	NASA/RSA	441	889	0.5	244	356	175	309	296
Silver ion	µg/L	Russia			NA	NA	NA	NA	NA	NA	NA	NA
Aluminum	µg/L	U.S.		NASA	43.1	NA	NA	NA	NA	NA	NA	NA
Arsenic	µg/L	U.S.	10	NASA	3.8	ND	ND	ND	ND	ND	ND	ND
Barium	µg/L	U.S.	1000	NASA	66.0	2.2	32.9	72.0	86.0	76.0	31.5	36.5
Cadmium	µg/L	U.S.	5	NASA	ND	22.0	0.1	0.1	0.1	ND	4.0	ND
Chromium	µg/L	U.S.	100	NASA	0.5	ND	0.4	0.4	ND	0.4	0.4	ND
Cobalt	µg/L	U.S.		NASA	ND	NA	NA	NA	NA	NA	NA	NA
Copper	µg/L	U.S.	1000	NASA	4.8	21.0	2.0	38.9	44.8	27.7	0.5	61.2

TABLE 5. STORED WATER RESULTS

Mission Sample Location Sample Description Sample Date Analysis/Sample ID	Units	Test Conducted by	Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	Mir 21 preflight RSC supplied water 11/2/95 95-1128-01	Mir 21 SVO-ZV stored water 3/27/96 96-0408-04	Mir 22 preflight RSC supplied water 6/3/96 96-0625-02	Mir 21 galley-hot stored water 8/15/96 96-0927-04	Mir 22 galley-hot stored water 9/5/96 96-0927-08	Mir 22 galley-cold stored water 9/5/96 96-0927-05	Mir 22 SVO-ZV stored water 9/5/96 96-0927-06	Mir 22 galley-cold stored water 9/23/96 96-0927-07
Metals contd.												
Iron	µg/L	U.S.	300	NASA	54.4	290	83.7	24.4	23.2	26.5	4.2	16.6
Mercury	µg/L	U.S.	2	NASA	0.9	NA	ND	NA	NA	NA	NA	NA
Manganese	µg/L	U.S.	50	NASA	21.3	23.7	7.0	6.5	7.2	7.4	0.6	0.4
Molybdenum	µg/L	U.S.		NASA	1.3	ND	ND	ND	ND	ND	ND	ND
Nickel	µg/L	U.S.	100	NASA	1.5	79.3	1.6	121	54.8	61.3	35.4	62.2
Lead	µg/L	U.S.	50	NASA	0.6	ND	ND	3.9	3.3	2.6	ND	0.6
Selenium	µg/L	U.S.	10	NASA	4.8	ND	ND	ND	ND	ND	ND	ND
Zinc	µg/L	U.S.	5000	NASA	5.0	549	0.5	25	23	19	34	45
Palladium	µg/L	U.S.		NASA	NA	NA	NA	NA	NA	NA	NA	NA
Silicon	µg/L	U.S.		NASA	ND	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon												
TIC (OI 1010)	mg/L	U.S.			26.7	17.5	NA	20.9	20.5	22.4	3.61	0.568
POC (OI 1010)	mg/L	U.S.			NA	NA	NA	NA	NA	NA	NA	NA
NPOC (OI 1010)	mg/L	U.S.			11.0	9.67	NA	7.79	10.2	6.98	30.5	31.3
TOC (OI 1010)	mg/L	U.S.	0.5/25	NASA/RSA	NA	NA	NA	NA	NA	NA	NA	NA
TIC (Sievers 800)	mg/L	U.S.			23.4	NA	32.9	36.5	39.2	39.7	6.86	1.50
TOC (Sievers 800)	mg/L	U.S.	0.5/25	NASA/RSA	8.72	NA	5.36	7.45	8.11	7.22	27.6	31.2
Total Organic Carbon												
TOC (Sievers 800)	mg/L	Russia	0.5/25	NASA/RSA	NA	NA	NA	9.9	8.1	10.4	30.2	29.8
Volatile Organics												
Acetaldehyde	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Acetone	µg/L	U.S.			79.7	86.4	ND	ND	ND	ND	13.95	12.13
Acryloniltrile	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Benzene	µg/L	U.S.	5.0	EPA	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	µg/L	U.S.	100	EPA	4.9	ND	7.25	3.48	4.36	6.46	ND	ND
Bromoform	µg/L	U.S.	100	EPA	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone	µg/L	U.S.			ND	ND	ND	ND	ND	ND	35.37	ND
Carbon disulfide	µg/L	U.S.			ND	ND	ND	ND	ND	2.01	1.42	ND
Chloroform	µg/L	U.S.	100	EPA	184.9	56.9	142.84	70.22	68.43	112.4	1.65	ND
Dibromochloromethane	µg/L	U.S.	100	EPA	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	µg/L	U.S.	75	EPA	ND	ND	ND	ND	ND	ND	ND	ND
Dichlorodifluoromethane	µg/L	U.S.	1000	EPALifetime HA	ND	ND	ND	ND	ND	ND	ND	ND
Diethyl ether	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Iodomethane	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Linolool	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	µg/L	U.S.	5	EPA	ND	3.8	ND	ND	ND	ND	ND	ND
4-Methyl-2-pentanone	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
alpha-Methyl styrene	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Perfluoro-1,3-dimethylcyclohexane	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Tetrahydrofuran	µg/L	U.S.			ND	14.8	ND	ND	ND	ND	ND	ND
Toluene	µg/L	U.S.	1000	EPA	ND	ND	ND	ND	ND	ND	11.9	5.33
Trichloroethene	µg/L	U.S.	5	EPA	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichlorotrifluoroethane	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND

TABLE 5. STORED WATER RESULTS

Mission Sample Location Sample Description Sample Date Analysis/Sample ID	Units	Test Conducted by	Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	Mir 21 preflight RSC supplied water 11/2/95 95-1128-01	Mir 21 SVO-ZV stored water 3/27/96 96-0408-04	Mir 22 preflight RSC supplied water 6/3/96 96-0625-02	Mir 21 galley-hot stored water 8/15/96 96-0927-04	Mir 22 galley-hot stored water 9/5/96 96-0927-08	Mir 22 galley-cold stored water 9/5/96 96-0927-05	Mir 22 SVO-ZV stored water 9/5/96 96-0927-06	Mir 22 galley-cold stored water 9/23/96 96-0927-07
Volatile Organics contd.												
m&p-Xylene	µg/L	U.S.	Total Xylenes 10000	EPA	ND	ND	ND	ND	ND	ND	ND	ND
o-Xylene	µg/L	U.S.	Total Xylenes 10000	EPA	ND	ND	ND	ND	ND	ND	ND	1.06
Semivolatile Organics												
Acetophenone	µg/L	U.S.			ND	ND	ND	ND	ND	1.2	1.6	ND
2-Aminonaphthalene	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Aniline	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Azobenzene	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Benzaldehyde	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Benzoic acid	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Benzothiazole	µg/L	U.S.			ND	ND	0.2	5.2	2.4	4.6	1.9	2.4
Benzyl alcohol	µg/L	U.S.			ND	ND	ND	1.0	ND	ND	62.4	18.9
Benzyl butyl phthlate	µg/L	U.S.	7000	EPA DWEL	ND	ND	ND	ND	ND	ND	2.6	1.6
2-Butoxyethanol	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
2-(2-Butoxyethoxy) Ethanol	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Butylated hydroxyanisole (BHA)	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
N-Butylbenzenesulfonamide	µg/L	U.S.			ND	ND	ND	ND	ND	ND	1.6	1.0
3-t-Butylphenol	µg/L	U.S.			ND	ND	ND	ND	ND	ND	0.8	6.4
Caffeine	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Caprolactam	µg/L	U.S.			ND	ND	ND	ND	ND	ND	576.7	87.7
tris-2-Chloroethyl phosphate	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Cyclododecane	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Cyclohexanone	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Decamethylcyclopentasiloxane	µg/L	U.S.			ND	ND	ND	1.7	0.2	ND	3.2	1.8
1,4 Diacetylbenzene	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
1,3- Dichlorobenzene	µg/L	U.S.	600	EPA	ND	ND	ND	ND	NA	NA	NA	NA
1,4-Dichlorobenzene	µg/L	U.S.	75	EPA	ND	ND	ND	ND	NA	NA	NA	NA
Di-n-butylamine	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Di-n-butyl phthalate	µg/L	U.S.	4000	EPA DWEL	ND	ND	0.4	0.2	ND	ND	1.1	ND
N,N-Dibutylformamide	µg/L	U.S.			ND	1.6	ND	ND	ND	ND	ND	ND
2,6-Di-t-butyl-1,4-benzoquinone	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
3,5-Di-t-butyl-4-hydroxybenzaldehyde	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
2,6-Di-t-butyl-4-methylphenol	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
2,4-Di-t-butylphenol	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
N,N-Diethylformamide	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
N,N-Diethyl-m-toluamide	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Diethylene glycol monoethyl ether	µg/L	U.S.			ND	ND	2.1	ND	ND	ND	ND	ND
Diethyl phthalate	µg/L	U.S.	5000	EPA Lifetime HA	ND	4.4	0.2	1.5	ND	1.6	1.2	0.9
Diisopropyl Adipate	µg/L	U.S.				ND		ND	ND	ND	ND	ND
N,N-Dimethylacetamide	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
N,N-Dimethylbenzylamine	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Dimethylcarbamyl chloride	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND

TABLE 5. STORED WATER RESULTS

Mission Sample Location Sample Description Sample Date Analysis/Sample ID	Units	Test Conducted by	Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	Mir 21 preflight RSC supplied water 11/2/95 95-1128-01	Mir 21 SVO-ZV stored water 3/27/96 96-0408-04	Mir 22 preflight RSC supplied water 6/3/96 96-0625-02	Mir 21 galley-hot stored water 8/15/96 96-0927-04	Mir 22 galley-hot stored water 9/5/96 96-0927-08	Mir 22 galley-cold stored water 9/5/96 96-0927-05	Mir 22 SVO-ZV stored water 9/5/96 96-0927-06	Mir 22 galley-cold stored water 9/23/96 96-0927-07
Semivolatile Organics contd.												
N,N-Dimethylformamide	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Dimethyl phthalate	µg/L	U.S.			ND	ND	ND	ND	ND	ND	0.8	0.4
Dimethylthiocarbamoyl chloride	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Dipropylene glycol methyl ether	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Dodecamethylcyclohexasiloxane	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Eicosane	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
2-Ethoxyethanol	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
2-Ethylhexanoic acid	µg/L	U.S.			ND	ND	ND	ND	ND	ND	16.6	4.5
2-Ethyl-1-hexanol	µg/L	U.S.			ND	ND	ND	ND	ND	ND	4.2	3.2
bis-2-Ethylhexyl adipate	µg/L	U.S.	400	EPA	ND	ND	ND	ND	ND	ND	ND	ND
bis-2-Ethylhexyl phthalate (Dioctyl phthlate)	µg/L	U.S.	6	EPA HA	ND	ND	0.4	0.2	ND	ND	2.0	16.1
4-Ethylmorpholine	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
4-Ethylphenol	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
1-Formylpiperidine	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Heneicosane	µg/L	U.S.			ND	ND	ND	ND	ND	NA	NA	NA
2-Heptanone	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanol	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
2-Hydroxybenzothiazole	µg/L	U.S.			ND	ND	ND	2.6	ND	ND	ND	ND
4-Hydroxy-4-methyl-2-pentanone	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Indole	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Isophorone	µg/L	U.S.	100	EPA Lifetime HA	ND	ND	ND	ND	ND	ND	ND	ND
Menthol	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
2-Mercaptobenzothiazole	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
3-Methyl-2-cyclohexen-1-one	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Methyl-4-hydroxybenzoate	µg/L	U.S.			ND	ND	ND	1.5	ND	3.7	ND	ND
2-Methyl-2,4-pentanediol	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
4-Methylphenol	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
2-Methylpyrazine	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
1-Methyl-2-pyrrolidinone	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Methyl sulfone	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
2-Methylthiobenzothiazole	µg/L	U.S.			0.1	ND	ND	ND	ND	2.4	0.8	1.1
Monomethyl phthalate	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	3.0
Neomenthol	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Nicotine	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Octadecanol	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Octamethylcyclotetrasiloxane	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Octanoic Acid	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
4-t-Octylphenol	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Oxindole	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Pentacosane	µg/L	U.S.			ND	26.7	0.8	ND	ND	ND	ND	ND
s-Phenethyl alcohol	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Phenol	µg/L	U.S.	1/4000	NASA/EPA	ND	ND	ND	1.2	6.0	3.9	24.8	6.2
Phenoxyacetic acid	µg/L	U.S.		Lifetime HA	ND	ND	ND	ND	ND	ND	ND	ND

TABLE 5. STORED WATER RESULTS

Mission Sample Location Sample Description Sample Date Analysis/Sample ID	Units	Test Conducted by	Maximum Contaminant Level (MCL)	Maximum Contaminant Level Source	Mir 21 preflight RSC supplied water 11/2/95 95-1128-01	Mir 21 SVO-ZV stored water 3/27/96 96-0408-04	Mir 22 preflight RSC supplied water 6/3/96 96-0625-02	Mir 21 galley-hot stored water 8/15/96 96-0927-04	Mir 22 galley-hot stored water 9/5/96 96-0927-08	Mir 22 galley-cold stored water 9/5/96 96-0927-05	Mir 22 SVO-ZV stored water 9/5/96 96-0927-06	Mir 22 galley-cold stored water 9/23/96 96-0927-07
Semivolatile Organics contd.												
2-Phenoxyethanol	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
N-Phenyl-2-naphthylamine	µg/L	U.S.			ND	ND	ND	ND	ND	ND	2.5	1.8
2-Phenylacetic Acid	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
2-Phenylphenol	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	0.3
2-Phenyl-2-propanol	µg/L	U.S.			ND	ND	ND	ND	ND	ND	1.2	ND
Phenyl sulfone	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Phthalide	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Squalene	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
1-alpha-Terpineol	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
1-Tetradecanol	µg/L	U.S.			ND	ND	3.2	ND	ND	ND	ND	ND
Tetramethylsuccinonitrile	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Tetramethylthiourea	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Tetramethylurea	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Toluene	µg/L	U.S.	1000	EPA	ND	ND	2.8	ND	ND	ND	4.7	ND
o-Toluic acid	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Triallyl-1,3,5-triazine-2,4,6(1H,3H,5H)-trione	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Tricosane	µg/L	U.S.			ND	23.6	ND	ND	ND	ND	ND	ND
Triethyl Phosphate	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Triethylamine	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
2,2,4-Trimethyl-1,3-pentanediol diisobutyrate	µg/L	U.S.			0.2	2.3	0.1	ND	ND	ND	ND	ND
Undecanoic Acid	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
2-Undecanone	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Urethane	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Vanillin	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Alcohols												
Ethanol	µg/L	U.S.			ND	ND	ND	2490	126	ND	22353	18331
Methanol	µg/L	U.S.			ND	ND	ND	502	ND	ND	ND	ND
1-Methoxy-2-propanol	µg/L	U.S.			ND	ND	NA	ND	ND	NA	NA	NA
2-Methyl-2-butanol	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
2-Methyl-2-propanol	µg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
2-Propanol	µg/L	U.S.			ND	430	ND	ND	ND	ND	ND	ND
Alcohols/Acetone												
Acetone	µg/L	Russia			NA	NA	NA	NA	NA	NA	NA	NA
Ethanol	µg/L	Russia			NA	NA	NA	NA	NA	NA	NA	NA
Isoamyl alcohol (3-Pentanol)	µg/L	Russia			NA	NA	NA	NA	NA	NA	NA	NA
Propyl alcohol	µg/L	Russia			NA	NA	NA	NA	NA	NA	NA	NA
Glycols												
1,2-Ethanediol	µg/L	U.S.	7000	EPA Lifetime HA	ND	ND	NA	ND	ND	ND	ND	ND
1,2-Propanediol	µg/L	U.S.			ND	ND	NA	ND	ND	ND	ND	ND
Glycols												
1,2-Ethanediol	µg/L	Russia	7000	EPA Lifetime HA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Propanediol	µg/L	Russia				NA					NA	

TABLE 5. STORED WATER RESULTS

Mission					Mir 21 preflight	Mir 21	Mir 22 preflight	Mir 21	Mir 22	Mir 22	Mir 22	Mir 22
Sample Location					RSC	SVO-ZV	RSC	galley-hot	galley-hot	galley-cold	SVO-ZV	galley-cold
Sample Description			Maximum	Maximum	supplied	stored	supplied	stored	stored	stored	stored	stored
		Test	Contaminant	Contaminant	water	water	water	water	water	water	water	water
Sample Date		Conducted	Level	Level	11/2/95	3/27/96	6/3/96	8/15/96	9/5/96	9/5/96	9/5/96	9/23/96
Analysis/Sample ID	Units	by	(MCL)	Source	95-1128-01	96-0408-04	96-0625-02	96-0927-04	96-0927-08	96-0927-05	96-0927-06	96-0927-07
Organic Acids												
Acetic acid	µg/L	U.S.			ND	NA	ND	NA	NA	NA	NA	NA
Acetic acid	µg/L	Russia				NA		NA	NA		NA	
Lactic acid	µg/L	U.S.			ND	NA	ND	NA	NA	NA	NA	NA
Propanoic acid	µg/L	U.S.			ND	NA	ND	NA	NA	NA	NA	NA
Aldehydes												
Formaldehyde	µg/L	U.S.	1000	EPA Lifetime HA	ND	12.6	4.4	8.1	6.9	4.7	6.3	6.4
Acetaldehyde	µg/L	U.S.			NA	NA	NA	NA	NA	NA	NA	NA
Carboxylates												
Acetate	mg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Formate	mg/L	U.S.			ND	ND	ND	ND	ND	ND	73.0	86.8
Lactate	mg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Amines												
Methylamine	mg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Urea	mg/L	U.S.			ND	ND	ND	ND	ND	ND	ND	ND
Organic Carbon Recovery	percent	U.S.			0.79	3.94	0.46	20.22	1.01	0.35	102.35	103.64

TABLE 6. HUMIDITY CONDENSATE RESULTS

Mission			Mir21	Mir21	Mir21	Mir21	Mir22	Mir22
Sample Location			CRS	CRS	CRS	CRS	EDV	EDV
Sample Description		Test	condensate	condensate	condensate	condensate	condensate	condensate
Sample Date		Conducted	3/1-4/1996	3/19-22/96	6/18-22/1996	07/23-26/96	9/10-12/96	9/16-18/1996
Analysis/Sample ID	Units	by	96-0403-01	96-0403-02	97-0124-21	97-0124-22	96-0928-02	96-0928-03
Conductivity	µS/cm	U.S.	156	134	173	157	506	375
Conductivity	µS/cm	Russia	NA	NA	178	165	497	383
pH	pH units	U.S.	6.65	6.49	6.30	6.40	7.59	7.22
pH	pH units	Russia	NA	NA	7.5	7.4	7.6	7.2
Turbidity	NTU	U.S.	NA	4.19	19.0	19.0	9.39	9.25
Color True	degrees	Russia	10	10	NA	NA	15	15
Odor at 20°C	grade	Russia	3	3	NA	NA	3	3
Taste at 20 °C	grade	Russia	NA	NA	NA	NA	NA	NA
Total Solids	mg/L	Russia	NA	NA	NA	NA	NA	NA
Total Hardness	meq/L	Russia	NA	NA	NA	NA	NA	NA
Chemical Oxygen Demand	mg O_2/L	Russia	250	90	240	200	272	180
Anions								
Bromide	mg/L	U.S.	ND	ND	ND	ND	NA	NA
Chloride	mg/L	U.S.	1.51	0.176	0.94	ND	6.2	3.4
Fluoride	mg/L	U.S.	0.241	0.091	ND	0.17	ND	ND
Nitrate as Nitrogen (NO3-N)	mg/L	U.S.	ND	ND	ND	0.06	ND	ND
Nitrite as Nitrogen (NO2-N)	mg/L	U.S.	ND	ND	ND	ND	ND	ND
Phosphate	mg/L	U.S.	ND	ND	ND	ND	ND	ND
Sulfate	mg/L	U.S.	0.361	ND	0.53	3.14	114	33.0
Cations								
Ammonia as Nitrogen (NH3-N)	mg/L	U.S.	15.3	2.72	25.1	18.1	26.6	27.8
Calcium	mg/L	U.S.	3.33	0.13	0.304	ND	ND	ND
Lithium	mg/L	U.S.	ND	ND	ND	ND	4.7	1.4
Magnesium	mg/L	U.S.	0.26	0.10	0.134	0.36	ND	ND
Potassium	mg/L	U.S.	1.68	ND	0.007	ND	8.6	9.8
Sodium	mg/L	U.S.	1.22	0.123	1.21	0.65	123.4	72.6
Minerals								
Ammonium (NH4)	mg/L	Russia	NA	NA	25	26	NA	47.5
Calcium	mg/L	Russia	NA	NA	NA	NA	NA	NA
Magnesium	mg/L	Russia	NA	NA	NA	NA	NA	NA
Metals								
Calcium	µg/L	U.S.	NA	NA	NA	NA	NA	NA
Magnesium	µg/L	U.S.	NA	NA	NA	NA	NA	NA
Sodium	µg/L	U.S.	NA	NA	NA	NA	NA	NA
Potassium	µg/L	U.S.	NA	NA	NA	NA	NA	NA
Silver	µg/L	U.S.	516	9.1	ND	ND	91.0	74.0
Silver ion	µg/L	Russia	NA	NA	NA	NA	NA	NA
Aluminum	µg/L	U.S.	NA	NA	166	70.2	NA	NA
Arsenic	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Barium	µg/L	U.S.	193	45.7	10.7	11.9	10.8	5.0
Cadmium	µg/L	U.S.	23.7	29.0	240	ND	8.7	8.3
Chromium	µg/L	U.S.	ND	ND	ND	161	1.2	1.5
Cobalt	µg/L	U.S.	NA	NA	ND	ND	NA	NA
Copper	µg/L	U.S.	102	15.5	38.5	ND	8.1	32.8
Iron	µg/L	U.S.	99.6	14.9	475	618	10.2	7.4
Mercury	µg/L	U.S.	NA	ND	ND	ND	NA	NA

TABLE 6. HUMIDITY CONDENSATE RESULTS

Mission			Mir21	Mir21	Mir21	Mir21	Mir22	Mir22
Sample Location			CRS	CRS	CRS	CRS	EDV	EDV
Sample Description		Test	condensate	condensate	condensate	condensate	condensate	condensate
Sample Date		Conducted	3/1-4/1996	3/19-22/96	6/18-22/1996	07/23-26/96	9/10-12/96	9/16-18/1996
Analysis/Sample ID	Units	by	96-0403-01	96-0403-02	97-0124-21	97-0124-22	96-0928-02	96-0928-03
Metals contd.								
Manganese	µg/L	U.S.	8.6	68.6	142	27.6	14.3	41.1
Molybdenum	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Nickel	µg/L	U.S.	475	574	671	106	14700	9150
Lead	µg/L	U.S.	51.0	68.7	311	139	33.2	17.0
Selenium	µg/L	U.S.	ND	ND	ND	ND	ND	4.2
Zinc	µg/L	U.S.	3.5	608	728	5334	45.0	56
Palladium	µg/L	U.S.	NA	NA	NA	NA	11.5	12.6
Silicon	µg/L	U.S.	NA	NA	NA	NA	NA	NA
Total Organic Carbon								
TIC (OI 1010)	mg/L	U.S.	14.5	12.7	NA	NA	19.5	6.30
POC (OI 1010)	mg/L	U.S.	NA	NA	NA	NA	NA	NA
NPOC (OI 1010)	mg/L	U.S.	51.6	39.6	NA	NA	33.6	34.7
TOC (OI 1010)	mg/L	U.S.	NA	NA	NA	NA	NA	NA
TIC (Sievers 800)	mg/L	U.S.	NA	NA	26.0	24.6	31.9	4.9
TOC (Sievers 800)	mg/L	U.S.	NA	NA	33.9	78.1	34.0	36.9
Total Organic Carbon								
TOC (Sievers 800)	mg/L	Russia	NA	NA	NA	75.0	NA	NA
Volatile Organics								
Acetaldehyde	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Acetone	µg/L	U.S.	79.2	114	44.16	70.06	18.53	19.82
Acryloniltrile	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Benzene	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Bromodichloromethane	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Bromoform	µg/L	U.S.	ND	ND	ND	ND	ND	ND
2-Butanone	µg/L	U.S.	ND	ND	ND	35.18	ND	ND
Carbon disulfide	µg/L	U.S.	71.2	11.0	13.56	1425.20	7.46	7.08
Chloroform	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Dibromochloromethane	µg/L	U.S.	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Dichlorodifluoromethane	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Diethyl ether	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Iodomethane	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Linolool	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Methylene chloride	µg/L	U.S.	ND	ND	5.32	4.56	2.57	1.77
4-Methyl-2-pentanone	µg/L	U.S.	ND	ND	ND	ND	2.17	ND
alpha-Methyl styrene	µg/L	U.S.	ND	ND	ND	ND	1.03	ND
Perfluoro-1,3-dimethylcyclohexane	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Tetrahydrofuran	µg/L	U.S.	ND	ND	30.38	27.94	ND	ND
Toluene	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Trichloroethene	µg/L	U.S.	ND	ND	ND	ND	ND	ND
1,1,2-Trichlorotrifluoroethane	µg/L	U.S.	ND	ND	ND	ND	ND	ND
m&p-Xylene	µg/L	U.S.	ND	ND	ND	ND	ND	ND
o-Xylene	µg/L	U.S.	ND	ND	ND	3.76	ND	ND

TABLE 6. HUMIDITY CONDENSATE RESULTS

Mission			Mir21	Mir21	Mir21	Mir21	Mir22	Mir22
Sample Location			CRS	CRS	CRS	CRS	EDV	EDV
Sample Description		Test	condensate	condensate	condensate	condensate	condensate	condensate
Sample Date		Conducted	3/1-4/1996	3/19-22/96	6/18-22/1996	07/23-26/96	9/10-12/96	9/16-18/1996
Analysis/Sample ID	Units	by	96-0403-01	96-0403-02	97-0124-21	97-0124-22	96-0928-02	96-0928-03
Semivolatile Organics								
Acetophenone	µg/L	U.S.	19.7	8.1	6.5	76.4	38.7	28.8
2-Aminonaphthalene	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Aniline	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Azobenzene	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Benzaldehyde	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Benzoic acid	µg/L	U.S.	108.6	ND	ND	ND	ND	ND
Benzothiazole	µg/L	U.S.	72.8	28.7	129.5	159.0	57.6	41.9
Benzyl alcohol	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Benzyl butyl phthlate	µg/L	U.S.	ND	ND	ND	ND	ND	ND
2-Butoxyethanol	µg/L	U.S.	ND	ND	ND	ND	ND	ND
2-(2-Butoxyethoxy) Ethanol	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Butylated hydroxyanisole (BHA)	µg/L	U.S.	ND	ND	7.5	12.4	9.6	7.0
N-Butylbenzenesulfonamide	µg/L	U.S.	ND	ND	3.2	ND	ND	ND
3-t-Butylphenol	µg/L	U.S.	98.0	128.6	867.6	342.0	377.5	265.9
Caffeine	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Caprolactam	µg/L	U.S.	ND	23.1	129.0	3572.6	ND	ND
tris-2-Chloroethyl phosphate	µg/L	U.S.	ND	5.8	ND	ND	ND	ND
Cyclododecane	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Cyclohexanone	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Decamethylcyclopentasiloxane	µg/L	U.S.	ND	5.6	ND	ND	4.0	1.5
1,4 Diacetylbenzene	µg/L	U.S.	ND	2.9	20.0	18.9	10.8	7.5
1,3- Dichlorobenzene	µg/L	U.S.	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Di-n-butylamine	µg/L	U.S.	ND	ND	6.4	ND	ND	ND
Di-n-butyl phthalate	µg/L	U.S.	ND	1.2	1.7	34.7	46.1	30.8
N,N-Dibutylformamide	µg/L	U.S.	ND	6.5	ND	ND	2.8	ND
2,6-Di-t-butyl-1,4-benzoquinone	µg/L	U.S.	ND	ND	ND	26.4	6.6	4.9
3,5-Di-t-butyl-4-hydroxybenzaldehyde	µg/L	U.S.	ND	ND	ND	13.8	ND	ND
2,6-Di-t-butyl-4-methylphenol	µg/L	U.S.	ND	16.0	ND	ND	ND	ND
2,4-Di-t-butylphenol	µg/L	U.S.	ND	ND	ND	ND	ND	ND
N,N-Diethylformamide	µg/L	U.S.	34.3	48.3	108.3	109.9	134.5	89.8
N,N-Diethyl-m-toluamide	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Diethylene glycol monoethyl ether	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Diethyl phthalate	µg/L	U.S.	3.0	5.1	ND	ND	4.6	ND
Diisopropyl Adipate	µg/L	U.S.	ND	ND	ND	ND	ND	ND
N,N-Dimethylacetamide	µg/L	U.S.	253.7	207.0	ND	664.7	695.7	471.8
N,N-Dimethylbenzylamine	µg/L	U.S.	ND	ND	11.2	11.7	ND	ND
Dimethylcarbamyl chloride	µg/L	U.S.	ND	ND	ND	127.1	ND	ND
N,N-Dimethylformamide	µg/L	U.S.	430.1	1134.7	ND	2284.0	3098.5	2153.2
Dimethyl phthalate	µg/L	U.S.	ND	ND	ND	8.2	ND	ND
Dimethylthiocarbamoyl chloride	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Dipropylene glycol methyl ether	µg/L	U.S.	91.1	ND	60.6	59.5	146.3	88.1
Dodecamethylcyclohexasiloxane	µg/L	U.S.	ND	0.6	8.7	9.8	ND	ND
Eicosane	µg/L	U.S.	ND	ND	ND	ND	ND	ND
2-Ethoxyethanol	µg/L	U.S.	ND	45.5	ND	214.2	180.3	171.7

TABLE 6. HUMIDITY CONDENSATE RESULTS

Mission			Mir21	Mir21	Mir21	Mir21	Mir22	Mir22
Sample Location			CRS	CRS	CRS	CRS	EDV	EDV
Sample Description		Test	condensate	condensate	condensate	condensate	condensate	condensate
Sample Date		Conducted	3/1-4/1996	3/19-22/96	6/18-22/1996	07/23-26/96	9/10-12/96	9/16-18/1996
Analysis/Sample ID	Units	by	96-0403-01	96-0403-02	97-0124-21	97-0124-22	96-0928-02	96-0928-03
Semivolatile Organics contd.								
2-Ethylhexanoic acid	µg/L	U.S.	ND	ND	ND	ND	ND	ND
2-Ethyl-1-hexanol	µg/L	U.S.	ND	ND	ND	ND	14.8	ND
bis-2-Ethylhexyl adipate	µg/L	U.S.	ND	ND	ND	ND	ND	ND
bis-2-Ethylhexyl phthalate (Dioctyl phthlate)	µg/L	U.S.	42.0	29.3	30.9	9.7	ND	ND
4-Ethylmorpholine	µg/L	U.S.	57.2	18.3	368.4	393.0	ND	5.1
4-Ethylphenol	µg/L	U.S.	ND	3.0	ND	4.9	ND	ND
1-Formylpiperidine	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Heneicosane	µg/L	U.S.	ND	ND	ND	ND	ND	ND
2-Heptanone	µg/L	U.S.	ND	ND	ND	ND	ND	ND
2-Hexanol	µg/L	U.S.	ND	ND	ND	ND	ND	ND
2-Hydroxybenzothiazole	µg/L	U.S.	67.1	94.4	16.5	102.0	7.8	5.3
4-Hydroxy-4-methyl-2-pentanone	µg/L	U.S.	38.7	24.7	39.2	93.7	204.4	136.6
Indole	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Isophorone	µg/L	U.S.	ND	4.9	ND	5.4	11.0	7.3
Menthol	µg/L	U.S.	ND	ND	ND	ND	ND	ND
2-Mercaptobenzothiazole	µg/L	U.S.	ND	40.6	ND	ND	ND	ND
3-Methyl-2-cyclohexen-1-one	µg/L	U.S.	5.0	1.4	ND	ND	ND	ND
Methyl-4-hydroxybenzoate	µg/L	U.S.	ND	ND	ND	ND	7.0	ND
2-Methyl-2,4-pentanediol	µg/L	U.S.	ND	ND	ND	31.5	ND	ND
4-Methylphenol	µg/L	U.S.	ND	ND	ND	ND	ND	ND
2-Methylpyrazine	µg/L	U.S.	ND	6.6	ND	ND	ND	ND
1-Methyl-2-pyrrolidinone	µg/L	U.S.	61.4	33.0	185.6	198.9	122.4	78.9
Methyl sulfone	µg/L	U.S.	5.5	4.7	4.3	50.6	21.4	ND
2-Methylthiobenzothiazole	µg/L	U.S.	25.9	10.6	16.4	78.6	22.1	15.7
Monomethyl phthalate	µg/L	U.S.	ND	7.7	ND	ND	ND	ND
Neomenthol	µg/L	U.S.	11.4	ND	ND	17.3	74.6	46.3
Nicotine	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Octadecanol	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Octamethylcyclotetrasiloxane	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Octanoic Acid	µg/L	U.S.	ND	ND	ND	ND	ND	ND
4-t-Octylphenol	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Oxindole	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Pentacosane	µg/L	U.S.	ND	ND	ND	2.3	ND	ND
s-Phenethyl alcohol	µg/L	U.S.	14.2	6.3	3.3	19.5	35.1	24.1
Phenol	µg/L	U.S.	ND	6.6	ND	ND	5.7	ND
Phenoxyacetic acid	µg/L	U.S.	ND	48.2	ND	ND	122.7	ND
2-Phenoxyethanol	µg/L	U.S.	ND	ND	ND	ND	ND	10.9
N-Phenyl-2-naphthylamine	µg/L	U.S.	15.3	4.8	15.3	55.5	29.3	18.7
2-Phenyl-2-propanol	µg/L	U.S.	32.6	12.7	99.5	91.0	85.8	57.8
Phenyl sulfone	µg/L	U.S.	10.7	15.1	63.0	28.6	93.3	63.8
Phthalide	µg/L	U.S.	2.7	7.3	ND	ND	ND	ND
Squalene	µg/L	U.S.	ND	ND	ND	ND	ND	ND
1-alpha-Terpineol	µg/L	U.S.	18.5	7.7	44.8	27.0	30.3	20.1
1-Tetradecanol	µg/L	U.S.	ND	ND	ND	ND	ND	7.3
Tetramethylsuccinonitrile	µg/L	U.S.	22.4	4.9	72.3	59.5	146.4	100.7

TABLE 6. HUMIDITY CONDENSATE RESULTS

Mission Sample Location Sample Description Sample Date Analysis/Sample ID	Units	Test Conducted by	Mir21 CRS condensate 3/1-4/1996 96-0403-01	Mir21 CRS condensate 3/19-22/96 96-0403-02	Mir21 CRS condensate 6/18-22/1996 97-0124-21	Mir21 CRS condensate 07/23-26/96 97-0124-22	Mir22 EDV condensate 9/10-12/96 96-0928-02	Mir22 EDV condensate 9/16-18/1996 96-0928-03
Semivolatile Organics contd.								
Tetramethylthiourea	µg/L	U.S.	26.6	9.1	338.4	1291.4	19.1	15.1
2-Phenylacetic Acid	µg/L	U.S.	ND	ND	ND	ND	ND	ND
2-Phenylphenol	µg/L	U.S.	4.3	1.6	ND	5.0	2.5	1.9
Tetramethylurea	µg/L	U.S.	23.5	11.7	134.4	226.1	66.8	42.2
Toluene	µg/L	U.S.	ND	1.9	ND	ND	ND	ND
o-Toluic acid	µg/L	U.S.	ND	80.5	ND	ND	ND	ND
1,3,5-Triallyl-1,3,5-triazine-2,4,6(1H,3H,5H)-trione	µg/L	U.S.	7.0	ND	12.5	13.4	8.4	6.8
Tricosane	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Triethyl Phosphate	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Triethylamine	µg/L	U.S.	ND	ND	ND	ND	ND	ND
2,2,4-Trimethyl-1,3-pentanediol diisobutyrate	µg/L	U.S.	8.6	ND	ND	ND	ND	ND
Undecanoic Acid	µg/L	U.S.	ND	ND	ND	ND	ND	22.9
2-Undecanone	µg/L	U.S.	ND	ND	ND	7.1	ND	ND
Urethane	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Vanillin	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Alcohols								
Ethanol	µg/L	U.S.	ND	ND	ND	ND	ND	ND
Methanol	µg/L	U.S.	ND	ND	116	ND	ND	ND
1-Methoxy-2-propanol	µg/L	U.S.	1760	1180	NA	ND	NA	NA
2-Methyl-2-butanol	µg/L	U.S.	ND	ND	ND	ND	ND	ND
2-Methyl-2-propanol	µg/L	U.S.	ND	ND	224	220	147	128
2-Propanol	µg/L	U.S.	ND	ND	ND	109	ND	ND
Alcohols/Acetone								
Acetone	µg/L	Russia	NA	NA	ND	ND	NA	NA
Ethanol	µg/L	Russia	NA	NA	ND	ND	NA	NA
Isoamyl alcohol (3-Pentanol)	µg/L	Russia	NA	NA	ND	ND	NA	NA
Propyl alcohol	µg/L	Russia	NA	NA	600	600	NA	NA
Glycols								
1,2-Ethanediol	µg/L	U.S.	ND	62000	ND	41547	12410	20580
1,2-Propanediol	µg/L	U.S.	ND	1430	ND	527	1400	1690
Glycols								
1,2-Ethanediol	µg/L	Russia	NA	NA	ND	7800	NA	NA
1,2-Propanediol	µg/L	Russia			300	ND		
Organic Acids								
Acetic acid	µg/L	U.S.	NA	NA	NA	NA	NA	NA
Acetic acid	µg/L	Russia			ND	ND		
Lactic acid	µg/L	U.S.	NA	NA	NA	NA	NA	NA
Propanoic acid	µg/L	U.S.	NA	NA	NA	NA	NA	NA
Aldehydes								
Formaldehyde	µg/L	U.S.	27.0	27.3	26.9	32.7	17.7	10.1
Acetaldehyde	µg/L	U.S.	NA	NA	153.1	>1840	NA	NA
Carboxylates								
Acetate	mg/L	U.S.	ND	ND	ND	0.31	ND	ND
Formate	mg/L	U.S.	ND	ND	ND	0.45	ND	ND
Lactate	mg/L	U.S.	ND	ND	ND	ND	ND	ND

TABLE 6. HUMIDITY CONDENSATE RESULTS

Mission			Mir21	Mir21	Mir21	Mir21	Mir22	Mir22
Sample Location			CRS	CRS	CRS	CRS	EDV	EDV
Sample Description		Test	condensate	condensate	condensate	condensate	condensate	condensate
Sample Date		Conducted	3/1-4/1996	3/19-22/96	6/18-22/1996	07/23-26/96	9/10-12/96	9/16-18/1996
Analysis/Sample ID	Units	by	96-0403-01	96-0403-02	97-0124-21	97-0124-22	96-0928-02	96-0928-03
Amines								
Methylamine	mg/L	U.S.	0.524	0.293	ND	ND	ND	ND
Urea	mg/L	U.S.	ND	ND	ND	6.78	ND	ND
Organic Carbon Recovery	percent	U.S.	3.82	67.15	6.47	32.70	26.25	30.19

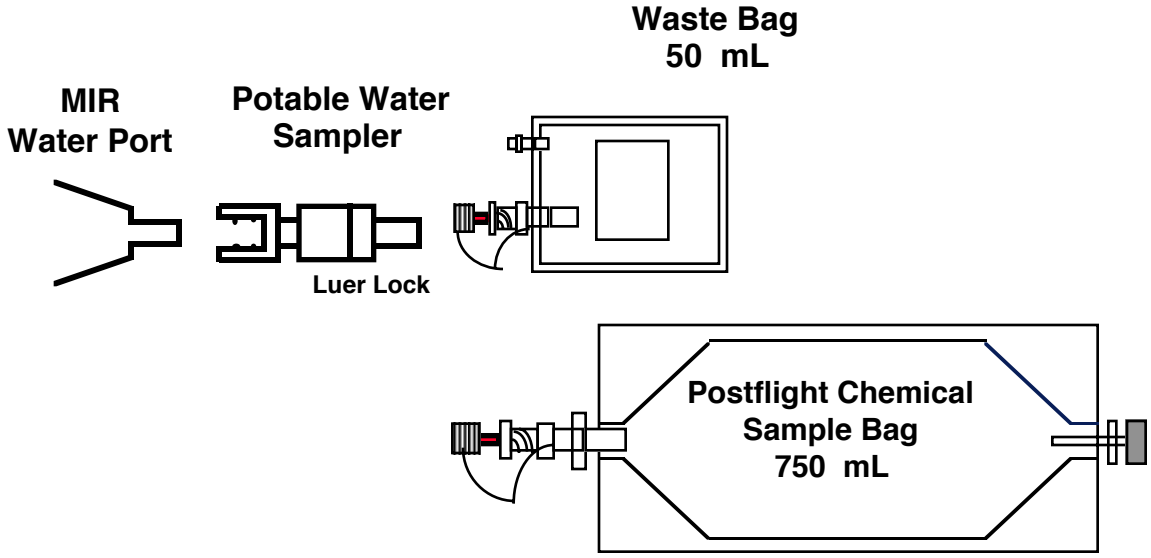

Figure 1. Sample Collection Methodology