Section 4 - Cargo Delivery & Return

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4.1 Summary Data on Cargo Delivered to/Returned From the *Mir* Under the *Mir* Shuttle/*Mir*-NASA Programs

While implementing these two programs, nine Shuttle vehicles docked with the *Mir* station (STS-71, -74, -76, -79, -81, -84, -86, -89, -91).

The Shuttle vehicles delivered **22,893.33 kg** of cargo to the *Mir*, including:

1. Docking module docked to the Kristall module – **4,096.22 kg**.
2. Russian cargo with a total mass of **8,627.14 kg**:

   - Food containers with food rations – ***2,515.56 kg***.
   - Outfitting hardware – ***4,015.56 kg*** (gyrodynes, storage batteries, current converters, and hardware for the following systems: Elektron-V, Vozdukh, thermal control system [TCS], telemetry, communications, computer complex, etc.)
   - Hardware to support extended manned flight – ***1,709.70 kg*** (LiOH cartridges, hardware for atmospheric analysis, individual hardware and cosmonaut equipment, personal hygiene aids, solid waste containers, water tanks, medical kits, flight data files, packages for cosmonauts, etc.);
   - Hardware to perform repair-maintenance work – ***242.42 kg*** (sealants, tools, special kits for maintenance work on the Elektron-V and Vozdukh systems, the TCS, the Spektr module, etc.);
   - Scientific experiments hardware – ***143.90 kg***

3. Water from Shuttle systems – **5,805.46 kg**.
4. Oxygen and nitrogen – **567.04 kg**.
5. American scientific hardware – **3,768.44 kg**, including hardware to support joint crew activities.
6. CNES hardware – **29.03 kg**.

The Shuttle vehicles returned **7,839.32 kg** of cargo from the *Mir* station, including:

1. Russian cargo with a total mass of **3,284.90 kg**.

   - Scientific experiment hardware and various data carriers – ***314.68 kg*** (film, video cassettes, diskettes, dosimeters, Greenhouse hardware, the Incubator-1M control and monitoring module, egg container-holder, container with Komza cassettes, various samplers, etc.)
   - Hardware to conduct research after extended use onboard the station, refurbishment, and re-use – ***2,532.65 kg*** (gyrodynes, teleoperator remote control mode (ТОРУ) hardware, Kurs, the Kvant-V system, Krater-V hardware, Alice equipment, communications equipment, hardware for the Elektron-V, Vozdukh, TCS, etc.);
   - Empty food containers for loading American food rations and repeat use – ***296.09 kg***;
   - Equipment and cosmonauts' preference items, symbols, etc. – ***141.48 kg***.

2. American scientific hardware – **4,479.72 kg**.
3. ESA hardware – **55.86 kg**.
4. DARA hardware – **7.74 kg**.
5. CNES hardware – **11.1 kg**.

Progress M (№ 224, 226, 227, 230, 231, 232, 233, 234, 235, 237, 236, 240, and 238) vehicles delivered **453.97 kg** of American scientific hardware to the *Mir* station.

Soyuz TM (№ 73 and 75) vehicles delivered **4.97 kg** of American scientific hardware to the *Mir* station.

The Spektr module delivered **705.47 kg** of American scientific hardware to the *Mir* station.

The Priroda module delivered **856.91 kg** of American scientific hardware to the *Mir* station.

The total mass of American scientific hardware delivered to the station onboard the Spektr and Priroda modules and the Soyuz TM and Progress M vehicles is **2,021.32 kg**.

Data on Cargo Traffic to the *Mir* on Shuttle Vehicles
(*Mir*-Shuttle/*Mir*-Nasa Programs)

Table 4.1

Year	Flight №	Shuttle №	Delivered			Returned	
			Russian hardware, kg	Water, kg	American scientific hardware, kg	Russian hardware, kg	American scientific hardware, kg
1995	01	STS-71 Spacelab	148.79	485 (technical)	78.51	326.17	121
	02	STS-74 Russian docking module	226.03	450.36 (50% technical; 50% drinking, condemned)	139.1	172.09	171.55 (U.S.) 9.12 (ESA)
1996	03	STS-76 (single module) Spacehab	860.27	684.9 (365-technical; 320-drinking)	477.23	331.85	115 (U.S.) 22.54 (ESA)
	04	STS-79 (double module) Spacehab	890.05	920.6 (559-technical; 360-drinking)	591.5	410.73	328 (U.S.) 238.1 (U.S. Misc.) 23.7 (ESA)
1997	05	STS-81 (double module) Spacehab	969.1	729.4 (50%-technical; 50%-drinking)	626.4	403.7	682.1
	06	STS-84 (double module) Spacehab	1,171.16	470.8 (50%-technical; 50%-drinking)	562.6	600.76	549.1 (U.S.) 7.74 (DARA) 1.1 (CNES)
	07	STS-86 (double module) Spacehab	1,948.3	778.5 (50%-technical; 50%-drinking)	660.6	419.6	707.5 (U.S.) 10 (CNES)
1998	08	STS-89 (double module) Spacehab	1,477.28	732.5 (50%-technical; 50%-drinking)	594.2	300.22	804.87 (U.S.) 0.5 (ESA)
	09	STS-91 (single module) Spacehab	936.16	553.4 (270-technical; 283-drinking)	38.30 (U.S.) 29.03 (CNES)	319.78	762.50
		Σ Mass:	Σ8,627.14	Σ5,805.46	Σ3,768.44 (U.S.)	Σ3,284.90	Σ4,479.72 (U.S.)
					29.3 - (CNES)		Σ55.86 - (ESA)
							Σ11.1 - (CNES)
							Σ7.74 (DARA)

Note 1: The cargo traffic data in this table was taken from the Working Group joint postflight reports.
Note 2: Flight STS-71 performed under the *Mir*-Shuttle program.

4.2 List of Russian Cargo on Shuttle Flights to the *Mir* Station

The tables below contain detailed data on the Russian hardware delivered and returned on Shuttle vehicles during the *Mir*-Shuttle and *Mir*-NASA programs.

Russian cargo delivered on STS-71 (*Mir*-Shuttle program)

Table 4.2

Description	Designation	Dimensions			Qty	Total Mass	Priority
		mm	mm	mm	ea.	kg	№
IELK (*Mir*-19)	115-9104-300	1060	550	400	2	80.00	1
Payload container (includes: 2 food containers with food rations - ΣMASS 14.47kg, УТЭ, personal items (*Mir*-19).	355ГК.3000А71-0	850	510	440	1	35.00	2
Food container (with food rations)	17КС.7860.200-01	380	305	123	1	8.79	3
Bracelet article (*Mir*-19)	К17.00.000.00	170	110	60	2	0.60	4
Personal dosimeter ИД-3М (*Mir*-19)	Хт2.805.602, IBMP-CPD-001	42	40	11	2	0.10	5
Sealing package	355ГК.4000-0	400	300	100	1	2.00	6
Cutting tool (for extravehicular activity, or EVA)	77КСО.1751А-0	1450	335	62	1	20.00	7
Wrench (for tightening screws on the Docking and Internal Transfer and System surface)	11Ф732.Г40002-0-04-11	203	50.8	d9.5	1	0.20	8
Supplemental FDF (*Mir*-19)	-	203	250	76	1	1.00	9
Gripper (tool for opening the APDA ring structural hooks)	ЗЗУ.6516.003	485	170	30	1	1.10	Various hardware
∑ MASS						**148.79**	
WATER transferred						**485**	
Oxygen						**35.2**	
Nitrogen						**40.0**	

Russian cargo returned on STS-71 (*Mir*-Shuttle Program)

Table 4.3

Description	Designation	Dimensions			Qty	Total Mass	Priority
		mm	mm	mm	ea.	kg	№
Kentavr article (*Mir*-18)	К39.00.000.00	375	255	90	3	3.30	1
Remote Control Operator Mode (ТОРУ) Equipment							
Single-phase static converter ПОС-80РН	ИЖЕА.435.137.004	248	186	96	2	6.00	2
КХ97-010М Device	КХ2.517.000	448	334	130	2	19.40	3
Translation and attitude control unit (БУПО)	11Ф615.8372А55-0	306	285	114	1	9.56	4
Power supply unit (БПС)	17КС.30Ю2311-0	359	185	284	1	7.88	5
Radio transmitter unit КЛ-108М	ТЭ2.015.226	315	250	114	1	4.80	6
Command generating unit (БФК)	11Ф615.8353А-0А55	375	230	211	1	7.94	7
Power switching unit БСК-1В	17КС.10Ю2704-0	221.5	194.5	76	2	3.56	8
Power switching unit БСК-2В	17КС.10Ю2706-0	221.5	194.5	76	1	1.74	9
Power switching unit БСК-5В	17КС.10Ю2708-0	221.5	194.5	76	1	2.04	10
Power switching unit БСК-7.5	17КС.10Ю2709-0	221.5	194.5	76	1	1.90	11
Power switching unit БСК-14	17КС.10Ю2713-0	221.5	194.5	76	2	3.48	12
11М617-1 Unit (ЦВУС-5)	ХА3.030.073	588	256	261	1	24.90	13
МС57301 Device, Buffer computer interface (ПМО)	ЩИ3.057.127	301	195	49	7	18.24	14
ША294 transmitter unit	ИЮ2.017.289	585	395	140	2	38.50	15
Storage Battery (800A)	ИКШЖ.563534.007	465	278	530	1	74.00	16
Radio station "Korona SK"	ИХ2.000.221	135	125	115	1	2.92	17
Dosimeter assembly	IBMP-PRD-001	42	40	11	5	0.15	18
IELK (*Mir* 18)	115-9104-300	1060	550	400	2	41.10	20
Package of personal items (*Mir* 18)	-	230	200	100	2	4.00	21
ТА963А-16 instrument	ИЮ2.158.045-14	190	260	300	1	11.80	22
Power switching unit БСК-5	17КС.10Ю2707-0	221.5	194.5	76	1	1.92	23
Set of books and souvenirs	-	550	300	200	1	7.70	24
Film and video cassettes	-	342.9	203.2	203.2	1	3.60	25
Handle (tool for opening APDA hatch)	11Ф732.Г1021-0А	200	100	100	1	0.64*	Various hardware
Gripper (tool for opening APDA ring structural hooks)	33У.6516.003	485	170	30	1	1.10*	Various hardware
IELK (NASA 1)	115-9104-300	1060	550	400	1	24.00*	Various hardware
∑ MASS						**326.17**	

Remark:

***** - These items transferred to NASA after the flight.

Russian cargo delivered on STS-74

Table 4.4

Description	Designation	Dimensions			Qty	Total Mass	Priority
		mm	mm	mm	ea.	kg	№
Docking Module (DM) with solar arrays	**316ГК.0000-0**	**5094**	**4902**	**4510**	**1**	**4096.22***	
Set of EDV containers	355ГК.0010А74-0	643	d334	d230	1	11.20	1
EDV cover assembly	11Ф615.8711-180А151		d330	105	6	20.70	2
EDV adapter	11Ф615.8711-100А15	140	60	d40.5	1	0.30	3
EDV fill indicator	11Ф615.8711-210А15-1	47	d19	-	1	0.01	4
Food container (with Russian food rations)	17КС.7860.200-01	380	305	123	21	132.40	5
Crew Family Package (*Mir*-Shuttle Program, Phase 1)	-				1	4.97	Various hardware
Set of adapters (adapter - 17КС.2061-0, 2 ea.)	355ГК.003.А74-0	195	160	95	1	0.58	Various hardware
Clamps	17КС.2062-10-10 17КС.2062-10-20 17КС.2062-10-30				6	0.00	Various hardware
Cargo in the Docking Module:							
Personal Hygiene Aids (СЛГ)	Хт4.160.603	225	120	140	10	9.50	
Personal Hygiene Aids (СЛГ-3)	Хт4.160.603-01	225	120	140	25	21.25	
Personal Hygiene Aids (СЛГ-Д)	Хт4.160.603-07	220	120	145	12	5.40	
Personal Hygiene Aids (СЛГ-Д)	Хт4.160.603-11	235	120	145	2	1.20	
Hair care item	Хт4.160.640	225	140	120	2	0.80	
Package of sanitary surface wipes	Хт4.160.003	225	140	120	2	2.00	
Kameliya-S athletic underwear	К19.00.000.00	330	230	40	24	7.92	
Komza cassette container	Фд.3.394.017-050	157	238	124	2	7.80	
∑ MASS						**226.03A**	
WATER transferred						**450.36**	
Oxygen						**26.80**	
Nitrogen						**20.09**	

Remark:

A - Total mass is based on the results of a weight check when transferring responsibility for cargo at Kennedy Space Center (KSC).

* The mass of the DM with the solar arrays (316ГК.0000-0) is shown for reference and has not been calculated into the mass for this table.

Russian cargo returned on STS-74

Table 4.5

Description	Designation	Dimensions			Qty	Total Mass	Priority
		mm	mm	mm	ea.	kg	№
МАГ-70 film case	-	-	d60	85	1	0.20	1
A-12 film case	-	-	d30	70	3	0.10	2
35 mm film case	-	-	d36	52	7	0.20	3
Komza cassette container	Фд.3.394.017-050	157	238	124	1	3.00	4
CA-20M film case	-	385	d305	355	2	44.00	5
Package with UN flag	-	320	90	90	1	0.10	6
ША294 transmitter unit	ИЮ2.017.289	400	142	597	1	19.00	7
TA082 Signal conditioning unit (БНУ)	ИВЯФ.468173.049	216	180	86	1	2.00	8
Vacuum valve unit (БВК)	17К.8711-0	318	267	241	5	35.00	9
Vacuum pump	17К.8710-300	330	206	104	3	21.00	10
Food container (empty)	17КС.7860.200-01	380	305	123	17	17.00	11
"Astra-2" experiment diskettes (3.5" - 4 ea. And 5.25" - 3 ea.)	-	140	140	51	1	0.30	12
HI-8 video cassettes (ALICE)	-	61	114	114	3	0.30	13
Greenhouse control unit	КМ01.010.00	381	216	114	1	4.20	14
Greenhouse lighting unit	КМ01.010.02.00	368	191	362	1	9.80	15
Betacam SP video cassettes	BCT-30MA	282	114	175	9	3.00	16
Cosmonaut Preference Kit	-	230	200	100	4	10.00	Various hardware
KAB 6180 container (atmospheric moisture condensate 0.15L)	10360.6180.000	-	d82	193	1	0.50	Scientific hardware
Egg container-holder	101896-500				1	2.00	Scientific hardware
Dosimeter assembly	IBMP-PRD-001	42	40	11	7	0.21	Scientific hardware
Dosimeter assembly	IBMP-APD-001	110	63	21	1	0.18	Scientific hardware
∑ MASS						**172.09A**	

Remark:

A - Total mass is based on the results of a weight check when transferring responsibility for cargo at KSC.

Russian cargo delivered on STS-76

Table 4.6

Description	Designation	Dimensions			Qty	Total Mass	Priority
		mm	mm	mm	ea.	kg	№
Bracelet article (NASA 2)	К17.00.000.00	170	110	60	1	0.3	1
IELK (NASA 2)	115-9104-300	1060	550	400	1	36.00	2
“Analysis-3” unit	КМ09.066.00.00	215	110	20	1	0.35	3
“Analysis-3” hose	77КСО.8210.100	850	d24.3		1	0.12	4
Food container (with food rations)	17КС.7860.200-01	380	305	123	36	221.00	5
Set of EDV containers	355ГК.0010А74-0	643	d334	d230	2	23.00	6
EDV cover assembly	11Ф615.8711-180А151		d330	105	12	42.40	7
EDV adapter	11Ф615.8711-100А15	140	60	d40.5	2	0.60	8
EDV fill indicator	11Ф615.8711-210А15-1	47	d19	-	2	0.02	9
Storage Battery (800A)	ИКШЖ.563534.007	465	278	530	3	228.8	10
Current converter (ПТАБ-1)	ЕИГА.435.241.001-01ТУ	380	320	186	3	39.60	11
“Inkubator-1M” control and monitoring module	КМ10.064.00.00	355	308	355	1	10.00	12
Personal Hygiene Aids (СЛГ)	Хт4.160.603	225	120	140	14	13.10	13
Personal Hygiene Aids (СЛГ-3)	Хт4.160.603-01	225	120	140	35	29.50	14
Personal Hygiene Aids (СЛГ-Д)	Хт4.160.603-06	220	120	140	10	3.40	15
Personal Hygiene Aids (СЛГ-Д)	Хт4.160.603-07	220	120	145	5	1.90	16
Penguin-3 suit	КН-9030-400	330	200	170	3	9.30	17
Kameliya-S athletic underwear	К19.00.000.00	330	230	40	20	6.70	18
Г16-М unit (gyrodyne) with fasteners	355ГК.0020А76-0	1040	d635	-	1	125.00	19
СА-20М film case	-	385	d305	355	2	58.60	20
Individual dosimeter ИД-3М (NASA 2)	Хт2.805.602, IBMP-CPD-001	42	40	11	1	0.05	21
Soft bag (Cosmonaut Family Package)	11Ф615.Б11710-0А55	340	310	90	2	9.70	Various hardware
∑ MASS						**860.27A**	
WATER transferred						**684.9**	
Oxygen						**35.2**	
Nitrogen						**20.0**	

Remark:

A - Total mass is based on the results of a weight check when transferring responsibility for cargo at KSC.

Russian cargo returned on STS-76

Table 4.7

Description	Designation	Dimensions			Qty	Total Mass	Priority
		mm	mm	mm	ea.	kg	№
К1-ВКА-03 instrument with three РТ-ВКА instruments	ЯУ2.000.031	696	460	390	2	148.91	1
ПТС-250АТ-2 instrument	2АТ.949.098	290	255	135	2	10.12	2
2Ф4-ВКА instrument	ЯУ3.468.011	214.5	124	42	2	2.09	3
Г16М unit (gyrodyne) with fasteners	355ГК.0020А76-0	1040	d635	-	1	120.53	4
МАГ-70 film case	-	-	d60	85	2	0.20	5
A-12 film case	-	-	d30	70	4	0.05	6
35 mm film case	-	-	d36	52	13	0.20	7
Cargo boom beam fragment	77КСТ.1220.01	-	d164	300	2	1.13	8
Food container (empty)	17КС.7860.200-01	380	305	123	37	37.00	9
"Vozdukh" system drying unit reversible valve	17К.8721-0				1	2.18	10
Cosmonaut Preference Kit	-	230	200	100	2	9.76	Various hardware
КАВ container (with condensate)	10360.6180.000		d82	193	2	0.76*	Scientific hardware
∑ MASS						**331.85A**	

Remark:

A - Total mass is based on the results of a weight check when transferring responsibility for cargo at KSC.

*** -** The mass of the КАВ container (10360.6180.000) is not considered in this table.

Russian cargo delivered on STS-79

Table 4.8

Description	Designation	Dimensions			Qty	Total Mass	Priority
		mm	mm	mm	ea.	kg	№
Bracelet article (NASA 3)	К17.00.000.00	170	110	60	1	0.14	1
Individual dosimeter, ИД-3М (NASA 3)	Хт2.805.602, IBMP-CPD-001	42	40	11	1	0.025	2
IELK (NASA 3)	115-9104-300	1060	550	400	1	34.10	3
Nitrogen purging unit	17КС.210Ю.1801-ОГУ	321	277	240	1	10.50	4
Food container (with food rations)	17КС.7860.200-01	380	305	123	37	238.53	5
Set of EDV containers	355ГК.0010А74-0	643	d334	d230	2	22.99	6
EDV cover assembly	11Ф615.8711-180А151		d330	105	12	41.00	7
EDV adapter	11Ф615.8711-100А15	140	60	d40.5	2	0.64	8
EDV fill indicator	11Ф615.8711-210А15-1	47	d19	-	2	0.023	9
Vacuum valve unit (БКВ)	17К.8711А-0	295	200	221	2	15.00	10
Personal Hygiene Aids (СЛГ)	Хт4.160.603	225	120	140	14	13.20	11
Personal Hygiene Aids (СЛГ-3)	Хт4.160.603-01	225	120	140	35	28.10	12
Personal Hygiene Aids (СЛГ-Д)	Хт4.160.603-06	220	120	140	10	3.45	13
Personal Hygiene Aids (СЛГ-Д)	Хт4.160.603-07	220	120	145	5	1.95	14
Penguin-3 suit	КН-9030-400	330	200	170	3	9.99	15
Kameliya-S athletic underwear	К19.00.000.00	330	230	40	20	6.72	16
Training loads harness (ТНК)	ТНК-У-1-1321_000	360	260	180	1	1.54	17
Athletic shoes (NASA 3)		340	140	100	1	0.82	18
CA-20M film case	-	385	d305	355	2	55.93	19
Storage Battery (800A)	ИКШЖ.563534.007	465	278	530	3	226.63	20
Current converter (ПТАБ-1)	ЕИГА.435.241.001-01ТУ	380	320	186	3	39.60	21
Penguin-3 suit	КН-9030-400	330	200	170	2	6.00	22
Soft bag (Cosmonaut Psychological Support Package)	11Ф615.Б11710-0А55	340	310	90	1	2.23	23
Soft bag (Cosmonaut Family Package)	11Ф615.Б11710-0А55	340	310	90	2	8.54	24
Letters	-				3	0.00	25
Г16-М unit (gyrodyne) with fasteners	355ГК.0020А76-0	1040	d635	-	1	122.40	26
∑ MASS						**890.05A**	
WATER transferred						**918.5**	
Oxygen						**42.0**	
Nitrogen						**12.5**	

Remark:

A - Total mass is based on the results of a weight check when transferring responsibility for cargo at KSC.

Russian cargo returned on STS-79

Table 4.9

Description	Designation	Dimensions			Qty	Total Mass	Priority
		mm	mm	mm	ea.	kg	№
Kentavr article (NASA 7)	К39.00.000.00	375	255	90	1	1.10	1
К1-ВКА-03 instrument with three РТ-ВКА instruments	ЯУ2.000.031	696	460	390	2	148.70	2
ПТС-250АТ-2 instrument	2АТ.949.098	290	255	135	2	10.00	3
2АОК1-ВКА instrument	ЯУ2.008.050	256	242	62	2	3.45	4
Air sampler - В (single-use)	-	259	114	102	6	3.77	5
Air sampler - ВД (extended use)	-	302	157	102	4	4.54	6
Air sampler - АК-1 (package with absorbent)	Хт4.160.007	150	50	10	3	0.30	7
Kvant-V system	ИЮ1.381.311	580	474	370	1	46.77	8
МАГ-70 film case	-	-	d60	85	2	0.41	9
А-12 film case	-	-	d30	70	2	0.00	10
35 mm film case	-	-	d36	52	11	0.20	11
Individual dosimeter ИД-3М	Хт2.805.602	42	40	11	2	0.23	12
СА-20М film case	-	385	d305	355	2	53.73	13
Komza cassette container	Фд.3.394.017-050	157	238	124	1	3.73	14
Food container (empty)	17КС.7860.200-01	380	305	123	35	29.27	15
Krater-V oven	У12.983.020	830	430	405	1	69.36	16
Krater-V control unit (ONIKS)	У12.390.305	342	246	172	1	5.64	17
Cosmonaut Preference Kit	-	230	200	100	2	2.91	18
БУ ДПО unit	77КСО.2310-0	220	220	155	2	6.77	19
ЛБ-1 unit	ИХ2.000.216	327	285	161	2	13.82	20
Gyrodyne attachment ring	355ГК.0020А76-101		d635	170.5	1	4.40	21
LIV video tape recorder	BVW-35P	348	296	140	1	6.63	22
Russian blood samples	-				4	0.23*	Scientific hardware
Orlan-DMA space suit cover-package	2АК-9000-6000-03 2АК-9803-300	1130	670	550	1	77.73*	Various hardware
∑ MASS						**415.73A**	

Remark:

A - Total mass is based on the results of a weight check when transferring responsibility for cargo at KSC.

***** - The mass of these items is not included in the total for this table. NASA transferred the blood samples and the Orlan-DMA space suit after the flight.

NASA 2 (Shannon Lucid) returned individual equipment

Table 4.10

Description	Designation	Dimensions			Qty	Total Mass	Priority
		mm	mm	mm	ea.	kg	№
Penguin-3 suit (NASA 2)	КН-9030-400	330	200	170	1	3.09	
“Forel” suit (NASA 2)	Г-9101-700	420	410	130	1	3.73	
“Sokol KV-2” space suit (NASA 2)	2АС-9000-1000	520	440	260	1	11.04	
∑ MASS						**17.86**	

Remark: NASA transferred all items after the flight.

Russian cargo delivered on STS-81

Table 4.11

Description	Designation	Dimensions			Qty	Total Mass	Priority
		mm	mm	mm	ea.	kg	№
Bracelet article (NASA 4)	К17.00.000.00	170	110	60	1	0.14	1
IELK (NASA 4)	115-9104-300	1060	550	400	1	34.80	2
Individual dosimeter ИД-3М (NASA 4)	Хт2.805.602, IBMP-CPD-001	42	40	11	1	0.05	3
Food container (with food rations)	17КС.7860.200-01	380	305	123	49	319.51	4
Set of EDV containers	355ГК.0010А74-0	643	d334	d230	2	22.97	5
EDV cover assembly	11Ф615.8711-180А151		d330	105	12	41.13	6
EDV adapter	11Ф615.8711-100А15	140	60	d40.5	2	0.45	7
EDV fill indicator	11Ф615.8711-210А15-1	47	d19	-	2	0.03	8
Personal Hygiene Aids (СЛГ)	Хт4.160.603	225	120	140	26	24.95	9
Personal Hygiene Aids (СЛГ-3)	Хт4.160.603-01	225	120	140	6	4.95	10
Personal Hygiene Aids (СЛГ-Д)	Хт4.160.603-06	220	120	140	27	9.22	11
Personal Hygiene Aids (СЛГ-Д)	Хт4.160.603-07	220	120	145	5	2.04	12
Penguin-3 suit	КН-9030-400	330	200	170	6	18.01	13
Kameliya-S athletic underwear	К19.00.000.00	330	230	40	35	11.53	14
Training loads harness (THK)	ТНК-У-1-1321_000	360	260	180	3	4.59	15
Athletic shoes	-	340	140	100	1	0.75	16
Sleeping bag СПМ-2МН	170-9061-00		d260	370	4	14.26	17
CA-20M film case	-	385	d305	355	2	57.48	18
Storage Battery (800A)	ИКШЖ.563534.007	465	278	530	3	227.95	19
Current converter (ПТАБ-1)	ЕИГА.435.241.001-01ТУ	380	320	186	2	32.55	20
Г16-М unit (gyrodyne) with fasteners (including the ring)	355ГК.0020А76-0	1040	d635	-	1	125.40	21
Soft bag (Cosmonaut Psychological Support Package)	11Ф615.Б11710-0А55	340	310	90	1	1.91	22
Soft bag (Cosmonaut Family Package)	11Ф615.Б11710-0А55	340	310	90	2	4.23	23
Komza cassette container	Фд.3.394.017-050	157	238	124	1	2.37	24
Letters	-				3	0.00	25
LiOH - CO2 scrubbers (USA)			d172,7	287	9	28.62*	26
Mir orbital complex external configuration training aid		304.8	228.6	25.4	1	1.14	27
ALICE adaptive frame	355ГК.0040А81-101				1	7.85	Temporary transfer
∑ MASS						**969.1 A**	
WATER transferred						**729.4**	
Oxygen						**26.2**	
Nitrogen						**19.1**	

Remark:

A - Total mass is based on the results of a weight check when transferring responsibility for cargo at KSC.

***** - The mass of the U.S. CO2 scrubbers (9 ea.) is not considered in the total mass of this table.

Russian cargo returned on STS-81

Table 4.12

Description	Designation	Dimensions			Qty	Total Mass	Priority
		mm	mm	mm	ea.	kg	№
Kentavr article (NASA 7)	К39.00.000.00	375	255	90	1	0.86	1
К1-ВКА-03 instrument with three РТ-ВКА instruments	ЯУ2.000.031	696	460	390	2	148.90	2
ПТС-250АТ-2 instrument	2АТ.949.098	290	255	135	2	10.66	3
2АОК1-ВКА instrument	ЯУ2.008.050	256	242	62	1	1.72	4
РТ-ВКА instrument	ЯУ2.998.054	114	96	30	1	0.27	5
КХ97-010М instrument	КХ2.517.000	448	334	130	1	10.76	6
Single-phase static converter (ПОС-80РН)	ИЖЕА.435.137.004	248	180	95.5	1	2.95	7
Signal transformer unit (БПС)	17КС.30Ю2311-0	359	185	284	1	8.04	8
Translation and attitude control unit (БУПО)	11Ф615.8372А55-0	306	285	275	1	9.58	9
БУ ДПО unit	77КСО.2310-0	220	220	155	2	6.95	10
СА-20М film case	-	385	d305	355	2	49.00	11
Optic and electronic unit (ALICE)	F/ALI/91/001-002	950	600	320	1	63.50	12
Container of “Antares” thermostats (ALICE)	F/FLI/91/003	540	430	300	1	27.00	13
Package of supplemental components (ALICE)	-		d250	80	1	1.18	14
AMPEX-733 video cassette	-	295	180	55	1	1.32	15
Removable cassette container СКК-9	Э10934-090-0	255	215	42	1	1.90	16
Removable cassette container СКК-10	Э10934-090-0	255	215	42	1	1.90	17
МАГ-70 film case	-	-	d60	85	1	0.09	18
А-12 film case	-	-	d30	70	2	0.04	19
35 mm film case	-	-	d36	52	15	0.32	20
Individual dosimeter ИД-3М (NASA 3)	Хт2.805.602	42	40	11	1	0.04	21
Pressure differential regulator (РПД)	17КС.21Ю.6086-0		d210	125.4	1	2.36	22
Vacuum pump	17К.8710-300	330	206	104	1	7.20	23
Vacuum valve unit (БВК)	17К.8711А-0	298	205	222	1	7.40	24
Food container (empty)	17КС.7860.200-01	380	305	123	34	31.90	25
Cosmonaut Preference Kit	-	230	200	100	2	3.50	26
Gyrodyne attachment ring	355ГК.0020А76-101		d635	170.5	1	5.40	27
КАВ 6180 container (atmospheric moisture condensate)	10360.6180.000	-	d82	193	4	1.59*	Scientific hardware
∑ MASS						**403.7A**	

Remark:

A - Total mass is based on the results of a weight check when transferring responsibility for cargo at KSC.

***** - The mass of the КАВ 6180 container is not considered in the total mass of this table.

NASA 3 (John Blaha) returned individual equipment

Table 4.13

Description	Designation	Dimensions			Qty	Total Mass	Priority
		mm	mm	mm	ea.	kg	№
IELK (NASA 3)	115-9104-300	1060	550	400	1	32.36	
Penguin-3 suit (NASA 3)	КН-9030-400	330	200	170	3	9.14	
Sleeping bag СПМ-2МН (NASA 3)	170-9061-00	370	d260	-	1	2.95	
∑ **MASS**						**44.45**	

Remark: NASA transferred all items after the flight.

Russian cargo delivered on STS-84

Table 4.14

Description	Designation	Dimensions			Qty	Total Mass	Priority
		mm	mm	mm	ea.	kg	№
Bracelet article	К17.00.000.00	170	110	60	1	0.09	1
IELK	115-9104-300	1060	550	400	1	34.00	2
Individual dosimeter ИД-3М	Хт2.805.602	42	40	11	1	0.045	3
Food container (with food rations)	17КС.7860.200-01	380	305	123	48	322.74	4
"Elektron-V" liquid unit with protective end caps	10134.5003.00.000 355ГК.0050 А84-0	1328	430	341	1	137.90	5
"Elektron-V" control unit	10134.4470.00.000	350	320	237	1	8.40	6
"Elektron-V" equipment package		220	180	80	1	1.40	7
"Vozdukh" equipment package		370	190	110	1	6.10	8
TCS equipment package			d400	230	1	8.77	9
Set of EDV containers	355ГК.0010А74-0	643	d334	d230	2	24.24	10
EDV cover assembly	11Ф615.8711-180А15-1		d330	105	12	41.40	11
EDV adapter	11Ф615.8711-100А15	140	60	d40.6	2	0.24	12
EDV fill indicator	11Ф615.8711-210А15-1		47	d19	2	0.08	13
Medical packages	Хт4.160.608-П4, Хт4.160.608-П5	225	145	75	2	0.46	14
Г16М unit (gyrodyne) with fasteners	355ГК.0020А76-0		1040	d635	1	125.00	15
Г15М unit	6АГ.369.641	465	310	306	1	25.15	16
Г16-5 unit	6АГ.369.835	571	300	200	1	21.00	17
Communications interface module (МСИ)	ХА3.035.122	250.5	150.5	85.5	1	3.35	18
Storage Battery (800А)	ИКШЖ.563534.007	465	278	530	3	227.62	19
Current converter (ПТАБ-1)	ЕИГА.435.241.001-01	380	320	186	1	13.17	20
Transmitter unit ША294	ИЮ2.017.289	585	395	140	1	19.20	21
Solid waste container (КТО)	А8-9060-500		453	d330	6	19.84	22
LiOH cartridges (USA)			d172.7	287	12	38.16	23
Personal Hygiene Aids (СЛГ)	Хт4.160.603	225	120	140	14	13.21	24
Personal Hygiene Aids (СЛГ-3)	Хт4.160.603-01	225	120	140	35	29.56	25
Personal Hygiene Aids (СЛГ-Д)	Хт4.160.603-06	220	120	140	10	3.41	26
Personal Hygiene Aids (СЛГ-Д)	Хт4.160.603-07	220	120	145	5	1.91	27
Penguin-3 suit	КН-9030-400	330	200	170	3	9.03	28
Kamelia-S athletic underwear	К19.00.000.00	330	230	40	35	11.67	29
Training Loads Harness (ТНК)	ТНК-У-1-1321_000	360	260	180	1	1.45	30
Athletic shoes		340	140	100	1	1.00	31
Sleeping bag СПМ-2МН	170-9061-00		d260	370	1	3.41	32
Package with absorbers for АК-1	Хт4.160.007	170	55	13	3	0.30	33
Package for solid-fuel oxygen generator (ТГК)	355ГК.0060А84-10 355ГК.0060А84-20		d250	300	1	1.96	34
Soft bag (Cosmonaut Psychological Support Package)	11Ф615.Б1710-0А55	340	310	90	1	5.22	35
Soft bag (Cosmonaut Family Package)	11Ф615.Б1710-0А55	340	310	90	2	10.67	36
∑ MASS						**1,171.16A**	
WATER transferred						**470.8**	
Oxygen						**22**	
Nitrogen						**18.5**	

Remark:

A - Total mass is based on the results of a weight check when transferring responsibility for cargo at KSC.

Russian cargo returned on STS-84

Table 4.15

Description	Designation	Dimensions			Qty	Total Mass	Priority
		mm	mm	mm	ea.	kg	№
Kentavr article	К39.00.000.00	375	255	90	1	0.55	1
К1-ВКА-35 instrument with three РТ-ВКА instruments	ЯУ2.000.036	696	460	390	1	74.45	2
К1-ВКА-03 instrument with one РТ-ВКА instrument	ЯУ2.000.031-03	696	460	390	1	71.55	3
ПТС-250АТ-2 instrument	2АТ.949.098	290	255	135	1	4.82	4
2Ф4-ВКА instrument	ЯУ3.468.011	214.5	124	42	2	2.18	5
"Elektron-V" liquid unit with protective end caps	10134.5003.00.000, 355ГК.0050 А84-0	1328	430	341	1	135.30	6
ЩА009 instrument	ИЮ2.007.016	280	80	170	1	2.40	7
Transmitter unit ЩА294	ИЮ2.017.289	585	395	140	3	57.90	8
СА-20М film case	-	385	d305	355	2	54.14	9
Digital User Exchange Unit (МОЦА-02)	ХА2.082.035	560.5	260.5	258.5	1	19.66	10
35mm film case	-		d36	52	6	0.18	11
AMPEX-733 cassettes	-	295	180	55	1	1.35	12
Individual dosimeter ИД-3М	Хт2.805.602	42	40	11	1	0.05	13
Filter FOA	10191.5274.000	230	d248		1	6.50	14
ЗПЛ-1 filter	10133.4029.000	300	309	342	2	30.90	15
Solid Fuel Oxygen Generator with package	6477.000	720	280	235	1	9.72	16
Package with absorbers for АК-1	Хт4.160.007	170	55	13	1	0.10	17
Gyrodyne attachment ring	355ГК.0020А76-101		d635	170.5	1	4.39	18
"Skorost" facility combustion chamber	17КС.70Ю.1001-0	360	218	124	1	1.90	19
3.5" diskette with "Astra-2" experiment	-	104	104	4.0	3	0.05	20
Condensate Water Recovery System (СРВ-К2) pipe	-	1700, 350	d30, d8		1	2.00	21
Cosmonaut Preference Kit	-	230	200	100	2	1.16	22
Acoustic guitar	РСТ РСФСР 83-72	940	340	110	1	1.69	23
Food container (empty)	17КС.7860.200-01	380	305	123	63	117.82	24
КАВ container (with condensate)	10360.6180.000		d82	193	2	0.91*	Scientific hardware
∑ MASS						**600.76A**	

Remark: *** -** The mass of the КАВ container (10360.6180.000) has not been considered in the total mass of this table.

A - Total mass is based on the results of a weight check when transferring responsibility for cargo at KSC

NASA 3 and NASA 4 (Jerry Linenger) returned individual equipment

Table 4.16

Description	Designation	Dimensions			Qty	Total Mass	Priority
		mm	mm	mm	ea.	kg	№
"Sokol KV-2" space suit, NASA 3 (John Blaha)	2AC-9000-1000	520	440	260	1	9.55	
"Sokol KV-2" space suit, NASA 4 (Jerry Linenger)	2AC-9000-1000	520	440	260	1	9.05	
Penguin-3 suit (NASA 4)	KH-9030-400	330	200	170	4	12.32	
Sleeping bag СПМ-2МН (NASA 4)	170-9061-00	370	d260	-	2	6.72	
Orlan-M space suit gloves	ГП- 10К-2-1060026	300	120	120	1 pair	1.14	
IELK cover (NASA 4)	115-9104-340				1	0.80	
Seat liner (NASA 4) from the IELK	ДМ.Л				1	4.90	
Light cargo (NASA 4) from the IELK	ДМ.Л				1	3.50	
∑ MASS						**47.98**	

Remark: NASA returned all items after the flight.

Russian cargo delivered on STS-86

Table 4.17

Description	Designation	Dimensions			Qty	Total Mass	Priority
		mm	mm	mm	ea.	kg	№
Bracelet article (NASA 6)	К17.00.000.00	170	110	60	1	0.15	1
IELK (NASA 6)	115-9104-300	1060	550	400	1	30.85	2
Individual dosimeter ИД-3М (NASA 6)	Хт2.805.602	42	40	11	1	0.025	3
Food container (with food rations)	17КС.7860.200-01	380	305	123	80	484.17	4
Air pressurization unit (БНП) (full)	11Ф732.Б1721-0А101	386	750	362	3	131.00	5
11М617-1 unit (ЦВУС-5)	ХА3.030.073	588	256	261	1	25.02	6
Set of EDV containers	355ГК.0010А74-0	643	d 334	d 230	1	11.15	7
EDV cover assembly	11Ф615.8711-180А15-1		d 330	105	6	20.35	8
EDV adapter	11Ф615.8711-100А15	140	60	d40.5	1	0.26	9
EDV fill indicator	11Ф615.8711-210А15-1	47	d 19		1	0.01	10
Solid waste container (КТО)	А8-9060-500	453	d 330		5	16.50	11
Vacuum valve unit (БВК)	17К.8711А-0	295	200	221	2	15.46	12
Г16М unit (gyrodyne) with fasteners	355ГК.0020А76-0	1040	d 635		1	122.58	13
Г15М unit	6АГ.369.641	456	340	306	1	25.20	14
Г16-5 unit	6АГ.369.835	571	300	200	1	20.70	15
Storage Battery (800А)	ИКШЖ.563534.007	465	278	530	9	682.25	16
Current converter (ПТАБ-1)	ЕИГА.435.241.001-01	380	320	186	2	26.58	17
Personal Hygiene Aids (СЛГ)	Хт4.160.603	225	120	140	25	23.47	18
Personal Hygiene Aids (СЛГ-3)	Хт4.160.603-01	225	120	140	40	33.74	19
Personal Hygiene Aids (СЛГ-Д)	Хт4.160.603-06	220	120	140	20	6.74	20
Personal Hygiene Aids (СЛГ-Д)	Хт4.160.603-07	220	120	145	5	1.85	21
Penguin-3 suit	КН-9030-400	330	200	170	5	16.07	22
Kameliya-S athletic underwear	К19.00.000.00	330	230	40	60	18.43	23
Training Loads Harness (ТНК)	ТНК-У-1-1321.000	360	260	180	1	1.51	24
Athletic shoes	-	340	140	100	1	0.81	25
Sleeping bag СПМ-2МН	170-9061-00		d 260	370	1	3.49	26
Operator restraints for repairing the solar array							
Base (with link rod)	Э77КСО-3157-520	600	460	235	2	8.50	27
Anchor	Э77КСО-3157-540	550	550	230	2	7.80	28
Rack	77КМ-3157-360	1350	500	60	2	1.79	29
Rod	Э77КСО-3157-550	996	132	40	2	3.60	30
Rack	Э77КСО-3157-300	270	d 100		2	1.09	31
Solar array repair parts:							
Beam	77КСО-5805-100	1280	470	400	1	18.31	32
Bracket (for Option № 2)	77КСО-5805-301	400	230	240	1	6.26	33
Mechanism for sealing the Solar array pod:							
Sealing cover with Mechanical Assembly and Accessories	-		d 800	581	1	66.40	34
Handle bar	77КСО-5806-300	760	155	135	1	2.80	35

Russian cargo delivered on STS-86 cont.

Table 4.17 cont.

Description	Designation	Dimensions			Qty	Total Mass	Priority
		mm	mm	mm	ea.	kg	№
Hull sealing equipment:							
Sealant Applicator	17КС.Б9640-0	620	420	230	4	44.54	36
Clamp	17КС.Б9329-5000	500	300	120	2	7.08	37
Package of flanges, 8 ea.	17КС.Б9329-5020	180	120	120	1	2.83	38
Package of flanges, 12 ea.	17КС.Б9329-5030	250	120	120	1	4.20	39
Clamp	17КС.Б9329-6000	300	260	250	2	5.63	40
Clamp	17КС.Б9329-7000	300	260	150	2	4.78	41
Brush	17КС.Б9329-240	375	140	50	2	0.83	42
Set of caps	17КС.Б9329-8000	300	210	300	1	6.60	43
Vacuum cleaner bags (USA)	SEG39123308-301				10	0.45	44
Soft bag (Cosmonaut Psychological Support Package)	11Ф615.Б1710-0А55	340	310	90	1	3.90	45
Soft bag (Cosmonaut Family Package)	11Ф615.Б1710-0А55	340	310	90	2	6.85	46
LiOH cartridges (USA)	-		d172.7	287	8	25.44	47
VHS video cassette with instructions for Spektr module repair	МГ-И	180	100	20	1	0.23	
Protective end caps with fasteners (for Elektron-V liquid unit)	355ГК.0050А84-50 355ГК.0050А84-20		d 353 d 380	71 155	1 1	6.45*	Temporary transfer
∑ MASS						**1,948.27A**	
WATER transferred						**780**	
Oxygen						**34**	
Nitrogen						**59**	

Remark:

***** - The mass of the protective end caps with fasteners (for the Elektron-V liquid unit) has not been considered in the total mass for this table.

A - Total mass is based on the results of a weight check when transferring responsibility for cargo at KSC.

Russian cargo returned on STS-86

Table 4.18

Description	Designation	Dimensions			Unit weight	Qty	Total weight	Priority
		mm	mm	mm	kg	ea.	kg	№
Kentavr article	К39.00.000.00	375	255	90	1.10	1	1.10	1
Instrument К1-ВКА-03 with one РТ-ВКА instrument	ЯУ2.000.031-03	696	460	390	69.50	1	71.50	2
2Ф4-ВКА instrument	ЯУ3.468.011	214.5	124	42	1.05	1	1.10	3
Sorbent set	ССК 0697	410	250	230	6.5	1	5.90	4
"Elektron-V" liquid unit with protective end caps	10134.5003.00.000, 355ГК.0050А84-0	1328	430	341	134.1	1	138.05	5
"Elektron-V" control unit	10134.4470.00.000	350	320	237	8.5	1	8.15	6
Fan	17К.8710-380	367	d 120		4.00	4	14.90	7
11М617-1 unit (ЦВУС-5)	ХА3.030.073	588	256	261	28.00	1	24.70	8
Vacuum valve unit (БВК)	17К.8711А-0	295	200	221	7.3	2	14.20	9
ЩА003 unit	ИЮ2.000.166	710	576	270	46.6	1	47.45	10
HI-8 video cassette	E5-90-HMEX	110	75	20	0.10	4	0.40	11
Individual dosimeter ИД-3М (NASA 5)	Хт2.805.602	42	40	11	0.05	1	0.025	12
Gyrodyne attachment ring	355ГК.0020А76-101		d635	170.5	5.40	1	4.45	13
Food container (empty)	17КС.7860.200-01	380	305	123	1.00	55	55.00	14
Cosmonaut Preference Kit	-	230	200	100	3.00	3	8.25	15
Science Hardware Platform ПНА-2	17КС.2482-0	820	300	150	10.62	1	9.55	16
Science Hardware Platform ПНА-3	17КС.2483-0	820	300	150	17.85	1	11.90	17
АК-1 sampler	Хт4.160.007	150	50	10	0.1	1	0.05	18
Package of condensate samples	11Ф615.8615-0А15	310	100	60	0.21	1	0.21	19
Betacam SP video cassette	BCT-30MA	175	115	31	0.31	9	2.95	20
∑ MASS							**419.6A**	

Remark:
A - Total mass is based on the results of a weight check when transferring responsibility for cargo at KSC.

NASA 5 (Michael Foale) returned individual equipment

Table 4.19

Description	Designation	Dimensions			Qty	Total Mass	Priority
		mm	mm	mm	ea.	kg	№
IELK (NASA 5)	115-9104-300	1060	550	400	1	34.00	
Penguin-3 suit (NASA 5)	КН-9030-400	330	200	170	**1**	3.00	
Sleeping bag СПМ-2МН (NASA 5)	170-9061-00	370	d260	-	1	3.41	
Training Loads Harness (THK) (NASA 5)	ТНК-У-1-21.000	360	260	180	1	1.45	
Athletic shoes (NASA 5)	-	340	140	100	1	1.00	
ПК-14 flight suit	2АГ-9004-1000				1	1.75	
Clothing	-				-	?	Not inventoried
Operator coveralls	К41.00.000.00				3	2.10	
Package ИЗОГ № 53	Хт2.787.001				1	0.50	
Box with personal hygiene kit (Komfort-1)	Хт6.875.057 Хт2.945.602				1	1.00	
∑ MASS						**48.21**	

Remark: NASA transferred all items after the flight.

Russian cargo delivered on STS-89

Table 4.20

Description	Designation	Dimensions			Qty	Total Mass	Priority
		mm	mm	mm	ea.	kg	№
Bracelet article (NASA 7)	К17.00.000.00	170	110	60	1	0.15	1
IELK (NASA 7)	115-9104-300	1060	550	400	1	31.14	2
Individual dosimeter ИД-3М	Хт2.805.602	42	40	11	1	0.025	3
Food container (w/joint food rations)	17КС.7860.200-01	380	305	123	77	453.15	4
Air pressurization unit (БНП) (full)	11Ф732.Б1721-0А101	368	750	362	2	86.40	5
Set of EDV containers	355ГК.0010А74-0	643	d334	d230	2	22.40	6
EDV cover assembly	11Ф615.8711-180А15-1		d330	105	12	40.75	7
EDV adapter	11Ф615.8711-100А15	140	60	d40.5	2	0.54	8
EDV fill indicator	11Ф615.8711-210А15-1	47	d19	-	2	0.03	9
Solid waste container (КТО)	А8-9060-500	453	d330	-	4	13.28	10
Air conditioning unit (БКВ-3) with protective cover	КВО.6705.00.000	615	625	855	1	82.35	11
Compressor unit (БКВ-3)	КВО.1565.000-01	350	d200	-	1	24.99	12
11М617-10 unit (ЦВУС-5)	ХА3.030.073	588	256	261	1	24.99	13
Central Exchange Module 11М617-2 (ЦМО) with 2 cables for the ЦМО	ХА3.031.104	250.5	275.5	158.5	1	9.44	14
Soft trash bag (КБО)	11Ф615.8715-0А15-01	310	310	100	10	8.35	15
Г16М unit (gyrodyne) with fasteners	355ГК.0020А76-0	1040	d635	-	1	125.00	16
Г15М unit	6АГ.369.641	456	340	306	1	25.00	17
Г16-5 unit	6АГ.369.835	571	300	200	1	20.75	18
Storage Battery (800А)	ИКШЖ.563534.007	465	278	530	4	304.80	19
Current converter (ПТАБ-1)	ЕИГА.435.241.001-01	380	320	186	3	40.22	20
Personal Hygiene Aids (СЛГ)	Хт4.160.603	225	120	140	25	23.44	21
Personal Hygiene Aids (СЛГ-3)	Хт4.160.603-01	225	120	140	60	50.39	22
Personal Hygiene Aids (СЛГ-Д)	Хт4.160.603-06	220	120	140	20	6.97	23
Personal Hygiene Aids (СЛГ-Д)	Хт4.160.603-07	220	120	145	5	2.11	24
Penguin-3 suit	КН-9030-400	330	200	170	5	14.72	25
Kameliya-S athletic suit	К19.00.000.00	330	230	40	60	19.55	26
Training Loads Harness (ТНК)	ТНК-У-1-1321.000	360	260	180	1	1.50	27
Athletic shoes	-	340	140	100	1	0.90	28
Sleeping bag СПМ-2МН	170-9061-00	-	d260	370	1	3.31	29
Soft bag (Cosmonaut Psychological Support Package)	11Ф615.Б1710-0А55	340	310	90	1	5.88	30
Soft bag (Cosmonaut Family Package)	11Ф615.Б1710-0А55	340	310	90	2	9.25	31
Г15М unit	6АГ.369.641	456	340	306	1	25.50	32
∑ MASS						**1,477.28A**	
WATER transferred						**732.5**	
Oxygen						**25.64**	
Nitrogen						**60.6**	

Remark:

A - Total mass is based on the results of a weight check when transferring responsibility for cargo at KSC.

Russian cargo returned on STS-89

Table 4.21

Description	Designation	Dimensions			Qty	Total Mass	Priority
		mm	mm	mm	ea.	kg	№
Kentavr article (NASA 6)	К39.00.000.00	375	255	90	1	1.10	1
Г16М unit (gyrodyne) with fasteners	355ГК.0020А76-0	1040	d635	-	1	125.80	2
КЛ106А synchronizer	ТЭ2.050.956	263	244	218	1	6.10	3
Solar array panel (МСБ) in transport container	17КС.5810-0; 11Ф615.Б1700-500А55.37	1370	700	390	1	44.55	4
МАГ-70 film case	-	-	d60	85	8	1.05	5
А-12 film case	-	-	d30	70	22	0.50	6
35mm film case	-	-	d36	52	32	1.10	7
Compressor unit (БКВ-3)	КВО.1565.000-01	350	d200	-	1	22.30	8
Central Exchange Module 11М617-2 (ЦМО)	ХА3.031.104	250.5	275.5	158.5	1	9.10	9
11М617-1 unit (ЦВУС-5)	ХА3.030.073	588	256	261	1	25.00	10
СКК-11 cassette	Э10934-090-0	225	215	42	1	1.80	11
Fan unit ВР-5	2АГ-7838-1000-02	130	240	170	1	2.15	12
“Platan-N” № 5 equipment	-	426	447	113	1	7.10	13
“Komplast” panel № 4	77КСД-7912-200	400	250	40	1	2.05	14
ИГЛА command processing unit (БОК)	37КЭ.2111-0	285	232	377	1	10.65	15
Individual dosimeter ИД-3М (NASA 6)	Хт2.805.602	42	40	11	1	0.05	16
AMPEX-733 video cassette	-	295	180	55	1	1.35	17
Food container (empty)	17КС.7860.200-01	380	305	123	5	5.10	18
Cosmonaut Preference Kit	-	340	310	90	3	12.97	19
Latch	77КСД-5361-200	90	75	60	1	0.45	20
Rod part	77КСД-5361-120	200	90	70	1	0.95	21
Bolt	-				1	0.00	22
Air conditioning unit (БКВ-3) protective cover	355ГК.0070А89-101	615	625	382	1	6.80	23
Condensate removal pump (НОК)	5033В	190	130	82	5	5.30	24
Betacam SP video cassette	ВСТ-30МА	175	115	31	14	4.00	25
HI-8 video cassette	E5-90HMEX	110	75	20	8	0.70	26
Parts					1	2.20	27
КАВ 6180 container (atmospheric moisture condensate)	10360.6180.000	-	d82	193	3	1.15*	Scientific hardware
∑ MASS						**300.220 A**	

Remark:

*** -** The mass of the КАВ 6180 container has not been considered in the total mass of this table.

A - Total mass is based on the results of a weight check when transferring responsibility for cargo at KSC.

NASA 6 (David Wolf) returned individual equipment

Table 4.22

Description	Designation	Dimensions			Qty	Total Mass	Priority
		mm	mm	mm	ea.	kg	№
IELK (NASA 6)	115-9104-300	1060	550	400	1	35.00	
Penguin-3 suit (NASA 6)	КН-9030-400	330	200	170	3	9.00	
Penguin-3 suit (*Mir* 24)	КН-9030-400	330	200	170	4	11.80	
Training Loads Harness (THK), (NASA 6)	ТНК-У-1-1321.000	360	260	180	1	1.4	
∑ MASS						**57.2**	

Remark: NASA transferred all items after the flight.

Russian cargo delivered on STS-91

Table 4.23

Description	Designation	Dimensions			Unit weight	Qty	Total weight	Priority
		mm	mm	mm	kg **T**	ea.	kg	№
Food container (with Russian food rations)	17КС.7860.200-01	380	305	123	7.00	40	271.42	1
Experimental food container (with Russian food rations)	17КС.260Ю 3200-0	380	305	123	7.00	3	19.76	2
Portable pressurization unit (БНП) (full)	11Ф732.Б1721-0А101	368	750	362	48.00	1	43.60	3
БНП pipe	17К.10292-520	-	d400	50	1.00	1	0.34	4
Set of EDV containers	355ГК.0010А74-0	643	d334	d230	11.50	2	23.55	5
EDV cover assembly	11Ф615.8711-180А151		d330	105	3.53	12	41.65	6
EDV adapter	11Ф615.8711-100А15	140	60	d40.5	0.28	2	0.60	7
EDV fill indicator	11Ф615.8711-210А15-1	47	d19	-	0.014	2	0.034	8
Solid water container (КТО)	А8-9060-500	453	d330	-	3.50	6	19.69	9
Soft trash bag (КБО)	11Ф615.8715-0А15-01	- (310)	d290 (310)	100	0.85	20	16.70	10
Г16-М unit (gyrodyne) with fasteners (including ring)	355ГК.0020А76-0	1040	d635	-	125.00	1	125.44	11
Г15М Unit	6АГ.369.641	465	340	306	25.50	1	25.14	12
Г16-5 Unit	6АГ.369.835	571	300	200	21.50	2	41.90	13
Storage Battery (800A)	ИКШЖ.563534.007	465	278	530	76.00	2	152.15	14
Current converter (ПТАБ-1)	ЕИГА.435.241.001-01ТУ	380	320	186	14.50	1	13.43	15
Personal Hygiene Aids (СЛГ)	Хт4.160.603	225	120	140	1.05	14	14.70	16
Personal Hygiene Aids (СЛГ-3)	Хт4.160.603-01	225	120	140	0.90	35	31.50	17
Personal Hygiene Aids (СЛГ-Д)	Хт4.160.603-06	220	120	140	0.45	10	4.50	18
Personal Hygiene Aids (СЛГ-Д)	Хт4.160.603-07	220	120	145	0.45	5	2.25	19
Biomagnistat	ЮГШИ.375523.002	400	d160	-	4.00	1	3.22	20
Heat insulated vacuum container (ТВК) (BIOKONT-T)	БТХ5.100.000	400	d170	-	2.50	1	2.30	21
ЯДРО-БАВ (NUCLEUS-BAS)	Хm4.160.667	200	100	70	2.50	1	2.13	22
РЕКОМБ-К (REKOMB-K)	БТХ4.100.000	150	100	100	0.50	2	1.32	23
“Biocorrosion” package	-	305	225	20	0.60	1	0.23	24
Diskette package (2 ea..) of the information system		104	104	10	0.05	1	0.05	25
Box with 3.5” diskettes, (7 diskettes)	-	104	104	40	0.19	1	0.23	26
Soft bag (Cosmonaut Psychological Support Package)	11Ф615.Б11710-0А55	340	310	90	2.7	1	2.74	27
Soft bag (Cosmonaut Family Package)	11Ф615.Б11710-0А55	340	310	90	5.00	2	10.73	28
Food container (with STS-89 food rations)	17КС.7860.200-01	380	305	123	7.00	5	29.62	29
Solid waste container (КТО)	А8-9060-500	453	d330	-	3.50	3	10.02	30
Personal Hygiene Aids (СЛГ-3) from STS-86	Хт4.160.603-01	225	120	140	0.90	20	16.87	31
Soft trash bag (КБО) from STS-89	11Ф615.8715-0А15-01	-	d290	100	0.85	10	8.35	32
∑ MASS						**209**	**936.164**	
WATER transferred					**41÷49**	**12.5 CWC**	**553.4**	
Oxygen							**24.3**	
Nitrogen							**65.7**	

Remark: **T** - Theoretical mass of a unit of hardware.

A - Total mass is based on the results of a weight check when transferring responsibility for cargo at KSC.

Note: Cosmonaut V. Ryumin delivered the Minolta Electronic Camera Diskette to *Mir* (0.02 kg).

Russian cargo returned on STS-91

Table 4.24

Description	Designation	Dimensions			Unit weight	Qty	Total weight	Priority
		mm	mm	mm	kg	ea.	kg	№
Kentavr article (NASA 7)	К39.00.000.00	375	255	90	1.10	1	1.10	1
Г16-М unit (gyrodyne) with fasteners	355ГК.0020А76-0	1040	d635	-	125.00	1	121.00	2
К1-ВКА-03 instruments with one РТ-ВКА instrument	ЯУ2.000.031-03	696	460	390	69.50	1	71.65	3
2Ф4-ВКА instrument № 5	ЯУ3.468.011	214.5	124	42	1.05	1	1.10	4
МОМС-2П power unit (БП)	М62.087.328	395	344	290	15.00	1	15.65	5
Gas analyzer control unit (БКГА)	37ГК.7881-0	515	273	220	8.50	1	9.55	6
Canon EOS 50E camera with attachments	-	150	90	50	2.12	1	2.15	7
Hasselblad camera with accessories (in a single package)	500 EL/M	350	270	250	6.00	1	4.15	8
35 mm film case	-	d36	52	-	0.04	4	0.125	9
Betacam SP video cassette	BCT-30MA	175	115	31	0.31	11	3.19	10
3.5’’ diskette	-	95	95	3	0.02	4	0.10	11
AMPEX-733 video cassette	-	295	180	55	1.35	6	6.80	12
Cassette with 35 mm film for the Minolta camera	-	d25	40	-	0.04	4	0.125	13
Package of cable samples	-	300	200	100	2.00	1	0.30	14
ЗПЛ-1 cartridge	10133.4029.000	300	309	342	16.0	1	14.20	15
ПКФ cartridge	5269.00.00	239	d128	-	2.40	1	1.65	16
Harmful contaminant filter (ФВП) cassette	6469.000	115	d394	-	8.00	1	10.80	17
P-16 dosimeter	Em2.805.000	307	164	121.5	2.50	1	3.05	18
Experimental food container (collapsed)	17КС.260Ю 3200-0	380	305	16	1.00	3	2.15	19
Biomagnistat	ЮГШИ.375523.002	400	d160	-	4.00	1	3.22	20
Heat insulated vacuum container (ТВК) (BIOKONT-T)	БТХ5.100.000	400	d170	-	2.5	1	2.27	21
ЯДРО-БАВ (NUCLEUS-BAS)	Хm4.160.667	200	100	70	2.5	1	2.13	22
РЕКОМБ-К (REKOMB-K)	БТХ4.100.000	150	100	100	0.50	2	1.32	23
“Biocorrosion” package	-	305	225	20	0.60	1	0.14	24
Individual dosimeter ИД-3М, (NASA 7)	Хт2.805.602	42	40	11	0.05	1	0.025	25
Cosmonaut Preference Kit	-	230	200	100	3.00	2	9.30	26
11М617-1 unit (ЦВУС-5)	ХА3.030.073	588	256	261	28.0	1	24.95	
Acoustic guitar	РСТ РСФСР 83-72	940	340	110		1	1.69	
Penguin-3 suit	КН-9030-400	330	200	170		2	5.90	
КАВ 6180 container (atmospheric moisture condensate)	10360.6180.000	-	d82	193	0.50	3	1.15*	Scientific hardware
Σ MASS							**319.785**	

Remark: - * The mass of the KAB 6180 container has not been included in the mass of this table.

NASA 7 (Andrew Thomas) returned individual equipment

Table 4.25

Description	Designation	Dimensions			Qty	Total Mass	Remark
		mm	mm	mm	ea.	kg	
IELK (NASA 7)	115-9104-300	1060	550	400	1	31.36	
Penguin-3 suit (NASA 7)	КН-9030-400	330	200	170	4	12.00	
Sleeping bag СПМ-2МН (NASA 7)	170-9061-00	370	d260	-	1	3.32	
Athletic shoes (NASA 7)	-	340	140	100	1	1.00	
Clothing	-				-	-	
ПК -14 flight suit	2АГ-9004-1000				1	1.14	
Operator coveralls	К41.00.000.00				3	3.64	
Eating utensils (NASA 7)					-	0.23	
∑ MASS						**51.69**	

Remark: All items transferred by NASA after the flight.

Summary of the mass of Russian logistics material components transported to *Mir* on the Shuttle

Table 4.26

Program	**“*Mir*-Shuttle”**	**“*Mir*-NASA”**								
Shuttle Flight №	STS-71	STS-74	STS-76	STS-79	STS-81	STS-84	STS-86	STS-89	STS-91	∑ mass for 9 flights
Total delivered including, kg:	695.29	723.19	1592.17	1861.65	1,743.80	1,688.56	2,820.50	2,296.02	1,578.46	14,999.64
•Russian logistical hardware	148.79	226.03	860.27	890.05	969.10	1,171.16	1,948.30	1,477.28	936.16	8,627.14
•water	485	450.36	684.9	920.60	729.4	470.8	778.5	732.5	553.4	5,805.46
•gases	61.5	46.8	47.0	51.0	45.3	46.6	93.7	86.24	88.9	567.04
Returned Russian hardware, kg	326.17	172.09	331.85	410.73	403.7	600.76	419.6	300.22	319.78	3,284.90

Remark: Under the “*Mir*-NASA” program:

1. A total of 14,304.35 kg were delivered, including:
   - Russian logistical hardware – 8,478.35 kg;
   - water – 5,320.46 kg;
   - gases – 505.54 kg

2. 2,958.73 kg of Russian hardware were returned.

4.3 Unique Features of *Mir*-Shuttle and *Mir*-NASA Orbiter Flights With Respect to Russian Cargo Accommodation

Under the above two programs the Orbiter was used to deliver various cargo in support of the joint flights. The layout of the Orbiter vehicles depended upon the primary objectives of the vehicle's flight to *Mir*. Therefore, the *Mir*-NASA Program utilized the SPACEHAB module and the *Mir*-Shuttle Program used the Spacelab module to deliver most of the cargo requiring pressurized stowage.

Both the SPACEHAB and the Spacelab modules were considered payloads (PL) rather than Shuttle components. Both were capable of carrying powered equipment connected to the onboard power supply and passive stowage kits. Russian equipment, with the exception of the Russian docking compartment, did not require power from the onboard power supply system. The SPACEHAB module was utilized in the *Mir*-NASA Program because it was more suitable for cargo accommodation. The pressurized SPACEHAB module housed most of the Russian cargo carried on the Orbiter.

The stowage areas in the crew compartment (mid-deck), airlock, docking compartment (Orbiter docking system, or ODS) designed for small articles or articles directly related to flight were utilized as authorized by NASA's Phase 1 Program Office.

Russian cargo received special attention in the course of Orbiter flight processing due to the fact that flights by the Shuttle to deliver cargo to the orbital facility were different from its typical flights. Russian cargo was divided into those that required hard-mounting and those that could be accommodated in stowage bags and lockers. In the process, late-load logistics were defined. Large items and hard-mounted hardware were installed aboard the Orbiter without the benefit of containers but rather to special attachment locations using interface adaptive hardware. Small items or kits were accommodated in standard stowage (lockers, flight bags of various sizes) available aboard the Shuttle.

A joint working group of U.S. and Russian experts was formed to manage the large variety of Russian and U.S. cargo and their accommodations on the Shuttle. The group also tracked U.S. hardware flown on Russian vehicles.

4.3.1 *Mir*-Shuttle Program

4.3.1.1 STS-71

During the STS-71 Shuttle flight, Russian cargo was accommodated in all the pressurized compartments suitable for hardware stowage, including the mid-deck (crew cabin), internal airlock, ODS, the Spacelab module located in the vehicle's payload bay.

Standard lockers and Volume D underneath the cabin floor were used as mid-deck accommodation. Special flight bags were utilized for cargo stowage in the internal airlock and the ODS.

Spacelab cargo accommodation consisted of flight bags attached to the ceiling and standard lockers installed in special racks. A vertical module loading technique was available for the late delivery items which, although not used during this mission, was utilized during subsequent flights to load the SPACEHAB module at the launch pad.

NASA developed a Spacelab-based rigid support of a special design to accommodate the return of a storage battery (Unit 800A).

4.3.2 *Mir*-NASA Program

4.3.2.1 STS-74

STS-74 delivered the Russian docking module (DM) with the two solar arrays, which was accommodated in the Shuttle's payload bay. The DM was installed to the ODS with the help of the remote manipulator system.

The bulk of the logistics was accommodated in special bags on the floor of the pressurized DM.

Some of the cargo was located in the mid-deck where standard lockers, Volume D under the cabin floor, and a special tray attached to the cabin floor were used as accommodations.

Special flight bags were employed to hold cargo in the internal airlock and the ODS.

4.3.2.2 STS-76

The unique feature of the STS-76 flight was the pressurized SPACEHAB single module installed in the vehicle's payload bay. This was the vehicle's first *Mir*-NASA flight with this module. Conscientious work on the part of Spacehab, Inc., the SPACEHAB contractor, and RSC-E experts assured efficient accommodation and attachment of Russian logistics.

A hard-mount design using a double rack was specially developed to carry large heavy items (in excess of 100 kg), such as the gyrodyne (Unit Г16M) and IELK, and was successfully utilized in every flight until the end of the *Mir*-NASA Program. This required the SPACEHAB contractor to modify the design of the double rack and RSC-E to manufacture an adapter (the gyrodyne fastening ring). A second double rack was modified to carry the IELK in a transfer bag, developed with the assistance of Russian specialists.

Special interface adapter plates were developed by the SPACEHAB contractor to accommodate three storage batteries (Unit 800A) on the SPACEHAB aft bulkhead.

It is worthy of note that a significant portion of the Russian cargo was installed using the MVAK at the launch pad (800A units, IELK - individual equipment and liner kit, food containers, etc.). In the past, many of these items were not loaded at the launch pad because of their weight. All the procedures for installing Russian cargo at the launch pad were developed by the SPACEHAB contractor in conjunction with RSC-E. The resulting experience in the vertical loading of the SPACEHAB module was subsequently utilized in the course of processing for every *Mir*-NASA flight.

Small portions of the Russian logistics (7 delivery and 6 return items) were accommodated in the mid-deck using standard stowage.

4.3.2.3 STS-79

Originally, the plan was to launch STS-79 on August 1, 1996. However, since it was necessary to replace the solid rocket boosters, the mission was postponed until mid-September 1996.

The unique feature of this flight was the use of the SPACEHAB double module located in the payload bay of this Orbiter vehicle. This was the first Shuttle flight utilizing the SPACEHAB double module configuration. The increased internal envelope of the SPACEHAB module allowed accommodation of a larger amount of cargo, including Russian hardware. The double SPACEHAB configuration was utilized in all subsequent missions except STS-91.

NASA had not planned to accommodate any Russian cargo in the mid-deck during STS-79. However, because of SPACEHAB mass limitations, such accommodation was allowed (3 delivery and 5 return items). These items were stowed in mid-deck lockers.

Furthermore, in the course of preflight processing there appeared some items requiring urgent delivery to *Mir* (nitrogen purge unit, vacuum valve units, and additional Penguin-3 suits), which called for late delivery. The nitrogen purge unit was filled with nitrogen under pressure and installed into the SPACEHAB module immediately prior to its rollout from the SPACEHAB Payload Processing Facility (SPPF).

4.3.2.4 STS-81

For the STS-81 flight almost all the Russian logistics were stowed in the pressurized SPACEHAB double module. A small portion of the cargo (4 delivery and 2 return items) was accommodated in the mid-deck. It is worthy of note that, unlike STS-79, this flight had a new nominal cargo accommodation in SPACEHAB. This new stowage location was on the module's rear section sub-floor. It enabled additional hard-mounted cargo to be accommodated and transported by the Orbiter. It should be noted that this flight used Energia-developed adapters launched by the Orbiter for the purpose of hard-mounting returning hardware (ALIS equipment).

4.3.2.5 STS-84

In this case, the SPACEHAB double module was again the Orbiter's primary location for cargo. The unique feature of this flight's stowage was the use of new attachment hardware on the center sub-floor panel and the aft bulkhead in the rear of the module. Thus, the SPACEHAB contractor modified the standard canoe tray design for stowage bags to a hard attachment design with tie-down straps to accommodate the Elektron-V liquid unit (134 kg) while Energia developed special Elektron-V caps suitable for use with the canoe's straps. These activities were performed in a quick time frame and late in the flight preparation final stage. Furthermore, the 800A unit attachment locations on the SPACEHAB's aft bulkhead were modified. The special design of these accommodations allowed their use for return cargo.

This flight returned more Russian cargo than any other flight (600.74-kg).

4.3.2.6 STS-86

The SPACEHAB module's loading flexibility allowing the stowage of large amounts of cargo at the launch pad assisted in delivering the most Russian hardware yet aboard this flight (1,948.27 kg).

The design of SPACEHAB's forward and aft bulkheads was specially modified for rigid attachment of nine storage batteries (Units 800A).

The peculiarity of this flight's processing was the fact that a significant part of the Russian logistics was delivered to KSC less than a month prior to launch because of the real-time developments aboard the station related to collision of the Progress cargo vehicle and the Spektr module. This flight carried 17 items of repair hardware (approximately 170 kg) in support of Spektr repair and recovery. A part of this hardware was stowed in the SPACEHAB double module while another part was placed in the ODS stowage bag.

In addition, at L-4 days an agreement was reached to deliver a *Mir* onboard computer (Unit 11M617-1). This item was stowed across two battery top plates on the SPACEHAB aft bulkhead two days prior to launch.

4.3.2.7 STS-89

This flight's primary stowage location was the SPACEHAB double module. Like STS-84 and STS-86 this flight utilized stowage locations in the rear of the module on the center and outer subfloor panels, the aft and the forward bulkheads and port and starboard racks. For example, two portable air pressurization units (APU) were located on the outer subfloor panels while the BKV-3 air conditioning unit was stowed in the canoe attached to the center subfloor panel. These items were secured with straps. The BKV-3 was equipped with a special Energia-developed cover for protection against the effect of the straps. The 800A units were installed in the modified stowage locations on the aft bulkhead. Special fasteners were designed for the SPACEHAB battery top plates to hold soft stowage bags which contained solid waste containers. This freed up additional volume used to stow other hardware. A part of the cargo (e.g., the Salyut-5 central computer) was located in the crew cabin mid-deck in flight bags.

For the first time, hardware was removed and replaced with other hardware during MVAK operations. The full, pressurized APU was removed from SPACEHAB's subfloor and replaced by BKV-3, which is the largest (615 x 625 x 855 mm) and heaviest (82.35 kg) item ever to have been installed at the launch pad.

4.3.2.8 STS-91

The final *Mir*-NASA Orbiter flight (STS-91) utilized a SPACEHAB single module for Russian logistics stowage. Inside the SPACEHAB module, Russian logistics were accommodated in double racks, on the forward and the aft bulkheads. In addition, some of the biotechnology experiment hardware (Biomagnistat, BIOKONT-T, YADRO-BAV, and REKOMB-K) was installed in the mid-deck several hours before launch due to shelf-life limitations.

4.3.3 Conclusion

In conclusion, it must be noted that throughout the *Mir*-Shuttle and the *Mir*-NASA Programs, each flight was used to develop and verify new stowage capabilities for Russian cargo, new attachment designs, to acquire experience in the vertical launch-pad loading of large and heavy equipment and cooperation between U.S. and Russian experts in the course of pre-flight Orbiter processing.

4.4 Principal Stages of Orbiter Processing for Carrying Russian Logistics

The implementation of the *Mir*-Shuttle/*Mir*-NASA Programs has seen both U.S. and Russian experts working together in the processing of nine Orbiter vehicles (STS-71, -74, -76, -79, -81, -84, -86, -89, -91) delivering Russian logistics to the *Mir* station.

4.4.1 Joint Documents

The WG-0/RSC E/NASA/0005 joint requirements document ("Mission Schedules and Cargo Traffic Plan") was developed in support of *Mir*-Shuttle/*Mir*-NASA Program implementation. This document showed the *Mir* station and Russian and U.S. vehicle flight schedules as defined in the *Mir*-Shuttle/*Mir*-NASA Programs. In addition, the 0005 document contained *Mir* traffic data. The appendices to this document showed integrated flight schedules and lists of cargo for delivery to and return from *Mir*.

Furthermore, another requirements document was developed for the *Mir*-NASA Program (WG-0/RSC E/NASA/0006, Catalog of Functional Cargo Transported by the Orbiter under the *Mir*-NASA Program). The data in the document were for use by RSC-E and NASA when planning and executing *Mir*-NASA flights. The document described cargo items for transfer between the Shuttle and the *Mir* orbital facility as well as the relevant requisite documents. This document is an official joint agreement with regard to operations with these cargo items both on the ground and in-flight defining also the hardware required to carry Russian items including interfaces.

It also described the procedures and the equipment required to implement the transfer and the data to be exchanged by RSC-E and NASA to support assessments and decisions relative to these operations. In addition, this document contained data with regard to the environment in the Orbiter's pressurized volume including contingency environmental parameters.

As the data of the flight schedule and Shuttle cargo complement changed for each flight, both documents went through a number of planned updates (L-6 months, L-3 months, L-1 month, preflight, and postflight versions).

As prescribed by the 0005 and 0006 requirements documents which list the cargo items to be transported to *Mir* by the Orbiter, flight-by-flight joint engineering documents were developed under the *Mir*-Shuttle/*Mir*-NASA Programs:

WG-3/RSC E/NASA/3411-1, Delivery and Return of Russian Payloads Aboard STS-71;

WG-3/RSC E/NASA/3413-2, Transportation of Russian Payloads Aboard STS-74;

ICD-SH/RL/M03 (M04-M09), SPACEHAB/Russian Logistics. Interface Control Document [ICD] (for STS-76, -79, -81, -84, -86, -89, -91).

These documents defined all the interfaces between the support structure of the Orbiter's pressurized volumes as well as the Spacelab/SPACEHAB modules and the Russian logistics transported in each of the Orbiter's nine flights depending on the specific cargo stowage location. Furthermore, these documents defined the requirements and the responsibilities of the parties relative to ground operations and payload integration. These joint documents served as the primary reference for Russian logistics operations at the Space Station Processing Facility (SSPF), the SPPF, and when installing part of the cargo at the launch pad at KSC.

All the documents were developed and coordinated prior to each of the nine flights as per the Phase 1 management plan for the joint effort of Russian and U.S. experts.

Following each Shuttle flight, the working group supporting Russian logistics processing for flight prepared a joint technical report. The report reflected all the sequential processing stages and the results of the completed flight.

4.4.2 Preflight Operations

4.4.2.1 Delivery lead times for cargo and hardware items to be installed aboard the Orbiter under the *Mir*-NASA Program were based on the requirements below:

- RSC-E informed NASA 10 to 6 months prior to launch of any request to transport large and heavy cargo (exceeding 80 kg) requiring rigid attachment.
- Large cargo items weighing in excess of 80 kg would be delivered to KSC at 6 to 4 months prior to Orbiter launch.

4.4.2.2 In the course of the *Mir*-NASA Program implementation, there were exceptions to the jointly agreed to requirements and constraints in the over 80 kg cargo category.

In the course of STS-84 processing, 1.5 months prior to launch, the program managers agreed to deliver hardware for the Elektron-V system to repair failed equipment. Considering the fact that one of the Elektron-V units was large (1,328 x 430 x 341 mm) and heavy (design mass of 117 kg) and was supposed to come as a late delivery, a decision was made to simulate its vertical SPACEHAB loading and installation. To support the implementation of this decision, RSC-E shipped a mock-up of the Elektron liquid unit to KSC.

RSC E, SPACEHAB/Boeing, and KSC experts simulated the unit's vertical loading, modified the framing and the caps, performed mechanical testing and agreed to the flight attachment setup.

The simulation served to verify the basic feasibility of MVAK loading of the flight unit into the Orbiter.

The Elektron-V flight article was delivered at L-1 month. The delivered weight with the end caps of 137.9 kg far exceeded the design mass. This caused the vertical loading of the flight unit to be impractical for reasons of lifting equipment maximum load constraint (up to 123 kg). The unit was installed with the SPACEHAB module horizontal, resulting in a delay to the SPACEHAB rollout from the SPPF for integration with the Orbiter at KSC.

In the course of STS-89 processing, less than 1 month prior to launch, the program managers agreed to deliver an air conditioning unit (BKV-3) to replace failed equipment aboard the station.

BKV-3 was delivered two weeks before the Shuttle launch. The mass of the unit was 82.35 kg.

Spacehab, Inc. made a BKV protective cover and a BKV mockup available for simulation.

BKV was installed in the location of one of the three portable APU located in the canoe in the middle of the subfloor of SPACEHAB's rear section. The operation to replace the pressurized APU with the BKV-3 was performed at the launch pad 5 days before launch with the Orbiter vertical.

Cargoes under 80 kg as well as soft and small articles (clothing, small tools and assemblies) were delivered to KSC at L-3 months to L-1 month.

4.4.2.3 In the course of the *Mir*-NASA Program implementation there were exceptions to the jointly agreed to requirements and constraints in the under 80 kg cargo category.

Decisions with regard to cargo delivery by the Orbiter (with late shipment to KSC) were made by the Phase 1 program management under extraordinary circumstances created by the real-time developments aboard *Mir* or other reasons of importance to the *Mir*-Shuttle/*Mir*-NASA Programs.

In the course of STS-71 processing, the following items were delivered less than a month prior to launch: sealing kits, cutting tool (EVA) and additional onboard station crew procedures (*Mir*-19). All of the above items were stowed several days before launch.

In the course of STS-74 processing, RSC-E representatives delivered a set of adapters for U.S.-made CO_2 absorbers at L-3 days. Additionally, the U.S. manufactured two kits of adapters of its own to ensure that the U.S. CO_2 absorbers would be used aboard *Mir* when delivered by the Orbiter. The U.S. and Russian adapter kits were installed in the mid-deck immediately prior to launch.

In the course of STS-76 processing, the Analysis-3 kit with hose was delivered at L-2 weeks for urgent delivery to *Mir* to support atmospheric station monitoring following Priroda docking. These items were stowed in mid-deck lockers.

In the course of STS-79 processing, two vacuum valve units (BVK), nitrogen purge unit (BPA), and two Penguin-3 suits were delivered at L-2 weeks for urgent delivery to *Mir*. BVK were delivered to *Mir* to replace failed valves while BPA was designed to support nominal atmosphere aboard the station.

In the course of STS-84 processing, the ША294 transmitter was submitted less than a month prior to launch for urgent delivery to the station to replace failed equipment. At L-3 days environmental monitoring hardware was delivered (hardware kits for Elektron-V, Vozdukh, TCS) as well as medical kits.

In the course of STS-86 processing, 17 items of repair equipment (total mass approximately 170 kg) were delivered at L-2 weeks in support of Spektr repair and recovery operations. Simulations were run of repair hardware integration in SPACEHAB and ODS flight bags. Three items of a hardware five-item set were stowed in the ODS.

At L-3 days, the onboard computer (Device 11M617) and a VHS tape containing Spektr repair instructions were delivered for integration aboard the Orbiter.

In the course of STS-89 processing, a compressor unit (BKV) and a central exchange module (ЦМО) were delivered at L-2 weeks for urgent delivery to the *Mir* station for failed equipment repair.

At L-5 days, an onboard computer (Device 11M617) was handed over to replenish the onboard store of spares.

In the course of STS-91 processing, biological experiment hardware was delivered several days prior to launch as well as a kit containing 3.5" diskettes for the computer system. All the hardware was installed in the Orbiter mid-deck.

Limited-life cargo (food and certain hygiene items) were delivered to KSC at L-1 month. At this time, Russian cargo was turned over to KSC personnel for integration. This did not include a time allowance for special operations in the course of the handover. The requirement for special operations, such as checkout, testing, or assembly dictated an earlier delivery date and was specified on a case-by-case basis.

4.4.2.4 Russian Hardware Requiring Special Processing Prior to Shuttle Integration (With the Exception of the Russian Docking Compartment Not Considered for the Purposes of This List):

- Unit Г16M (gyrodyne): required checkout, testing, and assembly to the fastening ring (adapter). (STS-76, -79, -81, -84, -86, -89, -91 processing)

- Units Г15M, Г16-5: required checkout and testing. (STS-84, -86, -89, -91. During STS-86 processing, one Unit Г16-5 failed to be certified for flight following testing)

- Water containers (EDVs): required assembly of six EDV housings into a single set to save volume on the Orbiter. (STS-76, -79, -81, -84, -86, -89, -91 processing)

- Incubator 1M Control and Monitoring Module: required water servicing and leak check (STS-76 processing).

- Nitrogen purge unit: required checkout, testing, and nitrogen pressure charging (STS-79 processing).

- ALIS Adapter: required interface compatibility checkout to support ALIS hardware safe return (STS-81 processing).

- Elektron-V liquid unit: required checkout, installation of end caps, and SPACEHAB integration simulation (STS-84 processing).

- Portable APU: required checkout, testing, and air pressure charging (STS-86, -89, -91; prior to STS-91 the APU was charged with nitrogen rather than air).

- Spektr repair equipment: required checkout, partial assembly, and installation simulation (STS-86 processing).

- Air conditioning unit (BKV-3): required checkout, installation of protective cover, and installation simulation (STS-89 processing).

- Compressor unit (BKV-3): required checkout (STS-89 processing).

- Biotechnology hardware (Biomagnistat, BIOKONT-T, YADRO-BAV, and REKOMB-K): required checkout, diagnostic testing (STS-91 processing).

The above items underwent ground processing based on special procedures. All the other equipment underwent such operations as are prescribed by the 0006 document as well as simulation of flight kits in the SPACEHAB module and the mid-deck.

The transport containers with RSC-E hardware for a specific Shuttle flight were delivered under a special customs clearance by a freight carrier acting for RSC-E. Following delivery into the U.S., the containers were brought to KSC, the Space Station Processing Facility (SSPF, or the SPPF). NASA provided storage and assembly space for the Russian cargo as specified in requirements listed in joint documents until such cargo was formally handed over (inspected) and integrated on the Orbiter. All the Russian cargo was stored in their transportation containers.

RSC-E deliveries included:

- a set of Russian logistics for a specific Orbiter launch;

- a set of auxiliary hardware for a specific Orbiter launch to attach the Russian logistics on the Shuttle;

- a set of ground support equipment designed for Russian cargo checkout, testing, and simulation;

- containers for Russian primary and auxiliary equipment carriage;

- containers for ground support equipment.

Ground hardware including handling tools, was delivered by RSC-E to KSC at the same time as the flight hardware.

NASA provided the following equipment:

- a set of ground support equipment designed for Russian cargo checkout, testing, and simulation;

- ground support equipment for Russian cargo integration and de-integration;

- support structure for Russian cargo in the Orbiter crew compartment;

- support structure for Russian cargo in the SPACEHAB and the Spacelab modules;

- Orbiter flight cargo stowage facilities (containers, stowage bags, etc.).

In the course of preflight processing, NASA photographed the hardware being handed over as well as the assembly of the U.S.-Russian interfaces. Copies of photographic data were made available to RSC-E.

NASA and RSC-E representatives performed visual inspection, measurement and weighing of cargo immediately after each separate portion of the cargo was removed from the transportation container. This verification served to confirm that the Russian cargo items had not been damaged in transit and are in compliance with the data listed in the joint working documents. Following visual inspection, NASA representatives filled out the transfer-of-responsibility form for the Russian cargo and took over the responsibility for each individual item of hardware.

The installation and stowage of Russian logistics aboard the Orbiter was performed by NASA experts based on the Shuttle schedule and the NASA documents respecting the integration and stowage of Russian logistics taking account of the requirements and constraints levied by RSC-E. SPACEHAB/Boeing personnel performed the installation and stowage of Russian cargo in the SPACEHAB module. NASA supplied all the fasteners, gaskets, and attachment and stowage tools required to integrate Russian logistics on the Orbiter. NASA provided detailed documentation with regard to Russian cargo integration to RSC-E representatives prior to these operations.

Throughout the *Mir*-NASA Program, RSC-E representatives received maximum access to monitoring Russian cargo processing, transportation, and final Orbiter stowage operations.

4.4.3 Joint Shuttle-*Mir* Mission Operations

As prescribed by distribution of responsibility agreements, the U.S. side was responsible for the special handling devices and de-integration tools in support of the removal of the Russian logistics from their stowage locations on the Orbiter as well as for their transfer to the *Mir* interface. The Russian side was responsible for the special handling devices and de-integration tools in support of the removal of the Russian logistics from their stowage locations on *Mir* as well as for their transfer to the Orbiter interface.

Mir-NASA program management was responsible for the transfer of hardware shown in jointly agreed to lists. MCC-H and MCC-M supplied NASA Phase 1 management with data to develop the transfer plan, including all measures and documents with regard to the transfer of the hardware shown in jointly agreed-to lists. The U.S. side was responsible for the cargo and operations aboard the Shuttle vehicle. The Russian side was responsible for the cargo on operations aboard the *Mir* station. Shuttle astronauts and *Mir* cosmonauts performed cargo transfer.

The accessories and tools for in-flight Russian cargo operations aboard *Mir* (including nominal installation) were provided by RSC-E. NASA supplied fasteners as well as any tools required to secure Russian cargo aboard the Orbiter.

NASA developed mechanical interfaces between Russian cargo and auxiliary hardware and the Orbiter structure taking into account the RSC-E requirements and recommendations for every specific Shuttle flight to *Mir*. The mechanical interfaces were defined in joint working documents 3411, 3413, or ICD.

A specially trained cosmonaut was responsible for the operations and procedures related to the transfer of Russian cargo from the *Mir* station to the vicinity of the Shuttle/*Mir* interface. Similarly, a specially trained U.S. astronaut was responsible for all operations related to the movement of this cargo from the above vicinity into the Orbiter and its stowage. NASA developed procedures for the transfer of Russian cargo from the Shuttle/*Mir* interface into the Shuttle. NASA also developed procedures for the stowage of the above cargo. Similarly, RSC-E developed all the procedures for the removal of the Russian cargo from the *Mir* station for transfer to the Orbiter.

The Orbiter crew recorded all cargo transferred to and from *Mir* in a log. This log contained information from the WG-0/RSC E/NASA/0005 joint document with regard to the cargo traffic plan. Also, data were available with respect to the location of the hardware to be transferred both on the Shuttle and *Mir*. One of the crew members made entries in the log showing the date and time of hardware transfer. At the end of each flight day, the Shuttle and *Mir* crews reported to the ground on work accomplished. Copies of the daily transfer log were sent to MCC-H and MCC-M. Transfer items were added to and updated as coordinated by the two Mission Control Centers.

An exchange of information on the preflight traffic planning and participation by working group membership in mission control operations proved a significant help to both the Mission Control Centers in monitoring and completing cargo transfer operations between the *Mir* station and the Orbiter vehicle during each joint flight.

4.4.4 Postflight Operations

Postflight operations related to Russian logistics were performed at KSC. If the Orbiter vehicle landed in another location (STS-76 landed in California), Russian cargo remained aboard the Shuttle until its delivery to KSC.

NASA developed a procedure for the removal of Russian cargo from the Shuttle. RSC-E, in turn, developed special instructions and constraints to these operations. NASA was responsible for complying with these requirements. RSC-E informed NASA one month prior to Orbiter launch of those return items that needed to be de-integrated from the vehicle earlier than the time specified in the joint agreements.

NASA provided the ground-support equipment required at KSC to de-integrate Russian logistics from the Shuttle. RSC-E supplied handling devices, as needed, for the stowage of the cargo in question in transportation containers. In the course of handling, measures were taken to prevent falls, impacts, or other incidents leading to damage.

RSC-E provided transportation containers for the return of Russian cargo to Russia following flight completion. RSC-E took delivery of its hardware at KSC. The RSC-E carrier arranged for the transportation of Russian cargo to the airport of departure for Russia. NASA informed the RSC-E carrier of cargo readiness for transportation. Transportation containers designed to carry Russian return cargo with the auxiliary hardware were shipped to KSC in advance.

NASA was responsible for the removal of Russian cargo from the Orbiter following its landing taking into account the requirements and constraints coordinated with RSC-E. NASA and RSC-E took an inventory of the return Russian cargo as required by the procedure for the official transfer of responsibility for the cargo to RSC-E. Any discrepancies discovered in the course of inventory taking were recorded. Any problems arising in connection with the inventory taken by NASA were resolved in conjunction with RSC-E and joint decisions were made prior to the transfer of responsibility.

The sequence of operations for the shipment of Russian cargo from KSC to RSC-E following a Shuttle landing is shown below.

1. NASA completed Shuttle off-loading and payload inventory based on the down cargo list.

Item 1 + 3 weeks

2. NASA and RSC-E prepared a transfer of responsibility document whereupon NASA transferred the payload to RSC-E representatives.

Item 1 + 2 days (Landing + 3 weeks + 2 days)

3. In the presence of NASA personnel, RSC-E packed all the payloads into containers using its own packaging material and NASA-provided material as required.

Item 2 + 4 days (Landing + 3 weeks + 2 days + 4 days)

4. RSC-E arranged for the insurance and air transportation of payload containers and supplied NASA with the information appropriate for the processing of customs documents.

5. Simultaneously with activities in Paragraph 3, NASA prepared paperwork for customs clearance.

6. NASA notified the RSC-E carrier responsible for the delivery of payload containers from KSC to the airport of departure that the cargo was ready to ship. The carrier delivered the transportation containers with payloads from KSC into customs, cleared cargo through customs, and delivered them to the airport for shipment to Russia (RSC-E).

Item 3 + 3 days (Landing + 3 weeks + 2 days + 4 days + 3 days)

Documentation required to carry Russian cargo to RSC-E was issued by NASA. NASA assured completion of all customs formalities in the U.S. RSA/RSC-E assured completion of all customs formalities in Russia.

4.5 Parties' Primary Accomplishments Under *Mir*-Shuttle/*Mir*-NASA Programs

1. The coordinated effort by the Joint Manifest Working Group under time critical conditions to the stowage of late items for delivery aboard the Orbiter.

2. A completely up-to-date set of engineering documents on cargo traffic (i.e. Document 0005, Document 0006, ICD).

3. The accommodation of large hardware items in the Shuttle mid-deck and SPACEHAB module: Elektron-V for STS-84 and Spektr repair hardware for STS-86, etc.

4. The expedited delivery of critical hardware to *Mir*.

5. Utilization of the U.S. cargo traffic database to generate joint documents.

6. The coordination and implementation of a very effective Orbiter stowage schedule for all limited-life Russian logistics.

7. The rapid (2 days) and efficient transfer of 4.5 tons of cargo to and from *Mir* using *Mir* and STS-86 crew.

8. The use by *Mir* of potable and technical water produced from the water generated by the Orbiter's power supply system.

9. The return of vehicle components (KURS, TORU, and Elektron-V) and gyrodynes by the Orbiter from *Mir* for reuse.

10. The accomplishment of the planned cargo traffic supply by Shuttle to *Mir* was achieved ahead of time (by the 8th mission).

11. The delivery of the large DM by the Orbiter and its docking with the *Mir* station.

12. Successful transfer of the electronic database during flight allowing real-time manifest updates by the Russian side.

13. In the course of the transfer of responsibility for the Russian logistics, SPACEHAB/Boeing and Russian experts utilized an efficient method allowing rapid return of cargo to Russia and delivery of hardware for flight. Making operations space available to the customer at the SPPF furthered the success of this process.

14. The familiarization with Russian cargo items by U.S. experts and the familiarization of Russian experts with the SPACEHAB module and Shuttle mid-deck stowage capability assisted in successful cargo traffic planning.

15. The cooperation on the part of SPACEHAB in developing and modifying interface hardware (such as modifications to the canoe, battery adapter plates, etc.), especially immediately prior to launch ensured successful accommodation of large, late manifested items.

16. The successful operations utilizing the module vertical access kit (MVAK) to load late-manifested Russian items.

17. For timely delivery of Russian cargo, the SPACEHAB Projects Group was required to obtain detailed knowledge of the cargo customs clearance and international transportation regulations.

18. To comply with Russian cargo requirements (e.g., with regard to the portable APUs, regular carriage of biotechnology hardware falling under the heading of hazardous cargo) PGOC and flight crew equipment lab personnel worked in close contact with the Joint Manifest and Schedules Working Group.

19. The information contained in the Russian Logistics Catalog (Document 0006) allowed experts to perform expedited assessments of Russian logistics accommodation and served as basis for the development of requirements levied against the complement, the dimensions, mass and ground handling operations.

20. Continuity of the Joint Manifest Schedules and Working Group membership throughout the *Mir*-NASA Program (i. e. use of the same experts for all the flights) fostered a working relationship and a free exchange of information allowing close contact and a high degree of trust and cooperation among group members. It allowed for timely solution of seemingly insurmountable problems and excluded unproductive use of work time.

21. During STS-89, for the first time, replacement of large Russian cargo was performed in SPACEHAB at the launch pad (an APU was replaced with the BKV-3 air conditioner) with the BKV-3 mass of 82.35 kg, the heaviest ever.

STS-79 astronaut Tom Akers performs an inventory of items to be transferred to the *Mir*

Mission Control Center - Moscow

Mission Control Center - Houston