

AS BUILT Documentation K 70101 Tank Farm Košice

Chapter 2.2 Plant description with flow diagram

- Process Description
 - Process Flow Diagram
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-

Process Description

Air Compression and Purification

Process Air is cleaned from dust and other particles in an air filter and then compressed to the required process pressure by a multi-stage centrifugal air compressor. The compressed air is cooled against cooling water and chilled water in a 2-stage direct contact cooler.

Then the air passes through a molecular sieve adsorber unit consisting of two cyclic operating adsorber vessels filled with two layers of activated alumina and molecular sieve material. Process air passes through one of the adsorbers where water, carbon dioxide and most of the hydrocarbons are removed from the air stream. Concurrently, the other adsorber is regenerated by dry waste nitrogen from the air separation unit. The regeneration gas is heated to improve and accelerate the desorption process. Before switching the regenerated bed to adsorption it is cooled to operating temperature by waste nitrogen.

Part of the dry and CO₂-free air is withdrawn as instrument air downstream the adsorber.

Liquefier and Internal Compression

The equipment arrangement of booster air compressor, expander driven compressors and main heat exchanger serves a dual purpose, as an air liquefier and for internal compression. The booster air compressor is used for both duties, liquefaction and internal compression.

After the adsorber unit the dry and CO₂ free air is split into two streams. The first portion is flowing straight to the main heat exchanger. The remaining air is compressed further in a booster air compressor and also fed to the main heat exchanger.

Main Heat Exchanger

One portion of the dry air (hereafter called "main air") passes directly to the main heat exchanger where it is cooled close to saturation against product streams leaving the heat exchanger and fed into the high pressure (HP) column.

The remaining process air having been compressed further in the booster air compressor (BAC) is cooled close to ambient temperature in a shell-and-tube after-cooler and thereafter cooled down in the main heat exchanger. A side-stream is withdrawn at the mid-point of the heat exchanger and expanded in two turbines operating in parallel. The expanded air is blended with main air from the cold-end outlet of the main heat exchanger. The remaining booster air is further cooled down and after the main heat exchanger reduced to HP column pressure. One part of this liquefied air is fed to the HP column; the other part is passed to the low pressure (LP) column via the subcooler.

Air Separation

In the HP column, the air streams are separated in oxygen rich bottom liquid and pure nitrogen at the top. The overhead vapour stream is condensed against boiling oxygen in the LP column sump. The condensed nitrogen serves as reflux for the HP and LP column, as gaseous nitrogen product, as liquid product and as refrigerant for the pure argon condenser. The liquid nitrogen product and LP column reflux stream are subcooled in the subcooler. In a cryogenic liquid nitrogen pump liquid nitrogen is brought to the required gaseous nitrogen pressure and thereafter vaporised in the main heat exchanger against air.

The bottom liquid of the HP column is subcooled, partially vaporised in the crude argon condenser and fed into the LP column.

In the LP column the final air separation takes place. Nitrogen gas is withdrawn from the top of the low pressure column, passes the subcooler and is heated to near ambient temperature in the main heat exchanger. It is then compressed to the desired pressure and serves as medium pressure product nitrogen.

Also a waste gas stream is withdrawn from the LP column and heated to ambient in the subcooler and subsequently in the main heat exchanger. The waste nitrogen gas is then utilised to produce chilled water in the chill tower and to regenerate the molecular sieve unit.

The liquid oxygen product is taken from the LP column sump, is pumped to the required pressure and vaporised in the main heat exchanger to provide GOX product. A part of the liquid oxygen is fed to the LOX storage tank.

Argon recovery by rectification

A zone of argon enriched oxygen gas exists in the lower part of the LP column. This gas is used as a feed stream for the crude argon column. In this column, most of the oxygen of the argon enriched side-gas is removed by cryogenic rectification.

The feed enters the bottom of the column, is condensed against oxygen rich liquid from the HP column and the bottom liquid is returned to the LP column. Part of the top product is withdrawn from the crude argon column and is fed into the pure argon column.

In the pure argon column, remaining nitrogen is removed by cryogenic rectification. The gas leaving at the top of the column, containing mostly nitrogen, is vented to atmosphere; the pure liquid argon product from the sump is transferred to the liquid argon (LAR) storage tank (low pressure). The liquid argon is withdrawn from the low pressure storage tank, pumped to the required product pressure and vaporised in ambient air vaporisers. It is then passed as gaseous argon product to the customer.

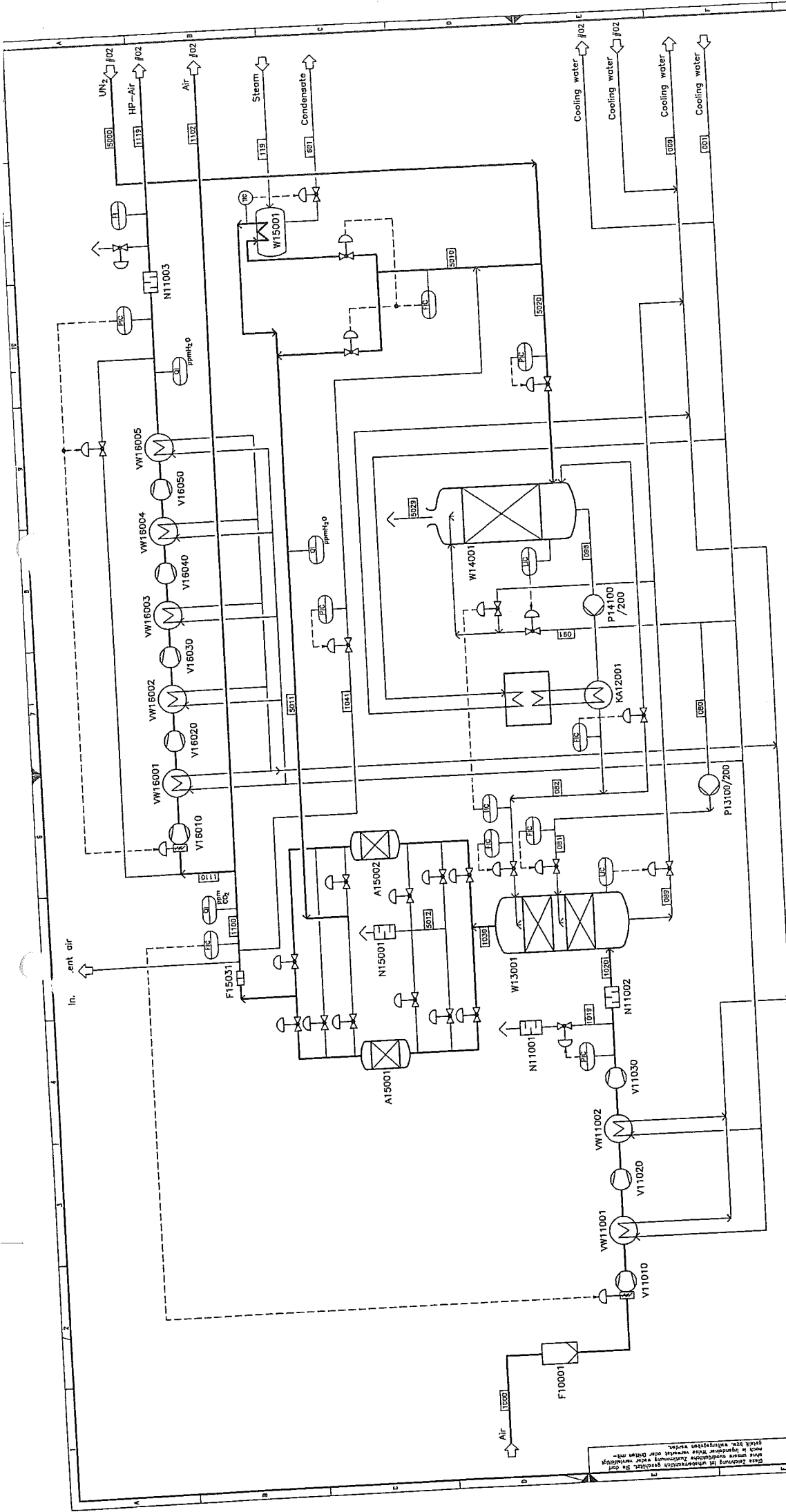
Back-up System

During shutdown or shortage of production of the air separation unit(s) the customer is provided with gaseous oxygen and gaseous nitrogen product from the back-up system.

Liquid oxygen is withdrawn from low pressure storage tanks, brought to the required pressures by cryogenic pumps, vaporised and heated to ambient temperature. The gas is fed into the product pipeline to the customer.

Liquid nitrogen is withdrawn from a low pressure storage tank, pumped to the required pressure by cryogenic pumps, vaporised and heated to ambient temperature. The gas is fed to the product pipelines.

Liquid argon withdrawn from the low pressure storage tank is pumped to the required product pressure and fed to a high pressure tank. Liquid from the high pressure tank is vaporised and heated to ambient temperature. The gas is fed to the product pipeline.



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Air compressor and purification

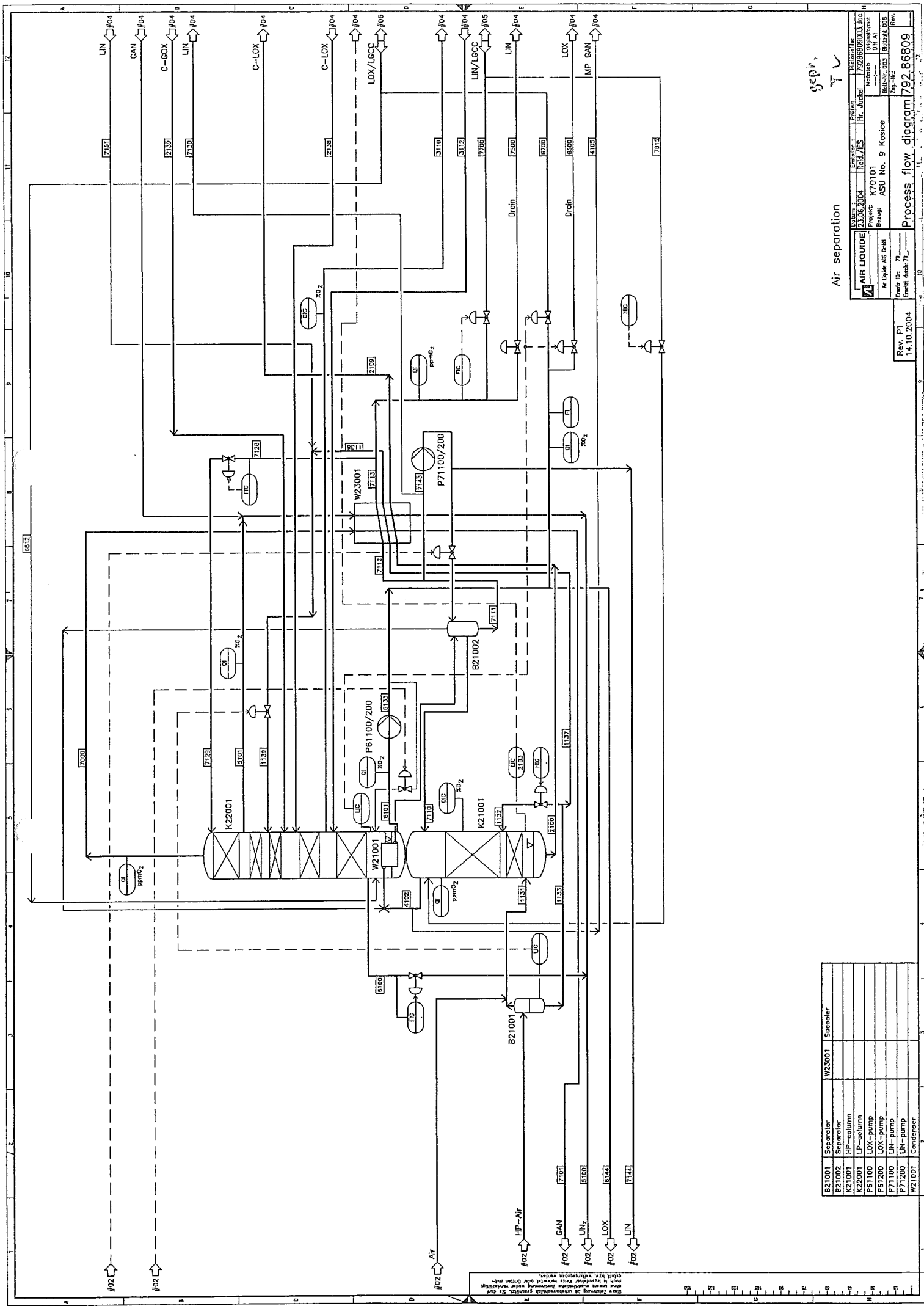
Version	23.06.2004	Author	Red/RS	Project	K70101	Sheet	7928609001.002
Project	K70101			Bezeichnung	K70101		
Bezeichnung	ASU No. 9 Kosice			Zeichner	Bilalich 006		
Erstellt	14.10.2004			Revis.	792.88809		

Rev. P1
14.10.2004

Process flow diagram

Code	Description	Code	Description	Code	Description	Code	Description
A15001	Mol sieve	V16001	Air compressor 3. st.	N11001	Heat exchanger	N11003	Silencer
A15002	Mol sieve	V16002	Booster 1. st.	V16003	Heat exchanger	N15001	Silencer
W13001	DCAC	V16003	Booster 2. st.	V16004	Heat exchanger		
W14001	Chill tower	V16004	Booster 3. st.	V16005	Heat exchanger		
W15001	Refrigerant	V16005	Booster 4. st.	F15031	Air filter		
F13100/200	Volatumpung	V16006	Booster 5. st.	KA12001	Refrigeration unit		

Das Diagramm ist ein Prozessflussdiagramm (PFD) für eine Luftkompressor- und -aufbereitungsanlage. Es zeigt den Materialfluss von der Luftzufuhr über verschiedene Kompressoren, Booster, Wärmetauscher und Filter bis zur Abgabe von Hochdruckluft (UN2) und Dampf/Kondensat. Die Anlage ist mit einer Kälteanlage (KA12001) und einem Wasserpumpenaggregat (F13100/200) ausgestattet. Die Zeichnung ist als Prozessflussdiagramm (PFD) gekennzeichnet.



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Air separation

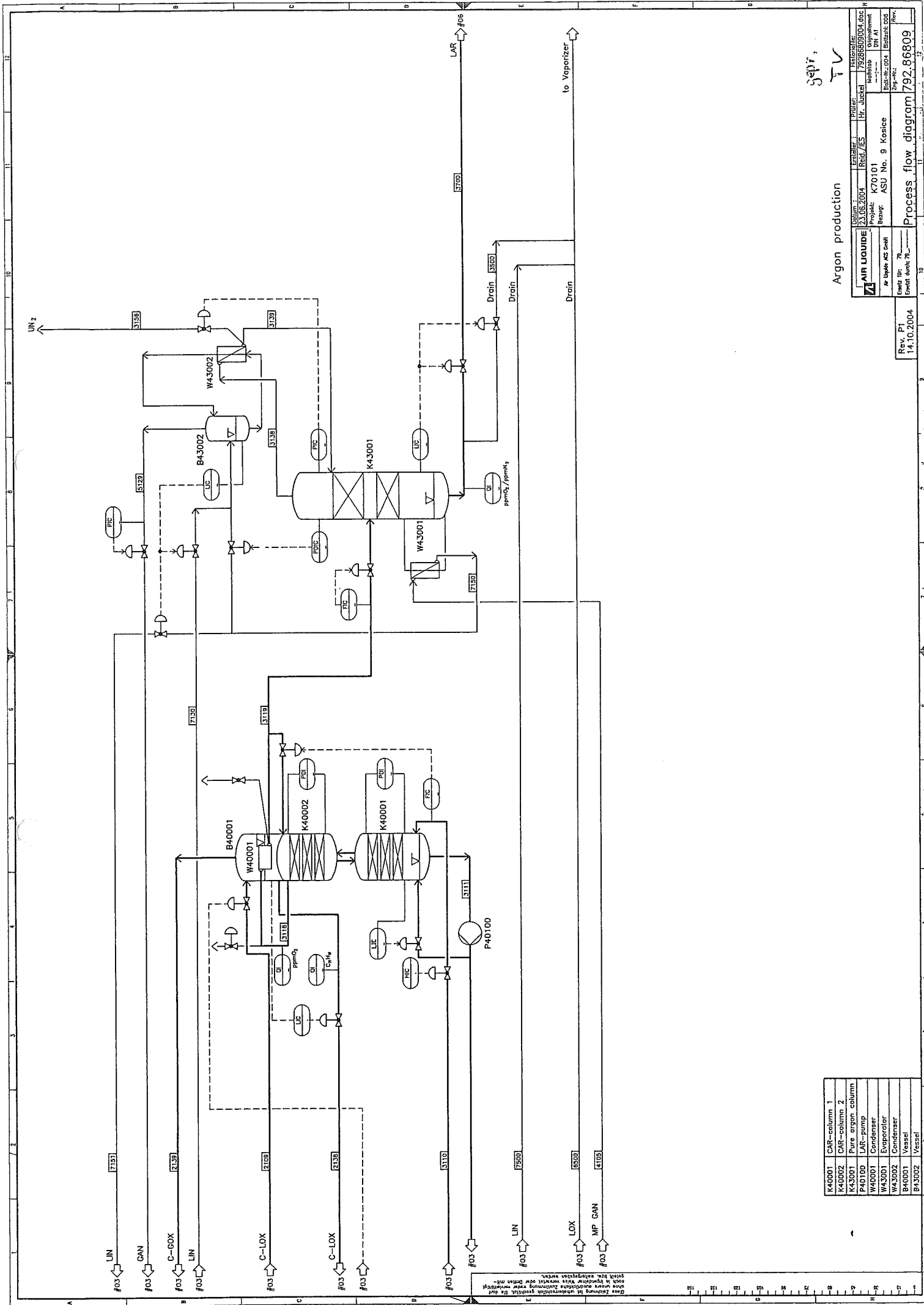
Revision	Author	Editor	Checker	Reviewer
1	AIR LIQUIDE	23.06.2004	Ref./ES	792869003.doc
Project: K70101				
Branche: ASU No. 9 Koscice				
Zug-Nr.: 792869003				
Zug-Nr.: 792869003				
Zug-Nr.: 792869003				

Rev. P1
14.10.2004

Process flow diagram 792.86809

Equipment	W23001	Successor
B21001 Separator		
B21002 Separator		
K21001 HP-column		
K22001 LP-column		
P61100 LOX-pump		
P71100 LIN-pump		
P71200 LIN-pump		
W21001 Condenser		

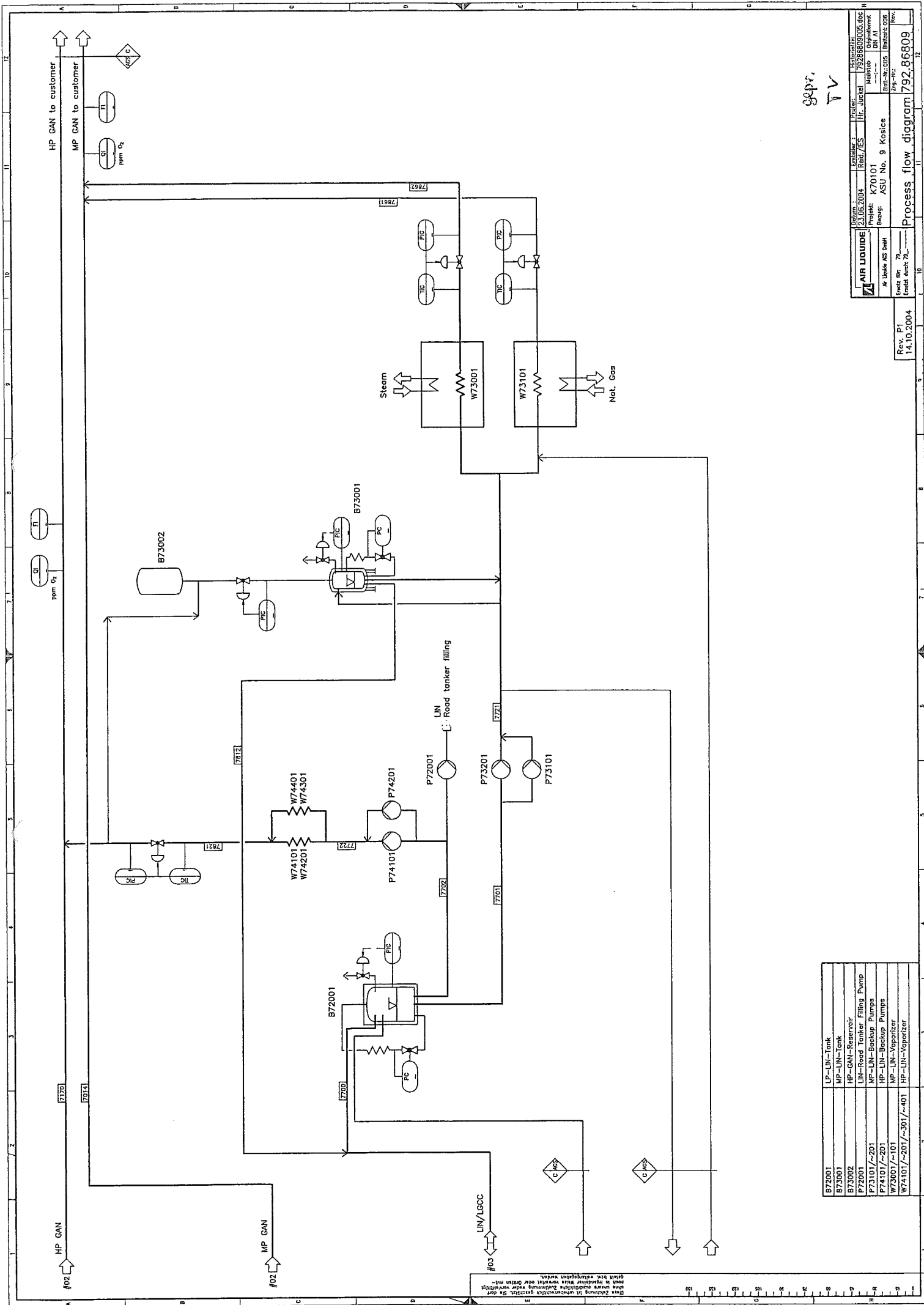
Die Zeichnung ist verbindlich zu betrachten. Sie darf nicht in irgendeiner Weise verändert oder ergänzt werden. Die Zeichnung ist verbindlich zu betrachten. Sie darf nicht in irgendeiner Weise verändert oder ergänzt werden.



K40001	CAR-column 1
K40002	CAR-column 2
K40001	Pure argon column
P40100	LAR-pump
W40001	Condenser
W43001	Evaporator
W43002	Condenser
B40001	Vessel
B43002	Vessel

Argon production

Uebung	23.08.2004	Entwurf	HR. JUEDEL	Prüfung	792868000.dwg
Projekt	K70101	Rechner	HR. JUEDEL	Prüfung	792868000.dwg
Gruppe	ASU No. 9	Kosice	HR. JUEDEL	Prüfung	792868000.dwg
Arbeits-Nr.	792868000	Blatt-Nr.	001	Blattzahl	008
Gezeichnet	HR. JUEDEL	Geprüft	HR. JUEDEL	Zeichnungs-Nr.	792868000
Rev. P1	14.10.2004	Rev.		Process flow diagram	792868000



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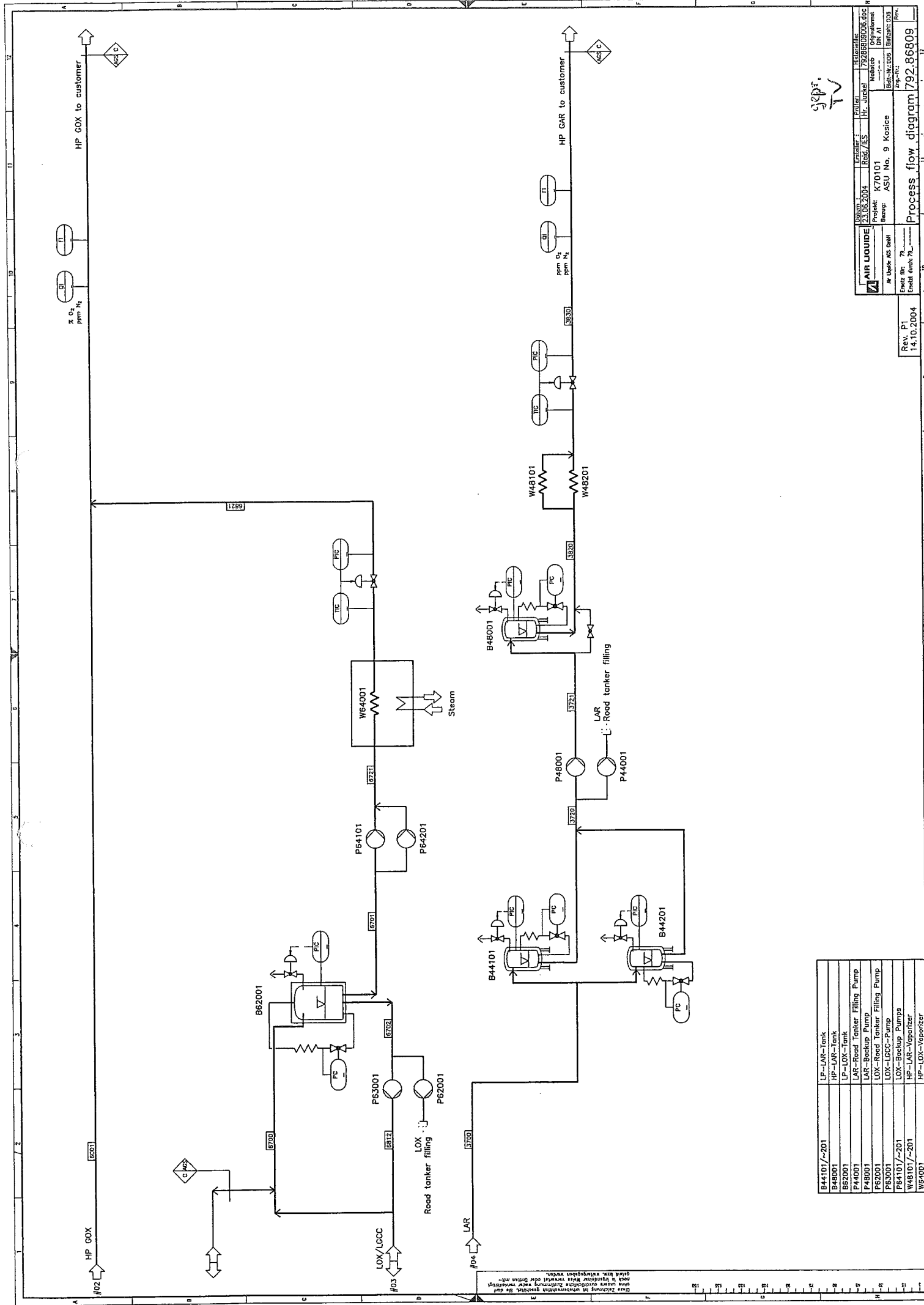
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TV

B72001	LP-LIN-Tank
B73001	MP-LIN-Tank
B73002	HP-GAN-Reservoir
P72001	LIN-Road Tanker Filling Pump
P73101 / ~201	MP-LIN-Backup Pumps
P74101 / ~201	HP-LIN-Backup Pumps
W73001 / ~101	MP-LIN-Vaporizer
W74101 / ~201 / ~301 / ~401	HP-LIN-Vaporizer

Version: 23.06.2004	Entwurf: 79286805005.dwg	Historie:
Projekt: K70101	Revis: 1	Revis: 1
Bezug: ASU No. 9 Kosice	Revis: 2	Revis: 2
Revis: 3	Revis: 3	Revis: 3
Revis: 4	Revis: 4	Revis: 4
Revis: 5	Revis: 5	Revis: 5
Revis: 6	Revis: 6	Revis: 6
Revis: 7	Revis: 7	Revis: 7
Revis: 8	Revis: 8	Revis: 8
Revis: 9	Revis: 9	Revis: 9
Revis: 10	Revis: 10	Revis: 10
Revis: 11	Revis: 11	Revis: 11
Revis: 12	Revis: 12	Revis: 12

Rev. P1
14.10.2004

Process flow diagram 792.86809



AIR LIQUIDE			Process Specification										Project: K70101 ASU No.9 Kosice Rev.: 2 Date: 14.10.04 By: TV / JJ				
Air Liquide AGS GmbH			According to PFD No: 792.86809; Rev. P1				Case:		Ambient Pressure [bar a]: 1.013				Humidity: 65%		Cooling Water Temperature [°C]: 16		
Design Conditions:			Ambient Temperature [°C]: 12		Mass Flow		Pres.	Temp.	Phase	Vapor Fraction	Composition (mol/mol)				Density	Remarks	
Case	Stream	Normal Flow	kg/h	bar(a)	K						N ₂	Ar	O ₂	H ₂	H ₂ O		
Normal	1 H2O		1700000	4	289	Liquid									1	999,1	
	LOX		1700000	4	289	Liquid									1	999,1	
LIN	1 H2O		1700000	4	289	Liquid									1	999,1	
	MaxGOX		1700000	4	289	Liquid									1	999,1	
MinGOX1	1 H2O		1700000	4	289	Liquid									1	999,1	
	MinGOX2		1700000	4	289	Liquid									1	999,1	
Normal	9 H2O		1700000	2	299	Liquid									1	997,0	
	LOX		1700000	2	299	Liquid									1	997,0	
LIN	9 H2O		1700000	2	299	Liquid									1	997,0	
	MaxGOX		1700000	2	299	Liquid									1	997,0	
MinGOX1	9 H2O		1700000	2	299	Liquid									1	997,0	
	MinGOX2		1700000	2	299	Liquid									1	997,0	
Normal	80 H2O		210000	4	289,1	Liquid									1	999,1	
	LOX		210000	4	289,1	Liquid									1	999,1	
LIN	80 H2O		210000	4	289,1	Liquid									1	999,1	
	MaxGOX		210000	4	289,1	Liquid									1	999,1	
MinGOX1	80 H2O		210000	4	289,1	Liquid									1	999,1	
	MinGOX2		210000	4	289,1	Liquid									1	999,1	
Normal	81 H2O		210000	8	289,2	Liquid									1	999,2	
	LOX		210000	8	289,2	Liquid									1	999,2	
LIN	81 H2O		210000	8	289,2	Liquid									1	999,2	
	MaxGOX		210000	8	289,2	Liquid									1	999,2	
MinGOX1	81 H2O		210000	8	289,2	Liquid									1	999,2	
	MinGOX2		210000	8	289,2	Liquid									1	999,2	
Normal	82 H2O		29654	9	284,8	Liquid									1	999,8	
	LOX		29654	9	285,2	Liquid									1	999,8	
LIN	82 H2O		29689	9	285,7	Liquid									1	999,7	
	MaxGOX		29691	9	285,3	Liquid									1	999,8	
MinGOX1	82 H2O		19920	9	288,1	Liquid									1	999,4	
	MinGOX2		19931	9	288,1	Liquid									1	999,4	
Normal	89 H2O		240095	5,87	300	Liquid									1	996,9	
	LOX		240091	5,83	300	Liquid									1	996,9	
LIN	89 H2O		240123	5,77	300	Liquid									1	996,9	
	MaxGOX		240134	5,81	300,1	Liquid									1	996,8	
MinGOX1	89 H2O		230234	5,53	297,5	Liquid									1	997,5	
	MinGOX2		230244	5,55	297,5	Liquid									1	997,5	
Normal	91 H2O		30000	4	289,1	Liquid									1	999,1	
	LOX		30000	4	289,1	Liquid									1	999,1	
LIN	91 H2O		30000	4	289,1	Liquid									1	999,1	
	MaxGOX		30000	4	289,1	Liquid									1	999,1	
MinGOX1	91 H2O		20000	4	289,1	Liquid									1	999,1	
	MinGOX2		20000	4	289,1	Liquid									1	999,1	
Normal	98 H2O		45009	1,04	283,6	Liquid									1	999,6	
	LOX		45009	1,04	284	Liquid									1	999,6	



Air Liquide AGS GmbH

Process Specification

Project: K70101 ASU No.9 Kosice
Rev.: 2
Date: 14.10.04
By: TV / JJ

According to PFD No: 792.86809; Rev. P1

Case:

Ambient Pressure [bar a]: 1,013

Humidity: 65%

Cooling Water Temperature [°C]: 16

Case	Stream	Normal Flow	Mass Flow	Pres.	Temp.	Phase	Vapor Fraction	Composition (mol/mol)				Density	Remarks
								N ₂	Ar	O ₂	H ₂		
LIN	98	H2O	kg/h	bar(a)	K			N ₂	Ar	O ₂	H ₂	H ₂ O	kg/m3
MaxGOX	98	H2O	45009	1,04	284,6	Liquid						1	999,5
MinGOX1	98	H2O	45009	1,04	284,1	Liquid						1	999,6
MinGOX2	98	H2O	44993	1,04	287,9	Liquid						1	999,1
Normal	119	H2O	1900	11	553	Vapor						1	999,1
LOX	119	H2O	1900	11	553	Vapor						1	4,440
LIN	119	H2O	1900	11	553	Vapor						1	4,440
MaxGOX	119	H2O	1900	11	553	Vapor						1	4,440
MinGOX1	119	H2O	1900	11	553	Vapor						1	4,440
MinGOX2	119	H2O	1900	11	553	Vapor						1	4,440
Normal	601	H2O	1900	1	353	Liquid						1	971,7
LOX	601	H2O	1900	1	353	Liquid						1	971,7
LIN	601	H2O	1900	1	353	Liquid						1	971,7
MaxGOX	601	H2O	1900	1	353	Liquid						1	971,7
MinGOX1	601	H2O	1900	1	353	Liquid						1	971,7
MinGOX2	601	H2O	1900	1	353	Liquid						1	971,7
Normal	1000	AIR	97035	1	285,1	Vapor		0,774	0,009	0,208		0,009	1,218
LOX	1000	AIR	97015	1	285,1	Vapor		0,774	0,009	0,208		0,009	1,218
LIN	1000	AIR	97573	1	285,1	Vapor		0,774	0,009	0,208		0,009	1,218
MaxGOX	1000	AIR	98517	1	285,1	Vapor		0,774	0,009	0,208		0,009	1,218
MinGOX1	1000	AIR	73009	1	285,1	Vapor		0,774	0,009	0,208		0,009	1,218
MinGOX2	1000	AIR	73044	1	285,1	Vapor		0,774	0,009	0,208		0,009	1,218
Normal	1019	AIR		5,87	368,8	Vapor		0,775	0,009	0,208		0,008	5,509
LOX	1019	AIR		5,83	368,6	Vapor		0,775	0,009	0,208		0,008	5,484
LIN	1019	AIR		5,77	368,1	Vapor		0,775	0,009	0,208		0,008	5,431
MaxGOX	1019	AIR		5,81	368,4	Vapor		0,775	0,009	0,208		0,008	5,461
MinGOX1	1019	AIR		5,31	364,5	Vapor		0,774	0,009	0,208		0,009	5,048
MinGOX2	1019	AIR		5,34	364,7	Vapor		0,774	0,009	0,208		0,009	5,074
Normal	1020	AIR		5,87	368,8	Vapor		0,775	0,009	0,208		0,008	5,509
LOX	1020	AIR		5,83	368,6	Vapor		0,775	0,009	0,208		0,008	5,484
LIN	1020	AIR		5,77	368,1	Vapor		0,775	0,009	0,208		0,008	5,431
MaxGOX	1020	AIR		5,81	368,4	Vapor		0,775	0,009	0,208		0,008	5,461
MinGOX1	1020	AIR		5,53	366,2	Vapor		0,774	0,009	0,208		0,008	5,232
MinGOX2	1020	AIR		5,55	366,4	Vapor		0,775	0,009	0,208		0,008	5,249
Normal	1030	AIR		5,82	287	Vapor		0,779	0,009	0,209		0,003	7,077
LOX	1030	AIR		5,78	287,3	Vapor		0,779	0,009	0,209		0,003	7,021
LIN	1030	AIR		5,72	287,7	Vapor		0,779	0,009	0,209		0,003	6,938
MaxGOX	1030	AIR		5,75	287,4	Vapor		0,779	0,009	0,209		0,003	6,982
MinGOX1	1030	AIR		5,5	288,6	Vapor		0,778	0,009	0,209		0,004	6,650
MinGOX2	1030	AIR		5,52	288,6	Vapor		0,778	0,009	0,209		0,004	6,674
Normal	1041	AIR		5,87	296,1	Vapor		0,781	0,009	0,21			6,915
LOX	1041	AIR		5,83	296,1	Vapor		0,781	0,009	0,21			6,868
LIN	1041	AIR		5,77	296,1	Vapor		0,781	0,009	0,21			6,797
MaxGOX	1041	AIR		5,81	296,1	Vapor		0,781	0,009	0,21			6,845



Air Liquide AGS GmbH

Process Specification

Project: K70101 ASU No.9 Kosice

Rev.: 2

Date: 14.10.04

By: TV / JJ

According to PFD No: 792.86809; Rev. P1

Case:

Humidity: 65%

Cooling Water Temperature [°C]: 16

Density

Remarks

Case	Stream	Normal Flow	Mass Flow	Pres.	Temp.	Phase	Vapor Fraction	Composition (mol/mol)				H ₂ O	Density	Remarks
		Nm ³ /h	kg/h	bar(a)	K			N ₂	Ar	O ₂	H ₂		kg/m ³	
MinGOX1	1041	AIR	18000	5,31	296,1	Vapor		0,781	0,009	0,21			6,255	only for start-up
MinGOX2	1041	AIR	18000	5,34	296,1	Vapor		0,781	0,009	0,21			6,290	only for start-up
Normal	1100	AIR	95378	5,62	296,1	Vapor		0,781	0,009	0,210			6,62	
LOX	1100	AIR	95358	5,58	296,1	Vapor		0,781	0,009	0,210			6,57	
LIN	1100	AIR	95911	5,51	296,1	Vapor		0,781	0,009	0,210			6,49	
MaxGOX	1100	AIR	96851	5,54	296,1	Vapor		0,781	0,009	0,210			6,53	
MinGOX1	1100	AIR	71574	5,36	296,1	Vapor		0,781	0,009	0,210			6,31	
MinGOX2	1100	AIR	92522	5,38	296,1	Vapor		0,781	0,009	0,210			6,34	
Normal	1102	AIR	66499	5,62	296,1	Vapor		0,781	0,009	0,210			6,62	
LOX	1102	AIR	50811	5,58	296,1	Vapor		0,781	0,009	0,210			6,57	
LIN	1102	AIR	36837	47595	5,51	296,1	Vapor	0,781	0,009	0,210			6,49	
MaxGOX	1102	AIR	51874	5,54	296,1	Vapor		0,781	0,009	0,210			6,53	
MinGOX1	1102	AIR	22686	5,36	296,1	Vapor		0,781	0,009	0,210			6,31	
MinGOX2	1102	AIR	36445	5,38	296,1	Vapor		0,781	0,009	0,210			6,34	
Normal	1103	AIR	51468	5,47	106	Vapor		0,781	0,009	0,210			20,06	
LOX	1103	AIR	39325	5,49	100,1	Vapor		0,781	0,009	0,210			21,89	
LIN	1103	AIR	36837	47595	5,43	102,2	Vapor	0,781	0,009	0,210			20,96	
MaxGOX	1103	AIR	51874	5,39	110,4	Vapor		0,781	0,009	0,210			18,67	
MinGOX1	1103	AIR	22686	5,32	99,5	Vapor		0,781	0,009	0,210			21,30	
MinGOX2	1103	AIR	36445	5,29	106,2	Vapor		0,781	0,009	0,210			19,27	
Normal	1104	LAIR	35140	56,83	106	Liquid		0,781	0,009	0,210			752	
LOX	1104	LAIR	30183	38998	56,77	100,1	Liquid	0,781	0,009	0,210			783	
LIN	1104	LAIR	35204	56,74	102,2	Liquid		0,781	0,009	0,210			772	
MaxGOX	1104	LAIR	44608	56,8	110,4	Liquid		0,781	0,009	0,210			728	
MinGOX1	1104	LAIR	24118	54,82	99,5	Liquid		0,781	0,009	0,210			785	
MinGOX2	1104	LAIR	27793	54,88	106,2	Liquid		0,781	0,009	0,210			750	
Normal	1110	AIR	43910	5,62	296,1	Vapor		0,781	0,009	0,210			6,62	
LOX	1110	AIR	56033	5,58	296,1	Vapor		0,781	0,009	0,210			6,57	
LIN	1110	AIR	59074	5,51	296,1	Vapor		0,781	0,009	0,210			6,49	
MaxGOX	1110	AIR	44978	5,54	296,1	Vapor		0,781	0,009	0,210			6,53	
MinGOX1	1110	AIR	48888	5,36	296,1	Vapor		0,781	0,009	0,210			6,31	
MinGOX2	1110	AIR	35163	5,38	296,1	Vapor		0,781	0,009	0,210			6,34	
Normal	1119	AIR	43910	57	298,1	Vapor		0,781	0,009	0,210			67,21	
LOX	1119	AIR	56033	57	298,1	Vapor		0,781	0,009	0,210			67,21	
LIN	1119	AIR	59074	57	298,1	Vapor		0,781	0,009	0,210			67,21	
MaxGOX	1119	AIR	44978	57	298,1	Vapor		0,781	0,009	0,210			67,21	
MinGOX1	1119	AIR	48888	55	298,1	Vapor		0,781	0,009	0,210			64,84	
MinGOX2	1119	AIR	35163	55	298,1	Vapor		0,781	0,009	0,210			64,84	
Normal	1131	AIR	63930	82522	5,47	105	Vapor	0,788	0,009	0,203			20,30	
LOX	1131	AIR	66195	85503	5,49	99,4	Vapor	0,783	0,009	0,208			22,12	
LIN	1131	AIR	62851	81159	5,43	100,8	Vapor	0,785	0,009	0,206			21,37	
MaxGOX	1131	AIR	59496	76725	5,39	109,3	Vapor	0,794	0,009	0,197			18,88	
MinGOX1	1131	AIR	48187	62242	5,32	102,7	Vapor	0,783	0,009	0,208			20,32	
MinGOX2	1131	AIR	46902	60533	5,29	105,2	Vapor	0,789	0,009	0,202			19,50	



Air Liquide AGS GmbH

Process Specification

Project: K70101 ASU No.9 Kosice
Rev.: 2
Date: 14.10.04
By: TV / JJ

Air Liquide AGS GmbH				According to PFD No: 792.86809; Rev. P1			Case:		Humidity: 65%			Cooling Water Temperature [°C]: 16		By: TV / JJ	
Design Conditions:				Ambient Temperature [°C]: 12			Ambient Pressure [bar a]: 1,013								
Case	Stream	Normal Flow	Mass Flow	Pres.	Temp.	Phase	Vapor Fraction	Composition (mol/mol)				Density	Remarks		
		Nm³/h	kg/h	bar(a)	K			N₂	Ar	O₂	H₂	H₂O	kg/m3		
Normal	1132 LAIR	15644	20253	5,47	97,4	Liquid		0,768	0,010	0,222			780		
LOX	1132 LAIR	14501	18749	5,49	97,4	Liquid		0,777	0,009	0,214			777		
LIN	1132 LAIR	13160	17023	5,43	97,3	Liquid		0,773	0,010	0,217			779		
MaxGOX	1132 LAIR	14878	19283	5,4	97,3	Liquid		0,760	0,010	0,230			783		
MinGOX1	1132 LAIR	11613	15015	5,32	97	Liquid		0,777	0,009	0,214			779		
MinGOX2	1132 LAIR	9819	12713	5,3	97	Liquid		0,767	0,010	0,223			782		
Normal	1133 LAIR	31288	40505	5,47	97,4	Liquid		0,768	0,01	0,222			780		
LOX	1133 LAIR	29003	37499	5,49	97,4	Liquid		0,777	0,009	0,214			777		
LIN	1133 LAIR	32900	42558	5,43	97,3	Liquid		0,773	0,01	0,217			779		
MaxGOX	1133 LAIR	37196	48206	5,4	97,3	Liquid		0,76	0,01	0,23			783		
MinGOX1	1133 LAIR	23227	30029	5,32	97	Liquid		0,777	0,009	0,214			779		
MinGOX2	1133 LAIR	24547	31783	5,3	97	Liquid		0,767	0,010	0,223			782		
Normal	1137 LAIR	15644	20253	5,47	97,4	Liquid		0,768	0,010	0,222			780		
LOX	1137 LAIR	14501	18749	5,49	97,4	Liquid		0,777	0,009	0,214			777		
LIN	1137 LAIR	19740	25535	5,43	97,3	Liquid		0,773	0,010	0,217			779		
MaxGOX	1137 LAIR	22317	28924	5,4	97,3	Liquid		0,760	0,010	0,230			783		
MinGOX1	1137 LAIR	11613	15015	5,32	97	Liquid		0,777	0,009	0,214			779		
MinGOX2	1137 LAIR	14728	19070	5,3	97	Liquid		0,767	0,010	0,223			782		
Normal	1138 LAIR	15644	20253	5,47	88,1	Liquid		0,768	0,010	0,222			829		
LOX	1138 LAIR	14501	18749	5,49	87,9	Liquid		0,777	0,009	0,214			827		
LIN	1138 LAIR	19740	25535	5,43	89,1	Liquid		0,773	0,010	0,217			823		
MaxGOX	1138 LAIR	22317	28924	5,4	89,6	Liquid		0,760	0,010	0,230			824		
MinGOX1	1138 LAIR	11613	15015	5,32	89	Liquid		0,777	0,009	0,214			821		
MinGOX2	1138 LAIR	14728	19070	5,3	89	Liquid		0,767	0,010	0,223			825		
Normal	1139 LAIR	15654	20265	1,32	81,5	Mixed	6,7%	0,768	0,010	0,222			81,11		
LOX	1139 LAIR	14511	18761	1,32	81,4	Mixed	6,5%	0,777	0,009	0,214			83,31		
LIN	1139 LAIR	19749	25546	1,31	81,4	Mixed	7,8%	0,773	0,010	0,217			70,13		
MaxGOX	1139 LAIR	22326	28935	1,31	81,5	Mixed	8,2%	0,760	0,010	0,230			67,00		
MinGOX1	1139 LAIR	11621	15025	1,31	81,4	Mixed	7,7%	0,777	0,009	0,214			70,93		
MinGOX2	1139 LAIR	14736	19080	1,31	81,4	Mixed	7,7%	0,767	0,010	0,223			70,98		
Normal	1160 AIR	8400	10853	56,85	182	Vapor		0,781	0,009	0,210			133		
LOX	1160 AIR	25480	32922	56,65	182	Vapor		0,781	0,009	0,210			132		
LIN	1160 AIR	23500	30363	56,65	182	Vapor		0,781	0,009	0,210			132		
MaxGOX	1160 AIR		56,87	182	Vapor			0,781	0,009	0,210			133		
MinGOX1	1160 AIR	24400	31526	54,69	190	Vapor		0,781	0,009	0,210			117		
MinGOX2	1160 AIR	7000	9044	54,9	180	Vapor		0,781	0,009	0,210			130		
Normal	1161 AIR	8400	10853	5,5	99,5	Mixed	99,5%	0,781	0,009	0,210			22,17		
LOX	1161 AIR	25480	32922	5,56	99,6	Mixed	98,9%	0,781	0,009	0,210			22,54		
LIN	1161 AIR	23500	30363	5,49	99,4	Mixed	98,8%	0,781	0,009	0,210			22,29		
MaxGOX	1161 AIR		5,39	109,9	Vapor			0,781	0,009	0,210			18,78		
MinGOX1	1161 AIR	24400	31526	5,38	104,6	Vapor		0,781	0,009	0,210			20,06		
MinGOX2	1161 AIR	7000	9044	5,32	99,1	Vapor		0,781	0,009	0,210			21,43		
Normal	1162 AIR	8400	10853	56,85	182	Vapor		0,781	0,009	0,210			133		
LOX	1162 AIR	12740	16461	56,65	182	Vapor		0,781	0,009	0,210			132		



Air Liquide AGS GmbH

Process Specification

Project: K70101 ASU No.9 Kosice

Rev.: 2

Date: 14.10.04

By: TV / JJ

According to PFD No: 792.86809; Rev. P1

Case:

Design Conditions:				Ambient Temperature [°C]: 12		Ambient Pressure [bar a]: 1,013		Humidity: 65%		Cooling Water Temperature [°C]: 16		Density	Remarks
Case	Stream	Normal Flow	Mass Flow	Pres.	Temp.	Phase	Vapor Fraction	Composition (mol/mol)					
		Nm³/h	kg/h	bar(a)	K			N₂	Ar	O₂	H₂	H₂O	kg/m3
LIN	1162 AIR	11750	15182	56,65	182	Vapor		0,781	0,009	0,210			132
MaxGOX	1162 AIR			56,87	182	Vapor		0,781	0,009	0,210			133
MinGOX1	1162 AIR	12200	15763	54,69	190	Vapor		0,781	0,009	0,210			117
MinGOX2	1162 AIR	7000	9044	54,9	180	Vapor		0,781	0,009	0,210			130
Normal	1163 AIR	8400	10853	5,5	99,5	Mixed	99,5%	0,781	0,009	0,210			22,17
LOX	1163 AIR	12740	16461	5,56	99,6	Mixed	98,9%	0,781	0,009	0,210			22,54
LIN	1163 AIR	11750	15182	5,49	99,4	Mixed	98,8%	0,781	0,009	0,210			22,29
MaxGOX	1163 AIR			5,39	109,9	Vapor		0,781	0,009	0,210			18,78
MinGOX1	1164 AIR	12200	15763	54,69	190	Vapor		0,781	0,009	0,210			20,06
MinGOX2	1164 AIR			54,9	180	Vapor		0,781	0,009	0,210			22,36
Normal	1165 AIR			5,5	99,3	Mixed	94,5%	0,781	0,009	0,210			822
LOX	1165 AIR	12740	16461	5,56	99,6	Mixed	98,9%	0,781	0,009	0,210			821
LIN	1165 AIR	11750	15182	5,49	99,4	Mixed	98,8%	0,781	0,009	0,210			823
MaxGOX	1165 AIR			5,39	109,9	Vapor		0,781	0,009	0,210			823
MinGOX1	1165 AIR	12200	15763	5,38	104,6	Vapor		0,781	0,009	0,210			825
MinGOX2	1165 AIR			5,32	98,9	Mixed	95,6%	0,781	0,009	0,210			827
Normal	2100 CLOX	46152	60992	5,46	98,9	Liquid		0,628	0,015	0,357			834
LOX	2100 CLOX	47247	62434	5,48	99	Liquid		0,628	0,015	0,357			834
LIN	2100 CLOX	43919	58060	5,42	98,8	Liquid		0,625	0,016	0,359			833
MaxGOX	2100 CLOX	42416	56053	5,39	98,7	Liquid		0,628	0,015	0,357			831
MinGOX1	2100 CLOX	34641	45802	5,31	98,6	Liquid		0,624	0,016	0,360			840
MinGOX2	2100 CLOX	31986	42322	5,29	98,6	Liquid		0,619	0,016	0,365			840
Normal	2109 CLOX	46152	60992	5,46	96,7	Liquid		0,628	0,015	0,357			985
LOX	2109 CLOX	47247	62434	5,48	96,7	Liquid		0,628	0,015	0,357			983
LIN	2109 CLOX	43919	58060	5,42	97,1	Liquid		0,625	0,016	0,359			982
MaxGOX	2109 CLOX	42416	56053	5,39	97,2	Liquid		0,628	0,015	0,357			983
MinGOX1	2109 CLOX	34641	45802	5,31	95,9	Liquid		0,624	0,016	0,360			983
MinGOX2	2109 CLOX	31986	42322	5,29	96,2	Liquid		0,619	0,016	0,365			993
Normal	2138 CLOX	9950	13603	1,38	85,6	Liquid		0,381	0,020	0,599			5,98
LOX	2138 CLOX	10894	14881	1,38	85,6	Liquid		0,387	0,020	0,593			5,94
LIN	2138 CLOX	11222	15319	1,37	85,4	Liquid		0,392	0,020	0,588			5,94
MaxGOX	2138 CLOX	9871	13484	1,37	85,5	Liquid		0,387	0,020	0,593			5,94
MinGOX1	2138 CLOX	8462	11560	1,37	85,5	Liquid		0,387	0,020	0,593			5,94
MinGOX2	2138 CLOX	5812	7968	1,37	85,8	Liquid		0,359	0,020	0,620			5,94
Normal	2139 CGOX	36202	47389	1,38	85,6	Vapor		0,695	0,014	0,290			5,94
LOX	2139 CGOX	36353	47553	1,38	85,6	Vapor		0,700	0,014	0,286			5,94
LIN	2139 CGOX	32697	42741	1,37	85,4	Vapor		0,705	0,014	0,281			5,94
MaxGOX	2139 CGOX	32545	42569	1,37	85,5	Vapor		0,701	0,014	0,285			5,94



Air Liquide AGS GmbH

Process Specification

Project: K70101 ASU No.9 Kosice
Rev.: 2
Date: 14.10.04
By: TV / JJ

According to PFD No.: 792.86809; Rev. P1

Case:

Humidity: 65%
Cooling Water Temperature [°C]: 16

Case	Stream	Normal Flow	Mass Flow	Pres.	Temp.	Phase	Vapor Fraction	Composition (mol/mol)				Density	Remarks
								N ₂	Ar	O ₂	H ₂	H ₂ O	
MinGOX1	2139	CGOX	26179	34242	1,37	85,5	Vapor	0,701	0,014	0,285			5,94
MinGOX2	2139	CGOX	26174	34355	1,37	85,8	Vapor	0,677	0,015	0,309			5,94
Normal	3110	GOX	26820	39293	1,35	92,5	Vapor		0,105	0,895			6,02
LOX	3110	GOX	26820	39309	1,35	92,5	Vapor		0,107	0,893			6,02
LIN	3110	GOX	23760	34760	1,34	92,4	Vapor		0,100	0,900			5,97
MaxGOX	3110	GOX	23760	34749	1,34	92,4	Vapor		0,098	0,902			5,97
MinGOX1	3110	GOX	19440	28494	1,34	92,4	Vapor		0,107	0,893			5,98
MinGOX2	3110	GOX	19800	28997	1,33	92,4	Vapor		0,104	0,896			5,93
Normal	3111	LOX	26075	37965	1,25	91,7	Liquid		0,080	0,920			1154
LOX	3111	LOX	26075	37982	1,25	91,7	Liquid		0,082	0,918			1154
LIN	3111	LOX	23100	33584	1,25	91,7	Liquid		0,074	0,926			1152
MaxGOX	3111	LOX	23100	33573	1,25	91,7	Liquid		0,073	0,927			1152
MinGOX1	3111	LOX	18900	27532	1,23	91,5	Liquid		0,082	0,918			1155
MinGOX2	3111	LOX	19250	28016	1,23	91,5	Liquid		0,078	0,922			1154
Normal	3112	LOX	26075	37965	8	92,2	Liquid		0,080	0,920			1153
LOX	3112	LOX	26075	37982	8	92,2	Liquid		0,082	0,918			1153
LIN	3112	LOX	23100	33584	8	92,2	Liquid		0,074	0,926			1151
MaxGOX	3112	LOX	23100	33573	8	92,2	Liquid		0,073	0,927			1151
MinGOX1	3112	LOX	18900	27532	8	92	Liquid		0,082	0,918			1154
MinGOX2	3112	LOX	19250	28016	8	92	Liquid		0,078	0,922			1153
Normal	3118	GAR	28224	50302	1,15	88,3	Vapor		1,000				6,50
LOX	3118	GAR	28222	50297	1,15	88,3	Vapor		1,000				6,50
LIN	3118	GAR	25006	44568	1,15	88,3	Vapor		1,000				6,50
MaxGOX	3118	GAR	25006	44569	1,15	88,3	Vapor		1,000				6,50
MinGOX1	3118	GAR	20472	36488	1,15	88,3	Vapor		1,000				6,50
MinGOX2	3118	GAR	20854	37168	1,15	88,3	Vapor		1,000				6,50
Normal	3119	LAR	745	1328	1,15	88,3	Liquid		1,000				1386
LOX	3119	LAR	745	1328	1,15	88,3	Liquid		1,000				1386
LIN	3119	LAR	660	1176	1,15	88,3	Liquid		1,000				1386
MaxGOX	3119	LAR	660	1176	1,15	88,3	Liquid		1,000				1386
MinGOX1	3119	LAR	540	962	1,15	88,3	Liquid		1,000				1386
MinGOX2	3119	LAR	550	980	1,15	88,3	Liquid		1,000				1386
Normal	3138	CGAR	610	1083	1,5	90,9	Vapor	0,014	0,986				8,26
LOX	3138	CGAR	611	1080	1,5	90,9	Vapor	0,025	0,975				8,23
LIN	3138	CGAR	541	963	1,5	91	Vapor	0,005	0,995				8,27
MaxGOX	3138	CGAR	541	963	1,5	91	Vapor	0,005	0,995				8,27
MinGOX1	3138	CGAR	443	790	1,5	91	Vapor	0,004	0,996				8,28
MinGOX2	3138	CGAR	452	805	1,5	91	Vapor	0,004	0,996				8,28
Normal	3139	CLAR	608	1080	1,5	90,7	Liquid	0,013	0,987				1360
LOX	3139	CLAR	609	1077	1,5	90,5	Liquid	0,025	0,975				1350
LIN	3139	CLAR	539	959	1,5	90,9	Liquid	0,005	0,995				1366
MaxGOX	3139	CLAR	539	960	1,5	90,9	Liquid	0,005	0,995				1366
MinGOX1	3139	CLAR	441	786	1,5	90,9	Liquid	0,004	0,996				1367
MinGOX2	3139	CLAR	450	801	1,5	90,9	Liquid	0,004	0,996				1367



Air Liquide AGS GmbH

Process Specification

Project: K70101 ASU No.9 Kosice

Rev.: 2

Date: 14.10.04

By: TV / JJ

Case:

According to PFD No: 792.86809; Rev. P1

Ambient Temperature [°C]: 12

Ambient Pressure [bar a]: 1,013

Humidity: 65%

Cooling Water Temperature [°C]: 16

Case	Stream	Normal Flow	Mass Flow	Pres.	Temp.	Phase	Vapor Fraction	Composition (mol/mol)				Density	Remarks
								N ₂	Ar	O ₂	H ₂		
Normal	3156	CGAR	2	kg/h	bar(a)	K		0,038	0,962			kg/m ³	
LOX	3156	CGAR	2	3,5	1,5	90,7	Vapor	0,069	0,931			8,22	
LIN	3156	CGAR	2	3,5	1,5	90,5	Vapor	0,014	0,986			8,17	
MaxGOX	3156	CGAR	2	3,5	1,5	90,9	Vapor	0,014	0,986			8,26	
MinGOX1	3156	CGAR	2	3,5	1,5	90,9	Vapor	0,010	0,990			8,26	
MinGOX2	3156	CGAR	2	3,6	1,5	90,9	Vapor	0,011	0,989			8,27	
Normal	3500	LAR	2	3,6	1,5	90,9	Vapor					8,27	
LOX	3500	LAR	2	1,74	1,74	92,6	Liquid	1				1359,7	max. 750 Nm ³ /h
LIN	3500	LAR	2	1,74	1,74	92,6	Liquid	1				1359,7	max. 750 Nm ³ /h
MaxGOX	3500	LAR	2	1,74	1,74	92,6	Liquid	1				1359,7	max. 750 Nm ³ /h
MinGOX1	3500	LAR	2	1,74	1,74	92,6	Liquid	1				1359,7	max. 750 Nm ³ /h
MinGOX2	3500	LAR	2	1,74	1,74	92,6	Liquid	1				1359,7	max. 750 Nm ³ /h
Normal	3700	LAR	2	1,74	1,74	92,6	Liquid		1,000			1360	
LOX	3700	LAR	2	1,74	1,74	92,6	Liquid		1,000			1360	
LIN	3700	LAR	2	1,74	1,74	92,6	Liquid		1,000			1360	
MaxGOX	3700	LAR	2	1,74	1,74	92,6	Liquid		1,000			1360	
MinGOX1	3700	LAR	2	1,74	1,74	92,6	Liquid		1,000			1360	
MinGOX2	3700	LAR	2	1,74	1,74	92,6	Liquid		1,000			1360	
Backup	3720	LAR	2	713	1,63	91	Liquid	1				1369,8	maximum flow, design flow: 240 Nm ³ /h; pump capacity is 200 l/min
Backup	3721	LAR	2	713	23	93	Liquid	1				1364,6	maximum flow, design flow: 240 Nm ³ /h; pump capacity is 200 l/min
Backup	3830	GAR	2	713	21	275	Vapor					1049,6	maximum flow, design flow: 240 Nm ³ /h
Normal	4102	GAN	2	87837	5,3	94,8	Vapor	0,999	0,001			21,93	
LOX	4102	GAN	2	87815	5,31	94,8	Vapor	0,999	0,001			21,98	
LIN	4102	GAN	2	84242	5,26	94,7	Vapor	0,999	0,001			21,77	
MaxGOX	4102	GAN	2	83959	5,23	94,6	Vapor	0,999	0,001			21,66	
MinGOX1	4102	GAN	2	65586	5,19	94,5	Vapor	0,999	0,001			21,50	
MinGOX2	4102	GAN	2	64771	5,17	94,5	Vapor	0,999	0,001			21,40	
Normal	4105	GAN	2	1025	5,3	94,8	Vapor	0,999	0,001			21,93	
LOX	4105	GAN	2	1025	5,31	94,8	Vapor	0,999	0,001			21,98	
LIN	4105	GAN	2	908	5,26	94,7	Vapor	0,999	0,001			21,77	
MaxGOX	4105	GAN	2	726	5,23	94,6	Vapor	0,999	0,001			21,66	
MinGOX1	4105	GAN	2	594	5,19	94,5	Vapor	0,999	0,001			21,50	
MinGOX2	4105	GAN	2	605	5,17	94,5	Vapor	0,999	0,001			21,40	
Normal	5000	UN2	2	41223	1,17	293	Vapor	0,998	0,002			1,35	
LOX	5000	UN2	2	51536	1,17	294,8	Vapor	0,998	0,002			1,34	
LIN	5000	UN2	2	48649	1,17	294,8	Vapor	0,993	0,004	0,003		1,34	
MaxGOX	5000	UN2	2	48488	1,17	292,4	Vapor	0,987	0,004	0,009		1,35	
MinGOX1	5000	UN2	2	23324	1,25	296,1	Vapor	0,997	0,003			1,42	
MinGOX2	5000	UN2	2	28341	1,25	293,3	Vapor	0,997	0,003	0,001		1,44	
Normal	5010	UN2	2	18000	1,17	292,9	Vapor	0,998	0,002			1,347	
LOX	5010	UN2	2	22514	1,17	294,8	Vapor	0,998	0,002			1,339	
LIN	5010	UN2	2	22545	1,17	294,8	Vapor	0,993	0,004	0,003		1,340	
MaxGOX	5010	UN2	2	22563	1,17	292,3	Vapor	0,987	0,004	0,009		1,353	



Air Liquide AGS GmbH

Process Specification

Project: K70101 ASU No.9 Kosice
Rev.: 2
Date: 14.10.04
By: TV / JJ

Case:

792.86809; Rev. P1

According to PFD No: 12

Ambient Temperature [°C]: 12

Ambient Pressure [bar a]: 1,013

Humidity: 65%

Cooling Water Temperature [°C]: 16

Case	Stream	Normal Flow	Mass Flow	Pres.	Temp.	Phase	Vapor Fraction	Composition (mol/mol)				H ₂ O	Density	Remarks
		Nm ³ /h	kg/h	bar(a)	K			N ₂	Ar	O ₂	H ₂		kg/m ³	
MinGOX1	5010	UN2	18000	22528	1,25	286,1	Vapor	0,997	0,003				1,424	
MinGOX2	5010	UN2	18000	22525	1,25	293,3	Vapor	0,997	0,003	0,001			1,438	
Normal	5011	UN2	18000	22515	1,12	473	Vapor	0,998	0,002				0,994	
LOX	5011	UN2	18000	22514	1,12	473	Vapor	0,998	0,002				0,994	
LIN	5011	UN2	18000	22545	1,12	473	Vapor	0,993	0,004	0,003			0,995	
MaxGOX	5011	UN2	18000	22563	1,12	473	Vapor	0,987	0,004	0,009			0,996	
MinGOX1	5011	UN2	18000	22522	1,12	473	Vapor	0,997	0,003				0,994	
MinGOX2	5012	UN2	18000	22523	1,12	473	Vapor	0,997	0,003				0,994	
Normal	5012	UN2	18000	22515	1,02	373	Vapor	0,998	0,002				0,922	cyclic temperature and moisture variation: ca. 0-100°C
LOX	5012	UN2	18000	22514	1,02	373	Vapor	0,998	0,002				0,922	cyclic temperature and moisture variation: ca. 0-100°C
LIN	5012	UN2	18000	22545	1,02	373	Vapor	0,993	0,004	0,003			0,923	cyclic temperature and moisture variation: ca. 0-100°C
MaxGOX	5012	UN2	18000	22563	1,02	373	Vapor	0,987	0,004	0,009			0,924	cyclic temperature and moisture variation: ca. 0-100°C
MinGOX1	5012	UN2	18000	22522	1,02	373	Vapor	0,997	0,003				0,922	cyclic temperature and moisture variation: ca. 0-100°C
MinGOX2	5012	UN2	18000	22523	1,02	373	Vapor	0,997	0,003				0,922	cyclic temperature and moisture variation: ca. 0-100°C
Normal	5020	UN2	23223	29048	1,17	292,9	Vapor	0,998	0,002				1,347	
LOX	5020	UN2	23203	29022	1,17	294,8	Vapor	0,998	0,002				1,339	
LIN	5020	UN2	20841	26104	1,17	294,8	Vapor	0,993	0,004	0,003			1,340	
MaxGOX	5020	UN2	20676	25918	1,17	292,3	Vapor	0,987	0,004	0,009			1,353	
MinGOX1	5020	UN2	5324	6663	1,25	296,1	Vapor	0,997	0,003				1,424	
MinGOX2	5020	UN2	4648	5817	1,25	293,3	Vapor	0,997	0,003	0,001			1,438	
Normal	5029	UN2	23653	29394	1,01	289,1	Vapor	0,98	0,002			0,018	1,175	
LOX	5029	UN2	23633	29368	1,01	289,1	Vapor	0,98	0,002			0,018	1,175	
LIN	5029	UN2	21228	26415	1,01	289,2	Vapor	0,975	0,004	0,003		0,018	1,177	
MaxGOX	5029	UN2	21060	26227	1,01	289,2	Vapor	0,969	0,004	0,008		0,018	1,177	
MinGOX1	5029	UN2	5423	6742	1,01	289,2	Vapor	0,978	0,003			0,018	1,175	
MinGOX2	5029	UN2	4735	5886	1,01	289,2	Vapor	0,978	0,003	0,001		0,018	1,175	
Normal	5100	UN2	41223	51563	1,27	96,9	Vapor	0,998	0,002				4,55	
LOX	5100	UN2	41203	51536	1,27	97	Vapor	0,998	0,002				4,54	
LIN	5100	UN2	38841	48649	1,27	96,8	Vapor	0,993	0,004	0,003			4,56	
MaxGOX	5100	UN2	38681	48488	1,26	96,7	Vapor	0,987	0,004	0,009			4,53	
MinGOX1	5100	UN2	23324	29191	1,29	97	Vapor	0,997	0,003				4,62	
MinGOX2	5100	UN2	22648	28341	1,29	97	Vapor	0,997	0,003	0,001			4,62	
Normal	5101	UN2	40413	50550	1,32	79,7	Vapor	0,998	0,002				5,91	
LOX	5101	UN2	40393	50524	1,32	79,7	Vapor	0,998	0,002				5,91	
LIN	5101	UN2	38124	47752	1,31	79,7	Vapor	0,993	0,004	0,004			5,87	
MaxGOX	5101	UN2	37964	47592	1,31	79,8	Vapor	0,987	0,004	0,009			5,87	
MinGOX1	5101	UN2	22738	28458	1,31	79,7	Vapor	0,996	0,003				5,87	
MinGOX2	5101	UN2	22051	27595	1,31	79,7	Vapor	0,997	0,003	0,001			5,87	
Normal	5129	GAN	810	1013	2,5	86	Vapor	0,999	0,001				10,71	
LOX	5129	GAN	810	1013	2,5	86	Vapor	0,999	0,001				10,71	
LIN	5129	GAN	717	897	2,5	86	Vapor	0,999	0,001				10,71	
MaxGOX	5129	GAN	717	896	2,5	86	Vapor	0,999	0,001				10,71	
MinGOX1	5129	GAN	586	733	2,5	86	Vapor	0,999	0,001				10,71	
MinGOX2	5129	GAN	597	746	2,5	86	Vapor	0,999	0,001				10,71	



Air Liquide AGS GmbH

Process Specification

Project: K70101 ASU No.9 Kosice
Rev.: 2
Date: 14.10.04
By: TV / JJ

According to PFD No: 792.86809; Rev. P1

Case:

Humidity: 65% Cooling Water Temperature [°C]: 16

Design Conditions:

Ambient Temperature [°C]: 12

Ambient Pressure [bar a]: 1,013

Normal Flow

Stream

Mass Flow

Pres.

Temp.

Phase

Vapor Fraction

Composition (mol/mol)

Density

Remarks

Case	Stream	Normal Flow	Mass Flow	Pres.	Temp.	Phase	Vapor Fraction	N ₂	Ar	O ₂	H ₂	H ₂ O	Density	Remarks
Normal	6001	GOX	28574	28	293	Vapor			0,003	0,997			37,50	
LOX	6001	GOX	24289	28	294,8	Vapor			0,003	0,997			37,25	
LIN	6001	GOX	28578	28	294,8	Vapor			0,004	0,996			37,26	
MaxGOX	6001	GOX	35722	28	292,4	Vapor			0,003	0,997			37,59	
MinGOX1	6001	GOX	15716	28	296,1	Vapor			0,003	0,997			37,07	
MinGOX2	6001	GOX	21431	28	293,3	Vapor			0,003	0,997			37,46	
Normal	6100	GOX		1,38	93	Vapor			0,004	0,996			5,973	0 - 200 Nm3/h
LOX	6100	GOX		1,38	93,1	Vapor			0,005	0,995			5,968	0 - 200 Nm3/h
LIN	6100	GOX		1,36	92,9	Vapor			0,005	0,995			5,892	0 - 200 Nm3/h
MaxGOX	6100	GOX		1,36	92,9	Vapor			0,005	0,995			5,892	0 - 200 Nm3/h
MinGOX1	6100	GOX		1,28	92,3	Vapor			0,005	0,995			5,571	0 - 200 Nm3/h
MinGOX2	6100	GOX		1,27	92,3	Vapor			0,004	0,996			5,524	0 - 200 Nm3/h
Normal	6101	LOX	28574	1,38	93	Liquid			0,003	0,997			1127	
LOX	6101	LOX	28575	1,38	93,1	Liquid			0,003	0,997			1127	
LIN	6101	LOX	28578	1,36	92,9	Liquid			0,004	0,996			1128	
MaxGOX	6101	LOX	35722	1,36	92,9	Liquid			0,003	0,997			1128	
MinGOX1	6101	LOX	21430	1,36	92,9	Liquid			0,003	0,997			1128	
MinGOX2	6101	LOX	21431	1,35	92,9	Liquid			0,003	0,997			1128	
Normal	6133	LOX	28574	29	95	Liquid			0,003	0,997			1124	
LOX	6133	LOX	28575	29	95	Liquid			0,003	0,997			1124	
LIN	6133	LOX	28578	29	94,9	Liquid			0,004	0,996			1125	
MaxGOX	6133	LOX	35722	29	94,8	Liquid			0,003	0,997			1125	
MinGOX1	6133	LOX	21430	29	94,8	Liquid			0,003	0,997			1125	
MinGOX2	6133	LOX	21431	29	94,8	Liquid			0,003	0,997			1125	
Normal	6144	LOX	28574	29	95	Liquid			0,003	0,997			1124	
LOX	6144	LOX	28578	29	95	Liquid			0,003	0,997			1124	
LIN	6144	LOX	28578	29	94,9	Liquid			0,004	0,996			1125	
MaxGOX	6144	LOX	35722	29	94,8	Liquid			0,003	0,997			1125	
MinGOX1	6144	LOX	15716	29	94,8	Liquid			0,003	0,997			1125	
MinGOX2	6144	LOX	21431	29	94,8	Liquid			0,003	0,997			1125	
Normal	6500	LOX		2,8	95,6	Liquid			0,003	0,997			1114,4	max. 4000 Nm3/h
LOX	6500	LOX		2,8	95,6	Liquid			0,003	0,997			1114,4	max. 4000 Nm3/h
LIN	6500	LOX		2,8	95,5	Liquid			0,004	0,996			1115,1	max. 4000 Nm3/h
MaxGOX	6500	LOX		2,8	95,5	Liquid			0,003	0,997			1114,9	max. 4000 Nm3/h
MinGOX1	6500	LOX		2,8	94,9	Liquid			0,003	0,997			1118,0	max. 4000 Nm3/h
MinGOX2	6500	LOX		2,8	94,9	Liquid			0,003	0,997			1118,0	max. 4000 Nm3/h
Normal	6700	LOX		2,8	95,6	Liquid			0,003	0,997			1114	
LOX	6700	LOX	3000	2,8	95,6	Liquid			0,003	0,997			1114	
LIN	6700	LOX		2,8	95,5	Liquid			0,004	0,996			1115	
MaxGOX	6700	LOX		2,8	95,5	Liquid			0,003	0,997			1115	
MinGOX1	6700	LOX		2,8	95,5	Liquid			0,003	0,997			1115	
MinGOX2	6700	LOX		2,8	95,4	Liquid			0,003	0,997			1115	
Backup	6701	LOX	34298	1,28	90,3	Liquid			0,004	0,996			1141,2	
Normal	6702	LOX		1,1	90,8	Liquid			0,003	0,997			1138	

Process Specification										Project: K70101 ASU No.9 Kosice				
Air Liquide AGS GmbH										Rev.: 2				
According to PFD No: 792.86809; Rev. P1										Date: 14.10.04				
Ambient Temperature [°C]: 12										By: TV / JJ				
Ambient Pressure [bar a]: 1,013										Humidity: 65%				
Cooling Water Temperature [°C]: 16														
Case	Stream	Normal Flow	Mass Flow	Pres.	Temp.	Phase	Vapor Fraction	Composition (mol/mol)				Density	Remarks	
		Nm³/h	kg/h	bar(a)	K			N₂	Ar	O₂	H₂	H₂O	kg/m3	
LOX	6702	LOX		1,1	90,8	Liquid			0,003	0,997			1138	
LIN	6702	LOX		1,1	90,8	Liquid			0,003	0,997			1138	
MaxGOX	6702	LOX	7144	1,1	90,8	Liquid			0,003	0,997			1138	
MinGOX1	6702	LOX		1,1	90,8	Liquid			0,003	0,997			1138	
MinGOX2	6702	LOX		1,1	90,8	Liquid			0,003	0,997			1138	
Backup	6721	LOX	34298	29	92,3	Liquid			0,004	0,996			1137,7	
Normal	6812	LOX		4	91,2	Liquid			0,003	0,997			1137	
LOX	6812	LOX		4	91,2	Liquid			0,003	0,997			1137	
LIN	6812	LOX		4	91,2	Liquid			0,003	0,997			1137	
MaxGOX	6812	LOX	7144	4	91,2	Liquid			0,003	0,997			1137	
MinGOX1	6812	LOX		4	91,2	Liquid			0,003	0,997			1137	
MinGOX2	6812	LOX		4	91,2	Liquid			0,003	0,997			1137	
Backup	6821	GOX	34298	28	288	Vapor			0,004	0,996			38,228	
Normal	7010	GAN	29750	1,13	293	Vapor		1,000					1,30	
LOX	7010	GAN	29750	1,13	294,8	Vapor		1,000					1,29	
LIN	7010	GAN	29750	1,12	294,8	Vapor		1,000					1,28	
MaxGOX	7010	GAN	29750	1,12	292,4	Vapor		1,000					1,29	
MinGOX1	7010	GAN	29750	1,12	296,1	Vapor		1,000					1,27	
MinGOX2	7010	GAN	29750	1,12	293,3	Vapor		1,000					1,29	
Normal	7014	GAN	29500	7,3	299	Vapor		1					8,234	
LOX	7014	GAN	29500	7,3	299	Vapor		1					8,234	
LIN	7014	GAN	29500	7,3	299	Vapor		1					8,234	
MaxGOX	7014	GAN	29500	7,3	299	Vapor		1					8,234	
MinGOX1	7014	GAN	29500	7,3	299	Vapor		1					8,234	
MinGOX2	7014	GAN	29500	7,3	299	Vapor		1					8,234	
Normal	7100	GAN	29750	1,31	79,6	Vapor		1,000					5,87	
LOX	7100	GAN	29750	1,31	79,6	Vapor		1,000					5,87	
LIN	7100	GAN	29750	1,3	79,6	Vapor		1,000					5,82	
MaxGOX	7100	GAN	29750	1,3	79,5	Vapor		1,000					5,83	
MinGOX1	7100	GAN	29750	1,31	79,6	Vapor		1,000					5,87	
MinGOX2	7100	GAN	29750	1,3	79,6	Vapor		1,000					5,82	
Normal	7101	GAN	29750	1,26	96,9	Vapor		1,000					4,51	
LOX	7101	GAN	29750	1,26	97	Vapor		1,000					4,50	
LIN	7101	GAN	29750	1,25	96,8	Vapor		1,000					4,48	
MaxGOX	7101	GAN	29750	1,24	96,7	Vapor		1,000					4,44	
MinGOX1	7101	GAN	29750	1,25	97	Vapor		1,000					4,47	
MinGOX2	7101	GAN	29750	1,25	97	Vapor		1,000					4,47	
Normal	7110	LIN	37658	5,29	94,8	Liquid		0,999	0,001				718	
LOX	7110	LIN	37612	5,31	94,8	Liquid		0,999	0,001				718	
LIN	7110	LIN	36017	45028	5,25	94,7	Liquid	0,999	0,001				719	
MaxGOX	7110	LIN	35925	44913	5,23	94,6	Liquid	0,999	0,001				719	
MinGOX1	7110	LIN	27251	34069	5,18	94,5	Liquid	0,999	0,001				720	
MinGOX2	7110	LIN	27678	34604	5,17	94,5	Liquid	0,999	0,001				720	
Normal	7111	LIN	32602	40758	5,29	94,8	Liquid	0,999	0,001				718	

Process Specification										Project: K70101 ASU No.9 Kosice			
										Rev.: 2			
										Date: 14.10.04			
										By: TV / JJ			
Design Conditions:			According to PFD No: 792.86809; Rev. P1		Case: 1,013		Humidity: 65%						
			Ambient Temperature [°C]: 12		Ambient Pressure [bar a]: 1,013		Cooling Water Temperature [°C]: 16						
Case	Stream	Normal Flow	Mass Flow	Pres.	Temp.	Phase	Vapor Fraction	Composition (mol/mol)			Density	Remarks	
		Nm³/h	kg/h	bar(a)	K			N₂	Ar	O₂	H₂	H₂O	
LOX	7111	LIN	32630	40794	5,31	94,8	Liquid						
LIN	7111	LIN	31366	39214	5,25	94,7	Liquid	0,999	0,001				718
MaxGOX	7111	LIN	31232	39046	5,23	94,6	Liquid	0,999	0,001				719
MinGOX1	7111	LIN	25266	31587	5,18	94,5	Liquid	0,999	0,001				719
MinGOX2	7111	LIN	24129	30167	5,17	94,5	Liquid	0,999	0,001				720
Normal	7112	LIN	36383	5,29	94,8	Liquid		0,999	0,001				718
LOX	7112	LIN	29130	36418	5,31	94,8	Liquid	0,999	0,001				718
LIN	7112	LIN	27866	34838	5,25	94,7	Liquid	0,999	0,001				719
MaxGOX	7112	LIN	27732	34671	5,23	94,6	Liquid	0,999	0,001				719
MinGOX1	7112	LIN	21766	27211	5,18	94,5	Liquid	0,999	0,001				720
MinGOX2	7112	LIN	20629	25791	5,17	94,5	Liquid	0,999	0,001				720
Normal	7113	LIN	29102	36383	5,29	81,6	Liquid	0,999	0,001				786
LOX	7113	LIN	29130	36418	5,31	81,6	Liquid	0,999	0,001				786
LIN	7113	LIN	27866	34838	5,25	81,6	Liquid	0,999	0,001				786
MaxGOX	7113	LIN	27732	34671	5,23	81,5	Liquid	0,999	0,001				786
MinGOX1	7113	LIN	21766	27211	5,18	81,2	Liquid	0,999	0,001				788
MinGOX2	7113	LIN	20629	25791	5,17	81,2	Liquid	0,999	0,001				788
Normal	7128	LIN	29102	36383	5,29	81,6	Liquid	0,999	0,001				786
LOX	7128	LIN	29130	36418	5,31	81,6	Liquid	0,999	0,001				786
LIN	7128	LIN	24866	31088	5,25	81,6	Liquid	0,999	0,001				786
MaxGOX	7128	LIN	23632	29545	5,23	81,5	Liquid	0,999	0,001				786
MinGOX1	7128	LIN	21766	27211	5,18	81,2	Liquid	0,999	0,001				788
MinGOX2	7128	LIN	20629	25791	5,17	81,2	Liquid	0,999	0,001				788
Normal	7129	LIN	29102	36383	1,31	79,6	Mixed	2,1%	0,999	0,001			208
LOX	7129	LIN	29130	36418	1,31	79,6	Mixed	2,1%	0,999	0,001			208
LIN	7129	LIN	24866	31088	1,3	79,6	Mixed	2,1%	0,999	0,001			207
MaxGOX	7129	LIN	23632	29545	1,3	79,5	Mixed	2,1%	0,999	0,001			207
MinGOX1	7129	LIN	21766	27211	1,31	79,6	Mixed	1,7%	0,999	0,001			242
MinGOX2	7129	LIN	20629	25791	1,3	79,6	Mixed	1,7%	0,999	0,001			241
Normal	7130	LIN			5,29	94,8	Liquid	0,999	0,001				718,0 normally no flow
LOX	7130	LIN			5,31	94,8	Liquid	0,999	0,001				718,0 normally no flow
LIN	7130	LIN			5,25	94,7	Liquid	0,999	0,001				718,6 normally no flow
MaxGOX	7130	LIN			5,23	94,6	Liquid	0,999	0,001				719,1 normally no flow
MinGOX1	7130	LIN			4,94	93,9	Liquid	0,999	0,001				722,9 normally no flow
MinGOX2	7130	LIN			4,93	93,9	Liquid	0,999	0,001				722,9 normally no flow
Normal	7143	LIN	3500	4376	5,29	94,8	Liquid	0,999	0,001				718
LOX	7143	LIN	3500	4376	5,31	94,8	Liquid	0,999	0,001				718
LIN	7143	LIN	3500	4376	5,25	94,7	Liquid	0,999	0,001				719
MaxGOX	7143	LIN	3500	4376	5,23	94,6	Liquid	0,999	0,001				719
MinGOX1	7143	LIN	3500	4376	5,18	94,5	Liquid	0,999	0,001				720
MinGOX2	7143	LIN	3500	4376	5,17	94,5	Liquid	0,999	0,001				720
Normal	7144	LIN	3500	4376	22	97,8	Liquid	0,999	0,001				709
LOX	7144	LIN	3500	4376	22	97,9	Liquid	0,999	0,001				709
LIN	7144	LIN	3500	4376	22	97,7	Liquid	0,999	0,001				710



Air Liquide AGS GmbH

Process Specification

Project: K70101 ASU No.9 Kosice
Rev.: 2
Date: 14.10.04
By: TV / JJ

According to PFD No: 792.86809, Rev. P1

Case:

Design Conditions: Ambient Temperature [°C]: 12

Ambient Pressure [bar a]: 1,013

Humidity: 65%

Cooling Water Temperature [°C]: 16

Case	Stream	Normal Flow	Mass Flow	Pres.	Temp.	Phase	Vapor Fraction	Composition (mol/mol)					Density	Remarks
		Nm ³ /h	kg/h	bar(a)	K			N ₂	Ar	O ₂	H ₂	H ₂ O	kg/m3	
MaxGOX	7144	LIN	3500	4376	22	97,7	Liquid	0,999	0,001				710	
MinGOX1	7144	LIN	3500	4376	22	97,6	Liquid	0,999	0,001				710	
MinGOX2	7144	LIN	3500	4376	22	97,5	Liquid	0,999	0,001				711	
Normal	7150	LIN	820	1025	5,3	94,8	Liquid	0,999	0,001				718	
LOX	7150	LIN	820	1025	5,31	94,8	Liquid	0,999	0,001				718	
LIN	7150	LIN	726	908	5,26	94,7	Liquid	0,999	0,001				719	
MaxGOX	7150	LIN	726	908	5,23	94,6	Liquid	0,999	0,001				719	
MinGOX1	7150	LIN	594	743	5,19	94,5	Liquid	0,999	0,001				720	
MinGOX2	7150	LIN	605	756	5,17	94,5	Liquid	0,999	0,001				720	
Normal	7151	LIN	10	12,0	2,5	86	Liquid	0,999	0,001				764	
LOX	7151	LIN	10	11,9	2,5	86	Liquid	0,999	0,001				764	
LIN	7151	LIN	9	11,1	2,5	86	Liquid	0,999	0,001				764	
MaxGOX	7151	LIN	9	11,2	2,5	86	Liquid	0,999	0,001				764	
MinGOX1	7151	LIN	8	9,9	2,5	86	Liquid	0,999	0,001				764	
MinGOX2	7151	ULIN	8	10,1	2,5	86	Liquid	0,998	0,002				764	
Normal	7170	GAN	3500	4376	21	293	Vapor	0,999	0,001				24,24	
LOX	7170	GAN	3500	4376	21	294,8	Vapor	0,999	0,001				24,08	
LIN	7170	GAN	3500	4376	21	294,8	Vapor	0,999	0,001				24,08	
MaxGOX	7170	GAN	3500	4376	21	292,4	Vapor	0,999	0,001				24,29	
MinGOX1	7170	GAN	3500	4376	21	296,1	Vapor	0,999	0,001				23,97	
MinGOX2	7170	GAN	3500	4376	21	293,3	Vapor	0,999	0,001				24,21	
Normal	7500	LIN			2,3	81,7	Liquid	0,999	0,001				784,4	max. 4100 Nm3/h
LOX	7500	LIN			2,3	81,7	Liquid	0,999	0,001				784,4	max. 4100 Nm3/h
LIN	7500	LIN			2,3	81,6	Liquid	0,999	0,001				784,9	max. 4100 Nm3/h
MaxGOX	7500	LIN			2,3	81,6	Liquid	0,999	0,001				784,9	max. 4100 Nm3/h
MinGOX1	7500	LIN			2,3	80,7	Liquid	0,999	0,001				789,1	max. 4100 Nm3/h
MinGOX2	7500	LIN			2,3	80,7	Liquid	0,999	0,001				789,1	max. 4100 Nm3/h
Normal	7700	LIN			2,3	81,7	Liquid	0,999	0,001				784	
LOX	7700	LIN			2,3	81,7	Liquid	0,999	0,001				784	
LIN	7700	LIN	3000	3751	2,3	81,6	Liquid	0,999	0,001				785	
MaxGOX	7700	LIN	4100	5126	2,3	81,6	Liquid	0,999	0,001				785	
MinGOX1	7700	LIN			2,3	81,3	Liquid	0,999	0,001				786	
MinGOX2	7700	LIN			2,3	81,2	Liquid	0,999	0,001				787	
Backup	7701	LIN	20000	24997	1,13	77,7	Liquid	1					802,2	
Backup	7702	LIN	3500	4374	1,13	77,7	Liquid	1					802,2	
Backup	7721	LIN	20000	24997	11,65	78,6	Liquid	1					800,9	
Backup	7722	LIN	3500	4374	22	79,5	Liquid	1					799,5	
Normal	7812	LIN			8	100,4	Liquid	0,999	0,001				686	
LOX	7812	LIN			8	100,4	Liquid	0,999	0,001				686	
LIN	7812	LIN			8	100,4	Liquid	0,999	0,001				686	
MaxGOX	7812	LIN			8	100,4	Liquid	0,999	0,001				686	
MinGOX1	7812	LIN	700	875	8	100,4	Liquid	0,999	0,001				686	
MinGOX2	7812	LIN			8	100,4	Liquid	0,999	0,001				686	
Backup	7821	GAN	3500	4374	21	275	Vapor	1					25,908	

<div><div><div></div><div>AIR LIQUIDE</div></div><div>Air Liquide AGS GmbH</div></div>		<div>Project: K70101 ASU No.9 Kosice</div> <div>Rev.: 2</div> <div>Date: 14.10.04</div> <div>By: TV / JJ</div>											
<div>Design Conditions:</div>		According to PFD No: 792.86809; Rev. P1		Case:		Cooling Water Temperature [°C]: 16							
		Ambient Temperature [°C]: 12		Ambient Pressure [bar a]: 1,013		Humidity: 65%							
Case	Stream	Normal Flow	Mass Flow	Pres.	Temp.	Phase	Vapor Fraction	Composition (mol/mol)				Density	Remarks
		Nm³/h	kg/h	bar(a)	K			N ₂	Ar	O ₂	H ₂	H ₂ O	
Backup	7861 GAN	16000	19997	7	288	Vapor	1						8,202
Backup	7862 GAN	20000	24997	7	288	Vapor	1						8,202
													only during steam shortage